D3.9_Overall Refurbishment Plan

DRAFT - 2

CS11 Primary school “Tsanko Dustabanov”

Gabrovo

INTELLIGENT ENERGY – EUROPE II

Energy efficiency and renewable energy in buildings

IEE/12/070

EuroPHit

[Improving the energy performance of step-by-step refurbishment and integration of renewable energies]

Contract N°: SI2.645928

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Technical References

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Abstract

This overall refurbishment plan provides an overview of the retrofit steps of a step-by-step refurbishment to EnerPHit standard to be undertaken for the project Primary school “Tsanko Dustabanov”.

First, the existing building will shortly be described, including building component and component conditions. In addition, the existing energy efficiency performance of the building will be described.

In a second step, the overall refurbishment plan will describe the retrofit steps to be undertaken until the refurbishment will finally be completed.

The EnerPhit standart will be achieved by a) improvement of the building envelope with new thermal insulation on the external walls, ground walls, the roofs and where it is possible the slabs on the ground., change of the windows with better ones and b) improvement on the heating and electricity systems.

The calculations were made with PHPP9 (passive house). The building consists of three blocks, connected on the ground level. They are constructed one after the other in a long period of time, which determines the differences in their building characteristics. This is why the energy model was made with three different PHPP calculations – one for each block.

25, Hristo Smirnenski Blvd., Gabrovo, BG

Figure 1: Aerial view of Primary school “Tsanko Dustabanov”, [Google maps, 2013]

1 General Project description

1.1 Motivation

The municipality of Gabrovo has long traditions in the energy efficiency. In the last 6 years 7 schools and 15 kindergartens were improved with measures for EE on the standard level. Now the Municipality wants to be a leader in defining the new NZEB criteria. In 2013 year the first Passive House in Bulgaria was built in Gabrovo – kindergarten Sun.

With this project the local authorities intends to create a model for refurbishment of an old building to the level of the new NZEB definition. Choosing a school for a pilot project the Municipality hopes to set an example to be followed and to raise the awareness of the community.

1.2 Existing Building

The building consists of three blocks, connected on the ground level. They are constructed one after the other in a long period of time, which determines the differences in their building characteristics. Whole the building is connected to the District heating. There are a boiler room and a separate heating system in each block. The total TFA is 5465 m^2.

1.3 Refurbishment steps

1.3.1 Retrofit steps within EuroPHit

The Project will propose refurbishment in the following steps:

Block A: Block A1: step 1) Roof insulation block A, wall insulation block A1; step 2) external wall insulation, new windows, shading, airtightness, ventilation, reducing thermal bridges; step 3) New District heating substation (the one from Gym could be used)

Block B: step 1) external wall insulation, change of windows, insulation of the perimeter of the foundations, airtightness , shading, ventilation; step 2) Adding thermal insulation on the roof above the existing one ; step 3) New District heating substation (the one from Gym could be used)

Block C: step 1) External wall insulation, ventilation, change of old PVC windows in the dressing rooms; step 2) Roof insulation; step 3) New LED lighting will replace the existing mercury lamps in the Gym. Fourteen solar panels for DHW will be added in block C (for the dressing rooms in the Gym). For achieving better comfort in the summer, new heat-pump air-to water to be installed in the Gym on later stages.

1.3.2 Further retrofit steps

Block A: Insulation under the floor slab above the unheated basement block A , New LED lighting

Block B: Insulation under the floor slab above the unheated basement block A , New LED lighting

Block C: change of aluminium windows

1.4 EnerPHit standard

The building will achieve the criteria for EnerPhit standard. The calculations were made with PHPP9 (passive house). The building consists of three blocks, connected on the ground level. They are constructed one after the other in a long period of time, which determines the differences in their building characteristics. This is why the energy model was made with three different PHPP calculations – one for each block.

1.5 Pictures

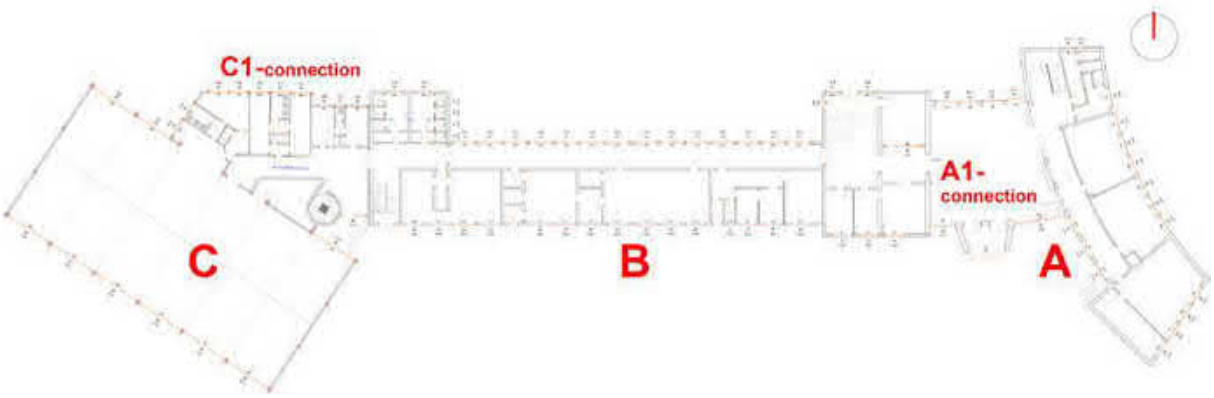


Figure 2: GROUNDFLOOR PLAN, not to scale

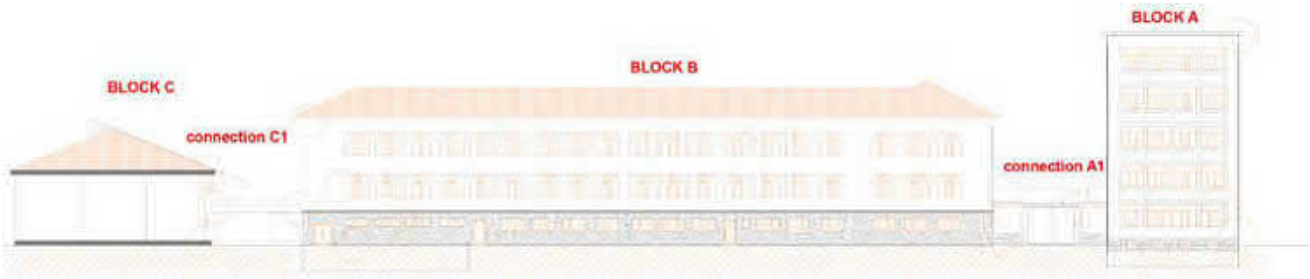


Figure 3: Elevation, not to scale

2 Existing building

2.1 General description

The building consists of three blocks, connected on the ground level. They are constructed one after the other in a long period of time, which determines the differences in their building characteristics. The building is connected to the District heating. There are a boiler room and a separate heating system in each block. The total TFA is 5465 m^2.

Block A is a five storey building with a basement. It is constructed in 1962. The TFA is 2040m^2. The block has concrete structure with columns, external brick walls (40 cm.) and concrete slabs. The flat roof is in very poor condition. The windows are wooden with very low thermal quality. There are fifteen classrooms - three on each storey. In the basement there are a boiler room and storages.

Block B is constructed in 1946. It consists of three floors and a partial basement. The TFA is 2480m^2. The block has concrete structure with columns, external brick walls (30 cm.) and concrete slabs. The pitched roof is wooden and has been renovated few years ago. Ten centimetres of glass wool insulation has been added above the last concrete slab. The windows are old and in very poor condition. The administration - offices, library, teachers room etc., are situated in the right part of this block. On the ground floor there are a canteen, a small theatre hall and a small study-kitchen. There are ten classrooms on the first and second floors. There is a basement with boiler room and storages under one fifth of the ground floor slab. This block is connected with block A and with block B by corridor on the ground floor.

Block C is a large gymnasium with area of 633m^2. It is commissioned in 1999. It has concrete floor and columns and pitched roof with steel construction. The roof is covered by tiles. There are five centimetres of thermal insulation on the roof. The external walls are made from twenty centimetres aerated concrete blocks (Ytong). There are aluminium windows with bad U value.

There is a one storey connection between Block B and Block D with area of 311m2, which comprises dressing rooms and bathrooms. The connection has a flat concrete roof without insulation. The twenty centimetres external brick walls are made from aerated concrete blocks. There are old PVC windows with bad thermal characteristics.

2.1.1 Building data

- Construction Time: Block A-1962, Block B-1946, Block C-1999
- Last retrofit: 2005
- Building use: school
- General condition: moderate
- Occupancy: 225 block A, 240 block B, 50 Block C
- Treated floor Area: 5465 m^2
- Other:

2.1.2 Client

- Municipality of Gabrovo
- 25, Hristo Smirnenski Blvd., Gabrovo, BG
- Email

2.2 Existing Building components

2.2.1 Existing building components, Block A

2.2.1.1 Floor slab to\ unheated basement

- Description floor covering – 2cm, cement screeding 3 cm, concrete floor slab - massive construction 20cm
- U-Value 1,79 W/(m²K)
- Installation date: 1962
- Condition: good
- Next replacement:
- Other:

2.2.1.2 External walls

- Description massive brick walls 40sm. with plaster
- U-Value 1,347 W/(m²K)
- Installation date: 1962
- Condition: good
- Next replacement:
- Other:
-

2.2.1.3 Windows

- Description wooden double windows
- U-Value 2.75 W/(m2K)
- Installation date: 1962
- Condition: very poor
- Next replacement:
- Other:

2.2.1.4 Roof / Top floor ceiling

- Description Flat roof, no insulation
- U-Value 3,072 W/(m²K)
- Installation date: 1962
- Condition: poor
- Next replacement:
- Other:

2.2.1.5 Heating

- Description District heating for blocks A and B
- Efficiency: 96%
- Installation date: 1970
- Condition: poor
- Next replacement: 2000

- Other:

2.2.2 Existing building components, Block B

2.2.2.1 Floor slab

- Description floor slab above the unheated basement - flooring, 2sm, screeding 3 sm.,concrete floor slab massive construction 20sm
- U-Value 1,790 W/(m²K)
- Installation date: 1946
- Condition: good
- Next replacement:
- Other:

2.2.2.2 External walls

- Description massive brick walls 30sm. with plaster
- U-Value 1,624 W/(m²K)
- Installation date: 1946
- Condition: good
- Next replacement:
- Other:

2.2.2.3 Windows

- Description
- U-Value 2,4 W/(m2K);
- Installation date: 1946
- Condition: very poor
- Next replacement: 2015
- Other:

2.2.2.4 Roof / Top floor ceiling

- Description Top floor ceiling with pitch roof with ventilated air space – unheated, concrete floor slab with 10 cm insulation of mineral wool
- U-Value 2,26 W/(m²K)
- Installation date: 2005
- Condition: good
- Next replacement:
- Other:

2.2.2.5 Heating

- Description District heating for blocks A and B
- Efficiency: 96%
- Installation date: 1970
- Condition: poor
- Next replacement: 2000
- Other:

2.2.3 Existing building components, Block C

2.2.3.1 Floor slab

- Description wood covering, screeding 3 sm.,concrete floor slab massive construction 15sm, gravel 15sm.
- U-Value 1,767 W/(m²K)
- Installation date: 1999
- Condition: good
- Next replacement:
- Other:

2.2.3.2 External walls

- Description aerated concrete blocks 25sm. with plaster
- U-Value 0,707 W/(m²K)
- Installation date: 1999
- Condition: good
- Next replacement:
- Other:

2.2.3.3 Windows

- Description aluminium windows, double glazing with white float glass 4/20/4mm
- U-Value 2.4 W/(m^2K)
- Installation date: 1999
- Condition: medium
- Next replacement: 2020
- Other:

2.2.3.4 Roof / Top floor ceiling

- Description construction: pitched roof: tiles, sandwich panel (poliuretane) , metal
- U-Value: 1.664 W/(m²K)
- Installation date: 1999
- Condition: good
- Next replacement:
- Other:

2.2.3.5 Heating

- Description: District heating
- Efficiency: 99%
- Installation date: 1999
- Condition: good
- Next replacement: 2024
- Other:

2.3 Energy efficiency of the existing building

2.3.1 Energy efficiency of the existing building, Block A

- Modelled specific heating demand: 250,1 kWh/(m²a)
- Modelled specific cooling demand / overheating frequency: 10,5%
- Modelled specific primary energy demand: no results in PHPP because of the overheating problems)

Average annual Gas/Oil bills (if available): to be confirmed

Average annual Electricity bills (if available): to be confirmed

2.3.2 Energy efficiency of the existing building, Block B

- Modelled specific heating demand: 163,8kWh/(m²a)
- Modelled specific cooling demand / overheating frequency: 4,1%%
- Modelled specific primary energy demand: 221.2 kWh/(m²a)

2.3.3 Energy efficiency of the existing building, Block C

- Modelled specific heating demand: 121,3 kWh/(m²a)
- Modelled specific cooling demand / overheating frequency: 7,9%
- Modelled specific primary energy demand: 196.5 kWh/(m²a)

For an overview of the energy efficiency of the existing building, see the verification spreadsheet of the PHPP 9 beta version [PHI 2013] on the next page.

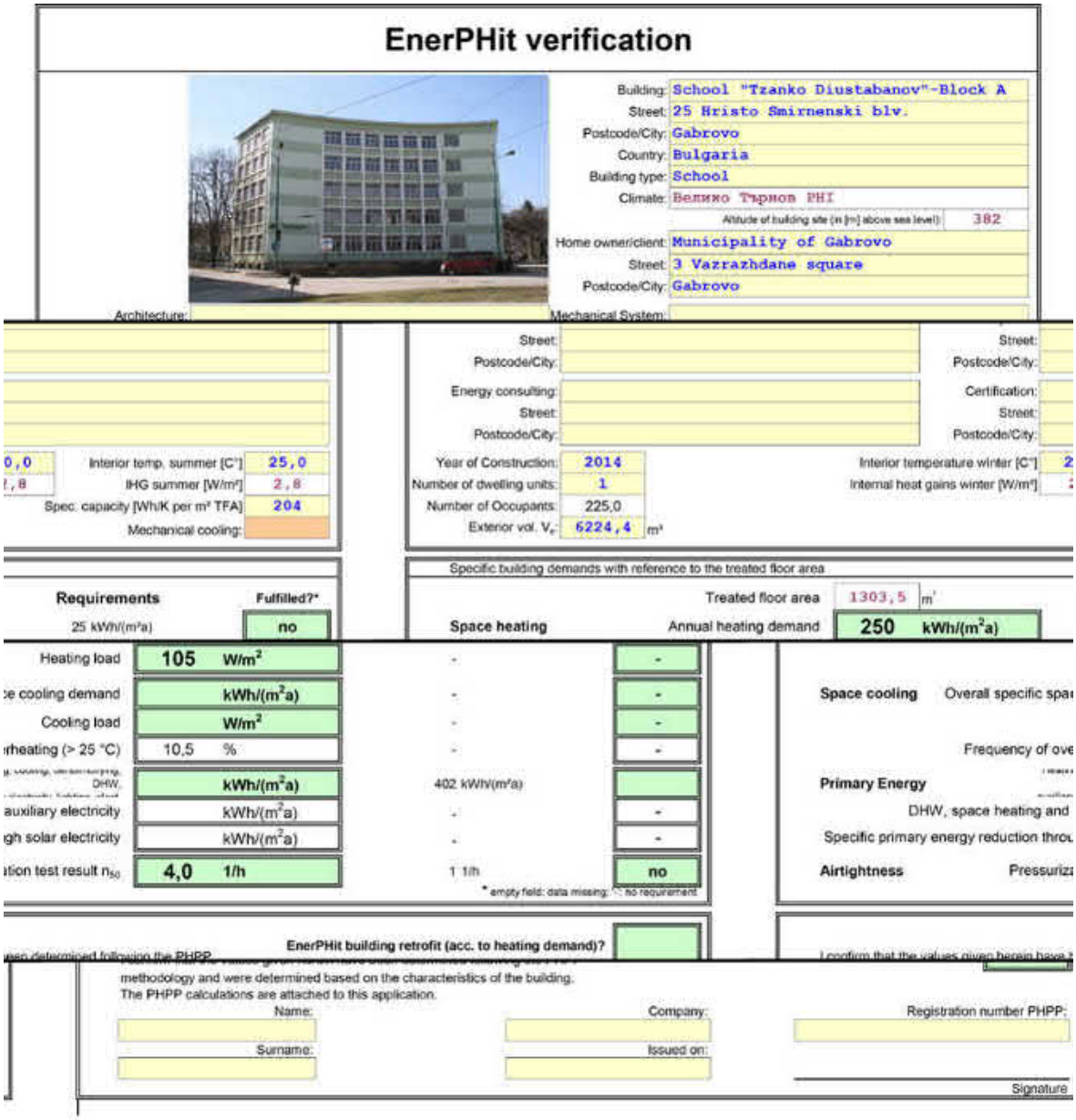
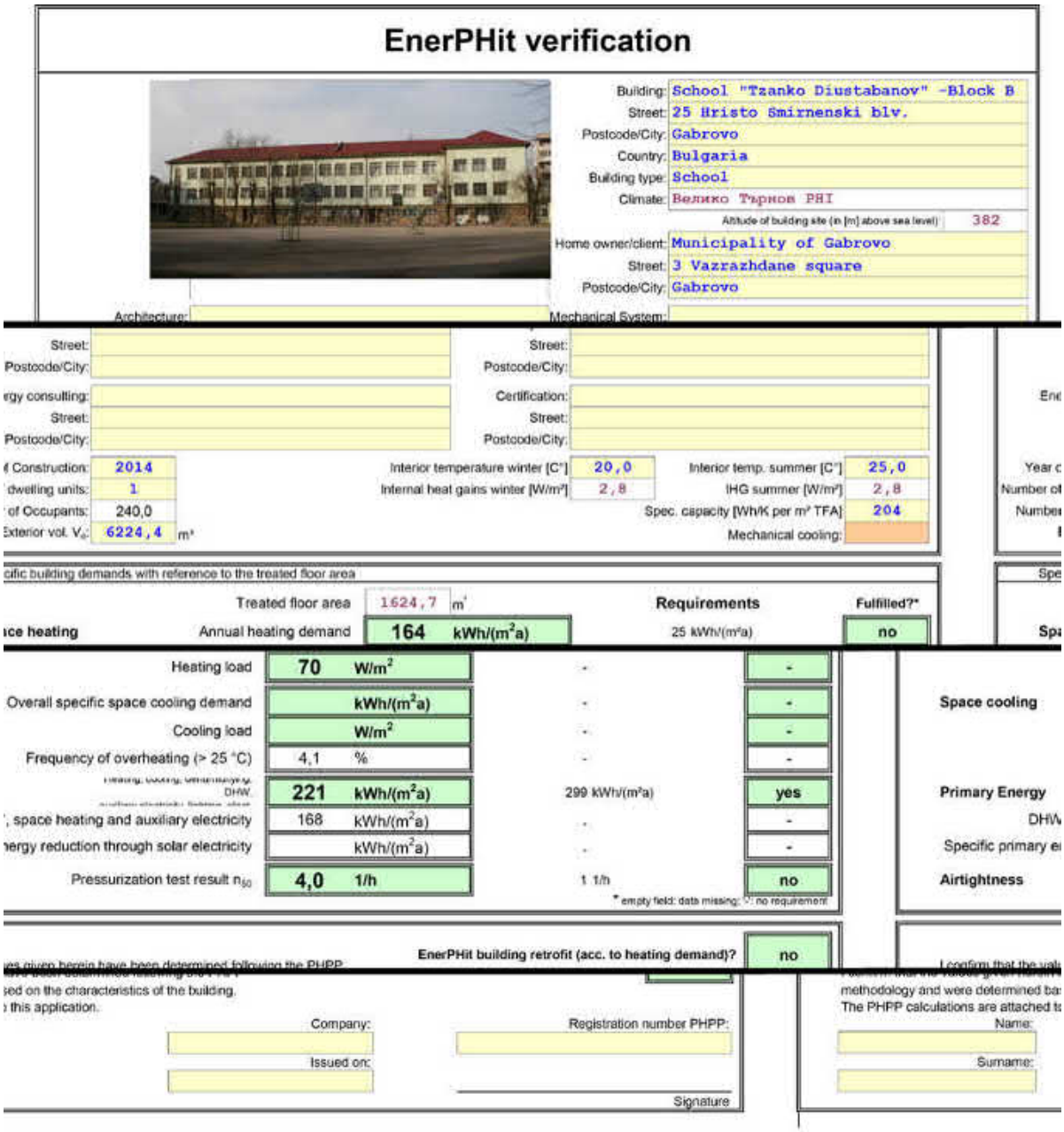


Figure 4: Specific energy efficiency values of the existing building –block A modelled with PHPP 9 Beta



EnerPHit verification

Building: School "Tzanko Diustabanov" -Block B
Street: 25 Hristo Smirnenski blv.
Postcode/City: Gabrovo
Country: Bulgaria
Building type: School
Climate: Велико Търново РНІ
Altitude of building site (in [m] above sea level): 382
Home owner/client: Municipality of Gabrovo
Street: 3 Vazrazhdane square
Postcode/City: Gabrovo
Architecture:
Mechanical System:
Street:
Postcode/City:
Certification:
Year of Construction: 2014
Number of dwelling units: 1
Number of Occupants: 240,0
Exterior vol. V_e: 6224,4 m³
Interior temperature winter [C°]: 20,0
Internal heat gains winter [W/m²]: 2,8
Interior temp. summer [C°]: 25,0
IHG summer [W/m²]: 2,8
Spec. capacity [Wh/K per m² TFA]: 204
Mechanical cooling:

Treated floor area: 1624,7 m²

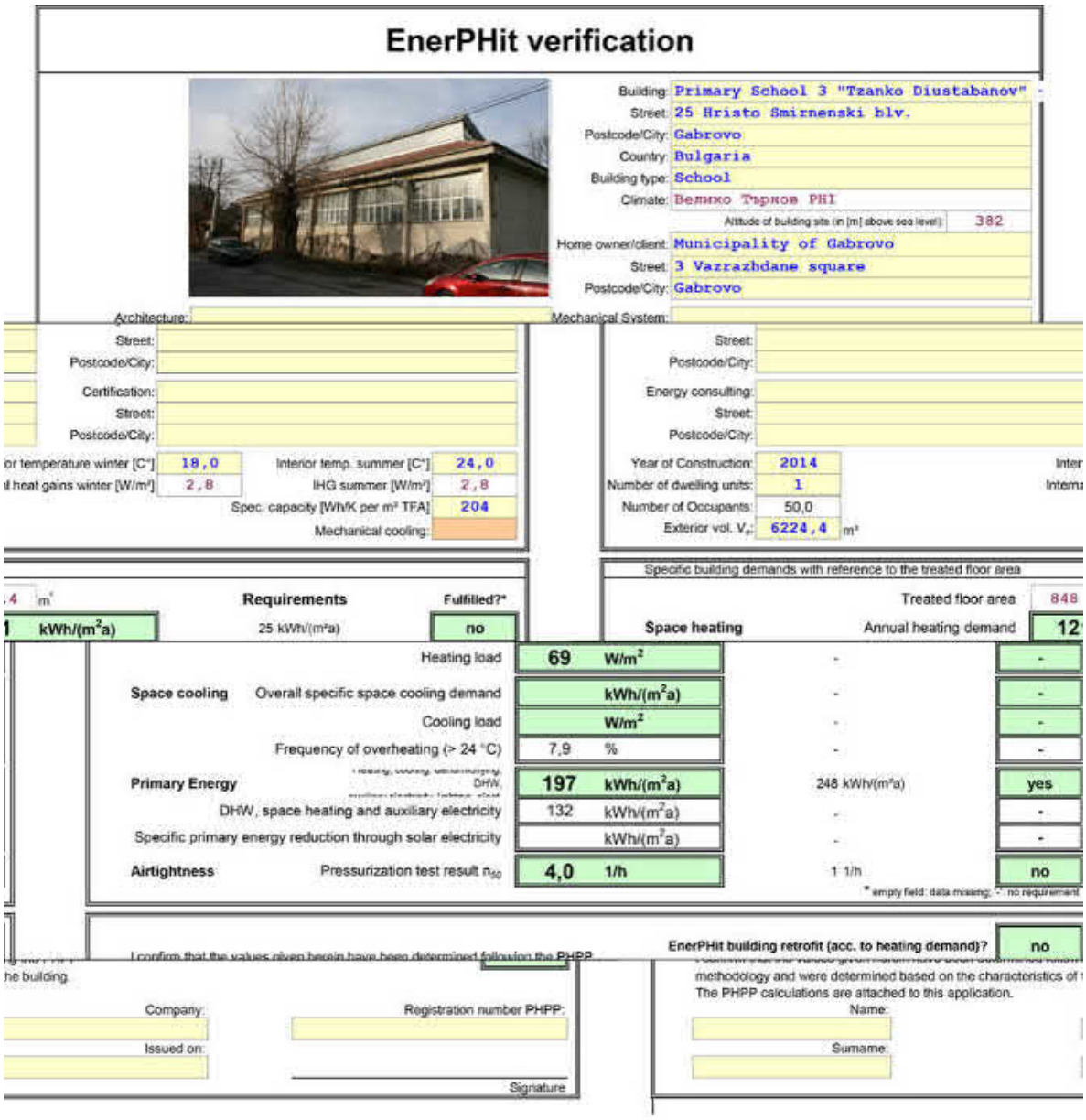
			Requirements	Fulfilled?*
Annual heating demand	164	kWh/(m²a)	25 kWh/(m²a)	no
Heating load	70	W/m²	-	-
Overall specific space cooling demand		kWh/(m²a)	-	-
Cooling load		W/m²	-	-
Frequency of overheating (> 25 °C)	4,1	%	-	-
DHW	221	kWh/(m²a)	299 kWh/(m²a)	yes
space heating and auxiliary electricity	168	kWh/(m²a)	-	-
energy reduction through solar electricity		kWh/(m²a)	-	-
Pressurization test result n_{50}	4,0	1/h	1 1/h	no

* empty field: data missing; -: no requirement

EnerPHit building retrofit (acc. to heating demand)? no

Company:
Registration number PHPP:
Issued on:
Signature
Name:
Surname:

Figure 5: Specific energy efficiency values of the existing building Block B, modelled with PHPP 9 Beta



EnerPHit verification

Building: Primary School 3 "Tzanko Diustabanov"
Street: 25 Hristo Smirnenski blv.
Postcode/City: Gabrovo
Country: Bulgaria
Building type: School
Climate: Велико Търново РНІ
Altitude of building site (in [m] above sea level): 382
Home owner/client: Municipality of Gabrovo
Street: 3 Vazrazhdane square
Postcode/City: Gabrovo

Architecture:
Street:
Postcode/City:
Certification:
Street:
Postcode/City:
Mechanical System:
Street:
Postcode/City:
Energy consulting:
Street:
Postcode/City:

ior temperature winter [C°] 18,0 | Interior temp. summer [C°] 24,0
al heat gains winter [W/m²] 2,8 | IHG summer [W/m²] 2,8
Spec. capacity [Wh/K per m² TFA] 204
Mechanical cooling:

Year of Construction: 2014
Number of dwelling units: 1
Number of Occupants: 50,0
Exterior vol. V_e: 6224,4 m³

Specific building demands with reference to the treated floor area

Treated floor area 848

		Requirements	Fulfilled?*
Space heating	Annual heating demand	25 kWh/(m²a)	no
	Heating load	69 W/m²	-
Space cooling	Overall specific space cooling demand	kWh/(m²a)	-
	Cooling load	W/m²	-
	Frequency of overheating (> 24 °C)	7,9 %	-
Primary Energy		197 kWh/(m²a)	248 kWh/(m²a) yes
	DHW, space heating and auxiliary electricity	132 kWh/(m²a)	-
	Specific primary energy reduction through solar electricity	kWh/(m²a)	-
Airtightness	Pressurization test result n_{50}	4,0 1/h	1 1/h no

* empty field: data missing; - no requirement

EnerPHit building retrofit (acc. to heating demand)? no

I confirm that the values given herein have been determined following the PHPP methodology and were determined based on the characteristics of the building.
The PHPP calculations are attached to this application.

Company:
Registration number PHPP:
Issued on:
Signature
Name:
Surname:

Figure 6: Specific energy efficiency values of the existing building Block B, modelled with PHPP 9 Beta

2.4 Pictures / Drawings

These pictures or drawings illustrate the existing building.

Figure 7: View towards Block A

Figure 8: View towards Block B

Figure 9: View towards Block A

3 Retrofit steps

3.1 Overall refurbishment Plan

3.1.1 Retrofit steps

The Project will propose refurbishment in the following steps:

Step 1 and Step 2: Thermal insulation of the roof and walls, replacement of windows, ventilation with heat recovery (depending on the condition of the roof insulation it could be done in the second step).

Step 3: RES implementation, new solar panels on the roof of the Gym. New heat sources.

Step 4: Insulation of ground floor or the walls in the basement (different solutions in each block) Replacement of the aluminium windows in the Gym.

The following tables shows the separation of the works in different blocks:

Step	Year	BLOCK A	Specific Heating Demand	Specific Primary Energy Demand
existing situation		constructed 1962, roof needs refurbishment , no insulation, old wooden windows in poor condition, heating system in poor conditions	250,1	
STEP 1	2015	Roof insulation block A, wall insulation block A1	188,6	257,8
STEP 2	2015	external wall insulation 25 cm. EPS – F, new windows, shading, airtightness, ventilation, reducing thermal bridges	24,2	128,8
STEP 3	2015	New District heating substation (the one from Gym could be used)	24,2	124,0
STEP 4	2020	Insulation under the floor slab above the unheated basement block A , New LED lighting	24,1	98,4

Figure 10: Overview refurbishment steps, Block A and A1(connection)

Step	Year	BLOCK B	Specific Heating Demand	Specific Primary Energy Demand
existing situation		constructed 1946, roof refurbished in 2005 with 10 cm. insulation, no insulation on the walls , old wooden windows	163,8	221,2
STEP 1	2015	external wall insulation 25sm. EPS, change of windows, insulation of the perimeter of the foundations, airtightness , shading, ventilation	29,8	114.3
STEP 2	2015	Adding 20 sm. Mineral wool on the roof above the existing 10 cm. (above the last floor slab)	22,5	108.4
STEP 4	2015	New District heating substation (the one from Gym could be used)	22,5	105.3
STEP 5	2020	Insulation under the floor slab above the unheated basement block A , New LED lighting	19,9	86.9

Figure 11: Overview refurbishment steps, Block B

Step	Year	BLOCK C-GYM	Specific Heating Demand	Specific Primary Energy Demand
existing situation		Constructed in 1999, aluminum windows in the GYM, PVC windows in the dressing rooms	121.3	196.5
STEP 1	2015	External wall insulation, ventilation, change of old PVC windows in the dressing rooms	96.4	193.9
STEP 2	2015	Roof insulation	46.3	151.9
STEP 3	2015	New LED lighting will replace the existing mercury lamps in the Gym.Fourteen solar panels for DHW will be added in block C (for the dressing rooms in the Gym). For achieving better comfort in the summer, new heat-pump air-to water can be installed in the Gym on later stages.	46.3	127.9

STEP 4	2020	change of aluminium windows	22.5	93.4

Figure 12: Overview refurbishment steps, Block C

3.1.2 Efficiency Improvements

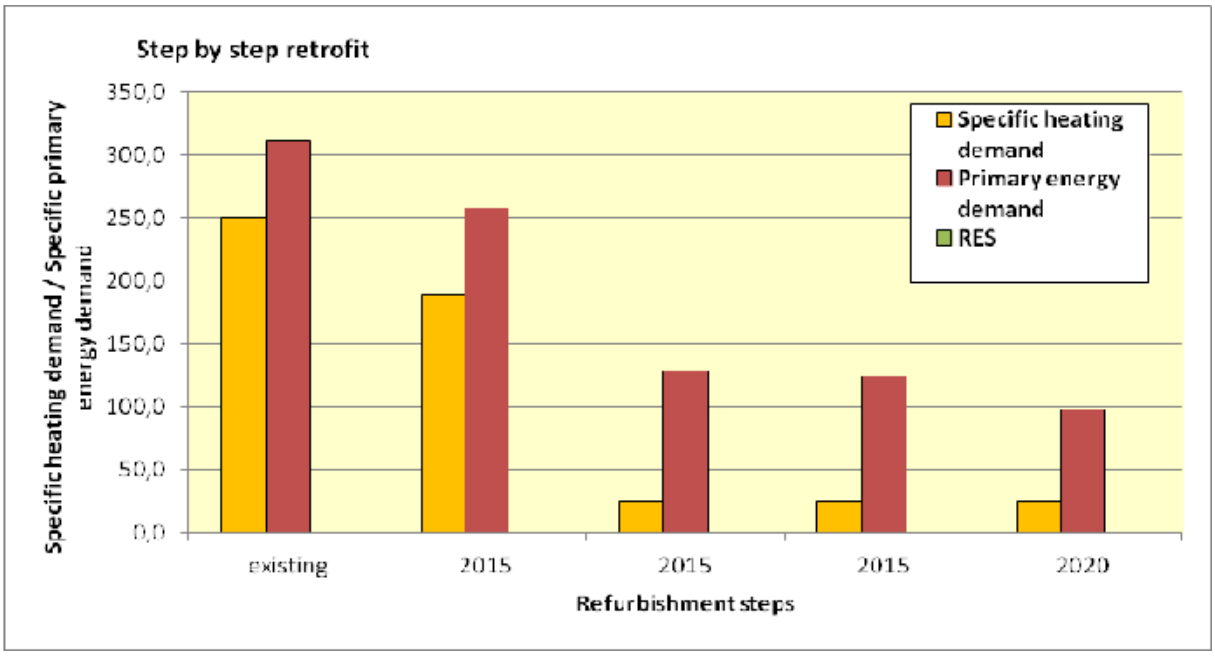


Figure 13: Overview energy efficiency improvement according to the overall refurbishment plan , Block A

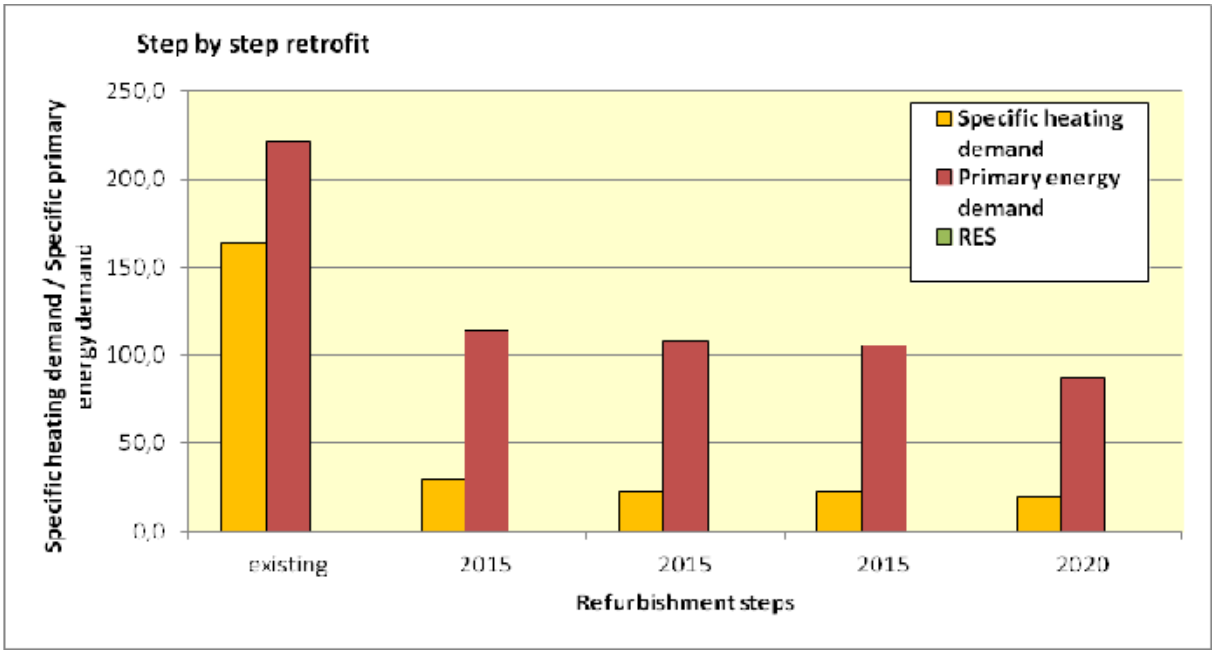


Figure 14: Overview energy efficiency improvement according to the overall refurbishment plan , Block B

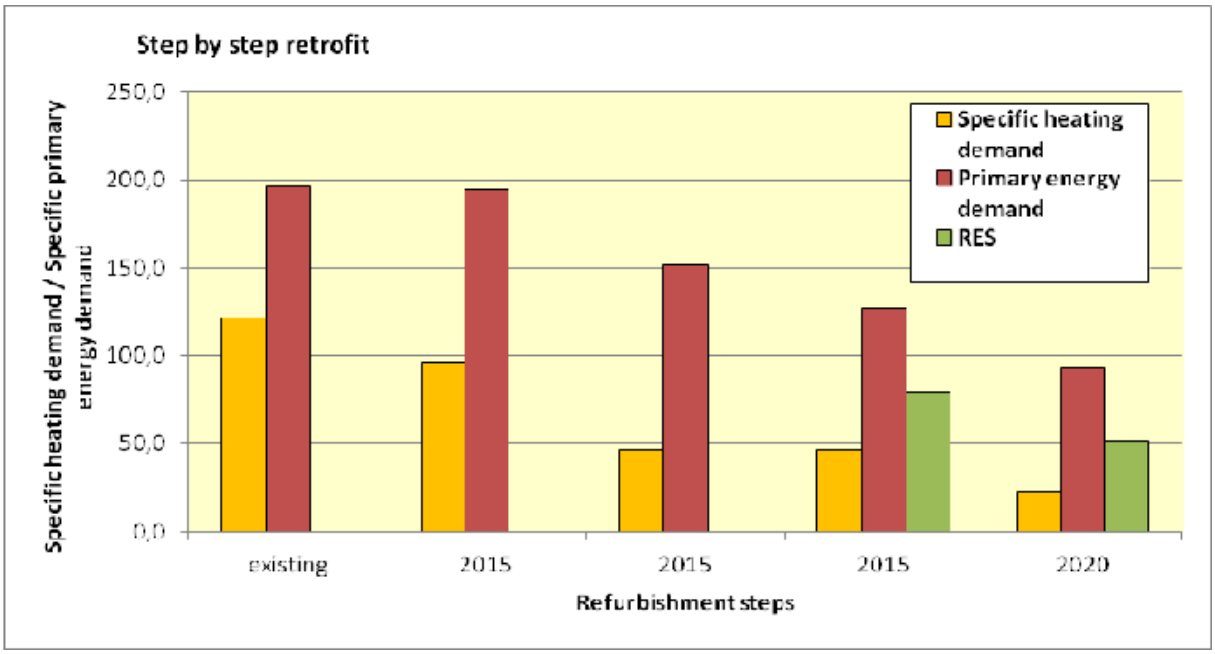


Figure 15: Overview energy efficiency improvement according to the overall refurbishment plan , Block C

3.2 Retrofit steps within EuroPHit

3.2.1 Retrofit step 1,block A

External thermal insulation applied on the roof of Block A, Insulation of the walls of block A1

- Start date: 2015
- Completion date: 2015
- Budget: 41 269 EUR
- Specific heating demand: 188,6 kWh/(m²a)
- Specific cooling demand / overheating frequency: 9,1%
- Specific primary energy demand: 257.8 kWh/(m²a)

3.2.1.1 New Envelope component

- Description: Block A - 30 sm. XPS applied on the roof , λ <0.035[W/(mK)], Block A1 - 25 sm. EPS – F with graphite , λ <0.032[W/(mK)], shading devices
- U-Value: roof block A U= 0,112 W/(m²K), walls block A1 U=0,12W/(m²K)
- Installation date: 2015
- Condition:
- Next replacement:
- Other:

3.2.2 Retrofit step 1, block B:

External thermal insulation applied to the walls, new windows, shading, ventilation

- Start date: 2015
- Completion date: 2015
- Budget: 247 858 EUR
- Specific heating demand: 29,8 kWh/(m²a)
- Specific cooling demand / overheating frequency: 6,5%
- Specific primary energy demand: 114.3 kWh/(m²a)

3.2.2.1 New Envelope component

- Description: 25 sm. EPS on the walls, λ <0.040[W/(mK)], new PVC windows
- U-Value: walls – 0,145 W/(m²K), windows 0,8 W/(m²K)
- Installation date: 2015
- Condition:
- Next replacement:
- Other:

3.2.2.2 New building equipment component

- Description MVHR
- Efficiency: 81%
- Installation date: 2015
- Condition:
- Next replacement:
- Other:

3.2.3 Retrofit step 1, block C:

External thermal insulation applied to the walls, change of old PVC windows, ventilation.

- Start date: 2015
- Completion date: 2015
- Budget: 45 262 EUR
- Specific heating demand: 96,5 kWh/(m²a)
- Specific cooling demand / overheating frequency: 0.8%
- Specific primary energy demand: 187.9 kWh/(m²a)

3.2.3.1 New Envelope component

- Description 20 sm. EPS –F on the walls, λ <0.032[W/(mK)], changing of the old PVC windows in the dressing rooms with new PVC windows with PH criterias
- U-Value 0,133 W/(m²K)
- Installation date: 2015
- Condition:
- Next replacement: 2065
- Other:

3.2.3.2 New building equipment component

- Description MVHR
- Efficiency: 81 %
- Installation date: 2015
- Condition:
- Next replacement: 2045
- Other:

3.2.4 Retrofit step 2, Blocks A:

Step 2 – Block A - external wall insulation, new windows, airtightness , ventilation, reducing thermal bridges, Block A1 – roof insulation

- Start date: 2015
- Completion date: 2015
- Budget: 238 849 EUR
- Specific heating demand: 24,2 kWh/(m²a)
- Specific cooling demand / overheating frequency: 8,2%
- Specific primary energy demand: 128,8 kWh/(m²a)

3.2.4.1 New Envelope component

- Description Block A - 25 sm. EPS with graphite with , λ <0.032[W/(mK)], shading devices, Block A1- 30 sm XPS on the roof
- U-Value Block A-walls U= 0,117 W/(m²K), Block A1 –roof U=0,112 W/(m²K)
- Installation date: 2015
- Condition:
- Next replacement:
- Other:

3.2.5 Retrofit step 2, Blocks B:

Adding 20 sm. Mineral wool above the existing 10 sm.

- Start date: 2015
- Completion date: 2015
- Budget: 25 871 EUR
- Specific heating demand: 22,5 kWh/(m²a)
- Specific cooling demand / overheating frequency: 6,4%
- Specific primary energy demand: 108,4 kWh/(m²a)

3.2.5.1 New Envelope component

- Description 20 cm. mineral wool, λ <0.041[W/(mK)]
- U-Value 0,129 W/(m²K)
- Installation date: 2015
- Condition:
- Next replacement:
- Other:

3.2.6 Retrofit step 2, Blocks C:

External thermal insulation applied to the roof.

- Start date: 2015
- Completion date: 2015
- Budget: 55 795 EUR
- Specific heating demand: 46,3 kWh/(m²a)
- Specific cooling demand / overheating frequency: 0.1%
- Specific primary energy demand: 151.9 kWh/(m²a)

3.2.6.1 New Envelope component

- Description 30 cm. XPS on the flat roof , λ <0.035[W/(mK)], 30sm. Mineral wool on the pitched roof, λ <0.041[W/(mK)]
- U-Value 0.101 W/(m²K) on the flat roof 0.113 W/(m²K) on the pitched roof
- Installation date: 2015
- Condition:
- Next replacement:
- Other:

3.2.7 Retrofit step 3, Blocks A:

New heat source

Start date: 2015

- Completion date: 2015
- Budget: 6249 EUR
- Specific heating demand: 24,2 kWh/(m²a)
- Specific cooling demand / overheating frequency: 8,2%
- Specific primary energy demand: 124,0 kWh/(m²a)

3.2.7.1 New building equipment component

- Description new district heating substation (the one from the GYM might be used)
- Efficiency:
- Installation date: 1999/2015
- Condition: good
- Next replacement: 2030
- Other:

3.2.8 Retrofit step 3, Block B:

- Start date: 2015
- Completion date: 2015

- Budget: 4045 EUR
- Specific heating demand: 22,5 kWh/(m²a))
- Specific cooling demand / overheating frequency: 6,4%
- Specific primary energy demand: 105,3 kWh/(m²a)

3.2.8.1 New building equipment component

- Description new district heating substation (the one from the GYM might be used)
- Efficiency:
- Installation date: 1999/2015
- Condition: good
- Next replacement: 2030
- Other:

3.2.9 Retrofit step 3, Block C:

New LED lighting in the Gym. Fourteen solar panels for DHW will be added in block C (for the dressing rooms in the Gym). new heat-pump

- Start date: 2015
- Completion date: 2015
- Budget: 34 026 EUR
- Specific heating demand: 46,3 kWh/(m²a)
- Specific cooling demand / overheating frequency:
- Specific primary energy demand: 127,9 kWh/(m²a)

3.2.9.1 New Envelope component

- Description
- U-Value
- Installation date:
- Condition:
- Next replacement:
- Other:

3.2.9.2 New building equipment component

- Description LED lighting in the GYM, Heat pump, 14 solar panels for DHW
- Efficiency:
- Installation date: 2015
- Condition:
- Next replacement:

- Other:

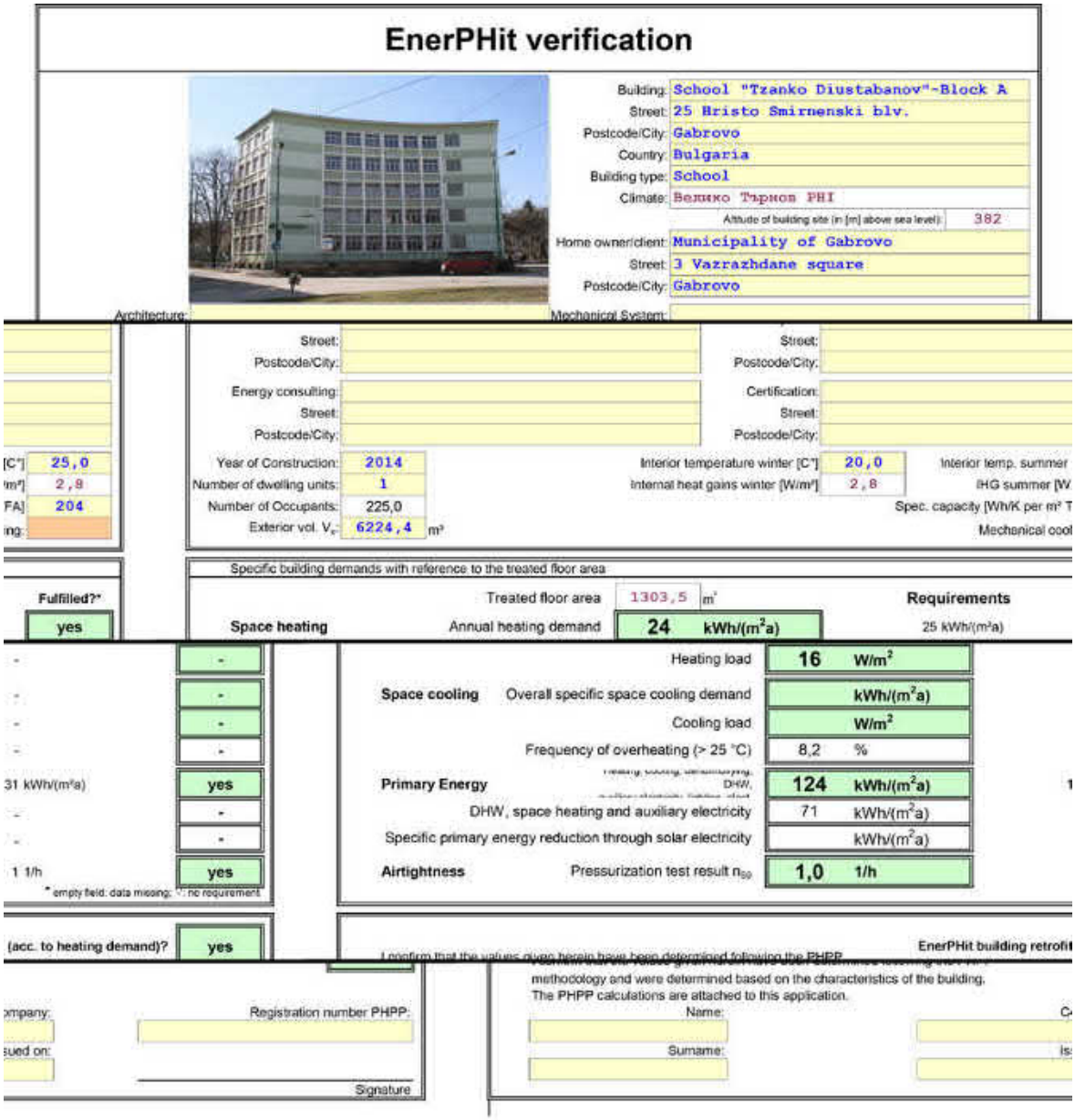


Figure 16: Specific energy efficiency values after measures within EuroPHit, Block A

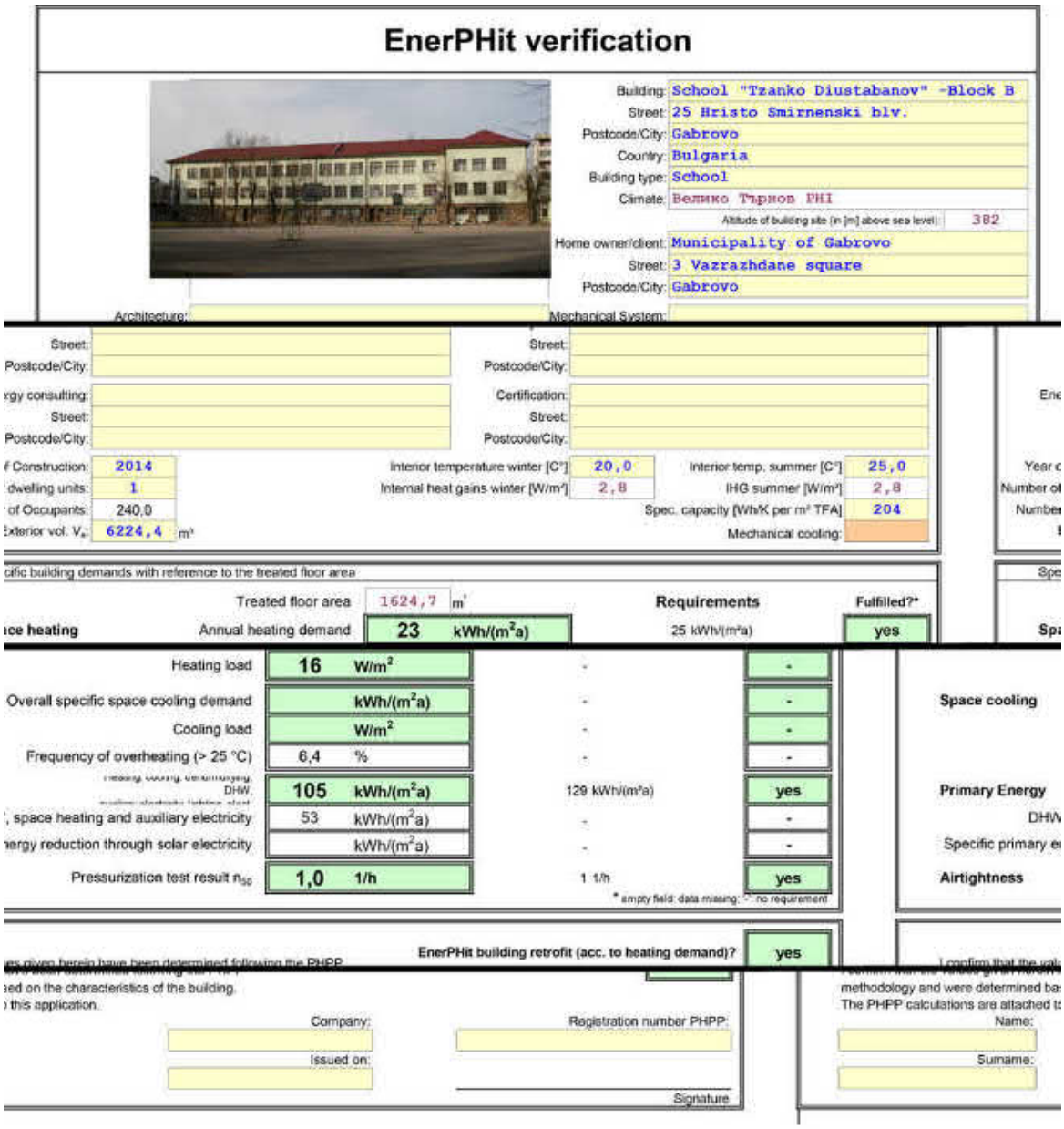
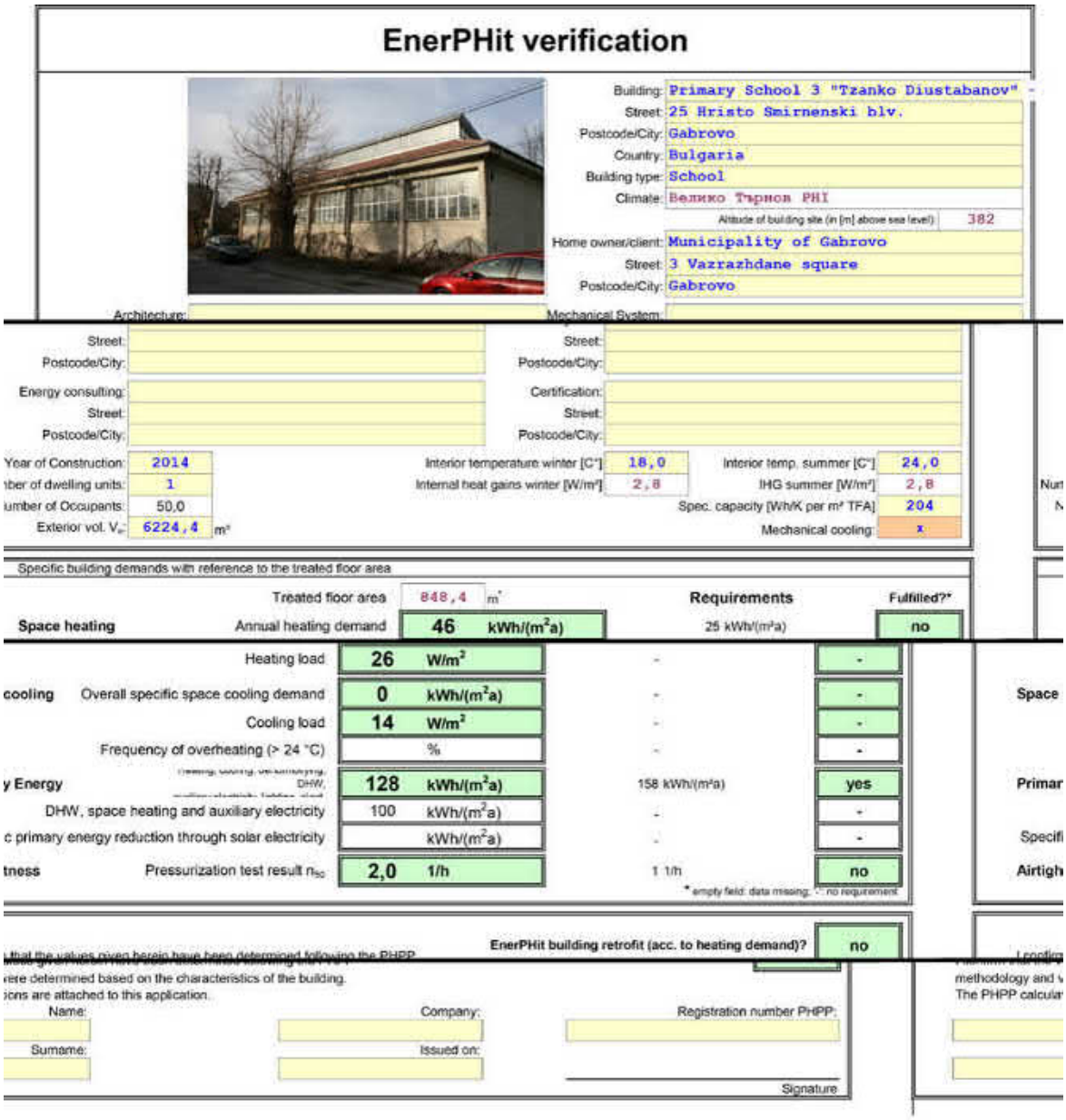


Figure 17: Specific energy efficiency values after measures within EuroPHit, Block B



EnerPHit verification

Building: Primary School 3 "Tzanko Diustabanov"
Street: 25 Hristo Smirnenski blv.
Postcode/City: Gabrovo
Country: Bulgaria
Building type: School
Climate: Велико Търново PHI
Altitude of building site (in [m] above sea level): 382
Home owner/client: Municipality of Gabrovo
Street: 3 Vazrazhdane square
Postcode/City: Gabrovo

Architecture:
Mechanical System:
Street:
Postcode/City:
Energy consulting:
Certification:

Year of Construction: 2014
Number of dwelling units: 1
Number of Occupants: 50,0
Exterior vol. V_e: 6224,4 m³
Interior temperature winter [C°]: 18,0
Internal heat gains winter [W/m²]: 2,8
Interior temp. summer [C°]: 24,0
IHG summer [W/m²]: 2,8
Spec. capacity [Wh/K per m² TFA]: 204
Mechanical cooling: x

Specific building demands with reference to the treated floor area

				Requirements	Fulfilled?*
	Treated floor area	848,4	m²		
Space heating	Annual heating demand	46	kWh/(m²a)	25 kWh/(m²a)	no
	Heating load	26	W/m²	-	-
cooling	Overall specific space cooling demand	0	kWh/(m²a)	-	-
	Cooling load	14	W/m²	-	-
	Frequency of overheating (> 24 °C)		%	-	-
y Energy		128	kWh/(m²a)	158 kWh/(m²a)	yes
	DHW, space heating and auxiliary electricity	100	kWh/(m²a)	-	-
c primary energy reduction through solar electricity			kWh/(m²a)	-	-
tness	Pressurization test result n_{50}	2,0	1/h	1 1/h	no

* empty field: data missing; - no requirement

EnerPHit building retrofit (acc. to heating demand)? no

...that the values given herein have been determined following the PHPP
...ere determined based on the characteristics of the building.
...ions are attached to this application.
Name:
Company:
Registration number PHPP:
Surname:
Issued on:
Signature

methodology and ...
The PHPP calcula...

Figure 18: Specific energy efficiency values after measures within EuroPHit, Block C

3.3 Future retrofit Steps

3.3.1 Retrofit step 4,\Blocks A:

Internal thermal insulation applied to ground floor slab above the unheated basement

- Start date: 2020
- Completion date: 2020
- Budget: 12 378 EUR
- Specific heating demand: 24,1 kWh/(m²a)
- Specific cooling demand / overheating frequency: 8,4%
- Specific primary energy demand: 98,4 kWh/(m²a)

3.3.1.1 New Envelope component

- Description 10 sm. Mineral wool above the unheated basement
- U-Value 0,334 W/(m²K)
- Installation date: 2015
- Condition:
- Next replacement:
- Other:

3.3.1.2 New building equipment component

- Description LED Lighting
- Efficiency:
- Installation date:
- Condition:
- Next replacement:
- Other:

3.3.2 Retrofit step 4,Blocks B:

Internal thermal insulation applied to ground floor slab above the unheated basement

Start date: 2020

- Completion date: 2020
- Budget: 11 583 EUR
- Specific heating demand: 19,9 kWh/(m²a)
- Specific cooling demand / overheating frequency: 6,4%
- Specific primary energy demand: 86,9 kWh/(m²a)

3.3.2.1 New Envelope component

- Description 10 sm. mineral wool above the unheated basement
- U-Value 0,334 W/(m²K)

- Installation date: 2015
- Condition:
- Next replacement:
- Other:

3.3.2.2 New building equipment component

- Description LED Lighting
- Efficiency:
- Installation date:
- Condition:
- Next replacement:
- Other:

3.3.3 Retrofit step 4,Blocks C:

Replacement of the existing aluminium windows with new aluminium windows, airtightness

- Start date: 2020
- Completion date: 2020
- Budget: 48 489 EUR
- Specific heating demand: 22.5 kWh/(m²a)
- Specific cooling demand / overheating frequency:
- Specific primary energy demand: 93.4 kWh/(m²a)

3.3.3.1 New Envelope component

- Description replacement of windows and doors
- U-Value 0.8 W/(m^{2}K),
- Installation date: 2020
- Condition:
- Next replacement: 2050
- Other:

3.4 Pictures / Drawings

The final details for step by step solutions are added in the last section.

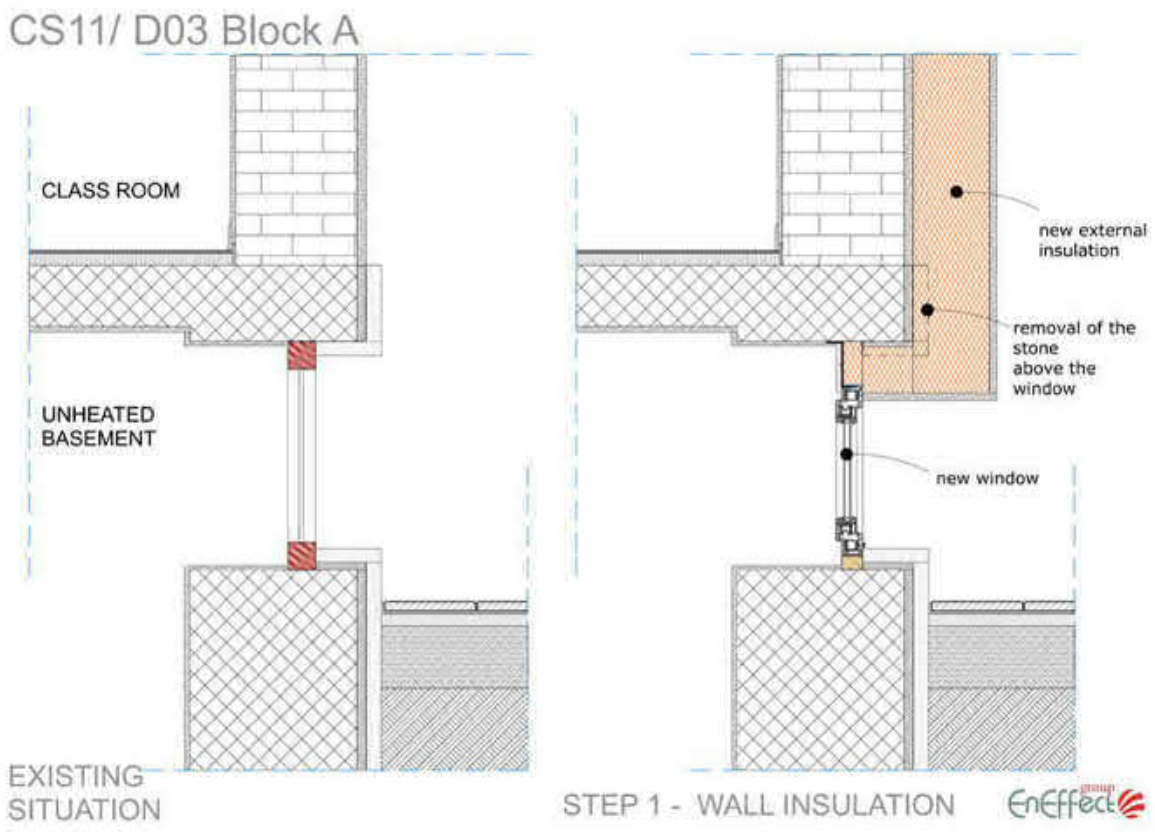


Figure 19: D03, block A, connection external wall / ground floor slab

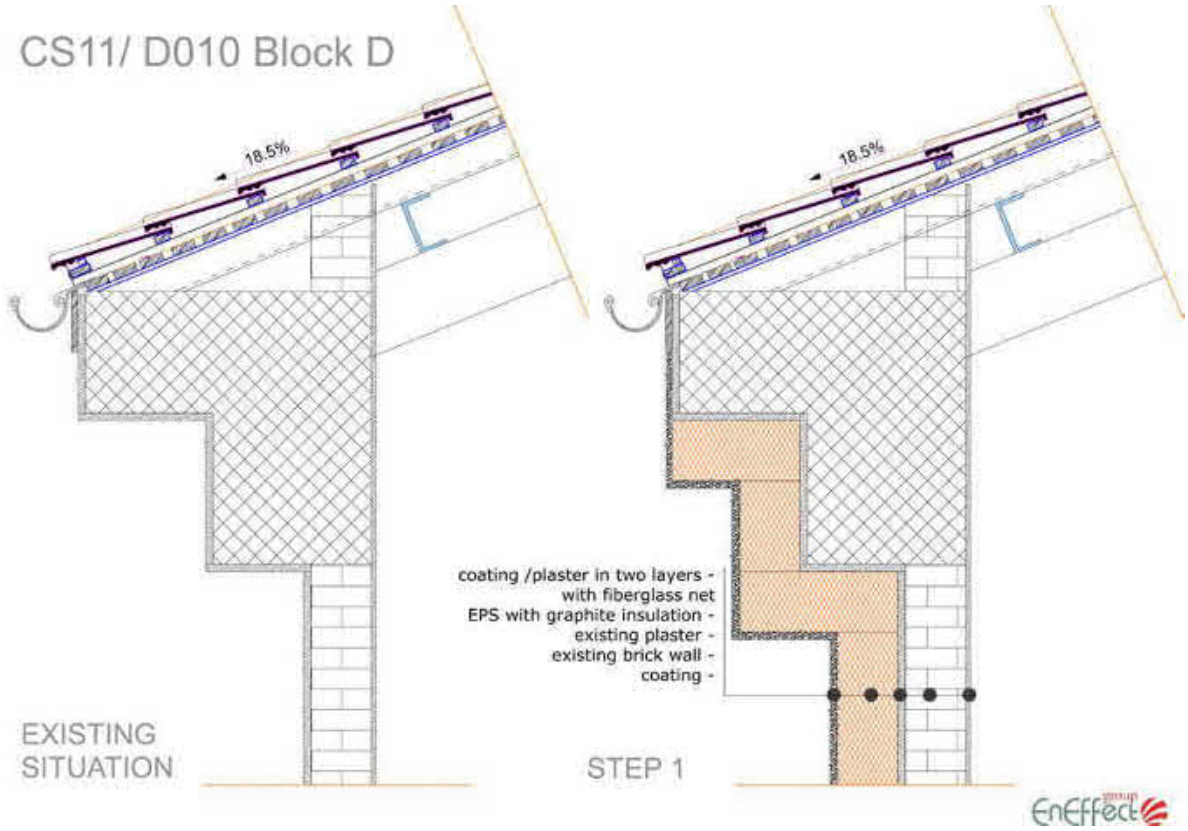


Figure 20: D10, block D, connection external wall / roof

4 Completion of step-by-step refurbishment to EnerPHit standard including RES

4.1 General description

4.1.1 Insulation

The walls will be insulated with 25 cm. EPS with graphite. Details for the insulation of the different kind of roofs will be developed to the level of the PH criterias. The basement walls will be insulated with 20 cm. XPS. The ground floor slab above the unheated basements will be insulated with 10 sm. mineral wool.

4.1.2 Windows & Doors

The old windows and doors will be replaced with new ones with U<0.85(W/m^{2}K). The aluminium windows in the Gym will be changed in few years, when their lifetime is over. Shading in early steps needs to be considered, because of the overheating problems.

4.1.3 Thermal Bridging

Because of the step-by-step refurbishment, the new thermal bridging during the different steps will be considered. In the Gym a special detail of the wall insulation around the windows will be developed in a way to allow easy future change of the windows.

4.1.4 Airtightness

The new airtight layer will be the existing external plaster of the walls, the concrete roof slabs and the concrete basement slab. With the change of the windows the airtightness to the PH requirements will have to be achieved. In block C (the Gym) airtight membrane will have to be added on the roof and sealed well to the external plaster for to assure the complete airtight layer.

4.1.5 Heating, Ventilation and Air conditioning.

Ventilation with more then 75 % recuperation is proposed for whole the building.

Five MVHR units will be installed in Blocks A, three - B and two - in Block C.

The existing district heating substations in blocks A and B are very old and inefficient (with double-pipe heat exchanger) . New efficient DH substations with reduced power will be installed.

4.1.6 Electrical System

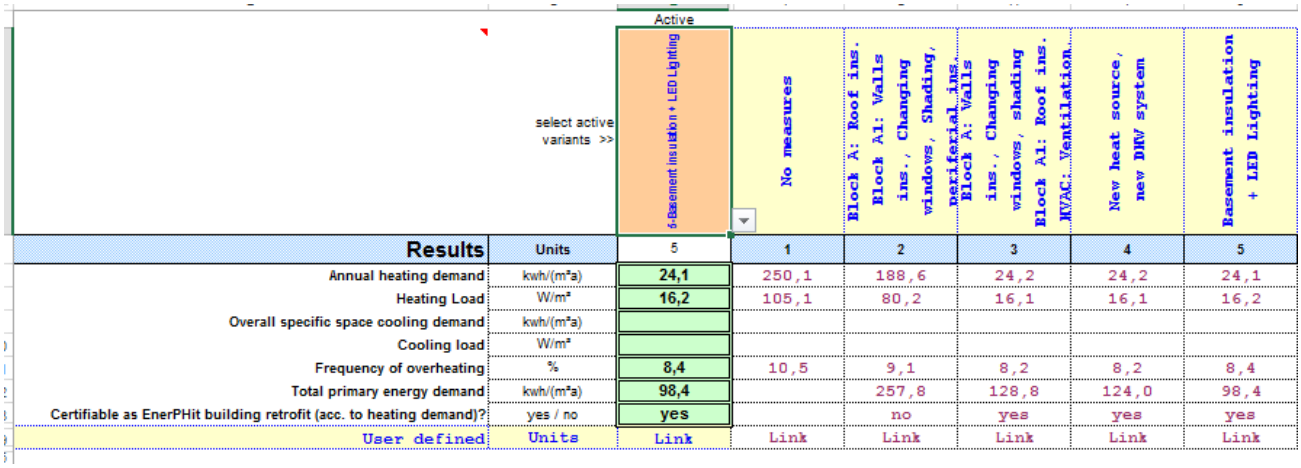
New LED lighting will replace the existing mercury lamps in the Gym and in the classrooms.

4.1.7 RES Implementation

Fourteen solar panels for DHW will be added in block C (for the dressing rooms in the Gym). For achieving better comfort in the summer, new heat-pump air-to water can be installed in the Gym on later stages.

4.2 Retrofit steps carried out

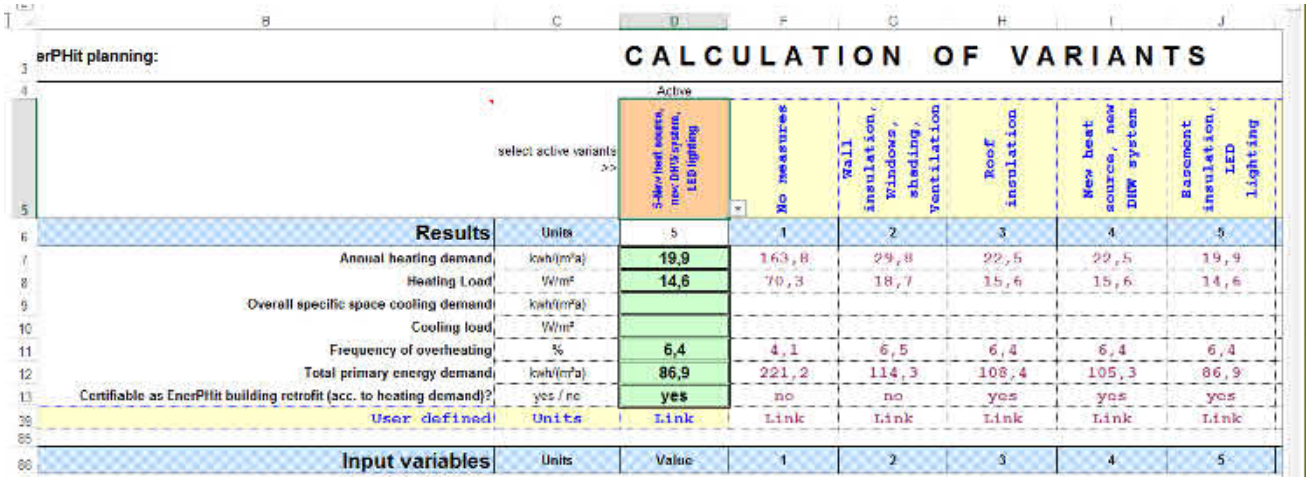
The following figures show the steps to the final stage by blocks:



		Active					
select active variants >>		6-Basement insulation + LED Lighting	No measures	Block A: Roof ins. Block A1: Walls ins., Changing windows, Shading, peripherial ins.	Block A: Walls ins., Changing windows, shading Block A1: Roof ins. HVAC: Ventilation	New heat source, new DHW system	Basement insulation + LED Lighting
Results	Units	5	1	2	3	4	5
Annual heating demand	kwh/(m²a)	24,1	250,1	188,6	24,2	24,2	24,1
Heating Load	W/m²	16,2	105,1	80,2	16,1	16,1	16,2
Overall specific space cooling demand	kwh/(m²a)						
Cooling load	W/m²						
Frequency of overheating	%	8,4	10,5	9,1	8,2	8,2	8,4
Total primary energy demand	kwh/(m²a)	98,4		257,8	128,8	124,0	98,4
Certifiable as EnerPHit building retrofit (acc. to heating demand)?	yes / no	yes		no	yes	yes	yes
User defined	Units	Link	Link	Link	Link	Link	Link

Figure 21: PHPP9 beta [PHI 2013] Variant sheet with the retrofit steps carried out, Block A

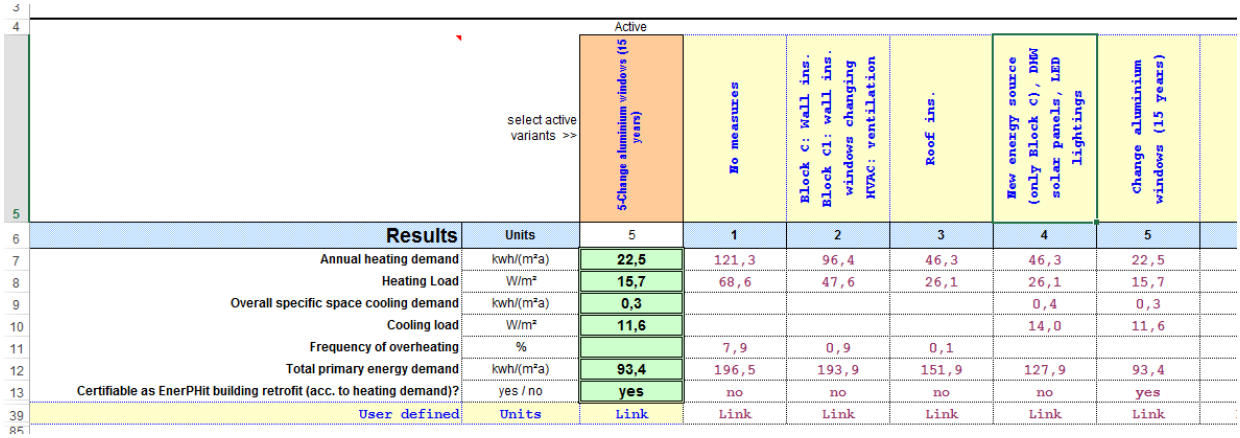
Block B



erPHit planning: CALCULATION OF VARIANTS

		Active					
select active variants >>		5-New heat source, new DHW system, LED lighting	No measures	Wall insulation, Windows, shading, Ventilation	Roof insulation	New heat source, new DHW system	Basement insulation, LED lighting
Results	Units	5	1	2	3	4	5
Annual heating demand	kwh/(m²a)	19,9	163,8	29,8	22,5	22,5	19,9
Heating Load	W/m²	14,6	70,3	18,7	15,6	15,6	14,6
Overall specific space cooling demand	kwh/(m²a)						
Cooling load	W/m²						
Frequency of overheating	%	6,4	4,1	6,5	6,4	6,4	6,4
Total primary energy demand	kwh/(m²a)	86,9	221,2	114,3	108,4	105,3	86,9
Certifiable as EnerPHit building retrofit (acc. to heating demand)?	yes / no	yes	no	no	yes	yes	yes
User defined	Units	Link	Link	Link	Link	Link	Link
Input variables	Units	Value	1	2	3	4	5

Figure 22: PHPP9 beta [PHI 2013] Variant sheet with the retrofit steps carried out, Block B



		Active					
select active variants >>		5-Change aluminium windows (15 years)	No measures	Block C: Wall ins. Block C1: wall ins. windows changing HVAC: ventilation	Roof ins.	New energy source (only Block C), DHW solar panels, LED lightings	Change aluminium windows (15 years)
Results	Units	5	1	2	3	4	5
Annual heating demand	kwh/(m²a)	22,5	121,3	96,4	46,3	46,3	22,5
Heating Load	W/m²	15,7	68,6	47,6	26,1	26,1	15,7
Overall specific space cooling demand	kwh/(m²a)	0,3				0,4	0,3
Cooling load	W/m²	11,6				14,0	11,6
Frequency of overheating	%		7,9	0,9	0,1		
Total primary energy demand	kwh/(m²a)	93,4	196,5	193,9	151,9	127,9	93,4
Certifiable as EnerPHit building retrofit (acc. to heating demand)?	yes / no	yes	no	no	no	no	yes
User defined	Units	Link	Link	Link	Link	Link	Link

Figure 23: PHPP9 beta [PHI 2013] Variant sheet with the retrofit steps carried out, Block C-GYM

4.2.1 Building data

- Completion Date: 2020
- Building use: school
- General condition: good
- Occupancy: 640 children are studying in this school on two shifts and 76 people personal takes care of them
- Treated floor Area: 5465 m^2
- Other:

4.2.2 Client

- Municipality of Gabrovo
- 69, Mogilov Blvd.,Gabrovo, BG
- Email
- Email

4.3 Description of Building components – blocks A

4.3.1 Floor slab

- Description no insulation
- U-Value 3,181 ;
- Installation date:
- Next replacement:
- Other:

4.3.2 External walls

- Description 20 sm. EPS with graphitte
- U-Value 0,142 W/(m^2K)
- Installation date: 2015
- Condition:
- Next replacement:
- Other:

4.3.3 Windows

- Description new PVC windows
- U-Value 0,8 W/(m^2K)
- Installation date: 2020
- Condition:
- Next replacement:
- Other:

4.3.4 Roof / Top floor ceiling

- Description 30 sm. Mineral wool on the lower slab of the
- U-Value 0,126 W/(m²K)
- Installation date: 2015
- Condition:
- Next replacement:
- Other:

4.3.5 Heating

- Description: new district heating substation (the one from the GYM might be used)
- Efficiency:
- Installation date: ` 1999/2015
- Condition:
- Next replacement: 2030
- Other:

4.4 Description of Building components – block B

4.4.1 Floor slab

- Description 15 sm. XPS above the unheated basement
- U-Value 0,206 W/(m²K)
- Installation date:
- Condition:
- Next replacement:
- Other:

4.4.2 External walls

- Description 20 sm. EPS-F with graphite
- U-Value 0,149 W/(m²K)
- Installation date: 2015
- Condition:
- Next replacement:
- Other:
- Other:

4.4.3 Windows

- Description new PVC windows
- U-Value 0,8 W/(m²K)
- Installation date: 2015

- Condition:
- Next replacement:
- Other:

4.4.4 Roof / Top floor ceiling

- Description 20 cm. Mineral wool above the existing 10 cm.
- U-Value 0,129 W/(m²K)
- Installation date:
- Condition:
- Next replacement:
- Other:

4.4.5 Heating

- Description
- Efficiency:
- Installation date:
- Condition:
- Next replacement:
- Other:

4.5 Description of Building components – block C

4.5.1 Floor slab

- Description
- U-Value 2.586 W/(m²K)
- Installation date:
- Condition:
- Next replacement:
- Other:

4.5.2 External walls

- Description 20 cm. EPS with graphitte
- U-Value 0,133 W/(m²K)
- Installation date: 2015
- Condition:
- Next replacement:
- Other:

4.5.3 Windows

- Description new PVC and aluminium windows
- U-Value 0,8 W/(m²K)
- Installation date: PVC 2015, aluminium 2020
- Condition:
- Next replacement:
- Other:

4.5.4 Roof / Top floor ceiling

- Description 30 sm. XPS, 30 mineral wool
- U-Value 0.101 W/(m²K) flat roof, 0.113 W/(m²K)pitched roof
- Installation date: 2015
- Condition:
- Next replacement:
- Other:

4.5.5 Heating

- Description heat pump, ventilation with heat recovery
- Efficiency:
- Installation date: 2015
- Condition:
- Next replacement:

Other:

4.6 Energy efficiency of the refurbished building

4.6.1 Energy efficiency of the refurbished building, Block A

Short description of the energy efficiency properties of the completed retrofit.

- Modelled specific heating demand: 24,1 kWh/(m²a)
- Modelled specific cooling demand / overheating frequency: 8,4%
- Modelled specific primary energy demand: 98.4 kWh/(m²a)

For an overview of the energy efficiency of the completed step-by-step refurbishment, see the verification spreadsheet of the PHPP 9 beta version [PHI 2013] on the next page.

4.6.2 Energy efficiency of the refurbished building, Block B

Short description of the energy efficiency properties of the completed retrofit.

- Modelled specific heating demand: 19,9 kWh/(m²a)
- Modelled specific cooling demand / overheating frequency: 6,4%
- Modelled specific primary energy demand: 86.9 kWh/(m²a)

For an overview of the energy efficiency of the completed step-by-step refurbishment, see the verification spreadsheet of the PHPP 9 beta version [PHI 2013] on the next page.

4.6.3 efficiency of the refurbished building, Block C

Short description of the energy efficiency properties of the completed retrofit.

- Modelled specific heating demand: 22.5 kWh/(m²a)
- Modelled specific cooling demand / overheating frequency:
- Modelled specific primary energy demand: 93.4 kWh/(m²a)

For an overview of the energy efficiency of the completed step-by-step refurbishment, see the verification spreadsheet of the PHPP 9 beta version [PHI 2013] on the next page**.**

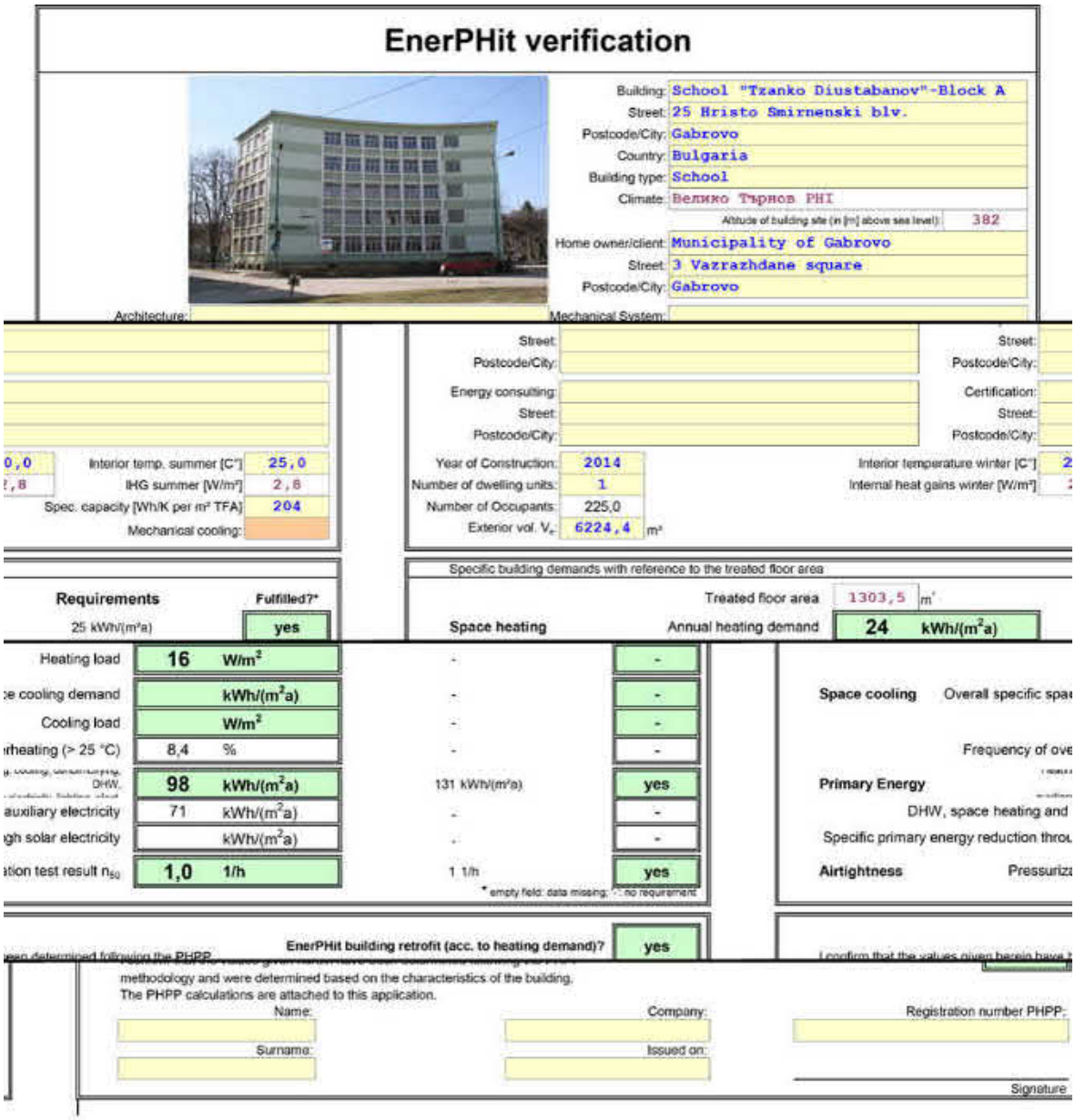


Figure 24: Specific energy efficiency values of the completed project modelled with PHPP 9 Beta, Block A

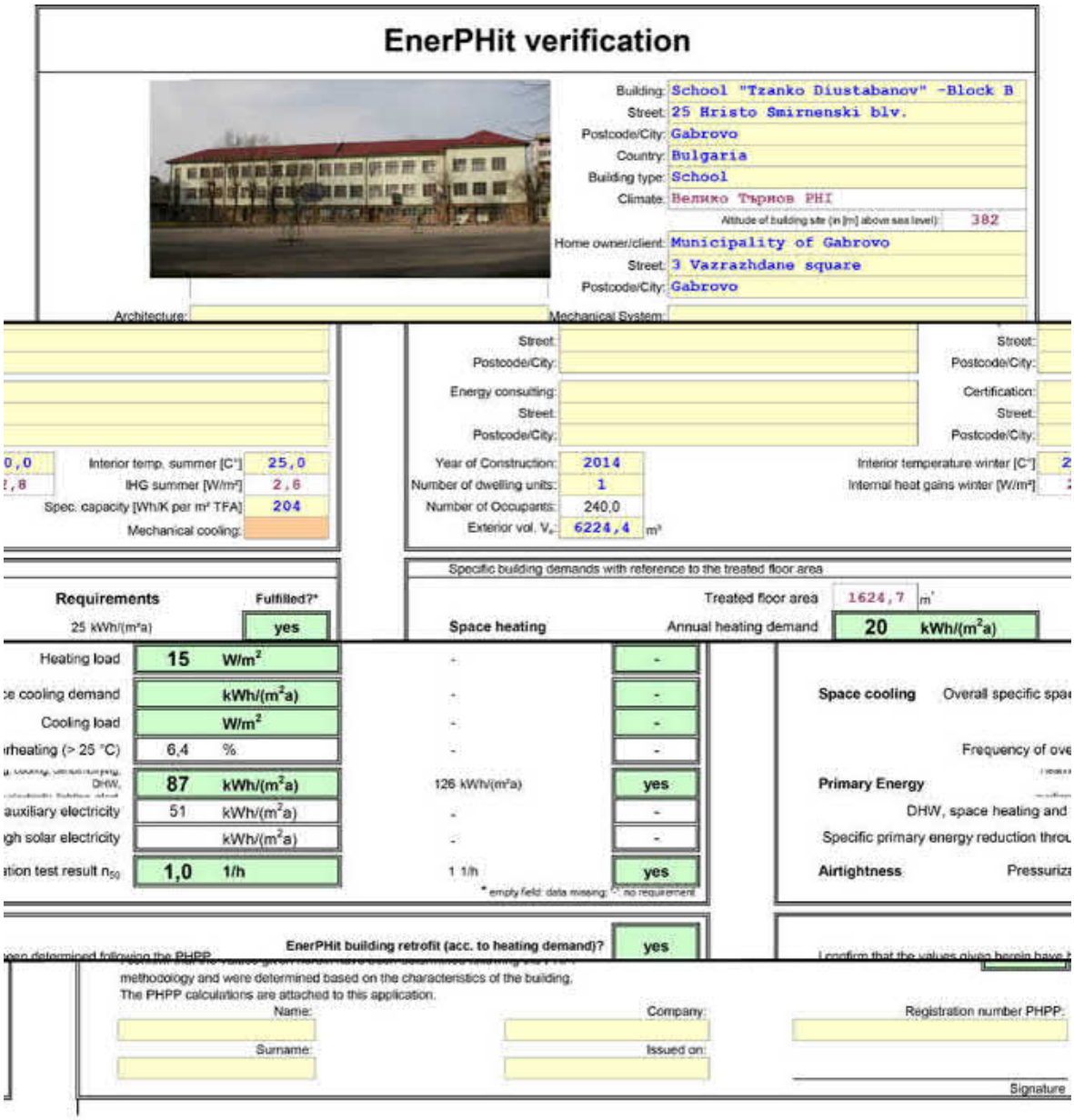


Figure 25: Specific energy efficiency values of the completed project modelled with PHPP 9 Beta, Block B

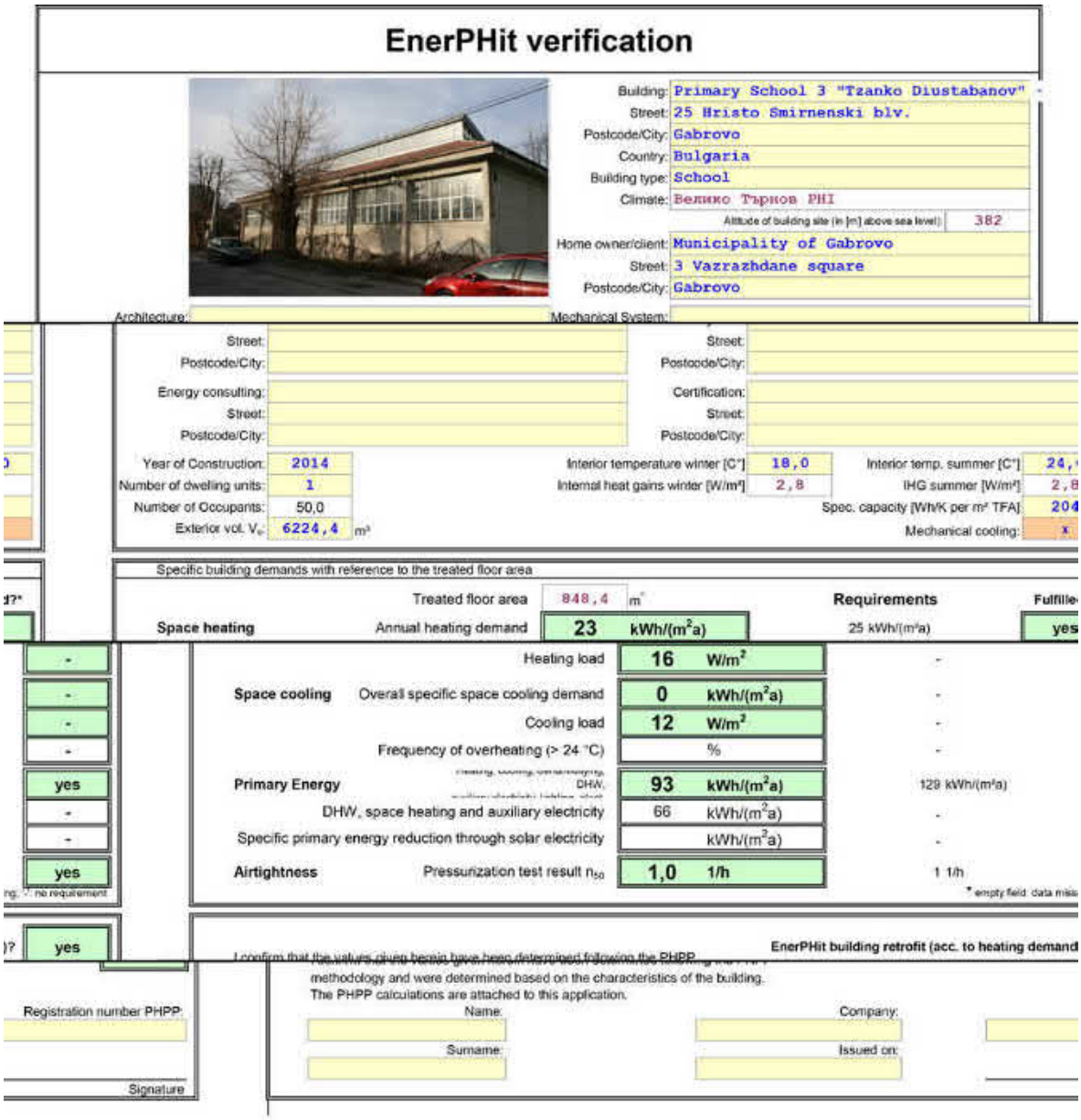


Figure 26: Specific energy efficiency values of the completed project modelled with PHPP 9 Beta, Block C

4.7 Pictures / Drawings

These pictures or drawings illustrate the final status of the retrofit.

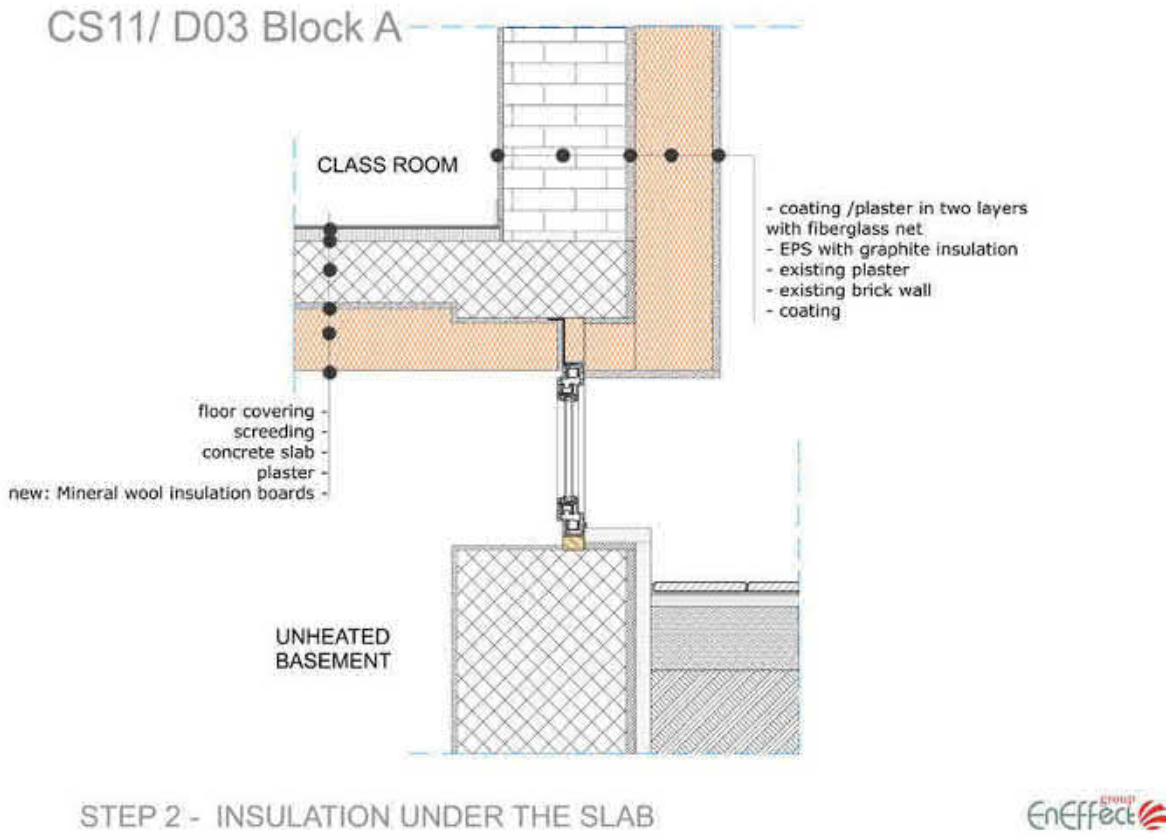


Figure 27: D03, block A, connection external wall / ground floor slab

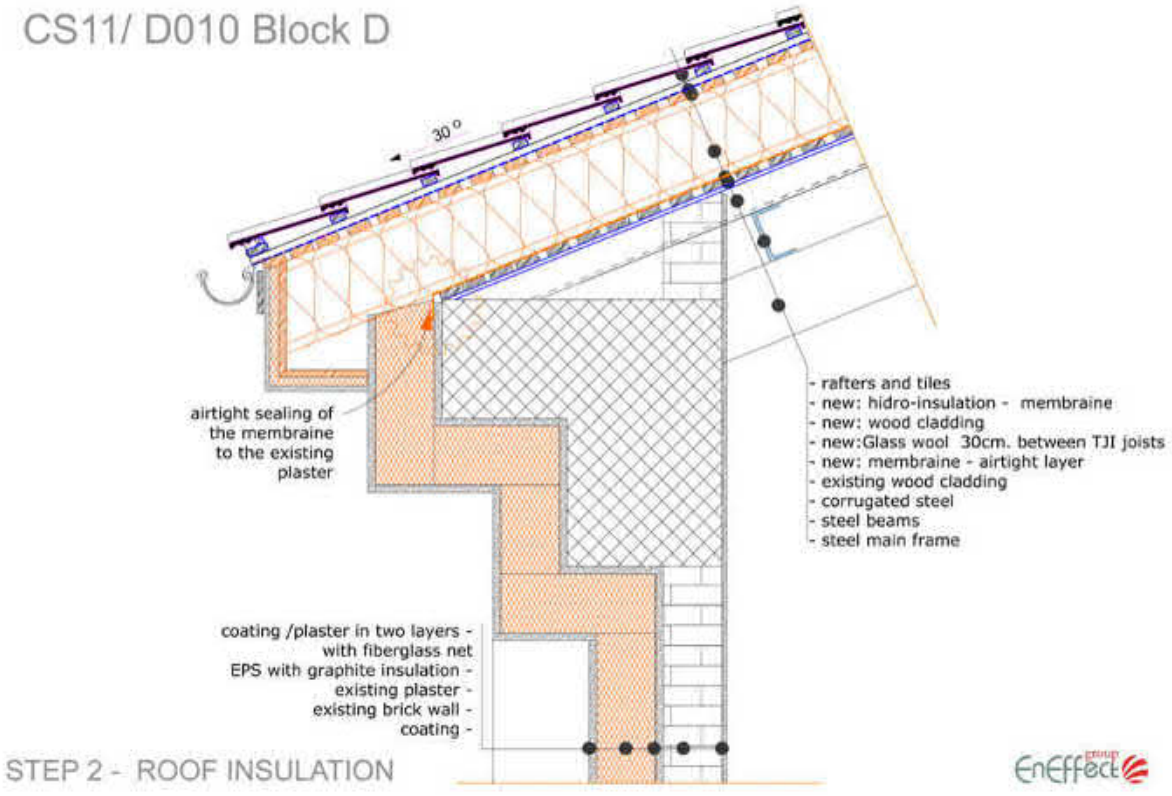


Figure 28: D10, block D, connection external wall / roof

5 RES Strategy / PV potential Evaluation *to be inserted following assessment by Onyx Solar*

5.1 Results of the PV potential analysis

Add a more detailed description of the results of the PV potential evaluation including specific properties, general comments, observations…

5.2 Description of the evaluated PV system

PV type	:
Location	:
Installed PV area [m²]	:
Installed peak power [Wp]	:
Annual RES gains [kWh]	:
Other	:

5.3 Installation of the RES / PV system

Add a more detailed description of the installation concept of the PV modules / RES systems…

5.4 Conclusion

Add a more detailed conclusion of the evaluation, what does it mean for the project…

5.5 Pictures / Drawings

These pictures or drawings illustrate the type and installation of the evaluated PV systems:

Figure 29: Pictures / drawings of evaluated PV system - not yet available

6 Refurbishment to the current National Standards

6.1 General Description

Bulgarian National Standard describes maximum value of the heat transfer coefficient on elements in building envelope. For walls (U=0,35 W/m2K), roof (U=0,28 W/m2K), floor (U=0,45 W/m2K) and door and windows (U=1,7 W/m2K). It does not limit the maximum value of the energy use, thus it cannot be directly compared with EnerPhit standart.

General description block A:

According to the national standards for this building specific energy demand for heating and ventilation is 74,7 kWh/m^{2}a (PHPP)/ 36,0 kWh/m^{2}a (Bulgarian official energy audit software EAB_V1.0(Whole building)) with 10% thermal bridges, Air change rate in 50 Pa up to 3 h^{-1}, windows ventilation.

General description block B:

According to the national standards for this building specific energy demand for heating and ventilation is 57,3 kWh/m^{2}a (PHPP)/ 36,0 kWh/m^{2}a (Bulgarian official energy audit software EAB_V1.0 (Whole building)) with 10% thermal bridges, Air change rate in 50 Pa up to 3 h^{-1}, windows ventilation.

General description block C:

According to the national standards for this building specific energy demand for heating and ventilation is 57,4 kWh/m^{2}a (PHPP)/ 36,0 kWh/m^{2}a (Bulgarian official energy audit software EAB_V1.0 (Whole building)) with 10% thermal bridges, Air change rate in 50 Pa up to 3 h^{-1}, windows ventilation.

6.2 Efficiency results comparison table block A

	Existing building	National regulations	EnerPHit standard	Differences [%]
Space heat demand [kWh/(m^2/a)]	250,1	74,7	24,1	20%
Primary energy demand [kWh/(m^2/a)]	105,1	37,0	16,2	20%
Heat Load [W/m^2]	312,4	156,8	98,4	19%

Figure 30: Comparison of efficiency results, block A

6.3 Efficiency results comparison table block B

	Existing building	National regulations	EnerPHit standard	Differences [%]

Space heat demand [kWh/(m²/a)]	163,8	57,3	19,9	23%
Primary energy demand [kWh/(m²/a)]	221,2	122,9	86,9	16%
Heat Load [W/m²]	70,3	30,5	14,6	23%

Figure 31: Comparison of efficiency results, Block B

6.4 Efficiency results comparison table block C

	Existing building	National regulations	EnerPHit standard	Differences [%]
Space heat demand [kWh/(m²/a)]	121,3	57,4	22,5	29%
Primary energy demand [kWh/(m²/a)]	196,5	167,8	93,4	38%
Heat Load [W/m²]	68,6	32,2	15,7	24%

Figure 32: Comparison of efficiency results, Block C

6.5 Building envelope comparison table block A:

	Existing building	National regulations	EnerPHit standard	Differences [%]
Airtightness Pressure test n50 [1/h]	4	3	1	50%
Building envelope				
Floor Slab [W/(m²K)]	2,012	0,463	1,096	
Walls to ground [W/(m²K)]				
Walls [W/(m²K)]	1,333	0,350	0,116	18%
Roof / Attic ceilings [W/(m²K)]	3,072	0,280	0,112	5%
Windows [W/(m²K)]	2,51	1,70	0,80	36%
Doors [W/(m²K)]	5,50	2,20	0,80	25%
Thermal bridging ΔU[W/(m²K)]				

Figure 33: Comparison of building envelope components, Block A

6.6 Building envelope comparison table block B:

	Existing building	National regulations	EnerPHit standard	Differences [%]
Airtightness Pressure test n50 [1/h]	4	3	1	50%
Building envelope				
Floor Slab [W/(m²K)]	1,609	0,350	0,145	13%
Walls to ground [W/(m²K)]	0,345	0,280	0,129	44%
Walls [W/(m²K)]	2,370	1,700	0,800	38%
Roof / Attic ceilings [W/(m²K)]	3,910	2,200	0,800	36%
Windows [W/(m²K)]	1,609	0,350	0,145	13%
Doors [W/(m²K)]	0,345	0,280	0,129	44%
Thermal bridging ΔU[W/(m²K)]				

Figure 34: Comparison of building envelope components, Block B

6.7 Building envelope comparison table block C:

	Existing building	National regulations	EnerPHit standard	Differences [%]
Airtightness Pressure test n50 [1/h]	4,0	3,0	1,0	50%
Building envelope				
Floor Slab [W/(m²K)]	1,977	0,450	1,977	
Walls to ground [W/(m²K)]				
Walls [W/(m²K)]	0,707	0,350	0,130	31%
Roof / Attic ceilings [W/(m²K)]	0,691	0,280	0,110	25%
Windows [W/(m²K)]	2,745	1,700	0,800	33%
Doors [W/(m²K)]	5,800	2,200	0,800	24%

Thermal bridging ΔU[W/(m²K)]				

Figure 35: Comparison of building envelope components, Block C

6.8 Building equipment comparison table block A

	Existing building	National regulations	EnerPHit standard	Differences [%]
Ventilation	**Natural**	**Natural**	**Mechanical**	
HR Efficiency [%]			81%	
Electric efficiency [Wh/m³]			0,40	
Ducting				
Heating	**District heating**	**District heating**	**District heating**	
Energy source	Central Hard Coal CGS 70% PHC heating	Central Hard Coal CGS 70% PHC heating	Central Hard Coal CGS 70% PHC heating	
Performance ratio of heat generation [%]	111 %	105 %	105 %	
Thermal output kW	N/A	N/A	150	
Insulation of pipes	50	50	50	
Domestic hot water	**-**	**District heating**	**District heating**	
Energy source	-	Central Hard Coal CGS 70% PHC heating	Central Hard Coal CGS 70% PHC heating	
Performance ratio of heat generation [%]		105 %	105 %	
Thermal output kW		N/A	50	
Insulation of pipes		50	50	
Cooling	**-**	**-**	**-**	
Energy source				
Performance ratio of cooling generation [%]				

Thermal output kW				
Insulation of pipes				

Figure 36: Comparison of building equipment, Block A

6.9 Building equipment comparison table block B

	Existing building	National regulations	EnerPHit standard	Differences [%]
Ventilation	**Natural**	**Natural**	**Mechanical**	
HR Efficiency [%]			81%	
Electric efficiency [Wh/m³]			0,40	
Ducting				
Heating	**District heating**	**District heating**	**District heating**	
Energy source	Central Hard Coal CGS 70% PHC heating	Central Hard Coal CGS 70% PHC heating	Central Hard Coal CGS 70% PHC heating	
Performance ratio of heat generation [%]	111 %	105 %	105 %	
Thermal output kW	N/A	N/A	150	
Insulation of pipes	50	50	50	
Domestic hot water	**-**	**District heating**	**District heating**	
Energy source	-	Central Hard Coal CGS 70% PHC heating	Central Hard Coal CGS 70% PHC heating	
Performance ratio of heat generation [%]		105 %	105 %	
Thermal output kW		N/A	50	
Insulation of pipes		50	50	
Cooling	**-**	**-**	**-**	

Energy source				
Performance ratio of cooling generation [%]				
Thermal output kW				
Insulation of pipes				

Figure 37: Comparison of building equipment, Block B

6.10 Building equipment comparison table block C

	Existing building	National regulations	EnerPHit standard	Differences [%]
Ventilation	**Natural**	**Mechanical**	**Mechanical**	
HR Efficiency [%]		50%	81%	
Electric efficiency [Wh/m³]		0,50	0,40	
Ducting				
Heating	**District heating**	**District heating**	**Heat pump**	
Energy source	Central Hard Coal CGS 70% PHC heating	Central Hard Coal CGS 70% PHC heating	Electricity	
Performance ratio of heat generation [%]	105 %	105 %		
Thermal output kW	N/A	N/A	150	
Insulation of pipes	50	50	50	
Domestic hot water	**-**	**District heating**	**District heating**	
Energy source	-	Central Hard Coal CGS 70% PHC heating	Central Hard Coal CGS 70% PHC heating	
Performance ratio of heat generation [%]		105 %	105 %	
Thermal output kW		N/A	50	

Insulation of pipes		50	50	
Cooling	**-**	**-**	**Heat pump**	
Energy source			Electricity	
Performance ratio of cooling generation [%]				
Thermal output kW			150	
Insulation of pipes			50	

Figure 38: Comparison of building equipment, Block C

6.11 RES implementation comparison table block A

	Existing building	National regulations	EnerPHit standard	Differences [%]
Renewables	None	None	None	

Figure 39: Comparison of RES implementation, Block A

6.12 RES implementation comparison table block B

	Existing building	National regulations	EnerPHit standard	Differences [%]
Renewables	None	None	None	

Figure 40: Comparison of RES implementation, Block B

6.13 RES implementation comparison table block C

	Existing building	National regulations	EnerPHit standard	Differences [%]
Renewables	None	None	Heat pump appliancies for heating and cooling 12,7 kWh/(m2a), sollar panels for domestic hot water (baths) 17,6 kWh/(m2a)	54,60%

Figure 41: Comparison of RES implementation, Block C

6.14 Conclusions

In the calculation of the specific heating demand according the National regulation the TFA is calculated by external dimensions of the heated volume, including the walls. This leads to much lower figures in comparison with the PHPP calculations, where the TFA is a net value of the built area.

The ventilation according the Regulations is not strictly defined. There is an air change rate of 0,6 1/h , that is considered in the calculations. This leads to uncontrolled use of the natural ventilation, higher heat losses and low quality of the air, especially in schools and kindergartens.

The mechanical ventilation with heat recovery is a good decision to both: air quality and energy efficiency.

Renovation of the buildings to the EnerPHit standard can increase effect of energy efficient refurbishment with more than 25 %.