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ANALYSIS OF ELECTRICAL ENERGY EFFICIENCY USING ALBEDO AND OVERALL THERMAL TRANSFER VALUE METHODS IN THE CONCEPT OF GREEN BUILDING

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KEYWORDS:
Albedo, Overall Thermal Transfer Value, Energy Efficiency, Green Building

ABSTRACT

The Arjosari Terminal is one of the national transportation nodes that need to provide services according to applicable standards and is provided 24 hours a day. This affects the use of electrical energy. One way to achieve efficient use of electricity is to apply the Green Building concept to buildings. Albedo analysis and Overall Thermal Transfer Value (OTTV) as the basis for analyzing Greenship criteria. To find out the value of energy efficiency, an analysis of Energy Consumption Intensity (IKE) is carried out. The Green Building concept implemented in the design of this terminal is to use building envelopes such as stop glass, GRC wall cladding panels, and ACP to reduce heat transfer. To reduce the effect of heat islands on the pavement surface, rigid, paving and cast floor hardeners are used. But this has not been done on the roof surface. The design still uses a metal deck and concrete slabs with a small area. In addition to using this material, LED lights are also used, placing switches close to doors and solar panels. After analyzing the albedo of the roof, it was obtained that the value was outside the standard, so it was necessary to change the metal deck roof to become a roof garden area and increase the concrete slab area. From the Overall Thermal Transfer Value analysis, the results show that the building envelope has been effective in reducing heat inside the building. The results of the analysis of the Greenship criteria obtained the results of the need to create green open areas or parks, increase natural ventilation and use power-saving equipment, one of which is by using an inverter escalator which can save 60% power. The garden and roof garden are part of a green open area. The application of the Green Building concept to the terminal design can produce an efficiency of 25.64%.

INTRODUCTION

The passenger terminal is one of the important infrastructures in supporting the smooth mobility of land transportation. Malang Arjosari Type A Passenger Terminal is a terminal that is quite busy with visitors (85,000 visitors/month). Each terminal in each class, both classes A, B, and C must provide services by applicable standards. The provision of services by applicable standards aims to provide convenience, security, and reliability for terminal users. Services are provided for passengers for 24 (twenty-four) hours. The 24 (twenty-four) hour service provided to users is also related to the use of energy, especially electricity, and water. Energy consumption, especially electricity, is high. With high energy consumption, it is necessary to discuss energy efficiency. One way to carry out energy efficiency, in this case in terminal buildings, is to apply the Green Building concept (Iqbal, 2022).

In the Detail Engineering Design of the Arjosari Terminal issued in 2019, it can be seen that in this new design, the terminal will be built on 2 (two) floors and will be equipped with escalator facilities as a means of mobilizing terminal users from the 1st floor to the 2nd floor. This escalator facility will increase the consumption of energy at this terminal (Hidayat, 2022). In addition, several terminal areas will be used as closed spaces with lots of glass instead of massive walls. With the condition of this closed space, it is necessary to add several AC units to increase comfort for users.

The connection with some of the things mentioned above, it is important to analyze energy efficiency, especially electrical energy. Energy efficiency analysis can be carried out, one of which is using an energy audit (Ekki, 2022). Energy efficiency is often associated with cost savings, but this is not always the case. The cost of achieving energy efficiency is not always cheap.

The basic principles used in energy-efficient building design guidelines (Design et al., 2012) are as follows:

a. Climate considerations
b. Location considerations
c. Natural lighting
d. Passive heating and cooling

One way to optimize passive heating and cooling is to use cross ventilation.

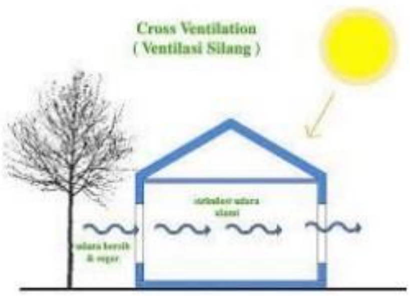

Figure1
ross Ventilation
Source : Ibrahim et al., 2022

The advantages of cross ventilation are:

1. Minimizing the use of Air Conditioners
2. Sunlight easily enters the room
3. Save Electric Power
4. Got thermal comfort

e. Humidity and natural ventilation

The minimum number of ventilation openings is 5% of the floor area of the room (SNI 03 6572 2001 Ventilation and Air Conditioning, 2001.)

f. Building environment and scenery
g. Materials used for walls, roofs, openings, ventilation, building access, natural light, glass, shading, airtightness
h. Building systems include, among others, electrical lighting, HVAC, boilers, building transportation systems, electrical systems, fire and safety systems, data and security systems, water, and building energy management systems.

i. Renewable energy sources and alternative energy sources such as energy reserves such as diesel power plants.

In the process of design and construction, several elements must be considered in developing energy-efficient construction, which in this study will support the efficiency of electrical energy, including:

j. An integrated design between architectural, structural, mechanical, and electrical aspects. In the early stages of this design, it is necessary to contribute ideas and technical knowledge in each field.
k. Choice of materials and technologies designed to save energy. The importance of choosing a material is a material that can reduce solar heat, especially indoors. For example, applying the use of walls in a room with a high level of lighting intensity.
l. The surrounding climatic conditions must be considered for human comfort. The climate data needed are temperature, humidity, solar radiation, wind, and rainfall. In addition, attention should be paid to elevation, slope, proximity to seawater, proximity to mountains and hills, and the type and range of plants.
m. Building operational and maintenance manual focused on energy efficiency measures.
n. Behavior that cares about energy consumption

The research objective is to analyze the application of the Green Building concept to the Arjosari terminal revitalization project and to analyze the amount of electrical energy efficiency in the Arjosari terminal revitalization project with the Green Building concept (Indonesia, 2013).

METODE PENELITIAN

Primary Data

Primary data is data in the form of room conditions and electronic devices used, the direction of solar lighting. The method for knowing the direction of the sun is as follows:

a. Make observations between the following hours
    - morning (05.30–09.00 WIB)
    - during the day (11.00–13.00 WIB)
    - afternoon (15-17.30 WIB)
b. Mark the North direction of an object used as an observation
c. Look in the direction of an object's shadow. You can use a compass tool.
d. The direction of the shadow is the opposite direction to the sun's rays.
e. Data direction of the shadow and the direction of the sun.

Secondary Data

Secondary data are Detailed Engineering Design, electricity costs/month, climate, weather, and environmental data, number of rooms and electrical equipment used, specifications of electrical equipment used, duration of electrical equipment usage per day, basic electricity rates, and data on existing terminals. Taken from the Type A Terminal profile book in East Java Province, information regarding the existing data of the Arjosari terminal is as follows:

- Location: Jl. Raden Intan Canal No.1, Arjosari, Malang City
- Coordinate Point: 7°55′59″S 112°39′29″E
- Land area: 28,150 m2
- Building area: 7,343.81 m2

- P3D Status: Has Become an Asset of the Director General of Hubdat
- Terminal Class: A2
- Production Data :
  - Vehicles: 207,023 Vehicles
  - Passengers: 1,254,046 people/month
  - Routes: 7 city transportation outside the province
  - 9 city transportation within the province

Figure 2
Arjosari Terminal on the Map
Source: terminalarjosari. (2023).

Albedo value

This albedo value is used for the heat island effect factor or surface heat effect. The calculation of the material albedo value is as follows (Kurnia, 2021):

$$\text{Total Albedo Value} = \frac{\sum(An \times Ln)}{\sum Ln} \quad (1)$$

Where :
An = material albedo value
Ln = area of material

Table 1
Surface Material Albedo Values

No	Surface Material	Albedo Value
1	Dry Sand	0,35-0,45
2	Wet Sand	0,20-0,30
3	Dry Soil	0,15-0,60
4	Wet Soil	0,07-0,28
5	Short Grass 2 cm	0,26
6	Grass 1 m long	0,16
7	Asphalt	0,05-0,20
8	Concrete	0,10-0,35

9	Brick	0,20-0,40
10	Paving	0,05-0,4
11	Gray Cement	0,35-0,4
12	Wide leaf vegetation	0,15-0,18
13	Light Gray Roofing Membrane	0,62
14	White Roofing Membrane	0,80
15	Corrugated Roof	0,1-0,15

Source : Pratiwi & Safitri, 2019

OTTV value

The Overall Thermal Transfer Value (OTTV) study is the total thermal transfer value of the outer wall which has a certain orientation or direction through the building envelope. OTTV has units of Watt/m2 and is regulated by SNI 03-6389-2011.

$$OTTV = \alpha\ [(UW \times (1 - WWR) \times TDEk] + (Uf \times WWR \times \Delta T) + (SC \times WWR \times SF) \qquad (2)$$

Where :
OTTV = The value of the overall thermal transfer on the outer wall that has a certain direction or orientation (W/m2);
α = absorbance of solar radiation;
UW = Thermal transmittance of opaque walls (W/m2 .K);
WWR = Ratio of the window area to the area of the entire exterior wall in the specified orientation;
TDEk = Equivalent temperature difference (K);
SF = Solar radiation factor (W/m2);
SC = Shading coefficient of the fenestration system;
If = Fenestrated thermal transmittance (W/m2 .K);
ΔT = Design temperature difference between the outside and the inside.
If the OTTV value is less than 35 W/m2, the calculation is finished. But if the OTTV value is greater than 35 W/m2.

Greenship Criteria Analysis

The Green Building concept used to achieve energy efficiency has several criteria that must be met. The Greenship criteria used are land use efficiency and energy efficiency and conservation (Indonesia, 2013).

Energy Consumption Intensity Value (IKE)

The intensity of energy consumption is the ratio of the amount of electrical energy used per month or year compared to the area of the room (Tiro et al., 2021). According to (Tiro et al., 2021), the equation for calculating Energy Consumption Intensity (IKE) is

$$\text{IKE of room} = \text{Total KWh} / \text{Room area (Kwh/m2)} \qquad (3)$$

Energy Efficiency Potential Value

From the Energy Consumption Intensity (IKE) value, the next step is to determine the amount of energy-saving potential. This determination is used to find out how much energy efficiency is (Tiro et al., 2021). Determination of the potential for energy savings or energy efficiency can be obtained by the equation:

Potential energy efficiency = (IKE room–IKE target) x area x Basic Electricity Tariff (4)

HASIL DAN PEMBAHASAN

Description of Primary and Secondary Data

The primary data needed is the direction of solar lighting. Observation of solar lighting data is as follows:

05.30 – 09.30 WIB: East direction
09.30 – 11.30 WIB: Northeast direction
11.30 – 13.30 WIB: North direction
13.30 – 16.00 WIB: Northwest direction
16.00 – 17.30 WIB: west direction

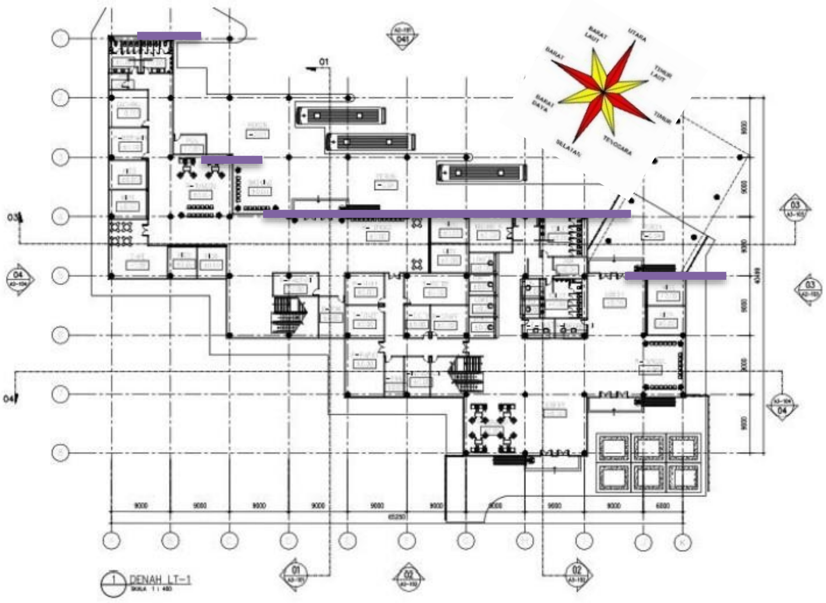

Figure 3
Hottest Part Due to The Sunlight
Source: Author Processed Data

Table 2
Climate, Weather, and Environment Data for Malang City

No.	Data	Information
1.	Temperature	Average Temperature: 22,7 – 25,1°C Maximum Temperature: 32,7°C Minimal Temperature: 18,4°C
2.	Humidity	Average Humidity: 79% - 86% Maximum Humidity: 99% Minimum Humidity: 40%
3.	Precipitation	Probability Precipitation: 43%
4.	Solar Radiation	Average Daily Solar radiation: 5.5%
5.	Wind	Wind Speed: 7,2 km/jam

		South Domination
6.	Rainfall	Average Rainfall: 255 mm
7.	Elevation	506 m
8.	Type Of Vegetation	andong merah tree, Puring dan Kol Banda

Sumber: Weather Spark. (2023).

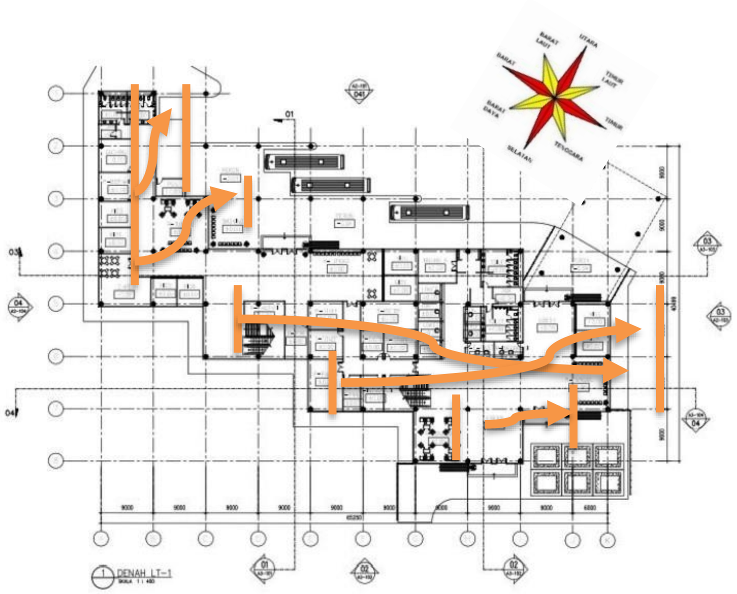

Figure 4
Position Of The Cross Ventilation Openings
Source: Author Processed Data

Based on Figure 4 about cross ventilation, the openings in the terminal building are placed on the south and north sides. Wind enters from the South side and leaves from the North side (green line)

Albedo value analysis

This albedo value is calculated to find out how big the effect of surface heat is. Albedo value depends on the type of material and the area of the material. In this revitalization project, 3 (three) types of materials affect the surface heat effect of the pavement, namely:

1. Rigid Pavement with an area of 39,912.6 m2 with a material albedo value of 0.35
2. Paving with an area of 1,369.2 m2 with a material albedo value of 0.4
3. Floor Hardener with an area of 4,255 m2 with a material albedo value of 0.4

The calculation of the albedo value on the roof of the building is as follows:

1. Metal deck with an area of 1,970.16 m2. Has a material albedo value of 0.15.
2. A concrete slab with an area of 1,550.54 m2. Has a material albedo value of 0.35.

The pavement albedo value is 0.36 > 0.3 (Ok). While the roof albedo value is 0.24 <0.3 (Not Ok). To improve the albedo value of the roof, it is necessary to change the roof material. Related to the Green Building concept, it is necessary to make a roof garden on the roof.

OTTV Value Analysis

The calculation of OTTV value is calculated from each side of the building (Hidayat, 2022). As an example

OTTV value (thermal transfer value) ACP Northwest side
= α x (Uw x (1-WWR) x TDek) = 0.551 x (0.411 x (1-0) x 10) = 2.3
Where :
• α-1 (Type of Material, according to table 1 of SNI) = 0.61
• α-2 (Color, according to Table 1 of SNI) = 0.91
• α = 0.61 x 0.91 = 0.551
Thermal Transmittance Value Uw = 1/(Total) ; R is Thermal Resistance (point 4.2.3 SNI)
• Router surface = 0.044
• R GRC = material thickness x coefficient (table 4 SNI) = 0.009 x 211 = 1.899
• R Air cavity = 0.16 (table 5 SNI)
• R Aluminum Mullion = material thickness x coefficient (table 4 SNI) = 0.001 x 211 = 0.211
• R Light Brick = material thickness x coefficient (table 4 SNI) = 0.08 x 1.488 = 0.12
• Rtotal = 0.411
The Window to Wall Ratio (WWR) value is the ratio of the number of openings compared to the wall area = opening area/wall area
• Wall area = 27 x 5.5 = 148.5 m2
• Opening area = 0 m2
• WWR = 0
The value of the temperature difference is equivalent to that of the wall, TDek = 10 (table 6 of SNI)

Table 3
OTTV Calculation Result (Overall Thermal Transfer Value)

No	Side	Conduction with the wall	Conduction With The Openings	Radiation Through The Openings	Total	Total Façade Area	OTTV
		Watt	Watt	Watt	Watt	m2	Watt/m2
		A	B	C	D=A+B+C	E	D / E
1	North	1.359,88	10.431,00	12.545,31	24.336,19	661,50	36,79
2	Northeast	-	-	-	-	-	-
3	East	-	-	-	-	-	-
4	Southeast	1.728,43	15.261,75	10.443,50	27.433,68	913,50	30,03
5	East	2.160,53	5.386,50	4.833,82	12.380,85	661,50	18,72
6	Southwest	-	-	-	-	-	-
7	West	-	-	-	-	-	-
8	Northwest	1.942,45	14.087,41	22.273,69	38.303,54	964,50	39,71
	Total	6.721,63	45.166,66	50.096,31	101.984,60	3.201,00	31,86

Sumber: Worksheet OTTV Calculation

The OTTV result of the terminal building is 31.86 W/m2. This result meets the set standard of 35 W/m2.

Analysis of Greenship Criteria

In applying the Green Building concept in the design of the Arjosari terminal, it can be seen that the application of the Green Building concept can be seen using building envelopes such as stops glass, GRC Wall Cladding panels, ACP to reduce heat transfer, to reduce the heat island effect of rigid pavement surfaces, paving and cast floor hardener. But this has not been applied to the roof surface, which is still using the metal deck and concrete slabs with a small area. In addition, LED lights are used, placing the switch close to the door and using solar panels. The Greenship criteria that have not been met are.

1. Green open areas that are still minimal. Open area 32.57% of the land area. 8.74% for rigid pavements which are used for transportation infrastructure. The vegetated green open area is only 2.5% of the green open area. So it is necessary to hold the addition of green open areas. Based on the author's research, what can be done to increase the green open area or landscape is to change the cast floor hardener area into a green area by providing plant vegetation for the yard. Besides that, it was added by changing the metal deck roof with a concrete plate structure, and the initial concrete plate area was made into a roof garden.

   If the floor hardener area is changed to a green area plus vegetation and the roof becomes a concrete slab and a roof garden, the albedo value will change as follows:
   1. Rigid Pavement with an area of 39,912.6 m2 with a material albedo value of 0.35
   2. Paving with an area of 1,369.2 m2 with a material albedo value of 0.4
   3. Green open space with a grass surface with an area of 4,255 m2, a material albedo value of 0.25
   4. Green open space with yard vegetation as cover, the area is assumed to be half (1/2) of green open space, namely 2,127.5 m2 with a material albedo value of 0.18.

   The calculation of the total albedo value of the 4 (four) materials above is 0.33 > 0.3 (Ok) As for the calculation of the albedo value on the roof of the building if the concrete plate is changed to a roof garden and the metal deck roof is changed to a concrete plate it is 0.31 > 0.3 (Ok)
2. Lack of openings or natural ventilation. Need to add some windows in the South and North as the dominant wind direction. In the initial design, there were no window openings. So the transparent building envelope is a stop-sol glass. The amount of natural ventilation needed is 5% of the floor area. The floor area is 4,185 m2. The area of natural ventilation required is 209.25 m2. If you use windows measuring 3.5 x 2.25 m2 that have been used in the terminal design, an additional 26 (twenty-six) windows are needed. However, this amount will not be applied in full. Only 10 (ten) windows were applied and optimized on the South and North sides according to the dominant wind direction. Then put 6 (six) windows on the South side and 4 (four) windows on the North side. This placement is based on the consideration of the available wall area on each side.

   Why isn't it fully implemented? This is related to the direction of sunlight and the limited area of the wall in the South and North. The sun shone brightly from the Northwest. So, if given a window opening in the Northwest it will add heat from that side into the room. This will increase the heat of the room temperature and increase the load on the performance of the cooling machine (AC). Besides that, it will increase the value of OTTV so that it can exceed the specified requirements.

   The addition of openings or natural ventilation in the form of windows on the South and North sides affects the value of the OTTV. The OTTV value is as follows:

Table 4
OTTV Calculation Results (Overall Thermal Transfer Value) With Adding Window Openings

No	Side	Conduction with the wall	Conduction With The Openings	Radiation Through The Openings	Total	Total Façade Area	OTTV
		Watt	Watt	Watt	Watt	m2	Watt/m2
		A	B	C	D=A+B+C	E	D / E
1	North	1.237,51	11.076,75	14.427,89	26.742,16	661,50	40,43
2	Northeast	-	-	-	-	-	-
3	East	-	-	-	-	-	-
4	Southeast	1.728,43	15.261,75	10.443,50	27.433,68	913,50	30,03
5	East	1.572,24	6.032,25	6.238,52	13.843,01	661,50	20,93
6	Southwest	-	-	-	-	-	-
7	West	-	-	-	-	-	-
8	Northwest	1.942,45	14.087,41	22.273,69	38.303,54	964,50	39,71
	Total	6.480,63	46.458,16	53.383,60	106.322,38	3.201,00	33,22

Source: Author Processed Data

The OTTV value of 33.22 W/m2 mentioned above still meets the requirements of SNI 6389:2011, namely a maximum of 35 W/m2.

Haven't used the lux sensor to adjust the lighting level in the room, motion sensors on lights, and escalators. Then the use of these tools will be added.

Analysis of Energy Consumption Intensity

Details of the total power of electrical devices used in the Terminal are 41,675.65 Kwh for buildings with air conditioning and 186,403.68 Kwh for buildings without air conditioning (Outdoor). Energy Consumption Intensity Value:

• IKE Building with Air Conditioning = Total Kwh/Room Area = 41,675.65/4,776.5 = 8.74 Kwh/m2
• IKE Buildings Not Air-conditioned (Outdoor) = Total Kwh/Room Area = 186,503.04/23,383.5 = 7.98Kwh/m2

Based on the IKE standard for air-conditioned buildings, the Electrical Energy Consumption in the terminal building is included in the efficient category for air-conditioned buildings and exceeds 7.4 Kwh/m2/month (for non-AC buildings).

Analysis of Energy Efficiency Potential Value

Based on the calculation of energy consumption intensity (IKE), it is known that the level of consumption in outdoor areas is still high. Efficiency is needed (Lestari, 2022). Efficiency can be done by adjusting the use of lamps or other electrical devices. PJU lights and Highmast LEDs and parks were initially used for 24 hours, then reduced to 14 hours/day (17.00 to 06.00). For use in buildings, it has met efficient standards. But you can make it more efficient by setting the duration of using the lights and air conditioning to 14 hours/day (11.00 to 24.00) and optimizing natural ventilation. If the AC is reduced by the time it is used, then the outdoor use of the AC is also reduced.

For escalators, you can use an inverter system to save energy. Escalators using an inverter consume an average of 43.49 kWh of power (Chamdareno & Hamimi, 2022) or can achieve an energy efficiency of 60% (Prakasa, E. R., & Andriawan, 2022).

Apart from the methods above, one alternative way that can be done is to use solar panels as alternative energy (Ali et al., 2021). In the Detail Engineering Design (DED) of the Arjosari terminal, JSKYE 350 Wp Solar Panels are used, namely solar panels with 350 Watt-Peak power. In DED there are 286 solar panels, which means that approximately 100,100 Watts or 100.1 Kwp is available. If solar panels are used as alternative energy, it will reduce the consumption of electrical energy by 100.1 Kwh, which is 149,558.24 kWh in buildings that are not air-conditioned, so for buildings that are not air-conditioned or outdoors, the IKE value is 6.4 kWh/m2/month (A quite efficient category). Whereas for air-conditioned buildings, the Energy Consumption Intensity (IKE) value is 4.2 kWh/m2/month, which is in the very efficient category.

The potential for energy savings or energy efficiency to be obtained is as follows:

• Air-conditioned building : (IKE building–IKE target) x total area = (8.74 – 4.2) Kwh/m2/month x 4,766.5 m2 = 21,639.91 Kwh/month

• Non-air-conditioned buildings : (IKE building–IKE target) x area = (7.98–6.4) Kwh/m2/month x 23,383.5m2 = 36,945.93 Kwh/month

The total potential for energy savings or energy efficiency is 58,585.84 kWh/month (25.64% of 228,178.69 kWh (initial value of electricity consumption/month))

CONCLUSION

Several analyzes have been carried out to obtain several conclusions, namely the Application of the Green Building concept in this project, namely using building envelopes such as stop sol glass, GRC Wall Cladding panels, and ACP to reduce heat transfer, reduce the heat island effect of rigid pavement surfaces, paving and cast floor hardener are used, but this has not been used on the surface the roof still uses metal deck and concrete plates with a small area. In addition, LED lights are used, placing the switch close to the door and using solar panels. In addition to the above, it is still necessary to add green open space, increase ventilation and use energy-saving devices such as escalators with inverter systems. The amount of electrical energy efficiency for air-conditioned buildings is 21,639.91 kWh/month and for non-AC/outdoor buildings is 36,945.93 kWh/month. The total efficiency of electrical energy is 58,585.84 kWh/month (25.64% from 228,178.69 Kwh (initial value of electricity consumption/month)).

The input suggestions that can be given by the author related to this research and for future research include the following, The as-built drawing document is used as material for future research, Research water-energy efficiency, Using software such as smart green building systems, net-zero building software, and energy modeling software to calculate energy consumption in baseline and designed buildings as well as Green building worksheets provided by the Green Building Council Indonesia.

BIBLIOGRAPHY

Ali, S. B. M., Hasanuzzaman, M., Rahim, N. A., Mamun, M. A. A., & Obaidellah, U. H. (2021). Analysis of energy consumption and potential energy savings of an institutional building in Malaysia. *Alexandria Engineering Journal*, *60*(1), 805–820.

Chamdareno, P. G., & Hamimi, A. H. (2022). Efisiensi Konsumsi Energi Listrik Pada Eskalator Menggunakan Inverter Dipusat Perbelanjaan. *RESISTOR (Elektronika Kendali Telekomunikasi Tenaga Listrik Komputer)*, *5*(1), 25–30.

Hidayat, M. S. (2022). STUDI OVERALL THERMAL TRANSFER VALUE (OTTV) DI GEDUNG KAMPUS UNIVERSITAS. *METRIK SERIAL TEKNOLOGI DAN SAINS (E) ISSN: 2774-2989*, *3*(2), 1–7.

Indonesia, G. B. C. (2013). Greenship untuk Bangunan Baru Versi 1.2. *Ringkasan Kriteria Dan Tolok Ukur*.

Iqbal, M. (2022). ANALISIS EFISIENSI PENGGUNAAN ENERGI LISTRIK-2022. *Jurnal Teknik Mesin, Industri, Elektro Dan Informatika (JTMEI)*, *1*(3).

Kurnia, A. B. D. K. (2021). *Penerapan kriteria green building pada aspek tepat guna lahan (appropriate site development) pada gedung graha rektorat universitas negeri malang/Ananda Bella Dwi Kurnia*. Universitas Negeri Malang.

Prakasa, E. R., & Andriawan, A. H. (2022). Analisa Efisiensi Energi Listrik Di PT. Bank X. *Jurnal Elsains: Jurnal Elektroi*, *4*(1), 2527–6336.

Tiro, J. A., Mukhlis, B., Kali, A., & Mahmudi, I. (2021). Konservasi Energi Listrik pada Bangunan Gedung Kantor Bupati Tojo Una-una. *Foristek*, *11*(2), 94–99.