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IMPLEMENTING BEST PRACTICES FOR IMPROVING ENERGY EFFICIENCY IN UNIVERSITIES

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BACKGROUND AND OBJECTIVES. Determining the direction of energy saving development is a significant aspect and is present in the policy of rational use of energy resources of leading countries, in most cases it affects the direct consumer and producer of energy, as well as administrative measures. Implementation of best practices of energy efficiency of all types of activities is a tool to improve energy autonomy of universities in Ukraine.

METHODS. The study used: the predictive method – to determine the progress of implementation of EU Directive 2012/27/EC in Ukraine; method of comparative analysis – to determine the optimal mechanisms to promote energy efficiency in different countries and the possibility of implementing this experience to create a system of energy efficiency in Ukrainian universities.

FINDINGS. Using and expanding the experience of participation in the project to provide energy efficient and comfortable conditions of study in Ukrainian universities together with the European Investment Bank and the Nordic Environment Corporation will allow to upgrade 200 teaching, research and support facilities in 21 universities to improve the energy efficiency of buildings and reduce operating costs of public higher education institutions; quality of teaching, learning, teaching, research and residential buildings. Implementation of such experience will improve the energy efficiency of universities, optimize mechanisms for state regulation, control and stimulation of energy efficiency; solve problems and expand the power of executive authorities and local governments, energy autonomy of universities.

CONCLUSION. The analysis of the successes and difficulties of higher professional education for people with disabilities shows that there is an objective need to consolidate the efforts of the higher education community with regional public organizations, executive authorities, regional and city institutions of health, education and social protection to support young people with disabilities.

KEYWORDS: energy efficiency; higher education institutions; universities; energy autonomy.

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
10	1	1

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ІМПЛЕМЕНТАЦІЯ НАЙКРАЩОГО ДОСВІДУ ПІДВИЩЕННЯ ЕНЕРГОЕФЕКТИВНОСТІ УНІВЕРСИТЕТІВ

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ПОСТАНОВКА ПРОБЛЕМИ ТА ЗАВДАННЯ. Визначення напряму розвитку енергозбереження є значним аспектом у політиці раціонального використання енергетичних ресурсів провідних країн. У більшості випадків це стосується як безпосереднього споживача та виробника енергії, так і заходів адміністративного впливу. Імплементація передового досвіду енергоефективності всіх видів діяльності є інструментом підвищення енергоавтономності університетів України.

МЕТОДИ. У дослідженні було використано: прогнозний метод – для визначення прогресу імплементації Директиви ЄС 2012/27/ЄС в Україні; метод порівняльного аналізу – для визначення оптимальних механізмів стимулювання енергозбереження у різних країнах та можливості імплементації цього досвіду для створення системи енергоефективності в українських університетах.

РЕЗУЛЬТАТИ. Врахування споживання енергоресурсів в українських університетах є обов'язковою умовою успішного впровадження реформи енергоефективності. Дані з урахуванням обліку енергії є базою реалізації енергоаудиту, впровадження систем енергоменеджменту, розробки проектів енергоефективності, аналізу результатів як окремих проектів, і реформи загалом. Також облік енергії створює стимули для ключових суб'єктів до економного та ефективного споживання, транспортування та виробництва енергії.

ВИСНОВКИ. Використання та розширення досвіду участі у проекті забезпечення енергозберігаючих та комфортних умов навчання в університетах України спільно з Європейським інвестиційним банком та Північною екологічною корпорацією дозволить оновити 200 навчальних, дослідницьких та допоміжних споруд у 21 університеті для покращення енергоефективності будівель та зменшення експлуатаційних витрат державних установ; якості викладання, навчання, навчальних, науково-дослідних та житлових будівель. Імплементація такого досвіду дозволить підвищити енергоефективність університетів, оптимізувати механізми державного регулювання, контролю та стимулювання енергоефективності; вирішити завдання та розширити повноваження органів виконавчої влади та органів місцевого самоврядування, енергоавтономію університетів.

КЛЮЧОВІ СЛОВА: енергоефективність; вищі навчальні заклади; університети; енергоавтономія.

INTRODUCTION.

Energy efficiency and energy saving are among the five strategic priorities of the country's economic modernization (Di Stefano, 2000). Ukraine has undertaken a number of international obligations to implement energy efficiency reforms by signing the Association Agreement with the European Union (EU), becoming a member of the Energy Community and joining the concept and goals of sustainable development of the United Nations (UN) (Gryshchenko et al., 2017). The basis for the creation of the energy efficiency system is the transposition of EU Directives, in particular Directive 2012/27/EC and Directive 2010/31/EC (Kaplun and Shcherbak, 2016). In order to achieve the maximum effect of the reform in each area of energy efficiency (buildings, transport, industry and energy supply) the preconditions for effective relations in the industry must be created, the development and adoption of legislation (Liu et al., 2019), tools and support mechanisms must be created. Large-scale implementation of energy efficiency requires not only technological, organizational and financial components of project implementation (Shaposhnikova, Shimov, 2016), but also a balanced and transparent system of relations between the key actors of the energy market (Shcherbak et al., 2019). Consequently, it is critical to ensure commercial accounting, modern energy management systems, professional market of energy auditors and communication campaigns to promote energy efficiency (Vieira et al., 2020).

The purpose of the study is to propose a mechanism for implementing best practices to improve the energy efficiency of universities. The study was conducted in 2021 on the basis of data from Kyiv National University of Technologies and Design (KNUTD).

RESULTS AND DISCUSSION.

One of the weaknesses of the Ukrainian energy sector is an underdeveloped industry of energy saving technologies and insufficient demand for these technologies, energy saving has not yet become a norm of life. Due to high electricity prices, the population of most western countries has a higher economic motivation to save energy resources than the population of Ukraine. Public policies of foreign countries apply quite a large list of economic incentives for their population (Nikolaieva, 2018). Some examples are presented in Table 1.

Currently, Ukraine is taking actions to organize cooperation with foreign countries in the field of energy efficiency. The key areas of cooperation between Ukraine and the EU in the field of energy efficiency can be (On energy saving: Law of Ukraine, 2021): the promotion of measures to ensure a favorable investment environment for cooperation between Ukraine and the EU in the field of energy efficiency; identification of best international practices in energy conservation and energy efficiency; improvement of training in energy conservation and energy efficiency; the selection, launch and maintenance of

specific energy efficiency projects; work of Ukraine and the EU in the field of synchronized. To date, the following results have been achieved by implementing the state program "Energy saving and energy efficiency for the period up to 2030": preparation of a regulatory framework in the field of energy efficiency; creation and launch of a system of state support measures for energy saving and energy efficiency; pilot training courses for state and municipal officials on energy management (Shcherbak et al., 2019). As foreign experience shows, in order to achieve the national goal to improve energy saving and energy efficiency, one of the priority areas should be the formation of a lean energy efficiency model.

Table 1

Analysis of incentive mechanisms for energy saving in different countries and their results

Country	Incentive mechanism	Result
Denmark	Centralization of heat supply systems	Primary fuel costs in the country have halved
	State subsidies in the amount of 30% of the cost of the construction of solar collector systems, installation of wind turbines and biomass boilers	Increased demand for renewable energy sources (RES)
Germany	When installing a wind turbine the owner receives from the state treasury 5 thousand euros.	
	Preferential crediting for construction or implementation of RES. The grid company is obliged by law to accept all energy generated by RES	
	Full or partial tax exemption for manufacturers of energy efficient technologies and equipment	Low cost of energy-efficient products
	For owners of dwelling houses who are planning to reconstruct their houses in order to increase their heating and technical characteristics, the tax burden is reduced by 20%.	Active participation of the private sector of economy in implementation of energy saving measures
	When installing a meter, the consumer is entitled to compensation from the budget in the amount of 50% of the costs actually incurred for the installation of the meter	
France	Tax deductions of 40% apply to owners who insulate houses commissioned before 1977	
	The cost of purchasing energy efficient equipment is tax deductible for citizens	High demand for energy efficient products
	The more efficient the electrical equipment is, the lower the electricity bill	
USA	Preferential energy bill rates for energy efficient buildings	Incentives to invest into building of energy efficient houses
	State subsidies of $50 to $200 when purchasing new, more energy-efficient appliances	Population switching to more energy efficient appliances
Taiwan	Government low-interest loans for the purchase of energy-efficient equipment	

End of Table 1

Country	Incentive mechanism	Result
Switzerland	All developers who decide to build a "passive house" (no heating required or low energy consumption) receive a government subsidy of €50,000	Decommissioning of existing nuclear power plants in the country
Japan	Government pays homeowners one-third of the cost of installing solar panels	Active transition of the private sector to solar energy
Brazil	Government subsidies for producers of sugar cane used to make biofuel (ethanol) for cars	The share of ethanol in total automobile fuel exceeds 50%
Ukraine	There are no direct incentive mechanisms. The state provides subsidies to regional budgets for co-financing of energy saving measures, but the implementation mechanism of this program is still under development	

Despite the fact that the draft law "On Energy Efficiency" has not yet received the status of law, the introduction of Directive 2012/27/EC has already made significant progress. For example, key legislation has been adopted to ensure 100% commercial metering of energy consumption, the creation of an energy audit market, and the creation of an Energy Efficiency Fund to support the population in implementing energy efficiency measures in homes (Figure 1).

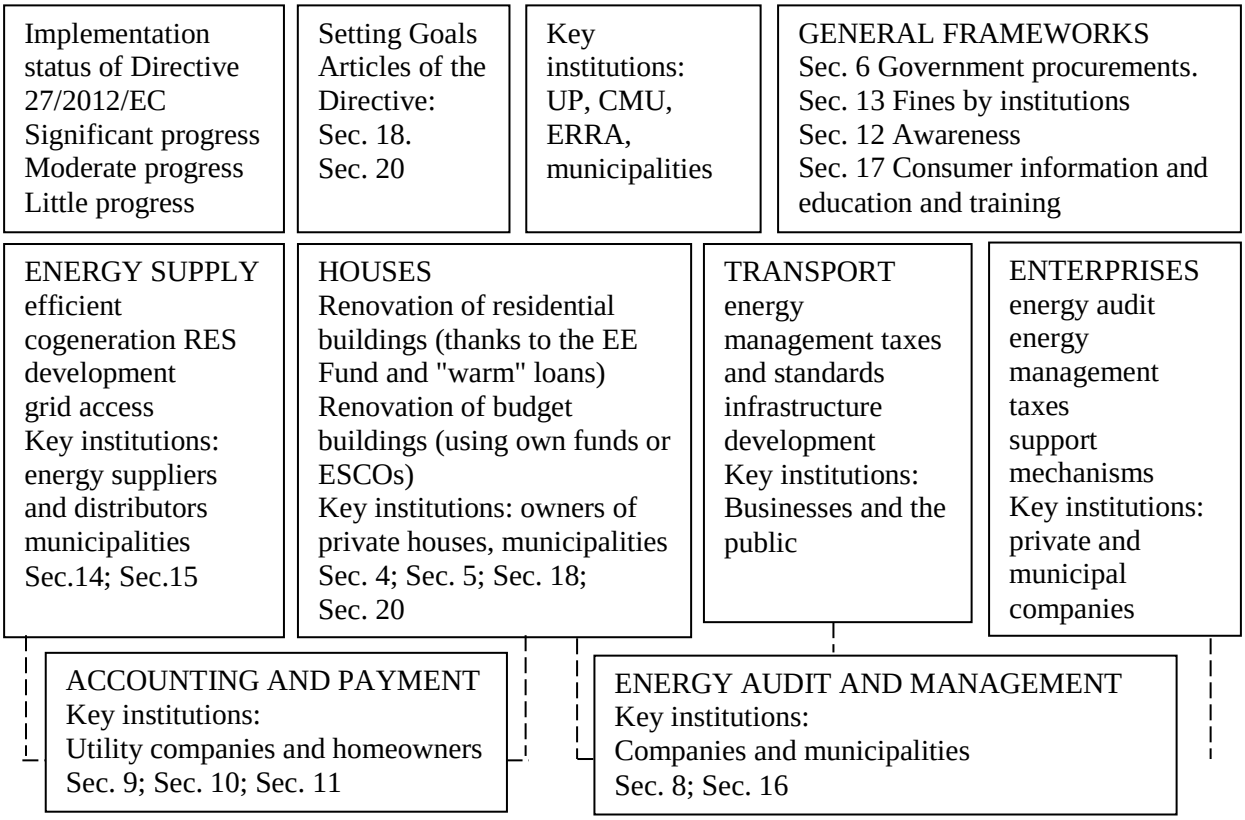

Fig. 1. **Progress in the implementation of the EU Directive 2012/27/EC in Ukraine**

Currently, the development of national educational standards in the energy sector is underway, competence centers are created on the basis of higher education institutions to carry out information and analytical and methodological work among students in the field of energy efficiency. Universities have responded most actively to the implementation of energy conservation and energy efficiency programs.

Many universities in the country held events aimed at energy saving. The European Investment Bank (EIB) provided a loan of around EUR 49 million for the energy efficiency of buildings of six Ukrainian universities within the framework of the Higher Education of Ukraine project. In addition, the universities will receive a EUR 10 million grant from the Eastern Europe Energy Efficiency and Environment Partnership (E5P). This project envisages the comprehensive thermo-modernization of institutions of higher education. Twenty higher education institutions will take part in two phases of the project. In the first stage, it will be the Vinnitsa National Technical University, National Technical University "Kharkov Polytechnic Institute", National University "Lviv Polytechnic", National University "Poltava Polytechnic named after Yuri Kondratyuk", National University "Chernihiv Polytechnic", Sumy State University. Work on thermo-modernization of the first six universities must begin in the autumn of 2022. Then they will be joined by another eight universities, which have won the right to take part in the second stage of the project on a competitive basis. Participation in this project will make it possible to reduce the cost of conducting mandatory energy audits and to perform them without outsourcing (On energy saving: Law of Ukraine, 2021). Universities, carrying out energy saving measures, should legally and reasonably receive tax, tariff and other benefits, which are very popular in foreign countries. After reviewing in detail the measures of energy saving policies of foreign countries there are many examples of incentives: state subsidies and soft loans for projects to implement energy saving technologies, low tariffs for energy efficient equipment and buildings modernized to save energy, and much more. This is when a high-quality energy audit will become profitable, and it will cease to be an incomprehensible mandatory procedure. After all, energy audit is a key tool for reducing the cost of consumed fuel and energy resources, which is very important for the economy of our country.

Understanding the inevitability of economic growth and, consequently, the inevitable growth of fuel and energy consumption and increased energy production, the international community has developed a number of new energy policy priorities, guiding the further development of energy in accordance with the principles of sustainable environmentally sound development. Energy policy should be based on the following three pillars: energy saving; energy efficiency; environmental safety.

The following examples of development and implementation of the energy efficiency projects are the most significant from the point of view of experience borrowing. NTU Ukraine "Kyiv Polytechnic Institute" has conducted energy audits of most academic buildings and dormitories. In most buildings of NTUU "KPI" the automatic accounting of electricity in real time is implemented (consumption is monitored hourly with the construction of graphs of active and reactive capacities). All university buildings are equipped with heat and water metering. Most buildings have automatic control of heating water supply. NTUU KPI developed a model program for MESU to reduce energy consumption by educational institutions and educational institutions subordinate to the Ministry of Education, which is funded from the state budget for 10–14 academic years, and methods of their examination.

Since 2004 the Energy Management Service of NTUU KPI was established, which is subordinate to the Vice-Rector for administrative work. The main activity is to calculate the limits of electricity, heat and water consumption, monitoring energy costs, developing energy efficiency program of the university, providing recommendations to units to improve energy efficiency, raising awareness of the university community on energy conservation, energy efficiency rating of units, holding the week. University energy conservation tips, conducting energy audits of university facilities. In order to visualize the real picture of the energy consumption of buildings and attract the attention of the university community, the relevant energy certificates are produced using the DISPLAY software. This became possible after signing a Charter with the European organization Energy Cite. The project of modernization of the lighting system of classrooms of academic buildings with the use of LED light sources was realized. At NTUU KPI IEE (building 22) a functioning system of energy supply based on a virtual station using solar, wind and biomass energy, which is monitored through a single operator center located in the same building.

CONCLUSION.

Development and implementation of energy-saving technologies should be based on a reasonable combination of requirements and regulations, including prosecution for violation of established norms, on the one hand, and economic incentives, on the other hand. Based on the experience of leading foreign countries, it should also be noted that the efficient development of energy efficiency cannot be achieved only by administrative measures and equipment upgrades, it is also necessary to develop the industry of energy-saving technologies, which is still not given due attention in Ukraine. The proposed mechanism is based on the best practices of energy efficiency in universities. It is based on the use of best practices of leading universities in Ukraine and represents a comprehensive integration of energy efficiency projects.

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ABBREVIATIONS:

%	Percentage
€	Euro
CMU	Cabinet of Ministers of Ukraine
EIB	European Investment Bank
ERRA	Energy Regulators Regional Association
EU	European Union
Fig.	Figures
HEI	higher education institution
IEE	Institute of Energy Saving and Energy Management
KNUTD	Kyiv National University of Technology and Design
LED	LED luminaires
MESU	Ministry of Education and Science of Ukraine
NTUU "KPI"	National Technical University of Ukraine "Kyiv Polytechnic Institute"
RES	Renewable energy sources
Sec.	Sector
UN	United Nations
UP	Ukrainian Parliament

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