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PECULIARITIES OF ASSESSING ECONOMIC EFFICIENCY OF IMPLEMENTING ENERGY SAVING SOLUTIONS IN CIVIL BIULDING

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Purpose. In condition of political instability, economic crisis, increasing globalization and increasing demands for social responsibility in the energy conservation and energy efficiency have been as economic and social stabilizers. With the introduction of energy efficiency measures should be considered to characteristics of objects, that modernized, characteristics of technical solutions, variable nature of utility tariffs. **Methodology.** In the article the methods of evaluating the effectiveness of the introduction of energy efficient solutions in civil buildings heating system. The application of the method of discounting taking into account additional factors input parameters facilities modernization. Produces the advantages and disadvantages of various options for funding energy efficiency measures in Ukraine. As the basic energy saving solution, which improves implementation efficiency heating systems various buildings considered automated monitoring and control of heat consumption. **Results.** Implementation of this solution enables optimize the heating of civil buildings, depending on environmental conditions, their characteristics and usage mode. **Originality.** To demonstrate the effectiveness of the proposed energy saving solutions designed its key performance indicators for the building of the executive committee of Kremenchuk city council of Poltava region, children's schools and secondary schools in the Kremenchuk. **Practical value.** In accordance with the criteria in the proposed solution have been recommending for implementation in practice of buildings for various purposes.

Key words: energy efficiency, economic efficiency, automation, dispatching, performance evaluation methods.

ОСОБЛИВОСТІ ОЦІНКИ ЕКОНОМІЧНОЇ ЕФЕКТИВНОСТІ ВПРОВАДЖЕННЯ ЕНЕРГОЗБЕРІГАЮЧИХ РІШЕНЬ У ЦИВІЛЬНИХ БУДИНКАХ

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В умовах політичної нестабільності, фінансово-економічної кризи, посилення глобалізації й підвищення вимог до соціальної відповідальності в суспільстві питання енергозбереження та підвищення енергоефективності можна розглядати як економічний і соціальний стабілізатор. При впровадженні заходів з енергозбереження необхідно враховувати особливості об'єктів модернізації, характеристики технічних рішень, змінний характер тарифів на комунальні послуги. У роботі розглянуто методи оцінки ефективності при впровадженні енергоефективних рішень у системи теплозабезпечення цивільних будівель. Обґрунтовано використання методу дисконтування з урахуванням додаткових чинників зміни вхідних параметрів об'єктів модернізації. Показано переваги й недоліки різних варіантів фінансування енергозберігаючих заходів в Україні. Як базове енергозберігаюче рішення, впровадження якого покращує енергоефективність систем теплозабезпечення будівель різного призначення, розглядається автоматизована система моніторингу й керування їх теплоспоживанням. Упровадження такого рішення дозволяє оптимізувати роботу систем опалення цивільних будівель залежно від умов навколишнього середовища, їх характеристик і режиму використання. Для наочної демонстрації ефективності запропонованого енергозберігаючого рішення розраховано його основні показники ефективності для будівель виконавчого комітету Кременчуцької міської ради Полтавської області, дитячих навчальних закладів і загальноосвітніх шкіл м. Кременчука. Відповідно до прийнятих у роботі критеріїв пропоноване рішення можна рекомендувати до впровадження в практику експлуатації будівель різного призначення.

Ключові слова: енергозбереження, економічна ефективність, автоматизація, диспетчеризація, методи оцінки ефективності.

PROBLEM STATEMENT. The need in sustainable economic growth and structural changes in the national economy places the problem of the rational use of energy resources onto the first place. Analysis of existing issues and development trends in the field of energy saving demonstrates the need in creating conditions to improve its investment attractiveness. It also requires improvement of methodological approach to evaluation of the energy saving measures in terms of limited investment resources. It should be added that the returning terms of investments, options of its alternative use depend on the objectivity of evaluating effectiveness of the energy-saving solutions. The level of assessing the efficiency of investment projects in the energy saving field is defined by the usage of modern methods of conducting it. Therewith the assessment should be based on the following groups of principles [1]:

1) principles of effectiveness (objectivity, systematic approach, complexity, limitation and alternative cost of resources);

2) principles of specificity (divergence of interests, dynamic, multi-temporal disparity between costs and benefits, incomplete information, risks and possible changes in the project settings).

Situation with energy saving in the most critical areas – housing and communal services, and budgetary sphere – deserves special attention. Recently, the situation with payment for consumed energy has much more complicated at the level of the final consumers caused by the sharp increase in utility tariffs. Herewith, heat consumption is the main component of the utilities cost. For example, the cost of heat provision for the budget sector in 2012–2016 was 70–80 %, and for the civil buildings – 50–60 %.

To solve the above mentioned problems, one is advised to follow recommendations [2, 3], covering issues of thermohomes and aimed at improving thermal performance of walling by insulating houses, technical re-equipment of intrahouse engineering systems to reduce power consumption and ensure optimal parameters of microclimate in the premises of these civil buildings.

One of the main means of thermomodernization is solutions for the automation and dispatching the buildings engineering systems, as well as technologies of monitoring their energy consumption [4–6].

Thus, energy saving solutions may have different performance indicators in different fields of applications (budget, business and municipal) in relation to the various initial data: the purpose of the building, the mode of use, etc. Besides, there is a certain inconsistency and subjectivity in the determination of tariffs, cost saving measures, resources savings, and the like; levelling seasonal fluctuations and inflation. So, it is necessary to use a system of restrictive factors that may account for changes in the input parameters of the objects of modernization: the scope, the mode of the building usage, technical characteristics of walling, etc. with the aim of increasing validity and reliability of the methods of evaluating effectiveness of implementing solutions for energy saving in civil buildings in an unstable economic environment. Therefore, the aim of this work is to substantiate the methodology for assessing effectiveness of implementation of the energy-saving solutions in the supply systems of various buildings.

EXPERIMENTAL PART AND RESULTS OBTAINED. The main problems of the energy saving in buildings are low rates of heat insulation in building structures, imperfection of the account of thermal energy consumption, lack of regulation of the heat load, autumn and spring excessive heating, etc. Today, these problems must be solved not only at the level of the utility sector, but also at the state level. Thus, the Ministry of Housing and Communal Services of Ukraine undertakes measures aimed at creating the mechanisms of economic interest of producers, suppliers and consumers, including residents of apartment buildings in the implementation of energy-saving technologies, such as thermomodernization, energy monitoring, saving energy consumption, energy management.

The relationship scheme of problems in the heating systems of buildings, energy efficiency measures in accordance with the characteristics of certain consumers of energy resources is presented in Fig. 1.

In modern conditions a significant number of methods and techniques for the effective implementation of energy saving technologies are developed and implemented. The analysis of existing evaluation methods [7–13], allows making its classification (Fig. 2), including static, dynamic, thermodynamic methods.

The methods of thermodynamic analysis includes determination of the macro energy criterion [8], enthalpy and exergy [9] methods and is based on the relationship between thermodynamic and economic characteristics of obtaining energy resource. In this case, any costs caused by the inefficiency of the technological subsystem, have two sides: the amount of resources expended and the funds necessary to offset these costs.

The ratio $\eta = Q_{inflow} / Q_{loss}$ is considered as a macro-energetic criterion where Q_{inflow}, Q_{loss} heat inflow and heat losses of the building, kW.

The primary analysis of this criterion shows that when $Q_{inflow} > Q_{loss}$, $\eta > 1.0$, the excessive heating of the building takes place and vice versa. When $\eta < 1$, the house is not sufficiently heated. The change in the range from 0.97 to 1.03 indicates maintaining comfortable conditions inside the house [8].

The main differences of enthalpy and exergy methods in terms of district heating are listed in Tab. 1 [9].

Methods assessing effectiveness is based on the static indicators used for preliminary assessment of the project. When comparing several projects at the same static targets there may be different risks in projects, lifetime of the investment project, which really affect its efficiency [10].

The basis of dynamic approaches to efficiency assessment of investment projects are such indicators as net present value cash flows (NPV), internal rate of return (IRR), discounted payback period of investment (BPB) and profitability index (PI). In general, dynamic methods take into account the cost of capital through time that allows estimating the profits lost from the choice of a particular method of the resource use, that is, the economic value of the resources [11].

As the basis for the methodology of assessing effectiveness implementing energy saving solutions in civil buildings, we have chosen the discount method because it allows determining the fair value of future cash flows by compound interest rule [12, 13]. In this case, the discounting is used in the evaluation of energy saving projects in the municipal energy sector requires additional consideration of the peculiarities of thermofacilities, existing and projected energy rates, etc.

Net present value, profitability index, internal rate of return, discounted payback period (Tab. 2) are taken as the basic indicators of investment project efficiency in the field of energy saving based on the dynamic method using developed system constraints.

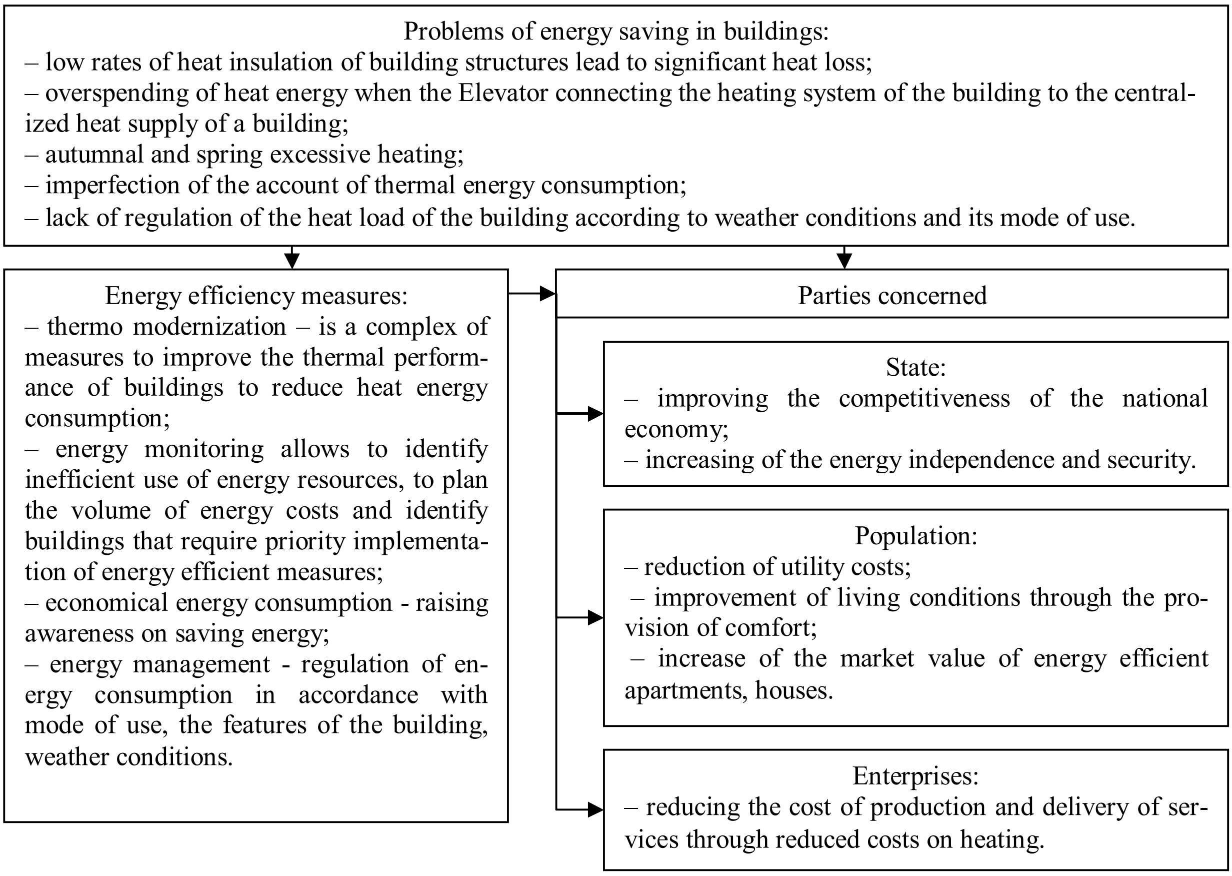

Figure 1 – Issues of the energy saving and peculiarities of realizing energy efficient measures in heat supply systems of different building

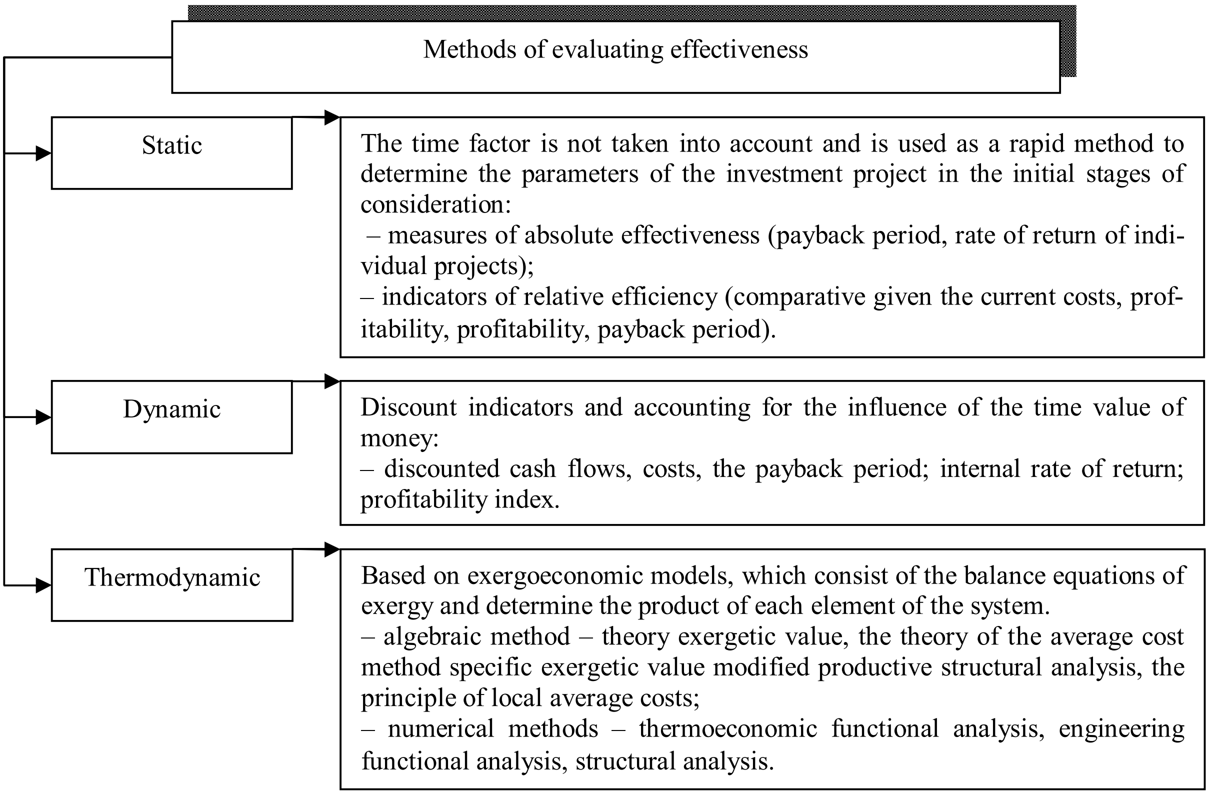

Figure 2 – Methodological approach to the assessment of energy saving measures

Table 1 – The differences between enthalpy and exergy methods

Enthalpy method	Exergy method
The method is based on the first law of thermodynamics and ignores the second law	The method takes into account both the first and the second laws of thermodynamics
The energy of the system does not depend on parameters	Exergy depends on the parameters of the environment
The energy of the system is always bigger than zero	Exergy is equal to zero when environmental parameters equals zero
Maximum energy loss in the cold source (condenser) heat power installations	Minimum exergy loss in the cold source (condenser) heat power installations
All fuel savings from district heating refers to production of electricity	Fuel savings from district heating refers to production of heat supplied by the user
Real combined heat and power plants (CHP, heat pumps and others) may have efficiency greater than 100 %	Real thermal power plants of any type always have efficiency less than 100 %

Table 2 – Efficiency indicators of the investment project in energy saving

Indicator	Net present value, NPV, UAH	Profitability index (PI)	Internal rate of return (IRR), %	Discounted payback period (VRV), years
Essence	It is defined as the difference between the future value of the stream of expected revenues and the present value of current and future costs of the project throughout its cycle	Ratio of the sum of the mentioned effects and the value of primary investments. Allows determining how much investor's capital will increase per monetary unit of investment costs	The interest rate at which the revenue from the project equals the cost of the investment project	It is a criterial basis for determining feasibility of projects
The method of calculation	$NPV=\sum_{t=0}^{t=T}\frac{CF_t}{(1+r)^t}-\sum_{t=0}^{t=T}\frac{(C_0)_t}{(1+r)^t}$	$PI=\frac{\sum_{t=0}^{T}\frac{CF_t}{(1+r)^t}-\sum_{t=0}^{T}\frac{(C_0)_t}{(1+r)^t}}{\sum_{t=0}^{T}\frac{(C_0)_t}{(1+r)^t}}$	$\sum_{t=1}^{T}\frac{CF_t}{(1+IRR)^t}-I_0=0$	$C_0=\sum_{t=1}^{BPB}\frac{CF_t}{(1+r)^t}$
Admissibility criteria for solutions	*NPV*>0 Incomes exceed expenses. The project can be recommended for funding	*PI*>1 Project is attractive for investments and will favour increase of the enterprise's capital and its market price. The project can be implemented	$IRR > r$ If IRR exceed the normal discount rate, the project can be recommended for financing	$BPB < BPB_{basis}$ The project is adopted
	NPV=0 The project income will be sufficient only to recover the invested capital. The project is break-even	*PI*=1 The project is break-even. It can be accepted with additional conditions	$IRR = r$ The project requires additional analysis	$BPB = BPB_{basis}$ The project is adopted
	NPV < 0 Income is less than promary expenditures. The project is not adopted	*PI* < 1 The project is unprofitable and it should be rejected	$IRR < r$ The investment doesn't pay off. The project is rejected	$BPB > BPB_{basis}$ The project is rejected

Notations adopted in Tab. 2: CF_t – cash flow of the year t, C_0 – initial investment, T – economic lifetime of the investment, t – number of years from the beginning of the project, r – interest rate of return required from the project.

To assess the suitability of one or another energy-efficient solution, certain eligibility criteria are used, which define numeric ranges of performance indicators, designed on thr life cycle of the project. The most acceptable is the solution characterized by positive discount income, profitability index is greater than one, the rate of return more than the value of internal regulations and minimum payback period.

One of the main obstacles to implementation of energy saving technologies is the lack of funding, which is mainly caused by limited possibilities of enterprises and population to self-financing its own investment energy saving projects (Tab. 3) [14].

Table 3 – Sources of financing energy saving measures in Ukraine

Sources of funding	Advantages	Disadvantages
Self-financing (own funds of enterprises, organizations and population)	– easiness of attractiveness; – independence from creditors; – lack of loan interest; – opportunity not to disclose commercial information; – no additional costs; – ensuring financial sustainability of the enterprise, its solvency in the long term, reducing the risk of bankruptcy	– insufficient own financial resources; – freezing own funds at the time of project implementation; – limit of development rates; – the risk of a shortfall in the expected level of profit; – risk of conflicts between the owners (reluctance to invest); – lack of external control over the use of funds
Borrowed funds (long-term loans from financial institutions, performance contracts)	– reasonably fast method of obtaining large amounts of financial resources; – strict external control; – no need in initial own capital to finance the project at the initial stage; – possibility of loss of ownership and control	– probability of losing control; – increasing payback period; – savings due to the project need to share with the lender; – additional costs for execution (assessment, insurance, pledge, surety), debt dependence, disclosure of commercial information; – risk of insolvency, increase in interest rates
Raised funds (state and local budgets, domestic and foreign investment: grants, international programs)	– do not require repayment; – possibility of preferential use of financial resources; – diversification of funding sources; – additional non-financial support	– bias of competitive selection of investment projects; – limited financial resources for large-scale projects; – delay the commercialization of energy efficient solutions; – strict usage of funds; – need in disclosure of commercial information

An automated system for monitoring and control of heat consumption is considered as a basic energy saving solution that improves the energy efficiency of heat supply systems of various buildings [5]. This solution allows improving energy efficiency of buildings due to weather and operational regulation of their consumption by performing the following activities:

1) assessment of the current energy consumption of the building;

2) analysis of the efficiency of energy conversion;

3) formation of the necessary modes of the building operation, providing the necessary parameters of engineering systems and optimization of the energy consumption.

The decision is based on the developed automated system of operational control and remote control of heat consumption of buildings (patent for useful model No. 85772 from 25.11.2013, bull. No. 25), which has a modular architecture that uses industrial equipment, industrial communication protocols between levels of local telecommunication network of the University and special software. The local level of the automated system includes a subsystem based on the measuring, executive, and regulatory elements that implement collecting and processing signals about the state of the building's heating and automatic mode, through the use of the developed software (certificate for the work No. 50946 from 27.08.2013) [6], change of heat consumption according to the weather depending algorithms. The server level of the system includes special software dispatch level (certificate of work No. 56600 23.09.2014) and allows managing a single local sub-systems on energy efficiency indicators.

The proposed solution promotes the visual and interactive comparative analysis of the absolute and specific consumption of heat energy by buildings from various time periods, it also promotes reduction of heat consumption due to the operational management of the equipment of calorific point. Also, the project has not only economic efficiency but also social (improvement of living and cultural living conditions, health status of employees and population) and environmental (increased energy and environmental security at the expense of optimizing energy consumption) ones.

The main advantages of the proposed solution include:

− an integrated approach: combination of thermal modernization, monitoring and conservation of energy use;

− versatility: possibility of application in different fields: public sector, businesses and citizens;

− individuality: ability to customize with the features of the building;

− interactivity: interactive and visual comparative analysis of absolute and specific energy consumption of buildings for certain types of energy and different time periods: hour, day, week, month, year, season.

Implementation of the proposed solution should be carried out in three phases: preparatory, investment and operational (Fig. 3).

At the same time, the main stage includes:

− modernization of the heat substation of the building by the installation of equipment for weather-compensated temperature control fluid;

− installation of devices for remote monitoring and control of equipment of calorific point of the building;

− introduction in practice the exploitation of buildings information support with web access for on-line analysis and control of their heat consumption.

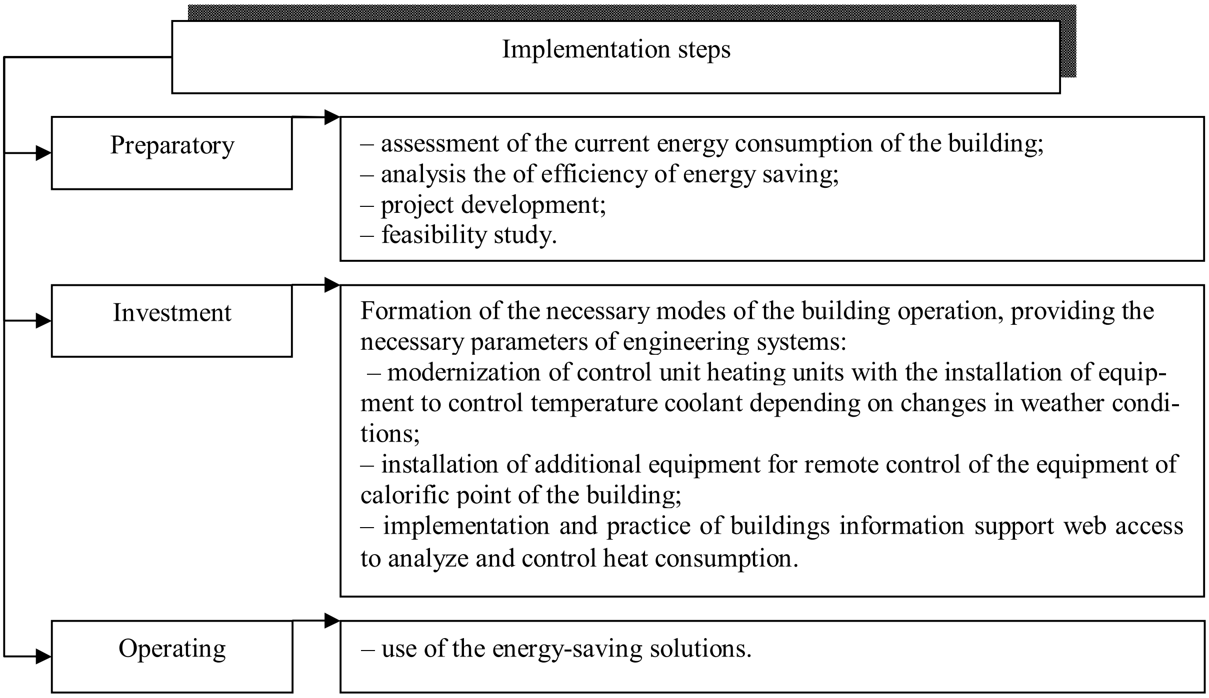

Figure 3 – Stages of implementing the proposed solution

To demonstrate the effectiveness of the proposed energy saving solutions we have calculated the main efficiency indicators of the investment project for the building of the Executive Committee of Kremenchuck city Council, Poltava region (Tab. 4–6). The node of the heat entering the building of the Executive Committee of Kremenchuck city Council, Poltava region must be upgraded. Its characteristics: heat load – 0.295 Gcal/h; volume − 2.2452.3 m^3; heated area – 5,700 m^2; number of floors − 5; regulation type of the heat load − central quality at the temperature chart; connecting the heating system of the house to the district heating system is dependent with the Elevator; heat meter − installed equipment to measure, but not used. Basic level of consumption is 770 Gcal for the heating period.

The building is located in the first climate zone, the normative parameters of heating period in accordance with DSTU-NBV.1.1-27:2010 "Construction climatology" are: $Z = 178$ – duration of the heating period, days; $T_{out} = -0{,}8$ °C medium regulatory ambient outside air temperature; $T_{in} = 18°$ medium regulatory ambient of the air temperature; °C; $D_d = Z(T_{in} - T_{out}) = 3346$ – number of degrees in the day for the building.

The analysis shows that the state of pipes in the heating room is satisfactory. However, there is no thermal insulation on the piping that leads to losing thermal energy and increasing above the standard microclimatic indicators in the thermal point due additional heat gain from uninsulated piping. There are no devices for regulating flow distribution between hydraulic rings and risers of the heating system. There is no possibility of automatic regulation of heat consumption according to the outside air temperature and usage of the building. Thus, the existing heating system is in urgent need of reconstruction, modernization and optimization using modern efficient equipment and implementing energy-saving technologies.

To solve the above described problems, it is necessary to install equipment to improve the hydraulic and thermal conditions in the extreme branches of the heating system of the building being in use. As in the standard circuits, electric valve, temperature sensors and electronic weather regulator provide regulation of the flow temperature depending on the weather conditions. The Energy Manager of the Executive Committee is included for remote control and management of ITP in the composition of the control system a data acquisition device with a communication interface with the workstation The Energy Manager installs special software on PC that monitors coolant temperature, air inside and outside the premises; change set points and settings of weather controller, storing information about the heat item in the file and the database.

The total investment cost of the project is 10.5 thousand US dollars, at the official NBU rate on 14.06.2015: 2.496.8681 UAH for 100 US dollars. Thus, the economic lifetime of the investment project is 10 years and the project implementation period is up to six months. The calculation of the performance indicators by the method of discounting (Tab. 2) is performed for different discount rates for different values of the projected heat energy saving due to the implementation of energy saving solutions (Tab. 4–6). The figures for the discount rate of 0.25 (credit funds) and 30 % projected savings are: net present value, NPV – 1 054 171 UAH; profitability index, PI – 4.4; the internal rate of return, IRR – 100.7 %; discounted payback period, DPP – 1.83 years. According to the adopted criteria Tab. 2 the project can be recommended for implementation.

Table 4 – The main efficiency indicators of the project using own funds

r=0.1	Economy of thermal energy, Gcal; %				
	53.9; 7	57.75; 8	77; 10	154; 20	231; 30
NPV, ths. UAN	248.5	333.7	504	1355.7	2207.3
PI	0.93	1.25	1.89	5.09	8.29
IRR, %	5.5	13.8	27.4	80.2	128.2
BPB, years	5.01	4.35	3.52	2.12	1.73

Table 5 – The main efficiency indicators of the project at the current discount rate of the NBU

r=0.18	Economy of thermal energy, Gcal; %				
	69.3; 9	84.7; 11	115.5; 15	154; 20	231; 30
NPV, ths. UAN	234.8	359.4	608.5	920	1542.9
PI	0.88	1.35	2.28	3.45	5.79
IRR, %	9.3	22.5	43.9	67.7	112.6
BPB, years	4.42	3.57	2.72	2.22	1.78

The analysis indicates the feasibility of applying developed solutions for objects of budgetary sphere and houses, as the criterion for acceptability of an investment project is considered the following condition: the value of PI must be greater than one. If PI is less than one, the project is considered inefficient, if it equals one, the project is break-even.

Table 6 – The main efficiency indicators when you use a credit at 25 % per annum

r=0.25	Economy of thermal energy, Gcal; %				
	77; 10	92.4; 12	130.9; 17	154; 20	231; 30
NPV, ths. UAN	181.3	280.3	533.6	676.2	1171
PI	0.68	1.05	2.00	2.54	4.4
IRR, %	6.4	19.1	44.9	57.9	100.7
BPB, years	4.42	3.59	2.61	2.33	1.83

Furthermore, the proposed solution by the adjusted methodology is assessed for buildings spewing heat load, but for different purposes (Tab. 7, Fig. 4). So, the duration of use and internal temperature of University building of the company is equal – five working days, two weekends. The tariffs for thermal energy in the enterprise are larger. The house should have higher temperature. The tariff is lower herewith.

Table 7 – Basic efficiency indicators of project for different types of buildings

Indicator	University, building	house	enterprise
NPV, ths. UAN	719.601	351.257	172.184
PI	4.12	2.01	0.99
IRR, %	133.1	79.37	54
BPB, years	2.1	3.8	5.9.

For businesses, the proposed solution can be considered break-even. It is important to add that the results of calculations will improve with decreasing levels of inflation in the country in this case, the results for the dynamic method are closer to the results of static one. The tariff rates and the volume of economy from the basic consumption (direct influence) have a great influence on the value of money flows on the project.

Thus, the developed solution is the most effective for objects of budgetary sphere, a comparison of the effectiveness of its application for pre-schools (KINDERGARTENS) and comprehensive schools (SOSH) m. Kremenchuck (Tab. 8, 9) for objects of budgetary sphere is carried out.

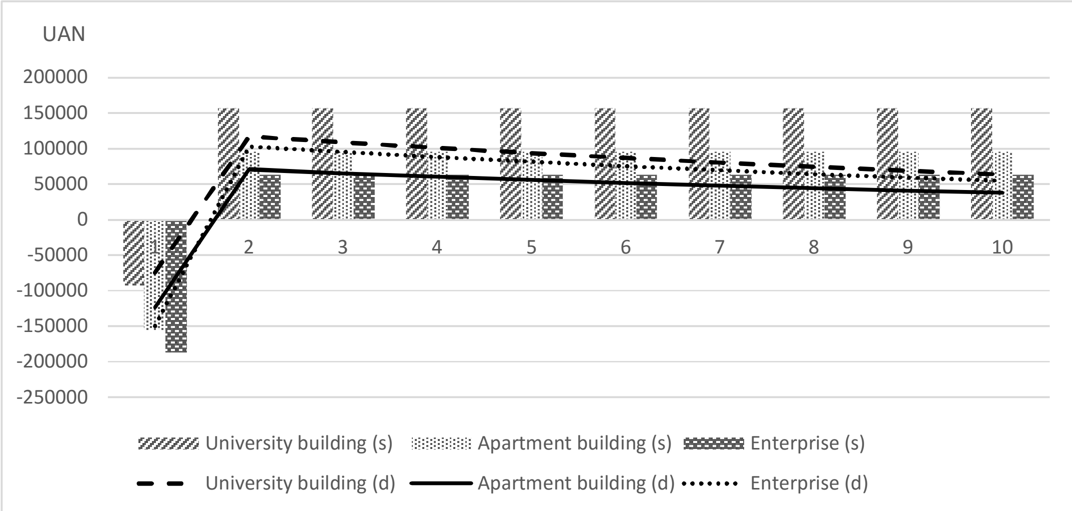

Figure 4 – Money flows in the year t (static and dynamic methods), UAH

Table 8 – Baseline data for comparison of efficiency of energy-saving solutions for budgetary sector institutions

	The amount of space, м^3	Load, Gcal/year	Basic consumption, Gcal	Rate, UAH	Capital costs, ths. UAH	Current costs, UAH	Savings from baseline consumption	
							%	Gcal
DOE № 3	13189	0.2400	361.5	1420.51	220	6594	15	54.2
DOE № 5	14706	0.2728	404.0	1420.51	220	6594	15	60.6
DOE № 25	4307	0.1022	202.5	1420.51	220	6594	15	30.4
DOE № 33	10790	0.2781	377.0	1420.51	220	6594	15	56.6
SOSH № 1	18337	0.6916	587.5	1420.51	220	6594	30	176.3
SOSH № 9	20031	0.2581	336.0	1420.51	220	6594	30	100.8
SOSH № 26	17286	0.3763	478.0	1420.51	220	6594	30	143.4
SOSH № 29	18128	0.2501	150.5	1420.51	220	6594	30	45.2

Table 9 – Efficiency indicators of investment for budget sector institutions

Indicator	DOE № 3	DOE № 5	DOE № 25	DOE № 33	SOSH № 1	SOSH № 9	SOSH № 26	SOSH № 29
NPV, ths. UAH	237.4	289	45.4	256.8	1222.2	613.2	956.9	164.8
PI	1.55	1.88	0.30	1.67	7.96	4.00	6.23	1.07
ARR, %	68.06	76.45	36.86	71.20	228.13	129.15	185.00	56.26
BPB, years	4.4	3.3	9.9	4.2	1.2	2.2	1.5	5.6

According to Tab. 8 and 9, the efficiency of the investment project in the field of energy efficiency is acceptable to all the budgetary sector institutions except the secondary school № 25 (PI less than one). The reason of the low efficiency for the secondary school № 25 is the low amount of savings from the baseline consumption – only 30.4 Gcal, formed due to the smallest space of all the institutions in the sample (4307 m3). Also the proposed solution for school No. 29 (PI is 1.07) can be considered not enough effective. The reason of the low efficiency for the secondary school № 29 is the low amount of savings from the baseline consumption – only 150.5 Gcal, the low amount of the economy from the baseline consumption (45.2 Gcal). Overall, the highest level of effectiveness in secondary schools compared to primary educational institutions is due to higher percentage savings from baseline (30 % vs. 15 %) in less time of buildings use.

CONCLUSIONS. Proposals to supplement existing methods of determining the economic effect from implementation of investment projects in the field of energy conservation are developed through the introduction of additional restrictive factors, that could account for the changes of input parameters. This allowed to form the following advantages of the proposed solution: integrated approach, versatility, individuality, interactiv-

ity. The authors consider the features of technical solutions with the automation and dispatching of heating of the administrative building of the Executive Committee of Kremenchuck city Council, Poltava region using the discounted flow method to calculate cost and technical performance. and analyse the results proving that the proposed solution meets the demands of the discounting method.

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ОСОБЕННОСТИ ОЦЕНКИ ЭКОНОМИЧЕСКОЙ ЭФФЕКТИВНОСТИ ВНЕДРЕНИЯ ЭНЕРГОСБЕРЕГАЮЩИХ РЕШЕНИЙ В ГРАЖДАНСКИХ ЗДАНИЯХ

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В условиях политической нестабильности, финансово-экономического кризиса, усиления глобализации и повышения требований к социальной ответственности в обществе вопросы энергосбережения и повышения энергоэффективности можно рассматривать в качестве экономического и социального стабилизаторов. При внедрении мероприятий по энергосбережению необходимо учитывать особенности объектов модернизации, характеристики технических решений, переменный характер тарифов на коммунальные услуги. В работе рассмотрены методы оценки эффективности при внедрении энергоэффективных решений в системы теплоснабжения гражданских зданий. Обосновано использование метода дисконтирования с учетом дополнительных факторов изменения входных параметров объектов модернизации. Представлены преимущества и недостатки различных вариантов финансирования энергосберегающих мероприятий в Украине. В качестве базового энергосберегающего решения, внедрение которого улучшает энергоэффективность систем теплоснабжения зданий различного назначения, рассматривается автоматизированная система мониторинга и управления их теплопотреблением. Внедрение такого решения позволяет оптимизировать работу систем отопления жилых и общественных зданий в зависимости от условий окружающей среды, их характеристик и режима использования. Для наглядной демонстрации эффективности предложенного энергосберегающего решения рассчитаны его основные показатели эффективности для зданий исполнительного комитета Кременчугского городского совета Полтавской области, детских учебных заведений и общеобразовательных школ г. Кременчуга. В соответствии с принятыми в работе критериями предлагаемое решение можно рекомендовать к внедрению в практику эксплуатации зданий различного назначения.

Ключевые слова: энергосбережение, экономическая эффективность, автоматизация, диспетчеризация, методы оценки эффективности.

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