Role of BIM - Technology in analyzing alternatives and choosing the best in energy consumption for buildings

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Abstract: The aim of this article is to highlight the role of Building Information Modeling in minimizing the energy consumption of a building. To achieve this, a project was selected in Iraq and the annual energy consumption in this project was determined. Through the analysis of the building using building information modeling, it was found that the addition of some alternatives during implementation effectively contributes to reducing energy consumption. For example, the use of foam Material above roofs reduces the Energy Use Intensity (EUI) to (1,135 MJ/m²/year), Electricity (294,591 kWh), and Fuel (117,587 MJ), and using Sand Stone in Wall Finishing reduces the Energy Use Intensity (EUI) to (1,116 MJ/m²/year), Electricity (228,898 kWh), and Fuel (496,223 MJ). Through these results, it appears that new materials must be incorporated into the building, as they are of high quality in thermal insulation and reduce energy consumption. By adding the alternative materials above, and from the results that appeared, it was found that these materials reduced the energy consumption of the building by a good percentage and thus obtaining a higher quality of the building by improving its performance.
Keywords: energy analysis of buildings, construction project, Building Information Modeling, analyzing alternatives.

Introduction

The construction industry needs radical and strategic changes rather than short-term changes and ad-hoc solutions to overcome its challenges and problems. [1]. The industry is often criticized by its' poor innovations comparing to other industries. Such judgment caused due to various reasons: Lack of high technology in design and construction [2].

Building information modeling (BIM) refers to the digital representation of a building's structural features. It is a digital 3D model that includes all of the spatial and functional features [3]. Projects mainly comprise three main stages: planning, design and construction [4]. Revit software is widely regarded as the most well-known Building Information Modeling (BIM) software in the architectural design market today [5]. Autodesk released this platform to the market in 2002 [6]. This platform is a product family that consists of Revit architecture, Revit structure, and Revit MEP [7]. The construction and operation of buildings contribute significantly to the consumption of resources and waste production [8]. More than 40% of energy consumption and correspondingly 30% of the CO2 emissions are caused by buildings globally [9, 10].

Energy Analysis of Actual Material

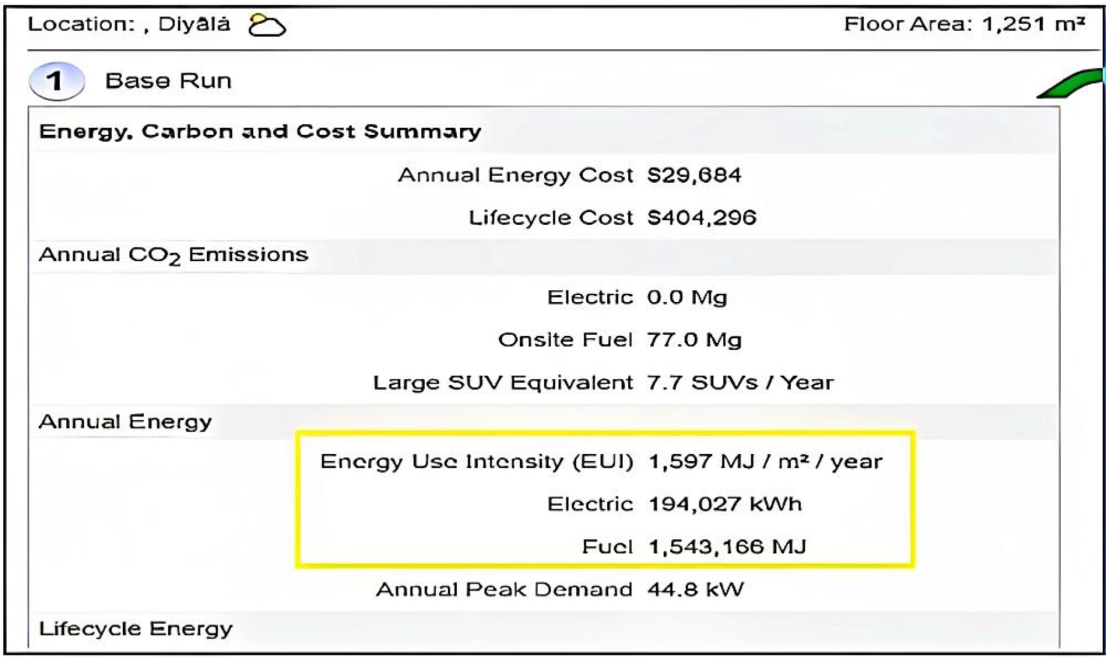

Figure 1. – Summary of energy simulation. (author).

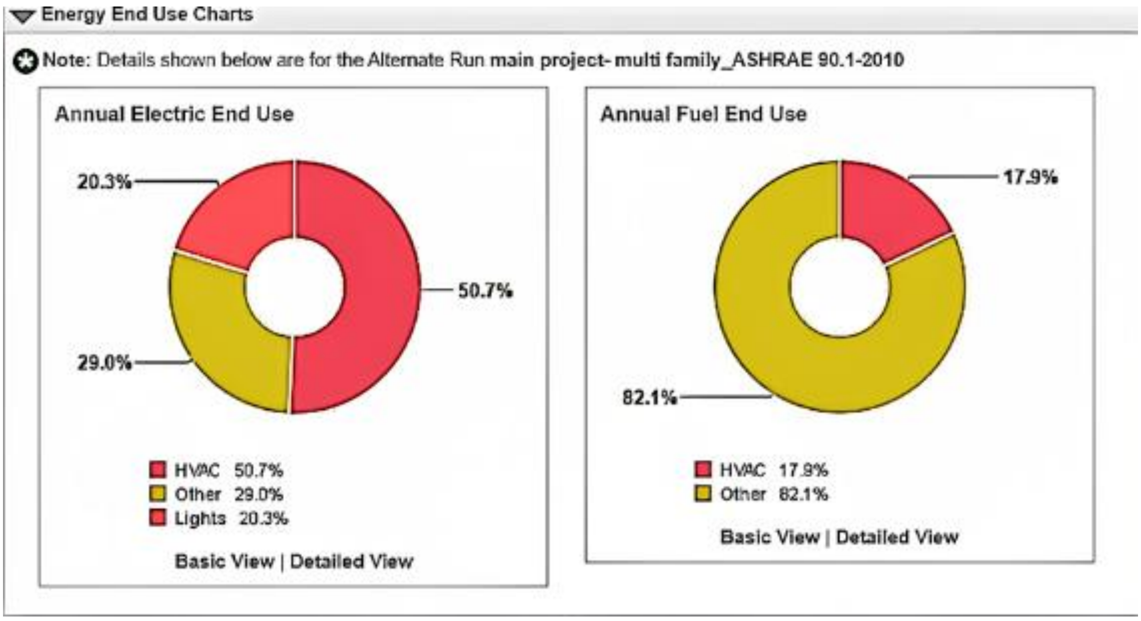

Figure 2. – Annual energy consumption.

Beyond the completion of generating procedure, the simulation of energy begins with the actual materials, the energy simulation summary evinces that the annual consumption of energy is (1,597 MJ/m2/year), and consumption of the energy of electricity is (194.027 kWh/year), and annual consumption of fuel is (1,543 MJ/year), as depicted in the Figure (1).

The annual percentage of electricity and fuel consumption get from simulated model to GBS before add materials Figure (2).

Add New Materials (alternatives)

Founded upon the analysis acquired from the evolved model, numerous materials as alternatives have been proposed for improving the building performance and reducing the consumption of energy, recognizing that the initial Energy Use Intensity (EUI) was (1,597 MJ/m2 /year), as in the next sections:

Using Foam Material above Roofs

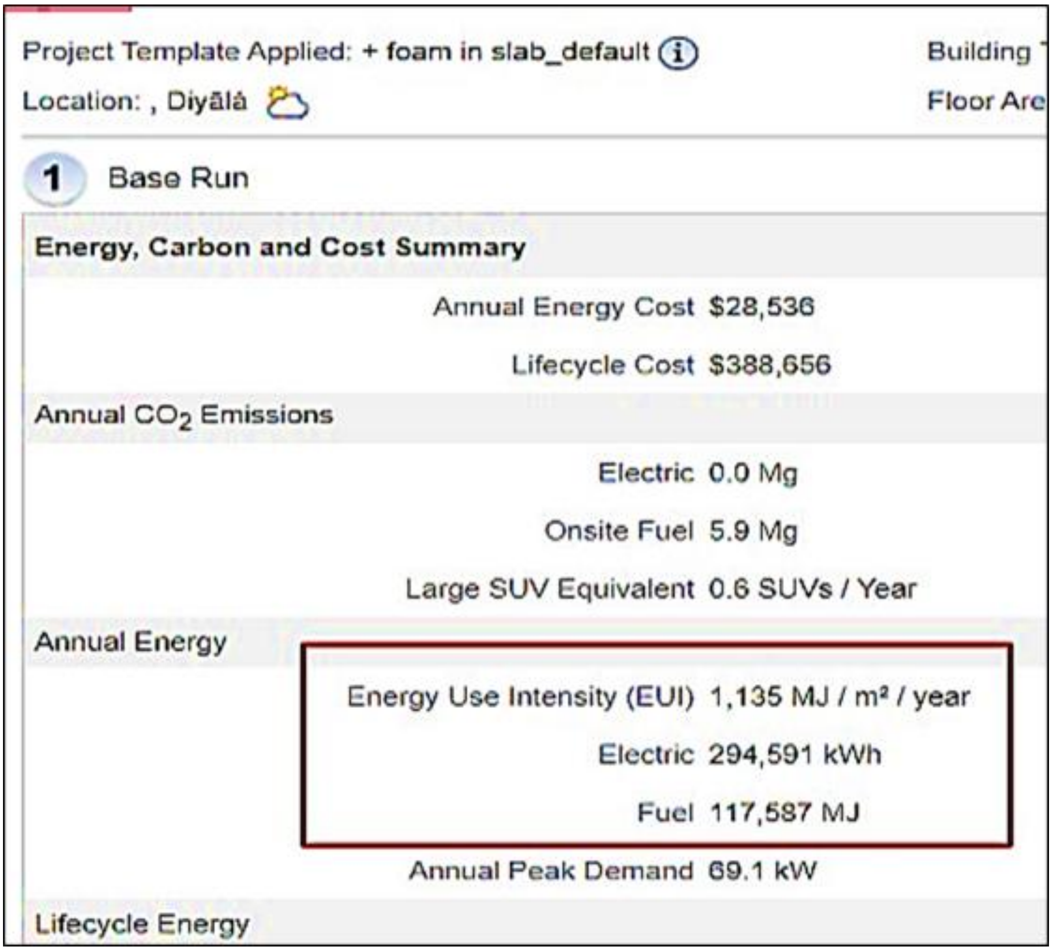

Figure 3. – Using foam material.

Due to its elevated thermal as well as acoustical insulating qualities, foam material is a too unlike use than the traditional concrete, and the outcomes of utilizing such material are displayed in the Figure (3) which reduces the EUI to (1,135 MJ/m²/year), Electricity (294,591 kWh), and Fuel (117,587 MJ).

Using Sand Stone in Wall Finishing

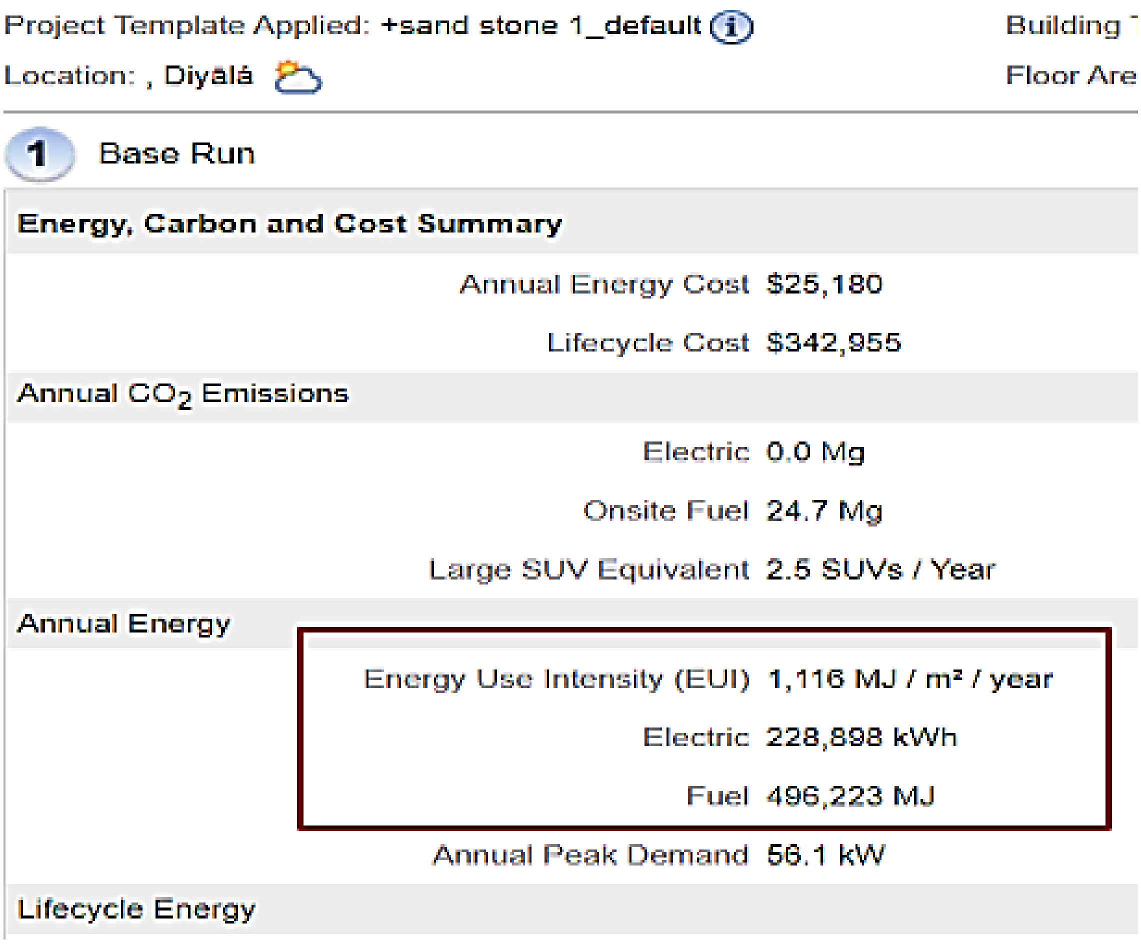

Figure 4. – Using sandstone.

The sand stone is a sedimentary rock made up of Calcium Carbonate, and Calcium and/or Magnesium. In the market, there're a broad range of sand stones, the domestic and foreign that dramatically differ in aesthetics, porosity, hardness, and density. The sand stone capability for adapting to various architectural styles, in addition to its longevity, pleasing natural color, and the ease of shaping, has entirely participated to the popularity of stone through the time. It is suggested to use this stone to find out how useful it is in reducing energy consumption to give an opinion on whether it is useful for use or not. The outcomes of utilizing such material are illustrated in the Figure (4) which reduces the EUI to (1,116 MJ/m²/year), Electricity (228,898 kWh), and Fuel (496,223 MJ).

Using Granite in finishing Wall

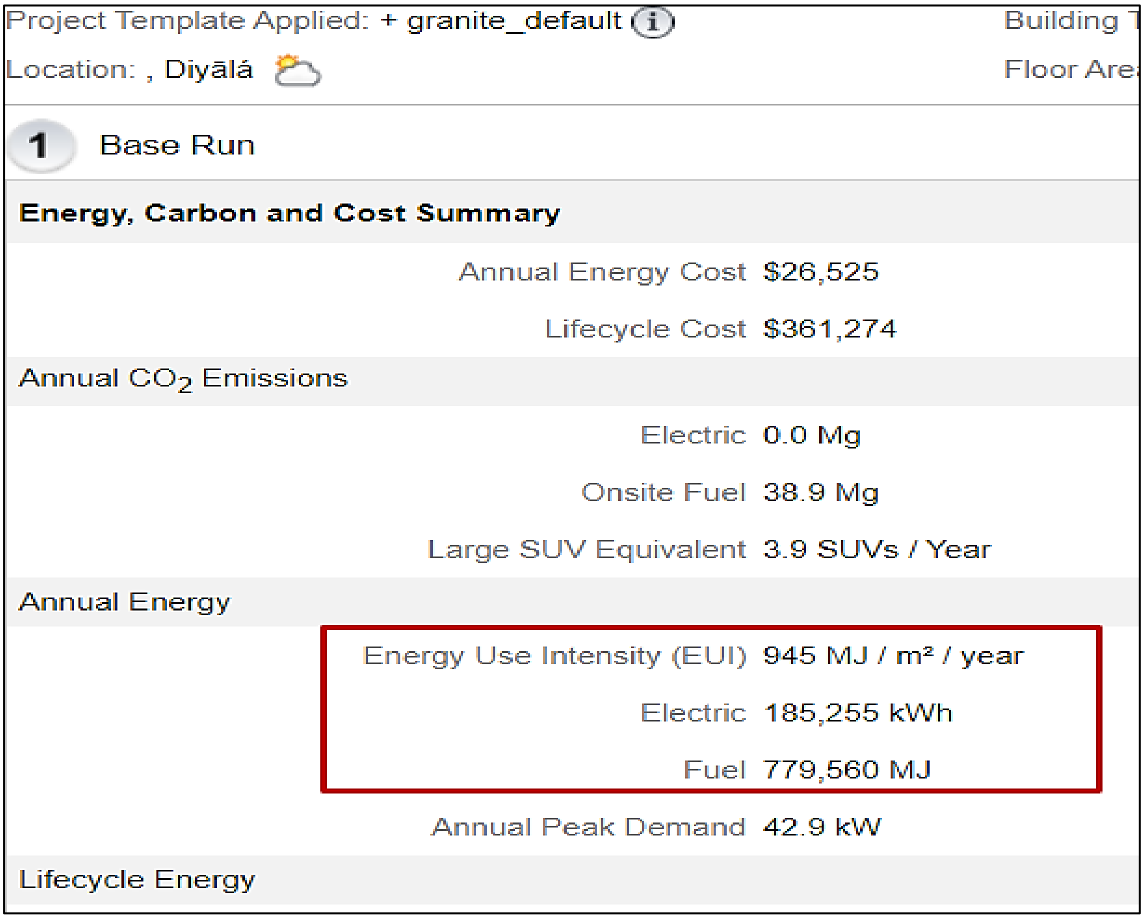

Figure 5. – Using granite.

The only natural stones harder than granite are diamonds, rubies, and sapphires. Therefore, choose granite when permanence, enduring color and texture, and complete freedom from deterioration and maintenance are prime requirements. Granite is highly heat, scratch, and stain-resistant, and is commonly used to face commercial and institutional buildings and monuments.

The researcher suggested using this granite to find out how useful it is in reducing energy consumption. The results are shown in figure (5), which decrease the energy use Intensity (945 MJ / m² / year), Electric (185,255 kWh), Fuel (779,560 MJ).

Using Fiber Glass Insulation in Finishing Walls

Figure 6. – Using fiber glass.

Such material possesses a complete list of desired features; it resists the inclement weather, it acts properly at sub-zero temperatures, it does not suffer from the corrosion, it is easy to keep, it possesses low thermal conductivity, it is robust, works properly in compression and tension, it is light, permits a smooth finish, and it is inexpensive in comparison with the concrete or else conventional materials. And, fiberglass is regarded as a future material due to its dielectric qualities. The insulation of fiberglass was analyzed for finding out how valuable it's in decreasing the consumption of energy in the building for deciding whether it's supportive or not. The outcomes of analysis of utilizing such material are evinced in the Figure (6) which reduces the EUI to (1,137 MJ/m²/year), Electricity (228,752 kWh), and Fuel (519,042 MJ).

Cellulose Insulation

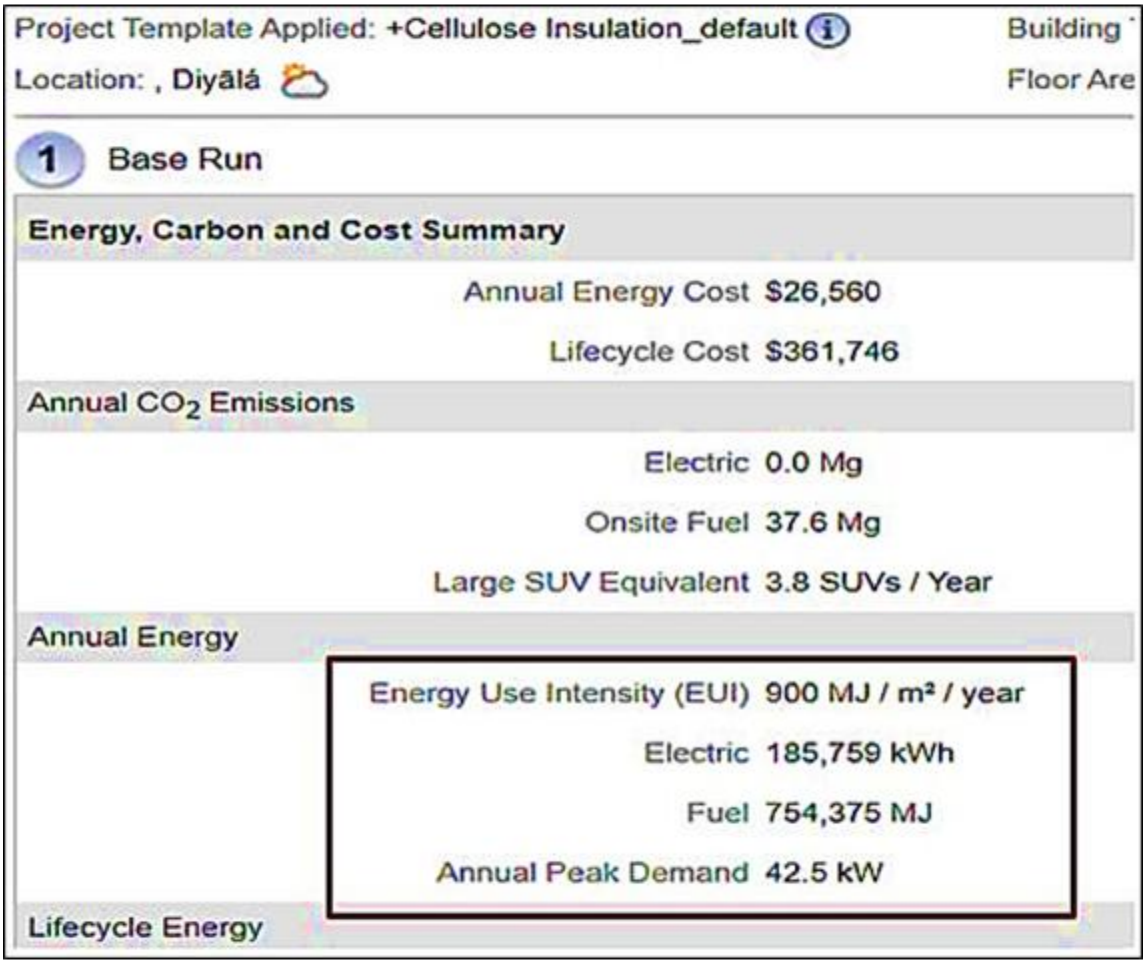

Figure 7. – Using cellulose insulation.

There's a need to utilize the cost effective, ecologically friendly materials, and techniques which diminish the construction impact in terms of its application of non-renewable resources as well as the consumption of energy. The insulation of cellulose fiber is an ecological thermal insulation material prepared from the re-cycled paper fibers.

The outcomes of analyses of utilizing such material are manifested in the Figure (7), which reduce the EUI to (900 MJ/m²/year), Electricity (185,759 kWh), and Fuel (754,375 MJ).

Using Double Glazing

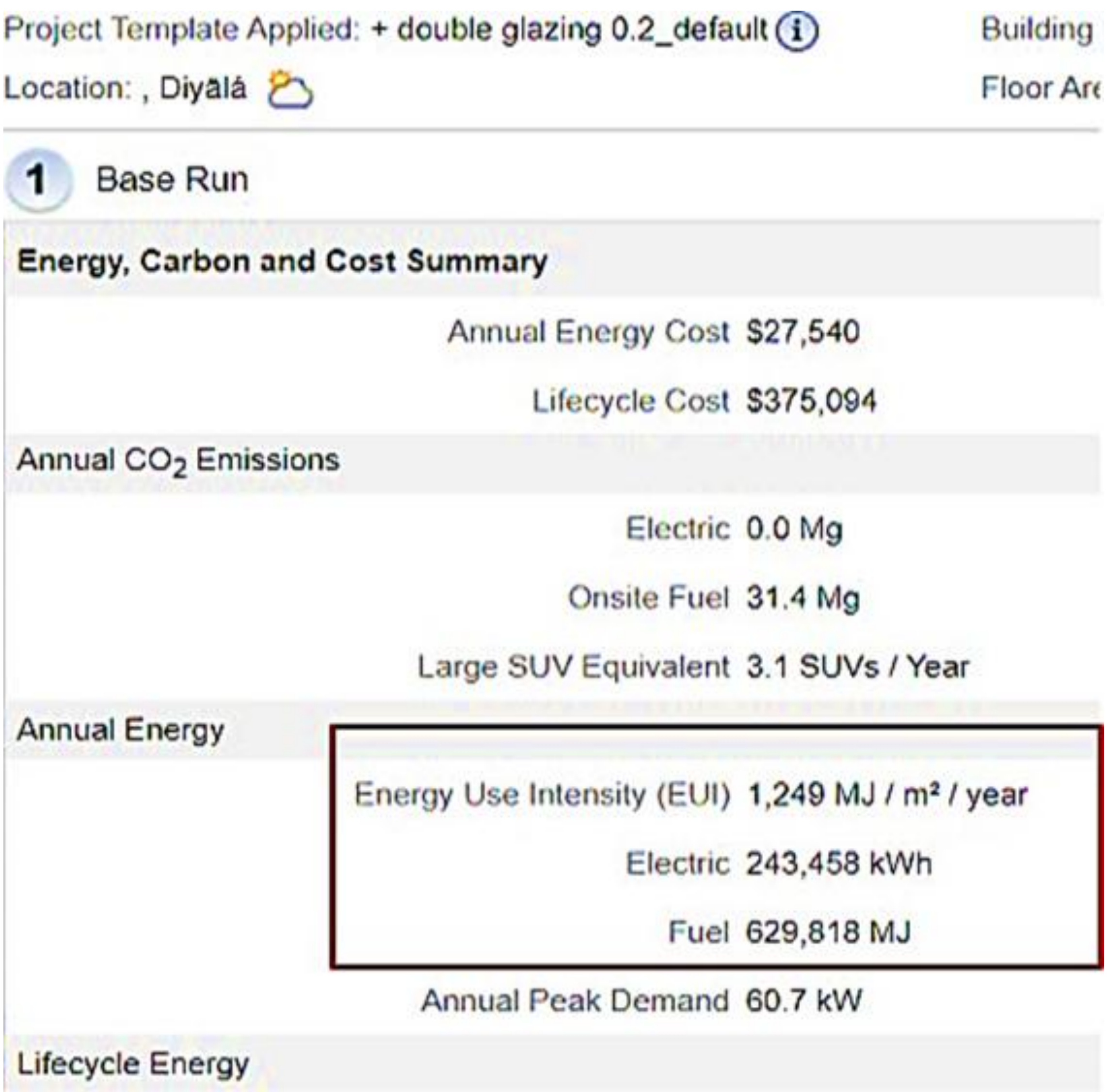

Figure 8. – Using double glazing.

Where, the double glazing has an elevated thermal resistance which can decrease the thermal circumstances transfer to the building, it was proposed to utilize double glazing for finding out how valuable it's in decreasing the consumption of energy from it for giving an view on whether it's valuable for using or not. The outcomes revealed that such analysis decreases the annual EUI to

(1,249 MJ/m²/year) and the consumption of the energy of electricity to (243,458 kwh) and fuel to (629,818 MJ), as revealed in Figure (8). The effect of all the previously mentioned alternatives on the performance of the building is presented in Figure (9) below which shows the improvements in energy consumption.

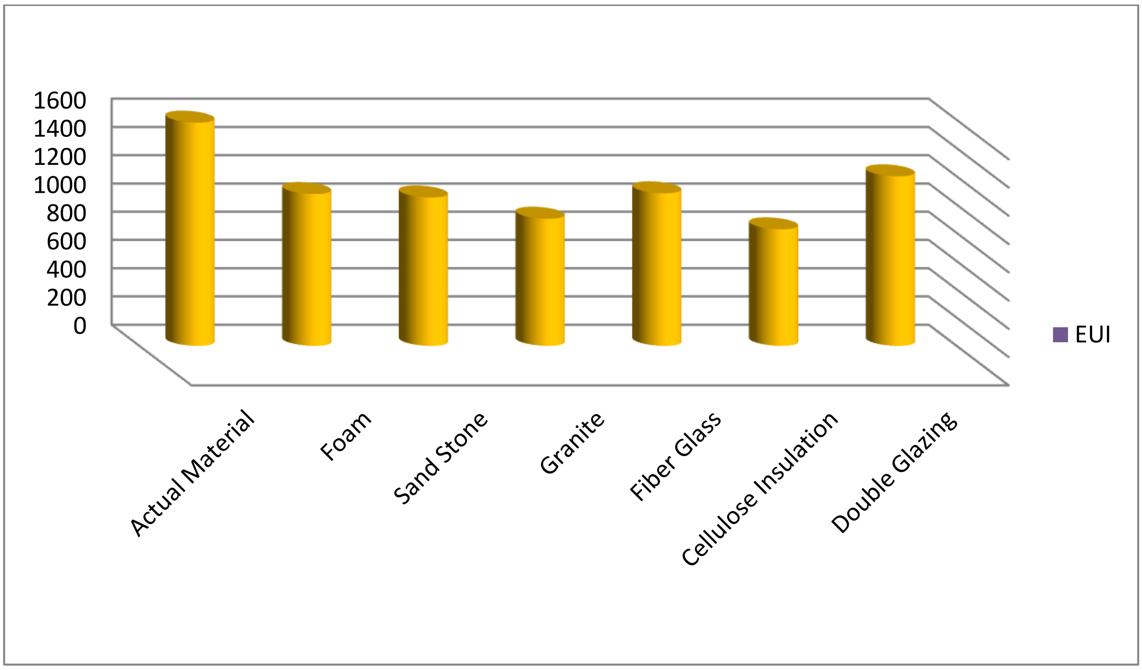

Figure 9. – The effect of alternatives on the energy consumption.

Selecting the Best Alternatives

For selecting the highly applicable alternatives, one has to recognize the decreasing consumption of the energy of each one, as illustrated in Table (1).

Table 1. – Annual energy analysis by using alternatives.

Alternatives	(EUI) MJ/m^2/year	Electric (kWh)	Fuel (MJ)
Actual Material (non-alternatives)	1,597	194.027	1,543
Foam material	1,135	294,591	117,587
Sand stone	1,116	228,898	496,223
Granite	945	185,255	779,560
Glass Fiber	1,137	228,752	519,042
Cellulose Insulation	900	185,759	754,375
Double glazing	1,249	243,458	629,818

Conclusion

Through these results, it appears that new materials must be incorporated into the building, as they are of high quality in thermal insulation and reduce energy consumption. By adding the alternative materials above, and from the results that appeared, it was found that these materials reduced the energy consumption of the building by a good percentage and thus obtaining a higher quality of the building by improving its performance.

So, the researcher recommends using granite in finishing wall, Cellulose Insulation, and foam material above roofs because it reduces the energy consumption by a considerable rate due to the reduction of the operation times of heating and cooling devices. In addition to the aesthetic qualities that they provide to the building, these materials have comprehensive qualities in improving the quality of the building, as they are considered materials resistant to weather conditions and temperature rises, and most of them are lightweight materials that do not increase the load on buildings, as is the case with traditional materials.

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