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## Building Information Modeling For Green and Energy Efficient Buildings Design

Nathan Dummenahally<sup>1</sup>

PhD Student, Department of Structural Engineering, Poznan University of Technology, Poznan, Poland<sup>1</sup>

**ABSTRACT:** This paper explains the design of green sustainable buildings that have positive effects on energy, environment and annual life cycle performance in terms of its thermal aspects of energy consumption during operational stage by using BIM and by assessing the configurations of local, alternative materials to find those that have the highest impacts on building performance by minimising the annual usage of operational energy, thereby improving the energy efficiency of the building.

**KEYWORDS:** Building Information Modelling, Energy analysis, conceptual design,

### I. INTRODUCTION

The whole world is now talking about climate change and green house effect. Buildings are the biggest source of carbon emissions and energy consumption around the globe. Construction sector is now focus on energy efficient and carbon reduction design technologies to reduce green house effect and to improve our environment. With Building Information Modelling (BIM) technology any Architecture, Engineering, Construction (AEC) industry can produce green and greater energy efficient buildings. BIM allows multidisciplinary informations which can be superimposed within one model and it creates sustainability measures and performance analysis throughout the design process [1] and [2]. The decisions for sustainable design of buildings are made in the pre-construction stages using BIM. In order to access the performance of buildings in the early design and pre-construction phases, access to building's form, materials, context, and technical systems are required. In BIM it is possible to visualize all these in one model.

The energy aspects of buildings depends on the early design process, energy consumed by a building can be reduce upto 80% by optimizing orientation, building shape, insulation and ventilation in the design process. Energy efficient buildings can be achieved through a holistic design with combination of energy efficient technologies like energy simulation analysis with Building Information Modelling [3]. A systematic approach is needed in implementing these integrated modelling with BIM, to effectively reach energy efficiency in new buildings. This strategic approach is ultimately the key to design of comfortable, competitive and energy efficient green buildings. Building Information Models are utilized throughout the building's life cycle, starting from initial design and continuing during use and facility management after the construction project has concluded.

### II. RELATED WORK

During implementation process of green constructions, sustainable design methods can be used to analyse the impacts of green buildings, including all aspects of lighting, energy efficiency, sustainability of materials and other building performances. It is very essential to combine the designs and the constructions of green technology, inturn making a design more reasonable and optimized, and finally achieving the accordance with energy efficient green buildings parameter [2], reported by E. Krygiel, B. Nies (2008). R.M. Dowsett and C.F. Harty (2013) describe two primary ways of using BIM with energy modeling. It can be used as a design tool that employs an iterative design process in conjunction with feedback from the energy model in order to develop energy-efficient design iterations [4]. Paulo Filipe de Almeida Ferreira Tavares et al, (2007) pointed out that the embodied energy, refers to the building energy consumed in material preparation, construction, and production phases, greatly affects the building life cycle.

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The BIM for life cycle building energy assessment energy consumption. Focus only on operation efficiency will bring great errors to building energy efficiency design, especially in low and zero energy consumption buildings[3].

## III.ENERGY MODELLING

To create more sustainable model understanding a building's energy needs is essential. BIM integrate the building models with energy analysis for accurate, routine evaluation based on geometrically suitable thermal models and local building code requirements. Rapid energy model designed by BIM as shown in the figure 1 produces a cohesive view of features and function in a format that everyone can understand and manipulate at any stage. As the project evolves, the project model can be refined with new type of analysis and new design alternatives. The construction team can quantify the most effective solutions before construction starts. Visualization capabilities of the model enhances the option of more sustainable design choice [4]. The energy models in the BIM combines all the relevant factors to predict the buildings energy demands to help proper design of HVAC, daylighting and all other energy related design components. BIM ensures energy model updated with the prominent changes made, with this it is easy to understand how building massing, building envelope, window locations, building orientation, and other parameters which affect energy demands.

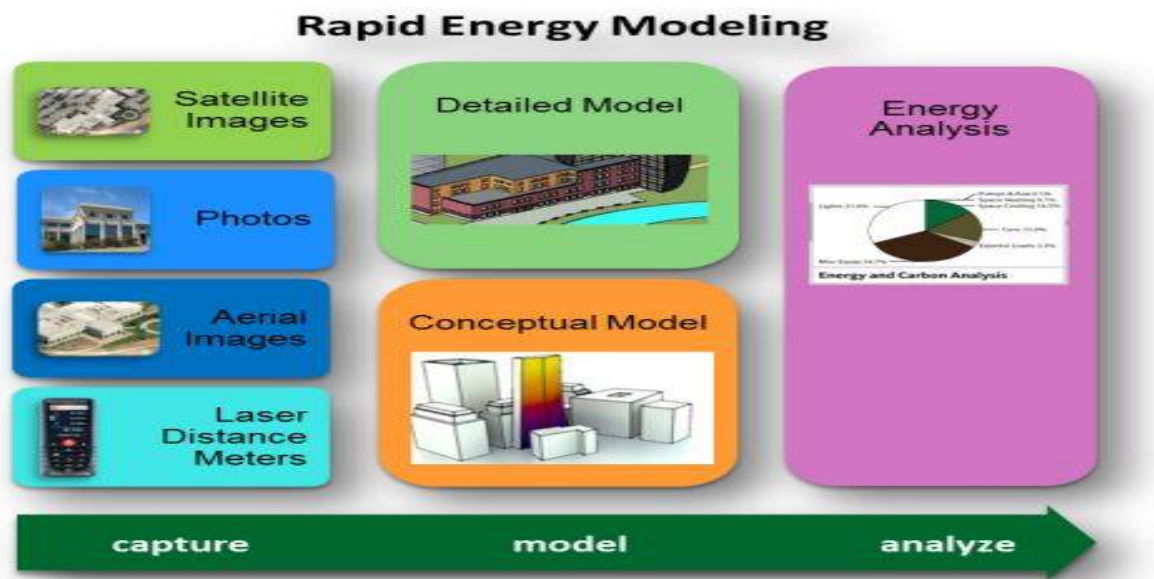


Figure 1: The steps to rapid energy model design for new buildings.

The below figure displays the three energy efficient building design concepts (i) Low energy building, (ii) Ultra low energy building and (iii) Zero and plus energy buildings. The choice between these 3 concepts will depend on stakeholders's ambition and also the cost and benefit situation, the design and building skills, materials and technologies available locally.

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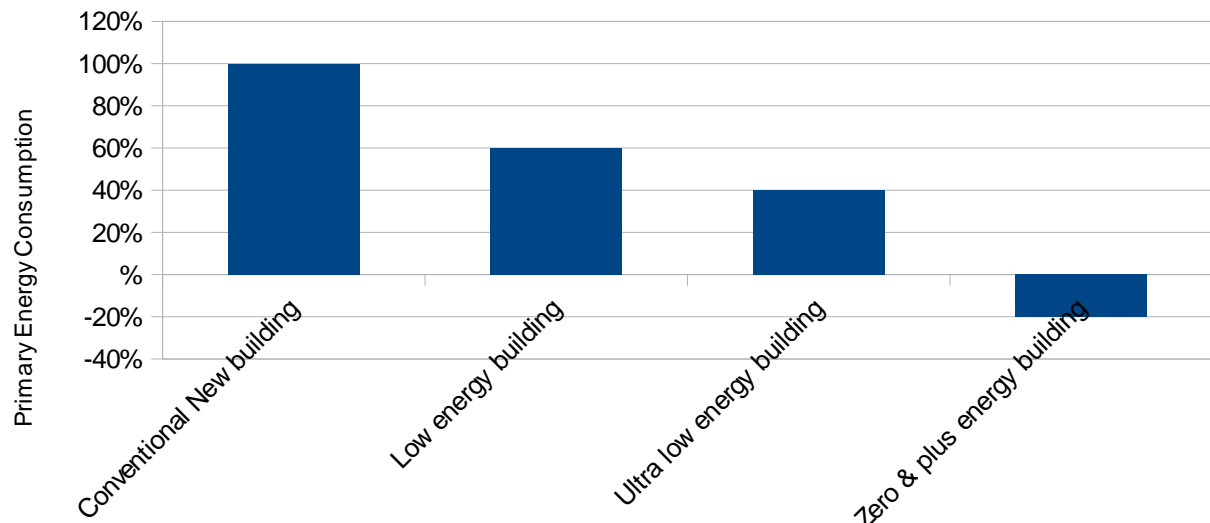
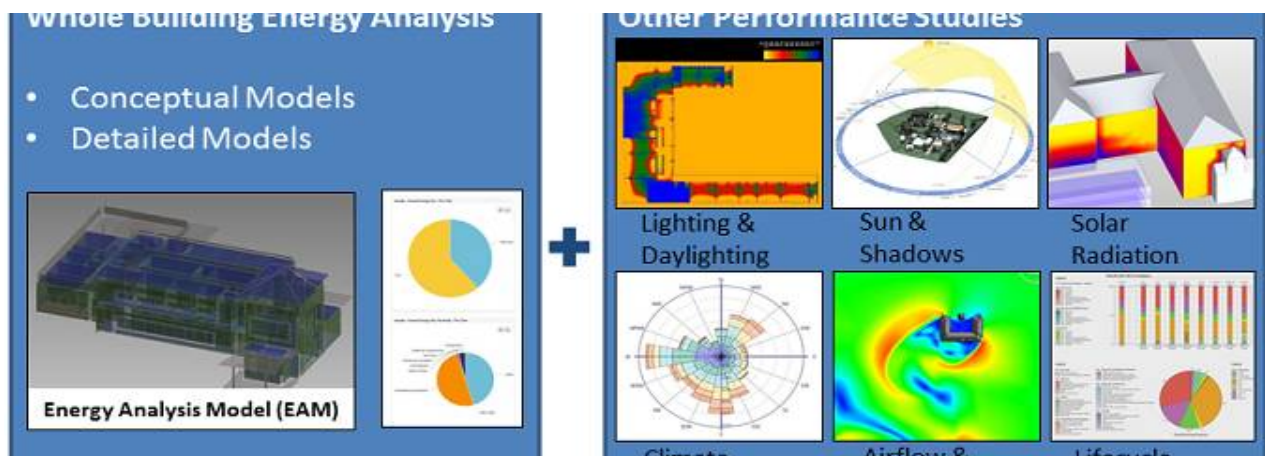


Figure 2: The steps to energy efficiency through a strategic approach for new buildings.

With demanding energy efficiency targets, the energy analysis should be performed in the conceptual design utilizing BIM. Either spatial or space group model are used here. Energy analysis are used to study alternative solutions based on space program mathematically and the used initial data and assumptions is documented. Analysis are used for testing for energy consumption targets, based on reference values are realistic and achievable. Target setting with the help of energy analysis account of special features of the design and enables identification of the main factors for energy efficiency at an early stage [5].



Preliminary energy consumption and condition simulations are made in schematic design to compare different facade, solar protection and technical system solutions. The indoor conditions of the chosen solution are calculated at least for different space types and the building energy consumption, and targets are updated accordingly to the model.

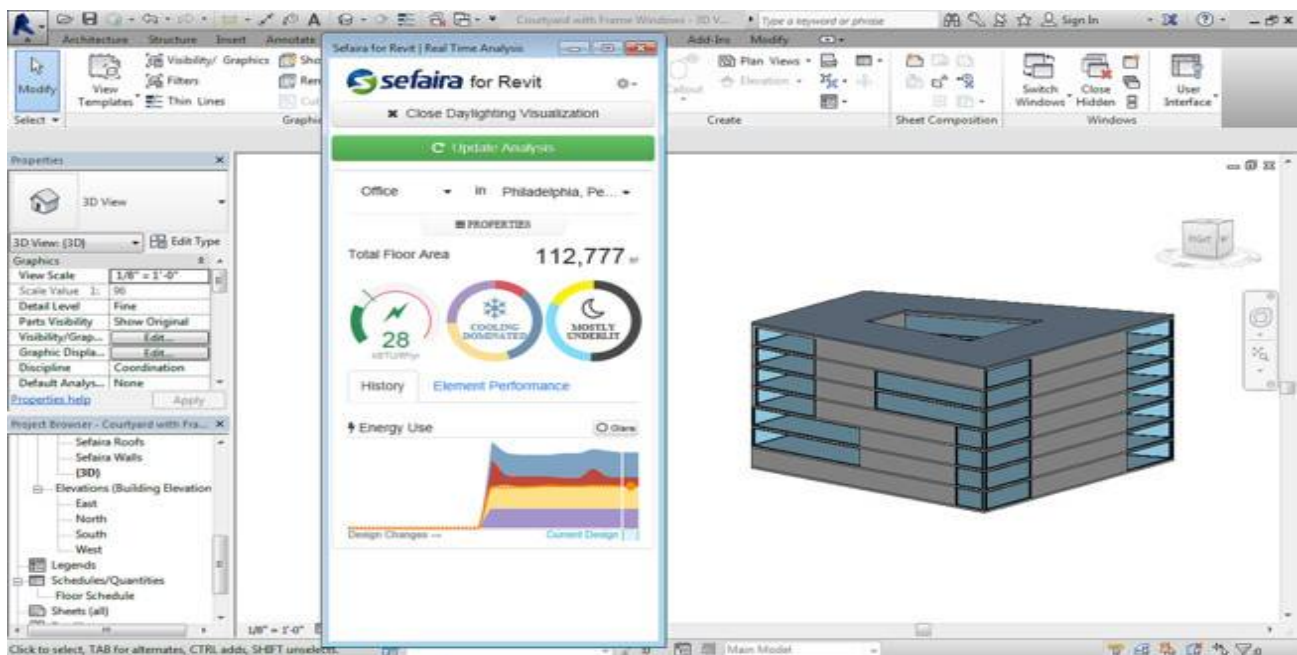
The BIM gives the better energy simulation model for all type of buildings. It ensures cost effectively integrated design, construction and maintenance of low energy buildings and positive energy buildings by using energy modelling techniques[3] . Use of BIM during design processes helps to evaluate energy efficiency and make recommendations for design alternatives that will enhance the building performance. By using BIM with specialized energy modeling software like Ground loop design, Dial+cooling, DesignBuilder, e-Bench etc., each and every part of the building,

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from mechanical, electrical and plumbing systems to interior climate daylighting can be simulated and optimized for energy efficiency.



The above figure shows the example of energy modelling analysis using Revit BIM and with specialized energy modeling software sefaira.

## IV. CONCLUSION

The strategic approach as well as conceptual design stage can help decision makers generate a better energy model while doing simulation using BIM. The BIM integrated platform moves the design decisions forward at the early stage specially when comparing different design alternatives and results in green and energy efficient buildings design.

## REFERENCES

- [1] Liz Schofield, "Lean BIM: Six reasons why construction needs to embrace BIM alongside Lean thinking", Leeds Beckett University, Technical report, November 2014.
- [2] E. Krygiel, B. Nies, "Green BIM: Successful Sustainable Design with Building Information Modelling", Wiley Publishing, Indianapolis, 75-86, 2008.
- [3] Paulo Filipe de Almeida Ferreira Tavares, Antonio Manuel de Oliveira Gomes Martins, "Energy efficient building design using sensitivity analysis- A case study, volume 39, 23-31, January 2007.
- [4] R.M. Dowsett and C.F. Harty. "Evaluating the benefits of bim for sustainable design – a review." TSBE conference paper, 2013.
- [5] Common BIM requirements, COBIM-2012, publication series 10, Finland, 2012.