0 BUSINESS CASE ANALYSIS: SUMMARY

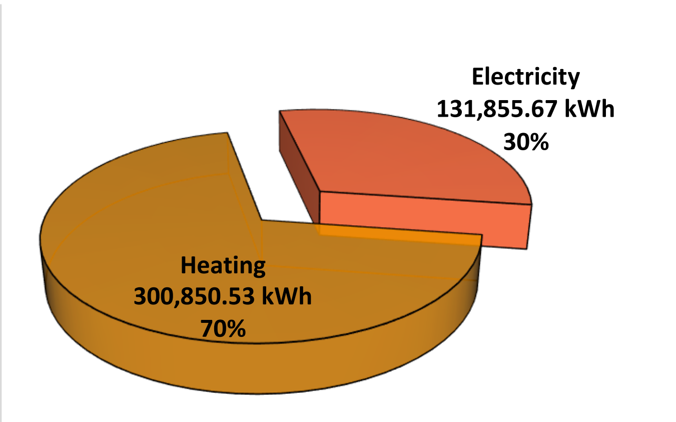
0.1 Importance of energy supply

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 utilization 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 building of Kindergarten Najdihojca, unit Biba, performs educational activity (pre-school childcare). Continuous supply of energy and water is crucial. The following sections present the structural analysis of energy consumption over the last three calendar years. For the purposes of a more simple comparison, all presented energy cost data in simplified energy audit report do not include VAT (the rate of VAT changed in July 2013). Furthermore, the assessments of the investment value for the implementation of the proposed measures and the assessments of cost savings due to implemented measures exclude VAT. In summary, **all values in the report that represent monetary values (EUR, €) exclude VAT.** Reference values in the analysis of the current state and the analysis of proposed measures have been selected and obtained from invoices issued by individual energy products and cold water. **The reference period includes the last three calendar years of 2013, 2014 and 2015.** Individual reference values for the selected periods and the determination of these values are more closely presented in section 9.1.

Figure 0.1: Average annual energy consumption (left) and costs (right) for energy products and water.



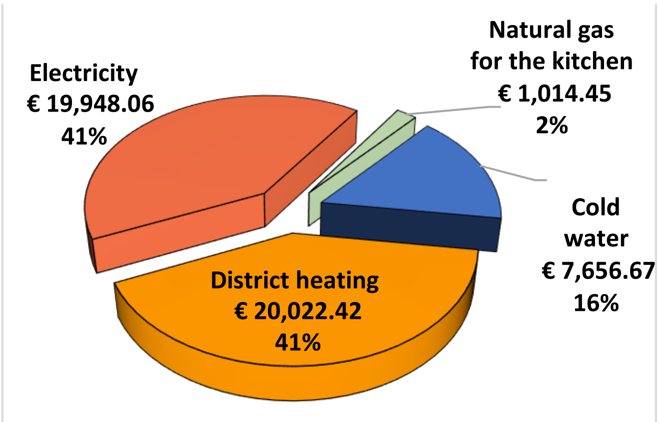


Table 0.1: Average annual energy consumption and costs in reference period

203–2015 Average	Consumption of energy products [kWh/year]	Cost of energy product [€/year]	CO_2 emissions [kg CO_2/year]	Primary energy [kWh/m²/year]	Energy rating [kWh/m²/year]
Heating	300,850.53	20,022.4	94,313.1	158.3	143.95
Electricity	131,855.67	19,948.0	64,609.2	157.7	63.09
Total:	**432,706.2**	**39,970.48**	**158,922.4**	**316.0**	**207.04**
	Consumption [m³/year]		**Costs [€/year]**		
Cold water	3,523.33		7,656.67		
				Total costs 2013–2015 [€/year]:	**47,627.15**

The copies of the invoices issued by the energy product suppliers suggest that the building, in order to operate and function, consumes about 70% of thermal energy for space heating, heating water, and food preparation in the kitchen. Of the total energy consumption, the share of energy use for lighting, kitchen and electrical devices, represents 30% of the total energy used. Around 2/5 of the funds (41%) are spent on thermal energy (space heating and water heating). The remaining costs are distributed in the following proportions: 41% for electricity, 16% for cold water supply from the water supply network, and 2% for natural gas (kitchen).

0.3 Key findings

Key findings of the simplified energy audit are as follows:

0.3.1 The building Vrtec Najdihojca, Enota Biba, located at the address Ljubeljska ulica 16, Ljubljana, uses three types of energy: district heating, natural gas and electricity.

0.3.2 District heating is used for space heating and water heating. Natural gas is used for food preparation. Electricity is used for lighting, kitchen appliances, ventilation and other devices required for the building's operation and implementation of activities.

0.3.3 Energy consumption during the analysed reference period is above average compared to similar buildings. Energy rating (heating + electricity) of comparable buildings is over 150 kWh/m²/year. Higher energy consumption is the result of poor thermal characteristics of the building's envelope and high consumption of electricity.

0.3.4 According to users and data obtained from microclimate measurements, the thermal comfort in the building is assessed as less satisfactory. The temperature of spaces farthest from the thermal station reaches the lower limit of the recommended temperature. Radiator heating is carried out based on the outdoor temperature. Room temperature is controlled by radiator valves, half of them missing thermostat heads.

0.3.5 The building is composed of different parts, constructed at different times. The part located at the south end of the building consists of a ground floor. The other part is in two floors (basement and ground floor). The supporting structure of the older part of the building consists of a full-brick wall of a standard format; the supporting structure of the newer part consists of hollow-brick wall (20 cm thick) and reinforced concrete bond (earthquake protection).

0.3.6 Thermal insulation of the façade is installed only in the smaller part of the older part of the building (west part of the building). Thermal insulation (16 cm thick) was installed recently. Other parts of the façade lack thermal insulation. The outside of the brick wall on the newer part of the building is fitted with siporex bricks (10 cm thick).

0.3.7 Two types of roof construction are present: slanted roof over unheated attic and slanted roof made of siporex roof panels over a heated space. The unheated attic is insulated towards heated rooms by 20 cm thick glass wool insulation placed on the floor of the unheated attic. The slanted roof constructed of siporex roof panels is –according to the existing project documentation – insulated by 5 cm thick thermal insulation placed over siporex panels and under tin roof panels with a ventilation layer.

0.3.8 Approximately two thirds of doors and windows was replaced in the last few years. Installed windows feature PVC window profile and double glazing with rare gas fill, and low-emissivity coating (U_g = 1.1 W/m²K).

Old, wood pane windows with thermopane glazing and without low-e coating make up approximately one third of windows on the building.

0.3.9 The thermal energy used for space heating and water heating is generated by a compact thermal station (year of manufacture: 1998), located in the boiler room in the basement of the building. Recently, plate heat exchanger for heating was replaced. Thermal station is partially renovated and partly outdated. The appointed maintenance person (the janitor) suggested that the circulator pump for space heating, water heating and radiator heating in the thermal station shows signs of malfunctioning – some more distant radiators do not heat up properly.

0.3.10 The existing documentation shows that the electrical installations and electrical distribution equipment in the building was first retrofitted between 1987 and 1988. The retrofit was properly implemented, point of connection is reliable; supply of electricity is impeccable. Electrical systems and low-voltage load shedding distributors have been properly maintained and function normally.

0.3.11 Lighting is relatively effective. Incandescent (filament) lamps are practically non-existent. A large proportion of lighting is made of lamps with fluorescent bulbs and ballasts, and lamps with energy-saving bulbs.

0.3.12 The most suitable investment and technical measures to improve EE of the building concern the building envelope (insulation of façade and slanted roof, replacement of doors and windows) and heating system (replacement of circulator pumps, installation of thermostat valves and hydraulic balance). The replacement of doors and windows anticipates installation of blinds (external venetian blinds).

0.3.13 Replacement of heat exchangers: Although the existing heat exchangers are in poor condition, their replacement will not generate any significant energy savings. The greatest energy savings potential regarding the thermal station lies in replacing circulator pumps.

0.3.14 The installation of thermostat valves and hydraulic balance should be the priority measure, as it is one of the more cost-effective measures and significantly affects achieving the optimal thermal environment.

0.3.15 Retrofit of the building's electricity system (and lighting) carries a smaller, but not insignificant EE potential. At the cursory inspection we noticed many light bulbs that were either broken or not installed at all. Therefore, it can be expected that the retrofit will yield lower savings (electricity) that could indeed be reached. Lower savings in lighting retrofit can also be expected due to current standards that dictate stricter requirements, increasing the number of lamps, consequently increasing the electrical power, and reducing the actual savings on account of electricity. Nevertheless, this would significantly improve the working conditions in the building, which is essential for its users.

0.3.16 In order to lower the energy consumption, it seems sensible to first implement soft (organisational) measures – systematic steering towards energy efficient user behaviour demands minimum investment and shortest payback period. We have proposed some organisational measures in connection with smaller financial investments (e.g. implementation of energy monitoring).

0.3.17 Other important factors include educating users, technical personnel training, and implementing targeted monitoring of operation and maintenance (energy cost planning, preventive maintenance and repair). Qualified personnel must be familiar with system operation on an hourly level. In this case, the deviations can be discovered as soon as they arise, while it is also possible to review past operations. Therefore, installation of suitable sensors and meters for remote reading are required, and an information system should be established.

0.4 Potential savings and required investments

The simplified energy audit points out possible measures for a more efficient energy use (EE), i.e., reducing the costs and consumption of heating, electricity and water. We have analysed economically viable measures and predicted the estimated payback period of an investment. The proposed measures are divided into two sections: the organisational measures and the investment measures. All proposed measures beneficially affect EE and reduction of costs. They differ in payback period of an investment and importance of implementation.

The basic set of anticipated measures has been modified based on our correspondence with the employees; technical solutions have been defined with the help of external associates from respective areas. In this way, we have also considered constraints and restrictions relating to the implementation of EE measures and lowering the maintenance cost.

Values and direction of individual investments are indicative, as is usual at the level of simplified energy audits. To present detailed technical solutions for specific measures, it is necessary to create implementation project (PZI), wherein the measures are analysed, and a detailed list of necessary works is provided. The retrofit project must include a description of technical measures, a description of possible risks arising from their individual or interactive influence, and guidelines for users to limit the risks through preventative and corrective measures.

The term *comprehensive energy retrofit* applies to a harmonised implementation of measures to ensure energy efficiency (e.g. on façade, roof, flooring) of the building's technical systems (e.g. heating, ventilation, air-conditioning, hot water) in order to make full use (if possible) of the economically viable potential for the energy retrofit. The main advantage of an integrated approach is the possibility of interactive optimisation of individual measures through a single larger-scale operation. Simplified energy audit report lists several scenarios arising from the financial, organisational and strategic capabilities and policies of the investor.

Four scenarios are included into a simplified energy audit:

- Scenario Zero (0) encompasses measures with minimal investment cost (mostly organisational measures).
- Scenario One (1) encompasses comprehensive energy retrofitting compliant with the Rules on efficient use of energy in buildings with a technical guideline on EE (PURES) and provides nearly zero-energy buildings, regardless of economic viability.
- Scenario Two (2) encompasses the entire technically feasible and economically viable potential of measures implemented. Scenario 2 represents the selected measures, which were identified as the most beneficial in terms of comprehensive energy retrofitting.

Table 0.2: Scenario 0: Proposed measures

No	Description of measure	Potential annual savings				Implement	Payback	Priority
		Heating	Electricity	CO_2	Costs	Total		
		MWh	MWh	kg	EUR	EUR	years	
ORGANISATIONAL MEASURES								
1.	Organisational measures Education and promoting Maintenance	5.98	2.64	3,204	800	€	1	I. I. I.
SPECIFIC ORGANISATIONAL MEASURES								
2.	Monitoring + Energy	15.93	5.27	7,683	1,876	12,000	6	II.
ALL MEASURES TOTAL		**21.91**	**7.91**	**10,887**	**2,676**	**13,000**	**5**	

NOTE:

All prices exclude VAT.

Price of electricity for 2015:	0.14670	€/kW
The price of end-use thermal energy in 2015	0.06918	€/kWh

Table 0.3: Scenario 1: Proposed measures

No	Description of measure	Potential annual savings				Investme	Payba ck	Priorit
		Heatin	Electric	CO_2	Costs	Total		
		MWh	MWh	kg	EUR	EUR	years	
TECHNICAL INVESTMENT MEASURES								
0.	Building envelope							
	Monitoring + Energy management	7.92	8.31	6,606	1,767	12,000.00	7	I.
1.	Building envelope							
	Thermal insulation of façade	34.53		11,050	2,389	46,500.00	19	I.
	Replacing windows	6.23		1,993	431	47,950.00	111	
	Replacing doors	1.16		371	80	6,000,00	21	
	Thermal insulation of slanted roof	17.26		5,522	1,194	51,950.00	44	
	Thermal insulation of wall ***facing the terrain***	5.94		1,900	411	7,620.00	19	
	Thermal insulation of floors towards unheated basement	4.67		1,493	323	16,320.00	51	
	Thermal insulation of floors towards air	0.67		213	46	1,500.00	33	
	Total	**70.45**	**0.00**	**22,543**	**4,874**	**177,840.0**	**36**	
2.	Mechanical system measures							
	Installation of thermostat valves and heads and	3.22		1,030	223	7,180.00	32	I.
	Circulator pump replacement		3.49	1,710	512	1,650.00	3	II.
	Installation of central ventilation system with heat	26.48	–10.80	3,183	248	144,000.0	> 100	III.
	Total	**29.70**	**–7.31**	**5,923**	**982**	**152,830.0**	**156**	
3.	Measures for electrical system							
	Lighting retrofit and installation of proximity		27.00	13,230	3,961	43,700.00	11	I.
TOTAL TECH & INV MEASURES		**108.07**	**27.998**	**48,302.1**	**11,583.**	**386,370.0**	**33**	

NOTE:

All prices exclude VAT.

Price of electricity for 2015:	0.1467	€/kW
Price of heating for 2015:	0.0691 8	€/kW h

Table 0.4: Scenario 2: Proposed measures

No	Description of measure	Potential annual savings				Investment	Payback	Priority
		Heating	Electricity	CO_2	Costs	Total		
		MWh	MWh	kg	EUR	EUR	years	
TECHNICAL INVESTMENT MEASURES								
0.	Building envelope							
	Monitoring + Energy	12.33	7.77	7,751	1,992	12,000.00	6	I.
1.	Building envelope							
	Thermal insulation of façade	34.53		11,050	2,389	46,500.00	19	I.
	Thermal insulation of wall facing the terrain	5.94		1,900	411	7,620.00	19	
	Thermal insulation of floors towards air	0.67		213	46	1,500.00	33	
	Total	**41.14**	**0.00**	**13,164**	**2,846**	**55,620.00**	**20**	
2.	Heating system							
	Installation of thermostat valves and heads and	3.95		1,264	273	7,180.00	26	I.
	Circulator pump		3.49	1,710	512	1,650.00	3	
	Total	**3.95**	**3.49**	**2,974**	**785**	**8,830.00**	**11**	
3.	Measures for electrical							
	Lighting retrofit and installation of proximity		27.00	13,230	3,961	43,700.00	11	I.
TOTAL TECH & INV		**57.413**	**38.258**	**37,118.**	**9,584.**	**120,150.0**	**13**	

NOTE:

All prices exclude VAT.
Price of electricity for 2015: 0.14670 €/kWh
Price of heating for 2015: 0.06918 €/kWh

0.5 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). In the process of this energy audit, an energy performance certificate was generated.

0.5.1 Scenario 1: Energy indicators before and after the implementation of nearly zero-energy retrofit

The red arrow marks the current state of building; the green arrow marks the state after the energy retrofit according to Scenario 1.

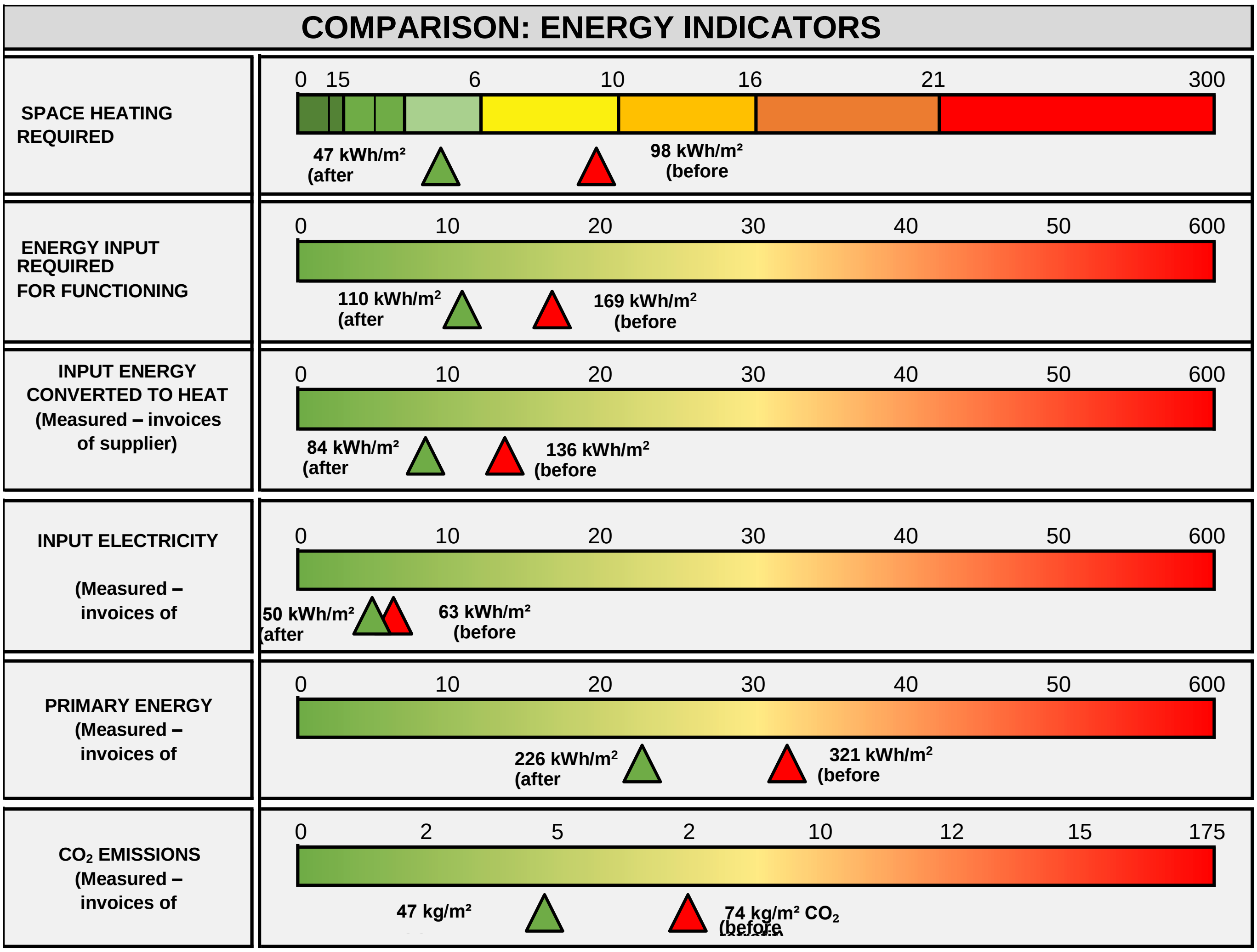


Figure 0.2: Comparison: Energy indicators