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## A CONSUMER MODEL FOR RESEARCHING THE INTEGRATIVE EFFICIENCY OF RENEWABLE ENERGY SOURCES – ENERGY SIMULATION

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### MODEL ODBIORCZY W BADANIU INTEGRACYJNEJ WYDAJNOŚCI ODNAWIALNYCH ŹRÓDEŁ ENERGII – SYMULACJA ENERGETYCZNA

#### Abstract

The object of this paper is an energy simulation of a consumer model in the environment of the energy simulation tool Design Builder. The consumer model represents part of a designed laboratory for research on renewable energy sources within the VUKONZE Project. The laboratory will be a newly built hall object on the grounds of the Technical University of Kosice where the constitutive research centers of individual faculties will be concentrated.

*Keywords: renewable energy sources, energy simulation, Design Builder*

#### Streszczenie

Obiektem niniejszego artykułu jest energetyczna symulacja modelu odbiorczego w środowisku narzędzia symulacji energetycznej Design Builder. Model odbiorczy reprezentuje część laboratorium zaprojektowanego do badania odnawialnych źródeł energii w ramach projektu VUKONZE. Laboratorium będzie nowym obiektem halowym zbudowanym na terenie Politechniki Koszyckiej, w którym skoncentrują się składowe ośrodki badawcze poszczególnych wydziałów.

*Słowa kluczowe: odnawialne źródła energii, symulacja energetyczna, Design Builder*

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## 1. Introduction

The research centre for renewable energy resources integration and performance efficiency (abbr. VUKONZE) is a corporate project of several faculties at the Technical University of Kosice funded from the EU. The centre with its technical equipment and instrumentation as well as concentration of research capacities has to support research and development in the area of the effective gain and utilisation of energy from renewable sources. The activities of individual faculties are concentrated on one research workplace that will be situated in a newly built hall at the campus of TU in Kosice.

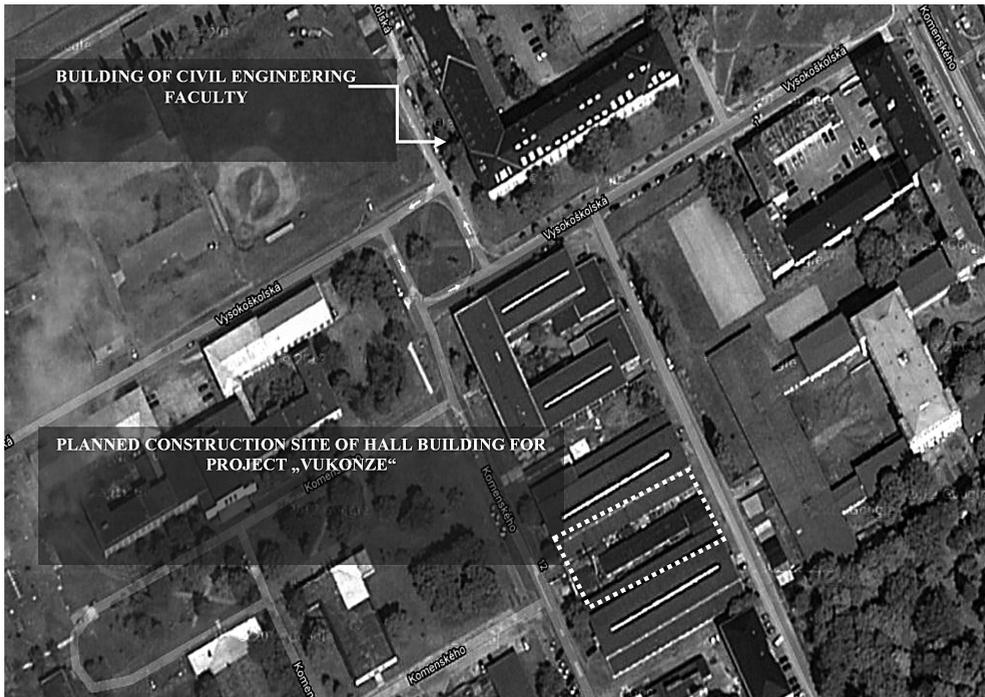


Fig. 1. Proposed placement of the planned workplace in Project VUKONZE

Rys. 1. Proponowane rozmieszczenie planowanego obiektu w projekcie VUKONZE

## 2. The meaning of a virtual energy model

One experimental space of the Faculty of Civil Engineering within the research workplace presents a “consumer model” – a family house – in the real scale installed in a “climate chamber”. It will be possible to simulate the conditions of external climate except the effect of solar radiation and wind by concrete requests of experimental tasks in the space of the “climate chamber”. Sensors and measuring equipment will be used, while the behaviour of the “consumer model” in the artificial environment will be monitored.

It will be necessary to know the energy inputs of designed experimental tasks for the creation or modification of required conditions:

- In the internal space of the “climate chamber” (e.g. for the assurance of required temperature in heat transfers between the chamber and the surrounding environment with defined operation),
- In the internal space of a single “consumer model” by defined conditions in the “climate chamber”.

For that reason, the virtual energy model of laboratory VUKONZE was created in the simulation energy program Design Builder. In addition, an energy simulation of the laboratory will be used to determine energy consumption in a single “consumer model” for variants of the HVAC systems (natural ventilation, mechanical ventilation, recovery, the use of renewable energy sources...). The obtained results concerning energy consumption according to energy carriers allow us to determine potential environmental impacts in the form of greenhouse gas emissions (CO<sub>2</sub>) and to elaborate an economic analysis that compares designed variants, e.g.:

- In terms of the operational costs,
- In terms of the efficiency of the investment costs.

### **3. The creation of a virtual energy model in the environment of the energy simulation program Design Builder**

The virtual energy model was created in wider connections similarly to the whole hall object of the VUKONZE workplace, except the “consumer model” installed in the “climate chamber” (Fig. 2). This makes it possible to simulate conditions in the hall space in the form of:

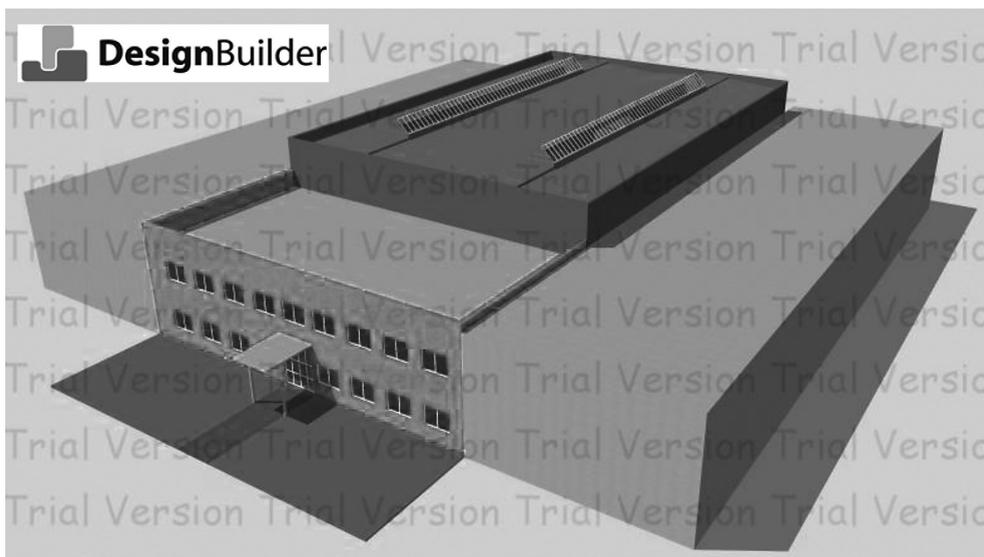


Fig. 2. Model of hall object for workplace VUKONZE (trial version)

Rys. 2. Model obiektu halowego dla zakładu pracy VUKONZE (wersja testowa programu)

- Definition of occupancy (number of people, energy output depends on activities and their presence in the space-time of the hall),
- Internal heat sources (equipment and activities),
- Passive solar gains (through windows in administrative parts and dormer windows in some parts of the hall).

The request of the research team members was to divide the internal space of the “climate chamber” into five separate segments in order to model different conditions of the external climate. This fact was included in the virtual energy model (Fig. 3): the space around the “consumer model” is divided into four separate parts, whereas the space above represents the fifth part. This makes it possible to simulate the conditions of the external climate in individual segments by setting the air temperature according to the requests of experimental tasks (this parameter will be ensured by the ventilation system).

The “consumer model” represents the last part of the virtual model. It is the object of a family house installed in the “climate chamber”. A separate group of the research team, which aims at the material solution of constructions for the “consumer model” and the “climate chamber”, will define their parameters to be used in the virtual energy model. In terms

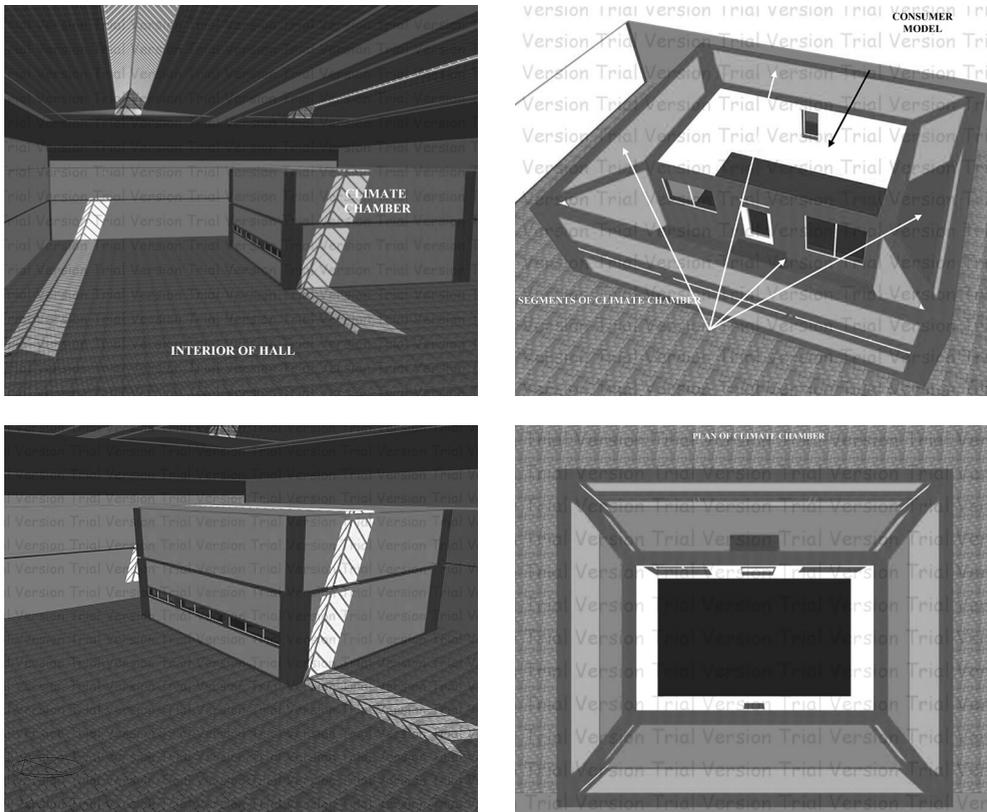


Fig. 3. Model of „climate chamber” with installed „consumer model” (trial version)

Rys. 3. Model „komory klimatycznej” z zainstalowanym „modelem odbiorczym” (wersja testowa programu)

of the HVAC systems, a special program facilitates simulation of the internal conditions in the “consumer model” in the form of:

- Definition of required inside-air temperature in vinculis on the time modes of HVAC activities,
- Heat gains from internal sources (lighting, PC, hot water storage and time of use),
- Definition of occupancy (number of people, energy output depends on activities and their presence in time),
- Ventilation concept (natural ventilation, mechanical ventilation, mechanical ventilation with recovery),
- Definition of mechanical ventilation mode (on the basis of people’s presence, on the basis of a defined time).

#### 4. Conclusions

Our effort was to create a simulation model with the support of the simulation tool Design Builder for the purposes of the VUKONZE Project so that it could simulate the real conditions of an experimental model at the most. It will be possible to obtain preliminary information about the energy demand and energy consumption of the “consumer model” as well as the “climate chamber” for planned experimental tasks. This simulation model represents a tool for planning and managing individual experimental tasks effectively with a view to the application of energy sources which will be available within the VUKONZE Project.

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#### References

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