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Research Paper

Greenship Data Center – A Green Data Centre Standard for Indonesia

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Abstract

Data centers are becoming increasingly important in today's digital age, as they offer a more sustainable and energy-efficient approach to managing and storing data. With the growing awareness of environmental impact and the need for sustainable practices, it is crucial to develop standardized rating tools for green data centers. This paper aims to provide a comprehensive overview of the development process of green data center standard rating tools, tailored to the unique context and challenges faced by Indonesia. The Greenship Data Center (DC) is developed by a collaboration between the Green Building Council Indonesia (GBC Indonesia) and IPUSTAH-ID (Ikatan Profesional Pusat Data Hijau Indonesia - Association of Indonesia Green Data Center Professionals). This paper also explores the key components and considerations for developing the Greenship DC. Furthermore, challenges and potential solutions will be addressed for implementing these rating tools in the Indonesian context.

Keywords: *Green Data Center, Sustainabilty, Rating System, Digital Twin*

INTRODUCTION

This paper aims to describe the development of green data center rating system specifically designed for Indonesia. Indonesia, being the fourth most populous country in the world, has a rapidly growing digital infrastructure. Meanwhile, Indonesia showcases various climate zones depending on location. Some regions, like coastal areas on Sumatra and Java, experience daily highs averaging 32°C and occasional peaks around 34°C over the past 20 years. Humidity can also surpass 80% in these areas (ASHRAE, 2021) (van Noordwijk, et al., 2020). As the demand for data centers increases, it becomes imperative to ensure that these data centers are built and operated in an environmentally friendly manner.

The objective of this paper is to provide a comprehensive overview of the development process for green data center standard rating tools, tailored to the unique context and challenges faced by Indonesia. By establishing a standardized rating system, we can incentivize and guide data center operators towards adopting greener practices, reducing energy consumption, and minimizing their carbon footprint. Green data centers are becoming increasingly important in today's digital age, as they offer a more sustainable and energy-efficient approach to managing and storing data (Mukherjee, Chakraborty, Sarkar, Ghosh, & Roy). With the growing awareness of environmental impact and the need for sustainable practices, it is crucial to develop standardized rating tools for green data centers (Gupta, 2021).

In order to take benefit by establishing such a standardized green DC rating tools, the Greenship Data Center (DC) is developed by a collaboration between the Green Building Council Indonesia (GBC Indonesia) and IPUSTAH-ID (*Ikatan Profesional Pusat Data Hijau Indonesia* – Association of Indonesia Green Data Center Professionals). To test such rating tools, we piloted the Indonesia's National Data Center (NDC) which is being built in an area of about 40,000 m^2 in

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Cikarang and will be inaugurated by the President of Indonesia in mid-2024.

GREENSHIP DATA CENTER: THE PROPOSED RATING SYSTEM OF GREEN DC FOR INDONESIA

The Importance of Green Data Center Certification for Indonesia

A nationally developed green data center certification is important for Indonesia due to several reasons. Firstly, as the fourth most populous country in the world, Indonesia has a massive demand for data storage and processing. With a rapidly growing digital infrastructure, there is an increasing need for data centers to support the country's digital transformation. However, traditional data centers consume significant amounts of energy, contributing to carbon emissions and environmental degradation.

By implementing the specific green data center certification in Indonesia, the country can reap numerous benefits. One of the primary advantages is the reduction of carbon emissions. Green data centers are designed to be energy-efficient, employing advanced technologies and practices to minimize power consumption. This would help Indonesia in achieving its climate change mitigation goals and contribute to global efforts in reducing greenhouse gas emissions.

Furthermore, the specific certification can promote innovation and attract investment in the digital sector. As the world becomes increasingly conscious of environmental sustainability, companies are seeking data centers that align with their green initiatives. By certifying data centers as environmentally friendly, Indonesia can position itself as a preferred destination for businesses looking for sustainable infrastructure. This would stimulate economic growth, create employment opportunities, and enhance the country's digital competitiveness.

Moreover, such a certification can contribute to the overall resilience and reliability of Indonesia's digital infrastructure. Traditional data centers often face challenges related to power outages and cooling issues, which can result in service disruptions. By adopting sustainable practices, data centers can enhance their energy backup systems, improve cooling efficiency, and implement disaster recovery measures. This would ensure uninterrupted data services, even during extreme weather conditions or emergencies.

To get such benefits mentioned above a nationally proposed green data center certification Rating has been developed – namely The Greenship Data Center – by a collaboration between the Green Building Council Indonesia (GBC Indonesia) and IPUSTAH-ID (Ikatan Profesional Pusat Data Hijau Indonesia – Association of Indonesia Green Data Center Professionals).

The Green Building Council Indonesia (GBC Indonesia) is an independent, non-governmental and not-for-profit organization fully committed to educating the public on environmental best practices and facilitating the sustainable transformation of the building industry. GBC Indonesia's objective is to transform the market and promote the adoption of green building principles to the public and society within the building sector. To accomplish its objectives, GBC Indonesia partners with various stakeholders in the construction industry, such as construction professionals, building material manufacturers, property developers, governmental bodies operating through the State-owned Enterprises (SOE or BUMN) sector, educational and research institutions, professional associations, and environmental organizations. The collaboration aims to enhance sustainability in the building sector.

GBC Indonesia engages in four core activities: market transformation, education and training, green building certification utilizing an exclusive Indonesian assessment tool named GREENSHIP, as well as certification programs conducted in partnership with other independent organizations, and collaborative programs with stakeholders. As an established member of the World GBC (Green Building Council), GBC Indonesia is the sole green building council organization in Indonesia holding global recognition.

Currently, GBC Indonesia is operating two distinct certification systems, i.e. self-proclaimed

green buildings, and certified green buildings. GREENSHIP certification is derived from several GREENSHIP rating tools that have already been created by GBC Indonesia, which currently encompass seven certification types:

1. Greenship New Building,
2. Greenship Existing Building,
3. Greenship Interior Space,
4. Greenship Homes,
5. Greenship Neighbourhood,
6. Greenship Net Zero Healthy, and
7. Greenship Data Center.

Greenship DC Rating System

a. The Scope of Greenship DC

The scope of Greenship DC encompasses a variety of Data Center types, from [1] Colocation, [2] Enterprise, [3] Cloud, [4] Edge, and [5] Micro.

Table 1. The Scope of Greenship DC

GREENSHIP DC				DC Types
No	**Data Center Facility**	**Sustainability**	**Meaning**	
1	**DCF +**	Greenship NB 2.0	DC as a new building	[1], [2], [3]
2		Greenship EB	DC as an existing building	[1], [2], [3]
3		Greenship Neighborhood	DC consists of several buildings	[1], [2], [3]
4		Greenship Interior Space	DC in a part of a building	[1], [2], [3]
5		Greenship Homes	Small DC in the form of containers, homes, rooms	[4], [5]

The rating tools currently being developed by GBCI are listed in the Sustainability column. The Greenship DC uses these existing rating tools to provide a wide range of services such as New Building DC (NB), Existing Building DC (EB), Multiple DC Buildings in a Neighborhood (GN), Indoor DC (IN), and Small DC in the form of containers, homes, rooms. Currently, the Greenship DC is developed based on the Greenship NB 2.0.

b. Topology of Data Center and Supporting Areas

The following figure illustrates the main areas of a standard data center and their relationships with each other and the spaces outside the data center. The Building Site consists of electrical substations or power station, water inlet, water treatment plant, waste-water treatment plant, telecommunication line and equipments, cooling equipments. Within the DC building as the building envelope, there are three main spaces, i.e. (1) general office space, (2) utility space, and (3) Data Center (DC). The utility space consists of telecommunications & equipment rooms, serving spaces outside DC. Moreover, within the DC, there are at least 6 rooms, i.e. (1) entrance room(s), (2) support staff offices, (3) operations center, (4) data center physical infrastructure (DCPI), (5) storage rooms & loading docks, and (6) computer room (TIA, 2017). See the following figure.

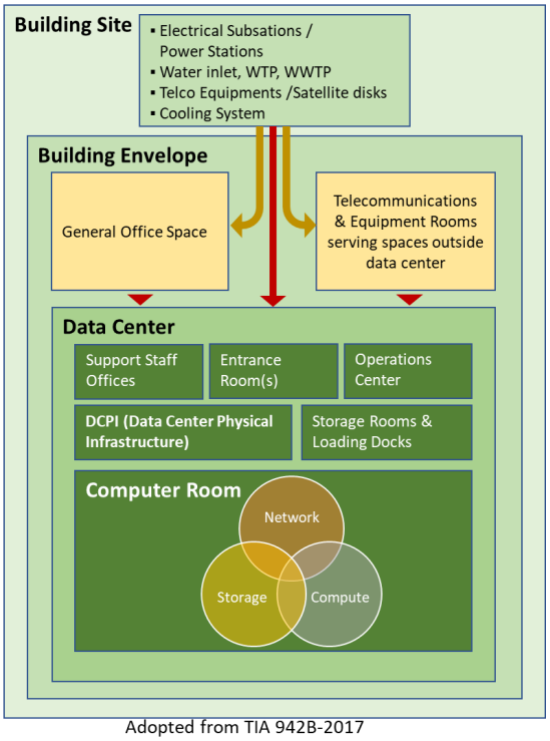


Figure 1. Topology of data center and supporting spaces

The Greenship DC pays attention not only to the environmentally friendly elements of various Data Center facilities and equipment but also to the comfort and health of the environment for humans in the Data Center environment. The following table shows the relationship between the category of Greenship DC and the above-mentioned spaces. The first element is included in the Data Center Facility (DCF) category and the second element is related to the Building Site and Building Envelope. The basis for formulating the second element is taken from Greenship New Building 2.0.

Table 2. The Service Provision By Each Category

	CATEGORY		BUILDING SITE	BUILDING ENVELOPE	DATA CENTER	
					Outside CR (occupied room)	Computer Room (non-occupied room)
	DCF	Data Center Facility	×	×	ü DCPI	ü ICT
GREENSHIP NB 2.0	ASD	Appropriate Site Development	ü	×	×	×
	EEC	Energy Efficiency and Conservation	×	ü	ü	ü
	WAC	Water Conservation	ü	×	ü	×
	MRC	Material Resources and Cycle	×	ü	ü	ü
	IHC	Indoor Health and Comfort	×	ü	ü	×
	BEM	Building Environment Management	ü	ü	ü	ü
	INN	Innovation	ü	ü	ü	ü

Note: DCPI: Data Center Physical Infrastructure; ICT: Information & Communication Technology

c. The I-TEAMS

The basic framework of the Greenship DC assessment tool can be grouped into 6 Dimensions namely (1) Information Technology, (2) Telecommunications, (3) Energy & Electricity, (4) Architecture, (5) Mechanical Facilities & Security Systems, and (6) Sustainability/Greenship and abbreviated as I-TEAMS. The following table shows an explanation of each of these categories.

Table 3. Explanation of Each Categories

	DIMENSION	DESCRIPTION	RELATED CATEGORY
1.	**I**nformation Technology	This rating tool is to ensure that ICT equipment implements energy resources conservation, efficiency, and sharing.	DCF
2.	**T**elecommunications	This rating tool is to measure the improvement of energy efficiency by implementing software-defined networks, micro-segmentation, and overlay networks.	DCF
3.	**E**nergy & Electricity	This rating tool is to measure the improvement of resources conservation, efficiency, and sharing by implementing energy and carbon usage effectiveness, cooling performance level, and green energy.	DCF
4.	**A**rchitecture	This rating tool is to measure the improvement of appropriate site development.	ASD
5.	**M**echanical Facilities & Security Systems	This rating tool is to measure the improvement of cooling, airflow, thermal, water usage management.	DCF
6.	**S**ustainability / Greenship	This rating tool is to measure the improvement of energy efficiency and conservation, water conservation, material resource and cycle, indoor health and comfort, and building environment management.	EEC WAC MRC IHC BEM INN

d. Certification Stages

- Design Recognition (DR)
  At this stage, the project team could get a temporary award for the project at the design and planning finalization stage based on the GREENSHIP assessment tool. If the application for the DR stage has already entered the construction stage, the assessment can use shop drawings as a substitute for tender drawings.
- Green Readiness (GR)
  At this stage the Data Center is ready to support the fulfillment of the green data center criteria. In general, what has been built and installed are electrical and mechanical supporting facilities such as cooling and lighting systems, however the ICT equipment in the data hall may not be fully operational. In data centers that provide collocation services, the priority is the functioning of electrical and mechanical support facilities.
- Green Operation (GO)
  At this stage, GO certification is given to a data center where ICT equipment is already functioning.

e. Certification Levels

The threshold criteria for Greenship DC certification levels are as follows.

Table 4. Threshold Criteria for Greenship DC Certification Levels

LEVEL	PERCENTAGE (%)	RECOGNITION*
PLATINUM	73 – 100	Global Leadership
GOLD	57 – 72	National Excellence
SILVER	46 – 56	Outstanding Performance

CERTIFIED	35 – 45	Best Practices

*) adopted from India Green Building Council (IGBC). URL: https://igbc.in/igbc-green-new-buildings.php

Digital Twin – the Cornerstone of Future Green Data Centers – The Ultimate Feature of Greenship DC

The Green Grid (TGG) created cooling performance metrics to ensure that energy savings do not compromise the facility's ability to house and protect equipment during normal and resilient operation throughout its lifespan. TGG defines the thermal conformance and thermal resilience of the IT as the cooling performance metrics. Data centre owners and operators can use these metrics to balance thermal performance and energy efficiency (Nemati, Zabalegui, Bana, & Seymour, 2018). Based on these metrics, TGG created the Cooling Performance Levels of Assessment to establish where a data center stands. Then the data center owner/operator can choose from four levels of performance assessment based on the accuracy and amount of information available about the facility (Seymour, Maira, David, Danny, & Veerendra, 2016). The fourth level requires the use of a calibrated Computational Fluid Dynamics (CFD) to replicate data center operations. This is what is referred to as the Digital Twin (Grieves, 2023).

The importance of digital twin technology in developing a green data center future cannot be overstated. As the demand for data centers continues to rise, so does the need for sustainable solutions that minimize energy consumption and reduce environmental impact. Digital twin technology offers a powerful tool to achieve these goals (Singh , Fuenmayor, Hinchy, & Qiao, 2021) (Crespi, Drobot, & Minerva, 2023).

One of the key benefits of digital twin technology is its ability to provide real-time monitoring and simulation of the data center environment. By creating a virtual replica of the physical infrastructure, data center operators can gain valuable insights into the performance and efficiency of different components (Suganya, Buhari, & Rajaram, 2022). This enables them to identify inefficiencies and optimize energy usage, ultimately reducing the carbon footprint of the data center. The ability to simulate different scenarios and workloads also allows for better capacity planning and resource optimization, further contributing to sustainability efforts (Cao, et al., 2023).

While the adoption of digital twin technology may present challenges such as data security concerns and initial costs, the long-term benefits far outweigh these obstacles. The ability to monitor and optimize energy usage, predict equipment failures, and simulate different scenarios for resource allocation positions data centers at the forefront of the green revolution. By embracing digital twin technology, data centers can play a vital role in developing a green and sustainable future, where efficient and environmentally friendly operations are at the forefront of their priorities (Corrado, DeLong,, Holt, Hua, & Tolk, 2022) (Onan Demirel, Irshad, Ahmed, & Tumer, 2021).

Having Platinum Level Certification, The Indonesia's National Data Center To Implement Digital Twin

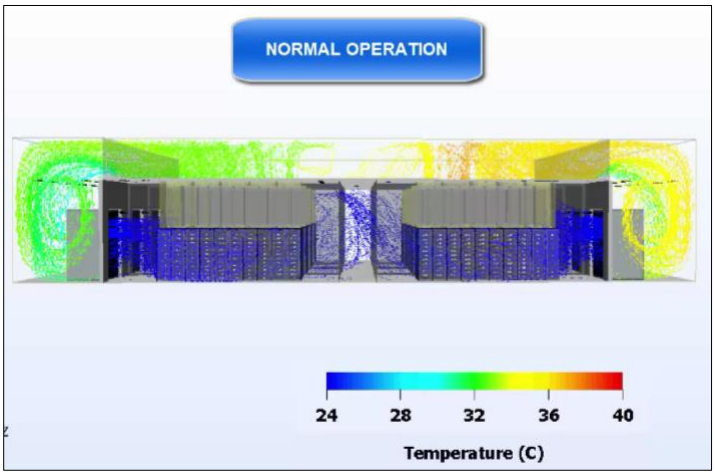
Figure 2. Indonesia's National Data Center located in Cikarang, West Java

Courtesy: The Ministry of Communications and Informatics (MCI), Republic of Indonesia.
Source: S. Nikzad (Aug 2023). Strengthening of e-Government Infrastructure in Jabodetabek Area. MCI, KSO Yodya-KNR, Ellipse Projects

One of the Indonesia's National Data Centers (NDC) is currently being built in Cikarang, West Java by the Government. It is estimated to be completed in October 2024. The government claims that it will be able to overcome the integration challenges that arise regarding the NDC. Integration challenges arise from several aspects such as physical development, procurement of technical instruments to operate NDC and preparation of supporting policies.

Development of the NDC follows to the availability and sustainability standards. The availability standard would comply to the SNI 8799-1: 2019 strata 4, Uptime Tier IV, and ANSI TIA 942-B :2017 Rate 4. Whereas the sustainability standard would comply to the Greenship DC Platinum level, and the certificate of Bangunan Gedung Hijau "*Utama* (Advance)" level. The NDC is built on the land area of 49,491 m2 consisting of the main building with IT rooms; training center building; other supporting infrastructures; and landscape, outdoor parking areas, and infrastructure. To make the ICT devices available according to the needs of the early stages, the sizing requirements consisting of at least 25,000 core processor, 200 TB memory and 40 Peta Byte storage.

Since the NDC has received the Platinum level of the Greenship DC, digital twin technology would be implemented.



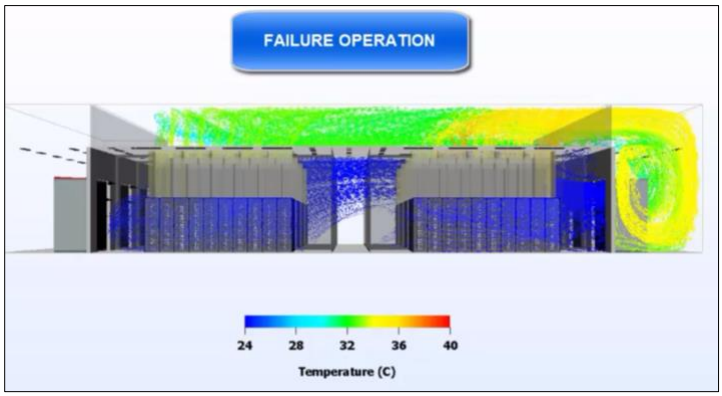


Figure 2. A typical simulation performed by using digital twin technology to show the airflow inside the data hall of the NDC.

Source: Ellipse Projects

CONCLUSIONS AND FURTHER RESEARCH

The Greenship Data Center (DC) is a certification rating tools for green data center. It is developed by regarding the specific conditions of Indonesia. In which, it is crucial considering its population, digital infrastructure growth, and climate conditions. It not only helps in reducing carbon emissions and achieving environmental sustainability goals but also leads to cost savings, promotes innovation, attracts investment, and enhances the resilience and reliability of the country's digital infrastructure. By prioritizing green practices, Indonesia can position itself as a leader in sustainable technology and contribute to a greener and more sustainable future.

The Greenship DC is developed by a collaboration between the GBC Indonesia and IPUSTAH-ID. A pilot test has been performed with the Indonesia's National Data Center (NDC) that achieved Platinum certification award.

In conclusion, Greenship DC as a green data center standard rating tools for Indonesia is a significant step towards achieving a more sustainable and environmentally conscious digital infrastructure. This paper has explained a comprehensive guide for the development and implementation of these rating tools, with the goal of creating a greener and more energy-efficient data center industry in Indonesia.

Further research to improve the Greenship DC rating tools standard can be listed at least in three areas. Firstly, digital decarbonization is a trend in the data center industry due to its ability to improve efficiency, enhance security, provide scalability, and promote environmental sustainability (Cao, Zhou, Hu, & Wang, 2022) (Ahwazi, Bordin, Mishra, & Horsch, 2021, December). Secondly, green data centers are essential components of the digital infrastructure supporting various industries and facilitating the transition to a sustainable digital future (Verdecchia, Lago, & de Vries, 2022) (Shuja, GanI, Shamshirband, Ahmad, & Bilal, 2016). Thirdly, digital technology, particularly green data centers, plays a vital role in achieving a net-zero future. By prioritizing the importance of digital technology, specifically highlighting green data center, we can pave the way for a more sustainable and environmentally friendly future (Brunschwiler, Smith, Ruetsche, & Michel, 2009) (Aldossary & Alharbi, 2022).

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