0 BUSINESS CASE ANALYSIS: SUMMARY

0.1 Importance of energy supply

Every office or residential building must provide living (or working) conditions of a proper quality. Ensuring a certain level of comfort and meeting other demands (e.g. buildings must be equipped with certain installations, hot water, access to data transfer, etc.) requires utilisation of energy. The energy consumption of a building depends on the building itself, installed equipment, as well as the needs, requirements, and behaviour of the users. Excessive energy consumption is reflected in higher costs and creates a negative impact on the environment. Energy audit of a building serves to collect data on the use of certain types of energy for different purposes, and the costs arising from it. At the same time, the energy consumption indicators reveal where the use of energy is higher than in comparable buildings. Possible measures and investment requirement estimates are discussed below.

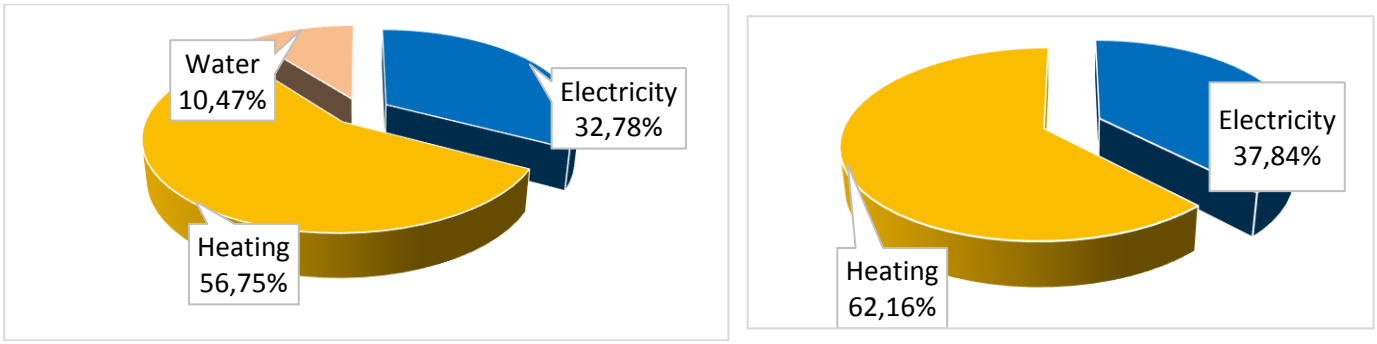
0.2 Consumption and costs of energy and water

The table below presents energy consumption and costs of energy products, as well as CO_2 emissions generated through energy use in 2015. The last column identifies the value of a specific cost of thermal and electric energy. The consumption of heat and electricity is shown in kWh, water consumption is shown in m^3.

In 2015, the primary school Oskar Kovačič - PŠ Rudnik consumed 14,706 kWh of electricity and 5,000 kWh of thermal energy for space heating (energy product: ELFO). In 2015, the water consumption in the building amounted to 526 m^3.

Table 1: Annual cost and consumption of energy for 2015:

	Consumption	Units	Share [%]	Cost [€]	Share [%]	CO_2 [kg]	CO_2 [%]	€/MWh
Electricity	14,706	kWh	22.59	1,870	32.78	8,191	37.84	127.15
Heating	50,400	kWh	77.41	3,237	56.75	13,457	62.16	64.22
Water	526	m^3		597	10.47			
TOTAL	**65,106 526**	**kWh m^3**		**5,703**		**21,648**		



Graph 1: The distribution of costs for energy and water (see left pie chart); CO_2 emissions in 2015 (right pie chart).

The table below presents energy product consumption for 2012–2015. In the given reference period, the average electricity consumption amounted to 15.72 MWh/year, the thermal energy consumption amounted to 133.1 MWh/year, and the water consumption amounted to 498 m^3/year.

The conditioned floor area of the building amounts to 811 m^2. The calculated energy rating for heating of the building (standard use) is 157 kWh/m^2, the energy rating for the building's operation (standard use) is 182.5

kWh/m, CO_2 emissions amount to 54.14 kg/m^3. The energy rating value exceeds the critical level (240 kWh/m^2) and greatly exceeds the the recommended values (80 kWh/m^2).

Table 2: Consumption of thermal and electric energy for 2012–2015

	Electricity [kWh]	Heating [kWh]	Water [m^3]	Total [kWh]
2012	16,445	182,539	452	198,984
2013	16,233	148,206	579	164,439
2014	15,495	151,200	434	166,695
2015	14,706	50,400	526	65,106
Average	15,720	133,086	498	148,806

0.3 Potential savings and required investments

0.3.1 Proposed Scenario

The table below displays a summary of individual measures to improve energy efficiency. All measures include a summary. Three scenarios of implementing measures for improvement of energy efficiency are included into the simplified energy audit:

- Scenario 1 – Implementation of measures with payback period of up to 6 years
- Scenario 2 – Implementation of organisational measures, installation of a targeted monitoring of energy use system, roof insulation, boiler room renovation, installation of thermostatic valves and hydraulic balance, and installation of water heating system with heat pump air/water (organisational measure 1, investment measures 1, 5, 6, 7, 8)
- Scenario 3 – Implementation of organisational measures, installation of a targeted monitoring of energy use system, replacement of doors and windows, façade renewal, roof insulation, boiler room renovation, installation of thermostat valves and hydraulic balance, and installation of water heating system with heat pump air/water (organisational measure 1, investment measures 1, 2, 3, 4, 5, 6, 7, 8)

Table 3: Summary of individual measures

No.	Description of measure	Potential annual savings				Investment €	Payback period [years]
		kWh		€			
		TE	EE	TE	EE		
Organisational measures							
1	Educating users, energy accounting, etc.	6,654	452	427	53	3,000	6.25
Investment measures							
1	Energy management	7,985	151	513	18	4,000	7.5
2	Replacement of doors and windows	14,639	0	940	0	38,500	41.0
3	Replacement of the main door and boiler room doors	1,996	0	128	0	3,270	25.5
4	Thermal insulation of façade	15,970	0	1,026	0	24,400	23.8
5	Roof insulation	49,242	0	3,162	0	43,260	13.7
6	Boiler room renovation	11,978	0	769	0	20,000	26.0
7	Installation of thermostat valves and hydraulic balance	6,654	0	427	0	3,000	7.0
8	Water heating system with heat pump air/water	0	1,508	0	176	4,000	22.7

Table 4: Summary of measures – Scenario 1

Scenario 1 – implementation of measures with payback period of up to 6 years			% savings on total value
Annual savings in electrical energy	/	/	/
Annual savings in heating	/	/	/
Annual savings in water	/	/	/
Total reduction of CO_2 emissions	/	/	/
Total annual reduction in costs	/	/	/
Total necessary investment	/	/	
Average payback period	/	/	

The shortest payback period is 6.25 years, namely for the implementation of organisational measures.

Table 5: Summary of measures – Scenario 2

Scenario 2 – Implementation of measures: organisational measure 1, investment measures 1, 5, 6, 7, 8			% savings on total value
Annual savings in electricity	2,046	kWh	13.57
Annual savings in heating	68,349	kWh	51.36
Annual savings in water	/	m^3	0
Total reduction of CO_2 emissions	19,389	kg	44.14
Total annual reduction in costs	4,629	€	44.9
Total necessary investment	77,260	€	
Average payback period	16.7	years	

Table 6: Summary of measures – Scenario 3

Scenario 3 – Implementation of measures: organisational measure 1, investment measures 1, 2, 3, 4, 5, 6, 7, 8			% savings on total value
Annual savings in electricity	2,046	kWh	13.57
Annual savings in heating	83,141	kWh	62.48
Annual savings in water	/	m^3	/
Total reduction of CO_2 emissions	23,338	kg	53.13
Total annual reduction in costs	5,579	€	54.13
Total necessary investment	143,430	€	
Average payback period	25.7	years	

0.3.2 Proposed Scenario

The proposed Scenario can be defined as:

A. The optimal scenario, where the anticipated measures include a comprehensive energy retrofit and a harmonised implementation of measures to ensure energy efficiency of the building envelope and the building's technical systems, in order to make full use (if possible) of the economically viable potential for the energy retrofit.
B. The optimal scenario, where the anticipated measures do not include a comprehensive energy retrofit, in order to make full use (if possible) of the economically viable potential for the energy retrofit.

The measure presented as the optimal measure (A or B, depending on the building) is defined below.

In this case, under item A, Scenario 3 is the optimal scenario; it anticipates implementation of the following measures:

- Installation of a targeted monitoring of energy use system
- Replacement of doors and windows
- Façade insulation
- Roof insulation
- Heating system retrofit
- Installation of thermostat valves and hydraulic balance of heating system
- Installation of water heating system with heat pump air/water

Implementation of these measures will generate savings in thermal energy (heating), and reduce the cost of energy product supply and CO_2 emissions. The table below lists anticipated savings resulting from the implementation of proposed measures in Scenario 2.

Table 5: Effects of proposed Scenario

	Electricity kWh	Heating kWh	Savings [€]	CO_2 emissions [kg]
Savings	2,046	83,141	5,579	23,338

Total investment cost amounts to € 143,430; payback period amounts to 25.7 years.

0.4 Energy indicators before and after the implementation of measures

In accordance with Energy Act (EZ-1) and Rules on the methodology for the production and issuance of energy performance certificates for buildings, all public buildings must have an energy performance certificate that defines the building's rating (band).

0.4.1 Energy indicators before the implementation of measures

The black arrow indicates the current state of the building. The white arrow denotes recommended values for public buildings.

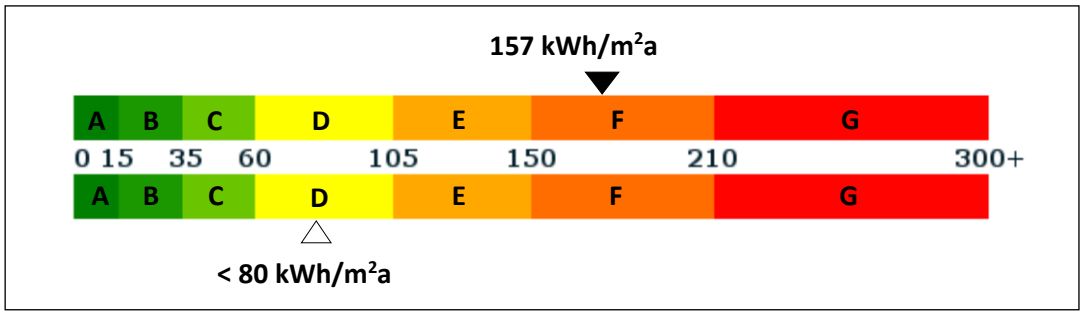


Figure 1: Thermal energy consumption before proposed measures

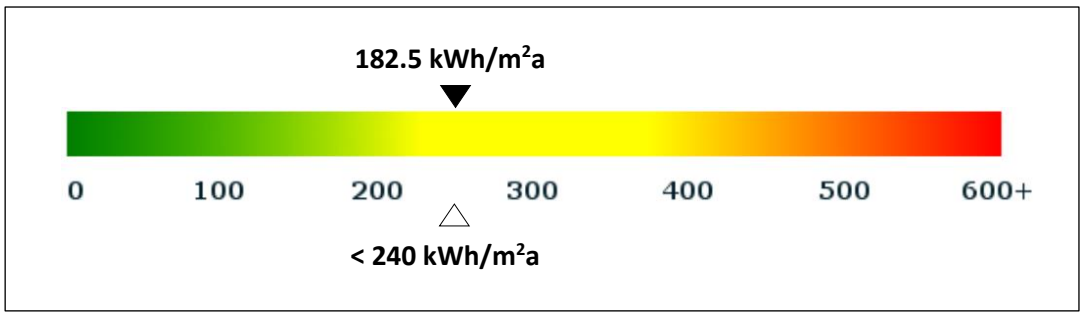


Figure 2: Energy input before proposed measures

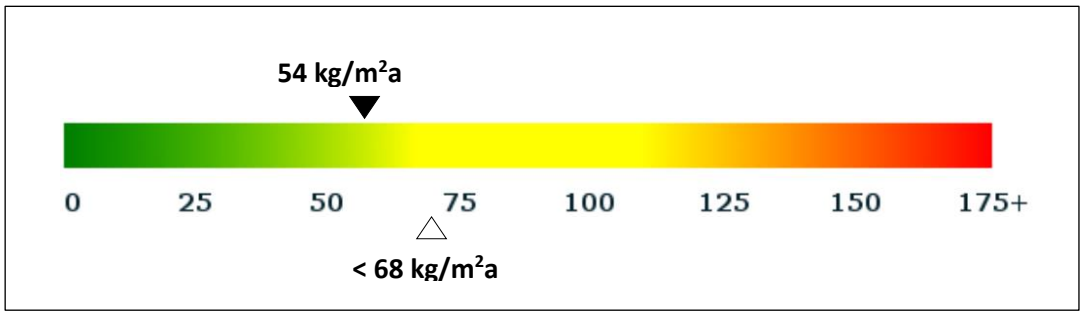


Figure 3:CO_2 emissions before proposed measures

0.4.2 Energy indicators after the implementation of measures

The black arrow indicates the planned state of the building after the measures have been implemented. The white arrow denotes recommended values for public buildings.

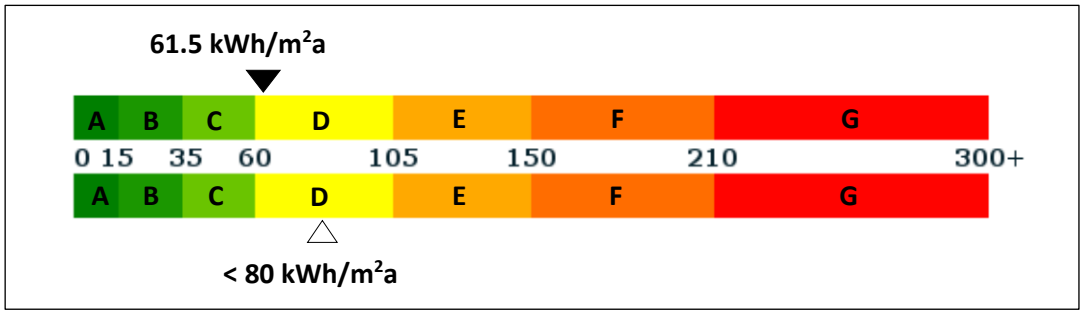


Figure 4: Thermal energy consumption after the proposed measures have been implemented

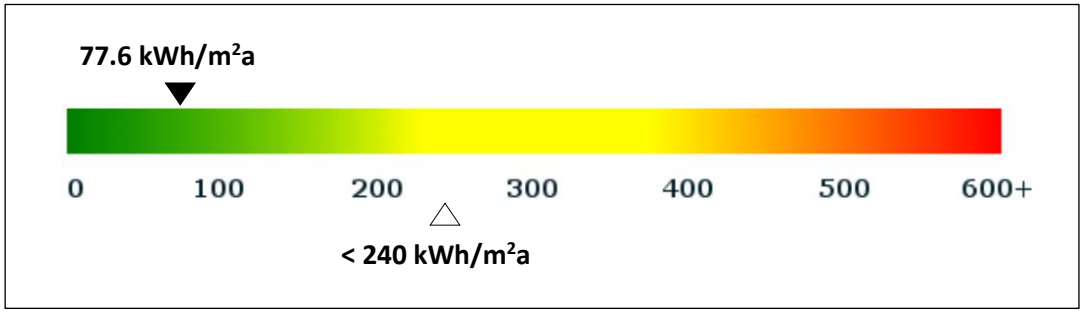


Figure 5: Energy input after the proposed measures have been implemented

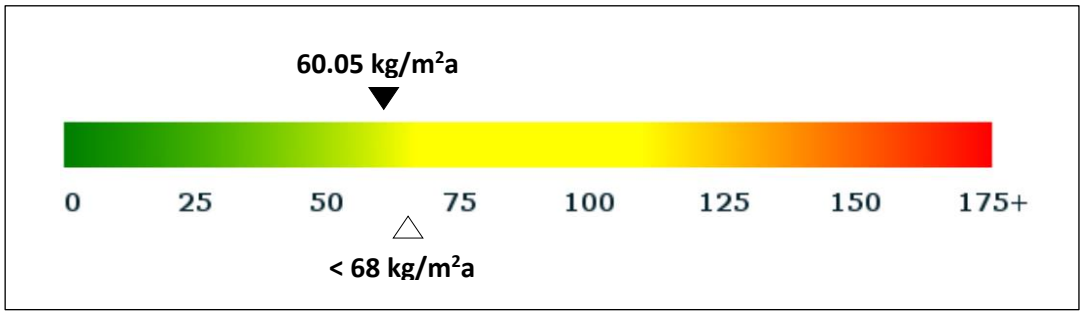


Figure 6: CO_2 emissions after the proposed measures have been implemented

0.5 Guidelines for implementation of measures

The implementation of measures defined by an energy audit is largely dependent upon the organisation's/institution's management; it also requires a qualified person (energy manager). If an organisation/institution does not have such a person at its disposal, it can employ an external contractor who is responsible for achieving energy efficiency goals. The cooperation between the organisation's/institution's management and the energy manager is crucial.

0.5.1 Organisational measures

Organisational measures can save a considerable amount of energy through relatively low costs. Implementation of organisational measures is the first step towards energy efficiency and represents the basis for all further investment measures.

0.5.2 Investment measures

Investment measures are usually associated with higher costs. Given the costs arising from the need to implement investment measures, they can be arranged as follows:

- Measures relating to simpler works performed by the technical maintenance staff in the context of regular or routine maintenance (e.g. replacement of a thermostatic valve, replacement of toilet tank, etc.);
- Measures that do not require additional documentation (e.g. building permit acquisition project, project to carry out works, etc.) – contracts may be awarded based on the list of works identified by an energy audit;
- Measures that require the preparation of project documentation that guides their implementation.
- This document lists one organisational measure – establishment of an energy management system and implementation of metering equipment (as necessary) with the corresponding control and communication technology to monitor the operation and the use of energy.

When the best scenario of investment measures is selected, the implementation of each individual measure requires a suitable preparatory phase, where all activities that are needed for the implementation are identified (e.g. preparation of project documentation, acquisition of building permit, award of a public contracts for the execution of works, selection of expert supervision: monitoring construction works, mechanical works, electrical works, formation of a project group responsible for the implementation of a measure, etc.), a detailed works schedule is produced, and all possible financing options are examined.

After a successful implementation of each measure is achieved, it is important to monitor its results/effects. If the desired results/effects are not reached, then the optimisation possibilities and corrective actions are to be explored and implemented.

For a better understanding of how to approach the implementation of an investment measure, the figure below shows the principal steps of implementing a measure.

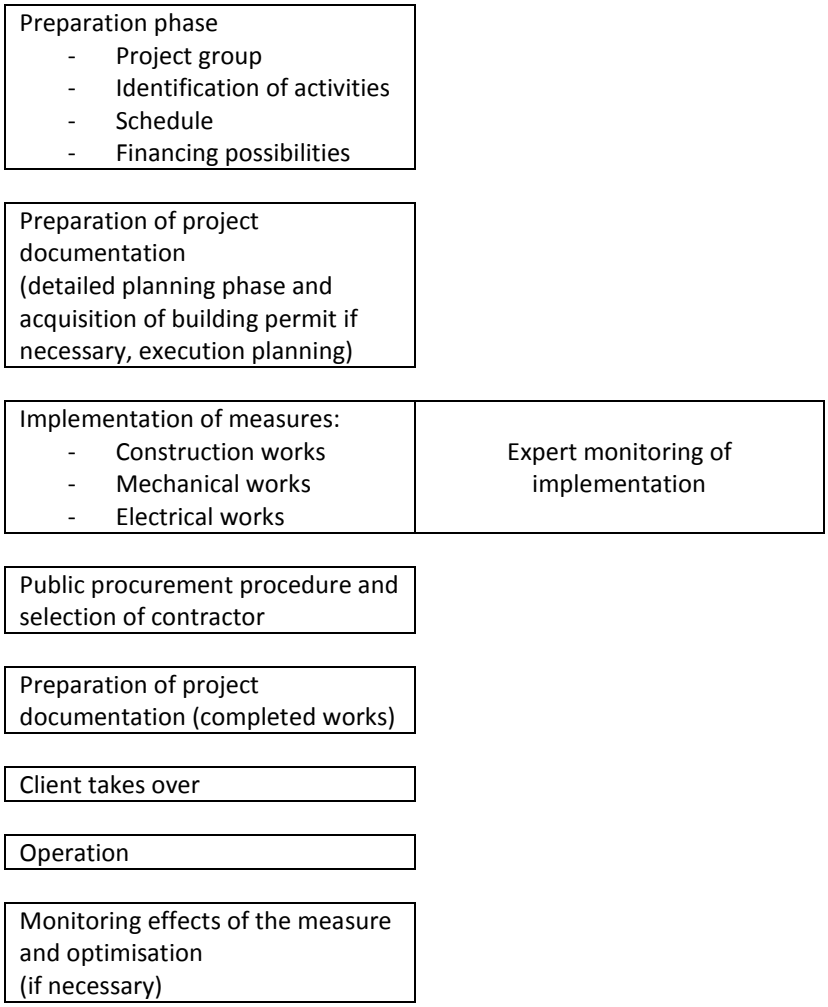


Figure 7: Measure implementation process