

ABSTRACT

of thesis in partial fulfillment of the requirements for the
Degree of Doctor of Philosophy
in 6D071800 – «Electroenergetics»
by

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IMPROVING OF LOW POWER SOLAR PV MODULES

The proposed thesis is devoted to the improvement of monocrystalline silicon PV modules with efficient installation parts.

The relevance of the study. Kazakhstan is located at latitudes between 42 and 55 degrees north, the potential of solar radiation on the territory of the country is quite significant and is 1300-1800 kWh / m² per year. Due to the continental climate conditions the total sunshine hours per year is 2200-3000. The significant potential of solar energy makes possible its effective use in Kazakhstan. There are all conditions for the development of solar energy as the primary type of alternative energy. Stocks of quartz raw materials needed to manufacture solar PV modules comprise 267 million tons. There are commercial deposits and other sources of minerals, including rare earth metals necessary for the production of solar cells - gallium, arsenic, cadmium, germanium.

The necessity of conversion and use of solar energy in large volumes is dictated by "Territorial Development Strategy of the Republic of Kazakhstan till 2015", the aim of which is to "ensure the sustainable development of the country and the creation of favorable conditions for the population on the basis of formation of competitive specialization in the regional and global economy, rational spatial organization of economic potential and population settlement".

Purpose of work - development and improvement of high performance PV modules with optimum power characteristics.

Subject of study. Climatic and geographical features of Kazakhstan, an acute shortage and high cost of energy, the need for the creation of local energy sources make the technical means of converting solar energy into electrical current an important object of study. The relevance of PVs as the object of study is determined by the following factors and benefits:

- promising opportunities to improve PV and increase their efficiency (up to 17% for monocrystalline silicon solar cell);
- lack of competitive PV with optimal energy performance, designed for use in sunny conditions of Kazakhstan;
- relatively low cost, simplicity and reliability of the installation, operation and maintenance, availability for the consumers not ensured with the centralized energy supply;
- environmental friendliness;
- autonomy (they are not intended to supply energy in the electrical network);

All of these define them as an important object of study but the methods to increase their effectiveness - as a subject of study.

Research methods. To solve the problems in the thesis the fundamental provisions of the theoretical foundations of phototechnique and photovoltaics, reliability theory were used. Also the practice of foreign scientists in the industry was used. Mathematical modelings were carried out and all calculations were done with Mathcad Prime 1.0, Mathcad 2003 software with the use of macros writing and graph building. Also Sprint Layout and Proteus 8 softwares were applied when modeling the control system chip. When 3D modeling the tracking system drive AutoCAD 2014 software was used.

Scientific novelty.

- The principle of sun tracking were proposed with additional functions that monitor the parameters of the PV (output voltage and current, time, temperature and power);

- The method of calculation and choice of the size of solar concentrators based on their mathematical modeling were proposed;

- An optimal method of cooling the surface of PV using a Peltier element was proposed.

Theoretical and practical significance of the study is the possibility of using its scientific and practical results in the subsequent production of solar energy converters with high efficiency, as well as the subsequent development of their physical models. The proposed technical solutions were used in the manufacture of a prototype of the solar installation, which was made at the laboratory of the Department of "Power and automation of technological complexes."

The main content of the work was published in 13 scientific articles and reports, including 6 articles in journals recommended by the Committee for Control of Education of MES RK and 2 articles in journals included in the Scopus database.