TECHNOLOGICAL PROPOSAL FOR THE IMPLEMENTATION OF RENEWABLE SOURCES TO MEET THE ENERGY CONSUMPTION IN RESIDENTIAL BUILDINGS FOR 2021

Ing. Minh Nguyen Tien

ABSTRACT

Energy intensity and energy consumption of the residential buildings is one of the key indicators that characterizes utility value of the construction project. The main reason for increasing the share of renewable energy sources (RES) is to achieve the objectives of the Europe 2020 strategy, which the EU has set five ambitious objectives on employment, innovation, education, social inclusion and climate and energy that should be met by 2020. The EU is committed to accelerating the process of ratification of the amendment, to maintain the continuity of the legal system. The issue of obtaining energy from renewable sources in addition to existing EU environmental strategies is key area where attention is focused policy. The article analysis of the potential implementation RES in the residential buildings with the requirements of the global consumption.

Key words: *Renewable energy, Wind, Thermal loses*

1 INTRODUCTION

We are depended on energy in all sector of human aktivity such as: housing, industry, transport and agriculture. So in 2012 the European strategy has introduced an ambitious plan: to increase the share of renewable sources in the overall energy integration to 20 %, reduce the production of greenhouse gas emissions by 20 % compared with 1990 levels, but without obligation to increase energy efficiency in buildings by 20 % by 2020. Tools and measures to accelerate the improvement of the energy performance of buildings and their implementation into the buildings with almost zero energy so that the supply of energy from renewable sources in the building or close by 2020, to achieve at least a 50 % reduction in primary energy. Energetic objectives related to the RES application that countries implement to 2020, meet three European countries – Bulgaria, Estonia and Sweden. Act No. 300/2012 provides that from January 1st 2021 will be necessary to meet the requirements of buildings with almost zero consumption. It means significantly higher emphasis on thermal protection of the building and the technology of the heating system. Thermal performance of the whole building envelope has to be taken into account more frequently. Balance between the material cost, technical equipment and the overall reduction of the progressive energy performance are the one of looking for optimal solutions. One of the factors is the composition of external cladding, which can determine the potential of energy savings [1, 2]. However to meet the current requirements, it is not only about the aspect related to thermal quality of the building, but also about the integration of renewable energy sources [4]. The main renewable sources are solar energy, wind energy, biomass, geothermal and others. Wind power is the renewable energy source, which is available to a wider population and compared to the solar system includes even more advantages. As compared with solar system, wind system can be more consistent and reliable sources of energy in the household. Energy of wind is much less dependent on weather conditions and can operate constantly, when the wind blows in a small scale.

2 CALCULATION METHODS, HYPOTHESES AND WIND TURBINE PROPOSAL

The concept of applying suitable wind turbines is analyzed in this paper. In the analysis, energy efficiency and economic payback are taken into account. The overall proposal concept is based on the requirements of the European strategy. This solution is applied to a specific site of a residential building, where there was a real wind intensity measured on the basis of monitoring data for the last 3 years by Slovak Hydrometeorological Institute (SHMÚ). The methodology takes into account building, thermal, technological and economic aspects, on basis of:

- Calculation and comparison of the results of the energy needs for heating (normalized) of the current draft R. (recommended 2016) as compared with variant I (goal-recommended condition valid from 2021) according [5],

- Optimal technological design and the number of wind turbines for residential house,

- Calculation of the total cost for heating, the cost of the application and the calculation of the payback period in different wind turbines,

In recent years, wind turbines have progressed many innovations and improvements, so they are becoming more inviting. Modern wind turbines are smaller, lighter, and more powerful than their previous concepts. Currently, we can install a small wind power much cheaper and able to produce more energy than older ones. These new wind-powered devices can contribute effectively to the improvement of turbine blades, to more powerful generators as well as to innovative design. A novelty on the market is a model WG 100 from MRT Wind GmbH from Germany. This innovative model of a wind turbine can produce energy right from wind speed of 1.5 m·s-1. (light breeze).

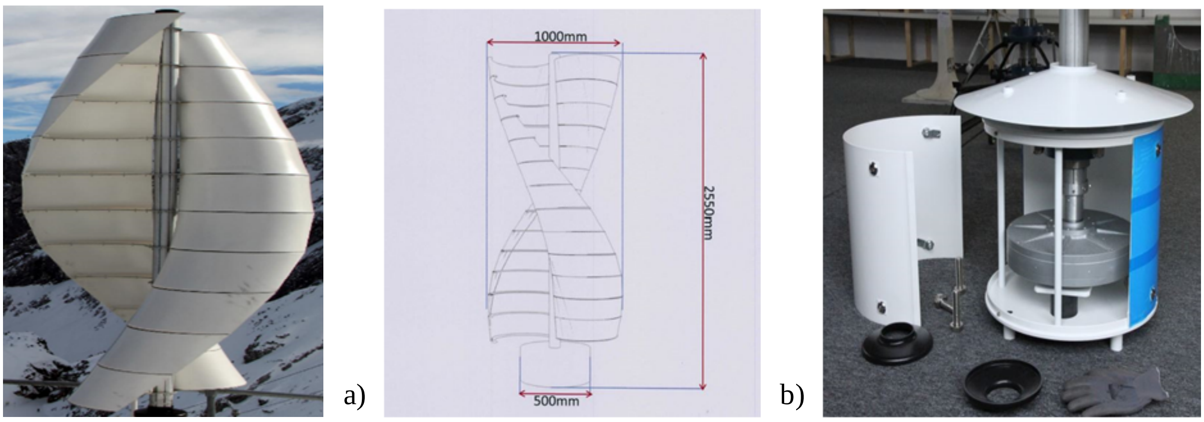

Fig. 1 . Wind turbine WG – 100; a– Basic dimensions; b – Generator

WG 100 is supplied as kits, components of the rotor of a wind, generator, inventor and cabinets for measuring electricity. All parts are interchangeable 100 WG. The total weight is about 100 kg, and total height of wind turbine with generator is 2.6 m. In addition type of WG 100-1.3 kW is also produced other types of the generator: 0.5 kW, 2.0 kW, as 4.0 kW, 5.0 kW. More powerful types differ from less powerful turbines not only in prices but also in the fact that they are available in the production of electricity from higher starting speed [3]. At the speed of the wind over the value of 1.5 m·s-1, which means a light breeze, wind turbine starts producing an electricity. The sail can receive wind from different sides and angles, even in the chimney effect. The maximum capacity is 1.3 kW at a speed of 9 m·s-1. The most important parameters in the application of a wind turbine are the average wind speed in the area of the object. On basis of cooperation with SHMÚ- Slovak Hydrometeorological Institute following charts were created for this study (Fig. 2).

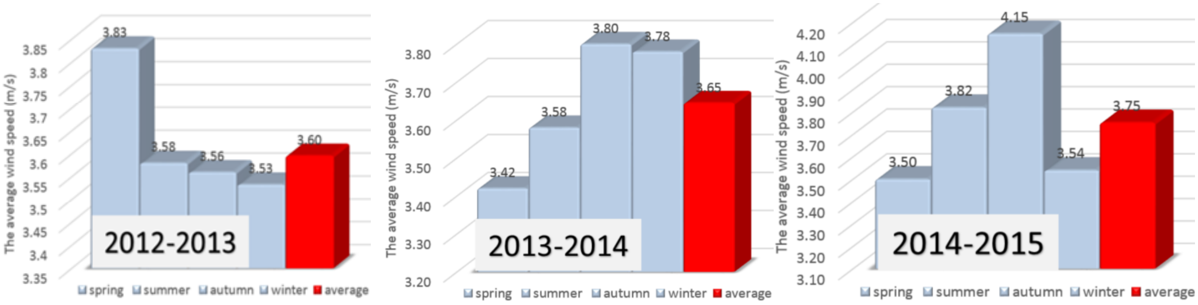

Fig. 2 . The avegare wind speed for the years 2013,2014,2015.

Energy production not depends only on the speed of the wind; however the speed of impact is of certain importance and the ability to create whirling movements become the turbine into theoperation state. The higher building is the more faster wind speed can be. (Fig. 3).

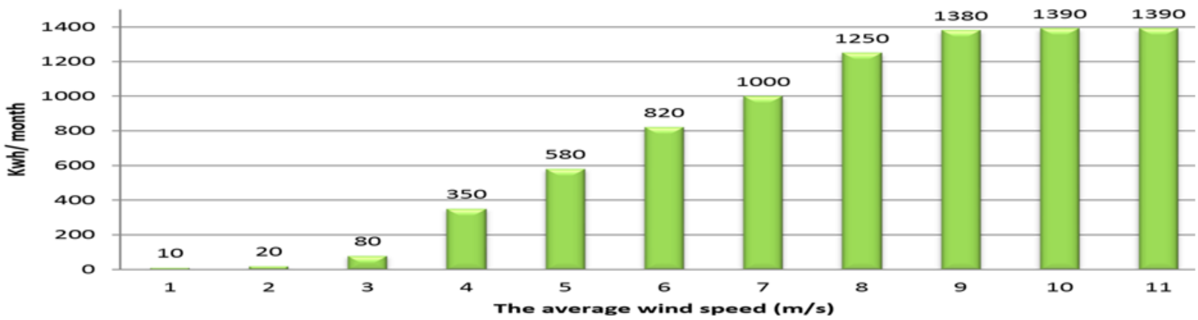

Fig. 3 . Wind turbine power dependence on average wind speed

3 THERMAL PERFORMANCE OF BUILDING ENVELOPE

Paper subject was analyzed for the referenced variant R. as compared with I. (valid from the year 2021) by using the program EHB [6] (Table 2). The concept of wind turbines (Fig. 1) was analyzed on the residential building, which is parametrically described in Table 1. The calculation was determined by the energy need for heating. According to the Slovak Decree No. 364/2012, the estimated energy class for the residential building is category A. The proposal of the design and technical adjustments of the residential building is relevant to the I. The aim is to meet the goal- recommended condition (I.) for thermal performance standard of external structures (particularly the floor above the non-heating space, the roof, the windows and exterior walls) and finally approaching to the standard of low energy residential building under classification category A1. The results of the calculations are demonstrated in Figure 4.

Building category	Case study residential building	
Number of aboveground stories	11	
Total floor area Ab	11046	m^2
The total built-up volume Vb	29345	m^3
The average structural heght H_k	2.66	m
The total heat-exchange area	7322	m^2
Factor of the building shape	0.25	m^{-1}

Table 1. Description of the analyzed residential building.

Constructions	Heat transfer coefficient UW/(m².K)			
	The current (recommended) condition 2016		Goal (recommended) condition 2020	
External wall	0.182	0.22*	0.124	0.15*
Roof	0.092	0.1*	0.08	0.1*
Ceiling above unheated space	0.115	0.5*	0.114	0.25*
Opening constructions	1	1.0*	0.6	0.6*

*Slovak target requirements for variations (for years 2016, 2021)

Table 2. Thermal performance of building envelope

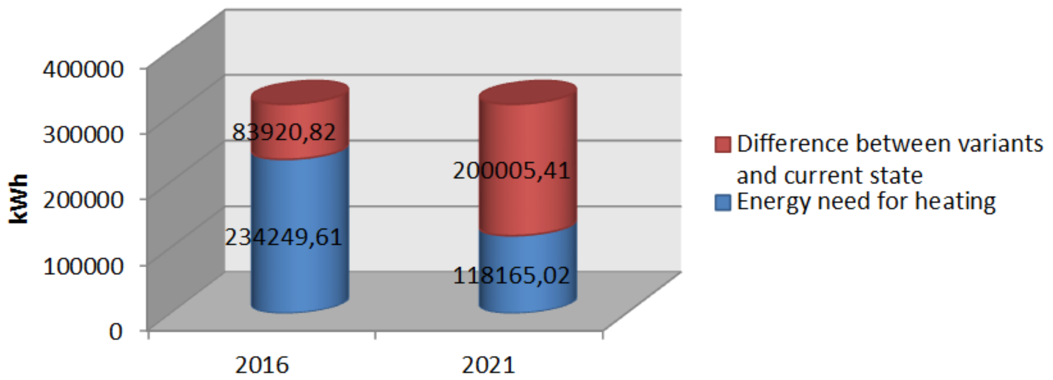

Fig. 4 . The total energy need for heating in variant.

As conclusion, for valid requirements in the year 2021 (I.), only changes in the peripheral structures are not sufficient for any project proposals. From this reason it is necessary to apply a recovery unit for case of residential building.

4 ASSESSMENT OF THE RENEWABLE ENERGY SOURCES INTEGRATION

Concerning to the economic aspect, at a price of 7000 € per turbine, so the total payback period on wind turbines, without the state support is approximately 9.2 years (Fig. 5). This period is calculated at a price level of 0.1531 € per kWh to Wind Turbine (W.T.) in 2016 according ZSE. However the price of electricity varies each year. According to Figure 5, it can be noticed the differences in the cost of heating significantly between the current proposal and those for the year 2021 (I.). These initial investments will be returned after app. 8.8 years without government subsidy and with assumption of the 40% national subsidies can be return already after 4 years.

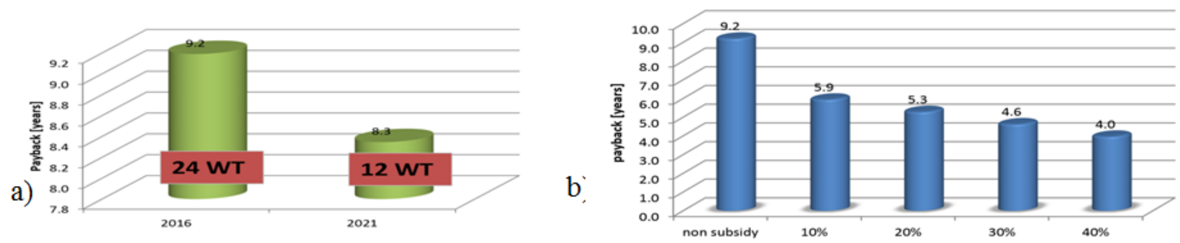

Fig. 5. a-Payback period for target years 2016, 2021 and number of wind turbine b- payback with subsidy

5 CONCLUSION

Paper presents the result of residential building case study integration of small wind turbine for optimizing energy efficiency and electricity support from renewable energy source in recently given target periods of technical standard. Results demonstrate inviting potential of implementation particular wind energy source, especially with relation to the building thermal and energy performance. Finally, this study represents app. 9.2 years payback period (there is 24 wind turbine), whereas with any support it might have even more significant reduction from customer's point of view . In 2015 thanks to national project call “zelenadomacnostiam” people can get some government subsidy from small machine with max 10kW power and finally it helps Slovakia have potential to meet requirements of recently given targets of European energetic strategy.

Literature

[1] Kosny, J., A New Whole Wall R-value Calculator, an Integral Part of the Interactive Internet-Based Building Envelope Materials Database for Whole-Building Energy Simulation Programs, 2004.

[2] Kosny, J. and A. O. Desjarlais. 1994. “Influence of Architectural Details on the OverallThermal Performance of Residential Wall Systems.” Journal of Thermal Insulation and BuildingEnvelopes, Vol. 18, July 1994.

[3] Nguyen Tien, M. The residential building Ruzinovska 44, Final diploma thesis, 2014

[4] Rabenseifer, R. - Minarovičová, K.: Environmental Analysis and a Suggestion for Assessment of Detached Houses. In: Denzero International conference: Sustainable energy by optimal integration of renewable energy sources. Debrecen, Hungary, Debrecen: University of Debrecen, 2013, pp. 172-182. ISBN 978-963-473-624-0.

[5] STN 73 0540-2, Thermal protection of buildings. Thermal performance of buildings and components. Part 2: Functional requirements, 2012. (in Slovak)

[6] Program OS.EHB.SK v. 3.1- 2013 – Thermal assessment, Thermal performance of buildings (Author: Rastislav Ingeli) – available online at: https://www.ehb.sk/ (in Slovak)