Technical Feasibility and Financial Analysis of Hybrid Wind-Photovoltaic System for Supply of One Educational Institution

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Abstract: The paper presents the results of analysis of technical feasibility of the grid-connected hybrid system for power supply of one educational institution. The system consists of a certain number of photovoltaic (PV) arrays, as well as small wind generators with total power of 1 kW, 3 kW and 5 kW. The system is connected to distribution network via appropriate inverter. The basic goal is to determine reducing the bill for electric energy, as well as pollutant emission reduction in the case of predefined load diagram. Detailed economic analysis is carried out using "Life Cycling Costs (LCC)" method. The money saving is determined in the cases of "normal" conditions about wind and solar energy (Belgrade). Typical meteorological year data (TMY2) were used by HOMER software tool. Results of the analysis show that hybrid wind/PV power system is economically viable.

Keywords: Energy efficiency, Renewable energy source, Solar energy, Wind energy, System Advisor Model software, HOMER software.

1. Introduction

Today's energy systems contain characteristics which are problematic. The use of fossil fuels is increased. Also, there is a growing demand of energy, as well as increasing emissions of pollutions in the atmosphere. The price of energy is greater in recent years. Due to these reasons, energy efficiency and saving, increasing usage of renewable energy and distributed generation becomes imperative.

The problems mentioned above can be effectively solved using renewable energy, especially solar, and wind energy. The hybrid power systems consist of two or more sources, used together to enable increased system efficiency. Those systems are characterized by significantly increased overall efficiency, the reliability, and the availability, when compared with individual systems. These systems are now used in industrial plants, buildings, educational and social institutions, and so on.

Mathematical models of solar and wind systems, as well as design and planning principles are presented in detail in [1-5]. Analyses of the hybrid systems proposed in Republic of Serbia are shown in [6-7].

Most commonly, the goals of solar systems installing on the educational institutions' roofs are social and economic. These projects commonly are intended to achieve next goals:

1. Determining the real potentials and possibilities to implement solar systems in Republic of Serbia,
2. Demonstration of ways of usage photovoltaic (PV) technology through practice education process,
3. Help to education institutions by electric energy bill saving, and
4. Promoting of the renewable energy sources usage, especially solar modules.

This paper analyzes the hybrid power system (solar and wind) for generating electricity for educational institutions, based on dynamic simulation. There are several adequate software tools for such analyses, as TRNSYS, System Advisor Model (SAM), and HOMER [8-10]. In this paper, System Advisor Model (SAM) software tool is used, because it is project-oriented. Also it contains high- fidelity models of elements, and comprises possibilities for detailed economic analysis. The wind system is analyzed by HOMER software tool [9], because it supports using of meteorological data for some places in Republic of Serbia. The PV model is presented in [11], as wind generator's model is shown in [12].

The basic goal of the paper is to analyze the influence of some technical parameters on the produced electrical energy, as the rated power, PV string's tilt, PV string's azimuth, and number of wind generators. There is a need to calculate money saving which an educational institution achieves, as well as decrease in CO_2 emission. Also, some economic analyses have been done.