ANNOTATION

dissertation work of Moldybayeva Nurgul on the topic:
«Construction of optimal systems for autonomous power supply of dairy farms with the use of renewable energy sources in the conditions of Almaty region» submitted for the requirements for degree of Doctor of Philosophy (PhD) within major 6D081200 – «Energy supply of agriculture»

Research rationale. Globally, the demand for electricity continues to rise due to increased consumption in the industrial, transportation, and residential sectors. Electricity generation accounts for more than 50% of all anthropogenic emissions released into the atmosphere. In Kazakhstan, the annual CO_2 emissions per capita are 14.16 tons, which is higher than the world average of 4.52 tons.

At the same time, limited fossil fuel reserves and growing concerns about global warming are driving the ever-increasing use of RES around the world. Despite the fact that RES require large investment costs, their use is rational, both in the economic, environmental and human aspects.

Kazakhstan, in accordance with the law and the Concept of Transition to a Green Economy, recognizes the need to implement projects in the field of RES and energy-saving technologies. The general institutional environment remains quite favorable for the large-scale implementation of green technologies. Investments in the RES sector are becoming increasingly attractive due to the growth prospects of this market and the potential for the development of new technologies.

Currently, in Kazakhstan, 255 rural settlements and 9 thousand farms located remotely do not have access to centralized power supply. Autonomous power supply to remote rural facilities based on renewable energy sources makes it possible to reduce specific capital investments for installed capacity and operating costs, increase the reliability of power supply, ensure uninterrupted production and consumption of electricity, increase energy and environmental safety, and develop the local economy.

The main task at the stage of design of RES in autonomous power systems is to select the optimal type of renewable energy sources or combination thereof, by identifying patterns of changes in the quality indicators of the system depending on the conditions of use and ensuring its maximum efficiency on this basis.

The existing methods and software packages for the selection of elements and systems of autonomous power supply using RES take into account the main factors affecting the efficiency of systems, determine the quantitative and qualitative composition of equipment and ultimately lead them to cost indicators.

At the same time, in order to further improve the decision-making stage when choosing an autonomous renewable power supply system (RPSS), it is necessary to develop an effective, user-friendly methodology.

An effective tool for solving the problem of substantiating the zones of optimal application of various types of RPSS is a systematic approach based on the complexity of the analysis of the object and strict systematization of research. Its important concept is to consider a system not as a simple sum of elements, but on the basis of the principle of interconnection and interdependence of phenomena in them.

The system approach not only allows to analyze the object, but also to carry out synthesis, i.e. to find a system that is optimal for the given conditions.

The purpose of the dissertation research is to increase the efficiency of autonomous renewable power supply systems by choosing their optimal type for operating conditions in remote agricultural facilities.

Objectives of the study:

- to identify the factors affecting the quality of various types of RPSS and to substantiate the system of indicators characterizing their efficiency;

- to develop a method for optimizing the RPSS that allows to identify the patterns of achieving the highest efficiency by systems of various types;

- to substantiate and determine the zones of optimal use of various types of RPSS;

- to develop an algorithm and a calculation program on a PC, which allow to determine the optimal structure for the construction of autonomous RPSS, including remotely for a specific practical case;

- to develop scientifically based recommendations for the selection of optimal autonomous RPSS.

Research methods. The method of system analysis and synthesis, the method of functional and structural analysis of systems, the FAST method of functional analysis of technical systems, and the heuristic method are used in the work.

The main statements to be defended:

- an effective tool for searching for optimal autonomous RPSS is the method of a systematic approach, which allows to perform a comprehensive analysis of the object and strict systematization of studies;

- system analysis of the RPSS shows that its quality is characterized by single indicators of the probability of failure-free operation, efficiency and cost of system elements depending on the capacity of the consumer with the possibility of bringing them to the complex "efficiency-cost" indicator;

- synthesis of the RPSS structure showed that there are zones of optimal use of various types of RPSS and their combinations depending on natural and climatic conditions, energy parameters of facilities and operational parameters of systems;

- the developed algorithm and the calculation program make it possible to determine the optimal structure for the construction of autonomous RPSSs, including remotely, using the Internet, and have practical value.

Description of the main results of the study. Indicators of the efficiency of RPSS and RES elements as a whole were found on the basis of theoretical studies in a given power consumption range. The heuristic method has formed the objective function of the efficiency indicator. The functional organization of the RPSS has been estimated. Analytical expressions of the dependence of the probability of failure-free operation, efficiency and cost of system elements on power consumption have been found. The synthesis of the optimal RPSS depending on the operating conditions and power consumption has been carried out according to the "efficiency-cost" criterion, the integral quality indicator, the complex criterion of efficiency, particular indicators of quality and the cost of systems.

Substantiation of the novelty and importance of the results obtained:

- the developed methodology for multi-criteria optimization of the structure of autonomous RPSS of remote agricultural facilities, taking into account the limitations on the conditions of the system operation and power consumption;

- the substantiated composition of indicators characterizing the quality of RPSS, with the possibility of reducing several single indicators to a complex "efficiency-cost" indicator;

- analytical expressions of the dependence of the probability of failure-free operation, efficiency and cost of system elements on power consumption;

- zones of optimal use, obtained as a result of the synthesis of the structure of an autonomous RPSS depending on the operating conditions and power consumption according to the "efficiency-cost" criterion, integral quality indicator, complex criterion of efficiency, particular indicators of quality and cost of systems;

- th developed recommendations for the selection of the optimal RPSS for the conditions of Kazakhstan, algorithm and calculation program on a PC.

Description of the PhD student's contribution to the preparation of each publication. The PhD student conducted a literature review, together with co-authors, took a direct part in research, processing and analysis of the results obtained, designed publications and carried out organizational work with the editorial boards of publishing houses.

Structure and volume of the dissertation. The doctoral dissertation consists of an introduction, 4 chapters, a conclusion, a list of references, 4 appendices. The dissertation is presented on 93 pages of computer text, contains 8 tables, 34 figures, 28 pages of appendices and 101 titles of literary sources.