«A study of the reliability of a solar-wind power supply system»

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The widespread use of power converters of renewable energy sources (RES) is limited by the presence of a number of obstacles connected with economic, regulatory, technical, and geographical factors. At the same time, technical factors include issues of connection and operation of facilities based on RES. The latter is complicated by the fact that the experience of operating power supply systems for agricultural facilities, including rural residential buildings, in the Russian Federation is still insufficient. For this reason, the evaluation of the reliability of renewable electricity supply systems is problematic. And when deciding on the suitability of converters of renewable energy for power supply systems, the accurate evaluation of the reliability of power supply and the possibility of providing it in accordance with the reliability category are required.

The purpose of the work is to conduct a study on the reliability of a solar-wind system for the power supply of a dwelling house.

In order to achieve this goal, it is necessary to solve the following tasks:

- To analyse existing methods for the reliability evaluation.
- To simulate the operation of a solar-wind power supply system.
- To calculate the reliability parameters of a solar-wind power supply system.
Solution methods

A, I, F, C, W are failed elements; A', I', F', S', W' are elements under repair or exposed to diagnostics; Xo, Yo, Zo are failures of circuit breakers when a request for the actuation takes place; X, Y, Z are failures of circuit breakers; F is a failure of photovoltaic modules with a decrease in the intensity of the solar radiation flux; V is a failure of a wind power installation when the wind speed decreases.

Design model of a solar-wind power supply system

A is a rechargeable battery; I is an inverter; X, Y, Z are circuit breakers; F is a unit with photovoltaic modules; C is a controller; W is a wind power installation.

When analysing the power supply system, it is advisable to divide the events into two types: those that occur in the presence of the design density of the solar and wind energy flows and those that occur in the presence of the off-design one.

A failure tree (the sufficient solar and wind energy intensity)

A failure tree (the insufficient solar and wind energy intensity)
Conclusions

Results, implementation

• It is preferably to conduct a study of the reliability of a solar-wind power supply system using a logical-probabilistic method by constructing a fault tree. This approach allows taking into account events that may cause a power supply system failure, including failures of its individual elements. The fault tree was obtained by sequential detailing the events related to the failures of the power supply system and its elements.

• A study of the reliability of the power supply system of a residential house for the climatic conditions of the Republic of Mari El was conducted. The total probability of failures was $69.32 \cdot 10^{-8}$. 
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