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Efficiency Values and Efforts to Increase Green Building Efficiency ITSB Campus, Cikarang, Bekasi

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ABSTRACT: *ITSB received the gold category award certification for green buildings in 2012. Calculating electricity and water efficiency values can be one method of assessing profits and the benefits of environmentally friendly or green buildings. Electricity consumption intensity is the amount of electricity used for each unit area of the building within one year. Calculating water use efficiency is done by looking at the volume of water used in activities in the company building. Based on Marseva (2014), water efficiency calculations are carried out by calculating water consumption and the savings made. Based on an assessment of the electricity efficiency of the ITSB campus was obtained at Rp. 34 228 740/month. The difference in the efficiency value of electricity use between actual use and the estimated standard use according to IDR. 30 968 860 regulations. Based on this assessment, it can be concluded that the electricity use of the ITSB campus, which implements green buildings, is efficient and profitable for building managers. Meanwhile, the ITSB campus water use assessment that implemented green buildings was found to be 12.98 liters/day/person. The water use efficiency obtained from implementing green buildings is 16%. These two assessments found that the total electricity and water use efficiency for ITSB campuses that implemented green buildings during 2016 was IDR. 678 890 260.*

Keywords: *energy efficient, green building, ITSB green building*

I. INTRODUCTION

Based on BPS data (2017), the increase in the economy in Indonesia continued to grow by 5.02% in 2016. This increase increasingly encourages high demand for the construction sector to support economic activities. Besides supporting the country's economy, the construction sector's growth can also potentially increase environmental damage. The need for rapid development means that resources and the environment as development inputs are starting to experience excessive use and tend to be exploited. The construction sector consumes 17% of clean water, 25% of wood products, 30 to 40% of energy, and 40 to 50% of raw materials used for construction and operation (World Green Building Council 2008 on Rachman 2011). The increase in material use in the construction sector can be seen from the increase in the value of material expenditure in 2015, which was 11.72% greater than in 2014 (BPS 2017). Inefficient use of construction materials could become a problem in the future.

The impact of development can be felt directly on electricity and water use. From BPS data (2015), it can be seen that there has been an increase in clean water consumption and demand for electricity as some of the primary raw materials in the construction sector. Increased consumption of clean water and electricity in the long term can become a severe problem threatening environmental conditions. Environmental problems in the construction sector According to Stern et al. (2007) on Fuerst et al. (2011), the construction sector contributes 20% of greenhouse gas emissions, although currently there is growing awareness in the construction sector of global warming and efforts are starting to be made by the construction sector to reduce the environmental impact it causes. In general, in implementing green buildings, the technical aspects of development must be

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considered, including using construction materials and environmental conditions. Apart from these things, there is a need for financial efficiency. In this case, one example of financial efficiency is increasing efficiency in building use (Ding, 2008) by implementing environmentally friendly technology.

Under the leadership of Gro Harlem Brundtland, the UN Commission on Environment and Development in 1987 agreed to the relationship between the concept of development and environmental management, which became known as the concept of sustainable development, namely development that can meet the living needs of today's society. Without ignoring the ability of future generations to meet their needs (Rachman, 2011). One form of sustainable development is green building. Karolides (2011) explains that ideally, a green building should not only consider environmental aspects but also building construction. Even though the construction costs are more significant, the maintenance costs are much smaller and more profitable. Armstrong (2011) further explained that green building structures must consider dynamic and ever-changing environmental conditions, such as buildings designed to face extreme conditions.

Firsani and Utomo (2012) stated that the construction sector involves many stakeholders, so the construction sector has enormous potential, including the potential to implement environmentally friendly building concepts. Siahaan (2004) explains that sustainable development emphasizes economic, environmental, and socio-cultural aspects. Furthermore, Danusastro (2010) on Rachman (2011) emphasized that sustainable development is a meeting point between the environmental, social, and economic spheres, which explains that sustainable development requires three sectors that are equally strong and mutually supportive, namely: economic growth, environmental protection from the consequences—Poor development and improving the quality of life of the community.

Increasing the efficiency of resources and energy utilization can provide benefits for building managers and users. Efficient use of energy and resources in using green buildings in the long term can benefit managers and users. The existence of the World Green Building Council, which oversees green buildings, is proof of the increasing public awareness of social and environmental conditions. Green building is an alternative to fulfilling the three elements of sustainable development. According to Kats (2003), green buildings implement sustainable development by utilizing energy, water, building materials, and land more efficiently than conventional buildings. With direct lighting and better air quality, green buildings contribute to building user's health, comfort, and increased productivity.

Ding (2008) explained that some green building assessment tools also consider various essential issues such as resource consumption (energy, land, and water), environmental capacity, and indoor comfort but do not include financial aspects. This, of course, contradicts the main principle of development, namely profit. Returning profits is essential to a project because environmentally friendly project activities will be expensive. One of the buildings that has implemented green building in Indonesia is ITSB (Bandung Institute of Technology and Science) in Deltamas, Cikarang Bekasi. ITSB received the gold category award certification for green building in 2012 from the Green Building Council Indonesia. Calculating the value of electricity and water efficiency can be one method of assessing profits and the benefits of an environmentally friendly or green building.

II. REVIEW OF LITERATURE

2.1. Electricity Usage

Energy consumption is the energy a building uses in a certain period, resulting from multiplying power and operating time (BSN, 2000). According to World Bank data (2017), Indonesia's energy consumption increases yearly. In 2013, the average energy consumption in Indonesia reached 788 kWh per capita. Based on Presidential Regulation Number 5 of 2006 concerning National Energy Policy, energy conservation is using energy efficiently and rationally without reducing vital energy. The calculation of energy use based on BSN SNI 03-6196-2000 can be seen using energy consumption intensity (IKE), which is the division between energy consumption and the unit area of the building. IKE calculation is done by looking at:

1. Details of building area and total building area (m2)
2. Building energy consumption per year (kWh per year)
3. IKE of buildings per year (kWh per m2 per year)

4. Building electricity usage costs (Rp. per kWh).

2.2. Water Efficiency

Water resources are a vital part of the life cycle. Almost all human activities use water. Excessive use of water resources can be a problem, so efficiency is needed. Based on the criteria that GBC Indonesia has created called green ship in the Water Conservation (WAC) category, there are two prerequisite criteria and six credit criteria that must be met by each building to obtain the maximum criteria value for efficient water use, namely:

A. Prerequisite Criteria:
1. Water meter (water metering)
2. Calculation of water use (water calculation)

B. Credit criteria:
a. Reducing water use (water use reduction)
b. Water features (water fixtures)
c. Water recycling
d. Alternative water sources (alternative water resources)
e. Rainwater harvesting
f. Landscaping water efficiency (water efficiency landscaping)

The comparison of water use will be calculated by comparing water savings in buildings that have implemented water efficiency based on GBCI criteria with the water use standards per person per day that have been set by the Ministry of Public Works and Public Housing, Directorate General of Human Settlements in the Drinking Water Development Guidebook is a necessity water in public facilities (education, government offices, etc.).

III. METHODS

3.1 Electrical energy

The calculation of the value of electrical energy use is carried out by looking at the electricity use in carrying out activities in the ITSB building. Electricity consumption intensity is the amount of electricity used for each unit area of the building within one year. This IKE value was obtained from an audit of electricity use in ITSB green buildings. The calculation of energy consumption intensity, according to Pasisarha (2012), is:

$$IKE = \frac{PE}{LB} \quad (1)$$

Information:
IKE: Energy Consumption Intensity
P.E: Electricity usage (KWh)
LB: Widebuilding (m2)

The indicators for determining energy consumption efficiency criteria use Minister of Energy and Mineral Resources Regulation Number 13 of 2012 concerning Saving on Electricity Use. Further energy use criteria can be seen in Table 1.

Table 1. Criteria for energy use in office buildings based on specific energy consumption (kWh per m2 per month)

Criteria	**Monthly Electricity Consumption (kWh per m2 per month)**	
	Air-conditioned	**Not Air Conditioned**
Very Efficient	Value < 8.5	Value < 3.4
Efficient	8.5 ≤ 14	3.4 ≤ 5.6

Quite Efficient	14 ≤ 18.5	5.6 ≤ 7.4
Wasteful	≥ 18.5	≥ 7.4

Source: Ministry of Energy and Mineral Resources (2012)

3.2 Water

Calculating water use efficiency is done by looking at the volume of water used in activities in the company building. Based on Marseva (2014), water efficiency calculations are carried out by calculating water consumption and the savings made. The formula for calculating water volume use is based on Marseva (2014):

$$KB = \frac{KA}{BP} \quad (2)$$

Information:
KB: Water consumption per month (liters)
KA: Water consumption (liters)
BP: Usage (months)

$$KH = \frac{KB}{PA} \quad (3)$$

Information:
KH: Water consumption per day (liters)
KB: Water consumption per month (liters)
P.A: Usage in one month (days)

$$PH = KS - KA \quad (4)$$

Information:
PH: Water savings (litres)
K.S: Standard water consumption (liters) based on the Directorate General of Human Settlements
KA: Actual consumption (litres)

$$E.F = \frac{PH}{KR} \quad (5)$$

Information:
E.F: Water efficiency
PH: Water savings (litres)
KR: Average consumption (litres)

$$EP = P \times J \times H \quad (6)$$

Information:
E.P: Marksavings economy
P: Savings (litres per person)
J: Number of residents (people)
H: PDAM price (Rp per m3)

PDAM Tirta Bhagasasi is a PDAM that provides clean water in the ITSB area, so the standard used is the tariff from that PDAM. ITSB, as an educational institution, is included in the particular social PDAM category with a tariff for using a water volume between 0 and 10 m^3 of IDR 1,400 per m^3 and a tariff for using a water volume of more than ten m^3 of IDR 1,400 per m^3.

IV. RESULT AND DISCUSSION

4.1 Calculation of the Value of Electrical Energy Use

The electricity usage of the ITSB Cikarang Bekasi Campus building is 126 kWh/m2/year (ITSB News, 2015). Based

on interviews with building managers, electricity usage at the ITSB Cikarang Bekasi Campus is included in the social electricity tariff category (Private Higher Education Academic Programs). so that the IKE value of the ITSB Cikarang Bekasi Campus per month is obtained at

$$\text{IKE} = \frac{126 \text{ kWh per m2 tahun}}{12 \text{ bulan}} \quad (7)$$

= 10.5 kWh per m2 permonth.

ITSB is included in the social electricity tariff group, with an IKE value of 10.5 kWh per m2 per month. Based on the Ministry of Energy and Mineral Resources' energy use criteria standards, the IKE value is considered efficient (for air-conditioned rooms 8.5 to less than 14). The efficient use of electricity can provide immense benefits in the long term and has excellent potential to cover the initial green building investment costs.

4.2 Calculation of Water Use Value

Water efficiency carried out by ITSB includes using recycled water systems and applying technology that supports water efficiency. The water recycling system at ITSB is carried out centrally and is linked to the water treatment system of Kota Deltamas, Bekasi. The remaining water used by ITSB is channeled to Deltamas City's centralized water recycling reservoir for further recycling. The water that has been recycled is then redistributed. Water use efficiency is calculated based on the amount used in ITSB. According to Marseva (2014), water efficiency calculations are based on the difference between standard and actual water use.

The ITSB campus building has 803 users. Water use at ITSB is divided into two conditions: before further construction and during the construction of advanced facilities. The calculations used from January to April, the month before construction begins, to get the actual water use efficiency value. Calculations of actual water use efficiency can be seen in Table 2.

Table 2. ITSB monthly water use in 2016

Month	Average consumption (m3)
January	245.8
February	228.7
March	233.9
April	292.1

Source: ITSB Management (2017)

The average amount of water used in 2016 before construction was 1 000 429 liters. On average, the building is used 24 days per month. So, the average water usage per month in 2016 before construction was

$$\text{liters of water usage/month} = \frac{1\,000\,429\ liter}{4}$$

= 250 107.3 liters/month (8)

$$\text{liters of water consumption/day} = \frac{250\,107.3\ liter}{24}$$

= 10 421.14 liters/day (9)

$$\text{Water usage litres/day/person} = \frac{10\,421.14\ liter}{803}$$

= 12.98 liters/day/person (10)

Water usage standards are based on the Directorate General of Human Settlements, Department of

Public Works in the Drinking Water Development Guidebook, namely water requirements in public facilities (education, government offices, etc.) with water usage criteria: 10% - 15% of domestic needs. Domestic use for HU (Public Hydrant)/TA (Water Terminal) is 120 liters/person/day, so it can be concluded that the water requirement in public educational facilities is 12 – 18 liters/person/day. So, the average water requirement for public education facilities is 15 liters/person/per day.

hence the difference in usage = 15 – 12.98
= 2.02 liters/person/day (11)

then water use efficiency $= \frac{2.02 \text{ liter/orang/hari}}{12.98 \text{ liter/orang/hari}} \times 100\%$
= 16% (12)

The results of actual water use efficiency calculations show that water use on the ITSB campus for water needs in public educational facilities is 16%.

4.3 Calculation of Efficiency Value in Rupiah

The use of electricity tariffs is based on the calculation results of the actual assessment using the 2019 social category electricity tariff applied, namely IDR 814.97/Kwh. To calculate the standard average electricity usage using standard office (commercial) criteria, namely 240 kWh/m2 per year, the resulting standard monthly value is 20 kWh/m2. The building area of the ITSB Bekasi Campus is 4,000 m2, so the estimated standard electricity usage calculation is:

Estimation standard use of electricity $= 20 \times 814.97 \times 4000$
= Rp. 65 197 600.00/month (13)

Electricity actual usage $= 10.5 \times 814.97 \times 4000$
= Rp. 34 228 740.00/month (14)

Electrical difference = Rp. 65 197 600.00 − Rp. 34 228 740.00
= Rp. 30 968 860.00 (15)

The water efficiency value is estimated by multiplying water consumption savings by the number of green building occupants and PDAM Tirta Bhagasasi's water tariff.

Daily water savings:
= 2.02 liters/person/day x 803 people = 1 623.9 liters/day
= 1.6239 m3/day (16)

Annual water savings:
= 1.6239 m3/day x 285 days
= 462 801 m3/year (17)

So, the water efficiency of the ITSB campus green building is obtained in Table 3 below.

Table 3. Calculation of water value efficiency

Water volume (m3)	Tariff (Rp/m3)	Amount (Rp)
10	1 400	14 000
10	1 400	14 000
462 781	1 400	647 893 400
Total		647 921 400

Source: processed data (2017)

The total ITSB campus Green Building efficiency assessment based on the use of electrical energy and water can be seen in Table 4 as follows.

Table 4. Calculation of total electricity and water efficiency

Efficiency	Amount (Rp)
electricity	30 968 860
water	647 921 400
Total	678 890 260

Source: processed data (2017)

4.4 Efforts to Increase Energy Efficiency

Efforts to increase energy use efficiency are also implemented and carried out by the ITSB Cikarang Bekasi campus building management. Implementation of regulations, use of technology, and use of tools that support the implementation of green building. For example, the implementation follows the Regulation of the Minister of Public Works and Public Housing No. 02/PRT/M/2015 concerning Green Buildings and Minister of Public Works Regulation 30/PRT/M/2006 concerning Technical Guidelines for Facilities and Accessibility in Buildings and the Environment. Apart from following these regulations, there are also regulations that green building managers must follow in the stages of obtaining green building certification from GBC Indonesia.

The requirements for obtaining green building certification are listed in the assessment used by GBC Indonesia in assessing buildings that implement green building using the categories prepared (Greenship-GBCI), namely: 1. Appropriate Site Development (ASD), 2. Energy Efficiency & Refrigerant (Energy Efficiency & Refrigerant/EER), 3. Water Conservation (WAC), 4. Material Resources & Cycle (MRC), 5. Air Quality & Air Comfort (Indoor Air Health & Comfort /IHC), and 6. Building Environmental Management (Building & Environment Management).

The ITSB Cikarang Bekasi campus received gold category award certification for green buildings 2012. To achieve this certification, the management of the ITSB Cikarang Bekasi campus must comply with the applicable regulations. Complete compliance with green building procurement regulations based on regulations can be seen in Table 5.

Table 5. Compliance with green building procurement regulations

No	Rules/Requirements	ITSB Campus Green Building		Information
		Done	Are not done	
1	Minister of Public Works Regulation 30/PRT/M/2006	√		Ministerial Regulation Regarding Technical Guidelines for Facilities and Accessibility in Buildings and the Environment
2	Regulation of the Minister of Public Works and Public Housing No. 02/PRT/M/2015	√		Ministerial Regulation Regarding Green Buildings
3	Greenship-GBCI			
	1. Appropriate Land Use	√		
	2. Energy Efficiency & Refrigerants	√		
	3. Water Conservation	√		
	4. Material Sources &	√		

		Cycles	
	5.	Air Quality & Air Comfort	√
6.	Building Environmental Management		√

Source: Primary Data (2018)

4.4.1 Electrical energy

One electrical energy savings the ITSB Campus carries out in electricity use is the heat (thermal) control strategy. In terms of lighting, the ITSB Cikarang Bekasi campus building uses natural lighting and most of the walls of the building use glass. Natural sunlight can replace electrical energy by using glass. However, direct lighting also causes a heating effect. Therefore, thermal (heat) control is carried out using various steps.

Using shades and filters is one of the strategies ITSB Cikarang Bekasi campus building managers use. Latifah (2015) explains that shading is a thermal control strategy using sun shaders. A sun shader is a component on a building facade or part of a building that functions as a shader for sunlight, and filters are a thermal control strategy using sun filters. Sun filters are components on building facades that function as filters for sunlight. In Figure 1, you can see shade filters in the ITSB Cikarang Bekasi campus building.

a b

Figure 1. Shade & Filter ITSB Cikarang Bekasi Campus (image a) and Double Glass (image b)

The type of glass used by green building managers at the ITSB Cikarang Bekasi Campus differs from that used in conventional buildings, namely the double glass type. Double glass filters the transmission of solar heat radiation into the building. Apart from that, by using double glass, the workload of the AC can be reduced, and noise can be reduced from the insulation capacity of the spacer/air cavity (Latifah, 2015). Apart from double glass, building managers also implement vertical gardens to reduce solar heat and improve the environment.

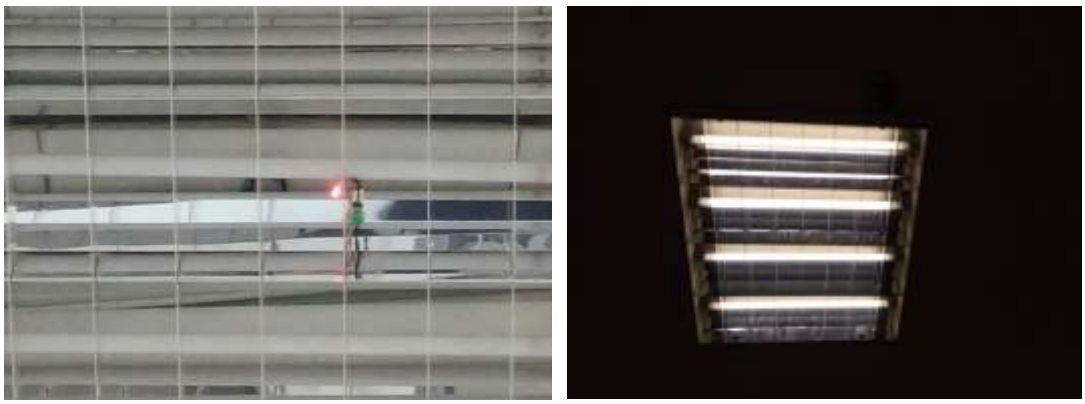
Vertical gardens, upright gardens, green walls, or living walls, which can also be called wall gardens, are plants and other garden elements that are arranged in such a way that they are perpendicular or close to perpendicular as a garden for a relatively long time (Budiarto, 2013). The management of the vertical garden aims to provide aesthetic value to the building design to make it more environmentally friendly. It also protects against direct sunlight and provides a cooling effect from the presence of plants. Apart from vertical gardens, the ITSB Cikarang Bekasi campus also has gardens surrounding the campus buildings. This can be seen in Figure 2.

a b

Figure 2. Vertical Garden (image a) and garden at the ITSB Cikarang Bekasi Campus (image b)

The use of double glass is intended to provide natural lighting. Natural lighting is possible with the many open spaces that provide sufficient light. Latifah (2015) explains that natural lighting has two purposes: 1. Visual comfort, which can be obtained through optimizing the use of natural lighting and designing appropriate light openings so that the natural light obtained meets visual work needs. 2. Aesthetics and atmosphere: Natural light is used for the beauty and atmosphere of the space.

The efficient use of lighting from electrical energy in the room is supported by LED lights and technology that can provide electrical efficiency. This technology uses LDR (Light Dependent Resistor) component technology. The LDR component is applied to every ITSB Cikarang Bekasi campus building room light. The LDR (Light Dependent Resistor) component is used as in Figure 3.



a b

Figure 3. LDR components (image a) and LED lights (image b)

Technology for room thermal regulation is also used. Apart from implementing ventilation (cross ventilation), which reduces air conditioning or AC, technology is also used to assess the room's carbon levels so that it can be known if the amount of carbon dioxide exceeds the threshold. The temperature control on the AC is also adjusted to the room temperature measuring device installed in each room to achieve electrical efficiency. The use of technology to measure CO2 levels and regulate temperature can be seen in Figure 4.

a b

Figure 4. CO2 Measuring Instrument (image a) and Room Temperature Measuring Instrument (image b)

Regulations to support efficient use of electricity are also enforced at the ITSB Cikarang Bekasi campus, one of which is using elevators. There are written regulations for students and students at the ITSB Cikarang Bekasi campus, namely that they are advised to use stairs to get to classrooms on the upper floors: unwritten rules or advice for young lecturers to use the stairs to get to the top floor. When the research was conducted, all ITSB Cikarang Bekasi campus building users complied with these regulations.

4.4.2 Water Energy

Equipment to support efficient water use includes double-flush toilets and tap faucets. The implementation of double flush toilets, which divide the small and large flush buttons according to their use, and pressure faucets to streamline hand washing water have been installed in all ITSB campus toilets. In double-flush toilets, water savings can be made by adjusting the amount of water based on usage. The average double flush toilet uses a ratio of 3:6, where the small flush button releases 3 liters of water and the large flush button releases 6 liters of water. This, of course, makes water use in green buildings more efficient. The use of tools can be seen in Figure 5.

a b

Figure 5. Flush Toilet (image a) and Press Faucet (image b)

Based on interviews with managers, inefficient water use occurs due to the gradual development of the ITSB campus and the ongoing development of the city of Deltamas Bekasi. Water users are not only building users (students, employees, lecturers, and cleaning service officers) but also people who carry out activities around the ITSB campus buildings. Deltamas City Management often holds activities. As the only building in the area, the ITSB campus becomes a water source when activities/events/competitions are held in the environment around the ITSB campus building.

V. CONCLUSION

Based on an assessment of the electricity efficiency of the ITSB campus it was obtained at Rp. 34 228 740/month. The difference in the efficiency value of electricity use between actual use and the estimated standard use according to IDR. 30 968 860 regulations. Based on this assessment, it can be concluded that the electricity use of the ITSB campus, which implements green buildings, is efficient and profitable for building managers. Meanwhile, the ITSB campus water use assessment that implemented green buildings was found to be 12.98 liters/day/person. The water use efficiency obtained from implementing green buildings is 16%. These two assessments found that the total electricity and water use efficiency for ITSB campuses that implemented green buildings during 2016 was IDR. 678 890 260.

Calculation of the efficiency of electrical energy use at the ITSB campus, Deltamas, Cikarang Bekasi, based on the energy use criteria of the Ministry of Energy and Mineral Resources is included in the efficient criteria (for air-conditioned rooms 8.5 - smaller than 14). Meanwhile, based on water use efficiency calculations, the results show that water use at the ITSB campus, Deltamas, Cikarang Bekasi, for water needs in public educational facilities is inefficient. Inefficient water use occurs because the ITSB campus is still under construction. Even though water use is not yet efficient, the ITSB campus management has used recycled water in water campus parks and implemented tools supporting efficient water use.

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