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Green Data Centres: A Pathway to Sustainable Energy and Digital Growth in India

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Abstract

India is experiencing rapid digital growth, but its data centres, which power this growth, largely rely on polluting fossil fuels like coal. This is a problem because India can produce a lot of green energy, such as wind, hydro, and solar. This paper examines the concept of Green Data Centres in India, focusing on their importance, challenges, and potential to drive sustainability in line with the United Nations Sustainable Development Goal (SDG) 7, which aims to ensure affordable, reliable, sustainable, and modern energy. Green Data Centres focuses on environmental responsibility by opting f o r energy-saving technologies, green energy sources like wind, hydro, and solar power, and practices that ensure sustainability and minimize their environmental impact. They play a significant role in minimizing carbon emissions, lowering operational costs, and helping businesses comply with environmental regulations.

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This study explores the challenges faced by Green Data Centres in India, categorized under policy, funding, and technology. Issues such as the absence of specific government policies, limited funding for green initiatives, and a shortage of skilled professionals hinder their development. Additionally, the country's reliance on coal-based electricity further undermines the benefits of renewable energy integration. To address these challenges, the paper proposes a framework for improving policies, simplifying funding mechanisms, and advancing green technologies. The framework also suggests fostering public-private partnerships, increasing financial incentives, and promoting training programs in energy-efficient practices. By adopting these measures, India can achieve widespread adoption of Green Data Centres, aligning with its digital growth and sustainability goals under SDG 7.

The findings of this paper highlight the critical need for India to balance digital progress with environmental sustainability, ensuring that its data centres contribute positively to a greener future.

Introduction

India is home to more than 248 data centres, with major hubs located in cities like Mumbai, Bangalore, Chennai, and Hyderabad (International Data Corporation, 2023). These data centres play an important role in supporting the country's conversion to digital, serving as a mainstay for the modern technological infrastructure. However, the rapid rise and expansion of these facilities come at a considerable environmental cost. Traditional data centres require massive amounts of energy to operate, much of which is derived from non-renewable sources like coal, contributing significantly to carbon emissions and environmental degradation. (International Energy Agency, 2022)

This paper focuses on the concept of Green Data Centres in India, examining their growing importance in the context of sustainability, the challenges they face, and their potential to foster progress in both energy efficiency and digital innovation. A Green Data Centre is designed to be environmentally friendly by opting for energy-saving technologies, utilizing green energy sources such as wind, hydro, and solar power, and reducing its overall environmental impact. These centres represent a forward-thinking approach to balancing India's digital growth with

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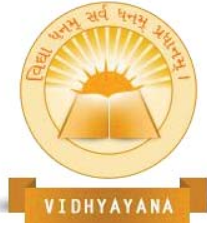
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its commitment to sustainability. (Uptime Institute, 2021).

The importance of Green Data Centres lies in their ability to address pressing environmental concerns while offering several tangible benefits. By reducing carbon emissions, they contribute significantly to mitigating climate change (Arjun Dave, 2023). Moreover, Green Data Centres lower operational costs for businesses through energy-efficient practices and renewable energy adoption. They also help organizations meet environmental regulations and sustainability goals, thereby enhancing their corporate social responsibility (CSR) image and competitiveness in the global market (Uptime Institute, 2021). Despite their advantages, the development of Green Data Centres in India is hindered by numerous challenges. One of the most significant barriers is India's heavy dependence on coal for generating electricity, which makes the conversion to green energy sources more complex and costly (International Energy Agency, 2022). Additionally, the country currently lacks specific government policies or regulatory frameworks to promote and support the establishment of Green Data Centres.

Limited financial incentives and funding options for adopting green technologies further exacerbate the issue. Another critical challenge is the shortage of skilled professionals and expertise in the field of energy-efficient data centre management, which slows the pace of innovation and implementation (Arjun Dave, 2023).

To address these challenges, the paper proposes a comprehensive framework aimed at fostering the development and widespread adoption of Green Data Centres in India. This includes recommendations for enhancing government policies to incentivize the usage of green energy and green technologies. Improved funding mechanisms, such as subsidies, grants, or tax benefits, could help businesses overcome financial barriers. Furthermore, investments in education and programs for training the people are required to build a skilled labour force that is capable enough to design and manage Green Data Centres effectively. Advancements in green technologies, such as energy-efficient cooling systems and smart power management solutions, are also critical to make these centres more viable and sustainable (International Data Corporation, 2023).

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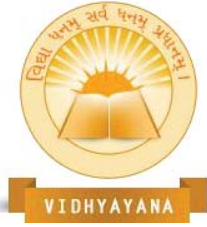
What is a Green Data Centre?

A green data centre is a place where data is managed, stored, and processed in an eco-friendly way. These centres focus on saving energy, cutting carbon emissions, and reducing harm to the environment by using renewable energy, efficient hardware, and modern cooling methods. (Uptime Institute, 2021)

Why is it Important?

Traditional data centres play a vital role in supporting digital infrastructure. Still, they also consume vast amounts of electricity, often relying on exhaustible energy sources like coal and natural gas. This heavy dependency on fossil fuels contributes significantly to greenhouse gas emissions, making data centres a notable contributor to the global carbon footprint. As the need for tech services continues to increase, so does the need for data centres, amplifying their environmental impact (International Energy Agency, 2022).

Green data centres offer a sustainable solution to this pressing issue. These facilities are designed to minimize their environmental impact by using energy-saving technologies and integrating green energy sources such as wind, hydroelectric power, or wind. Unlike traditional data centres, which often waste significant amounts of energy due to inefficient cooling systems and outdated equipment, green data centres prioritize energy efficiency. They incorporate advanced technologies like energy-efficient servers, optimized cooling systems, and smart power management to reduce energy consumption while maintaining high performance. (Arjun Dave, 2023)

One of the most important benefits of green data centres is their ability to lower operational costs. By consuming less electricity and relying more on renewable energy, businesses can save significantly on energy bills. Additionally, green technologies, such as efficient servers and innovative cooling methods, ensure that energy is used more effectively, further driving down costs. Because of this, green data centres are not only environmentally responsible but also profitable in the long run (European Commission, 2020). In the modern world, where the effects of climate change are becoming increasingly perceptible, businesses face growing pressure to

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adopt sustainable practices.

Stakeholders, investors, and consumers are demanding greater accountability and environmental responsibility. Green data centres enable companies to align with these expectations by significantly reducing their carbon emissions. By transitioning to sustainable operations, businesses can improve their reputation, connect with environmentally aware customers, and demonstrate their commitment to tackling climate change.

Moreover, as governments around the world enforce stricter environmental regulations, the adoption of green data centres helps businesses stay compliant with these standards. Many countries have introduced policies aimed at reducing carbon emissions and promoting the use of renewable energy. Companies that fail to meet these requirements may face penalties or restrictions. Green data centres provide a proactive approach to compliance, ensuring that businesses not only meet regulatory standards but also exceed them, positioning themselves as leaders in sustainability. (International Data Corporation, 2023).

Green initiatives in data centres are also key to driving innovation. The incorporation of gr energy sources, advanced cooling technologies, and intelligent energy management systems is setting new benchmarks for efficiency and sustainability in the tech industry. These innovations create a chain reaction and inspire other sectors to use similar methods and technologies.

The Challenge of Coal Dependency in India's Data Centres

India is currently the third-largest producer of green energy in the world, showcasing remarkable progress in generating clean energy from sources like wind, hydro, and solar power (International Energy Agency, 2022). These renewable energy initiatives are a significant step toward reducing the country's dependency on non-renewable resources and mitigating environmental issues such as carbon emissions and pollution. The advancement of wind and solar power projects across the country has been particularly noteworthy. India established itself as a global leader in these areas.

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Additionally, the use of hydroelectric power further strengthens the country's renewable energy portfolio, contributing to its goals of sustainability and energy independence. (European Commission, 2020).

However, despite these advancements, a significant portion of India's electricity still comes from coal. This non-renewable energy source is one of the largest contributors to greenhouse gas emissions.

Coal-based power plants are the main source of energy in the country, forming the foundation of India's electricity generation system. This heavy dependency on fossil fuels undermines the environmental goods of India's growing green energy sector. Data centres, which are essential for powering India's digital economy, depend heavily on the national electricity grid for their operations. Unfortunately, since the majority of the electricity on the grid is generated from coal, most data centres end up using fossil fuel-based energy, even in a country with significant renewable energy production. This reliance on coal-based electricity negates many of the potential environmental benefits that could be achieved if data centres were powered primarily by clean energy sources. (International Energy Agency, 2022).

In essence, while India has made tremendous strides in green energy development, the widespread reliance on coal for electricity poses a significant challenge. It highlights the need for a more integrated approach that connects renewable energy production directly with energy-intensive industries like data centres. By addressing this gap, India can maximize the benefits of its progress in clean energy and significantly reduce the environmental impact of its growing digital infrastructure.

Largest source of electricity generation in India, 2022

Coal
72%
of total generation

Electricity generation, India, 2022

Coal 72.0% | Natural gas 3.0% | Hydro 9.6% | Wind 4.4% | Solar PV 5.8%

Fig: Shows that coal is the largest source of electricity generation in India for the year 2022, accounting for 72% of the total electricity produced. A bar chart below the statistic highlights the share of other energy sources: natural gas (3.0%), hydro (9.6%), wind (4.4%), and solar PV (5.8%), emphasizing India's heavy dependency on coal for producing electricity.

Parameters and their Challenges

There are many challenges to building green data centres in India. These challenges fall under three main areas: Policy, Funding, and Technology. One big problem is that the government does not have clear policies specifically aimed at green data centres, and the existing sustainability rules are not well enforced for current facilities. Getting approvals or incentives for using renewable energy is often slowed down by complex government processes (Arjun Dave, 2023). Another challenge is the high initial cost of building green data centres, which discourages businesses since there are few affordable loans or funding options for green projects. On the technology side, there are not enough training programs focused on green technologies or sustainable practices. Many professionals are also unaware of how important energy-efficient systems are for data centres. India faces additional problems due to the high cost of importing technology and expertise from other countries, as well as low investor confidence because green investments take a long time to provide returns. (European Commission, 2020)

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India's National Data Centre Policy has gaps that make it difficult to develop truly green data centres. For example, there are no mandatory rules requiring the use of renewable energy. While the policy encourages it, the decision is left to individual companies, so many data centres continue to rely on fossil fuels like coal, which is the main source of energy in India. The policy also does not include detailed environmental rules for data centres. There are no strict limits on energy use, carbon emissions, or water consumption, which means data centres can operate without doing much to lower their environmental impact. Financial incentives like tax breaks or subsidies to support green technologies are also limited. This makes it harder for operators to invest in energy-efficient infrastructure due to the high costs involved. (Arjun Dave, 2023)

Another key issue is the lack of rules about water use. Data centres use large amounts of water for cooling. Still, the policy does not address this, which can lead to overuse and put stress on local water supplies, including areas with water scarcity. Additionally, there is no requirement for data centres to monitor and publicly report their energy use, carbon emissions, or water consumption. Without this transparency, it is hard to measure and improve sustainability efforts. The policy also does not set clear standards for energy efficiency, leaving operators without clear goals to reduce energy use and environmental harm. Fixing these issues is important for making data centres in India greener and more sustainable. (International Energy Agency, 2022).

Currently, the Union Budget does not allocate specific funding for developing data centres in India, even though they are critical for the country's digital infrastructure. Data centres play an important role in securely managing data for key government programs like Digital India, Smart Cities, and e-governance. Meeting the rising demand for clean and energy-efficient data centres is difficult without sufficient funding. Investing in sustainable technologies such as green energy sources and advanced cooling systems can help reduce pollution and make data centres more efficient over time. By providing financial support for data centres, the government can strengthen its programs and promote a greener digital future. (Uptime Institute, 2021)

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The table below provides an analysis of the current scenario and what could be done better for each parameter policy, funding, and technology to overcome these challenges and achieve green data centres in India.

Proposed framework of parameters

Parameter	Current Scenario	What Could Be Done Better
Policy	- Renewable energy policies exist, but there is no direct focus on green data centres.	- Introduce specific policies for green data centres, including mandatory energy efficiency standards.
	- Complex processes to avail subsidies and approvals.	- Simplify procedures for subsidies and permissions.
	- Limited enforcement of sustainability regulations.	- Enforce stricter regulations and provide incentives for green certification (e.g., tax benefits, subsidies).
		- Foster public-private partnerships to scale up green initiatives.
Funding	- High upfront costs deter businesses from adopting green technologies.	- Offer low-interest loans or financial incentives for green infrastructure investments.
	- Limited funding options specifically for green data centres.	- Create dedicated green technology funds or grants.
	- Lack of investor confidence due to long payback periods.	- Attract foreign investments by offering tax exemptions and simplifying investment processes.
		- Highlight long-term cost savings through awareness campaigns.
Technology (Skill Set)	- Shortage of professionals skilled in energy-efficient and renewable energy technologies.	- Introduce specialized training programs and certifications for green data centre technologies in technical institutes.
	- Dependence on imported solutions for advanced technologies.	- Promote local research and development to create cost-effective, locally tailored solutions.

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	- Low awareness among professionals about sustainable practices in data centres.	- Encourage collaboration between academia and industry to upskill the workforce and develop innovative solutions.
		- Provide incentives for companies to invest in employee training on green technologies.

While writing this paper, we encountered several challenges that made it difficult to fully address the topic of Green Data Centres and their potential in India. These challenges not only highlighted gaps in available information but also emphasized the complexities involved in transitioning traditional data centres to sustainable operations.

Lack of Publicly Available Data

One of the most significant hurdles we faced was the lack of publicly available data on data centres that still rely heavily on fossil fuels. It wasn't easy to assess the true impact of operations by the data centres on the environment as companies do not disclose detailed information about their energy sources. For example, while companies may publish sustainability reports, these often focus on future goals and commitments rather than providing transparent data on current energy consumption and carbon emissions. This lack of transparency is a global issue. According to the International Energy Agency (IEA), data centres and data transmission networks account for about 1% of global electricity use, a significant portion of which still comes from non-renewable sources. However, pinpointing exactly how much of this energy is derived from fossil fuels is challenging because many organizations do not differentiate between renewable and non-renewable sources in their reporting.

Gap Between Intent and Action

Another challenge we identified was the gap between the intent to adopt sustainable practices and the actual implementation of these initiatives. Many data centres have publicly announced their commitment to becoming "green" by opting for green energy, saving more energy, and

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minimizing their carbon footprint. However, in practice, progress has been slower than anticipated. For instance, a study by Uptime Institute in 2021 revealed that while 65% of data centre operators reported having a sustainability strategy in place, only 43% had implemented specific measures to track and reduce their carbon emissions. This discrepancy suggests that while the intent to go green is widespread, the path to implementation is fraught with challenges, including financial constraints, lack of expertise, and the need for significant infrastructural changes. (Uptime Institute, 2021).

Limited Information on Challenges Faced by Data Centres

We also struggled to find detailed information about the challenges faced by data centres that have delayed implementing green initiatives or have only recently started transitioning to sustainable practices. Understanding these challenges is crucial for developing practical and actionable solutions. For example, many data centres cite the high cost of opting for green energy systems and energy- efficient technologies as a significant hindrance. Installing solar panels, wind turbines, or advanced cooling systems requires substantial investment, which smaller companies or those operating on tight margins may find prohibitive. Additionally, data centres located in regions with unreliable access to renewable energy face logistical challenges in sourcing green power consistently. A case in point is India, where the energy grid is still largely dependent on coal. While some data centres have begun integrating renewable energy, others struggle with inconsistent power supply or lack of incentives to make the switch. This creates a situation where even those willing to adopt green practices may face insurmountable hurdles.

Lack of Previous Research

Another major challenge we encountered was the noticeable lack of previous research, projects, or even detailed articles on the topic of fossil fuel consumption by data centers. While there is growing awareness about the environmental impact of data centres, much of the existing research focuses on general energy consumption and carbon emissions without delving into the specifics of fossil fuel dependency. For example, a 2020 report by the European Commission pointed out that data centres need to use energy more efficiently and rely more on green energy.

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However, it did not provide detailed case studies or examples of how data centres reliant on fossil fuels can make the transition. This lack of detailed guidance leaves a significant gap for researchers, policymakers, and industry stakeholders looking to address the issue comprehensively.

Examples of Challenges

A real-world example that illustrates these challenges is the case of a major global tech company that pledged to make its data centres 100% renewable by 2030. While this commitment received widespread praise, reports revealed that as of 2022, only 60% of the energy used in its data centres came from renewable sources. The remaining 40% was still derived from fossil fuels, primarily due to the lack of renewable energy infrastructure in certain regions where the company operates (Arjun Dave, 2023). This example underscores the gap between ambitious goals and the practical difficulties of achieving them. Another example is smaller data centre operators in developing countries like India, where renewable energy infrastructure is not as advanced as in developed nations. These operators often rely on diesel generators for backup power due to frequent electricity outages, further increasing their dependence on fossil fuels. Changing it into green energy would require significant changes in government policies, financial incentives and upgrading the technologies.

Opportunities for Improvement

Despite these challenges, we believe there are opportunities to work through these difficulties and speed up the adoption of green practices in data centres. For instance, governments can play an important role by introducing policies that incentivize the use of green energy in data centres. Tax breaks, subsidies, or grants for adopting green technologies can help offset the high upfront costs. Additionally, companies can invest in order to create more affordable and efficient green technologies. For example, advancements in cooling technologies, such as liquid cooling systems or the use of AI to optimize energy consumption, can make green practices more accessible to data centres of all sizes.

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Collaboration between industry stakeholders is also essential. By sharing their practices, stories of their success, and mistakes that have occured, leaving space for improvements, all of this can help data centres prevail over difficulties and speed up their transition to sustainability.

The challenges we encountered while writing this paper highlight the complexities of transitioning data centres to sustainable operations. From the lack of publicly available data to the gap between intent and action, these issues underscore the need for greater transparency, research, and collaboration. By looking over these challenges, we can look forward to a greener and more sustainable digital infrastructure that combines with universal efforts to resist climate change.

Conclusion

Green Data Centres are becoming an essential part of India's approach for a sustainable and digitally advanced future. They not only help in reducing harmful carbon emissions but also lower operational costs for businesses and ensure compliance with environmental laws. However, despite their importance, India faces significant challenges in making data centres environmentally friendly. The heavy reliance on coal for electricity limits the benefits of renewable energy. At the same time, the lack of clear government policies specifically targeting Green Data Centres creates uncertainty. Funding is another major hurdle, as high initial costs and limited financial support discourage companies from adopting green technologies. Furthermore, there aren't enough skilled professionals to design and operate energy-efficient systems, which further slows down progress.

To address these issues, India must develop clear policies that enforce sustainability standards, simplify subsidy and approval processes, and incentivize businesses to adopt green practices. Financial challenges can be tackled by introducing low-interest loans, dedicated funds for green technologies, and tax incentives to attract investments. On the technological front, there is a need for training programs, industry-academia collaborations, and local research to create cost-effective solutions suited for India's needs.

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Although this paper highlights the benefits and challenges of Green Data Centres, the lack of publicly available data, limited research on fossil fuel consumption, and gaps between intent and action in sustainability efforts make it difficult to provide a comprehensive analysis. Despite these challenges, the findings stress the importance of urgent and coordinated efforts by the government, businesses, and the technology sector to overcome these obstacles. By addressing these issues, India can take major strides in making a greener, more Eco-friendly digital future, ensuring that its digital transformation aligns with environmental goals.

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