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USE OF DYNAMIC SIMULATION SOFTWARE WHEN DESIGNING A FAMILY HOUSE – CASE STUDY

Annotation: Ultra-low-energy house is a term known very well to engineers and architects all over the world. In these times of minimizing an energy loads and negative emissions, energy efficient houses (ultra-low-energy, net-zero houses, positive houses) are one of the best ways to meet European "20-20-20" targets. The main topic of this paper is a case study of a family house using dynamic assessment simulation on energy performance designed for Slovak Republic climate. Two-storey family house was designed taking in account architectural, environmental and constructional requirements of today´s European directives focusing on energy performance and energy efficiency. Our goal was to find out how the designed building will perform energetically so we could predict and minimize environmental load on nature and society in case of its actual realization.

Keywords: family house, heat demand for heating, simulation

Introduction. Building energy performance assessment is crucial to ascertain the efficiency of energy use in buildings and is the basis to make any decision for enhancing energy efficiency. Globally, buildings consume nearly half of the total energy produced, and consequently responsible for a large share of CO2 emissions. The adoption of highly efficient energy production systems as well as high performance materials is being encouraged more and more in order to achieve the Nearly Zero Energy Buildings target. Energy efficient design (to create ultra-low-energy building, net-zero building or even energy-plus building) is a response to local climate conditions and global energy consumption. Thermal building simulation is a powerful tool to assess the energy performance of a building. Design Builder is currently the most comprehensive user-friendly Energy Plus interface. To sum it all, simulation software Design Builder is one of the most effective tools on the market, which can play very important part in the process of building design. When using Design Builder correctly, engineers can predict building behaviour throughout a reference year loaded to database. It can also calculate future cost of the building as well as illustrate cost optimization when changing materials, HVAC systems etc.

Building location. Košice lies in the North Temperate Zone and has a borderline continental and marine climate with four distinct seasons. If defined as marine due to the winters just above −3°C (27°F), it would be one of the farthest inland areas with this climate type.

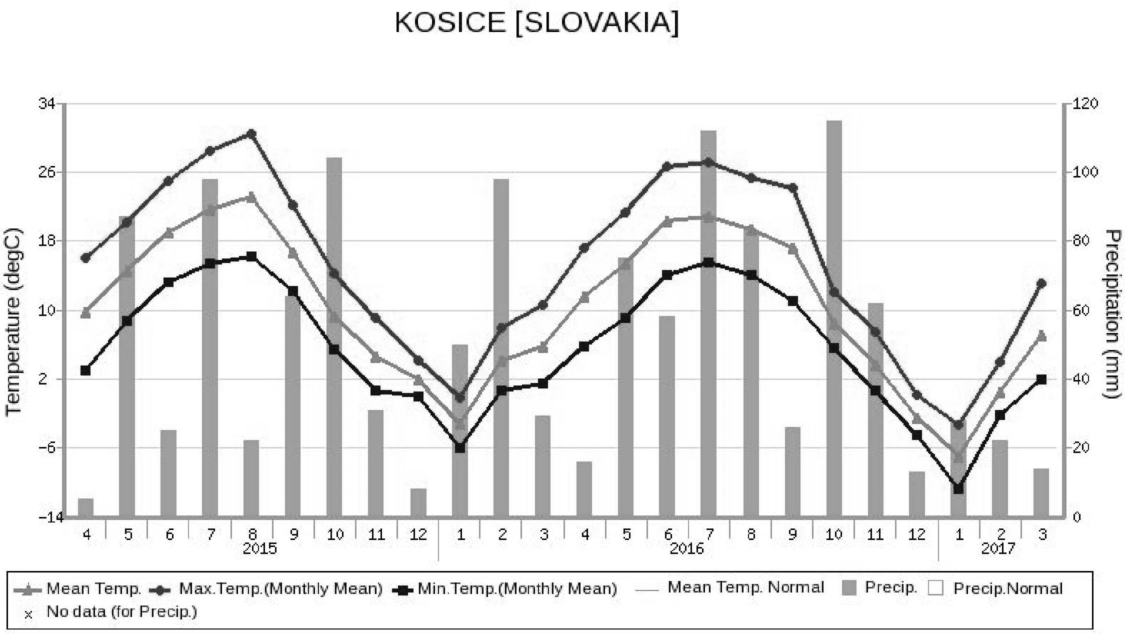

Figure 1: Weather data for Košice, Slovakia 2015 – 2017

It is characterized by a significant variation between hot summers and cold, snowy winters. Evaluated family house is located in Kosice-Krasna, a municipal part of Kosice city.

Figure 2: Location

Building characteristic. Two-storey family house represents a typical type of residential buildings built in this area. The floor layouts were designed for a family of two parents and three kids and the concept of a whole house was made according to the latest energy efficient standards. Building is based on concrete footing foundation. The family house envelope was designed from materials with high thermal capacity insulated from outside with a thick layer of polystyrene (ETICS system) to minimize the heat loses during the heating period as well as to prevent the heat infiltration during the summer period. Roof structure creates unconditioned spade between insulated ceiling and top of the roof. Transparent parts of building envelope were designed as wood-aluminum, triple glazed windows Internorm with outside louvers for a regulation of solar gains through the windows.

Table 1: Physical and thermal parameters of building

Shape factor (A/V ratio)	0.78 1/m
Volume of building space	726.18 m^3
Total heat transfer surface	569.48 m^2
Total floor area	222.09 m^2
Wall U-Value	0.148 $W/(m^2.K)$
Insulated ceiling U-Value	0.123 $W/(m^2.K)$
Ground floor R-Value	4.38 $(m^2.K)/W$
Wood-aluminum U-Value Internorm HF 350	0.60 – 0.95$W/(m^2.K)$

Simulations. Building simulations were set up with the DesignBuilder v4 software, in which building performance date were generated by the simulation engine EnergyPlus. EnergyPlus is a building simulation program used by United States Department of Energy and has been extensively tested by field measurements and empirical methods.

Figure 3: House visualization

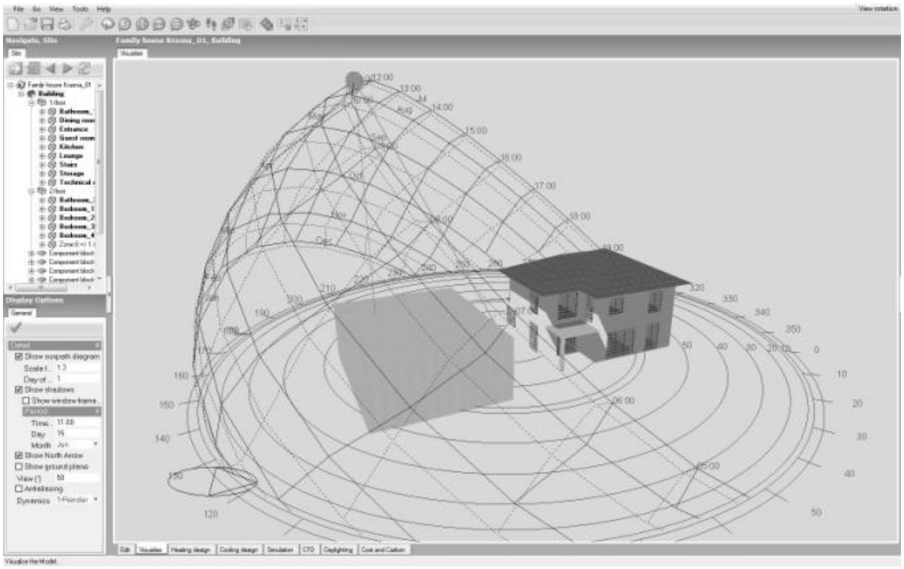

Figure 4: Family house in DesignBuilder software

Building energy performance assessment is crucial to ascertain the efficiency of energy use in buildings and is the basis to make any decision for enhancing energy efficiency.

Results. Monthly heat demand for heating is illustrated by Figure 5. As it can be seen, depending on weather conditions, occupancy, solar gains through exterior glazing, external infiltration and external ventilation, heat demand for space heating has its maximum in winter. To be specific, maximum heat demand for heating of over 7 kWh/m^2 has occurred in months December and January.

On the other hand, minimum heat demand for space heating, as seen on Figure 5, is during summer period. Solar gains through exterior windows has its maximum in May 1,86 kWh/m^2.

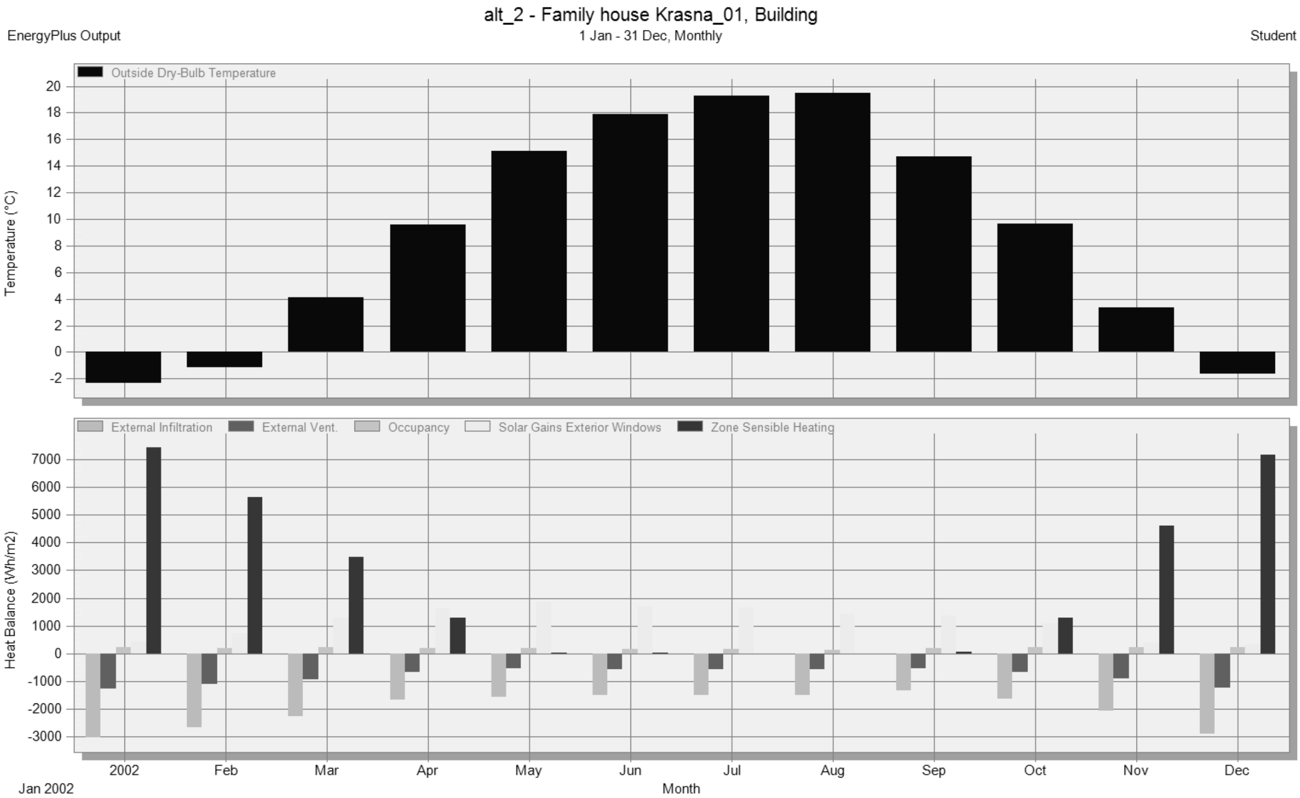

Figure 5: Monthly heat demand for space heating in relation to outside temperature and internal gains

Heat losses by external infiltration are highest in winter period with maximum of 3 kWh/m2 in December. Heat losses by external ventilation have maximum in November and December, with value 1,3 kWh/m2.

Conclusion. Nowadays, dynamic simulation software are on the rise. In the pre design stage, it is possible to optimize the future energy performance of a building. It is a very helpful tool for predicting energy behaviour, and all in all – to save future expenses. In this case study, we were able to find out future heat gains and heat losses as well as to predict heat demand for space heating with its maximums. After simulation is done, it is possible to look into critical values and, already in pre design stage, change structures, glazing orientation, technologies etc.

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Annotation

This paper shows how the dynamic simulation software can be used in the pre-design stage. It shows, on case study family house, how the object behave when put into reference year of Kosice and possibilities of optimization to reach the higher energy performance of the building..

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