Application of sustainable energy sources in telecommunication facilities - experiences from exploitation of m:tel Republika Srpska

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***Abstract*— M:tel Republika Srpska has launched a pilot project on application of renewable energy sources. The m:tel Republika Srpska has decided to create a pilot project in which solar panels and wind generators are installed at eight sites. Locations were selected to estimate profitability of sustainable energy sources in practical use.**

This paper showcases problems and results obtained during the implementation of the pilot project. In paper introduction, an information about energy potential of renewable energy sources and energy costs in Serbia and Republika Srpska is given. Second section shows pilot project on application of renewable energy sources in m:tel Republika Srpska, including description of location, statistics and calculations. Furthermore, it lists some of the problems in implementation and functionality. Final section discuses problems that appeared during pilot project and gives direction for future projects.

Keywords- wind generators, solar energy, renewable energy

I. INTRODUCTION

The modern age is characterized by the need for additional sources of energy. Sources of energy based on fossil fuels are limited. Sustainable energy sources are underused. New technologies enable effective use of available energy sources. However, standard technologies and equipment use energy inefficiently and are not environmentaly friendly. Switching to energy sources that are inexhaustible, and whose exploitation is available to all, reduces operating costs and reduces environmental pollution.

The threat of global warming and potential changes in climate caused by global warming, are engaging scientific and professional organizations, which establish policies, procedures, recommendations and publicity campaigns. They are trying to influence the society to change individual behavior towards nature [2]. Percentage of energy from renewable energy sources in total energy consumption in Serbia is 21.2%. Serbia's obligation is to increase the share of renewable energy use to 29% by the end of 2020. The energy potential of renewable energy sources in Serbia is over 4 million tonnes of oil equivalent (toe) per year, which is equivalent to almost half of the annual energy needs. 0.6 million ten is in unused hydro potential (14%), 0.2 million ten is in unused geothermal energy (4.5%), 0.2 million toe is in unused wind power (4.5%) and 0.6 million ten is in unused solar radiation (14%). For electricity generated from small hydropower, guaranteed price per kilowatt-hour is 7.8 to 9.7 euro cents, from 11.4 to 13.6 euro cents for electricity from biomass, biogas electricity price is guaranteed from 12 to 16 euro cents, for electricity from wind power price of 9.5 euro cents [1]. These data refer to the territory of the Republic of Serbia, but similar data exist for the territory of Republika Srpska.

II. IMPLEMENTATION OF SUSTAINABLE ENERGY SOURCES IN M:TEL REPUBLIKA SRPSKA

Telecommunication companies are high-profit companies. They have potential to invest in modern solutions. One of the serious problems of telecommunication companies is organization of power of facilities. Number of objects of a telecommunication company is counted in hundreds and thousands. For each object it is necessary to organize a reliable uninterrupted power supply. A significant number of facilities is located in remote locations, such as mountain peaks. In addition to problems with the arrival to the facilities, there is a serious problem in bringing of new equipment as well as spare parts for existing equipment. A large part of the year, these facilities are completely inaccessible from the ground and from the air.

One of the key problems that arises in the application of sustainable sources of energy to power telecommunication facilities (particularly mobile telephony base stations) is the choice of location for installation. Location for installation of power system is determined by the location of the telecommunication system. Location of telecommunication systems depend on the conditions of predicting radio signal coverage. This is the reason for frequent conflicts in the choice of location.

The primary condition for optimal choice of locations, from the point of radio coverage, is often a compromise on the optimum location in terms of wind potential (as a primary energy source in hybrid systems of sustainable energy sources).

Empirical data shows that, except in extreme circumstances, there is reduced number of departures of maintenance crew. At one location (a photovoltaic system with battery packs) several years ago there was no need for intervention. The only serious intervention occurred after recent vandalism of breaking solar panels.

In the mountain peaks there are often present renewable energy sources and their use increases reliability of the facilities. Solar energy and wind energy are mostly used, but there are solutions using fuel cells. Fuel cells are much less dependent on external factors, but problem of delivering and storing hydrogen is still not well resolved, so in this pilot project only wind generators and solar panels are used. The m:tel Republika Srpska has decided to create a pilot project in which solar panels and wind generators are mounted at eight locations. Locations were selected to estimate profitability of sustainable energy sources. Calculation was made for expected power and required tilting angle of the solar panels that could generate maximum power. At all locations, the equipment was installed by approved manufacturers. The data obtained for one location are:

Estimation of PV electricity generation for site installation 1,0 kW PV panels:

- Location: 44o 25' 48" N, 16o 30' 32" E
- Installed peak PV power: 1,0 kWp
- Estimated performance ratio: 0,75
- Module inclination:
  - April-September: 25o
  - October-March: 60o
- Module orientation: South.

The graph below shows the (estimated) amount of electric power you can expect each month from a PV system with the given properties.

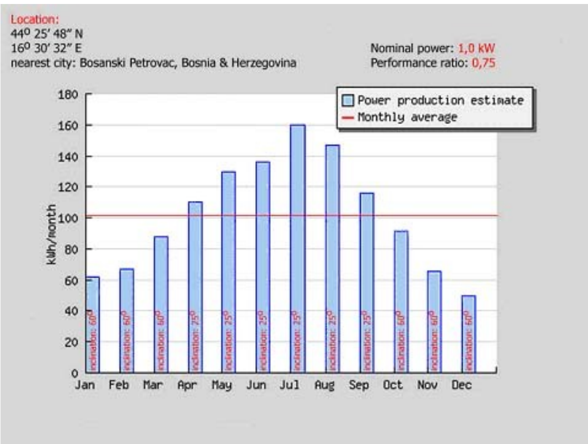

Figure 1. Graphical presentation of estimated amount of electric power each month from described PV system.

Optimal inclination angle for site:

- Location: 44o 25' 48" N, 16o 30' 32" E.

The following table shows optimal inclination angle for PV panel installation at the given site.

TABLE I. OPTIMAL INCLINATION ANGLE FOR PV PANEL INSTALLATION AT DESCRIBED SITE

Month	Optimal inclination, degree
Jan	64
Feb	56
Mar	43
Apr	28
May	15
Jun	9
Jul	13
Aug	25
Sep	40
Oct	53
Nov	62
Dec	65
Year	35

Optimal inclination angle is: 35 degrees (highest annual power production).

Annual irradiation deficit due to shadowing (horizontal): 0,2 %.

For the calculation of wind generators, we used data of Hydrometeorological Institute. Measures of the following quantities: wind speed, temperature and air pressure, were performed every hour using anemometer at a height of 10m. Wind rose is made based on the available data.

Wind rose is the distribution of the speed and frequency of occurrence of that speed in polar coordinates. As clearly stated in the margin, sectoral division of the circle into eight sections is approved. The frequency of occurrence of a wind from some direction is defined as the ratio of the number of occurrences of the wind from defined direction and the total number of occurrences of wind, for a period of ten years. European wind atlas adopts the division into 12 sectors, but in this calculation division into eight sectors is used, considering the format of the available data. Shown wind rose is formed on the basis of data from Table II, below. Wind rose is shown in Fig. 2

TABLE II. DATA OF HYDROMETEOROLOGICAL INSTITUTE

Wind direction	**C**	**N**	**NE**	**E**	**SE**	**S**
Frequency (%)	3,90	18,80	22,00	5,50	2,50	14,80
Average speeds (m/s)		11,80	10,90	5,70	6,20	12,90
Wind direction	**SW**	**W**	**NW**	**Sum**	**Average speed**	
Frequency (%)	23,50	5,30	3,80	100,00		C - silence
Average speeds (m/s)	13,00	6,50	5,30		10,6	

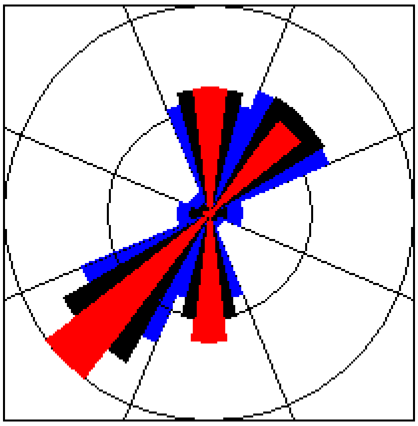

Figure 2. The rose of wind.

Fig. 3 shows the one of mounted objects.

Figure 3. One of mounted objects.

Standard equipment, which can be found on the market, was installed. It is well known that wind generators manufacturers guarantee reliable operation up to the wind speed of 120km/h. Also, it is expected that solar panels under the Sun temperature, be able to melt snow and ice deposits.

Practice has shown that the problem of application of sustainable energy sources in the mountains is much more complex than expected. Gust of wind can be over 250 km/h, in which case the wind generators in standard production could not withstand such wind speeds. The authors have identified three problems.

The first problem is the failure of moving parts of wind generator, and after fracture (damage) wind generator was out of function. Fig. 4 shows the wind generator and solar panels after the gust of wind.

Figure 4. Wind generator and solar panels after the gust of wind.

After the accident, the manufacturer has offered another solution in which the current solution with two rotary wings is replaced with a solution working with five wings. Fig. 5 shows the rotating part of the power generator with five rotary wings. The photographing was made in a test laboratory, where the immunity to electrostatic discharge was tested.

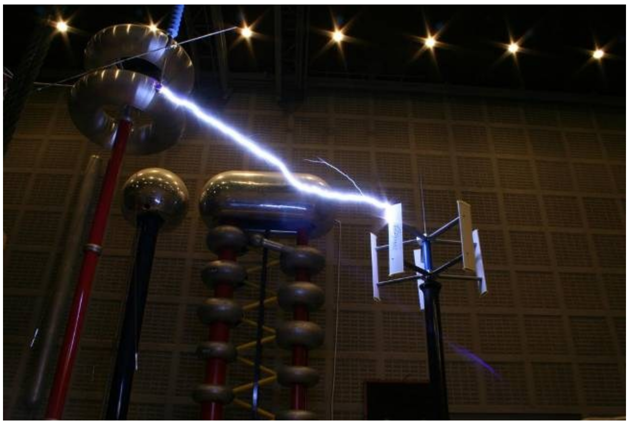

Figure 5. Rotating part of the power generator with five rotary wings.

Second problem is stability of supporting column of wind genetarors. Theoretical calculations have proven false. At locations where a gust of wind was present long-term, columns were broken.

Fig. 6 and Fig. 7 show columns after the third intervention by the firm that installed them. A solution with lattice towers, as well as solution with columns of solid materials was implemented. In the test location, neither of the used solutions withstood the test under real operating conditions. It is obvious that the problem of mounting columns lays beyond the capabilities of firms dealing with it. Therefore, it is necessary to include academic institutions that could find a solution that would be able to withstand long-term impacts of wind in the mountains.

Figure 6. Column of wind genetaror after third intervention by a company that it was mounted.

Figure 7. The instability of wind generator column.

The third problem that is occurring is extremely low temperature with increased wind speeds. Fig. 8, Fig. 9, Fig. 10 and Fig. 11 show one location of m:tel Republika Srpska in winter conditions. It is obvious that the wind generator and solar panel can not be functional due to the large deposits of ice and snow.

Figure 8. Location of m:tel Republika Srpska in winter conditions (1).

Figure 9. Location of m:tel Republika Srpska in winter conditions (2).

Figure 10. Location of m:tel Republika Srpska in winter conditions (3).

Figure 11. Location of m:tel Republika Srpska in winter conditions (4).

III. CONSLUSION

The m:tel Republika Srpska has installed eight of these facilities. Three sites, which were at the height of below 1000m showed results worse than expected. The speed of wind was sufficient to generate the required amount of electricity. At these locations, there was no damage to the equipment, but since it did not provide the expected results, these locations are moving elsewhere.

At four locations the results approximate equal expected values, so they are still in use.

At one location, the natural conditions were such that wind generators are not able to survive, and the solar panels were not usable in winter.

Telecommunication companies are leaders in the application of new electronic technologies. One of the areas of intensive work is the application of sustainable energy sources.

This paper describes initial experiences with the implementation of sustainable energy sources in m:tel Republika Srpska, which did not meet expectations. It is obvious that the use of sustainable energy sources in the high mountains requires a more comprehensive approach than the previous and the inclusion of experts in mechanical and electrical engineering. Access to readily available structures in the market is not optimal criteria for equipment selection and as a result a breakdown of installed equipment is possible.

Of course, that does not mean there is no place for the application of sustainable energy sources in these conditions, but it is necessary to include the appropriate experts to get the expected result.

ACKNOWLEDGMENT

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