TRANSLATION from Romanian language

Energy Audit

Gym Hall within the Technical Energy College from Electricienilor street, no. 1, Sibiu municipality

Beneficiary:
Sibiu City Hall
Illegible signature, Official stamp

Drafted by:
Energyauditor for buildings
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Illegible signature, Official stamp

2025

Energy Audit Report of the building:
Gym Hall within the Technical Energy College from Electricienilor street, no. 1, Sibiu

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Energy Audit Report of the building

Gf Gym Hall within the Technical Energy College from Electricienilor street, no. 1, Sibiu

A. ANALYSIS REPORT AND ENERGY CERTIFICATION

1. **General information regarding the building**

The scope of the works consists into the thermal-energy evaluation of the gym hall within the Technical Energy College located in Sibiu municipality, Electricienilor street number 1. Its height regime is groundfloor.

The evaluation was carried out based on:

1. Survey of the studied building prepared by ALLBIZZ SRL
2. Cadastre of the studied building.
3. Inspections carried out during on-site visits.
4. Photo survey.
5. Investigations carried out on-site to establish the envelope structure.
6. The initial standard project carried out by IPCT

The results obtained based on the energy evaluation of the building and its heating, hot water preparation and lighting installations serve for the Energy Certification of the building, as well as for the preparation of the Energy Audit Report which includes the technical solutions for the refurbishment/modernization of the construction items and installations related.

The energy audit is carried out in order to evaluate the possibilities of improving the energy performance of the building, given the context of the refurbishment and modernization works of the gym hall of the Technical Energy College.

1.1. Architectural and thermal insulation elements

The building is located in the municipality of Sibiu, Str. Electricienilor, no. 1, and was built in a single section. The building was designed in 1971 and built in the immediate following period.
The main access to the building is on the SW side parallel to Electricienilor street between axes 4 and 6, axis A,

Height regime: ground floor.

The gym hall is an independent building that does not adjoin other buildings. From the architectural point of view, the envelope consists into:

- walls of 30 cm thick masonry;
- PVC windows with double glazing;

- ground slab consisting into screed and reinforced concrete slab
- floor above the ground floor made of prefabricated reinforced concrete beams over which narrow strips with gaps were provided.

From the point of view of the strength structure, the building is divided into 2 building areas, namely the gym hall area and the annex area with the function of locker rooms. The gym hall area has a free height of 6.50m, and the locker room area has a maximum height of 2.90m

The building's roof is made in the form of a wooden frame with a profiled sheet metal covering, in two layers.
The roof is built between the elevations +8.10 and -8.83 m, considering the elevation +0.00 m as the ground floor elevation.
The floor elevation is approximately 10 cm above the elevation of the landscaped land.

Through the design, the beneficiary requests the implementation of energy efficiency measures, repairs to damaged items, complete modernization of exterior finishes, replacement/repair of the heating system, preparation of hot running water and the existing artificial lighting, introduction of an organized mechanical ventilation system. The works will lead to the improvement ofthe operating conditions, by:

- improving the conditions of interior circulation;
- reducing energy consumption;
- reducing maintenance costs for heating, hot running water, mechanical ventilation and lighting;
- rational use of interior space in accordance with the regulations in force;
- increasing hygrothermal comfort in the building;
- achieving the specific requirements of the space intended as educational establishment;

1.2 Strength structure items

The architectural part comprises one block, with a regular rectangular shape with one side provided along Electricienilor Street and the second perpendicular to the street. The dimensions in plan are 33.45 m long and 20.90 m wide.

According to the technical expert report, the structural system is of the reinforced concrete frame type that works with the masonry walls.

From the strength structure point of view, the gym hall consists into two building areas (the gym hall area and the locker room area). The structure of the gym hall area is made of reinforced concrete columns with dimensions of 35x75cm and 30x30cm and prefabricated reinforced concrete beams over which some strips with round openings are placed. The structure of the locker room consists into reinforced concrete columns measuring 30x40cm and 30x30cm, reinforced concrete beams and a floor composed of hollow strips and partially a reinforced concrete floor in the monolithic version.

The perimeter closures are 30 cmthick and the interior ones are 30cmand 12.5 cm.

The additional frame has a strength structure in the form of a wooden structure, over which there is a corrugated sheet metal covering..

The technical condition of the building is proper with some local deficiencies (degraded exterior plaster, leaky carpentry, the sidewalks around the building are detached from the tiles and have a reverse slope, the base has infiltrations). The frame of the building was built after the construction was completed..

1.3 Heating and hot running water systems

The building hasall utilities: electricity, water and sewage, gas.

The building is equipped with internal heating systems. In the building there is a special room intended for the heating plant between axes A and B and axis 1 where the heating and hot water production system is installed. The heating plant consists of two Viessmann Vitodens 200-W heating plants. The same heating plants are used to produce hot water, which is stored in a Viessmann Vitocell 100 boiler.

The heating plant distribution system consists of fan coils in the gym and static bodies in the gym and in the locker rooms

The radiators in the rooms are equipped with classic valves**.**

1.4 Ventilation systems

The building is not equipped with organized ventilation systems.

1.5 Air conditioning/cooling systems

Not applicable. The building is not equipped with installations to ensure air conditioning.

1.6 Lighting systems

Artificial lighting is provided by fluorescent lighting fixtures..

2. Building energy performance evaluation

2.1 Determination of the corrected thermal strengthts of the construction elements of the building; how the thermal and energy performance requirements are met

2.1.1. Geometric characteristics of the building's thermal envelope

The geometric characteristics of the building were determined according to the methodology depending on the construction elements and are presented in the table below:

Construction element	S [sqm]
Exterior masonry wall 30 cmthick	558.1
Slab on theground	541.2
Floor abovethe ground floor	541.2
Exterior carpentry	129.4
Developed built area	582.66

2.1.2. Thermal-technical characteristics of the construction materials

The thermal-technical characteristics of the building materials that make up the building elements are presented in the table below..

No crt.	Material name	Characteristics p [kg/m³]	Characteristics γ [W/mK]	Increase percentage	calculation thermal conductivity
1	Reinforced concrete	2400	1.62	1.1	1.782
2	Lime-cement mortar	1700	0.87	1.1	0.957
3	Cement mortar	1800	0.93	1.1	1.023
3	Solid brick masonry	1800	0.80	1.15	0.92
4	Simple concrete screed	2000	1.16	1.03	1.195
5	Fir wood	550	0.17	1.1	0.187
6	Gravel filler	1800	0.70	1	0.70
7	Top soil	1800	1.160	1	1.16
8.	Coalash and slag	650	0.290	1.1	0.319

2.1.3. Unidirectional thermal strenghts and corrected with the effect of thermal attics, construction elements of the building thermal envelope

The unidirectional thermal strengths are determined by using the following formula:

$$R = R_{si} + \sum \frac{\delta_j}{a_j \lambda_j} + R_{se} = \frac{1}{h_i} + \sum \frac{\delta_j}{a_j \lambda_j} + \frac{1}{h_e} \left[\frac{m^2 K}{W}\right]$$

- h_i - internal surface heat transfer coefficient [W/m^2K];
  h_e - external surface heat transfer coefficient **[W/m^2K];**
- a - thermal conductivity increase coefficient depending on the condition and age of the materials, acc.to page 2.2, Mc001 Chapter 2.1.;
- γ – regulated thermal conductivity

The calculation of the corrected thermal strength is carried out according to the formula:

$$R' = rR$$

- R - the unidirectional specific thermal strength related to the area *A*,
- R' – corrected thermal strength ;
- r - correction coefficient for thermal attics;
- S= envelope elements area

Construction element	S [sqm]	R [sqmK/W	R [-]	R' [sqmK/W	R'$_{min}$ [sqmK/W]
NE masonry exterior wall	161.3	0.478	0.82	0.39	3.00
NW masonry exterior wall	122.9	0.478	0.92	0.44	3.00
SW masonry exterior wall	150.7	0.478	0.78	0.37	3.00
SE masonry exterior wall	123.3	0.478	0.91	0.44	3.00
Floor slab	541.2	0.545	0.97	0.53	4.50
Floor slab on the ground floor under the attic	541.2	0.623	0.98	0.61	5.00
NE Exterior windows	52.8	0.43	1	0.430	0.83
SW Exterior windows	64.3	0.43	1	0.430	0.83
SE Exterior windows	2.1	0.43	1	0.430	0.83
NW Exterior doors	1.9	0.37	1	0.37	0.77
SW Exterior doors	8.3	0.37	1	0.37	0.77

The last column in the table with R'min represents the minimum required strength provided by the norm for buildings with school function - Corrected thermal strenghts recommended for the renovation of existing non-residential buildings (according to page 2.9.b Mc00l-2022). It is noted that the thermal strengths of the envelope elements are lower than the minimum strengths requested by the rule.

2.1.3 Operating schedule, definition of the calculation formula and zoning

The building functions as a gym with an operating schedule of 8 hours per day, 5 days per week, from Monday to Friday according to the table below:

Energy Audit Report of the building:

GymHallwithin the TechnicalEnergyCollege fromElectricienilor street, no. 1, Sibiu

Operating scenario (Building / building unit / apartment occupancy schedule)

		Number ofusage hours per day [h]								Total hours[h]	
		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	No.of days	Week	Month
	W1	x	x	x	x	x			15	40	
January	W2	x	x	x	x	x				40	120
	W3	x	x	x	x	x				40	
		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	No.of days	Week	Month
	W3			x	x	x				24	
	W4	x	x	x	x	x				40	
	W5	x	x	x	x	x				40	
February									15		120
	W6	x	x								
										16	
		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	No.of days	Week	Month
	W6			x	x	x				24	
	W7	x	x	x	x	x				40	
	W8	x	x	x	x	x				40	164
March	W9	x	x	x	x	x			23	40	
	W10	x	x	x	x	x				40	
		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	No.of days	Week	Month
	W10										120
	W11	x	x	x	x	x				40	
	W12	x	x	x	x	x				40	
April	W13	x	x	x	x	x			15	40	
		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	No.of days	Week	Month
	W13	x	x	x	x	x				40	
May	W14	x	x	x	x	x				40	
	W15	x	x	x	x	x			25	40	200
	W16	x	x	x	x	x				40	
	W17	x	x	x	x	x				40	
		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	No.of days	Week	Month
	W17				x	x				16	
	W18	x	x	x	x	x				40	
	W19	x	x	x	x	x				40	176
June	W20	x	x	x	x	x			22	40	
	W21	x	x	x	x	x				40	
		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	No.of days	Week	Month
	W21										
	W22	x	x	x	x	x				40	
	W23	x	x	x	x	x				40	120
July	W24	x	x	x	x	x			15	40	
		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	No.of days	Week	Month
August									0		0

		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	No.of days	Week	Month
September	W24										
	W25	x	x	x	x	x				40	
	W26	x	x	x	x	x			20	40	
	W27	x	x	x	x	x				40	160
	W28	x	x	x	x	x				40	
		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	No.of days	Week	Month
October	W28										
	W29	x	x	x	x	x				40	
	W30	x	x	x	x	x			20	40	160
	W31	x	x	x	x	x				40	
	W32	x	x	x	x	x				40	
		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	No.of days	Week	Month
November	W32	x	x	x	x	x				40	
	W33	x	x	x	x	x				40	
	W34	x	x	x	x	x				40	
	W35	x	x	x	x	x			20	40	200
	W36	x	x	x	x	x				40	
		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	No.of days	Week	Month
December	W36	x	x	x	x	x				40	
	W37	x	x	x	x	x				40	120
	W38	x	x	x	x	x			15	40	

2.1.5 The need of airfor ventilation

The building is not equipped with an organized ventilation system. Manual ventilation of the rooms, especially the classrooms, is carried out by unscheduled opening of the windows. At the same time, ventilation will also be carried out by air infiltration from the outside.

2.1.6. **How the recommended thermal performance requirements are met in terms of thermal strength and hygrothermal comfort**

The building does not comply with the recommended thermal performance requirements in terms of thermal strength and hygrothermal comfort.

2.2 Determination of the annual primary energy consumption forheating

The annual energy consumption for heating is determined according to Chapter 3ofMC00l-2022, depending on the external and internal climatic parameters.

External climatic parameters

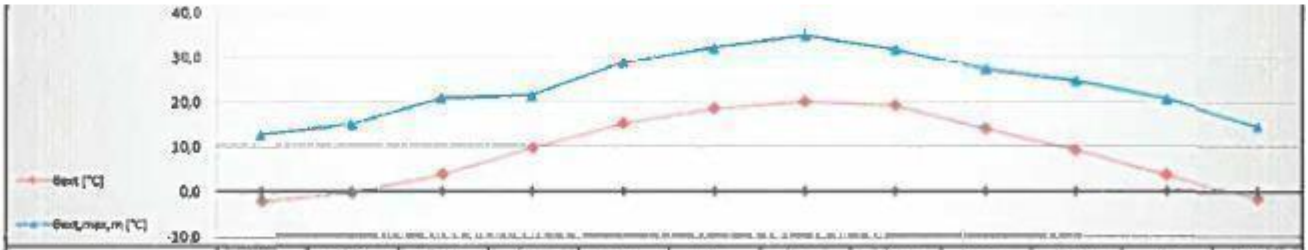
Conventional external calculation temperature

For winter, the conventional calculation temperature of the external air is considered depending on the climatic zone where the locality Sibiu is located (zone III), according to the MC00l-2022 Methodology, Chapter 2.1.1, as follows:

$$\theta_e = -18°C$$

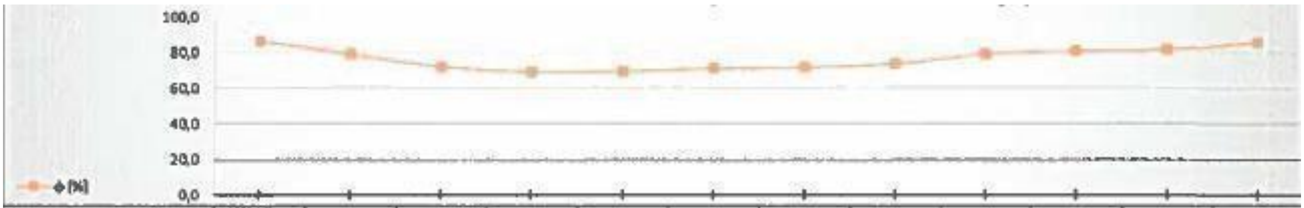
CLIMATE DATA for Sibiu

Monthly average values & monthly maximum values of the exterior temperature [°C]



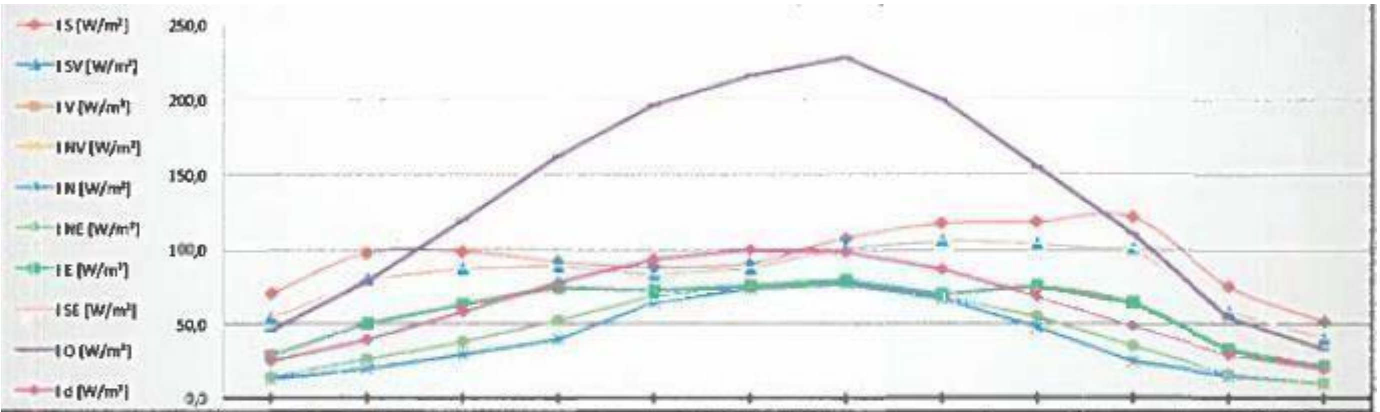
	Ian	Feb	Mar	Apr	Mai	Iun	Iul	Aug	Sep	Oct	Noi	Dec
θ ext [°C]	-2,3	-0,3	3,8	9,7	15,2	18,5	20,1	19,2	14,0	9,2	3,6	-1,5
θ ext,max,m [°C]	12,8	15,0	20,9	21,5	29,0	32,5	35,1	32,1	27,4	24,8	20,7	14,7

Monthly average values of the relative humidity ofthe external air [%]



	Ian	Feb	Mar	Apr	Mai	Iun	Iul	Aug	Sep	Oct	Noi	Dec
φ [%]	86,2	78,8	72,1	69,0	69,5	70,9	71,4	73,7	79,0	80,5	81,4	86,1

Monthly average values of the solar radiation intensity[w/sqm]



	Ian	Feb	Mar	Apr	Mai	Iun	Iul	Aug	Sep	Oct	Noi	Dec
I S [W/m²]	69,9	97,2	98,3	91,7	87,6	90,6	107,2	116,9	118,0	121,1	75,1	51,7
I SV [W/m²]	54,0	79,6	86,9	88,7	82,5	87,1	101,0	105,5	103,3	100,3	58,5	40,1
I V [W/m²]	28,3	49,4	62,8	73,8	72,2	75,5	78,9	69,3	74.8	63,6	33,2	21,3
I NV [W/m²]	13,7	26,0	37,3	51,5	68,0	74,3	77,6	67,6	54.4	34,9	16,0	10,3
I N [W/m²]	12,5	19,4	29,0	38,9	63,9	73,2	76,3	65,9	47,1	24,2	14,8	9,9
I NE [W/m²]	13,7	26,0	37,3	51,5	68,0	74,3	77,6	67,6	54,4	34,9	16,0	10,3
I E [W/m²]	28,3	49,4	62,8	73,8	72,2	75,5	78,9	69,3	74,8	63,6	33,2	21,3
I SE [W/m²]	54,0	79,6	86,9	88,7	82,5	87,1	101,0	105.5	103,3	100,3	58,5	40,1
I O [W/m²]	45,4	78,3	119,1	162,0	195,9	216,1	228,1	199,8	154,7	109,9	54,1	32,9
I d [W/m²]	25,0	38,9	57,9	77,7	92,7	99,8	97,9	86,4	68,3	48,3	29,5	19,9

Interior climate parameters

The interior temperature for calculating the building while using has the following value:

$$\Theta_{i,u} = 19\ [°C]$$

Calculation of heat loss coefficients Htr and Hve

Calculation of the building's heat loss coefficient through ventilation, Hve

$$H_{ve} = \frac{\rho_a c_a n_a V\, b_{ve}\, f_{ve}}{3.6}$$

- p_a- air density;
- c_a-specific air heat;
- n_a- average number of air changes
- V - heated volume
- b_{ve} air inlet temperature isthe outside air temperature
- f_{ve} correction factor for monthly calculation.

Calculation of the heat loss coefficient of the building, by transmission, Htr

$$H_{trfinal} = H_d + H_g + H_{iu} + H_a$$

H_d -direct heat transfer coefficient between heated spaces and the exterior through the building envelope $\left[\frac{W}{K}\right]$

Hg -heat transfer coefficient through the ground $\left[\frac{W}{K}\right]$

H_{iu} -heat transfer coefficient through transmission through unheated spaces $\left[\frac{W}{K}\right]$

H_{ve} - Heat transfer coefficient through ventilation $\left[\frac{W}{K}\right]$

H_a- heat transfer coefficient through transmission to adjacent buildings $\left[\frac{W}{K}\right]$

Energy Audit Report of the building:

Gym Hall within the Technical Energy College from Electricienilor street, no. 1, Sibiu

1	ZTC1.1	θint;inc [°C]	θint;rac [°C]	A use;zi [m²]	q [m³/h]
		19.0		552.4	1781.6

Cm;zi/Ause;zi [J/m²K]: 165000

Code	A e,i joinery Nr.	A e,i joinery [m²]	A e,i joinery [m²]	A e,i [m²]	Direction	r [-]	R' [m²K/W]	U'i [W/m²K]	Type of adjacent building	Adjacent area code	Hg [W/K]	Hd [W/K]	Hiu [W/K]	Hve [W/K]
PE1				161,3	NE		0,39	2,56	Ext.			411,37		
PE1				122,9	NV		0,44	2,28	Ext.			280,47		
PE1				160,7	SV		0,37	2,69	Ext.			405,75		
PE1				123,3	SE		0,44	2,30	Ext.			283,21		
PL attic				541,2	ORIZ		0,61	1,64	ZT				886,45	
SOL ground				541,2	ORIZ		0,53	1,88	Ground		175,53			
					NV				Ext					
FE-PVC		52,8	52,8		NE		0,43	2,33	Ext.			122,79		
FE-PVC		64,3	64,3		SV		0,43	2,33	Ext.			149,61		
FE-PVC		2,1	2,1		SE		0,43	2,33	Ext.			4,84		
UE-PVC		1,9	1,9		NV		0,37	2,68	Ext.			5,06		
UE-PVC		8,3	8,3		SV		0,37	2,68	Ext.			22,08		
														587,88
											175,53	1685,18	886,45	587,88

Legend: PE – exterior wall; PL – floor; FE – exterior windows; UE-exterior doors

LOSSTOTHE GROUND		Thermal features				Thermal flow features						
Exposed area [m]	Walls thickness [m]	ɰ wf [W/mK]	γg [W/mK]	P c [W/mK]	Ʊ {m)	α	ß	r	Θ_{int} [C]	Θ_{int} [K]	Θ_e [C]	Θ_e [K]
102.50	0.30	1.38	0.3	1.26E-0.6	2.20	0	1	1	14.7	4.0	9.1	11.4

	Ian	Feb	Mar	Apr	Mai	Iun	Iul	Aug	Sep	Oct	Noi	Dec	
θint;inc [°C]	19,0	19,0	19,0	19,0	19,0	19,0	19,0	19,0	19,0	19,0	19,0	19,0	HEATING
θint;rac [°C]													COOLING
θint;adj [°C]													
θext [°C]	-2,3	-0,3	3,8	9,7	15,2	18,5	20,1	19,2	14,0	9,2	3,6	-1,5	
b [-]	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	
H ia [W/K]													Max
H a [W/K]	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,0
H g [W/K]	154,09	165,18	179,05	191,98	200,50	202,32	196,97	185,88	172,01	159,09	150,57	148,74	
H u [W/K]	886,45	886,45	886,45	886,45	886,45	886,45	886,45	886,45	886,45	886,45	886,45	886,45	886,5
H tr [W/K]	2725,72	2736,81	2750,88	2763,61	2772,13	2773,96	2768,61	2757,51	2743,64	2730,72	2722,20	2720,37	2774,0

HEATING	Decreased day	
	$\Delta t_{H,red,y}$	12
	$n_{rep,red,y}$	5
	$f_{H,red,y}$	0,36

HEATING	decreased night	
	$\Delta t_{H,red,y}$	
	$n_{rep,red,y}$	
	$f_{H,red,y}$	0,00

HEATING	decreased weekend	
	$\Delta t_{H,red,y}$	48
	$n_{rep,red,y}$	1
	$f_{H,red,y}$	0.29

RĂCIRE		
	$\Delta t_{C,red,wknd}$	
	$n_{rep,red,y}$	
	$f_{C,red,wknd}$	0,00
	$b_{C,red,wknd}$	
	$a_{C,red,wknd}$	1,00

$\eta_{HU,rvd}$	
$(\Delta x \cdot t)_{a,sup}$	
φ V;comf2	
$f_{DHU,C,sa}$	

Low	
$a_{H,0}$	0,8
$\tau_{H,0}$	70
H final [W/K]	3361,84

Internal intakes

Next, internal intakes are calculated based on the occupants and equipment located inthe building.

1	ZTC1.1

	Type	Thermal power Predefinit Nr	Thermal power Predefinit [W]	User [W]	Operating period Ian [zile]	Feb [zile]	Mar [zile]	Apr [zile]	Mai [zile]	Iun [zile]	Iul [zile]	Aug [zile]	Sep [zile]	Oct [zile]	Noi [zile]	Dec [zile]	No.of hours/ day [h]
1	heavy duty occupants	30	9000		15	15	23	15	25	22	15	0	20	20	25	15	8
2	Lighting - Tungsten Halogene	6	1200		15	15	23	15	25	22	15	0	20	20	25	15	8
3	Lighting - T26 lunear fluorescent	11	396		15	15	23	15	25	22	15	0	20	20	25	15	8
4																	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	
	Total power and operating hours		10596	0	120,0	120,0	184,0	120,0	200,0	176,0	120,0	0,0	160,0	160,0	200,0	120,0	1680,0

Solar gains

Solar gains were calculated based on:

$a_{sol,k}$ radiation absorption coefficient

$g_{gl,n,wt}$ total solar energy transmission coefficient at normal incidence

$g_{gl,wt}$;- total average solar energy transmission coefficient

$F_{fr,win}$-window frame surface fraction

$F_{sky,k}$. -visibility factor between element and sky

$F_{sh,dir}$ shading factor for direct solar radiation intensity

1	ZTC1.1

	Code	Type	A_{eli} [m²]	U_{eli} [W/m²K]	Direction	Inclination angle Entered	Inclination angle [°]	$\alpha_{sol,k}$ [-]	$g_{gl,n,w}$ [-]	$g_{gl,w}$ [-]	$F_{fr,w}$ [-]	$F_{sky,k}$ [-]	$F_{sh,dir}$ [-]
1	PE1	DULL	161,27	2,55	NE		90	0,40				0,50	0,90
2	PE1	DULL	122,86	2,28	NV		90	0,40				0,50	0,70
3	PE1	DULL	150,66	2,69	SV		90	0,40				0,50	0,70
4	PE1	DULL	123,31	2,30	SE		90	0,40				0,50	0,90
5	PL bridge	INTERIOR	541,16	1,64	ORIZ								
6	SOL-grsain 7	GROUND	541,16	1,88	ORIZ		0						
7					NV								0,90
8	FE-PVC	TRANSPARENT	52,80	2,33	NE		90		0,60	0,54	0,21	0,50	0,90
9	FE-PVC	TRANSPARENT	64,33	2,33	SV		90		0,60	0,54	0,21	0,50	0,70
10	FE-PVC	TRANSPARENT	2,08	2,33	SE		90		0,60	0,54	0,21	0,50	0,90
11	UE-PVC	TRANSPARENT	1,89	2,68	NV		90		0,60	0,54	0,84	0,50	0,70
12	UE-PVC	TRANSPARENT	8,25	2,68	SV		90		0,60	0,54	0,84	0,50	

Monthly solar contribution by elements – Qsol; eli [kWH]

	Dec.(0)	Ian	Feb	Mar	Apr	Mai	Iun	Iul	Aug	Sep	Oct	Noi	Dec	Total
1	1,17	1,56	2,80	5,21	4,71	10,48	31,22	22,11	0,00	22,94	5,12	2,77	1,17	
2	0,62	0,83	1,49	2,76	2,50	5,55	15,55	11,72	0,00	12,17	2,71	1,47	0,62	
3	24,37	32,96	46,04	65,17	43,59	68,16	51,47	40,47	0,00	61,27	78,99	54,35	24,37	
4	21,87	29,58	41,32	58,48	39,12	61,17	46,19	38,32	0,00	54,99	70,89	48,78	21,87	
5														
6														
7														
8	2,50	3,33	6,31	13,89	12,51	27,52	79,38	56,63	0,00	52,84	11,30	8,48	2,50	
9	64,59	86,96	128,21	214,62	142,87	221,47	161,67	127,82	0,00	174,31	215,40	157,04	64,59	
10	2,69	3,62	5,33	8,92	5,94	9,21	6,72	5,31	0,00	7,25	8,96	6,53	2,69	
11	0,01	0,02	0,04	0,06	0,07	0,16	0,45	0,32	0,00	0,30	0,06	0,04	0,01	
12	2,41	3,24	4,78	6,00	5,32	8,25	6,02	4,76	0,00	6,49	8,03	5,85	2,41	
13														
14														
15														3346,7
16														
17														
18														
19														
20														
21														
22														
23														
24														
25														
26														
27														
28														
29														
30														
	120,2	162,1	236,3	377,1	256,6	412,0	399,7	305,4	0,0	392,5	401,5	283,3	120,2	

The heat lost as a result of thermal radiation to the sky is:

$$Q_{sky,eli}=4037,8 \text{ KWh/year}$$

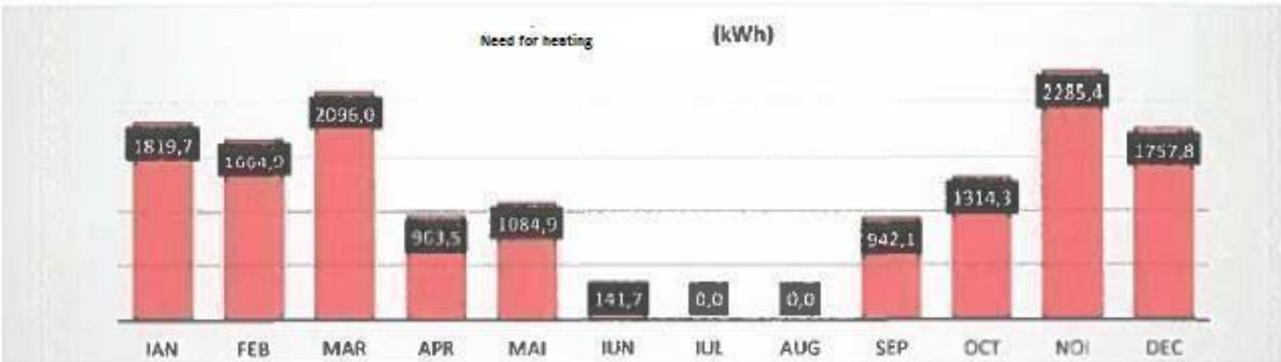
Need for heating

The table below presents the heating requirements for the gym building for each month.

Need for heating [kWh]

	ZTC code	Ian	Feb	Mar	Apr	Mai	Iun	Iul	Aug	Sep	Oct	Noi	Dec	Total
1	ZTC1.1	1819,7	1664,9	2096,0	963,5	1084,9	141,7	0,0	0,0	942,1	1314,3	2285,4	1757,8	14070,

	ZONE	Ian	Feb	Mar	Apr	Mai	Iun	Iul	Aug	Sep	Oct	Noi	Dec	Total
1	ZT1	1819,7	1664,9	2096,0	963,5	1084,9	141,7	0,0	0,0	942,1	1314,3	2285,4	1757,8	14070,
	Total ZT	1819,7	1664,9	2096,0	963,5	1084,9	141,7	0,0	0,0	942,1	1314,3	2285,4	1757,8	14070,



Determining the heating period

Next, the number of degree days for the winter period is established. The following graph shows the average monthly and external equilibrium temperatures. The external equilibrium temperature Θ_e is the external temperature for which it is not necessary to increase the heating.

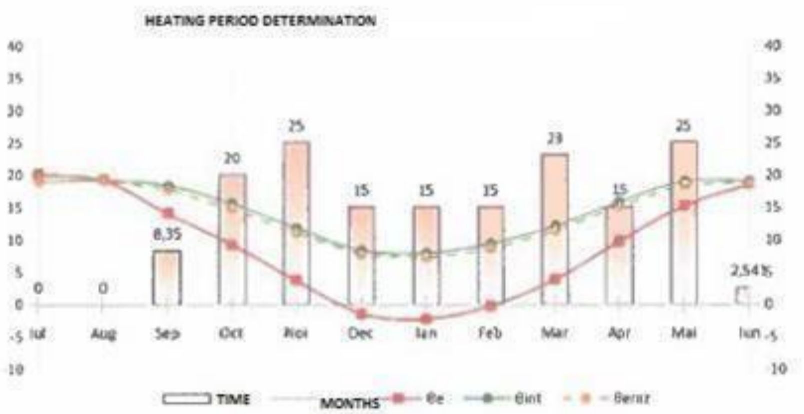
Θh(tr,ve;sol,int,)-Heat transferred by transmission for heating, ventilation, solar gains, internal gains

T_H-time constant of the heated area

Intermittent heating is taken into account through the γ coefficients.

1	ZTC1.1	$H_{gl,H,adj}$	87,51	[W/K]

Month	Hours	$Q_{Htr,cont}$	$Q_{Hve,cont}$	$Q_{Hht,cont}$	τ_H	$Q_{H,sol}$	Q_i	$Q_{H,sol}$	$Q_{H,int}$	$Q_{H,gn}$	$Q_{H,tr}$	$Q_{H,ve}$	$Q_{H,ht}$	$\gamma_{H,cont}$	γ_H	a_H	$\eta_{H,gn}$	$Q_{H,nd}$	f_H	Humidity - f_{HU}	$Q_{HU,nd}$
[-]	[h]	[kWh]	[kWh]	[kWh]	[h]	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]	[-]	[-]	[-]	[-]	[kWh]	[-]	[-]	[kWh]
Dec	120	4322	1446	5768	7,3	120	290	-170	1295	1125	1976	694	2670	0,19	0,42	0,90	0,67	1758	1,00	0,12	0,0
Ian	120	4490	1503	5993	7,3	162	289	-126	1295	1168	2046	721	2767	0,19	0,42	0,90	0,67	1820	1,00	0,13	0,0
Feb	120	4099	1362	5461	7,3	236	280	-43	1292	1249	1964	683	2647	0,22	0,47	0,90	0,65	1665	1,00	0,12	0,0
Mar	184	5039	1644	6683	7,2	377	379	-2	1973	1971	2664	895	3560	0,29	0,55	0,90	0,61	2098	1,00	0,15	0,0
Apr	120	2109	656	2765	7,1	257	265	-8	1294	1286	1378	427	1805	0,46	0,71	0,90	0,55	964	1,00	0,07	0,0
Mai	200	1678	447	2125	7,1	412	471	-59	2142	2083	1650	438	2088	0,97	1,00	0,90	0,47	1085	1,00	0,08	0,0
Iun	176	501	52	553	7,1	400	444	-44	1887	1843	501	52	553	3,29	3,33	0,90	0,22	142	0,12	0,01	0,0
Iul	120	0	0	0	7,1	305	306	-1	1295	1294	0	0	0	0,00	0,00	0,90	0,00	0	0,00	0,00	0,0
Aug	0	0	0	0	0,0	0	0	0	23	23	0	0	0	0,00	0,00	0,80	0,00	0	0,00	0,00	0,0
Sep	160	1621	470	2091	7,2	393	425	-33	1718	1685	1425	408	1833	0,80	0,92	0,90	0,49	942	0,42	0,07	0,0
Oct	160	2894	922	3816	7,3	401	422	-20	1719	1698	1851	589	2441	0,44	0,70	0,90	0,56	1314	1,00	0,09	0,0
Noi	200	5488	1811	7299	7,3	283	468	-185	2142	1958	2817	955	3772	0,26	0,52	0,90	0,63	2285	1,00	0,16	0,0
Dec	120	4322	1446	5768	7,3	120	290	-170	1295	1125	1976	694	2670	0,19	0,42	0,90	0,67	1758	1,00	0,12	0,0
		32241		42553		3347	4538	-891	18074	17383	18272	5863	24135					14870			0



	Θ_e	Θ_{int}	Θ_{ernz}	TIME (DAYS)
Iul	20,10	19,00	19,00	0,00
Aug	19,20	19,13	19,13	0,00
Sep	14,00	18,34	17,79	8,35
Oct	9,20	15,47	14,77	20,00
Noi	3,60	11,72	10,99	25,00
Dec	-1,50	8,34	7,59	15,00
Ian	-2,30	7,92	7,14	15,00
Feb	-0,30	9,38	8,57	15,00
Mar	3,80	12,08	11,29	23,00
Apr	9,70	15,75	15,06	15,00
Mai	15,20	18,93	18,43	25,00
Iun	18,50	19,00	18,77	2,54

The graphabove shows:

Θ_e= monthly average external temperature, in Celsius degrees

Θ_{int}= monthly average internal temperature, in Celsius degrees

Θemz- monthly average equilibrium temperature, in Celsius degrees

From the intersection of the two graphs, the number of heating days is determined, namely 164 days.

Energy consumption for heating

The heating consumption is calculated according to the type of source, the regulation, distribution and transmission of the heating system. The heat losses through emission for the heating elements were calculated. The following table shows the results for the energy consumption through emission. Additionally, the auxiliary energy consumption given by the circulation pumps was taken into account.

Total heating energy emission calculation

Heating energy emission calculation: 19669,578 kWH/year

Specific heating energy consumption: 35,61 kWh/sqm.year

Total floor reference area: 552,39 [m²]

	Ian	Feb	Mar	Apr	Mai	Iun	Iul	Aug	Sep	Oct	Noi	Dec	Total
ZT1	1092.0	1102,7	1762,7	1324,3	3649.4	3622,6	0.0	0,0	2408,5	1714,3	1897.0	1096.1	19669,578
TOTAL	1092,0	1102,7	1762,7	1324,3	3649,4	3622,6	0,0	0,0	2408,5	1714,3	1897,0	1096,1	19669,578

Equipments electricity consumption	
ZT1	0,000
TOTAL	0,000

Considering the previous data and the energy system, one calculated the energy consumption for heating:

	Ian	Feb	Mar	Apr	Mai	Iun	Iul	Aug	Sep	Oct	Noi	Dec
QH;dis.in [kWh]	2911,744	2767,584	3858,657	2287,808	4734,340	3764,297	0,000	0,000	3350,603	3028,607	4182,375	2853,854
QW;dis,in [kWh]	3089,810	3084,382	4701,929	3077,911	5096,099	4488,318	3073,382	43,707	4065,053	4090,545	5105,196	3089,260
QV;dis,in [kWh]	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
QC;dis,in [kWh]	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
Qge out tot [kWh]	6001,555	5851,966	8560,586	5365,719	9830,439	8252,614	3073,382	43,707	7435,656	7119,152	9287,571	5943,123

The table shows the monthly calculation for heating, hot water consumption, ventilation, air conditioning and the total.

Total specific annual primary energy consumption for heating

Based on the heating consumption, the specific primary energy consumption of the building for heating can be calculated as:

$$q_{inc} = 79{,}40 \left[\frac{kWh}{\text{year sqm}}\right]$$

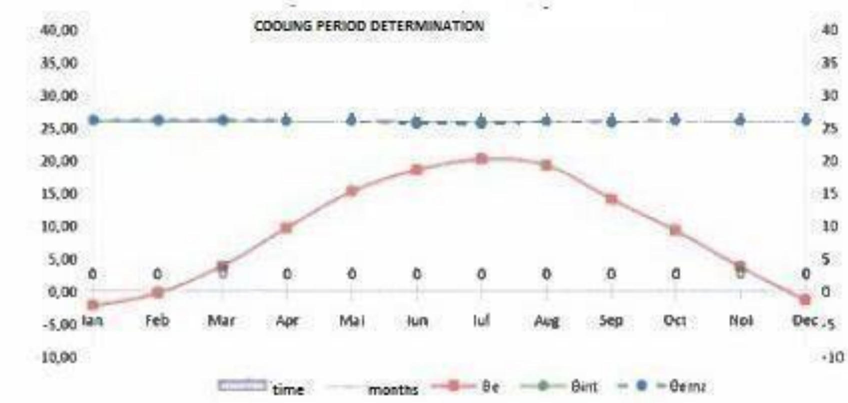
The building, from the heating point of view, falls into class C, with a specific annual primary energy consumption of 79.40 kWh/sqm per year

2.2 Determination ofannual primary energyconsumption for cooling

The building is not equipped with an organized air conditioning system, in this case it is not mandatory to calculate the energy requirement for cooling (the building has no energy consumption for cooling). However, a calculation was made to determine the energy requirement for air conditioning and the overheating indicator.

1	ZTC1.1	$H_{gr,C,eq}$	1070,15	[W/K]

Month	Hours	$Q_{C;tr}$	$Q_{C;ve}$	$Q_{C;ht}$	τ_C	$Q_{C;sol}$	Q_r	$Q_{C;sol}$	$Q_{C;int}$	$Q_{C;gn}$	$\gamma_{C;gn;cont}$	a_C	$\eta_{C;ht}$	$Q_{C;nd;cont}$	$a_{C;red;adapt}$	$Q_{C;nd}$	f_C	f_{DHU} (Dehumidification)	$Q_{DHU;nd}$ (Dehumidification)
[-]	[h]	[kWh]	[kWh]	(kWh)	[h]	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]	[-]	[-]	[-]	[kWh]	[-]	[kWh]	[-]	[-]	[kWh]
Dec	120	5862	1940	7802	5,8	0	0	0	0	0,0	0,00	0,88	0,00	0,0	1,00	0,0	0,00	0,00	0,00
Ian	120	6035	1996	8031	5,8	0	0	0	0	0,0	0,00	0,88	0,00	0,0	1,00	0,0	0,00	0,00	0,00
Feb	120	5653	1855	7509	5,8	0	0	0	0	0,0	0,00	0,88	0,00	0,0	1,00	0,0	0,00	0,00	0,00
Mar	184	7440	2401	9842	5,7	0	0	0	0	0,0	0,00	0,88	0,00	0,0	1,00	0,0	0,00	0,00	0,00
Apr	120	3686	1150	4836	5,7	0	0	0	0	0,0	0,00	0,88	0,00	0,0	1,00	0,0	0,00	0,00	0,00
Mai	200	4318	1270	5588	5,7	0	0	0	0	0,0	0,00	0,88	0,00	0,0	1,00	0,0	0,00	0,00	0,00
Iun	176	2827	776	3603	5,7	400	444	-44	1878	1834,3	0,51	0,88	0,32	690,4	1,00	690,4	0,86	0,48	0,00
Iul	120	1593	416	2009	5,7	305	306	-1	1285	1284,9	0,64	0,88	0,37	549,1	1,00	549,1	1,00	0,38	0,00
Aug	0	0	0	0	0,0	0	0	0	0	0,0	0,00	0,80	0,00	0,0	1,00	0,0	1,00	0,00	0,00
Sep	160	3701	1128	4829	5,8	229	248	-19	1001	981,9	0,20	0,88	0,16	202,0	1,00	202,0	0,58	0,14	0,00
Oct	160	4960	1580	6540	5,8	0	0	0	0	0,0	0,00	0,88	0,00	0,0	1,00	0,0	0,00	0,00	0,00
Noi	200	8058	2634	10692	5,8	0	0	0	0	0,0	0,00	0,88	0,00	0,0	1,00	0,0	0,00	0,00	0,00
Dec	120	5862	1940	7802	5,8	0	0	0	0	0,0	0,00	0,88	0,00	0,0	1,00	0,0	0,00	0,00	0,00
		54133		71281		934	997	-44	4165	4101				1441		1441			0,00



	θ_e	θ_{int}	θ_{emz}	TIME (DAYS)
Ian	-2,30	26,00	26,00	0,00
Feb	-0,30	26,00	26.00	0,00
Mar	3,80	26,00	26,00	0,00
Apr	9,70	26,00	26,00	0,00
Mai	15,20	26,00	26,00	0,00
Iun	18,50	26,00	25,67	0,00
Iul	20,10	26,00	25,62	0,00
Aug	19,20	26,00	26,00	0,00
Sep	14,00	26,00	25,83	0,00
Oct	9,20	26,00	26,00	0,00
Noi	3,60	26,00	26,00	0,00
Dec	-1,50	26,00	26,00	0,00

This calculation showed that the temperature graphs do not intersect, which leads to the conclusion that currently the building does not need an air conditioning system.

CALCULATION OF THE NUMBER OF OVERHEATING HOURS

Area with the highest overheating risk is: ZT C1.1.

Reference floor area: 552.39 sqm

Reference interior volume: 3562.9155m^3

Area infiltrations ratio: 0.50 vol/h

Ground thermaltransfer coefficient calculated instationary mode: 202.5 W/K

Thermal transfer coefficient through transmission: 2571.6 W/K
Specific thermal capacity: 45.8 Wh/m^{3}K
Internal intakes: 2848.4 W

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1271,5	1271,5	1949.7	1271,5	2119,[illegible]	1864.[illegible]	1271,5	0,0	1695,4	1895.4	2119,[illegible]	1271,5

Solar intakes: 0.6 KWh/day

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sвp	Oct	Nov	Dec
162,[illegible]	236.[illegible]	377,1	258,6	412,	399.7	305,4	0,0	392,[illegible]	401,[illegible]	283,[illegible]	120,2

Does the mechanical ventilation system exist? No

Fresh air flow provided by the ventilation system from the building: 1781.5 m^3/h
0,50 vol/h

Ventilation system yield: 1%
Temperature range during the summer: 15.00 K
Ventilation ratio due to opening the windows during the night: vol/h
Number of overheating hours (temperature > 26 degrees) : 380hours
Percentage of total yearly number of hours: 4.33 %

2.4 Determination of the primary energy consumption for preparing the hot running water

General data

Water temperature data
Hot running water temperature: 60°C
Cool water temperature: 10°C
Temperature difference allowed: 5°C
Average temp: 57.5°C
Hot running water accumulationtemp: 60°C
Burried pipes depth: (m)

Recirculation pipe: does not exist
General heating meter: does not exist
Does the hot running water system exist: Yes, it works

14. Sports building for students: b– with showers inthe sanitary groups, for one student per program

V_{day}	Days											
l/zi	Ian	Feb	Mar	Apr	Mai	Iun	Iul	Aug	Sep	Oct	Noi	Dec
3499,7	15	15	23	15	25	22	15	0	20	20	25	15

Water loss consumption - increase coefficients f_1, f_2

• f_1 Sites supplied in the local system — single-lever faucets systems

- average number of daily consumption units 30.00 Number of students: 30
- V w, f, day– specific need for one consumer 101,00 unit/day
- V w,day– necessary hot running water volume 3030,00 l/day
- V w,l,s day– volume corresponding to water loss 469.95 l/day

	Ian	Feb	Mar	Apr	Mai	Iun	Iul	Aug	Sep	Oct	Noi	Dec
No.of hot water consumption hours - no recirculation	120	120	184	120	200	176	120	0	160	160	200	120
No.of operating hours of the reciuculation pump	120	120	184	120	200	176	120	0	160	160	200	120
Qw, nd, monthly [kWh/month	3021,5	3021,5	4832,9	3021,5	5035,8	4431,5	3021,5	0,0	4028,6	4028,6	5035,8	3021,5

Qw, nd, annually ZT1 =42300.532 [kwh/year] Qw, nd, annually ZT1 =76.58 [kwh/sqm.year]

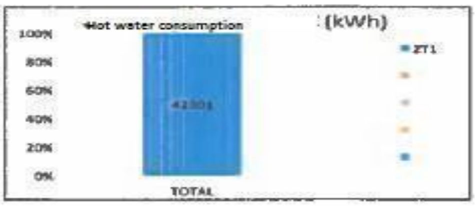
Totalinsurance energycalculation –SUMMARY

Total need for energy for hot water consumption - 42300.532 [kwh/year]

Specific need for energy for hot water consumption - 76.58 [kwh/sqm.year]

Total reference area of the floor: 552.39 sqm

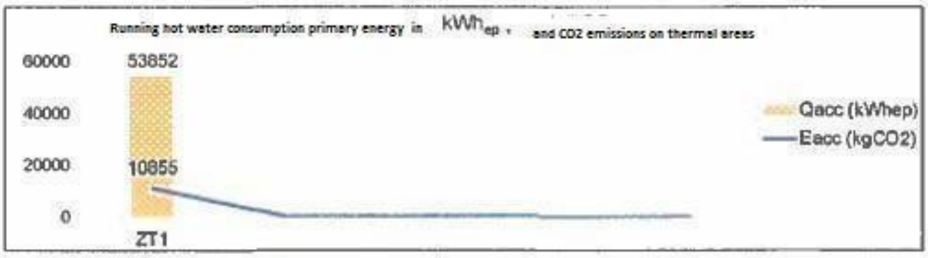
	Ian	Feb	Mar	Apr	Mai	Iun	Iul	Aug	Sep	Oct	Noi	Dec
ZT1	3021,5	3021,5	4832,9	3021,5	5035,8	4431,5	3021,5	0,0	4028,6	4028,6	5035,8	3021,5
TOTAL	3021,5	3021,5	4832,9	3021,5	5035,8	4431,5	3021,5	0,0	4028,6	4028,6	5035,8	3021,5



Energy consumption for preparation, distribution, storage and generation of hot running water

#	AREA	Qw,nd	Qw,dis,tot	Qw,sto	Qw,g	Qw,total	Ww	Qw,total	Ww	Qacc	Eacc
um	[-]	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]	[kWh]	[kWh_{ep}]	[kWh_{ep}]	[kWh_{ep}]	[$kgCO_2$]
1	ZT1	42300,532	153,027	572,033	2797,475	45823,067	95,711	53612,989	239,278	53852,267	10855,427
TOTAL		42300,532	153,027	572,033	2797,475	45823,067	95,711	53612,989	239,278	53852,267	10855,427

#	AREA	Qw,max
um	[-]	[kW]
1	ZT1	6,714
TOTAL		6,714



$Q_{W,h,total}$	53852,267	[kWh/ yr]	$Q_{W,h,spec}$	97,49	[kWh/m^2, yr]
CO2 emissions	10855,427	[$kgCO_2$/ yr]	Specific CO2 emissions	19,65	[$kgCO_2/m^2$ yr]

The building, in terms of the preparation of hot running water, falls into class G, having a specific annual primary energy consumption of 97.49 kWh/sqm/year

2.5 Determining the annual primary energy consumption for mechanical ventilation

The building is not equipped with a mechanical ventilation system. According to Mc00l-2022, for non-residential buildings for which ventilation is not provided by a dedicated centralized mechanical ventilation system, a virtual consumption of electricity for ventilation is required corresponding to a classification into energy efficiency class E - the maximum consumption limit, namely 39kWh/sqm/year in case of buildings destined for education.

2.6 Determining the annual primary energy consumption for lighting

The calculation of the energy requirement for lighting, in case of the building analyzed, is carried out starting fromthe power installed, which was estimated.

ZT code: ZT1 ZT area category:04 – educational establishments ZT area destination: g-gym hall
power estimated: yes Floor reference area: 552.39 sqm Lighting power known: 4400,0 [W]

Length, L:55.24 [m]	Lighting level, E_m:300 [lx]
Width, W:10.00 [m]	Maintainance factor, FM: 0,7[–]
Height, h_m:6.45 [m]	Lighting area percentage: 100% [%]
Room index, K: 1.313 [-]	Lighting charging batteries: No
Lighting source distribution, UFF: 10%	Stand-by for lighting control: No
Type of flow: direct	Type of lighting source:T26 linear fluorescent lamp
Power density per flow: 0.0287 [W/x]	Occupation control: 1 – Manual On/Off
Power density: 8.71 W/sqm	emergency light battery consumption:0 [kWh/sqm.year]
Estimated lighting power: 4812.72 W	stand-by energy consumption: 0 [kWh/sqm.year]
Correction factor, Fmf: 1.14 [-]	constant lighting factor, Fc: 1 [-]
Absence factor, Fa: 0.3 [-]	control II dependency factor, Foc: 1 [-]
Power decrease factor, F_{CA}: 1.00 [-]	occupation dependency factor, F_c: 0.9 [-]
Sourse efficiency factor, F_L: 0.95 [-]	

Natural light dependency factor

Type of natural light control: Manual

Constantly controlledsystem: No	Natural light dependency factor, Fd:0.544 [-]

Thermalarea results – ZT1

- Usage hours/day: 1800	Safety lighting charging power, Pem: 0.0 W
- Usage hours/night: 200	power lighting controls-Ppc:0.0 W

- Total usage hours: 2000
- Total electricity lighting annual consumption: 5108.300 [kWh/year]
- LENI (Preliminary) indicator:9.25 [kWh/sqm.year]

Energy consumption for lighting

Wtotal: 12770.750 [kWh/year]	LENI:23.12 [kWh/sqm.year]
CO2 emissions: 1366.470 [kgCo2/year]	Specific CO2 emissions: 2.47 [[kgCo2/sqm.year]

The building, froma lighting point of view, falls into class C, with a specific annual primary energy consumption of 23.12 kWh/sqm. year.

2.7 **Determining the annual consumption ofprimary energy from renewable energy sources**

Not applicable

2.8 **Determining the annual primary energy consumption, quantities of equivalent CO2 emitted and RER indicator**

Energy consumption before refurbishment

Consumer	HEATING	HRW	VENTILATION	COOLING	LIGHTING	Energy from renewable sources	TOTAL
Final thermal energy consumption [MWh/year]	38.427	45.823	0.000	0.000	0.000	0.000	82.250
Final electricity consumption [MWh/year]	0.494	0.096	8.617	0.000	5.108	7.158	14.315
Primary energy consumption [MWh/year]	43.854	53.852	21.543	0.000	12.771	7.158	132.020
Specific energy consumption [kWh/sqm.year]	79.39	97.49	39	0	23.12	12.96	239.00
ENERGY EFFICIENCY CLASS	C	G	E	-	C	-	D

The primary energy consumed to ensure comfort in the building is determined, 239 kWh/sqm, year - CLASS D.

Based on the total annual consumption of thermal and electrical energy, the annual CO2 equivalent emissions are determined. The specific amount of CO2 is 42.1 kg/sqm. year - Class D.

The RER indicator is determined with the relationship

$$RER = \frac{E_{p,regen}}{E_p} \cdot 100 = 5{,}42\%$$

3. Drafting of the energy performance certificate

The building's energy performance certificate is drafted according to Mc00l-2022. The actual building falls into energy efficiency class D.

3.1 Mentioning the energy features of the reference building

- The reference building is a virtual building associated with the real building that is being analyzed from the energy performance point of view. This concept allows the comparison of the thermotechnical and energy characteristics of the real building with the “reference” values.
- The reference buildingisdefined asfollows:

  - for the construction elements that are part of the building envelope, the recommended values of the corrected thermal resistances indicated in MC001-2022 table 2.9b for the current refurbished non-residential buildings are chosen (chapter 2.2.2.)

  - from the energy point of view, by the maximum primary energy consumption value indicated in MCOOI-2022 table 2.10b (chapter 2.3.) for buildings intended for the education system, climate zone III (82.70kWh/sqm.year), considering the building equipped with all technical systems (heating, Hot running water, lighting, ventilation and cooling)

  - from the pollution level point of view, by the value of equivalent CO_2 emissions indicated in MC001-2022 table 2.10b (chapter 2.3.), for buildings intended for the heating system. climate zone III (13.10 $kgCO_2$/sqm. year), considering the building equipped with all technical systems (heating, Hot running water, lighting, ventilation and cooling)

<table>
<tr><th colspan="3">Reference building</th></tr>
<tr><th colspan="2">Primary energy consumption [kWh/sqm.year]</th><th>CO2 emissions [kgCO2/sqm.year]</th></tr>
<tr><td>Heating</td><td rowspan="5">82,70</td><td rowspan="5">13,10</td></tr>
<tr><td>Hot running water</td></tr>
<tr><td>Cooling</td></tr>
<tr><td>Ventilation</td></tr>
<tr><td>Lighting</td></tr>
<tr><td>Class</td><td>B</td><td>B</td></tr>
</table>

Energy Audit Report of the building:

Gym Hall within the Technical Energy College from Electricienilor street, no. 1, Sibiu

3.2 ENERGY PERFORMANCE CERTIFICATE

drafted according to the Calculation Methodology of the Buildings Energy Performance no.001

DATAREGARDING THE CPE AND THE ENERGY AUDITOR IDENTIFICATION

CPE number 000129/550311

Valid 10 years until13.05.2025 if no major changes appear

Cruciat Radu-Iuliu Energy auditor Certificate SSA/02258

DATAREGARDING THE BUILDING/BUILDING BLOCKCERTIFIED NZEB NO

Building category: school/highschool/college

Year of building/major refurbishment:

Building address: Sibiu, Electricienilor street no.1 , Sibiu county

Floor reference area: 552.39 sqm

GPS coordinates (lat x long): 45.78439x 24.16891

Built/developed area: 582.66/582.66 sqm

Height regime: Gf

Reference interior volume: 3572.07 m3

CPE drafting purpose: Information

Calculation programme used: ENERG version 04/2024

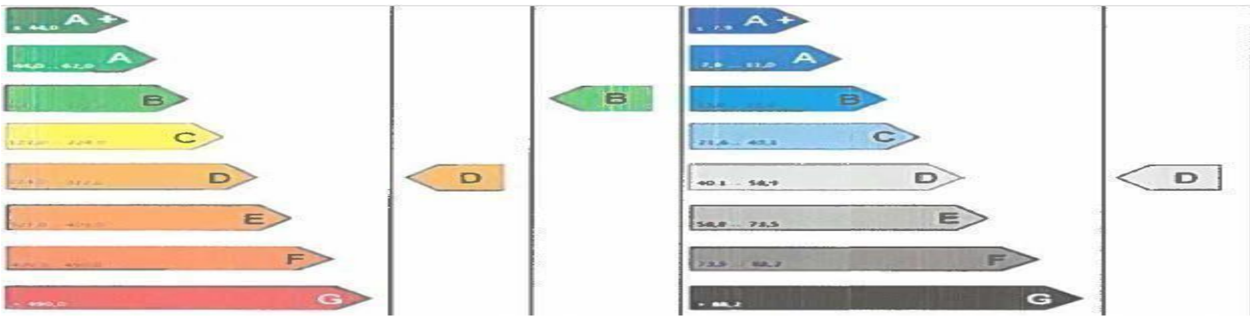
ENERGY PERFORMANCE TRUE BUILDING REFERENCE BUILDING CO2 EMISSIONS LEVEL

kWh/sqm.year – totalprimaryenergy

kgCo2/sqm.year

High energy performance

Low pollution level

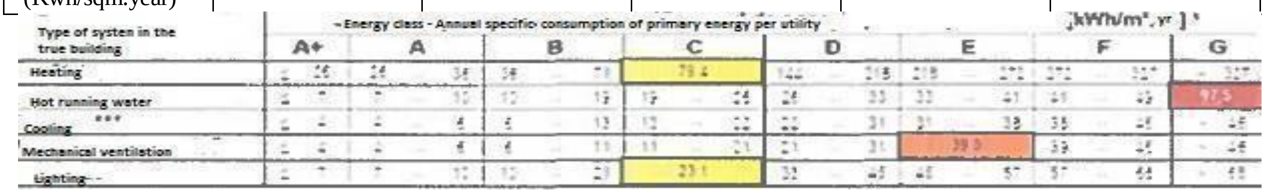


Total annual specific energy consumption (kWh/sqm.year)	Final	148.9	25.9	CO2 equivalent emissions level (kgCo2/sqm.year)	42.1
	primary	239.0			

low energy performance

low pollution level

Annual specific energy consumption from renewable sources (Kwh/sqm.year)	Thermal solar	Electricsolar	Heat pumps	Biomass	Other SREtype	Total SRE
	0.0	0.0	0.0	0.0	13.0	13.0


Energy class - Annual specific consumption of primary energy per utility [kWh/m², yr] *

Type of systen in the true building	A+	A	B	C	D	E	F	G
Heating	[illegible]	[illegible]	[illegible]	79.4	[illegible]	[illegible]	[illegible]	[illegible]
Hot running water	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	97.5
Cooling ***	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Mechanical ventilation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	39.5	[illegible]	[illegible]
Lighting	[illegible]	[illegible]	[illegible]	23.1	[illegible]	[illegible]	[illegible]	[illegible]

*values calculated ***number of hours of a year when the interior temperature exceeds the comfort temp.

**t/ethermal/electric in free regime, during the summer = 380h(is 0 ifthe cooling consumption is calculated)

Auditor’s signature and stamp

B. ENERGY AUDIT REPORT

4. Description of thethermal refurbishment/modernization solutions

Following the assessment of the current situation, one observes that the envelope elements do not comply with the minimum requirements set out in the Methodology for calculating the indicative energy performance of buildings Mc 001-2022, approved by ordinance no. 16/2023.

The measures provided by the energy audit aim to bring the construction within the minimum requirements established by Mc00l-2022 and to meet the eligibility conditions requested for accessing funds through the Swiss-Romanian Cooperation Program for Energy Efficiency and Renewable Energy, namely Supporting the Transformation of Current Public Buildings into NZEBs.

According to the specific guide - Conditions for accessing funds are:

• In order to ensure the energy performance of the building, the financing will target the in-depth energy renovation of public buildings (primary energy savings of over 60%).

• Upon the investment completion, the building refurbished should obtain the Aor B energy performance certificate

According to the specific guide - the eligible intervention works are: thermal refurbishment works of the building envelope elements;

thermal refurbishment works of the heating system/Hot running water supply system;

installation of alternative systems for producing electricity and/or heat for own consumption; use of renewable energy sources; installation/refurbishment/modernization of air conditioning systems to ensure indoor air quality;

refurbishment/modernization works of lighting systems in buildings; integrated energy management systems for buildings;

intelligent shading systems for the hot season; modernization of technical systems of buildings;

provision ofcharging stations for electric cars, according to the provisions of Law no. 372/2005 on the energy performance of buildings, republished;

4.1. Presentation of solutions and packages for the thermal refurbishment ofthe building

Solution 1. This solution will improve the thermal strength of the envelope elements, namely the exterior walls and the floor above the ground floor.

The thermal insulation of the exterior walls with a layer of fireproof expanded polystyrene or mineral wool 15 cm thick on the exterior. It is recommended that the thermal insulation used has a thermal conductivity of γ<0.038 W/mK

By applying the solution, an increase above the minimum level of thermal transfer strength of the opaque part of the envelope will be achieved. Also, applying the solution will lead to the correction of thermal attics. The base of the structure will be thermally insulated with fireproof extruded polystyrene boards at least XPS300 thick of 5-10 cm.

Thermal insulation of the floor above the ground floor with natural sheep wool insulation with a thickness of 25 cm and a minimum thermal strength of γ<0.038 W/mK.

Solution 2. Replacing the external double-glazed windows and doors with aluminum or PVC carpentry, with frames and sashes provided with pentachamber profiles and galvanic metal reinforcement profiles, triple thermal insulation windows treated on the outside with low-e. Two sealing gaskets will be provided between the frame and the sashes and on the contour of the thermal insulation windows.

By replacing the carpentry, the final strength of the windows and doors will be increased above the minimum level, cold air infiltration will be reduced, and thermal attics at the contact between the window and door frames with the closing walls will be improved. The new windows will have a minimum thermal resistance of Rmin=0.83 sqm K/ W (or a transfer coefficient lower than U = 1.2 W/sqm K) and respectively Rmin 0.77 sqm K/ W (or a transfer coefficient lower than U = 1.3 W/sqm K) for doors.

Solution 3. The solutionrefers to the building's installations.

3.1. In order to increase the efficiency of the heating system, condensing gas boilers will be installed in the high school building. The new boilers will serve the high school building, the workshop building and the sports hall.

3.2. A 60 kWh Hoval installation will be installed on the roof of the gym hall, which will also ensure the space ventilation. The boiler will be used to take over consumption peaks during the winter period and will be adapted to prioritize the use of heat pumps as much as possible. The calculation considered a heat pump with a COP4. It is recommended to change the heat distribution network and it is also recommended to replace the damaged static bodies with new ones.

3.3. A system of photovoltaic solar panels will be installed on the roof of the high school building on the SW and/or SE orientations to produce electricity for lighting, heat pumps and for preparing hot running water. The photovoltaic panels will be connected to the S.E.N. in order to benefit from compensation in accordance with the regulations in force.

3.4. Ventilation in the gym hall is ensured by the new aggregate mounted on the roof which also ensures heating of the sports hall. According to SR EN 16798-1, the minimum fresh air flow established for an occupant in schools is 15 m^3/h/person. It is recommended that the fans be operated automatically depending on the CO_2 level. The calculation considered a heat transfer efficiency of 75%.

3.6 The lighting fixtures will be replaced with some LED lighting sources. Along with these modifications, the electrical system condition will be inspected and if it shows any damage, it will be repaired. It is recommended to use presence sensors for circulation spaces.

Related works. The following is a brief description of the related works that will be carried out together with the main thermalrefurbishment works:

• Local repair of the existing envelope elements that pose a risk of detachment.

• Repair of any leaks in the framework. If necessary, the framework elements will be replaced or reinforced.

• The rainwater collection systems of the framework will be repaired or replaced.

• The installations and equipment installed on the building facades will be dismantled and reassembled.

• The protective sidewalks around the building will be repaired or replaced in order to remove any infiltrations to the foundations and basement of the building.

• Water losses from the installations will be removed. If necessary, the cold water distribution installations, household and rainwater sewer collectors up to the connection/connection shaft will be repaired/replaced.

• The current thermal and waterproofing layers will be removed.

• The prefabricated roof will be removed from the area where the ventilation-heating device will be installed and a steel support structure will be provided.

For the economic calculation, the following packages are proposed:

Package 1 is a package consisting into the implementation of solutions 1 and 2. Within the package, the thermal insulation of the exterior walls with a 15 cm thermal insulation layer is carried out, the thermal insulation of the floor above the ground floor with a 25 cm thermal insulation layer and the replacement of the existing carpentry.

The recalculated thermal resistances of the construction elements in case of applying package 1 are synthetically presented in Table 1.

Table 1

Construction element	S [sqm]	R [sqmK/W]	R [-]	R’ [sqmK/W	R’min [sqmK/W]	Criteria Fulfilled
NE exterior masonrywall	161,3	4,43	0,79	3,49	3,00	YES
NWexterior masonrywall	122,9	4,43	0,89	3,96	3,00	YES
SWexterior masonrywall	150,7	4,43	0,69	3,05	3,00	YES
SE exterior masonrywall	123,3	4,43	0,89	3,95	3,00	YES
Ground slab	541,2	0,545	0,99	0,54	4,50	NO

Flooring on the ground floor under the attic	541,2	6,89	0,80	5,56	5,00	YES
NE exterior windows	52,8	0,830	1	0,830	0,83	YES
SWexterior windows	64,3	**0,830**	I	0,830	0,83	YES
SE exterior windows	2,1	0,830	1	0,830	0,83	YES
NWexterior doors	1,9	0,770	1	0,770	0,77	YES
SWexterior doors	8,3	0,770	1	0,770	0,77	YES

The ground slab does not comply with the minimum strength specified by the code. The works related to the energy improvement of these parts of the envelope are expensive and not economically justified.

Package 2 is a package consisting of the implementation of package 3. This package consists of the refurbishment of the installations, namely: heat pumps, a new heating plant, a ventilation system with heat recovery and a photovoltaic panel system were installed. Additionally, the package includes measures to improve the lighting system. In order for the solution package to meet the minimum requirements given by the calculation methodology, the use of renewable sources and the introduction of a mechanical ventilation system for the investigated building are requested.

A photovoltaic panel system with an installed power of 18 kWh is implemented. The calculation considered a number of 45 photovoltaic panels on the roof of the high school to reduce the consumption of electricity for the operation of heat pumps, a Hot running water preparation plant and the lighting system. Polycrystalline photovoltaic panels with a maximum power of 400 W were used for the calculation. The photovoltaic panels are mounted on the SE or SW side of the roof of the high school building. To determine the electrical energy produced by the photovoltaic panels, the position of the building, the cardinal orientation on which the panels are mounted and their inclination to the horizontal were taken into account.

The following table presents in order:

Solar radiation on a horizontal surface;

f_{head}- correction factor of the global intensity of solar radiation function of the inclination angle of the solar collectors and the angle of deviation from the cardinal direction SOUTH

It inclined- solar radiation on an inclined surface;

E_{li} total lunar energy

ENERGYPRODUCTION RESULTS

	Ian	Feb	Mar	Apr	Mai	Iun	Iul	Aug	Sep	Oct	Noi	Dec	Total
$I_{T,Oriz}$ [W/m²]	45,4	78,3	119,1	162,0	195,9	216,1	228,1	199,8	154,7	109,9	54,1	32,9	1598,3
thead	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	
$I_{inclinat}$ [W/m²]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,00
$I_{inclinat}$ [W/m²]	62,0	99,2	134,1	166,6	189,1	203,7	218,4	201,7	170,4	139,7	73,6	45,8	1704,1
N_{zi}	31	28	31	30	31	30	31	31	30	31	30	31	365
$P_{max\ 1000}$ [W]	400,0	400,0	400,0	400,0	400,0	400,0	400,0	400,0	400,0	400,0	400,0	400,0	
A_{panou} [m²]	2,11	2,11	2,11	2,11	2,11	2,11	2,11	2,11	2,11	2,11	2,11	2,11	
A_{tot} [m²]	95,11	95,11	95,11	95,11	95,11	95,11	95,11	95,11	95,11	95,11	95,11	95,11	
ε_{PV}	0,21	0,21	0,21	0,21	0,21	0,21	0,21	0,21	0,21	0,21	0,21	0,21	
η_t	0,97	0,97	0,97	0,97	0,97	0,97	0,97	0,97	0,97	0,97	0,97	0,97	
η_{inv}	0,90	0,90	0,90	0,90	0,90	0,90	0,90	0,90	0,90	0,90	0,90	0,90	
$E_{inc,i}$ [kWh]	4384,155	6341,300	9489,081	11410,248	13382,167	13949,831	15451,232	14273,785	11671,550	9887,350	5039,825	3223,806	118504,33
$E_{u,i}$ [kWh]	630,338	810,365	1314,242	1490,403	1765,588	1755,469	1986,142	1839,740	1489,624	1333,138	683,389	464,850	15563,28
Emissions [$kgCO_2$]	168,6	216,8	351,6	398,7	472,3	469,6	531,3	492,1	398,5	356,6	182,8	124,3	4163,18
η_{intake}	22,1%	21,7%	21,3%	20,7%	20,3%	20,0%	19,8%	19,8%	20,3%	20,7%	21,5%	22,2%	

TOTAL ENERGYPRODUCED: 15583.285 [kWh/year]
TOTALSPECIFIC ENERGYPRODUCED: 28.17 [kWh/sqm.year]
TOTAL CO2 EMISSIONS AVOIDED: 4163.179 [kgCO2/year]
TOTAL CO2 EMISSIONS AVOIDED OF THE AREA: 7.54 [kgCO2/sqm.year]

The total energy produced by photovoltaic panels over a year is obtained with the formula:

$$E_{tot} = \sum E_{li} = 15563.28\ kWh/year$$

$$E_{specific} \quad 28/17 \text{ KWh/sqm.year}$$

The CO2 emissions avoided by installing the photovoltaic panels are4 tons/year or 7.54 kg/sqm/year.
Within package2, the ventilation of the gym hallis carried out by installing a heat recovery fan with a recovery efficiency of at least 75%.

Also in package 2, a Hoval air-to-air heat pump is provided, which will be mounted on the roof of the gym hall and will ensure the heating and ventilation of the gym hall. The locker rooms will be heated using a heat pump also provided in the thermal point of the high school. In the calculation, a single heat pump was considered conventional, which ensures the heating and preparation of hot running water. The following table presents the heat pump output for heating and preparing the hot running water.

Month	Ian	Feb	Mar	Apr	Mai	Iun	Iul	Aug	Sep	Oct	Noi	Dec
$\theta_{gen,ext}$ [°C]	-2,3	-0,3	3,8	9,7	16,2	18,5	20,1	18,2	14,0	9,2	3,6	-1,5
No.of days	15	15	23	15	25	7	5	0	8	20	25	15
t_{ci} [h]	360	360	552	360	600	176	120	0	200	480	600	360
Q_{gen,dis,out_1} [kWh]	3029,2	3029,2	4644,8	3029,2	5048,7	4442,8	3029,2	0,0	4038,9	4038,9	5048,7	3029,2
θ_{gen,dis,out_1} [°C]	60,0	60,0	60,0	60,0	60,0	60,0	60,0	60,0	60,0	60,0	60,0	60,0
Q_{gen,dis,out_2} [kWh]	3143,3	2976,2	4099,4	2381,8	4731,4	3717,4	0,0	0,0	3370,0	3156,7	4446,5	3076,8
θ_{gen,dis,out_2} [°C]	36,2	35,2	33,1	30,2	27,4	25,8	25,0	25,4	28,0	30,4	33,2	35,8
$\theta_{gen,in}$ [°C]	-2,3	-0,3	3,8	9,7	15,2	18,5	20,1	19,2	14,0	9,2	3,6	-1,5
$\theta_{gen,sto,out}$ [°C]	45,0	45,0	45,0	45,0	45,0	45,0	45,0	45,0	45,0	45,0	45,0	45,0
$E_{H,gen,in}$ [kWh]	1720,2	1610,9	2126,6	1132,5	1842,8	748,0	510,0	0,0	852,0	1522,2	2324,8	1676,8
$Q_{H,gen,ls,rbl}$ [kWh]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
$Q_{H,gen,ren,in}$ [kWh]	1896,8	2373,2	5238,0	4278,5	7937,3	2540,3	1785,0	0,0	2628,1	5673,4	5606,8	2087,0
$W_{H,gen,aux}$ [kWh]	88,0	80,5	106,3	56,6	92,1	37,4	25,5	0,0	42,6	76,1	116,2	83,8
$E_{H,gen,bu,in}$ [kWh]	3,0	3,0	3,0	0,0	0,0	3,0	3,0	0,0	3,0	0,0	3,0	3,0
$Q_{H,gen,out}$ [kWh]	590,7	957,9	2722,8	2381,8	4731,4	3,0	3,0	0,0	3,0	3156,7	2885,8	737,6
$Q_{W,gen,out}$ [kWh]	3029,2	3029,2	4644,8	3029,2	5048,7	3288,3	2295,0	0,0	3480,1	4038,9	5048,7	3029,2
$Q_{H,gen,sto,out}$ [kWh]	55,7	50,7	51,3	45,8	43,9	42,4	42,5	43,7	43,1	47,6	50,0	55,3

Final calculation – heat pump energy performance (PdC)
Total electricity consumed : 16066.712 [kWh/year]
Total consumption of the back-up source energy: 24.000 [kWh/year]
Total heat loss from auxiliary source: 0.000 [kWh/year]
Total energy supplied for heating: 18173.643 [kWh/year]
Totalenergy amount from renewable sources: 42044.331 [kWh/year]
Total energy supplied for hot running water: 39961.399 [kWh/year]
Total auxiliary energy: 803.336 [kWh/year]
Energy supplied for storage: 572.039 [kWh/year]

Package 3 is a maximal package that includes all the solutions proposed above (solutions 1-3) for both the envelope elements and the building installations. The calculation for the heat pump was redone similar to the previous package. The following table shows only the final results for the heat pump. It can be seen that the heat pump will take over approximately 85% of the heating load, the rest continuing to operate on the heating plant.

Final calculation – heat pump energy performance (PdC)
Total electricity consumed : 12787.372 [kWh/year]
Total consumption of the back-up source energy: 18.000 [kWh/year]
Total heat loss from auxiliary source: 0.000 [kWh/year]
Total energy supplied for heating: 7346.826 [kWh/year]
Totalenergyamount fromrenewable sources: 33800.275 [kWh/year]
Total energy supplied for hot running water: 39258.821 [kWh/year]
Total auxiliary energy: 639.369 [kWh/year]
Energy supplied for storage: 622.2024 [kWh/year]

The determination of final energy consumption before and after refurbishment is carried out in accordance with MC00l-chapters 3 and 4 following the same steps detailed in the previous chapters.

The following table shows the annual consumption of thermal energy, electricity, primary energy and specific primary energy for heating, hot water consumption, ventilation, cooling, lighting followed by energy from renewable sources. The calculations were made for each package separately. The last column shows the consumption reductions of each indicator in the package compared to the unrefurbished building.

Packages		INC	ACC	VENT	R	LIGHTING	Energy from renewable sources	TOTAL	Decrease compared to CNR (%)
CNR	Thermalenergy [MWh/year]	36.427	45.823	0	0	0	0	82.25	
	Electricity [MWh/year]	0.494	0.096	8617	0	5108	7158	14.315	
	Primaryenergy [MWh/year]	43.8354	53.852	21.543	0	12.771	7158	132.0194	
	Specialprimary energy [MWh/year]	79.39	97.49	39	0	23.12	12.96	239	
P1	Thermalenergy [MWh/year]	12.827	46.74	0	0	0	0	59.567	27.6
	Electricity [MWh/year]	0.434	0.129	8617	0	5108	7144	14.288	0.2
	Primaryenergy [MWh/year]	16.093	55.007	21.543	0	12.771	7144	105.414	20.2
	Specialprimary energy [MWh/year]	29.13	99.58	39	0	23.12	12.93	190.83	20.2
P2	Thermalenergy [MWh/year]	36.325	43.076	0	0	0	0	79.401	3.5
	Electricity [MWh/year]	6488	11.666	1775	0	2634	19.06	22.563	-57.6
	Primaryenergy [MWh/year]	31.332	19636	2536	0	3763	19.06	57.267	56.6
	Specialprimary energy [MWh/year]	56.72	35.55	4.59	0	6.81	34.5	103.67	56.6
P3	Thermalenergy [MWh/year]	8671	43.19	0	0	0	0	51.861	36.9
	Electricity [MWh/year]	2792	11.358	1775	0	2634	17.06	18.559	-29.6
	Primaryenergy [MWh/year]	5312	17.88	2171	0	3222	17.06	28.585	78.3
	Specialprimary energy [MWh/year]	9.62	32.37	3.93	0	5.83	30.88	51.75	78.3

According to the calculation methodology, the maximum allowable values of the total primary energy consumption for the major refurbishment of the current building is 82.7 kWh/m2, year and the CO2 emissions are 13.1 kg/m2.year. It is observed that the works that make the scope of this work (the works in package 3) cause a significant reduction in consumption as a result of the interventions in the envelope but also due to the introductionofrenewable energyproduction sources.

5. **Analysis of the economic efficiency of interventions works**

The second activity carried out during this stage consists into the analysis of the energy effects of applying each solution presented above.

This analysis involved the reassessment of the basic energy indicators of the building in each new option. Mainly, it concerns the annual energy consumption of the building, the primary energy consumption and the CO emissions resulting from applying each measure, and the extent to which this is reduced compared to the current situation.

Observing the energy effects of the various solutions, two solution packages were created, obtained by coupling the solutions presented previously. In calculating the investment cost, only the cost of investments that have a direct influence on the energy efficiency of the building was taken into account.

5.1. Economic calculation premises

The following were assumed and calculated respectively:

The amounts necessaryto carry out the investment works are considered to be at the disposal of the investment beneficiary, who does not have to resort to bank loans;

- Economic calculations are carried out in EUR;
- The specific cost of unsubsidized thermal energy is 94 EUR/ MWh;
- The specific cost of electricity is 212 EUR/ MWh;

In this regard, the annual final energy consumption [MWh/year], onsite renewable energy consumption (photovoltaic panels, heat pump), total final energy consumption with payment, non-renewable and renewable primary energy consumption and equivalent CO2 emissions [ton CO2/year] are taken into account. These values were determined for each solution package.

CNR – UNREFURBISHED BUILDING

Solution/ Package Class	Final energy consumption acc.to Mc001					REG onsite energy consumption (PTS,PV,CE,mH)		Total final energy consumption with payment		Primary energy consumption acc.to Mc001			CO2 equivalent emissions acc.to Mc001
	Heating	HRW	Ventilation	Cooling	Lighting	Electric	Thermal	Electric	Thermal	NREG	REG	Total	
	(MWh,year)					(MWh,year)		(MWh,year)		(MWh,year)			(tCO2-e/year)
CNR	36.9	45.9	8.6	0.0	5.1	0.0	0.0	14.3	82.3	124.9	7.2	132.0	23.3
Class	C	G	E	-	C							D	D

CR- REFURBISHED BUILDING

Solution/ Package Class	Final energy consumption acc.to Mc001					REG onsite energy consumption (PTS,PV,CE,mH)		Total final energy consumption with payment		Primary energy consumption acc.to Mc001			CO2 equivalent emissions acc.to Mc001	RER
	Heating	HRW	Ventilation	Cooling	Lighting	Electric	Thermal	Electric	Thermal	NREG	REG	Total		
	(MWh,year)					(MWh,year)		(MWh,year)		(MWh,year)			(tCO2-e/year)	%
P1	13.3	45.9	8.6	0.0	5.1	0.0	0.0	14.3	59.6	98.3	7.1	105.4	17.9	6.78
Class	A	G	E	-	C							C	C	
P2	42.8	54.7	1.8	0.0	2.6	15.6	58.7	7.0	20.7	38.2	19.1	57.3	7.4	67.06
Class	B	E	A	-	A+							B	B	
P3	11.5	54.5	1.8	0.0	2.6	15.6	47.1	3.0	4.7	11.5	17.1	28.6	2.5	84.78
Class	A+	D	A+	-	A+									

In the following table, for each package, the final energy savings, the variation in energy consumption from renewable sources, the total final energy savings charged, the primary energy savings and the CO_2 emission reductions compared to the unrefurbished building were calculated.

REFURBISHED VS UNREFURBISHED BUILDING

Solution/ Package	Final energy consumption acc.to Mc001					REG onsite energy consumption (PTS,PV,CE,mH)		Total final energy consumption with payment		Primary energy consumption acc.to Mc001			CO2 equivalent emissions acc.to Mc001	
	Heating	HRW	Ventilation	Cooling	Lighting	Electric	Thermal	Electric	Thermal	NREG	REG	Total		
	(MWh,year)					(MWh,year)		(MWh,year)		(MWh,year)			(tCO2-e/year)	%
P1	23.7	-0.9	0.0	0.0	0.0	0.0	0.0	0.0	22.7	26.6	0.0	26.6	5.4	23.1
P2	-5.9	-8.8	8.8	0.0	2.5	15.6	58.7	7.3	61.8	88.7	-11.9	74.8	15.9	68.3
P3	25.5	-8.8	8.8	0.0	2.5	15.6	47.1	11.3	77.5	113.3	-9.9	103.4	20.7	89.1

5.2. Economic efficiency indicators used in the economic analysis of the solutions:

The third activity undertaken within this team consists into the economic analysis of the implementation of the proposed individual solutions and the proposed solution packages. This analysis involves the evaluation of:

• the investment costs of the refurbishment options,
• the life span of the refurbishment options,
• the energy savings due to implementing the refurbishment options. Taking into account the specific cost of thermal energy, the following is determined:
• theinvestment recovery period for each refurbishment option;
• the percentagereduction in energy consumption;

For a better understanding of the terms presented in this chapter, we will present the definitions in accordance with the Mc00l methodology.

• Energy modernization measure - Intervention on the construction and its related systems, with the aim of reducing the building's energy consumption.
• Lifetime of the modernization solution - The estimated life time for the modernization solution analyzed, for which the considered parameters remain unchanged from the initial stage, at the time of implementing the respective solution.
• Investment payback period - The duration of the investment recovery through the savings achieved as a result of the reduction in energy consumption due to applying the energy refurbishment/modernization measures.
• Net present value - The projection at time “0” of all the costs involved in the application of a measure/solution for the energy modernization of the building, depending on the depreciation rate of the currency considered - in the form of the average annual depreciation and the average annual rate of increase in the energy cost.

Global updated cost CG - Sum of the updated initial investment costs, annual operating costs and replacement costs as well as disposal costs if necessary, over a fixed calculation period (20 years for commercial buildings, 50 years for residential buildings, 30 years for other building categories)

• Operating cost COrun - The operating cost that includes the maintenance cost, the operational cost and the energy cost for the time step considered.

• COma Maintenance costs - The cost of measures related to the conservation and restoration of the desired quality for the building, construction element or system. This includes the annual costs for inspection, cleaning, interventions, repairs as part of preventive maintenance, the cost of consumable materials.

• COen Energy costs - The cost of energy, including fixed items and tariffs and taxes applicable at national level.

• CORpl - Replacement cost of the component or system Replacement investment for a component of the building, based on the estimated economic life cycle during the calculation period.

* COC02 Greenhouse gas emissions cost - Monetary value of the environmental damage due to general CO2 emissions from energy use in buildings (20/35/50 Eur/t CO2 from 2020/2025/2030). CO2 emissions reflect the effects of all greenhouse gases weighted according to their global warming potential, expressed in kilograms of CO2 equivalent over a period of 100 years.

• RATdev Price change rate - Changes in the prices of energy, products, building systems, services, labour, maintenance and other costs over time. This rate may differ from the inflation rate.

The economic analysis of energy modernization measures for the current buildings leads to the choice of economically efficient measures, through the prism of economic indicators, among which the fundamental indicator is the updated global cost (CG).

The effective implementation of an energy modernization project also involves the analysis of the possible financing of the project, from the point of view of the possible financing scheme to be applied and from the point of view of the affordability of the project beneficiary.

The Updated GlobalCost (CG) is given bythe relationship:

$$CG = CO_{init} + \sum [\sum^{rC} \left(CO_{a(i)}(j) * \left(1 + RAT_{xx(i)}(j)\right) + CO_{CO2(i)}(j) + CO_{fin(TLS)}(j) - Val_{ft}t(j)\right]$$

where:

CG total investment cost in year “0” [Euro];

CO_{init} initial investment cost;

$CO\,a(i)\,(j)$ the annual cost of renovation component or measure jfor year i;

$RATxx(i)$ price change rate for year I of renovation component or measure j

COCO2 (j)- cost of CO2 emissionsformeasurej in yeari

CO_{fin}.(TLS)(j)- final cost for decommissioning anddisposal in thelast year of the TLS lifecycle of component j or of the building (related to the first year T0);

Val $_{fct}$(j)—residual value of component j in yearTCat the end of the calculation period (related to the first year T0);

$$\Delta VNA_{(m)} = C_{(m)} - \sum \Delta C_{E_k} \cdot X_k$$

VNA related to additional investment due to theapplying theenergy modernization projects and energy savings resulting from applying the aforementioned projects:

where:

$C_{(m)}$ - the investment cost related to the energy modernization project, at the level of year "0", [Euro];

ΔC_E- reduction in annual operating costs following the implementation of energy modernization projects at the level of the reference year, [Euro/year]:

$$\Delta C_{E_k} = c_k \cdot \Delta E_k$$

where:

ΔE_K - represents the estimated annual energy saving k, obtained by implementing an energy modernization measure, [kWh/year],

ck - represents the current cost of the energy unit k, [Euro / kWh]

The following table shows the total investment cost and the other parameters of the economic calculation for the unrefurbished building (CRN) and for therefurbished building, respectivelyfor each package (CR-P), the total investment cost and the other parameters of the economic calculation.

Dimension	MU	CNR	CR-P1	CR-P2	CR•P3
Reference floor area	sqm	552.39			
Investment initial total cost	[EUR VAT included)	0,0	156432.6	105373.0	261805.6
Investment specific cost	EUR.sqm VAT included	0.0	283.2	190.8	474,0
Maintainance annual cost	EUR VAT included/year	7650.0	1455.0	2850.0	3090.0
Average annual rate maintenance cost	%	6.0			
Annual operating costs	EUR VAT included/year	0,0	0,0	0,0	0,0
Average annual rate operating costs	(%)	3.0			
Annual final thermal energy consumption	MWh/year	82.3	59.6	20.7	4.7
Thermal energy unit cost	EUR VAT incl./MWh	94.0	94.0	94.0	94.0
Annual thermal energy cost	EUR VAT included/year	7731.6	5599.2	1945.2	444.8
Annualaveragethermal energy increaserate	%	5,0			
Annual final electricity consumption	MWh/year	14.3	14.3	7.0	3.0
Electricity unit cost	EUR VAT incl./MWh	212,0	212,0	212,0	212,0
Annual electricity cost	EUR VAT included/year	3034.8	3029.1	1484.2	634.9
Annualaverage electricity increaserate	%	5,0			
Periodic replacement costs	EUR VAT included/year	38420.0	38420.0	105373.0	105373.0
Annual average replacement costs increase rate	%	5,0			
Decommisioning costs	EUR VAT included)	0,0	0,0	0,0	0,0
CO2 equivalent emissions/year	tCO2e/year	23.3	17.9	7.4	2.5
Specific CO2 cost	EUR/ tCO2e		20.0		
Annual CO2 equivalent emissions costs [2025]	EUR VAT included/year	465.4	358.0	147.6	50.8
Package life cycle	years	-	20	20	20
Calculation period/Global cost calculation period	years		20		
Residual value	EUR VAT included	0,0	0,0	0,0	0,0
Costs update rate{interest rate)	%	3.0			

The condition for an investment in the energy modernization solution to be efficient is the following:

CG < 0

In this economic analysis of the refurbishment options, the following assumptions and values were taken into account:

- thebeneficiary bears the cost without bank credit;
- economic calculations are made in euros;
- annual rateof increase in maintenance costs6%
- annual rate of increase in the cost of heat and electricity 5%;
- annual rate of increase in replacement costs 5%;
- annual rate of depreciation of the currency(Euro) 3%;
- in each package it is considered that the thermal and electrical systems including photovoltaic and solar panels are replaced after 20 years
- the calculation of the investment cost does not include the interior finishes of the building, the repair of the cold water supply system and the sewage system, the organization of construction site, design services, other related expenses (management, consultancy, etc.) or costs for the building to comply with other national requirements (ISU, DSP, etc.)

The following table showsthe energycosts consumed forthe unrefurbished building and for each package

Dimension	UM	CNR	CR-PI	CR-P2	CR-P3
Annual final thermal energy consumption	[MWh/year]	82.251	59.566	20.694	4.733
Thermal energy unit cost	[Eur VAT included/MWh	94			
Annual thermal energy cost	EURVAT included/year	7731.594	5599.204	1945.236	444.902
Annual final electricity consumption	[MWh/year]	14.315	**14.288**	7.001	2.995
Electricity unit cost	Eur VAT included/MWh	212			
Electricity annual cost	EURVAT included/year	3034.78	3029.056	1484.212	634.94

The following tables show the savings calculation for the packages considered compared to the unrefurbished building, taking into account the maintenance costs, electricity and thermal energy, CO_2, replacement costs and residual value.

CNR – UNREFURBISHED BUILDING										
0		1	2	3	4	5	6	7	8	9
YEAR		Annual maintainance cost CNR	Annual operating cost CNR	Updated thermal energy cost CNR	Updated electricitycost CNR	Periodic replacement costs CNR	Residual value replacement costs CNR	Decommissioning costs CNR	Annual CO2 equivalent emissions costs CNR	Updatedoperating costs CNR
2025	0	7650.0	0,0	7731.6	3034.8	38420.0	0,0	0,0	465.4	18881.8
2026	1	7872.8	0,0	7881.7	3093.7	0,0	0,0	0,0	814.5	19662.7
2027	2	8102.1	0,0	8034.8	3153.8	0,0	0,0	0,0	814.5	20105.1
2028	3	8338.1	0,0	8190.8	3215.0	0,0	0,0	0,0	814.5	20558.4
2029	4	8581.0	0,0	8349.8	3277.4	0,0	0,0	0,0	814.5	21022.7
2030	5	8830.9	0,0	8512.0	3341.1	0,0	0,0	0,0	814.5	21498.4
2tJ"41	6	9088.1	0,0	8677.2	3406.0	0,0	0,0	0,0	1163.5	22334.8
2032	7	9352.8	0,0	8845.7	3472.1	0,0	0,0	0,0	1163.5	22834.1
2033	8	9625.2	0,0	9017.5	3539.5	0,0	0,0	0,0	1163.5	23345.7
2034	9	9905.6	0,0	9192.6	3608.2	0,0	0,0	0,0	1163.5	23869.9
2035	10	10194.1	0,0	9371.1	3678.3	0,0	0,0	0,0	1163.5	24407.0
2036	11	10491.0	0,0	9553.0	3749.7	0,0	0,0	0,0	1163.5	24957.3
2037	12	10796.6	0,0	9738.5	3822.5	0,0	0,0	0,0	1163.5	25521.1
2038	13	11111.0	0,0	9927.6	3896.8	0,0	0,0	0,0	1163.5	26098.9
2039	14	11434.6	0,0	10120.4	3972.4	0,0	0,0	0,0	1163.5	26691.0
2040	15	11767.7	0,0	10316.9	4049.6	0,0	0,0	0,0	1163.5	27297.7
2041	16	12110.4	0,0	10517.3	4128.2	0,0	0,0	0,0	1163.5	27919.4
2042	17	12463.2	0,0	10721.5	4208.4	0,0	0,0	0,0	1163.5	28556.5
2043	18	12826.2	0,0	10929.7	4290.1	0,0	0,0	0,0	1163.5	29209.4
2044	19	13199.7	0,0	11141.9	4373.4	0,0	0,0	0,0	1163.5	29878.5
2045	20	13584.2	0,0	11358.2	4458.3	0,0	0,0	0,0	1163.5	30564.2

YEAR		Annual maintainance cost CR	Annual operating cost CR	Updated thermal energycost CR	Updated electricity cost CR	Periodic replacement costs CR	Residual value replacement costs CR	Decommissioning costs CR	Annual CO2 equivalent emissions costs CR	Updated operating costs CR	CASH FLOW	VNA
CR-P1 (REFURBISHED BUILDING – PACKAGE 1)												
2025	0	1455.0	0,0	5599.2	3029.1	38420.0	0,0	0,0	358.0	10441		156433
2026	1	1497.4	0,0	5707.9	3087.9	0,0	0,0	0,0	626.5	10920	-8743	147690
2027	2	1541.0	0,0	5818.8	3147.8	0,0	0,0	0,0	626.5	11134	-8971	138719
2028	3	1585.9	0,0	5931.7	3209.0	0,0	0,0	0,0	626.5	11353	-9205	129513
2029	4	1632.1	0,0	6046.9	3271.3	0,0	0,0	0,0	626.5	11577	-9446	120067
2030	5	1679.6	0,0	6164.3	3334.8	0,0	0,0	0,0	626.5	11805	-9693	110374
2031	6	1728.5	0,0	6284.0	3399.5	0,0	0,0	0,0	895.0	12307	-10028	100346
2032	7	1778.9	0,0	6406.1	3465.5	0,0	0,0	0,0	895.0	12545	-10289	90058
2033	8	1830.7	0,0	6530.4	3532.8	0,0	0,0	0,0	895.0	12789	-10557	79501
2034	9	1884.0	0,0	6657.3	3601.4	0,0	0,0	0,0	895.0	13038	-10832	68669
12035	10	1938.9	0,0	6786.5	3671.4	0,0	0,0	0,0	895.0	13292	-11115	57554
2036	11	1995.3	0,0	6918.3	3742.7	0,0	0,0	0,0	895.0	13551	-11406	46148
2037	12	2053.5	0,0	7052.6	3815.3	0,0	0,0	0,0	895.0	13816	-11705	34443
2038	13	2113.3	0,0	7189.6	3889.4	0,0	0,0	0,0	895.0	14087	-12012	22431
2039	14	2174.8	0.0	7329.2	3964,9	0,0	0,0	0,0	895.0	14364	-12327	10104
2040	15	2238.2	0,0	7471.5	4041.9	0,0	0,0	0,0	895.0	14647	-12651	-2547
2041	16	2303.4	0,0	7616.6	4120.4	0,0	0,0	0,0	895.0	14935	-12984	-15531
2042	17	2370.4	0,0	7764.5	4200.4	0,0	0,0	0,0	895.0	15230	-13326	-28857
2@3	18	2439.5	0,0	7915.2	4282.0	0,0	0,0	0,0	895.0	15532	-13678	-42535
2044	19	2510.5	0,0	8068.9	4365.1	0,0	0,0	0,0	895.0	15840	-14039	-56574
2@5	20	2583.7	0,0	8225.6	4449.9	0,0	0,0	0,0	895.0	16154	-14410	-70984

The calculation was redone for each package, resulting into the following recovery times for each of the packages::

Renovation measures package	Decreased duration of „investment recovery”	Global cost [Eur VAT included] **(20** years)	Package hierarchy**f(CG)**
CNR	-	496332.7	-
CR-P1	l5	425349	III
CR-P2	8	261063.1	I
CR-P3	15	375439.6	11

C. Conclusions

Following the energy and economic analyses presented in the calculation notes and the interpretation of the results obtained, the following conclusions were reached.

1. The energy audit was carried out for the Gym Hall of the Technical Energy College located within the premises of the Technical Energy College located in the municipality of Sibiu. It was carried out taking into account the in-depth thermal refurbishment works expected by the beneficiary.

2. The building envelope in the current situation does not comply with the minimum strengths provided bythe regulations in force.

3. Based on the calculations of specific consumption and the penalties granted in the energy rating, the certified building is classified into energy class D (overall) with a specific primary energy consumption of 239.0 kWh/m2/year, compared to the reference building which is classified into energy class B with a specific primary energy consumption of 82.70 kWh/m2/year. Regarding the level of equivalent CO2 emissions, the current building falls into class D with 42.1 kgCO2/rn^2/year, compared to the reference building which is classified into class B with 13.10 kgCO2/rn2/year-

4. The following solutions, developed in detail in chapter 4.1, are proposed for the building investigated:

• Solution 1.

- Thermal insulation ofthe exterior walls with a layer of expanded polystyrene or mineral wool with a thickness of 15 cm and a thermal conductivity γ<0.038 W/mK
- Thermal insulation of the floor above the ground floor with sheep wool-based insulation material with a thickness of25 cmand a minimumthermal strength ofγ<0.038 W/mK, over which a wooden floor will be built.

• Solution 2.

- Replacing the exterior windows with efficient carpentry whichthermal strength is at least Rmin = 0.83 m2 K/ W.
- Replacing the exterior doors with efficient carpentry which thermal strength is at least Rmin = 0.77 m2 K/ W.

• Solution3. Modifying the building's installations as follows:
o Introducing a new heat production system composed of heat pumps and condensing gas boilers that will serve three building units (high school, workshop and gym hall). Gas-fired central heating will take over any peaks in consumption.
o A photovoltaic panel system with a capacity of 18 kWh will be installed on the high school's roof on the SE or SW orientations
o A heat recovery fan system with anaverage thermal transfer efficiency of75% will be installed.
o The lighting fixtures and lighting sources will be replaced with LEDs. Presence sensors will be used for circulation spaces.
The energy and economic analyses presented in the calculation notes in this document highlight the qualities of the different refurbishment packages. Thus:
1. The P1 package is a package that includes solutions S1-S2 and is recovered in 15 years. The package of measures leads to an increase in the thermal strengths of the opaque envelope up to the minimum strenghts requested by the codes in force. In terms of primary energy consumption and CO_2 emissions, the package does not fallwithin the minimum values provided by the methodology. With this package of measures, the annual primary energy saving is 20.2% (from132 MWh/year to 105 MWh/year) and CO_2 emissions are reduced by 23.1% (from 23.3 tons/year to 17.9 tons/year)
2. Package P2 is a package that includes solution S3 and is recovered in 8 years. The package of measures leads to increased efficiency of systems and the use of renewable energy sources. This package does not fall within the minimum values provided by the methodology in terms of primary energy consumption and CO_2 emissions. With this package of measures, the annual primary energy saving is 56.6% (from132 MWh/year to 57 MWh/year) and CO_2 emissions are reduced by 68.3% (from 23.3 tons/year to 7.4 tons/year)
3. Package P3 is a maximum package in terms of investment that includes solutions S1-S3 and is recovered in 15 years. The package of measures leads to an increase in both the thermal strength of the envelope to the minimum strenghts requested by the codes in force and a reduction in consumption within the minimum values provided by the methodology. With this package of measures, the annual primary energy saving is 78.3% (from 132 MWh/year to 28.6 MWh/year) and CO_2 emissions are reduced by 89.1% (from 23.3 tons/year to 2.5 tons/year). The results obtained following the application of the package of measures are presented in tabular form below.

Fulfillment indicator for package P3	Indicator value before renovation	Indicator value after renovation	Reduction (%)
Total finalthermalenergy consumption (MWh/year)	**82.25**	51.861	36.95
Total final electricity consumption(MWh/year)	14.315	18.559	**-29.65**
Total primary energy consumption(MWh/year)	**132.02**	28.585	78.35
Total specific primary energy consumption (kWh/m2year)	239	**51.75**	78.35
Energyclass	D	A	
Amount of CO2 equivalent emissions (kg CO2/m2,year)	42.1	4.6	89.07
Environmental class	D	*A+*	
Finalthermalpayment energy[MWh/year]	82.3	4.7	94.29
Finalelectricitypayment [MWh/year]	14.3	3	79.02

4. Applying the package of measures proposed is economically feasible, amortizing the investment value over a period of 15 years. The value is lower than the shelf life of the package, which is estimated at 20 years, and causes significant energy reductions.

5. The results of the building's energy audit represent the calculation basis for the feasibility study that establishes the appropriate refurbishment option for the beneficiary of the building under analysis. Once the refurbishment option has been identified, it will proceed to its design and then to the execution of the refurbishment works according to the refurbishment project.

6. Based on the technical and economic analyses carried out, it is recommended to implement the P3 package, as it represents the efficient and compliant solution with the regulations in force. Following the application of thermal refurbishment measures, the building becomes energy efficient, falling into energy performance class A. The financial evaluation included in the energy audit cannot be used as documentation to substantiate the request for financing or crediting the proposed works, however, based on the energy audit, it is easy to proceed to the preparation of the feasibility study, for the approval of the economic indicators of the investment.

Energy auditor for buildings

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D. Recommendations forthe owners

- Informing the responsible technical staff about the expected energy savings;
- Correct understanding of how the building and its installations should operate at a general and detailed level
- Designating a representative to monitor the execution of the thermal refurbishment works;
- Establishing an energy saving policy in operation;
- Analyzing energy bills and energy supply contracts and modifying them if necessary. It is recommended to choose suppliers that produce energy from renewable sources.
- Hiring an energy manager;
- Adapting and adjusting the heating plants of the spaces to the reduced heat requirement as a result of the execution of the intervention works;
- Washing the heating installation, including theradiators, at regular intervals of 3 years;
- Correctthermo-hydraulic balancing of the heating elements;
- Checking and changing batteries that are not perfectly sealed;
- Replacing classic light bulbs with energy-efficient ones;
- Maintaining proper ventilation ofoccupied spaces. The ventilation system with heat recovery will be maintained in working order;
- Periodic inspections of the own central heating systems and their adjustment according to the manufacturers' instructions will be respected. Gas detectors will be installed by the owners.

E. Bibliography

The preparation of the energy audit report of the building was carried out in accordance with the provisions of the new Methodology Mc 001/2022, regarding the calculation of energy consumption of buildings.

Other related documents are:

- Normative regarding the thermotechnical calculation of building construction elements. Indicative: C107/2005, approved by the Order of Transport, Construction and Tourism no. 2055/29.11.2005, as amended and completed;
- Normative for the design, execution and operation of central heating installations, indicative 113-2015, approved by Order of the Minister of Regional Development and Public Administration no. 845/12.10.2015
- Normative for the design, execution and operation of ventilation and air conditioning installations, indicative 15-2010, approved by Order of the Minister of Regional Development and Tourism no. 1.659/22.06.2011
- Normative for the design and execution of sanitary installations, indicative I9-2015, approved by Order of the Minister of Regional Development and Public Administration no. 818/06.10.2015

- Regulations for the design, execution and operation of electrical installations related to buildings, reference I7-2011, approved by Order of the Minister of Regional Development and Tourism no. 2,741/01.10.2011

- Framework solutions for the thermo-hygro-energetic refurbishment of the envelope of existing residential buildings, reference SC 007-2013, approved by Order of the Minister of Regional Development and Public Administration no. 2,280/05.07.2013.

- Guide for the design and execution of thermal refurbishment works of apartment buildings, reference GP 123-2013, approved by Order of the Minister of Regional Development and Public Administration no. 2,211/26.06.2013, as amended and completed.

- Law no. 372/2005 on the energy performance of buildings, republished,

- Law no. 10/1995 on qualityin construction, republished, asamended and completed

- Law no. 50/1991 on the authorization of construction works, republished, as amended and completed

F. ENERGY ANALYSIS SHEET

A. GENERAL DATA

Building layout plan

Building: Gym Hall
Address: Electricienilor street no.1, Sibiu county
Owner: Sibiu City Hall
Building category:
educational establishment (nurseries, kindergardens, schools, highschools, universities)
Climate area where the building is located: III
Wind area where the building is located: IV
Wind exposure level: sheltered
Height regime of the building: groundfloor
Construction structure: double strength structure made ofreinforced concrete frames and load-bearing masonry
Documents related to the construction and its systems:
architecture survey for each type of representative level
construction representative sections

B. Features of the living/heated space

Built area (sqm): 582.66
Built unfolded area (sqm): 582.66
Reference area of the heated space floor (sqm): 552.39
Reference volume of the heated space (m^3): 3572.07
Reference area of the cooled space floor (sqm), as appropriate: -

:
Free average height of one level(m): 2.8 and 7.5
Occupation level of the heated space [no.of operating hrs of the heating system]: 8h/210 days
Ratio between the area of the closed balconies facade and the total area of the facade provided with balconies/loggia: -

Average depth of the groundwater (m): -
Average height of the underground compared to the systematized land elevation: -
Perimeter of the building basement floor (m): 102.5

C. BUILDING CONSTRUCTIVE STRUCTURE IDENTIFICATION
Dull exterior walls

Exterior wall– masonry

No. crt.	Material	γ [W/mK]	δ [m]	a	R [m²K/W]
1	Lime mortar plaster	0.87	0.02	1.1	0.021
2	Solid brick masonry	0.8	0.24	1.15	0.261
3	Cement mortar plaster	0.93	0.03	1.1	0.029
δi=8 δe=24			R0	=	0.478

Exterior walls condition: dampness
Finishings condition: partially fallen plaster
Type and colour of the finishing materials:
- type: plaster
- colour: white

Dividing joints for building sections: Not applicable

Walls to annex areas(staircase, dumpsters): Not applicable
Ground slab:

No.crt	Material	k [W/mK]	δ [m]	a	R [m² K/W]
1	Sandstoneand quartzite	2.03	0.01	1.03	0.005
2	Plain concrete	1.16	0.05	1.03	0.042
3	Reinforced concrete slab	1.62	0.1	1.05	0.059
4	Gravel fill	0.7	0.1	1	0.143
5	Top soil	1.16	0.15	1	0.129
δi = 6 δe= 12			R0	=	0.545

:

Total area of the ground slab [sqm]: 541.2

Terrace/Roof

Type of terrace/roof: trusstype roof

Terrace/roof condition: dry

Last repair of the terrace/roof: morethan 5 years ago

Finishings materials: corrugated sheet

No. Crt.	Material	λ [W/mK]	6 [m]	a	R [m²K/W]
1	Corrugated sheet	58	0.005	1	0
2	Roof boarding	0.17	0.025	1.1	0.134
			R0	=	0,301

δi=8

δe=24

Total roof area[sqm]: 576.4

Floor under the attic:

No. Crt.	Material	λ [W/mK]	δ [m]	a	R
1	Reinforced concreteslab	1.62	0.14	1.1	0.079
2	Cement mortar plaster	0.87	0.02	1.03	0.022
3	Ash and slag	0.290	0.1	1.1	0.313
				=	0.623

αi= 8

αe= 12

Total area of the floor under the attic [sqm]: 541.2

Exterior windows/doors

Carpentry condition: good

EW/ ED	Description	Area [sqm]	Type of carpentry	Sealing grade	Shutter (i / e)
EW	Windows R=0.43	119.2	PVC carpentry Insulated glass	With outdated sealing that is no longer flexible	No
ED	Doors R=0.37	10.1	PVC carpentry Insulated glass	With outdated sealing that is no longer flexible	No

Other construction elements: Not applicable

Mobile construction elements from joint spaces: Not applicable

D. INTERIOR HEATING SYSTEM
Does the heating system exist: Yes
Need for calculation heating [W]: 124390
Energy source for heating the spaces: own source, gas fuel
Type of heating source: heating with static bodies

Dataregarding the interior heating system with static bodies:
Type of thermal heating: lower
Connection to the centralized heating source: singleconnection
Thermal energy meter: does not exist
Thermal and hydraulic adjustment items: on the distribution network
The static bodies are not equipped with adjustment fittings or at least half of the current adjustment fittings are not operating
Interior heating system condition in terms of deposits: the static bodies have been dismantled and washed/cleaned fully more than three years ago
Separation and drainagefittings of the heating pipes: The hitting pipes are provided with separation and drainage fittings, operational
Heating system vessels/ventilation fittings: Thereare manual ventilation valves
Are there heat cost allocators installed on the heating systems? No

Type of heating body/Type of heating system	Number of heatingbodies [pcs.] Number of static bodies[pcs.]			Thermal equivalent area [sqm]		
	In the living area	In the common area	Total	In the living area	In the common area	Total
iron	12	3				
ventilation convector	3					

Heating source –own thermal system

Nominal power: 2x60kW

Are there ISCIR documents: YES

Regulation/automation system and regulation equipments: NO

Are there invoices for the last 5 years that can be examined: YES

E. DATA REGARDING THE HOT RUNNING WATER
Is there a system for preparing the hot running water: Yes
Energy source for preparing the hot waterof the spaces: Own source – gas thermal system
Cool water/hot water consumption points:
basins: 2
washers: 0
bidets: 0
urinals: 0
showers: 6
bath: 0
WC : 2
dishwasher: 0
washing machine: 0
Fittings condition: good
Connectiontothe centralized heating system: single connection
Recirculation pipe: does not exist
Debit metresofthe consumption points: do not exist
ADDITIONAL INFORMATION
Are there any invoices for hot running water for the last 5 years that can be examined: NO
Cool water temperature in the area: 10°C

F. DATA REGARDING THE VENTILATION/ AIR CONDITIONING SYSTEM

Data regarding the air conditioning system
Is there a ventilation and air conditioning system: NO

Dataregarding the ventilation system
Type of ventilation: natural

G. DATA REGARDING THE LIGHTING SYSTEM
Type of lighting fixtures: fluorescent
Lighting system control: no automatic detection of the users' presence
Lighting fixtures condition: good
Electrical conductors condition: good

Illegible signature, Official stamp

G. PhotoAnnex

Photo 1 – Main entrance, one can see the main access to the hall

Photo 2 – Right side entrance

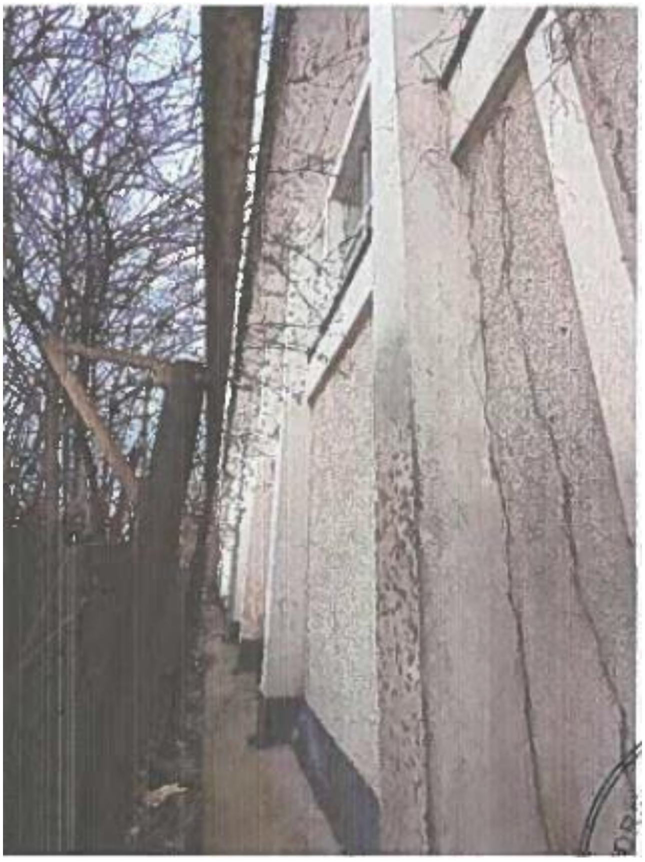


Photo 3 – Rear entrance

Photo 4 – Locker rooms

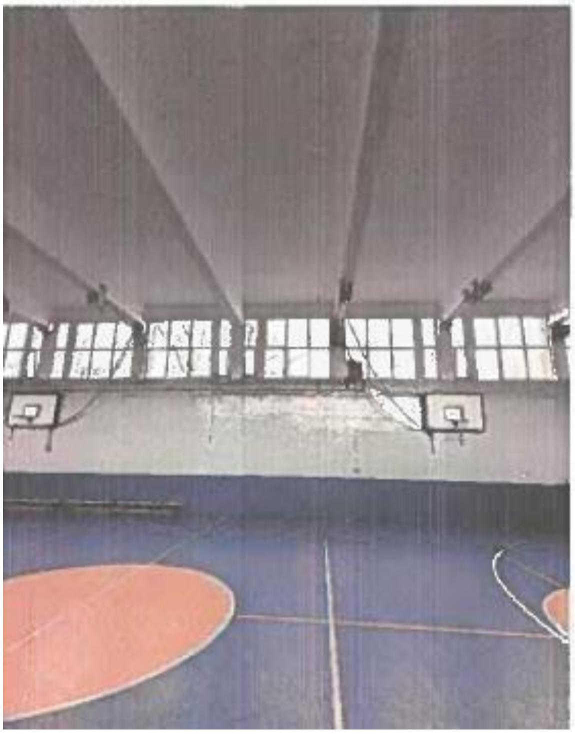


Photo 5 – Photo of the gym hall

Photo 6 – Photo of the thermal system, one cansee the two boilers providing heating and the boiler for storing the hot running water

H. Other annexes

- Copy of Energy Auditor's ID
- Construction Survey
- Energy Certificate for the current building
- Energy Certificate Annex

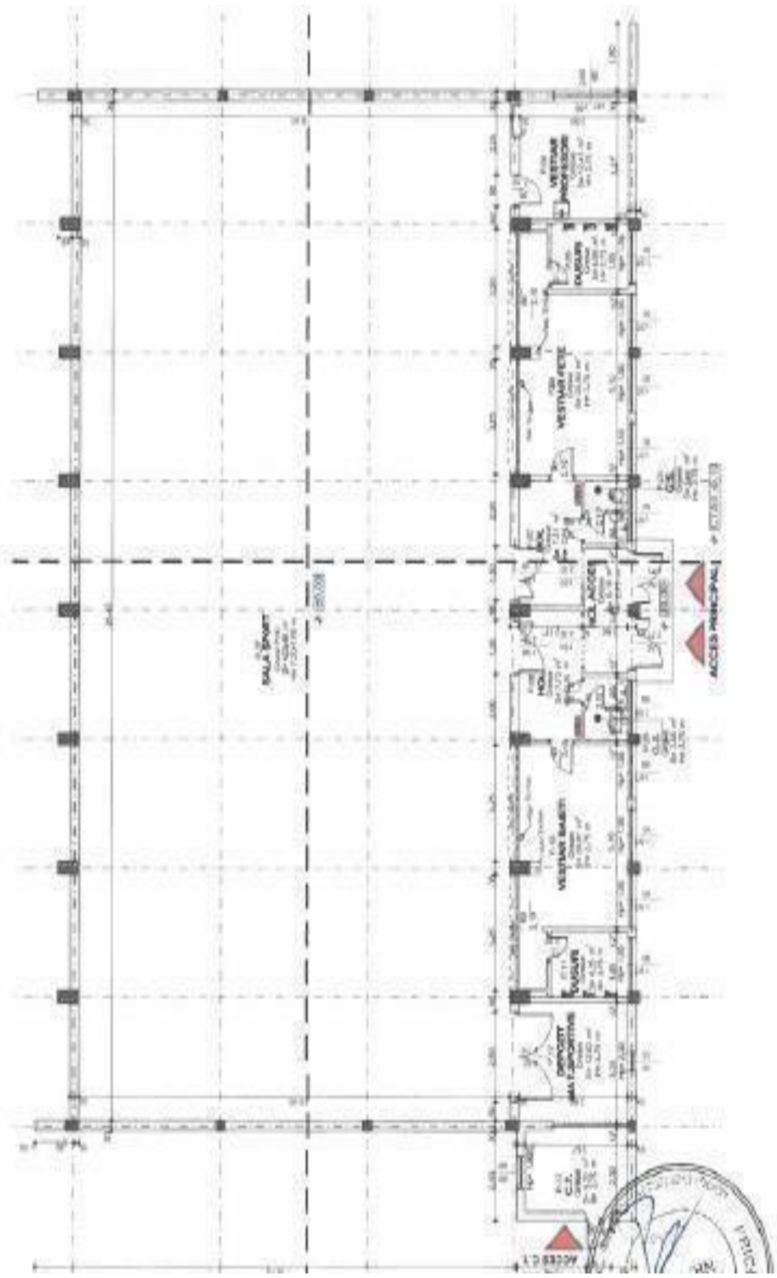
MINISTRY OF REGIONAL DEVELOPMENT, PUBLIC ADMINISTRATION AND EUROPEAN FUNDS

Mr. PRICOPIE GH. GHEORGHE-ANDREI General manager
Personal identification number: 1850607460121 Illegible signature, Official stamp
Job: Engineer CERTIFIED
ENERGY AUDITOR FOR BUILDINGS Holder's signature - Illegible signature
Professional degree: I This badge is valid only accompanied by the attestation
Specialization: CONSTRUCTIONS AND INSTALLATIONS certificate of the energy auditor for buildings
Date of issue: 08.02.2017 Series SSA number 02249

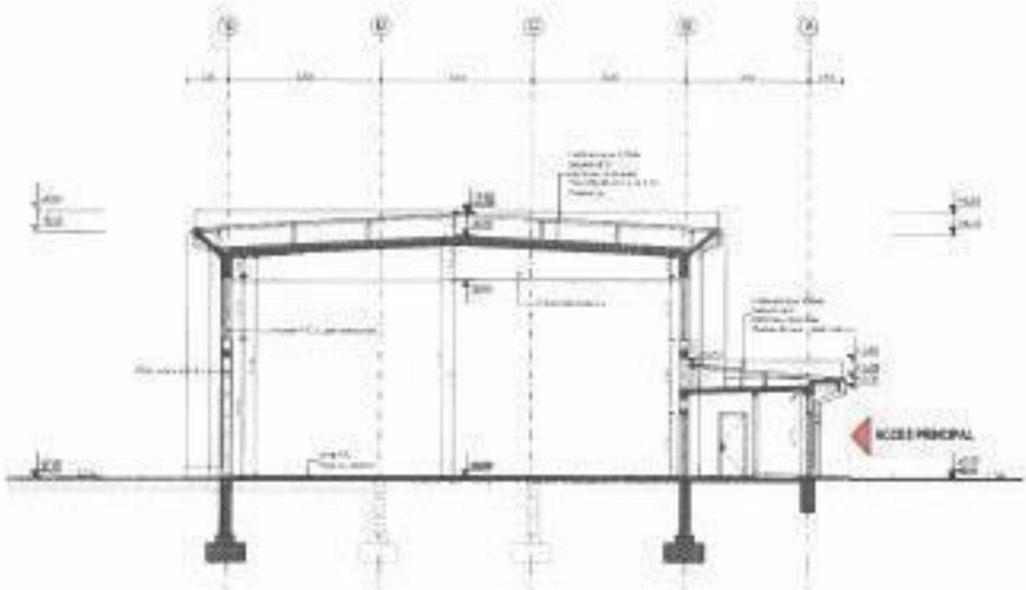
This badge will be endorsed bythe issuing entity from 5 to 5 years from the date of issue
Valid until: 08.02.2022
Validity extension until: 08.02.2027

Mr. CRUCIAT I.RADU-IULIU General manager
Personal identification number: 1850707324784 Illegible signature, Official stamp
Job: Engineer CERTIFIED
ENERGY AUDITOR FOR BUILDINGS Holder's signature - Illegible signature
Professional degree: I This badge is valid only accompanied by the attestation
Specialization: CONSTRUCTIONS AND INSTALLATIONS certificate of the energy auditor for buildings
Date of issue: 08.02.2017 Series SSA number 02208

This badge will be endorsed by the issuing entity from5 to 5 years from the date of issue
Valid until: 08.02.2022
Validity extension until: 08.02.2027



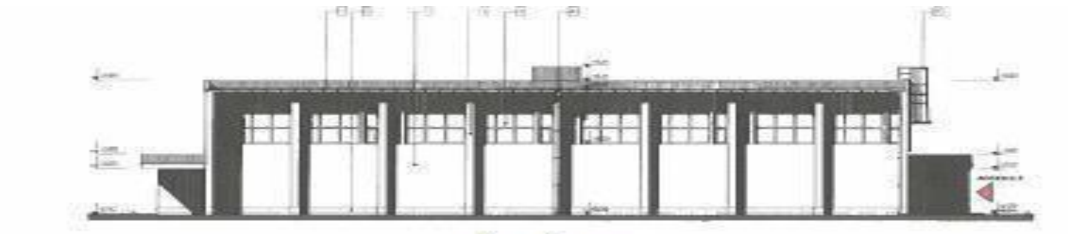
Ground floor survey



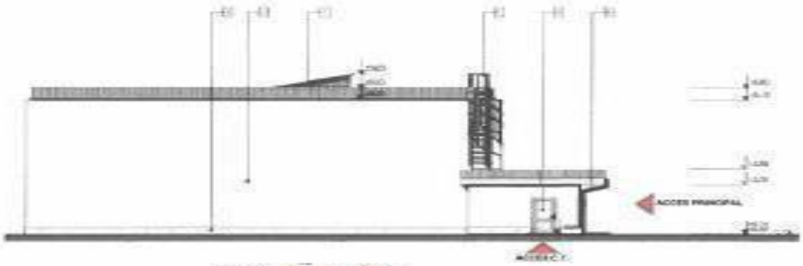
Transversal section

Roof structure survey

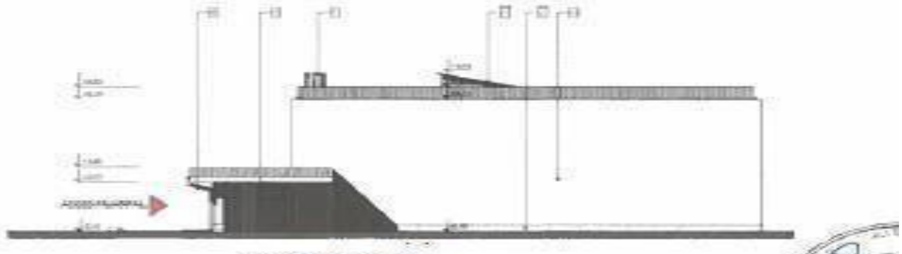
Main entrance



Rear entrance



Rear side entrance



Right side entrance

RECOMMENDATIONS FOR INCREASING THE ENERGY PERFORMANCE
ANNEX 1 to the Energy Performance Certificate no. 000128/ 550311
for the BUILDING/BUILDING BLOCK/APARTMENT from Sibiu, str. Electricienilor no. 1, Sibiu County

1. Solutions recommended for the envelope ofthe building/building block/apartment
Increasing the thermal strength of the external walls above the minimum value provided by the technical regulations in force, by external thermal insulation
Increasing the thermal strength of the roof (floor under the attic), above the minimum value provided by the technical regulations in force, by external thermal insulation
Replacing the current exterior joinery with energy-efficient joinery.
Installing devices toshade the facades or protect against solar radiation duringthe winter.

2. Solutions recommended for installations related to the building/building block/apartment.
Replacing the used pipes for the heating agent and possibly insulatingthem (same forthe columns).
Replacing the used pipes for hotwater distribution for heating and possibly insulating them (same forthecolumns).
Installation of thermostatic valves on the heating elements
Installation ofautomatic balancing valves at the base of the heating/cooling columns
Ensuring the quality of the indoor air through organized natural ventilation, mechanical ventilation or hybrid ventilation
Use of sanitary fittings with reduced total hot water consumption (use of economic diffusers at the consumption points)
Replacement of seals and repair of defective hot water fittings, installed on sanitary objects.
Provision of a minimum automation/regulationsystem ifit does not exist, for heating/cooling/ventilation
Adjustment/cleaning of the equipment in the heating/air conditioning system, if it exists, and the equipment operates inefficiently
Installation of lighting fixtures with economical sources instead of the existing, inefficient ones
Installation of presence sensors for automatic activation of the lighting system
Use of renewable energy sources to increase the environmental performance of buildings
Use of thermal energy recovery equipment (air-to-air heat exchangers, water heaters, etc.)
Periodic cleaning of the chimneys and flues for the exhaust of combustion gases, if applicable

3. Related measures (corresponding to the energy calculation stages) for increasing the energy performance of the certified building:

A - General organizational measures
Informing building users (owners/tenants) about the advantages of energy savings and pollution reduction
Encouraging occupants/administrators to use the building and its facilities correctly, being motivated to reduce the energy consumption
Choosing the correct way how the building should operate both as a whole and at the level of individual blocks
Designating a representative tomonitor the execution ofthermal refurbishment works in case of building refurbishment
Permanent recording of energy consumption, including analysis of energy bills
periodic review ofenergysupply contracts and their amendment, if necessary
providing energy consultancy services from specialized companies (which also ensure the proper maintenance of the building facilities)

B - Local measures to reduce the energy consumption
dismantling and washing of heatemitting equipment (heaters, fan-convectors, etc.) removing objects that prevent the heat from the radiators from reaching the room
introducing a reflective surface between the radiator and the expansion wall that reflects the heat back into the room thermo-hydraulic balancing of the heating units
replacing sanitary fixtures
hydraulic balancing of the hot running water distribution network air balancing of air distribution networks
correctionof the settings ofthe automatic operating parameters of the equipment

Estimated totalcosts (excluding VAT) of the measures proposed to increase the energy performance ≥ 100.000 EUR:
Estimated total energy savings: ≥ 60%
Estimated investment recovery duration: ≥ 10 years

List of the steps that need to be taken to implement the energy-saving and environmental performance improvement measures:
Renovation ofthe thermal envelope of the building
Use of energy from renewable sources
Building modernization.
Implementation of ventilation with heat recovery

Information on financial incentives or other funding opportunities:
European Funds
Government Funds
Own Funds

TECHNICAL INFORMATION REGARDING THE CERTIFIED BUILDING
ANNEX 2 to the Energy Performance Certificate no. 000128/ 550311
for the BUILDING/BUILDING BLOCK/APARTMENT from Sibiu, str. Electricienilor no. 1, Sibiu County

A.DATA REGARDING THE CERTIFIED BUILDING

Type ofbuilding: existing
Building category: educational establishment – school/highschool/college
Climate zone where the building is located: III
Wind energy area where the building is located: IV
Height regime of the building: groundfloor
Constructive structure of the building:

- structural masonry walls
- reinforced concrete frames

Number and type ofapartments/building blocks/thermal areas and floor reference areas:

Type of apart/block/area destination		Reference area of an apart/block/thermalarea ZTC or ZTU [sqm]		Number of similar apartments/blocks/thermal area		Total reference area/type [sqm]	
C1	C2	C1	C2	C1	C2	C1	C2
ZTC.1.1		552.39		1		552.39	
ZTU1		552.39		1		552.39	
TOTAL				2		**1104.78**	

Total reference area of the floor of the building or building block: 552.39 sqm
Reference interior volume V, of the building/building block: 3572.07 m^3

- Geometric and thermal characteristics of the envelope:

	Type of construction element		Thermal strength corrected calculated $[m^2K/W]$		Thermal strength corrected regulated $[m^2K/W]$		Area $[m^2]$	
	C1	C2	C1	C2	C1	C2	C1	C2
R1.	PE1		0,39				161,3	
R2.	PE1		0,44				122,9	
R3.	PE1		0,37				150,7	
R4.	PE1		0,44				123,3	
R5.	PL attic		0,81		5		541,2	
R6.	SOL sandstone 7		0,53		2,9		541,2	
R7.	FE-PVC		0,43		0,5		119,2	
R8.	UE-PVC		0,37		0,5		10,1	
			Total area of the envelope	S_E $[m^2]$			1769,8	

Building form factor S_g/V: 0.50 $^{m-1}$

Details of the annual specific consumption of primary energy[kWh/m^2 years, respectively of annual specific equivalent CO2 emissions [kgCo2/m^2.year]

Type of installation system	Real building			Reference building	
	Specific consumption Primary/linear energy	CO2 equivalent annual specific emissions	Energy performance class	Primary energy specific consumption	CO2 equivalent annual specific emissions
Heating	86.8/ 79.4	15.8	C		
Hot runningwater	83.1 / 97.5	19.7	G		
Cooling					
Mechanical ventilation	15.6/ 39.0	4.2	E		
Lighting	9.2 / 23.1	2.5	C		
TOTAL/CLASS	174.7 / 239.0	42.1	D	82.7	13.1

Standard number of persons inside the building/building block: 300.00 people

B. DATA REGARDING THE INTERIOR HEATING SYSTEM

Existence of the heating system: yes, functional
Current energy source for heating the spaces: ownsource (individual system, naturalgas fuel)
Type of heating system: heating with static bodies, power plant

Type of static body	Number of staticbodies (pcs)			nominal thermal power [kW] for theheating flow/return temperature/interior temperature of . ...Celsius degrees
	Area	In the living/work space	In the common spaces	
steel fan coil unit	ZTC1.1 ZTC1.1	12 3	3	40[kW] 55/45 19[°C] 50[kW] 55/55 19[°C]
TOTAL		15	3	

- central heating with hot air, with systems like steel fan coil units
- Type of thermal agent distribution: lower
- Calculation heat requirement (necessary thermal energy): 124.39 kW
- Energy necessary for humidification: 0.00 kW
- Total thermal power installed for heating: 120/kW(thermal/electric)
- Connection to thecentralized heating source: standard diameter –0 mm

available pressure: 0 mmCA

- Heating meter: does not exist
- Costs allocator: does not exist
- Thermal and hydraulic adjustment elements:

atconnection/heating source level

at static bodies level

Total length of the distribution network located inunheated spaces: 0.00 m

Unheated space denomination	Section diameter (mm) / Sectionlength(m)								
ZTU1- attic									

Total standard flow of the heating agent: 3531.87 l/h

Occupation level of the heated space(operating schedule of the heating facility)

Area	Work day	Weekend day		
Hours	8			
Interior temperature (°C)	19			

Data regarding the heating system with hot air generators:

Number/air flow: 3 m^3/h

C. DATA REGARDING THE HOT RUNNING WATER SYSTEM

Does the hot running water system exist? Yes, it is operating
Energy source for preparing hot running water: ownsource (individual thermal system with natural gas fuel)
Type of equipments for preparing the hot running water: boiler with accumulation (number/volume) 1/200 l
Number of sanitary items per types:

Washbasin	2	Bathtub	0
Washers	0	WC	2
Bidets	0	Dishwasher	0
Urinals	0	Washing machine	0
Shower	6		

Total number of hot running water consumption points: 8
Thermal power necessary for preparing the hot running water: 0 kW
Maximum thermal power installed for preparing the hot running water: 0 kW
Connection to the heating centralized system:
- nominal diameter: 0 mm
- necessary pressure: 0 mmCA

The hot running water recirculation pipe: does not exist
The general hot running water meter: does not exist
Debit metres of the consumption points: do not exist

D. INFORMATION REGARDING THE COOLING/AIR CONDITIONING SYSTEM

Does the cooling/air conditioning system exist: no– ignoret he energy consumption for cooling/air conditioning

Time of one year when the interior temperature exceeds the free comfort temperature during the summer: 380 hrs

Reference volume of the air-conditioned area: 3583 m3

Average nominal value of the EER performance coefficient of the cooling source: 0.00

The coldness necessary for cooling (refrigeration capacity): 0.00 kW
The coldness necessary for dehumidication (latent power): 0.00 kW
Total refrigeration power installed in the building: 0.00 Kw

E. INFORMATION REGARDING THE MECHANICAL VENTILATION SYSTEM

Does the mechanical ventilation system exist: No, ignore the electricity for residential buildings, respectively a virtual consumption of electricity is requested for non-residential buildings (acc.to Mc001 provisions, chapter 5.3)

Minimum fresh air flow for ventilation according to the legal rules, under standard terms/ensured by the mechanical ventilation system from the building: 0 m_3/h

Is there a heat recoverer? No

F. INFORMATION REGARDING THE LIGHTING SYSTEM

Does the lighting system exist: Yes, it is functional
Type of control/adjustment system of the lighting system: no adjustment (on/off)

Type of lighting system: fluorescent
Electrical network condition/ lighting conductors network condition: Used
Total electricity necessary for the lighting system, corresponding tothe normal useof the spaces/insuring the normal lighting level: 5.00 kW
Total installed electricity of thelighting system: 5.00 kW

G. INFORMATION REGARDING THE ENERGY RENEWABLE SOURCES
Solar thermal panel system: does not exist
Photovoltaic panels systems: does not exist
Used for: electricity production
Heat pump: does not exist
Biomass usage system: does not exist
Wind farm: does not exist
Thermal energy exported: 0.00 kWh/year (produced on-site)
Electricity exported: 0.00 kWh/year (produced on-site)
Thermal energy exported from renewable sources: 0.00 kWh/year (produced on-site)
Electricity exported from renewable sources: 0.00 kWh/year (produced on-site)
Primary energy indicator EP_p: 239.0 kWh (m_2.a)
RER_P indicator: 5.42 %
CO_2 emissions indicator: 42.1 kgCO_2 (m^2.a)

H.SITE PHOTOS

CRUCIAT I. RADU-IULIU
ROMÂNIA
M.D.R.A.P.F.E.
Nr. 02208
AE I ci
AUDITOR ENERGETIC PENTRU CLĂDIRI

MIHALACHE ANDREEA-CRISTINA

Semnat digital de MIHALACHE ANDREEA-CRISTINA
Data: 2026.04.17 09:24:29 +03'00'

ORDINUL MINISTRULUI JUSTIȚIEI NR. 1575/C/19
MIHALACHE ANDREEA - CRISTINA
Traducător și interpret Autorizat
Lb. Engleză
Aut.33686/2012
* ROMÂNIA *