Chapter 18
Energy-Saving Systems Using Photovoltaic Modules

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ABSTRACT

The chapter presents the results of the development of two systems. The first is a photovoltaic system parallel to the power supply network of LED lamps. The algorithms of the system operation for both working and emergency lighting are shown. The basic operating modes of the system are considered taking into account the criterion of the minimum cost of electricity generated. These modes provide the most complete use of solar energy in the working day with minimal additional costs, allowing the consumer to save on electricity and increase the reliability of the emergency lighting system. The second system is a solar photovoltaic module built into a standard double-glazed window sash size 730x700 (mm), which is designed to charge a block of lithium-ion batteries with a capacity of 6.8 Ah with an output voltage of 5.25 V, the energy of which can be used to power any device having a USB 2.0 connector. The results of calculation of the required peak photovoltaic power of the module are presented; the technology of its sealing is described.

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INTRODUCTION

The use of renewable energy sources began with ground-based systems of low power. They were located in regions where there were no centralized power supply networks to provide the minimum necessary energy for small social and industrial facilities. However, as a result of successful work in a reducing the cost of produced energy, as well as in connection with the growing environmental problems and to ensure the energy security of countries over the past 15-20 years, the world is almost explosive growth in the use of renewable energy sources. Access to reliable and sustainable energy stimulates investment, including public investment, to developing a wide range of renewable energy converters into consumer energy formats in order to fully realize the potential of renewable energy of a country. Renewable energy systems included in the centralized energy networks of countries provide up to 30% of energy consumption (Murdock, Adib et al., 2018). Currently, renewable sources occupy a leading place in terms of growth of their share in world energy production. Among the various types of renewable energy sources, solar energy occupies a leading position in terms of growth rates, reaching a total (worldwide) capacity of more than 500 GW (Beauvais, Chevillard, Paredes, Heisz, Rossi & Schmela, 2019).

Today, the energy produced from photovoltaic modules is competitive with fossil fuel generating plants (Beauvais, Chevillard, Paredes, Heisz, Rossi & Schmela, 2019). However, there are still problems hindering their mass distribution. Among the restraining reasons, first of all, we note the significant initial capital investments, the need for the use of batteries for guaranteed power supply during periods of energy shortage and the complexity of effective systems based on smart grid networks. If the first reason is mainly solved by the state providing stimulating investments, the rest require the search for new solutions to simplify the system without significantly reducing its functionality. To solve such problems, an energy-saving photovoltaic system is designed, which allows led lamps to work in parallel with photovoltaic modules and General-purpose power supply.

BACKGROUND

The development of solar energy naturally occurred in the direction of low-power power systems to power plants with a capacity of tens and hundreds of megawatts. However, currently photovoltaic modules with a capacity of hundreds of watts have not lost their relevance. Especially widely autonomous systems are used in agriculture both in animal husbandry (Tursunov, Sabirov, Hwoan, Turdiev, Shirmatov & Yuldoshev, 2013) and in crop production (Ismanzhanov & Tashiev, 2016). The use of low-power systems in urban environments is due not least to the advanced development of energy-efficient low-current electronics and lighting equipment at a constant current. Solar photovoltaic modules provide electricity of this kind without losses for conversion. All this directly contributes to the development of systems where a significant part of the network operates on direct current (Dragičević, Vasquez & Guerrero, 2016). Switching to DC networks, reduces conversion losses and avoids additional devices, increasing reliability and reducing cost. Therefore, the power supply of the load with direct current from photovoltaic panels, it is expedient to carry out directly. Accordingly, in the presented photovoltaic system, the work of led lamps is carried out directly on a direct current, but in parallel to the led modules, the energy from the grid is also supplied. The paper presents in detail the approaches to such parallel operation of led lamps from photovoltaic modules and power supply. The approach of the proposed solution differs

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