

NATIONAL ECONOMICS AND MANAGEMENT

Lilija Nakashidze,

D.Sc. (Technical Sciences), senior scientific researcher

Tetiana Hilorme,

Ph.D. (Economical sciences), Associate Professor

Oles Honchar Dnipro national university, Ukraine

Iryna Nakashydz

Ph.D. (Philological sciences)

Dnipro national university of railway transport

named after academician V. Lazaryan, Ukraine

PECULIARITIES OF CONSTRUCTION OF AIR-CONDITIONING SYSTEMS ON THE BASIS OF USE OF RENEWABLE ENERGY SOURCES

Abstract. *Paper presents the developed method of calculating the energy efficiency of the application of different systems of providing climatic conditions in the premises based on the use of the energy of the Sun and the environment. It is advisable to use performance indicators for generating each of the elements of the system.*

Keywords: *renewable energy sources, air-conditioning system, RES converters, solar radiation, heat pump.*

The use of energy efficient climate systems in facilities based on the use of renewable energy is intended to reduce the consumption of energy resources, which contributes to the implementation of the strategy of energy conservation and sustainable development. The introduction of such an innovation (Lyashkov, V.I. (2005), Nakashidze, L.V. (2014), Renewable energy technologies: cost analysis series: Renewable Power Generation Costs. IRENA Secretariat (2012)) allows:

- increase the thermal efficiency of the base fence of the building;
- to improve the thermal comfort of the premises;
- to increase the level of regulation of heating systems and heat supply of buildings;
- to increase the efficiency of heat supply systems, including the use of decentralized heat supply, etc.

Designing and creating efficient energy systems provided for the use of renewable energy is a multifactorial task. One of the major problems of such innovative power plants is the identification of the features of the interfacial and interchangeability of its basic structural elements.

Energy supply systems that utilize solar radiation, the heat of ventilation emissions, and other renewable energy sources are multicomponent and technically complex in an integrated manner. These energy systems are an aggregate of a number of subsystems and elements. At the same time there is interaction at different levels, that is, between individual elements and subsystems, as well as with the environment. Therefore, when designing these energy systems, it is proposed to use an approach that involves hierarchical decomposition.

According to (Saaty, T. I. (1990)), the following steps are envisaged for the projected system:

- decomposition of the task of designing the air-conditioning and energy supply system, which uses renewable energy as the energy carrier. The key is to determine the main criteria for evaluating the performance of such a system;
- sequential aggregation of systems, which are presented in the form of models of objects of design and models of functioning of complex system of energy supply at decomposition; creation of a hierarchy that reflects the structure of the air-conditioning system and the energy supply, the process of its functioning;
- construction of a hierarchical structure of the problems of designing the air-conditioning system and energy supply on the basis of a hierarchy of its description;
- development of iterative procedures for verification and refinement of solutions obtained at different hierarchical levels of solving the problem of designing air-conditioning and energy supply systems, which include RES converters, heat pumps, heat accumulators, etc.

The difficulties associated with the development of the above procedures are due to the need to take into account the large amount of information, relationships that arise between the components of the air-conditioning system and the energy supply of the building, i.e. engineering systems, structures of the structure (Nakashidze. L.V. (2013), Nakashidze L.V., Gabrinets V.A., Trofimenko A.V. (2015)).

For example, it is important to determine the mechanisms for redistribution of energy flows and their correction for renewable energy converters that are part of the energy supply system as an element of the conversion of energy from solar radiation.

In order to assess the completeness of the use of the components of the climate system in the premises based on the use of RES, it is proposed to use the interconnections that occur during the operation of the air-conditioning and energy systems. These interconnections are defined by (Nakashidze, L.V., Nakashidze, I. S. & Brynin, Y. S. (2018)):

- objective operating conditions (solar insolation level, ambient temperature, wind speed, etc.);
- normative indicators for thermal energy (hot water temperature, heating system temperature, coolant temperature, etc.) that are controlled by the user.

According to the proposed methodological approach, it is envisaged to make a hierarchical decomposition to the level of interconnections that occur in the elements of the climate system in premises based on the use of RES (Renewable energy technologies: cost analysis series: Renewable Power Generation Costs. IRENA Secretariat (2012)). For example, the definition of energy fluxes that occur when solar radiation is received by a RES converter.

The appropriate choice of design solutions is made on the basis of the general measure of technical adaptation of the constituent elements ((Nakashidze. L.V. (2013), Nakashidze L.V., Gabrinets V.A., Trofimenko A.V. (2015))) (for example, RES converter, heat pump, heat accumulator) to the operation in the general system of providing climatic conditions (Gil'orme, T., Ryzhyk, Y., & Yaresko, A. (2016), Nakashidze, L.V., Nakashidze, I. S. & Brynin, Y. S. (2018)) in premises based on the use of RES at different conditions.

When predicting the composition and layout of a climate system in a facility based on the use of renewable energy, it is advisable to use indicators of the

efficiency of generating each of the elements. This indicator is additive. For example, if the capacity of a climate system in RES-based premises is taken as an indicator of generation efficiency, it consists of:

- RES converters (the main element of the transformation of solar radiation into thermal energy);
- heat pump (the main element of environmental energy conversion);
- heat accumulator (accumulation and redistribution of received energy), etc.

The efficiency of the air-conditioning and energy supply system, which is a complex technical system for efficient use during the year (cold season, warm season and transition period), is calculated based on the characteristics of its subsystems listed above.

As an example of such characteristics can be the efficiency of conversion of solar radiation by RES converters, the degree of conversion of the heat pump, etc.

Thus, the methodology is based on the fact that when designing an air-conditioning and energy system:

- functional connections are established taking into account its purpose;
- distinguished basic groups of dependencies that reflect its properties (characteristics).

Based on the use of hierarchical decomposition technique, a number of schematic solutions of the systems of providing climatic conditions in the premises based on the use of the energy of the Sun and the environment have been formed.

Indoor climate systems based on renewable energy use have the following common features:

- 'mechanical' connection to the objects of traditional architecture of elements intended for use of alternative energy sources (solar collectors, photovoltaic batteries, etc.) leads to the fact that the functionality of the energy supply systems is not realized enough, the load on the structure increases, the architecture of buildings is changed is not always successful;
- the need for an individual approach to design and design solutions complicates the large-scale implementation of such energy systems.

Combining heat pumps and RES converters with other components of the air-conditioning and energy systems while using multiple sources of renewable energy and environmental heat extends the potential of such systems. The combination of alternative energy sources has certain features, in the determination of which it is necessary to:

- take into account the interdependent requirements that determine the nature and quality of the functioning of energy supply systems;
- carry out a structural analysis of energy supply systems to reveal the nature of interconnections and the purpose of each of its subsystems;
- explore the features of controls and feedback mechanisms;
- determine the degree of impact on the energy systems of operating conditions to improve the reliability and energy efficiency of the whole system;
- define algorithms of functioning of subsystems of the power supply system taking into account their interaction.

This allows to predict during design such a set of three-dimensional architectural and engineering solutions, which are the result of scientific methods

defined by a set of technical solutions that meet the objectives of minimizing energy consumption for the needs of the object of placement of the energy supply system.

The peculiarities of combining the components of climate systems in the premises based on the use of solar energy and the environment are determined by:

- specifics of the object of accommodation of the air-conditioning and energy supply system, ie requirements for the quality of thermal and electric energy, type and parameters of load, requirements for the energy supply schedule;
- economic, environmental, architectural, social and other limits;
- climatic and landscape characteristics of the region of location of the energy supply system;
- the level of provision of traditional and unconventional energy sources, taking into account their potential;
- features of the interplay of individual components of the energy supply system.

Air-conditioning and power supply systems with RES converters, heat pumps, heat accumulators and other structural elements must be multifunctional, i.e. the positive features of the individual elements must be mutually complementary and interconnected. Mutual adaptation of constituent elements when changing external and internal conditions is achieved through:

- equipping power supply systems with adaptive-modular components, which are characterized by possible variants of the ratio of the number of different types of power grid elements and the interconnections between them;
- the possibility of flexible group construction and restructuring of different types of components, the description of which requires the creation of space-time and combinatorial model of the system;
- the ability to use flexible control algorithms.

Indoor climate systems based on the use of solar energy and the environment with a coolant are classified according to the following characteristics:

- by destination - hot water systems, heating and combined (heat supply systems);
- by time work during the year - seasonal and year-round;
- by terms of coverage of consumers - individual, group, centralized;
- by the nature of the movement of the coolant - without circulation, with natural or forced circulation;
- by the number of contours - single, double and multi-contour;
- by the mode of heat extraction with constant or variable temperature of the coolant;
- by existence of a duplicate energy source - with or without backup.

Combined air-conditioning and energy systems have more complex schemes than others. Based on the fact that energy must be perceived and converted into thermal energy, accumulated and transmitted to the consumer, the common components of the systems are energy receivers and accumulators, circulation pumps or fans and heat exchangers. The features of circuit diagrams depend on the structure of the storage tanks (open or closed selection of coolant), the type of storage tank (combined with a heat exchanger or used coil heater), the location of the battery system and duplicate sources, as well as from many other factors. Energy efficiency

is largely determined by the efficiency of its receiver. RES converters, which combine both fencing and receiver functions, are the defining element of the developed circuit solutions for energy systems using solar energy and environmental energy. Low-potential environmental heat is utilized through a thermodynamic cycle of heat pumps with the appropriate arrangement of equipment.

The method of calculation of energy efficiency of application of different systems of providing of climatic conditions in premises on the basis of use of energy of the Sun and the environment is developed.

On the basis of the experimental data obtained during the operation of the air-conditioning and energy supply system, the efficiency of the use of different types of renewable energy sources is shown, and the possibility of reducing by 65 ... 70% of the total heat load in the home air-conditioning.

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