Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 134 (2016) 9 – 13

Procedia Engineering

www.elsevier.com/locate/procedia

9th International Scientific Conference Transbaltica 2015

# Expedience of Applying Solar and Wind Hybrid Power-Plants in Railway Infrastructure Objects

Gediminas Vaičiūnas*, Gintautas Bureika, Lionginas Liudvinavičius

*Vilnius Gediminas Technical University, J. Basanavičiaus g. 28, LT-03224 Vilnius, Lithuania*

**Abstract**

The level of technical development and the diversification of energy sector of Lithuanian Railways, the scale of using of renewable energy sources have been defined in this article. The necessity and expediency of implementation of solar and wind hybrid power-plant in railway infrastructure objects have been reasoned. The methodology for calculation of rational proportion between solar and wind hybrid power-plant potential and electric energy demand, which notable varies during the year, have been proposed by authors. Based on suggested formula have been demonstrated that the wind potential part of solar and wind hybrid power-plant of Lithuanian rolling-stock depots and stations should be about 75%, and the solar – 25%. The procedure applied by authors for determination of proportions of hybrid plant shared power is universal. Finally, basic conclusions and recommendations are given.


Peer-review under responsibility of the organizing committee of Transbaltica 2015

*Keywords:* renewable energy sources; PV models; hybrid RES power plants; energy demand.

## 1. Introduction

The modern-day challenge of the global energy sec-tor is the principal reduction of the environmental pollution (The Kyoto… 1997) and the initiation of the break of the installation of renewable energy sources in all sectors of the economy (National… 2012). There is quite some focus from the producers of railway transport means on the use of kinetic energy accumulated by the energy accumulation and recovering systems (Bureika et al. 2011;

* Corresponding author
*E-mail address:* gediminas.vaiciunas@vgtu.lt


Peer-review under responsibility of the organizing committee of Transbaltica 2015
doi:10.1016/j.proeng.2016.01.030

Liudvinavičius et al. 2011, Liudvinavičius et al. 2010). The forecasts show that the share of energy from renewable sources of the Republic of Lithuania, which can be achieved by the available local sources, will account for 23% in 2020 (The Law… 2011). The priority should be on the exploitation of the local potential of energy from renewable sources (hereinafter – the RES). State Company "Lithuanian Railways" (hereinafter – the LG) is one of the largest Lithuanian transport companies with the objects of infrastructure situated throughout the entire territory of the country. The sector of the LG infrastructure consumes approximately 80 thousand MWh of electricity a year and is one of the largest electricity consumers in the country. Thus, a solid contribution of the LG in the installation of RES technologies would be a significant support for the Republic of Lithuanian in the implementation of the ambitious plans of the EU in the area of clean and sustainable energy (Communication... 2011). The energy sector of the LG infrastructure in completely non-diversified in respect of energy sources: nearly 100% of the consumed electric power is received from the electricity networks of the main electricity supplier – AB "LESTO", whereas the buildings of the LG are heated by the thermal energy and natural gas supplied by the central heating systems. The use of the RES power-plants in the LG infrastructure objects is expected to reduce the costs of rolling-stock repair and maintenance of stations and level-crossings, whereas the environment would not be contaminated with hazardous substances at all.

In the opinion of the authors, it is best to start the installation of the RES in the largest electricity and thermal energy consumers – the rolling-stock depots. The large roofs of the industrial buildings of these objects can be ideally used for the installation of solar photo-voltaic (hereinafter – the PV) elements. Given that the solar PV element of the area of 1 $m^2$ generates (150–180) kWh of electricity a year under Lithuanian conditions (Kytra 2006), and that the total area of roofs of Vilnius rolling-stock depots is up to 12 thousand $m^2$, the share of approximately 1.8 thousand MWh of the amount of electric power can be obtained by solar power-plants in these depots. The time of pay-back of solar power-plant is directly dependent on the installed power: the more powerful is the power-plant, the faster is the payback time (Vaičiūnas et al. 2014).

Another attractive RES is the wind, the annual aver-age speed of which amounts to (4–5) m/s in our country. It is completely sufficient for the rational use of wind power-plants in the territory of Lithuania. The main users (objects) of the LG energy are located near the residential territories alongside the railway lines. It shall be noted that due to the noise caused by the rotating blades, the wind power-plants must be installed as far from the residential areas/settlements as possible. On the other hand, it is more rational to built wind power-plants namely in those territories, where no natural or artificial obstacles are present (i.e., forests, large trees, high bushes, hills, buildings, engineering structures, etc.).

The particularities of the varying potential of solar and wind power-plants gives rise to the necessity to connect the energy systems of both types of these power-plants. This ensures a relatively good continuity of supply of electricity to the objects of the LG infrastructure in case of variation of their energy demand during the day and during the year. The article reasons the proposal to install hybrid solar and wind power-plants in the objects of LG infrastructure and, thus, to make the rational use of the advantages of the RES power-plants.

## 2. Design of the total power of solar and wind hybrid power-plant

The concept of hybrid electric power-plant is offered pursuant to the significant variation of the energy costs of railway production objects during the year. When the efficiency of solar power-plant decreases by several time in Lithuania during the winter period, the shortage of the generation of electric power in the hybrid power-station could be compensated by the wind power-plant, the efficiency of which becomes significantly higher during the cold period due to stronger and more frequent winds. When installing RES power-plants in the objects of LG infrastructure, it is possible and rational to make a technical coordination of these particularities of variation of solar and wind potential. The methodology was created for this purpose.

Pursuant to the statistical data of the electricity consumption of Vilnius locomotive depot (hereinafter – the LT-1) of 2010–2013, the monthly distribution of electricity costs was composed. The percentage distribution of electric power in LT-1 is provided in Figure 1.

The electricity is used for the production process, lighting or heating, it means that the costs were higher during the winter months and lower – during the summer. This consistency of variation of electric power costs best matches