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ASSESSMENT OF ENERGY EFFICIENCY BUILDINGS OF HEALTH CARE INSTITUTIONS OF THE CITY OF ODESA CERTIFIED IN 2025

Abstract. *The purpose of the study is to assess the state of energy efficiency of health care facilities and classify recommended measures for modernization and increasing the level of energy efficiency. A statistical analysis of 17 energy certificates of buildings of health care facilities in the city of Odesa, entered into the register of USESFC in 2025, was performed. Quantitative and percentage processing of data on energy efficiency classes, periods of operation and surface area of buildings was carried out with the help of a Microsoft Excel spreadsheet. The study revealed the unsatisfactory condition of the enclosing structures, in particular, the indicators of the heat transfer resistance of the walls, ceilings and coatings are only 20.3...41.2 % of the normatively permissible. The structure of actual annual energy consumption was established: heating (51 %), hot water supply (27 %), lighting (11 %), cooling (8 %), ventilation (3 %). The analysis of the specific consumption of primary energy and emissions of greenhouse gases confirms the low energy independence of the fund, the excess of the specific consumption of primary energy over the specific energy consumption is 27.3 %. Significant exceeding of the limit levels of energy consumption during heating and cooling by 3 times of the limit value was revealed. A classification of recommended measures for modernization and improvement of the level of energy efficiency will be given. We see prospects in the need for a systematic transition to the nZEB and ZEB standards, the introduction of individual heat points and online monitoring.*
Key words: buildings of medical institutions, information on energy consumption of buildings, energy certification, energy efficiency, primary energy.

Statement of the problem. Over the past five years, the construction sector has undergone a fundamental paradigmatic transformation, transforming from a passive consumer of resources to an active element of an intelligent energy system. Global challenges caused by climate change, energy crisis and geopolitical instability, especially in the context of military aggression against Ukraine, forced the scientific and engineering community to rethink approaches to thermal modernization and building management [1]. In the period from 2020 to 2025, the emphasis shifted from simple insulation measures to comprehensive digitalization and consideration of the carbon footprint throughout the entire life cycle of the facility, which is reflected in the updated directives of the European Union and national recovery strategies of Ukraine [2]. The construction industry significantly affects global warming, but the lack of accurate data inhibits the implementation of effective countermeasures [3]. The main share of energy consumption is accounted for by heating and climate systems (HVAC). To improve the situation, it is necessary

to stimulate energy-efficient modernization, develop «green» electricity and ensure international support for the introduction of construction technologies that do not harm the environment.

Analysis of the latest research. In Ukraine, the reform of the health care system continues, the main goal of which is to provide citizens of Ukraine with equal access to quality medical services, as a result of changes in the orientation of the system so that the patient is at the center of it [4]. The design and construction of health care facilities should be carried out on the basis of an analysis of the demand for medical services for the population of the relevant territorial community, on the territory of which the construction/reconstruction of health care facilities is planned [4].

The article [5] examines the classifications of medical institutions in Ukraine and in foreign countries, emphasizes the dependence of the design of the architectural and planning organization of health care institutions on the purpose, scope of application and type of medical institution.

The study [6] justified the new requirements for the infrastructure and management of a health care institution in the conditions of martial law and the post-war period in order to ensure its following properties: safety, adaptability and sustainability. It was established that the process of post-war reconstruction of the health care system should guarantee a new vision of the activities of health care institutions. Accordingly, a set of tools that should ensure physical (power), information, food and energy security of a health care facility is defined.

The conducted study [7] of the basic principles of architectural planning of medical institutions allows us to single out three main mandatory principles of designing health care institutions: flexibility, integration and inclusiveness. The specified principles reflect modern trends in the development of medicine (adaptability to transformations, patient orientation, comprehensiveness in the provision of medical services) and ensure the effectiveness of the future functioning of a medical institution designed with a specific consideration in mind. At the same time, each project is an independent and unique architectural solution of a health care facility building.

Modern design and construction solutions often combine residential and non-residential premises in one building volume, harmonizing their joint functioning with non-standard solutions for typical construction. The authors of the article [8] note that the shortage of land plots for the construction of dispensaries in a separate building leads to the fact that built-in health care facilities have become widespread and are located mainly in non-residential premises of residential buildings (1st, 2nd and basement floors), which is an element of hybrid construction.

Today, energy certification of buildings is not just a technical procedure for evaluating enclosing structures or engineering systems, but a central element of a global strategy for decarbonization and ensuring energy independence. In a world where the building sector is responsible for 40 % of total energy consumption and 36 % of energy-related greenhouse gas emissions, the transformation of the existing stock and the transition to zero emissions become an existential issue for modern civilization [9, 10].

Basic information on the state of energy efficiency of buildings in the EU is contained in EPC certificates [10]. The creation of such certificates is always a compromise between the cost of verification and the accuracy of the results. If it is impossible to get accurate data about the walls or roof without significant costs, experts use standard government indicators.

According to clause 17.1 [11], health care facilities must be designed, built and equipped in such a way as to ensure the rational use of energy resources, the durability of enclosing structures during operation and the fulfillment of the main requirement for energy saving and energy efficiency.

According to clause 17.3 [11], health care buildings during new construction should be designed with an energy efficiency class not lower than that established in the order [12]. According to clause 3.4 of the appendix to the order [12], the limit value of the specific energy consumption of buildings of health care facilities for heating and cooling (EP_p), for the temperature zone of Ukraine: I – EP_p = 30 kWh/m^3; II – EP_p = 26 kWh/m^3.

According to clause 17.2 [11], the design of health care facilities in terms of energy efficiency indicators of buildings, heat technical indicators of enclosing structures (thermal insulation shell) is carried out in accordance with BC B.2.6-31:2021 [13].

The purpose of the work. Assessment of the state of energy efficiency of buildings of health

care institutions in the city of Odesa certified in 2025 and development of recommended measures to modernize and increase the level of energy efficiency of these buildings.

Research methodology. Ensuring the transparency of certification processes in Ukraine is implemented through the operation of the Unified State Electronic System in the Field of Construction (USESFC). This nationwide information platform is aimed at streamlining construction activities and leveling corruption factors by ensuring maximum publicity of data. The functionality of the USESFC covers the entire life cycle of the construction object: from the stage of obtaining town planning conditions and restrictions to the moment of commissioning. It is assumed that the consolidation and standardization of information from differentiated sources will be achieved through the generation of basic documentation directly within the System by relevant entities.

The Public Portal of the Unified System is its open component, which aims to provide unimpeded and free access to verified information for all categories of users. At the current stage of development, the Portal offers tools for precise data search with the possibility of their spatial visualization on a digital map, as well as basic modules for analytical processing. In addition, the platform offers online services adapted to the needs of both professional and novice users. The expansion of the Portal's functionality takes place iteratively, in accordance with the pace of modernization of the USESFC.

According to the regulatory requirements, from December 1, 2020, energy auditors are required to register the issued energy certificates in the specified system. This ensures the formation of a unified database of energy efficiency indicators of buildings at the state level.

An important detail is that the certificate is an extract from an energy audit report and is valid for 10 years. The certificate shows the energy efficiency class, construction information, geometric characteristics, description of engineering systems and, most importantly for existing buildings, recommendations for improving efficiency, which must be technically and economically justified.

The technical foundation of certification is provided by the norms of BC B.2.6-31:2021 "Thermal insulation and energy efficiency of buildings" [13], which came into force in September 2022. These norms significantly strengthened the requirements for heat transfer resistance of enclosing structures compared to the previous edition of 2016.

The standard DSTU 9190:2022 «Energy efficiency of buildings. The method of calculating energy consumption during heating, cooling, ventilation, lighting and hot water supply» [14], which is based on ISO 52000 modular standards. The calculation is made taking into account the climatic zones of Ukraine (I zone – north and center, II zone – south) and is based on the energy balance of the building.

Classification is carried out by comparing the calculated values of specific energy consumption with the limit values established in BC B.2.6-31:2021 [13]. The class scale is visualized in the certificate similarly to the European model. Today, Class C is considered the minimum acceptable for new buildings, while the move to nZEB will effectively require projects to comply with Class A or B.

Research results. Within the framework of the study, 17 Energy Certificates of buildings of health care institutions of the city of Odesa certified in 2025 were analyzed with the help of the USESFC [15]. Microsoft Excel spreadsheet was used for statistical data processing. On the basis of the obtained arrays of information, diagrams illustrating the nature of correlations and functional dependencies between the key parameters of the studied objects were constructed.

For the informativeness of the research, three-dimensional sector diagrams are provided based on the data of 17 energy certificates of buildings of health care institutions in the city of Odesa certified in 2025: classes of energy efficiency (Figure 1), periods of the start of operation (Figure 2) and number of floors (Figure 3), which shows the contribution of each value to the total amount in volume by quantitative and percentage ratio.

The analysis of the reduced heat transfer resistance of the enclosing structures according to their type (Figure 4) shows that the state of energy efficiency of these structures is unsatisfactory (according to the percentage ratio of the actual average to the minimum permissible values determined by the results of certification): external walls (39.7 %), combined coverings (41.2 %), covering of heated attics or technical floors (30.7 %), attic floors of unheated attics (26.9 %), ceilings over unheated basements (20.3 %), translucent structures (74.3 %), external doors (85 %).

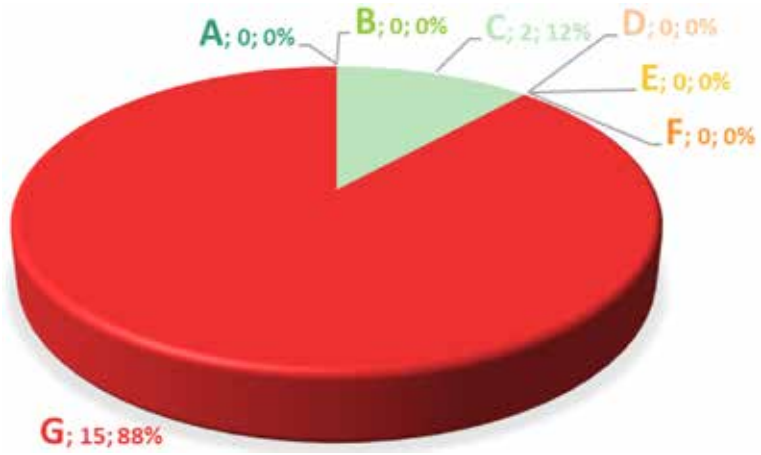

Fig. 1. Volumetric sector diagram of energy efficiency classes (A, B, C, D, E, F, G) of buildings of health care institutions of the city of Odesa certified in 2025: quantitative value (pcs) and percentage ratio

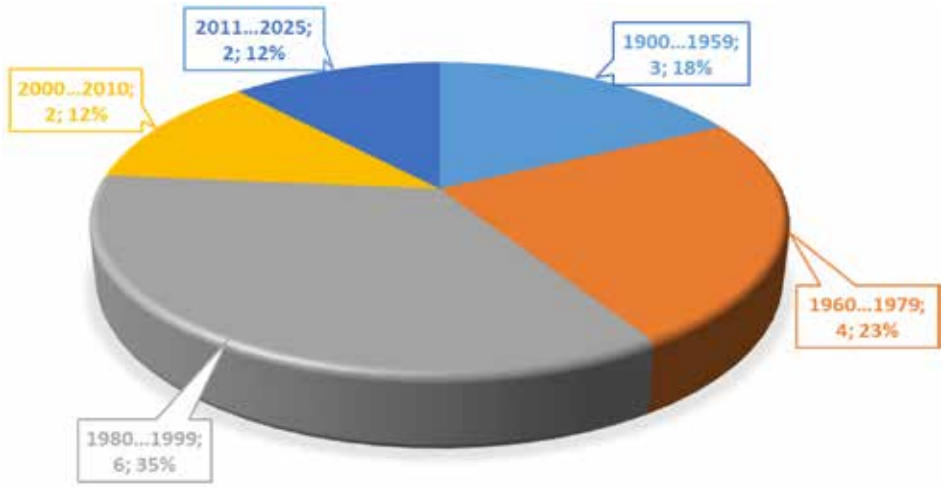

Fig. 2. Volumetric sector diagram of the periods of the start of operation (1900...2025) of buildings of health care institutions of the city of Odesa certified in 2025: quantitative value (pieces) and percentage ratio

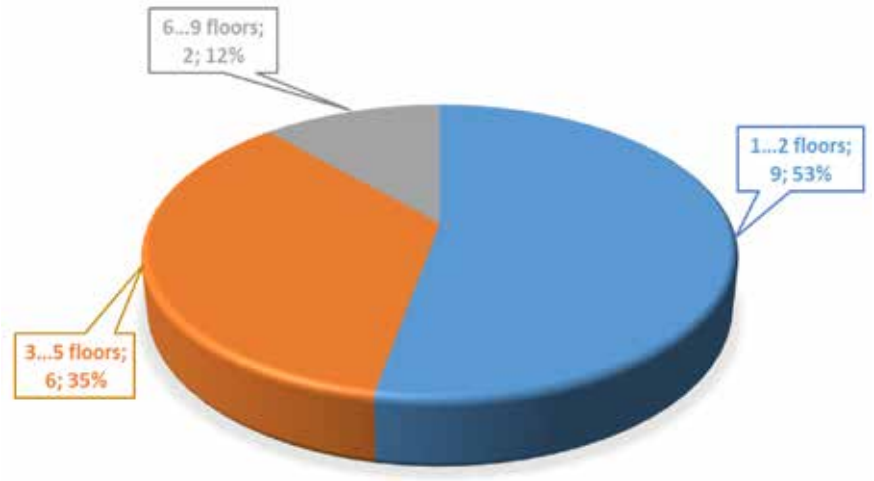

Fig. 3. Volumetric sector diagram of the number of floors (1...9 floors) of buildings of health care institutions in the city of Odesa certified in 2025 (by three groups): quantitative value (units) and percentage ratio

The analysis of the annual energy consumption of buildings of health care institutions in the city of Odesa certified in 2025 (Figure 5) shows the state of the actual energy consumption of these buildings (according to the average value of the quantitative and percentage ratio determined by the certification results): energy consumption during heating (63.2 kWh/m^3; 51 %), energy consumption during cooling (10.2 kWh/m^3; 8 %), energy consumption for hot water supply (33.8 kWh/m^3; 27 %), energy consumption for ventilation (3.8 kWh/m^3; 3 %), energy consumption for lighting (13.9 kWh/m^3; 11 %).

The analysis of the annual energy efficiency indicators of the buildings of health care institutions of the city of Odesa certified in 2025 (table 1 and figure 6) shows the state of the actual level of energy efficiency of these buildings (according to the average value of the quantitative indicators determined by the results of certification): specific energy consumption (61.83 kWh/m^3), specific energy consumption for heating and cooling (78.71 kWh/m^3), specific primary energy consumption (252.13 kWh/m^3), specific greenhouse gas emissions (112.63 kg/m^2). It should be noted that the excess of the specific

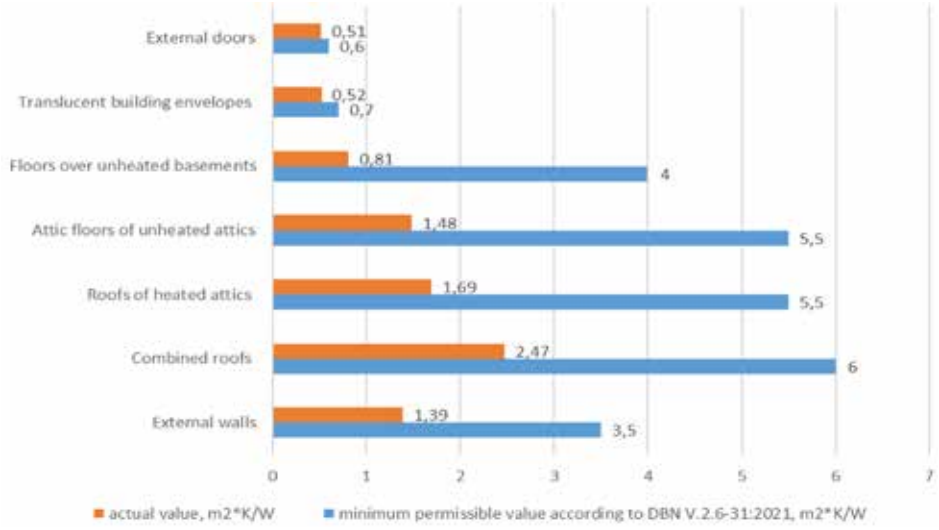

Fig. 4. Linear histogram of the comparison of the averaged value of the reduced heat transfer resistance of the enclosing structure of buildings of health care institutions of the city of Odesa certified in 2025: actual and minimum permissible value

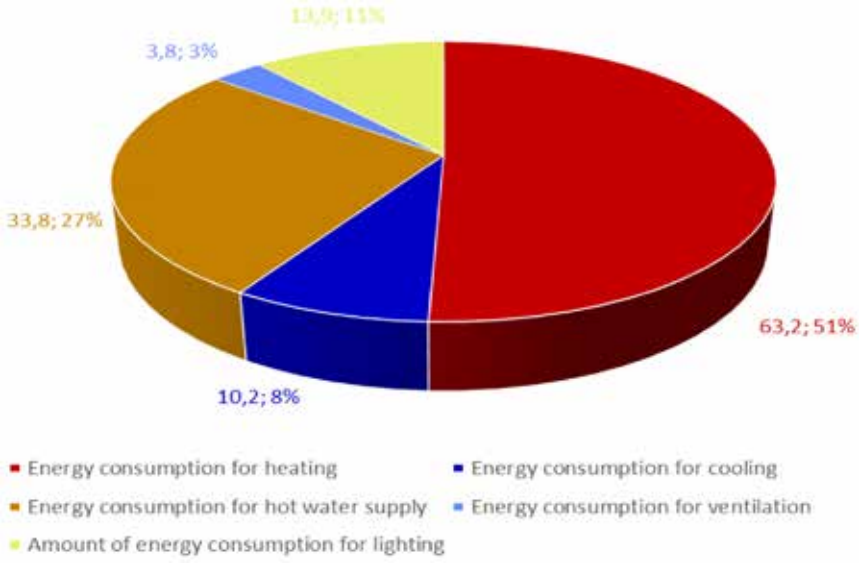

Fig. 5. Volumetric pie chart of the average annual energy consumption of buildings of health care institutions in the city of Odesa certified in 2025: quantitative value (kWh/m^3) and percentage ratio

Table 1. Annual average indicators of energy efficiency of buildings of health care institutions of the city of Odesa certified in 2025

The name of the indicator energy efficiency	Determined by the results of certification	Borderline value [12]
Specific energy consumption, kWh/m^3	61,83	not established
Specific energy consumption during heating and cooling, kWh/m^3	78,71	26
Specific consumption of primary energy, kWh/m^3	252,13	not established
Specific emissions of greenhouse gases, kg/m^2	112,63	not established

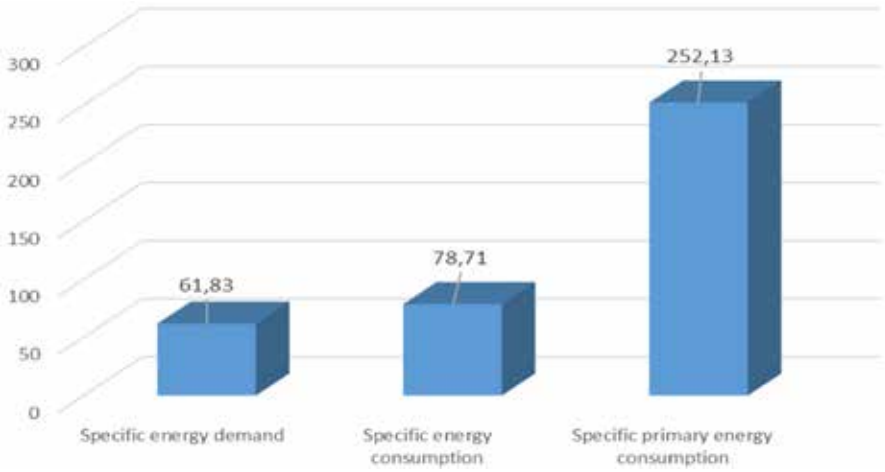

Fig. 6. Volumetric bar chart of the average value of annual energy efficiency indicators (kWh/m^3) of buildings of health care institutions in the city of Odesa certified in 2025

consumption of primary energy over the specific energy consumption is 27.3 %, which is very large. Significant exceeding of the maximum levels of energy consumption during heating and cooling by 3 times of the maximum value (exceedance of 302.7 %) was revealed.

In each of the 17 Energy Certificates of buildings of health care institutions of the city of Odesa certified in 2025, recommended measures for modernization and increasing the level of energy efficiency are given. We have classified them into the following categories:

1) *prevention of heat loss through the structure of the building*: application of an additional layer of insulating material on the external walls, replacement of windows and entrance doors, insulation of the attic and basement floor, reduction of infiltration due to sealing of seams and sealing of window and door structures;

2) *prevention of losses in heating and hot water supply systems in non-conditioned areas of the building*: insulation and reduction of the length and size of the heating network, replacement of existing ones with more efficient systems;

3) *heat is supplied without the necessary adjustment for heat input*: installation of weather-dependent automation at the entrance to the building or on boilers, installation of thermostatic valves on all radiators, installation of a temperature control system in the room to adjust heat supply based on real demand;

4) *prevention of losses through the ventilation system*: ventilation is provided naturally and is not controlled in any way, and uncontrolled ventilation is one of the main sources of energy losses.

Conclusions. The energy audit of buildings has been transformed from a reference document into an element of a global security strategy. For the Ukrainian context, this issue has three critical aspects: economic (minimization of state subsidies and population accounts), security (strengthening of the state's energy autonomy), and environmental (compliance with international climate obligations). A study of energy efficiency indicators was carried out according to 17 Energy Certificates of buildings of health care institutions of the city of Odesa

certified in 2025 using the Energy Efficiency register on the portal of the Unified State Electronic System in the Field of Construction (USESFC). Microsoft Excel spreadsheet was used for statistical data processing.

The analysis of the reduced heat transfer resistance of the enclosing structures showed that the state of energy efficiency of these structures is unsatisfactory, in particular, the enclosing structures cover only a part of the minimum permissible: external walls (39.7 %), combined coverings (41.2 %), covering of heated attics or technical floors (30.7 %), attic ceilings of unheated attics (26.9 %), ceilings over unheated basements (20.3 %), transparent structures (74.3 %), external doors (85 %).

The analysis of annual energy consumption showed the state of actual energy consumption of these buildings: energy consumption during heating (63.2 kWh/m^3; 51 %), energy consumption during cooling (10.2 kWh/m^3; 8 %), energy consumption during hot water supply (33.8 kWh/m^3; 27 %), energy consumption during ventilation (3.8 kWh/m^3; 3 %), energy consumption during lighting (13.9 kWh/m^3; 11 %).

The analysis of annual energy efficiency indicators showed the state of the actual level of energy efficiency of these buildings: specific energy consumption (61.83 kWh/m^3), specific energy consumption for heating and cooling (78.71 kWh/m^3), specific primary energy consumption (252.13 kWh/m^3), specific greenhouse gas emissions (112.63 kg/m^2).

Particular attention should be paid to the prompt reduction of energy consumption through the installation of individual heat points and the implementation of online monitoring systems. Obtaining an energy certificate is only the first step towards rational operation of health care buildings.

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ОЦІНКА ЕНЕРГОЕФЕКТИВНОСТІ БУДІВЕЛЬ ЗАКЛАДІВ ОХОРОНИ ЗДОРОВ'Я МІСТА ОДЕСИ СЕРТИФІКОВАНИХ У 2025 РОЦІ

Анотація. *Метою дослідження є оцінка стану енергоефективності будівель закладів охорони здоров'я та класифікація рекомендованих заходів з модернізації й підвищення рівня енергетичної ефективності. Виконано статистичний аналіз 17 енергетичних сертифікатів будівель закладів охорони здоров'я міста Одеси, внесених до реєстру ЄДЕССБ у 2025 році. За допомогою табличного процесора Microsoft Excel проведено кількісну та відсоткову обробку даних щодо класів енергоефективності, періодів експлуатації та поверховості будівель. Дослідження виявило незадовільний стан огороджувальних конструкцій, зокрема показники*

опору теплопередачі стін, перекриттів та покриттів становлять лише 20,3...41,2 % від нормативно допустимих. Встановлено структуру фактичного річного енергоспоживання: опалення (51 %), гарячого водопостачання (27 %), освітлення (11 %), охолодження (8 %), вентиляції (3 %). Аналіз питомого споживання первинної енергії та викидів парникових газів підтверджує низьку енергонезалежність фонду, перевищення питомого споживання первинної енергії над питомим енергоспоживанням складає 27,3 %. Виявлено значне перевищення граничних рівнів енергоспоживання при опаленні та охолодженні у 3 рази від граничного значення. Наведена класифікація рекомендованих заходів з модернізації та підвищення рівня енергетичної ефективності. Перспективи вбачаємо в необхідності системного переходу до стандартів nZEB та ZEB, впровадження індивідуальних теплових пунктів та онлайн-моніторингу.

Ключові слова: будівлі медичних закладів, інформація про енергоспоживання будівель, енергетична сертифікація, енергетична ефективність, первинна енергія.

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