BOOSTEE-CE

DELIVERABLE T3.3.1

D.T3.3.1 – Pilot actions preparation **06/2018**

D.T3.3.1: Pilot actions preparation

A.T3.3 Preparation and procurement of pilot actions

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Authors		
	Name (organization)	**Name, e-mail**
WP leader	Mazovia Energy Agency (MAE), PP5	Aleksandra Luks, a.luks@mae.com.pl
Contributing participants	Municipality of Judenburg (JUD) (PP10) Energy Agency Upper Styria (EAO) (PP11)	Eva Volkar, E.Volkar@judenburg.at Helfried Kreiter, h.kreiter@judenburg.at Gernot Bärnthaler, gernot.baernthaler@eao.st

1. Introduction and aims

This deliverable is a kind of pre-investment report, which contains all information and data about buildings that allow for a description of the condition of the buildings and the pilot action.
Conducting research and analysis of selected buildings as pilot actions is necessary to ensure the identification of energy-related problem areas. Data collected from building owners given in the chapters below determine the current state of the facilities. It also provides the information needed to specify the energy profile of the buildings. In addition, it defines the measures and actions that were taken to implement the pilot action.
The aim of the document is presentation of plan preparatory activities to investment for the PA. This document describes activities as part of the tasks undertaken for each pilot action.

PILOT ACTION - **PA2. PA2 in a school complex in Judenburg-Lindfeld (AT) - Comprehensive School incl. polytechnical school**

2. Description of the PA building(s)

The description of the building provides basic building and administrative information. It allows to determine the location and the prevailing geographical conditions, the surroundings of the building. In addition, construction data is an example for similar construction solutions.

Type of building: Educational
Owner / investor: Municipality of Judenburg
Year of construction: 1965-1966
Year of use (if different from year of construction): -
Gross building area [m^2]: 6 057
Building volume [m^3]: 18 213
Building envelope total surface area [m^2]: 6 764
Shape factor (A/V ratio) [m^{-1}]: 0,33
The shape factor A/V is the ratio of the total surface area of all external walls (including windows and doors), roofs, floors on the ground or ceilings over the unheated basement, ceilings above the crossings, separating the heated part of the building from outside air to the volume of the heated part of the building, increased by the volume of heated rooms in the utility attic or in the basement and reduced by the volume of separate staircases, elevator shafts, open recesses, loggias and galleries.
It is best if the building shape factor is as low as possible. This means that the building should be as compact as possible, similar in shape to a sphere or cube, that is, solids characterized by the lowest A/V ratio. Considering energy consumption, a building with a high A/V ratio "consumes" more energy.
Typology (number of floors): 3
Number of building users: 500
Location: Lindfeldgasse 9-11, A-8750 Judenburg

Available technical documentation: ◉ **Yes** ○ **No**

Energy audit Year: 2010

Technical drawings Year: 1966

Building project for thermo-modernization of the building Year:

General, technical review of the building Year:

Figure 1: Photos of building available for the PA2 (© Municipality of Judenburg).

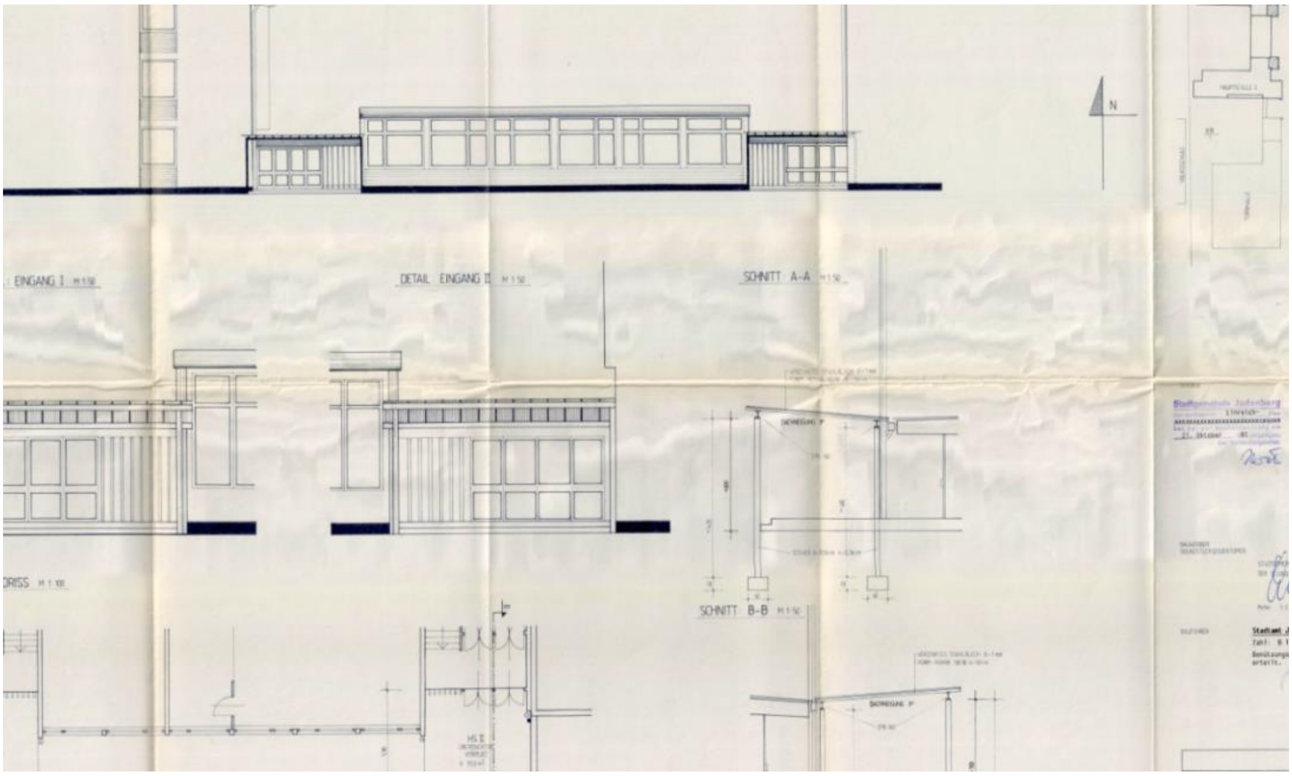


Figure 2: Typology of building available for the PA2 (source: Municipality of Judenburg).

3. Energy PA building(s) profile

Collecting energy data allows to determine the energy profile of the building. It provides information on the insulation of external partitions and the condition of energy systems (heating/cooling, ventilation, electricity, hot water preparation) in buildings.

3.1. External partitions

The technical and construction status of the building envelope influences significantly the heat loss to the environment. The used construction and thermal insulation material is important. In order to improve standards, a norm, regulation is established for each partition in each country. For existing buildings in the case of low insulation, it is recommended to carry out thermo-modernization.

3.1.1. External walls

Walls total surface area [m^2]: 2 091,8

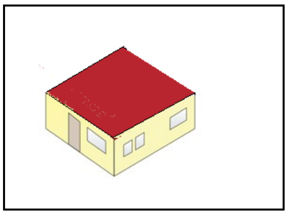
Envelope material (different layers):

No.	Material	Thickness [m]	Thermal conductivity [W/mK]	Heat transfer coefficient for external wall [W/m²K]	Defined heat transfer coefficient for external wall (according to the norm, national regulations) [W/m²K][1]
1	Brick	0,38		1,2	none

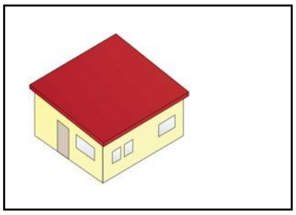
3.1.2. Roof

Type of roof:

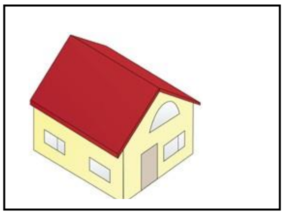
☐ Flat roof



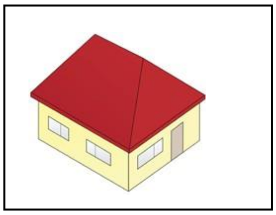
☒ Pent roof



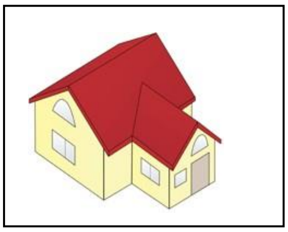
☐ Gable roof



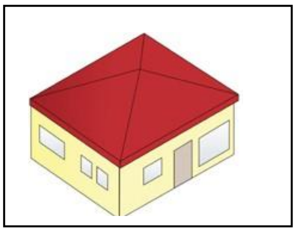
☐ Hip roof



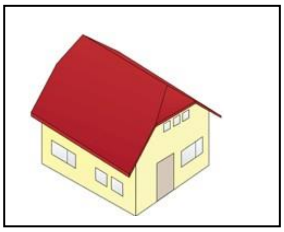
☐ Multi-hip roof



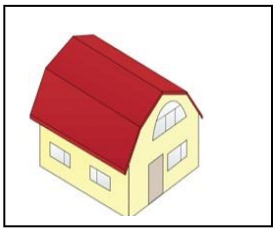
☐ Tented roof



☐ Half-hipped roof



☐ Mansard roof



Roof slope [°]: 12 **in direction: S**
Roof total surface area [m²]: 1 686,40
Envelope material (different layers):

No.	Material	Thickness [m]	Thermal conductivity [W/mK]	Heat transfer coefficient for roof [W/m²K]	Defined heat transfer coefficient for roof (according to the norm, national regulations) [W/m²K]
1	tin	0,005		0,55	none
2	wood	0,05			
3	Glass wool	0,10			
4	concrete	0,20			

3.1.3. Ground floor (basement)

Floor total surface area [m²]: 1 686,40

[1] If there are more U coefficients than one in your country, exchange all of them with the division, what they mean (e.g. recommended, required etc.)

Envelope material (different layers):

No.	Material	Thickness [m]	Thermal conductivity [W/mK]	Heat transfer coefficient for floor [W/m²K]	Defined heat transfer coefficient for floor (according to the norm, national regulations) [W/m²K]
1	screed	0,08		1,35	
2	styrofoam	0,02			
3	concrete	0,20			

3.1.4. Basement ceiling (if the building has a basement)

Total surface area [m^2]: 1 686,40
Envelope material (different layers):

No.	Material	Thickness [m]	Thermal conductivity [W/mK]	Heat transfer coefficient for floor [W/m²K]	Defined heat transfer coefficient for floor (according to the norm, national regulations) [W/m²K]
1	Concrete	0,2		1,5	
2	Screed	0,06			
3	wood	0,025			

Basement
Is the basement heated ? ☒ **Yes** ☐ **No**
Basement walls total surface area [m^2]: 621,25
Envelope material (different layers):

No.	Material	Thickness [m]	Thermal conductivity [W/mK]	Heat transfer coefficient for external wall [W/m²K]	Defined heat transfer coefficient for external wall (according to the norm, national regulations) [W/m²K]
1	Concrete	0,39		1,2	

3.1.5. Windows

Type:
☐ single window, single glazed
☒ combined window, double glazed
☐ combined window, three panes
☐ single-frame window, double low-emission glass, argon chamber
☐ single-frame window, three glass panes, two (external) glasses are made of ordinary glass, and the inner glass of low-emission glass, the chambers between the glasses are filled with argon
☐ single-frame window, three glass panes, all glasses are made of low-emission glass, the chambers between the glasses are filled with argon
☐ other (what ?)...

Shading (sun protection):
☐ curtains
☒ roller shutters
☐ wooden shutters
☐ internal blinds

☐ awnings
☐ other (what ?) ……………………………………………………………………………………………

Material (PVC, wood, aluminum, wood-aluminum): wood-aluminium
Number of windows: 260
Windows total surface area [m^2]: 592
Diffusers in windows (YES or NO): NO
Heat transfer coefficient [W/m^2K]: 1,3
Defined heat transfer coefficient (according to the norm, national regulations) [W/m^2K]:

Thermo-modernization (if carried out)
Year: 2008
Type of windows: combined window, double glazed
Material: wood-aluminium
Number of windows (if all windows are not replaced on the new ones): -
Windows total surface area [m^2]: 592
Diffusers in windows (YES or NO): NO
Heat transfer coefficient [W/m^2K]: 1,3

3.1.6. Doors

Material (wood, aluminum, PVC etc.): glass-aluminium
Number of doors: 3
Doors total surface area [m^2]: 36
Heat transfer coefficient [W/m^2K]: 1,2
Defined heat transfer coefficient (according to the norm, national regulations) [W/m^2K]:

3.2. Systems energy data

High efficiency of energy systems and the type of energy source determines its consumption. Also important is the issue of installed control and control systems that help ensure optimal thermal conditions.
Energy parameters characterizing the building:
Total non renewable primary energy demand [GJ/year or kWh/year]: no data
Final energy demand [GJ/year or kWh/year]: 762 389 kWh/year (Data based on the energy certificate)

District heating and electricity only from renewable sources

Energy consumption (heating) [GJ/year or kWh/year]: 688 049 kWh/year
Efficiency of the heating system [%]: 98
Energy consumption (hot water preparation) [GJ/year or kWh/year]: 31 842 kWh/year
Efficiency of the hot water preparation system [%]: 90
Energy consumption (cooling) [GJ/year or kWh/year]: no cooling system
Type of energy source (gas boiler, coal boiler, electricity, municipal heating network, biomass boiler, cogeneration, RES etc.):

heating: municipal heating network (industrial waste heat from biomass)
hot water: electricity

Regulation and control of systems in the building:
☒ thermostatic valves

☐ heat dividers
☒ motion sensors (light, partly)
☐ electricity meters
☐ water meters
☒ other (what ?)...outside temperature sensors..........
Annual fuel consumption [kg or m^3 or kWh or GJ]: 495 031 kWh district heating (real consumption)
Electricity consumption [kWh/year]: 75 699
Ordered power [MW]: 0,341
Lighting type (traditional incandescent lamps; halogen bulbs; fluorescent lamps; LED lamps): LED, halogen bulbs
Power of light bulbs [W]: no data
Number of lighting points: no data
Ventilation type (according to the table 1): natural ventilation

Ventilation type	Short description
Natural ventilation	based on natural processes occurring in the environment (using gravity)
Mechanical (forced) ventilation	air exchange is due to the operation of an electric motor driven ventilator. Using the mechanism gives us the ability to control the system
Mechanical ventilation with heat recovery	operates on the principle of mechanical ventilation extended by a recuperator responsible for the recovery of heat from exhaust air from the building
Hybrid ventilation	combination of natural and mechanical ventilation. This system works alternately depending on atmospheric conditions, using natural forces due to the difference in temperature and external air movement (wind) and the mechanics of the fan in the ventilation duct improving the ventilation conditions in case of need
Mixing (blasting) ventilation	based on mixing the contaminated air in the building with clean air and expelling it out. Fresh air flows through the air diffuser system
Displacement ventilation	based on the separation of the two zones (the lower zone to about 1.1 m (sitting position) or the 1.8 m (standing position) and the upper part) in which the different characteristics of the air will be felt

Table 1: Description of type ventilation.

Building energy profile
The energy consumption in construction is distinguished by three types of energy - primary energy (EP), final energy (EK) and utility energy (EU). Primary energy refers to the energy contained in sources, including fuels and carriers, necessary to cover the final energy demand, taking into account the efficiency of the entire chain of acquisition, conversion and transport to the end user. A concept that is important from the point of view of a sustainable development strategy. The ratio of non-renewable primary energy inputs to the generation and delivery of an energy or energy carrier for technical systems is the difference between primary energy and final energy. The final energy is heat and auxiliary energy, which must be delivered to the boundary of the heating system (building) with a given efficiency in order to cover the energy demand for heating and ventilation of rooms. A concept that is important from the point of view of the building's user who incurs costs related to the operation of the building. The efficiency of the system is a conversion of final energy into utility energy. The utility energy concerns energy for heating and ventilation as well as for preparing domestic hot water, regardless of the type and efficiency of the heating device. A concept that is important from the designer's point of view, characterizing thermal insulation and building tightness. The concepts are presented below.

$$EU \xrightarrow{\eta} EK \xrightarrow{w_i} EP$$

Annual demand for non renewable primary energy EP [kWh/m²/year]

District heating and electricity only from renewable sources

Non renewable primary energy demand for heating	Non renewable primary energy demand for cooling	Non renewable primary energy demand for ventilation	Non renewable primary energy demand for preparation of hot water	Non renewable primary energy demand for electricity	Sum (1+2+3+4+5)
1	**2**	**3**	**4**	**5**	**6**
3,2	0	0	0	0	3,2

Annual final energy demand EK [kWh/m²/year]

Final energy demand for heating	Final energy demand for cooling	Final energy demand for ventilation	Final energy demand for preparation of hot water	Final energy demand for electricity	Sum (1+2+3+4+5)
1	**2**	**3**	**4**	**5**	**6**
106,1	0	0	5,7	10,9	122,7

Annual utility energy demand EU [kWh/m²/year]

Utility energy demand for heating	Utility energy demand for cooling	Utility energy demand for ventilation	Utility energy demand for preparation of hot water	Utility energy demand for electricity	Sum (1+2+3+4)
1	**2**	**3**	**4**	**5**	**6**
4,4	0	0	0		4,4

Energy class of the building (according to the table 2): D average energy-intensive building

The EU indicator is a building quality indicator. In general, the smaller the EU, the less energy we lose through the outer baffles of the building. It refers to the energy which is consumed and goes from the building's heating system to the individual rooms, and the heat loss (through penetration and ventilation) to the environment. The EU indicator value in the table below includes only heating/cooling.

Energy class	Energy assessment	EU indicator [kWh/m²/year]
A++	zero-energy building	≤ 10
A+	passive building	up to 15
A	low-energy building	from 15 to 45
B	energy-saving building	from 45 to 80
C	average energy efficient building	from 80 to 100
D	average energy-intensive building	from 100 to 150
E	energy-consuming building	from 150 to 250
F	high-energy consuming building	over 250

Table 2: Building energy class (source: Association for Sustainable Development).

Electricity price [in your own currency: CZK or EUR or HRK or HUF or PLN]

All-in-price: 0,109 EUR/kWh

Energy (heating) price [in your own currency: CZK or EUR or HRK or HUF or PLN]
All-in-price: 0,12 EUR/kWh

Summary and evaluation of the energy building status
The building is after thermo-modernization in 2008 involving the replacement of window joinery.
The building's energy system includes the heating system, the hot water preparation system and the power system. The efficiency of the heating system and the preparation of domestic hot water is very high. The building uses annually 795 590 kWh, 86% of which is for heating despite installed thermostatic valves. The energy class classifies it as an average energy-intensive building.
The building is not equipped with cooling systems and ventilation is done through windows and ventilation ducts.

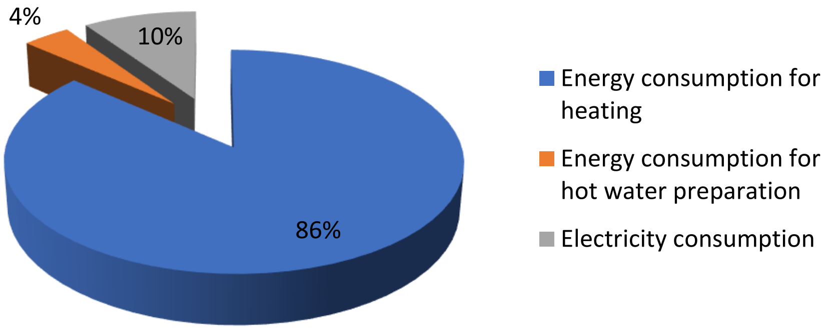


Figure 3: Energy consumption balance of the building for the PA2 – Comprehensive School.

PILOT ACTION - **PA2. PA2 in a school complex in Judenburg-Lindfeld (AT) - Primary school Lindfeld**

2. Description of the PA building(s)

The description of the building provides basic building and administrative information. It allows to determine the location and the prevailing geographical conditions, the surroundings of the building. In addition, construction data is an example for similar construction solutions.

Year of construction: 1962
Year of use (if different from year of construction): -
Gross building area [m^2]: 1 762,8
Building volume [m^3]: 6 522,4
Building envelope total surface area [m^2]: 2 730,59
Shape factor (A/V ratio) [m^{-1}]: 0,42
The shape factor A/V is the ratio of the total surface area of all external walls (including windows and doors), roofs, floors on the ground or ceilings over the unheated basement, ceilings above the crossings,

separating the heated part of the building from outside air to the volume of the heated part of the building, increased by the volume of heated rooms in the utility attic or in the basement and reduced by the volume of separate staircases, elevator shafts, open recesses, loggias and galleries.
It is best if the building shape factor is as low as possible. This means that the building should be as compact as possible, similar in shape to a sphere or cube, that is, solids characterized by the lowest A/V ratio. Considering energy consumption, a building with a high A/V ratio "consumes" more energy.
Typology (number of floors): 2
Number of building users: 100
Location: Lindfeldgasse 7, A-8750 Judenburg

Available technical documentation: ◉ **Yes** ○ **No**

Energy audit Year: 2010

Technical drawings Year: 1962

Building project for thermo-modernization of the building Year:

General, technical review of the building Year:

Figure 4: Photos of building available for the PA2. (© Municipality of Judenburg)

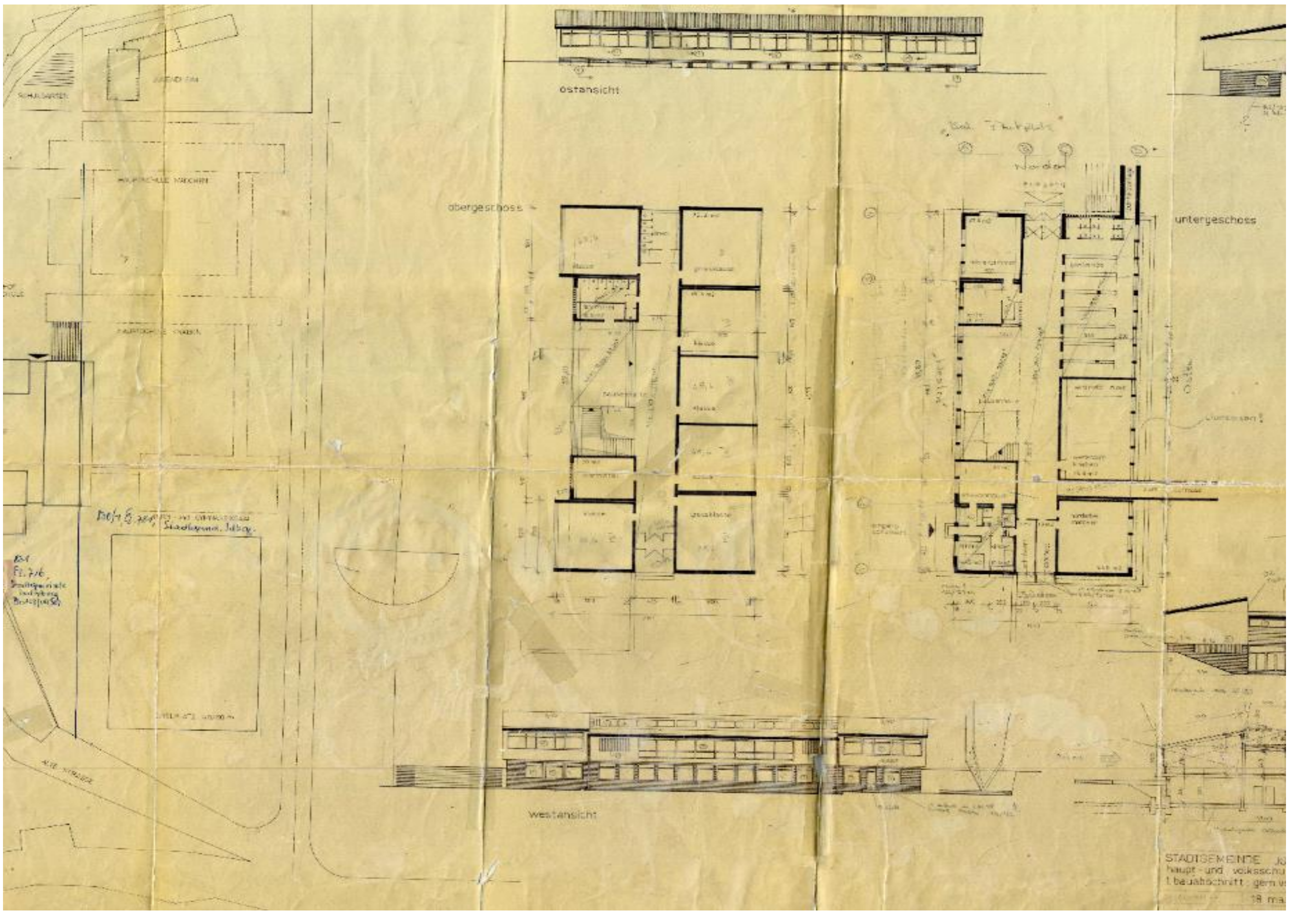


Figure 5: Typology of building available for the PA2 (source: Municipality of Judenburg).

3. Energy PA building(s) profile

Collecting energy data allows to determine the energy profile of the building. It provides information on the insulation of external partitions and the condition of energy systems (heating/cooling, ventilation, electricity, hot water preparation) in buildings.

3.1. External partitions

The technical and construction status of the building envelope influences significantly the heat loss to the environment. The used construction and thermal insulation material is important. In order to improve standards, a norm, regulation is established for each partition in each country. For existing buildings in the case of low insulation, it is recommended to carry out thermo-modernization.

3.1.1. External walls

Walls total surface area [m^2]: 609,72

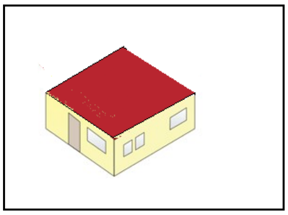
Envelope material (different layers):

No.	Material	Thickness [m]	Thermal conductivity [W/mK]	Heat transfer coefficient for external wall [W/m²K]	Defined heat transfer coefficient for external wall (according to the norm, national regulations) [W/m²K][2]
1	Brick	0,38		1,2	none

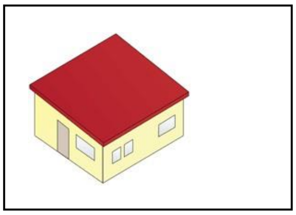
3.1.2. Roof

Type of roof:

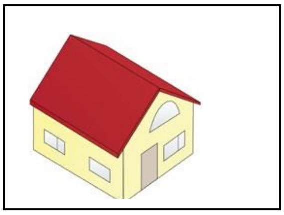
☐ Flat roof



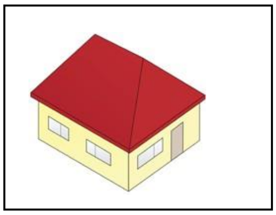
☒ Pent roof



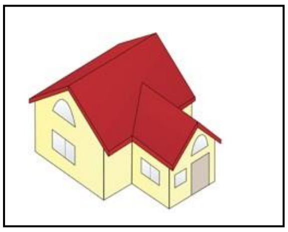
☐ Gable roof



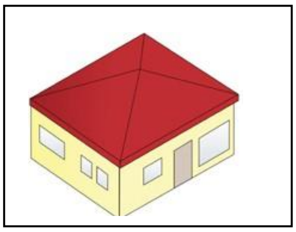
☐ Hip roof



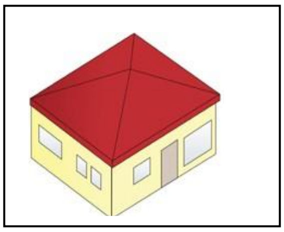
☐ Multi-hip roof



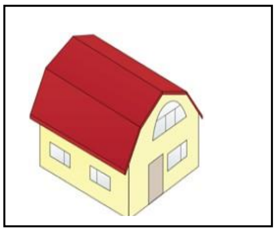
☐ Tented roof



☐ Half-hipped roof



☐ Mansard roof



Pent roof 1:
Roof slope [°]**:** 12 **in direction: E**

Pent roof 2:
Roof slope [°]**:** 12 **in direction: W**

Roof total surface area [m^2]: 881,41
Envelope material (different layers):

No.	Material	Thickness [m]	Thermal conductivity [W/mK]	Heat transfer coefficient for roof [W/m²K]	Defined heat transfer coefficient for roof (according to the norm, national regulations) [W/m²K]
1	tin	0,005		0,55	none
2	wood	0,05			
3	Glass wool	0,10			
4	concrete	0,20			

[2] If there are more U coefficients than one in your country, exchange all of them with the division, what they mean (e.g. recommended, required etc.)

3.1.3. Ground floor

Floor total surface area [m^2]: 881,41
Envelope material (different layers):

No.	Material	Thickness [m]	Thermal conductivity [W/mK]	Heat transfer coefficient for floor [W/m²K]	Defined heat transfer coefficient for floor (according to the norm, national regulations) [W/m²K]
1	screed	0,08		1,35	
2	styrofoam	0,02			
3	concrete	0,20			

3.1.4. Basement ceiling (if the building has a basement)

Total surface area [m^2]: 0
Envelope material (different layers):

No.	Material	Thickness [m]	Thermal conductivity [W/mK]	Heat transfer coefficient for floor [W/m²K]	Defined heat transfer coefficient for floor (according to the norm, national regulations) [W/m²K]
1					

Basement
Is the basement heated ? ☐ **Yes** ☐ **No**
Basement walls total surface area [m^2]: 0
Envelope material (different layers):

No.	Material	Thickness [m]	Thermal conductivity [W/mK]	Heat transfer coefficient for external wall [W/m²K]	Defined heat transfer coefficient for external wall (according to the norm, national regulations) [W/m²K]
1					

3.1.5. Windows

Type:
☐ single window, single glazed
☒ combined window, double glazed
☐ combined window, three panes
☐ single-frame window, double low-emission glass, argon chamber
☐ single-frame window, three glass panes, two (external) glasses are made of ordinary glass, and the inner glass of low-emission glass, the chambers between the glasses are filled with argon
☐ single-frame window, three glass panes, all glasses are made of low-emission glass, the chambers between the glasses are filled with argon
☐ other (what ?)……………………………………………………………………………………………

Shading (sun protection):
☐ curtains
☒ roller shutters
☐ wooden shutters

☐ internal blinds
☐ awnings
☐ other (what ?) ……..

Material (PVC, wood, aluminum, wood-aluminum): wood-aluminium
Number of windows: 85
Windows total surface area [m^2]: 358,78
Diffusers in windows (YES or NO): NO
Heat transfer coefficient [W/m^{2}K]: 1,3
Defined heat transfer coefficient (according to the norm, national regulations) [W/m^{2}K]: -

Thermo-modernization (if carried out)
Year: 2008
Type of windows: combined window, double glazed
Material: wood-aluminium
Number of windows (if all windows are not replaced on the new ones):
Windows total surface area [m^2]: 358,78
Diffusers in windows (YES or NO): NO
Heat transfer coefficient [W/m^{2}K]: 1,3

3.1.6. Doors

Material (wood, aluminum, PVC etc.): glass-aluminium
Number of doors: 2
Doors total surface area [m^2]: 10
Heat transfer coefficient [W/m^{2}K]: 1,3
Defined heat transfer coefficient (according to the norm, national regulations) [W/m^{2}K]:

Thermo-modernization (if carried out)
Year: 2008
Material: glass-aluminium
Number of doors (if all doors are not replaced on the new ones): 2
Doors total surface area [m^2]: 10
Heat transfer coefficient [W/m^{2}K]: 1,3

3.2. Systems energy data

High efficiency of energy systems and the type of energy source determines its consumption. Also important is the issue of installed control and control systems that help ensure optimal thermal conditions. Energy parameters characterizing the building:

Total non renewable primary energy demand [GJ/year or kWh/year]: no data
Final energy demand [GJ/year or kWh/year]: 313 105 kWh/year

District heating and electricity only from renewable sources

Energy consumption (heating) [GJ/year or kWh/year]: 287 651 kWh/year
Efficiency of the heating system [%]: 98
Energy consumption (hot water preparation) [GJ/year or kWh/year]: 8 298 kWh/year

Efficiency of the hot water preparation system [%]: 90
Energy consumption (cooling) [GJ/year or kWh/year]: no cooling system
Type of energy source (gas boiler, coal boiler, electricity, municipal heating network, biomass boiler, cogeneration, RES etc.):

heating: municipal heating network (industrial waste heat from biomass)
hot water: electricity

Regulation and control of systems in the building:

☒ thermostatic valves
☐ heat dividers
☒ motion sensors (light)
☐ electricity meters
☐ water meters
☒ other (what ?)……………….outside temperature sensors……………………………….

Annual fuel consumption [kg or m^3 or kWh or GJ]: 132 579 kWh district heating
Electricity consumption [kWh/year]: 20 681
Ordered power [MW]: 0,132
Lighting type (traditional incandescent lamps; halogen bulbs; fluorescent lamps; LED lamps): LED, halogen bulbs
Power of light bulbs [W]: no data
Number of lighting points: no data
Ventilation type (according to the table 1): natural ventilation

Building energy profile

The energy consumption in construction is distinguished by three types of energy - primary energy (EP), final energy (EK) and utility energy (EU). Primary energy refers to the energy contained in sources, including fuels and carriers, necessary to cover the final energy demand, taking into account the efficiency of the entire chain of acquisition, conversion and transport to the end user. A concept that is important from the point of view of a sustainable development strategy. The ratio of non-renewable primary energy inputs to the generation and delivery of an energy or energy carrier for technical systems is the difference between primary energy and final energy. The final energy is heat and auxiliary energy, which must be delivered to the boundary of the heating system (building) with a given efficiency in order to cover the energy demand for heating and ventilation of rooms. A concept that is important from the point of view of the building's user who incurs costs related to the operation of the building. The efficiency of the system is a conversion of final energy into utility energy. The utility energy concerns energy for heating and ventilation as well as for preparing domestic hot water, regardless of the type and efficiency of the heating device. A concept that is important from the designer's point of view, characterizing thermal insulation and building tightness. The concepts are presented below.

$$EU \xrightarrow{\eta} EK \xrightarrow{w_i} EP$$

Annual demand for non renewable primary energy EP [kWh/m²/year]
106,1 District heating and electricity only from renewable sources

Non renewable primary energy demand for heating	Non renewable primary energy demand for cooling	Non renewable primary energy demand for ventilation	Non renewable primary energy demand for preparation of hot water	Non renewable primary energy demand for electricity	Sum (1+2+3+4+5)
1	**2**	**3**	**4**	**5**	**6**
5,0	0	0	0	0	5,0

Annual final energy demand EK [kWh/m²/year]

Final energy demand for heating	Final energy demand for cooling	Final energy demand for ventilation	Final energy demand for preparation of hot water	Final energy demand for electricity	Sum (1+2+3+4+5)
1	**2**	**3**	**4**	**5**	**6**
165,6	0	0	11	10,9	177,2

Annual utility energy demand EU [kWh/m²/year]

Utility energy demand for heating	Utility energy demand for cooling	Utility energy demand for ventilation	Utility energy demand for preparation of hot water	Utility energy demand for electricity	Sum (1+2+3+4)
1	**2**	**3**	**4**	**5**	**6**
2,4			0		2,4

Energy class of the building (according to the table 2): D average energy-intensive building
The EU indicator is a building quality indicator. In general, the smaller the EU, the less energy we lose through the outer baffles of the building. It refers to the energy which is consumed and goes from the building's heating system to the individual rooms, and the heat loss (through penetration and ventilation) to the environment. The EU indicator value in the table below includes only heating/cooling.

Electricity price [in your own currency: CZK or EUR or HRK or HUF or PLN]
All-in-price: 0,109 EUR/kWh

Energy (heating) price [in your own currency: CZK or EUR or HRK or HUF or PLN
All-in-price: 0,12 EUR/kWh

Summary and evaluation of the energy building status
The building is after thermo-modernization in 2008 involving the replacement of window and door joinery.
The building's energy system includes the heating system, the hot water preparation system and the power system. The efficiency of the heating system and the preparation of domestic hot water is very high. The building uses annually 316 630 kWh, 91% of which is for heating despite installed thermostatic valves. The energy class classifies it as an average energy-intensive building.
The building is not equipped with cooling systems and ventilation is done through windows and ventilation ducts.

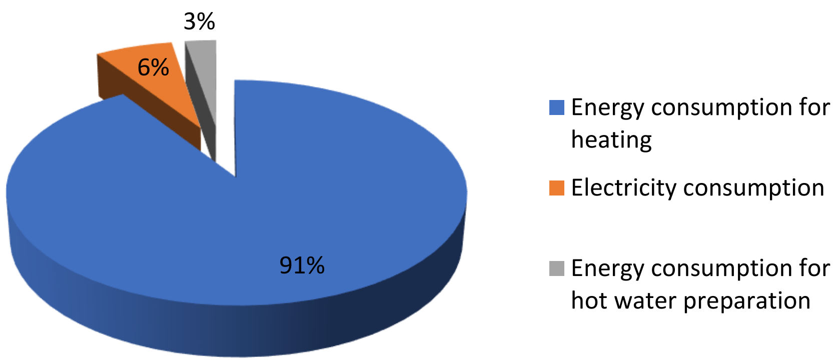


Figure 6: Energy consumption balance of the building for the PA2 – Primary School.

PILOT ACTION - **PA2. PA2 in a school complex in Judenburg-Lindfeld (AT) - Sports hall Lindfeld (Lindfeldhalle)**

2. Description of the PA building(s)

The description of the building provides basic building and administrative information. It allows to determine the location and the prevailing geographical conditions, the surroundings of the building. In addition, construction data is an example for similar construction solutions.

Year of construction: 1970
Year of use (if different from year of construction): -
Gross building area [m^2]: 2 700
Building volume [m^3]: 16 830
Building envelope total surface area [m^2]: 6 009
Shape factor (A/V ratio) [m^{-1}]: 0,36
The shape factor A/V is the ratio of the total surface area of all external walls (including windows and doors), roofs, floors on the ground or ceilings over the unheated basement, ceilings above the crossings, separating the heated part of the building from outside air to the volume of the heated part of the building, increased by the volume of heated rooms in the utility attic or in the basement and reduced by the volume of separate staircases, elevator shafts, open recesses, loggias and galleries.
It is best if the building shape factor is as low as possible. This means that the building should be as compact as possible, similar in shape to a sphere or cube, that is, solids characterized by the lowest A/V ratio. Considering energy consumption, a building with a high A/V ratio "consumes" more energy.
Typology (number of floors): 1
Number of building users: 1000
Location: Lindfeldgasse 5, A-8750 Judenburg

Available technical documentation: ◉ **Yes** ○ **No**

Energy audit Year: 2010

Technical drawings Year: 1970

Figure 7: Photos of building available for the PA2. (© Municipality of Judenburg).

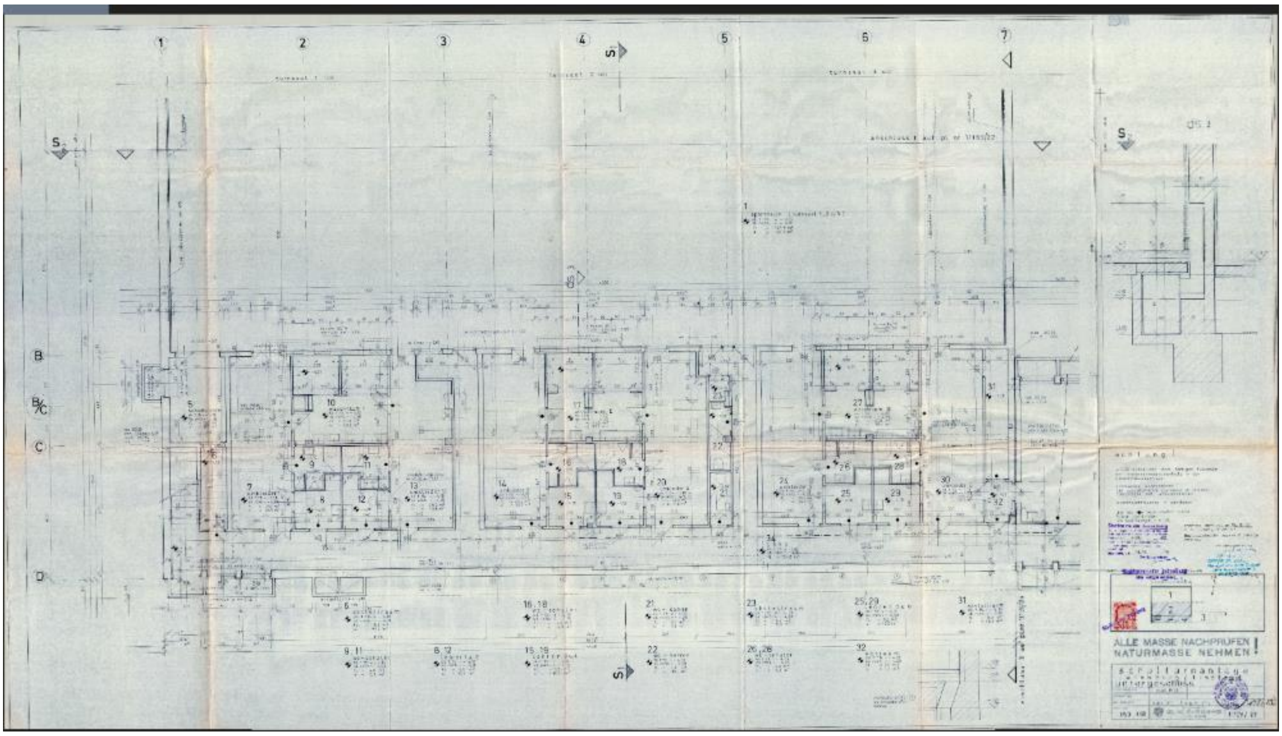


Figure 8: Typology of building available for the PA2 (source: Municipality of Judenburg).

3. Energy PA building(s) profile

Collecting energy data allows to determine the energy profile of the building. It provides information on the insulation of external partitions and the condition of energy systems (heating/cooling, ventilation, electricity, hot water preparation) in buildings.

3.1. External partitions

The technical and construction status of the building envelope influences significantly the heat loss to the environment. The used construction and thermal insulation material is important. In order to improve standards, a norm, regulation is established for each partition in each country. For existing buildings in the case of low insulation, it is recommended to carry out thermo-modernization.

3.1.1. External walls

Walls total surface area [m^2]: 474

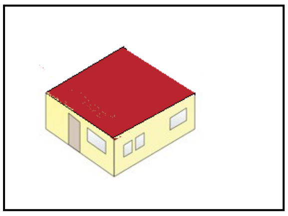
Envelope material (different layers):

No.	Material	Thickness [m]	Thermal conductivity [W/mK]	Heat transfer coefficient for external wall [W/m²K]	Defined heat transfer coefficient for external wall (according to the norm, national regulations) [W/m²K][3]
1	Concrete	0,57		1,2	none
2	Insulation	0,05			

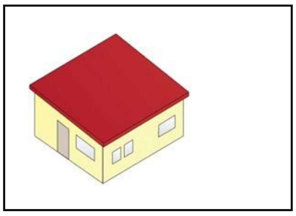
3.1.2. Roof

Type of roof:

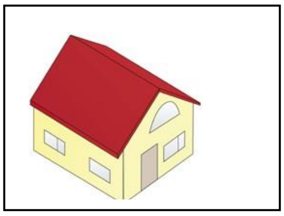
☒ Flat roof



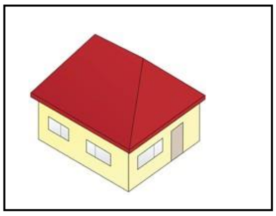
☐ Pent roof



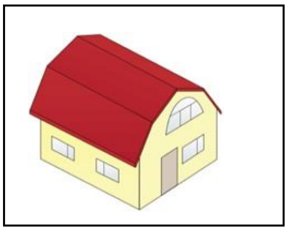
☐ Gable roof



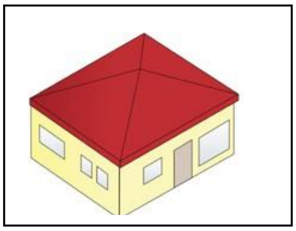
☐ Hip roof



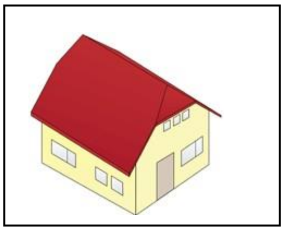
☐ Multi-hip roof



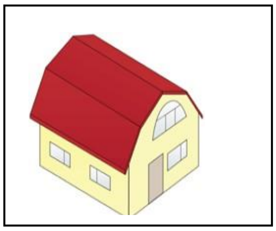
☐ Tented roof



☐ Half-hipped roof



☐ Mansard roof



Roof slope [°]: 0 **in direction:** N/A
Roof total surface area [m²]: 2 700
Envelope material (different layers):

No.	Material	Thickness [m]	Thermal conductivity [W/mK]	Heat transfer coefficient for roof [W/m²K]	Defined heat transfer coefficient for roof (according to the norm, national regulations) [W/m²K]
1	Tin-insulation-construction (Thyssen-construction)	0,40		0,6	none

[3] If there are more U coefficients than one in your country, exchange all of them with the division, what they mean (e.g. recommended, required etc.)

3.1.3. Ground floor

Floor total surface area [m²]: 2 700
Envelope material (different layers):

No.	Material	Thickness [m]	Thermal conductivity [W/mK]	Heat transfer coefficient for floor [W/m²K]	Defined heat transfer coefficient for floor (according to the norm, national regulations) [W/m²K]
1	screed	0,10		1,35	
2	styrofoam	0,03			
3	concrete	0,20			
4	wood	0,04			

3.1.4. Basement ceiling (if the building has a basement)

Basement ceiling = building ceiling (room is 7 m high)
Total surface area [m²]: 2 700
Envelope material (different layers):

No.	Material	Thickness [m]	Thermal conductivity [W/mK]	Heat transfer coefficient for floor [W/m²K]	Defined heat transfer coefficient for floor (according to the norm, national regulations) [W/m²K]
1	Tin-insulation-construction (Thyssen-construction)	0,40		0,6	

Basement
Is the basement heated ? ☒ **Yes** ☐ **No**
Basement walls total surface area [m²]: 474

Building reaches 4 m into the ground.

Envelope material (different layers):

No.	Material	Thickness [m]	Thermal conductivity [W/mK]	Heat transfer coefficient for external wall [W/m²K]	Defined heat transfer coefficient for external wall (according to the norm, national regulations) [W/m²K]
1	Concrete	0,57		1,2	
2	Insulation	0,05			

3.1.5. Windows

Type:
☐ single window, single glazed
☒ combined window, double glazed
☐ combined window, three panes

☐ single-frame window, double low-emission glass, argon chamber
☐ single-frame window, three glass panes, two (external) glasses are made of ordinary glass, and the inner glass of low-emission glass, the chambers between the glasses are filled with argon
☐ single-frame window, three glass panes, all glasses are made of low-emission glass, the chambers between the glasses are filled with argon
☐ other (what ?)…………………………………………………………………………………………………

Shading (sun protection): no shading
☐ curtains
☐ roller shutters
☐ wooden shutters
☐ internal blinds
☐ awnings
☐ other (what ?) ………..

Material (PVC, wood, aluminum, wood-aluminum): aluminium
Number of windows: fixed window
Windows total surface area [m^2]: 134
Diffusers in windows (YES or NO): no
Heat transfer coefficient [W/m^2K]: 2,7
Defined heat transfer coefficient (according to the norm, national regulations) [W/m^2K]:

3.1.6. Doors

Material (wood, aluminum, PVC etc.): aluminium
Number of doors: 2
Doors total surface area [m^2]: 9
Heat transfer coefficient [W/m^2K]: 2,7
Defined heat transfer coefficient (according to the norm, national regulations) [W/m^2K]:

3.2. Systems energy data

High efficiency of energy systems and the type of energy source determines its consumption. Also important is the issue of installed control and control systems that help ensure optimal thermal conditions.

Energy parameters characterizing the building:

Total non renewable primary energy demand [kWh/year]: no data
Final energy demand [GJ/year or kWh/year]: 889 326 kWh/year

District heating and electricity only from renewable sources

Energy consumption (heating) [GJ/year or kWh/year]: 826 102 kWh/year
Efficiency of the heating system [%]: 98
Energy consumption (hot water preparation) [GJ/year or kWh/year]: 22 162 kWh/year
Efficiency of the hot water preparation system [%]: 90
Energy consumption (cooling) [GJ/year or kWh/year]: no cooling system
Type of energy source (gas boiler, coal boiler, electricity, municipal heating network, biomass boiler, cogeneration, RES etc.):

heating: municipal heating network (industrial waste heat from biomass)
hot water: electricity

Regulation and control of systems in the building:

- ☒ thermostatic valves
- ☐ heat dividers
- ☒ motion sensors (light)
- ☐ electricity meters
- ☐ water meters
- ☒ other (what ?)………………outside temperature sensors…………………………………….

Annual fuel consumption [kg or m^3 or kWh or GJ]: 256 355 kWh district heating
Electricity consumption [kWh/year]: 64 752
Ordered power [MW]: 0,188
Lighting type (traditional incandescent lamps; halogen bulbs; fluorescent lamps; LED lamps): LED, halogen bulbs
Power of light bulbs [W]: mainly incandescent lamps 58 W, mostly two lamps in one casing
Number of lighting points: no data
Ventilation type (according to the table 1): mechanical (forced) ventilation

Building energy profile

The energy consumption in construction is distinguished by three types of energy - primary energy (EP), final energy (EK) and utility energy (EU). Primary energy refers to the energy contained in sources, including fuels and carriers, necessary to cover the final energy demand, taking into account the efficiency of the entire chain of acquisition, conversion and transport to the end user. A concept that is important from the point of view of a sustainable development strategy. The ratio of non-renewable primary energy inputs to the generation and delivery of an energy or energy carrier for technical systems is the difference between primary energy and final energy. The final energy is heat and auxiliary energy, which must be delivered to the boundary of the heating system (building) with a given efficiency in order to cover the energy demand for heating and ventilation of rooms. A concept that is important from the point of view of the building's user who incurs costs related to the operation of the building. The efficiency of the system is a conversion of final energy into utility energy. The utility energy concerns energy for heating and ventilation as well as for preparing domestic hot water, regardless of the type and efficiency of the heating device. A concept that is important from the designer's point of view, characterizing thermal insulation and building tightness. The concepts are presented below.

$$EU \xrightarrow{\eta} EK \xrightarrow{w_i} EP$$

Annual demand for non renewable primary energy EP [kWh/m²/year]
District heating and electricity only from renewable sources

Non renewable primary energy demand for heating	Non renewable primary energy demand for cooling	Non renewable primary energy demand for ventilation	Non renewable primary energy demand for preparation of hot water	Non renewable primary energy demand for electricity	Sum (1+2+3+4+5)
1	**2**	**3**	**4**	**5**	**6**
9,3	0	0	0	0	9,3

Annual final energy demand EK [kWh/m²/year]

Final energy demand for heating	Final energy demand for cooling	Final energy demand for ventilation	Final energy demand for preparation of hot water	Final energy demand for electricity	Sum (1+2+3+4+5)
1	**2**	**3**	**4**	**5**	**6**
311,2	0	0	16,4	0,6	328,2

Annual utility energy demand EU [kWh/m²/year]

Utility energy demand for heating	Utility energy demand for cooling	Utility energy demand for ventilation	Utility energy demand for preparation of hot water	Utility energy demand for electricity	Sum (1+2+3+4)
1	**2**	**3**	**4**	**5**	**6**
5,4	0	0	0		5,4

Energy class of the building (according to the table 2): E energy-consuming building
The EU indicator is a building quality indicator. In general, the smaller the EU, the less energy we lose through the outer baffles of the building. It refers to the energy which is consumed and goes from the building's heating system to the individual rooms, and the heat loss (through penetration and ventilation) to the environment. The EU indicator value in the table below includes only heating/cooling.

Electricity price [in your own currency: CZK or EUR or HRK or HUF or PLN]
All-in-price: 0,109 EUR/kWh

Energy (heating) price [in your own currency: CZK or EUR or HRK or HUF or PLN]
All-in-price: 0,12 EUR/kWh

Summary and evaluation of the energy building status
The building's energy system includes the heating system, the hot water preparation system, mechanical ventilation system and the power system. The efficiency of the heating system and the preparation of domestic hot water is very high. The building uses annually 913 016 kWh, 91% of which is for heating despite installed thermostatic valves. The energy class classifies it as an energy-consuming building.
The building is not equipped with cooling system.

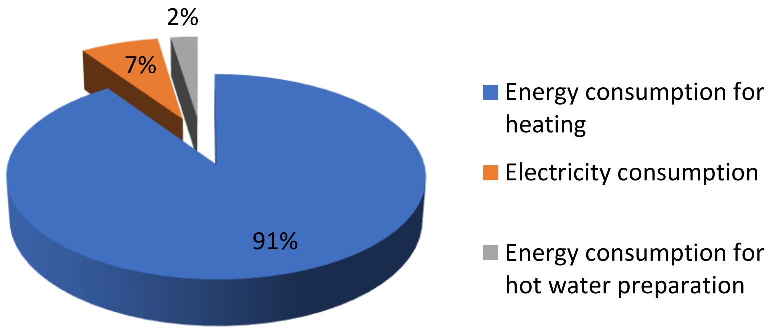


Figure 9: Energy consumption balance of the building for the PA2 – Sports hall.

4. Definition of the required resources to run the investment

This chapter describes the measures and activities that were implemented to start the investment in the appropriate order and assign a time schedule and costs. These are only preparatory activities to undertake investment.
The steps that were taken in order to prepare an investment or to carry out other activities are presented in the appropriate order.

PA2						
No.	Preparatory work	Preparatory work description	Time schedule	Cost (EUR)	Market research	Selected external expert
1	Preparation of PA	Survey on status quo (building structure, building physics, technology and consumption)	11.2017 – 12.2017		DONE	Done by PP JUD + EAO
2		Definition of user requirements	11.2017 – 2.2018		DONE	Done by PP JUD + EAO
3		Research on available technologies for heating control and expert companies	1.2018– 3.2018		DONE	Done by PP JUD + EAO
4		Enlargement of the project for optimization of heat distribution, hydraulic situation, regulation and control	2.2018 – 5.2018		DONE	Done by PP JUD + EAO
5		Selection of technology	2.2018 – ongoing		STARTE D	Done by PP JUD + EAO
6		Decision of municipal councils resolution	outstanding		NOT STARTE D	Done by PP JUD + EAO

Table 3: Time schedule and cost estimate of preparatory activities in the PA2.

Table 4 shows the time periods for the investment preparation period, implementation of activities and subsequent monitoring and evaluation of results.

	2018												2019												2020				
Month	Jan	Feb	Mar	April	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	April	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	April	May
Project month	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
PA2																													

Table 4: PA2 Activities plan.

start of WPT3 | PA preparations | PA implementation | PA monitoring/evaluation | end of PA | end of WPT3

Explanation:

PA preparations – A set of activities that are used to initiate the right investment, such as the selection of experts, contractors, collecting data and information, and other administrative work.

PA implementation – A set of activities like installation of equipment, systems, implementation of the OnePlace platform, promotional activities.

PA monitoring/evaluation – Checking whether the expected results are received.

5. Definition of problems in the implementation of PA

Each investment may encounter barriers of a financial, administrative, organizational or substantive nature. Therefore, it is important to define possible problems that may arise when investing in energy efficiency.

Problems (with expected delays):

1. The initial idea in this project was to install smart meters for refining the energy monitoring of the building complex, measurement for each single building for sharing the consumption and costs to each part.
2. During this project we did detailed audits on the district heating system, the heating distribution and hydraulic system, as well as on the regulation and control system. The result of this was, that we came to the conclusion, that we have enough data for sharing the energy consumption and costs to each building part. Additional measuring equipment will result in costs, but there will be no additional benefit.
3. For long term energy saving it is necessary to optimize the heating distribution and hydraulic system, as well as the regulation and control system. We prepared a call for tender, and we discussed possible solutions with potential contractors on site, do carry out the best solution.

4. This process costs more time, so there is a small delay of some weeks at the moment, to get the offers from the companies.
5. But the budget needed for the investment is also higher than expected, so it needs time to plan the financing of the investment, because it is not in the annual budget of the municipality. Investments on the systems are only possible during the summer holidays. In the actual year it is not possible anymore, so we plan to do the investment in summer 2019, if we can get a positive decision.

6. Conclusions

Energy data and administrative description of the building are valuable and necessary information when developing energy audits and conducting investments aimed at improving energy efficiency. Subsequent implementation of pilot project areas will be based on the presented data and will be described in the next reports (D.T3.1.3, D.T3.2.1 and D.T3.2.2).

During carrying out energy data for room heating we found out, that the energy consumption calculated in the energy certificates are significantly higher than the real energy consumption of the building:

Calculated heating energy demand (energy certificate):	1 958 765 kWh
Real energy consumption, based on the energy bill:	883 965 kWh

This means also, that the classification of the building is much better in the reals situation than from the energy certificates. The heat energy consumption in average of the building complex is 80 kWh/m², this means energy class “B”.