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Analysis of the Application of Green Building Concepts in Educational Buildings Case Study: Building B, Faculty of Biology UGM Yogyakarta

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Abstract. The building sector is one of the world's largest energy consumers. This problem is further exacerbated by our dependence on non-renewable energy sources. More than 90% of the world's energy comes from fossil energy including oil, natural gas and coal whose availability in nature continues to decrease because they cannot be renewed. Green design is a reaction to the global environmental crisis. Green design which also leads to eco design, or design for environment is the art of designing physical objects and the surrounding environment to balance sustainable principles with economic, social, and ecological aspects. As a construction actor, you are required to be able to produce a building design that does not require too much energy consumption and also of course considers the comfort of the occupants in it. In an effort to develop the campus, Universitas Gadjah Mada seeks to make the UGM campus a Green Campus. One of the buildings at UGM and the first building at UGM to be certified as a green building by the Green Building Council Indonesia (GBCI), namely Building B, Faculty of Biology UGM with 43% energy savings points, 30% water and 65% efforts to utilize local materials . From the Energy sector, this building applies a small percentage of window/glass openings, uses reflective paint so as to minimize heat that will be transmitted into the building, external shading devices (shading), applies insulation on the roof, a variable refrigerant type HVAC system (VRF).) with a high COP so that it can save more energy and use artificial lighting / energy-saving lamps. From the water sector, using a toilet fixture with a low flow so that it can save water. Meanwhile, the use of materials includes the use of clay tiles, hebel walls and other materials that are local products.

Keywords: Green Building, Energy Saving, Green Campus, Faculty of Biology UGM

INTRODUCTION

Global warming is a problem arising mainly caused by too many greenhouse gases in the atmosphere, so that these gases envelop the earth and reflect heat radiation back to the earth's surface [1]. The presence of greenhouse gases in the atmosphere becomes too global. The presence of greenhouse gases in the atmosphere becomes excessive due to the burning of fossil fuels such as coal, gas and oil or land clearing and forest burning [3]. Actually, there are many other greenhouse gases such as methane to water vapor. However, CO_2 has the greatest risk in climate change because this gas continues to accumulate in the atmosphere in large quantities [7].

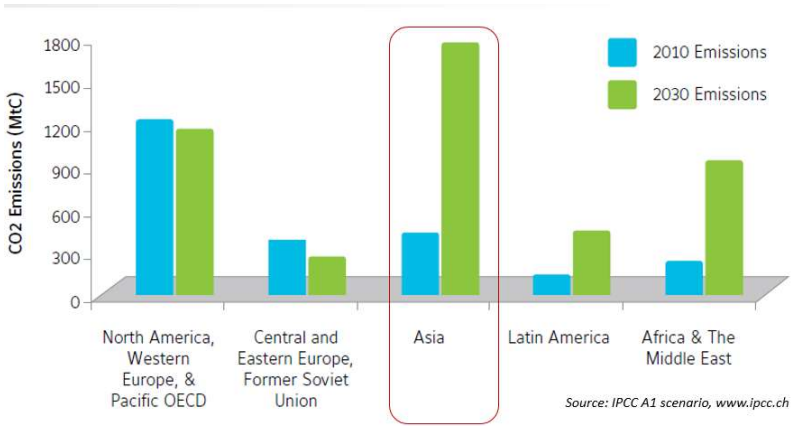
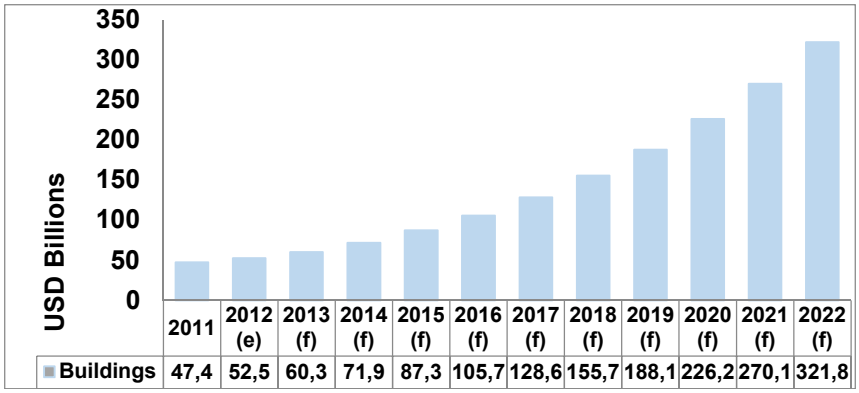


FIGURE 1. Graph of Countries that produce CO2 emissions
Source : IPCC A1 scenario



	2011	2012 (e)	2013 (f)	2014 (f)	2015 (f)	2016 (f)	2017 (f)	2018 (f)	2019 (f)	2020 (f)	2021 (f)	2022 (f)
Buildings	47,4	52,5	60,3	71,9	87,3	105,7	128,6	155,7	188,1	226,2	270,1	321,8

FIGURE 2. Graph of CO2 Emissions in Indonesia
Source : IPCC A1 scenario

The graph above shows that countries in Asia (including Indonesia) are the areas with the highest CO_2 emissions compared to other countries. The following graph demonstrates this point, showing that CO2 emissions in Indonesia rise year over year. [6].

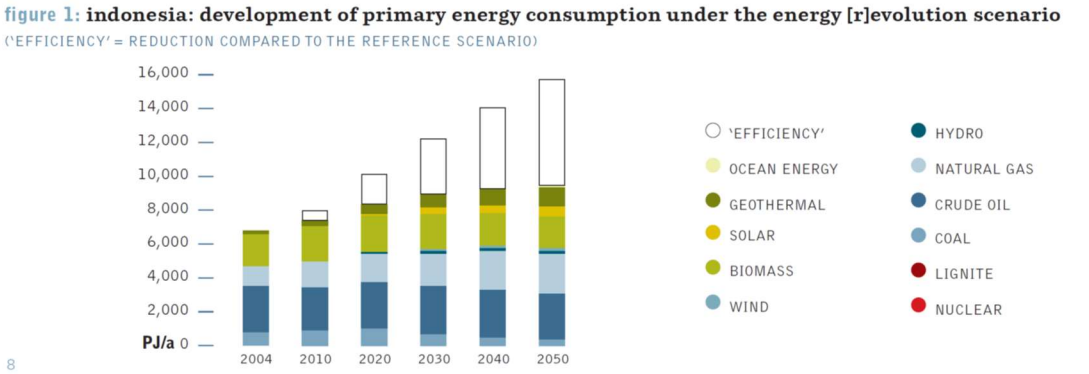


FIGURE 3. Graph of the development of energy consumption in Indonesia
Source: Energy [r]evolution. A sustainable Indonesia energy outlook

Based on the graph of the development of energy consumption in Indonesia, the amount is increasing every year and until 2050 it will reach 16000 J/a. The graph above illustrates the main sources of energy consumption come from renewable energy sources, non-renewable energy sources and others. Those who reach and others, among others, come from buildings [8]. With the amount of energy consumption in renewable and non-renewable energy sources

which are almost the same every year, the amount of efficiency that must be carried out every year will always increase from other sectors [4]. From the graph below, the total efficiency that we have to do until 2050 is approximately 33.4%.

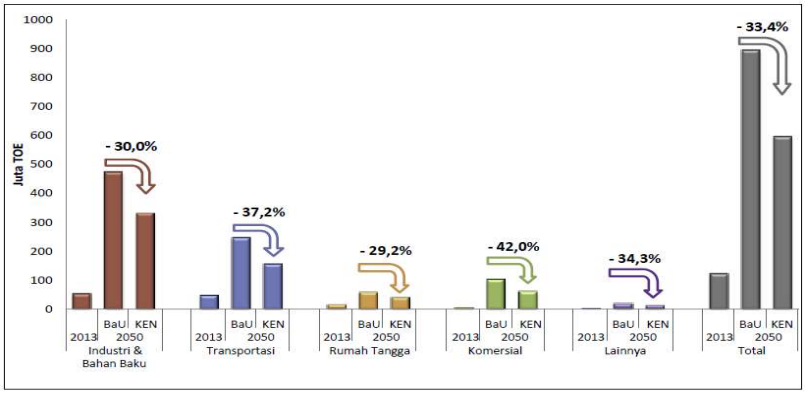


FIGURE 4. Energy Saving Potential Graph
Source: Energy [r]evolution. A sustainable Indonesia energy outlook

Green design is a reaction to the global environmental crisis [2].. Green design which also leads to eco design, or design for environment is the art of designing physical objects and the surrounding environment to balance sustainable principles with economic, social, and ecological aspects [5].. .

To develop the campus, Universitas Gadjah Mada seeks to make the UGM campus a Green Campus. One of the buildings at UGM and the first building at UGM to be certified as a green building by the Green Building Council Indonesia (GBCI), namely Building B, Faculty of Biology, UGM.

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METHODOLOGY

The research object chosen this time is the campus building, Building B, Faculty of Biology, UGM. Building B (Sinar Mas Building) Faculty of Biology UGM has an area of more than 5,800 m2 consisting of 5 floors and includes 3 classrooms, a plant systematics laboratory, a plant physiology laboratory, a plant microtechnical laboratory, a plant taxonomy laboratory, a general biology laboratory, a teaching laboratory. , library and monitoring room.

The method used is the field observation method, then simulation calculations are carried out using the Edge Building online application. This EdgeBuilding application is used to measure the level or savings points on the building [9].

FIGURE 5. Overview of Building B, Faculty of Biology, UGM.
Source: Personal Documentation, 2018

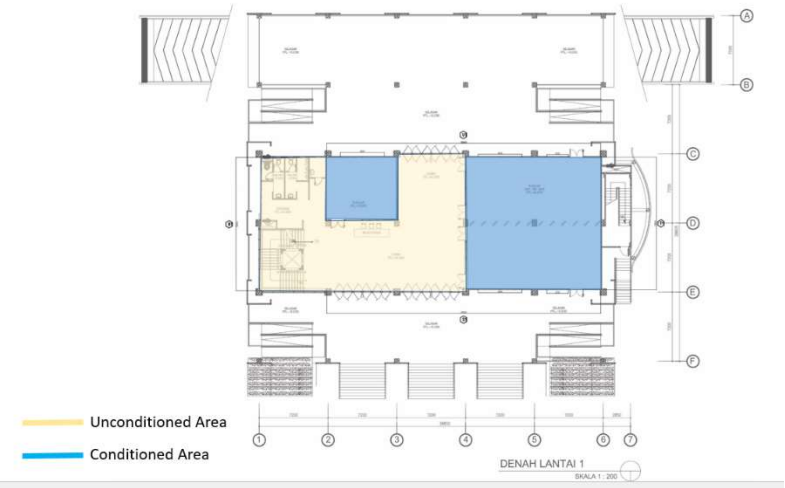

FIGURE 6. Floor Plan 1 Building B Faculty of Biology UGM.
Source : DPE Lab Documentation, 2018

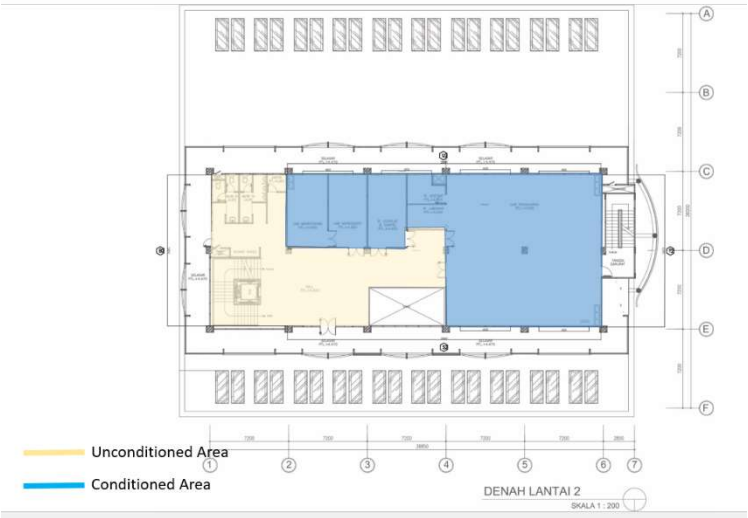

FIGURE 7. Floor Plan 2 Building B Faculty of Biology UGM.
Source : DPE Lab Documentation, 2018

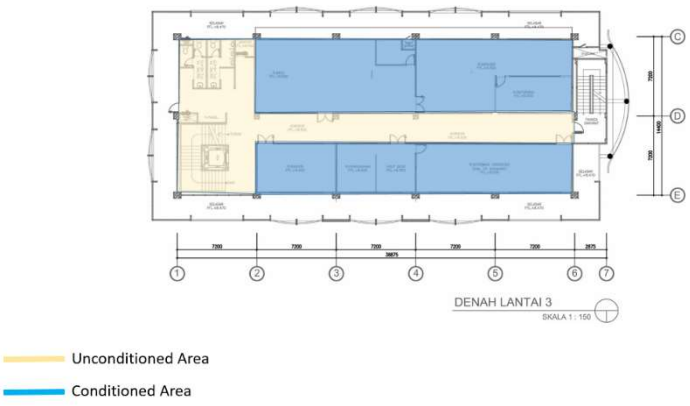

FIGURE 8. Floor Plan 3 Building B Faculty of Biology UGM.
Source : DPE Lab Documentation, 2018

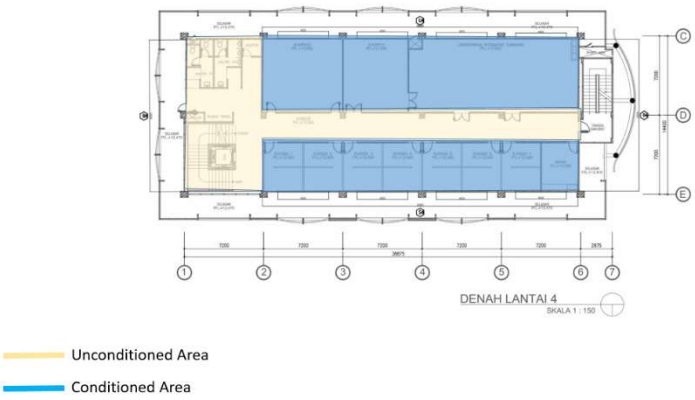

FIGURE 9. Floor Plan 4 Building B Faculty of Biology UGM.
Source : DPE Lab Documentation, 2018

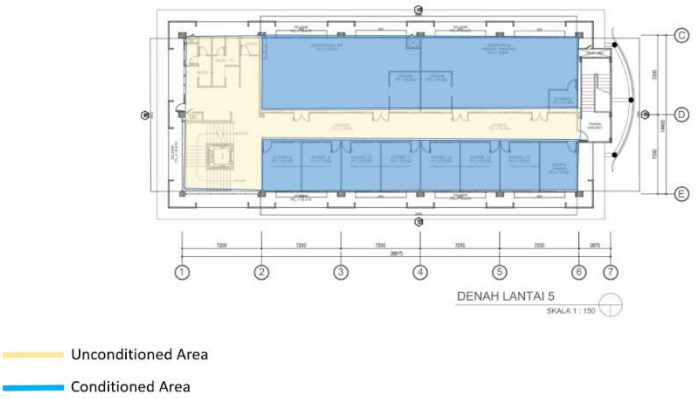

FIGURE 30. Floor Plan 5 Building B Faculty of Biology UGM
Source : DPE Lab Documentation, 2018

RESULT AND DISCUSSION

Universitas Gadjah Mada as one of the oldest and largest campuses in Indonesia is currently starting to concern about the application of the green campus concept. Aspects that must be integrated to achieve a green campus concept are smart energy, smart building, smart water, smart public service, smart mobility and smart rubbish [10]. One of the efforts made by UGM and in collaboration with Sinar Mas is to build educational facilities at the Faculty of Biology with the concept of smart energy, smart building and smart water so that it can be declared a green building.

Building B of the Faculty of Biology UGM is an educational facility declared a green building or the first environmentally friendly building in Yogyakarta. This building was built on an area of approximately 5,800 m^2 in Padukuhan Barek, Depok, Sleman, Yogyakarta. This building consists of 5 floors which includes 3 classrooms, a Plant Systematics Laboratory, a Plant Physiology Laboratory, a Plant Structure and Development Laboratory which is a teaching laboratory and a library. This building has a good building concept, as well as a pilot project in an educational institution and is expected to be applied to the community.

This building was developed with the concept of a green building or green building according to the standards of the Green Building Council Indonesia with design, material selection, layout, energy, and water supply, to the placement of other supporting facilities prioritizing efficiency factors. In addition, it also adopts the concept of earthquake-resistant structures along with providing access for persons with disabilities

FIGURE 41. Building B Faculty of Biology

Based on the results above, several design applications were applied to this building so that it managed to get the title of Green Building. Some of these design applications include: application:

1. Window to Wall Ratio
   Window to Wall Ratio is the ratio of the size of the openings/windows/transparent elements in the building envelope compared to the outside of the building envelope. Building B Biology has a WWR ratio of 12.6%. The smaller the WWR, the smaller the energy consumed by the building because less heat will be transferred into the building.

2. Reflective paint/ tiles for roof
   The smaller the ability of a material on the roof and walls to absorb heat, the higher the heat generated by the material so that the higher the heat that will enter the building. The roof material of this building has a solar reflectance of 33%. It is proven that the actual roof paint is brown and glossy. The roofing material absorbs quite a lot of heat. While the wall material uses a white paint finish with a solar reflectance of 70%. The higher the solar reflectance value, the better the material because it can reject heat to be passed into the building.

3. External shading devices
   This external shading serves to dispel heat that will enter the building. The type of shading used in Building B, Faculty of Biology, UGM is the eggcrate type so that the shading density is quite good and is quite capable of minimizing heat that will enter the building.

4. Insulation of roof
   In point 2, it is explained that the roof covering material uses materials with dark and glossy colors. The color of the roofing material has an impact on the ability to absorb heat which is quite high. Therefore, there is a need for roof insulation in the form of a layer of aluminum foil to help reduce heat that is transmitted through the roofing material.

5. Variable refrigerant volume (VRV) cooling system
   The artificial ventilation system used is the Variable Refrigerant Volume system with a COP value of 4.5. In the SNI concerning ventilation, it is regulated that the minimum standard of the COP value for being somewhat energy efficient is 3.7. The use of COP 4.5 in this building indicates that the artificial ventilation design is quite capable of saving energy because it has a value above 3.7.

6. Energy saving light bulbs for internal spaces
   The lamps used are LED energy-saving lamps, so they are quite capable of minimizing energy consumption from lamps.

7. Low flow sanitary
   The sanitary equipment used applies a water-saving system, so that it is quite capable of reducing water consumption in buildings.

CONCLUSION

According to estimates made using the EDGE application, Building B at the Faculty of Biology UGM saved 43% of energy, 30% of water, and 65% of embodied energy. Building B of the Faculty of Biology UGM employs several design strategies that have helped this building earn a Green Building certificate from EDGE (Excellent Design for Greater Efficient), according to the findings of the observations and data collection that has been conducted. These strategies include:

1. Energy
   The percentage of small window/glass openings, using reflective paint so as to minimize the heat that will be transmitted into the building, external shading devices (shading), applying insulation to the roof, a variable refrigerant type of HVAC system (VRF) with a high COP so that it can save more energy and use artificial lighting/energy-saving lamps.
2. Water
   Using low-flow toilet fixtures to save water
3. Material
   The use of clay tiles, hebel walls and other materials that are local products.

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