Chapter 6
Strategies to Achieve Carbon Neutrality and Foster Sustainability in Data Centers

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ABSTRACT

Data centers and transmission networks are crucial in the digital age, with the market expected to grow from $50 billion in 2021 to $120 billion by 2030. However, their extensive computing infrastructure and continuous operation generate significant heat, necessitating energy-intensive cooling systems. The IEA report revealed that data center power consumption surged by over 60% between 2015 and 2021, with transmission networks experiencing a 60% usage increase. Addressing these growing energy demands poses significant challenges for the industry, with some countries considering restrictions on new data center licenses due to environmental concerns. To mitigate the climate impact, the industry must prioritize the procurement of low-carbon or carbon-free electricity to reduce Scope 2 emissions related to electricity, heating, and cooling. Tech giants like AWS, Google, and Meta/Facebook have already adopted ambitious public targets, either running on carbon-free electricity or investing in global projects for cost-effective and large-scale emissions reduction.

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INTRODUCTION

In the age of digital transformation, the significance of data centers and communication networks has grown substantially within our globally interconnected landscape. This is evident in the anticipated market growth, set to rise from $50 billion in 2021 to $120 billion by 2030. Despite their pivotal role in supporting our digital lifestyles, there are environmental considerations associated with the essential functions they perform. Data centers, consisting of servers, storage devices, and networking equipment, consume considerable amounts of electricity due to their extensive computing infrastructure. The continuous operation of these components generates significant heat, necessitating energy-intensive cooling systems to maintain optimal temperatures. As the size and quantity of data centers increase, they have become a major contributor to the growing global demand for energy. A recent report from the IEA highlighted a substantial surge of more than 60 percent in data center power consumption between 2015 and 2021, with a similar increase of 60 percent in the usage of transmission networks.

Addressing the escalating energy requirements of data centers and their associated electricity grids poses significant confronts for the industry, with a number of countries contemplating limitations on new data center permits due to ecological distress. Simply improving energy efficiency is insufficient to efficiently alleviate the climate brunts of data centers. It is crucial for the industry to prioritize the adoption of low-carbon or carbon-free electrical energy to decrease Scope 2 emissions related to power, temperature, and breezy. This transition is already underway, as major tech companies like AWS, Google, and Meta/Facebook, which rank highest purchasers of clean energy since 2010 (Chavadi & Thangam, 2023), have set ambitious public targets surpassing common 100 percent renewable energy commitments. These companies, with extensive data center infrastructure, either operate globally on carbon-free electricity around the clock or invest in global projects to ensure cost-effective and large-scale emissions reduction.

Data centers currently contribute to nearly 2% of the global energy consumption. Despite ongoing concerns about the escalating energy use in data centers for more than a decade, large-scale cloud service providers (CSPs) have effectively addressed this issue by employing IT virtualization and optimizing power and thermal management infrastructure. Enterprises, historically less adept at data center efficiency than CSPs, are progressively transitioning their workloads and applications to the cloud (Sanyal et al, 2023). However, the COVID-19 pandemic's swift acceleration of digital transformation resulted in a heightened demand for data centers, reigniting apprehensions about their future energy consumption. Consequently, customers, regulators, and investors of data center service providers are advocating for environmentally sustainable growth within the industry. Data center sustainability serves as a framework for comprehending the overall operational costs and offers a means to decrease these costs through innovative solutions (Chavdi et al., 2023). The technological requisites related to maintaining and operating a facility significantly impact the overhead and emissions associated with providing data center services. This encompasses IT devices (such as processing and data storage systems), the foundational network grid used for transferring and managing operational data, and the thermal and electrical systems employed to operate all this equipment (device42.com, 2023).

Green or sustainable data centers stand at the vanguard of the sustainability movement, transforming the environmental impact of the tech industry. Through the application of energy-efficient methodologies, utilization of renewable energy sources, and integration of cutting-edge cooling technologies, these environmentally conscious facilities strive to diminish carbon footprints while ensuring seamless data processing. Embracing such centers is pivotal for fostering a greener and more sustainable future (Meenu, 2021).As society increasingly relies on data-driven technologies; the importance of energy-efficient and

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