JEL Classification: L10

UDC: 338:378

ENERGOMODERNIZATION OF BUDGET EDUCATIONAL INSTITUTIONS ON THE BASIS OF IMPLEMENTATION OF THE MECHANISM OF ENERGY CONSTRUCTIONS

O. SHEVCHENKO [1]
[1] Kyiv National University of Technologies and Design, Ukraine

Introduction. Taking into account the rapid growth of energy tariffs and the lack of proper budget financing, efficient use of energy resources and energy efficiency is one of the tools for increasing the competitiveness of universities [5], since it enables to redistribute the saved funds to develop its own scientific and educational potential. As practice shows to date, outsourcing energy service projects are one of the most effective mechanisms for implementing the energy potential of universities. An important feature of such projects is to increase the efficiency of the use of energy resources as a result of their implementation. After the implementation of the energy service project, an educational institution can obtain significant cost savings and improve energy management. It is this circumstance that has become the basis for widespread practice of implementation of such energy-saving projects, through the creation of specialized energy service companies (ESCOs) in the world and is beginning to be intensively implemented in Ukraine.

Aim. Study of the legislative field and ways of energy modernization of higher educational institutions of Ukraine with the help of investment programs, based on the introduction of the ESCO energy service contracts mechanism and the use of renewable energy sources.

Research methods. In the article were used such general scientific empirical and theoretical methods as: expert analysis; systematic and analytical analysis (to determine the feasibility of implementing energy service contracts when making managerial decisions and disclosing the principles and tools of the energy services mechanism), the method of analogy and comparative reflection.

Results. The expediency of introduction of the energy management mechanism of budget institutions of higher educational institutions of Ukraine on the basis of ESCO's energy service contract is considered. The results of the development of a financial model for the use of renewable energy sources are presented.

Conclusions. Recommendations are given and negative and positive aspects of the implementation of the energy service contracts mechanism are based on international experience and in connection with the improvement of the legislative field aimed at supporting energy service projects in the budget sphere in Ukraine.

Keywords: energy service contract, ESCO, energy management systems, increase of energy efficiency, higher educational establishments.

Problem statement and its connection with important scientific and practical tasks. Investment projects related to energy saving tend to be characterized by lower rates of internal rate of return (IRR) and periods of payback due to the need to invest significant funds at an early stage. However, the main reasons that prevent most HEIs from using energy saving potential is the lack of sufficient qualified own experts and experience in implementation of energy saving projects, as well as lack of financial resources for their implementation. In addition, at this stage, the investment development of projects is poorly developed with the purpose of attracting investments for modernization of objects of the budget sphere, and banks are concerned about the high risks of implementing energy-saving projects and the lack of legal guarantees for the repayment of the loans granted. In these circumstances, one of the opportunities for improvement is the implementation of energy efficiency projects by involving energy service contracting mechanisms and partnerships with energy services companies (ESCOs).

In Ukraine, a number of legislative acts aimed at enhancing the investment attractiveness of the country, including in the field of energy efficiency and energy saving, were adopted by introducing a new mechanism for energy modernization of buildings of budget institutions - the mechanism of the energy service.

Such acts include the Laws of Ukraine: "On Amendments to the Budget Code of Ukraine (regarding the implementation of energy efficiency measures in budgetary institutions)", "On Amendments to the Law of Ukraine" On Energy Conservation"; "On Investment Activity"; "On introducing new investment opportunities, guaranteeing the rights and legitimate interests of business entities for large-scale energy modernization" [2]; "On the Energy Efficiency Fund" [3], which establishes the general legal, economic and social conditions of investment activity in Ukraine and aimed at ensuring the protection of the rights, interests and property of the subjects of investment activity, as well as determine the legal and economic bases of the implementation of the energy service to increase energy efficiency, the efficiency of objects of state and communal property. In pursuance of these Laws, the Model Energy Service Contract [5] and the Ministry of Finance of Ukraine approved the Order of 06.11.2015 №996 "On Making Changes to the Economic Classification of Budget Expenditures", according to which an economic classification was added – the classification of budget expenditures under item 2276 "Payment for the Energy Service" (Order of the Ministry of Finance No. 11 dated January 14, 2007 "On Budget Classification"), which will allow budget institutions to formulate expenditures, with taking into account the costs incurred by "energy service contracts". Particularly significant are the existing changes to the Budget Code, which stipulate the existence of a long-term commitment to the energy service contract - the conclusion during the budget period of an energy service contract, under which it is necessary to make payments during the same period and / or in the future, subject to the availability of cost savings for the payment of utilities and energy. Thus, the legislative basis for the successful introduction of the energy service mechanics in the universities of Ukraine has now been formed.

Analysis of recent publications on the problem. Although the modern approach to defining the basic principles and concepts for the implementation of the energy service contract mechanism is rather new, a large number of studies in this area have now been published. A recognized leader in the modern paradigm of the development of this mechanism is the researcher Shirley Hansen (Hansen, Shierly J.), who has given a large number of his scholarly works to interpret this question. Among them there is a well-known book: "ESCO Worldwide: Lessons Learned in 49 Countries", in which Pierre Langlois and Paolo Bertoldi, the scientist, gave an assessment of the current development of ESCO's energy services in different countries around the world [9].

The significant contribution of foreign researchers to the implementation of energy services and mechanisms based on the ESCO approach has been formulated in the writings of such researchers as J. Weisman, Steve Sorrell [12], Sandra Backlund, Patrick Thollander [6], Edward Vine [14], Felix Suerkemper, Paolo Bertoldi, Wolfgang Irrek, Bruno Duplessis, Nicola Labanca [11] and others.

Among national scholars and scientists in the post-Soviet space, who are studying the issues of energy service mechanisms and other issues of project financing were I.A. Bashmakova, V.V. Bocharova, S.P. Denysyuk, B.S. Irniyazov, M.P. Kovalko, E.E. Nikitina, A.V. Prahovnik, S.B. Sivaev, V.A. Stepanenko, O.M. Sukhodoli, O.O. Lyakhova, Yu.I. Shulga and others.

The results of individual studies related to renewable energy sources that are used as an alternative substitute for traditional energy sources in energy service projects and aimed at the implementation of sustainable development goals are not studied. In this direction, we can mention the work of Daniel Schinnerl, Jan W. Bleyl and others. However, it should be noted that the number of studies in this direction is not significant and requires further versatile research.

Presentation of the main results and their justification. The prototype of the term "energy service contract" was the so-called Performance Contract (ESPC – Energy-savings performance contract). For the first time, the legal instrument originated in the United States. Currently, the legal regulation of performance contracts is carried out in accordance with the provisions of the US Energy Policy Act of 1992 (EPACT 1992). The Code of Federal Regulations (CFA) consolidates the concept of performance contract and the main responsibilities of the parties.

The US experience has been used in the European Union, where performance contracts have been used since the 80's of the last century. The legal definition of a performance contract, the so-called "energy contract", was entrusted by the European Commission only in 2006, within the framework of the Energy Services Directive 2006/32/EU of 5 April 2006 and improved by a new definition in accordance with Directive 2012/27E of 25 October 2012 "On Energy Efficiency" as an "Energy Efficiency Contract". "Energy performance contracting" is a contractual agreement between a beneficiary and a supplier of energy efficiency improvement measures that is subject to verification and control throughout the contract period, where investments in such an event (work, supply or service) are paid in accordance with an agreed energy efficiency improvement contract or another agreed energy efficiency criterion such as cost savings" [1]. That is, the payment for the attracted financial resources and performed ESCO work is carried out by the customer after the project implementation at the expense of funds that are economic effect of the introduction of energy-saving technologies. In addition, the customer does not distract his own funds for the implementation of the project Fig. 1.

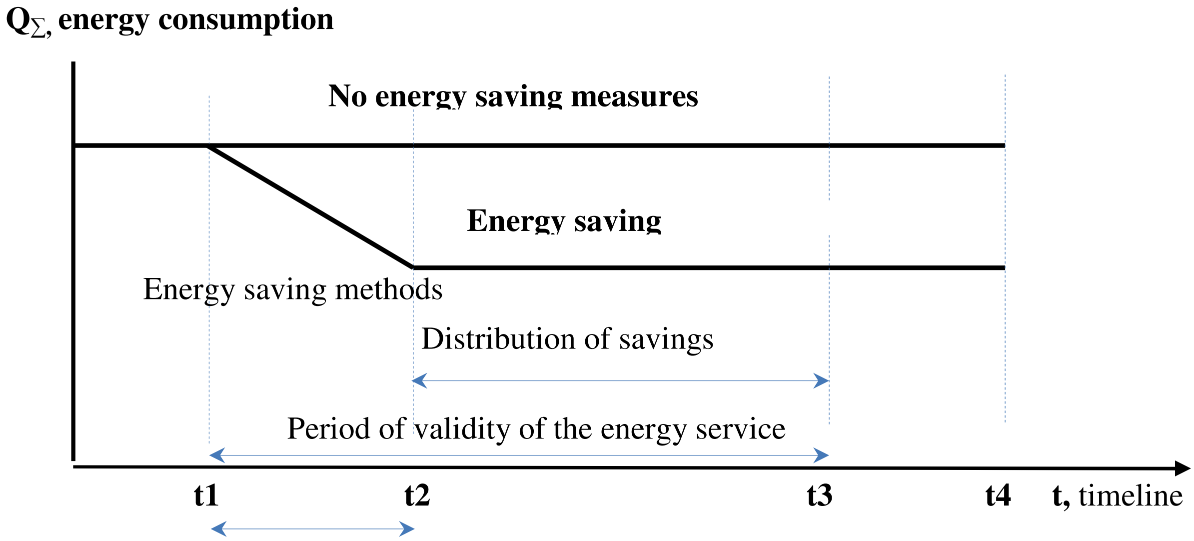

Fig. 1. **Scheme of energy consumption after the introduction of an energy service contract**

In accordance with the Model of Energy Service Contract [4] payment of the billing period Px_n is calculated by formula:

$$Px_n = \frac{B \times (БP_n - ФP_n) \times T_n}{100\%}, \quad (1)$$

n – defined settlement period (not more than 10 years); *B* – agreed by the parties the percentage of the annual reduction of customer costs; $БP_n$ – the basic level of consumption of fuel and energy resources and / or housing and communal services in natural terms for the relevant billing period; $ФP_n$ – the actual level of consumption of fuel and energy resources and / or housing and communal services in the relevant accounting period, recorded by accounting devices; T_n – price (tariff) for fuel and energy resources and / or housing and communal services, effective at the end of the relevant billing period.

The exemplary energy service contract provides for the definition of such essential conditions: a list of measures, terms and conditions for the implementation of the energy service (paragraph 1, appendix 1–2), the contract price (paragraph 2), the base level of energy consumption and utilities (p. 4–6, annex 3), the level of reduction of consumption and / or expenses (Annex 4.5), the validity of the energy service contract (items 9–10), the procedure for payment for the energy service (paragraphs 11–15, annex 6), rights and obligations parties (p. 21–26), responsibility for non-fulfillment of obligations under the agreement (p. 27–30), conditions, order and consequences of termination of contracts (p. 31–33), the procedure of transfer of property (section 34), the adjustment procedure and assessment by the implementation energy service (p. 35, Annex 7).

The existence of such a normative basis greatly simplifies the management decision to enter into a contract in order to obtain energy services. In this case, the effectiveness of such an energy service contract E_{ec} can be represented as a functional complex dependence:

$$E_{ec} = f\ (Q_{ec}, L_{ec}, t_n), \qquad (2)$$

Q_{ec} – the share of savings to be paid by ESCO to the customer (at least 80% and no more than 90% savings); L_{ec} – level of reduction of customer's expenses on energy:

$$L_{ec} = Q_{no}\ \text{x}\ T_0, \qquad (3)$$

Q_{no} – Declared by ESCO company savings in physical units; T – tariff, valid on the date of announcement of purchase;

t_n – period of validity of the energy service contract) – according to the current legislation it should be no more than 10 years.

These indicators are determined by the ESCO at the stage of preparation of the tender offer. On its basis, the estimated efficiency indicator of the proposed energy service contract is calculated by the customer.

An important stage in the management decision regarding the conclusion of an energy service contract is the choice of the type of acceptable business model and ESCO executor.

In order to assess the ESCO qualification, the international standard BS EN 15900, which defines the minimum requirements for energy efficiency services, and Annex A provides an example of the process for providing energy efficiency services, can be used as additional material. BS EN 15900 can be used as a guide for customers and suppliers of energy efficiency services, as referred to in Article 1 of Directive 2006/32 / EU.

The study of existing options gives the author the opportunity to offer three options for selecting for a specific situation model of Table 1.

Table 1

Variants of business models of energy service contracts for ESCO

	Business model of the energy service contract		
	Light (low cost)	**Base** (medium-cost)	**Complex** (high cost)
	1	2	3
Feature of the model	Energy efficiency measures with zero investments are carried out by ESCO, which include energy conservation guarantees within the term of the agreement 2–3 years. ESCO recommends further measures with a certain level of investment. If a decision is taken on the implementation of such measures, the share of achieved savings from these measures can be attributed to the guarantee provided by ESCO for saving. All fixed assets and technical equipment belong to the owner of the facility.	ESCO carries out a full range of works: planning and implementation of technical measures, financing of technical equipment, maintenance and energy management during the term of the contract; Guarantee full cost recovery due to energy savings and maintenance costs over a specified period. The customer of the energy service pays the savings that is actually achieved. The term of the contract is 3–5 years. Fixed price (payment) related to the implementation of the main requirements of the project, throughout the term of the contract. The technical equipment is transferred to the customer after the project has been approved.	This business model expands the area covered by the base model. ESCO is additionally responsible for the planning, installation and financing of thermal insulation of buildings. Significant investment costs. Long term payback period of the project. Longer term of the contract (more than 5 years with further prolongation)
Energy-saving measures	Operative optimization of systems of lighting, heating, ventilation and use of hot water generation. Training and motivation of the Customer's personnel. ESCO is responsible for maintenance of technical equipment.	Measures in the field of electricity consumption (lighting, air conditioning, ventilation etc.). Measures in the field of heating (installation of heat pumps, central (individual) heat points, solid fuel boilers), installation of distribution heating system, heat recovery system, cooling system, hot water generation).	ESCO in addition to the Basic Model carries out: - measures for the repair of fencing constructions and complex insulation of the customer's buildings; - replacement of most power plants; - installation of inte-grated control systems;

Continuation of *Table 1*

	1	2	3
		Installation of thermal equipment using alternative energy resources (boiler on biomass, wind turbines, solar collectors etc.).	- cogeneration; - utilization of heat; insulation of protective structures: external walls, overlappings, basements; the use of alternative energy sources etc.
Financial Scheme	ESCO carries out staff costs for the periodic inspection of buildings and technical equipment. They receive monthly or quarterly payments from a budget institution, and the rest of the payments – after the final account of achieved energy savings.	The main financing method is financing by ESCO funds, which can attract credit funds from financial institutions. Other funding methods: additional financing of projects by the customer of the energy service financing of projects with the attraction of funds for energy efficiency, financing of all works on project planning and investment costs from the customer's own budget, the energy service or at the expense of loans borrowed by the customer.	Basic funding methods: - financing from ESCO funds (ESCO can attract loans from financial institutions) financing from ESCO funds in conjunction with financing from energy efficiency funds. Other funding methods: - additional financing of projects by the customer of the energy service one-time or parts during the duration of the contract); - financing of projects with attraction of state subsidies; - a combination of the above methods of financing.
Assessment and monitoring	Energy savings are calculated on the basis of invoices for the energy consumed and the specified energy cost baseline or (if it is not yet available) – then based on metric readings. It is necessary to take into account the an-nual correction of climate, at need, chan-ge to use building or high level of savings	Energy savings, which is confirmed by a fixed price for energy during the contract period, is subtracted from energy and water costs or meters. ESCOs periodically control energy and water consumption, often through remote monitoring and remote access to the building automation system. All energy consumption data is collected and documented, together with revisions in the annual report and in the annual savings account.	All energy savings (from repair and technical measures) are subtracted from energy and water accounts or readings of fixed-energy meters ESCO is responsible for periodically controlling energy consumption, adjusting technical parameters, annual reports from energy saving and annual savings accounts.

Continuation of *Table 1*

	1	2	3
	in implementing measures, carried out by the owner of the building.	ESCO takes care of the quality assurance and maintenance of all installed technical devices	
ESCO risks	Determination of the baseline energy consumption, energy saving guarantees and operational errors. Adjustments related to user behavior adjustments related to other energy saving measures, made by the owner of the building control over energy saving	Economic risks (possibility of non-achievement of savings and, consequently, non-reimbursement of expenses of ESCO; wrong calculation of the base level of energy consumption and, consequently, incorrect calculation of energy saving; increase in investment in projects). Technical risks (failure of technical equipment or errors in its collection). Administrative Risks (Municipality Delay with definition of tariffs or subsidies; untimely adoption installation works).	Економічні ризики Economic risks ESCO (absence of ESCO experience in calculating heat insulation measures; increased complexity of calculation of savings for thermal insulation measures; high possibility of additional costs for replacement of equipment that may fail; limited period of fixed interest on a loan for a long period of project implementation) Technical and administrative risks of ESCO (low quality of planning of ventilation systems, the role of which is much greater due to changes in the heat load on heating, the need for harmonization of legal supply New, connected with the reconstruction of the facades of buildings)
Strategies for risk reduction	Accurate calculation of energy savings; ESCO's experience in operating and optimizing technical equipment; participation of experienced project intermediaries at the preparatory stage project;	Involvement of experienced mediator during project preparation (baseline verification, reliability of the guarantee saving and calculated costs, checking planning); detailed planning and calculation of savings and investments; the establishment and observance of clear rules of contracts that relate to the	Cooperation of ESCO with external architects, engineers and other companies and balancing of all savings; use of a deep approach to the calculation of savings; thermal insulation measures calculation of expenses for repayment of loans,

Continuation of *Table 1*

	1	2	3
	definition of clear contractual rules to avoid conflicts.	responsibilities of counterparties; ESCO should experience in using technical equipment and employing skilled personnel.	with taking into account possible increase in interest rate; when planning measures to take into account the constraints in the field of heritage protection, a higher degree of coordination of actions
Main benefits	Detailed control over the annual energy consumption of each buildings; real savings are measured and documented; Expanded proposals for measures in buildings with low or high investment; cooperation between the state body (budgetary institution) and experienced ESCO; entry into the market of new ESCOs and municipalities, with little private-public partnership experience, short duration of the contract	Detailed control over the annual energy consumption of each building; the ability to measure and document real savings; obtaining real savings in the amount of 20 to 50%; (depending on activities) increase in the market value of the building; reduction of investment costs of the customer of the energy service in comparison with purchases without ESCO; training of technical staff through trainings.	Reduction of heat load for heating and air conditioning in buildings; improvement of indoor climate; the best quality of indoor space and, consequently, a lower level of morbidity of users; increase of architectural quality through renovation of facades of buildings; Better reputation of the building through the provision of environmentally sound construction.

The next step in the implementation is the need to assess the existing energy saving potential of the university. Based on the studies of the Joint Research Center (JRC) of the European Commission [17], it is appropriate to assume in the first approximation that the typical measure of the energy service mainly concerns lighting and heating systems. LED bulbs, electronic ballasts, presence sensors, and the construction of an internal energy management system are the most interesting technologies on which ESCO can successfully develop a business plan as a first step in cooperation. According to JRC experts, such energy savings measures in Europe are applied to 60% of existing public buildings, including training. The correct combination of these technologies (depending on the type of building and the main end-use) can lead to an average energy saving (r) of up to 25% with a maximum payback period of 8 years.

Using these assumptions, you can calculate the investment costs associated with these recovery measures in the opposite direction. In fact, they can simply be obtained by multiplying the annual economic savings by the payback period:

$$s = r \text{ x } (FEC_H \text{ x } (p_{el} \text{ x } H_{el} + p_f \text{ x } (1 - H_{el})) + FEC_{other} \text{ x } p_{el}), \quad (4)$$

r – energy saving factor; FEC_H – final energy consumption for heating of a certain territory and FEC_{other} for other end uses; p_{el} and p_f are prices for electricity and fossil fuelso; H_{el} – the percentage of buildings heated by electrical systems.

JRC calculations based on available EUROSTAT data [17] showed that European Union education institutions could save 16719 GW of energy and save 1319 million. EUR with a need for investment of 11301 million. EUR

Currently, due to the difficult economic situation, ESCO services for Ukraine provide an opportunity for universities to introduce energy saving measures that are financed by the customer due to the achieved energy saving and the costs spent on their purchase. ESCO, in the framework of the signed agreement, guarantees the specified savings, as well as that the cost of energy after the implementation of energy saving measures will not exceed predetermined factors. The technical risk of the customers of the energy service is minimal. When preparing an energy service contract, the parties determine the following key factors: financial savings in cash equivalent; saving of fuel and energy resources in kind, etc. At the same time, if the project's level of energy saving during the implementation period of the contract is not reached, ESCO does not receive remuneration in the planned volume.

In practice, there are several ESCO types in the world (Table 2) agreements:

- Energy supply and energy management ("Chauffage");
- Distribution of income from achieved savings (Shared Savings);
- First-Out, First Pay-Out, Fast Returns and Returns;
- With guaranteed savings (Guaranteed Savings),
- BOOT: creation – ownership – exploitation – transfer of ownership (build-own-operate-transfer (BOOT).

One of the most economically advantageous for ESCO is energy service projects for energy supply implemented with the use of the green tariff. Such projects are intended for the supply of electricity produced using solar, wind, hydro and bio energy. Electricity generated from renewable energy sources is supplied to the general grid and is paid for by the green tariff on the wholesale electricity market, thus stimulating the replacement of natural gas in the heat supply sector.

Table 2

Distribution of risks, territorial distribution and key characteristics of various types of energy service contracts [16]

Type of contract with ESCO	**Key features**	**Distribution of risks between customer and ESCO**			**Most spread count-ries**
		not comp-leted	**Finan-cial**	**Tech-nical**	
Contract for energy supply and energy management "Chauffage" Schauffage (translation from French – heating).	The resource provider is the provider of energy services. Supply of energy resources is carried out at a fixed price during the term of the contract. Long term contract. Guaranteed reduction in resource consumption at the level of 3–10%. ESCO is the owner of energy saving equipment	ESCO	ESCO / Customer	ESCO	France, EU countries
An agreement to distribute revenues from achieved savings (Shared Savings)	Distribution of revenues from savings resulting from technical re-equipment of the customer. ESCO finances the implementation of the project and assumes all financial and risks associated with failure to reach the planned level of energy efficiency. The share of the customer in the distribution of income is about 20. Suitable at the initial stage of development of the national market of energy services services [16, p. 6].	ESCO	ESCO	ESCO / Custo-mer	China, Japan, Australia, Brazil, Philip-pines, India South Africa
First-Out, First Pay-Out	This type of contract is a variation of the model of saving distribution. The difference - 100% of the proceeds received from the implementation of the project, remains in ESCO until full payback with the predicted level of profitability. Distribution of income between ESCO and the customer after the return on investment or full transfer of all rights to the project from ESCO to the customer, including the right to receive the entire amount of profit from	ESCO	ESCO	ESCO / Custo-mer	USA, OAI, Jordan

Continuation of *Table 2*

Type of contract with ESCO	Key features	Distribution of risks between customer and ESCO			Most spread count-ries
		not comp-leted	Finan-cial	Tech-nical	
Guaranteed Savings Agreement	ESCO takes a commitment to the customer to reduce the cost of energy resources. During the term of the contract ESCO is responsible for covering the costs of energy suppliers. The customer does not pay for the energy directly to the suppliers, and monthly pays the energy service company through an intermediary, which usually amounts to 85-90% of the basic cost of the customer's energy. The amount actually provided by the savings does not directly affect the customer's payments. In all circumstances, the customer reduces energy costs by 10-15%. ESCOs have a full risk of saving.	ESCO	ESCO / Customer	ESCO	Canada, Japan
BOOT contract for: building-own-operate-transfer (BOOT) .	The basis of the agreement is a public-private partnership in which ESCO concludes a contract with a partner in the public sector. The BOOT project is considered as a way of developing a large public infrastructure project through private funding.	ESCO	ESCO / Customer	ESCO	South Africa, Thailand, Colombia

According to the "Energy Strategy of Ukraine for the period up to 2035 "Safety, Energy Efficiency, Competitiveness", approved by the Cabinet of Ministers of Ukraine from August 18, 2017, No. 605-p, it was determined that by 2020 the share of "green" energy, at the expense of renewable resources , in the general fuel and energy balance of Ukraine (GFEBU) should be at least 8%, and by 2035 this figure should reach 25%. Particular attention deserves attention to the projects related to the construction of cogeneration (trigeneration) systems using biomass, biofuels and waste energy, the share of which in the GFEBU of the indicated Energy Strategy is planned at the level of 4.9% in 2020 and 11.9% in 2035.

The use of cogeneration units in universities will reduce the cost of heating and hot water supply, and the possibility of selling ESCOs, generating electricity using the "green" tariff, will significantly reduce the payback period of the implemented investment project.

The financial model, which confirms the assumptions, was designed by specialists of LLC "CLIAR ENERGY" in the framework of preparation of a commercial proposal for the NTU of Ukraine "Kyiv Polytechnic Institute. Igor Sikorsky". According to the terms of this project, with almost 30% discount on the cost of thermal energy for the consumer (planned annual sales of heat – 28208 Gcal), compared to the approved tariffs in force in Ukraine and the sale of electricity to the wholesale market at the "green" tariff (planned annual electricity sales – 47191 thousand sq. year), the payback period of the project is no more than three years, and internal rate of return (Internal Rate of Return, IRR) of 25%. As a fuel for CHP, it is suggested to use wood waste. The norms of the complex emissions into the atmosphere, according to calculations, are almost three times lower than those set for natural gas boiler-houses. Thus, the environmental microclimate in the university will be improved, the budget for energy costs reduced, millions of cubic meters of expensive Russian gas replaced by local renewable raw materials.

In addition, the value and innovation of the offer of LLC "KLIAR ENERGY" is that, in addition to the construction of a cogeneration complex (electricity generation – 6.3 MW of electricity and thermal generation – 4.5 MW), on its basis it is planned to create a scientific and educational training base for profile students and graduate students, as well as the opening of an experimental research laboratory for the development of Ukrainian technologies in the field of energy.

Conclusions and perspectives of further research. Implementation of the ESCO-mechanism is another urgent step to support the energy-efficient state strategy aimed at improving energy security and reducing Ukraine's energy dependence on imported energy and increasing the number of renewable energy projects.

At present, the domestic legislative base for supporting the development of the energy services market and the long experience of foreign countries is an essential prerequisite for increasing the number of state institutions ready to make a decision on the launch of the ESCO-mechanism. At the same time, the increase in the number of participants in the energy services market, in the budget sphere, prompts the development of tendencies to reduce the contractual price, including at the expense of cheaper loans, and will require the development of specialized educational programs and qualified methods for assessing the effectiveness of energy service projects and risk reduction mechanisms.

The author's experience in practical development of a financial model for the construction of a cogeneration complex in the territory of a higher educational institution confirmed the investment attractiveness of the project and presented new possibilities for introducing innovative forms of its possible functioning, especially on the basis of the specifics of the university.

The mechanisms for the formation and development of energy service clusters and public-private partnerships to support the development of the energy service contracts institute can effectively contribute to solving the above-mentioned tasks. The core of the energy service cluster should be energy service companies that manage the implementation of specific energy saving projects. Implementation of the mechanism of energy service clusters in practice will allow the development of national developments and their inclusion in specific investment projects with subsequent implementation in production in order to achieve the capitalization of the effects of reduction energy intensity of products and increase of value added. In Ukraine, due to the slow dissemination of the idea of an energy service contract, the idea of clusterization requires a more detailed study.

References	**Література**
1. Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EU and 2010/30/EU and repealing Directives 2004/8/EU and 2006/32/EU. Official Journal of the European Union No. I. 315/1 dated 14.11.2012.	1. Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EU and 2010/30/EU and repealing Directives 2004/8/EU and 2006/32/EU. Official Journal of the European Union No. I. 315/1 dated 14.11.2012.
2. Pro zaprovadzhennia novykh investytsiinykh mozhlyvostei, harantuvannia prav ta zakonnykh interesiv subiektiv pidpryiemnytskoi diialnosti dlia provedennia masshtabnoi enerhomodernizatsii: Zakon Ukrainy [The Law of Ukraine on introducing new investment opportunities, guaranteeing the rights and legitimate interests of business entities for large-scale energy modernization]. Information from the Verkhovna Rada, 2015, No. 26, 220 [in Ukrainian].	2. Про запровадження нових інвестиційних можливостей, гарантування прав та законних інтересів суб'єктів підприємницької діяльності для проведення масштабної енергомодернізації: Закон України // Відомості Верховної Ради (ВВР). – 2015. – № 26. – Ст. 220.
3. Pro Fond enerhoefektyvnosti: Zakon Ukrainy [The Law of Ukraine on the Energy Efficiency Fund]. Official Bulletin of Ukraine from 04.08.2017, No. 61 [in Ukrainian].	3. Про Фонд енергоефективності: Закон України // Офіційний вісник України. – 04.08.2017. – № 61.
4. Pro zatverdzhennia Prymirnoho enerhoservisnoho dohovoru: Postanova Kabinetu Ministriv Ukrainy vid 21.10.2015 No. 845 [Resolution of the	4. Про затвердження Примірного енергосервісного договору: Постанова Кабінету Міністрів України від

Cabinet of Ministers of Ukraine On Approval of the Model of Energy Service Contract dated October 21, 2015, No. 845]. The Official Bulletin of Ukraine dated November 13, 2015, No. 88, 30, article 2922, code of act 79185/2015 [in Ukrainian].
5. Gryshchenko, I.M., Kaplun, V.V., Dyachenko, M.V. et al. (2013). Upravlinnya enerhospozhyvannyam u vyshchykh navchal'nykh zakladakh: monohrafiya [Management of power consumption in higher educational institutions: monograph]. Ed. I.M. Gryshchenko. Kyiv KNUTD. 245 p. [in Ukrainian].
6. Backlund, S., Thollander, P. (2011). The' energy-service gap: What does it mean? In: CEEE 2011 SUMMER STUDY, Energy efficiency first: The foundation of a low-carbon socie. Retrieved from: http://liu.diva-portal.org/smash/get/diva2:453827/fulltext01.pdf.
7. Bertoldi, P., Rezessy, S., Vine, E. (2006). Energy service companies in European countries: Current status and a strategy to foster their development. Energy Policy, 34: 1818–1832.
8. BS EN 15900:2010 Energy efficiency services. Definitions and requirements.
9. Hansen, S.J., Bertoldi, P., Langlois, P. (2009). ESCOs Around the World: Lessons Learned in 49 Countries. Lilburn: The Fairmont Press. 377 p.
10. ISO 50001:2011. Energy management systems Requirements with guidance for use.
11. Labanca, N., et al. (2015). Energy efficiency services for residential buildings: market situation and existing potentials in the European Union, Journal of Cleaner Production. Retrieved from: http://dx.doi.org/10.1016/j.jclepro2015.02.077.
12. Sorrell, S. (2007). The economics of energy service contracts. Energy Policy, 35(1): 507–521. doi:10.1016/j.enpol.2005.12.009.
13. Schinnerl, D., Bleyl, J.W. (2008). "Energy Contracting" to Achieve Energy Efficiency and Renewables using Comprehensive Refurbishment of Buildings as an example. In: Urban Energy

21.10.2015 № 845 // Офіційний вісник України. – 13.11.2015. – № 88. – С. 30. – Ст. 2922. – Код акту 79185/2015.
5. Грищенко І.М. Управління енергоспоживанням у вищих навчальних закладах: Монографія / І.М. Грищенко, В.В. Каплун, М.В. Дяченко та ін.; За ред. І.М. Грищенка. – К.: КНУТД, 2013. – 245 с.
6. Backlund S. The' energy-service gap: What does it mean? / S. Backlund, P. Thollander // CEEE 2011 SUMMER STUDY, Energy efficiency first: The foundation of a low-carbon socie. Retrieved from: http://liu.diva-portal.org/smash/get/diva2:453827/fulltext01.pdf.
7. Bertoldi P. Energy service companies in European countries: Current status and a strategy to foster their development / P. Bertoldi, S. Rezessy, E. Vine // Energy Policy. – 2006. – # 34. – P. 1818–1832.
8. BS EN 15900:2010 Energy efficiency services. Definitions and requirements.
9. Hansen S.J. ESCOs Around the World: Lessons Learned in 49 Countries / Shierly J. Hansen, P. Bertoldi, P. Langlois. – Lilburn: The Fairmont Press, 2009. – 377 p.
10. ISO 50001:2011. Energy management systems Requirements with guidance for use.
11. Labanca N. Energy efficiency services for residential buildings: market situation and existing potentials in the European Union / N. Labanca et al. // Journal of Cleaner Production. – 2015. – http://dx.doi.org/10.1016/j.jclepro2015.02.077.
12. Sorrell S. The economics of energy service contracts / S. Sorrell // Energy Policy. – 2007. – Vol. 35, № 1. – P. 507–521. doi:10.1016/j.enpol.2005.12.009.
13. Schinnerl D. "Energy Contracting" to Achieve Energy Efficiency and Renewables using Comprehensive Refurbishment of Buildings as an

Transition edited by Peter Droege. Elsevier.

14. Vine, E. (2005). An international survey of the energy service company (ESCO) industry. Energy Policy, 33: 691–704.

15. Energy Performance Contracting in the European Union Joint Research Centre Institute for Energy and Transport. European Commission. Retrieved from: http://www.euesco.org/fileadmin/euesco_daten/pdfs/euESCO_response_concerning_EPC.pdf.

16. ESCO Market Report for Non-European Countries 2013. Joint Research Centre Institute for Energy and Transport. European Commission. Retrieved from: http://iet.jrc.ec.europa.eu/energyefficiency/publication/esco-market-report-non-european-countries-2013-0.

17. Bertoldi, P. (2017). Practices and opportunities for Energy Performance Contracting in the public sector in EU Member States 2017. Retrieved from: http://publications.jrc.ec.europa.eu/repository/bitstream/JRC106625/kjna28602enn.pdf.

example / Daniel Schinnerl, Jan W. Bleyl // Urban Energy Transition / Edited by Peter Droege. – Elsevier, 2008.

14. Vine E. An international survey of the energy service company (ESCO) industry / E. Vine // Energy Policy. – 2005. – # 33. –P. 691–704.

15. Energy Performance Contracting in the European Union Joint Research Centre Institute for Energy and Transport // European Commission. Retrieved from: http://www.euesco.org/fileadmin/euesco_daten/pdfs/euESCO_response_concerning_EPC.pdf.

16. ESCO Market Report for Non-European Countries 2013 // Joint Research Centre Institute for Energy and Transport // European Commission. Retrieved from: http://iet.jrc.ec.europa.eu/energyefficiency/publication/esco-market-report-non-european-countries-2013-0.

17. Bertoldi P. Practices and opportunities for Energy Performance Contracting in the public sector in EU Member States 2017 / P. Bertoldi. – Retrieved from: http://publications.jrc.ec.europa.eu/repository/bitstream/JRC106625/kjna28602enn.pdf.