

BRING SUSTAINABILITY WHERE IT MATTERS MOST

WHITEPAPER

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THE EDGE DATA CENTER OPPORTUNITY

The rise of edge computing has ushered in a new era in digital infrastructure, characterized by a distributed network of data processing and storage capabilities. This paradigm shift is not about replacing existing data center hubs and hyperscale facilities, but rather augmenting them with edge data centers located closer to enterprises. Edge data centers play a pivotal role in this evolving landscape, combining nearby access to cloud service providers, coupled with low latency access to local users. As the digital economy continues to evolve and expand, with increasing reliance on real-time data processing and AI-driven services, the demand for both edge computing and the data centers that power it is expected to surge.



SUPPORTING GROWTH IN ECONOMIC HUBS

For many enterprises just beginning their migration to hybrid cloud architectures, the local edge data center provides a most convenient solution. Bringing cloud services close to their locality accessible via direct connection, providing for a certified and compliant energy system and by ensuring a best-in-class in local network access, to support applications as they evolve and require lower latency.

Edge data centers also are uniquely positioned to support growth and innovation in specific sectors by providing tailored IT services that meet the unique requirements of different industries and regions. For instance, in manufacturing hubs like Leipzig or Sophia Antipolis, edge data centers can enable real-time data processing and analytics for smart factories, predictive maintenance, and supply chain optimization. In logistics centers like Antwerp and Lille, edge data centers can support efficient inventory management, route optimization, and last-mile delivery solutions. By providing low-latency, high-performance computing capabilities close to the point of need, edge data centers can enhance productivity, efficiency, and competitiveness in various sectors.

LEVERAGING EXISTING EXCHANGE POINTS

To enable edge computing and minimize environmental impact, it is strategically important to locate edge data centers in areas with existing network infrastructure. Edge Data Centers augment Network exchange points, such that they become marketplaces, where service providers and content providers interconnect. By co-locating edge data centers with network exchange points, operators can leverage existing connectivity, reduce latency, and optimize network performance. This approach not only enables optimal connectivity to local users, but also reduces the need for additional infrastructure, thereby reducing the environmental footprint.

ENABLING THE GROWTH OF AI

Artificial Intelligence (AI) is rapidly transforming industries and societies, with applications ranging from natural language processing and image recognition to autonomous systems and decision-making tools. However, AI workloads often require significant computational power and low latency to deliver real-time insights and actions. Edge data centers play a critical role in supporting the growth of AI by providing the necessary infrastructure for training, deploying inference, and running AI models at the edge. The proximity of edge data centers to end-users enables faster processing, reduced network congestion, uncomplicated data sovereignty and security for AI applications.

CONCLUSION

Edge data centers present a significant opportunity to drive economic growth, innovation, and sustainability. By supporting specific economic hubs, leveraging existing infrastructure, and enabling the growth of AI, edge data centers can help unlock the full potential of the digital economy while minimizing environmental impact. In the following chapters, we will explore how edge data centers can further enhance their sustainability profile through sector coupling and other innovative approaches.

BRINGING SUSTAINABILITY WHERE IT MATTERS MOST

The rise of edge computing has ushered in a new era in digital infrastructure, characterized by a distributed network of data processing and storage capabilities. This paradigm shift is not about replacing existing data center hubs and hyperscale facilities, but rather augmenting them with edge data centers located closer to enterprises. Edge data centers play a pivotal role in this evolving landscape, combining nearby access to cloud service providers, coupled with low latency access to local users. As the digital economy continues to evolve and expand, with increasing reliance on real-time data processing and AI-driven services, the demand for both edge computing and the data centers that power it is expected to surge.

INTRODUCTION: WHY SUSTAINABILITY MATTERS

The drive towards sustainability is no longer a choice but a necessity. Businesses that fail to adapt risk losing their social license to operate and facing potential regulatory actions. Moreover, consumers are increasingly demanding sustainable products and services, making sustainability a key differentiator in the marketplace. For edge data centers, embracing sustainability is not only about complying with regulations or meeting consumer expectations; it's also an opportunity to create shared value for the local community. By reducing energy consumption, reusing excess heat, and supporting local renewable energy sources, edge data centers can contribute to a cleaner, healthier, and more resilient environment.

SECTOR COUPLING: A WAY OF THINKING

Sector coupling is an innovative approach that integrates different sectors, such as energy, heat, transport, and industry, to optimize resource use and reduce emissions. In the context of edge data centers, sector coupling means integrating the data center with other critical infrastructure in the local community. This integration can take various forms, such as reusing excess heat from the data center to warm nearby buildings, using the data center's computing power to optimize energy grids, or generating renewable energy on-site to power both the data center and the local community. By breaking down silos and fostering collaboration between different sectors, sector coupling enables a more holistic and sustainable approach to resource management.

The ongoing energy transition, with its shift towards renewable sources like solar and wind power, further emphasizes the need for sector coupling. Renewable energy sources are often variable and decentralized, requiring flexible demand and storage solutions to ensure grid stability. Edge data centers, with their ability to adjust their power consumption and potentially store energy, can play a crucial role in balancing the grid and integrating renewable energy sources.

DESIGN CONSIDERATIONS

HEAT REUSE

Excess heat generated by servers and other equipment in data centers represents a valuable resource that can be harnessed for various purposes. By capturing and redistributing this heat, edge data centers can provide heating for nearby buildings, swimming pools, or industrial processes. Heat reuse not only reduces the need for fossil fuel-based heating systems but also improves the overall energy efficiency of the community.

GRID STABILIZATION

The increasing penetration of renewable energy sources poses challenges to grid stability due to their variable nature. Edge data centers can contribute to grid stabilization by offering flexible load and demand response capabilities. By adjusting their power consumption in response to grid conditions, edge data centers can help balance supply and demand, ensuring a reliable and stable power supply for the entire community.

ON-SITE GENERATION

Edge data centers can further enhance their sustainability profile by generating their own renewable energy on-site. This can be achieved through solar panels, wind turbines, biogas systems, or even hydrogen fuel cells. On-site generation not only reduces reliance on the grid but also contributes to the local renewable energy supply, promoting energy independence and resilience.

CONCLUSION

Sector coupling offers a powerful framework for edge data centers to become active contributors to a sustainable future. By integrating with other sectors and leveraging their unique capabilities, edge data centers can reduce emissions, optimize resource use, and create shared value for the local community. The following chapter will delve deeper into the practical implementation of sector coupling, showcasing real-world examples and best practices.

SECTOR COUPLING IN PRACTICE

REAL-WORLD EXAMPLES AND BEST PRACTICES

The concept of sector coupling may seem theoretical, but it's already being implemented in various forms across the globe, demonstrating its potential to transform the sustainability landscape of edge data centers. In this chapter, we delve into real-world examples and best practices that highlight the tangible benefits and opportunities of sector coupling.



CASE STUDIES

HEAT REUSE IN ACTION

- Several edge data centers have successfully implemented heat reuse projects, showcasing its feasibility and benefits. For instance, in Eschborn, Germany, a nLighten data center is providing carbon-free heat to a public swimming pool and a nearby office building.
- In other locations, excess heat from data centers is being used for district heating networks, greenhouses, or even fish farms, creating a circular economy where one industry's waste becomes another's resource.

GRID STABILIZATION PIONEERS

- Edge data centers are increasingly participating in demand response programs, where they adjust their power consumption in response to grid signals. This flexibility helps grid operators balance supply and demand, especially during peak periods or when renewable energy generation is low.
- Some data centers are also exploring the use of energy storage systems, such as batteries or flywheels, to further enhance their grid stabilization capabilities.

ON-SITE GENERATION SUCCESS STORIES

- Many edge data centers are already powered by on-site renewable energy sources. Solar panels are a popular choice, especially for data centers located in sunny regions.
- Other data centers are exploring wind power, biogas, or even hydrogen fuel cells, depending on the local resource availability and regulatory environment.

BEST PRACTICES FOR IMPLEMENTING SECTOR COUPLING

COLLABORATION AND PARTNERSHIPS

- Successful sector coupling projects often involve collaboration between data center operators, local authorities, energy providers, and other stakeholders.
- Building strong partnerships and fostering open communication are essential for identifying synergies, overcoming regulatory hurdles, and ensuring project success.

TECHNOLOGY AND INNOVATION

- Advancements in technology, such as smart grid solutions, energy storage systems, and heat recovery technologies, are crucial enablers of sector coupling.
- Data center operators should stay abreast of the latest innovations and invest in technologies that can enhance their sustainability performance and enable seamless integration with other sectors

COMMUNITY ENGAGEMENT

- Engaging with the local community is vital for building trust and support for sector coupling projects.
- Data center operators should proactively communicate the benefits of their projects, address any concerns, and seek opportunities for collaboration with local businesses and residents.

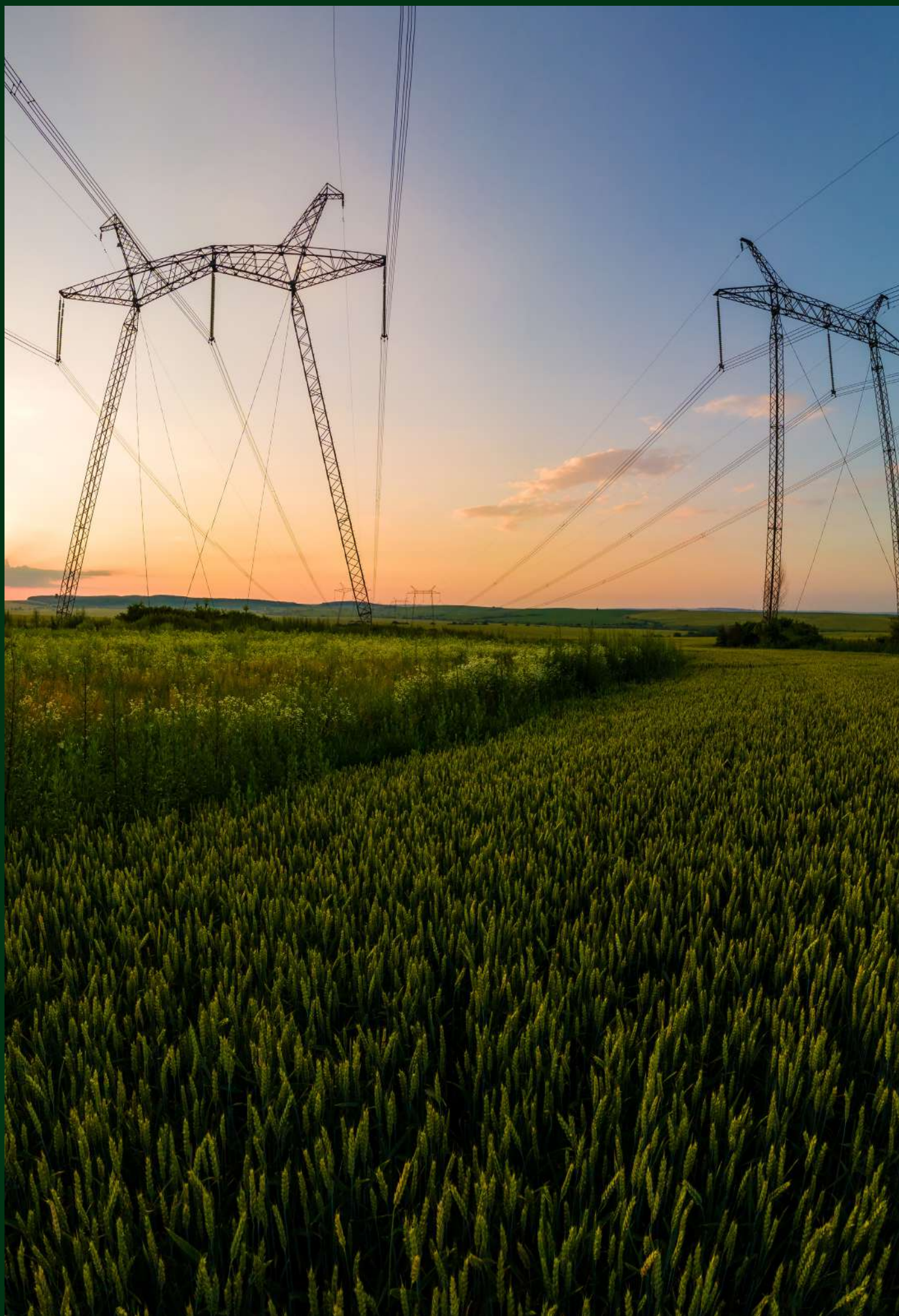
POLICY AND REGULATORY FRAMEWORK

- A supportive policy and regulatory framework is essential for promoting sector coupling. Governments can play a crucial role by providing incentives, streamlining permitting processes, and establishing clear guidelines for collaboration between different sectors.

CONCLUSION

Sector coupling is not a distant vision but a present reality. Edge data centers are leading the way in demonstrating the feasibility and benefits of integrating with other sectors to achieve greater sustainability and circularity. The real-world examples and best practices highlighted in this chapter provide a roadmap for other data center operators and stakeholders to follow.

By embracing sector coupling, edge data centers can not only reduce their environmental impact but also create shared value for the local community, contribute to grid stability, and foster a more resilient and sustainable energy system. The future of data centers lies in collaboration, innovation, and a commitment to bringing sustainability where it matters most.



MEASURING PROGRESS

QUANTIFYING THE IMPACT OF SECTOR COUPLING

The success of sector coupling initiatives hinges on the ability to accurately measure and track their impact. nLighten's extension of the Carbon Free Energy (CFE) measurement method provides a robust framework for quantifying the environmental benefits of integrated sustainability practices in the data center industry.

THE INTEGRATED CFE SCORE (ICFEn)

The ICFEn represents a significant advancement in sustainability reporting by considering both carbon-free electricity and heat generated and consumed within the data center ecosystem. This holistic approach allows for a more accurate assessment of the overall carbon footprint, encompassing not only the data center itself but also the interconnected buildings and systems benefiting from heat reuse or other forms of sector coupling. By incorporating both electricity and heat, the ICFEn provides a comprehensive picture of carbon-free energy utilization, enabling data center operators to identify areas for improvement and track progress towards their sustainability goals.

TRANSPARENCY & ACCOUNTABILITY

The enhanced ICFeN methodology and the introduction of the Integrated Avoided Emissions metric promote transparency and accountability in the data center industry. By providing clear and measurable indicators of sustainability performance, these tools enable data center operators to communicate their environmental impact to stakeholders, including customers, investors, and regulators. This transparency fosters trust and encourages further innovation in sustainable practices, driving the industry towards a greener future.

DRIVING INDUSTRY-WIDE ADOPTION

nLighten's collaboration with FEEM¹ and the development of these innovative measurement criteria set a new standard for sustainability reporting in the data center sector. By demonstrating the feasibility and benefits of quantifying the impact of sector coupling, nLighten is encouraging industry-wide adoption of these practices. As more data center operators embrace these measurement tools, the industry will be better equipped to track progress, identify best practices, and collectively contribute to a more sustainable and decarbonized future.

1. FEEM (Fondazione Eni Enrico Mattei) is a leading international institute providing analysis on Economy, Energy and Environment at a global and local scale. They carry out high-quality research addressing the world's greatest challenges to foster a widespread understanding of global issues among stakeholders and to contribute to policy engagement.

CONCLUSION

The ability to measure and quantify the impact of sector coupling initiatives is paramount for driving progress towards a sustainable future. nLighten's extended ICFEn methodology, with its Integrated Carbon Free Energy score and Integrated Avoided Emissions metric, provides the tools necessary to track and communicate the environmental benefits of these practices.



ABOUT US

DUTCH DATA CENTER ASSOCIATION

The Dutch Data Center Association (DDA) is the trade association of data centers in the Netherlands. The DDA unites leading data centers in the Netherlands in a common mission: the strengthening of economic growth and the profiling of the data center sector to government, media, and society.

The DDA expresses industry views on regulatory and policy issues. It demonstrates leadership by facilitating and encouraging members to implement operational improvements in the form of best practices. The DDA promotes education and contributes to technical standards, which enables the data center industry in the Netherlands and abroad to further distinguish itself.

The DDA closely collaborates with Digital Gateway to Europe, which promotes the Netherlands as an international data hub. The DDA also collaborates with market operators, the government, and other interested parties. Furthermore, the DDA actively collaborates with European trade associations to strengthen the digital infrastructure industry as a whole and is a member of VNO NCW, the largest employers organization in the Netherlands.

Dutch Data Center Association

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nLIGHTEN

nLighten is a digital infrastructure platform focused on developing and operating innovative edge data centers across Europe's key economic hubs. The strategically distributed data centers deliver best-in-class network access to enterprises, private users, and the mobile workforce. nLighten is working towards establishing a pan-European presence in all major cities and smaller business hubs, offering low-latency, proximity to end users, ensuring seamless connectivity and reliable, real-time data processing.

nLighten also takes a forward-thinking approach to sector coupling, aiming to integrate its data centers into local infrastructures to support the energy transition and help communities reduce their carbon footprint.

Founded in 2021 by a core team with years of experience and a wide-ranging expertise in the data center industry, nLighten was created with the vision of aligning next-generation edge data centers with the global shift towards sustainability.

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