Conference Paper

Autodesk Green Building Studio an Energy Simulation Analysis in the Design Process

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Abstract

Commercial buildings are buildings that spend a lot of energy. This is reinforced by the data that the city that has an expenditure center in Indonesia. To allow energy use can be solved by passive design in architecture. In this study, energy calculations will be carried out using the Autodesk Revit application where previously there was no discussion about energy use at the center using Autodesk Green Building Studio (GBS) analysis by comparing one building with the use of materials differently. The method used in this study is creating three scenarios. Where the scenario B-01 is using a lot of glass but given a double facade in the north, east and south, B-02 is little use of glass and no double skin façade, the B-03 many openings without façade double skin. Each scenario is simulated and results. From the results of Autodesk GBS discussion in the EUI category, Life Cycle Energy Use, Carbon Emissions, and also the Use of Electricity. From the comparison of some of the most optimal scenario categories in energy is scenario B-01. In the simulated Shopping Center building in Autodesk GBS, buildings with more use of glass and openings will be more efficient in energy use.

Keywords: BIM, Energy Building, Green Building Studio, Shopping Centre, Green Technology

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1. Introduction

Eight of the ten largest electricity consumers in Indonesia are shopping centers located in Jakarta, the two remaining Indonesian international airports [1]. A shopping center in Jakarta can consume the same amount of electricity as two cities in various parts of Java, combined [2]. At its peak, electricity use in a large number of shopping centers in Jakarta can reach a capacity of 40 MW [3].

In this phenomenon in Jakarta, this is a reflection of the city of Bandung which is a big city in Indonesia. At least, there are 62 shopping centers in the city of Bandung and will continue to mushroom over time, and the energy consumed will continue to grow.

In fact, in the department store business, energy is vital, especially in electricity use, the portion of the application and allocation of funds to provide it is the biggest thing. It can be seen that equipment such as lights, elevators, escalators, air conditioners (AC) to air conditioning systems are some of the dominant tools in operating in the world of department stores.

It is essential to implement energy efficiency programs in this shopping center to save energy costs (from a business perspective), to reduce greenhouse gas (GHG) emissions (from a perspective environment), and provide more significant energy reserves for other regions in Indonesia.

One method that is now used to streamline the use of electrical energy is the audit of electrical energy. Electricity audit is an increase in energy efficiency used or the process of saving energy. In this process include the existence of an energy audit which is a method to calculate the level of energy consumption of a building or building, where the results will be compared with the Building Standard IKE Building in Indonesia and then look for solutions to save energy consumption. if the level of energy consumption exceeds the existing standard.

The statement also supports the energy efficiency of this building that with the current global attitude towards environmental sustainability and the latest report of the AIA (American Institute of Architect) regarding answering architectural challenges by 2030, it is clear that energy design must be an essential part of the design process. The latest energy modeling software must enable architects to design new metrics, differences that are very important for the success of the program. Because of energy modeling, architects need to know that it will not come at the expense of conceptual value from work. [4]

Energy calculations can be done in an easy and fast way, and this technology can be done with BIM. BIM itself is building information modeling. Where this application can integrate between professions such as architects, civilians, and contractors. Also, BIM is a technology in which a three-dimensional model in which all data is integrated.

Previously, there were facade studies with different materials with case studies of Multimedia Nusantara University, where The building of ASEAN Energy Award 2014 won for Energy Efficient Building category in Tropical Building in Vientiane, Laos and awarded as 'Most Energy Efficient New Building' in the 2013 National Energy Efficiency Awards. This result of energy simulation performance by Autodesk Green Building Studio supports the theory that thermal properties of the material with lower solar heat gain coefficient (SHGC) could decrease the cooling loads in the cooling period. It can be seen that triple glazing has the lowest heat gain coefficient among the other materials configurations and results from this research proved it. Other than that, because of triple glazing has a high value of thermal resistance and low cost of heat transfer coefficient; it also makes it the excellent material for insulation. [5] But the differences with this study, the case study in this study is a shopping center, where the need for utilities is more and has a more complex facade.

In this study, energy calculations will be carried out using the Autodesk Revit application (one of the BIM-based software) where previously there was no further discussion regarding energy use simulations in shopping centers using the Autodesk Green Building Studio analysis feature by comparing one building with the use of materials and different openings. So that knowing the use of useful building materials is also an advantage and disadvantage in its use of energy efficiency.

2. Definition

2.1. Building information modelling

BIM (Building Information Modeling) is a data-rich three-dimensional geometric model. The information contained in it can be used for other purposes such as predicting energy consumption, structural performance, costs, scheduling, clashes between preconstruction systems, and can even be used for the use of facility management. BIM represents the building as a database that is integrated with all information in the building. BIM can also simplify the analysis that is often complicated and difficult. With this technology. BIM has made it easier for various professions to work, such as architects, contractors, researchers, and so on. BIM can aid in the following aspects of sustainable design. [6]

- Building orientation (to select the best building orientation that results in minimum energy costs)
- Building massing (to analyze building form and optimize the building envelope)
- Daylighting analysis
- Water harvesting (to reduce water needs in a building)
- Energy modeling (to reduce energy needs and analyze renewable energy options such as solarenergy)- Sustainable materials (to reduce material needs and to use recycled materials)

2.2. Autodesk green building studio (GBS)

Autodesk® Green Building Studio is a flexible (online) cloud-based service that allows you to run building performance simulations to optimize energy efficiency and work towards carbon neutrality at the beginning of the design process. Green Building Studio® helps expand the ability to design high-performance buildings at a fraction of the time and cost of conventional methods. [6]

The energy used can be analyzed in both conceptual and detailed information building models. Shows three simulation workflows of the main energy of an Autodesk tool: building elements, conceptual mass, and gbXMl exports that explain in Figure 1. [8]

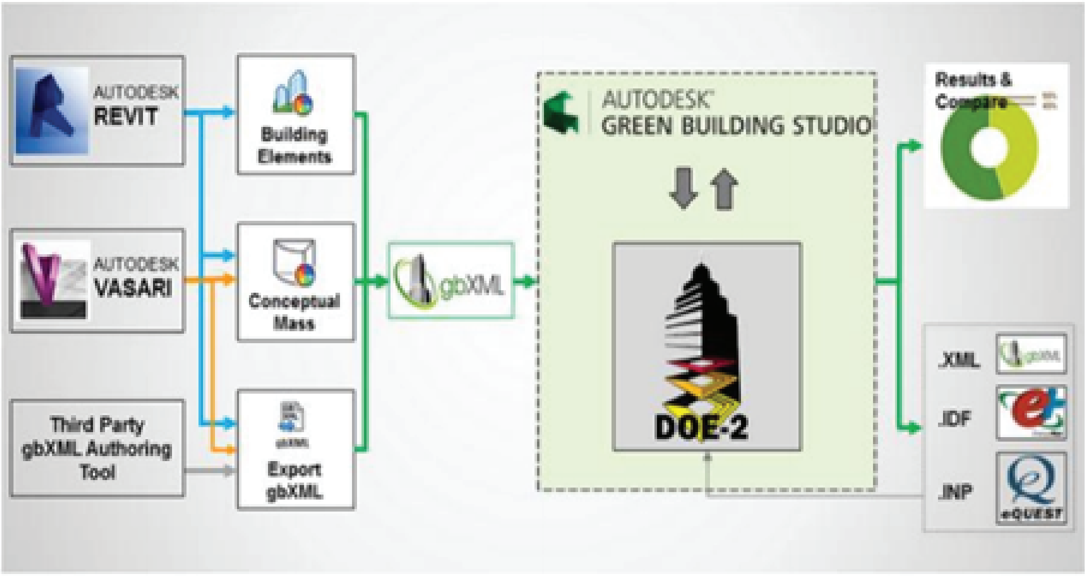


Figure 1: Autodesk GBS Validations and Process. Source: *https://www.theseus.fi/bitstream/handle/10024/75095/Le_MinhKhoi.pdf*.

This option applies to Revit as a detailed building information model. All building elements (walls, doors, windows, ceilings, roofs) are used to create an Energy Analytical Model (EAM) automatically. This information is then forwarded to Green Building Studio for energy simulation. Energy settings are used to modify the building, location, and some detailed models and energy. Finally, energy simulation can be activated by clicking the Run Energy Simulation panel. Running a simulation must be named for the results displayed which can be displayed in the Results & Compare panel. [9]

The following are the pros and cons when using Green Building Studio:

Pros:

- Automatically in terms of processing, it doesn't need much data input, and everything is connected to the cloud.

- A little preparation is needed if the model is integrated with Revit (BIM application).

- Fast transition from Revit Model to gbXML format.

- Has a simple appearance, easy to use.

Cons:

- Requires an internet connection because all data is integrated with the cloud.

- Problem with large files.

- Data results are less specific.

- The type of analysis is minimal.

3. Methods

This research was conducted to compare the results of energy calculations using the Autodesk GBS (Green Building Studio) application by making three scenarios for the same building. The scenario in question is to make the design of the sheath different in terms of material and also whether there is a double skin façade. So, from several scenarios, it can show optimal results for the design of the building envelope to make energy efficient. This scenario is divided into the B-01 scenario, B-02 scenario, and B-03 scenario.

As mentioned earlier, this study will use the Autodesk GBS application to calculate building energy. Autodesk GBS itself is a plugin from Autodesk Revit. So there is no need to manually input a lot of data from the building to be studied. Climate data is included in the cloud in the Autodesk GBS application, so there is no need to enter climate data. But some data must be inputted and checked first, namely:

- Location and coordinates

- Value in the Energy Settings Tab

- U-Value of the material to be studied

The following is the flow in making this Figure 2 below:

3.1. Case study

The Shopping Center Building that will be discussed in this study is in the SWK (Sub-City Area) Gedebage, Bandung City, Indonesia. This SWK Gedebage is located in the eastern part of Bandung City. In the future, SWK is planned as an integrated area of Technopolis. General Description of Gede Bage Area Based on Bandung City Spatial Plan 2011-2031, Gede Bage District covering 980 ha and Rancasari covering 955 ha is designated as City Sub-Region (SWK) Gede Bage. In the RTRW, SWK Gede Bage is intended for offices, government, green open spaces, settlements, rice fields that are shown in Figure 3, trade, and services. Based on the facts above, the planned

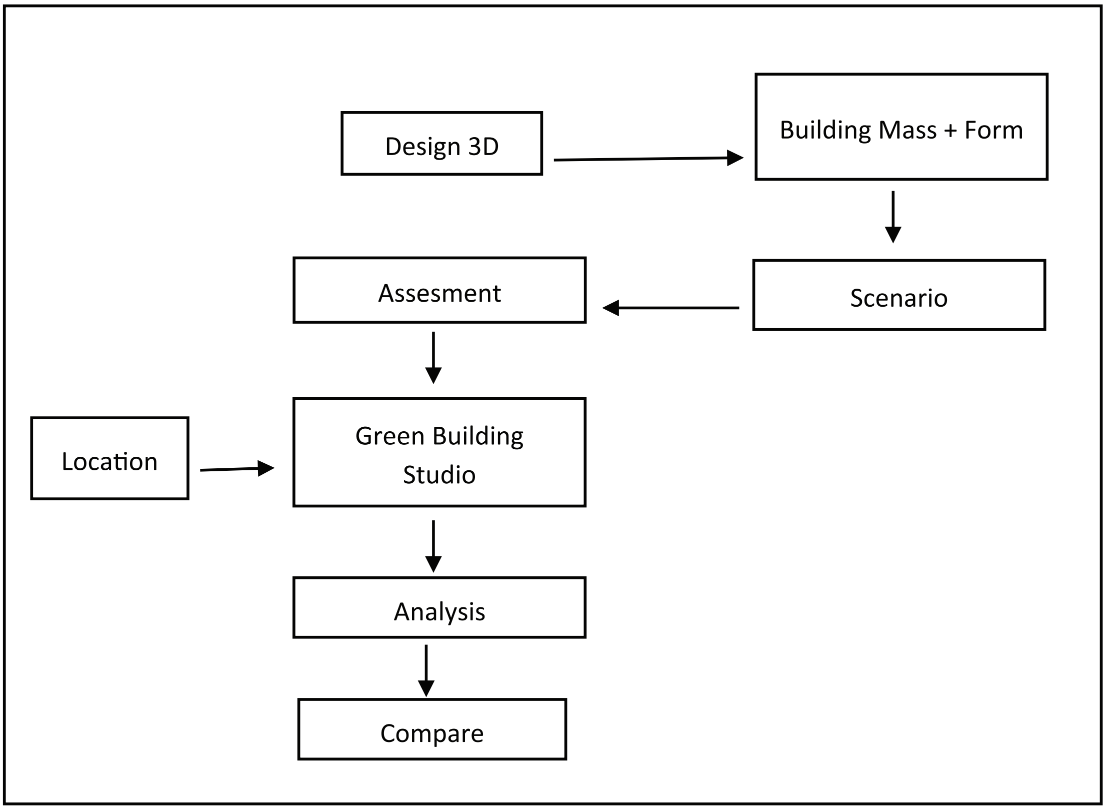


Figure 2: Research Framework.

development of the Teknopolis area is only 800 ha in the Gede Bage Subdistrict which has 979.3 ha because of the balance of growth. Gede Bage, an area in East Bandung that never seemed to be taken into account. For many years this area was better known as a rice field area, not a few of which became part of a sleeping area. This area that is close to Cibiru and Sapan areas is better known as an area that often becomes a flood subscription if the rainy season. Also, the Gede Bage area is known as the container terminal, the Gede Bage primary market, and is now also known as the Gelora Bandung Lautan Api (GBLA) stadium. Gede Bage sub-district township was previously a mix of land use that mapped the area. When the area is still a flooded subscription area, according to the RTRW of Bandung City in 2015-2031, it will build a new city center to spread the population evenly. The city center development plan is Gede Bage, which will have city-scale facilities such as squares, city mosques, campuses, government buildings, schools, and others. [10] Therefore, to support all activities that will be centered on Gedebage, the Shopping Center is needed to fulfill the daily needs, improve the regional economy, and also for entertainment.

In terms of climate, this area has the highest temperature of 35 °C, and the lowest reaches 11 °C. The temperature can benefit the building to reduce the use of artificial air because air temperatures in this area are relatively comfortable. This area has a wind

Figure 3: Maps Location and Site Edge. Address: Jl Soekarno Hatta No. 385 (Teknopolis Gedebage integrated area) Coordinates: - 6.9356248,107.6945656,2670.

speed that is not too tight that is equal to 3 mph. Also, because this place is a tropical region, this region has quite high humidity, which ranges from 700% - 93%. [11]

The site is relatively flat land and is traversed by the Cimanuk River. Rice fields dominate the existing site. With these natural features, the Shopping Center was built in response to the river and will create a river promenade that responds to the river on the site. Also, due to alluvial soil types, the structure and construction for the foundation are made to a depth of 30 m below the soil surface.

The site that is intended for buildings that will be adjacent to the TOD (Transit Oriented Development) area so that the site is quite strategic and easily accessible and has potential economic benefits. There's preliminary site plan of Gedebage Shopping Center refer to Figure 4.

3.2. Building data

The building that will be simulated is the Preliminary design from the Shopping Center with a total of 11 floors, where four floors are basements, and seven floors are the main building. This Shopping Center has a total floor area of 34,877 m^2.

Figure 4: Preliminary site plan of Gedebage Shopping Center.

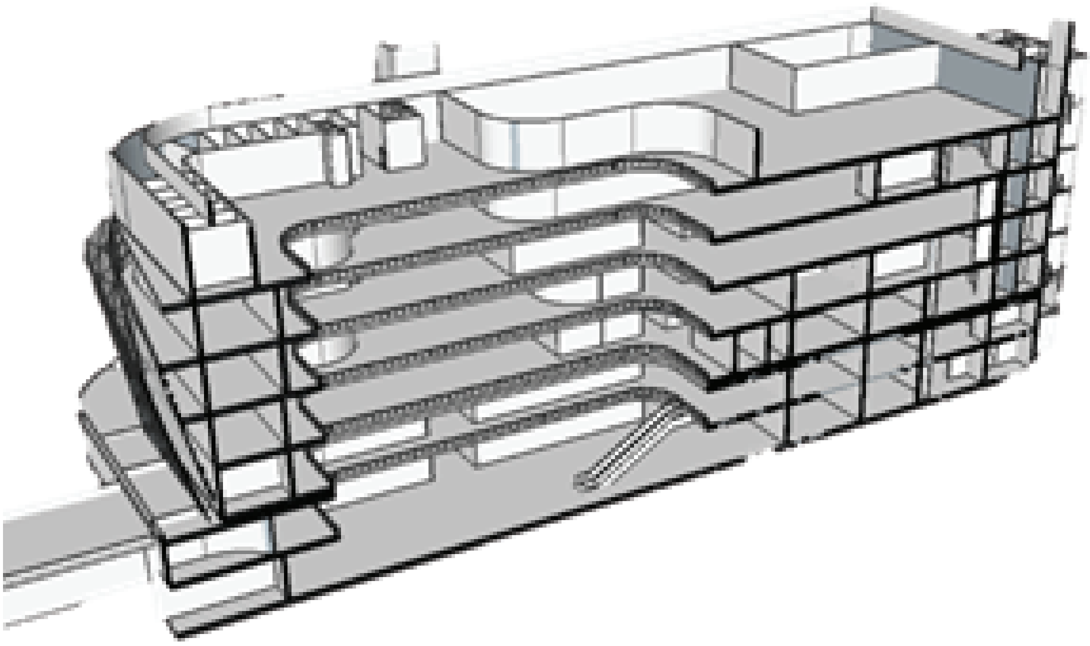


Figure 5: Building Section.

In response to the climate, in Figure 5 a void design is displayed at the Shopping Center designed to allow sunlight to enter the building, that explained in Figure 5. So it can save the use of lights during the day. The roof used is a type of transparent material: Double Glazing, allowing light to enter the building.

Figure 6: Building a Preliminary Perspective.

Several scenarios are made to determine the effect of different building materials on energy use in a building, in which:

1. B-01: A preliminary building for shopping centers in Gedebage uses a lot of glass, but has been given a double skin façade (DSF) in the north, east, and south.
2. B-02: Is a preliminary shopping center building in Gedebage with little use of glass and openings. In this scenario do not use double skin façade (DSF).
3. B-03: It is a building of a preliminary shopping center in Gedebage with the use of dominant glass and openings. In this scenario do not use double skin façade (DSF).

Visualization of the material that applied to the building explained in Figure 6.

The following is a data table about building performance factors for each building B-01, B-02, and B-03:

4. Result & Discussions

The research process is divided into four stages, where the first step is to determine the location of research on GBS which is a plugin from Autodesk Revit. The input is

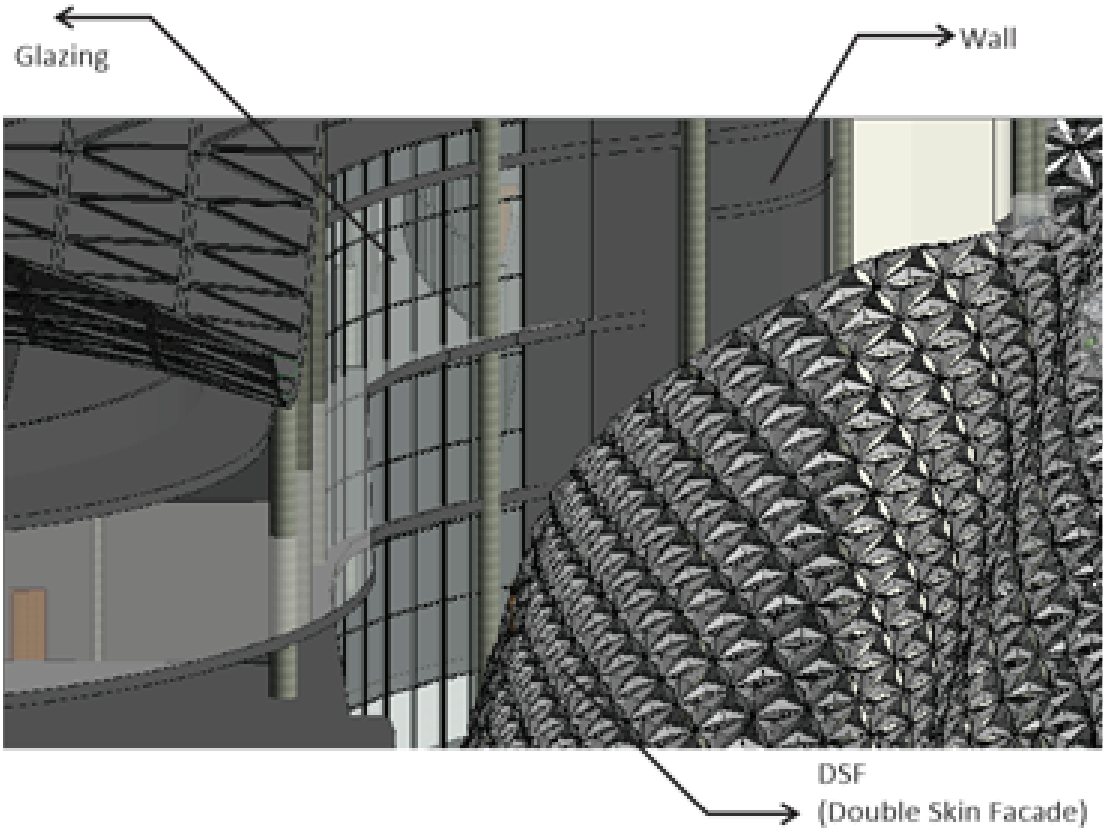


Figure 7: Visual of Material.

TABLE 1: Information About Building Performance Factor between three scenes.

No	Type of Building	Exterior Wall Area	Exterior Window Ratio
1	B-01	9.633 m^2	0.47
2	B-02	12.355 m^2	0.07
3	B-03	8.790 m^2	0.62

done in the form of a coordinate point or set the location pin manually to determine the location accurately. After the location of the building is determined, the model is constructed with several scenarios. Climate data does not need to be inputted in the GBS application. This is because GBS has been integrated with the cloud on the internet which is climate data of a region. Because of this, simulations on GBS can only be done with an internet connection (online).

The scenario made in the model is to distinguish the number of openings in the building. Making these openings are made by changing the wall material into the glass. The last stage is to simulate each scenario of the building and compare the results with each other.

When the simulation is done, the need to set parameters and values in the energy settings tab. This value is very crucial and will affect the results of simulations on GBS. The settings tab surface of GBS refers to Figure 8.

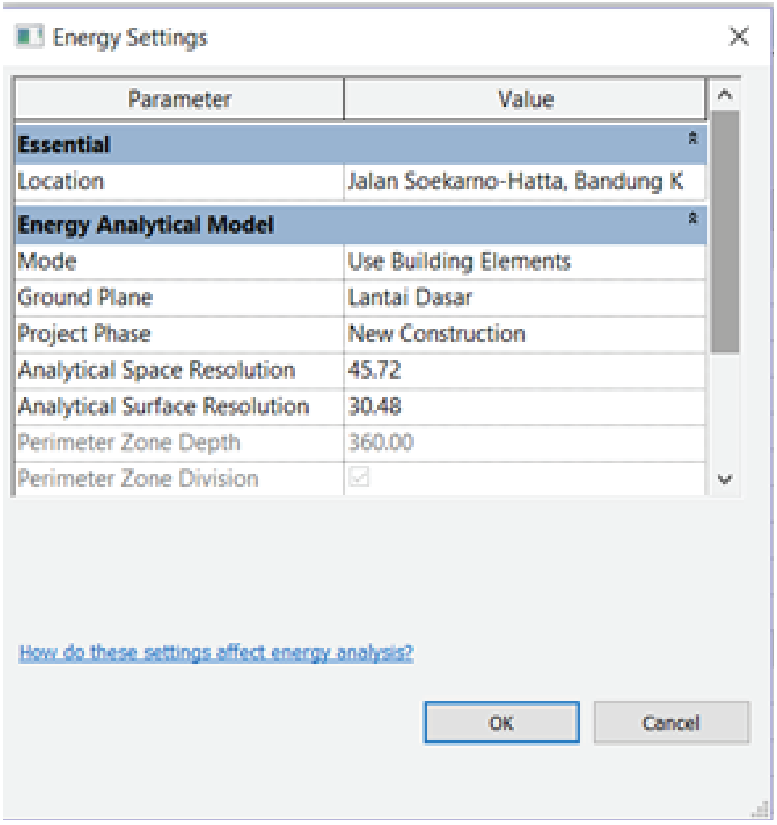


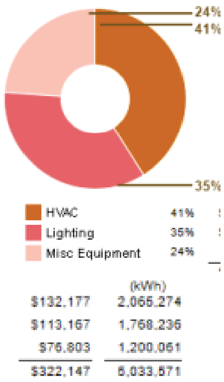
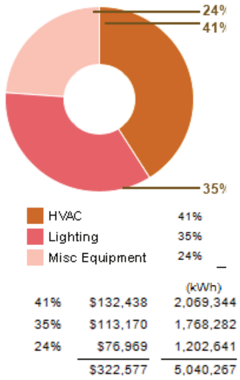
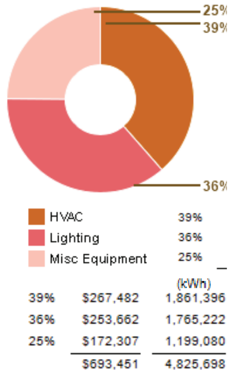
Figure 8: Location Setting on Autodesk GBS.

Calculating energy in the Gedebage Shopping Center building with different scenarios result from several categories such as Building Data, building performance factors, energy use intensity, energy life cycle usage / use, renewable energy potential, annual carbon emissions, energy usage: fuel, energy use: electricity, monthly heating load, monthly cooling load, monthly fuel consumption, monthly electricity consumption, monthly peak demand, annual annual wind up, monthly design data, annual temperature, daily weather averages, and humidity data.

Simulations are carried out at Autodesk Cloud, and the results can be obtained at Autodesk on the Green Building Studio website. The following is a table to compare B-01 buildings (buildings using glass and given a double skin façade), B-02 (buildings with little use of glass and openings), B-03 (buildings with lots of glass without double skin façade).

In the calculation category of EUI (Energy Utilization Intensity) all scenarios have met SNI IKE standards for Shopping Center buildings with a maximum EUI standard of 330

Table 2: Result Comparisson Between B-01, B-02, and B-03.

<table>
<tr><th>No</th><th>Result Category</th><th>B-01</th><th>B-02</th><th>B-03</th></tr>
<tr><td>1</td><td>Energy Use Intensity</td><td>144 kWh sm yr</td><td>145 kWh sm yr</td><td>139 kWh sm yr</td></tr>
<tr><td>2</td><td>Life Cycle Electricity Use</td><td>151.007.040 kWh</td><td>151.208.100 kWh</td><td>144.771.030 kWh</td></tr>
<tr><td>3</td><td>Energy Use : Electricity</td><td>
</td><td>
</td><td>
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kWh sqm/year. All scenarios: building B-01, B-02, or B-03 each have EUI number 144 kWH sqm/year, 145 kWh sqm/year, and 139 kWh sqm/year the chart refer to Figure 9.

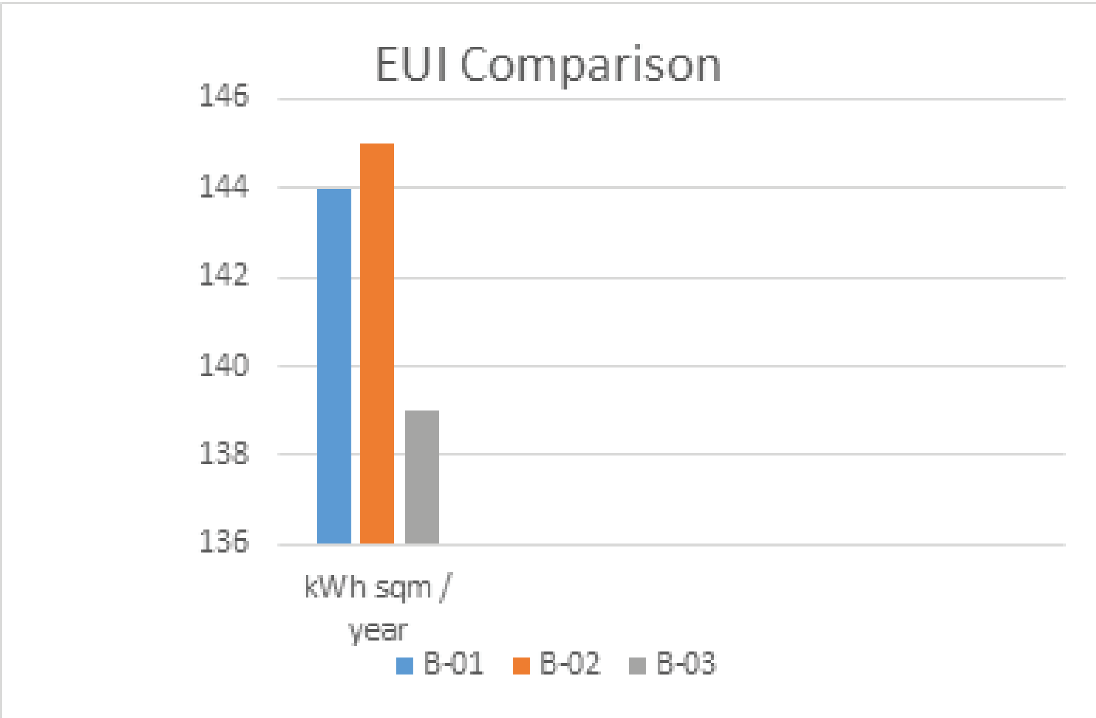

Figure 9: EUI Comparison Chart.

This shows, that more use of glass or openings in buildings, will save energy use. This result is different from previous studies where the results of the study show that the greater the WWR of a building, the greater the OTTV value and the maximum external cooling load. This is explained by the increasing window opening so that solar radiation and heat conduction through the window entering the building increases. [11]

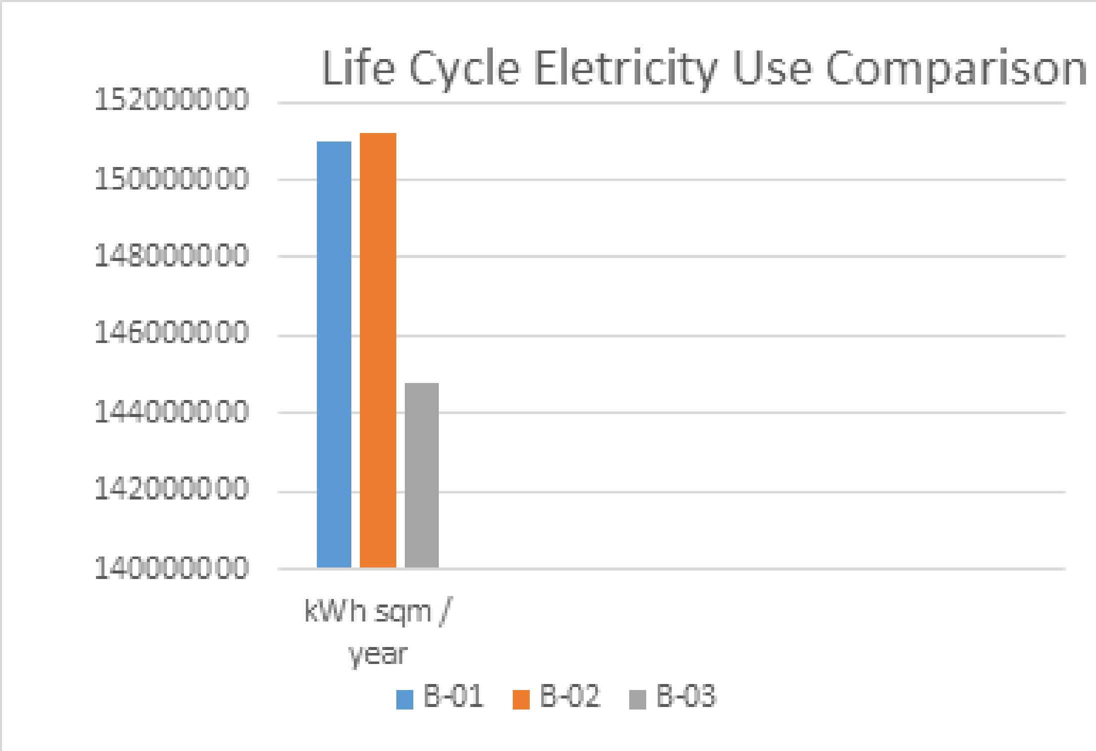

Figure 10: Life Cycle Electricity Use Comparison Chart.

Building lifecycle energy demand can be reduced by the use of passive and active technology. [12] In the Life Cycle Electricity Use Calculation category for each building B-01, B-02, and B-03, the numbers are 151,007,040 kWh, 151,208,100 kWh, and 144,771,030 kWh, the chart refer to Figure 10.

In the annual carbon emissions category, each building B-01, B-02, and B-03 have carbon emissions of 1,291 metric tons/year, 38 metric tons/year, and 2,172 metric tons/year, the chart refer to Figure 11. This has a result of inversely proportional to the results of the previous results.

This shows that the more glass used, the higher the carbon emissions produced. This can happen because the U value of the glass is higher than the U-wall value. These results are supported by previous research which states that materials with small SHGC and U-value values can reduce energy. [13]

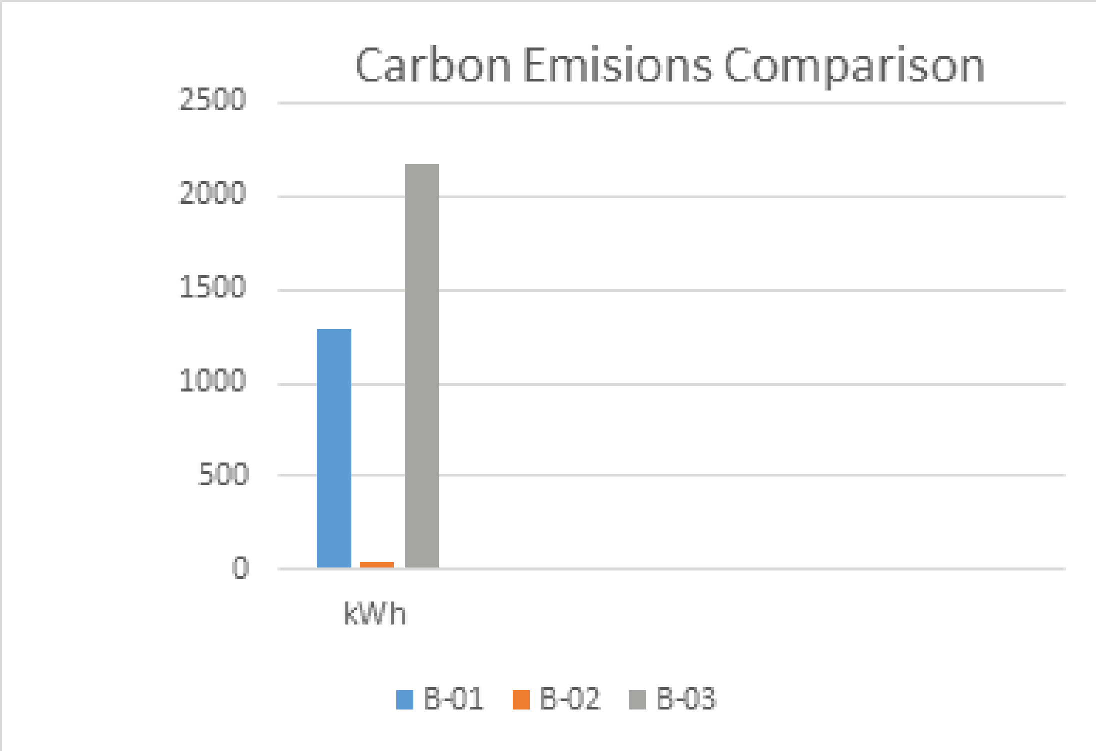

Figure 11: Carbon Emisions Comparison Chart.

In the category of Energy Usage: Electricity, to build B-03, most use HVAC as described in the previous paragraph. While the most economical is shown to build B-02 where the use of HVAC, Lightning, and Misc Equipment is less than other buildings.

5. Conclusions

1. The use of Autodesk GBS can facilitate architects, academics, and researchers to simulate and calculate the energy in buildings more easily and quickly.

2. In the simulated Shopping Center building in Autodesk GBS, buildings with more use of glass and openings will be more efficient in energy use, while buildings with less use of glass and more openings will be used in energy use.

3. In buildings with the use of glass in Autodesk GBS, it is known to be more wasteful in the use of HVAC. So that an ideal building is to build using glass with a low U value or with a double skin façade.

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