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 behavior 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

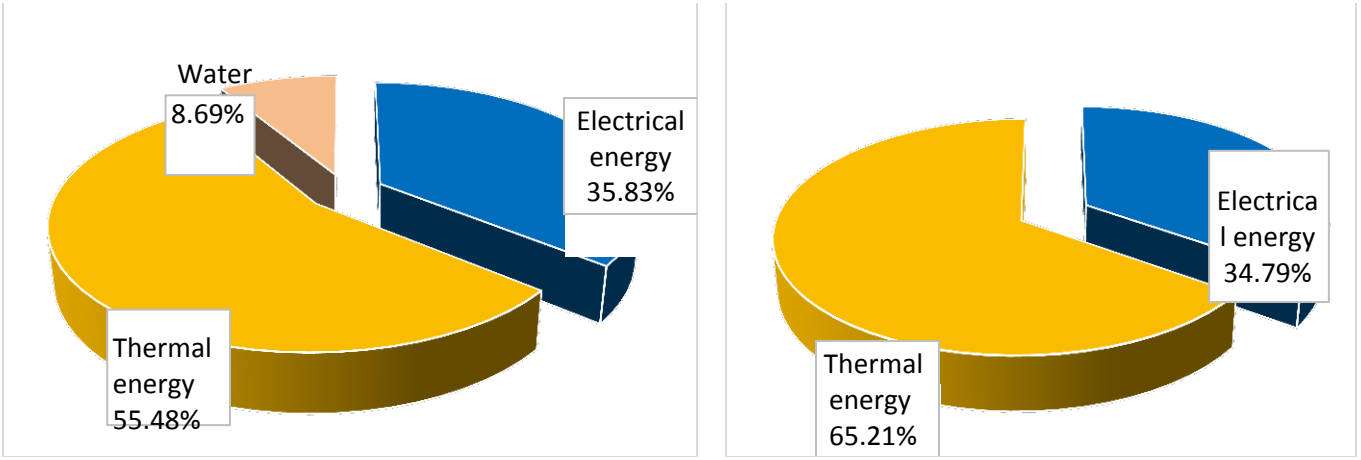
0.2 Consumption and costs of energy and water

The table below lists energy consumption and cost energy products, as well as CO_2 emissions generated by the employed energy products in 2015. The last column identifies the value of a specific cost of thermal and electrical energy. The consumption of heat and electricity is shown in kWh, water consumption is shown in m^3.

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

				Cost		CO_2		Price
2015	Consump	Units	% kWh	€	% €	kg CO_2	% CO_2	€/MWh
Electricity	103,441	kWh	25.83	13,472	35.83	57,617	100.00	130.24
Heating	296,950	kWh	74.17	20,862	55.48	0	0.00	70.25
Water	2,575	m^3		3,269	8.69			
Total	**400,391**	**kWh**		**37,603**		**57,617**		
	2,575	**m^3**						

In order to operate and function, the building used 400.4 MWh of energy in 2015. Thermal energy (district heating and natural gas), used for space heating, water heating and food preparation, represents the larger part of energy consumption. Thermal energy amounted to 74.17%; electricity consumption amounted to 25.83%.



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

Table 2: Consumption of thermal and electrical energy for 2013, 2014, and 2015

YEAR	Electricity [kWh]	Heating [kWh]	Water [m3]	Total [kWh]
2013	96,659	316,810	2,719	413,469
2014	100,452	259,480	2,359	359,932
2015	103,441	296,950	2,575	400,391
Average	**100,184**	**291,080**	**2,551**	**391,264**

The table below lists energy product consumption for 2013–2015. In the given reference period, the electrical energy consumption amounted to 100.2 MWh/year, the thermal energy consumption amounted to 291.1 MWh/year, and the water consumption amounted to 2,551 m^3/year. The thermal energy consumption includes the amount of heat used for space heating and the amount of heat used of heating water.

The energy rating amounts to 180.01 kWh/m^2; total energy rating amounts to 243.17 kWh/m^2. The energy rating value exceeds the critical level (240 kWh/m^2) and greatly exceeds the recommended values (80 kWh/m^2).

0.3 Potential savings and required investments

The table below displays a summary of individual measures to achieve a better energy efficiency. All measures include a summary. Four scenarios of implementing measures for achieving a better energy efficiency are included into a simplified energy audit:

- Scenario 1 – Implementation of measures with payback period of up to 6 years
- Scenario 2: Implementation of measures on technical systems
- Scenario 3: Optimal[1] scenario of EE measures (organisational measure 1, investment measures 1, 2, 3)
- Scenario 4: Implementation of all proposed measures (except for those that are mutually exclusive)

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	EE education and implementation of energy	15,741	--	1,149	--	6,400	5.6
Investment measures							
1	Floor renovation towards air	9,334	--	679	--	6,695	9.9
2	Renovation of exterior walls	73,937	--	5,378	--	56,290	10.5
3	Renewal of doors and windows	59,231	--	4,308	--	178,400	41.4
4	Ceiling renovation towards unheated area	5,859	--	426	--	1,830	4.3
5	Terrain floor renovation	9,584	--	697	--	80,100	114.9

[1] Optimal scenario selected on grounds of various factors: the amount of savings, the payback period, the feasibility of measures considering the current state of the building, the necessity of implementing the measure for better maintenance.

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	/	kWh	/
Annual savings in heating	17,222	kWh	7.12
Annual savings in water	/	m^3	/
Total reduction of CO_2 emissions	5,511	kg	376.41
Total annual reduction in costs	1,571	€	9.45
Total necessary investment	6,400	€	
Average payback period	5.2	years	

Table 5: Summary of measures – Scenario 2

Scenario 2: Implementation of measures on technical systems			% savings on total value
Annual savings in electrical energy	/	kWh	/
Annual savings in heating	/	kWh	/
Annual savings in water	/	m^3	/
Total reduction of CO_2 emissions	/	kg	/
Total annual reduction in costs	/	€	/
Total necessary investment	/	€	
Average payback period	/	years	

Table 6: Summary of measures – Scenario 31

Scenario 3: Implementation of proposed measures			% savings on total value
Annual savings in electrical energy	/	kWh	/
Annual savings in heating	173,176	kWh	71.59
Annual savings in water	/	m^3	/
Total reduction of CO_2 emissions	55,416	kg	37.85
Total annual reduction in costs	11,936	€	71.79
Total necessary investment	249,615	€	
Average payback period	20.9	years	

Table 7: Summary of measures – Scenario 3

Scenario 4: Implementation of all measures			% savings on total value
Annual savings in electrical energy	/	kWh	/
Annual savings in heating	180,099	kWh	74.45
Annual savings in water	/	m^3	/
Total reduction of CO_2 emissions	57,632	kg	39.36
Total annual reduction in costs	12,633	€	75.99
Total necessary investment	329,715	€	
Average payback period	26.1	years	

0.3.1 Proposed Scenario

Section 0.3 defines the effects of individual measures and the overall effect of the measures, depending on the chosen scenario.

Scenario 1 includes the implementation of measures with payback period of up to 6 years; Scenario 4 represents the implementation of all measures.

Scenario 2 represents the measures to be implemented on technical systems.

Scenario 3 was recognised as the optimal set of measures on grounds of various factors: the amount of savings, the payback period, the feasibility of measures considering the current state of the part of the building, the necessity of implementing the measure for better maintenance. Scenario 3 meets the conditions of a *comprehensive energy retrofit*, whereby the building may qualify for the grants. Scenario 4 meets also meets the conditions of a *comprehensive energy retrofit*, whereby the building may qualify for the grants.

The term *comprehensive energy retrofit* applies to a harmonised implementation of measures to ensure energy efficiency of the building's envelope and its technical systems in order to make full use (if possible) of the economically viable potential for the energy retrofit.

Below, the measures within Scenario 3 (optimal scenario) are summarised:

- **Organisational measures**
  - Informing and educating about energy efficiency

- **Investment measures**
  - Façade insulation
  - Replacement of doors and windows
  - Ceiling insulation towards unheated area
  - Floor insulation towards unheated area

Implementation of these measures will generate savings in thermal and electrical energy, 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 3.

Table 8: Effects of proposed Scenario

	Electricity [kWh]	Heating [kWh]	Savings [€]	CO_2 emissio
Savings	--	173,176	11,936	55,416

Total investment cost amounts to € 249,615; payback period amounts to 20.8 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.

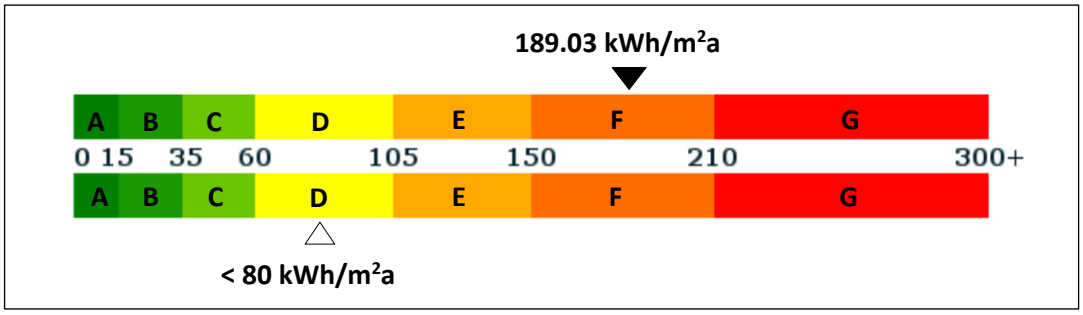


Figure 1: Thermal energy consumption before proposed measures

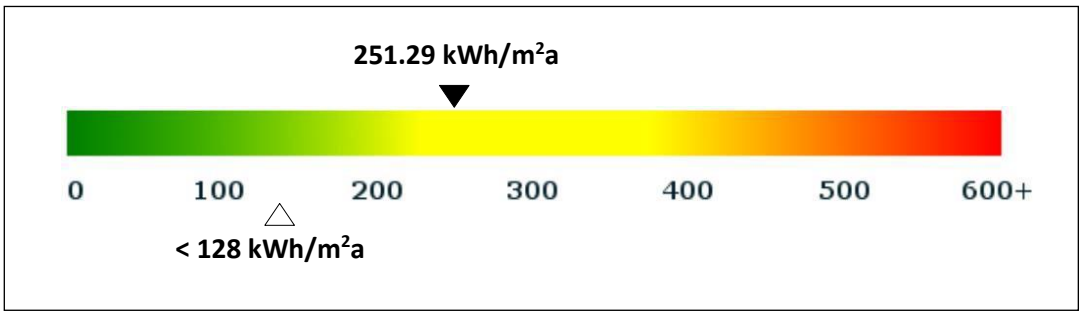


Figure 2: Energy input before proposed measures

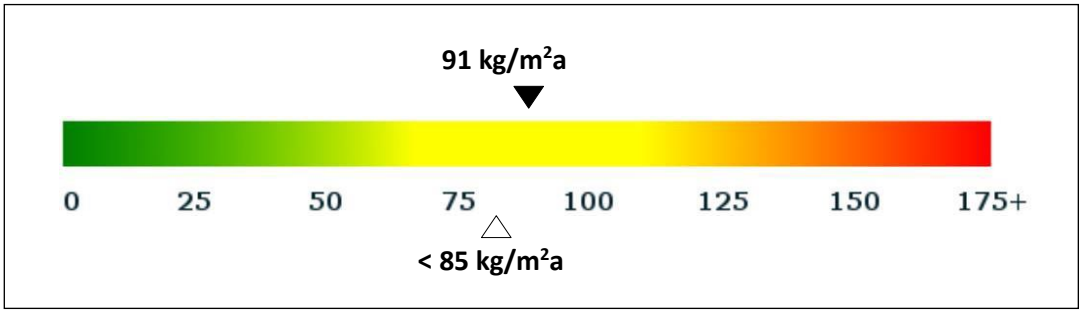


Figure 3: CO_2 emissions before the implementation of proposed measures

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.

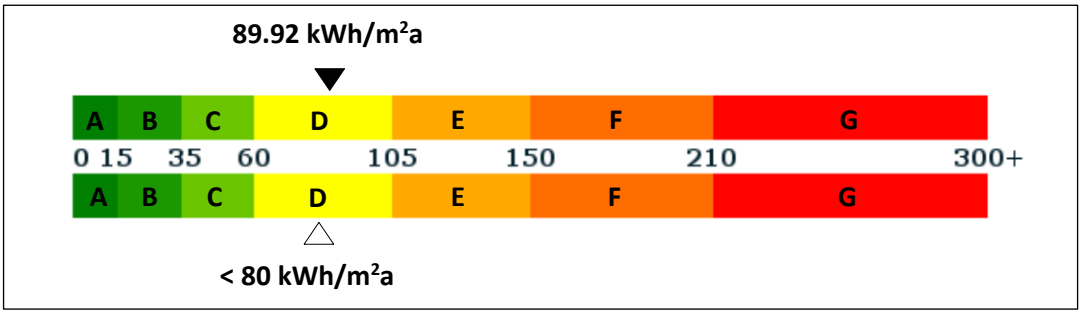


Figure 4: Thermal energy consumption after the proposed measures have been implemented

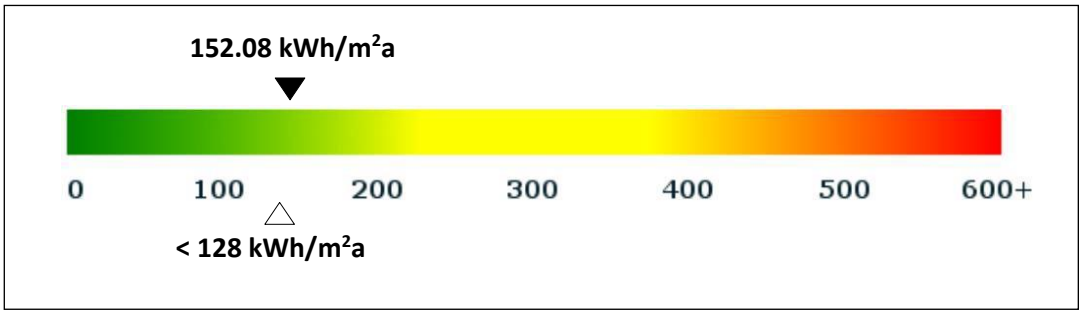


Figure 5: Energy input after the proposed measures have been implemented

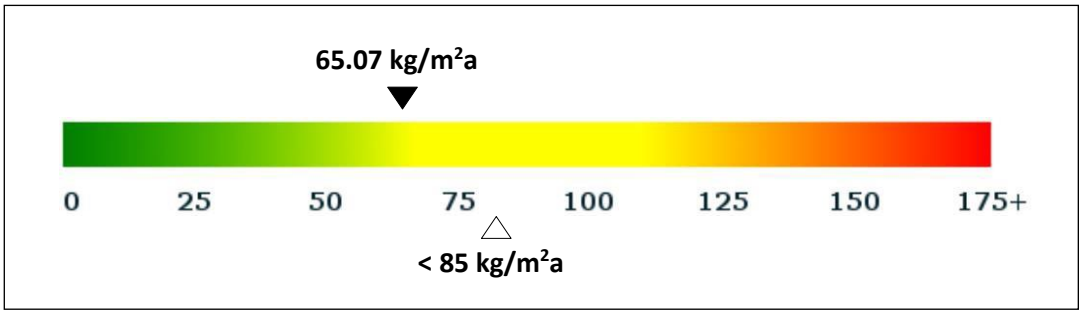


Figure 6: CO_2 emissions after the proposed measures have been implemented

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.

This document identifies one organisational measure, namely informing and educating about energy efficiency.

This should be done by energy manager, who organises presentations, workshops, and other appropriate means (posters, warnings, etc.) to present the measures to all users. Organisational measures to achieve a more efficient energy use in heating, ventilation, lighting, devices, etc., should be presented. Consider the ways to motivate users to comply with the organisational EE 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 manager 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.

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 are to be explored.

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.

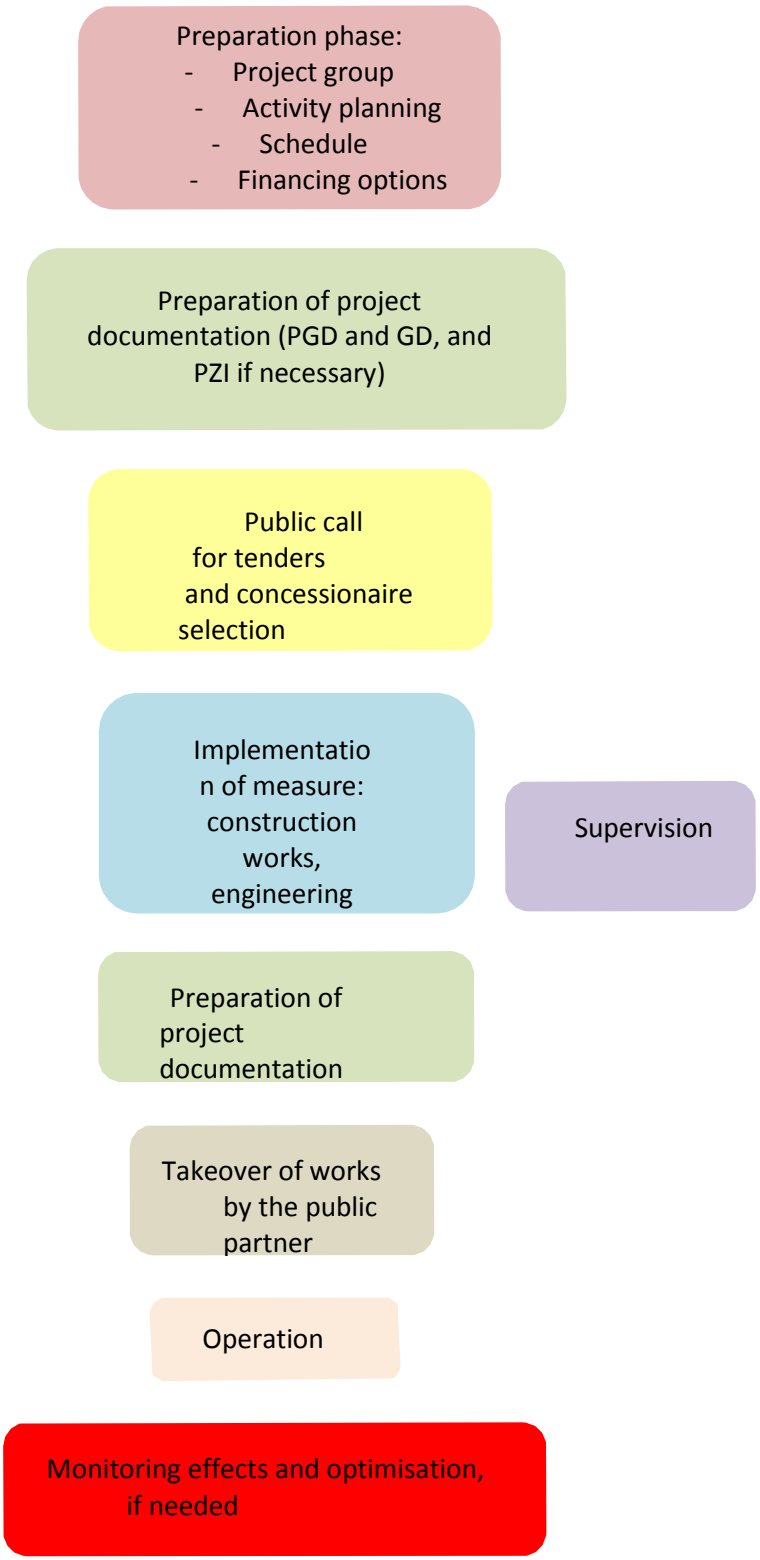


Figure 7: Measure implementation process