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.

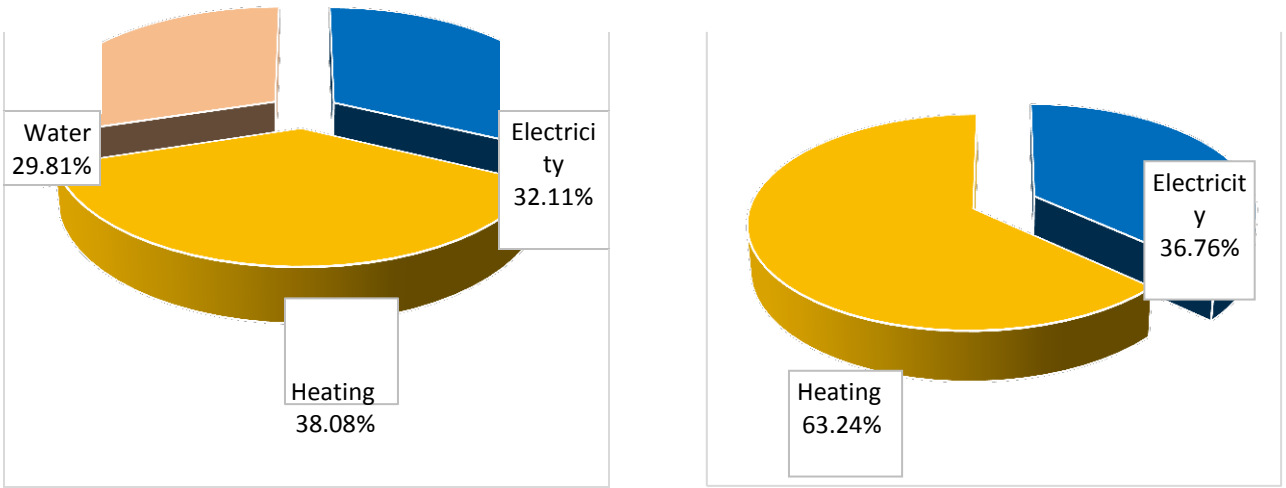
0.2 Consumption and costs of energy and water

The table below lists energy consumption and 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.

In 2015, the building used a total of 133,961 kWh. Thermal energy consumption (district heating) amounted to 97,100 kWh.
Electricity consumption amounted to 36,861 kWh. In 2015, the water consumption in the building amounted to 1,269 m^3.

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

	Consumption	Units	Share [%]	Cost [€]	Share [%]	CO_2 [kg]	CO_2 [%	€/MWh
Electricity	36,861	kWh	27.52	5,622	32.11	18,062	36.76	152.52
Heating	97,100	kWh	72.48	6,668	38.08	31,072	63.24	68.67
Water	1,269	m^3		5,219	29.81			
TOTAL	**133,961 1,269**	**kWh**	**17,509**			**49,134**		



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 2013–2015. In the given reference period, the electrical energy consumption amounted to 35.8 MWh/year, the thermal energy consumption amounted to 91.5 MWh/year, and the water consumption amounted to 1,157 m^3/year.

The conditioned building area is 720 m^2. The calculated energy rating for heating of the building (standard use) is 132.42 kWh/m^2, the calculated energy rating for the building's operation (standard use) is 182.22 kWh/m, CO_2 emissions amount to 66.77 kg/m^3. The energy rating value falls below the critical level (240 kWh/m^2), but exceeds the recommended values (80 kWh/m^2).

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

	Electricity [kWh]	**Heating [kWh]**	**Water [m^3]**	**Total [kWh**
2013	35,415	98,246	986	133,661
2014	35,297	79,315	1,215	114,612
2015	36,861	97,100	1,269	133,961
Average	**35,858**	**91,554**	**1,157**	**127,411**

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. Three 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: installation of a targeted monitoring of energy use system, façade insulation, replacement of windows and doors, roof insulation, installation of thermostat valves (organisational measure 1, investment measures 1, 2, 3, 4).
- Scenario 3 – implementation of all measures (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	Installation of a targeted monitoring of energy use system	3,437	0	233	0	2,500	10.73
Investment measures							
1	Ceiling insulation towards the attic	16,491	0	1,118	0	28,308	25.33
2	Replacement of doors and windows	3,025	0	205	0	14,025	68.41
3	Roof insulation	15,804	0	1,071	0	12,540	11.71
4	Installation of thermostat valves	2,750	0	186	0	1,650	8.85
5	Lighting	0	1,922	0	308	7,200	23.86

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	/	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	

The shortest payback period is 8.85 years, namely for the implementation of the organisational measure *Installation of thermostat valves*.

Table 5: Summary of measures – Scenario 2

Scenario 2 – implementation of measures: organisational measure 1, investment measures 1, 2, 3, 4			% savings on total value
Annual savings in electrical energy	0	kWh	0
Annual savings in heating	33,659	kWh	35.03
Annual savings in water	/	m^3	/
Total reduction of CO_2 emissions	10,771	kg	22.4
Total annual reduction in costs	2,281	€	18.87
Total necessary investment	59,023	€	
Average payback period	25.87	years	

Table 6: Summary of measures – Scenario 3

Scenario 3 – implementation of measures: organisational measure 1, investment measures 1, 2, 3, 4, 5			% savings on total value
Annual savings in electrical energy	1,922	kWh	5.36
Annual savings in heating	33,659	kWh	35.30
Annual savings in water	/	m^3	/
Total reduction of CO_2 emissions	11,713	kg	24.36
Total annual reduction in costs	2,583	€	21.36
Total necessary investment	66,223	€	
Average payback period	25.64	years	

0.3.1 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:

- Organisational measure:
  - Installation of a targeted monitoring of energy use system
- Investment measures:
  - Façade insulation
  - Replacement of doors and windows
  - Roof insulation
  - Installation of thermostat valves

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 7: Effects of proposed Scenario

	Electricity [kWh]	Heating [kWh]	Savings [€]	CO_2 emissio
Savings	0	33,659	2,281	10,771

Total investment cost amounts to € 59,023; payback period amounts to 25.87 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.

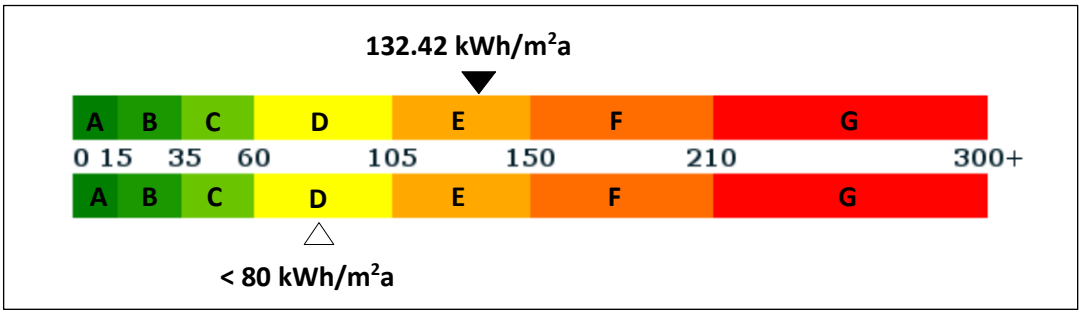


Figure 1: Thermal energy consumption before proposed measures

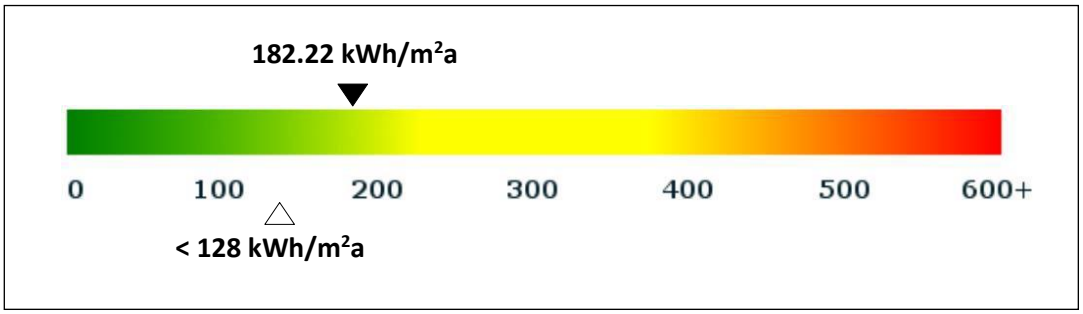


Figure 2: Energy input before proposed measures

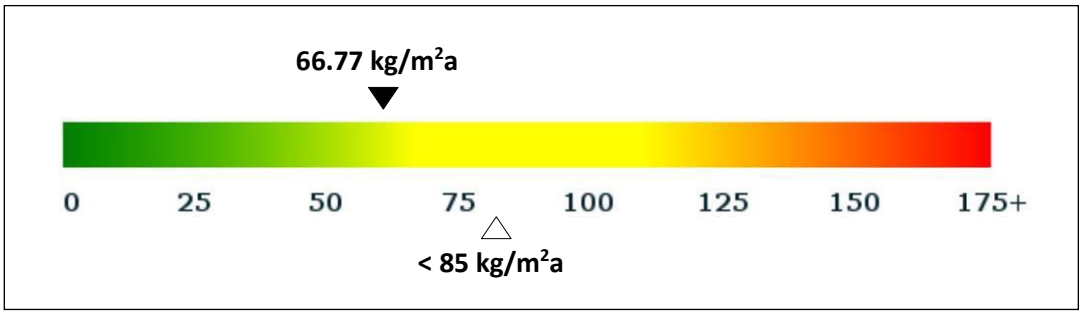


Figure 3: CO_2 emissions before the implementation of proposed measures

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.

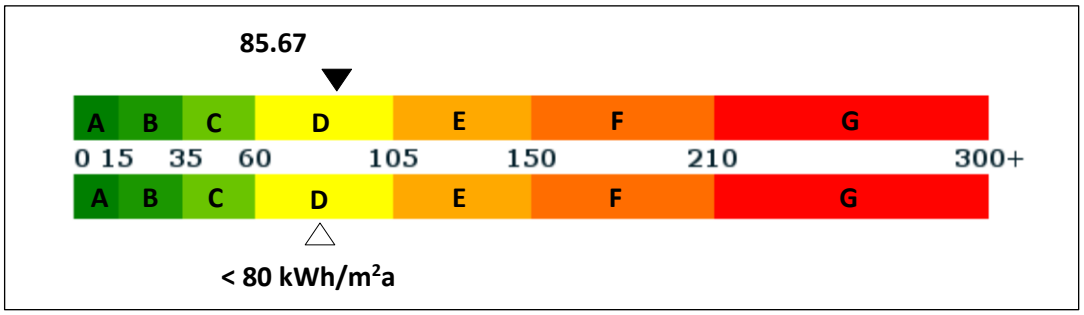


Figure 4: Thermal energy consumption after the proposed measures have been implemented

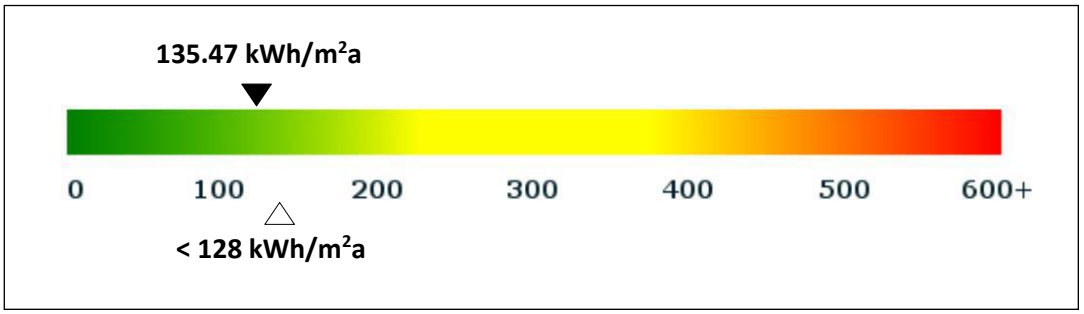


Figure 5: Energy input after the proposed measures have been implemented

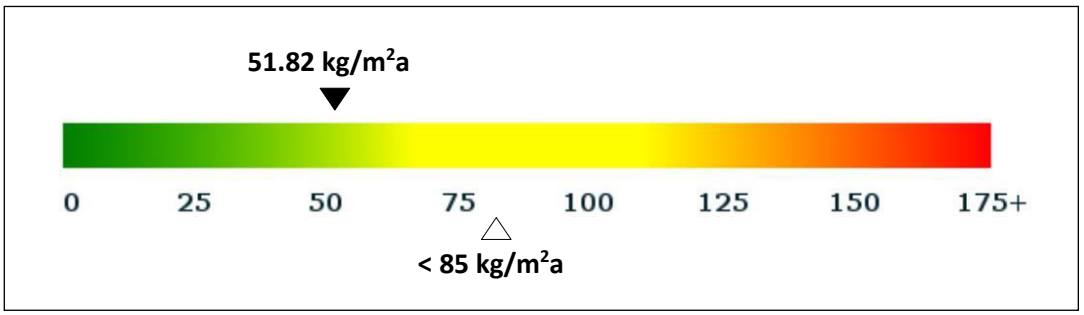


Figure 6: CO_2 emissions after the proposed measures have been implemented

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 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.

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.

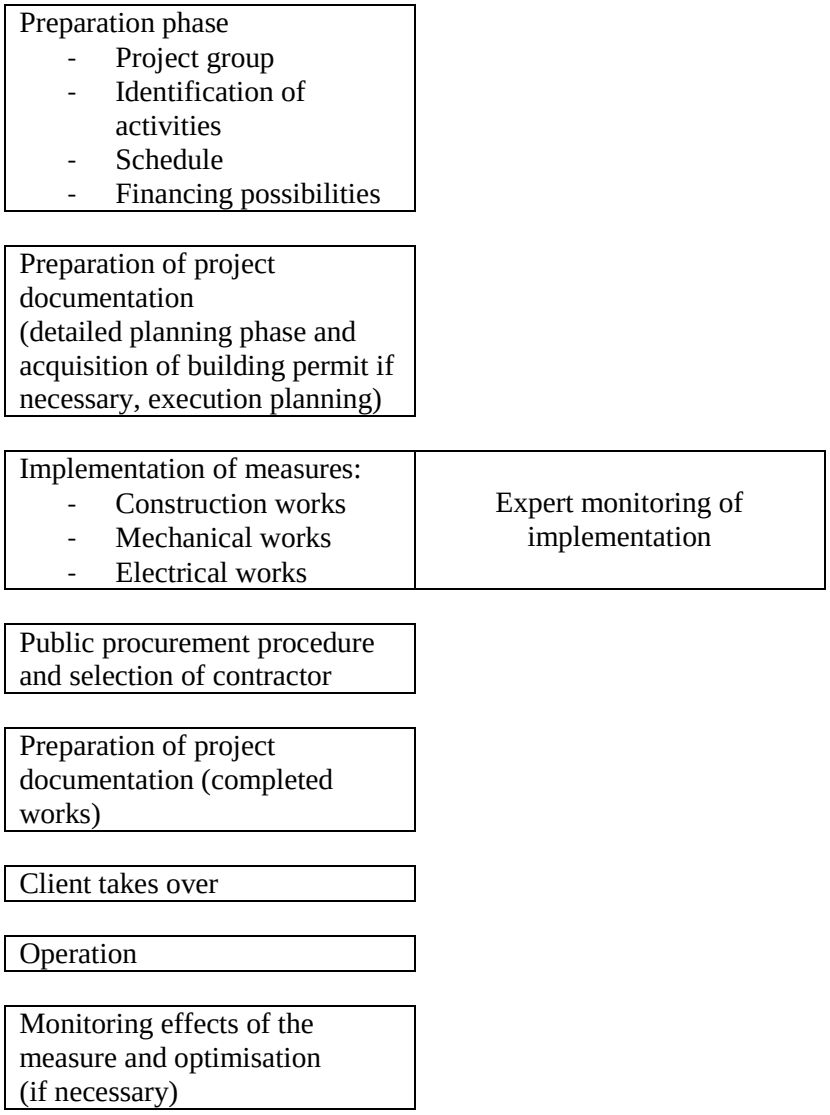


Figure 7: Measure implementation process