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THE USE OF BIM TO ACHIEVE ZERO ENERGY BUILDING

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Abstract. This Article introduces the advantage of using Building Information Modeling (BIM) technology to achieve the Zero Energy (ZE). A zero-energy building (ZE), also is known as a Zero Net Energy (ZNE) building, or Net-Zero Energy Building (NZEB). Net zero building is a building which is zero net energy consumption, which means that the total amount of energy used by the building on an annual basis is equal to the amount of renewable energy created on the site. A net Zero-Energy Building (ZEB) is a residential or commercial building with greatly reduced energy needs through efficiency gains such that the balance of energy needs can be supplied with renewable technologies. In the concept of the net ZEB is a building which could reduce energy needs through efficiency and gain that balance of the energy needs via different renewable technologies. This paper will touch the necessity of integrating solar panels and wind energy design with BIM (Building Information Modeling) and how could that lead to achieve and reach the ZNEB (Zero Net Energy Building). The article will discuss the gap between modeling tools in energy and the achievement of sustainable features in models that produce for best design results and construction material in the project by using BIM (Building Information Modeling) to reach the ZNEB (Zero Net Energy Building).

Keywords: *Zero Net Energy (ZNE); Zero Energy Building; Zero Energy; Net-Zero Energy Building (NZEB); Zero-Energy Building (ZEB); Building Information Modelling (BIM)*

ВИКОРИСТАННЯ ІМБ-ТЕХНОЛОГІЙ ДЛЯ ДОСЯГНЕННЯ НУЛЬОВОГО ЕНЕРГОСПОЖИВАННЯ БУДІВЕЛЬ

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Анотація. Висвітлено перевагу використання технології інформаційного моделювання будівель (ІМБ) для досягнення нульової енергії. Чиста нульова будівля – це така, яка дорівнює нульовому чистому енергоспоживанню, що означає, що загальна кількість енергії, що використовується будівлею на щорічній основі, дорівнює кількості відновлюваної енергії, що створюється на ділянці. Чиста будівля з нульовою енергією – це житлова або комерційна споруда із значно зменшеними потребами в енергії за рахунок підвищення ефективності, завдяки якій баланс енергетичних потреб може забезпечуватися відновлюваними технологіями. Концептуально така будівля може зменшити потреби в енергії за рахунок ефективності та отримати нульовий баланс енергетичних потреб за допомогою різних відновлюваних технологій. Це дослідження торкнеться необхідності інтеграції сонячних панелей та проектування енергії вітру з ІМБ, а також

питання, як це допоможе досягти нульової енергії. Розглянуто розрив між моделювальними інструментами в енергетиці та досягненням стійких характеристик у моделях, що забезпечують найкращі результати проектування та будівельних матеріалів у проекті за допомогою ІМБ.

Ключові слова: чиста нульова будівля; нульова енергія; нульове енергоспоживання; відновлювана енергія, інформаційне моделювання будівель

I. Introduction. A perfect ZEB definition first should meet energy efficiency, and then use renewable energy resources available on the site. Available energy resources which are delivered on any site, such as wood, ethanol, or biodiesel are valuable, but do not considered as renewable resources.

This paper is discussing the importance of reaching the efficiency of the zero energy and sustainability of this energy. Many methods and standards have been considered and implemented to achieve a better energy performance of buildings, including the Nearly Zero Energy Building (NZEB) concept, this paper discuss some of the definitions for the Net Zero Energy (NZE), also this article will make a point of view on how could any building achieve the zero energy concept. Selecting the requirement energy needed of a building from the first definition will lead us to specific end uses for this energy. Energy efficiency of each element is the first step to indicate the overall efficiency as the ratio of the energy demand handled by the building to the energy consumed by the building.

Net Zero could be achieved, by cooperation in the planning, designing, constructing and operating levels. The only solution for reaching a net zero building is BIM technology. Any project without using BIM will require more time and that will not achieve the efficiency. BIM made that easier and efficiency by grouping all the project stages. By implementing BIM approach, new processes requiring new project roles/tasks and responsibilities are being driven.

BY moving to Nearly Zero-Energy Buildings (NZEB), the new concepts of design and control needed to be developed because the need of (NZEB) by detailing and multidisciplinary approach. The article discusses a method for NZEB project delivery by using Building Information Modelling (BIM) environment. Starting from construction

phase and handover. In this article will show how could BIM technology for achieving direct energy modelling within the BIM programs.

A Net-Zero Energy Building (NZEB) could be a residential or commercial building which should decrease the requirement energy. Efficiency could come from using balance of by suppling the renewable energy technologies.

II. Goals. The definition of ZE (Zero Energy) needs to be clearer in a compact type for achieving the effectiveness and acceptance. The definition, nomenclature address should show how energy consumption and what energy types needed to be used to include in its definition. Considering zero energy using as a real method for achieving sustainable renewable energy with Building Information Technology (BIM).

The main aim of this paper is to discuss possible requirements for achieving NZEB (Nearly Zero Energy Building) by using BIM (Building Information Modelling) technology.

Definitions:

1. Net Zero site energy: A site ZEB produces minimum as much energy as it uses in a year, when accounted for at the site.

2. Net Zero Source Energy: A source ZEB produces at least as much energy as it uses in a year, when accounted for at the source. Source energy refers to the primary energy used to generate and deliver the energy to the site. To calculate a building's total source energy, imported and exported energy is multiplied by the appropriate site-to-source conversion multipliers.

3. Net Zero Energy Costs: In a cost ZEB, the amount of money the utility pays the building owner for the energy the building exports to the grid is at least equal to the amount the owner pays the utility for the energy services and energy used over the year.

4. Net Zero Energy Emissions: A net-zero emissions building produces at least as much

emissions-free renewable energy as it uses from emissions-producing energy sources [1].

Renewable energy sources, although is available for free, but still have a very overflow value which needs to be used efficiently in a “sustainable method” examples for renewable energy sources, geothermal sources allow for efficient resource uses because of their high ability factor [5].

Renewable energy sources, such as solar and wind, interrupted by natural. The capacity

factor, defined as the ratio between power average over period of time and maximum power, is almost 20 % for solar and 30 % for wind composition. RFC could be used to store the overflowing energy when the renewable sources are available, by converting electricity to hydrogen, and then to generate electricity from hydrogen when the renewable energy sources (solar, wind) are not enough, as shown in Figure 1 [6].

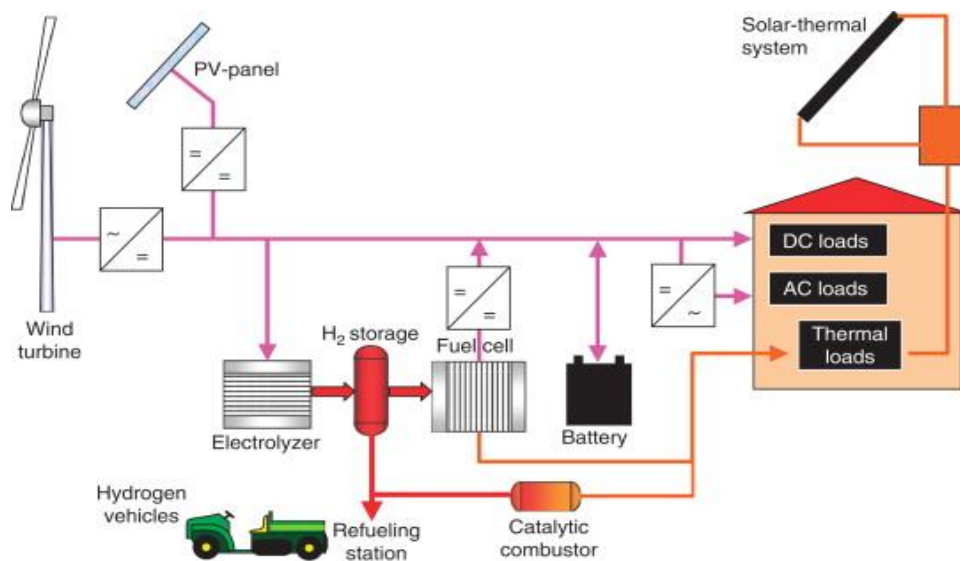


Fig. 1. Regenerative fuel cell system [6]

III. Energy modelling and BIM. This article indicates the importance of the cut out between actually energy modelling tools and applying the features of sustainable available features into the models they produce for better design situation and constructions materials choices. During previous studies, the energy modelling has achieved high level with the integration to all design level steps, especially with using Building Information Model (BIM) and the Green Build eXtensible Markup which uses the Language (gbXML) as a file type. For more further, also was discovered that BIM-integrated energy modelling tools are it often lacks its capabilities in integrating renewable energy sources such as geothermal wells, wind turbine, and photovoltaic panels. The article introduces point of view to include such sustainable equipment to foretell energy generation to achieve the Zero Net Energy (ZNE) also, this article provide solutions for

better integration between design and construction materials. Selection is by analysing simulated energy consuming with different parametric inputs, such as site location, size of the building, and material types [7].

The most main factors that effects on the building position are the site location and analysis. Those factors could be a main reason the location for the orientation and facade of the buildings and linked with the construction process and steps of the landscape around the location. Throughout the planning process, the topography of the site, vegetation, and the weather conditions are important factors. By analysing the site by the traditional way it will not achieve accuracy and has disadvantages, such as lack of quantitate analysis, subjective factors are excessive, can't deal with huge amount of information and data. If advantages of BIM and GIS are used, there is ability to

create a simulation locative data modelling sites and scenarios of the building. At the stage of planning, by using BIM to assess the site conditions and characteristics, there will be possibility to get an ideal management for the project by taking it to achieve the Zero Net Energy (ZNE) plus any additional decisions, traffic flow line of the project and organizing the relationships and building layout.

IV. Green 2.0 system. System high-level architecture Green 2.0 has been designed and one of the software delivery model known as Software-as-a-Service (SaaS). according to this model, one of the centrally hosted version of the application is applied, with one of the configuration (network, hardware, OS) and the users of the system directly access the software using a small client (i. e., web browser), through a web-based user interface. The SaaS model overcomes many limitations that constrain traditional software use, deployment, and evolution and as the software is online accessible all over the world, so we could get the wanted cooperation level. In addition, the SaaS model is a comfortable model with supporting integration with third-party protocols and application programming interfaces (APIs), making it easier to collect data, presentation and functionality from

multiple services (e. g., cloud services). For simplifying the SaaS model, the high-level architecture of Green 2.0 is consisting of a number of separated coupled independent components. Software components confirm the separation of importance in regard of the wide-ranging functionality available during Green 2.0. (Fig. 2). One of the main targets of the Green2.0 project is the parametric analysis of the sustainability of alternative building designs, that explains why we should use this important point and uses it for achieving the (NZEB). A quantitative approach, has been reached in previous studies this confirmation is based on simulation results directly obtained from the processed BIM model. As we could use other possibility for selected components of the building will offer the ability of individual evaluation in any level of the total building design while maintaining that information is updated and accreted. There is a purpose for building green, including economic, environmental and social benefits.

However, new sustainability requires a call for an integrated and synergistic design strategy that integrates the building life-cycle with each green experience in the project. The purpose for green building mainly related to life-cycle estimate [8].

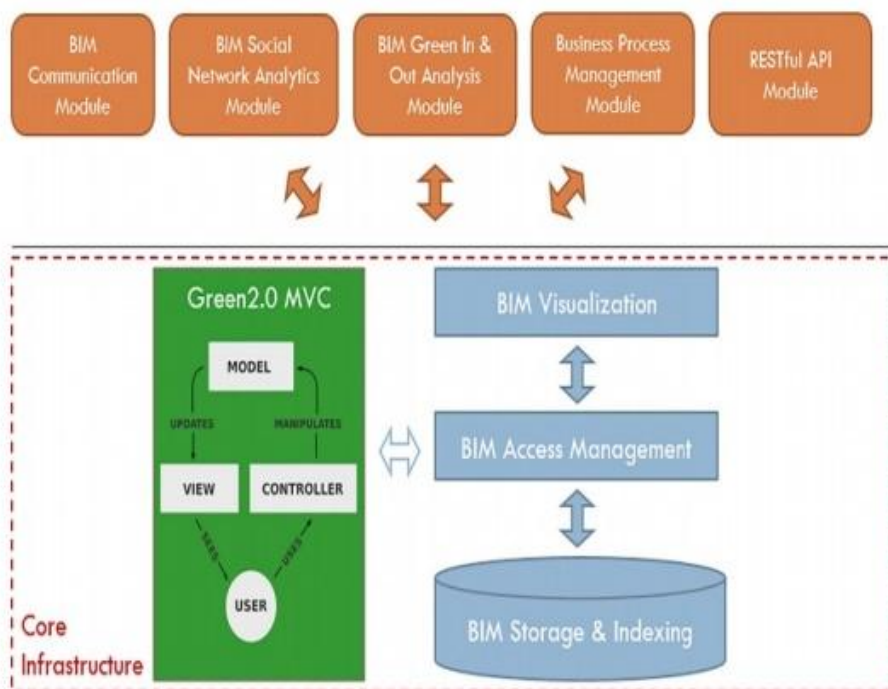


Fig. 2. Green 2.0 High-level Architecture [8]

V. PV extensions in BIM. Recently, most of BIM programs provide excellent featured

tools for Building design, with a support for PV devices [9]. For supporting the integration design and analysis of BIPV, some of PV components (families in Autodesk Revit) are in use. Those components include photovoltaic

panels, inverters, photovoltaic curtain wall, solar skylights, photovoltaic awnings, photovoltaic tiles, etc. Fig. 3 shows an example of BIM-based PV components (Families in Revit) [9].

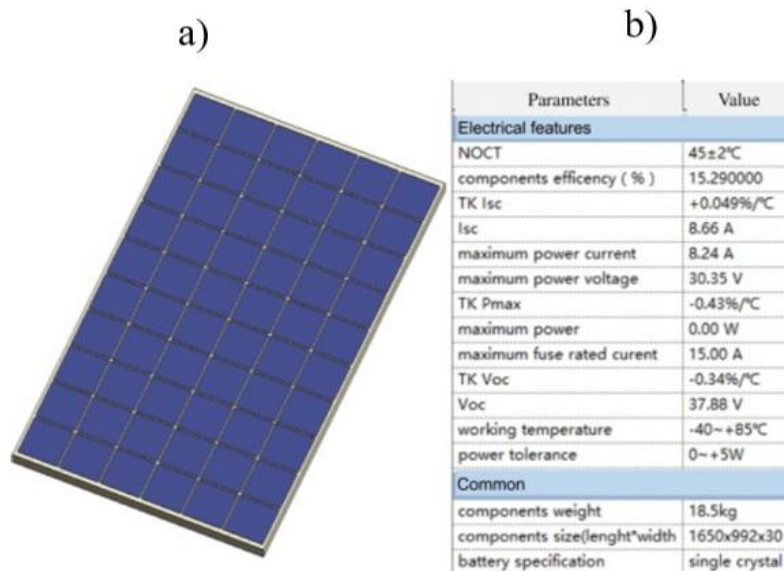


Fig. 3. Photovoltaic panel model in BIM (9)

a) Geometry model: for providing the suitable support for the BIPV design for BIM, the PV modules the design contain all needed geometry information, e. g.. Sizes, materials, and shapes. The 3D parametric modelling is supported as well. The PV panel tilt angle parameter setting and BIM models are shown in Fig. 3.

b) PV-specific properties: The specification of PV panels plus the characteristics are also considered, e. g. silicon type, conversion efficiency, power output, etc. In order to expand the power wiring

Between the panels, the PV panel is defined as electrical device in Revit. By doing so, PV panels can directly reuse the electrical subsystem defined in Revit. Important point should be taken care of that connection between PV panels they are DC because the Revit provides the limited supports for DC connection [9]. Fig. 4 shows the high demand

on the PV panels.

VI. Computational Fluid Dynamics (CFD) Simulation based on BIM for analysing the wind environment around the building. Simulation tool based on BIM to achieve the Zero Net Energy Buildings possible, energy consumption evaluation of the building and

Performance of the environment should be taken from the design process including maintenance to destruction stages and all levels in the project. Studies related to BIM technology are important these days for the analysis on buildings to achieve the NZEB and it is becoming popular these days. BIM-based eco-friendliness analysis on the designs of building has the ability in saving the time for such analysis using design choices and building information (materials, dimensions, etc.) what designers did during design stage.

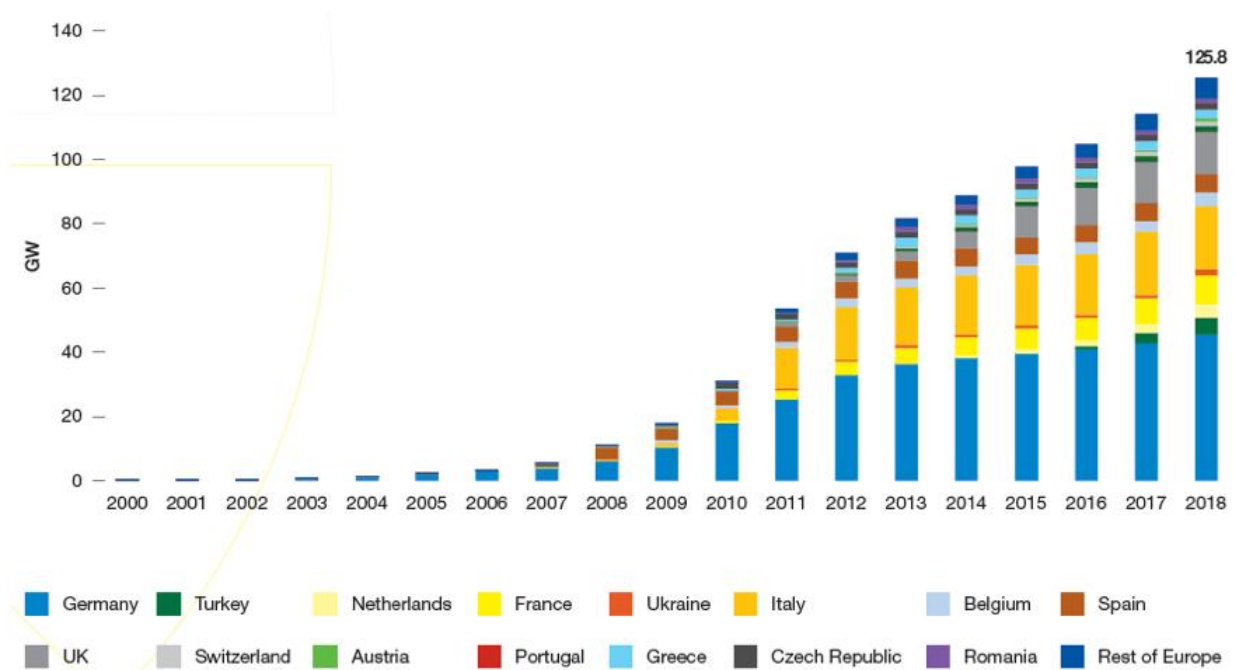


Fig. 4. Statistics for total solar PV installed in Europe in the past years [9]

Paper discuss the evaluation of the performance based on BIM and finding a method for wind environment to be taken starting from the design stage and any process in the project Design Builder is one of the interfaces used for CFD simulations using BIM files. Design Builder could make energy load calculation basic CFD analysis building by using BIM files. BIM files, energy

consumption estimation and outdoor/indoor air current distribution and process are in gbXML form, and could be processed by ArchiCAD, Revit [10]. The program is simple using, also used to consider the calculation results of the building environment and energy to the design to be considered in the early design stage. Fig. 5 shows this process.

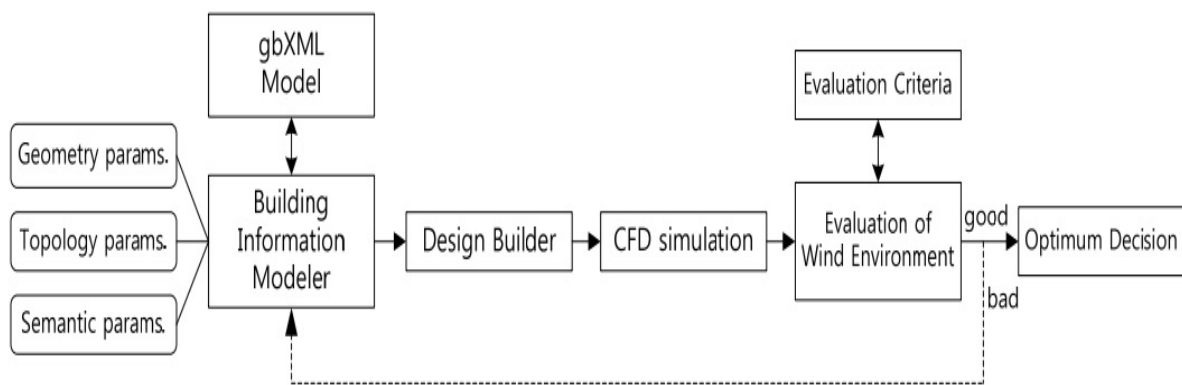


Fig. 5. BIM and wind environment evaluation process [10]

After importing BIM models, target analysis area should be set. This process is called a domain setting. Size of the influences in Domain effects in CFD calculation results, that's why building layout, building heights and topography should be considered in the domain setting.

Conclusion. With using and integrating BIM technology equivalent with the green building services in Revit, analysis of energy for any project can smoothly achieve the Zero Net Energy Building (ZNEB) concept. Analysis of energy report created in Revit along with Green 2.0 or CFD offers more accurate and

graphical impersonation of data. This process provides a clear visualize for designers to analyse at any level in the project for the building energy requirement parameters, orientation. BIM is a powerful method for providing an easier and simple way to achieve the (ZNEB) during the whole lifetime of the building. Smart early decisions in the design stage of construction, including the selection of

materials and systems with low energy consumption are part of not only reducing the embedded energy content of a building (construction), but makes buildings more sustainable. This article touched on how to use BIM as a method to achieve the Net Zero Energy Building (NZEB) and considering the BIM tools either in wind or PV panels.

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