WIND AND SOLAR ENERGY AS A PART OF THE DESIGN OF CONSTRUCTION EQUIPMENT

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ABSTRACT

Construction site equipment is still part of the construction of all civil structures. The trend in the reduction intensity of buildings. This principle of reducing intensity is also applicable in the actual construction of the construction site equipment. During the construction is the possibility of using alternative sources in the design of construction equipment, which may contribute to the overall efficiency of construction. While the construction site is an integral part of construction and an important role in overall efficiency in terms of realization time, cost, performance of workers and use of deployment mechanisms. Alternative sources are a cost- efficient means of contributing to sustainable development value. And provides added value for the possibility of successful allocation BREEAM.

Key words: *Solar energy, Renewable energy, Wind energy, Construction site*

1 INTRODUCTION

We are depended on energy in all sector of human aktivity such as: housing, industry, transport and agriculture. So implementation of alternative sources into operation proves that we can cooperate with nature. And by reducing CO2 production, essential consumer safety it provides for construction workers - (improving productivity) and last but not least opportunity to get a BREEAM (Building Research Establishment's Environmental Assessment Method) certificate.

Currently humanity solves one of the main challenges, namely to ensure the sufficient supply for maintaining continuous development of society without negatively affecting the creation and protection of the environment. In construction, still require stricter conditions for the energy efficiency in buildings, not only in their design, but also from the beginning of the construction of buildings [1]. Wind energy has its origin in the solar energy. The surface of the Earth, on the solar radiation turn out to, is unevenly heated. As a result, there is a temperature difference of the ambient air, which form the conditioning factors of the differential pressures. Warmer air heated from the earth's surface rises up and cooler air is pushed to the surface. This results in motion - the air mass flow from the higher pressure area to a lower pressure area that forms the subject of wind. These two systems are complementary [4].

Solar energy falling on the earth's surface is the richest available source of energy. In view of its huge potential in the natural state and its quality properties is also from an economic side an alternative inexhaustible energy source [3].

1.1 Data for the solution

The paper presents an application of selected renewable energy sources in the construction site during the implementation of the multifunctional residential building. Residential building is located in Bratislava - Ružinov. The multifunctional building has 11 floors and one underground. In the project

is designed also an outdoor parking, which is located on the south side. This place will be used during construction for location of construction equipment. The planned location of renewable sources such as wind and collector systems are contemplated the area over cabins. Assumed of the construction period is 15 months. Renewable energy for the construction site equipment are designed to cover the need electricity for the purposes of construction.

2 RENEWABLE ENERGY SOURCES

2.1 Solar collectors

In the calculation of solar energy systems is the most important step to determine the optimal collector area and the number of collectors that provide the required of the energy cover in the time period according to the timetable, given the size of the structure. For application we choose for a given area collectors Ak (m2) heat balance for a certain period and determine the ratio of energy consumption covered by solar energy and additional resources [7]. The total collector area Ak is calculated from the formula:

$$A_k = \frac{Q_n}{Q_k} \quad (1)$$

where Qn = the thermal energy needed for the day or month (kWh); Qk- energy captured by the collectors for the day or month (KWh/m2), by the time of the equipment operation.

$$Q_k = \eta_k \times Q_s \quad (2)$$

where ηk = effectiveness of collectors shall be determined by calculation or it is specified by manufacturer; Qs = solar energy falling on the panels (kWh/m2).

To the exact calculation Qk takes into account: at the time of clear days effect on sunlit surface on the overall intensity of solar radiation continuously, but in cloudy sky acts only the intensity of diffuse radiation. Time rotation of clear and cloudy sky during a certain period is usually unknown and for climate data, express the average monthly relative sunshine.

$$S_m = \frac{T_{real}}{T_{teor}} \quad (3)$$

where Sm= average monthly sunshine (-); Treal = actual time interval determines the energy for the day sunlit area 1 m2 (10-14hod); Tteor. = theoretical time interval determines the energy for the day sunlit area 1 m2 (6h-18h).

After taking into account factors that can affect the performance of the collectors we have created a table with the following values. The collectors will be placed on the southern side of the construction site in 45° degrees.

In Table1. are measured the average values of solar radiation energy Hs the month (kWh/m2) for selected part - Bratislava.

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Energy per day (kWh/m2) in 45°	3.26	5.27	6.73	7.88	9.57	9.64	9.57	7.88	6.73	5.27	3.26	2.69
Average sunrise S_m	0.25	0.31	0.42	0.53	0.57	0.61	0.63	0.63	0.58	0.44	0.24	0.21

Table 1. Average value of solar energy [7]

2.2 Wind turbines

To determine the type of wind turbine preferred to the building, it is necessary to know some of the main parameters for the building. One of the most important parameter is the average wind speed at a given nearby, the height of the proposed building, or a building in a built or unbuilt territory, and around the building are not above the higher buildings or whether it is not located in the protection zone and etc. In cooperation with the Slovak Hydrometeorological Institute was established a graph for the period 2010-2015 for this locality [6]

It can be said that the wind speed is over the last three years stable and not changing. The average wind speed for this location is about 3.6 m/s.

For the calculation of energy needs it is necessary to know the length of the workday, which is 10 hours and apparent input power for the construction site equipment. Specifically, for offices lighting, washrooms, changing rooms and construction sites. [5]

To calculate the apparent input power for construction site equipment is used this formula:

$$S' = 1.1 \times \sqrt{(0.5 \times P_1 + 0.8 \times P_2 + P_3)^2 + (0.7 \times P_1)^2} \quad (4)$$

where S' = apparent input power (kVA); *1,1* = the contingency reserve coefficient of increase input power; P_1 = installed capacity of the electric motors on the construction site (kW); P_2 - installed capacity of the interior lighting power (kW); P_3 - installed capacity of the outdoor lighting (kW).

The aim is to cover P_2 and P_3.

Determination of the input power P_2

- Lighting offices – 20 W/ m^2 — 91.7 m^2 x 20 W/ m^2 = 1.834 kW
- Lighting washrooms, changing rooms - 10 W/m^2 — 170.3 m^2 x 10 W/ m^2 = 1.703 kW
- Lighting store – 8W/ m^2 — 50 m^2 x 8 W/ m^2 = 0.4 kW

Determination of the input power P_3

- Lighting construction site — 0.5 km x 5kW = 2.5 kW

Total input power - 6.446 kW

The selected part of the electricity consumption to be covered will be 32.30 kW/per day, when it considered with 5 hours of continuous use of all equipment simultaneously.The total free floor area of the proposed cabins is 86.4 m2.

2.3 Proposal of renewable energy sources for construction site equipment

For multifunctional residential building is designed in figure 2.

- for wind system type: figure.1 - Zephyr Airdolphin Mark-Zero Z-1000-24 with specific data such as Blade diameter: 1.8m, Weight: 17.5 kg power system: NdFeB permanent magnet three-phase synchronous motor is mounted, Winds from the starting power - 2 m/s, Material of blades - carbon fiber surface, body material - cast aluminum, body structure - Japanese traditional craft screw less card Tenon. It is considered to cover by the turbine at least 2.4 kWh/per day. The manufacturer declares that the turbine at a wind speed of 3.6m/s can produce 1.21 kWh/day. The required area to install the turbines are 2 m2. For construction site equipment are designed two turbines.

- the type of solar system: FV module Amerisolar 250Wp, poly-crystalline photovoltaic modules with aluminum frame with 16.9% efficiency. With dimensions 1.64 m x 0.99 m x 0.04 m. The total weight of construction is 18.5 kg. Considering all the factors that can have a major impact on the design, figures are presented in Table 2. The dimensioned number of photovoltaic panels for the construction site equipment is 34 units.

Features	
Average energy	3.28 kWh/m^2/da
Effectiveness	0.17%
Area for 1 panel	1.6 m^2
Real power	0.89 kWh/ panel
Energy need to be covered	29.88 kWh/day
Needed solar number	33.69 panels
Available are upper cabin	86.4 m^2

Table 2. Average value of solar energy [9]

Fig. 1 Zephyr Airdolphin [8]

2.4 Advantages of using renewable sources during construction

The implementation of these alternative equipment have many advantages at the beginning of construction. Not only the reduction of CO2 production during construction, as well as independent power to ensure continuous operation cabins. And also it allows the investor a better chance to get world BREEAM rating (Building Research Establishment's Environmental Assessment Method). BREEAM is the world's foremost environmental assessment method and rating system for buildings. A BREEAM assessment uses recognized measures of performance, which are set against established benchmarks, to evaluate a building's specification, design, construction and use. The measures used represent a broad range of categories and criteria from energy to ecology. They include aspects related to energy and water use, the internal environment (health and well-being), pollution, transport, materials, waste, ecology and management processes [2].

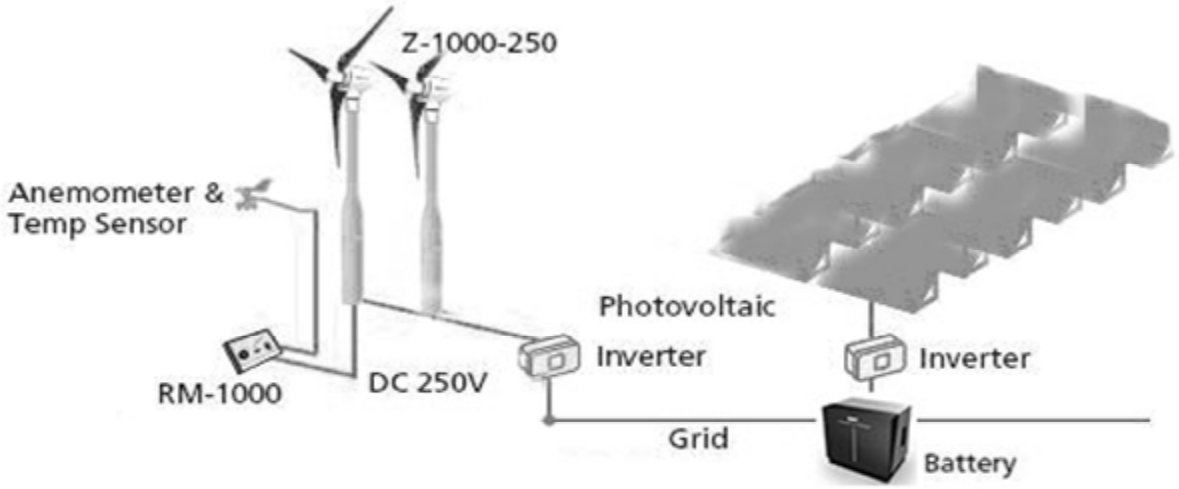

Fig. 2 An illustrative connection diagram of wind and solar system (8)

3 CONCLUSION

The result of this article is an implementation the alternative sources for the design of construction equipment, focusing on the way the supply of construction equipment electricity using of alternative sources for interior and exterior lighting construction site. The overall design of the system supply is positioned so that the guaranteed minimum loss of electricity. The whole system of alternative sources can be put together according to the requirements of each construction equipment and contractor according to their preferences. An important feature is lifetime of semi-crystalline solar panels expected time of 20-25 years and wind turbine 20-23 years. For all designed panels and turbines can be used for many construction turnarounds with a low cost of installation and removal. Implementation of renewable sources met one of the requirements (Responsible construction practices- Environmentally Aware- Alternative energy so-users have been considered) which provide greater global BREEAM rating. With this proposal we present that nature is part of us all and last but not least can help Slovakia to a higher percentage to use BREEAM.

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