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.

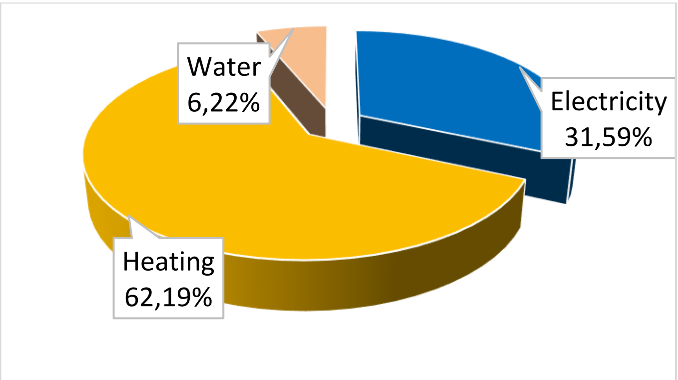
0.2 Consumption and costs of energy and water

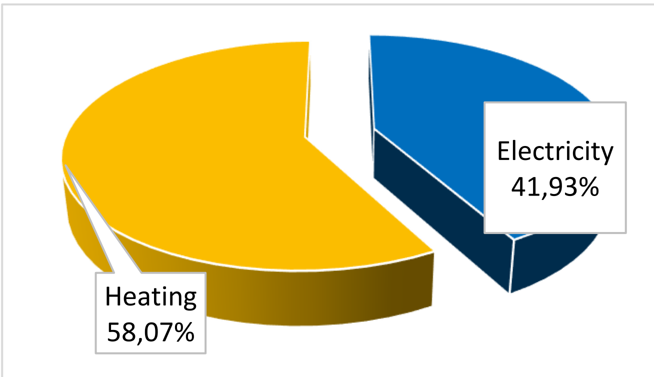
The table below lists energy consumption and costs of used energy products, as well as CO_2 emissions generated in 2015. The last column identifies the value of a specific cost of heat and electric energy. The consumption of heat and electricity is presented in kWh, water consumption in m^3.

In 2015, the operation of primary school Mirana Jarca consumed 142,862 kWh of electricity and 423,800 kWh of thermal energy for heating (energy product: district heating). In 2015, the water consumption in the building amounted to 2,129 m^3.

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

	Consumption	Units	Share [%]	Cost [€]	Share [%]	CO_2 [kg]	CO_2 [%]	€/MWh
Electricity	142,862	kWh	25.21	17,071	31.59	79,574	41.93	119.49
Heating	423,800	kWh	74.79	33,608	62.19	110,188	58.07	79.30
Water	2,129	m^3		3,360	6.22			
TOTAL	**566,662 2,129**	**kWh m^3**		**54,039**		**189,762**		





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 lists energy product consumption for 2012–2015. In the given reference period, the electrical energy consumption amounted to 145,660 MWh/year, the thermal energy consumption amounted to 411,450 MWh/year, and the water consumption amounted to 2,117 m^3/year.

The conditioned floor area of the building amounts to 4,884 m^2. The calculated energy rating for heating of the building (standard use) is 87.51 kWh/m^2, the energy rating for the building's operation (standard use) is 117.33 kWh/m, CO_2 emissions amount to 39.36 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	145,535	461,580	2,138	607,115
2013	149,348	422,150	2,029	571,498
2014	144,894	338,270	2,173	483,164
2015	142,862	423,800	2,129	566,662
Average	145,660	411,450	2,117	557,110

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, replacement of doors and windows, façade renewal, installation of thermostat valves and hydraulic balance, and replacement of gym reflectors (organisational measure 1, investment measures 1, 2, 3, 4, 5)

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.	20,154	4,370	1,536	517	5,000	2.44
Investment measures							
1	Energy management	30,231	8,740	2,303	1,035	15,000	4.49
2	Installation of thermostatic valves and hydraulic balance	20,154	0	1,536	0	15,000	9.77
3	Insulation of all exterior walls	52,400	0	3,992	0	102,000	25.55
4	Replacement of windows in the old part and extension, and replacement of doors	102,570	0	7,815	0	251,000	32.12
5	Replacement of gym reflectors	0	11,653	0	1,380	9,000	6.52

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	13,109	kWh	9
Annual savings in space heating	50,385	kWh	11.79
Annual savings in water	/	m^3	/
Total reduction of CO_2 emissions	20,402	kg	10.61
Total reduction in annual costs	3,585	€	7.2
Total necessary investment	20,000	€	
Average payback period	5.58	years	

The shortest payback period is 5.58 years, namely for the implementation of the organisational measures and energy management.

Table 5: Summary of measures – Scenario 2

Scenario 2 – implementation of measures: organisational measure 1, investment measures 1, 2, 3, 4, 5.			% savings on total value
Annual savings in electrical energy	24,762	kWh	17
Annual savings in space heating	225,509	kWh	52.77
Annual savings in water	/	m^3	/
Total reduction of CO_2 emissions	72,425	kg	37.76
Total reduction in annual costs	12,031	€	24.16
Total necessary investment	397,000	€	
Average payback period	33	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 2 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
- Replacement of gym reflectors

- Installation of thermostatic valves and hydraulic balance of heating system

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	24,762	225,509	12,031	72,425

Total investment cost amounts to € 397,000; payback period amounts to 33 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.

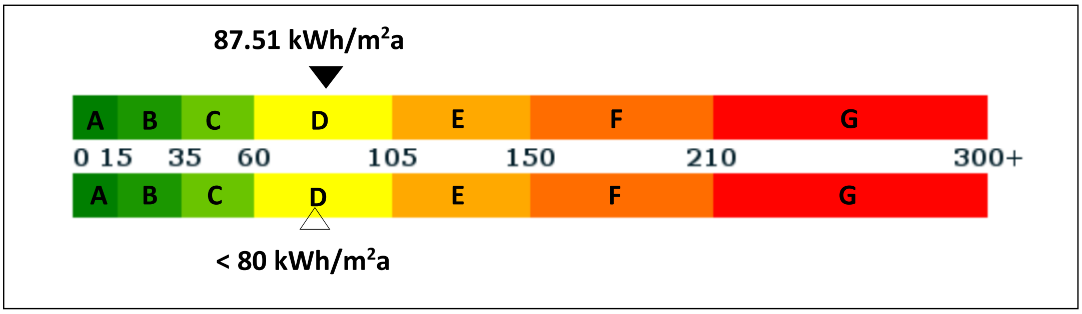


Figure 1: Thermal energy consumption before proposed measures

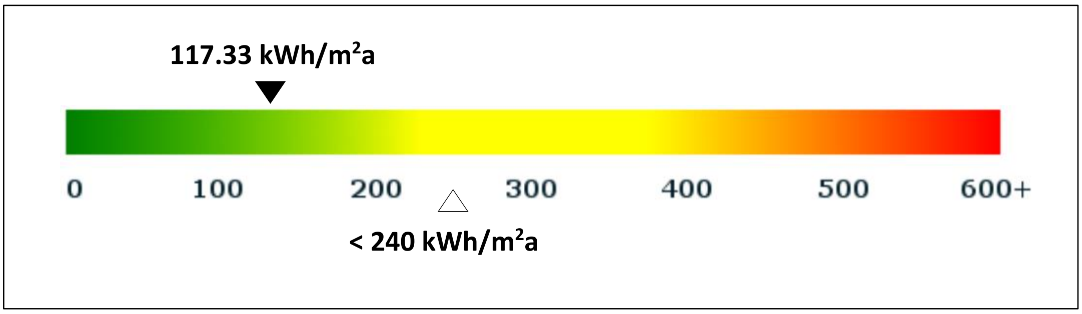


Figure 2: Energy input before proposed measures

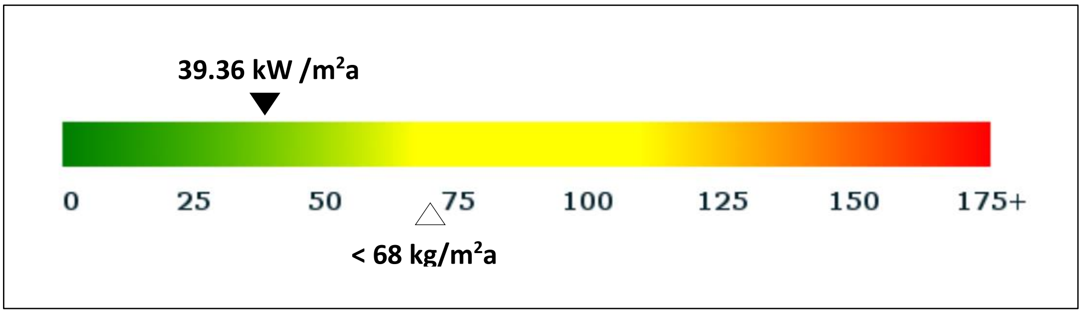


Figure 3:CO_2 emissions before proposed measures

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.

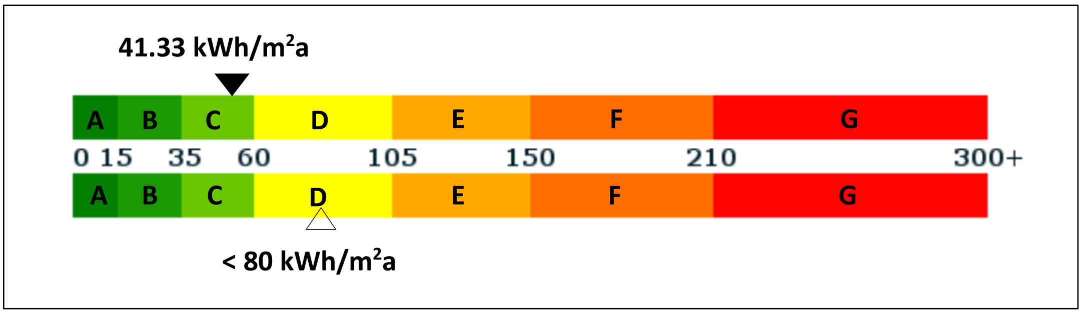


Figure 4: Thermal energy consumption after the proposed measures have been implemented

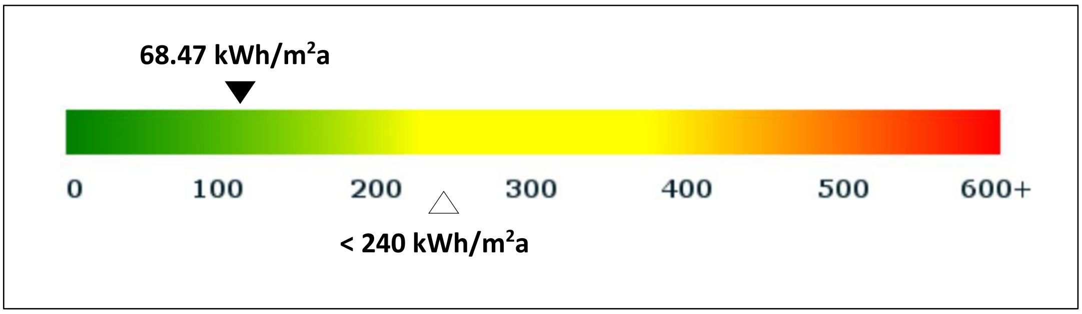


Figure 5: Energy input after the proposed measures have been implemented

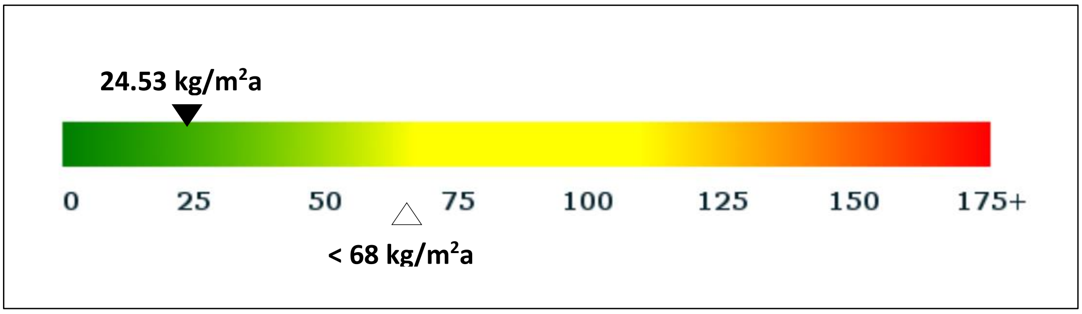


Figure 6: CO_2 emissions after the proposed measures have been implemented

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. The collaboration 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.

Preparation phase
- Project group
- Identification of activities
- Schedule
- Financing possibilities

Preparation of project documentation
(detailed planning phase and acquisition of building permit if necessary, execution planning)

Implementation of measures: - Construction works - Mechanical works - Electrical works	Expert monitoring of implementation

Public procurement procedure and selection of contractor

Preparation of project documentation (completed works)

Client takes over

Operation

Monitoring effects of the measure and optimisation (if necessary)

Figure 7: Measure implementation process