TRANSLATION from the Romanian language

Energy Audit

Highschool building within the Technical Energy College from Electricienilor street, no. 1, Sibiu municipality

Beneficiary:
Sibiu City Hall
Illegible signature, Official stamp

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2025

Energy Audit Reportof thebuilding:
Highschoolbuilding withinthe Technical Energy College from Electricienilor street, no. 1, Sibiu

CONTENTS

Page

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Energy Audit Report of the building

Gf+2F Highschoolbuilding 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 Highschool building within the Technical Energy College located in Sibiu municipality, Electricienilor street number 1. Its height regime is groundfloor and two floors.

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 in 1966

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.

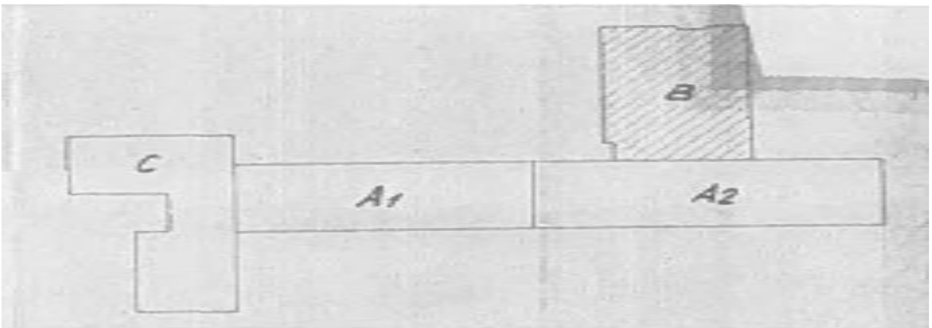
The energy audit is carried out in order to evaluate the possibilities of improving the energy performance of the building, given the context of the refurbishment and modernization works of the Highschool building of the Technical Energy College.

1.1. Architectural and thermal insulation elements

The building is located in the municipality of Sibiu, Str. Electricienilor, no. 1, and was built in five sections.

The High School building of the Technical Energy College, located in Electricienilor Street, no. 1, Sibiu municipality, is made of four sections with the height regime Gf+2F. The building was designed by Electromontaj Trust by adapting the I.P.C.T. High School standard project with 20 classes, from 1966 and was built in the immediate following period.

The high school has a complex shape in plan that approaches the shape of an L with the long side facing Electricienilor Street and the short side facing Semaforului Street. The structure is divided into 4 sections according to the following sketch:



Section A, consisting of two building blocks. A1 and A2 separated by a settlement joint, is a regular section with a rectangular shape in plan with a length of 57 m and a height of approximately 10.9 m. The section is divided into two openings, one in which the 4.27 m hall is organized and one in which the 6.57 m classrooms are organized. The spans are all 3 m each. A classroom is arranged on three spans of 3 m each. Starting from the end facing Vasile Aaron Street, in the first span there is a sanitary group followed by 4 classrooms each organized in 3 spans. In the next 2 spans there is a reading room and the access hall to the high school. In the last 4 spans the secretariat, archive and the principals' offices were organized.

Section B also has a almost regular shape that can be classified as a rectangle with dimensions of 21.5 m x 13.39 m. The block is composed of a 6.57 m opening where classrooms are organized. a 2.75 m opening in which a hall is organized and a 3.77 m opening in which a stairwell, storeroom and cabinets are organized. Section B is separated by a seismic joint from section A. Section B is organized in 7 3 m spans.

Section C is arranged towards Vasile Aaron Street and is organized in an L shape. The body is composed of a classroom and a laboratory. A corridor and a stairwell are provided towards the center of the body. The body maintains the organization in 3 m spans of the other bodies from which it is separated by a seismic joint.

Outside the mentioned sections on the SE side of the high school, adjacent to section B, there is positioned its thermal power plant, a body with a height regime P. The section has an irregular shape that is inscribed in the plan in a rectangle with dimensions 14.1x13.1 m

The building is provided with a technical channel in which the pipes for distributing the thermal agent are arranged. In front of the classrooms, technical channels are provided through which the pipes serving each classroom are passed.

The main access to the building body is made on the SW side parallel to Electricienilor Street. Outside it, there is another access located on the opposite facade.

Height regime: ground floor and 2 floors for the bodies that make up the high school and ground floor for the thermal power plant body.

The high school body is an independent building that does not border other buildings. From an architectural point of view, the envelope is made up of:

- masonrywalls with thicknesses of30 cm;
- PVC windows with double glazing;
- ground slab composed ofscreed and reinforced concrete slab
- floor over the 2nd floor made ofreinforced concrete.
- floor over technical channel made ofreinforced concrete.

The building's strength structure is made of load-bearing masonry walls provided on both directions of the structure.

The height regime of the building body is +12.37 m from the +0.00 m elevation, represented by the floor elevation. The building is equipped with two stairwells.

The building's roof is made in the form of a wooden frame with a ceramic tile covering made in several waters. The roofofthe thermal power plant is of the non-circulatory terrace type.

The roof of the high school is made between elevations +10.95 and +15.51 m, considering the +0.00 m elevation as the ground floor elevation. The elevation the floor is located approximately 60 cm above the level of the landscaped land.

Through the design topic, the beneficiary requests the implementation of energy efficiency measures, repairs to damaged elements, the complete modernization of the exterior finishes, the replacement/repair of the heating system, the preparation of hot running water and the existing artificial lighting.

The works will lead to the improvement ofthe operating conditions, by:

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

1.2 Strength structure items

The architectural part comprises 4 bodies. Bodies A and B are regular bodies with a rectangular shape in plan. They are provided with a corridor and generally with classrooms arranged in 3 bays of 3 m each. Body C has a plan shape that approaches the shape of an L.

According to the technical expert report, the structural system is a dual one, made of load-bearing masonry walls that work together with reinforced concrete frames.

The frames are generally provided at a distance of 3 m and the masonry walls are provided between the classrooms and along the hallway.

The perimeter closures are 30 cm thick and the interior ones are 25 cm and 12.5 cm. The additional frame has a resistance structure in the form of a wooden structure, over which there is a ceramic tile covering.

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

1.3 Heating and hot running watersystems

The building has all utilities: electricity, water and sewage, gas.
The building is equipped with internal heating systems. There is a special room in the building serving as a central heating plant between axes 23 and 24 and axes N-M where the heating and hot water production system is installed. The heating system consists of two Viessman Vitoplex 100 heating plants. The same heating plants are used for the production of hot water.
The heating distribution system consists of a network of pipes located in the technical channel that connect the heating plants to the steel radiators
The radiators in the rooms are equipped with classic taps**.**

1.4 Ventilation systems

The building is not equipped with organized ventilationsystems.

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	1618.1
Slab on the ground	324.8
Floor abovethe last floor	1145.0
Floor above the thermal facility	151.9
Exterior carpentry	1136.7
Developed built area	5348.6

2.1.2. Thermal-technical characteristicsof the construction materials

Thethermal-technicalcharacteristicsofthe building materialsthat makeup the building elements are presented in the table below..

No crt.	Material name	Characteristics		Increase percentage	calculation thermal conductivity
		p [kg/m³]	γ [W/mK]		
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^{2}K];
  h_e – external surface heat transfer coefficient **[W/m^{2}K];**
- a- thermalconductivity 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	474.1	0.507	0.72	0.37	3.00
NW masonry exterior wall	281.4	0.507	0.75	0.38	3.00
SW masonry exterior wall	487.4	0.507	0.71	0.36	3.00
SE masonry exterior wall	375.2	0.507	0.77	0.39	3.00
Floor slab	972.1	0.545	0.91	0.50	4.50
Floor over technical channel	324.8	0.357	0.97	0.35	4.50
Floor on theground floor under the attic	1145.0	0.623	0.93	0.58	5.00
PVC NE Exterior windows	365.9	0.43	1	0.43	0.83
PVC NE Exterior doors	14.0	0.41	1	0.41	0.77
PVC NW Exterior windows	235.2	0.43	1	0.43	0.83
PVC NW Exterior doors	7.2	0.41	1	0.41	0.77
PVC SW Exterior windows	343.7	0.43	1	0.43	0.83
PVC SW Exterior doors	14.1	0.41	l	0.41	0.77
PVC SE Exterior windows	149.4	0.43	1	0.43	0.83
PVC SE Exterior doors	7.2	0.41	1	0.41	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.

2.1.4 Operating schedule, definition ofthe calculation formula and zoning
The building functions as a highschool 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:

Highschoolbuilding withinthe TechnicalEnergyCollege fromElectricienilor street, no. 1,

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

		Number of usage hours per day[h]								Total hours [h]	
		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	No.of days	Week	Month
	W1	10	10	10	10	10			15	50	
January	W2	10	10	10	10	10				50	150
	W3	10	10	10	10	10				50	
		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	No.of days	Week	Month
	W3			10	10	10				30	
	W4	10	10	10	10	10				50	
	W5	10	10	10	10	10				50	
February									15		150
	W6	10	10							20	
		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	No.of days	Week	Month
	W6			10	10	10				30	
	W7	10	10	10	10	10				50	
	W8	10	10	10	10	10				50	230
March	W9	10	10	10	10	10			23	50	
	W10	10	10	10	10	10				50	
		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	No.of days	Week	Month
	W10										150
	W11	10	10	10	10	10				50	
	W12	10	10	10	10	10				50	
April	W13	10	10	10	10	10			15	50	
		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	No.of days	Week	Month
	W13	10	10	10	10	10				50	
May	W14	10	10	10	10	10				50	
	W15	10	10	10	10	10			25	50	250
	W16	10	10	10	10	10				50	
	W17	10	10	10	10	10				50	
		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	No.of days	Week	Month
	W17				10	10				20	
	W18	10	10	10	10	10				50	
	W19	10	10	10	10	10				50	220
	W20	10	10	10	10	10			22	50	
June	W21	10	10	10	10	10				50	
		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	No.of days	Week	Month
	W21										
	W22	10	10	10	10	10				50	
	W23	10	10	10	10	10				50	150
July	W24	10	10	10	10	10			15	50	
		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								20		200
	W25	10	10	10	10	10				50	
	W26	10	10	10	10	10				50	
	W27	10	10	10	10	10				50	
	W28	10	10	10	10	10				50	
		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	No.of days	Week	Month
October	W28								20		200
	W29	10	10	10	10	10				50	
	W30	10	10	10	10	10				50	
	W31	10	10	10	10	10				50	
	W32	10	10	10	10	10				50	
		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	No.of days	Week	Month
November	W32	10	10	10	10	10			25	50	250
	W33	10	10	10	10	10				50	
	W34	10	10	10	10	10				50	
	W35	10	10	10	10	10				50	
	W36	10	10	10	10	10				50	
		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	No.of days	Week	Month
December	W36	10	10	10	10	10			15	50	150
	W37	10	10	10	10	10				50	
	W38	10	10	10	10	10				50	

2.1.5 The need of air for 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 complywith the recommended thermal performance requirements in terms of thermal strength and hygrothermal comfort.

2.2 Determination of the annual primary energy consumption for heating

The annual energyconsumption for heating is determined according to Chapter 3 of MC00l-2022, depending on the external and internal climatic parameters.

External climatic parameters

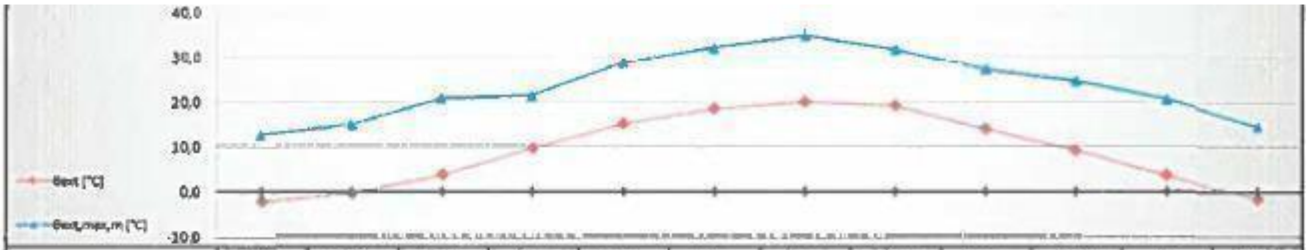
Conventional external calculation temperature

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:

$$\Theta_e = -18°C$$

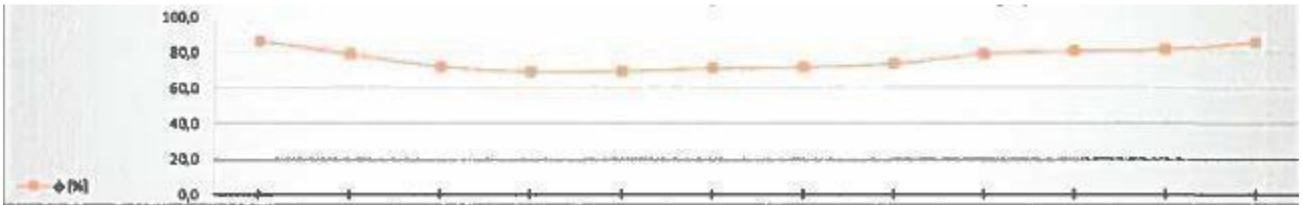
CLIMATE DATA for Sibiu

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



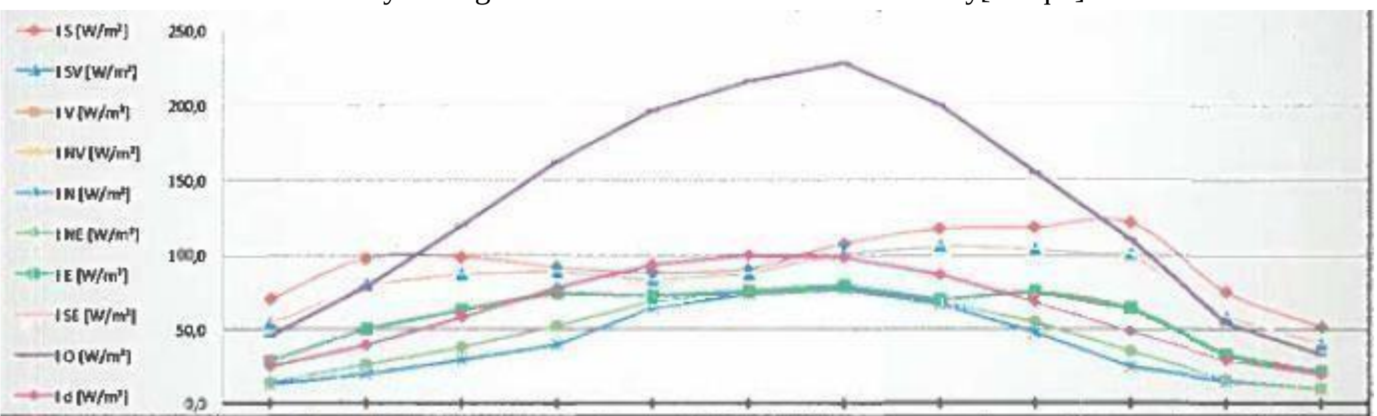
	Ian	Feb	Mar	Apr	Mai	Iun	Iul	Aug	Sep	Oct	Noi	Dec
θ_{ext} [°C]	-2,3	-0,3	3,8	9,7	15,2	18,5	20,1	19,2	14,0	9,2	3,6	-1,5
$\theta_{ext,max,m}$ [°C]	12,8	15,0	20,9	21,5	29,0	32,5	35,1	32,1	27,4	24,8	20,7	14,7

Monthly average values ofthe relative humidityof the 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 ofthe 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: $\Theta_{i,u}$ = 20 [°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 is the 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 $\left[\frac{W}{K}\right]$

1	ZTC1.1	θint;inc [°C]	θint;rac [°C]	A use;zi [m²]	g [m³/h]		Thermal inertia class	Average
		20,0		3580,0	14290,2	14290,2	Cm;zi/Ause;zi [J/m²K]:	165000

	Code	A e;i carpentry Nr.	[m²]	[m²]	A e;i [m²]	Orientare	r [-]	R' [m²K/W]	U'i [W/m²K]	Type of adjacent space	Adjacent area code	Hg [W/K]	Hd [W/K]	Hiu [W/K]	Hve [W/K]
1	PE1				474,1	NE	0,72	0,37	2,74	Ext.			1298,82		
2	PE1				281,4	NV	0,75	0,38	2,63	Ext.			739,99		
3	PE1				487,4	SV	0,71	0,36	2,78	Ext.			1354,02		
4	PE1				376,2	SE	0,77	0,39	2,56	Ext.			961,08		
5	PL attic				1145,0	ORIZ		0,58	1,72	ZT	ZTU1			1968,92	
6	PI - ground				972,1	ORIZ		0,50	2,01	Sol		556,14			
7	PI- technical channel				324,8	ORIZ		0,35	2,89	ZT	ZTU2			939,06	
8	FE-PVC		365,9	365,9		NE		0,43	2,33	Ext.			851,03		
9	UE-PVC		14,0	14,0		NE		0,41	2,43	Ext.			34,00		
10	FE-PVC		235,2	235,2		NV		0,43	2,33	Ext.			546,88		
11	UE-PVC		7,2	7,2		NV		0,41	2,43	Ext.			17,51		
12	FE-PVC		343,7	343,7		SV		0,43	2,33	Ext.			799,27		
13	UE-PVC		14,1	14,1		SV		0,41	2,43	Ext.			34,25		
14	FE-PVC		149,4	149,4		SE		0,43	2,33	Ext.			347,51		
15	UE-PVC		7,2	7,2	14,0	SE		0,41	2,43	Ext.			17,51		4715,77
16	PI-central				151,9	ORIZ	0,8	0,26	3,87	Ext.			587,85		
17															
18															
19															
20															
21															
												556,14	7589,70	2907,97	4715,77

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]
281.00	0.30	1.68	0.3	1.26E-0.6	2.20	0	1	1	16.9	3.4	9.1	11.4

	Ian	Feb	Mar	Apr	Mai	Iun	Iul	Aug	Sep	Oct	Noi	Dec	
θintinc [°C]	20,0	20,0	20,0	20,0	20,0	20,0	20,0	20,0	20,0	20,0	20,0	20,0	HEATING
θintrac [°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	
Hia [W/K]													Max
Ha [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
Hg [W/K]	558,23	574,33	585,55	588,89	583,46	570,70	554,05	537,95	526,73	523,39	528,82	541,58	
Hu [W/K]	1298,18	1298,18	1298,18	1298,18	1298,18	1298,18	1298,18	1298,18	1298,18	1298,18	1298,18	1298,18	1298,2
Htr [W/K]	9446,11	9462,21	9473,43	9476,77	9471,34	9458,59	9441,93	9425,84	9414,61	9411,27	9416,71	9429,46	9476,8

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

COOLING	Decreased day	
	$\Delta t_{H;red;y}$	
	$n_{rep;red;y}$	
	$f_{H;red;y}$	0,00

COOLING	Decreased weekend	
	$\Delta t_{H;red;y}$	48
	$n_{rep;red;y}$	1
	$f_{H;red;y}$	0,29

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

$\eta_{H,U;nd}$	
$(\Delta x \cdot 1)_{a,sup}$	
φ V;comf2	
$f_{DHU;C;ss}$	

Low	
$a_{H;0}$	0,8
$\tau_{H;0}$	70
H final [W/K]	14192,54

Internal intakes

Next, internal intakes are calculated basedon theoccupants and equipment located in the building.

1	ZTC1.1

	Type	Thermal power: Predefined Nr	Predefined [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]
1	soft activity occupants	600	66990		21	21	31	21	31	30	21	0	28	28	30	21
2	lighting - linear fluorscent T26	600	18000		21	21	31	21	31	30	21	0	28	28	30	21
3	Desktop-type computers	50	17500		21	21	31	21	31	30	21	0	28	28	30	21
4																
5																
6																
7																
8																
9																
10																
11																
12																
13																
14																
15																
	Total power and operating hours		102490	0	168,0	168,0	248,0	168,0	248,0	240,0	168,0	0,0	224,0	224,0	240,0	168,0

Legend: zile = days

	Interuor heat intakes: Ian [kWh]	Feb [kWh]	Mar [kWh]	Apr [kWh]	Mai [kWh]	Iun [kWh]	Iul [kWh]	Aug [kWh]	Sep [kWh]	Oct [kWh]	Noi [kWh]	Dec [kWh]	TOTAL: Type of source [kWh]	TOTAL: Annually [kWh]
1	11254,32	11254.32	16613.52	11254,32	16613,52	16077.60	11254,32		15005.76	15005,76	16077,60	11254,32	151665.36	
2	3024,00	3024.00	4464.00	3024,00	4464.00	4320.00	3024,00		4032.00	4032,00	4320,00	3024,00	40752,00	
3	2940,00	2940.00	4340.00	2940,00	4340,00	4200.00	2940.00		3920.00	3920.00	4200,00	2940,00	39620,00	
4														
5														
6														
7														
8														232037,36
9														
10														
11														
12														
13														
14														
15														
	17218,32	17218.32	25417,52	17218,32	25417,52	24597,60	17218,32	0,00	22957,76	22957,76	24597,60	17218,32		

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 Introduced	[°]	$\alpha_{sol;k}$ [-]	$g_{gl;n;wi}$ [-]	$g_{gl;wi}$ [-]	$F_{fr;wi}$ [-]	$F_{sky;k}$ [-]	$F_{sh;ob}$ [-]
1	PE1	DULL	474,12	2,74	NE		90	0,60				0,50	0,90
2	PE1	DULL	281,38	2,63	NV		90	0,60				0,50	0,90
3	PE1	DULL	487,41	2,78	SV		90	0,60				0,50	0,90
4	PE1	DULL DULL	375,20	2,56	SE		90	0,60				0,50	0,90
5	PL pod	INTERIOR	1145,00	1,72	ORIZ								
6	Pl - sol	GROUND	972.10	2.01	ORIZ		0						
7	Pl techn.chann	INTERIOR	324,80	2,89	ORIZ								
8	FE-PVC	TRANSPARENT	365.94	2.33	NE		90		0,60	0,54	0,21	0,50	0,90
9	UE-PVC	TRANSPARENT	13,98	2.43	NE		90		0,60	0,54	0,56	0,50	0,90
10	FE-PVC	TRANSPARENT	235.16	2.33	NV		90		0,60	0,54	0,21	0,50	0,90
11	UE-PVC	TRANSPARENT	7.20	2.43	NV		90		0,60	0,54	0,56	0,50	0,90
12	FE-PVC	TRANSPARENT	343,68	2.33	SV		90		0,60	0,54	0,21	0,50	0,90
13	UE-PVC	TRANSPARENT	14.09	2.43	SV		90		0,60	0,54	0,56	0,50	0,90
14	FE-PVC	TRANSPARENT	149.43	2.33	SE		90		0,60	0,54	0,21	0,50	0,90
15	UE-PVC	TRANSPARENT	7.20	2.43	SE		90	0,60	0,60	0,54	0,56	0,50	0,90
16	Pl-central	ROOF	151.90	3.87	ORIZ		0	0,60				1,00	0,90
17													

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

	Dec.(0)	Ian	Feb	Mar	Apr	Mai	Iun	Iul	Aug	Sep	Oct	Noi	Dec	Total
1	6,90	9,22	16,58	30,84	27,90	61,94	184,80	130,88	0,00	135,81	30,30	16,39	6,90	
2	3,93	5,25	9,45	17,57	15,90	35,29	105,29	74,57	0,00	77,38	17,26	9,34	3,93	
3	196,06	265,19	370,40	524,26	350,69	548,37	414,04	325,57	0,00	492,90	635,45	437,25	196,06	
4	139,16	188,22	262,90	372,12	248,92	389,23	293,88	231,09	0,00	349,86	451,04	310,35	139,16	
5														
6														
7														
8	21,67	28,82	54,69	120,31	106,34	238,41	687,71	489,72	0,00	457,74	97,89	58,10	21,67	
9	0,46	0,61	1,15	2,54	2,29	5,03	14,51	10,33	0,00	9,66	2,07	1,18	0,46	
0	13,92	18,52	35,15	77,31	69,62	153,20	441,93	314,70	0,00	294,15	62,90	38,05	13,92	
1	0,24	0,31	0,59	1,31	1,18	2,59	7,47	5,32	0,00	4,97	1,06	0,61	0,24	
2	554,57	748,80	1100,83	1842,75	1226,68	1901,57	1388,11	1097,48	0,00	1496,62	1849,48	1348,38	554,57	
3	12,55	16,90	24,92	41,71	27,77	43,65	31,42	24,84	0,00	33,88	41,87	30,52	12,55	
4	241,12	324,70	478,63	801,21	533,35	826,78	603,54	477,17	0,00	650,72	804,14	588,26	241,12	
5	6,42	8,64	12,74	21,32	14,19	22,00	16,06	12,70	0,00	17,32	21,40	15,60	6,42	
6	99,77	138,27	225,97	445,64	397,24	807,60	610,88	580,39	0,00	582,67	431,84	250,79	99,77	38923,8
7														
8														
9														
0														
1														
2														
3														
4														
5														
6														
7														
8														
9														
0														
	1296,8	1751,4	2594,0	4298,9	3024,1	5035,1	4999,6	3774,8	0,0	4603,7	4446,7	3096,8	1296,8	

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

$$Q_{sky,eli}=24492.4\ KWh/year$$

Need for heating

The table below presents the heating requirements for the highschool 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	16115,5	15108,7	19707,6	10252,4	7461,1	1082,8	0,0	0,0	7678,7	13931,7	20648,2	15594,1	127580,8

	ZONE	Ian	Feb	Mar	Apr	Mai	Iun	Iul	Aug	Sep	Oct	Noi	Dec	Total
1	ZT1	16115,5	15108,7	19707,6	10252,4	7461,1	1082,8	0,0	0,0	7678,7	13931,7	20648,2	15594,1	127580,8
	Total ZT	16115,5	15108,7	19707,6	10252,4	7461,1	1082,8	0,0	0,0	7678,7	13931,7	20648,2	15594,1	127580,8

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.

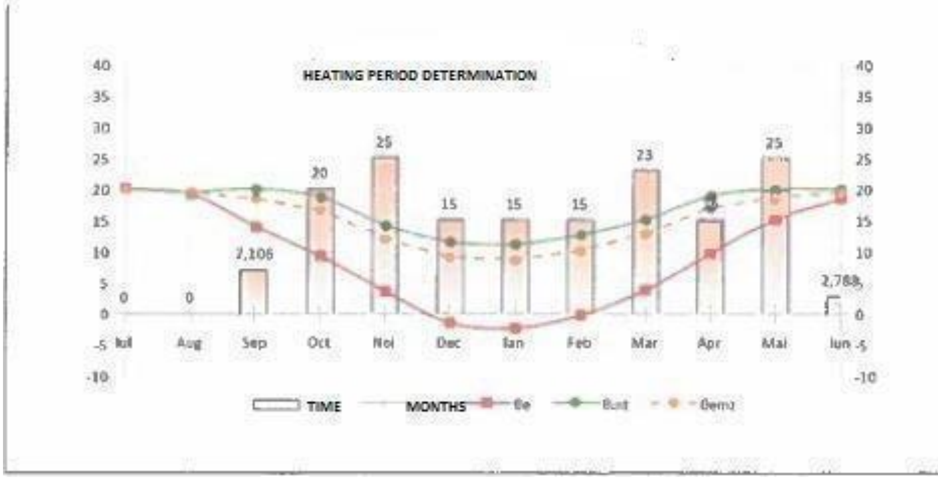
Ɵh(tr,ve;sol,int,)-Heat transferred by transmission for heating, ventilation, solar gains, internal gains

T_H-time constant of the heated area

Intermittent heating is taken into account through the γ coefficients.

1	ZTC1.1	$H_{gr,H,adj}$	336,66 [W/K]

Month [-]	Hrs [h]	$Q_{H,tr;cont}$ [kWh]	$Q_{H,ve;cont}$ [kWh]	$Q_{H,ht;cont}$ [kWh]	τ_H [h]	$Q_{H,sol}$ [kWh]	Q_r [kWh]	$Q_{H,sol}$ [kWh]	$Q_{H,int}$ [kWh]	$Q_{H,gn}$ [kWh]	$Q_{H,tr}$ [kWh]	$Q_{H,ve}$ [kWh]	$Q_{H,ht}$ [kWh]	$\gamma_{H,gn;cont}$ [-]	γ_H [-]	a_H [-]	$\eta_{H,gn}$ [-]	$Q_{H;nd}$ [kWh]	f_H [-]	Humidification f_{HU} [-]	Humidification $Q_{HU;nd}$ [kWh]
Dec	150	28839	15208	44048	11,2	1297	1758	-481	17259	16798	18395	9151	27546	0,38	0,61	0,96	0,61	15594	1,00	0,12	0,0
Ian	150	29877	15774	45651	11,1	1751	1750	1	17259	17260	18965	9459	28423	0,38	0,61	0,96	0,61	16116	1,00	0,13	0,0
Feb	150	27471	14360	41831	11,1	2594	1895	699	17255	18154	18412	9126	27538	0,43	0,66	0,96	0,59	15109	1,00	0,12	0,0
Mar	230	34302	17571	51873	11,1	4299	2299	2000	25458	27458	25070	12246	37316	0,53	0,74	0,96	0,56	19708	1,00	0,15	0,0
Apr	150	15063	7286	22349	11,1	3024	1605	1419	17258	18677	13714	6508	20222	0,83	0,92	0,96	0,51	10252	1,00	0,08	0,0
Mai	250	12570	5659	18229	11,1	5035	2358	2177	25458	27635	12570	5659	18229	1,51	1,52	0,96	0,39	7461	1,00	0,06	0,0
Iun	220	4216	1556	5773	11,1	5000	2692	2307	24637	26945	4216	1558	5773	4,66	4,67	0,96	0,17	1083	0,13	0,01	0,0
Iul	150	0	0	0	11,2	3775	1856	1919	17259	19178	0	0	0	0,00	0,00	0,96	0,00	0	0,00	0,00	0,0
Aug	0	0	0	0	0,0	0	0	0	41	41	0	0	0	0,00	0,00	0,80	0,00	0	0,00	0,00	0,0
Sep	200	12261	5659	17920	11,2	4604	2579	2025	22997	25022	12261	5659	17920	1,39	1,40	0,96	0,41	7679	0,36	0,06	0,0
Oct	200	20822	10186	31008	11,2	4447	2558	1889	22999	24867	18583	8885	27468	0,80	0,91	0,96	0,51	13932	1,00	0,11	0,0
Noi	250	37266	19335	56601	11,2	3099	2842	257	24637	24894	25265	12363	37628	0,44	0,66	0,96	0,59	20648	1,00	0,16	0,0
Dec	150	28839	15208	44048	11,2	1297	1758	-481	17259	16798	18395	9151	27546	0,38	0,61	0,96	0,61	15594	1,00	0,12	0,0
		222664		335292		38924	24492	14431	232517	246944	167451	80612	248063					127581			0



	θ_e	θ_{int}	θ_{emz}	TIME [DAYS]
Iul	20,10	20,00	20,00	0,00
Aug	19,20	19,49	19,40	0,00
Sep	14,00	20,00	18,50	7,11
Oct	9,20	18,62	16,63	20,00
Noi	3,60	14,09	12,09	25,00
Dec	-1,50	11,44	9,10	15,00
Ian	-2,30	11,07	8,66	15,00
Feb	-0,30	12,60	10,17	15,00
Mar	3,80	15,09	12,84	23,00
Apr	9,70	18,90	16,95	15,00
Mai	15,20	20,00	18,74	25,00
Iun	18,50	20,00	19,37	2,79

The graph above shows:

Θ_e= monthly average externaltemperature, in Celsius degrees

Θ_{int}= monthlyaverage 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 162.89 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 emission energy calculation

Heating emission energy consumption calculation 34154,893 [kWh/-yr]
Specific heating energy emission consumption 9,54 [kWh/m².yr]

Total floor reference area 3580,00 [m²]

	Ian	Feb	Mar	Apr	Mai	Iun	Iul	Aug	Sep	Oct	Noi	Dec	Total
ZT1	2348,7	2418,9	3953,7	3235,0	5051,8	2346,1	0,0	0,0	4159,3	4192,4	4091,9	2357,2	34154,893
TOTAL	2348,7	2418,9	3953,7	3235,0	5051,8	2346,1	0,0	0,0	4159,3	4192,4	4091,9	2357,2	34154,893

Equipments electric consumption control	
ZT1	0,000
TOTAL	0,000

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

	Ian	Feb	Mar	Apr	Mai	Iun	Iul	Aug	Sep	Oct	Noi	Dec
QH;dis;in [kWh]	18720,828	17772,878	24006,973	13683,051	12814,392	3481,494	0,000	0,000	11924,620	18388,065	25125,220	18204,770
QW;dis;in [kWh]	3275,072	3254,558	4869,532	5271,845	5270,602	5060,325	3221,542	172,741	4245,225	4258,375	5296,927	3273,231
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]	0	0	0	0	0	0	0	0	0	0	0	0

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:

$$q_{inc} = 60{,}3 \left[\frac{kWh}{year \cdot m^2}\right]$$

The building, from a heating point of view, falls into class C, with a specific annual primary energy consumption of 60.3 kWh/sqm per year.

2.3 Determination of annual primary energy consumption 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	$H_{gr,C,adj}$	1554,63	[W/K]

Month [-]	Hrs [h]	$Q_{C,tr}$ [kWh]	$Q_{C,ve}$ [kWh]	$Q_{C,ht}$ (kWh)	τ_C [h]	$Q_{C,sol}$ [kWh]	Q_I [kWh]	$Q_{C,sol}$ [kWh]	$Q_{C,int}$ [kWh]	$Q_{C,gn}$ [kWh]	$\gamma_{C,gn;cont}$ [-]	a_C [-]	$\eta_{C,ls}$ [-]	$Q_{C;nd;cont}$ [kWh]	$a_{C;red;wknd}$ [-]	$Q_{C;nd}$ [kWh]	f_C [-]	Dehumidification f_{DHU} [-]	$Q_{DHU,nd}$ [kWh]
Dec	150	38266	19453	55718	10,5	0	0	0	0	0,0	0,00	0.95	0,00	0,0	1,00	0,0	0,00	0.00	0,00
Ian	150	37319	20018	57337	10,4	0	0	0	0	0,0	0,00	0.95	0,00	0,0	1,00	0,0	0,00	0,00	0,00
Feb	150	34920	18604	53523	10,4	0	0	0	0	0,0	0,00	0,95	0,00	0,0	1,00	0,0	0,00	0,00	0,00
Mar	230	45714	24079	99792	10,4	0	0	0	0	0,0	0.00	0.95	0,00	0,0	1,00	0,0	0.00	0.00	0,00
Apr	150	22486	11530	34016	10,4	0	0	0	0	0,0	0,00	0,95	0,00	0,0	1,00	0,0	0,00	0,00	0,00
Mai	250	24856	12733	37588	10,4	0	0	0	0	0,0	0,00	0,95	0,00	0,0	1,00	0,0	0,00	0,00	0,00
Iun	220	14970	7781	22751	10,4	5000	2692	2307	24605	26912,4	1,18	0,95	0,53	14904,8	1,00	14904,8	0,87	0,46	0,00
Iul	150	8428	4173	12602	10,4	3775	1856	1919	17226	19144,8	1,52	0,95	0,59	11738,1	1,00	11738,1	1,00	0,36	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	200	22046	11318	33364	10,5	3074	1722	1352	15336	16688,0	0,50	0,95	0,33	5831,6	1,00	5831,6	0,64	0,18	0,00
Oct	200	30650	15845	46494	10,5	0	0	0	0	0,0	0,00	0,95	0,00	0,0	1,00	0,0	0,00	0,00	0,00
Noi	250	49592	26408	76000	10,5	0	0	0	0	0,0	0,00	0,95	0,00	0,0	1,00	0,0	0,00	0,00	0,00
Dec	150	38266	19453	55718	10,5	0	0	0	0	0,0	0,00	0.95	0,00	0,0	1,00	0,0	0.00	0,00	0,00
		327345		499187		11848	6270	5578	57187	62745				32475		32475			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	24,11	0,00
Iul	20,10	26,00	23.80	0,00
Aug	19,20	26.00	26.00	0.00
Sep	14,00	26.00	24,81	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 calculationshowed 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: 3580 sqm
Reference interior volume: 11814 m^3

Area infiltrations ratio: 0.50 vol/h
Ground thermal transfer coefficient calculated in stationary mode: 558.9 W/K
Thermal transfer coefficient through transmission: 887.9 W/K
Specific thermal capacity: 45.8 Wh/m^3K
Internal intakes: 34163.3 W

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
17218.3	17218.3	254171.5	17218.3	254171.5	24697.6	17218.3	0,0	22597.8	2297.8	24597.6	17218.3

Solar intakes: 6.8 KWh/day

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sвp	Oct	Nov	Dec
1751.4	2594.0	4298.9	3024.1	5035.1	4999.6	3774.8	0,0	4603.7	4446.7	3098.8	1295.8

Doesthe mechanical ventilation system exist? No

Freshair flow provided bythe ventilation system fromthe building: m^3/h
0,00 vol/h

Ventilation system yield: %
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) : 241 hours
Percentage of total yearly number of hours: 2.75 %

2.4 Determination of the primary energy consumption for preparing the hot running water Energy consumption evaluation for preparing the hot running water is made starting from the hot running water consumption for one person per day and depending on the activities carried out by such persons.

HOT RUNNING WATER ENERGY CONSUMPTION CALCULATION

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
Generalheating meter: does not exist
Doesthe hot running water system exist: Yes, it works

1. ZT1 Reference area: 3580.0 sqm
Living area: 0.0 sqm

Energy source for preparing the hot running water:
Own source (individual thermal plant): natural gas

Recirculation pump: NO
Centralized heating with connection to a thermal point: local central
Type of equipments for preparing the hot running water: Boiler with accumulation 1 volume: 2000 l
Debit metres on the consumption points: do not exist
Daily schedule for hot running water: 8 hrs/day
Number of sanitary items uses: 100 1/day

Sanitary items
WC: 25 Urinals: 9 Hot water consumption points: 19
Washbasins: 19 Cool water cons. points: 63

13. Schools without washers or bathrooms
a. Schools without washers or basins for one student per program

V_{day}	Days											
l/. day	Ian	Feb	Mar	Apr	Mai	Iun	Iul	Aug	Sep	Oct	Noi	Dec
3517,0	15	15	23	25	25	24	15	0	20	20	25	15

Facilities supplied in local system
Systems equipped with single command remote controls
f- average number of daily consumption units = 609.00 [0]
Number of students: 600 people
$V_{w,f,day}$ = specific need for one consumer : 5.00 l/unit,day
$V_{w,day}$ = volume need of hot running water [3045.00] l/day
$V_{w,l,s\ day}$ = volume corresponding to water loss 471.98 l/day

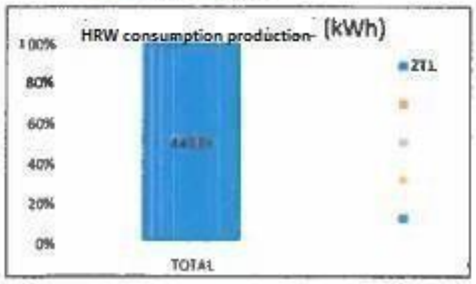
	Ian	Feb	Mar	Apr	Mai	Iun	Iul	Aug	Sep	Oct	Noi	Dec
Number of hot running water consumption days - no recirculation	120	120	184	200	200	192	120	0	160	180	200	120
Number of operating days of the recirculation pump	120	120	184	200	200	192	120	0	160	180	200	120
Qw, nd monthly [kWh/month]	3038,4	3038,4	4855,9	5060,7	5060,7	4858,3	3038,4	0,0	4048,6	4048,6	5060,7	3038,4

Qw,nd, annual, ZT1 44939,080 [kWh/an] Qw,nd, annual, spec., ZT1 12,55 [kWh/m²,an]

Total energycalculation for providing the necessary hot running water – SUMMARY

Total energy necessary for hot running weter	44939,080	[kWh/ yr]
Specific energy necessary for hot running weter	12,55	[kWh/m², yr]
Floor total reference area	3580,00	[m²]

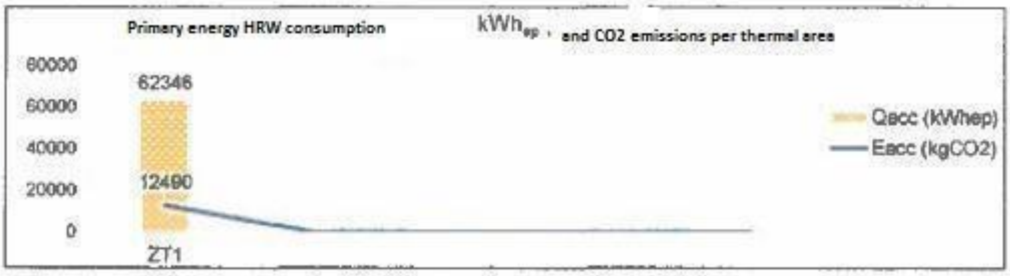
	Ian	Feb	Mar	Apr	Mai	Iun	Iul	Aug	Sep	Oct	Noi	Dec
ZT1	3036,4	3036,4	4855,9	5060,7	5060,7	4858,3	3036,4	0,0	4046,6	4048,6	5060,7	3036,4
TOTAL	3036,4	3036,4	4855,9	5060,7	5060,7	4858,3	3036,4	0,0	4048,4	4048,6	5060,7	3036,4



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	44939,080	389,368	2161.507	4858,001	52347,976	439,601	61247,131	1099,004	62346,135	12489.514
TOTAL		44939,080	389,388	2161,507	4858,001	52347,976	439,601	61247,131	1099,004	62346,135	12489,514

#	AREA	Qw,max
um	[-]	[kW]
1	ZT1	0,332
TOTAL		0,332



$Q_{W,in,total}$	62346,135	[kWh/ yr]	$Q_{W,in,spec}$	17,42	[kWh/m², yr]
CO2 emissions	12489,514	[$kgCO_2$/ yr]	Specific CO2 emissions	3,49	[$kgCO_2/m^2$ yr]

The building, in terms ofthe preparation of hot running water, falls into class B, having a specific annual primary energy consumption of 17.42 kWh/sqm/year

2.5 Determining the annual primaryenergy 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 energyconsumption for lighting

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

ZT code: ZT1 ZT area category:04 – educational establishments ZT area destination:a-classroom

power estimated: yes

Floor reference area: 3580.00 sqm
Lighting power known:4400,0 [W]

Length, L: 358.00 [m]
Lighting level, E_m: 300 [lx]

Width, W: 10.00 [m]
Maintainance factor, FM: 0,6[–]

Height, h_m:3.30 [m]
Lighting area percentage: 100% [%]

Room index, K: 2.948 [-]
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: 0.0221 [W/x]
Occupation control: 1 – Manual On/Off

Power density: 8.40 W/sqm
emergency light battery consumption: 0 [kWh/sqm.year]

Estimated lighting power: 30070.40 W
stand-by energy consumption: 0 [kWh/sqm.year]

Correction factor, Fmf: 1.33 [-]
constant lighting factor, Fc: 1 [-]

Absence factor, Fa: 0.25 [-]
control II dependency factor, Foc: 1 [-]

Power decrease factor, F_{CA}: 1.00 [-]
occupation dependency factor, F_c: 0.95 [-]

Sourse efficiency factor, F_L: 0.95 [-]

Natural light dependency factor

Type of natural light control: Manual

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

Thermal area results – ZT1

- Usagehours/day: 1000
- Usagehours/night: 200
- Total usage hours: 2000
- Total electricity lighting annual consumption: 33690.370 [kWh/year]
- LENI(Preliminary) indicator: 9.41 [kWh/sqm.year]

Safety lighting charging power, Pem: 0.0 W

power lighting controls-Ppc: 0.0 W

Energy consumption for lighting

Wtotal: 84225.925 [kWh/year]
LENI:23.53 [kWh/sqm.year]

CO2emissions: 9012.174 [kgCo2/year]
Specific CO2 emissions: 2.52 [[kgCo2/sqm.year]

The building, from lighting point of view, falls into class C, with a specific annual primary energy consumption of 23.53 kWh/sqm. year.

2.7 Determining the annual consumption of primary 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]	181.224	52.348	0.000	0.000	0.000	0.000	233.572
Final electricity consumption [MWh/year]	1.856	0.440	55.848	0.000	33.690	45.917	91.834
Primary energy consumption [MWh/year]	216.672	62.347	139.620	0.000	84.226	45.917	502.865
Specific energy consumption [kWh/sqm.year]	60.52	17.42	39	0	23.53	12.83	140.47
ENERGY EFFICIENCY CLASS	B	B	E	-	C	-	C

The primary energy consumed to ensure comfort in the building is determined, 140.47 kWh/sqm, year - CLASS C.
Based on the total annual consumption of thermal and electrical energy, the annual CO_2 equivalent emissions are determined. The specific amount of CO_2 is 22.2 kg/sqm. year.
The RER indicator is determined with the relationship

$$RER = \frac{E_{p,regen}}{E_p} \cdot 100 = 9.14\%$$

3. Drafting of the energyperformance certificate

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

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 building is defined as follows:

  - for the construction elements that are part of the building envelope, the recommended values of the corrected thermal strengths 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 CO2 emissions indicated in MC001-2022 table 2.10b (chapter 2.3.), for buildings intended for the heating system. climate zone III (13.10 kgCO2/sqm. year), considering the building equipped with all technical systems (heating, hot running water, lighting, ventilation and cooling)

Reference building		
Primary energy consumption [kWh/sqm.year]		CO2 emissions [kgCO2/sqm.year]
Heating	82.70	13.10
Hot running water		
Cooling		
Ventilation		
Lighting		
Class	B	B

3.2 ENERGY PERFORMANCE CERTIFICATE

drafted according to the Calculation Methodology ofthe Buildings EnergyPerformance no.001

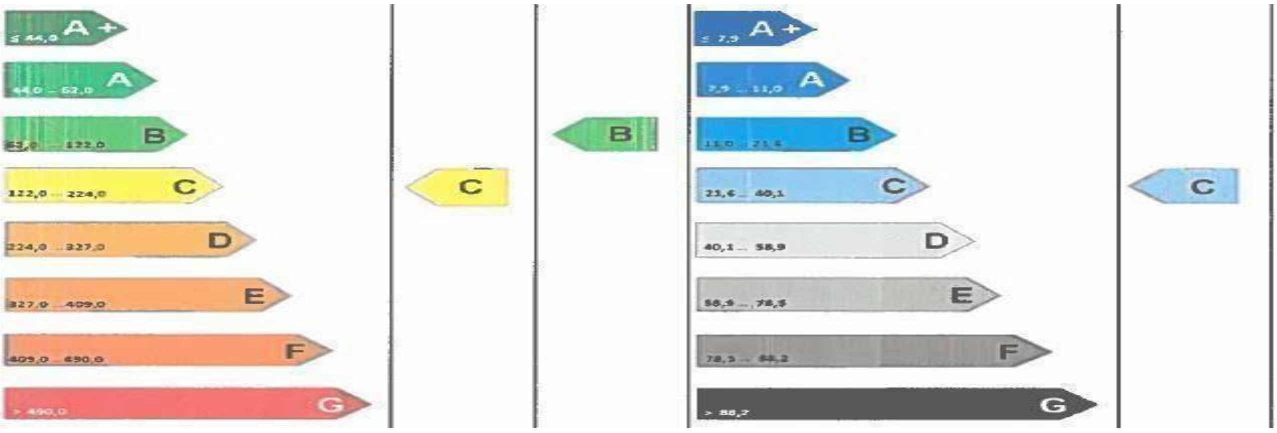
DATAREGARDING THE CPE AND THE ENERGY AUDITOR IDENTIFICATION

CPE number 000131/550311 Valid 10 years until 13.05.2025 if no major changes appear Cruciat Radu-Iuliu Energyauditor Certificate SSA/02258 grade I

DATA REGARDING THE BUILDING/BUILDING BLOCK CERTIFIED NZEBNO

Building category: school/highschool/college Year of building/major refurbishment: 1966
Building address: Sibiu, Electricienilor street no.1 , Sibiu county Floor reference area: 3580.00 sqm
GPS coordinates (lat x long): 45.78454x 24.16796 Built/developed area: 1389/3835 sqm
Height regime: Gf+2F Reference interior volume: 12678.00 m3
CPE drafting purpose: Information Calculation programme used: ENERG+ version 04/2024

ENERGY PERFORMANCE TRUE BUILDING REFERENCE BUILDING CO2 EMISSIONS LEVEL
kWh/sqm.year – total primaryenergy kgCo2/sqm.year
High energyperformance Low pollution level



Total annual specificenergy consumption (kWh/sqm.year)	Final	65.1	25.7	CO2 equivalent emissions level (kgCo2/sqm.year)	22.2
	primary	140.3	82.7		

low energyperformance high pollution level

Annual specific energy consumption from renewablesources (Kwh/sqm.year)	Thermal solar	Electric solar	Heat pumps	Biomass	Other SREtype	Total SRE
	0.0	0.0	0.0	0.0	12.8	12.8

Type of installation system true building	Energy class / Annual specific consumption of primary energy per utility (kWh/m².yr) *							
	A+	A	B	C	D	E	F	G
Heating	≤ 26	26 – 36	60.3	71 – 144	144 – 218	218 – 272	272 – 327	> 327
Hot running water	≤ 7	7 – 10	17.4	19 – 26	26 – 33	33 – 41	41 – 49	> 49
Cooling ***	≤ 4	4 – 6	6 – 13	13 – 22	22 – 31	31 – 38	38 – 46	> 46
Mechanical ventilation	≤ 4	4 – 6	6 – 11	11 – 21	21 – 31	39.0	39 – 46	> 46
Lighting	≤ 7	7 – 10	10 – 21	23.6	33 – 45	45 – 57	57 – 68	> 68

*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 = 241h (is 0 ifthe cooling consumption is calculated)
Auditor's signature and stamp

B. ENERGY AUDIT REPORT

4. Description of the thermal 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 A or B energy performance certificate

According to the specific guide - the eligible intervention works are:

thermal refurbishment works of the building envelope elements;
thermal refurbishment worksofthe building envelope
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 energysources;
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 oftechnical systems of buildings;
provision of charging 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 of the building

Solution 1. This solution will improve the thermal strength of the envelope elements, namelyexterior walls, floor above the last floor and floor above the technical channel.

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 $\gamma < 0.038$ 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 last floor with natural sheep wool insulation with a thickness of 25 cm and a minimum thermal strength of γ<0.038 W/mK.

Thermal insulation of the floor above the technical channel with polystirene or mineral wool thick of 10 cm. We recommend that the thermal insulation used to have a thermal conductivity 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 strength 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 solution refers to the building's installations.

3.1. In order to increase the efficiency of the heating system,a condensing gas boiler will be installed in the current thermal plant. It wil serve for overtaking the eventual consumption peaks, the building heating following to be made mainly by using heat pumps.

3.2. A air-water heat pump will be installed. The boiler will be used to take over the consumption peaks during the winter and will be adjusted as to prioritize as much as possible the use of heat pumps. The calculation took into account one heat pump with COP4. We recommend to change the thermal agent distribution network and we also recommend to replace the used static bodies with new ones.

3.3 A system of 90 photovoltaic panels (36 kWh) will be arranged on the roof structure, on SW and/or SE directions that will produce electricity for the lighting system, for the heat pumps , and for preparing the hot running water. The photovoltaic panels will be connected to the national network in order to benefit froma compensation according to the regulations in force.

3.4 Ventilation will be made in an organized manner. Ventilation systems will be provided with heat recovery in each class. They have been calculated for an efficient heat recovery of 72%.

3.5 The lighting fixtures will be replaced with some led fixtures. Once with these changes one will inspect the electrical system condition and if it shows damages, they will be repaired. We recommend to use the presence sensors for the circulation areas.

Related works. The following is a brief description of the related works that will be carried out together with the main thermal refurbishment 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, the thermal insulation of the floor above the technical channel with a 10 cm thermal insulation layer and the replacement of the existing carpentry.

The corrected, recalculated thermal strengths 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'min [sqmK/W]	Criteria Fulfilled
NE exterior masonry wall	474.1	3.03	3.00	YES
NWexterior masonry wall	281.4	3.12	3.00	YES
SWexterior masonry wall	487.4	3.08	3.00	YES
SE exterior masonry wall	375.2	3.21	3.00	YES
Ground slab	972.1	0.53	4,50	NO
Floor over the last floor below the attic	1145.0	5.86	5.00	YES

Flooring over thetechnical channel	324.8	2.66	2.50	YES
NE exterior windows	365.9	0.83	0.83	YES
NE exterior doors	14	0.77	0.77	YES
NW exterior windows	235.2	**0.83**	0.83	YES
NW exterior doors	7.2	**0.77**	0.77	YES
SWexterior windows	343.7	0.83	0.83	YES
SW exterior doors	14.1	0.77	0.77	YES
SE exterior windows	149.4	0.83	0.83	YES
SE exterior doors	7.2	0.77	0.77	YES

The ground slab does not comply with the minimum strengthspecified 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 36 kWh is implemented. The calculation considered a number of 90 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:

I1 Solar radiationon 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

CALCULATION OF ENERGY PRODUCED BY THE PHOTOVOLTAIC PANELS

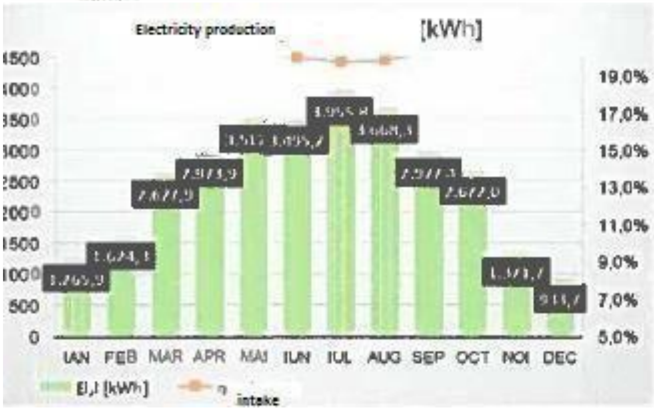
Thermal area related to the photovoltaic solar system: ZT1
Entry data photovoltaic system
Type of panel: 400 Wp Monocrystalline Yield = 21%
Maximum electrical power: 400 W

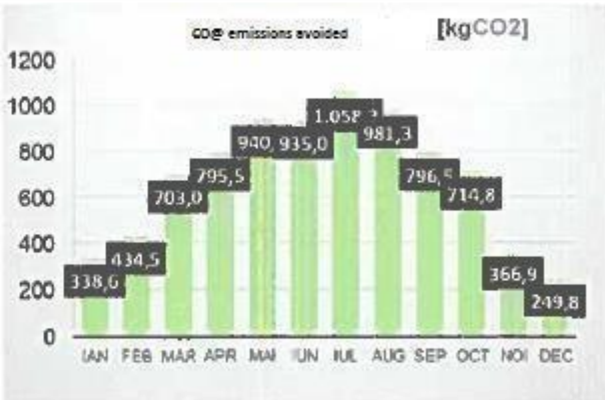
Nominal yield: 21% | Installation method: onthe building
Solar panel area: 2.11 sqm | Calculation method: complex
Number of solar panels: 90 | Panels orientation: SW
Total electrical power: 36.000,0 W | Inclination angle: 36%
Nominal temperature: 45°C
Module temperature coefficient: 0.4%
Energy loss expressed in percentages:

Dust: 0.01% Age: 0.1% | Initial degradation: 0.1% | Availability: 1% | Inverter loss: 10%
Shadowing: 0.25% | Cables: 0.2% | Producer:0.15% | FV panels: 0.2%
Snow: 0.5% | Connections: 0.1% | Imperfections: 0.2% | Total energy loss: 2.81%

ENERGYPRODUCTION RESULTS

	Ian	Feb	Mar	Apr	Mai	Iun	Iul	Aug	Sep	Oct	Noi	Dec	Total
$I_{T,Orz}$ [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	1596,3
neíd	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]	62,2	99,5	134,1	166,2	188,3	202,8	217,4	201,1	179,4	140,1	73,9	45,8	1701,8
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]	190,22	190,22	190,22	190,22	190,22	190,22	190,22	190,22	190,22	190,22	190,22	190,22	
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_i	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]	8808,525	12715,374	18978,081	22768,329	26853,402	27768,410	30767,439	28458,992	23332,483	19824,348	10119,972	6478,364	236673,72
E_{u} [kWh]	1265,910	1624,336	2627,928	2973,949	3517,059	3495,232	3955,763	3668,289	2977,441	2671,979	1371,653	933,746	31083,29
Emisii[kgCO_2]	338,6	434,5	703,0	795,5	940,8	935,0	1058,2	981,3	796,5	714,8	366,9	249,8	8314,78
η_{intake}	22,1%	21,7%	21,3%	20,7%	20,3%	20,0%	19,8%	19,8%	20,3%	20,7%	21,5%	22,1%	





TOTAL ENERGY PRODUCED: 31083.285 [kWh/year]
TOTAL SPECIFIC ENERGY PRODUCED: 8.65 [kWh/sqm.year]
TOTAL CO2 EMISSIONS AVOIDED: 8314.779 [kgCO2/year]
TOTAL CO2 EMISSIONS AVOIDED OF THE AREA: 2.32 [kgCO2/sqm.year]

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

$$E_{tot} = \sum E_{li} = 31083.285 \ kWh/year$$

Específic 8.68 KWh/sqm.year

The CO_2 emissions avoided by installing thephotovoltaic panels are8.314tons/year or 2.32 kg/sqm/year.
Also, package 2 provides a heat air-water pump. The calculation considered conventionally a single heat pump that provides the heating and the hot running water preparation. The following table shows for package 2 the heat pump production for heating and hot running water preparation.

Month	Ian	Feb	Mar	Apr	Mai	Iun	Iul	Aug	Sep	Oct	Nol	Dec
$\theta_{gen,ext}$ [°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
No.of days	15	15	23	15	25	8	5	0	8	20	25	15
t_{ci} [h]	360	360	552	360	600	192	120	0	185	480	600	360
Q_{gen,dis,out_1} [kWh]	3084,7	3083,1	4723,1	5126,9	5122,7	4916,6	3071,4	0,0	4098,5	4101,9	5135,0	3084,2
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]	22264,2	20787,4	27077,3	13922,8	13522,9	3274,6	0,0	0,0	12768,2	18927,8	28882,8	21579,5
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]	4695,7	4314,6	5610,7	3637,3	4165,1	1900,7	1171,7	0,0	2097,5	4235,0	6149,1	4534,8
$Q_{H,gen,ls,rbl}$ [kWh]	117,4	107,9	140,3	90,9	104,1	47,5	29,3	0,0	52,4	105,9	153,7	113,4
$Q_{H,gen,ren,in}$ [kWh]	3763,9	4347,5	8306,9	5592,3	13043,0	2852,8	1827,8	0,0	2454,1	8584,6	8944,9	4005,8
$W_{H,gen,aux}$ [kWh]	234,8	215,7	280,5	181,9	208,3	95,0	58,6	0,0	104,9	211,7	307,5	226,7
$E_{H,gen,bu,in}$ [kWh]	3,0	3,0	3,0	3,0	3,0	3,0	3,0	0,0	3,0	3,0	3,0	3,0
$Q_{H,gen,out}$ [kWh]	5260,6	5474,2	9057,2	4014,7	11984,2	0,0	0,0	0,0	403,6	6714,7	9808,2	5346,0
$Q_{W,gen,out}$ [kWh]	3084,7	3083,1	4723,1	5126,9	5122,7	4753,5	2999,5	0,0	4098,5	4101,9	5135,0	3084,2
$Q_{H,gen,sto,out}$ [kWh]	210,8	191,1	193,5	171,6	170,0	164,5	163,5	172,7	164,5	178,5	191,2	209,2

Final calculation – heat pump energy performance (PdC)
Total electricity consumed : 42512.126 [kWh/year]
Totalconsumption ofthe back-up source energy: 33.000 [kWh/year]
Total heat loss from auxiliary source: 1062.803 [kWh/year]
Totalenergy supplied for heating: 60063.468 [kWh/year]
Total energy amount from renewable sources: 63823.513 [kWh/year]
Total energy supplied for hot running water: 45313.178 [kWh/year]
Total auxiliary energy: 2125.606 [kWh/year]

Energy supplied for storage: 2181.010 [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.

The following table $E_{H,gen,in}$ shows the electricity consumed in each month fromthe heat pump.

PdC capacity at maximum load : 14.00 KW
Number of heat pumps : 2 pcs
Total PdC system capacity at maximum load: kW
Total PdC system capacity at maximum load: 28.00 kW
Maximum load effciiency: 4.00
Reference input temperature: 25.00 °C
Reference output temperature: 35.00 °C

Auxiliary electric power: 1400 kW
Part of auxiliary electricity consumed: 0.05
Minimum value of thepartial load: 0.10
Factor mult.cont.sar.min: 0.90
Time constancy for ON/OFF operating mode:
Emitter thermal inertia category: 2

Heat pump model: PdC Air-Water (Pn<100 kW)

Auxiliary electrical power for storage: 3.00 kW

Back-up source energy efficiency: 1.00

Mass pump flow: 3.00 m^3/h

Recoverable part of stand-by loss: 0.75

Type of refrigeration agent used: R41δa

Part of auxiliary energy recovered as thermal energy: 0.26

Conversion factor: 1725.00 kgCo2/kg

Part of auxiliary energy recovered: 0.50

Loss ratio: 6.00%

Part of electricity to the distribution subsyst: 0.50

Refrigerant capacity: 6.00 kg

Correction factor depending on the aux.comp.temp: 0.00

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	15,2	18,5	20,1	19,2	14,0	9,2	3,6	-1,5
No.of days	15	15	23	15	25	8	5	0	7	20	25	15
t_{ci} [h]	360	360	552	360	600	192	120	0	160	480	600	360
Q_{gen,dis,out_1} [kWh]	3087,8	3086,4	4728,2	5132,6	5126,4	4917,7	3070,0	0,0	4102,2	4106,6	5139,6	3087,3
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]	7430,7	6562,0	7720,7	2978,5	2417,5	485,4	0,0	0,0	1894,2	4106,8	8796,7	7104,7
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]	4248,2	3850,3	3998,7	2880,3	2320,9	1900,7	1171,7	0,0	1655,6	2347,2	4512,4	3899,7
$Q_{H,gen,ls,rbl}$ [kWh]	106,2	91,3	99,9	87,0	58,0	47,5	29,3	0,0	41,4	58,7	112,8	100,0
$Q_{H,gen,ren,in}$ [kWh]	4212,8	5011,2	8432,2	5430,8	5223,0	2652,8	1827,8	0,0	2191,4	5866,2	9423,9	4540,3
$W_{H,gen,aux}$ [kWh]	212,3	182,5	199,8	134,0	116,0	96,0	58,8	0,0	82,8	117,4	225,6	200,0
$E_{H,gen,bu,in}$ [kWh]	3,0	3,0	99,9	87,0	58,0	3,0	3,0	0,0	3,0	58,7	112,8	3,0
$Q_{H,gen,out}$ [kWh]	6258,0	5486,7	7720,7	2978,6	2417,5	0,0	0,0	0,0	0,0	4106,8	8796,7	6353,7
$Q_{W,gen,out}$ [kWh]	3087,8	3086,4	4728,2	6132,6	5126,4	4763,5	2999,6	0,0	3846,9	4106,6	5139,6	3087,3
$Q_{H,gen,sto,out}$ [kWh]	170,0	159,0	170,0	164,5	170,0	164,5	132,4	173,0	164,5	170,0	164,5	170,0

Final calculation – heat pump energy performance (PdC)
Total electricity consumed : 32481.608 [kWh/year]
Total consumption of the back-up source energy: 414.440 [kWh/year]
Total heat loss from auxiliary source: 812.040 [kWh/year]
Totalenergy supplied for heating: 42130.826 [kWh/year]
Total energy amount from renewable sources: 55032.317 [kWh/year]
Total energy supplied for hot running water: 45094.837 [kWh/year]
Total auxiliary energy: 1624.080 [kWh/year]
Energy supplied for storage: 1972.257 [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]	181.224	52.348	0	0	0	0	233.572	
	Electricity [MWh/year]	1.856	0.44	55.848	0	33.69	45.917	91.834	
	Primaryenergy [MWh/year]	216.672	62.347	139.62	0	84.226	45.917	502.865	
	Specialprimary energy [MWh/year]	60.52	17.42	39	0	23.53	12.83	140.47	
P1	Thermalenergy [MWh/year]	88.951	52.236	0	0	0	0	141.187	39.6
	Electricity [MWh/year]	1.682	0.439	55.848	0	33.69	45.83	91.659	0.2
	Primaryenergy [MWh/year]	108.277	62.215	139.62	0	84.226	45.83	394.338	21.6
	Specialprimary energy [MWh/year]	30.24	17.38	39	0	23.33	12.8	110.15	21.6
P2	Thermalenergy [MWh/year]	171.867	47.753	0	0	0	0	219.62	6.0
	Electricity [MWh/year]	48.089	20.081	19.089	0	16.351	63.881	103.61	-12.8
	Primaryenergy [MWh/year]	239.241	41.634	39.303	0	33.665	63.881	353.843	29.6
	Specialprimary energy [MWh/year]	66.83	11.63	10.98	0	9.4	17.84	98.84	29.6
P3	Thermalenergy [MWh/year]	45.023	47.607	0	0	0	0	92.63	60.3
	Electricity [MWh/year]	22.568	18.571	19.089	0	16.351	53.714	76.579	16.6
	Primaryenergy [MWh/year]	48.084	34.842	35.333	0	30.265	53.714	148.524	70.5
	Specialprimary energy [MWh/year]	13.43	9.73	9.87	0	8.45	15	41.48	70.5

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 introduction of renewable energy production 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 necessary to 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 CO_2 emissions [ton CO_2/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	183.1	52.8	55,8	0.0	33.7	0.0	0.0	91.8	233.6	456.9	45.9	502.9	79.8
Class	B	B	E	-	C							C	C

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	90.6	52.7	55.8	0.0	33.7	0.0	0.0	91.7	141.2	348.5	45.8	394.3	57.9	11.62
Class	A	B	E	-	C							B	B	
P2	220.0	67.8	19.1	0.0	16.4	24.2	107.6	79.4	112.1	290.0	-63.9	353.8	48.4	37.16
Class	B	E	B	-	A							B	B	
P3	67.6	66.2	19.1	0.0	16.4	31.1	89.2	45.5	3.4	94.8	53.7	148.5	13.6	60.12
Class	A+	A	B	-	A							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 CO2 emission reductions compared to the unrefurbished building were calculated.

REFURBISHED VS UNREFURBISHED BUILDING															
Solution / Package	Final energy saving acc. to Mc001					REG- onsite energy consumption variation		Total priced final energy saving		Primary energy saving				CO2 equivalent emissions saving	
	Heating	HRW	Vantilation	Cooling	Lighting	Electric	Thermal	Electric	Thermal	NREG	REG	Total			
	[MWh/yr]					[MWh /yr]		[MWh/yr]		[MWh/ yr]			[%]	[tCO2/an]	[%]
P1	92,4	0,1	0,0	0,0	0.0	0,0	0,0	0,2	92,4	108,4	0,1	108,5	21,6	21,9	27,4
P2	-36,9	-15,0	36,8	0,0	17,3	24,2	107,6	12,4	121,5	167,0	-18,0	149,0	29,6	31,4	39,4
P3	115,5	-13,4	36,8	0,0	17,3	31,1	89,2	48,3	230,1	382,1	-7,8	354,3	70,5	68,2	83,0

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,
• theenergy savings dueto implementing the refurbishment options.

Taking into account the specific cost of thermal energy, the following is determined:

• the investment recovery period for eachrefurbishment option;
• the percentage reduction 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 ofenergy, 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 economicallyefficient measures, throughthe prismof 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 j for year i;

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

COCO2 (j)- cost of CO2 emissions formeasure j in year i

CO_{fin}.(TLS)(j)- final cost for decommissioning and disposal in the last year of the TLS life cycle of component j or of the building (related to the first year T0);

Val $_{fct}$(j)—residual value of component j in year TC at 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 the applying the energymodernization 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, respectively for each package (CRP), the total investment cost and the other parameters of the economic calculation.

Dimension	MU	CNR	CR-P1	CR-P2	CR•P3
Floor reference area	sqm	3580			
Investment initial total cost	[EUR VAT included)	0,0	580910.0	228646.0	809556.0
Investment specific cost	EUR.sqm VAT included	0.0	162.3	63.9	226.1
Maintainance annual cost	EUR VAT included/year	8702.4	2450.0	3455.0	4191.0
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	233.6	141.2	112.1	3.4
Thermal energy unit cost	EUR VAT incl./MWh	94.0	94.0	94.0	94.0
Annual thermal energycost	EUR VAT included/year	21955.8	13721.6	10533.9	322.6
Annualaverage thermal energy increase rate	%	5,0			
Annual final electricity consumption	MWh/year	91.8	91.7	79.4	45.5
Electricityunit cost	EUR VAT incl./MWh	212,0	212,0	212,0	212,0
Annual electricity cost	EUR VAT included/year	19468.8	19431.7	16840.0	9645.2
Annual average electricity increaserate	%	5,0			
Periodic replacement costs	EUR VAT included/year	61346.9	61346.9	82312.6	88447.2
Annual average replacement costs increase rate	%	3,0			
Decommisioning costs	EUR VAT included)	0,0	0,0	0,0	0,0
CO2 equivalent emissions/year	tCO2e/year	79.8	57.9	48.4	13.6
Specific CO2 cost	EUR/ tCO2e		20.0		
Annual CO2 equivalent emissions costs [2025]	EUR VAT included/year	1595.4	1157.8	967.0	271.4
Package life cycle	years	-	30	20	20
Calculation period/Global cost calculation period	years		30		
Residual value	EUR VAT included	0,0	0,0	30624.1	32905.5
Costs update rate{interest rate)	%	3.0			

The condition for an investment inthe energy modernization solutionto be efficient is the following:
CG < 0
In this economic analysis of therefurbishment options, the following assumptions and values were taken into account:
• the beneficiary bears the cost without bank credit;
• economic calculations are made in euros;
• annual rate ofincrease in maintenance costs 6%
• annual rate ofincrease in the cost of heat and electricity 5%;
- annual rate ofincrease in replacement costs 5%;
- annual rate of depreciation ofthe 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 shows the energy costs consumed for the unrefurbished building and for each package

Dimension	UM	CNR	CR-PI	CR-P2	CR-P3
Annual final thermal energy consumption	[MWh/year]	233.572	141.187	112.063	3.432
Thermal energy unit cost	[Eur VAT included/MWh	94			
Annual thermal energy cost	EUR VAT included/year	21955.768	13721.578	10533.922	322.608
Annual final electricity consumption	[MWh/year]	91.834	**91.659**	79.434	45.946
Electricity unit cost	Eur VAT included/MWh	212			
Electricity annual cost	EUR VAT included/year	19468.808	19431.708	16840.008	9645.152

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	Updated operating costs CNR
2025	0	8702,4	0,0	21955,8	19468,8	61346,9	0,0	0,0	1595,4	51722,4
2026	1	8955,9	0,0	22382,1	19846,8	0,0	0,0	0,0	2792,0	53976,8
2027	2	9216,7	0,0	22816,7	20232,2	0,0	0,0	0,0	2792,0	55057,6
2028	3	9485,2	0,0	23259,7	20625,1	0,0	0,0	0,0	2792,0	56161,9
2029	4	9761,4	0,0	23711,4	21025,6	0,0	0,0	0,0	2792,0	57290,3
2030	5	10045,7	0,0	24171,8	21433,8	0,0	0,0	0,0	2792,0	58443,3
2031	6	10338,3	0,0	24641,2	21850,0	0,0	0,0	0,0	3988,5	60818,0
2032	7	10639,5	0,0	25119,6	22274,3	0,0	0,0	0,0	3988,5	62021,9
2033	8	10949,3	0,0	25607,4	22706,8	0,0	0,0	0,0	3988,5	63252,0
2034	9	11268,3	0,0	26104,6	23147,7	0,0	0,0	0,0	3988,5	64509,1
2035	10	11596,5	0,0	26611,5	23597,2	0,0	0,0	0,0	3988,5	65793,6
2036	11	11934,2	0,0	27128,2	24055,4	0,0	0,0	0,0	3988,5	67106,3
2037	12	12281,8	0,0	27655,0	24522,5	0,0	0,0	0,0	3988,5	68447,8
2038	13	12639,5	0,0	28192,0	24998,6	0,0	0,0	0,0	3988,5	69818,7
2039	14	13007,7	0,0	28739,4	25484,0	0,0	0,0	0,0	3988,5	71219,6
2040	15	13386,5	0,0	29297,4	25978,9	0,0	0,0	0,0	3988,5	72651,4
2041	16	13776,4	0,0	29866,3	26483,3	0,0	0,0	0,0	3988,5	74114,6
2042	17	14177,7	0,0	30446,3	26997,6	0,0	0,0	0,0	3988,5	75610,0
2043	18	14590,6	0,0	31037,4	27521,8	0,0	0,0	0,0	3988,5	77138,4
2044	19	15015,6	0,0	31640,1	28056,2	0,0	0,0	0,0	3988,5	78700,4
2045	20	15453,0	0,0	32254,5	28601,0	0,0	0,0	0,0	3986,5	80296,9
2046	21	15903,1	0,0	32880,8	29156,3	0,0	0,0	0,0	3988,5	81928,7
2047	22	16366,2	0,0	33519,2	29722,5	0,0	0,0	0,0	3988,5	83596,5
2048	23	16842,9	0,0	34170,1	30299,6	0,0	0,0	0,0	3988,5	85301,2
2049	24	17333,5	0,0	34833,6	30888,0	0,0	0,0	0,0	3988,5	87043,6
2050	25	17838,4	0,0	35510,0	31487,7	0,0	0,0	0,0	3988,5	88824,6
2051	26	18357,9	0,0	36199,5	32099,1	0,0	0,0	0,0	3988,5	90645,1
2052	27	18892,6	0,0	36902,4	32722,4	0,0	0,0	0,0	3988,5	92505,9
2053	28	19442,9	0,0	37619,0	33357,8	0,0	0,0	0,0	3986,5	94408,2
2054	29	20009,2	0,0	38349,4	34005,5	0,0	0,0	0,0	3988,5	96352,6
2055	30	20592,0	0,0	39094,1	34665,8	0,0	0,0	0,0	3988,5	98340,4

CR-P1 (REFURBISHED BUILDING – PACKAGE 3)

YEAR		Annual maintainance cost CR	Annual operating cost CR	Updated thermal energycost CR	Updated electricitycost CR	Periodic replacement costsCR	Residual value replacement costs CR	Decommissioning costsCR	AnnualCO2 equivalent emissions costs CR	Updated operating costs CR	CASH FLOW	VNA
2025	0	4191,0	0,0	322,6	9645,2	88447,2	32906,5	0,0	271,4	14430	-	809556
2026	1	4313,1	0,0	328,9	9832,4	0,0	0,0	0,0	475,0	14949	-39027	770529
2027	2	4438,7	0,0	335,3	10023,4	0,0	0,0	0,0	475,0	15272	-39785	730743
2028	3	4568,0	0,0	341,8	10218,0	0,0	0,0	0,0	475,0	15603	-40559	690184
2029	4	4701,0	0,0	348,4	10416,4	0,0	0,0	0,0	475,0	15941	-41350	648834
2030	5	4837,9	0,0	355,2	10618,7	0,0	0,0	0,0	475,0	16287	-42157	606678
2031	6	4978,9	0,0	362,1	10824,8	0,0	0,0	0,0	678,5	16844	-43974	562704
2032	7	5123,9	0,0	369,1	11035,0	0,0	0,0	0,0	678,5	17206	-44815	517889
2033	8	5273,1	0,0	376,3	11249,3	0,0	0,0	0,0	678,5	17577	-45675	472214
2034	9	5426,7	0,0	383,6	11467,7	0,0	0,0	0,0	678,5	17957	-46553	425661
2035	10	5584,8	0,0	391,0	11690,4	0,0	0,0	0,0	678,5	18345	-47449	378212
2036	11	5747,4	0,0	398,6	11917,4	0,0	0,0	0,0	678,5	18742	-48364	329848
2037	12	5914,8	0,0	406,3	12148,8	0,0	0,0	0,0	678,5	19148	-49299	280549
2038	13	6087,1	0,0	414,2	12384,7	0,0	0,0	0,0	678,5	19565	-50254	230294
2039	14	6264,4	0,0	422,3	12625,2	0,0	0,0	0,0	678,5	19990	-51229	179065
2040	15	6446,8	0,0	430,5	12870,3	0,0	0,0	0,0	678,5	20426	-52225	126840
2041	16	6634,6	0,0	438,8	13120,3	0,0	0,0	0,0	678,5	20872	-53242	73598
2042	17	6827,9	0,0	447,4	13375,0	0,0	0,0	0,0	678,5	21329	-54281	19316
2043	18	7026,7	0,0	456,1	13634,7	0,0	0,0	0,0	678,5	21796	-55342	-36026
2044	19	7231,4	0,0	464,9	13899,5	0,0	0,0	0,0	678,5	22274	-56426	-92452
2045	20	7442,0	0,0	473,9	14169,4	0,0	0,0	0,0	678,5	22764	-57533	-149985
2046	21	7658,8	0,0	483,1	14444,5	88447,2	0,0	0,0	678,5	111712	29783	-120202
2047	22	7881,8	0,0	492,5	14725,0	0,0	0,0	0,0	678,5	23778	-59819	-180020
2048	23	8111,4	0,0	502,1	15010,9	0,0	0,0	0,0	678,5	24303	-60998	-241019
2049	24	8347,7	0,0	511,8	15302,4	0,0	0,0	0,0	678,5	24840	-62203	-303222
2050	25	8590,8	0,0	521,8	15599,5	0,0	0,0	0,0	678,5	25391	-63434	-366656
2051	26	8841,0	0,0	531,9	15902,4	0,0	0,0	0,0	678,5	25954	-64691	-431347
2052	27	9098,5	0,0	542,2	16211,2	0,0	0,0	0,0	678,5	26530	-65975	-497323

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	-	2231375.4	-
CR-P1	27	2121874.9	III
CR-P2	10	1637868.1	I
CR-P3	18	1495234.7	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 Highschool building 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 by the 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 energyconsumption of82.70 kWh/m2/year. Regarding the level ofequivalent 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 of the exterior walls with a layer of expanded polystyrene or mineral woolwith 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 of 25 cm and a minimum thermal strength ofγ<0.038 W/mK, over which a wooden floor will be built.
- Thermal insulation of the floor over the technical channel with a layer of expanded polystyrene or mineral wool with a thickness of 10 cm and a minimum thermal resistance of γ<0.038 W/mK, over which a wooden floor will be built

• Solution 2.

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

• Solution 3. 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 Highschool building). Gas-fired central heating will take over any peaks in consumption.
o A photovoltaic panel system with a capacityof 18 kWh will be installed on the high school's roof on the SE or SW orientations
o A heat recovery fan system with an average thermal transfer efficiency of 75% will be installed.
o The lighting fixtures and lighting sources will be replaced with LEDs. Presence sensors will be used for circulation spaces.

The energyand economic analyses presented in the calculation notes in this document highlight the qualities ofthe different refurbishment packages. Thus:

1. The P1 package is a package that includes solutions S1-S2 and is recovered in 27 years. The package of measures leads to an increase in the thermal strengths of the opaque envelope up to the minimum strenghts requested bythe codes in force. In terms of primary energyconsumption and CO2 emissions, the package does not fall within the minimum values provided by the methodology. With this package of measures, the annual primary energy saving is 21.6% (from 502.865 MWh/year to 394.34 MWh/year) and CO2 emissions are reduced by27.4% (from 79.8 tons/year to 57.9 tons/year). It is noted that the recovery period is long but falls within the construction's lifespan of 30 years.
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 bythe methodology in terms of primary energy consumption and CO2 emissions. With this package of measures, the annual primary energy saving is 29.6% (from 502.865 MWh/year to 353.843 MWh/year) and CO2 emissions are reduced by 39.4% (from 79.8 tons/year to 48.4 tons/year)
3. Package P3 is a maximum package in terms of investment that includes solutions S1-S3 and is recovered in 18 years. The package of measures leads to an increase in both the thermal strength of the envelope to the minimum strenghts requested bythe 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 70.5% (from 502.865 MWh/year to 148.524 MWh/year) and CO2 emissions are reduced by83% (from 79.8 tons/year to 13.6 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 final thermal energy consumption (MWh/year)	**233.572**	92.63	60.3
Total final electricity consumption(MWh/year)	91.834	76.579	**16.6**
Total primary energy consumption(MWh/year)	**502.865**	148.524	70.5
Total specific primary energy consumption (kWh/m2year)	140.47	**41.478**	70.5
Energyclass	C	A+	
Amount of CO2 equivalent emissions (kg CO2/m2,year)	22.3	3.8	83.0
Environmental class	C	A+	
Final thermal payment energy[MWh/year)	233.57	3.4	98.5
Final electricity payment [MWh/year]	91.83	45.5	50.5

4. Applying the package of measures proposed is economically feasible, amortizing the investment value over a period of 18 years. The value is lower than the shelf life of the package, which is estimated at 20 years, and causes significant energy reductions. The long recovery time is caused by the high intervention costs at the high school envelope level. However, considering the significant CO2 reductions of 83%, package 3 is recommended.

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.

Energyauditor for buildings	Drafted by
eng. Cruciat Radu	Energy auditor for buildings
	eng. Pricopie AndreiGheorghe
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D. Recommendations for the owners

- Informing the responsible technical staff about the expected energysavings;
- 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 ofthe spaces to the reduced heat requirement as a result of the execution of the intervention works;
- Washing the heating installation, including the radiators, at regular intervals of 3 years;
- Correct thermo-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 of occupied spaces. The ventilation system with heat recoverywill 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 ofenergy 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 onthe energy performance of buildings, republished,
- Law no. 10/1995 on quality in 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: Highschool building
Address: Electricienilor street no.1, Sibiu county
Owner: Sibiu City Hall
Building category:
educationalestablishment (nurseries, kindergardens, schools, highschools, universities)
Climate area where the building is located: III
Wind area wherethe building is located: IV
Wind exposure level: sheltered
Height regime ofthe 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 ofrepresentative level
construction representative sections
Building technical basement condition: flooded/floodable basement (water discharge may be due to the exterior sewerage)

B. Features of the living/heated space
Built area (sqm): 1389
Built unfolded area (sqm): 3835
Reference area ofthe heated space floor (sqm): 3580
Reference volume of the heated space (m^3): 12678
Reference area of the cooled space floor (sqm), as appropriate: -
Free average height of one level (m): 2.8 and 3.5
Occupation level of the heated space [no.of operating hrs of the heating system]: 10h/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): -

C. BUILDING CONSTRUCTIVE STRUCTURE IDENTIFICATION
Dull exterior walls

Exterior wall – masonry

No. crt.	Material	γ [W/mK]	δ [m]	a	R [m^2K/W]
1	Lime mortar plaster	0.87	0.02	1.1	0.021
2	Solid brick masonry	0.8	0.25	1.15	0.290
3	Cement mortar plaster	0.93	0.03	1.1	0.029
δi=8 δe=24			R0	=	0.507

Exterior walls condition: condensation stains
Finishings condition: partially fallen plaster
Type and colour of the finishing materials:
- type: plaster
- colour: grey

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 [m^2 K/W]
1	Sandstone and 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

Totalarea ofthe ground slab [sqm]: 972.1

Terrace/Roof
Type ofterrace/roof: trusstype roof
Terrace/roof condition: dry
Last repair ofthe terrace/roof: more than 5 years ago
Finishings materials: corrugated sheet

No. Crt.	Material	λ [W/mK]	6 [m]	a	R [m²K/W]
1	Corrugated sheet	0.8	0.01	1.05	0.012
2	Roof boarding	0.17	0.025	1.1	0.134
			R0	=	0,313

δi=8
δe=24
Totalroofarea[sqm]: 1652

Floor under the attic:

No. Crt.	Material	λ [W/mK]	δ [m]	a	R [m²K/W]
1	Reinforcedconcrete slab	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
	δi=8 δe=12			=	0.623

Totalarea ofthe floor under the attic [sqm]: 1145
Floor under the technical channel:

No. Crt.	Material	λ [W/mK]	δ [m]	a	R [m²K/W]
1	Reinforcedconcrete slab	1.62	0.1	1.05	0.059
2	Cement mortar plaster	1.16	0.05	1.03	0.042
3	Ash and slag	2.03	0.01	1.03	0.005
	δi=8 δe=12			=	0.357

Totalarea of the floor under the technical channel [sqm]: 324.8

Floor under the thermal plant:

No. Crt.	Material	λ [W/mK]	δ [m]	a	R [m²K/W]
1	Limestone	2.09	0.01	1.03	0.005
2.	Simple concrete	1.16	0.05	1.03	0.042
3	Reinforced concrete slab	1.62	0.15	1.05	0.088
4	Cement mortar	0.93	0. 0	1.03	0.021
	δi=8 δe=24			=	0.323

Total area of the floor under the thermal plant [sqm]: 151.9

Exterior windows/doors

Carpentry condition: good

EW/ ED	Description	Area [sqm]	Type of carpentry	Sealing grade	Shutter (i / e)
EW	Windows R=0.43	1094.2	PVC carpentry insulated glass	With outdated sealing thatis no longer flexible	No
ED	Doors R=0.37	42.5	PVC carpentry insulated glass	With outdated sealing thatis 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]: 127581
Energy sourcefor heating thespaces: own source, gas fuel
Type of heating source: heating with static bodies

Data regarding the interior heating system with static bodies:
Type of thermal heating: lower
Connection tothe centralized heating source: single connection
Thermal energy meter: does not exist
Thermal and hydraulic adjustment items: on the distribution network, on columns, on the static bodies
The static bodies arenot equipped with adjustment fittings or at least half of the current adjustment fittings are not operating
Distribution network located in unheated spaces: - length: 326; - nominal diameter: 88.9; thermal insulation: yes
Interior heating systemcondition in terms of deposits: the static bodies havebeen dismantled and washed/cleaned fully more than three years ago
Separation and drainage fittings of the heating pipes: The hitting pipes areprovided 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 heating bodies [pcs.] Number of static bodies[pcs.]		
	In the living area	In the common area	Total
steel	175		175

Heating source – own thermal system

Nominal power: 2x250kW

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. DATAREGARDING THE HOT RUNNING WATER
Is there a system for preparing the hot running water: Yes
Energy source for preparing the hot water of the spaces: Own source – gas thermal system
Cool water/hot water consumption points:
basins: 19
washers: 0
bidets: 0
urinals: 9
showers: 0
bath: 0
WC : 25
dishwasher: 0
washing machine: 0
Fittings condition: there are small liquid losses
Connection to the centralized heating system: single connection
Recirculation pipe: does not exist
Debit metres ofthe 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

Hot water distribution network located in unheated spaces:
Length : 94 m
Thermal insulation: yes
There is an insulation, but it is wet

F. DATAREGARDING THE VENTILATION/ AIR CONDITIONING SYSTEM

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

Data regarding the ventilation system
Type of ventilation: natural

G. DATAREGARDING THE LIGHTING SYSTEM
Type of lighting fixtures: fluorescent
Lighting systemcontrol: no automatic detection ofthe users' presence
Lighting fixtures condition: good
Electrical conductors condition: good

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G. PhotoAnnex

Photo 1 – Entrance from Electricienilor street

Photo 2 – SE side entrance

Photo 3 – Thermal plant

Photo 4 & 5 – Photo of the thermal plant, boiler and distribution network

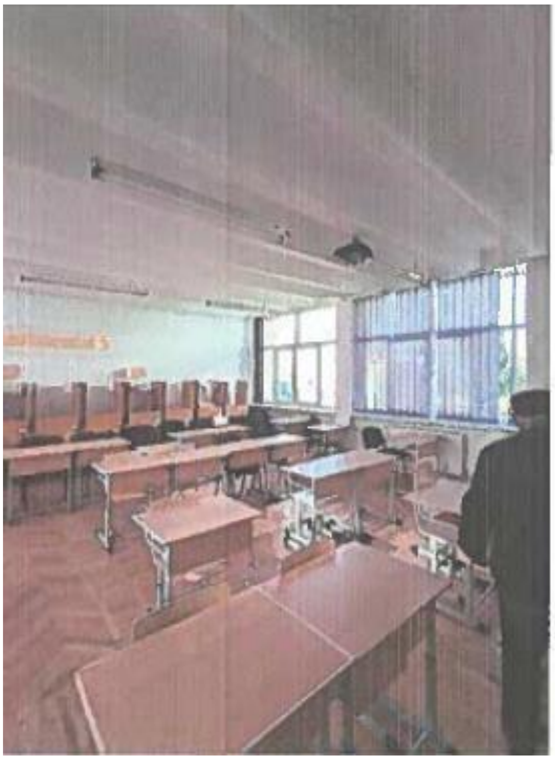

Photo 6 – Classroom

Photo 7 - Classroom

Photo 8 – Hall

Photo 9 - Woodentruss

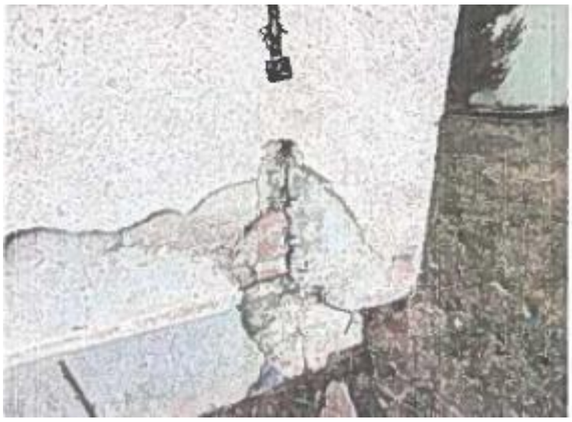

Photo 10 - Exterior plaster and base degradations

Photo 11 – Lighting system

H. Other annexes

- Copy of Energy Auditor's badge
- Construction Survey
- Energy Certificate for the current building
- Energy Certificate Annexes

MINISTRY OF REGIONAL DEVELOPMENT, PUBLIC ADMINISTRATION AND EUROPEAN FUNDS

Mr. PRICOPIE GH. GHEORGHE-ANDREI
Personal identification number: 1850607460121
Job: Engineer CERTIFIED
ENERGY AUDITOR FOR BUILDINGS
Professional degree: I
Specialization: CONSTRUCTIONS AND INSTALLATIONS
Date of issue: 08.02.2017 Series SSA number 02249

General manager
Illegible signature, Official stamp

Holder's signature - Illegible signature
This badge is valid only accompanied by the attestation certificate of the energy auditor for buildings

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

Mr. CRUCIAT I.RADU-IULIU
Personal identification number: 1850707324784
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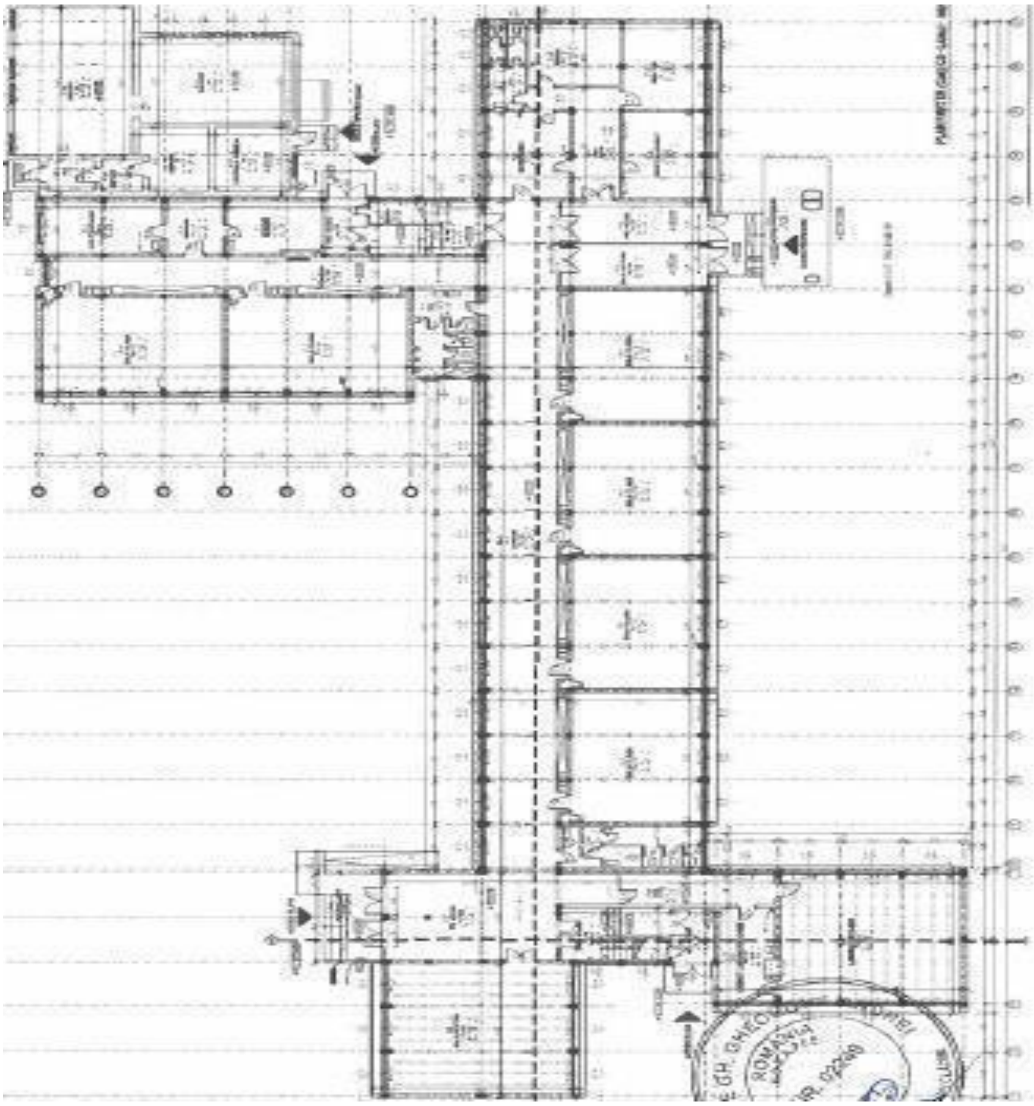
ENERGY AUDITOR FOR BUILDINGS
Professional degree: I
Specialization: CONSTRUCTIONS AND INSTALLATIONS
Date of issue: 08.02.2017 Series SSA number 02208

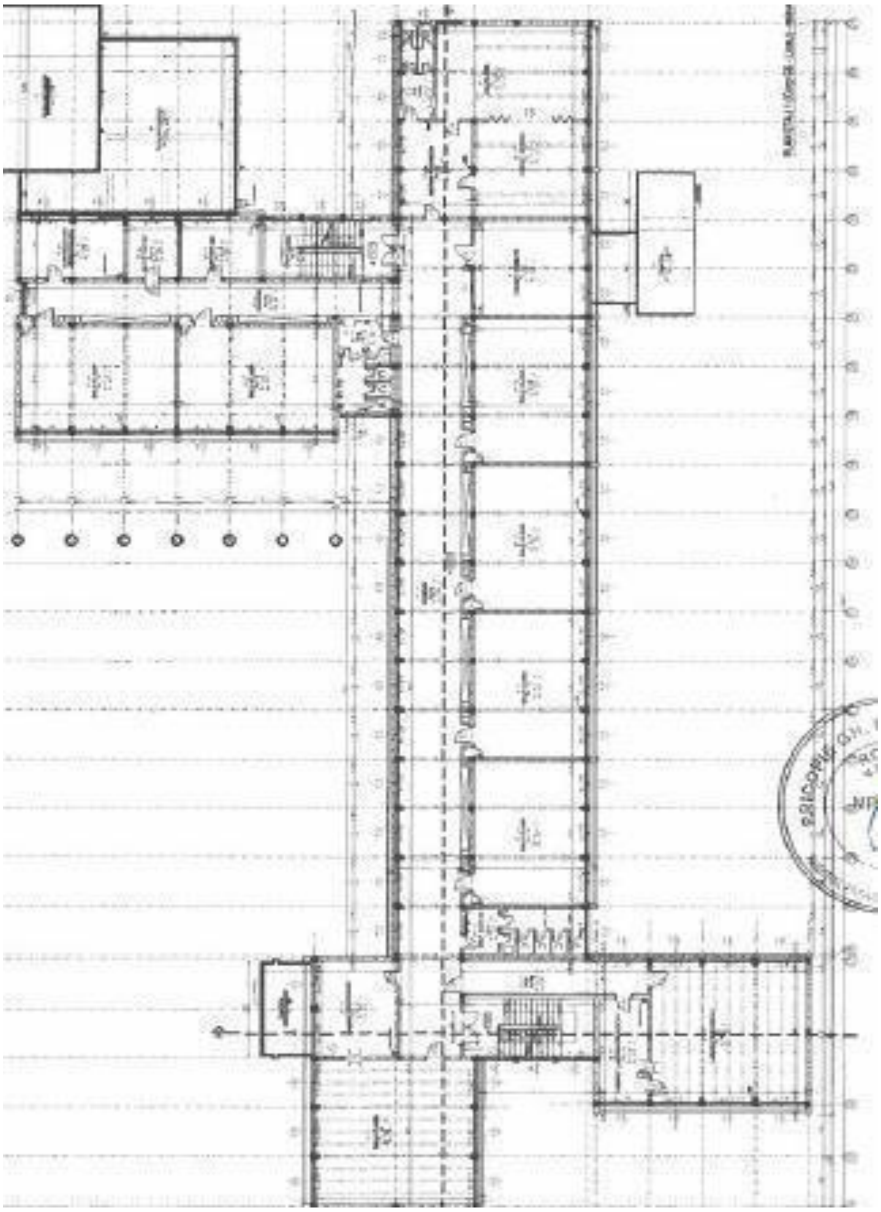
General manager
Illegible signature, Official stamp

Holder's signature - Illegible signature
This badge is valid only accompanied by the attestation certificate of the energy auditor for buildings

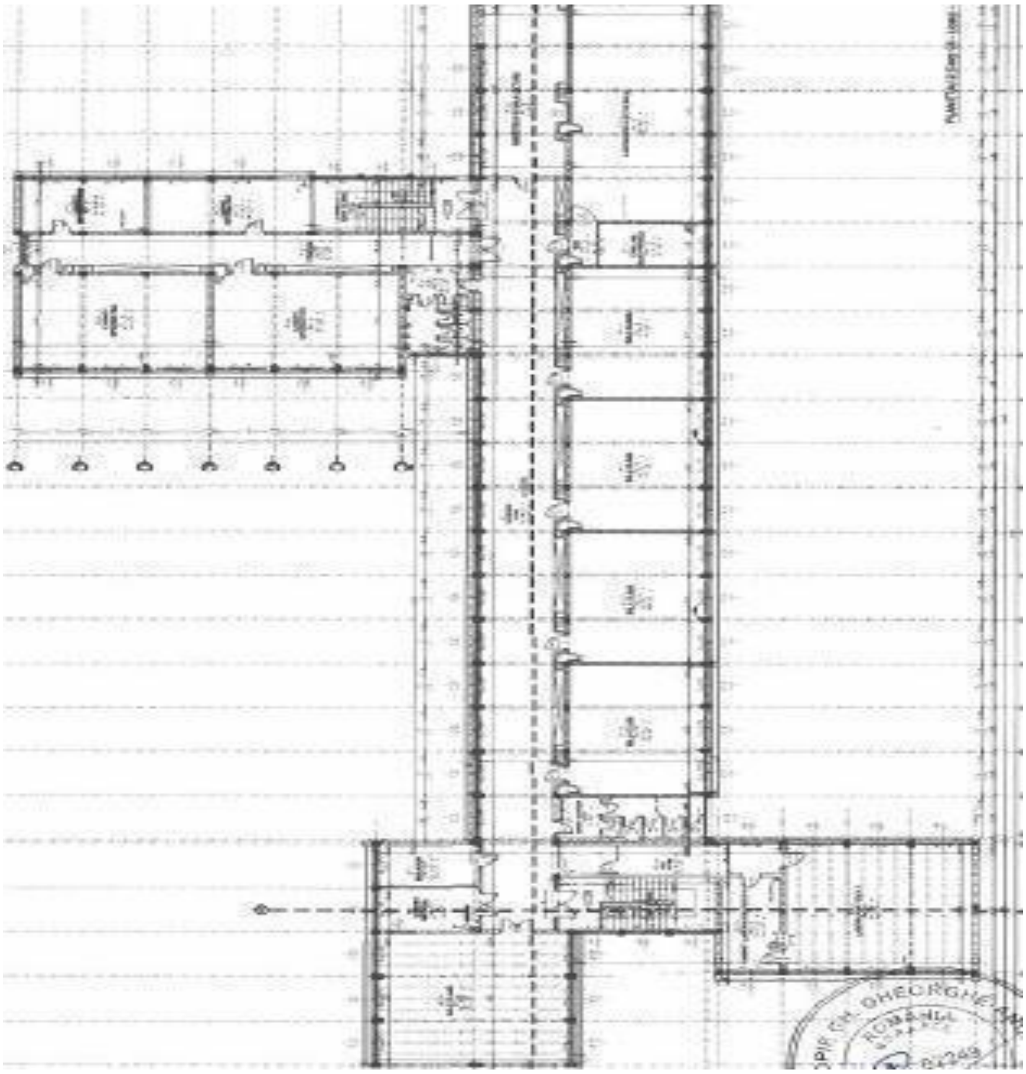
This badge will be endorsed by the issuing entity from 5 to 5 years from the date of issue
Valid until: 08.02.2022
Validityextension until: 08.02.2027



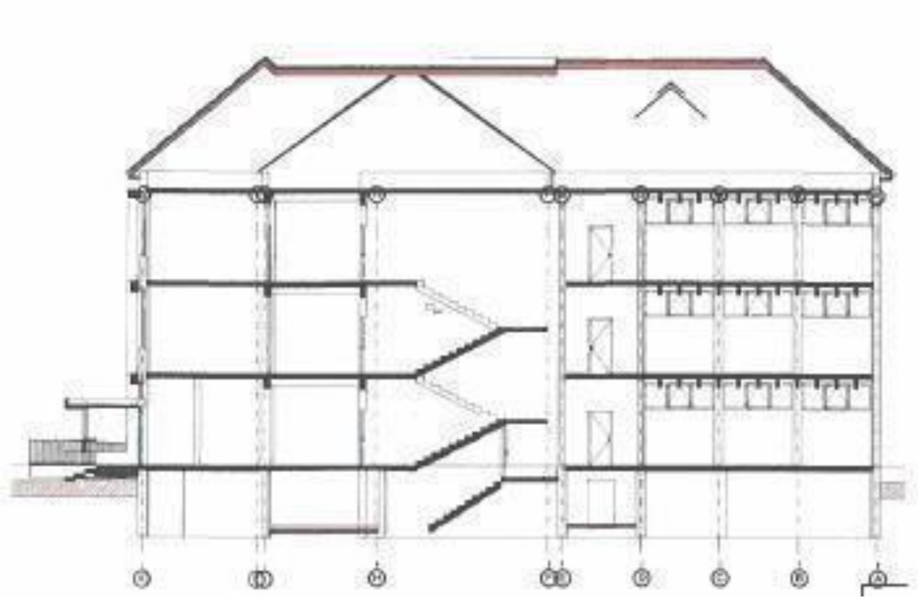
Groundfloor survey



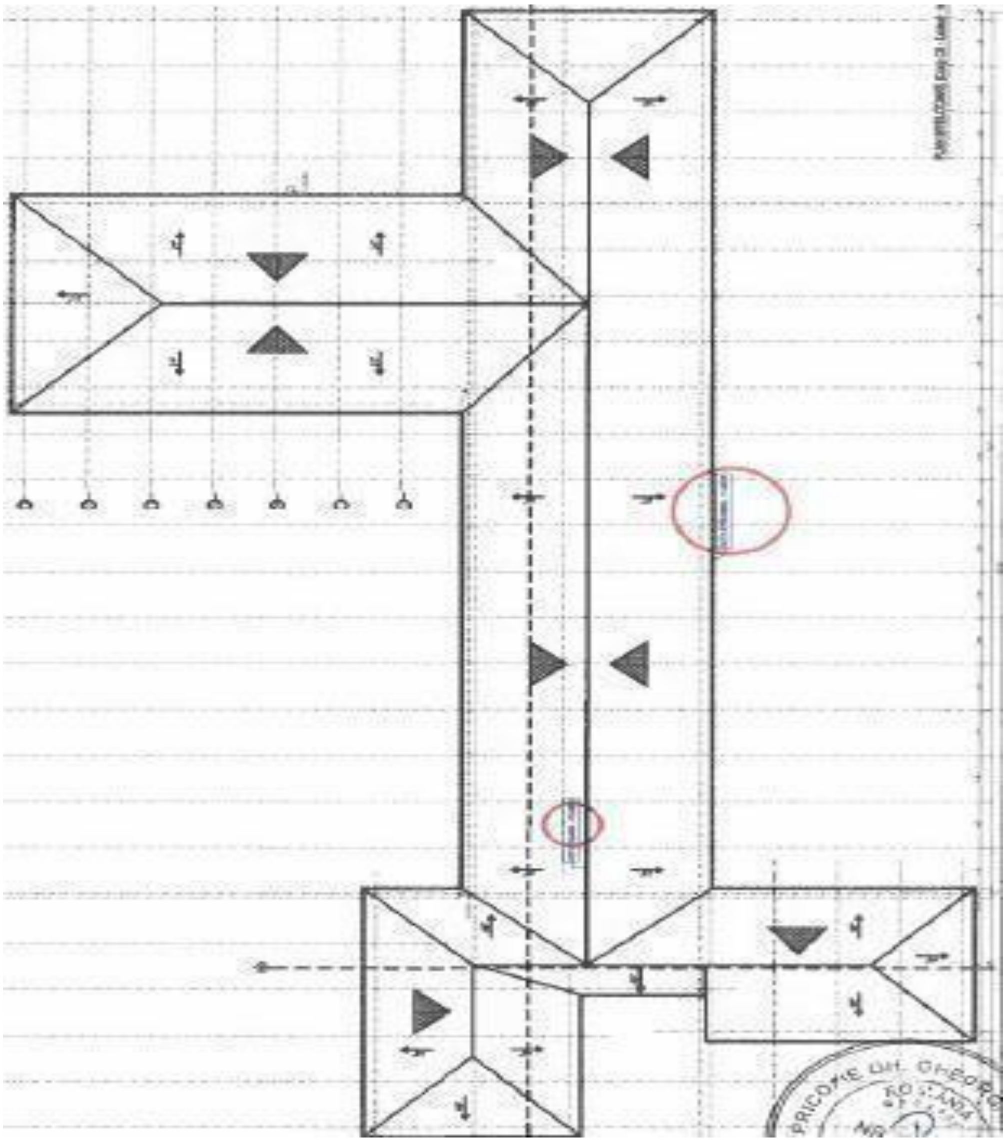
First floor survey



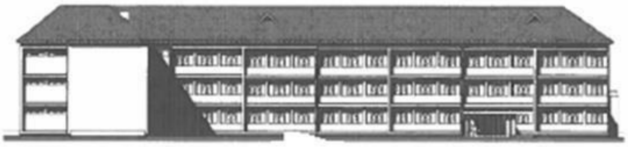
Second floor survey



Section



Roof truss survey



Main entrance

Rear entrance

Left side entrance

Right side entrance

RECOMMENDATIONS FOR INCREASING THE ENERGY PERFORMANCE
ANNEX 1 to the EnergyPerformance Certificate no. 000131/ 550311
for the BUILDING/BUILDING BLOCK/APARTMENT from Siblu, str. Electricienilor no. 1, Sibiu County

1. Solutions recommended for the envelope of the building/building block/apartment
Increasingt he 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 underthe attic), ifany, above the minimum value provided bythe technical regulations in force, by external thermal insulation
Replacing the current exterior joinery with energy-efficient joinery.
Assembling on the exterior carpentry or on the exterior walls of the hygroadjustable ventilation grids in order to avoid the increase in the interior moisture and providing the quality of the interior air
Installing devices to shade the facades or protect against solar radiation during the winter.

2. Solutions recommended for installations related to the building/building block/apartment.
Replacing the used pipes for the heatingagent and possiblyinsulating them (same for the columns).
Replacing the used pipes for hot water distribution for heating and possibly insulating them (same for the columns).
Installation of thermostatic valves on the heating elements
Installation of automatic 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/regulation system if it does not exist, for heating/cooling/ventilation
Changing the equipments from the thermal plant, if any, and if the equipments are worn andtorn, with modern andenergetically efficient equipments
Adjustment/cleaning of the equipment in the heating/air conditioningsystem, if it exists, andthe 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. Relatedmeasures (correspondingto the energy calculationstages) forincreasingthe 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 andits facilities correctly, beingmotivated 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 to monitor the execution of thermal refurbishmentworks in case of building refurbishment
Permanent recording of energy consumption, including analysis of energy bills
periodic review of energy supply 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 heat emitting equipment (heaters, fan-convectors, etc.)
removing objects that prevent the heat from the radiators from reaching the room
introducinga reflectivesurface between the radiator and the expansion wall that reflects the heat back intothe 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
correction of the settings of the automatic operating parameters of the equipment

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

List of the steps that need to be taken to implement the energy-saving and environmental performance improvement measures:
Envelope renovation
Carpentry replacement
Thermal insulation of the attic floor and of the floor over the thermal channel
Use of energy from renewable sources
Installations 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 EnergyPerformance Certificate no. 000131/ 550311
for the BUILDING/BUILDING BLOCK/APARTMENT from Siblu, str. Electricienilor no. 1, Sibiu County

A.DATAREGARDING THECERTIFIED BUILDING

Typeof building: existing
Construction year: 1966
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, 2 floors
Constructive structure of the building:
- structural masonry walls
- reinforced concrete frames

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

Typeof apart/block/area destination		Reference area of an apart/block/thermal areaZTC 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 ZTU1 ZTU2		3580 1145 324.8		1 1 1		3580 1145 324.8	
TOTAL				3		5049.8	

Total reference area ofthe floor ofthe building or building block: 3580.00 sqm
Reference interior volume V, of the building/building block: 12678.00 m^3

o Geometric and thermal characteristics of the envelope:

	Type of construction element		Thermal strength corrected calculated [m²K/W]		Thermal strength corrected standard [m²K/W]		Area [m²]	
	C1	C2	C1	C2	C1	C2	C1	C2
R1.	PE1		0,37				474,1	
R2.	PE1		0,38				281,4	
R3.	PE1		0,36				487,4	
R4.	PE1		0,38				375,2	
R5.	PL_{attic}		0,58		5		1145	
R6.	Pl - $_{ground}$		0,5		2,9		972,1	
R7.	$Pl-_{technical\ channel}$		0,35		2,9		324,8	
R8.	FE-PVC		0,43		0,5		1094,2	
R9.	UE-PVC		0,41		0,5		42,5	
R10.	Pl-central		0,26		5		151,9	
	Total envelope area		S_E [m²]				5348,6	

Building form factor S_g/V: 0.42 $^{m-1}$

Details of the annual specific consumption of primaryenergy[kWh/m² years, respectively of annual specific equivalent CO2 emissions [kgCo2/m².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	51.0/60.3	12.1	B		
Hot runningwater	14.7/17.4	3.5	B		
Cooling					
Mechanical ventilation	15.6/ 39.0	4.2	E		
Lighting	9.4 / 23.5	2.5	C		
TOTAL/CLASS	90.7/ 140.2	22.2	C	82.7	13.1

Standard number of persons inside the building/building block: 609.00 people

B. DATAREGARDING THE INTERIOR HEATING SYSTEM

Existence ofthe heating system: yes, functional

Current energy source for heating the spaces: own source(individual system, natural gas fuel)

Type of heating system: heating with static bodies power plant

Type of static body	Number of static bodies (pcs)			nominal thermal power [kW] for the heating flow/return temperature/interior temperature of ….Celsius degrees
	Area	In the living/work space	In the common spaces	
steel	ZTC1.1	175		270[kW] 55/45 20[°C]
TOTAL		175		270

- Type of thermal agent distribution: lower
- Calculation heat requirement (necessary thermal energy): 539.32 kW
- Energy necessary for humidification: 0.00 kW
- Total thermal power installed for heating: 500/kW(thermal/electric)
- Connection to the centralized heating source: standarddiameter – 0 mm
  available pressure: 0 mmCA
- Heating meter: doesnot exist
- Costs allocator: doesnot exist
- Thermal and hydraulic adjustment elements:

at connection/heating source level atcolumns level

at static bodies level

Total length of the distribution network located in unheated spaces: 0.00 m

Unheatedspace denomination	Section diameter (mm) / Section length(m)								
ZTU1- attic ZTU2–technical channel									

Total standard flow of the heating agent: 23840.10 l/h

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

Area	Work day	Weekend day		
Hours	10			
Interior temperature (°C)	20			

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: own source (individual thermal system with natural gas fuel)
Type of equipments for preparing the hot running water: boiler with accumulation (number/volume) 1/2000 l
Number of sanitary items per types:

Washbasin	19	Bathtub	0
Washers	0	WC	26
Bidets	0	Dishwasher	0
Urinals	9	Washing machine	0
Shower			

Totalnumber of hot running water consumption points: 19
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:
- nominaldiameter: 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 – ignore the energy consumption for cooling/air conditioning

Time of one year when the interior temperature exceeds the freecomfort temperature during thesummer: 241 hrs

Reference volume of the air-conditioned area: 11814 m3

Average nominal value of the EER performance coefficient of thecooling 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 therea heat recoverer? No

F. INFORMATION REGARDING THE LIGHTING SYSTEM

Does the lighting system exist: Yes, it is functional

Type of control/adjustment system of thelighting system: noadjustment (on/off)

Type of lighting system: fluorescent

Electrical network condition/ lighting conductors network condition: Used

Total electricity necessary for the lighting system, corresponding to the normal use of thespaces/insuring the normal lighting level: 10.00 kW

Total installed electricity of the lighting system: 10.00 kW

G. INFORMATION REGARDING THE ENERGY RENEWABLE SOURCES

Solar thermal panel system: does not exist

Photovoltaic panels systems: does not exist

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: 140.3 kWh (m_2.a)

RER_P indicator: 9.14 %

CO_2 emissions indicator: 22.2 kgCO2 (m^2.a)

Drafted by,

Buildings energyauditor

Cruciat Radu-Iuliu

H.SITE PHOTOS

MIHALACHE ANDREEA-CRISTINA

Semnat digital de MIHALACHE ANDREEA-CRISTINA
Data: 2026.04.17 09:25:10 +03'00'

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