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DEVELOPMENT OF ENERGY MANAGEMENT SYSTEM IN ACCORDANCE WITH ISO 50000:2011 REQUIREMENTS FOR MUNICIPAL INSTITUTIONS

Table of contents

INTRODUCTION

Today, important tasks for any organization are saving of energy resources and rising of energy efficiency, because significant share of expenses is payments for fuel and energy resources (FER). World practice shows that energy efficiency can be achieved not only by technical measures, but also due to organization changes in management system of institutions and organizations. Energy management system [1] allows controlling the use of energy resources, identifying the most effective ways to reduce its consumption, thus allowing to reduce expenses on fuel, electric power, heat energy and water resources.

Energy management in accordance with GOST R 50001-2012 definition [2] is a complex of interrelated and interacting elements, aimed at formation of energy policy, development of objectives and measures to achieve these goals. This standard is applicable for all types of organizations, and system implementation is very effective not only in manufacturing industry but also in municipal sector. Main goal of the energy management from our point of view is not just a measures development for energy efficiency improvement, but also creation of a mechanism that will give reliable information about current consumption, dynamics of its changes and will help in creation of awarding system that will generate incentives for all employees who participated in energy saving measures.

Energy management system (EnMS) allows getting information about energy efficiency within the regions or organizations and its branches as well as identifying of the energy resources over-expenditure and narrow places. All this makes possible optimization of finance and systematic minimization of other costs.

The urgency of this work is caused by requirements of the Federal Law No. 261-FZ "On energy saving and energy efficiency increasing ", where is stated the reduction mandatory on energy consumption at municipal institutions. Attempts to solve problem of energy efficiency in public sector have been repeatedly confirmed by considerable number of publications. But most of these works are concentrated on private objectives and individual institutions, while insufficient attention is paid to formulation and system implementation of energy efficiency tasks at departments and municipalities. At global level, the problem of efficient energy management is mostly considered on example of industry facilities or building's projects, but not on the objects that implements services to existing buildings. Therefore scientific-based system methods for solution the identified problems are currently not exist.

Objective: creation of systematic and methodology base for energy management system in municipalities based on scientific methods of evaluation and monitoring the energy efficiency and creation efficiency evaluation system for institutions or organizations that performs administrative, educational, social, cultural or other functions and ensure effective investment in energy saving measures.

Key words: energy management, energy efficiency, energy savings, standardization, certification, municipal institutions.

1. ENERGY MANAGEMENT AS A MODERN TOOL FOR ENERGY SAVINGS

1.1. Energy management based on ISO 50001 – foundation of competitiveness for enterprises and organizations

Energy management system allows controlling the energy consumption, identifying the most effective ways to minimize it, thus allowing costs reducing on fuel, power, thermal energy and water resources for institutions and organizations [3].

After introduction of EnMS at metallurgical factory "Zapovednik-rostal" (Ukraine) they have managed to reduce consumption of natural gas by 3% at first half of the year and about 5% by the second year. Introduction of energy management system into municipal institutions of Kamensk-Uralsky have shown 5% of energy savings per year. These results are not isolated, and can be achieved by all enterprises and organizations.

Nowadays it is more than 400 of organizations in the world that have implemented energy management system and already certified under international standard ISO 50001.

By itself, ISO 50001 means continuous improvement. The cycle consists of following phases: 1) planning; 2) implementation; 3) inspection; 4) development. Thereby, company will receive structured guide of energy consumption optimization and management system of this process.

Process of implementation the energy management system lasts at least nine months in general. By expiration time it is performed the internal audit for analyzing of functioning within energy management system. And then if company or organization is interested in certification there will be carry out the precertification and certification audits. After receiving the certificate it may be conducted the consulting audit during following three years and later recertification audit in order to confirm proper functioning of the system.

It is important to note that potential of the energy management system is very high, and certification under international standard allows having successful partnership. Even at the initial phase with zero investment in EnMS the introduction of the system allows achieving significant savings, due to energy consumption that takes in average about 25% form the total costs in municipal institutions.

Final task for EnMS is reducing of energy costs that will systematically minimize and optimize financial and resource expenses and therefore main goal is to accomplish investments in the most efficient measures to achieve benefits and returning of invested funds as soon as it possible (Fig.1).

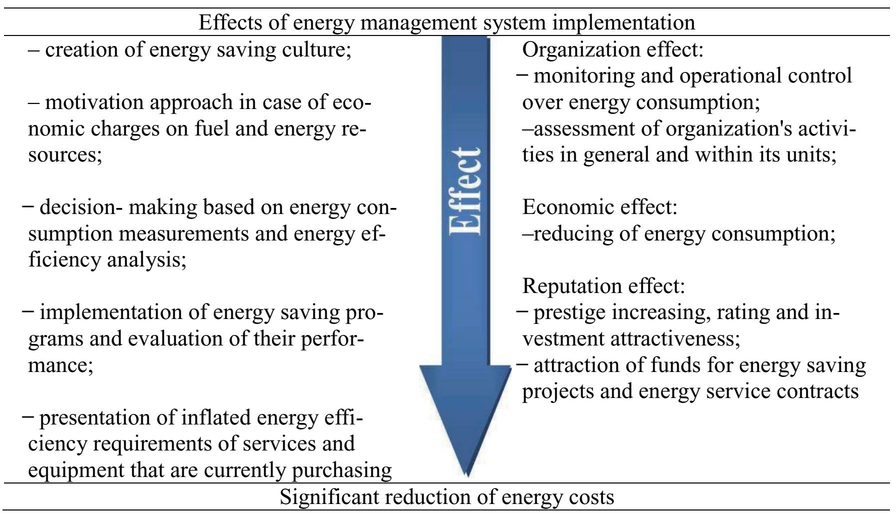


Fig. 1. Effects from introduction the energy management system

ISO 50001:2011 does not contain pre-established energy efficiency indicators and energy management is carried out towards primarily to the large energy consumers because such type of consumers where are having greater possibilities for energy efficiency rising.

Stages of system implementation

Implementation process includes following stages:

1. Diagnostic audit which corresponds with ISO 50001 international standard requirements. Audit consists of documents analysis, verification of its compliance with necessary requirements, and practical procedures standard rather than just "technical" surveys of equipment and facilities.

2. Training for employees.

3. Development and implementation of individual energy management system.

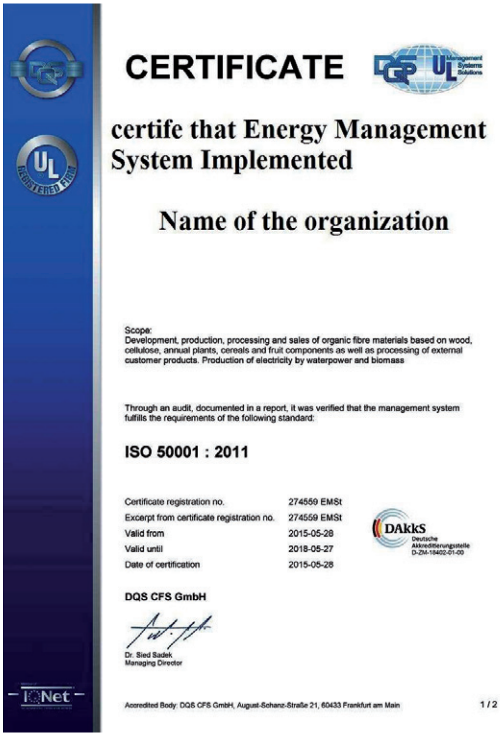
4. Confirmation of tasks execution by internal and precertification audit.

5. Certification audit by international company.

The issued certificate is valid for three years. For its confirmation it is necessary to precede the supervisory audit after 11 and 24 months. At the end of certificate validity period (Fig. 2) it can be prolonged with recertification audit.

1.2. Comparison of Russian and International standards for energy management system implementation

Energy management system is based on national and international standards. Ordinary, development of international standards is based on national projects



CERTIFICATE

certife that Energy Management System Implemented

Name of the organization

Scope:
Development, production, processing and sales of organic fibre materials based on wood, cellulose, annual plants, cereals and fruit components as well as processing of external customer products. Production of electricity by waterpower and biomass

Through an audit, documented in a report, it was verified that the management system fulfills the requirements of the following standard:

ISO 50001 : 2011

Certificate registration no.	274559 EMSt
Excerpt from certificate registration no.	274559 EMSt
Valid from	2015-05-28
Valid until	2018-05-27
Date of certification	2015-05-28

DAkkS Deutsche Akkreditierungsstelle D-ZM-18402-01-00

DQS CFS GmbH

Dr. Sied Sadek
Managing Director

Accredited Body: DQS CFS GmbH, August-Schanz-Straße 21, 60433 Frankfurt am Main 1 / 2

Fig. 2. Certificate of ISO 50001:2011 implementation

and managed to prove its effectiveness in the issue of energy saving. The predecessors of ISO 50001:2011 "Energy management systems. Requirements with guidance for use" had been standards from several countries: USA (ANSI/MSE 2000:2008), South Korea (KS A 4000:2007), China (GB/T 23331:20009) and PanEuropean energy management standard EN 16001:2009. Implementation of energy management system based on requirements of ISO 50001 has already obtained the national status in sixteen European countries.

Russia Federation applies domestic standardization system, so it was decided to create a technical committee that will develop a national standard to adopt internationally well-known approach. Representatives of our country were not involved in discussion process by international organization standardization on ISO 50001 therefore situation with creating national approach becomes significantly complicated from position of borrowing and developing the best suitable practices for domestic organizations and institutions. Further there are peculiarities in Russian national standard GOST R ISO 50001:2012 that have been caused difficulties within applying international energy management methodology in accordance with existing regulations of Russian federal legislation.

In fact GOST R 50001 is a translation of main ISO 50001 provisions. The problem is in correctness of Russian translation of terms and disagreements with applicable laws and regulations in accordance with GOST R 53905-2010 "Energy savings. Terms and definitions", where are fixed and determined 108 terms and some of definitions differ from those that are indicated in GOST R 50001.

Further there are examples of translated terminology from International energy management system standard and definitions in accordance with normative documents in Russia.

Differences in term definitions of energy management systems

GOST R 50001-2012 term: energy management system is set of elements interconnected and interacting with each other that based on energy policy, its goals, processes and procedures that allows achieving of these goals.

GOST R 53905-2010 term: energy management system is complex of measures aimed to automate process of energy accounting, identification and elimination of irrational energy consumption and to maintain reasonable energy consumption through the technology processes.

Terms definition in GOST R 50001-2012 does not specified all peculiarities, focusing only on targeted energy saving measures, forming simplified representation of EnMS content, structure and modules.

Definition of energy efficiency terms

Interpretation of term ISO 50001:2011: "Energy performance" vs term GOST R 50001-2012: "Energy efficiency".

In translation it cannot be applied the word "*effectiveness*" instead of "*performance*" because English-Russian dictionaries do not provide such an option and literal translation for this term is efficiency or productivity. In Federal law No. 261-FZ and GOST R 54195-2010, GOST R 54196-2010, GOST R 54197-2010 is being used standard term "Level of energy efficiency". Application of proposed above alternative translation "energy efficiency" helps to put up together GOST R 50001-2012 approach and Russian standards.

Differences in terminology between standard and law

Definition in accordance with GOST R 50001:2012: Energy efficiency is ratio or other quantitative relationship between efforts, services and produced goods or energy that were input and consumed.

Definition according to Federal Law No. 261-FZ: Energy efficiency is description reflecting the ratio of useful effect from energy resources application to energy resources costs, that have been incurred in order to obtain this effect, and applied to products, technology process, legal entity or individual entrepreneur.

The definition given by the Federal Law is more accurate and can refer to process or product and to type of activity.

For getting information about current state of energy consumption in ISO is carried out the energy analysis. In accordance with Russian regulatory documents it should be accomplished with the energy survey.

Definition in accordance with GOST R 50001:2012: Energy analysis is determination of energy performance in organization that based on data and other information that allows identifying of opportunities for activities improvement.

Definition in Federal Law No. 261-FZ: Energy survey is collection and processing of information about energy resources usage in order to obtain reliable data on energy consumption, energy efficiency, identifying opportunities of energy saving and energy efficiency with reflection of received results in energy passport.

Federal law No. 261-FZ survey requirements in comparison with GOST 50001:2011 one described more accurately and widely. Table 1 shows examples of comparison between ISO 50001:2011 and Federal law provisions No. 261-FZ. Note that energy management system works continuously, while energy audit is carried out every five years.

Comparison of quality management system and energy management systems

Quality management system (QMS) is management approach that relies on participation of all employees (staff in all divisions and at all levels of organizational structure).

Standard GOST R ISO 50001:2012 sets up the requirements which applicable to energy usage and consumption mode, including measurements, documentation and reporting, designing and practices addressed to equipment, systems, processes and personals in the field of energy that necessary for organization functioning.

Table 1

Comparison of ISO 50001 with Federal law No. 261-FZ provisions within energy management system

ISO 50001:2011 provisions	Federal law No. 261-FZ provisions
Energy analysis and energy survey goals	
For energy review development organization should: a) assist analyzing of applied and consumed energy, based on measurements and other data, i.e.: – identifying available sources of energy; – conducting an assessment of current energy use and consumption within last periods. b) identify areas of significant energy use based on energy consumption analysis, i.e. – identifying other variables that effects on large energy consumption; – determining of current energy performance of building's, equipment condition, systems and processes related to large energy consumption; – assess future use and energy consumption; c) identify, prioritize and register opportunities to improve energy outputs	Main objectives of energy audit are: 1) obtaining objective data on amount of used energy resources; 2) determination of energy efficiency; 3) determination of potential for energy saving and energy efficiency; 4) development a set of measures on energy saving and energy efficiency increasing and estimation of their cost [4]
Periodicity	
Through the planned intervals, organization should evaluate compliance of its activity with legal and other requirements; that it has committed to perform and that are related to energy consumption	Obligatory power inspection is conducted not less than once every five years, the frequency at voluntary screening is not set

Therefore, approach for developing the EnMS system should be different than applied for QMS. The main thing in EnMS is not regulation of technological and business processes, but monitoring and analysis of energy consumption.

1.3. Conclusions

In standard GOST R 50001:2011 that Russia has adopted there are number of differences in terms and definitions in comparison with other Russian laws and regulations. This complicates implementation of the energy management system at Russian enterprises and organizations. Therefore, during the certification process it should be given the coordinate discrepancies of work in accordance with national legal system, all provisions and requirements as well as clear understanding of used terms that will significantly simplify process of GOST R 50001:2011 implementing.

2. ANALYSIS OF ENERGY CONSUMPTION IN PUBLIC INSTITUTIONS

2.1. Energy consumption analysis of Belgorod

To analyze the effectiveness form implementation of energy management system there have been considered structures of energy consumption in Belgorod.

Structure of energy consumption in Belgorod is presented in Table 2 and Fig.3.

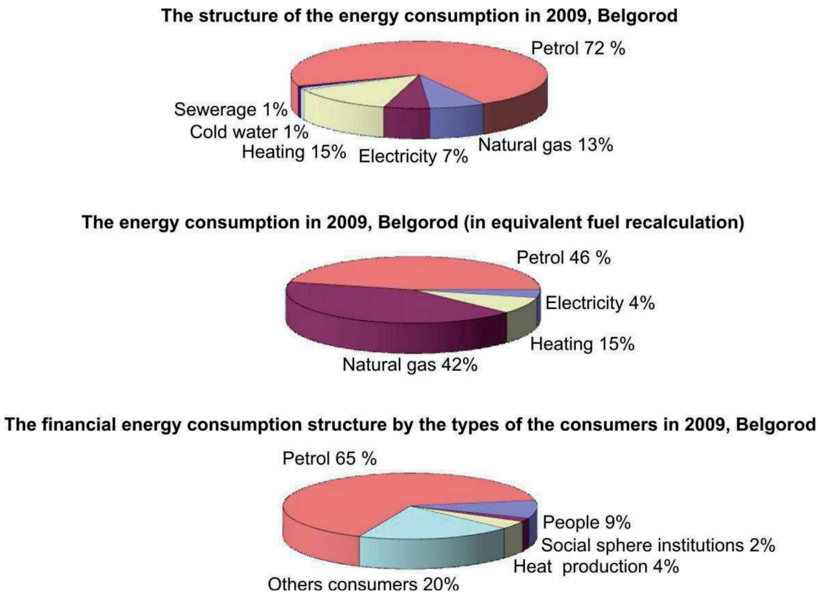


Fig.3. Structure of energy consumption in Belgorod city

Table 2

Energy consumption in municipal institutions and organizations, Belgorod 2009

Name		Government management establishments	Education	Culture	Public health and Social policy	Municipal enterprise	Total, according to budget establishments	Total
Number of objects		21	129	34	63	164	247	411
Nnumber of people								
staff		1991	7460	821	5888	1919	16160	18079
students (full time and half time day)		– / 604	46410 / –	– /5161	–	–	46410/5765	46410
visitors		503968		790286	3141703	3760	4435957	4439717
Total square, m^2		41370,6	421732,9	18252,1	148810,9	43237,7	630166,5	673404,2
Total energy consumption in 2009, thou. rub		37256,10	142820,09	4323,20	59169,52	181070,64	243568,91	424639,55
Electric power	Thou. kW	12715,97	9935,47	454,75	6387,43	100942,53	29493,62	130436,15
	Thou. rub	25496,19	20467,06	914,80	12798,04	173318,73	59676,09	232994,82
Heating power	Gcal	5198,08	56170,12	2446,76	17316,80	–	81131,76	81131,76
	Thou. rub	6225,52	71583,20	3118,20	21646,03	–	102572,95	102572,95
Hot water supply	Thou. m^3	8,30	731,35	1,63	290,36	–	1031,64	1031,64
	Thou. rub	120,47	37281,33	107,60	14829,42	–	52338,82	52338,82

Table 2. Continued

Name		Government management establishments	Education	Culture	Public health and Social policy	Municipal enterprise	Total, according to budget establishments	Total
Cold water	Thou.m^3	27,58	441,42	4,54	227,98	49,04	701,52	750,56
	Thou. rub	276,26	3866,31	48,50	3299,30	526,19	7490,37	8016,56
Sewerage	Thou. m^3	37,86	904,31	5,74	426,08	48,70	1373,99	1422,69
	Thou. rub	383,67	8085,43	58,10	4637,90	410,12	13165,10	13575,22
Natural gas	Thou. m^3	185,80	120,49	45,60	148,68	561,55	500,57	1062,12
	Thou. rub	457,89	393,90	152,00	481,49	2099,04	1485,28	3584,32

For energy consumption comparison in the city it is presented energy balance in terms of conditional fuel (Fig.4). As it can be seen from Fig.4, the greatest amount of energy is produced from natural gas, but due to its low cost in comparison with electric power largest expenses is accounted on electric power.

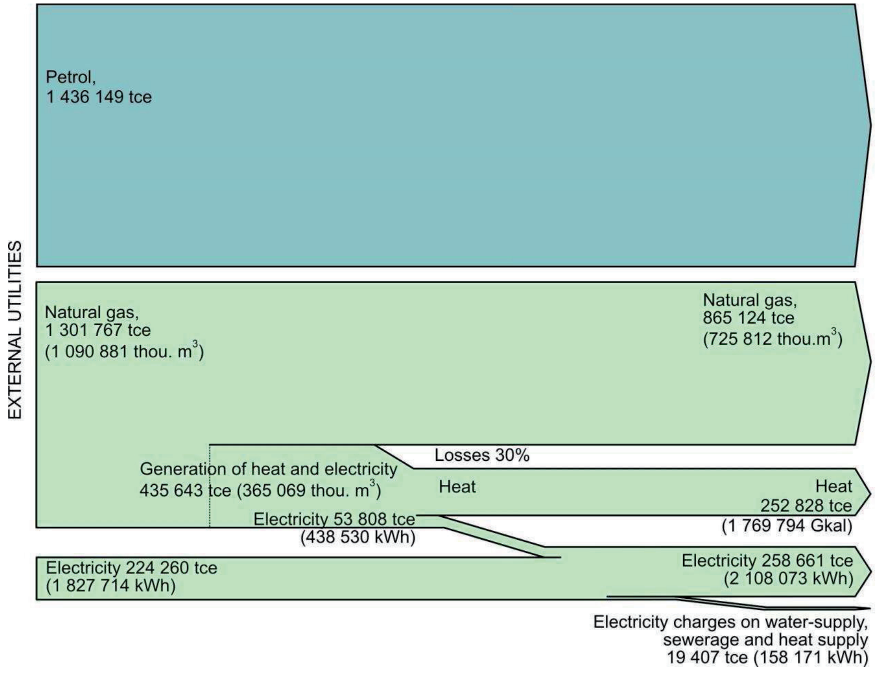


Fig.4. Energy consumption of Belgorod city

From power consumption analysis of Belgorod it can be concluded that highest energy consumption accounts on motor fuel, heating and hot water supply and highest financial costs – for motor fuel and electric power.

For energy management, there were considered the municipal property in Belgorod. From direct control have been dropped out "other consumers" (business objects), energy resources generation and multidwelling units.

Characteristics and energy consumption of municipal institutions and organizations

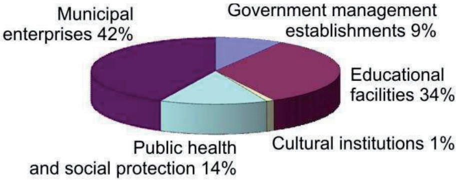
Structure of shares for municipal institutions and organizations is presented in Table 3.

Cost structure for consumers and energy are shown in Fig. 5.

Table 3

Share of municipal institutions, organizations and apartment houses in context of Belgorod urban energy consumption

Name of resource	Energy utilities consumption			Energy utilities costs		
	Public offices(PO) and Municipal enterprises (ME)	Multid-welling units	Total	Public offices and Municipal enterprises	Multid-welling units	Total
Electric power	5,8%	12,2%	18,0%	3,8%	12,2%	16,1%
Heating energy	7,3%	74%	81,3%	7,3%	17%	81,3%
Natural gas	0,1%	13,5%	13,6%	0,1%	13,5%	13,6%
Cold water	3,2%	81,4%	84,6%	2,2%	71,8%	74,0%
Sewerage	5,1%	75,7%	80,8%	3,9%	74,8%	78,7%



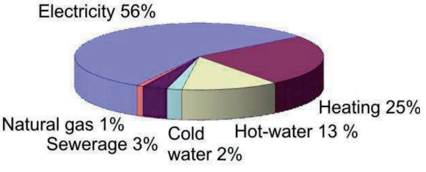


Fig. 5. Structure of energy resources costs

Large energy expenditures were revealed in municipal establishments "Belgorod water channel" and "Belgorod electric transport" (Fig. 6). In municipal institutions significant part of budget spends on energy consumption. Thus main directions of power consumption decreasing are following:

- reduction of expenses on heating and hot water supply in municipal institutions;
- reduction of technology consumption in municipal establishments "Belgorod water channel" and "Belgorod electric transport".

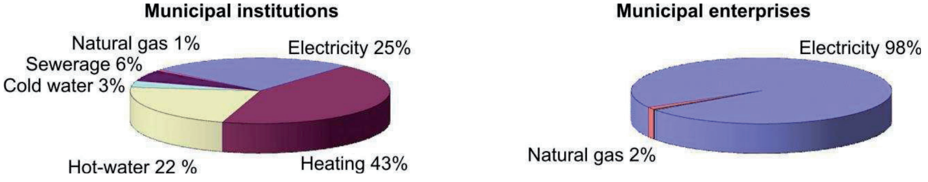


Fig. 6. Comparison of energy costs patterns in municipal establishments and enterprises

Below it is presented comparison of energy consumption in municipal institutions and enterprises in monetary terms and in conditional fuel terms, and consumption for each type of energy source (Fig.7-11).

As it can be seen from the analysis, heating and electric power takes most of energy expenses. Several organizations consume almost the entire volume of energy resources. They are municipal enterprise "Management of public amenities", department of education, health department, municipal enterprise "Belgorod water channel" and municipal establishments "Urban electric transport". All the rest organizations take small part as contributors in total energy consumption. Thus it is more effective to reduce electric power and heat energy consumption for heating and hot water supply in these five major consumers [5-6].

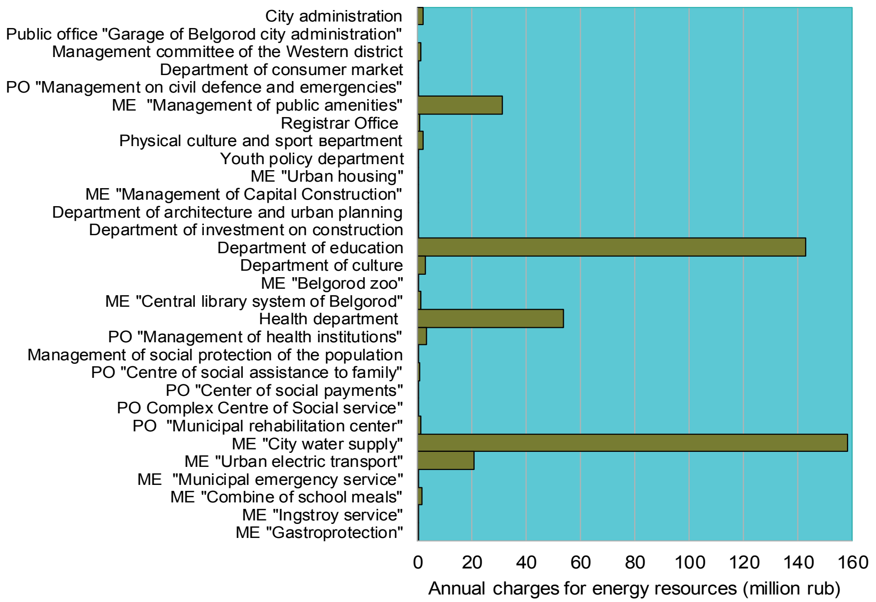


Fig. 7. Energy consumption in municipal establishments and municipal enterprises

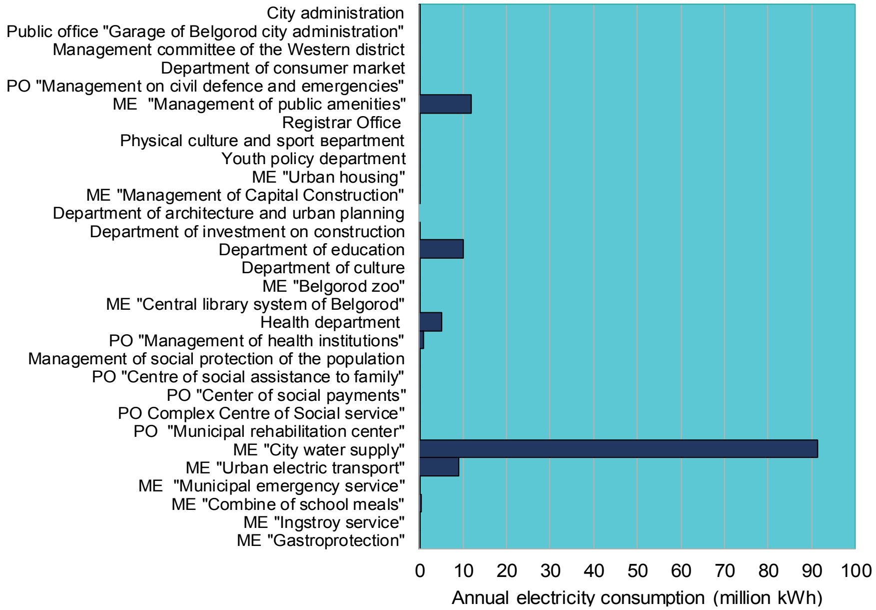


Fig. 8. Electricity power consumption in municipal establishments and enterprises

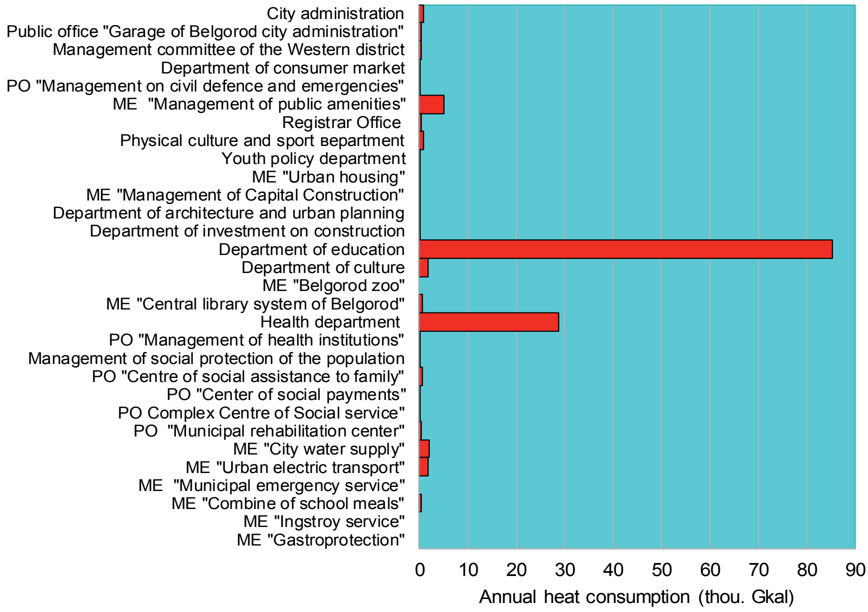


Fig. 9. Heat energy consumption in municipal establishments and enterprises

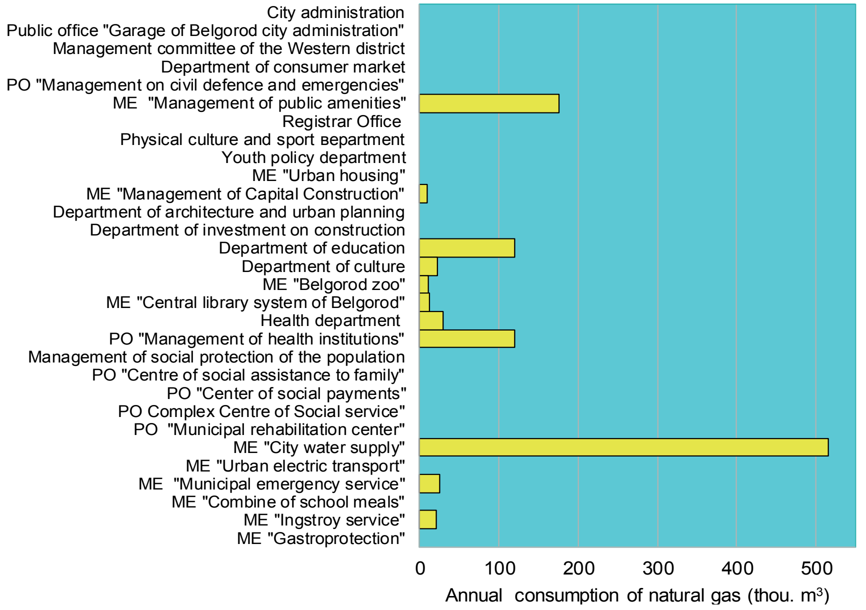


Fig. 10. Natural gas consumption in municipal establishments and enterprises

2.2. Analysis of energy consumption in educational institutions

General characteristics of educational institutions

There are 152 institutions in Belgorod with total area rate at 421 733 m^2, including 46 schools, 64 preschool education establishments (PEE), 38 institutions of additional education (IAE), 4 administrative units. In 2009 there were working 7 460 employees and studying 46410 pupils in institutions.

During the year all education institutions consumed energy resources in total amount of 142, 82 million rubles (in prices of 2009 year). Structures of energy costs are presented on Fig. 12-13.

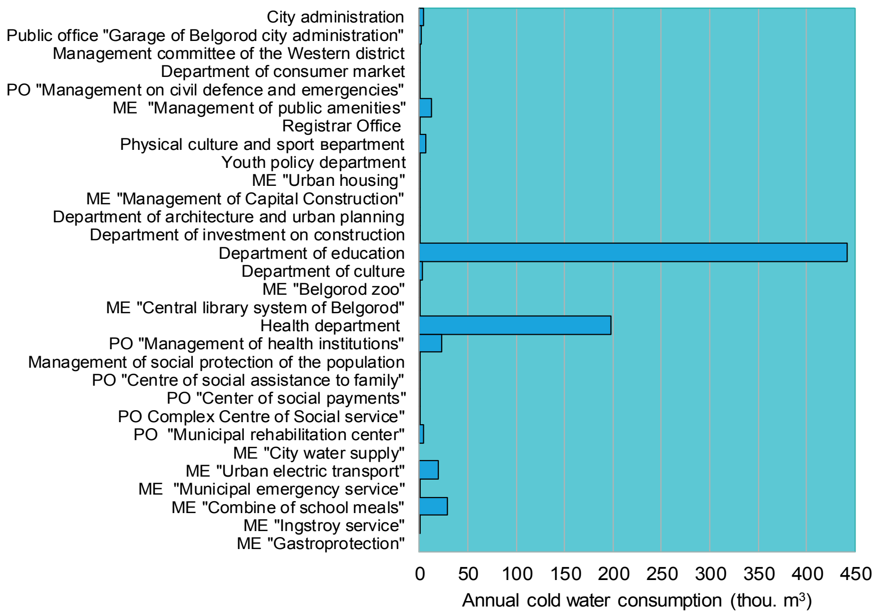


Fig. 11. Cold water consumption in municipal establishments and enterprises

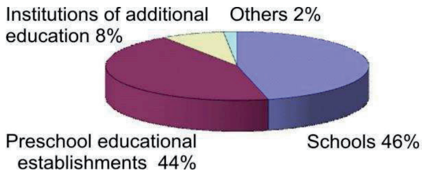


Fig. 12. Subdivisions energy costs

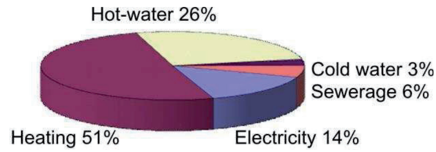


Fig.13. Types energy costs

As it can be seen from analysis, heating and hot water supply takes main part of energy costs (75%). Majority of education objects were built 20-30 years ago, when energy resources were very cheap. At that time improvement of thermal protection in buildings was simply not economically profitable. Here it is an express-assessment of educational institutions efficiency in Belgorod, accomplished according to annual heat consumption (Fig. 14). Specific index is determined as follows:

$$q = 106Q / (4183Sh),$$

where Q is heat consumption during year, GJ; S – area, m^2; h – average height of a floor, m.

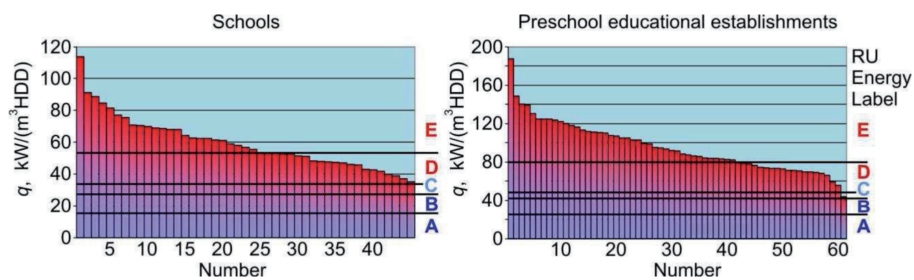


Fig.14. Belgorod buildings ranking of educational institutions in energy efficiency order

According to analysis results there are more than half of the buildings belong to lowest energy efficiency class – groups E, and rest – to the class of low efficiency which is group D.

Currently, the majority of fixed heat losses in objects associated with factors:

- unsatisfactory state of thermal contour of building (windows and doors);
- poor ventilation;
- non-regulated heating load, leads to considerable excess of temperature in buildings relatively to normative, and as a result – heating energy overconsumption.

Assessment of efficiency and savings potential

For actual analysis of energy consumption there were selected institutions, which have been equipped with all types of energy resources metering devices. Also efficiency indicators - specific energy resources consumption were defining (Table 4).

For potential determination it have been calculated the correlation coefficient between energy efficiency indicators and characteristics of institutions (area of buildings, number of people, share of new windows (Table 5). There is an inverse correlation between the consumption of thermal energy, area and number of people; and between electric power consumption and amount of people [7]. Thus the larger institutions have greater energy efficiency.

For total energy costs comparison it have been used estimation rating systems of R:

$$R = \sum d_i e / e_{av},$$

where d_i – is share of energy in total amount of expenditures; e – is specific consumption of energy resource; e_{av} – average consumption of energy resource for all institutions in the sample.

Results of ranked calculation for indicator R are presented in Table 4.

Table 4

Energy efficiency indicator

Index	Surface, m^2	Numbers of employees and pupils, pers.	Part of modernized window blocks	Thermal energy, J/m^2	Electric energy, kWh/pers.	Cold water, m/pers.
Schools (20 institutions)						
Total	124693	15149	–	–	–	–
Average	6235	757	12,0	0,59	143,15	7,08
Minimum	1024	212	–	0,42	69,57	3,78
Maximum	9904	1658	51,3	1,30	286,13	17,33
Preschool educational establishments (34 institutions)						
Total	158536	18370	–	–	–	–
Average	3373	391	10,0	1,09	256,55	11,55
Minimum	948	156	–	0,42	108,44	3,78
Maximum	9904	1658	57,4	1,51	366,76	21,88
Sum total						
Total	204704	24602	–	–	–	–
Average	3791	456	12	0,79	186,72	8,80
Minimum	948	156	–	0,42	69,57	3,78
Maximum	9904	1658	57,4	1,51	366,76	21,88

Table 5

Correlation parameters

Parameters	Energy efficiency indicators		
	Heat energy	Electric power	Cold water
Surface	-0,80	-0,60	-0,32
Numbers of employees and pupils	-0,66	-0,68	-0,30
Part of modernized window blocks	-0,09	-0,15	0,01
Heat energy efficiency consumption indicator	–	0,45	0,33
Electric energy efficiency power indicator	–	–	0,33

As it can be seen (Fig.15), the total energy efficiency for different institutions may differ more than in three times.

To calculate the potential economy E it have been used deviation of energy efficiency indicators from regulatory or average value:

$$E = \Sigma C \cdot X \cdot (e - e_{av}),\ \text{for}\ e > e_{av},$$

where C is cost of energy resource per unit; X is indicator used to calculate the specific consumption (area or number of people).

Potential savings in average is 13%, for different institutions it may be up to 40%. For large institutions it is insignificant, but the dependencies between annual energy costs and potential savings does not exist [8].

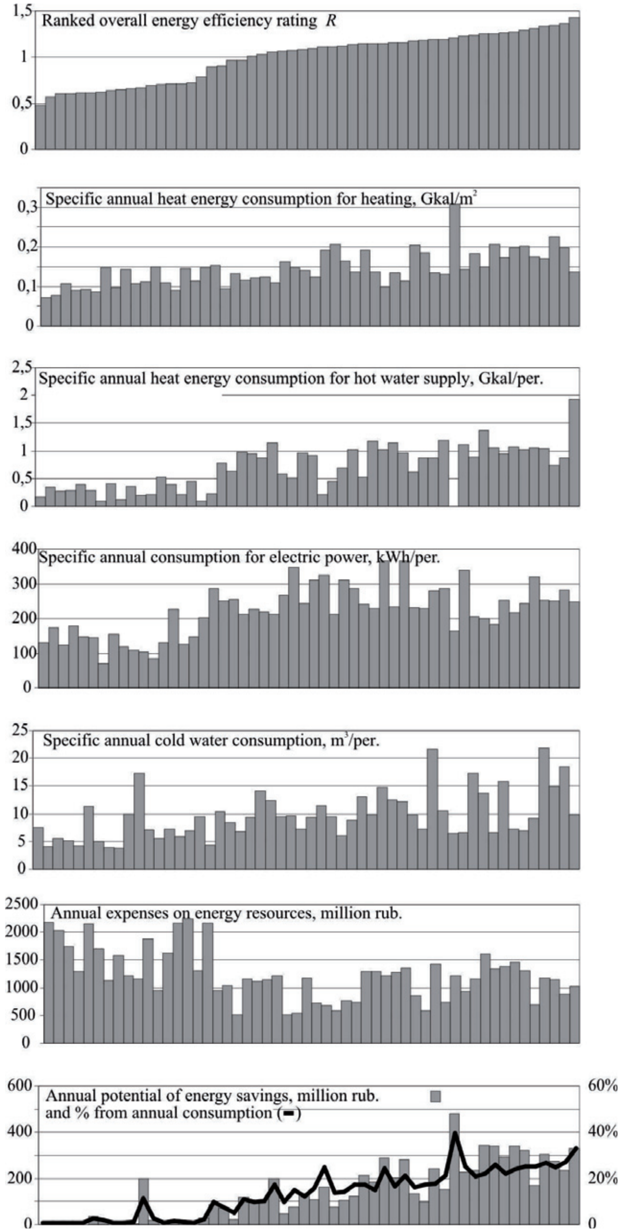


Fig.15. Energy efficiency indicators and potential energy savings

Thus, to determine the optimal structure of investment in energy saving measures to achieve the greatest energy savings it is required a differentiated approach that takes into account individual performance of each institution.

2.3. Analysis of power consumption in institutions of Belgorod

For more detailed analysis the objects were divided into categories:

- pre-school institutions (kindergartens), here in after PEE;
- municipal educational institutions (schools), here in after MEI;
- institutions with partial or full accommodation (houses, boarding schools, nursing homes);
- institution of administrative type (administration).

Based on analysis it is revealed that type of institutions structure has a significant impact on its energy usage.

Total consumption of electric power can be divided into two types [9]:

- consumption for lighting (internal, external);
- household consumption (office equipment, computers, household appliances, air conditioner).

The following diagram (Fig. 16) shows average distribution of energy consumption for each type of the institutions.

As it can be seen from the diagrams, the prevailing share of electric power consumption varies depending on institution kind. Thus, in kindergartens and institutions with a temporary or permanent accommodation the basic part of consumption includes: household equipment (63% and 55%, respectively).

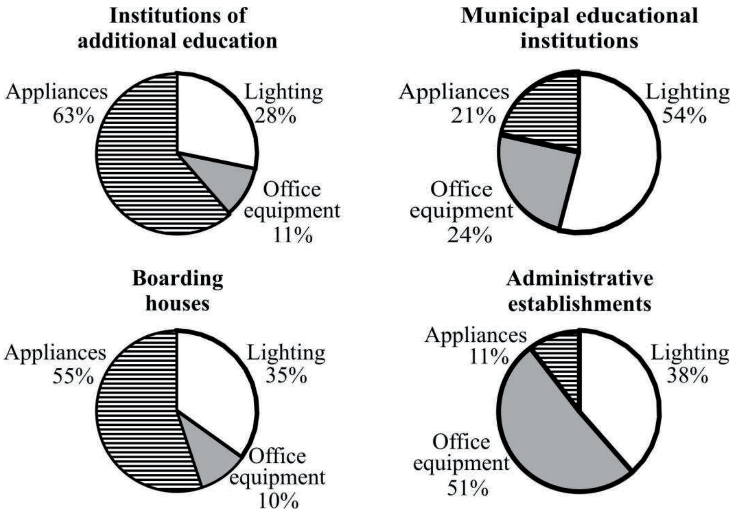


Fig. 16. Structure of electric power consumption in institutions of different types

In schools or other educational establishments, it is lightning (54%), and in administrative buildings it is equipment (51%).

Dividing electrical power expenditures for the internal and external lighting is caused by work specifications of institutions (Fig. 17).

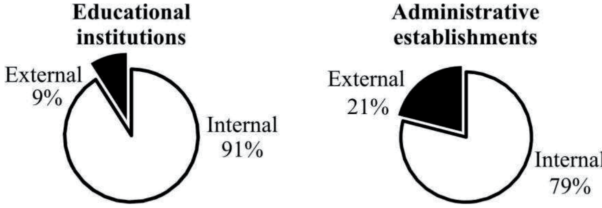


Fig. 17. Structure of electric power consumption for lighting

Received data shows that municipal educational institutions in comparison with administrative institutions does not have so much adjoining territories, which requires additional lighting, and spend 9 and 21% of the total electric power consumption, respectively. Along with internal lighting the outdoor lighting adds a significant share in total electric power consumption. More clearly it is reflected in the administrative structures.

It should be noted that type of fixed lamps plays an essential role. The presence of energy saving lamps saves about 70% from the expenditures on electric power lighting (Fig. 18).

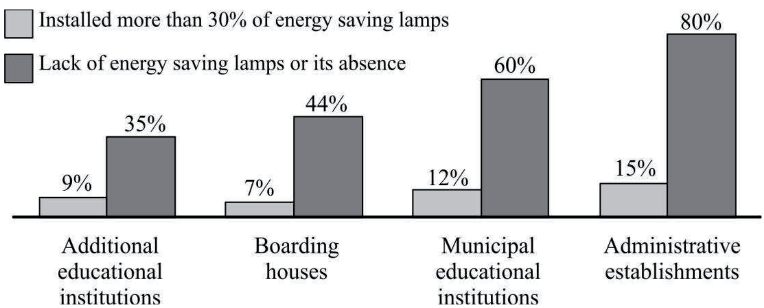


Fig. 18. Share of electric power consumption for lighting
in case of energy saving lamps installation and its absence

On the basis of actual data there were calculated coefficients (Table 6) which describes area and number of people per one luminaire.

This indicator shows covering area by one unit of luminaries for different objects.

Table 6

Energy efficiency parameters

Type of organization	Specific quantity of luminaries		Specific capacity of luminaries	Annual costs of electric power for lighting, thou. rub.	
	for 1000 m^2	per person	for 1000 m^2	per person	for 1000 m^2
PEE	137	5,3	6,2	0,235	11,6
MEI	181	0,6	6,8	0,054	31,2
Boarding houses	156	4,8	6,0	0,182	39,0
Administrations	987	14,2	29,6	0,426	115,3

2.4. Conclusions

Paper presents the rating of Belgorod organizations efficiency. On the basis of municipal objects analysis the graphs of structural type consumptions as well as indicators of energy efficiency are shown. The conclusion is that total energy efficiency of various institutions may differ more than in three times and larger institutions have greater energy efficiency. It is shown that for determining the optimal structure of investment in energy saving measures for the greatest energy saving achievements it is required a differentiated approach taking into account individual performance of each individual institution.

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3. TECHNIC AND ECONOMIC SUBSTANTIATION

Due to entry into the force of Russian Federal law No. 261-FZ "On energy savings and energy efficiency" from November 23, 2009 and publication of order by Belgorod area government from December 28, 2009 No. 482 "About realization on territory of Belgorod region Federal law No. 261-FZ from November 23, 2009» it appears necessity in energy saving management and monitoring of energy consumption on regional level.

Power management can be implemented by means of development and calculation of indicators, and forecasting the dynamics of indicators of development for energy saving measures for municipal institutions and municipal enterprises.

Monitoring of energy consumption and energy saving is carried out by means of drawing up the balance and calculation of the main indicators in apartment buildings.

Decision regarding the volume of such works requires an individual approach, based on a careful assessment of the technical and economic aspects.

Aim of this work is to evaluate the efficiency of objects in municipal sphere and evaluation of energy saving measures that implemented to improve energy efficiency.

The work was carried out in preparation of the target program "energy saving and energy efficiency improvement of city district "City of Belgorod" for 2011-2015".

Main goals of the program "Energy saving and energy efficiency of the city district "City of Belgorod" for 2011-2015":

- *development* of economic and organizational conditions for effective energy use in municipal institutions and enterprises of Belgorod city;
- *diminution* of budget expenditures on utilities and services payments, that consumed by municipal institutions and enterprises, through the rational energy resource use;
- *maintain* a comfortable thermal conditions inside buildings to improve the quality of life on municipal institutions and enterprises;

To achieve these goals it is necessary to solve the following main tasks:

- evaluate actual energy efficiency parameters for buildings and compose energy passport for all objects;
- implement system for accounting and monitoring indices;
- create a system of indicators that characterize energy efficiency in municipal institutions and enterprises;
- perform technic and organizational measures to reduce energy consumption;
- create municipal regulatory base for energy surveys, energy savings and promotion of the energy efficiency;
- organize energy saving training courses.

On the output of the program it will be provided:

- annual reduction of the energy consumption not less than 3% – 15% for the whole period of the program implementation;
- *diminution* of budget expenditures on utilities and services payments, that consumed by municipal institutions and enterprises, through the rational energy resource use;

- improvement of energy efficiency indicators;
- implementation of system for monitoring the energy consumption in each object.

In municipal organizations and enterprises of Belgorod city it must be performed following activities:

- energy audit in institutions to determine their energy efficiency;
- installation of equipment for general and individual metering systems, heating regulating, hot – cold water and gas regulating. Service and calibration of equipment on time;
- adjustment and service of engineering systems;
- system monitoring of energy consumption indicators;
- organizational measures for controlling energy – expenditures and efficiency indicators;
- training course on energy–saving methods and events for responsible persons;
- replacement and modernization of window blocks;
- modernization of lighting systems based on energy efficient lighting devices;
- reconstruction of district heating substation;
- bringing in a proper way both thermal contours in buildings and ventilation systems; complete overhaul of internal heating systems and domestic hot water supply on educational objects of institutions in accordance with title lists for carrying out capital and current repairs of buildings.

3.1. Determination of project's costs

During execution of the study it was spent financial resources on the following articles:

Remuneration for fellow researcher:

$$P = S \cdot n + B = 8826 \cdot 4 + 1000 = 36304 \text{ rub},$$

where P – amount payment, rub;

S – employee wage for 1 month, rub;

n – amount of working time, month;

B – award, rub.

Remuneration for project supervisor:

$$P = S_h \cdot n_h + B_m = 135 \cdot 300 + 2000 = 42500 \text{ rub},$$

where P is amount of payment, rub;

S_h – salary for 1 hour, rub;

n_m – amount of working time, hours;

B_m – award for supervisor, rub.

Remuneration for scientific consultant:

$$P = S_h \cdot n_h = 300 \cdot 30 = 9000 \text{ rub.},$$

where P is amount of payment, rub;

S_h – salary for 1 hour, rub;

n – amount of working time, hours.

Expenses on computer technologies:

$$P = M \cdot n_r = 50 \cdot 140 = 7000 \text{ rub.},$$

where P is amount of payment, rub;

M – cost for 1hour of computer time, rub;

n_a – rent time, hour.

Expenses on scientific and technic information:

Sum of expenses on scientific and technic information consists of the cost for literature purchasing which is 920 rub.

Electric power cost:

$$P = P_{1el} \cdot N \cdot t = 4{,}19 \cdot 0{,}65 \cdot 360 = 980{,}46 \text{ rub.},$$

where P is amount of payment for electric power, rub;

P_{1el} – cost for 1 kWh of electric power, rub;

N – average power consumed by installation during experiments, kW;

t – time spent on carrying out the experiments, hour.

Example of the calculation is presented in Table 7- 8.As it can be seen from the resulted data, organizational events demands small costs, but it can lead to considerable economy of power resources. It shows efficiency of the energy management system implementation.

Table 7

Estimated cost of the research

Name	Amount, rub.
1. Remuneration for fellow researcher	36304
2. Remuneration for project supervisor	42500
3. Remuneration for scientific consultant	9000
4. Expenses on computer technologies	7000
5. Expenses on scientific and technic information	920
6. Electric power cost	980
Total costs	96704

Table 8

Target indicators in the field of energy saving and energy efficiency rising that reflects savings for certain types of energy resources (in 2014)

Name of indicators	Unit of measure	Target values					
		2010	2011	2012	2013	2014	2015
Electric power saving	thou. kWh	28641	57282	85923	114564	143205	171846
	thou. rub	68971	137943	206914	275885	344857	413828
Heat energy saving	thou. Gcal	53	106	159	212	265	319

	thou. rub	62964	125928	188891	251855	314819	377783
Water saving	thou.m^3	1117	2235	3352	4469	5586	6704
	thou. rub	9767	19534	29302	39069	48836	58603
Natural gas saving	thou. m^3	32726	65453	98179	130906	163632	196359
	rub	143756	287511	431267	575023	718778	862534

As a result of program implementation it is expected:

- reducing of the relative cost for local budget on utilities payment for municipal organizations not less than 9 307 thousand rubles annually and costs for enterprises on energy resources not less than 15 739 thousand rubles (in prices of 2014);
- reducing of specific energy indicators and energy consumption in enterprises and organizations on municipal territory not less than 15% in comparison with 2014 (base year):

During 2010-2015 within Belgorod city it is projected energy savings in total amount of 3978768 thousand rubles.

3.2. Predictable effect

Results from the program implementation are following:

- 100 % presence of the energy passports and acts of energy inspections in all organizations, institutions and enterprises of municipality;
- reduction of specific energy consumption indicators in enterprises and organizations on the territory of municipality not less than 15% in comparison with 2014 (base year);

- lower relative costs for local budget on municipal organizations' utilities payment.

Implementation of measures from the program will bring additional effects:

- formation of effective mechanisms to control energy resource consumption in municipal organizations in all levels and to reduce fiscal expenditures on utilities;
- reduction of energy costs in municipal organizations and for citizens and enterprises in municipal formation;
- creating of conditions for designing long-term energy saving programs to develop and maintain fuel and energy balance of municipality;
- creating of conditions for developing goods and services market in the sphere of energy saving;
- implementation of modern energy efficient construction solutions at design stage; application of energy efficient building materials, technologies and structures, systems of energy saving expertise.

3.3. General list of measures. Calculation of payback from energy saving measures

In this section have been presented justification of the power saving events for three Municipal Health Establishments:

- City children's polyclinic No. 4 (Table 9-15);
- City hospital No. 6 (Table 16-23);
- City maternity hospital (Table 24-29).

Calculation of energy saving effect from the wall and attic warming overlapping with a heater of a different thickness is fulfilled. It is shown that technical parameters make considerable impact on economic parameters (Fig.19-21). The most effective alternative has chosen and feasibility report on offered provisions has resulted.

A. City children's polyclinic No. 4

Table 9

Energy saving measures for "City children's polyclinic No. 4"

Insulation of attic and basement

Thickness of insulation, cm		4	10	15	17	22
Attic	Price for m^2 of isolation with specified thickness, thou. rub.	1,1136	1,284	1,426	1,4828	1,6248
	Total cost, thou. rub.	5675,5	6543,9	7267,7	7557,1	8280,8
	Heat energy savings, Gcal	100,99	177,89	214,37	225,25	246,6
	Economic effect, thou. rub.	115,58	203,59	245,34	257,79	282,23
	Payback period, years	49,104	42,143	39,623	33,315	31,341
Basement	Total cost, thou. rub.	824,5	950,6	1055,8	1097,8	1203,0
	Heat energy savings, Gcal	1,67	5,86	8,3	9,1	10,77
	Economic effect, thou. rub.	1,91	6,71	9,50	10,41	12,33
	Payback period, years	68,383	53,748	41,145	39,412	33,597

Comments. Heat, sound and fire insulation with elevated hardness and resistance of floors above ceilings, floors, basements, floors with electrical heating

Table 10

Energy saving measures for "City children's polyclinic No. 4"

Insulation of walls (with plastering layer)

Thickness of insulation, cm		2	5	8	12	18
Walls	Price for m^2 of isolation with specified thickness, thou. rub.	1,88	2	2,12	2,28	2,52
Walls	Total cost, thou. rub.	8481	9022	9563	10285	11368
	Heat energy savings, Gcal	117	215,23	271,55	317,56	357,9
	Economic effect, thou. rub.	133,90	246,32	310,78	363,44	409,61
	Payback period, years	63,3	46,6	37,8	35,3	32,8

Comments. Insulation of walls (thermal, acoustic and fire insulation of exterior step in buildings and constructions of various purpose with a subsequent plastering on reinforcing grid)

Table 11

Energy saving measures for "City children's polyclinic No. 4"

Insulation of walls (ventilated facades)

Thickness of insulation, cm		4	8	12	18
Walls	Price for m^2 of isolation with specified thickness, thou. rub.	4,5	4,7	4,8	4,9
	Total cost, thou. rub.	20440,4	20981,7	21523,0	22244,8
	Heat energy savings, Gcal	188,99	271,55	317,56	357,9
	Economic effect, thou. rub.	216,29	310,78	363,44	409,61
	Payback period, years	94,5	67,5	59,2	54,3

Comments. Insulation of walls (Heat, sound and fire insulation layer with air gap in external walls of buildings (ventilated facades) for various purposes. Plate captured with black or white glass), 75kg/m3

Table 12

Energy saving measures for "City children's polyclinic No. 4"

Indicators	Total cost, thou. rub.	Energy savings	Economic effect, thou. rub.	Payback period, years
Installation of reflective screens for heating elements	92,81	26 Gcal	36,44	2,547
Pasting of energy saving film (selective coating)	931,91	40,8 Gcal	56,44	9,51
Installation of a system for heating load balancing	370	98,7 Gcal	136,7	2,7
Replacement of incandescent lamps	4,9	7644 kWh	18,8	0,26
Replacement of windows	789,7	20,35 Gcal	28,16	11

Table13

Energy saving measures for "City children's polyclinic No. 4"

Reconstruction of the building (insulation and installation of reflecting screens)

Name	Value
Total cost, thou. rub.	
Attic insulation (insulation IZOVOL)	8280,8
Insulation of basement (insulation IZOVOL)	1203,0
Insulation of walls with a subsequent plastering on reinforcing grid	11368
Insulation of walls (ventilated facades)	22244,8
Pasting of energy saving film on windows (selective coating)	931,91
Installation of reflective screens	92,81
Total	44121,32

Table13. Continued

Name	Value
Indicators	
Heat energy savings, Gcal	739
Economic effect, thou. rub.	1022,7
Payback period, years	22,1

Table 14

Energy saving measures for «City children's polyclinic No. 4".

Reconstruction of the building (recommended)

Name	Value
Total cost, thou. rub.	
Replacement of windows	789,7
Pasting of energy saving film on windows (selective coating)	931,91
Installation of reflective screens	92,81
Installation of a system for heating load balancing	370,00
Total	2184,5
Indicators	
Heat energy savings, Gcal	222
Economic effect, thou. rub.	307,8
Payback period, years	7,097

Table 15

Energy saving measures for «City children's polyclinic No. 4"

Low cost, average and long term measures

Name	Annual savings of energy resources		Costs, thou. rub.	Average payback period, years
	In physical terms	Value terms thou. rub.		
Organizational and low-cost measures				
Replacement on energy saving lamps	7644,2 kWh	18,8	4,9	0,26
Average costs				
Installation of radiator reflectors	26 Gcal	36,44	92,81	2,55
Installation of a system for heating load balancing	98,7Gcal	136,7	370	2,7
Long term and large measures				
Replacement on triple-pane plastic windows	20,35 Gcal	28,16	789,7	11
Pasting of energy saving films on new plastic window	40,78 Gcal	56,44	931,91	9,51
Name	Annual savings of energy resources		Costs, thou. rub.	Average payback period, years
	In physical terms	Value terms thou. rub.		
Total, thousand tons of equivalent fuel including energy resources due to its types	30Tonne of coal equivalent	276,54	2189,33	7,903
Heat energy	185,83 Gcal	257,74	2184,42	8,463
Electric power	7644,2 kWh	8,80	4,9	0,26

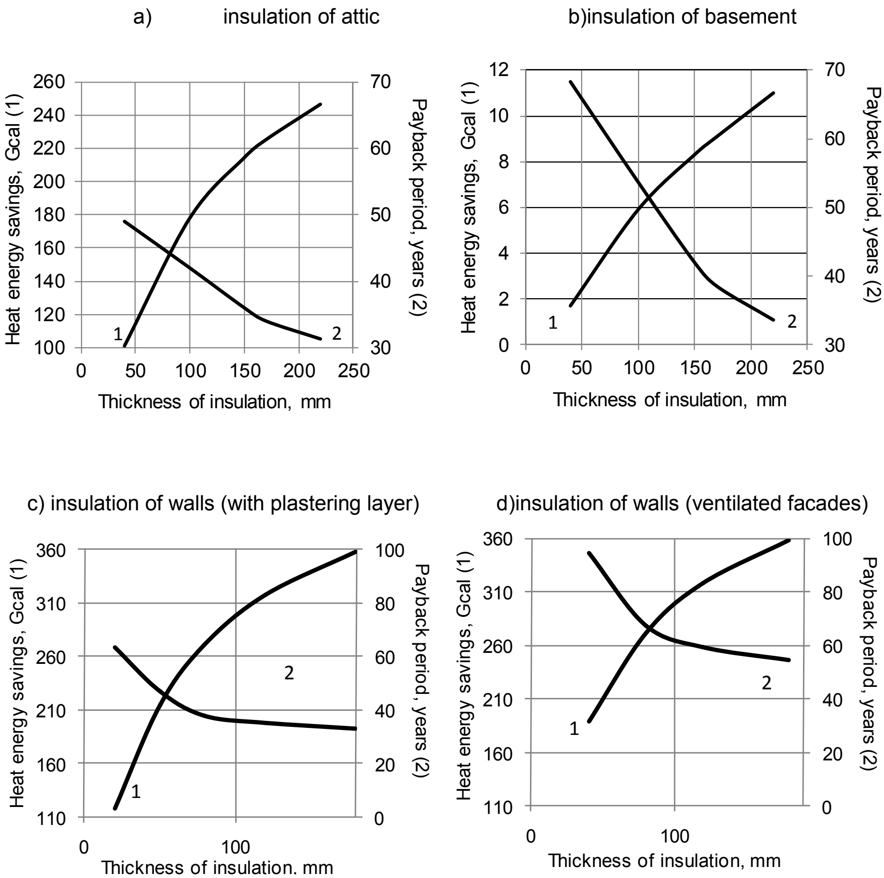

Fig. 19. Dependence of insulation thickness on energy efficiency parameters of "City children's polyclinic No. 4"

B. City hospital No. 6

Table 16

Energy saving measures for "City hospital No. 6"

Insulation of attic and basement*

Thickness of insulation, cm		4	10	15	17
Attic	Price for m^2 of isolation with specified thickness, thou. rub.	1,1136	1,284	1,426	1,4828
	Total. rub.	1326,0	1528,9	1698,0	1765,6
	Heat energy savings, Gcal	102,87	121,08	129,69	132,25
	Economic effect, thou. rub.	117,73	138,57	148,43	151,36
	Payback period, years	16,263	19,440	22,033	23,665
Thickness of insulation, cm		4	10	15	17
Basement	Price for m^2 of isolation with specified thickness, thou. rub.	1326,0	1528,9	1698,0	1765,6
	Total. rub.	2,92	6,3	8,46	9,21
	Heat energy savings, Gcal	3,34	7,21	9,68	10,54
	Economic effect, thou. rub.	49,79	31,05	27,37	22,50
	Payback period, years	2,92	6,3	8,46	9,21

Comments. Insulation of attic and basement (Heat, sound and fire insulation with elevated hardness and resistance of floors above ceilings, floors, basements, floors with electrical heating)

Table 17

Energy saving measures for "City hospital No. 6"

Insulation of walls (with plastering layer)

Thickness of insulation, cm		2	5	8	12
Walls	Price for m^2 of isolation with specified thickness, thou. rub.	1,88	2	2,12	2,28
	Total cost, thou. rub.	2772	2949	3126	3361
	Heat energy savings, Gcal	44,06	79,34	99,2	115,22
	Economic effect, thou. rub.	50,43	90,80	113,53	131,87
	Payback period, years	35,0	27,5	25,5	22,5

Comments. Insulation of walls (thermal, acoustic and fire insulation of exterior step in buildings and constructions of various purpose with a subsequent plastering on reinforcing grid)

Table 18

Energy saving measures for "City hospital No. 6"

Insulation of walls (ventilated facades)

Thickness of insulation, cm		4	8	12	18
Walls	Price for m^2 of isolation with specified thickness, thou. rub.	4,5	4,7	4,8	4,9
	Total cost, thou. rub.	6680,4	6857,3	7034,2	7270,1
	Heat energy savings, Gcal	70	99,2	115,22	129,13
	Economic effect, thou. rub.	80,11	113,53	131,87	147,79
	Payback period, years	43,4	30,4	26,3	24,2

Comments. Insulation of walls (Heat-, sound- and fire insulation layer with air gap in external walls of buildings (ventilated facades) for various purposes. Plate captured with black or white glass), 75kg/m^3

Table 19

Energy saving measures for "City hospital No. 6"

Indicators	Total cost, thou. rub.	Energy savings	Economic effect, thou. rub.	Payback period, years
Installation of reflective screens for heating elements	50,4	13 Gcal	14,44	3,489
Pasting of energy saving film (selective coating)	354,34	23,85 Gcal	27,30	12,98
Installation of individual heating system	220	82 Gcal	93,9	2,3
Installation of a system for heating load balancing	110	18,9 Gcal	21,7	5,1
Replacement of incandescent lamps	6,7	5827 kWh	14,3	0,46
Replacement of windows	1039,7	44,28 Gcal	50,68	20,5

Table 20

Energy saving measures for "City hospital No. 6". Reconstruction of the building

Name	Value
Total cost, thou. rub.	
Replacement of windows	1039,7
Installation of individual heating system	220
Insulation of walls with subsequent plastering on reinforcing grid	3715,3
Insulation of walls (ventilated facades)	7270,1
Insulation of basement (insulation IZOVOL)	1934,7
Pasting energy savings film on window (selective coating)	354,3
Installation of reflective screens	50,397
Total	9249,2
Indicators	
Heat energy savings, Gcal	298
Economic effect, thou. rub.	340,6
Payback period, years	27,158

Table 21

Energy saving measures for "City hospital No. 6"

Reconstruction of the building (recommended)

Name	Value
Total cost, thou. rub.	
Replacement of windows	1039,7
Installation of individual heating system	220
Attic insulation (insulation IZOVOL)	1326,1
Pasting of energy saving film on windows (selective coating)	354,3
Installation of radiator reflectors	50,397
Balancing system	110,00
Total	3100,4
Indicators	
Heat energy savings, Gcal	282
Economic effect, thou. rub.	322,9
Payback period, years	9,603

Table 22

List of typical energy efficiency measures for "City hospital No. 6"

Low cost, average and long term measures

Name	Annual savings of energy resources		Costs, thou. rub.	Average payback period, years
	In physical terms	Value terms thou. rub.		
Organizational and low-cost measures				
Replacement on energy saving lamps	5826,5kWh	14,3	6,7	0,46

Table 22. Continued

Name	Annual savings of energy resources: In physical terms	Annual savings of energy resources: Value terms thou. rub.	Costs, thou. rub.	Average payback period, years
Average costs				
Installation of radiator reflectors	13Gcal	14,44	50,4	3,5
Installation of a system for heating load balancing	18,9Gcal	21,7	110,0	5,1
Installation of individual heating system	82Gcal	93,9	220,0	2,3
Long term and large measures				
Replacement of old design windows on plastic triple-pane windows	44,28Gcal	50,68	1039,70	20,5
Attic insulation (insulation IZOVOL 4 cm)	12,87Gcal	117,73	1326,00	16,3
Pasting of energy saving films on new plastic window	23,85Gcal	27,30	354,34	13,0
Total, thousand tons of equivalent fuel including energy resources due to its types	44,34Tonne of coal equivalent	340,05	3107,1	9,1
Heat energy	284,9Gcal	325,75	3100,44	9,48
Electric power	5,83 kWh	14,30	6,7	0,46

The most expensive activity is warming of attic that is why it was considered more detail (Fig. 20).

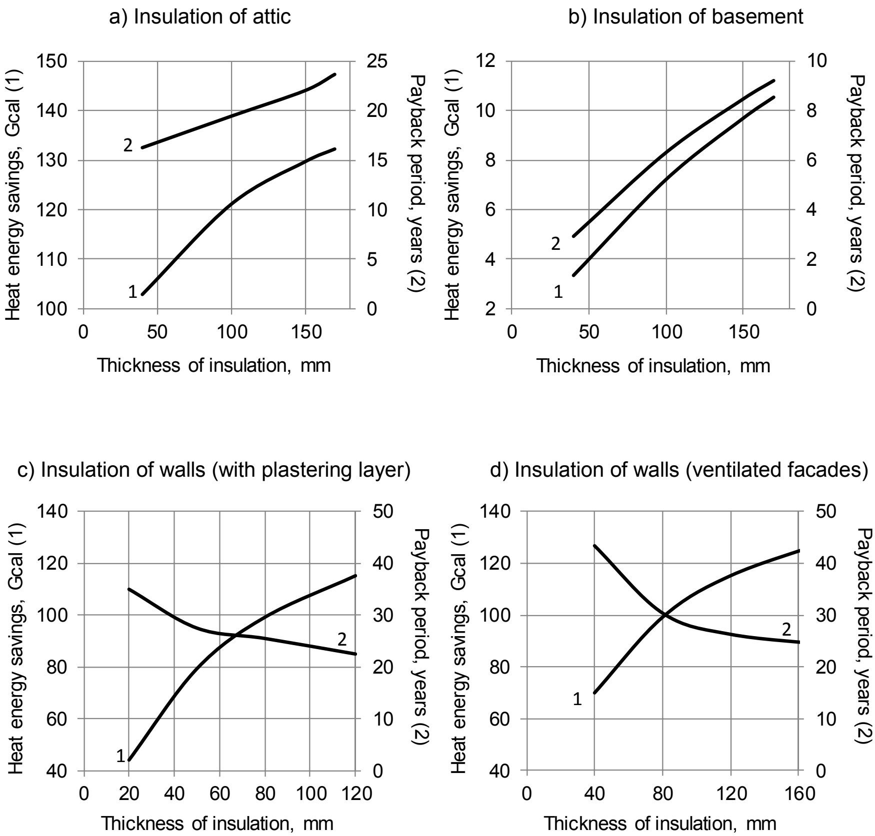

Fig. 20. Dependence of insulation thickness on energy efficiency parameters of "City hospital No. 6"

C. City maternity hospital

Table 23

Energy saving measures for "City maternity hospital"

Insulation of attic

Thickness of insulation, cm		4	10	15	17	22
Attic	Price for m^2 of isolation with specified thickness, thou. rub.	1,1136	1,284	1,426	1,4828	1,635
	Total cost, thou. rub.	1277,3	1472,7	1635,6	1700,8	1863,6
	Heat energy savings, Gcal	113,63	161,07	177,54	181,92	189,9
	Economic effect, thou. rub.	130,05	184,34	203,19	208,20	217,33
	Payback period, years	9,822	9,989	8,550	8,169	8,05

Comments. Heat-, sound- and fire insulation with elevated hardness and resistance of floors above ceilings, floors, basements, floors with electrical heating

Table 24

Energy saving measures for "City maternity hospital"

Insulation of walls (with plastering layer)

Thickness of insulation, cm		2	5	8	12	18
Walls	Price for m^2 of isolation with specified thickness, thou. rub.	2	2,12	2,28	2,52	2,85
	Total cost, thou. rub.	4506	4777	5137	5678	6422
	Heat energy savings, Gcal	74,21	137,08	173,92	204,43	231,52
	Economic effect, thou. rub.	84,93	156,88	199,05	233,96	264,97
	Payback period, years	43,1	30,4	25,8	24,3	24,2

Comments. Insulation of walls (thermal, acoustic and fire insulation of exterior step in buildings and constructions of various purpose with a subsequent plastering on reinforcing grid)

Table 25

Energy saving measures for "City maternity hospital"

Insulation of walls (ventilated facades)

Thickness of insulation, cm		4	8	12	18
Walls	Price for $m^2$of isolation with specified thickness, thou. rub.	4,5	4,7	4,8	4,9
	Total cost, thou. rub.	10209,4	10479,8	10750,2	11110,7
	Heat energy savings, Gcal	120,12	173,92	204,43	231,52
	Economic effect, thou. rub.	137,47	199,05	233,96	264,97
	Payback period, years	34,3	22,6	21,9	20,9

Comments. Insulation of walls (Heat-, sound- and fire insulation layer with air gap in external walls of buildings (ventilated facades) for various purposes. Plate captured with black or white glass), 75kg/m^3

Table 26

Energy saving measures for "City maternity hospital"

Indicators	Total cost, thou. rub.	Energy savings	Economic effect, thou. rub.	Payback period, years
Installation of reflective screens for heating elements	53,78	16 Gcal	17,78	3,024
Pasting of energy saving film (selective coating)	612,91	49,53 Gcal	56,69	10,81
Installation of a system for heating load balancing	210	23,3 Gcal	26,7	7,9
Replacement of incandescent lamps	4,1	23207 kWh	57,1	0,1
Replacement of windows	444,6	17,98 Gcal	20,58	12,6

Table 27

Energy saving measures for "City maternity hospital"

Reconstruction of the building

Name	Value
Total cost, thou. rub.	
Insulation of walls with a subsequent plastering on reinforcing grid	6421,5
Attic insulation (insulation IZOVOL))	1863,6
Replacement of windows	444,6
Pasting of energy saving film (selective coating)	612,9
Installation of radiator reflectors	53,784
Total	9396,4
Indicators	
Heat energy savings, Gcal	269
Economic effect	308,2
Payback period, years	30,484

Table 28

Energy saving measures for "City maternity hospital"

Reconstruction of the building (recommended)

Name	Value
Total cost, thou. rub.	
Replacement of windows	444,6
Attic insulation (insulation IZOVOL)	1635,6
Pasting of energy saving film (selective coating)	612,9
Installation of radiator reflectors	53,784
Balancing system	210
Total	2956,9

Table 28. Continued

Name	Value
Indicators	
Heat energy savings, Gcal	280
Economic effect, thou. rub.	320,8
Payback period, years	9,218

Table 29

List of typical measures on energy saving and energy efficiency for "City maternity hospital"

Name	Annual savings of energy resources		Costs, thou. rub.	Average pay-back period, years
	In physical terms	Value terms thou. rub.		
Organizational and low-cost measures				
Replacement on energy saving lamps	23207 kWh	57,1	4,1	0,1
Average costs				
Installation of radiator reflectors	16 Gcal	17,78	53,8	3,0
Long term and large measures				
Replacement on plastic triple-pane windows	17,98 Gcal	20,58	444,6	12,6
Attic insulation (insulation IZOVOL 15 cm)	189,9Gcal	217,33	1863,6	8,05
Pasting of energy saving films on new plastic window	49,53Gcal	56,69	612,91	10,8
Installation of a system for heating load balancing	23,3 Gcal	26,7	210	7,9
Total, thousand tons of equivalent fuel including energy resources due to its types	43,52Tonne of coal equivalent	382,04	2961	7,75
Heat energy	284,35Gcal	324,94	2956,9	9,10
Electric power	23,21 kWh	57,1	4,1	0,1

The most expensive activity is warming of attic that is why it was considered more detail (Fig. 21).

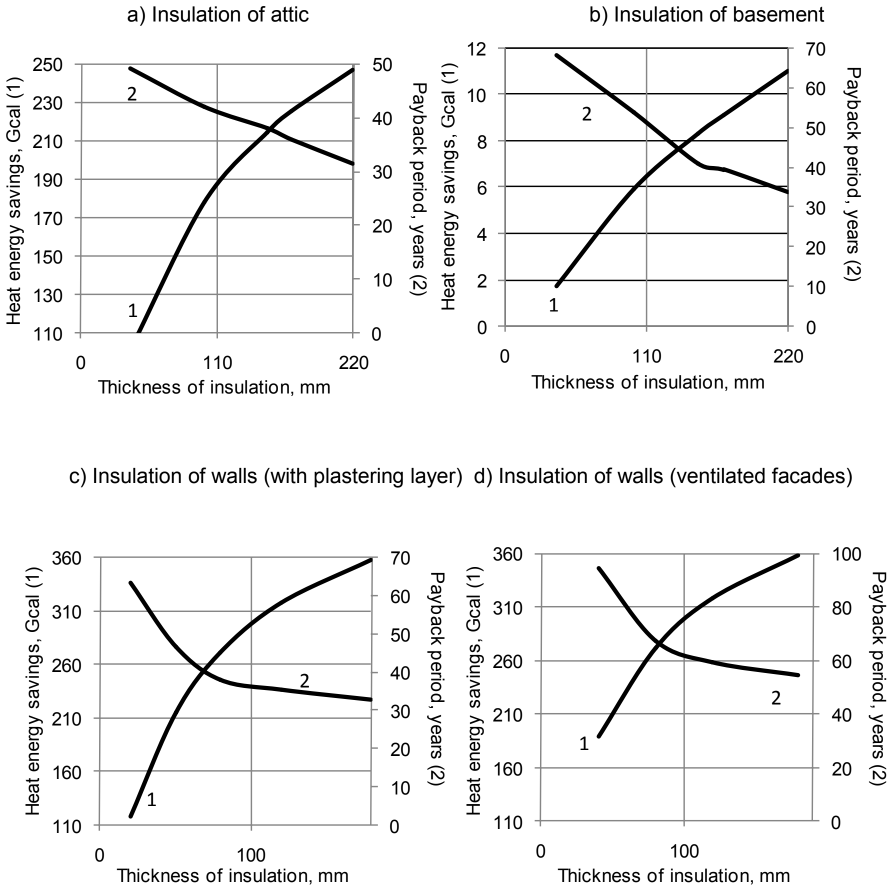

Fig. 21. Dependence of insulation thickness on energy efficiency parameters of "City maternity hospital"

3.4. Calculation of profitability index

To identify what is the best object to invest in it has been calculated the index of profitability.

$$PI = \frac{\sum Ef}{\sum Ex}, \text{ where}$$

$\sum Ef$ – is total saving for all year, thou. rub;

$\sum Ex$ – is total expenditures, thou. rub ;

"City children's polyclinic No. 4":

$$PI = \frac{\sum Ef}{\sum Ex} = \frac{10 \cdot 276,54}{2189,33} = 1,263$$

"City hospital No. 6":

$$PI = \frac{\sum Ef}{\sum Ex} = \frac{10 \cdot 340,05}{3107,1} = 1,094$$

"City maternity hospital":

$$PI = \frac{\sum Ef}{\sum Ex} = \frac{10 \cdot 382,04}{2961} = 1,29$$

3.5. Conclusions

In this section of paper it has been intended economic potential of implementation the energy management system, in particular energy audit. It is provided a list of measures for saving the electric power, thermal energy and water resources. The sequences of these events are prescribed.

It were also being calculated in this section the economic costs of implementation the scientific project in framework of municipal institutions. Expenditures on each stage of implementation the energy management were being calculated as well as payback period of the project and economic effect.

It was being used the profitability index to determine the most effective venue as a main stage of the energy management program. Energy audit it will be better to choose for Municipal Budget Health Establishments "City maternity hospital" rather than Municipal Budget Health Establishments "City hospital No. 6" or Municipal Budget Health Establishments "City children's polyclinic No. 4, because its profitability index has the highest value –1, 29 in contrast with 1,094 and 1,263 respectively. Thereby it were being determined the greatest potential municipal institutions and its economy by utility payments, and it potential energy efficiency. There are listed below all recommended measures for Municipal Budget Health Establishments "City children's polyclinic No. 4".

1. Replacement of incandescent lamps:

- Total cost of the event is 4,9 thou. rub.;
- Savings in natural expression 7644,2 kWh;
- Economic effect 18,8 thou. rub;
- Payback period of 0,26 year.

2. Installation of radiator reflectors:

- Total cost of the event 92,81 thou. rub.;
- Savings in natural expression 26 Gcal;
- Economic effect 36,44thou. rub.;

- Payback period is 2,5 years.

3. Installation of a system balancing of the heating load:
   - Total cost of the event 370 thou. rub.;
   - Savings in natural expression 98, 7 Gcal;
   - Economic effect 136,7thou. rub.;
   - Payback period 2,7 years.

4. Replacement of the windows:
   - Total cost of the event 789,7 thou. rub.;
   - Savings in natural expression 20,35 Gcal;
   - Economic effect 28,16thou. rub.;
   - Payback period 11 years.

5. Pasting of energy saving film:
   - Total cost of the event 931,91 thou. rub.;
   - Savings in natural expression 40, Gcal;
   - Economic effect 56,44thou. rub.;
   - Payback period 9,51 years.

Recommended measures on Municipal Budget Health Establishments "City children's polyclinic No. 6".

1. Replacement of incandescent lamps:
   - Total cost of the event is 6,7 thou. rub.;
   - Savings in natural expression 5826,5 kWh;
   - Economic effect 14,3thou. rub.;
   - Payback period of 0,66 year.

2. Installation of radiator reflectors:

- Total cost of the event 50,4 thou. rub.;
- Savings in natural expression 13 Gcal;
- Economic effect 14,43thou. rub.;
- Payback period is 3,5 years.

3. Installation of a system balancing of the heating load:

- Total cost of the event 110 thou. rub.;
- Savings in natural expression 18,9 Gcal;
- Economic effect 21,07thou. rub.;
- Payback period 5,1 years.

4. Replacement of the windows:

- Total cost of the event 1326 thou. rub.;
- Savings in natural expression 12,18 Gcal;
- Economic effect 17,3thou. rub.;
- Payback period 16,3 years.

5. Pasting of energy saving film:

- Total cost of the event 354,347 thou. rub.;
- Savings in natural expression 23,85 Gcal;
- Economic effect 27,3thou. rub.;
- Payback period 13 years.

6. Installing Individual Heating Plant (IHP):

- Total cost of the event 220 thou. rub.;
- Savings in natural expression 82 Gcal;
- Economic effect 93,9thou. rub.;
- The payback period 2,3 years.

Further, it is proposed the list of the most effective activities for energy management system implementation, which were directly selected due to calculation of the index of profitability.

Recommended measures on Municipal Budget Health Establishments " City maternity hospital".

1. Replacement of incandescent lamps:
    - Total cost of the event is 4,1 thou. rub.;
    - Savings in natural expression 23207 kWh;
    - Economic effect 57,1thou. rub.;
    - Payback period of 0,1year.

2. Installation of radiator reflectors:
    - Total cost of the event 53,8 thou. rub.;
    - Savings in natural expression 16 Gcal;
    - Economic effect 17,78thou. rub.;
    - Payback period is 3 years.

3. Installation of a system balancing of the heating load:
    - Total cost of the event 210 thou. rub.;
    - Savings in natural expression 23,3 Gcal;
    - Economic effect 26,7thou. rub.;
    - Payback period 7,9 years.

4. Replacement of the windows:
    - Total cost of the event444,6 thou. rub.;
    - Savings in natural expression 17,98 Gcal;
    - Economic effect 20,58thou. rub.;

- Payback period 12,6 years.

5. Pasting of energy saving film:

- Total cost of the event612,91 thou. rub.;
- Savings in natural expression 49,53 Gcal;
- Economic effect 56,69thou. rub.;
- Payback period years 10,8 years.

6. Insulation of attic:

- Total cost of the event 1863,6 thou. rub.;
- Savings in natural expression 189,9 Gcal;
- Economic effect 217,33 thou. rub.;
- Payback period 8,05 years.

As you can see from the latest data, Municipal Budget Health Establishments “City maternity hospital” is the most perspective building for implementation energy saving program, because its energy efficiency indicator is much perspective than one’s for Municipal Budget Health Establishments “City hospital No. 6” and Municipal Budget Health Establishments “City children's polyclinic No. 4.” Therefore it is recommended to carry out the research on the basis of proposed institution.

4. DEVELOPMENT OF ENERGY MANAGEMENT SYSTEM FOR PUBLIC INSTITUTIONS

4.1. Structure of documents through implementation period of energy management system

International organization for standardization has developed requirements and guidance for use regarding Western market countries. Therefore, Russian standards are not always adapted to national conditions.

Table 31 presents proposed plan for implementation the EnMS which was adapted to specifics of the Russian system within budget institutions and organizations.

The first step is decision-making of the company management about integration the system and defining organizational structure. At this stage it is important to define areas of responsibility for senior management and to appoint the EnMS responsible manager, as well as to develop a list of specific documentation. At the first stage it is necessary to appoint organization order of designation for responsible coordinators to develop and support the EnMS. Then it is necessary to analyze the energy resources consumption data and to develop the energy balance of organization, its departments, or objects (with selection of the objects and units on the bases of indicator significance from total energy consumption). The obtained results are presented in the energy passport of the organization. Further there are energy policies of the organization and energy efficiency indicators developed: definition of controlled indices and attained level. By itself, the energy policy is a document where are fixed all the main goals and focus of activities in the field of energy efficiency.

Table 31

EnMS implementation plan

Name of the stage	The list of developed documentation
1. Defining the organizational structure	
1.1 Responsibility zone definition of the senior management and appointment of responsible manager for EnMS	1. Orders for organization regarding definition of responsible coordinators for the development and operation EnMS
1.2. Energy resources consumption analysis and development of energetic balance of organization, departments and units. Select objects and departments that are significant in the total energy consumption.	2. Energy passport of organization.
1.3. Development of an energy policy for the organization and identification of indicators for energy efficiency (definition of controlled indices and the level that should be achieved)	3. Energy policy it is regulation on the main goals and directions of activities the area of energy efficiency
1.4. Definition of responsibilities for the manager who responsible for development and implementation EnMS	4. Job description of the responsible manager
1.5. Formation of the organizational structure for responsible stuff that m charge of EnMS formation and functioning in the units and departments	5. Statement about the EnMS organizational and personnel structure
1.6. Definition of responsibilities for EnMS representatives in units and departments	6. Job descriptions of EnMS responsible in units and departments
1.6. Organization of training for EnMS representatives m units and departments	7. Certificate of the internal auditor
2. Development of energy consumption and energy efficiency monitoring system	
2.1. Development of a EnMS data collection mechanism (definition of controlled indices, periodicity of data and storage technology)	8. Regulations of the EnMS monitoring data and methodology of conducting and storage of the documentation
2.2. Verification of compliance with the legal and environmental restrictions	9. Instruction control of regulatory and environmental requirements associated with the implementation of energy policy

Table 31. Continued

Name of the stage	The list of developed documentation
3. Development of energy saving program	
3.1. Elaboration of actions for achieving the required values and classification (based on the expected savings, payback period and the period of implementing the planned measures) with distribution of responsibilities between the responsible executors and terms of performance also financial mechanism	10. Implementation action schedule actions
3.2. Definition of requirements for energy efficiency of purchased goods and services	11. Changes/additions to the regulations for the procurement of goods. works, services
4. Determination of the EnMS action order	
4.1. Determination of indicators control order of the energy efficiency and performance of energy-saving measures: comparison of the achieved indicators with regulatory- and data of similar profile organizations, including the periodicity of control, types and forms of the reporting documentation	12. Rules of indicators control of energy efficiency and implementation of energy saving measures (internal audit)
4.2. Develop a motivation system (rewards and responsibilities) for achievement of the EnMS established indicators	13. Statement about motivation of employees within EnMS
4.3. Providing openness of the information about the energy policy and its implementation, including the list of required information, timing and spacing of its submission and updating. information dissemination channels	14. Regulation on the placing of information about the energy policy, performance and its implementation in public sources

The next step is defining of duties for responsible manager to develop and implement the EnMS and writing this job description. The first step for EnMS responsible employee is creation of organizational structure, ensuring the formation and functioning of EnMS in departments and objects with the help of personnel organizational structure in accordance with energy management system provisions. After working on EnMS job descriptions for responsible employees in all departments and facilities the responsible manager must certify the competence of all authorized staff and if it is necessary, to carry out training courses. Thus responsible stuff will be able to receive certificate of internal auditor.

The second stage will be developing the monitoring system of energy consumption. It consists of data collection mechanism for EnMS, including identification of controlled indices, method and frequency of their receipt and storage technologies. The information obtained is recorded in regulations of monitoring the EnMS data and in methodology of documentation conducting and storage. Also it should be spelt out the control system of environmental and regulatory requirements that associated with energy policy implementation and take into account compliance with legal and environmental constraints.

The third stage is development of the energy saving program, which includes measures for achieving required values and classification of anticipated savings, payback period and period of planned measures implementation; distribution of responsibilities between executors and deadlines; financial mechanism. Thus, the schedule of events realization is carried out. One of the most important points for compliance is determination of energy efficiency requirements of purchased goods and services, there are necessary to make changes/additions with regulation on procurement of goods, works and services.

The fourth stage is determination of the order actions within EnMS. This stage involves creation of regulations for controlling the energy efficiency indicators and implementation of the energy saving measures, that is, internal audit, which will determine the procedure for monitoring energy efficiency and implementation of energy saving measures, comparison of its performance with regulatory numbers and similar organizations data, including monitoring frequency, types and forms of reporting documentation. The important point of successful achievements that were planned is coordination of Interactive staff at all levels. Motivation for employees is reinforced by bonuses and responsibility provisions and defines by achievements indicator in the framework of energy management system.

As it is clear, the main aspect of the energy management system is a clear documentation structure at all stages of EnMS action. Therefore, regulation establishment on publishing information about energy policy and its implementation performance must be display in public sources. Intervals of information updating should be taken into account as well as existing channels of information distribution.

According to ISO 50001 and GOST R 50001 determination of special document's package have been left to organization discretion [10]. The proposed document structure in comparison with the list of documents that were defined by U.S. Department of Energy has much smaller volume. The differences between these two approaches are given in Table 32.

Table 32

Comprising of document systems

U.S. Department of Energy	Proposed structure
1. Getting Started 1.1. Make the business case 1.1.1. Identify key internal influencers 1.1.2. Understand your business drivers 1.1.3. Prepare sales pitch 1.1.4. Brief top management 1.2. Secure top management commitment 1.2.1. Establish the scope and boundaries	1.Order of organization in charge of determining the focal points for development and supporting EnMS

Table 32. Continued

U.S. Department of Energy	Proposed structure
1.2.2. Appoint a management representative 1.2.3. Assign the members of the energy team 1.2.4. Define the energy policy 1.2.5. Create organizational awareness 1.2.6. Ensure continual improvement	
1.3. Establish the structure for EnMS 1.3.1. Set the timeframe for implementation 1.3.2. Develop the implementation plan 1.3.3. Establish communication channels 1.3.4. Celebrate success often 1.4. Understand EnMS documentation 1.4.1. Energy Manual Guidelines 1.4.2. EnMS Documentation Guidance Table 1.4.3. Examples of documents 1.4.4. Examples of records 1.4.5. Making Decisions on EnMS Documentation Checklist	2. Organization energy passport
2. Profile Your Energy Situation 2.1. Identify, evaluate and track legal and other requirements 2.2. Acquire, analyze and track energy data	3.Energy policy – regulations on the main goals and directions of activity in the field of energy efficiency
2.3. Determine significant energy uses 2.4. Identify energy opportunities 2.5. Prioritize energy opportunities	4. Job Description for Responsible Manager
2.6. Establish baseline and determine Energy Performance 2.6.1. Get stakeholder requirements for measuring performance	5. Regulation on the organizational structure of personnel EnMS
2.6.2. Establish a baseline 2.6.3. Develop a list of possible EnMS 2.6.4. Determine factors that affect EnMS 2.6.5. Select and test EnMS 2.6.6. Analyze EnMS to determine performance	6. Job descriptions responsible for EnMS in units and facilities

Table 32. Continued

U.S. Department of Energy	Proposed structure
3. Develop Objectives, Targets and Action Plans 3.1. Establish energy objectives and targets 3.2. Formulate energy management action plans	7. Certificate of internal auditors
4. Reality Check: Stop! Look! Can I Go? 4.1. Review the status of your efforts 4.2. Perform a sanity check on resources 4.3. Identify accomplishments and lessons learned 4.4. Conduct a management review 4.5. Communicate across the organization	8. Regulations of the monitoring EnMS data and methodology of maintaining the documentation
5. Manage Current State and Improvements 5.1. Manage and control information 5.2. Determine operational controls 5.3. Ensure competence of personnel	9. Instruction of environmental control and regulatory requirements associated with the implementation of energy policy
5.4. Ensure awareness of personnel 5.5. Define purchasing specifications for energy supply	10. Implementation schedule of events
5.6. Incorporate energy considerations in procurement 5.7. Manage energy considerations in design 5.8. Communicate internally 5.9. Decide on external communications	11. Changes/additions to the regulation on procurement of goods, works, services
6. Check the System 6.1. Monitor, measure and analyze key characteristics 6.2. Calibrate monitoring and measuring equipment 6.3. Evaluate legal and other compliance 6.4. Plan and conduct internal audits 6.5. Take action to correct and prevent nonconformities 6.6. Check and use the evidence	12. Schedule of energy efficiency indicators monitoring and implementation of energy saving measures (internal audit)

Table 32. Continued

U.S. Department of Energy	Proposed structure
7. Sustain And Improve The System 7.1. Collect information for management review	13. Provision of employees motivation within EnMS
7.2.Conduct management reviews 7.3. Ensure continual improvement	14. Regulations on information placement of the energy policy and its implementation in public sources

After four stages of implementation the energy management system organization itself could reduce most of expenditures and avoid up to 10% of the energy costs during first couple of years, owing to continuous identification of weak points in terms of energy consumption and acceptance on the basic of measures. In average the investments in energy saving technologies will be repaid less than in two years by reducing power consumption by 5-50%.

4.2. Peculiarities of motivation program for employees within energy saving program

Creation of personnel incentive system (motivation program) plays a huge role in the performance of company as it aims to motivate employees to efficient and high-quality work, which will cover not only employer expenses on production process, and salary, but also will bring a certain profit. Also it allows increasing of employees' involvement in energy saving program and gives everyone an opportunity to contribute substantially and more proactive [11].

One of the most effective tools to motivate employees' is a bonus system through the savings under energy saving program. An important thing is determination of the bonus size dependency from energy resources savings and level of employees' responsibility for energy consumption.

Existing system of motivation the labor activity at present has been ineffective, because most of the time it have been used an equalizing system of payments and size of employees earnings slightly depends on personal labor contribution into final result of company's activities or there is no connection between significance of staff's duties and salary.

Specifics of work in institutions or organizations which performs administrative, education, social, cultural or other functions are following: there is no accounting for specific actual energy consumption for business units and objects and therefore it is impossible to determine energy savings; due to large number of staff it is difficult to define for employees particular requirements, their personal contribution in energy efficiency and determine exact bonus size, that they will receive at observance of requirements and what sanctions will follow in case of its violation.

Thus, it is necessary to create a modern motivation system, which leads to personnel activity increasing at the expense of premiums and allowances through the energy saving program.

The project objectives are: determining of volume savings during reporting period; defining of organizational structure for each type of power consumption separately; defining of structure for responsible stuff and their duties on each object; determination of distribution order for funds which will be received from the energy savings.

Calculation of potential energy savings and determination of the bonus size for employees starts with approving by company of planned resources expenditure or its consumption at the same previous period, and its actual consumption over reporting period.

Definition of volume savings during reporting period

Reporting period is established in accordance with the planned intervals by organization or enterprise. It could be month or quarter, even a year. This step is necessary to obtain reliable information on the expenditure of existing economic resources and for effective analysis and further energy resources planning. During the reporting period it is necessary to fix consumption for each type of resources separately (hot and cold water supply, natural gas, electric power, fuel, heat energy). Through the implementation period there can be difficulties because at present time there have not been developed methodology for evaluation of physical economy in the systems of heat and power supply for buildings with adduction of energy and water consumption to comparable conditions, namely, to the same weather conditions and to the same desired comfort in premises. The importance of correct estimation for physical economy caused the fact that this is one of the potential cash flow sources that determine economic efficiency of the whole project. Thus, determination of the energy or water physical economy is very difficult.

For calculation of economic effect from implementation energy savings program it must be observed following conditions: actual reduction of energy consumption more than three percent in comprising with previous year under comparable conditions should be achieved regarding the needs of planned consumption and confirmed by accounting data and meter readings; amount of energy consumption and energy savings are determine by established commercial and technical metering devices of energy consumption; planning and accounting of expenses on energy resources for municipal institutions is conducted with its allocation in separate line in the code 223 "Utilities" of budget expenditure classification and reports on energy resources consumption presents to chief administrator of budget funds; sanitary and construction standards is compiled; there are no debts for consumed energy.

It should be also noted that it is not an energy savings if it caused by the following facts: energy tripping because of non-payment or engineering systems repair; degradation of quality services due to malfunctions of utilities, and also through the approving of lower rates than it were planned.

Definition of savings can be made in two ways:

1. Determination of variation between standards (limits) and actual consumption:

$$C_{h.\,w} = (N_{lim.\,h.\,w} - N_{f.\,h.\,w})P_{h.\,w};$$

$$C_{c.w} = (N_{lim.\,c.\,w} - N_{f.\,c.\,w})\,P_{c.\,w};$$

$$C_{n.\,g} = (N_{lim.\,n.\,g} - N_{f.\,n.\,g})\,P_{n.\,g};$$

$$C_{el.} = (N_{lim.\,el.} - N_{f.\,el})\,P_{el};$$

$$C_{f} = (N_{lim.\,f} - N_{f.\,f})\,P_{f};$$

$$C_{heat.e} = (N_{lim.\,heat.e} - N_{ф.\,heat.\,e})\,P_{heat.\,e}\,,$$

Where $C_{h.\,w}$, $C_{c.w}$, $C_{n.\,g.}$, $C_{el..}$, $C_{f.}$, $C_{heat.e.}$ – are actual reduction of consumption for each type of fuel and energy resources in terms of value (hot water cold water, natural gas, fuel and heat energy, respectively), P– is a unit price of resource in current conditions.

Then total actual consumption in value terms is following:

$$C = \Sigma(N_{\mathrm{lim.}\,i} - N_{\mathrm{f.}\,i})P_i\,,$$

where C is total actual consumption of all energy resources in physical terms; $N_{\mathrm{lim.}}$ and N_{f} are established (limited) norms and actual consumption norms, respectively.

2. Definition of savings due to difference in consumption between the past and current year:

$$C = \Sigma\ (N_{\text{f. last. } i} - N_{\text{f. } i})\ P_i\ ,$$

where $N_{\text{f.}}$ – power norms for the last year on all energy resources in natural units; N_{flast}– consumption norms for the current year.

How to use savings

Funds from energy savings can be directed on bonus payments for employees and on energy saving measures.

Usually, energy saving measures involves: permanent improvement of energy management system functioning, introduction of energy saving technologies and equipment, technical and metrological maintenance of metering devices, also quality training of staff.

Percentage ratio of the shares is determined by management. It can be equal distribution of 50% on 50% or highlighting of priority area in any proportion (for instance 30% and 70%) at discretion of senior management.

Assessment of potential savings

Amount of electric power that were consumed is largely depends on employee's schedule, namely from ratio of the day length and working day duration (Table 33-34).

Cost of lighting is directly proportional to the room square. This fact has been analyzed and results presented below with its correlations values in Table 35-36.

Table 33

Duration of daylight hours

Month	Quantity of daylight hours
From January to March	6-7
From April to August	10-11
From September to October	7
From November to December	6-7

Table 34

Quantity of lamp hours

Name of institution	Summer time, h	Winter time, h
Municipal educational institutions (MEI)	6	8
Pre-educational establishments (PEE)	5	8
Boarding houses	5	11
Administrations	4	7

Table 35

Cost per lighting unit

Name of institution	Expenses, .	Average square, m^2
Municipal educational institutions (MEI)	31,2	1800
Pre-educational establishments (PEE)	11,6	300
Boarding houses	3,9	500
Administrations	115,3	90

Table 36

Standards of consumption of electric power, lux

Establishments	Lightness Lx/ m^2	Number of lamps/m^2	Capacity per one lamp, W	Established capacity, W
MEI	500	4	36	144
PEE	300	3	36	102
Boarding houses	250	2	36	72
Administrations	400	4	36	144

Comments. Number of halogen lamps/m^2– with a ceiling height of not more than 3 m

Determination of energy consumption structure for each type of units and objects separately

For effective energy resource accounting and analysis it is important to define consumption within each object by emitting each type of resource.

If the necessary resource is impossible to allocate in facility it should be determine its partial energy consumption from the total with the help of computational methods.

$$A_i = AN_i/N,$$

where A_i , N_i – actual and normative (calculated) consumption in subdivision or object; A, N – actual and normative (calculated) consumption in facility, or in its part, where resource consumption is determined by metering devices.

Determination of structure for employees that in charge for energy consumption on places

Determination of responsibilities structure for employees' on energy consumption areas depends on existing organizational structure in enterprises. Thus, responsible for coordination, functioning, developing and implementation of the energy management system shall be appointed in accordance with scope of implemented activities, departments' provisions and regulations of its staff as well as complexity of products' unification and level of infrastructure development in the region.

Structure of responsible staff in organization can be: linear (i.e., appointment of responsible in each workshop, units, and so on), functional (distribution of duties between employees of entire division), project destination (employees perform same tasks under the leadership of coordinating center).

Essential duties of authorized person in charge are following: development and implementation of programs in the field of energy saving and energy activity increasing; establishing requirements for energy saving program; information support of measures to increase energy activity in accordance with normative and legislative federal and regional regulations; monitoring and coordination of energy saving and energy efficiency program implementation.

As a part of savings duties it should be noted:

- knowledge of normative – legal base in the field of energy saving and energy efficiency;

- knowledge of principles for energy management and system interaction with other services and organizations;

- participation in development and implementation of the energy saving programs, guidelines for objectives achievements, as well as establishment of rules and methods for energy saving in organization through energy efficiency programs implementation and lower energy intensity to the level of more experienced organizations with similar profile.

Determination of distribution order of received funds from power savings

Size of bonus is usually determined by amount of annual savings in percent, because it is important for employer to develop more effective interventions of employee's in process of resources conservation and implementation of innovations in organizations.

Period that defines bonus payment depends on the result of the ongoing savings. So, for example, for workers from activities which, first of all, depends on the result of the introduction of the innovation decisions or other measures for saving fuel and energy resources and materials, the bonuses can be monthly or quarterly character. When the calculation of efficiency savings made in periods, the duration of large, to ensure payment of bonuses of this category of workers can be achieved by uniform distribution of the formed Fund rewards for saving energy and materials for the next after the evaluation period.

As a parameter for personal contribution estimation of the staff and management it can be used personnel indicators of workload that performed by this function, their intensity, quality, level of labor organization and others.

In case of workers and employees, whose participation in process of realization the energy resources and fuel saving measures consists of development and implementation of activities, as well as control compliance of this main provisions and bonuses for energy resources and materials savings, the best is to determine a longer period of these measures implementation. This will ensure a positive effect from implementation of these activities over long term:

$$E = E_1 + E_s + E_r$$

where there are three article of distributions: E_1 – leaders (management), E_s– subdivisions, E_r – responsible staff.

When it comes to decision making about rewarding, it is worth to note both material and moral work stimulation of personnel for productivity increasing, efficiency and moral formation of personality. It means both psychological and moral incentives in a special form of public recognition expression towards employee and enhances his prestige. It can be awarding or pennants ceremony, public announcement of gratitude, posting of photos on board of honors.

4.3. Implementation of automated information analytic energy management system

Nowadays, most of specialists in the field of power energy and active political figures are concentrating their attention on fundamental problems of management connected with resource-saving technologies, new organization of social and economic systems and ecological and nuclear safety for open society. It is caused not only by low energy efficiency of Russian economy, but also due to increasing cost of the energy resources especially in budget sphere. Annually government management establishments spend overwhelming part of the budget on municipal utilities.

As a solution of these problems it is proposed adaptation of the world practice principles and methods of the energy resources management (EnMS).

Attempts to solve energy efficiency problems in public sector have been repeatedly confirmed by a considerable number of publications on this subject. But most of these works are concentrated on private technical and economic objectives, while insufficient attention is paid to system of tasks formulation and implementation of energy efficiency at municipal level, and not for individual institutions [12-13].

At the global level, the problem of efficient energy management is that in most cases it is considered at the industrial facilities or on buildings projects, but not on the structures that implement services to the existing buildings. Therefore, the evidence-based system methods of tasks solution are currently demand.

Nowadays, there are no instruments for continuous monitoring and evaluation of energy efficiency at regional and municipal level and for large government establishments and commercial organizations whose activity is performing of administrative and management functioning and services delivery, and where major share of energy consumption relates to public utilities.

Also available regulatory and methodological framework for evaluation the average standards for energy use and indicators do not take into account specifics of institution and technical characteristics of its buildings. This situation does not allow assessing real potential energy savings and effective directions of investment.

It should be noted that the absence of unified information analytic system, that oriented on large non-productive consumers with an extensive territorial network involves increasing of already considerable share of utilities costs for all customer's groups [14-17].

It should be noted that in case of development the proposed management system were taken into consideration that was not being accounted:

1. Focusing on energy analysis for final consumers.

2. Rapid information receiving.

Initial information is supposed to be received from three sources. This approach has been approved year ago as part of Research and Development work on example of Grayvoronsky area of the Belgorod region and proved its effectiveness (Fig. 22).

Data on monthly energy consumption will automatically flow from the energy supply companies. Budget establishments once a year will make or modify individual data on their activities. Data about monthly consumption of energy will automatically flow from the power supply companies.

Budget institutions once a year will make or modify individual data on its activities. Also it will be entered statistical facts into the system [18-22].

This integration will provide efficiency and accuracy of data and minimize bureaucratic load on employees in state-financed organization.

In the "Energy Region" program there are 2 levels of users:

- Budget establishments;
- Government establishments.

At the bottom level of the system it is possible to accomplish monitoring and analyzing of current energy consumption, comparing their performance with other organizations, and implements awarding system for employees.

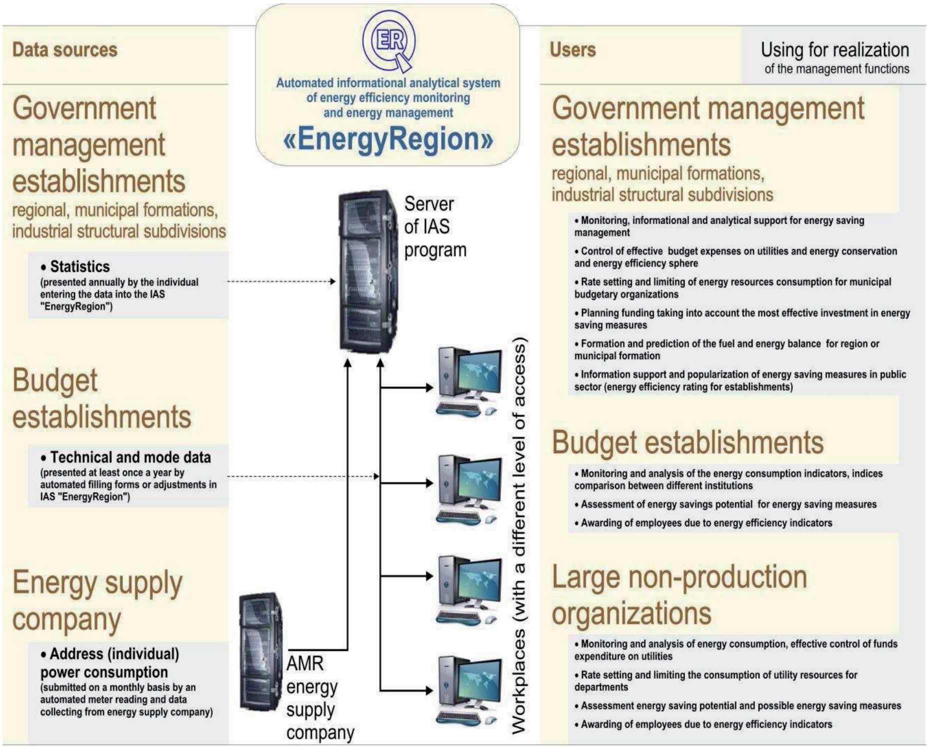

Fig.22. Structure of automated information analytic system for energy management

Currently there have been implemented several similar commercial projects. Their developers are not only universities but also public and commercial organizations:

- Federal state budget institution of high professional education "Ivanovo State Energy University" (information – analytic system of energy balances IAS FEB);
- State budget institution "Energy saving institute" Sverdlovsk region ("Energy Efficiency Rating of Sverdlovsk Region as a municipal formation");
- Center of efficient energy use CENEF, Moscow; "Energy balances of Russian regions";

- International Organization for Standardization ISO 50001 - Energy Management Systems USA («Leadership in Energy and Environmental Design»), UK «Building Research Establishment Environmental Assessment Method», Germany «Deutsche Gesellschaftfür Nachhaltiges Bauen».

Main features of these systems are following: focusing on energy resources for generation, long period of analyzing which is one year and orientation on manufacturing sector.

Thus, main advantages of proposed system in contrast with already existing are following:

- Firstly, operative analysis of information with monthly period;
- Secondly, focusing on improving of energy efficiency for consumers, rather than for energy produce and transmission companies;
- Third, analyzing and forecasting of effects for implementation management solutions of energy- saving measures.

4.4. Conclusions

This paper presents energy management technique within Russian management system and gradual way of introduction energy management system in accordance with ISO 50001 for Russian organizations. Distinctive features of proposed structure are:

- list of developed documents that suitable in accordance with Russian recording style and system of normative documents;
- implementation of system is carried out on the basis of already available divisions and responsibilities are distributed among existing stuff;

- in developed countries should be adopted terminology with possible replacement on terms and definitions that have been traditional for this country;

- proposed system pays less attention on procedures for final performers, regulation of their main activities, using energy efficiency and documentation of process of obtaining analysis for energy consumption;

- structure of responsible stuff defines duties for each site that gives more streamlined and structured process of obtaining information for each sector and thus make it easier, better organized, effective and more target to regulation methods.

Paper shows that proposed hierarchy is optimum in implementation processes of the most effective management within budget organizations at municipality or region with further application on federal level. Therefore it is required implementation of intended interaction between users of all levels. It was revealed that existing methods of energy efficiency management do not account all peculiarities of public sector.

All the facts above proves the necessity of mutual permanent connection of all structure elements for effective and systematic energy management with the main goal of cost utilities reduction that were planned for consumers, increasing of energy efficiency in budget institutions, ensuring long-term structure's changes in public services in general and effective investment in energy-saving measures at regional level.

5. SUMMARY CONCLUSIONS

1. This paper presents comparisons between Russian standard GOST R 50001:2011 and international ISO 50001. In the adopted Russian standard GOST R 50001:2011 there are a number of differences in terms and definitions in comparison with other Russian laws and regulations. This fact complicates implementation of the energy management system at Russian enterprises and organizations. Therefore, during the certification process it should be given work discrepancies and accomplished coordination process with national legal system its provisions and requirements as well as understanding of terms meaning that were used. It will significantly simplify the process of implementing the GOST R 50001:2011.

2. It have been calculated the rating efficiency of Belgorod organizations. Analyses have been based on data from municipal objects therefore there are presented consumptions for different type's structure and indicators of energy efficiency have been derived. In total energy efficiency for different institutions may vary more than in three times and larger institutions have higher level of energy efficiency. It have been shown that for determination of structure for optimal investments in energy saving measures and achievement of the best energy savings results it is required a differentiated approach taking into account performance of each institution individually.

3. Calculation of economic potential for energy management system implementation has been calculated carefully. List of measures for power, energy and water saving are presented. The sequences of these events are prescribed.

It have been determined the most effective measures as a main stage for energy management program using profitability index so then it will be easier to choose objects where it will be more effectively to carry out the energy audit.

Also it have been calculated the economic costs through implementation period of this scientific project on example of municipal institution. Costs at each stage of project's implementation have been calculated as well as payback period and economic effect.

4. Paper presents energy management system implementation within Russian system of management and its gradual way of implementation in accordance with the requirements of ISO 50001 for Russian organizations.

Distinctive features of the project are following:

- updated list of documents that corresponds with Russian managements and normative documents;
- implementation of EMnS is carried out on the basis of already existed divisions, and employees' responsibilities are distributed among existing stuff;
- adopted in developed countries terminology have been replaced as much as it possible with terms and definitions that traditional for our country;
- proposed system focuses not on procedures for final performers and regulating its main activities using energy efficiency, but on documenting the process of obtaining the energy consumption analysis;
- structure of responsible stuff defines duties for each site that gives more streamlined and structured process of obtaining information for each sector and thus make it easier, better organized, effective and more target to regulation methods.

Research shows that proposed hierarchy is optimum in implementation of the most effective management within budget organizations at municipality or region with further application on federal level. Therefore it is required implementation of intended interaction between users of all levels. It was revealed that existing methods of energy efficiency management do not account all peculiarities of public sector.

It was revealed that existing methods of energy management could not account all peculiarities in public sector.

All the facts above proves the necessity of mutual permanent connection of all structure elements for effective and systematic energy management with the main goal of cost utilities reduction that were planned for consumers, increasing of energy efficiency in budget institutions, ensuring long-term structure's changes in public services in general and effective investment in energy-saving measures at regional level.

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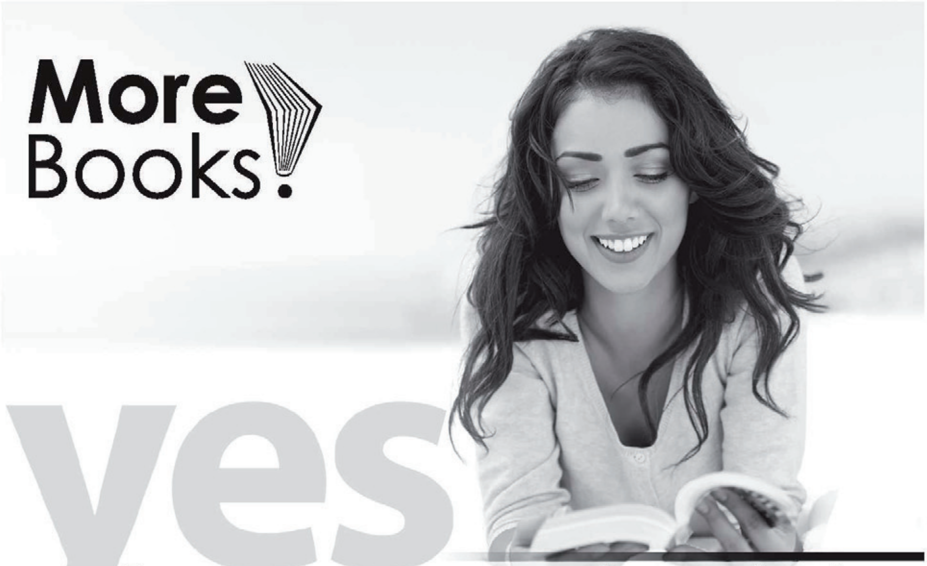
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