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Increasing Electrical Efficiency with the Application of Green Building Certificates in High-rise Buildings (Case Study of Bahana Tower Building)

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Abstract:- Green Building Certification is a green building assessment system in Indonesia that requires a project to meet a series of prerequisites and earn credits in several predetermined categories. In the certification, process several criteria are indeed a requirement, including ASD (Appropriate Site Development), EEC (Energy Efficiency and Conservation), WAC (Water Conservation), MRC (Material Resources and Cycle), IHC (Indoor Air Health and Comfort) and BEM (Building Environment Management). In this study, the focus will be on the efficiency of the use of water and electricity. The evaluation was carried out by discussing the use of water or WAC and the efficiency of electricity use (EEC). after the WAC and EEC evaluations were carried out to see the efficiency of water and electricity, electricity and water cost savings were obtained of 5 billion per year or equivalent to 61 percent of the Baseline (Refer to the SNI Standard). With a payback period with investment costs for 2 years 8 months 46 days.

***Keyword**:- Green Building, Baseline, Efficiency.*

I. INTRODUCTION

A. Background

The issue of Global Warming is currently the concern of most of the world's people today. One of the causes is carbon dioxide emissions from burning fossil fuels. The effects of global warming itself can be felt lately. Some scientists believe that the recent climate anomaly is one of the consequences of global warming. To minimize this effect, the world agreed to reduce the greenhouse effect, by making it energy-efficient.

Development in the field of building construction or property from year to year is growing both in terms of design and quality of the building. Currently, the development of many building constructions leads to green buildings or commonly called Green Buildings. In the United States, investors are starting to look at green building opportunities as a long-term investment because the operational costs of green buildings are more efficient than conventional buildings (Biyanto, 2014). Green building is an environmentally friendly building concept that has become a special concern in various countries and has begun to be applied in Indonesia. The green building concept is one of the energy-saving efforts that can be applied to a building.

Green buildings or often referred to as Green Buildings include in various ways including energy use, waste management, and waste minimization, and environmental quality in buildings. To determine whether the building is a Green Building by applying the standards set by GBCI (Green Building Council Indonesia). Among the standards is to use 6 aspects for new buildings that have been set. These aspects are ASD (Appropriate Site Development), EEC (Energy Efficiency and Conservation), WAC (Water Conservation), MRC (Material Resources and Cycle), IHC (Indoor Air Health and Comfort), and BEM (Building Environment Management). By implementing Green Building, it will provide many advantages including low operating and building maintenance costs due to the efficient use of electrical energy and water. In addition, the environmental quality is quite good, with the efficient use of energy and water used for savings.

B. Formulation of The Problem

How to efficiently use electricity and water in the Bahana Tower Building, using the standards set by the Green Building in Indonesia, namely the GBCI Standard, in particular the use of parameters from EEC and WAC?

C. Research Purpose

The purpose of this study is to streamline the use of electricity and water in the building at the Bahana Tower Building (with the limits of the EEC and WAC parameters), into a Green Building standard in Indonesia, namely the GBCI Standard

II. METHOD

The study began with an assessment of the Green Building criteria in the Bahana Tower building. The collection and analysis of building data were carried out. by looking for theoretical references that are relevant to the cases or problems found.

Case analysis with a quantitative research approach to calculate the OTTV value in the Bahana Tower building. OTTV or Overall Thermal Transfer Value is a proportion calculation based on orientation, area, conduction, and radiation capability and this can be accommodated in calculating the heat transfer value. The quantitative approach was chosen because the research process uses data coverage

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in the form of numbers and statistics with the following process (OTTV calculation according to SNI 03-6389-2011):

- Calculation of Heat Transfer through conduction by material still (Qw)
- Calculation of Heat Transfer through conduction by transparent materials (Qf1)
- Calculation of Heat Transfer through radiation by transparent material (Qf2)

So that the calculation of the OTTV value can be formulated as follows :

$$OTTV = \alpha\,[(Uw\;x\;(1 - WWR)xTDek] + (U1\;x\;WWR\;x\;\Delta T) + (SC\;x\;WWR\;x\;SF)$$

Ket :

OTTV: the Overall Thermal Transfer Value on the outer wall that has a certain direction or orientation (W/m2)

α : Absorbance of Solar Radiation

Uw : Translucent wall thermal transmittance (W/m2.K)

WWR : The ratio of the window area to the area of the entire outer wall at the specified orientation.

$TDek$: Equivalent temperature difference (K)

SF : Solar Radiation Factor

SC : Shade Coefficient of Penetration System

U1 : Fenentration Thermal Transmittance (W/m2. K)

ΔT : The design temperature difference between the outside and the inside (taken 5K)

In addition to the calculation in terms of EEC (in this case the main thing is the calculation of OTTV), it is also taken into account in terms of water savings in this case the parameter used is WAC (Water Conservation). In calculating water efficiency using WAC parameters, namely using the parameters that have been set by GBCI (Green Building Council Indonesia). The parameters and calculation of each parameter will be explained more clearly in the analysis and discussion.

III. RESEARCH RESULTS AND DISCUSSION

D. Standard Condition of Bahana Tower Building

Bahana Office Tower is an office building located in the Mega Kuningan area. It is an office building in South Jakarta since 1998. Located in the Mega Kuningan area which is one of the best business areas in Jakarta, it certainly provides added value for this building.

This building has 49 floors with a composition of 45 floors and 4 basements, has a GFA (Gross Floor Area) floor area of 139,479 m2, and an NLA (Net Lettable Area) area of 62,280.90. In addition, this building has a facade area of 27,289.62 m2 and a user capacity of 5190 people (assuming 12 m2/person). In this study, the facade used is assumed to use clear glass without shading and spandrel. And also this building uses an air cooling system with a centralized system using Chiller Water Cool.

E. Building Eligibility Requirements

A building must meet the building eligibility requirements before the appraisal process is carried out. This eligibility requirement has been regulated and stipulated in the Greenship for Constructed Buildings based on Law No. 28 of 2002 concerning buildings. The building eligibility requirements that must be met include the following:

1. The area of the Bahana Tower building

The Bahana Tower building has met the minimum building eligibility requirements because it has a total area of 139,479.79 m2, with 49 floors, with details of the area as shown in the following table:

Table 1
The Overall Area of the Bahana Tower

Floor	Sqm (m^2)
B1-4	48.266,00
1	1.970,29
M	1.966,76
2-5	12.418,83
6-9	7.492,69
10-30	40.187,83
31-43	25.296,40
44	1.883,00
Total	**139.479,79**

2. The Function of the Building According to the Land Use Based on the Local RTRW

The Regional Spatial Plan (RTRW) is a general spatial plan for the city area, as an elaboration of the national RTRW and provincial RTRW. This RTRW plan contains objectives, policies, urban spatial planning strategies, urban spatial structure plans, urban spatial pattern plans, determination of urban strategic areas, directions for the use of urban space, as well as provisions for controlling the use of urban space.

Based on the results of the information and observations that have been made at the location, it was found that the land allotment in the site area of the Bahana Tower Building has met the spatial requirements as an office building. This is by Law no. 28 of 2002 concerning Buildings, Article 6 paragraph (1) concerning the Government which requires buildings with social and cultural functions to comply with the location allotment regulated in the Regional Regulation on Regency/Municipal Spatial Planning. The results of observations made in the area have indeed been determined as office locations. Because the Bahana Tower building is located in Mega Kuningan where it is an office building.

3. Ownership of Environmental Management Efforts (UKL) or Environmental Monitoring Efforts (UPL)

Based on Law no. 32 of 2009 concerning Environmental Protection and Management in Article 34 states that every type of business that does not include changing the landscape and exploiting natural resources must have an Environmental Management and Environmental Monitoring Business (UKL-UPL). According to the results of information and observations that have been made at the location, it is known that all building areas in the Bahana

Tower Building have environmental documents, both AMDAL and UKL-UPL. In this case, the environmental permit and building construction permit are some of the conditions that must be met in making a building a Green Building.

4. Building Compatibility with Earthquake Resistance Standards

A high-rise building must have a standard of resistance to earthquakes. This has been regulated in Law no. 28 of 2002 concerning Buildings, Article 18 paragraph (1), namely regarding the requirements for the ability of a strong and stable building structure up to the maximum loading conditions of the building to support live loads and dead loads, as well as the ability to support loads that arise due to natural behavior. , like an earthquake.

Based on the information and observations that have been obtained at the location, it is known that the Bahana Tower Building has the main structure in the form of reinforced concrete, which is designed as an earthquake-resistant building, with the foundation structure using a cobweb foundation. This shows that the Bahana Tower Building has met the building eligibility requirements for earthquake resistance standards.

5. Conformity of the Building to the Accessibility Standards for Persons with Disabilities

Based on Law no. 28 of 2002 concerning Buildings, Article 31 concerning the provision of facilities and accessibility for persons with disabilities and the elderly is a must for all buildings, except residences. The regulation is clarified in Ministerial Regulation No. 30/PRT/M/2006, namely the Technical Guidelines for Facilities and Accessibility in Buildings and the Environment. The facilities in the Bahana Tower Building can be seen in the table below:

Table 2
Principles of Implementing Building Facilities for Persons with Disabilities in the Bahana Tower Building

No.	Technical Guidelines and Accessibility	Application in the Bahana Tower
1.	Room Base Size	OK
2.	Door	OK
3.	Stairs	OK
4.	Lift	OK
5.	Sink	OK
6.	Toilet	OK
7.	Furniture	OK
8.	Control and Equipment	OK
9.	Telephone	OK
10.	Sign	OK

6. Building Compliance with Fire Safety Standards

Based on Law no. 28 of 2002 concerning Buildings, in Article 17 paragraph (1), namely regarding building safety requirements which include the requirements for the building's ability to support loads, as well as the building's ability to break down and cope with fire and lightning hazards.

In addition, the capability of the building also includes security against fire hazards, either through active or passive protection systems. Active protection systems available on every floor of the Bahana Tower Building include fire alarms, warning systems, and light fire extinguishers (APAR). Based on on-site observations, fire alarms, hydrant systems, and light fire extinguishers (APAR) on each floor of the building are functioning properly.

In a Green Building certification, the main requirements in the Green Building assessment must be met. The 6 qualifications mentioned above are the initial basis for proceeding to the next certification. So to get Green Building certification, you must meet the 6 eligibility mentioned. In this case, the Bahana Tower building has met the eligibility requirements, so that it is continued with an assessment of other aspects that are prerequisites and conditions for determining Green Building certification. But in this case, the author only limits to a discussion of EEC and WAC related to energy efficiency.

F. Efisiensi and Konservasi Energi (EEC)

Energy Efficiency and Conservation (EEC) is very important for a building because the need for energy use in buildings varies from the construction stage to building operations and maintenance. The operation of air conditioning, escalator facilities, and artificial lighting is the largest energy consumption compared to other facilities.

EEC prerequisite 1 will be met if a building has a kWh meter to measure electricity consumption. The Bahana Tower building has a kWh meter (TR Panel) which has the task of delivering electricity to each side of the building, so the EEC prerequisite 1, namely the installation of the Sub-Meter has been fulfilled.

Prerequisite EEC Criterion 2 emphasizes the function of the building to teach users about their concern for the environment, namely by calculating the overall thermal transfer value (OTTV). Calculation of OTTV formed 24 alternatives that are taken into account, with the following results:

a. 6 alternatives with OTTV value < 26 Watt/m2,
b. 8 alternatives with OTTV values between 27 – 35 Watt/m2,
c. 10 alternatives with OTTV values > 35 Watt/m2.

From the results of the three alternative categories above, the Bahana Tower Building meets the first alternative with an OTTV value of <26 Watt/m2.

EEC 1 for a building, which is an energy-saving measure. As is well known, fossil energy which is the primary energy source to produce electrical energy is non-renewable energy and has many negative impacts. The energy-saving measure (EEC 1) carried out by the Bahana Tower Building is considered quite effective by suppressing the overall thermal transfer value (OTTV) on 4 typical floors.

EEC 2, i.e. natural lighting. The Bahana Tower building has transparent/glass openings, with a total of 481 transparent/glass openings. This transparent opening serves as natural lighting in the building. So it can be concluded that the Bahana Tower Building has met the criteria for natural lighting

EEC 3 deals with ventilation. The management of the Bahana Tower Building focuses on the ventilation system in a closed room, namely equipping it with an air conditioning system or AC, because most of the building area is a closed room.

EEC 4 on new buildings arises because 30-40% of the world's total greenhouse gas emissions come from the construction sector of a building. This is because most of its operations use fossil fuels as an energy source. If allowed to continue, it is predicted that in the next 20 years, greenhouse gas emissions from the development sector will be doubled. The Bahana Tower building has been designed as an environmentally friendly building.

EEC 5 is a bonus criterion, namely renewable energy on-site. The results show that by utilizing renewable energy, the Bahana Tower Building has an additional power of 1,844.61 kW, with a backup power percentage of 8.08%. So it can be concluded that the Bahana Tower Building has met the criteria for renewable energy on the site (EEC 5).

The results of the Energy Efficiency and Conservation (EEC) criteria at the Bahana Tower Building can be summarized in the table below:

Table 3
Summary of Earning Efficiency and Energy Conservation (EEC) Points at Bahana Tower

Code	Criteria	Fulfill		Points
		Yes	No	
ECC P1	Sub-meter installation	√	-	
ECC P2	OTTV Calculation	√	-	
ECC 1	Water-Saving Steps	√	-	15
ECC 2	Natural Lighting	√	-	4
ECC 3	Ventilasi	√	-	1
ECC 4	Effects of Climate Change	√	-	1
ECC 5	Renewable Energy on Site	√	-	5
Total Poin				**26**

G. Water Conservation (WAC)

In the Green Building assessment for a building, the category of water conservation or WAC becomes an important part because it is intended to raise awareness of the importance of saving water and water-saving measures for water use in buildings from the design planning stage. The WAC category for a building is divided into 6 assessment criteria with 2 prerequisite criteria, which are as follows:

WAC P1 (first prerequisite) is Water Metering (Sub-Meter), namely the installation of water metering equipment at certain locations in the water distribution system. The Bahana Tower building has met WAC prerequisite 2 because it has a Water Metering (sub-water meter) that is functioning and well organized. With the installation of Water Metering (sub-water meter) in the Bahana Tower Building, the recording of water use can be monitored properly so that the building management can implement water conservation policies.

WAC P2 (second prerequisite) is Water Calculation, which is the calculation of water use using the water calculation worksheet from GBCI. WAC P2 (Water Calculation) is aimed at building designers because by knowing the amount of clean water that will be consumed for building operations and maintenance, building designers can predict whether water consumption planning has been planned to save water or not. The use of water on a wet day is the same as the use of water on a dry day. The use of clean water is 34,637.3 L/day, while the use from recycling is 117,128.27 L/day. This means that the use of water on wet days in the Bahana Tower Building is mostly sourced from recycled water (plant irrigation, flushing toilets, and cooling towers).

The proportion of water use on wet days is 13,484.86 L (38.93%), for irrigation water needs 27,860 L (100%), flushing water needs 4,777.3 L (20.80%), and the need for cooling tower water is 15,485.48 L (23.36%).

WAC 1 focuses on reducing water use (still the same as the prerequisite WAC), namely to prevent the clean water crisis that has started to occur in several regions in Indonesia recently. The reduction in the use of source water in the Bahana Tower Building is in the category > 45% - 50% because it has clean water consumption of 48.39% (7 points). These results indicate that the Bahana Tower Building complies with WAC 1.

WAC 2 is to promotes water-saving efforts by installing high-efficiency water features. The Bahana Tower building selected 925 water-saving features (99%), while the selection of low-efficient water features was 12 (12%). This shows that almost all water feature selections use water-saving features. This means that the benchmark criteria for the Water Fixture (WAC 2) in the Bahana Tower Building are met.

WAC 3 is to provide water from recycled sources sourced from building wastewater to reduce the need for water from primary sources. The Bahana Tower building uses all used gray water that has been recycled for the needs of the flushing and cooling tower systems so that the Water Recycle (WAC 3) benchmark is met.

WAC 4 focuses on alternative water sources. The Bahana Tower building uses more than one alternative water source, including AC condensation water, used water for ablution, or rainwater, so for WAC criteria 4.

WAC 5 is to encourages the use of rainwater or rainwater runoff as a source of water to reduce the need for water from the main source. The Bahana Tower building has

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a rainwater storage tank capacity of 100 m3, with a percentage of rainwater storage capacity of 144%. This means that the Bahana Tower Building has been able to provide rainwater storage tank installations with a capacity of 100% from the calculation above, thus earning 3 points.

This WAC 6 has 2 benchmarks. Benchmark 1 is met with all water needs for landscaping such as the front yard, left side, right side, and backyard at the Bahana Tower Building being met from water other than the main source (other water sources). Benchmark 2 is the use of garden watering technology, the Bahana Tower Building uses drip irrigation garden flush technology which is supported by a sensor timer that can streamline garden watering directly to the ground.

Table 4
Summary of Earning Water Conservation Points (WAC) at Bahana Tower

Code	Criteria	Fulfill		Points
		Yes	No	
WAC P1	Sub-meter installation	√	-	
WAC P2	Water Usage Calculation	√	-	
WAC 1	Reducing Water Usage	√	-	7
WAC 2	Water Fixture	√	-	3
WAC 3	Water Recycle	√	-	3
WAC 4	Alternative Water Resource	√	-	2
WAC 5	Rain Water Harvesting	√	-	3
WAC 6	Water Efficiency Landscaping	√	-	2
Total Poin				**20**

H. Calculation of the efficiency of using electrical energy in buildings

In terms of implementing Green Building in the Bahana Tower building, efficiency can be obtained in the use of electrical energy in the building. Among these efficiencies can be obtained from EEC and WAC.

1. EEC

Table 5
Evaluation Results Using EEC

Desain	OTTV	Investasi Façade	Saving Money	Tahun	Bulan	Hari
1	21,47	Rp15.035.401.056	Rp4.960.952.762	2	11	41
2	23,55	Rp13.633.053.264	Rp4.876.326.836	2	8	46
3	18,61	Rp17.413.707.904	Rp5.068.701.603	3	4	37

From the results of the evaluation using the optimal EEC and by the GBCI standard, the value of the most optimal savings was obtained using OTTV 23.55 with a payback period calculation with an investment value of 13.6 billion and saving money of 4.8 billion per year and money back within 2 years and 8 months. and 46 days.

2. WAC

Tabel 6
Evaluation Results Using WAC

No	Penggunaan	Volume (m3) (a)	sataun (m3)	Harga Satuan (b)	Total Harga (Tahun) (c = a*b)
1	Baseline	53.976,78	m3	Rp12.550,00	Rp677.408.589,00
2	Design	34.849,73	m3	Rp12.550,00	Rp437.364.097,93
DEVIASI PENGHEMATAN					**Rp240.044.491,07**

In addition to EEC, an investment in WAC also gets a reduction in monthly payments. As seen above, it can be concluded that in a year the cost of water usage can be saved by 240 million (assuming the cost of PDAM per liter is 12,500).

The main energy use in this building is the use of clean water and electrical energy. In this case, the electrical energy used includes the use of water-cooled chillers, the use of lights, and others. While the use of clean water is used for toilet needs, whether it is washing hands, defecating, urinating, etc.

In determining the use of energy consumption in a building, there is one factor that must be considered, namely the OTTV or Overall Thermal Transfer Value of a building surface is a calculation method carried out to determine theoretically the amount of heat load that will enter through a building surface construction (walls and walls). roof) in buildings that use cooling equipment (AC).

IV. CONCLUSION

Based on the discussion that has been carried out in the previous chapter, conclusions can be drawn for thesis research as follows:

1. The efficiency of water use in buildings per year can reduce costs by 240 million by using alternative fixtures and alternative use of water.
2. The use of electrical energy can be efficient in a year of 4.8 billion with a payback period with an investment value of 2 years 8 months 46 days.

SUGGESTION

It is better to do thorough research with the requirements to achieve a building that is Green Building with GBCI Standards.

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