Research Report

Powering the Future: Advancing Green Data Centers in Indonesia

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This report presents the findings of a collaborative research initiative undertaken by the Centre for Strategic and International Studies (CSIS) Indonesia, Tenggara Strategics, Universitas Prasetiya Mulya, UMBRA Strategic Legal Solutions, and the Indonesian Solar Energy Association (AESI). The research team also benefited from contributions by experts from the University of California, Berkeley, and the University of Indonesia. The research assesses the potential of green data center deployment in Indonesia as a catalyst for accelerating renewable energy adoption, with the ultimate objective of supporting Indonesia's achievement of its national renewable energy targets.

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The views expressed in this report are solely those of the authors, written on behalf of CSIS Indonesia, Tenggara Strategics, Universitas Prasetiya Mulya, UMBRA Strategic Legal Solutions, and the Indonesian Solar Energy Association (AESI), and do not necessarily reflect the views of the resource persons and their institutions or supporting researchers.

The authors used ChatGPT solely for English language editing and clarity. All arguments, analyses, interpretations, and conclusions are entirely the authors' own.

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CHAPTER 1:
Introduction

1.1. Background

Indonesia's digital economy is expanding rapidly alongside advances in artificial intelligence (AI), driving strong growth in demand for data centers. The World Bank estimates that Indonesia's data center capacity will grow by 16.8 percent annually through 2029, reaching 1.41 gigawatts (GW). This rapid expansion, however, is accompanied by a sharp increase in electricity consumption, underscoring the urgent need for more energy-efficient and environmentally sustainable solutions to limit carbon emissions. At the same time, Indonesia's abundant renewable energy resources present a strategic opportunity: the development of green data centers could serve as a catalyst for accelerating clean energy deployment while supporting long-term digital growth.

Nonetheless, the sector's growth continues to face challenges due to intense competition from neighboring countries. Although Indonesia currently hosts the largest digital economy in the region – with a market value estimated at US$90 billion in 2024 – its data center capacity remains relatively small at approximately 456 MW, far behind Singapore (1.4 GW) and Malaysia (1.3 GW). Singapore has long established itself as the regional data center hub, while Malaysia has, in recent years, accelerated its capacity expansion through proactive policies and incentives that attract global investors.

This study finds that Indonesia's data center readiness remains relatively low, leading hyperscale investors to show limited interest in placing new investments in the country compared with its regional peers. Broadly speaking, Indonesia has yet to establish a comprehensive policy framework specifically governing data center development, particularly in relation to sustainability. Data centers that attempt to apply green data center principles in Indonesia generally rely on generic regulations or national green building standards, rather than international standards such as ISO 14001 on environmental management system and ISO 50001 on energy management system. As a result, the implementation of environmental management and energy efficiency practices in this sector has not yet aligned with global best practices.

In addition, access to Indonesia's vast renewable energy potential, estimated at 3,686 GW, remains highly constrained, with only a limited number of locations possessing adequate infrastructure to directly harness these resources. Consequently, site options for sustainable data center development remain limited, even as hyperscale companies increasingly prioritize the use of renewable energy in operating their green data centers. This underscores the importance of renewable energy policy reform to attract foreign investment and accelerate the development of green data centers.

Based on modeling conducted by the Green Data Center Study Consortium, the current cost of using renewable energy for data centers in Indonesia remains relatively high. At present, the most competitive mechanism to finance data center energy needs is through the Renewable Energy Certificate (REC) scheme offered by the state utility PT PLN. However, not all hyperscale companies are willing to rely on RECs, as many prefer direct connections between data centers and renewable energy sources to ensure transparency and the verifiable sustainability of the energy supply.

To attract greater investment in green data centers, Indonesia must strengthen both its digital readiness and the greening of its power grid. Digital readiness requires regulatory reforms in the digital sector, alongside sustained efforts to develop digital talent through enhanced digital literacy and the expansion of a skilled technology workforce. Meanwhile, greening the grid entails increasing the share of renewable energy within the national electricity system, reducing dependence on fossil fuels, and strengthening grid capacity to make it more flexible and capable of integrating renewable energy sources efficiently.

1.2. Scope of the Report

This report is intended to serve as a foundational strategic guide for investors, developers, policymakers, and enterprise stakeholders seeking to develop green data centers in Indonesia that is not only commercially sound but also aligned with Indonesia's national development goals and global sustainability imperatives. The scope of this report encompasses the following chapters:

Chapter 2: The Imperative for A Paradigm Shift

Chapter 2 underscores a paradigm shift in how data infrastructure is developed and managed amid the accelerating global adoption of artificial intelligence (AI). It begins by examining how the global AI megatrend has fueled an unprecedented surge in data center energy demand, intensifying pressures on power systems and sustainability goals. The discussion then situates this challenge within the broader context of environmental, social, and governance (ESG) imperatives, highlighting the growing scrutiny of carbon footprints and the necessity for energy-efficient operations. The chapter concludes by introducing the concept of the *green data center* — a transformative approach that integrates renewable energy, advanced cooling technologies, and resilient design to balance digital expansion with environmental responsibility.

Chapter 3: Southeast Asia and Indonesia's Digital Rise

Chapter 3 explores the rapid ascent of Southeast Asia — particularly the Singapore-Johor-Batam (SJB) corridor — as a dynamic hub in the global digital economy. It first positions the region as a new epicenter for digital growth, supported by expanding internet connectivity, increasing digital adoption, and strong investment flows. The chapter then analyzes projected demand across Southeast Asia, emphasizing how data consumption and cloud service needs are expected to multiply in the coming decade. Turning to Indonesia, it characterizes the nation's "digital tsunami," driven by a booming digital economy and massive user base. The discussion also assesses Indonesia's baseline data center capacity and current market landscape, before projecting future demand to 2035, revealing the country's potential to emerge as a leading data center powerhouse in the region.

Chapter 4: Indonesia's Digital Readiness

Chapter 4 assesses Indonesia's digital readiness for green data centers, highlighting progress alongside persistent gaps in data governance, cybersecurity, sustainability readiness, and ease of investment. On data governance, Indonesia has made important progress through the enactment of the Personal Data Protection Law, yet key elements—including the establishment of an independent data protection authority, clarity on cross-border data transfers, data localization requirements, and effective enforcement mechanisms—are still in development. Cybersecurity regulations are similarly evolving, with overlapping mandates and compliance obligations that continue to pose challenges for data center operators. Indonesia's green data center readiness lags behind regional peers Singapore and Malaysia. Despite efforts to attract investment, the investment process remains complex, requiring engagement with multiple institutions rather than a single-window authority. Indonesia also faces a shortage of human resources with strong digital capabilities. These gaps constrain Indonesia's competitiveness in attracting green data center investment.

Chapter 5: Site Selection: A Strategy of Resilience and Sustainability

Chapter 5 examines Indonesia's data center landscape and advances a strategic framework for more resilient and sustainable site selection. It begins by mapping the current geospatial distribution of data centers, highlighting the heavy concentration in Greater Jakarta and Batam. While this clustering has historically delivered efficiency, market proximity, and strong connectivity, it also exposes structural vulnerabilities, including heightened geological and climate risks, dependence on a carbon-intensive power grid, and widening latency and access disparities between Java and outer regions. Building on this diagnosis, the chapter introduces a site selection framework anchored in four pillars: energy, environment, infrastructure, and the socioeconomic landscape. Using a multi-criteria assessment and scoring methodology, it evaluates alternative locations capable of supporting next-generation, green data center development. The analysis identifies the North Sumatra highlands, IKN Nusantara, and North Sulawesi as priority sites, offering complementary advantages in renewable energy availability, climate efficiency, and resilience. Together, these findings outline a strategic roadmap for decentralizing Indonesia's data infrastructure while aligning digital expansion with long-term sustainability and national resilience objectives.

Chapter 6: Power Market and Renewable Energy Supply

Chapter 6 analyzes Indonesia's power market, highlighting both the structural challenges and emerging pathways for the development of green data centers. The electricity sector remains dominated by coal-fired generation, limiting the availability of low-emission power essential for data centers seeking to meet sustainability commitments. While Indonesia's power governance structure ensures system reliability, constraints in generation mix, transmission and distribution, and limited access to captive renewable power restrict data centers' ability to procure clean energy directly. As a result, options such as direct power purchase agreements with renewable energy producers remain difficult to implement. In this context, market-based instruments have become important transitional mechanisms. RECs and Greenhouse Gas Emission Reduction Certificates (SPE GRK) provide data center operators with alternative means to demonstrate renewable energy use and emissions reductions.

Chapter 7: Power Supply and Investment for Data Centers

Chapter 7 examines the power dynamics underpinning Indonesia's data center expansion, focusing on future power supply and investment requirements under varying energy transition scenarios. Using the TIMES-Indonesia model, adapted from the IEA's Energy Technology Systems Analysis Program, the study assesses cost-effective energy mixes and emission trajectories for two key locations—MM2100 Industrial Area in Bekasi and Nongsa Digital Park in Batam—over the 2025–2035 horizon. Four scenarios were analyzed: Business-as-Usual (BAU), 100 percent Renewable Energy (RE), 100 percent Solar Photovoltaic (PV), and REC. The results reveal a sharp transition toward solar dominance by 2035, with PV and battery systems replacing grid reliance, though at the cost of vast land use and significant capital requirements. The investment analysis underscores that while the 100 percent RE and PV scenarios align with sustainability goals; they entail massive capital expenditures, driven largely by solar and battery installations. Under the four scenarios, the REC mechanism is the most cost effective of power supply for green data centers in Indonesia.

Chapter 8: Navigating the Future of Green Data Centers

Chapter 8 outlines strategic pathways for advancing green data centers in Indonesia by addressing digital readiness, renewable energy supply, and grid decarbonization. While Indonesia's large and rapidly growing digital economy offers strong potential, structural and regulatory constraints continue to limit overall digital readiness, underscoring the need for targeted reforms. The chapter also explores alternative mechanisms to supply renewable electricity directly to data centers, including purchases from integrated license holders and the participation of developer affiliates as independent power producers. Where direct access remains constrained, renewable energy certificates are identified as the most viable interim solution. Ultimately, the chapter emphasizes that sustained efforts to green the national power grid are essential to enhance Indonesia's competitiveness and attract long-term investment in green data center development.

CHAPTER 2:

The Imperative for a Paradigm Shift

2.1. The Global AI Megatrend and the Data Center Energy Surge

Artificial intelligence (AI) has been under development since the 1950s, but its adoption has accelerated dramatically in recent years. This rapid global uptake is fundamentally reshaping the scale, intensity, and strategic importance of digital infrastructure. As AI applications become increasingly embedded across sectors, they are driving an unprecedented surge in demand for data centers and the energy required to power them.

Between 2020 and 2024, AI adoption among large firms increased from just over 15 percent to nearly 40 percent. This acceleration has had profound economic implications. Companies that deploy AI or integrate it into their core operations accounted for approximately 65 percent of the total increase in market capitalization of the S&P 500 between November 2022—when ChatGPT was launched—and 2024. In absolute terms, AI-related firms contributed an estimated US$12 trillion of the US$16 trillion increase in the S&P 500's market value over this period.[1]

AI development is closely intertwined with advances in computing technology and the declining cost of semiconductor chips. These chips constitute the physical backbone of AI infrastructure, ranging from central processing units (CPUs), which underpin traditional computing, to graphics processing units (GPUs) and specialized accelerators such as tensor processing units (TPUs), which are optimized for AI workloads. Improvements in GPU performance have significantly reduced training times, enabling AI models to process much larger datasets within shorter timeframes.

The size of training datasets has increased exponentially over the past decades, as illustrated in Figure 1. Training data volume is a critical determinant of model performance, as larger datasets allow for deeper learning and more sophisticated pattern recognition. Early AI systems were trained on fewer than 100 data points, whereas today's advanced models are trained on trillions of data points. For example, the International Energy Agency (IEA) estimates that GPT-4 was trained on approximately 4.9 trillion data points, requiring around 2.2×10^{25} computational operations. The training process took an estimated 14 weeks and consumed approximately 4,242 gigawatt hours (GWh) of electricity.[2]

Such large-scale model training relies heavily on data centers as critical enabling infrastructure. Whereas firms historically stored and processed data on-site, growing data volumes and computing requirements have driven a shift toward centralized, highly secure data storage and processing facilities. Today, data centers handle more than 95 percent of global internet traffic, ensuring real-time connectivity for billions of users worldwide.

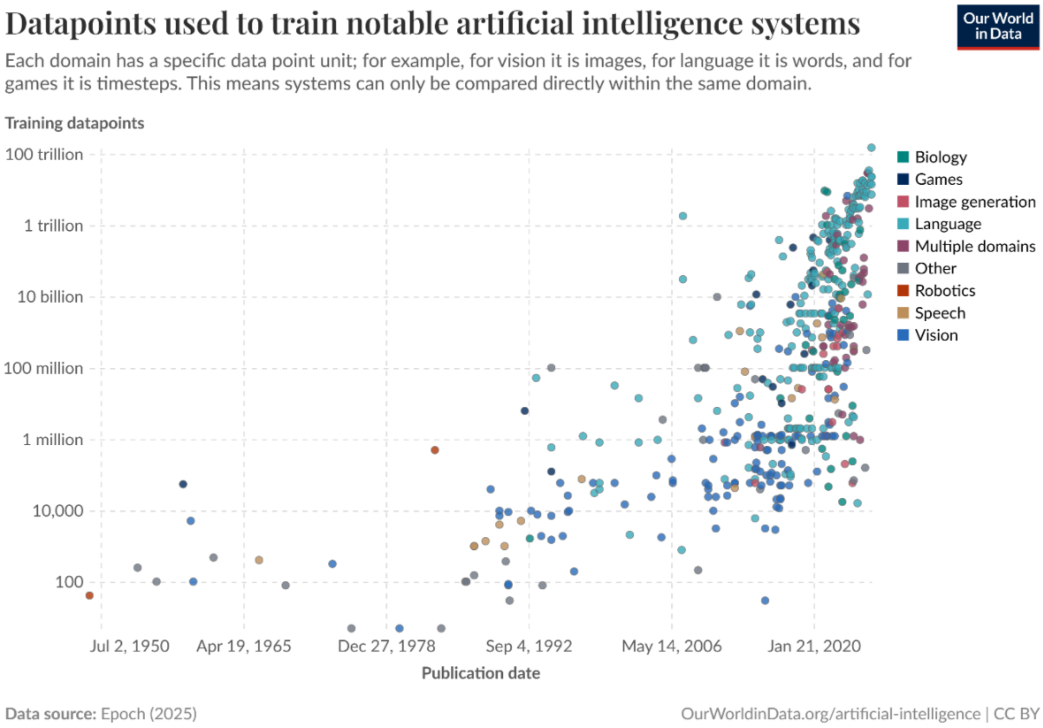
Demand for data centers is increasingly driven by major technology companies, including Amazon, Meta, Google, and Microsoft, which are rapidly integrating AI into their core business models. These hyperscalers respond by developing and training large language models (LLMs) and other data-intensive AI systems, significantly increasing computing and energy requirements. As a result, hyperscalers' share of global data center demand is projected to rise from 25 percent in 2023 to 45 percent by 2028. Meanwhile, colocation providers—third-party operators that lease data center capacity to firms—are expected to maintain a stable market share of around 50 percent over the same period.

Several leading institutions have published estimates of future data center demand growth, with projected compound annual growth rates (CAGR) ranging from 12 percent to 20 percent over the coming years (Table 1). According to Boston Consulting Group (BCG), global data center demand is expected to grow at a CAGR of approximately 16 percent between 2023 and 2028, increasing total capacity from around 60 GW to 127 GW by

2028. McKinsey, meanwhile, presents a slightly different outlook, projecting global data center demand to rise from 57 GW to as much as 152 GW under its best-case scenario.[3]

Global investment in data centers has surged in line with rapidly rising demand for digital infrastructure. As capital expenditure by major technology companies has expanded significantly, data center investments have become increasingly attractive, offering strong returns to investors. Global data center investment doubled between 2022 and 2024, reaching an estimated US$500 billion in 2024.[4]

Figure 1. Datapoints used to train notable artificial intelligence systems



Source: Our World in Data (2025)

Table 1. Data center CAGR forecast

Institution	CAGR	Estimation period
BCG	16%	2023-2028
JLL	15% - 20%	2023-2027
McKinsey	12% - 15%	2023-2030
Goldman Sachs	15%	2024-2027

Source: BCG, JLL, McKinsey, Goldman Sachs

Despite this growth, investment remains concentrated in major economies, reflecting the existing geographic distribution of data infrastructure. The United States accounts for approximately 45 percent of global data center capacity, followed by Germany (4.4 percent) and the United Kingdom (4.3 percent). However, data center development is increasingly expanding beyond the Western world. Countries such as China, India, Brazil, Singapore, Malaysia, Kenya, and the United Arab Emirates have attracted substantial investment from major technology firms seeking to serve regional markets. Indonesia, while still lagging behind established data center hubs, is expected to narrow this gap, with total data center capacity projected to reach 2.5 GW by 2035. This expansion is supported by increasingly favorable incentive frameworks aimed at attracting data center investment.

At the same time, the rapid expansion of data centers has led to a sharp increase in electricity demand, elevating energy availability and sustainability to critical constraints on future growth. An average AI-focused data center consumes as much electricity as approximately 100,000 households, while a 1-GW facility can require power equivalent to that used by around 800,000 households in the United States. As data center development accelerates in both mature and emerging markets, aligning digital infrastructure growth with clean, reliable, and affordable energy systems has become essential — reinforcing the strategic importance of green data centers as a foundation for sustainable digital expansion.[5]

2.2. The Sustainability Imperative: Energy, Carbon, and ESG Pressures

The projected surge in data center demand—supercharged by the energy-intensive requirements of artificial intelligence (AI)—carries a profound and unavoidable consequence: a rapidly expanding appetite for electricity. Globally, data centers already account for an estimated 1–2 percent of total electricity consumption, a share that the International Energy Agency (IEA) warns could double by 2026, driven largely by AI workloads and cryptocurrency mining. As Indonesia prepares to add gigawatts of new data center capacity, it faces a critical juncture at which the trajectory of its digital growth is inseparable from the sustainability of its energy system and its national climate commitments.

This challenge extends far beyond rising electricity demand; it directly confronts the carbon footprint of the digital economy. Indonesia's power grid remains heavily dependent on fossil fuels—particularly coal—meaning that each additional megawatt of data center capacity built under current conditions risks locking in significant future carbon emissions. A conventional 100-megawatt (MW) data center campus operating around the clock can consume as much electricity as a small city, and when powered by the prevailing grid mix, it becomes a substantial source of carbon dioxide emissions. At the scale implied by a projected 2.5 GW of data center demand by 2035, the absence of a strategic shift toward cleaner energy would place Indonesia's climate targets under considerable strain.

These environmental realities are increasingly shaping investment decisions in the global digital infrastructure market. The era in which data centers were developed with a singular focus on uptime and connectivity is rapidly fading. Environmental, social, and governance (ESG) considerations have become central to how data center projects are evaluated, financed, and ultimately approved. Global capital markets are intensifying scrutiny of the environmental performance of their investments, with major asset managers, lenders, and development finance institutions embedding ESG criteria into capital allocation decisions. For data center developers seeking international financing, the ability to demonstrate a credible pathway toward low-carbon and energy-efficient operations is no longer optional; it is a prerequisite for access to capital.

At the same time, the hyperscale technology companies driving data center demand are bound by ambitious corporate climate commitments. Industry leaders such as Microsoft, Google, and Amazon have pledged to power their global operations with 100 percent renewable energy and to achieve carbon neutrality—or even carbon negativity—within the coming decade.[6] [7] [8] These commitments are not aspirational statements; they are core business strategies that directly influence investment and site selection decisions. Increasingly, hyperscalers will not invest in new data center regions unless there is a clear, bankable, and scalable pathway to procure clean energy.

This convergence of pressures—the physical reality of rising energy consumption, the environmental risks of carbon-intensive power systems, and the financial discipline imposed by ESG-driven capital markets—creates an unequivocal imperative. For Indonesia to attract high-quality data center investment while ensuring that digital expansion does not come at an unacceptable environmental cost, sustainability must be placed at the center of data center development. The next generation of digital infrastructure cannot simply replicate past models at a larger scale; it must be deliberately designed, located, and operated to align digital growth with long-term energy security and climate objectives.

2.3. Green Data Centers: Redefining Infrastructure for Sustainability

The evolution of data centers reflects the broader trajectory of computing and digital infrastructure. Early forms of data centers can be traced back to the banking sector, notably with the deployment of ERMA Mark II (Electronic Recording Method of Accounting) by the Stanford Research Institute for the Bank of America in 1959. These early mainframe systems laid the foundation for centralized computing and data processing. As hardware technologies advanced — allowing computers to become smaller, more powerful, and more energy-efficient — data centers evolved from housing isolated mainframes into critical infrastructure supporting large-scale data storage, processing, and internet-based applications. Today, data centers serve as the backbone of modern digital services, enabling reliable operation across finance, commerce, and government.

In contemporary terms, data centers have evolved into highly integrated facilities that centralize computing, data storage, network operations, and digital service delivery. They are supported by sophisticated systems designed to ensure continuous, secure, and resilient operation, including redundant power supply, advanced cooling, and robust physical security. These facilities are engineered to operate on a 24/7 basis, reflecting the always-on nature of the digital economy. As computing demands have grown — particularly with the rise of cloud computing and artificial intelligence — data centers have become increasingly complex systems composed of multiple interdependent components.

Broadly, modern data centers consist of four core elements: physical infrastructure, IT systems and networking equipment, power supply systems, and cooling systems.

a. Physical infrastructure

The physical infrastructure of a data center provides the foundation for hosting IT equipment, support systems, and operational spaces. It can be broadly divided into three functional areas. First, the IT room houses servers and telecommunications equipment in a tightly controlled environment. These systems are highly sensitive to temperature and humidity, requiring precise climate control to ensure operational integrity and reliability. At the same time, IT equipment generates significant heat, necessitating effective thermal management to prevent performance degradation and, increasingly, to enable heat reuse or energy efficiency improvements. Second, data center support areas accommodate critical systems such as uninterruptible power supplies (UPS), cooling and ventilation equipment, and electrical switchboards. These systems are essential to ensuring power continuity, operational resilience, and protection against outages or fluctuations. Third, ancillary spaces — including offices, control rooms, lobbies, and restrooms — support the day-to-day management and security of data center operations.

b. IT systems and networking equipment

IT systems and networking equipment form the functional core of data center operations. These include servers, storage systems, and networking hardware. Servers perform the primary computing functions, processing and managing data across a wide range of applications, from simple workloads to complex, AI-driven tasks. Storage systems—using hard disk drives, solid-state drives, and cloud-based architectures—enable the handling of vast and rapidly growing volumes of data. Networking equipment, including routers, switches, and telecommunications systems such as fiber-optic networks and wireless connections, provides secure and reliable connectivity both within the data center and to external networks. Together, these systems ensure high-speed data transmission, operational security, and seamless integration with global digital ecosystems. As data centers continue to expand in scale and importance, this traditional infrastructure model is increasingly being re-evaluated through the lens of efficiency, resilience, and sustainability—paving the way for the emergence of green data centers as the next stage in the evolution of digital infrastructure.

c. Power supply systems

As highly electrified facilities, data centers depend on robust and resilient power supply systems to ensure uninterrupted operation. These systems must deliver consistent, high-quality electricity to both IT and non-IT equipment, supporting continuous 24/7 operations. Any disruption in power supply can lead to service outages, data loss, or hardware damage, making power reliability a critical design priority. Primary electricity supply is typically sourced from the national grid, but data centers must be protected against power interruptions, voltage fluctuations, and frequency instability.

To address these risks, uninterruptible power supply (UPS) systems are integrated to provide instantaneous backup power and to protect sensitive equipment from power quality disturbances. While UPS systems usually supply power for only a short duration, they play a crucial role in bridging the gap between grid failure and longer-term backup solutions. For extended outages, modern data centers are equipped with backup generators—most commonly diesel or gas-fired—to maintain operations until grid power is restored. Power distribution units (PDUs) and switchboards then manage the controlled delivery of electricity across servers, networking equipment, cooling systems, and ancillary facilities, ensuring redundancy and operational resilience throughout the facility.

As data centers are required to operate continuously and at high load factors, energy efficiency has become a central concern. Data centers can consume up to 100 times more electricity per unit area than conventional office buildings. Consequently, the deployment of high-efficiency UPS systems, power factor correction devices, and intelligent power management solutions is essential to reducing energy losses, lowering operating costs, and minimizing environmental impacts. Increasingly, data center operators are also integrating renewable energy sources—either through on-site generation or power purchase agreements—to support low-carbon operations and enhance long-term energy security.

d. Cooling systems

Cooling systems are a critical component of data center infrastructure, designed to maintain optimal temperature and humidity levels that ensure the reliable operation of IT equipment and a safe working environment for personnel. Servers and networking hardware generate substantial heat during operation, and excessive temperatures can trigger system failures, unplanned shutdowns, or permanent equipment damage. Prolonged exposure to high temperatures also shortens the lifespan of IT assets, increasing replacement costs and undermining operational efficiency.

As a result, the design and performance of cooling systems play a decisive role in both the reliability and cost structure of data center operations. Cooling solutions typically include a combination of air-conditioning units, chilled water systems, airflow management technologies, and monitoring systems that regulate environmental conditions in real time. Because cooling can account for a significant share of total data center energy consumption, inefficient cooling designs can substantially increase operating costs and carbon emissions.

In response, modern data centers are increasingly adopting advanced and energy-efficient cooling technologies, such as hot- and cold-aisle containment, liquid cooling, free cooling, and heat recovery systems. These innovations not only reduce energy consumption but also improve system resilience and scalability. As data center capacity expands — particularly in emerging markets — cooling efficiency has become a defining feature of green data centers, directly linking infrastructure design to sustainability, operational resilience, and long-term cost competitiveness.

Green data centers

Across their lifecycle, data centers generate significant environmental impacts — from construction and continuous operation to equipment decommissioning. Because data centers operate 24/7, energy efficiency must be embedded from the design stage, particularly in building layouts and cooling systems, which account for a large share of energy use. While facilities are often located near urban centers to serve end users, they typically depend on electricity and water sourced from surrounding regions, creating additional pressures on power grids and water resources.

During operations, reducing environmental impact hinges on the deployment of energy-efficient ICT equipment, sustainable cooling technologies, and access to reliable low-carbon energy. As data center capacity expands, improvements in server efficiency, software optimization, and network design are essential to limiting electricity consumption and associated emissions. Sustainability considerations extend beyond operations to end-of-life management. Decommissioned servers and equipment generate substantial electronic waste, which must be addressed through systematic reuse, repair, redistribution, and recycling to minimize environmental harm and resource loss.

As data center demand grows exponentially, the cumulative footprint—encompassing greenhouse gas emissions, water use, and e-waste—must be carefully managed to safeguard both environmental sustainability and investment resilience. Greening data centers is therefore not only an environmental imperative, but also a risk mitigation strategy against climate-related hazards such as heat stress, water scarcity, and energy system disruptions. As defined by the International Telecommunication Union (ITU), a green data center is “a repository for the storage, management, and dissemination of data in which the mechanical, lighting, electrical, and computer systems are designed for maximum energy efficiency and minimum environmental impact.”

CHAPTER 3:

Southeast Asia and Indonesia’s Digital Rise

3.1. Southeast Asia: A New Epicenter for Growth

While the global surge in AI and data demand sets the stage, it is in Southeast Asia where this trend finds its most fertile ground for explosive growth. The region, home to over 680 million people, is rapidly transforming from a collection of developing economies into a unified, hyper-connected digital bloc. This ascent is not merely an extension of global trends but a unique convergence of demographic dividends, rapid digitalization, and strategic geopolitical positioning, making it the new global epicenter for digital infrastructure investment.

The bedrock of this transformation is the region's massive and deeply engaged online population. Unlike mature markets in the West, a significant portion of Southeast Asia's populace leapfrogged the desktop era entirely, with the smartphone serving as their first and primary gateway to the digital world. This has cultivated a digitally native consumer base of over 480 million internet users who are prolific generators of data[9]. Their intense online engagement consistently ranks among the highest globally with daily screen times often exceeding eight hours in key markets like Indonesia and the Philippines. This fuels a torrential data stream from e-commerce, streaming services, and a vibrant creator economy[10]. This insatiable demand for content is reflected in stark projections: monthly data usage per smartphone is expected to more than double by 2029, reaching 42 gigabytes in a signal of the massive processing and storage capacity required to serve this market[11].

This burgeoning digital activity is the engine of a regional digital economy on a trajectory to exceed US$300 billion by 2025[12]. As data solidifies its status as a strategic national asset, a wave of data sovereignty is sweeping across the region. Governments in Indonesia, Vietnam, and Malaysia have moved decisively to implement data residency and localization laws, transforming the landscape for global technology firms. These regulations are no longer mere compliance hurdles; they are foundational pillars of national security and economic control. For global cloud providers and multinational corporations, an in-region data center has shifted from a strategic advantage to a non-negotiable prerequisite for market access. This regulatory pressure is forcing a fundamental infrastructure shift, from serving the region remotely to building robust, sovereign-compliant facilities on local soil.

Adding another layer of urgency is the region's emergence as a geopolitical "Goldilocks" zone. Amidst escalating tech and trade tensions between the United States and China, Southeast Asia has become a crucial, relatively neutral ground for digital infrastructure. Global enterprises are actively executing "China Plus One" strategies for their data, diversifying their Asian footprint away from traditional hubs like Hong Kong to mitigate geopolitical risks. This has catalyzed a significant flow of investment into the region, which is widely perceived as a stable and secure harbor for mission-critical operations.

Ultimately, the race to capture the Southeast Asian market is being fought in the cloud. Public cloud adoption is accelerating at a blistering pace, with all major hyperscalers such as Amazon Web Services, Google Cloud, and Microsoft Azure aggressively establishing and expanding their cloud regions. This "cloud race" is a direct and powerful catalyst for hyperscale data center construction. Now, as the subsequent wave of AI adoption begins to crest, the demand for intensive, high-density computing will amplify this need exponentially.

3.1.1. Singapore-Johor-Batam Corridor

The primary beneficiary of this confluence of forces has been the Singapore–Johor–Batam (SJB) corridor, which has rapidly emerged as the region’s premier data center hub. Anchored by Singapore’s mature digital ecosystem and world-class global connectivity, the corridor reflects a unique balance of technological leadership and regional interdependence. However, Singapore’s physical constraints — particularly in land and energy availability — have generated a powerful *spillover effect*, driving substantial new developments in neighboring Johor in Malaysia and Batam in Indonesia as both seek to capture the excess demand. While the success of the SJB corridor underscores Southeast Asia's growing strategic relevance, it also highlights the need for greater geographic diversification to build long-term resilience.

Within the SJB corridor, Singapore remains the dominant player, with data center capacity exceeding 1.4 GW, followed by Malaysia at around 1.3 GW, and Batam trailing significantly with less than 200 MW. Singapore established its position as a regional hub for global companies between 2014 and 2018, supported by early investments in data centers and extensive undersea cable networks that connect it to major global markets. Yet, as digital demand surges across Asia, other Southeast Asian nations have moved to compete, capitalizing on Singapore's limitations in land availability and power supply.

In 2019, Singapore imposed a moratorium on new data center developments due to energy and land constraints, which redirected demand to nearby countries — particularly Johor and Batam. Beyond these two, new markets such as Chonburi (Thailand) and Hanoi (Vietnam) have also begun to emerge, expanding the region's data infrastructure landscape. Among Singapore's neighbors, Malaysia has proven most prepared to absorb the spillover. Through the Malaysian Investment Development Authority (MIDA), the Malaysian government has actively promoted Johor as a prime destination for data center investment, emphasizing its proximity to Singapore, ample land availability, skilled workforce, and supportive incentives. Consequently, Johor's data center capacity is rapidly expanding and is poised to rival Singapore's in the near future.

The rise of the SJB corridor signals that Southeast Asia is no longer merely a high-growth digital market—it has become a strategic necessity for global connectivity and cloud infrastructure. The combination of a massive and digitally engaged population, a vibrant online economy, supportive regulatory environments, and its critical geopolitical position has created unprecedented, sustained demand for scalable, high-quality data infrastructure. Within this evolving regional landscape, Indonesia—Southeast Asia's demographic and economic powerhouse—is positioned to play a decisive role. The question is no longer *if* large-scale investment will flow into the region, but *where* it can be directed most strategically, sustainably, and profitably.

3.1.2. Projecting Demand in Southeast Asia

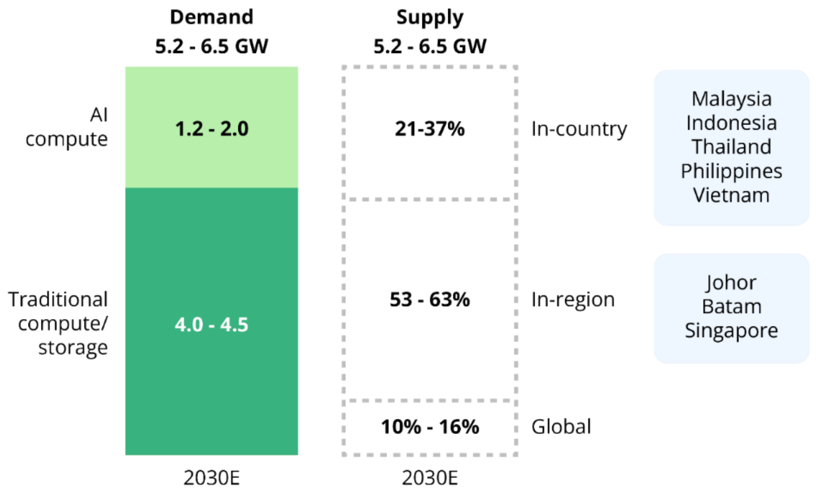
Data centers are predominantly located in major economies, with only around 10 percent situated in developing countries[13]. However, this geographic concentration is beginning to shift as data center expansion increasingly extends into developing regions, including Southeast Asia. As one of the world's fastest-growing regions, Southeast Asia presents a vast population of internet users and a demographic profile with higher population growth than most Western economies. The rapid rise of the Internet of Things (IoT), artificial intelligence (AI), and edge computing has driven a surge in data traffic across the region. In response to this escalating demand, major technology companies are investing in data centers across Southeast Asia to maintain optimal service quality and customer experience.

With internet penetration rates ranging between 73 and 83 percent, Southeast Asia already generates substantial data traffic. The growing integration of AI into everyday life further amplifies data consumption. Monthly data usage per smartphone user is projected to increase by 2.5 times from 17 GB to 42 GB between 2023 and 2029[14]. his investment potential is reinforced by robust infrastructure in both telecommunications and the power sector. The region's seamless connectivity to global submarine cable networks and its generally favorable investment climate have further attracted global technology players.

The Southeast Asian data center market offers compelling returns for investors. Typical net profit margins range from 15 to 40 percent, with relatively short payback periods of four to ten years. These investments also generate recurring revenues, providing stable cash flows for investors. With such attractive market dynamics and business fundamentals, data center investments in Southeast Asia are projected to grow at a compound annual growth rate (CAGR) of 9.6 percent, increasing capacity from 10 GW to 19 GW. This growth rate surpasses the global average of 8.2 percent, underscoring the region's strong potential in the data center industry.

Artificial intelligence remains the primary driver of Southeast Asia's data center expansion. The global AI market is expected to grow at a CAGR of 20 percent between 2022 and 2030, from US$0.5 trillion to U$2.1 trillion. According to projections by the Boston Consulting Group (BCG), the global AI boom will cause AI computing demand in Southeast Asia to surge tenfold rising from 1.2 GW to 2 GW and, in turn, drive total data center demand to triple, reaching between 5.2 and 6.5 GW by 2030 (Figure 2).[15]

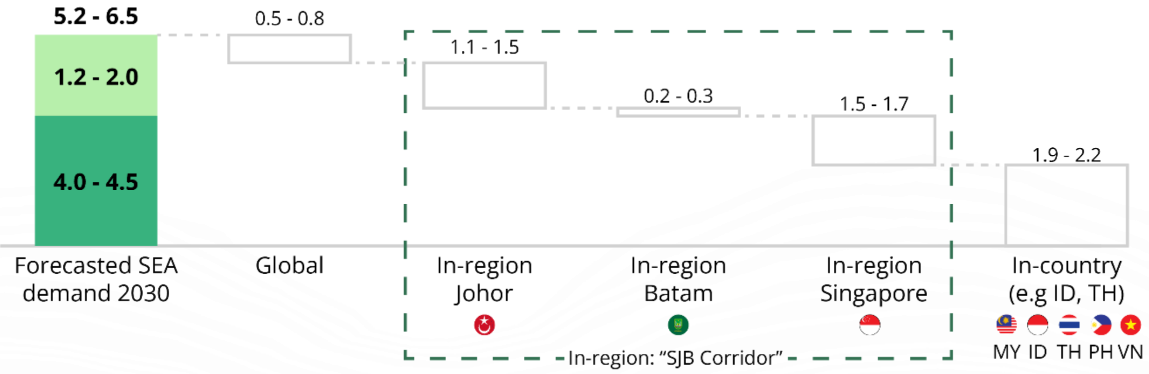
Figure 2. Demand and supply of data center in Southeast Asia, 2030



Source: BCG

The surging demand in the region is primarily concentrated within the SJB corridor, which accounts for approximately 55 percent of total capacity. For AI-related computation alone, around 0.7 to 1.2 GW of data center demand is expected to be absorbed within the SJB corridor. Among the three hubs, Singapore captures the largest share of demand, followed by Johor and Batam, as illustrated in Figure 3. About 35 percent of regional data center demand—equivalent to between 1.9 and 2.2 GW—is distributed among other Southeast Asian countries, with Indonesia absorbing the largest share. The remaining 10 percent is met by global sources.

Figure 3. Forecasted spillover demand 2030, in gigawatt

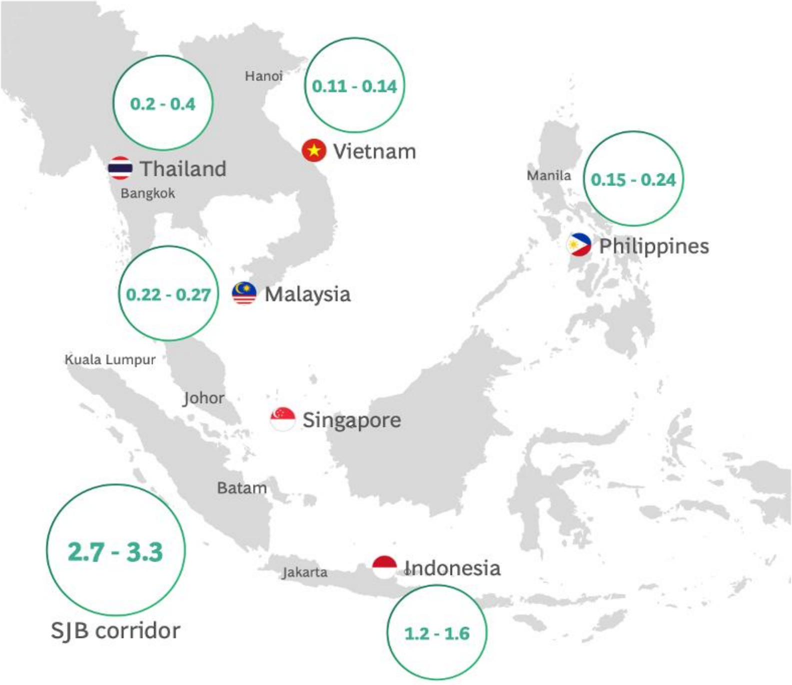


Source: BCG

Rising demand for AI computing is driving rapid growth in data center capacity across Southeast Asia, with development increasingly concentrated in the Singapore–Johor–Batam (SJB) corridor, as illustrated in Figure 4. To meet the projected growth in data center demand over the coming years, Southeast Asian nations must address several infrastructure challenges. From the energy perspective, ensuring a sufficient and reliable power supply will be critical for data center development. This must be supported by improvements in power transmission infrastructure and the promotion of energy efficiency across facilities—reflected in achieving lower Power Usage Effectiveness (PUE) ratios—to ensure optimal operational performance.

Another key issue is the growing demand for renewable energy. Global technology companies, particularly hyperscalers, are advancing toward net-zero emissions by developing green data centers. These facilities require higher upfront investment compared to conventional ones but contribute to long-term sustainable economic growth across Southeast Asia. To remain competitive and attract such investments, countries in the region must accelerate renewable energy development and integration into their national grids.

Figure 4. Projected data center capacity 2030, in gigawatt



Source: BCG

Beyond power supply, reliable water resources and robust telecommunications infrastructure are also essential to support data center operations. Addressing these infrastructure needs will require strong government involvement through sound regulations and targeted incentives. With the right policy framework, the overall investment cost for data centers can be reduced, thereby enhancing cost competitiveness and attracting more sustainable digital infrastructure development in the region.

3.2. Indonesia's Digital Tsunami

Indonesia's economy — and particularly its digital economy — is the largest in Southeast Asia. In 2024, the value of Indonesia's digital economy reached approximately US$90 billion, more than tripling from US$27 billion in 2018.[16] [17]It is projected to expand further to US$109 billion by 2025. This remarkable growth is driven primarily by the rapid rise of the e-commerce sector, which has significantly transformed consumer behavior. Given that household consumption accounts for around 55 percent of Indonesia's GDP, the country's strong consumer base continues to underpin the robust expansion of its digital commerce.

Critical digital infrastructure, especially data centers, plays a pivotal role in sustaining Indonesia's digital economy. Although Indonesia's AI adoption index stands at 61.0 — below that of some neighboring countries — the nation's vast base of internet users underscores the importance of reliable data center capacity to maintain seamless digital connectivity. With millions of Indonesians engaging online daily, strong data infrastructure has become essential to support the constant exchange of information and services.

According to the latest national survey, Indonesia is home to approximately 221.5 million internet users, representing a substantial penetration rate of 79.5 percent of the population. These users are highly active, spending an average of 7 hours and 38 minutes online each day. This sustained digital engagement generates massive volumes of data through e-commerce transactions, digital financial services, social media interactions, and streaming content.

Such extensive digital activity demands a robust and scalable infrastructure to store, process, and distribute data securely and efficiently. Data centers, therefore, have evolved from being peripheral IT facilities into the critical backbone of Indonesia's digital ecosystem. Their strategic development is now central to sustaining the nation's digital momentum and realizing its broader economic potential.

Several key forces are propelling the continued expansion of Indonesia's data center industry. First, the sheer scale and rapid growth of the country's digital economy ensure persistent demand for data processing and storage[18]. Second, there is a structural shift among Indonesian enterprises from inefficient on-premises servers to third-party colocation and cloud services. Third, rising concerns over data governance and sovereignty are prompting corporations to localize their data within national borders. Fourth, the accelerating adoption of artificial intelligence by both individuals and organizations is further amplifying computational demand. Collectively, these four drivers form a strong and predictable foundation for sustained growth in Indonesia's digital infrastructure landscape.

3.2.1. Baseline Capacity and Current Market Landscape

The data center market in Indonesia has existed since the early 2000s, yet its significant expansion has become particularly evident in recent years. According to Data Center Indonesia (PT DCII), the sector grew by an average of 33 percent annually between 2020 and 2023. By 2024, the market value is estimated to have reached US$3.7 billion (Rp57.7 trillion), supported by total investments of approximately US$634 million (Rp9.8 trillion).[19] This rapid growth is reflected in the increasing presence of hyperscalers in the country, many of whom are expanding their data center capacities and offering managed cloud services.

The momentum of Indonesia's data center ecosystem accelerated when Singapore imposed a moratorium on the construction of new data centers between 2019 and 2022. This policy redirected global demand toward alternative locations in Southeast Asia, notably Indonesia and Malaysia, which were able to accommodate the spillover demand.

Technological advancement has also contributed to the rise of Tier 3 data centers across Indonesia, indicating the industry's growing sophistication. A key feature of Tier 3 facilities is N+1 redundancy for all critical systems, including power, cooling, and network infrastructure, ensuring continuous operation through at least one additional backup component beyond the required capacity.

Since 2019, several global technology companies have invested in developing data center facilities in Indonesia (see Table 2). Beyond establishing physical infrastructure, firms such as Microsoft, Google, and Amazon Web Services (AWS) have also launched initiatives to enhance Indonesia's digital talent ecosystem. Their sustained commitments position Indonesia as a distinctive and increasingly competitive hub within the Southeast Asian data center landscape.

Table 2. Foreign companies' notable data center investment in Indonesia

Company	Notable investment	Data center type
AWS	US$ 5 billion investment between 2021 to 2036	Cloud data center
Microsoft Azure	US$ 1.7 billion investment between 2024 to 2028, to establish AI-ready data center	Cloud data center
Princeton digital	US$ 1 billion investment to expand data center to Batam	
Digital realty	US$ 287 million to add 27 MW capacity	Colocation data center, wholesale data center
Google	Currently have 3 facilities with expected economic contribution up to Rp 1,400 trillion in the next 5 years	Cloud data center
EdgeConnex	Acquire GTN 7MW data center and expand data center business reaching 120 MW	Edge data center
Oracle	US$ 6 billion investment in Batam	
Equinix	Establish a data center with approximately US$ 74 million investment	Edge data center, colocation data center
Tencent	US$500 million investment to develop 3rd data center	
Huawei	US$ 300 million investment between 2022 to 2027	

Source: Various sources

Another major driver of data center development in Indonesia has been growing concern over data governance. Many developing countries have begun addressing this issue, as digital activities have not produced reciprocal benefits for their economies. Large populations in these countries often become sources of data that are transferred and stored overseas, while global companies leverage this data to develop digital products and services. This dynamic leaves developing countries as mere consumers rather than producers in the digital economy, deriving limited local benefit from their own data resources. Such asymmetry has prompted many governments to tighten data governance regulations, compelling hyperscalers to localize data storage and processing within national borders.

Fueled by these developments and other enabling factors, Indonesia's data center ecosystem has entered a new phase of growth. Global digital companies have increasingly invested in the country to capture its expanding market potential, accelerating the pace of data center construction and investment. According to Data Center Map, Indonesia currently hosts 136 data centers, including facilities that are under construction.

A study by the commercial real estate services company Cushman & Wakefield projects that Indonesia's data center market will reach a total live IT load capacity of approximately 970 megawatts (MW) by 2025, with market revenue to rise to US$4.21 billion in 2025, driven by the growing adoption of cloud and colocation services, alongside strong government support for digitalization. This marks a dramatic increase from only 53 MW in 2020, underscoring the rapid acceleration of digital infrastructure development.

Despite this progress, the market remains significantly underserved. A key indicator of data center capacity per capita highlights this gap. Indonesia currently operates at just 1.5 watts per capita, far below Japan's mature market level of approximately 10 watts and vastly behind Singapore's 183 watts per capita. This disparity reflects not only the infrastructural gap but also the enormous latent potential for future growth, emphasizing the scale of development required for Indonesia to align with global digital economies.

Behind Malaysia

Despite the rapid expansion of its data center sector, Indonesia continues to face challenges in competing with other Southeast Asian countries for foreign investment. Recent developments in the region illustrate how Malaysia has successfully attracted significant foreign capital into its data center ecosystem, most notably in Johor, which benefits from its strategic proximity to Singapore. Malaysia currently outpaces its regional peers, capturing 40 percent of Southeast Asia's data center market in 2023, equivalent to approximately US$4 billion in investment. In contrast, Indonesia remains considerably behind, with a market size of around US$1.5 billion — comparable to that of Thailand.[20]

Several factors contribute to Malaysia's stronger growth in the data center sector, one of the most significant being access to renewable energy. Energy availability has become increasingly critical as global companies pursue decarbonization goals over the coming years. Achieving these targets is impossible without transitioning to cleaner energy sources, particularly since data centers consume vastly more electricity than average households or businesses. In Indonesia, however, the power sector has yet to create enabling conditions for data centers to source renewable energy, despite the country's abundant renewable potential. By contrast, Malaysia facilitates access to renewable energy through mechanisms such as power wheeling and the establishment of green industrial parks.

In addition to renewable energy access, neighboring countries have introduced various incentives to attract foreign investors, including lower electricity tariffs and tax benefits. These cost advantages enhance Malaysia's competitiveness, especially compared with Singapore, where high land prices and energy costs can constrain large-scale investment.

Malaysia also surpasses Indonesia in terms of digital infrastructure readiness. The country has made rapid progress in 5G network deployment, supporting the implementation of smart city initiatives. Furthermore, Malaysia's recent legal reforms allow foreign vessels to manage subsea cable infrastructure, an essential element for global data connectivity. In contrast, Indonesian regulations restrict such operations by foreign vessels, requiring them to obtain special permits from the Ministry of Transportation. This regulatory barrier complicates efforts by global technology firms to integrate Indonesian data centers into their proprietary global fiber-optic networks.[21]

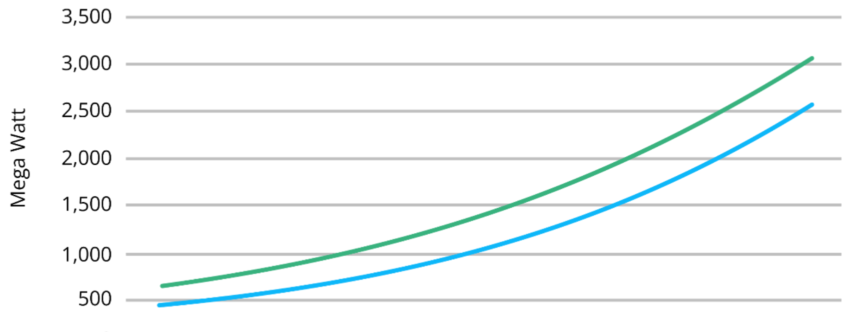
The current data center market in Indonesia represents a dynamic ecosystem comprising global hyperscalers, international colocation providers, and strong domestic players. However, this competitive landscape remains heavily concentrated in two geographic areas of Greater Jakarta and Batam, a structural vulnerability that will be examined in the next chapter.

3.2.2. Projecting Demand to 2035

This study seeks to estimate the growth of data center demand and supply in Indonesia over the coming years. The baseline figure for current supply is drawn from the Ministry of Investment and Downstream, which reports a total national data center capacity of 430 megawatts (MW) as of 2024.[22] To project future growth, this study employs the compound annual growth rate (CAGR) of data center companies' capital expenditures between 2020 and 2024 as a proxy for supply expansion. Of the 56 companies engaged in data center operations, financial data were available for 14 firms. The analysis indicates that their capital expenditures grew at an average annual rate of 19.6 percent.

On the demand side, projections are based on estimates from the World Bank. The data center demand in Indonesia is expected to reach 650 MW by 2025 and to grow at a CAGR of 16.8 percent between 2023 and 2029. Extrapolating from this rate, total demand is projected to reach approximately 3.06 gigawatts (GW) by 2034, as illustrated in Figure 5.

Figure 5. Data center supply and demand estimation, 2024-2034



	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Demand	650	759	886	1,034	1,208	1,410	1,646	1,922	2,244	2,620	3,059
Supply	430	514	615	735	879	1,060	1,256	1,501	1,795	2,146	2,566

Source: Authors' calculation

The recent advancements in artificial intelligence (AI) have also become a major catalyst for the development of Indonesia's data center ecosystem. Indonesia is currently the world's fourth-largest internet user base, and its population demonstrates strong optimism toward AI technologies. According to the Artificial Intelligence Index Report 2025, approximately 80 percent of Indonesians believe that AI-powered products and services provide more benefits than drawbacks.

Indonesia also leads the AI market in Southeast Asia, accounting for roughly 30 percent of the region's total market value. This strong position is underpinned by a vast and digitally engaged consumer base, coupled with growing confidence in AI adoption across industries. The domestic AI market is projected to expand rapidly, with a compound annual growth rate (CAGR) of 24.8 percent through 2031. Within this expansion, machine learning is expected to play a central role, representing around 40 percent of the market by 2025, as service industries increasingly adopt AI technologies to enhance operational efficiency and productivity.[23]

The advent of generative AI is a paradigm-shifting catalyst, fundamentally altering the scale, nature, and energy requirements of data center demand. This is not just a quantitative increase; it is a qualitative transformation towards high-density computing, where a single server rack can consume over ten times the power of a standard one.

To accurately forecast this future, the study develops a segmented projection model based on Business Model (Hyperscale, Colocation, Enterprise) and Workload Density (Standard vs. AI-Ready). This framework allows us to model the nuanced market shifts that will dictate future infrastructure needs. Applying this model to

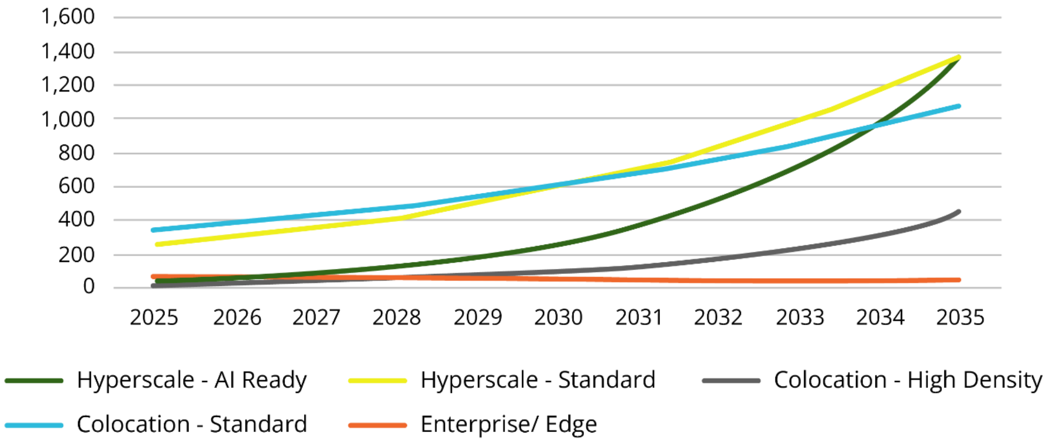
Indonesia's 650 MW baseline, our analysis projects a dramatic escalation. The study forecasts that total data center capacity demand will surge to nearly 1.6 gigawatts by 2030 and exceed 4.2 gigawatts by 2035, a nearly ten-fold increase in just over a decade.

Table 3. Projected Data Center Capacity Demand in Indonesia by Segment (MW IT Load), 2024-2035

Segment	Baseline 2024 (MW)	Assumed CAGR	2030 Projection (MW)	2035 Projection (MW)
Hyperscale - AI Ready	39	38%	269	1,348
Hyperscale - Standard	221	18%	597	1,365
Colocation - High Density	16	35%	98	441
Colocation - Standard	309	12%	609	1,074
Enterprise / Edge	65	-2%	58	52
Total Capacity (MW)	650	~20% (Blended)	1,631	4,280

Source: Authors' calculation based on data from Bappenas, Structure Research, IEA, and market growth drivers

Figure 6. The Shifting Composition of Data Center Demand in Indonesia, 2024-2035



Source: Authors' calculation

The projected 4.2 gigawatts (GW) of total capacity, while impressive, does not fully capture the magnitude of the coming transformation. The most critical insight lies in the dramatic shift in the market's composition. In 2024, high-density workloads account for only 37 megawatts (MW), or approximately 9 percent of total capacity. By 2035, this segment is expected to surge to more than 2 gigawatts — representing nearly half of Indonesia's entire data center capacity.

This transformation represents both a profound challenge and an enormous opportunity. The narrative of the coming decade is not merely about expanding the number of data centers but about constructing an entirely new generation of facilities at an unprecedented scale. The infrastructure required to sustain more than 2 GW of high-density, AI-driven workloads — each with specialized demands for power, cooling, and engineering — differs fundamentally from the systems that support today's market. This projected wave of high-density demand renders the current strategy of geographic concentration in Greater Jakarta strategically unsustainable and underscores the urgent need for a new paradigm in Indonesia's data center development — one that this report will explore in the following sections.

CHAPTER 4:

Indonesia’s Digital Readiness

As neighboring countries such as Singapore and Malaysia consolidate their positions as the most competitive data center markets in Southeast Asia, Indonesia faces increasing structural pressure to strengthen its digital readiness. The regional success of Singapore and Malaysia is closely linked to their advanced digital ecosystems, regulatory clarity, and infrastructure preparedness, which together make them more attractive destinations for digital infrastructure and hyperscale investment.

Indonesia, by contrast, remains in the process of developing a clear and comprehensive framework for green data centers. This challenge is not unique to Indonesia; even global leaders in the sector continue to debate how “greenness” should be defined and measured — whether primarily through energy mix, operational efficiency, building standards, or full lifecycle considerations. The absence of a universally accepted definition has complicated policymaking and investment decisions across markets.

In practice, Indonesia has adopted an incremental approach. Currently, a data center may be considered “green” if it meets two criteria embedded in existing national frameworks: compliance with green building certification standards and participation in renewable energy certification schemes, such as RECs or their equivalents. While these instruments enable operators to signal environmental responsibility, they fall short of constituting a dedicated, sector-specific standard for green data centers.

Further complexity arises from the dual nature of data centers as both physical infrastructure and providers of digital services. Beyond environmental performance, data center operators must comply with Indonesia’s evolving data governance regime. Although significant progress has been made — most notably with the enactment of the Personal Data Protection (PDP) Law in 2022 — key elements, including enforcement mechanisms and the establishment of an independent supervisory authority, remain under implementation. Consequently, while Indonesia is advancing toward a more robust digital governance framework, many aspects of compliance for data centers, as both buildings and service platforms, are still being defined.

4.1. Data Governance

Data governance is a critical pillar of a resilient data center ecosystem, as it defines the rules governing how data are stored, accessed, and transferred. In the absence of clear and predictable governance frameworks, investors and operators face regulatory uncertainty, increasing perceived risk and discouraging the large, long-term capital commitments that data center development requires.

Beyond domestic considerations, robust data governance is essential for enabling cross-border data flows. Countries that align their regulatory regimes with widely recognized international standards — such as the European Union’s General Data Protection Regulation (GDPR) or Singapore’s Personal Data Protection Act (PDPA) — are better positioned to function as regional data hubs. Clear and interoperable rules provide businesses with confidence that data handling practices will comply with global requirements, whereas weak or ambiguous governance can isolate markets and constrain growth.

Effective data governance also underpins trust among both domestic users — such as financial institutions, healthcare providers, and government agencies — and international clients. These stakeholders require assurance that their data are protected by enforceable privacy and security standards. Strong governance frameworks not only build this trust but also enhance the credibility and competitiveness of a country’s data centers within the global digital economy.

Table 4. Data Governance Benchmarking Across Indonesia, Malaysia, Singapore and the EU

Indicators	Indonesia	Malaysia	Singapore	EU
Data localization	Critical sectors (healthcare, energy, finance, defense) must be stored locally Private data can be transferred with binding contracts and consent from the owner	Private data can be transferred to whitelisted countries	Private data can be transferred freely	Minimum requirement: Standard Contractual Clauses (SCC). Emphasizes free flow of data but only within EU/EEA
Supervisory authority	Not yet active: Data Protection Authority (DPA) Interim authority: Ministry of Communications and Digital (Komdigi)	Specialized authority for personal data only: Personal Data Protection Department (JPDP)	Personal Data Protection Commission (PDPC)	National: DPA of each member country Regional: European Data Protection Board (EDPB)
Cross border	Formal adequacy: Case-by-case mechanism supposed to be performed by the DPA which is still missing.	No formal adequacy mechanism: Contract based	No formal adequacy mechanism; must be transparent with safeguard mechanisms	Formal adequacy depending on partner country: 1. Gold standard: Formal adequacies that are comparable to the GDPR (Japan, UK, Switzerland) 2. Standard Contractual Clauses (SCC), Binding Corporate Rules (BCR) or Code of Conduct certification mechanism for all countries without
Enforcement strength/detection mechanism	Complaints driven detection	Complaints driven detection	Active PDPC monitoring and discretion: Action will only be taken if "significant harm" is detected	The national DPAs are compelled to perform proactive audits

Source: Internal analysis based on Indonesia's personal data protection (PDP) law, Malaysia's personal data protection act (PDPA) 2010, Singapore's Data Management Framework (DMF) and the EU's General Data Protection Regulation (GDPR)

Against this backdrop, assessing Indonesia's data governance framework in comparison with international peers is essential. Indonesia has made notable progress with the enactment of the Personal Data Protection (PDP) Law in 2022 and related regulations. However, the practical effectiveness of these measures must be evaluated against more mature regimes, particularly the European Union, which is widely regarded as the global benchmark, as well as Singapore and Malaysia, which represent regional leaders in Southeast Asia. Such benchmarking highlights both Indonesia's advancements and the remaining gaps that could be addressed to strengthen investor confidence and regulatory certainty.

While Indonesia's data governance framework reflects a strong emphasis on data sovereignty, it also reveals ongoing tensions between protection and flexibility, especially in terms of innovation. Requirements related to data localization and case-by-case approval for cross-border data transfers create a cautious regulatory environment. Without more streamlined mechanisms and fully independent oversight, these constraints risk limiting international collaboration and dampening Indonesia's attractiveness as a regional data center hub.

Data Localization

Indonesia mandates strict data localization requirements for certain critical sectors, including public services, financial services, and other industries designated as strategically important by the state. This approach is one of the most distinctive features of Indonesia's data governance regime. Unlike the European Union, which permits cross-border data transfers provided that adequate protections or approved safeguards are in place, Indonesia's framework places greater emphasis on keeping sensitive data stored and processed domestically.

While this model offers strong safeguards for data sovereignty and national security, it has also been criticized as overly restrictive, particularly in sectors such as healthcare and medical research, where cross-border data sharing is essential for innovation and collaboration. In contrast, Singapore and Malaysia have adopted more flexible, sector-specific approaches to data localization, allowing international data flows under clearly defined conditions that balance national interests with economic competitiveness and technological innovation.

Institutional Authority

Indonesia has yet to establish a fully operational Data Protection Authority (DPA). Although the Personal Data Protection (PDP) Law mandates the creation of such an authority, it is placed under the direct authority of the President, which limits its institutional independence when compared with the European Union's national supervisory authorities or Singapore's Personal Data Protection Commission (PDPC). This institutional arrangement has raised concerns regarding the DPA's capacity to function as an impartial and autonomous regulator, particularly in cases involving politically sensitive data or disputes between state and private actors.

Cross Border Data Transfers

Cross-border data transfers from Indonesia are governed by a case-by-case approval mechanism, making the country's regime among the more restrictive in Southeast Asia. While this approach allows for close government oversight and strong control over sensitive data flows, it also risks creating administrative bottlenecks as the volume of transfer requests increases.

By comparison, the European Union's GDPR applies similarly high standards for personal data protection but relies on predefined adequacy decisions and standardized safeguards, such as contractual clauses, to provide businesses with predictable and scalable compliance pathways. Singapore and Malaysia have adopted comparable rules-based approaches, streamlining cross-border data transfers while maintaining robust protections. These frameworks reduce regulatory burden and uncertainty without compromising data security, offering a model that balances oversight with efficiency.

Enforcement and Compliance

At present, enforcement of Indonesia's data protection regime is largely complaints-driven, with no systematic or proactive auditing mechanism in place. Combined with the absence of a fully independent Data Protection Authority (DPA), this represents a key weakness in the overall governance framework. By contrast, supervisory authorities in the European Union possess extensive investigative and enforcement powers, including the authority to conduct audits and impose substantial sanctions. Singapore's PDPC similarly undertakes active compliance monitoring and can levy significant financial penalties. Malaysia, while less robust than these regimes, also operates through a functioning authority with established oversight and enforcement mechanisms.

4.2. Cybersecurity Regulations

Indonesia's cybersecurity framework aligns with internationally recognized technical standards in areas such as encryption, authentication, and intrusion detection, establishing a baseline level of compliance with global practices. This alignment is particularly important for interoperability and for protecting digital infrastructure, especially in sectors designated as critical information infrastructure (CII).

However, Indonesia's regulatory approach remains relatively narrow and reactive. Cybersecurity audits are limited in scope and frequency, reflecting the absence of a dedicated Data Protection Authority (DPA) or a comprehensive mechanism for proactive oversight. By contrast, jurisdictions such as the European Union and

Singapore empower their DPAs or specialized cybersecurity agencies to conduct regular audits and compliance reviews, thereby strengthening systemic resilience against evolving cyber threats.

The lack of a DPA also creates a gap in incident management. In more mature regulatory frameworks, a central authority establishes standardized breach reporting requirements, mandates clear disclosure timelines, and oversees remediation and follow-up actions. In Indonesia, the absence of such an authority has resulted in fragmented practices and regulatory uncertainty, leaving organizations with limited guidance on how to manage cybersecurity incidents in a consistent and legally compliant manner.

Overall, Indonesia's cybersecurity regulations remain heavily focused on CII sectors, while broader data-driven industries are subject to fewer mandatory obligations and, consequently, weaker safeguards. Although adherence to global technical standards provides a solid foundation, the absence of proactive auditing mechanisms and an empowered supervisory authority continues to constrain the maturity of Indonesia's cybersecurity ecosystem relative to benchmarks such as the EU and Singapore.

Table 5. Cybersecurity Benchmarking Across Indonesia, Malaysia, Singapore and the EU

Indicators	Indonesia	Malaysia	Singapore	EU
Encryption	Strong encryption expected for regulated sectors, assisted and supervised by the cybersecurity authority (BSSN).	Global sectoral rules, such as the ISO 270001. Banks must follow the central bank's (BNM) Risk Management for information Technology (RMiT) regulation.	CSA/PDPC baseline. Critical information infrastructure (CII) and personal data require certified managers.	"State-of-the-art" encryption mandate. The GDPR recommends periodic review and updates to the most modern encryption mechanism.
Authentication	Refer to BSSN baseline for CII, with higher mandatory standards for finance and telecom.	Multifactor authentication (MFA) required in the RMiT	MFA baseline for CII; Authorities (PDPC/CSA) are provided access controls.	GDPR recommends the use of MFA and provides a guideline for authentication protocols.
Intrusion detection protocol	Mandatory incident reporting and some BSSN monitoring for CII.	General national guideline aligned with ISO/IEC 27001; Direct monitoring for regulated sectors	Continuous monitoring for CII, standardized incident response guideline published by the Cyber Security Agency (CSA)	The EU periodically updates their cybersecurity directive (NIS2, the Network and Information Security Directive 2), which covers all sectors.
Audit frequency	Regulatory framework for a data protection authority (DPA) is available but not yet implemented. Audits are conducted based on reports.	Annual audits for banks/telecom sector. The rest are audited based on reports.	The PDPC have discretion to conduct audits. CII are subject to audits by Commissioners/sector regulators.	DPAs of member states are advised to perform proactive audits

Source: Internal analysis based on Indonesia's BSSN standards, Malaysia's PDPA 2010, Singapore's PDPA 2012 and the EU's GDPR

4.3. Green Data Center Readiness

Green data center readiness refers to the extent to which a country's policy environment enables the development and operation of data centers that are demonstrably more energy-efficient and lower-carbon than conventional facilities. In this study, readiness is defined not only by technical capability, but more by the presence of coherent and supportive policies that make green data center development commercially viable.

In practical terms, green data center readiness is reflected in three key policy dimensions. First, incentive-based policies that make green data centers more attractive than conventional alternatives, such as preferential permitting, priority grid access, or capacity allocations. Second, regulatory clarity through well-defined sustainability standards and environmental assessment frameworks that simplify compliance. Third, value-adding mechanisms that link green data centers to broader policy instruments, including carbon markets, renewable energy certificates, and green finance schemes.

In Indonesia, green data center readiness remains at a relatively early stage compared with the European Union and regional peers such as Singapore and Malaysia. While several foundational elements are in place—including Greenship building certifications, PLN’s REC scheme, and a nascent carbon market—these instruments are still evolving and lack strong integration into a dedicated green data center framework. By contrast, the EU and Singapore offer clearer compliance pathways and more seamless integration with carbon markets and sustainable finance mechanisms.

Table 6. Green Data Center Benchmarking Across Indonesia, Malaysia, Singapore and the EU

Indicators	Indonesia	Malaysia	Singapore	EU
Environmental impact compliance	Entirely domestic environmental impact assessments (EIA). Local framework (AMDAL) applied in all cases with additional monitoring framework (UKL-UPL) for larger scale projects.	General environmental impact assessments (EIAs) in key hubs (e.g., Johor). Smaller sites are managed entirely by the department of environment (DOE)	Case-by-case EIA and integrated with overall city planning- driven by necessity due to Singapore's limited land mass.	Member-states are responsible for their own EIAs, large projects stronger links to energy planning. Multilateral projects are subject to the 2014 EU EIA Directive.
Sustainability compliance	Voluntary: Greenship DC; PLN RECs available (does not change physical mix).	GreenRE/GBI; GITA/GITE support; emerging sustainability guidance for data centers (DC)	BCA Green Mark for DC often required for capacity allocation.	EU code of conduct for DC under the energy efficiency directive (EED); EU sustainability rating system available.
Integration with national goals	DC development is aligned with NDC/RUEN, but not directly; Renewable targets are based on green DC growth projections.	NETR targets for DC; Net energy market (NEM) and 3rd-party PPAs available for DC	Green DC Roadmap; capacity linked to carbon/efficiency metrics.	Fit for 55/REPowerEU; national energy & climate plans directly address DC development
Carbon Credits	Certificates for emission reduction (PSE-GRK) have been developed, but their use is still limited due to being relatively new.	Follows the Verra framework for verifying carbon credits standard (VCS). The local Malaysian Burse (BCX) facilitates their trading.	Primarily uses the Tax and International Carbon Credits (ICCs) framework. Companies may use eligible ICCs to offset part of their tax liability under the Carbon Pricing Act.	EU emissions trading system (ETS). Proven carbon offset can be converted intu EU Allowances (EUA) and traded on the carbon market.

Source: Internal analysis based on Indonesia’s AMDAL and UKL-UPL framework, Malaysia’s GreenRE/GBI, Singapore’s Green DC Roadmap and the EU’s EED

Malaysia, although it does not yet directly link green data centers to a national carbon market, adds value through stronger spatial and industrial integration. Initiatives such as green industrial zones in Johor, where data centers are co-located with renewable energy projects and supported by targeted investment incentives, illustrate a more coordinated approach to green data center development.

The primary gap in Indonesia lies in the absence of comparable value-added incentives for green data centers, which currently makes conventional facilities more attractive from an investment perspective. As a result, despite Indonesia's strong underlying demand for data center services, hyperscale investment in green data centers has tended to favor neighboring markets — particularly Singapore and Malaysia — where policy environments are more conducive to sustainable data center development.

4.3.1. Environmental Impact Compliance

Indonesia's framework for environmental impact compliance is anchored in the long-established Environmental Impact Analysis (AMDAL), which has been in place since the early 1980s and remains the primary instrument for assessing environmental impacts of large-scale projects. Although AMDAL was not originally designed with data centers in mind, it has been applied to these facilities in practice. Smaller data centers are subject to the lighter Environmental Management and Monitoring Plan (UKL–UPL), ensuring that facilities of all scales fall within the scope of environmental oversight.

Building on this foundation, Indonesia has gradually introduced complementary instruments to demonstrate sustainability in data center development. The Greenship certification, introduced by the Green Building Council Indonesia in 2010, adapts global green building principles to the local context and provides voluntary recognition for energy-efficient and environmentally responsible design. More recently, PLN's REC scheme, launched in 2020, allows data center operators to substantiate claims of renewable energy use. Collectively, these instruments reflect Indonesia's incremental effort to adapt general environmental and energy frameworks to the growing demands of digital infrastructure.

A significant regulatory development occurred in 2025, when the Ministry of Energy and Mineral Resources (ESDM) issued Ministerial Regulation (Permen) No. 8/2025, formally aligning energy management and environmental standards for data centers with ISO 50001 (Energy Management Systems) and ISO 14001 (Environmental Management Systems). This represents a shift from reliance on primarily domestic standards toward internationally recognized benchmarks, with the potential to harmonize Indonesia's previously fragmented approach to data center sustainability. However, enforcement mechanisms and compliance procedures under the regulation remain under development, meaning that while the regulatory direction is now clear, implementation capacity is still evolving.

By comparison, leading green data center markets such as the EU and Singapore established sector-specific environmental frameworks earlier, reinforcing their competitiveness. In the EU, environmental compliance for data centers is supported by binding instruments such as the Energy Efficiency Directive, sustainability reporting requirements, and the widely adopted Code of Conduct for Data Centers, which together provide clear and harmonized benchmarks across member states. Singapore, meanwhile, has implemented a data center–specific environmental compliance regime, including standards such as Green Mark for Data Centers and technical specifications under SS 715, complemented by public grants to reduce compliance costs.

Malaysia's approach remains closer to Indonesia's in that it relies on broader green building and green technology frameworks, including GreenRE and the Green Building Index (GBI). However, Malaysia mitigates compliance gaps by pairing these frameworks with stronger fiscal incentives, such as the Green Investment Tax Allowance (GITA) and Green Investment Tax Exemption (GITE), which lower upfront costs and significantly enhance the financial viability of green data center investments.

4.3.2. Sustainability Compliance

In terms of sustainability compliance, the EU and Singapore offer the clearest and most predictable pathways for data center operators. In the EU, alignment with the Fit for 55 package and EU Taxonomy criteria facilitates access to green financing, reduces regulatory uncertainty, and strengthens eligibility for sustainable investment frameworks. Singapore similarly embeds sustainability into market access: under its Green Data Centre Roadmap, the allocation of scarce new data center capacity is explicitly conditioned on operators meeting stringent energy-efficiency and sustainability benchmarks, ensuring that greener facilities are prioritized over conventional developments.

Malaysia adopts a different but effective approach by leveraging fiscal incentives such as the Green Investment Tax Allowance (GITA) and the Green Investment Tax Exemption (GITE). These instruments tie financial benefits to sustainability performance, lowering operating costs and making compliance economically attractive for investors. While Malaysia's framework is less prescriptive than Singapore's, it compensates through strong financial inducements that materially improve project viability.

By comparison, Indonesia relies largely on cross-sector green incentives rather than data center–specific sustainability policies. As a result, green data centers do not enjoy a clear regulatory or commercial advantage over conventional facilities. A frequently cited constraint by market participants is the limited access to direct renewable power purchase agreements (PPAs), which restricts operators' ability to secure long-term clean energy supply and weakens the business case for green data center investments.

4.3.3. Integration with National Goals

Integration with national development and climate objectives is most explicit in the EU and Singapore. In the EU, data centers are directly embedded in National Energy and Climate Plans (NECPs) and the broader Fit for 55 frameworks, ensuring that the sector contributes to long-term emissions reduction and energy efficiency targets. Singapore adopts a similarly integrated approach, aligning data center development with national digital economy and sustainability strategies, and conditioning land and power allocations on meeting defined green performance thresholds.

Malaysia also demonstrates a strong linkage between data center expansion and national decarbonization objectives through its National Energy Transition Roadmap (NETR). The roadmap explicitly enables corporate renewable energy procurement and positions data centers as part of the country's broader energy transition strategy. Indonesia, by comparison, references green data centers within overarching policy instruments such as its Nationally Determined Contribution (NDC), the National Energy General Plan (RUEN), and the Electricity Supply Business Plan (RUPTL) 2025–2034.

The key distinction lies in policy prioritization. In Indonesia, data center growth is largely incorporated into aggregate energy demand projections and treated as a business-as-usual (BAU) scenario—predominantly reliant on fossil fuel–based generation—rather than as a distinct policy lever for accelerating decarbonization. While this approach establishes baseline capacity expectations, it does not actively steer investment toward green data centers. In contrast, Malaysia's NETR explicitly links data center development to renewable procurement mechanisms and decarbonization targets. As a result, Indonesia's integration with national goals reflects recognition of the sector's strategic importance but lacks the targeted policy instruments needed to systematically advance green data center development.

4.3.4. Carbon Credits and Other Added-Value Mechanisms

The EU remains the global leader in integrating data centers into carbon finance and circular economy mechanisms. Facilities aligned with the EU Taxonomy can access concessional and sustainable financing, while requirements such as waste-heat recovery create additional value streams and improve overall system efficiency. Singapore similarly offers structured value-added mechanisms, including green financing schemes, grants for energy-efficiency upgrades, and well-established REC and PPA frameworks that allow operators to credibly demonstrate renewable energy sourcing.

Malaysia provides comparable opportunities by pairing fiscal incentives with a growing voluntary carbon market through the Bursa Carbon Exchange (BCX), enabling data center operators to monetize sustainability performance and offset emissions. Indonesia, by contrast, remains at an early stage of development. PLN's RECs primarily support emissions disclosure rather than materially shifting the electricity mix supplied to data centers, limiting their impact on actual emissions reductions. While Indonesia's emerging carbon trading platform (SPE/IDXCarbon) shows promise, it has yet to gain sufficient depth or establish clear linkages with the data center sector.

As a result, added-value mechanisms—such as structured green financing, tradable carbon instruments, and monetizable efficiency gains—remain less predictable and less accessible in Indonesia than in competing jurisdictions, reducing the overall attractiveness of green data center investments despite strong underlying demand.

4.3.5. Availability of Digital Talent

Despite being a country with relatively high digital inclusion, with Indonesia's digital penetration rate reaching around 80.5 percent in a country with a population of 230 million spread across several islands,[24] the availability of deployable digital talent in Indonesia is rather constrained. This constraint is not driven by a lack of interest or participation in the digital economy, but by structural weaknesses in how digital skills are formed and retained.

The first structural issue is that a large portion of Indonesia's digital workforce is self-taught. While this has enabled rapid participation in the digital economy and supported the growth of consumer-facing platforms, it has also resulted in uneven skill depth and limited exposure to enterprise-grade systems. Self-directed learning often emphasizes application-layer development over foundational competencies such as system architecture, cybersecurity, cloud operations, and large-scale integration. As a result, many digital workers are productive in narrow roles, such as API or application development, but they may struggle with moving outside of that specific digital field.

A second issue is the thin middle layer of experienced talent. Entry-level developers, around three or less years of experience, are relatively abundant, and top-tier engineers do exist, but the Indonesian market is narrow for mid-career professionals with five to ten years of experience who can bridge strategic objectives and day-to-day execution. This creates bottlenecks in team structure, forcing firms to concentrate responsibility in a small number of senior individuals or rely on external vendors. For investors, this translates into slower scalability as digital operations grow in complexity or regional scope.

Talent retention further compounds these challenges. Indonesia faces persistent difficulty retaining its most capable digital professionals, particularly at the mid-career level. Engineers and technical managers with regional experience are actively recruited by firms in neighboring markets, and increasingly by foreign companies through remote work arrangements. These opportunities often offer higher effective compensation, clearer career progression, and exposure to regional or global mandates that are still relatively limited within Indonesia's domestic digital ecosystem. Over time, this weakens institutional knowledge accumulation and raises turnover risk for local operations.

4.4. Ease of Investment

Ease of investment captures how conducive the overall regulatory and market environment is for capital deployment into new data center projects. In this context, the focus is less on sector-specific sustainability requirements and more on the broader framework that determines how smoothly investors can establish and operate facilities. This includes the predictability of permitting processes, the clarity of investment incentives, the openness of foreign investment regimes, and the reliability of utilities and infrastructure. A country with high ease of investment provides not just tax or fiscal incentives, but also a stable and transparent environment that reduces project risks and timelines.

Indonesia has begun to build a foundation for attracting green data center investment by offering general tax incentives for green procurement and environmentally friendly projects. These incentives apply broadly, so green data centers are eligible, but they are not specifically tailored to the sector in the way seen in countries like Malaysia with their green investment tax incentive (GITA/GITE) framework. This general approach means that while investors can capture fiscal benefits, many of these benefits still apply for conventional data centers who only partially adopt green operational standards.

4.4.1. Digital Ecosystem

Despite its massive domestic market, the maturity of digital ecosystem in Indonesia is still insufficient to drive the demand for data center in Indonesia. Data center hubs tend to serve large geographic markets, which means that once an ecosystem is established in. However, the size should also be accompanied with the maturity of digital ecosystem to drive the demand of data center and attract the global player investing in green data center. In term of the competitive landscape, country such as Singapore or Malaysia, can dominate demand for the entire region due to the maturity of the digital industry, allowing room for innovation. Meanwhile, the advancement of the digital industry–including AI technology–is challenged by many barriers in Indonesia. The inadequate supportive policy and restrictive policy for data governance pose violation risk for the developer in Indonesia to train model. This barrier toward innovation in technology develop risks being sidelined if it cannot match the policy support, efficiency and reliability offered by neighboring hubs.

Connectivity and latency further complicate Indonesia's position. While Jakarta and Batam benefit from strong connectivity due to multiple subsea cables and internet exchanges, much of the country remains limited by moderate latency and weaker interconnectivity. This is critical, because data centers cannot deliver their full performance potential if latency issues persist, making Indonesia less competitive as a regional hub.

Table 7. Ease of Investment Indicators Comparing Indonesia, Malaysia, Singapore and the EU

Indicators	Indonesia	Malaysia	Singapore	EU
Tax Incentives	General green tax incentives only (corporate tax and buildings). No specialized tax incentive for green data centers	Existing companies constructing or converting to green data centers qualify for Green Investment Tax Allowance (GITA) and Green Income Tax Exemption (GITE)	Specialized tax deductions: Green data centers qualify as "Investment Allowance for energy-efficient equipment" under the Green Investment Program	Discretion of member states: Generally, obtains tax credits or accelerated depreciation calculations
Non-tax incentives	Generalized accelerated permits and customs exemptions for equipment classified as "energy-efficient" and some other equipment related to data centers (cooling systems, smart sensors, etc.)	Loans for renewable/efficient projects through the Green Technology Financing Scheme (GTFS)	Access to Green Mark certification support, grants (e.g., Energy Efficiency Fund, Resource Efficiency Grant)	Various Grants under the EU Green Deals for green data centers
Latency and connectivity	Good: Jakarta/Batam area, where subsea cable landing stations and data center clusters are concentrated Moderate: The rest of Indonesia	Strong: Due to proximity to Singapore, good subsea access around Johor/KL hubs;	Excellent all around: Singapore is the global subsea hub with dense interconnectivity; lowest regional latency.	Excellent: Amsterdam, Frankfurt and London are global hubs; dense peering around west Europe Good: From the Mediterranean border to East Europe
Access to energy	Moderate: Centralized PLN grid, but capacity varies by site; PLN provides REC and pseudo-PPA are possible with PLN involvement.	Strong: High grid capacity and multiple renewable options (NEM, 3rd-party PPAs, captive solar)	Good: Limited grid capacity, but policy supports via green imports and cross-border PPAs.	Excellent: Strong grids across the regions, widespread renewable PPAs, and progressive obligations like waste-heat reuse.

Source: Based on internal analysis of Indonesia's green tax incentives, Malaysia's GreenRE/GBI and GTFS, Singapore's Green Mark BCA initiative and the EU's Green Deal

4.4.2. Regulatory Fragmentation

Another key factor affecting ease of investment is regulatory fragmentation, particularly the way data center–related oversight is distributed across multiple institutions. In Indonesia, data centers are not governed under a single, unified regulatory framework, but instead fall under the overlapping authority of several ministries and agencies, including the Ministry of Industry, the Ministry of Communication and Digital Affairs, the Investment Coordinating Board (BKPM). Each institution approaches data centers from a different policy lens—

industrial facilities, digital service providers, or critical infrastructure—resulting in parallel compliance obligations that are not always well synchronized

Beyond the Ministry of Industry and the Ministry of Communication and Digital Affairs, data center investors in Indonesia must also contend with several other ministries whose mandates intersect with different aspects of data center development. The Ministry of Energy and Mineral Resources is involved due to data centers' heavy reliance on electricity and energy sourcing, particularly for power supply arrangements and renewable energy access. The Ministry of Environment and Forestry plays a role because data centers are subject to environmental permitting and impact assessments, while the Ministry of Public Works and Housing is relevant as data centers remain regulated as physical buildings subject to construction and green building standards.

In addition, the Ministry of Agrarian Affairs and Spatial Planning oversees land use and zoning compliance, which directly affects site selection and project feasibility. The Ministry of Investment (BKPM) acts as the primary entry point for foreign investment but does not replace sectoral approvals from line ministries. For facilities handling sensitive or strategic data, the National Cyber and Crypto Agency becomes relevant from a cybersecurity and critical infrastructure perspective. Finally, local governments retain authority over certain permits and local approvals, adding another layer of coordination for investors.

In stark contrast, Singapore offers a highly centralized and investor-oriented governance model for data center development. Data centers are clearly recognized as a distinct class of digital infrastructure, with the Economic Development Board (EDB) acting as the primary entry point for investors and coordinating requirements across agencies such as IMDA, URA, BCA, and PDPC. For investors, this translates into a predictable approval pathway, clear accountability, and faster decision-making across licensing, data governance, cybersecurity, and sustainability obligations.

Malaysia has adopted a similarly streamlined approach, with the MIDA serving as the single lead agency for data center investments. MIDA coordinates investment approvals and incentives while working alongside MDEC and other authorities on digital policy, land, energy, and data governance issues. This centralized interface significantly reduces regulatory friction and uncertainty for investors, offering a more coherent and time-efficient process than Indonesia's fragmented institutional landscape and reinforcing Malaysia's appeal as a regional hub for hyperscale and green data centers.

4.4.3. Digital Talent

Another issue is the availability and scalability of digital talent, which compounds the regulatory challenges faced by investors. Even where permitting and licensing hurdles can be navigated, the ability to staff, operate, and scale data center and digital infrastructure investments in Indonesia remains constrained by structural weaknesses in the digital labor market. This reflects structural gaps in skill depth rather than a lack of participation in the digital economy.

As digital investments scale, these constraints become more pronounced. The limited availability of mid-career professionals with experience operating complex or mission-critical systems increases reliance on a small number of key individuals, raising execution and continuity risks. Talent retention further amplifies this challenge, as experienced digital professionals are actively recruited by firms in neighboring regional hubs, making it more difficult for investors to sustain and expand operations at speed within Indonesia.

Ultimately, strengthening digital readiness is not merely a regulatory exercise but a strategic prerequisite for Indonesia to compete effectively for data center investment in an increasingly crowded regional market. To attract hyperscalers and long-term capital, Indonesia must move beyond transitional arrangements and provide a coherent, predictable, and investable digital ecosystem — one that enables data centers to operate efficiently, securely, and sustainably while remaining fully integrated into regional and global digital network.

CHAPTER 5:

Site Selection: A Strategy of Resilience and Sustainability

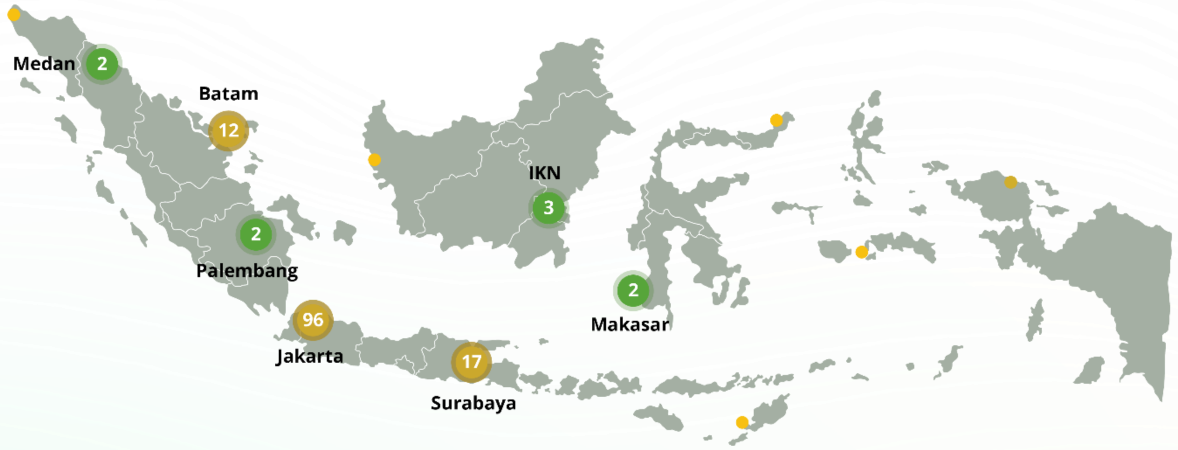
While digital readiness determines whether a country can attract and support data center investment in principle, data centers ultimately remain a form of physical infrastructure, anchored by land, power, and network connectivity. This makes site selection a decisive factor in translating policy intent and market demand into viable projects. This consideration is even more critical for green data centers, which are particularly sensitive to site characteristics. Such facilities are preferentially located in areas with reliable access to renewable energy.

Against this backdrop, the following chapter explores potential sites for new data center development in Indonesia, not only to relieve mounting pressure on established hubs such as Jakarta and Batam, but also to identify locations that could support the next generation of hyperscale investment and green data centers. The analysis considers how geographic factors interact with Indonesia's broader digital readiness constraints, highlighting sites where infrastructure, energy access, and scalability can be aligned to support sustainable data center growth.

5.1. A Strategy of Concentration

A geospatial assessment of Indonesia's operational data center landscape reveals a stark and persistent pattern: the country's critical digital infrastructure is overwhelmingly concentrated within a single, narrowly defined economic corridor. Stretching from Jakarta through the industrial zones of Bekasi and Karawang, the Greater Jakarta region has become the undisputed core of Indonesia's digital backbone. Our analysis indicates that approximately 80 percent of the nation's total data center capacity is located within this corridor. This extreme spatial concentration is the most defining characteristic of Indonesia's current data center ecosystem—and its most significant structural vulnerability—exposing the sector to heightened systemic, operational, and sustainability risks.

Figure 7. Geospatial Map of Data Center Facilities in Indonesia



Source: Datacentermap

This concentration is not accidental but the logical outcome of historical development dynamics. As Indonesia's primary political, financial, and demographic center, Jakarta offered the path of least resistance for early data center development. It provided unmatched proximity to corporate headquarters, the country's deepest pool of skilled digital labor, and—critically—direct, low-latency access to the Indonesia Internet Exchange (IIX), where most domestic internet traffic is exchanged. The adjacent industrial estates of eastern Jakarta further reinforced this trend by offering suitable land availability, established utility infrastructure, and relatively reliable power supply for larger, purpose-built facilities.

However, what began as a pragmatic and efficient strategy has now hardened into a state of hyper-concentration. The current configuration represents not a healthy cluster, but an excessive dependence on a single geographic area to host the digital assets of an archipelagic nation of more than 280 million people. In practice, Indonesia's data center architecture resembles a dominant central hub with only a limited number of underdeveloped regional nodes. This structural imbalance runs counter to the core principles of resilience, redundancy, and geographic diversification that underpin modern, robust digital infrastructure systems.

As a result, the risks inherent to the Greater Jakarta region — whether geological, climatic, or infrastructural — are no longer confined to individual facilities. Instead, they translate directly into systemic risks to the continuity and reliability of Indonesia's digital economy as a whole. The sections that follow examine these vulnerabilities in greater detail, demonstrating why the legacy model of extreme geographic concentration is increasingly misaligned with Indonesia's long-term digital, energy, and sustainability objectives.

5.2. Incumbent Hubs: Jakarta (The Core) and Batam (The Gateway)

Within Indonesia's highly concentrated data center landscape, two incumbent hubs dominate market activity, each serving a distinct strategic function: Greater Jakarta as the domestic core, and Batam as the country's primary international gateway. Understanding the differentiated roles of these locations is essential to assessing both the current strengths of Indonesia's data center ecosystem and the systemic vulnerabilities embedded within it.

5.2.1. Greater Jakarta: The Domestic Core

The Greater Jakarta corridor is, and is likely to remain for the foreseeable future, the primary hub for data center development in Indonesia. Its dominance is underpinned by a powerful and self-reinforcing ecosystem. As the nation's political, financial, and commercial center, Jakarta hosts the highest concentration of end users and enterprise demand, creating a strong gravitational pull for latency-sensitive digital services. It functions as the heart of Indonesia's digital circulatory system, anchored by the Indonesia Internet Exchange (IIX), where the majority of domestic internet traffic is exchanged.

For content providers, financial institutions, and e-commerce platforms focused on the Indonesian market, a presence in Jakarta is effectively non-negotiable to ensure optimal response times and service reliability. This demand has driven the development of large, carrier-neutral colocation campuses in industrial zones east of Jakarta, including Cibitung, Cikarang, and Karawang. These campuses have evolved into major interconnection hubs, where cloud service providers, network operators, and enterprise customers co-locate, reinforcing powerful network effects that further entrench Jakarta's dominance.

This dense connectivity and mature ecosystem constitute Jakarta's greatest strengths. However, as explored in the subsequent risk analysis, the same concentration of critical digital infrastructure in a geologically and climatically vulnerable area also represents its most significant liability.

5.2.2. Batam: The International Gateway

Located just across the Singapore Strait, Batam has developed a distinct and strategically important role as Indonesia's primary international data center gateway. Its value is derived largely from its proximity to Singapore, the leading digital and connectivity hub in Southeast Asia. Batam serves as a key landing point for multiple international subsea cables, offering the lowest-latency connection between Indonesia and global networks routed through Singapore's telecommunications infrastructure.

This positioning makes Batam particularly attractive for enterprises prioritizing international connectivity over domestic market proximity. It has become an integral component of the increasingly interconnected Singapore–Johor–Batam (SJB) data center corridor, capturing spillover demand from Singapore as land and power constraints tighten there. Batam's designation as a Free Trade Zone (FTZ) further enhances its appeal by offering tax and regulatory advantages tailored to international investors.

In line with Batam's gateway function, the Indonesian government has established Nongsa Digital Park as a dedicated digital special economic zone. Covering approximately 42 hectares, the zone is supported by a package of fiscal and non-fiscal incentives designed to attract foreign investment, including tax holidays of up to 10 years for investments exceeding Rp100 billion, tax allowances for smaller investments, exemptions from import duties, streamlined permitting, and extended "golden visa" facilities. Through these measures, the government aims to attract up to Rp40 trillion in investment by 2032. As of 2024, nine data centers have been developed in Batam, including facilities operated by major international players such as DayOne (formerly GDS Digital) from China.[25] [26] [27]

While Batam offers a lower exposure to certain natural disaster risks compared to Greater Jakarta, it shares similar climatic constraints, including a hot and humid lowland environment that limits cooling efficiency. Moreover, Batam functions less as a standalone national hub and more as a near-shore extension of the Singaporean data center market, serving a fundamentally different role from Jakarta's domestically oriented core.

Together, Jakarta and Batam define the current architecture of Indonesia's data center market. Jakarta provides depth, scale, and domestic reach; Batam delivers international connectivity and strategic access to global networks. Yet both hubs are concentrated in the western part of the archipelago, and their collective dominance underpins the systemic risks examined in the following sections—highlighting the growing need for geographic diversification and a more resilient national data center strategy.

5.3. Structural Vulnerabilities of the Concentrated Model

The dominance of the Greater Jakarta and Batam hubs, while historically rational, has embedded a series of deep and systemic vulnerabilities into Indonesia's digital infrastructure. These vulnerabilities are not marginal operational issues, but fundamental, geographically rooted risks that undermine the resilience, sustainability, and inclusiveness of the national digital economy. A closer examination of these structural weaknesses highlights the strategic limitations of Indonesia's current hyper-concentrated data center model.

5.3.1. Geological and Climate Risk: The Ring of Fire and Lowland Exposure

The most acute vulnerability of the Greater Jakarta hub lies in its geographic setting. Located on the seismically active island of Java, the region sits squarely within the Pacific Ring of Fire, one of the world's most earthquake-prone zones. The proximity of major fault systems, including the Lembang and Baribis faults, exposes a disproportionate share of Indonesia's digital infrastructure to seismic risk. In parallel, Jakarta's low-lying coastal geography makes it highly susceptible to flooding, extreme weather events, and accelerating land subsidence. A single severe geological or climatic event in this corridor could trigger cascading disruptions, with potentially catastrophic consequences for Indonesia's digital services, financial systems, and public administration.

Beyond the risk of acute shocks, both Jakarta and Batam face chronic climatic inefficiencies. Situated in hot and humid lowland environments, data centers in these locations must rely on energy-intensive mechanical cooling systems operating at high loads throughout the year. This structural reliance results in higher Power Usage Effectiveness (PUE) ratios, elevated water consumption, and larger operational carbon footprints. As computing loads become more energy- and heat-intensive—particularly with the rise of AI—the climatic constraints of these incumbent hubs increasingly undermine their long-term efficiency and sustainability.

5.3.2. Energy and Grid Risk: Carbon Lock-in and Systemic Exposure

A second major vulnerability arises from energy dependence. Concentrating hundreds of megawatts of data center capacity within a single metropolitan region places mounting pressure on the Java–Bali electricity grid. Although this grid is the most developed in Indonesia, it remains heavily reliant on fossil fuels, particularly coal. As a result, new data center capacity in the Greater Jakarta corridor is structurally tied to a carbon-intensive energy mix.

This dependence creates a form of "carbon lock-in" that poses significant strategic risks. For hyperscale operators and global investors—many of whom are bound by strict net-zero and renewable energy commitments—locations that cannot offer credible, scalable access to clean energy are becoming increasingly uncompetitive. As ESG considerations tighten across global capital markets, the inability of incumbent hubs to decouple growth from carbon-intensive power supply threatens Indonesia's ability to attract the next wave of high-value, sustainability-driven investment in digital infrastructure.

5.3.3. Latency and the Digital Divide: Performance Gaps Beyond Java

The hyper-concentrated model also produces pronounced performance disparities across the archipelago, reinforcing a persistent digital divide. Users and enterprises in Greater Jakarta benefit from ultra-low latency and high service reliability, while performance deteriorates markedly for users located in other major population and economic centers such as Sumatra, Kalimantan, Sulawesi, and eastern Indonesia. Data requests originating in cities like Makassar or Medan must travel hundreds or even thousands of kilometers to Jakarta-based facilities, introducing latency that degrades service quality.

This latency gap is more than a technical inconvenience; it is a structural barrier to innovation and regional development. It constrains the deployment of latency-sensitive applications—such as real-time industrial IoT, advanced manufacturing systems, telemedicine, autonomous mobility, and high-frequency financial services—outside Java. By centralizing digital infrastructure, the current model inadvertently disadvantages regions targeted for economic diversification and growth, reinforcing Java-centric development patterns. A truly national digital strategy requires a more distributed data center architecture — one that brings computing capacity closer to end users across the archipelago, enhancing resilience, performance, and inclusive digital development.

5.4. Why the Current Model Unsustainable

The analysis presented in this chapter demonstrates unequivocally that Indonesia's data center landscape — despite its rapid recent expansion — is built on a structurally flawed foundation of hyper-concentration. The long-standing practice of clustering critical digital infrastructure almost exclusively within the Greater Jakarta corridor, while historically pragmatic, is no longer fit for purpose. It reflects a legacy phase of digital development and is fundamentally misaligned with the contemporary requirements of resilience, sustainability, and spatial equity needed to support the gigawatt-scale, AI-driven capacity projected for Indonesia in the coming decades.

This concentration strategy has produced a dangerous trilemma of interrelated vulnerabilities. First, it undermines physical resilience by situating the nation's digital backbone in an area exposed to high seismic risk and chronic climatic inefficiency, resulting in elevated operational costs and heightened exposure to systemic failure. Second, it constrains sustainable growth by tethering expansion to a carbon-intensive power grid, weakening Indonesia's competitiveness in attracting ESG-driven hyperscale investors and global technology firms. Third, it entrenches spatial inequality by perpetuating a digital divide, imposing higher latency and reduced service quality on users and enterprises outside Java, and thereby suppressing the development of regional digital ecosystems.

The strategic imperative is therefore both clear and urgent. Persisting with the existing model is not merely suboptimal; it is inherently unsustainable, compounding risk with each additional megawatt deployed within the same overburdened corridor. Securing Indonesia's digital future requires a decisive break from this legacy paradigm and a transition toward a more balanced and resilient architecture based on intelligent geographic diversification.

Accordingly, the next section shifts from diagnosis to prescription. This study introduces a new multi-criteria framework — the Four Pillars of Green Data Center Site Selection — designed to identify and prioritize locations capable of mitigating these structural vulnerabilities and enabling a more resilient, sustainable, and inclusive digital future for the Indonesian archipelago.

5.5. The Four Pillars of Green Data Center Site Selection

The assessment of Indonesia's existing data center landscape underscores the urgent need to move beyond the legacy paradigm of geographic concentration. Addressing the structural vulnerabilities identified in the preceding section requires a fundamental shift — from a site selection strategy driven by short-term convenience to one grounded in long-term resilience and sustainability. As data centers are capital-intensive assets with operational lifespans measured in decades, their geographic location irreversibly shapes performance outcomes, cost structures, environmental footprints, and exposure to systemic risks over time. A rigorous, forward-looking site selection framework is therefore the single most critical enabler of next-generation digital infrastructure development.

This section introduces such a framework, structured around four interdependent pillars: Energy, Environment, Infrastructure, and Socioeconomics. Together, these pillars provide a holistic basis for evaluating prospective locations, balancing technical feasibility with sustainability, resilience, and inclusive economic impact. Each pillar is operationalized through a set of measurable criteria designed to capture both current conditions and long-term strategic advantages.

The Four Pillars framework serves not only as a conceptual guide but also as the analytical foundation for the quantitative scoring model presented in the following section, which systematically evaluates and ranks candidate locations based on their ability to support resilient, low-carbon, and future-ready data center development.

5.5.1. Pillar 1: Energy – Abundant, Reliable, and Renewable Supply

Energy is the lifeblood of any data center and consistently represents the largest component of operational expenditure (OPEX), frequently accounting for more than 50 percent of total lifecycle costs. For a green data center, not only the price but also the source, stability, and carbon intensity of electricity are decisive determinants of long-term financial and sustainability performance:

- Proximity to High-Capacity Renewable Sources

  The primary objective of site selection is to secure access to clean, reliable, and competitively priced power. While solar and wind generation play an important role in diversified renewable portfolios, the continuous, 24/7 operational profile of data centers requires access to stable baseload energy. In the Indonesian context, this makes regions endowed with substantial geothermal and hydroelectric resources particularly attractive.[28] Proximity to large-scale renewable generation reduces transmission losses and, critically, enables the structuring of direct PPAs**.** Such long-term contracts allow operators to lock in predictable electricity prices, mitigate exposure to fossil-fuel price volatility, and meet the stringent renewable energy procurement requirements of global hyperscale tenants.[29]

- Grid Stability and Power Quality

  Grid reliability is non-negotiable for achieving the industry standard of “five nines” (99.999 percent) uptime. Site assessment must therefore incorporate a rigorous evaluation of the local and regional grid, including historical performance indicators such as the System Average Interruption Duration Index (SAIDI) and System Average Interruption Frequency Index (SAIFI) published by the national utility, PLN. Locations served by modern, well-maintained grids with redundant substations and transmission lines materially reduce outage risk and lessen dependence on costly and carbon-intensive backup generation.

5.5.2. Pillar 2: Environment – Climate, Risk, and Sustainability

This pillar emphasizes alignment with the local environment: leveraging natural conditions to enhance efficiency while minimizing exposure to long-term physical risks.

- Favorable Climate for Cooling

  Cooling systems are the second-largest source of energy consumption in data centers after the IT load, often accounting for 30–40 percent of total electricity use.[30] Climatic conditions therefore have a direct and material impact on OPEX. Highland regions with lower average temperatures and reduced humidity offer significant advantages by enabling extended use of free-air cooling or more efficient chilled-water systems. These conditions improve Power Usage Effectiveness (PUE) — the industry’s benchmark for energy efficiency—delivering sustained cost savings over the facility’s lifespan.[31]

- Low Natural Disaster Risk

  Long-term operational resilience requires siting facilities in geologically and environmentally stable zones. A comprehensive hazard assessment, drawing on data from institutions such as the National Agency for Disaster Countermeasure (BNPB) and the Meteorology, Climatology, and Geophysics Agency (BMKG), is essential. This assessment should evaluate seismic exposure, proximity to active faults and volcanoes, and susceptibility to secondary risks such as flooding, liquefaction, and tsunamis based on historical records and hazard mapping.[32]

- Sustainable Resource Management

  Environmental sustainability extends beyond electricity consumption to encompass water and waste management. For facilities employing water-based cooling systems, access to a reliable and sustainable water source—without competing with local community needs—is critical and should be measured using Water Usage Effectiveness (WUE) metrics.[33] In addition, responsible site selection considers the availability of regional infrastructure for waste handling, particularly the safe recycling of electronic waste (e-waste) generated during regular hardware refresh cycles.

5.5.3. Pillar 3: Infrastructure – Digital and Physical Connectivity

A data center's strategic value is ultimately defined by its ability to connect users, enterprises, and platforms reliably and with minimal latency.

- Digital Connectivity

  Prospective sites must be embedded within a dense and diverse fiber-optic ecosystem. Carrier neutrality — the presence of multiple competing network operators—is a core requirement, ensuring redundancy against network failures while fostering competitive pricing for bandwidth.[34] Locations must offer low-latency connectivity to major domestic peering points such as the Indonesia Internet Exchange (IIX) and, where strategically relevant, direct access to international subsea cable landing stations to support regional and global traffic flows.

- Physical Connectivity

  Beyond digital infrastructure, data centers are large-scale industrial facilities that depend on robust physical access. Reliable highways and reasonable proximity to airports and seaports are essential for the transport of heavy equipment during construction and for ongoing operations, including hardware replacement, maintenance, and staffing mobility.

5.5.4. Pillar 4: Socioeconomic Landscape

The final pillar addresses the institutional and social conditions that shape investment feasibility and long-term operational viability.

- Government Support and Favorable Zoning

  Active support from national and local authorities can materially reduce regulatory risk and development timelines. This includes transparent and predictable permitting processes and spatial planning frameworks (RTRW) that explicitly designate areas for industrial or high-technology use. Locations within Special Economic Zones (KEK) often provide additional advantages, including fiscal incentives, streamlined customs procedures, and simplified administrative requirements, strengthening overall project economics.[35]

- Economic Factors and Scalability

  Land availability and affordability directly influence upfront CAPEX. Equally important is the capacity for future expansion. Hyperscale data center development typically follows a phased, campus-based model, making the availability of adjacent land for subsequent buildouts a critical site selection criterion.

- Human Resources and Security

  Sustained operations require access to skilled human resources, including engineers, IT specialists, and security personnel. Site evaluation must therefore consider the depth of the local labor market or the location's attractiveness for talent relocation. In parallel, a stable social environment and low security risk are indispensable for safeguarding high-value, mission-critical assets.

5.6. Analysis on Potential Locations

This section applies the multi-criteria framework developed earlier to systematically identify and evaluate the most promising regions for green data center development in Indonesia. Building on the diagnosis of structural vulnerabilities in the current market, the analysis now shifts toward a data-driven prescription for future investment. It begins by outlining the strategic opportunity created by existing spatial and structural imbalances, followed by a detailed assessment of high-potential candidate locations—both incumbent hubs and greenfield alternatives. Each location is then evaluated through a quantitative site-scoring matrix, yielding an objective, evidence-based set of investment priorities and recommendations.

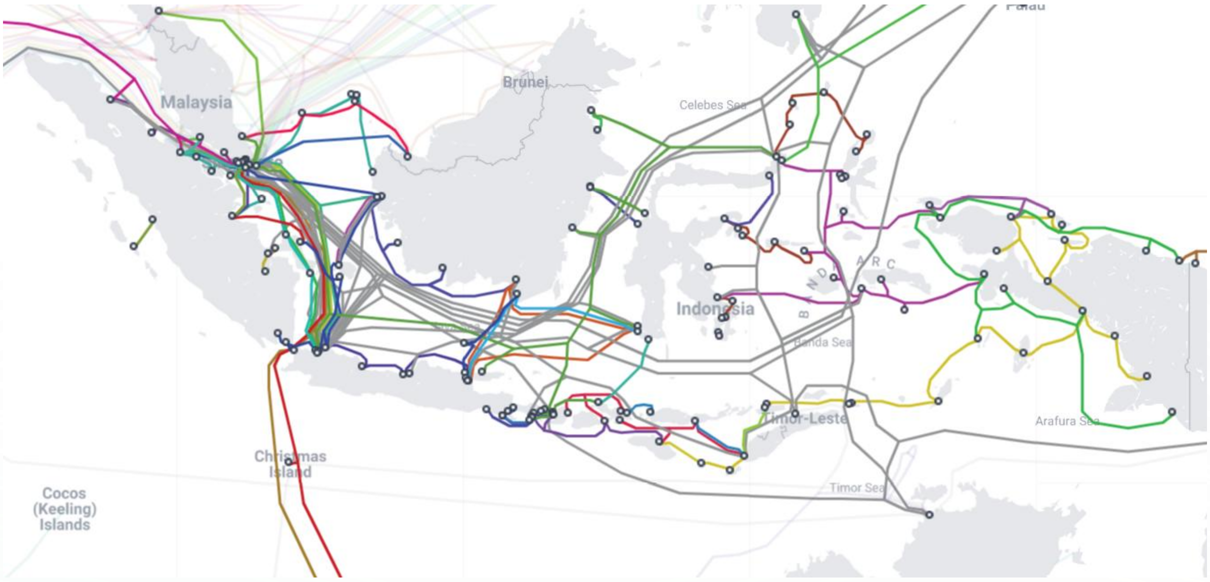
5.6.1. The Strategic Opportunity Gap: Aligning Supply with Demand

A strategic assessment of Indonesia reveals a pronounced geographic mismatch between the current distribution of data center capacity and the future drivers of digital demand and sustainable energy supply. As discussed in the previous section of this chapter, the vast majority of existing capacity is concentrated in the Greater Jakarta area, tightly coupled to the carbon-intensive Java–Bali grid and exposed to elevated seismic and climate risks.

In contrast, Indonesia's most abundant and scalable renewable energy resources are located largely outside this core hub. The country's world-class geothermal potential is concentrated along Sumatra's volcanic belt, while major hydroelectric resources are found in North Sumatra and Sulawesi.[36] This spatial disconnect between digital infrastructure and clean energy availability highlights a compelling strategic opportunity: to develop new data center hubs in regions closer to sustainable power sources and emerging demand centers. Bridging this gap would enable a more resilient, cost-efficient, and geographically balanced digital ecosystem—one that aligns future data center growth with Indonesia's long-term energy transition and digital development objectives.

To ensure a comprehensive assessment, this study evaluates five representative locations across the Indonesian archipelago. These include the two dominant incumbent hubs — Jakarta and Batam — alongside three high-potential greenfield sites identified through the application of sustainability, resilience, and strategic relevance criteria. Dense and redundant fiber optic connectivity is a foundational prerequisite for any viable data center location. Figure 8 maps Indonesia's major domestic and international subsea cable networks, providing essential context for assessing the connectivity and strategic positioning of each candidate location.

Figure 8. Indonesia's National and Subsea Fiber Optic Network Map



Source: Submarine Cable Map

1. Jakarta

As the national capital and undisputed economic epicenter, Greater Jakarta remains the default location for data center investment and the primary benchmark against which all alternative sites must be assessed. Its advantages are deeply entrenched, reflecting its central role within Indonesia's digital ecosystem.

As clearly illustrated by the network map, nearly all major domestic terrestrial fiber routes converge in Greater Jakarta, providing unmatched network density and direct, ultra-low-latency access to the Indonesia Internet Exchange (IIX). For latency-sensitive use cases—including financial services, e-commerce, and real-time content delivery—this proximity is effectively non-negotiable, ensuring the fastest possible connectivity to Indonesia's largest concentration of end-users and enterprise headquarters. This digital gravity is reinforced by a parallel physical advantage: the region hosts the country's largest and most mature pool of technical and engineering talent required for advanced data center operations. For the purposes of this analysis, the focus is on established industrial clusters such as MM2100 Industrial Town in Bekasi (–6.3144, 107.0905), which typifies high-density, modern data center deployment in the Jakarta corridor.

However, as demonstrated in the preceding analysis, Jakarta also exemplifies the risks inherent in hyper-concentration. Its structural dominance comes at the cost of significant, interrelated vulnerabilities:

- High geological and climate risk**:** pronounced exposure to seismic activity, flooding, and land subsidence.
- Carbon-intensive energy supply**:** reliance on the fossil-fuel-dominated Java–Bali grid, effectively locking operators into a high-emissions baseline.
- Operational inefficiency**:** persistently hot and humid climatic conditions that elevate cooling demand, increase energy consumption, and result in structurally higher Power Usage Effectiveness (PUE).

Consequently, while Greater Jakarta represents the apex of domestic connectivity and market access, it simultaneously embodies the core sustainability and resilience challenges confronting Indonesia's data center sector. Any alternative location must therefore demonstrate a clear and credible ability to mitigate these drawbacks in order to be considered a strategically superior option.

2. Batam

Batam's strategic value is singular, powerful, and visibly depicted on the network map. It functions as Indonesia's primary international connectivity gateway, a role derived almost entirely from its immediate geographic proximity to Singapore, the digital nexus of Southeast Asia. Batam serves as a critical landing point for a multitude of international subsea cables, offering the lowest-latency path from Indonesia to global networks. This makes it the premier location for enterprises that prioritize international performance over domestic reach, such as global cloud platforms, content delivery networks, and financial institutions.

This unique position has made Batam a key component of the increasingly integrated Singapore-Johor-Batam (SJB) data center corridor. It effectively captures "spillover" demand from the land- and power-constrained Singaporean market, a role amplified by its status as a Free Trade Zone (FTZ), which provides significant tax and regulatory incentives for international investors. For this analysis, our focus is on the Nongsa Digital Park (NDP) (Coordinates: 1.1886, 104.1054), which has become the epicenter of data center development and digital talent in the region.

While Batam offers a significantly lower natural disaster risk profile compared to Jakarta, it is not without its own strategic limitations. It shares a similarly hot and humid lowland climate, leading to the same operational inefficiencies and high costs associated with cooling. Critically, it has limited indigenous, large-scale renewable energy sources, forcing a reliance on a localized, often gas-powered grid. Batam, therefore, represents the "connectivity-first" strategy, making it an excellent benchmark for international performance but simultaneously highlighting the critical need for locations with stronger, inherent sustainability and efficiency credentials.

3. IKN Nusantara capital city and East Kalimantan

Selected Batam's strategic value is singular and clearly reflected in the network topology. It functions as Indonesia's primary international connectivity gateway; a role derived almost entirely from its immediate proximity to Singapore — the digital nexus of Southeast Asia. Batam serves as a critical landing point for multiple international subsea cable systems, providing the lowest-latency route between Indonesia and global networks. This positioning makes Batam the preferred location for enterprises that prioritize international performance over domestic reach, including global cloud providers, content delivery networks, and cross-border financial institutions.

This connectivity advantage has positioned Batam as a key node within the increasingly integrated Singapore–Johor–Batam (SJB) data center corridor. The island effectively captures "spillover" demand from Singapore's land- and power-constrained market, a dynamic further reinforced by Batam's Free Trade Zone (FTZ) status, which offers favorable tax treatment and streamlined regulatory processes for foreign investors. For the purposes of this analysis, the focus is on Nongsa Digital Park (NDP) (1.1886, 104.1054), which has emerged as the principal hub for data center development and digital talent in Batam.

Despite these strengths, Batam is not without strategic limitations. Although its natural disaster risk profile is materially lower than that of Greater Jakarta, it shares similar climatic constraints as a hot and humid lowland environment, resulting in elevated cooling requirements and structurally higher operating costs. More critically, Batam lacks access to large-scale indigenous renewable energy resources, leading to continued reliance on a localized grid that is often gas-powered.

Batam therefore exemplifies a “connectivity-first” development model. While it serves as a strong benchmark for international latency and cross-border performance, it also underscores the limitations of relying on locations that lack inherent sustainability, energy efficiency, and long-term decarbonization potential.

4. North Sumatra

The highlands of North Sumatra—particularly the areas surrounding Lake Toba and the Sarulla Valley—stand out for a rare and compelling convergence of attributes that position the region as arguably Indonesia’s most attractive location for sustainable, cost-efficient, and large-scale data center development. While other candidate locations exhibit individual strengths, North Sumatra offers an unmatched synergy between abundant baseload renewable energy and an exceptionally favorable operating climate.

The region’s foremost advantage is direct access to two of Indonesia’s most significant clean energy assets: the Sarulla geothermal complex (330 MW), one of the largest geothermal facilities globally, and the Asahan hydroelectric system, with installed capacity exceeding 600 MW. Together, these resources provide a stable, high-volume, and price-predictable supply of 24/7 renewable power. This directly addresses the dominant driver of operational expenditure (OPEX) while simultaneously meeting the stringent Environmental, Social, and Governance (ESG) requirements of global hyperscale and cloud operators.

This energy advantage is further reinforced by geography. Situated at elevations exceeding 1,200 meters above sea level, the Siborong-borong Highlands (2.2215, 98.9400) benefit from substantially cooler temperatures and lower humidity than any other candidate location assessed. These conditions are ideal for extensive use of free-air cooling and highly efficient hybrid cooling systems, dramatically reducing the energy intensity of thermal management in a tropical context. The combination of low-cost baseload green power and natural cooling potential makes North Sumatra uniquely suited for power-dense hyperscale or AI-oriented data center campuses, enabling ultra-low Power Usage Effectiveness (PUE) and a structurally superior Total Cost of Ownership (TCO).

From a connectivity perspective, the network map indicates that major terrestrial fiber routes already traverse North Sumatra. While a targeted “last mile” fiber extension would be required to connect a highland site, this constitutes a manageable, one-time infrastructure investment. In contrast, the region’s energy and climatic advantages are permanent structural features, delivering sustained financial, operational, and sustainability benefits across the full lifecycle of the facility.

5. North Sulawesi

The Manado–Bitung economic corridor in North Sulawesi offers a distinctive and highly strategic advantage as Indonesia’s eastern gateway for international digital connectivity. As highlighted in the network map, the region functions as a critical landing point for trans-Pacific subsea cable systems, including SEA–US, providing a rare, direct, and low-latency connection to North America. This route bypasses the increasingly congested maritime pathways and peering hubs of Singapore and Greater Jakarta, making North Sulawesi particularly attractive for content delivery networks (CDNs), global gaming platforms, and other latency-sensitive applications serving Pacific and North American markets.[37]

This connectivity strength is reinforced by an enabling investment environment. The presence of the Bitung Special Economic Zone (KEK) (1.4850, 125.1650) offers a suite of fiscal and regulatory incentives tailored to attract export-oriented and high-value digital infrastructure investment.[38] In addition, access to baseload renewable power from the nearby Lahendong geothermal fields enhances the region’s sustainability profile and supports the development of lower-carbon data center operations.

Most critically, North Sulawesi's complete geographic, tectonic, and power-grid separation from Java and Kalimantan positions it as a premier disaster recovery (DR) location within Indonesia's digital infrastructure landscape. For operators with primary facilities in Greater Jakarta—or even in lower-risk locations such as IKN—a secondary site in North Sulawesi enables a best-practice business continuity and redundancy strategy. This spatial diversification significantly reduces correlated risk and ensures operational continuity in the event of large-scale regional disruptions.

5.6.2. Multi-Criteria Assessment and Scoring Framework

To translate the qualitative profiles of the candidate locations into an objective and comparable evaluation, this study applies a multi-criteria scoring matrix. Each of the five locations is assessed on a standardized scale of 1 to 10 against the specific indicators defined under the four analytical pillars outlined earlier in this section.

To reflect their relative strategic importance, the pillars and associated criteria are weighted according to their contribution to the core objective of this chapter: identifying sites that best support the development of green, resilient, and cost-efficient data centers. A combined weighting of 60 percent is therefore assigned to the Energy and Environment pillars, as these factors are the primary determinants of long-term sustainability and operational cost performance. The remaining weight is distributed across Infrastructure and Socioeconomic considerations.

All scores are derived from publicly available and verifiable sources, including government agency data (BNPB, ESDM), regional spatial and development plans (RTRW), and infrastructure and connectivity maps (PLN, TeleGeography). The rationale underpinning each score is documented in detail in Table 8, ensuring transparency and replicability of the assessment.

Table 8. Site Selection Scoring Matrix and Final Results

Criteria	Weight (%)	JKT	BTM	SMT	IKN	SUL
Pillar 1: Energy	30	0.9	1.2	2.7	2.25	2.25
Access to RE	15	2	3	10	7	8
Grid Stability & Cost	15	4	5	8	8	7
Pillar 2: Environment	30	0.6	1.2	2.55	2.25	1.65
Low Disaster Risk	15	2	6	7	10	6
Favorable Climate	15	2	2	10	5	5
Pillar 3: Infrastructure	25	2.4	1.95	1.15	1.45	1.7
Connectivity & Latency	15	10	9	5	7	8
Logistics & Workforce	10	9	6	4	4	5
Pillar 4: Economy	15	1	1.2	1.05	1.35	1.15
Gov't Support & Land	10	6	8	7	9	8
Socio-Political Stability	5	8	8	7	9	7
Total Weighted Score	**100**	**4.9**	**5.55**	**7.45**	**7.3**	**6.75**

Score Explanation

- **Jakarta (JKT)**
  Jakarta records a perfect score for digital connectivity (10) and a high score for logistics and workforce availability (9), reflecting its role as Indonesia's primary digital and economic hub. However, these strengths are outweighed by severe structural constraints. The region is heavily penalized for its very high geological and climate risk (2) due to its location in the Pacific Ring of Fire, its unfavorable hot and humid climate for efficient cooling (2), and its limited access to large-scale renewable energy (2), given its dependence on the fossil-fuel-dominated Java–Bali grid..

- **Batam (BTM)**
  Batam scores highly on international connectivity (9) and government support (8), underpinned by its Free Trade Zone (FTZ) status and proximity to Singapore. Its overall risk profile is improved relative to Jakarta, with a moderate disaster risk score (6). However, Batam shares similar structural weaknesses, including an unfavorable lowland tropical climate for cooling efficiency (2) and limited access to indigenous baseload renewable energy (3)
- **North Sumatra (SMT)**
  North Sumatra achieves the highest possible scores for energy and environmental efficiency, reflecting its direct access to large-scale baseload renewable power (10) from the Sarulla geothermal and Asahan hydroelectric complexes, as well as its ideal highland climate for cooling (10). These advantages are partially offset by moderate disaster risk (7) and comparatively weaker existing digital and physical infrastructure (4.5), which would require targeted investment.
- **IKN Nusantara (IKN)**
  IKN Nusantara scores a perfect 10 for disaster risk due to its exceptional geological stability and ranks very high for government support (9) as a designated National Strategic Project. Its energy score (7.5) reflects strong policy commitments to renewable development, although these are not yet fully operational. The infrastructure score (5.5) captures its current greenfield status, with core systems still under construction.
- **North Sulawesi (SUL)**
  North Sulawesi performs strongly across several strategic dimensions, scoring high on access to baseload geothermal energy (8) from the Lahendong fields and on international connectivity (8) via direct trans-Pacific links such as the SEA–US subsea cable. Its designation as a Special Economic Zone (KEK) underpins robust government support (8). The principal constraint is a moderate disaster risk score (6), driven primarily by regional volcanic activity.

Analysis of Quantitative Results

The scoring matrix provides clear quantitative validation of the report's central thesis. The incumbent hubs — Jakarta (4.9) and Batam (5.55) — are mathematically confirmed as suboptimal locations for future-proof, sustainable data center investment. Their weaker performance is driven primarily by structural deficiencies in the heavily weighted Energy and Environment pillars, which constrain long-term cost efficiency, resilience, and ESG alignment.

By contrast, the greenfield locations form a distinct top tier, demonstrating materially stronger profiles for next-generation development:

- **North Sumatra Highlands (Final Score: 7.45)**

  North Sumatra emerges as the highest-scoring location in the assessment. Its dominance is driven by perfect scores in the two most critical determinants of sustainable operations: direct access to large-scale baseload renewable energy and an exceptionally favorable climate for efficient cooling. These advantages translate directly into superior Power Usage Effectiveness (PUE) and a structurally lower Total Cost of Ownership (TCO), while simultaneously meeting the stringent ESG requirements of global hyperscale and AI operators. Quantitatively, this confirms North Sumatra as the most commercially and environmentally compelling location for large-scale deployments.
- **IKN Nusantara (Final Score: 7.30)**

  IKN Nusantara ranks a close second, reinforcing its position as a top-tier strategic candidate. Its score is anchored by a perfect rating for disaster risk mitigation and strong performance in government support, reflecting its status as a National Strategic Project. While some infrastructure elements remain under development, the results validate IKN's role as Indonesia's premier location for resilience-driven and sovereignty-critical workloads, where physical security, continuity, and long-term stability are paramount.
- **North Sulawesi (Final Score: 6.75)**

  North Sulawesi establishes itself as a strong and differentiated strategic alternative. Its balanced score is supported by unique trans-Pacific connectivity, access to geothermal baseload power, and strong institutional backing through its KEK designation. These characteristics position North Sulawesi as an optimal location for specific use cases, particularly as a Pacific-facing international gateway and as a geographically isolated Disaster Recovery (DR) site that materially enhances national-level digital resilience.

5.6.3. A Two-Pronged Portfolio Strategy

Based on the preceding analysis, this report recommends that Indonesia's national green data center strategy move beyond a monolithic, one-size-fits-all approach. Instead, it should adopt a two-pronged portfolio strategy that deliberately leverages the complementary strengths of its top-tier locations. This approach balances commercial competitiveness with national resilience, while mitigating the systemic risks inherent in geographic concentration.

Prioritize the North Sumatra Highlands for Large-Scale Commercial *and* AI Development

- Rationale:
  The North Sumatra Highlands present the strongest commercial proposition for the fastest-growing segments of the global data center market, particularly hyperscale and AI workloads. Its structural advantages—direct access to large-scale baseload renewable energy and a naturally cool highland climate—translate into materially lower Total Cost of Ownership (TCO) and superior ESG performance. These attributes align closely with the economic, sustainability, and procurement requirements of leading global technology firms, making the region Indonesia's most competitive platform for export-oriented and power-intensive digital infrastructure.
- Action:
  Initiate immediate, in-depth feasibility assessments, including detailed geotechnical and environmental studies, alongside early-stage negotiations for long-term PPAs with geothermal and hydroelectric operators in the region. Parallel planning for last-mile connectivity and industrial zoning should be undertaken to accelerate time to market.

Develop IKN Nusantara as the National Hub for Resilience and *Digital* Sovereignty

- Rationale:
  IKN Nusantara plays a distinct and strategic role as the anchor for national resilience and digital sovereignty. Its exceptional geological stability and strong state backing position it as the optimal location for hosting government data, critical financial infrastructure, and mission-critical enterprise systems where uptime, security, and risk mitigation are paramount. While it may not yet match North Sumatra's cost efficiency, its value lies in ensuring continuity of core national functions and reducing systemic exposure to single-region shocks.
- Action:
  Engage proactively with the IKN Authority (Otorita IKN) to secure land allocation within designated technology zones and to co-develop clear specifications for power, fiber, and redundancy requirements. This should be accompanied by coordinated planning with energy and telecommunications stakeholders to ensure that infrastructure development aligns with the long-term needs of high-availability data center operations.

CHAPTER 6:

Power Market and Renewable Energy Supply

The rapid growth of Indonesia's data center sector has elevated electricity supply from a background utility concern to a central determinant of the country's resilience, sustainability, and investment viability. Data centers are highly energy-intensive assets, requiring uninterrupted, cost-predictable, and increasingly low-carbon power. These requirements can be met depending on how Indonesia's power system is structured, how renewable energy is deployed, and how electricity is governed and planned. The experience of existing hubs in Greater Jakarta and Batam illustrates these dynamics: concentrated in lowland regions exposed to seismic risk, flooding, and climatic stress, these locations face rapidly rising power demand, structurally high cooling loads, and persistently elevated carbon intensity.

Sustainable expansion depends not only on-site suitability but also on supportive power governance, market mechanisms, and renewable energy access. This chapter examines how Indonesia's power system conditions and the feasibility of sustainable data center development. It explores the institutional, market, and infrastructural dimensions of electricity supply that influence access to reliable and low-carbon power, and assesses how these dynamics interact with geographic risk, investment decisions, and long-term resilience. By situating electricity supply and system constraints, the chapter provides a foundation for understanding how power availability and market structure shape the expansion of data centers across the Indonesian archipelago

6.1. Power Governance Structure

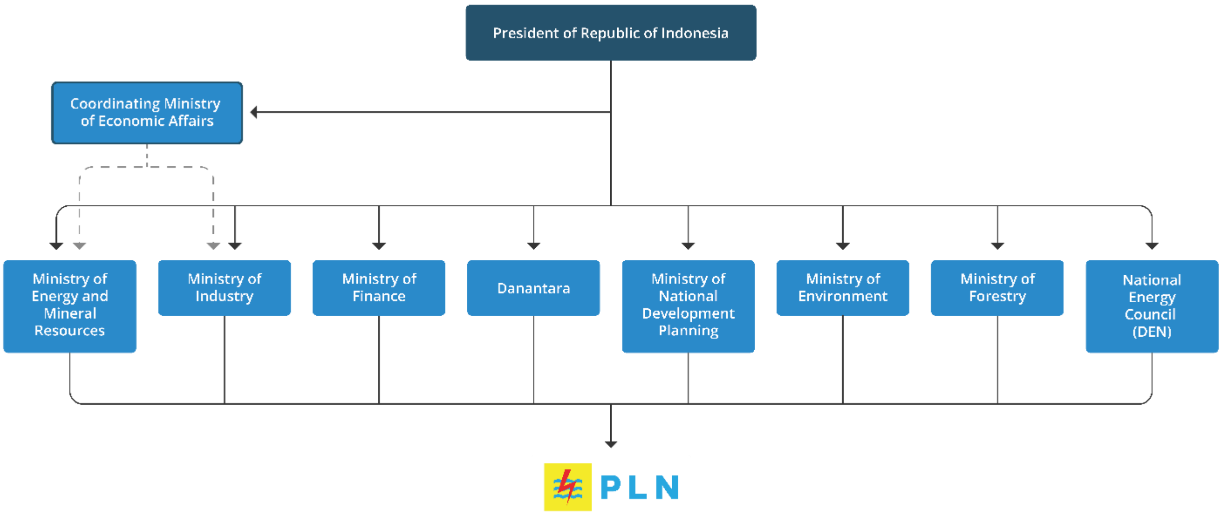
Indonesia's ambition to become a regional digital hub is closely intertwined with the evolution of its electricity sector. Driven by the rapid expansion of cloud computing, artificial intelligence, and digital public infrastructure, demand for data centers has accelerated significantly. This growth elevates the reliability, affordability, and sustainability of electricity supply as decisive factors shaping investment and competitiveness. At the same time, global data center operators are increasingly committing to low-carbon operations, placing growing pressure on host countries to provide access to renewable and verifiably green electricity. Against this backdrop, this chapter examines Indonesia's electricity system and regulatory framework to assess how the existing power sector structure can support the development of green data centers, while identifying the opportunities and constraints in aligning rising digital demand with the country's energy transition objectives.

The power industry has largely retained the characteristics of a conventional utility model, with only incremental reforms introduced over the past several decades. Established in 1965, PT Perusahaan Listrik Negara (PLN) remains the state-owned utility responsible for electricity generation, transmission, distribution, and retail services until now. The sector has historically operated as a vertically integrated system, a common structure across many countries in East Asia, the Pacific, and Sub-Saharan Africa. Although the government has introduced limited private-sector participation through the Independent Power Producer (IPP) scheme to improve efficiency, expand access, and reduce fiscal pressures, the electricity market continues to function as a centralized single-buyer model, with PLN retaining ultimate authority over system planning and electricity procurement.

While this model has supported rapid electrification and tariff affordability, Indonesia's electricity sector continues to face structural challenges that are increasingly salient for green data center development. These include overlapping governance arrangements, persistent regional disparities in electricity reliability, continued dependence on coal-fired generation, and the limited integration of renewable energy into the grid. Collectively, these constraints complicate efforts to supply large-scale, energy-intensive digital infrastructure with low-carbon electricity in a manner that is both reliable and scalable.

At the institutional level, Indonesia's electricity sector is governed through a highly centralized and multi-layered framework that reflects its historical emphasis on system control, price stability, and universal service provision. Authority over electricity planning, licensing, and system operation is concentrated in the central government and exercised largely through PT PLN, which holds exclusive supply rights across most regions under the business area (Wilus) framework. While this structure has been effective in coordinating nationwide electrification, it also results in a regulatory environment characterized by fragmented oversight and extensive approval requirements. For renewable energy development, this translates into complex coordination across land, environmental, energy, and spatial planning authorities, as well as limited flexibility for direct power sourcing outside existing grid and procurement arrangements. As a result, integrating renewable electricity particularly for large, continuous-demand users such as data centers remains institutionally and administratively more complex than expanding conventional generation, limiting the options through which green electricity can be sourced in Indonesia.

Figure 9. Institutions and Governance of Indonesia's Electricity Sector



Source: Asian Development Bank

Figure 9. illustrates Indonesia's electricity governance system, which is highly centralized and led by the executive branch under the President. Strategic direction and agenda-setting are concentrated at the executive level, policy implementation and oversight are dispersed across multiple ministries and state institutions with overlapping mandates. While regional governments play a supporting role—particularly through licensing, spatial planning, and the provision of local fiscal incentives—the core authority over electricity planning, regulation, pricing, and system operation remains concentrated at the national level. This centralized governance model reflects Indonesia's longstanding emphasis on energy security, price stability, and universal access, but it also shapes how renewable energy and large-scale electricity consumers, such as data centers, are integrated into the system.

At the sectoral level, Coordinating Ministry for Economic Affairs is in charge of coordinating policies including renewable energy between Ministry of Energy and Mineral Resources (MEMR), Badan Pengaturan BUMN, and Ministry of Industry. Ministry of Energy and Mineral Resources (MEMR) plays an important role that serves as the primary regulator, overseeing electricity policy, licensing, and technical standards through its Directorate General of Electricity and the Directorate General of New Renewable Energy and Energy Conservation[39].

Fiscal and financial control rests with the Ministry of Finance, which plays a pivotal role in sustaining the electricity sector through subsidies, compensation mechanisms, state guarantees, and development financing. Institutional oversight of PLN has been further consolidated through Indonesia's sovereign wealth fund, Danantara, which now supervises PLN's management, capital expenditure, and financial performance[40]. Together with the Ministry of Finance (MOF) and the Ministry of National Development Planning (Bappenas), these institutions form a tightly interconnected governance framework that links electricity policy, national development priorities, and fiscal management[41].

The Ministry of Environment is responsible for regulating environmental protection and climate policy, including environmental impact assessments, emissions standards, and climate-related reporting obligations, which shape how PLN designs and operates its power generation and transmission projects. Meanwhile, the Ministry of Forestry regulates the use and management of forest areas, overseeing permits for power plants and transmission infrastructure located in or crossing forest zones, thereby influencing where and under what conditions PLN can develop electricity infrastructure. National energy direction is further shaped by the National Energy Council (DEN), which formulates the National Energy Policy and long-term energy planning frameworks, although its coordinating role remains largely advisory.[42]

This institutional structure has been effective in mobilizing large-scale investment and maintaining system-wide coordination, but it also constrains flexibility in electricity sourcing and procurement. For green data centers, access to renewable electricity is therefore shaped less by bilateral market arrangements and more by regulatory pathways, state planning decisions, and fiscal considerations.

Instead of being integrated with the overall electricity procurement plan, the development of renewable power plants requires securing multiple permits across the project lifecycle—including land acquisition, procurement, construction, and operation—each involving different ministries and approval processes. Among renewable options, solar power stands out for its relatively short construction timeline compared to other renewable energy technologies, making it one of the more feasible pathways for accelerating renewable electricity deployment under the current regulatory framework.

6.2. Power Supply System

Indonesia's electricity supply system can be broadly categorized into two pathways: electricity delivered to end users via the public grid and electricity generated for self-consumption through captive power systems. These pathways differ in their institutional arrangements, regulatory oversight, and implications for renewable energy access.

Captive power systems, consist of generation, transmission, and distribution facilities that are built and operated by companies or business entities to meet their own electricity needs. Operating independently of PLN and the public grid, captive power accounts for a substantial share of Indonesia's total electricity generation. Historically, it has been concentrated in energy-intensive industries — such as nickel smelting, mineral processing, pulp and paper, cement, and textiles — which require a large, stable, and continuous supply of electricity.

Electricity supplied through the public grid, by contrast, follows an integrated value chain of generation, transmission, and distribution before reaching consumers. This supply system is the one that dominating Indonesia's electricity supply. As shown in Figure 10, this grid-based system is dominated by PLN, which plays a central role at each stage of the value chain. Private sector participation is largely limited to electricity generation through Independent Power Producers (IPP).

6.2.1. Power Generation

Electricity supply for all regional market segments is provided by both PLN and independent power producers (IPPs). However, all grid-connected generation is sold to PLN, which remains the sole off-taker and the exclusive operator of transmission and distribution networks. IPPs are prohibited from entering the transmission and retail stages.

This generation structure has important implications for the supply of renewable electricity to energy-intensive users such as green data centers. Given PLN's role as the sole off-taker of grid-connected generation and its control over transmission and distribution, access to renewable electricity through the public grid is shaped primarily by PLN's generation mix and procurement decisions rather than by direct bilateral arrangements between consumers and renewable energy producers. In practice, PLN's inflexible contractual and dispatch arrangements have entrenched coal-fired generation within the grid, reinforcing its disproportionate presence in the electricity ultimately supplied to end users.

With coal continuing to dominate the generation mix, green data centers seeking to source low-carbon electricity face structural constraints within the grid-based system. As a result, alternative supply pathways have emerged as a practical option for increasing renewable electricity use.

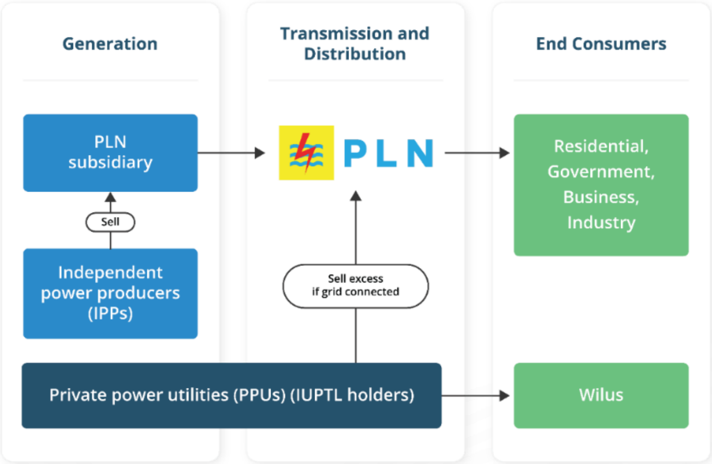
6.2.2. Transmission and Distribution

Beyond generation, electricity delivery in Indonesia relies on transmission and distribution networks that are fully controlled by PLN, reinforcing its central role within the vertically integrated power system. PLN manages the transmission of high-voltage electricity across regions, with the most developed and interconnected network located in the Java–Bali system. Outside Java–Bali, transmission networks are far less interconnected, resulting in fragmented regional grids where infrastructure expansion is often economically challenging, particularly in remote areas.

At the distribution stage, electricity is stepped down and supplied to end users through networks almost entirely owned and operated by PLN. Under the national electricity law, PLN holds exclusive rights over most distribution business areas, effectively preventing other entities from distributing electricity within assigned zones. While Private Power Utilities (PPUs) may be authorized to distribute electricity under distribution licenses (IUPTLU), access to PLN's distribution network remains tightly restricted. Independent producers therefore must either sell electricity to PLN or develop separate distribution infrastructure, an option that is typically costly and impractical. In addition, distribution tariffs are set by the central government, further limiting flexibility within the grid-based system.

Taken together, the vertically integrated structure of generation, transmission, and distribution leaves limited scope for large consumers to directly influence electricity sourcing. For energy-intensive users such as green data center, these constraints help explain the growing relevance of alternative supply arrangements. In parallel to grid-based supply, captive power systems operated by PPUs generate electricity for on-site consumption and operate outside the public grid.

Figure 10. Indonesia's Electricity Supply Structure



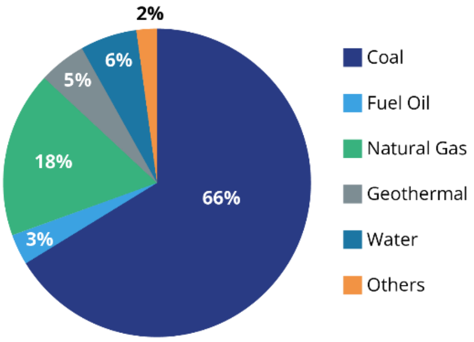
Source: Agora Energiewende, NewClimate Institute, Energy Research Institute.

6.3. Renewable Energy in a Coal-Dominated Landscape

Indonesia's electricity system is dominated by thermal power generation, primarily coal-fired plants, alongside a smaller but growing contribution of renewable energy sources such as hydropower, solar, and wind. While this generation structure has historically ensured supply reliability and low electricity costs, it poses growing challenges for decarbonization and for energy-intensive users seeking low-carbon electricity. Green data centers whose operations depend on large, continuous, and reliable power supply are increasingly constrained by Indonesia's coal-heavy electricity mix. As a result, access to renewable electricity for data centers is shaped not only by resource availability, but also by institutional factors, including PLN's dominance over generation and network infrastructure, market rigidity, as well as limited mechanisms for direct renewable procurement.

These structural constraints are reflected in Indonesia's current electricity generation mix, which remains heavily skewed toward fossil fuels. As shown in Figure 11, coal continues to dominate power generation, while renewable energy sources account for only a small share of total electricity supply. This imbalance illustrates the gap between Indonesia's renewable energy potential and its realized deployment. Explaining why access to low-carbon electricity remains limited for large consumers such as green data center.

Figure 11. Electricity Power Production Composition in 2024, Based on Sources



Source: PLN Annual Report 2024

Coal remains the dominant source of power generation, accounting for 66.43 percent of the total energy mix and underscoring the country's continued reliance on fossil fuels. Natural gas follows at 18 percent, serving as a significant but secondary source. Hydropower and geothermal energy contribute 6 percent and 5 percent respectively, representing the primary renewable energy sources within the current mix. Diesel accounts for 3 percent, largely to meet peak demand or supply remote areas, while other sources including biomass and solar, collectively contribute only 2 percent. Overall, the data highlight the limited penetration of renewable energy and the persistent dominance of coal in Indonesia's power sector.

The entrenched dominance of coal within Indonesia's power generation mix also creates structural barriers for the wider integration of renewable energy into the public electricity system. Data centers pursuing green or low-carbon operations face limited flexibility in sourcing renewable electricity through the public grid, where procurement is shaped by PLN's planning and off-taking framework. As a result, captive power arrangements become the most practical pathways for facilities that demand renewable energy in bulk. However, captive power arrangements also contribute to reinforcing coal-based within Indonesia's industrial sector. Rather than facing a scarcity of renewable resources, data centers operate within a system where coal-based generation remains structurally embedded, reinforcing reliance on alternative mechanisms such as captive generation or renewable energy certificates to meet decarbonization commitments.

This can be seen through captive power capacity data, whereby coal-fired additions consistently outpace those from renewable sources. According to a joint report by the Centre for Research on Energy and Clean Air (CREA) and Global Energy Monitor (GEM), between July 2023 and July 2024 total captive coal-fired power plant (CFPP) capacity increased by 15 percent, equivalent to 7.2 GW, of which approximately 4.5 GW came from newly developed captive CFPPs. This pattern reflects a longer-term trajectory, as captive CFPP capacity expanded from 5.7 GW in 2019 to 15.2 GW by July 2024.[43]

Despite being blessed with abundant renewable resources, Indonesia remains far from realizing its clean energy potential. As of 2023, renewables made up only about 14 percent of the national energy mix, well below the 23 percent target set for 2025 in the National Energy Policy (KEN). This shortfall is rooted in systemic bottlenecks, outdated infrastructure, rigid market structures, and PLN's vertically integrated monopoly, which controls generation, transmission, distribution, and sales. PLN's role as the sole off taker makes its willingness and capacity to reform pivotal, not only for Indonesia's decarbonization but also for global electricity transition efforts.

In line with its net zero emission (NZE) target for 2060, the government has launched the Electricity Supply Business Plan (RUPTL) 2025-2034, which aims to add 69.5 GW of new generation capacity. Notably, 75 percent of this capacity is planned to come from new and renewable energy (NRE), battery storage, and pumped storage facilities—marking a strategic pivot away from coal. If implemented effectively, this transition could create an estimated 1.7 million new jobs, cut greenhouse gas emissions, strengthen national energy resilience, and attract greater investment in NRE[44].

Yet integrating NRE into PLN's existing end-to-end system presents technical, regulatory, and economic challenges. Unlike fossil fuels, intermittent sources such as solar and wind require more flexible grid management and sometimes additional transmission capacity. Here, the concept of power wheeling—or shared use of PLN’s transmission and distribution networks by Independent Power Producers (IPPs)—has emerged as a potential enabler. Under a controlled, non-competitive market scheme, power wheeling could allow renewable projects in resource-rich but remote regions to supply large consumers (especially RE100 multinational companies) without building new transmission infrastructure, thus lowering costs and accelerating renewable uptake.

However, regulatory constraints under Law No. 30/2009 and Government Regulation No. 14/2012 currently limit wheeling to non-competitive markets and prevent multi-seller arrangements in a single service area[45]. This means PLN retains priority rights over network use and operational control under an economic dispatch model. Power wheeling principle has been also mentioned PP No.23/2014 which outlines clauses regarding the rules for joint use of transmission and distribution networks through a lease mechanism or commonly known as power wheeling. Power wheeling is also regulated in MEMR Regulation No.11/2021 allowing the private sector through Business activities providing electricity for own use (IUPTLS) to work together with PLN and use the transmission network[46]. In the New and Renewable Energy Bill (RUU EBT), the power wheeling is addressed as the government intend to accelerate the renewable energy development in Indonesia.

Without careful reform, opening access prematurely risks congestion, financial strain on PLN, and unintended cost increases for consumers. This slow growth underscores the urgency for policy and market reforms that address integration challenges, ensure fair grid access, and incentivize private investment, all while safeguarding grid reliability and affordability. Green data centers on the other hand require renewable energy sources. Following the demand towards data center, flexibility of electricity generation, transmission, and generation will be inevitable.

6.4. Renewable Energy Supply to Data Centers

Existing regulations provide data centers with both direct and indirect access to renewable energy through various mechanisms. Direct access to renewable energy could be pursued through a number of mechanisms to be explained below, all involving a complicated mechanism involving a subsidiary as an IPP, an integrated IUPTLU holder (PLN or private entity with Wilus), and/or a captive power.

A green data center may develop its own power plant to supply facilities directly under a "self-use" electricity supply framework. Electricity supply for self-use encompasses various combinations of generation, transmission, and distribution. In these instances, the supply is restricted to specific purposes, such as primary, backup, emergency, or temporary use. Developers must secure an Electricity Supply Business License for Self-Use (IUPTLS) if their capacity exceeds 500 kW. For capacities below 500 kW, entities are only required to submit a formal report to the Ministry of Energy and Mineral Resources or the Governor of a province where the business is located.

To supply renewable energy to data centers, businesses must obtain the appropriate licenses, either under a single-activity operation or an integrated operation model. As shown in Table 9, several types of licenses apply to electricity supply businesses using public grid.

Alternatively, green data centers could source renewable energy indirectly from PLN through RECs. RECs are market-based instruments introduced by PLN to enable customers to track, verify, and claim the use of electricity generated from renewable energy sources. Legally, REC is defined as a certificate representing electricity generated by a renewable energy power plant in accordance with nationally and/or internationally recognized standards (Article 1(7) of Bappebti Regulation No. 11/2024). In practice, RECs function by separating the environmental attributes of renewable electricity from its physical delivery through the power grid, allowing these attributes to be traded independently of actual electricity flows.

Under PLN’s Green as a Service (GEAS) program, RECs are issued for electricity generated from verified renewable energy power plants and tracked through an electronic system that ensures transparency and prevents double counting. This mechanism has been actively promoted by PLN to industrial and multinational investors including data centers, as a means of meeting Scope 2 greenhouse gas accounting, RE100, and Science Based Targets initiative (SBTi) requirements. In Indonesia’s vertically integrated electricity system, where access to physical renewable electricity through the grid remains constrained by PLN’s generation mix and procurement framework, RECs therefore serve as a pragmatic compliance and reporting instrument. They allow corporate consumers to document renewable electricity use without entering direct PPAs or developing on-site generation, while remaining fully embedded within PLN's grid-based supply structure.

Table 9. Licenses for Electricity Supply Business for Public Interest

Type of Electricity Business	Primary Licenses
Electricity Generation	Generation IUPTLU
Electricity Transmission	Transmission IUPTLU
Electricity Distribution	Distribution IUPTLU
Integrated Business 1: Generation, transmission, distribution, and sale of electricity in an integrated business.	Integrated IUPTLU Stipulation of Wilus Ratification of RUPTL
Integrated Business 2: Generation, transmission, and sale of electricity in an integrated business.	
Integrated Business 3: Generation, distribution, and sale of electricity in an integrated business.	

6.4.1. Direct Access to Renewable Energy

Under existing regulations, green data centers have four distinct schemes available for acquiring electricity directly, each presenting unique opportunities and challenges.

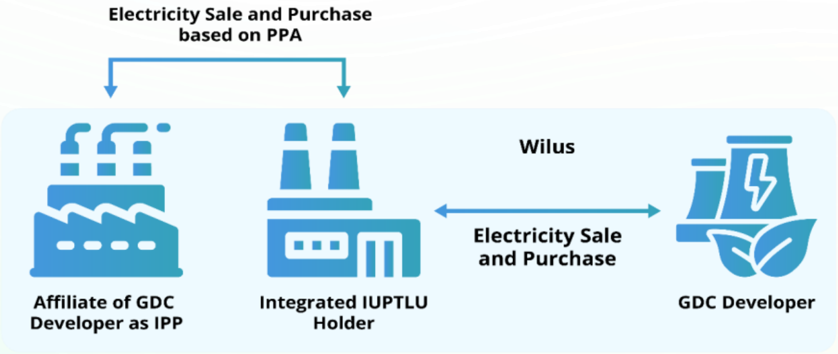
1. Affiliates as IPPs

In this scheme, green data center developer has an affiliate acting solely as an IPP. Then, the green data center affiliate sells electricity to the integrated IUPTLU holder (PLN or private entity with Wilus) whose Wilus is where the green data center is located. Then, the integrated IUPTLU holder sells electricity to the green data center.

As an IPP, the green data center affiliate must secure a PPA with the integrated IUPTLU holder. Complications arise when PLN serves as the integrated IUPTLU holder, as the green data center developer becomes subject to Presidential Regulation No. 112 of 2022 on the Acceleration of Renewable Energy Development for Electricity Supply (PR 112/2022). This regulation recognizes two procurement mechanisms: direct selection and direct appointment. Under the direct selection mechanism, IPPs must participate in a competitive bidding process, with bids evaluated based on the lowest price offered within the applicable ceiling price, including for renewable energy projects such as solar PV systems, with or without battery energy storage systems.

Despite the fact that green data centers provide guaranteed electricity demand, the current regulatory framework does not allow procurement through direct appointment in this context, resulting in prolonged approval processes. Under Presidential Regulation 112/2022, green data center developers are required to undergo the direct selection process to obtain a PPA with PLN, involving both a PPA between the IPP and PLN and a separate PPA between PLN and the green data center developer. To accelerate investment in green data centers, existing regulations — particularly Government Regulation No. 14 of 2021 and Presidential Regulation 112/2022 — should be amended to streamline the process. Such revisions could allow the use of a direct appointment mechanism by PLN for IPPs based on committed electricity demand from end users.

Figure 12. Affiliates as IPPs



2. Integrated Electricity Supply

Under this scheme, the green data center affiliate holds an integrated IUPTLU and conducts a fully integrated electricity supply business, covering electricity generation, transmission, and distribution. The affiliate sells electricity directly to the green data center developer. To operate under this integrated structure, the green data center affiliate is required to obtain a designated electricity business area (Wilus) stipulation and secure ratification of the Electricity Supply Business Plan (RUPTL).

Following the issuance of the Wilus stipulation, the green data center affiliate must also apply for approval of the electricity tariff charged to the end user. The tariff is calculated based on the electricity generation cost (BPP) plus a reasonable business margin. The proposed tariff must be submitted to the Ministry of Energy and Mineral Resources (MEMR) and is subject to approval by the House of Representatives (DPR).

Figure 13. Integrated Electricity Supply

3. Captive power

While the previous two schemes illustrate electricity supply businesses serving the public interest, this scheme focuses on green data center developers that generate electricity exclusively for their own use. This arrangement is commonly referred to as a captive power structure, under which no electricity is sold to third parties. To implement this scheme, a green data center developer is required to obtain an Electricity Supply Business License for Own Use (IUPLTS).

In the modeling presented, the scheme assumes a 100 percent solar photovoltaic (PV) configuration. In practice, captive power arrangements are typically implemented through an operational lease, whereby the green data center developer contracts a solar PV developer. Under this structure, the PV developer acts as the lessor and is responsible for installing, operating, maintaining, and leasing the rooftop solar system to the green data center as the lessee, without any transfer of ownership at the end of the lease period.

This operational lease structure is regulated under MEMR Regulation No. 2/2024. Under this regulation, the installed capacity of rooftop solar is determined based on the green data center's electricity demand and the applicable capacity quota. Consequently, green data centers located within PLN-designated Wilus areas must comply with the available rooftop solar quota, which totals 5,476 MW for the 2024–2028 period. In addition, green data center developers are required to obtain approval from the integrated IUPTLU holder for the construction and installation of rooftop solar systems.

Figure 14. Captive power

4. Grid Joint Utilization

Joint utilization, or rental, of electricity transmission and/or distribution facilities applies when the electricity supplier is different from the owner of the transmission or distribution infrastructure. This mechanism is intended to ensure compliance with electricity system quality and reliability standards.[47]

Article 47(2) of MEMR Regulation No. 11/2021 requires owners of electricity transmission and/or distribution facilities to open access to their infrastructure for joint utilization. Under this scheme, multiple parties may be involved. Owners of transmission and distribution facilities include integrated IUPTLU holders, IUPTLU holders for electricity transmission, IUPTLU holders for electricity distribution, and IUPTLS holders that own transmission and/or distribution assets. These facility owners may provide system interconnection by leasing their transmission and/or distribution lines to integrated IUPTLU holders, IUPTLU holders for electricity generation, or IUPTLS holders.

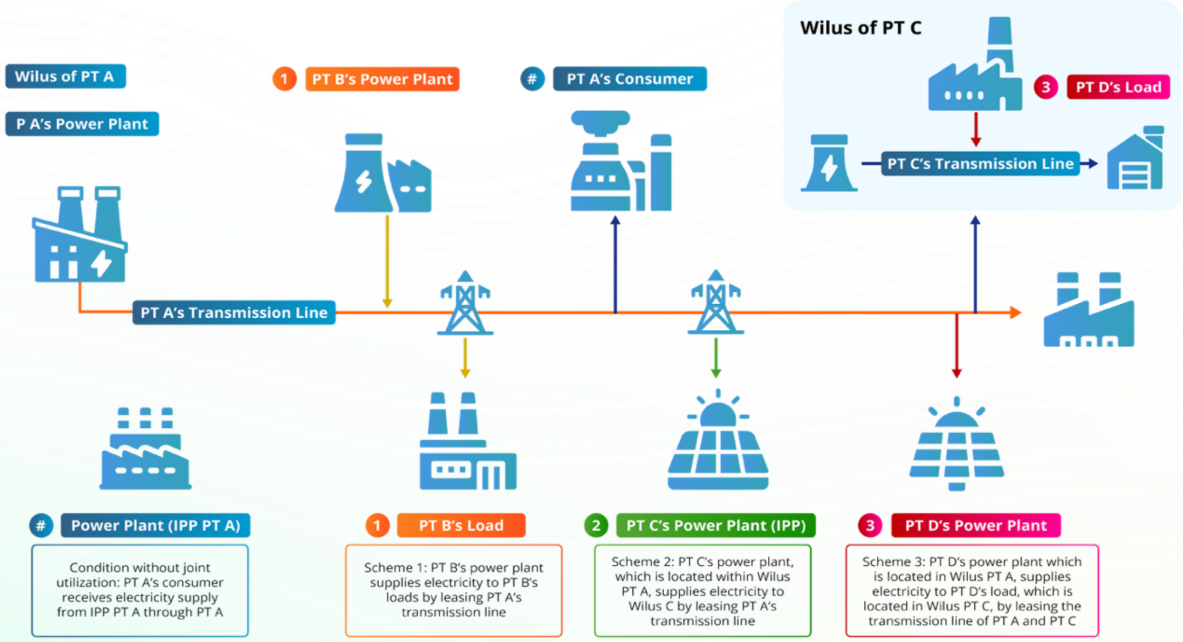
Figure 15 illustrates the joint utilization schemes and the parties involved. In most cases, the transmission line owned by PT A, acting as the transmission license holder, is utilized, except in Case 3, where transmission lines owned by both PT A and PT C are used.

In addition to joint utilization, rental of transmission and/or distribution facilities may also be conducted to ensure sufficient electricity supply within a specific Wilus.[48] Under this arrangement, an IUPTLU holder cooperates with a holder of a Power Supply Support Services Business License for Public Interest (*Izin Usaha Jasa Penunjang Tenaga Listrik* or IUJPTLU) through the rental of electricity installations, including transmission and/or distribution lines.

Joint utilization has been widely implemented in many countries, including Southeast Asian countries such as Singapore, Malaysia, and Vietnam. This approach provides greater flexibility for green data centers to access renewable energy from power plants. However, joint utilization has not yet been effectively implemented in Indonesia. To date, MEMR has not issued any IUPTLU specifically for electricity transmission, even though the regulatory framework allows transmission lines owned by transmission IUPTLU holders to be jointly utilized.

Beyond the absence of transmission IUPTLU issuance, IUPTLS holders also face constraints under the joint utilization scheme. While transmission facilities owned by IUPTLS holders may theoretically be jointly utilized, obtaining an IUPTLS requires ownership of a power plant. Entities that solely own transmission or distribution facilities are therefore ineligible to hold an IUPTLS. These regulatory limitations pose significant hurdles for industry players, including green data center developers, and remain a major barrier to accelerating renewable energy deployment in Indonesia.

Figure 15. Grid Joint Utilization



Condition without joint utilization: PT A's consumer receives electricity supply from IPP PT A through PT A

Scheme 1: PT B's power plant supplies electricity to PT B's loads by leasing PT A's transmission line

Scheme 2: PT C's power plant, which is located within Wilus PT A, supplies electricity to Wilus C by leasing PT A's transmission line

Scheme 3: PT D's power plant which is located in Wilus PT A, supplies electricity to PT D's load, which is located in Wilus PT C, by leasing the transmission line of PT A and PT C

6.4.2. RECs as Indirect Access to Renewable Energy

In this scheme, integrated IUPTLU holders (PLN or private entities) sell electricity directly to green data center developers. The electricity supply may originate from the IUPTLU holder's own power plants or from independent power producers (IPPs) through PPAs. To claim that the electricity is sourced from renewable energy, green data center developers may purchase RECs from PLN, either in unbundled form (REC only) or bundled form (REC combined with electricity).

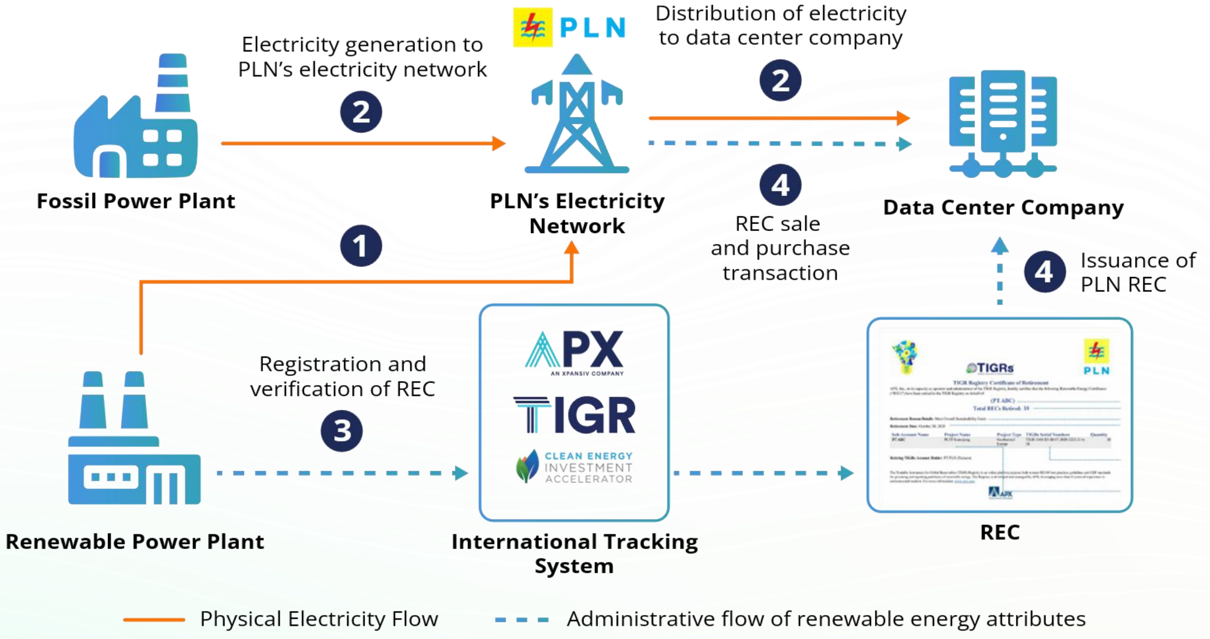
This scheme reduces barriers for green data center developers, as it eliminates the need to invest in and develop their own power plants. Developers only require licenses related to data center operations, without the need for electricity generation permits.

Despite its convenience, the REC mechanism remains controversial among industry players. Some stakeholders question the credibility and environmental integrity of RECs, while many green data center operators prefer direct access to renewable energy rather than certificate-based claims. Nevertheless, in the Indonesian context, where access to renewable energy is constrained by unresolved joint utilization issues, RECs can serve as a pragmatic interim solution.

However, a notable example of REC adoption by Amazon Web Services (AWS) – one of the world's largest green data center operators – can break the myth of the validity of the REC purchase. Rather than purchasing existing RECs, AWS opted for newly issued RECs linked to PLN's commitment to develop 210 MW of new solar power capacity across four projects in Java and Bali. [49] In these projects, AWS acts as the primary off-taker, enabling the development of additional renewable energy capacity through a demand-driven model and setting a precedent for other industry players in Indonesia.

Figure 16 illustrates how RECs operate within Indonesia's electricity system by distinguishing between physical electricity flows and the administrative flow of renewable energy attributes. The scheme further illustrates the dual-track nature of REC implementation for data centers. First, electricity generated from both fossil-fuel and renewable power plants is injected into PLN's electricity network and physically delivered to data center facilities as grid electricity (Steps 1 and 2). Second, in parallel to this physical flow, the renewable electricity produced by certified renewable power plants is registered and verified through an international tracking system, which records generation data and issues the corresponding renewable energy attributes (Step 3).

Figure 16. Operation of Renewable Energy Certificates within Indonesia's Grid-Based Electricity System



Source: PT PLN

These attributes are then converted into RECs and made available for purchase by data centers through a separate administrative transaction with PLN (Step 4). Upon completion of the transaction, PLN issues and retires the RECs on behalf of the data center, allowing renewable electricity consumption to be claimed through verified accounting rather than direct physical delivery. This dual structure underscores how RECs function as an accounting-based solution within Indonesia's vertically integrated power system, enabling corporate decarbonization claims while the physical electricity supply remains unchanged.

In practice, several energy-intensive users and data center operators in Indonesia have already utilized PLN's REC scheme as part of their decarbonization strategies. For example, Telkom has purchased RECs to cover electricity consumption across 69 Points of Presence (POP) nationwide, targeting reductions in Scope 2 greenhouse gas emissions, which account for most the company's total emissions[50]. Similarly, EDGE Data Center has acquired 404 REC units (equivalent to 404 MWh) to support sustainability-oriented business operations, utilizing 100 percent REC from PLN[51]. PT Princeton DGDC Pekanbaru has also reported that REC purchases align with its efforts to reduce emissions using green energy while maintaining reliable electricity supply from PLN[52]. These cases illustrate how RECs are currently being used by data center operators in Indonesia as a pragmatic instrument to document renewable electricity use within the constraints of the existing grid system.

Beside RECs, the Greenhouse Gas Emission Reduction Certificate or *Sertifikat Pengurangan Emisi Gas Rumah Kaca* (SPE-GRK) is used in the industry to decarbonize their business activities. SPE-GRK, commonly known as a type of carbon credit, is an official instrument for the industry player to verify a project or business entity's reduction in greenhouse gas emission (GHG). Despite their similar characteristics, RECs and SPE-GRK serve different purposes for the business. RECs are designed to document the use of renewable electricity and are directly linked to electricity consumption. While SPE-GRK certifies verified emission reductions through avoiding, diminishing, or eliminating GHG (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbon, and sulfur hexafluoride) from the baseline achieved by specific projects or activities across multiple sectors.

Taken together, this chapter has demonstrated that Indonesia's electricity system presents both opportunities and constraints for data center development. The vertically integrated structure of the power sector, PLN's dominant role in generation and network operations, and the continued reliance on coal shape the availability, cost, and carbon intensity of electricity supplied to large consumers. While mechanisms such as captive power, RECs, and carbon credits (SPE-GRK) provide pathways for data centers to manage emissions reporting and sustainability commitments, they do not fully resolve underlying challenges related to long-term power reliability, scalability, and direct access to physical renewable electricity.

Data centers tend to require uninterrupted power supply, predictable electricity pricing, and increasingly low-carbon energy sources to meet global ESG, RE100, and net-zero commitments. Thus, electricity supply is not merely an operational input but a core investment consideration. Decisions over the site selection, capacity expansion, and capital allocation are therefore closely tied to the structure of Indonesia's power system and the available procurement mechanisms discussed in the next chapter. Chapter 7 builds on this analysis by focusing specifically on renewable energy power supply and investment for data centers.

CHAPTER 7:

Power Supply and Investment for Data Centers

Electricity supply is a key determinant of data center investment viability, shaping site selection, capacity expansion, and both capital and operational costs. In Indonesia, where the grid remains coal-dependent and renewable integration varies by region, power availability, reliability, cost, and carbon intensity directly influence investment risk and sustainability outcomes. Understanding these constraints is essential for assessing the competitiveness of data center projects.

This chapter evaluates how alternative electricity supply pathways affect costs and emissions for data centers, comparing grid-based supply, renewable captive generation, and market-based renewable procurement. Two representative locations—MM2100 Industrial Area in Greater Jakarta and Nongsa Digital Park in Batam—are analyzed through 2035 using power system optimization modeling. The chapter quantifies generation mixes, emissions trajectories, and electricity costs across scenarios, providing a clear, data-driven foundation for strategic, sustainable, and financially viable investment decisions.

7.1. Power Supply to Data Centers

7.1.1. Model Overview

The evaluation of data center power system planning through 2035 is conducted using a power system optimization approach based on the TIMES-Indonesia model. TIMES-Indonesia is derived from the generator model developed under the International Energy Agency's Energy Technology Systems Analysis Program (IEA-ETSAP). The model is used to identify the lecost energy mix and corresponding emissions trajectories through 2035 for two data center locations: the MM2100 Industrial Area in Bekasi, Greater Jakarta, and Nongsa Digital Park in Batam, as specified in Equations (1) and (2).

$$Total\ Discounted\ System\ Cost = \sum_{y \in YEARS} (1+d)^{REFYR-y} \times ANNCOST_y \quad (1)$$

$$ANNCOST\,(y) = INV(y) + FOM(y) + VOM(y) \quad (2)$$

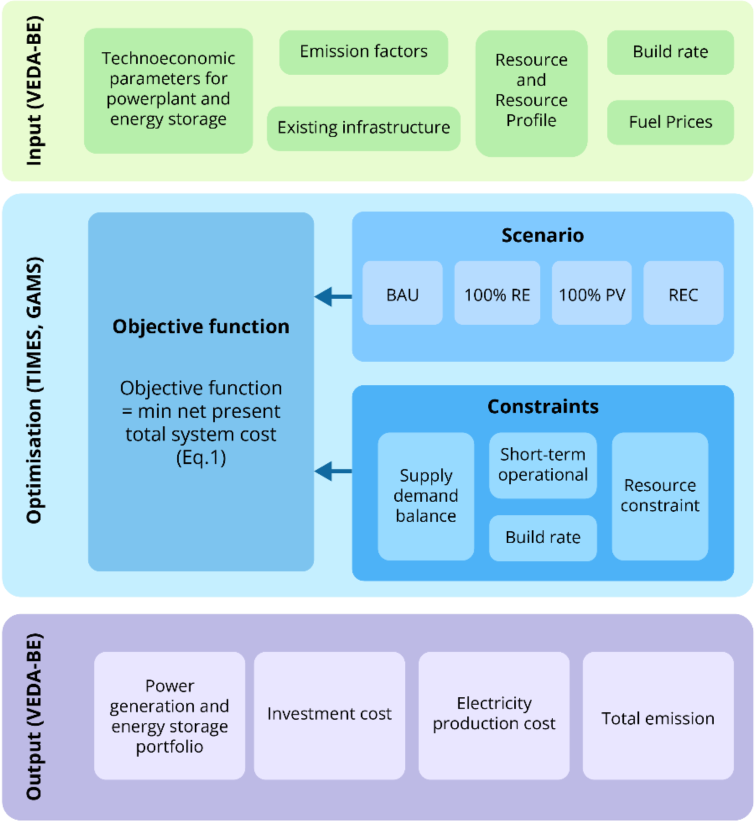
In the model, *y* denotes the modeled year, *d* the discount rate, *REFYR* the reference year, and *ANNCOSTy* the total annual system cost in year *y*. *INV(y)* represents investment costs in year y, *FOM(y)* fixed operation and maintenance costs in year in US dollar and *VOM(y)* variable operation and maintenance costs for year y in US dollar. The TIMES-Indonesia model has been applied extensively in previous studies to analyze Indonesia's power sector and energy transition pathways.[53] [54]

Several assumptions were applied in this model:

1. The assessment is limited to two locations: MM2100 Industrial Area (Bekasi) dan Nongsa Digital Park (Batam).
2. The modeling time span horizon spans from 2025 to 2035
3. A discount rate of 10 percent is applied, consistent with the standard for developing countries.
4. Fuel prices are projected based on crude oil prices listed in the *World Energy Outlook 2021* 'Stated Policy' scenario [55]

5. The existing power generation mix for the Java region (Bekasi) and the Sumatra region (Batam) is consistent with the 2025-2034 RUPTL.
6. Grid losses are assumed to be 10 percent.

Figure 17. Model Framework



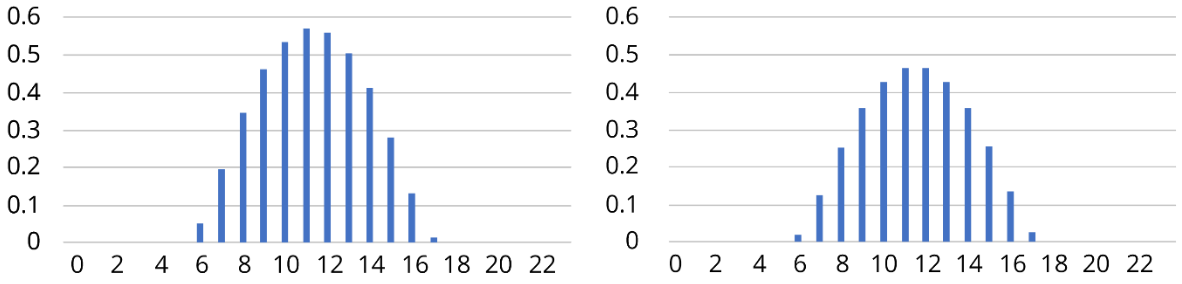
The data required to construct the model are presented in Figure 1. The techno-economic parameters, emission factors, and plant operational parameters are consistent with those used in previous studies. [56] [57] Regional resource potential data were determined based on a set of simplifying assumptions. For land-based solar photovoltaic (PV) and onshore wind technologies, land availability was derived from Lawrence Berkeley National Laboratory (LBNL) datasets using a 15-kilometer radius. For floating solar PV and offshore wind, available areas were estimated using spatial data from the Free Map Tools platform. Solar PV and wind resources are assumed to be fully deployable across the identified land and water areas, with resource availability held constant over the modeling horizon. Biomass resource potential was estimated based on regional availability of palm oil waste biomass and forestry residues. The estimated resource potentials for each technology are summarized in Table 10.

Table 10. Regional Resource

Resource	MM2100 Industrial Area	Nongsa Digital Park (NDP)
Land-based PV	0.182 GW	0.317 GW
Floating PV	0 GW	1.548 GW
Onshore Wind	0.0015 GW	0.0027 GW
Offshore Wind	0 GW	0.0015 GW
Biomass	6.74 PJ	1,526.51 PJ

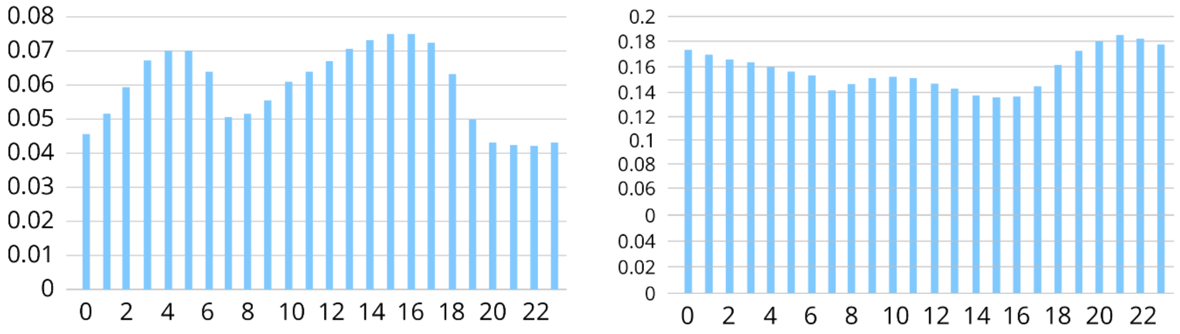
The values presented in Table 10 are supported by the solar PV resource profiles shown in Figure 18 and the wind resource profiles shown in Figure 19, which illustrate the average hourly variations over a one-year period for both the MM2100 Industrial Area and Nongsa Digital Park. [58]

Figure 18. Solar PV profiles in MM2100 Industrial Area (left); Nongsa Digital Park (right)



Source: Authors' calculation

Figure 19. Wind profiles in MM2100 Industrial Area (left); Nongsa Digital Park (right)



Source: Authors' calculation

7.1.2. Scenario Development

To address the issues discussed above, this study analyzes four scenarios, as summarized in Table 11. The **business-as-usual (BAU)** scenario represents the baseline condition, in which the production process is supplied entirely by electricity from the regional grid. The **100 percent renewable energy (RE)** scenario assumes that by 2035, the entire production process is powered by renewable energy sources, with an additional option to trade biomass from other regions to Java. The **100 percent PV** scenario describes a system in which the production process relies exclusively on solar photovoltaic (PV) generation, supported by battery energy storage. Meanwhile, the **REC** scenario represents the implementation of Renewable Energy Certificates, a market-based mechanism that enables the purchase of electricity generated from renewable energy power plants, while still achieving a 100 percent renewable energy target by 2035.

Table 11. Scenarios

Scenarios	Description
BAU	The power generation mix remains unchanged from the existing condition (100% Grid electricity).
100% RE	The production process will be powered entirely by renewable energy sources by 2035, including an additional biomass trading option from other regions to Java.
100% PV	Production process powered exclusively by photovoltaic (PV) solar energy, without any land availability constraint.
REC	Production process under the 100% RE scenario with the implementation of a Renewable Energy Certificate (REC) mechanism.

To support the implementation of the REC scenario, several data inputs and assumptions were applied regarding REC potentials and cost structures, as shown in Table 12.

Table 12. REC potentials and cost structure (RUPTL, 2025)

Power Plant	Capacity (MW)	REC Cost (MUSD/PJ)
Large Hydro	1,138	0.50
Small Hydro	9	0.75
Geothermal	330	0.59
Wind Farm	75	0.84
Solar PV	-	0.92

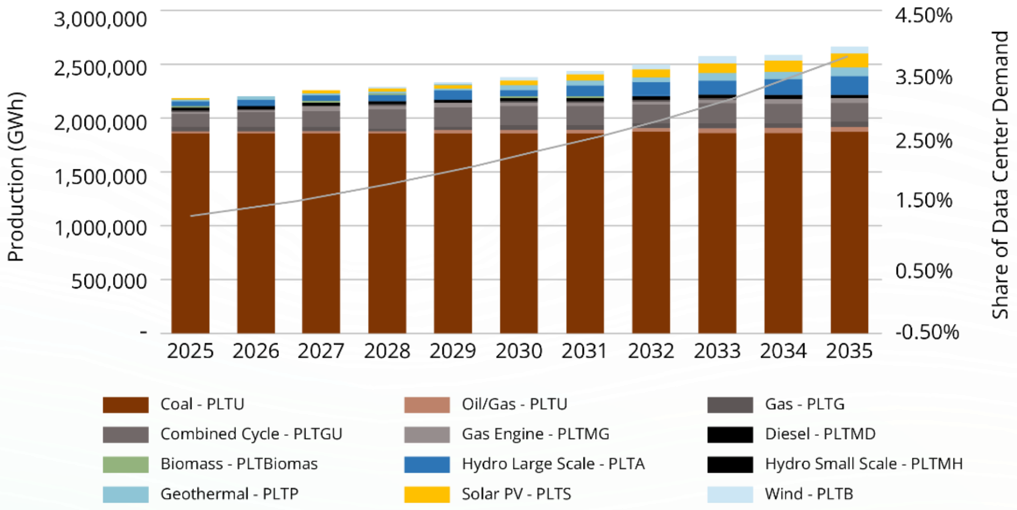
Source: PLN, 2025

7.1.3. Results of Four Scenarios

Based on the RUPTL, Indonesia's electricity demand is projected to increase from approximately 362,916 GWh in 2025 to around 580,687 GWh in 2034, representing an average annual growth rate of 4.8 percent. Coal- and gas-fired power plants are expected to remain the primary sources of electricity supply in the medium term, while the share of renewable energy is projected to increase gradually. [59] [60] When additional electricity demand from data centers is considered — estimated to contribute between 1.33 percent and 3.83 percent of total national demand — total power generation requirements increase accordingly. However, given the moderate overall growth in electricity demand and the relatively limited contribution from data centers, there is no immediate need for large-scale capacity expansion. Instead, higher utilization of existing generation capacity, reflected in increased capacity factors, would be sufficient to accommodate the additional load.

The national electricity generation mix from 2025 to 2035 is illustrated in Figure 20. Coal-fired power plants (PLTU) continue to dominate the portfolio, supplying approximately 70–86 percent of total electricity generation over the analyzed period. Nevertheless, their share declines gradually as renewable energy sources increase their combined contribution, indicating a slow but steady transition toward a more diversified and lower-carbon power system.

Figure 20. Production Portfolio

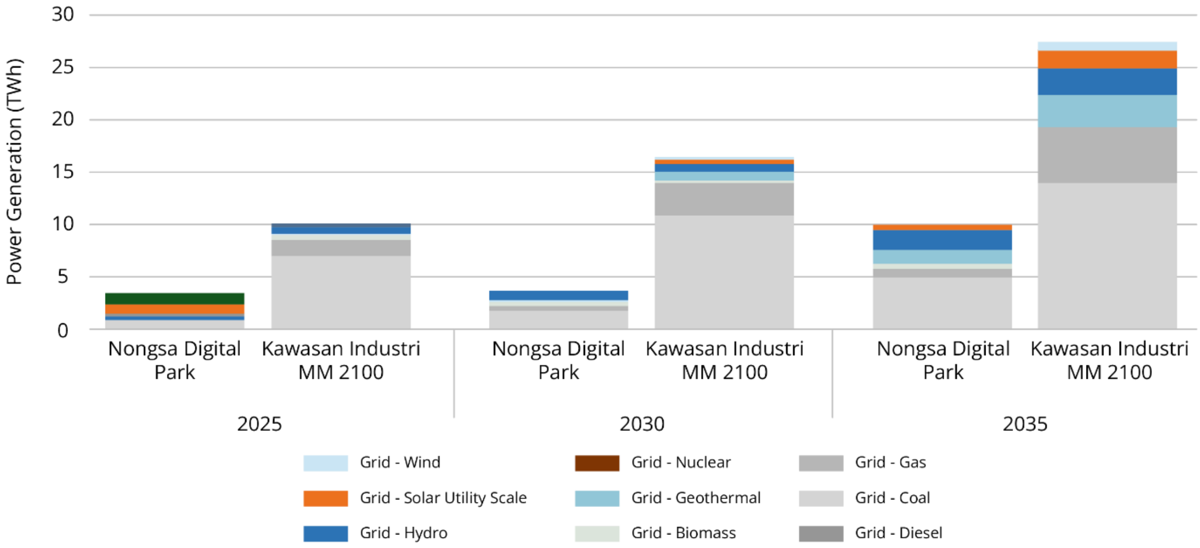


Source: RUPTL 2025

BAU Scenario

The power generation mix under the business-as-usual (BAU) scenario is shown in Figure 21. In this scenario, the grid plays a central role in meeting electricity demand at both Nongsa Digital Park (NDP) in Batam and the MM2100 Industrial Area in Bekasi in 2025. As the BAU scenario relies entirely on grid-supplied electricity, the differences in the generation mix shown in Figure 21 reflect the distinct grid compositions of the Java and Sumatra systems, as projected in the Electricity Supply Business Plan (RUPTL).

Figure 21. Power Generation Mix for BAU Scenario

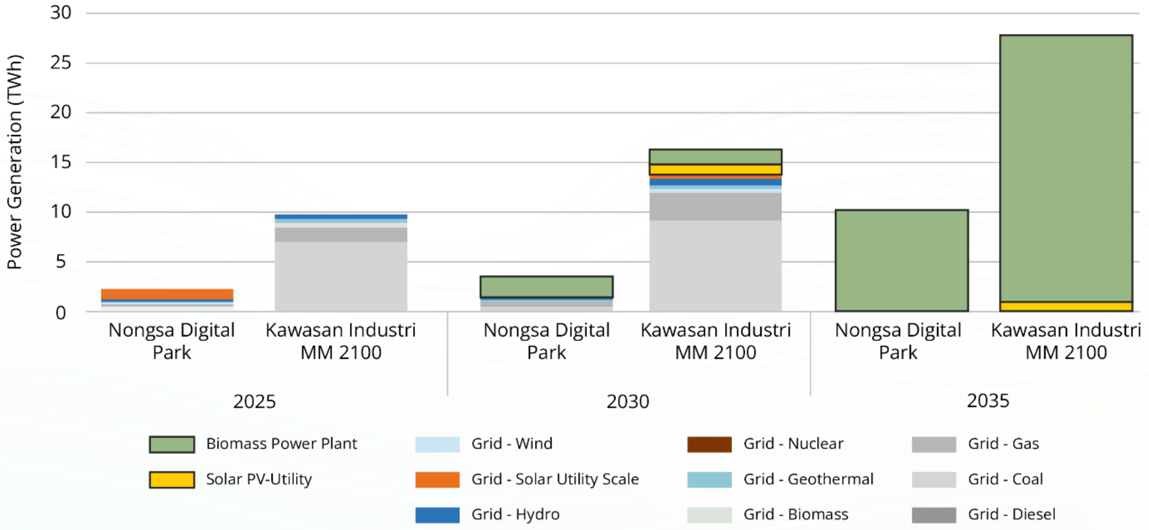


Source: RUPTL (2025)

100 percent RE Scenario

Figure 22 presents the power generation mix under the 100 percent renewable energy (RE) scenario. In this scenario, grid electricity is assumed to be unavailable for data centers at both the MM2100 Industrial Area and Nongsa Digital Park by 2035. Consequently, the development of captive power plants becomes mandatory to meet electricity demand at both locations. These captive systems are limited to renewable energy technologies—biomass, solar photovoltaic (PV), and wind—based on the resource potential available at each site. Other renewable sources, such as geothermal and hydropower, are excluded to reflect the site-specific constraints at MM2100 Industrial Area and Nongsa Digital Park.

Figure 22. Power Generation Mix for 100% RE Scenario



Source: Authors' calculation

At Nongsa Digital Park, electricity supply initially relies entirely on the grid in 2025 but gradually reduces its dependence over time, declining to 42.93 percent by 2030 and reaching zero grid use by 2035. Assuming large-scale biomass power development is feasible and that biomass resources are sufficiently abundant —

consistent with Sumatra's biomass potential — the generation portfolio transitions to 100 percent biomass-based power by 2035.

By contrast, conditions at the MM2100 Industrial Area differ markedly. The availability of local renewable energy resources—including biomass in Java, land for solar PV deployment, and wind potential — is insufficient to meet data center electricity demand. To address this constraint, the scenario allows for inter-island biomass trade, enabling biomass supply from regions outside Java. As a result, Bekasi's power generation mix in 2035 comprises 3.53 percent solar PV, 0.01 percent wind power, and 96.47 percent biomass power. Achieving this portfolio requires importing approximately 94.77 percent of biomass from islands outside Java.

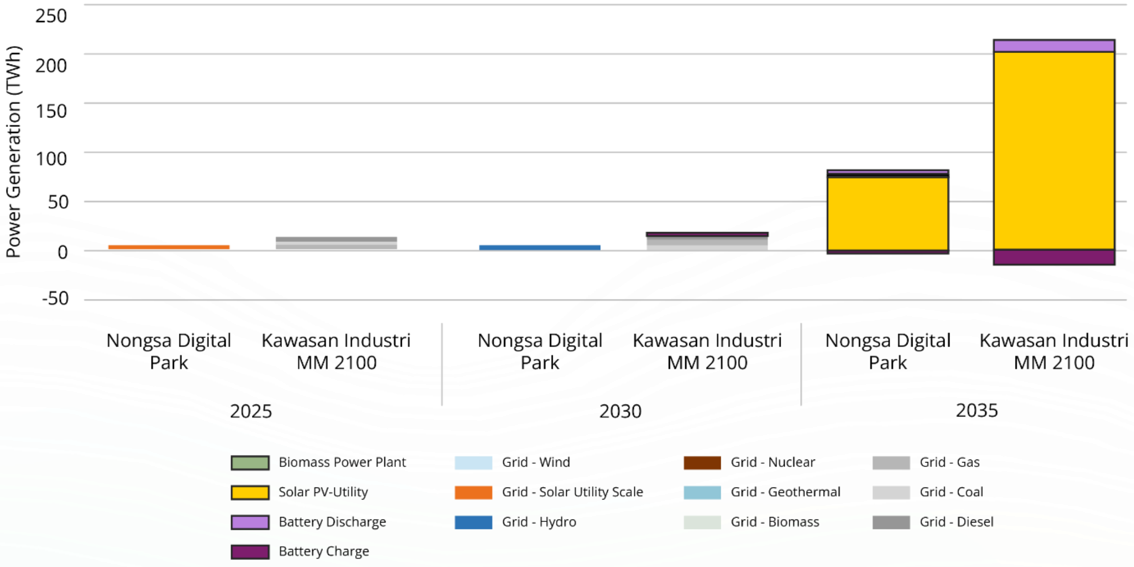
100 percent PV Scenario

The 100 percent PV scenario is a specialized case designed to assess the land area requirements for solar photovoltaic (PV) deployment if the entire electricity demand of data centers at both the MM2100 Industrial Area and Nongsa Digital Park were to be supplied exclusively by utility-scale solar PV. In this scenario, all other renewable energy resources are excluded, and the analysis focuses solely on shifting electricity supply from the grid to solar PV systems supported by battery energy storage.

Because the optimization is based on a least-cost framework, Figure 23 shows that the power generation portfolios at both locations remain dominated by grid electricity in 2030. However, a rapid transition toward solar PV occurs thereafter, with PV fully dominating the system by 2035. By that year, Nongsa Digital Park is projected to require 17.69 GW of installed solar PV capacity, supported by 1.34 GW of battery storage, while the MM2100 Industrial Area requires 39.46 GW of installed solar PV capacity along with 3.69 GW of battery storage.

The key insight from this scenario is the scale of land required to support such deployment. Solar PV installations at the MM2100 Industrial Area and Nongsa Digital Park would require approximately 1,838 km² and 4,102 km² of land, respectively — equivalent to 55 times and 215 times larger than the estimates reported in the Lawrence Berkeley National Laboratory (LBNL) study.

Figure 23. Power Generation Mix for 100% PV Scenario



Source: Authors' calculation

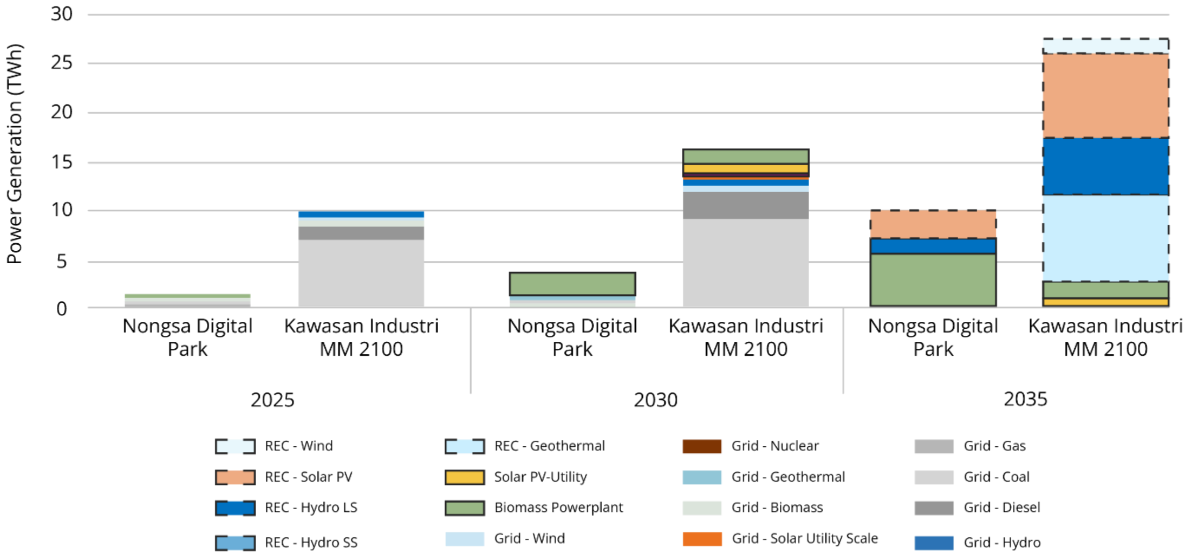
REC Scenario

Figure 24 presents the power generation mix under the Renewable Energy Certificate (REC) scenario. In this scenario, RECs are introduced into the system as a market-based mechanism. A key modeling assumption is that REC-based electricity is treated as distinct from physical grid electricity, even though RECs represent purchase credits rather than direct power delivery. The underlying electricity is still transmitted through the main grid, while emissions associated with REC-based electricity are assumed to be zero, or carbon neutral. The RECs included in the model are categorized into five types — large-scale hydropower, small-scale hydropower, geothermal, solar photovoltaic (PV), and wind — each assigned a different price, as specified in Table 12.

Compared with the other scenarios, the REC scenario produces a markedly different generation portfolio. Reliance on REC-based electricity increases sharply, reaching 43 percent of total electricity demand in Nongsa Digital Park and 90 percent in the MM2100 Industrial Area. In Nongsa Digital Park, the remaining 57 percent of electricity demand continues to be supplied by biomass power plants, reflecting their relatively lower generation costs compared with alternative non-REC sources.

In the MM2100 Industrial Area, non-REC electricity supply consists of 6.43 percent from biomass power plants and 3.53 percent from utility-scale solar PV. This outcome reflects constraints on locally available biomass resources in Java, combined with the assumption that inter-island biomass trading is not permitted in this scenario. In addition, limited land availability restricts large-scale solar PV deployment. The composition of REC types entering the system also varies across locations, as REC availability in the model is constrained by the estimated potential of each REC category, to more accurately reflect conditions in Indonesia

Figure 24. Power Generation Mix for REC Scenario



Source: Authors' calculation

7.1.4. CO2 Emission Trajectory

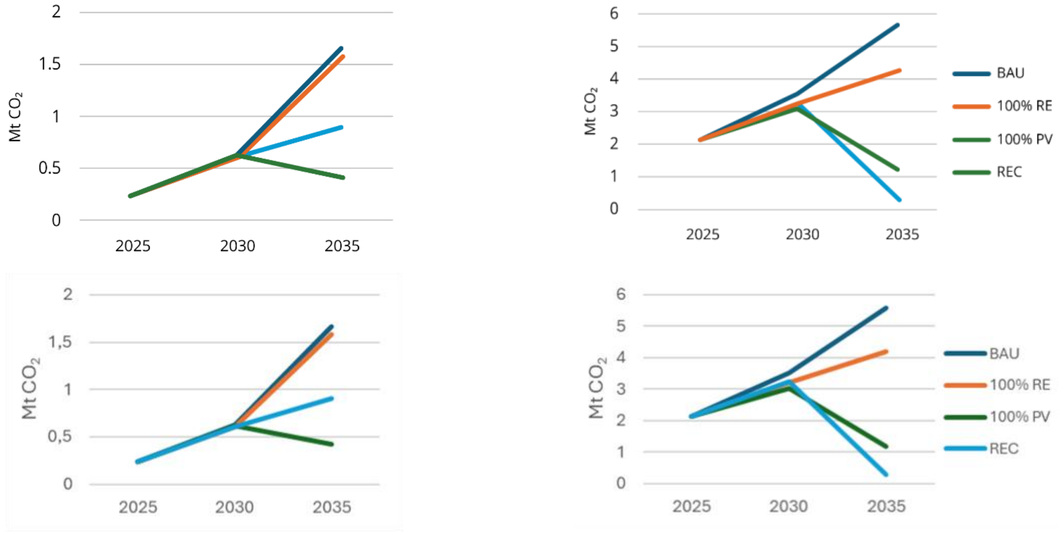
Figure 25 illustrates the projected CO_2 emission trajectories for the MM2100 Industrial Area and Nongsa Digital Park under the four analyzed scenarios. In Nongsa Digital Park, the business-as-usual (BAU) scenario shows a sharp increase in emissions, particularly between 2030 and 2035, reaching 1.67 Mt CO_2 by the end of the period. This increase is driven by rising electricity demand combined with continued reliance on electricity sources that are not low emission. Similarly, under the BAU scenario, emissions in the MM2100 Industrial Area rise steadily, reaching 5.57 Mt CO_2 by 2035.

Beyond the BAU case, the 100 percent renewable energy (RE) scenario also exhibits a gradual increase in emissions over time. This outcome is attributable to the extensive use of biomass-fired power plants, with biomass not assumed to be carbon neutral in the model. Instead, biomass generation is assigned an emission factor of 572.4 g/kWh of CO_2. As a result, emissions reach 1.58 Mt CO_2 in Nongsa Digital Park and 4.19 Mt CO_2 in the MM2100 Industrial Area by 2035.

A similar emissions pattern is observed under the REC scenario in Nongsa Digital Park, where biomass power plants continue to account for 57 percent of the generation mix. This reliance leads to ongoing emissions growth, with total emissions reaching approximately 0.9 Mt CO_2 by 2035.

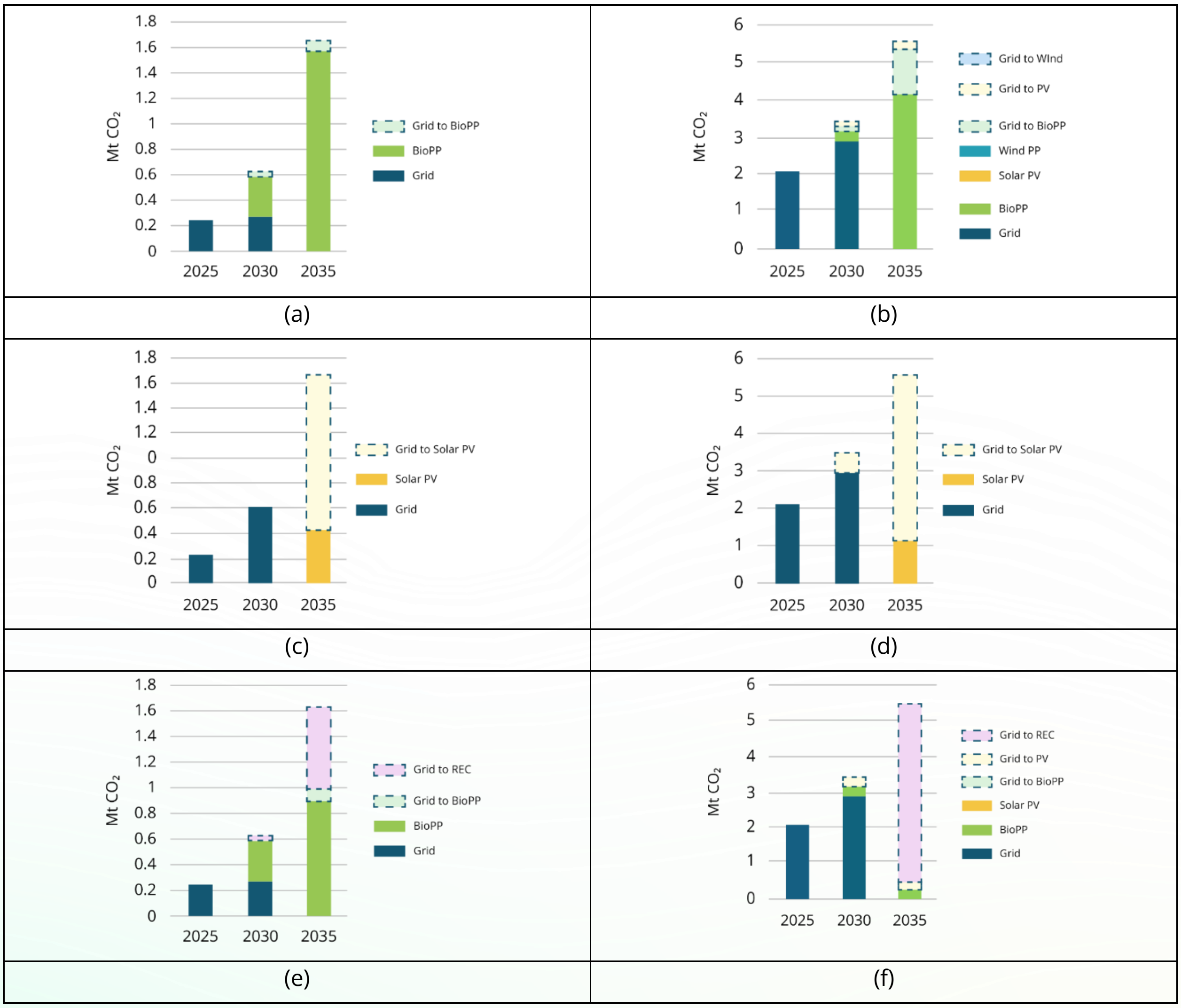
Figures 25(a) to 25(f) illustrate the CO_2 emission reductions achieved under each scenario relative to the business-as-usual (BAU) scenario for both regions.

Figure 25. CO₂ Emission Trajectory for Nongsa Digital Park (Left) and MM2100 Industrial Area (Right)



Source: Authors' calculation

Figure 26. Emission Reductions of Each Scenario for Each Region



Source: Authors' calculation

Figure 25(a) shows emission reductions in Nongsa Digital Park under the 100 percent renewable energy (RE) scenario. In this case, shifting electricity supply from the grid to biomass-fired power plants reduces emissions by 81.6 kt CO_2, equivalent to 4.9 percent of BAU emissions in 2035. In the MM2100 Industrial Area, shown in Figure 25(b), the same scenario results in a reduction of 1.21 Mt CO_2, or 21.77 percent relative to BAU. Solar PV and wind power contribute only marginally to emission reductions — 3.03 percent and 0.01 percent, respectively — reflecting their limited penetration due to resource constraints.

Figures 25(c) and 25(d) present CO_2 emission reductions under the 100 percent PV scenario. As this scenario is designed to assess the scale of solar PV deployment required if PV were forced to meet total electricity demand, emissions are correspondingly forced downward through a single-technology solution. As a result, emission reductions are substantial, reaching 79 percent in the MM2100 Industrial Area and 74.4 percent in Nongsa Digital Park relative to BAU by 2035.

Figures 25(e) and 25(f) show CO_2 emission reductions under the REC scenario. In both regions, reductions are driven primarily by REC-based electricity purchases, which are assumed to be carbon neutral. In Nongsa Digital Park, emissions decline by 0.65 Mt CO_2, equivalent to 43.83 percent of BAU emissions, with an additional reduction of 0.11 Mt CO_2 (6.87 percent of BAU) from biomass power generation. In the MM2100 Industrial Area, emission reductions are significantly larger, reflecting the high reliance on RECs, which account for 90 percent of electricity supply. This results in a reduction of 5.08 Mt CO_2, or 91.18 percent relative to BAU in 2035. Further reductions are achieved through solar PV deployment of approximately 0.17 Mt CO_2 and biomass power generation of around 0.04 Mt CO_2.

7.2. Electricity Investment Cost for Data Centers

7.2.1. Capital Expenditure

Capital expenditure (CapEx) refers to the investment required to develop captive power plants to supply electricity to data centers at the MM2100 Industrial Area and Nongsa Digital Park. Figure 27 presents the total upfront investment needed to meet electricity demand under each scenario. Under the business-as-usual (BAU) scenario, no additional investment is required at either location, as electricity demand is fully met by the grid.

By contrast, the REC scenario entails relatively lower investment requirements than the 100 percent RE and 100 percent PV scenarios. This is because the REC mechanism does not require the construction of new generation assets; instead, electricity demand is effectively met through the purchase of renewable energy certificates rather than physical power plants. Under this scenario, required investments amount to approximately US$500 million for Nongsa Digital Park and US$316 million for the MM2100 Industrial Area.

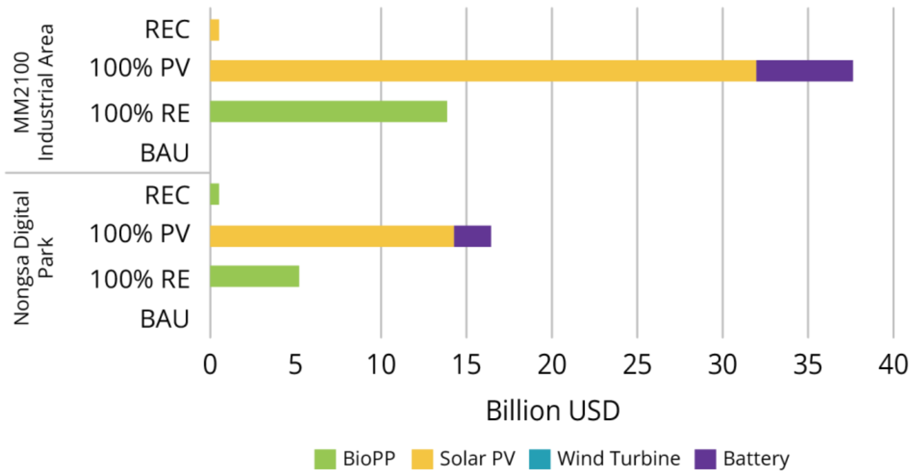
The higher investment requirement at Nongsa Digital Park reflects a shift in electricity supply from full reliance on the grid to a greater dependence on biomass-fired power plants. In contrast, the MM2100 Industrial Area continues to rely predominantly on REC-based electricity due to constraints on local renewable resource availability, resulting in lower overall capital investment.

The 100 percent renewable energy (RE) and 100 percent PV scenarios illustrate the substantial increase in capital expenditure (CapEx) associated with large-scale deployment of captive power plants. Under the 100 percent RE scenario, total investment requirements reach nearly US$5 billion for Nongsa Digital Park and more than US$13 billion for the MM2100 Industrial Area. In both locations, investment is dominated by biomass-fired power plants, accounting for 100 percent of total CapEx in Batam and 99 percent in the MM2100 Industrial Area. The remaining 1 percent in the MM2100 Industrial Area is allocated to solar PV, wind power, and battery storage.

The cost implications are even more pronounced under the 100 percent PV scenario. Because utility-scale solar PV—an intermittent energy source—is assumed to supply the entire electricity demand, battery energy storage becomes a mandatory component to balance supply and demand. With solar PV capital costs projected to remain relatively high in 2035, large-scale deployment entails substantial expense, further compounded by the high cost of battery storage. As a result, the 100 percent PV scenario requires investments of approximately US$16.2 billion for Nongsa Digital Park and US$37.3 billion for the MM2100 Industrial Area.

While the 100 percent PV and 100 percent RE scenarios entail very large investments, the costs captured in this analysis represent only those directly borne by data center operators. By contrast, under the business-as-usual (BAU) and REC scenarios, the relatively low direct investment requirements mask the need for additional generation capacity connected to the grid, which would instead be financed by PLN. From this perspective, rising electricity demand inevitably necessitates new investment; however, the entity responsible for bearing these costs varies depending on the power procurement pathway adopted.

Figure 27. Investment Cost



Source: Authors' calculation

7.2.2. Electricity Production Cost

Figures 28(a)–28(d) illustrate the evolution of electricity production costs under different scenarios for both the MM2100 Industrial Area and Nongsa Digital Park. In 2025, all scenarios are assumed to rely entirely on grid-supplied electricity as the baseline. Electricity prices at Nongsa Digital Park (7.67 US cents/kWh) reflect Sumatra's generation costs, which are slightly higher than those at the MM2100 Industrial Area (7.65 US cents/kWh), where prices are determined by Java's generation mix. These baseline costs are calculated based on the electricity generation composition outlined in the Electricity Supply Business Plan (RUPTL). [61]

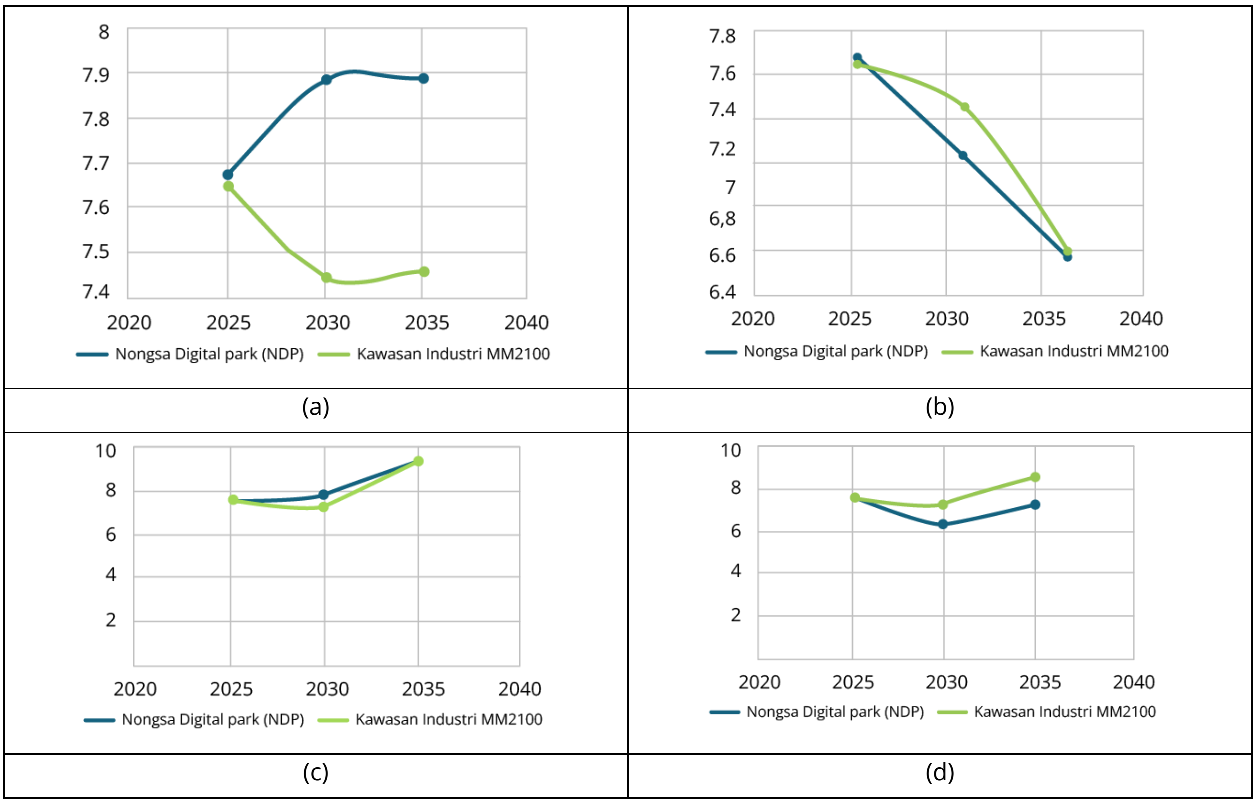
Under the BAU scenario (Figure 28a), electricity prices at Nongsa Digital Park increase modestly, reaching 7.89 US cents/kWh by 2035. In contrast, the MM2100 Industrial Area experiences a gradual decline in production costs over the same period, with prices falling to 7.45 US cents/kWh by 2035. These divergent trends are driven primarily by differences in the projected grid generation mixes in each region. [62]

The 100 percent RE scenario (Figure 28b) yields the lowest electricity production costs among all scenarios. This outcome is driven by the dominance of biomass-fired power generation in both MM2100 Industrial Area and Nongsa Digital Park, which reduces overall system costs. By 2035, electricity production costs decline sharply to 6.62 US cents/kWh at Nongsa Digital Park and 6.67 US cents/kWh at the MM2100 Industrial Area.

In contrast, the 100 percent PV scenario (Figure 28c) exhibits steadily rising electricity costs over time. Reliance on solar photovoltaic (PV) generation and battery energy storage — both of which retain relatively high capital costs through 2035 — drives a continuous increase in the levelized cost of electricity (LCOE). By 2035, production costs reach approximately 9.31 US cents/kWh in both regions, representing an increase of more than 21 percent relative to the 2025 baseline.

Finally, under the REC scenario (Figure 28d), electricity cost trajectories diverge between the two locations. At Nongsa Digital Park, where 57 percent of the generation mix is supplied by biomass power plants, electricity costs decline to 7.28 US cents/kWh by 2035. In contrast, the MM2100 Industrial Area experiences a sustained increase in costs, with LCOE rising to 7.88 US cents/kWh by 2030 and further to 8.77 US cents/kWh by 2035. This increase reflects the heavy reliance on REC-based electricity, which remains consistently more expensive than grid power because REC prices are added on top of the underlying grid electricity cost.

Figure 28. Electricity Production Cost of Each Scenario for Each Region



(a)

(b)

(c)

(d)

Source: Authors' calculation

7.2.3. The Way Forward

Overall, the REC scenario represents the lowest-cost option among the four scenarios. This indicates that investors seeking to develop green data centers in Indonesia can, in the near term, achieve renewable energy sourcing indirectly through renewable energy certificates. A critical question, however, is whether REC-based procurement will be considered acceptable — particularly by hyperscalers. Many hyperscalers prefer direct access to renewable energy and have therefore selected locations that allow direct procurement of renewable electricity.

Nevertheless, some hyperscalers have demonstrated a degree of flexibility. A relevant example is Amazon Web Services, which already utilizes RECs under specific conditions, notably when the certificates are tied to the development of new renewable energy projects.[63] In this context, PLN has shown some flexibility in accommodating hyperscalers' preferences. This approach could be expanded by offering REC mechanisms that are explicitly linked to new renewable capacity, or by jointly exploring alternative REC-based arrangements that are acceptable to both PLN and hyperscalers.

Over the longer term, however, neither PLN nor the government has a viable alternative to progressively greening the grid. Ultimately, enabling the large-scale development of green data centers will require direct access to low-carbon electricity through physical connections to renewable generation, rather than continued reliance on indirect procurement mechanisms.

CHAPTER 8:

Navigating the Future of Green Data Centers

Despite existing governance and infrastructure constraints, Indonesia offers substantial upside for investors seeking long-term exposure to the region's digital and energy transitions. A key strength lies in the government's increasing alignment of digitalization and decarbonization agendas. Policy frameworks such as the Digital Indonesia Roadmap and the National Energy Master Plan (RUEN) recognize data centers as strategic infrastructure and encourage the adoption of renewable energy and energy-efficient technologies in digital operations. In addition, the Ministry of Communication and Digital Affairs has issued voluntary Green Data Center Guidelines aligned with international standards, providing an important signal of policy direction for ESG-oriented investors.

Nevertheless, significant challenges remain. The development of Indonesia's green data center ecosystem is constrained by low digital readiness and limited access to renewable energy, particularly the difficulty of securing direct renewable power supply. Addressing these constraints through improvements in digital governance, regulatory clarity, and renewable energy access is essential to unlocking investment. Ultimately, accelerating the greening of the national power grid will be critical to enhancing Indonesia's competitiveness in attracting green data center investment.

8.1. Improving Digital Readiness

Digital readiness encompasses governance, connectivity, and operational factors that shape investor confidence and determine the competitiveness of Indonesia's data center market. These factors influence not only the ease of data center development and operation but also the ability of facilities to integrate seamlessly into regional and global digital networks. As demand for data center capacity surges, gaps in Indonesia's digital readiness have become increasingly apparent, highlighting structural shortcomings.

Despite Indonesia's large domestic market, the country lags behind key Southeast Asian competitors in digital readiness, limiting the growth potential for green data center investment. Regional leaders, such as Singapore, benefit from advanced digital governance frameworks, clear regulations on data protection and cross-border data flows, and robust digital infrastructure—collectively fostering high network quality and strong investor confidence.

8.1.1. Single-Entity Gateway for Hyperscale Investment

A critical aspect of digital readiness is the ease with which investors can enter, navigate, and operate within a country's regulatory framework. In Singapore, the Economic Development Board (EDB) serves as the primary interface for data center and hyperscale investments, coordinating requirements across digital, cybersecurity, planning, and sustainability regulators. Investors can engage the EDB as a single point of contact throughout the data center lifecycle, receiving clear guidance on approval sequencing and technical compliance.

Malaysia adopts a similar approach through the Malaysian Investment Development Authority (MIDA), which functions as a single gateway for data center and hyperscale investment, coordinating approvals, incentives, and engagement with relevant line ministries. Unlike Singapore, however, MIDA's role is more facilitative than directive.

By contrast, Indonesia's data center investment landscape remains complex. No designated lead institution exists to serve as a single-entry point, requiring investors to engage multiple ministries and agencies directly — covering industrial classification, digital services regulation, energy sourcing, environmental permitting, land use, and cybersecurity. This fragmented approach complicates investment, particularly for green and hyperscale projects that require early alignment on energy sourcing, sustainability standards, and digital governance.

Establishing a dedicated lead entity could provide a centralized interface akin to the EDB or MIDA, streamlining licensing, coordinating cross-sectoral approvals, and improving policy signaling. Such an entity would not replace sectoral regulators but would reduce administrative burdens, enhance inter-ministerial coordination, and create a more attractive environment for investors. Without this institutional focal point, Indonesia risks underutilizing its large domestic market and delaying the development of a competitive, sustainable data center ecosystem, as investors favor jurisdictions offering clearer regulatory pathways and lower entry barriers.

8.1.2. Connectivity Standardization for Digital Infrastructure Development

Connectivity—particularly network quality and latency—is a critical determinant of ease of entry for data center investment. While Indonesia performs above the Southeast Asian average, its network standards remain below what is required to function as a regional data center hub. Leading markets such as Singapore benefit from ultra-low latency, dense internet exchange ecosystems, and extensive subsea cable connectivity, enabling their facilities to serve regional and global workloads with minimal performance loss.

In Indonesia, major telecommunications and digital infrastructure providers have publicly committed to improving national connectivity through investments in subsea cables, terrestrial fiber networks, and expanded internet exchange capacity. Progress, however, has been uneven. Delays and cost overruns frequently stem not from technical limitations but from regulatory and administrative fragmentation.

Local governments often have authority to set fees, conditions, and rights-of-way for cable and fiber deployments, resulting in inconsistent pricing, prolonged negotiations, and uncertainty across jurisdictions. Consequently, despite strong private-sector investment, governance-related obstacles continue to constrain latency reduction and network quality improvements, reinforcing Indonesia’s gap with regional leaders in digital readiness.

8.1.3. Addressing the Absence of the Data Protection Authority

Much of Indonesia's data governance is constrained by the vacant position of its Data Protection Authority, as mandated under Law No. 27 of 2022 on Personal Data Protection (UU PDP). This supervisory body is intended to oversee compliance, issue technical guidelines, and enforce sanctions for data protection violations. Its absence has created a significant regulatory gap, leaving enforcement fragmented across ministries and resulting in inconsistent interpretations of compliance standards.

The vacancy also undermines Indonesia’s role in cross-border data governance. The Data Protection Authority is responsible for assessing the adequacy of foreign data protection regimes and approving mechanisms such as Standard Contractual Clauses (SCCs) or Binding Corporate Rules (BCRs). In its absence, the Ministry of Communication and Digital Affairs (Kominfo) handles these functions on a case-by-case basis, causing administrative bottlenecks. Consequently, Indonesia struggles to meet international compliance expectations, limiting seamless data-sharing arrangements with other jurisdictions and reducing investor confidence in the country’s data governance framework.

8.1.4. Digital Talent Retention

Beyond regulatory structure, digital talent availability represents another binding constraint on Indonesia’s digital readiness. While Indonesia produces a large number of digital workers, there are insufficient incentives to retain mid-level professionals with five to ten years of experience, who are critical for scaling and operating complex digital infrastructure such as data centers or even as system administrators. These professionals are actively drawn to neighboring regional hubs that offer clearer career progression and more competitive compensation structures. Addressing retention at this middle layer is therefore a priority, as without a stable core of experienced talent, improvements in regulatory clarity and connectivity alone will not translate into scalable or resilient digital investment outcomes.

8.2. Greening the Grid

Green data centers require stable, high-quality electricity supply with a significant proportion sourced from renewable energy. Indonesia possesses abundant renewable resources — solar, wind, hydro, and geothermal — but the current energy mix remains heavily reliant on fossil fuels, especially coal, and access to renewable electricity for commercial-scale users such as data centers is constrained by regulatory, technical, and market barriers. Without dedicated measures, the growth of green data centers risks perpetuating dependence on carbon-intensive electricity, undermining environmental objectives, and discouraging investment, especially from hyperscalers. While RECs offer a practical way for data center operators to claim renewable energy use, they do not substitute for the integration of renewable energy into the power system.

Several pathways are available to accelerate greening the grid. These include allowing direct renewable energy procurement, expanding the grid, enhancing grid stability through stand-alone battery energy storage systems (BESS), and prioritizing the dispatch of renewable energy. Although these measures will take time to implement, they are essential to accelerating renewable energy deployment, decarbonizing the economy, and securing Indonesia's long-term competitiveness in the digital and green economy.

8.2.1. Direct Access to Renewable Energy

Direct access to renewable energy for green data centers require complicated mechanisms of licensing and transactions. The core of the problem is that data centers could not enter corporate PPAs directly with independent power producers (IPPs), even if the IPPs are their own subsidiaries. They have to go through a third party, an integrated IUPTLU holder (PLN or private entity with Wilus), and/or a captive power system.

To enhance renewable energy access for green data centers, Indonesia should enable direct procurement of clean electricity by allowing data center operators to enter into corporate PPAs with independent power producers (IPPs). Streamlining permitting and contract approval processes will reduce administrative bottlenecks and encourage long-term investments in renewable energy projects. Additionally, aggregating demand across multiple data centers can improve the commercial viability of renewable energy developments, creating economies of scale and strengthening the business case for sustainable energy supply.

Introducing a clear regulatory framework for power wheeling would further support this objective by allowing renewable electricity generated off-site to be transmitted through existing grid infrastructure to data center facilities. Transparent wheeling charges and non-discriminatory grid access would be essential to ensure bankability and investor confidence.

8.2.2. Grid Integration of Renewables and Expansion

To support the integration of renewable energy into Indonesia's power system, investment in grid modernization is essential. Upgrading infrastructure to accommodate intermittent renewable sources will ensure stability and reliability for high-demand users, including data centers. Expanding transmission and distribution capacity — particularly in regions with abundant renewable resources — will facilitate efficient delivery of clean electricity to major data center hubs, reducing bottlenecks and enhancing system resilience.

However, grid expansion requires substantial investment and is often less attractive for private financing. PLN also faces capacity constraints in modernizing and extending the grid to connect remote generation sites to high-demand locations, including green data centers. Government intervention is therefore critical to support grid expansion. Transmission projects can be facilitated through various government-backed mechanisms, including state capital participation, public–private partnerships (PPPs), sharia-compliant financing, deferred payment schemes, and dedicated financing institutions such as PT Sarana Multi Infrastruktur.

The private sector can also play a role through models that improve commercial viability. One promising approach is a Build–Own–Operate–Transfer (BOOT) arrangement, under which a private entity finances, constructs, and operates transmission lines under a long-term joint utilization scheme. At the end of the contract, the assets are transferred to PLN, which assumes capital recovery and operational costs according to agreed mechanisms. This model can help overcome PLN's limitations in transmitting renewable electricity from remote generation sites to green data centers concentrated in major urban areas, while leveraging private investment to accelerate grid modernization.

8.2.3. Stand-Alone Battery Energy Storage System (BESS)

Battery energy storage systems (BESS) are commonly used to store surplus renewable electricity and discharge it during periods of peak demand. BESS can be deployed alongside a single renewable generator or operated as a stand-alone facility serving multiple generators. Stand-alone BESS provides greater flexibility by allowing multiple renewable energy sources to share storage capacity, thereby enhancing grid stability, mitigating intermittency, and reducing curtailment. By improving reliability and enabling higher penetration of renewable energy, stand-alone BESS plays a critical role in supporting a cleaner and more resilient power system.

Despite these benefits, Indonesia's current regulatory framework does not explicitly recognize or regulate stand-alone BESS. This study proposes two operational models: PLN-owned BESS and third party-owned BESS. In the PLN-owned model, stand-alone BESS would be owned, installed, operated, and maintained by PLN. Such facilities could arguably be classified as part of transmission activities. To provide legal clarity and regulatory certainty, Government Regulation No. 14/2012 may need to be amended to explicitly recognize stand-alone BESS as part of transmission. This amendment could clarify that transmission encompasses the transfer of electricity from power plants to stand-alone BESS for storage, prior to delivery to the distribution system or use for inter-system transmission.

The third party-owned model allows storage assets to be owned by private entities and operated under contractual arrangements with PLN and/or other market participants. Drawing on international best practices, third party-owned BESS can be structured under two schemes: tolling agreements and capacity agreements. Under a tolling agreement, a private company owns the BESS, provides operation and maintenance services, and leases storage capacity exclusively to PLN. Under a capacity agreement, multiple off-takers—including PLN, other integrated IUPTLU holders, and IUPTLS holders—procure storage capacity and grid stabilization services from a third-party BESS provider. These models provide flexibility in financing, ownership, and operational responsibility, enabling broader deployment of stand-alone BESS to support renewable energy integration.

8.2.4. Must-Dispatch Mechanism for Renewable Energy

Under MEMR Regulation No. 5 of 2025, PLN is required to prioritize the dispatch of renewable power plants and take their operational conditions into account when planning and executing electricity dispatch. In practice, this means renewable generation should be dispatched ahead of conventional sources to maximize renewable energy utilization within the electricity system.

Implementation, however, faces significant challenges. PLN is simultaneously bound by MEMR Regulation No. 10 of 2017, which mandates that dispatch planning follow least-cost principles while considering the technical operating conditions of power plants to meet load forecasts. Since renewable energy generation is generally more expensive than conventional sources, this requirement can limit the actual dispatch of renewables. Over time, this misalignment may reduce the profitability of renewable energy generators and weaken incentives for further investment.

8.3. Toward a Regional Green Data Center Hub

Enhancing digital readiness and greening the electricity grid can accelerate the development of green data centers across Indonesia. With abundant renewable energy resources, the country is well positioned to become a regional hub for sustainable digital infrastructure. Reliable access to clean energy, combined with predictable regulatory frameworks and strong digital readiness, strengthens investor confidence and encourages long-term investment in green data center projects. In addition to supporting the digital sector, expanding renewable energy use advances Indonesia's broader climate objectives, including reducing carbon intensity in the electricity sector and facilitating the transition to a low-carbon energy system.

To realize Indonesia's potential as a regional green data center hub, strong cross-sectoral collaboration between the digital and electricity sectors is essential. Key power-sector stakeholders include the Ministry of Energy and Mineral Resources (MEMR), PT PLN (Persero), the Ministry of Industry (MOI), the Ministry of Finance (MOF), and Bappenas. In the digital sector, oversight is primarily provided by the Ministry of Communication and Digital Affairs (Komdigi), coordinated by the Coordinating Ministry for Political, Legal, and Security Affairs. Effective coordination among these agencies is critical to ensure that renewable energy availability aligns with the operational needs of green data centers, supporting both sustainable electricity supply and the growth of Indonesia's digital infrastructure.

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