POSIBILITIES FOR ENERGY SAVING IN A STUDENT HOSTEL "MARITZA 4" OF UNIVERSITY OF FOOD TECHNOLOGIES

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Abstract: Energy audit of the student hostel "Maritza 3" of University of Food Technologies – Plovdiv is done. The data about the building energy consumption and about the present state of the building installations and enclosing elements are collected and analyzed. Computer model of the real energy consumption is created and the appropriate measures for energy saving are proposed. The potential for reducing of energy consumption and CO2 emissions are defined.
Keywords: energy efficiency, energy audit, buildings.

Introduction:

Energy efficiency is vital for the European Union. More and more citizens and firms feel the impact of increased energy bills. The dependence of Europe and Bulgaria in particular from the import of fuels will grow and the security of fuels supply is going to get worse. Reducing energy consumption is the most appropriate long-term answer to that. Energy saving is the most immediate and cost efficient way to overcome the key energy challenges regarding sustainable development, security of supply and competitiveness. Avoided energy consumption through energy savings is becoming the most important energy source. Buildings are the biggest consumers of energy. At the same time they have enormous potential for energy savings. If we reduce their energy intensity the quotas of CO2 emission will be release and then countries can sell them.

The aim of this study is to establish the possibilities for reducing energy consumption of the student hostel at keeping the normative parameters of the living areas.

Materials and methods:

The building of the student hostel "Maritza 4" is studied. It was put into exploitation in 1986. The building has central heat supply. The building's facade is shown on fig.1.

Fig. 1. Facade of the student hostel

The building model investigation is done with the "EAB Software" in accordance with the regulations on energy efficiency, and the economic analysis of the proposed energy saving measures (ESM) – with the "ENSI Economy" software in real interest rate - 6.73%. The building falls into climate zone 6 – Plovdiv. The current price of heat energy is 110 BGN per MWh with VAT. The economic life of the proposed ESM is set according to [4].

Results and discussion:

The building has a basement and five flours. The basement is partially heated. The building construction is a large-area formwork. The total built-up area is 947.3 m2 the developed area - 5846.47 m2 heated area - 4938.65 m2 and gross heated volume is 13882.75 m3. For types of outside walls are established. The basement's exterior walls are made of reinforced concrete, double plastered and with a bush-hammered outside surface. Their whole thickness is 43 cm. The walls of the 5 floors are both sides plastered multilayered panel with a thickness of 30 cm of the north and south facades and 25 cm of the western and eastern facades. All three facades of niches under the windows along the eastern and western facades are both sides plastered reinforced concrete panel with a total thickness of 20 cm. The windows are mainly wooden with double glassing, and in the foyer there is a metal window, starting at 40 cm from the ground and get to the roof. The woodworks are in poor condition, frames are deformed, some of them are rotten and can't be repaired. There are broken and missing windows on the facades. The building's roof is a flat cold roof with an air layer with 1, 1 m thickness. The roof of the window niches is a hot roof. The building has three types of floors – floor, bordering with outside air (bay); floor of a heated basement; floor above a nonheated basement.

The heat supply substation is mounted in the basement. It is risently renovated and is in good condition. The circulating pump and the heat exchanger are new. There are installed and a new closed expansion tank. For metering is installed new ultrasonic heat meter. The heating operates 20 hours a day at 22 0C inside temperature and 4 hours a day (twice in 2 hours a day) at 18 0C. Domestic water is heated all year round. The condition of the pipe work in the substation is good. The pipes are well insulated. At very few places there is partially damaged insulation of pipelines. The heating installation has a scheme with a lower distribution and radiation pattern. The isolation of the pipes in the basement is destroyed only in a few places, but aside from that, it is in relatively good condition. In the room for celebrations the pipes are not insulated.

Energy consumption: The energy consumption for 3 years (2008 ÷ 2010) is analyzed. The specific heat consumption for heating is between 175 и 201 kWh/DD. The consumption of electric energy is average 34 % from the total energy consumption.

The computer model of the building [2, 3, 4] is worked out. The reference models of energy consumption of building are composed in accordance with the legal standards, operating during the year of bringing of the building into exploitation (1980), and the legal standards operating at the time of the audit doing (2011).

The model calibration is done considering the energy consumption for domestic hot water, lighting and electrical appliances with a referent heat consumption for space heating of 104, 4 kWh per year. Unknown model parameters (infiltration - 0, 96 h-1, design temperature - 22 0C, temperature with reduction - 18 0C) are established. The baseline energy consumption for space heating is obtained through normalization of the model and it is 104.4 kWh per year. The current class of energy consumption is "F" according to [6].

Establishing the potential for reducing of energy costs, simulating of energy saving measures and economic analysis:

The building's energy saving potential is established from the model analysis. The results from calibration of the model, reflecting the actual state of the object, base model state and the obtained impact of the introduction of the ESM are presented in Figure 2.

Параметър	Еталон	Състояние	Базова линия	Чувствителност kWh/m²a	ЕС мерки	Спестяване
1. Отопление	**16,6 kWh/m²a**					
U - стени	0,38 W/m²K	1,78 >	1,78	+ 0,1 W/m²K = 2,02	0,45 >	23,25
U - прозорци	2,00 W/m²K	2,95 >	2,95	+ 0,1 W/m²K = 1,32	2,00 >	10,91
U - покрив	0,24 W/m²K	0,68 >	0,68	+ 0,1 W/m²K = 1,56	0,23 >	6,11
U - под	0,32 W/m²K	0,93 >	0,93	+ 0,1 W/m²K = 1,57	0,68 >	3,42
Фактор на формата	0,33 -	0,33	0,33		0,33	
Относ. площ прозорци	17,8 %	17,8	17,8		17,8	
Коеф. на енергопрем.	0,45 -	0,45 >	0,45		0,45 >	
Инфилтрация	0,50 1/h	0,96	0,96	+ 0,1 1/ h = 6,60	0,50	26,16
Проектна темп.	20,0 °C	22,0	22,0	+ 1 °C = 7,50	20,0	12,82
Темп. с понижение	18,0 °C	18,0	18,0	+ 1 °C = 1,49	18,0	
Приноси от						
Вентилация (отопл.)	kWh/m²a	0,00 ...	0,00 ...		0,00 ...	
Осветление	kWh/m²a	4,09 ...	4,09 ...		3,34 ...	
Други	kWh/m²a	16,55 ...	16,55 ...		13,53 ...	
Сума 1	**kWh/m²a**	**90,2**	**90,2**		**18,8**	
Ефект. на отдаване	100,0 %	100,0	100,0		100,0	
Ефект.разпред.мрежа	95,0 %	94,6	94,6		94,6	
Автом. управление	97,0 %	97,0	97,0		97,0	
Е П / ЕМ	96,0 %	96,0	96,0		96,0	
Сума 2	**kWh/m²a**	**102,4**	**102,4**		**21,3**	
КПД на топлоснабд.	98,0 %	98,0	98,0		98,0	
Сума 3	**kWh/m²a**	**104,4**	**104,4**		**21,8**	

Fig. 2. Results from the energy consumption model before and after ESM

The next ESM are proposed:

Replacement of existing wooden windows with aluminum windows with a thermal break, and double glass package and "k" glass. The summary heat transfer coefficient of windows reduces to 2 W/(m2K). The effect is saving of 20 140 BGN, or 17.57% reduction in heat consumption and results in reduced infiltration and heat transfer through windows. At a new windows price of 160 BGN per m2, the necessary investments are 140 480 BGN and payback period is 7.0 years;

Thermal insulation of external walls and jetty with 7 centimeters fiber. The effect is saving of 14 490 BGN per year, or 12.64% reduction in heat consumption and a reduction of the thermal transfer through the walls and jetty. At a new insulation price of 50 BGN per m2 the necessary investments are 75 779 BGN and payback period is 5.23 years;

Thermal insulation of roof, made of mineral wool mattresses with 10 cm thickness placed on the attic floor in under roof space and thermal insulation of the roof of the sub window niches with 7 cm fiber. The effect is saving of 3 320 BGN, or 2.9% reduction in heat consumption and a reduction of the thermal transfer through the roof. At a new

insulation price of 30 BGN per m2 for mineral wool and 50 BGN per m2 for fiber the necessary investments are 33 181 BGN and payback period is 10.0 years;

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Параметър	Еталон	Състояние		Базова линия		След ECM	
	kWh/m²	kWh/m²	kWh/a	kWh/m²	kWh/a	kWh/m²	kWh/a
1. Отопление	16,6	104,4	515 866	104,4	515 866	21,8	107 570
2. Вентилация (отопл.)	0,0	0,0	0	0,0	0	0,0	0
3. БГВ	60,6	60,6	299 448	60,6	299 448	60,6	299 448
4. Помпи. вент.(отопл.)	1,0	1,0	5 093	1,0	5 093	1,0	5 093
5. Осветление	8,9	8,9	43 915	8,9	43 915	8,9	43 915
6. Разни	36,0	36,0	177 662	36,0	177 662	36,0	177 662
Общо (отопление)	123,1	211,0	1 041 984	211,0	1 041 984	128,3	633 688

Обща отопляема площ 4 939

Fig. 3. Results from building energy consumption's model, before and after ESM

Table 4. The economic indicators from the implementation of proposed ESM

ENERGY SAVING MEASURES (ESM)	CURRENT SITUATION	SITUATION AFTER IMPLEMENTATION OF ESM	ENERGY SAVINGS	
	кWh/year	кWh/year	кWh/year	%
Replacement of 878 m2 windows with double glazed aluminum windows	1 041 984	927 151	183 068	17,57
Thermal insulation of external walls and jetty	1 041 984	910 248	131 736	12,64
Thermal insulation of roof	1 041 984	1 011 818	30 166	2,9
Installing of radiator's thermostatic valves	1 041 984	978 658	63 326	6,08
Total for the whole package of ESM	4 167 936	3 827 875	408 296	39,19

Installation of thermostatic valves on heating units. The effect is saving of 6 970 BGN, or 6.08 percent reduction in heat consumption and it is expressed in control and maintenance of the set temperature in the rooms. At price of 30 BGN per valve the necessary investments are 4 800 BGN, and payback period is 0.7 years.

The economic indicators from the implementation of proposed ESM are presented in Table 4 and Fig. 4. The assessment of the individual indicators of the individual ECM shows that the measure with the highest percentage of energy savings is the replacement of windows, and a measure with the shortest return period is a measure of improved room temperature management by installing of thermostatic radiator valves.

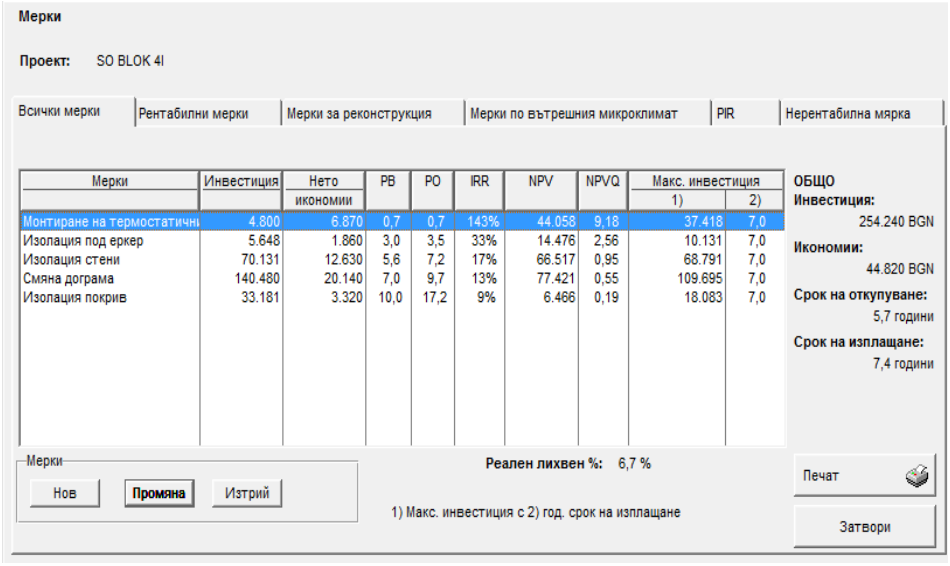

Fig. 4. Results from the economic analysis of proposed ESM

Conclusion:

From the obtained results can be drawn the following conclusions:

1. By the building's model study it is established that the potential of thermal energy saving is over 39 %, which is 448 726 kWh saved primary energy annually. Full utilization of this potential requires investments of 254 240 BGH with payback period of 5.7 years. The building will have class of energy consumption B [6] and energy certificate class A [5] after ESM introducing.

2. Environmental impact in results of realized heat savings will be reduction of CO2 emissions in the atmosphere with 139, 6 tons annually.

3. Additional investments will be necessary for isolation the walls (238.57 m2) and jetty (226.22 m2) of under roof space and for hydro insulation of the roof.

4. The results show that the consumed heat energy for domestic hot water heating is 28.74 % from the building's total energy consumption. This energy could be supplied from renewable (solar or geothermal) energy source. Furthermore, the existing incandescent lamps can be replaced with more energy efficient lamps. This will result in savings of 1.62 % electric energy.

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