D3.9_Overall Refurbishment Plan

DRAFT-2

CS10 Primary school “St.St. Kiril and Methodius”

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

Co-funded by the Intelligent Energy Europe Programme of the European Union

Technical References

Project Acronym	EuroPHit
Project Title	Improving the energy performance of step-by-step refurbishment and integration of renewable energies
Project Coordinator	Jan Steiger Passive House Institute, Dr. Wolfgang Feist Rheinstrasse 44/46 D 64283 Darmstadt jan.steiger@passiv.de
Project Duration	1 April 2013 – 31 March 2016 (36 Months)

Deliverable No.	D3.9
Dissemination Level	PU
Work Package	WP3_Practical Implementation
Lead beneficiary	04_MosArt
Contributing beneficiary(ies)	09_EnEffect Group
Author(s)	Iglika Lutzkanova
Co-author(s)	
Date	25.10.2014
File Name	EuroPHit_D3.9_CS10_20141025_EnEffect_OverallRefurbPlan.doc

Table of Contents

Co-funded by the Intelligent Energy Europe Programme of the European Union

List of tables and figures

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 “St.St. Kiril and Methodius”.

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 standard will be achieved by a) improvement of the building envelope with new thermal insulation on the roofs, external walls, ground walls, and where it is possible - the slabs on the ground, b) change of the windows with better ones when their lifespan is over.

The calculation were made with PHPP9 (passive house). The building consists of three similar block A, B and C. The Gym (Block D) connects to the other blocks by a corridor on the Ground floor. This is why we use one PHPP model for blocks A,B and C and another one for the GYM-Block D.

69, Mogilov Blvd.,Gabrovo, BG

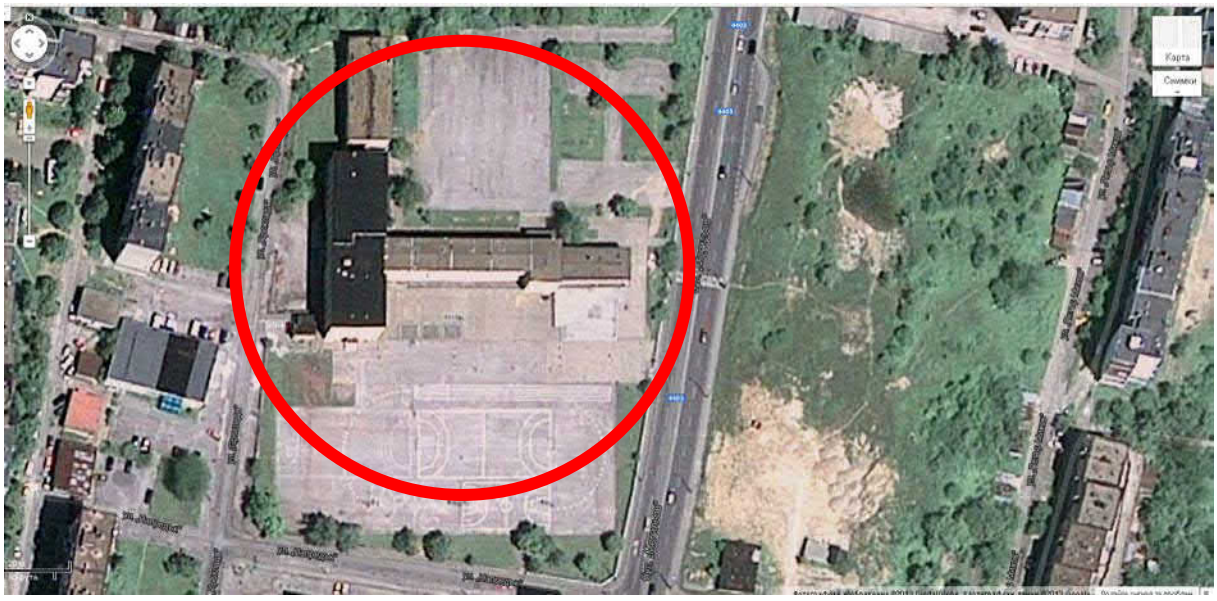


Figure 1: Aerial view of Primary school “St.St. Kiril and Methodius”, [Google maps, 2013]

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

Short description of the existing building.

The building is constructed in 1970. It has concrete structure with external brick walls (25 cm.) and concrete slabs. The roof is flat double roof with ventilated space between the two slabs. The hydro insulation of the roof is in poor condition. There is no any thermal insulation. The fully heated basement (blocks B, C and D) is partially below the ground level. The windows in whole building have been replaced in 2005 with PVC (U=2.2 W/m^{2}K) and aluminium (in the gym, U=2.2 W/m^{2}K) with double glazing with white float glass 4/20/4mm. Since 2013, the school is connected to the central gas heating.

Six hundred and forty children are studying in this school on two shifts and seventy six people personal takes care of them. The TFA of the building is 7312m^2.

1.3 Refurbishment steps

1.3.1 Retrofit steps within EuroPHit

Short description of the works to be carried out until March 2016.

The Project will propose refurbishment in the following steps:

STEP 1- ROOF insulation

STEP 2 – external WALL INSULATION – mounting EPS with graphite insulation on the walls, shading of the existing windows in East and West facades, reduction of the radiators, improving of the airtightness, VENTILATION with heat recovery, solar panels for DHW

STEP 3 – External underground walls insulation, perimeter insulation, insulation above the ground floor slab in the Gym.

1.3.2 Further retrofit steps

STEP 4 – Replacement of WINDOWS: The PVC windows will be replaced in 10 years, when they will be 20 years old. The aluminium windows will be replaced in 20 years, when they will be 30 years old.

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 similar block A,B and C. The Gym (Block D) connects to the other three blocks by a corridor on the Ground floor.

This allows us to run two different PHPP calculations – one for the blocks A,B,C and one for Block D**.**

1.5 Pictures

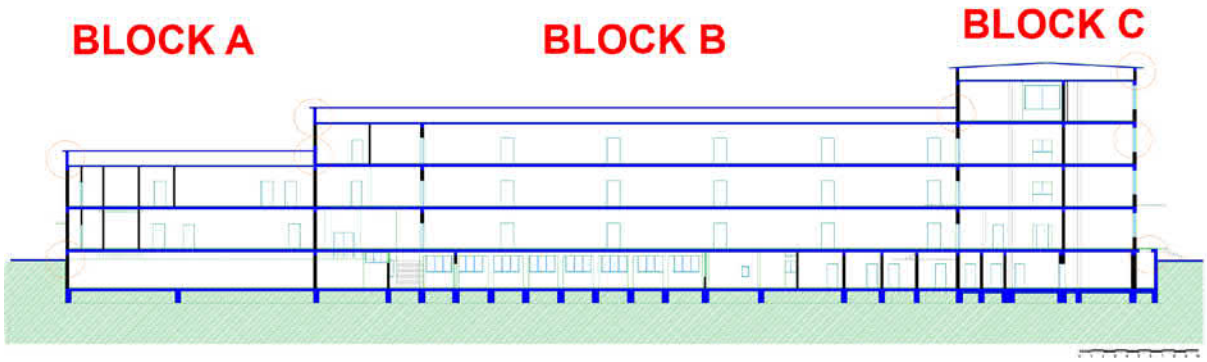


Figure 2: SECTION 2-2, not to scale

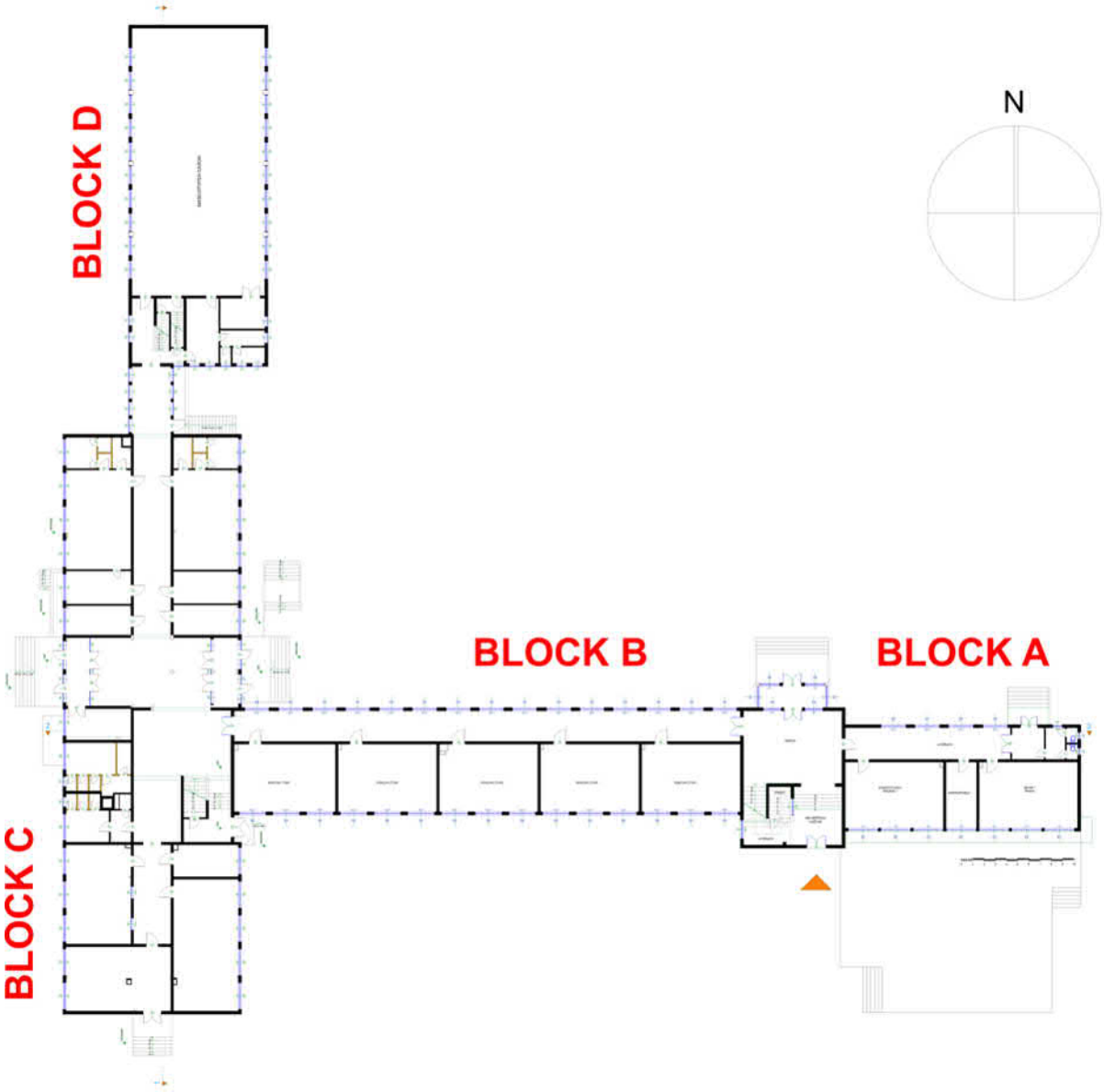


Figure 3: GROUNDFLOOR PLAN, not to scale

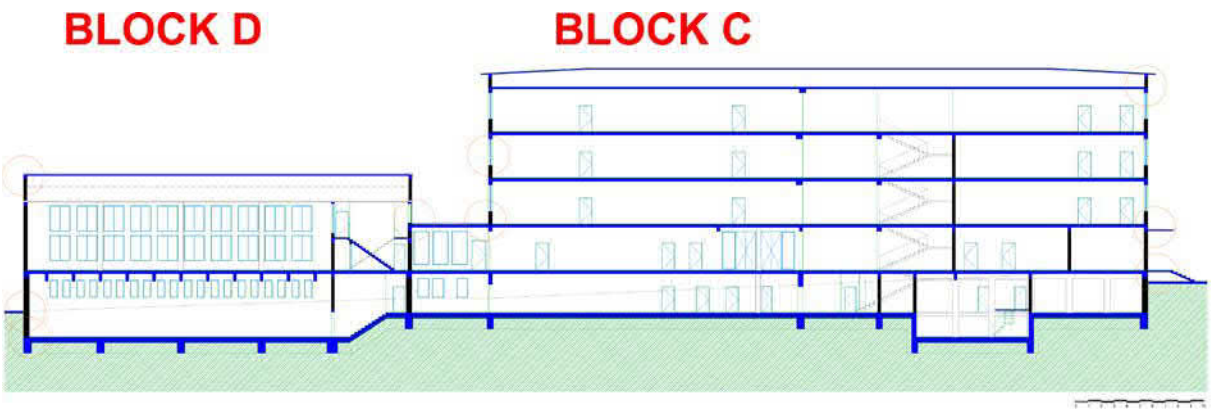


Figure 4: SECTION 1-1, not to scale

2 Existing building

2.1 General description

The building is constructed in 1970. It has concrete structure with external brick walls (25 cm.) and concrete slabs. The roof is flat double roof with ventilated space between the two slabs. The hydro insulation of the roof is in poor condition. There is no any thermal insulation. The fully heated basement (blocks B, C and D) is partially below the ground level. The windows in whole building have been replaced in 2005 with PVC (U=2.2 W/m^{2}K) and aluminium (in the gym, U=2.2 W/m^{2}K) with double glazing with white float glass 4/20/4mm. Since 2013, the school is connected to the central gas heating.

Six hundred and forty children are studying in this school on two shifts and seventy six people personal takes care of them. The TFA of the building is 7312m^2.

The building consists of four blocks. Block A, Block B and Block C are connected through the corridors on each level. Block D - the Gym - is connected with block D only in the basement.

Block A is a two storey building with partial basement. It has TFA of 394m^2. It locates the administration of the school, computer rooms, small canteen. The basement is a technical corridor for installations.

Block B consists of three floors and a basement, with total area of 2116m^2. It comprises 15 classrooms. There are a kitchen, a dining room and storage rooms in the basement. The kitchen is in poor condition.

Block C consists of four floors and a basement with total area of 3997m^2.

There are 23 rooms: five specialized laboratories, two computer rooms, 16 classrooms.

There are a small gym, storage rooms, a boiler and workshops in the basement.

Block D consists of one floor and a basement with total area of 810m^2. It comprises two gyms, one above the other.

2.1.1 Building data

- Construction Time: 1970
- Last retrofit: 2005
- Building use: school
- General condition: moderate
- Occupancy: 640 children are studying in this school on two shifts and 76 people personal takes care of them.
- Treated floor Area: 7312m2
- Other:

2.1.2 Client

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

2.2 Existing Building components

2.2.1 Floor slab

- Description: floor covering – 2cm, cement screeding 3 cm, concrete floor slab - massive construction 15cm, gravel 15cm.
- U-Value 3,181 W/(m²K)
- Installation date: 1970
- Condition: good
- Next replacement:
- Other:

2.2.2 External walls

- Description massive brick walls 25sm. with plaster
- U-Value 1,326 W/(m²K)
- Installation date: 1970
- Condition: good
- Next replacement:
- Other:

2.2.3 Ground walls

- Description concrete 40 cm, plaster.
- U-Value 2,865 W/(m²K)
- Installation date: 1970
- Condition: good
- Next replacement:
- Other:

2.2.4 Windows

- Description Blocks A,B,C -PVC windows; Block D – aluminium windows, double glazing with white float glass 4/20/4mm
- U-Value Blocks A,B,C -- 2.2 W/(m2K); Block D –2.2 W/(m2K)
- Installation date: 2005
- Condition: medium
- Next replacement: Block A,B,C-2025, Block D-2030
- Other:

2.2.5 Roof / Top floor ceiling

- Description Blocks A,B,C – flat double roof with ventilated space between the two slabs, Block D-flat hot roof, no thermal insulation
- U-Value Blocks A,B,C - 1.551W/(m²K); Block D 2,26 W/(m²K);
- Installation date: 1970
- Condition: poor
- Next replacement: 2015
- Other:

2.2.6 Heating

- Description Since 2013, the school is connected to the central gas heating.
- Efficiency:
- Installation date: 2013
- Condition: good
- Next replacement: 2038
- Other:

2.3 Energy efficiency of the existing building

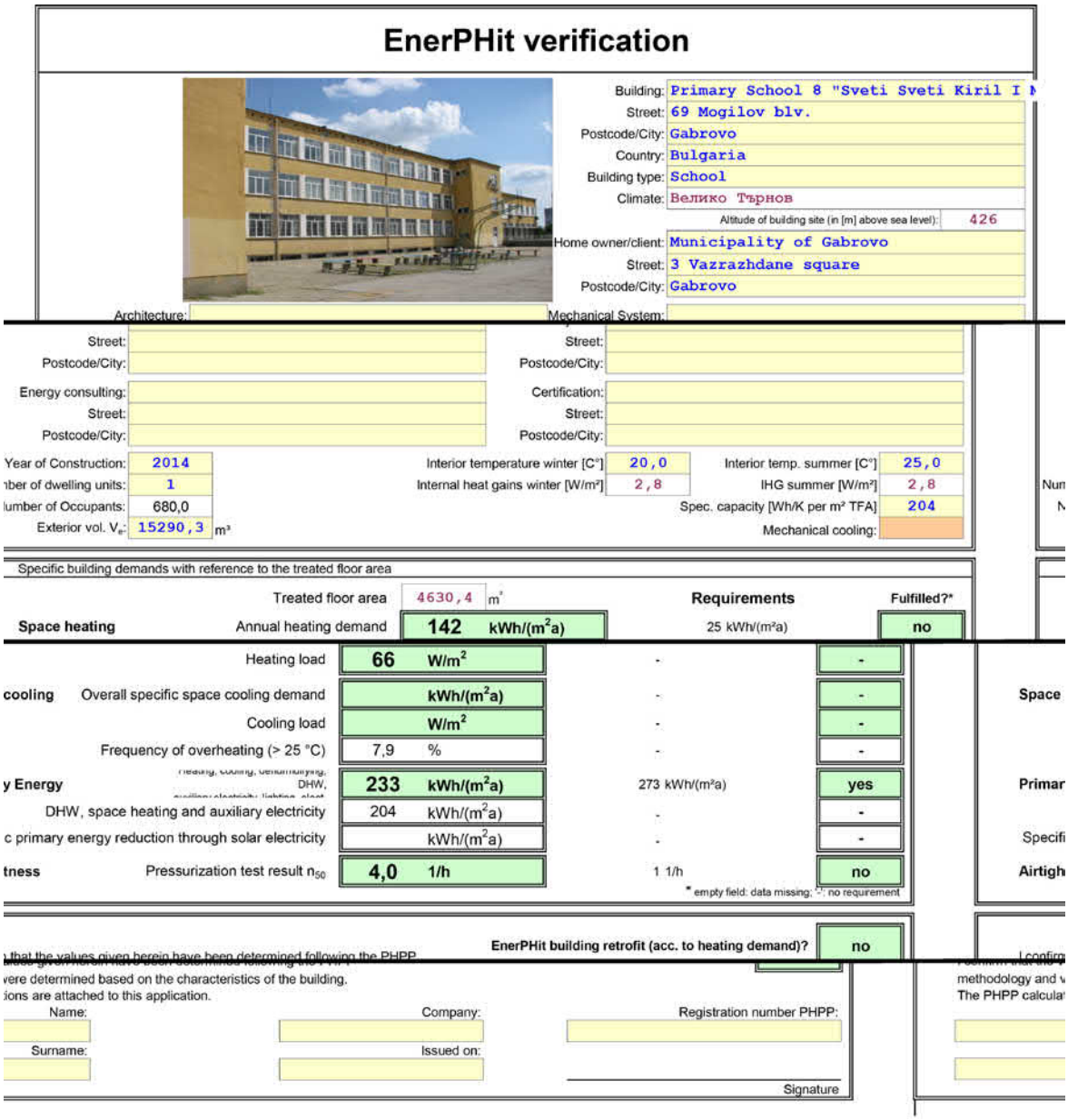
Short description of the energy efficiency properties of the existing building.

- Modelled specific heating demand:
  Blocks A, B,C 142,4 kWh/(m²a), Block D-228,4 kWh/(m²a)
- Modelled specific cooling demand / overheating frequency:
  Blocks A, B,C -7,9%, Block D 11,3%
- Modelled specific primary energy demand:
  Blocks A, B,C 233,5 kWh/(m²a) , Block D - overheating

Average annual Gas/Oil bills (if available):

Average annual Electricity bills (if available):

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.



EnerPHit verification

Building: Primary School 8 "Sveti Sveti Kiril I M
Street: 69 Mogilov blv.
Postcode/City: Gabrovo
Country: Bulgaria
Building type: School
Climate: Велико Търнов
Altitude of building site (in [m] above sea level): 426
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
Interior temperature winter [C°] 20,0
Interior temp. summer [C°] 25,0
Number of dwelling units: 1
Internal heat gains winter [W/m²] 2,8
IHG summer [W/m²] 2,8
Number of Occupants: 680,0
Spec. capacity [Wh/K per m² TFA] 204
Exterior vol. V_e: 15290,3 m³
Mechanical cooling:

Specific building demands with reference to the treated floor area

				Requirements	Fulfilled?*
	Treated floor area	4630,4	m²		
Space heating	Annual heating demand	142	kWh/(m²a)	25 kWh/(m²a)	no
	Heating load	66	W/m²	-	-
cooling	Overall specific space cooling demand		kWh/(m²a)	-	-
	Cooling load		W/m²	-	-
	Frequency of overheating (> 25 °C)	7,9	%	-	-
y Energy	Heating, cooling, dehumidifying, DHW, auxiliary electricity, lighting, plant	233	kWh/(m²a)	273 kWh/(m²a)	yes
	DHW, space heating and auxiliary electricity	204	kWh/(m²a)	-	-
c	primary energy reduction through solar electricity		kWh/(m²a)	-	-
tness	Pressurization test result n_{50}	4,0	1/h	1 1/h	no

* empty field: data missing; "-": no requirement

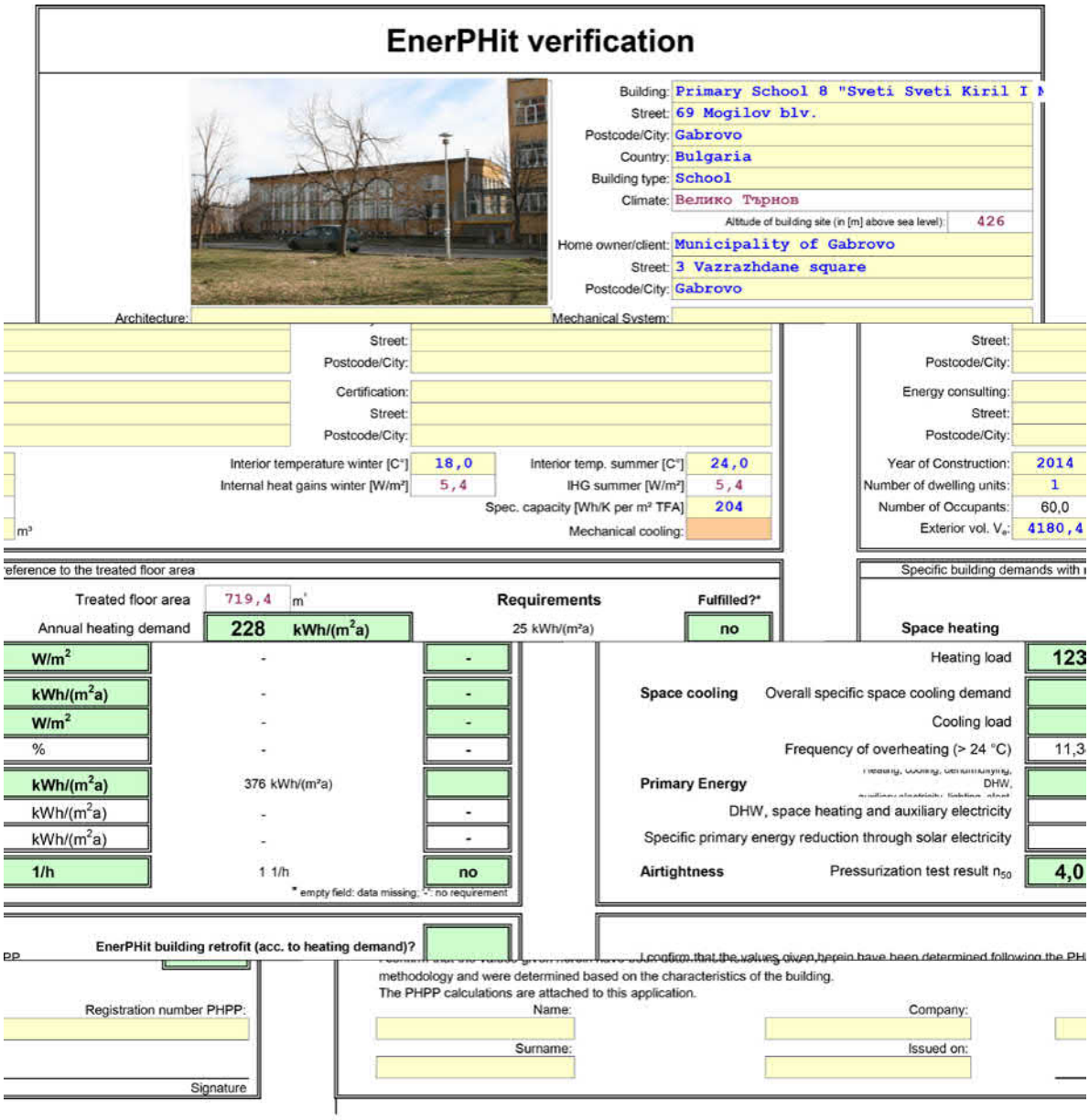
EnerPHit building retrofit (acc. to heating demand)? no

...that the values given herein have been determined following the PHPP ... were determined based on the characteristics of the building. ...ions are attached to this application.

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

...I confirm ... methodology and ... The PHPP calcula...

Figure 5: Specific energy efficiency values of the existing building –blocks A,B,C modelled with PHPP 9 Beta, Blocks A,B,C



EnerPHit verification

Building: Primary School 8 "Sveti Sveti Kiril I M
Street: 69 Mogilov blv.
Postcode/City: Gabrovo
Country: Bulgaria
Building type: School
Climate: Велико Търнов
Altitude of building site (in [m] above sea level): 426
Home owner/client: Municipality of Gabrovo
Street: 3 Vazrazhdane square
Postcode/City: Gabrovo
Architecture:
Mechanical System:
Street:
Postcode/City:
Certification:
Street:
Postcode/City:
Energy consulting:
Street:
Postcode/City:
Interior temperature winter [C°] 18,0
Internal heat gains winter [W/m²] 5,4
Interior temp. summer [C°] 24,0
IHG summer [W/m²] 5,4
Spec. capacity [Wh/K per m² TFA] 204
Mechanical cooling:
Year of Construction: 2014
Number of dwelling units: 1
Number of Occupants: 60,0
Exterior vol. Ve: 4180,4
m³
reference to the treated floor area
Specific building demands with
Treated floor area 719,4 m²
Annual heating demand 228 kWh/(m²a)
Requirements
25 kWh/(m²a)
Fulfilled?*
no
Space heating
W/m² - -
Heating load 123
kWh/(m²a) - -
Space cooling
Overall specific space cooling demand
W/m² - -
Cooling load
% - -
Frequency of overheating (> 24 °C) 11,3
kWh/(m²a) 376 kWh/(m²a)
Primary Energy
DHW,
kWh/(m²a) - -
DHW, space heating and auxiliary electricity
kWh/(m²a) - -
Specific primary energy reduction through solar electricity
1/h 1 1/h no
Airtightness
Pressurization test result n50 4,0
* empty field: data missing; "-" no requirement
EnerPHit building retrofit (acc. to heating demand)?
I confirm that the values given herein have been determined following the PH
methodology and were determined based on the characteristics of the building.
The PHPP calculations are attached to this application.
Registration number PHPP:
Name:
Company:
Surname:
Issued on:
Signature

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

2.4 Pictures / Drawings

These pictures or drawings illustrate the existing building.

Figure 7: View towards Block A and Block B

Figure 8: View towards Block B and Block C

3 Retrofit steps

3.1 Overall refurbishment Plan

Short description of the overall refurbishment plan. Include information of the components to be exchanged or the building parts to be retrofitted and the estimated dates for the measures according to the plan.

3.1.1 Retrofit steps

The Project will propose refurbishment in the following steps:

STEP 1- ROOF insulation

STEP 2 – external WALL INSULATION – mounting EPS with graphite insulation on the walls, shading of the existing windows in East and West facades, reduction of the radiators, improving of the airtightness, VENTILATION with heat recovery, solar panels for DHW

STEP 3 – External underground walls insulation, perimeter insulation, insulation above the ground floor slab in the Gym.

STEP 4 – Replacement of WINDOWS: The PVC windows will be replaced in 10 years, when they will be 20 years old. The aluminium windows will be replaced in 15 years, when they will be 25 years old.

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

step	Year	BLOCK A,B,C	Specific Heating Demand	Specific Primary Energy Demand
existing situation		Constructed in 1970, no insulation, roof in bad conditions, from 2005 -new PVC windows in blocks A,B,C and new aluminum windows in block D (the gym). Since 2013, the school is connected to the central gas heating.	142,4	233,5
STEP 1	2015	Roof insulation above the last floor slab	111	196,4
STEP 2	2015	external wall insulation, new kitchen appliances and DHW - solar panels in block B, shading blockC airtightness , ventilation, reducing thermal bridges-cutting canopies and stairs	50.5	117,0

STEP 3	2015	Insulation under the floor slab above the basement , in the technical corridor in block A, , insulation of the perimeter of the foundations block A ,Insulation of the perimeter walls of the heated basement in Block B and C	44.1	120,5
STEP 4	2025	change of PVC windows, shading blocks A,B	17,3	80.5

Figure 9: Overview refurbishment steps Blocks A,B,C

step	Year	BLOCK D-GYM	Specific Heating Demand	Specific Primary Energy Demand
existing situation		Constructed in 1970, no insulation, roof in bad conditions, from 2005 - new aluminum windows in block D (the gym). Since 2013, the school is connected to the central gas heating.	228,4	Overheating,no result in PHPP
STEP 1	2015	External roof insulation	153,8	322,7
STEP 2	2015	external wall insulation, airtightness , shading, ventilation, DHW - solar panels	76,0	194,3
STEP 3	2015	insulation of the perimeter walls of the heated basement, interior floor insulation above the floor slab	54,6	171,4
STEP 4	2025	change of aluminium windows	18,4	116,2

Figure 10: Overview refurbishment steps, Block C

3.1.2 Efficiency Improvements

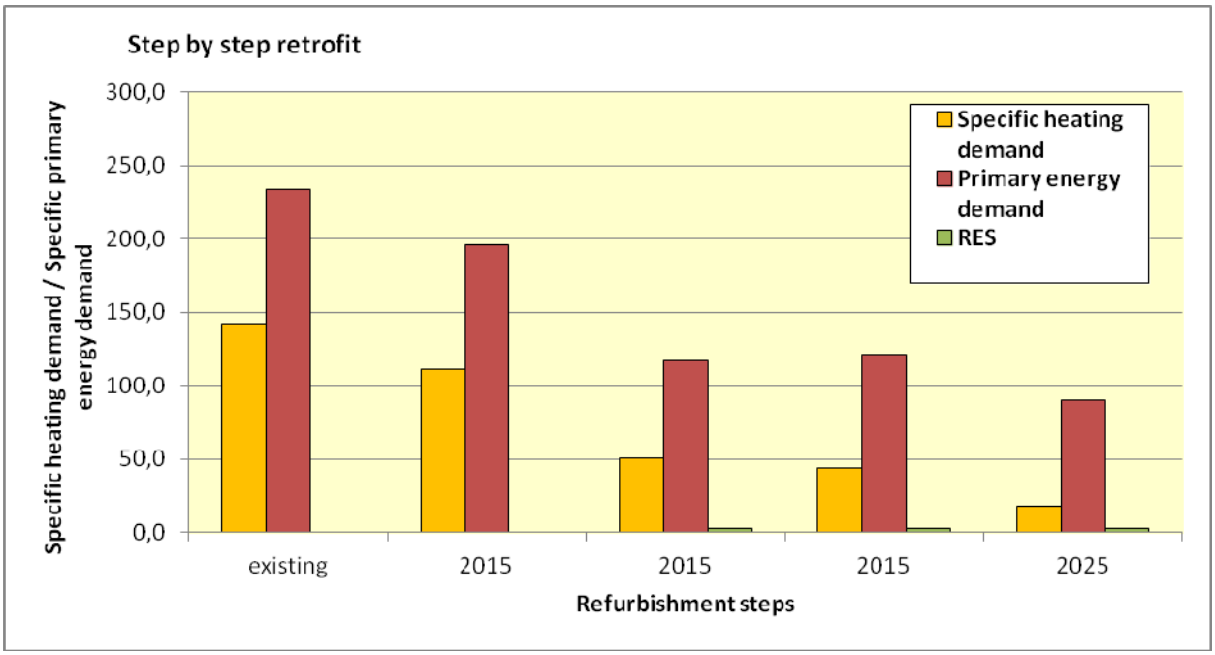


Figure 11: Overview energy efficiency improvement according to the overall refurbishment plan , Blocks A,B,C

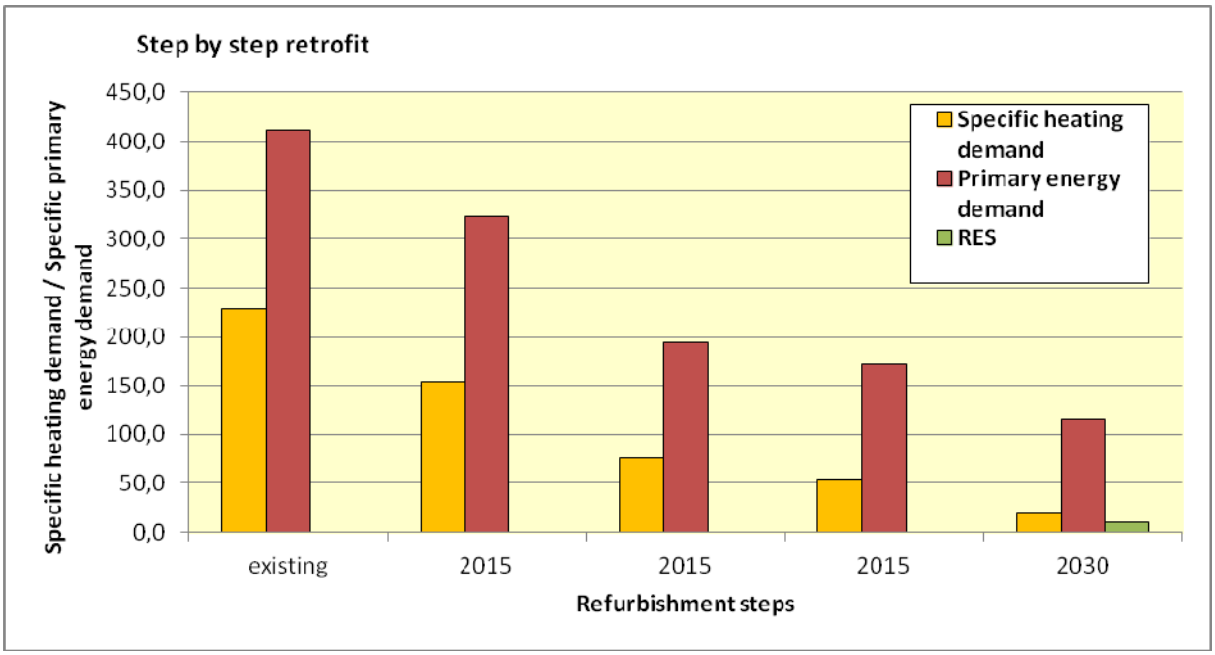


Figure 12: Overview energy efficiency improvement according to the overall refurbishment plan , Block D

3.2 Retrofit steps within EuroPHit

3.2.1 Retrofit step 1,blocks A,B,C:

External thermal insulation applied lower slab of the. flat double roof with ventilated space between the two slabs

- Start date: 2015
- Completion date: 2015
- Budget: 63 196 EURO
- Specific heating demand: 111,0 kWh/(m²a)
- Specific cooling demand / overheating frequency: 2,9%
- Specific primary energy demand: 196,4 kWh/(m²a)

3.2.1.1 New Envelope component

External thermal insulation applied above the lower slab of the flat double roof with ventilated space between the two slabs

- Description: Blocks A,B,C – 30 sm. Mineral wool , λ <0.041[W/(mK)]
- U-Value: 0,126 W/(m²K)
- Installation date: 2015
- Condition:
- Next replacement: 2065
- Other:

3.2.1.2 New building equipment component

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

3.2.2 Retrofit step 1, block D:

External thermal insulation applied to the roof.

- Start date: 2015
- Completion date: 2015
- Budget: 20 985 EURO
- Specific heating demand: 153,8 kWh/(m²a)
- Specific cooling demand / overheating frequency: 3.3%

- Specific primary energy demand: 322,7 kWh/(m²a)

3.2.2.1 New Envelope component

- Description 30 sm. XPS, λ <0.035W/(mK)
- U-Value 0,113 W/(m²K)
- Installation date: 2015
- Condition:
- Next replacement:
- Other:

3.2.2.2 New building equipment component

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

3.2.3 Retrofit step 2, Blocks A,B,C:

Step 2 – external wall insulation, new kitchen appliances and DHW - solar panels in block B, shading blockC airtightness , ventilation, reducing thermal bridges-cutting canopies and stairs

- Start date: 2015
- Completion date: 2015
- Budget: 380 458 EURO
- Specific heating demand: 50,5 kWh/(m²a)
- Specific cooling demand / overheating frequency: 5,4%
- Specific primary energy demand: 117,0 kWh/(m²a)

3.2.3.1 New Envelope component

- Description devices: 20 sm. EPS with graphite with , λ <0.032[W/(mK)], shading
- U-Value: 0,142 W/(m²K)
- Installation date: 2015
- Condition:
- Next replacement:
- Other:

3.2.3.2 New building equipment component

- Description (DHW or hybrid), : HVAC, DHW & kitchen appliances, airtightness, solar panels
- Efficiency:
- Installation date:
- Condition:
- Next replacement:

3.2.4 Retrofit step 2, Blocks D:

Short descriptions of works to be carried out: external wall insulation, airtightness , shading, ventilation, DHW - solar panels

- Start date: 2015
- Completion date: 2015
- Budget: 67 053 EURO
- Specific heating demand: 76,0 kWh/(m²a)
- Specific cooling demand / overheating frequency: 3,5%
- Specific primary energy demand: 194,3 kWh/(m²a)

3.2.4.1 New Envelope component

- Description 20 sm. EPS with graphite , λ <0.032[W/(mK)], shading devices
- U-Value 0,142 W/(m²K)
- Installation date: 2015
- Condition:
- Next replacement:
- Other:

3.2.4.2 New building equipment component

- Description ventilation, DHW - solar panels
- Efficiency:
- Installation date:
- Condition:
- Next replacement:

3.2.5 Retrofit step 3, Blocks A,B,C:

Short descriptions of works to be carried out.

Step 3 - Ground walls insulation; insulation of the technical corridor

- Start date: 2015
- Completion date: 2015
- Budget: 19 869 EURO
- Specific heating demand: 44,1 kWh/(m²a)
- Specific cooling demand / overheating frequency: 4,2%
- Specific primary energy demand: 120,5 kWh/(m²a)

3.2.5.1 New Envelope component

New external thermal insulation applied on the groundwalls.

- Description 18 sm. XPS
- U-Value 0,181 W/(m²K)
- Installation date: 2015
- Condition:
- Next replacement:
- Other:

New insulation above the unheated basement.

- Description 20 sm. EPS
- U-Value 0,187 W/(m²K)
- Installation date: 2015
- Condition:
- Next replacement:
- Other:

3.2.5.2 New building equipment component

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

3.2.6 Retrofit step 3, Block D:

Internal thermal insulation applied to ground walls and ground floor slab.

- Start date: 2015

- Completion date: 2015
- Budget: 25 844 EURO
- Specific heating demand: 54,6 kWh/(m²a)
- Specific cooling demand / overheating frequency: 7,8%
- Specific primary energy demand: 171,4 kWh/(m²a)

3.2.6.1 New Envelope component

FLOOR

- Description 10 sm. XPS above the ground floor slab
- U-Value 0,302 W/(m²K)
- Installation date:
- Condition:
- Next replacement:
- Other:

GROUNDWALLS

- Description internal insulation - 15 cm multipor , λ <0.045[W/(mK)]
- U-Value 0,271 W/(m²K)
- Installation date: 2015
- Condition: 2015
- Next replacement:
- Other:

3.2.6.2 New building equipment component

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

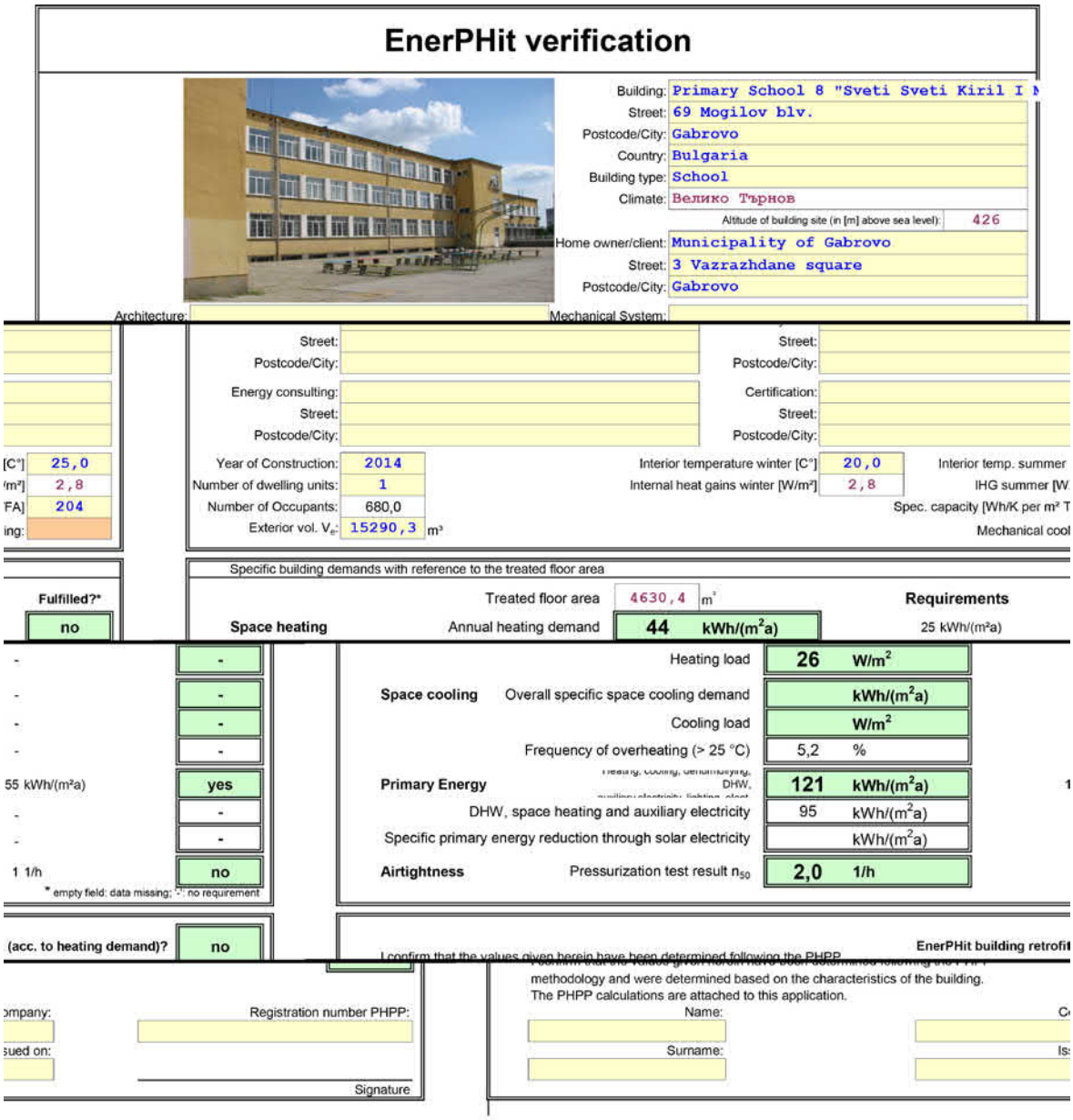


Figure 13: Specific energy efficiency values after measures within EuroPHit, Blocks A,B,C

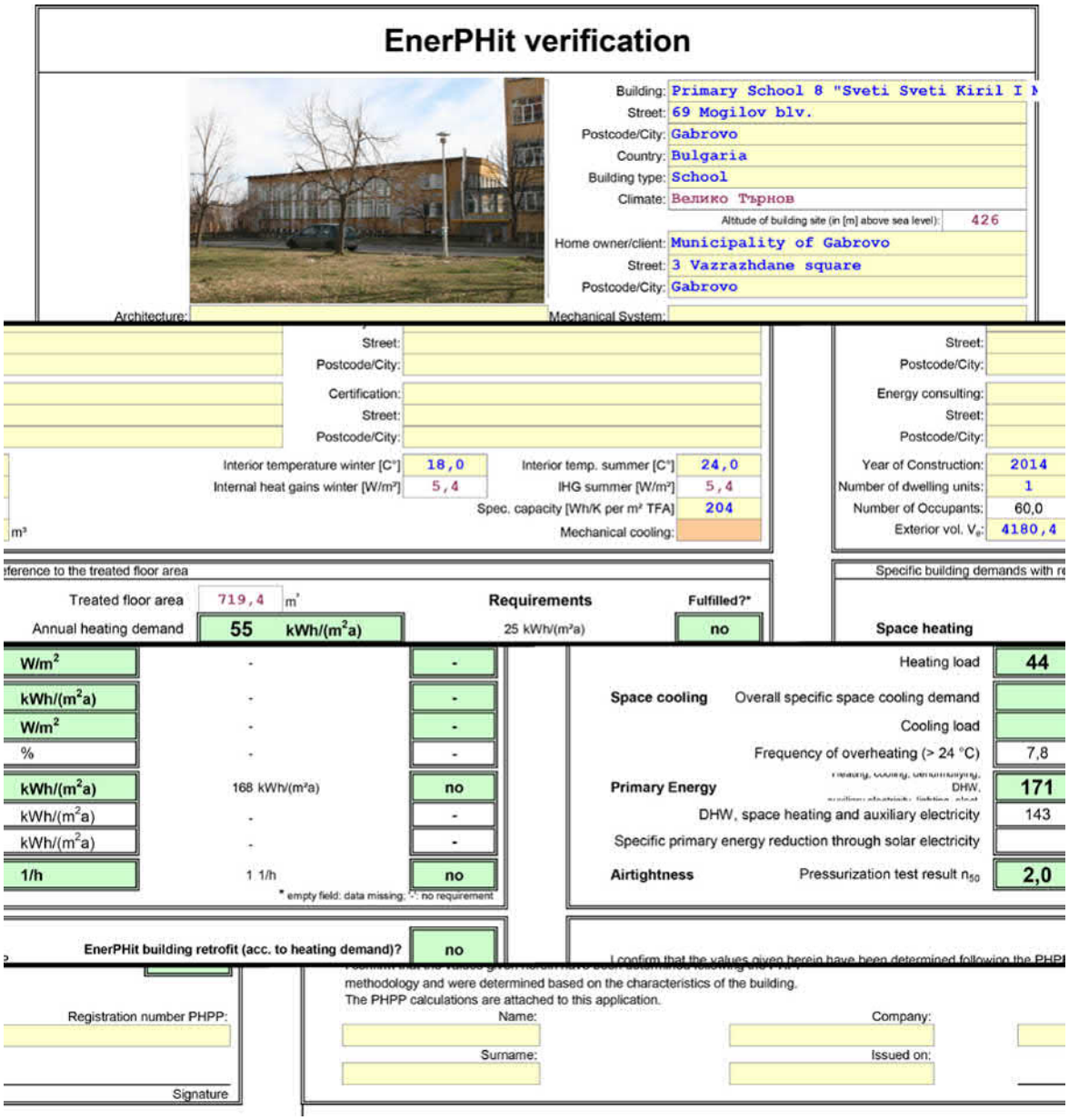


Figure 14: Specific energy efficiency values after measures within EuroPHit, Blocks D

3.3 Future retrofit Steps

3.3.1 Retrofit step 4,\Blocks A,B,C:

Replacement of the existing PVC windows with new PVC windows, airtightness.

Step 4 (after 10 years) - Windows

- Start date: 2025
- Completion date: 2025
- Budget: 230 152 EURO
- Specific heating demand: 17,3 kWh/(m²a)
- Specific cooling demand / overheating frequency:
- Specific primary energy demand: 80,5 kWh/(m²a)

3.3.1.1 New Envelope component

- Description replacement of windows and doors
- U-Value 0.8 W/(m²K),
- Installation date: 2025
- Condition:
- Next replacement: 2050
- Other:

3.3.1.2 New building equipment component

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

3.3.2 Retrofit step 4,\Blocks D:

Replacement of the existing aluminium windows with PVC windows, airtightness

- Start date: 2030
- Completion date: 2030
- Budget: 67 593 EURO
- Specific heating demand: 18,4 kWh/(m²a)
- Specific cooling demand / overheating frequency: 7,3%
- Specific primary energy demand: 116,2 kWh/(m²a)

3.3.2.1 New Envelope component

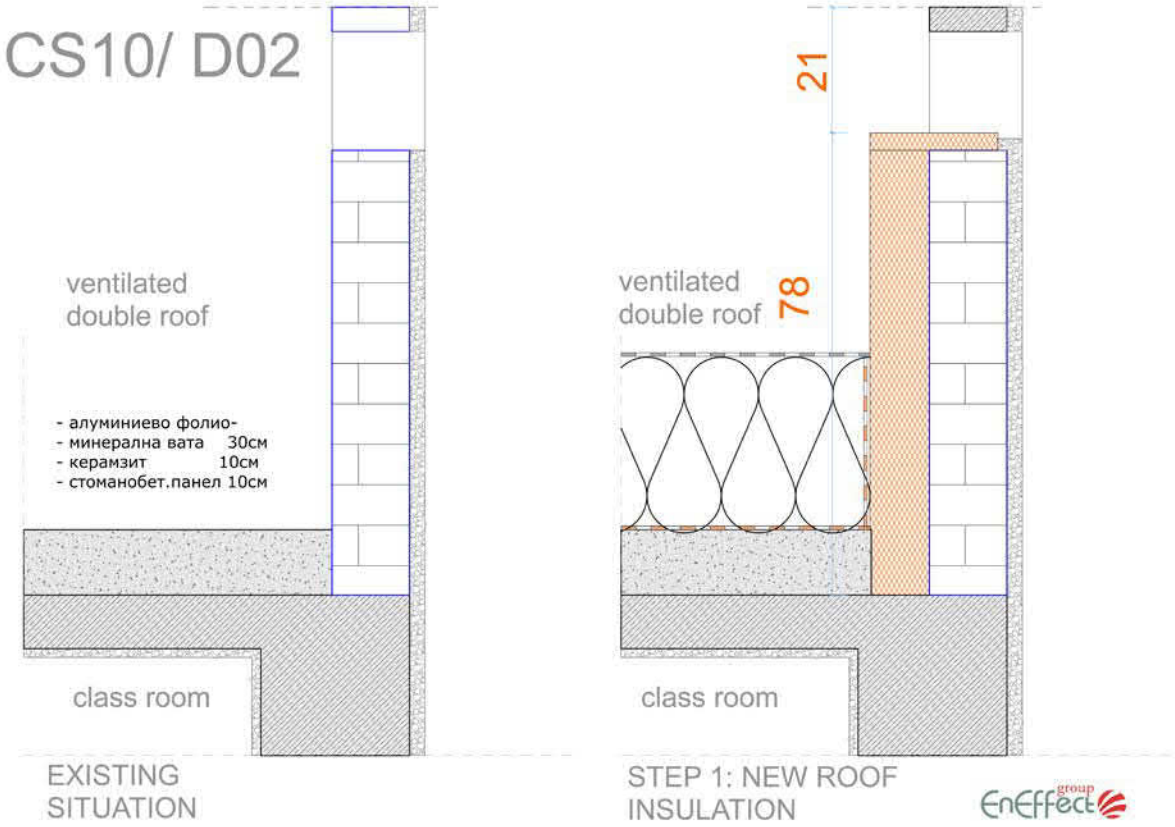
- Description replacement of windows and doors
- U-Value 0.8 W/(m²K),
- Installation date: 2030
- Condition:
- Next replacement: 2055
- Other:

3.3.2.2 New building equipment component

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

3.4 Pictures / Drawings

These pictures or drawings illustrate the retrofit process.



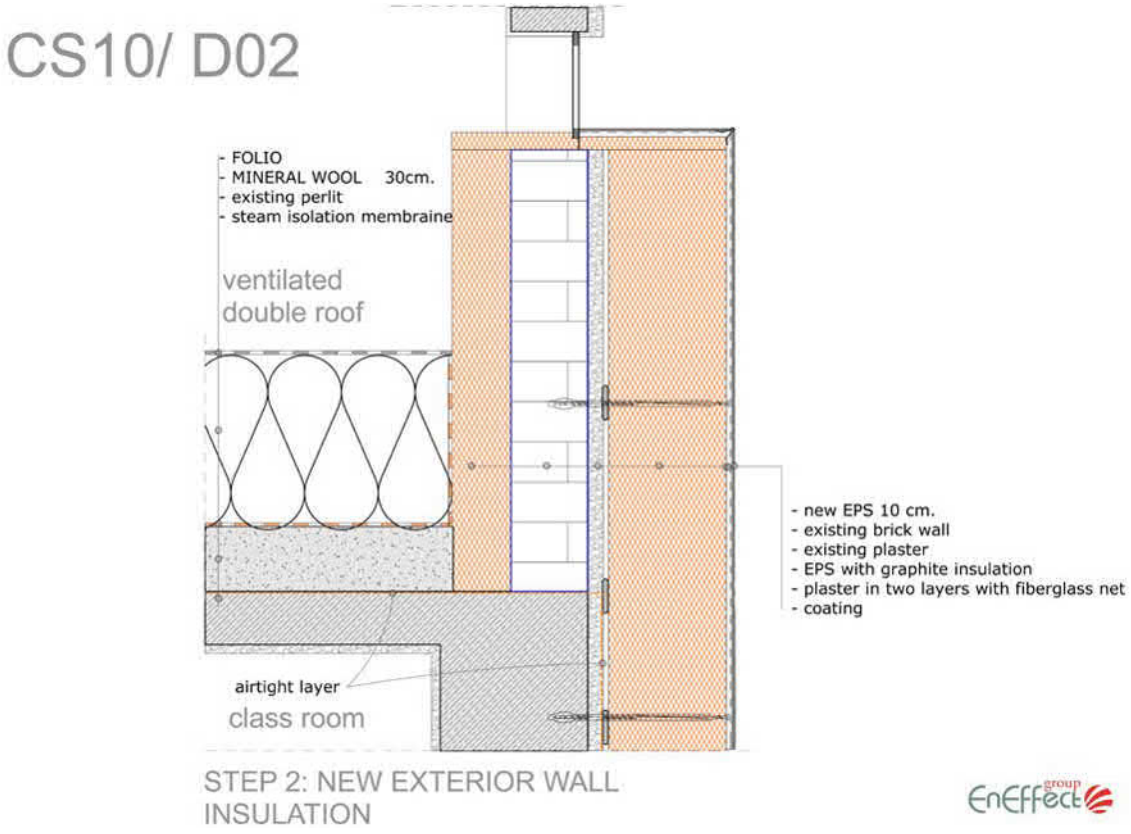


Figure 15: D02 - Connection: double ventilated roof - external wall

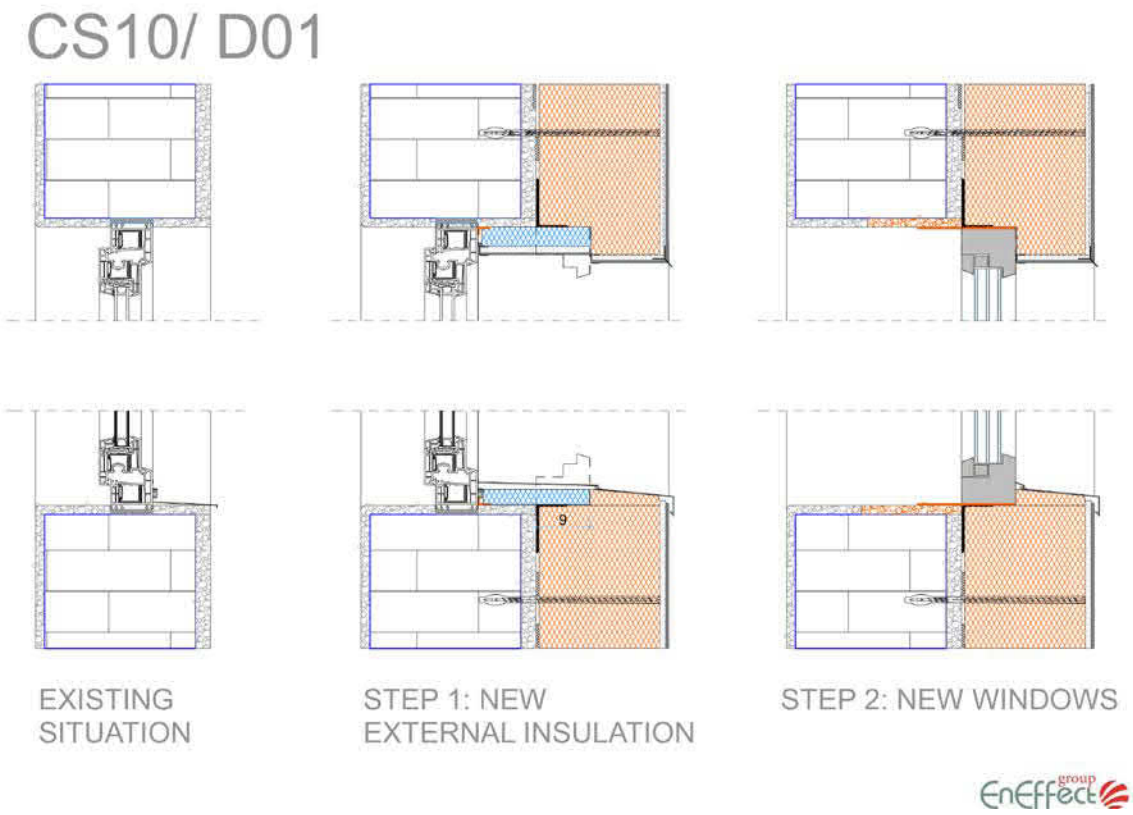


Figure 16: D01 - Connection: windows- external wall

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

4.1 General description

Add a more detailed description of the completed refurbishment including specific properties, general comments, observations…

4.1.1 Insulation

The walls will be insulated with 20 cm. EPS with graphite. Insulation of 30 cm. glass wool will be added above the lower slab of the double ventilated roof. The roof of the Gym will be insulated with 30 cm. XPS. The basement walls will be insulated with 15 cm. XPS. The new floor insulation of 15 cm. XPS will be added in the Gym. Thermal insulation under the ground floor slab will be added in technical corridor in block A and in the old boiler room in block C.

4.1.2 Windows & Doors

The existing PVC and aluminium windows and doors will be replaced with new ones with $U<0.85(W/m^2K)$. This is proposed to be done in few years, when the lifetime of the existing windows is over. Shading of the existing windows will have to be provided in early stages, 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. The wall insulation around the windows will be done 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. The airtightness of the existing windows will have to be improved. With the change of the windows the airtightness to the PH requirements will have to be achieved.

4.1.5 Heating, Ventilation and Air conditioning.

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

Nine MVHR units will be installed in Blocks A,B,and C and four others - in Block D.

The existing Central gas heating boiler, installed in 2013, can be replaced with condensing gas boiler with a capacity of 65-70 kW after its lifetime is over (in 25 years).

4.1.6 Electrical System

Kitchen equipment is more then 30 years old. It will be changed with new one with high energy efficiency.

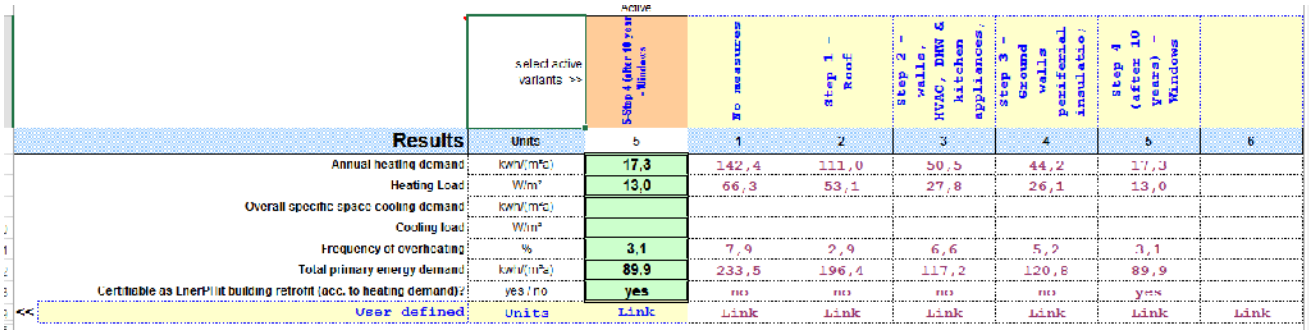
New LED lighting will replace the existing mercury lamps in the Gym.

4.1.7 RES Implementation

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

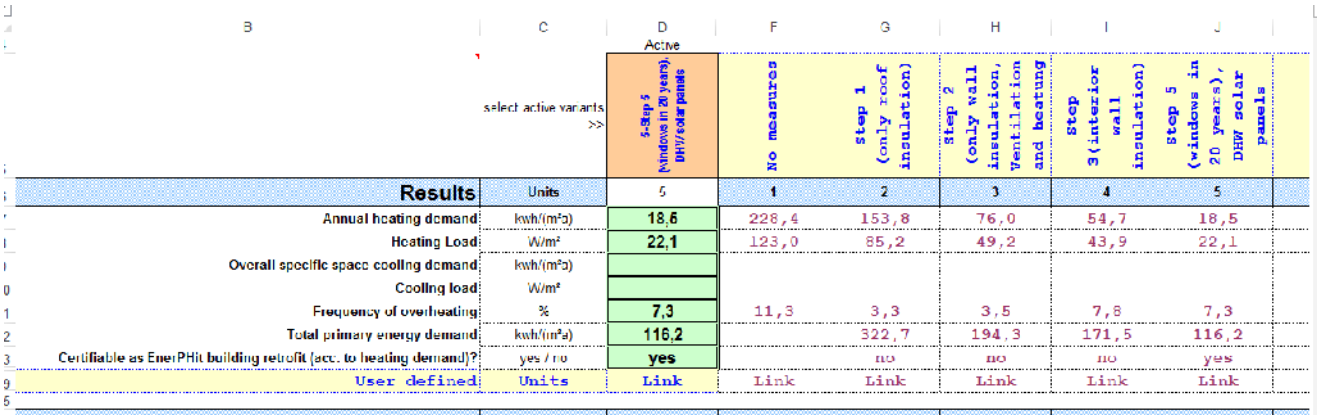
4.2 Retrofit steps carried out

The following



		Active						
	select active variants >>	5-Step 4 (after 10 years - Windows	No measures	Step 1 - Roof	Step 2 - walls, HVAC, DHW & kitchen appliances;	Step 3 - Ground walls perifecial insulation)	Step 4 (after 10 years) - Windows	
Results	Units	5	1	2	3	4	5	6
Annual heating demand	kWh/(m²a)	17,3	142,4	111,0	50,5	44,2	17,3	
Heating Load	W/m²	13,0	66,3	53,1	27,8	26,1	13,0	
Overall specific space cooling demand	kWh/(m²a)							
Cooling load	W/m²							
Frequency of overheating	%	3,1	7,9	2,9	6,6	5,2	3,1	
Total primary energy demand	kWh/(m²a)	89,9	233,5	196,4	117,2	120,8	89,9	
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	Link

Figure 17: PHPP9 beta [PHI 2013] Variant sheet with the retrofit steps carried out, block A,B,C



	B	C	D	F	G	H	I	J
			Active					
		select active variants >>	5-Step 5 (windows in 20 years), DHW/solar panels	No measures	Step 1 (only roof insulation)	Step 2 (only wall insulation, Ventilation and heating	Step 3 (interior wall insulation)	Step 5 (windows in 20 years), DHW solar panels
Results	Units		5	1	2	3	4	5
Annual heating demand	kwh/(m²a)		18,6	228,4	153,8	76,0	54,7	18,5
Heating Load	W/m²		22,1	123,0	85,2	49,2	43,9	22,1
Overall specific space cooling demand	kwh/(m²a)							
Cooling load	W/m²							
Frequency of overheating	%		7,3	11,3	3,3	3,5	7,8	7,3
Total primary energy demand	kwh/(m²a)		116,2		322,7	194,3	171,5	116,2
Certifiable as EnerPHit building retrofit (acc. to heating demand)?	yes / no		yes		no	no	no	yes
User defined	Units		Link	Link	Link	Link	Link	Link

Figure 18: PHPP9 beta [PHI 2013] Variant sheet with the retrofit steps carried out, Block D-GYM

4.2.1 Building data

- Completion Date: 2030
- 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: 7312m2
- Other:

4.2.2 Client

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

4.3 Description of Building components – blocks A,B,C

4.3.1 Floor slab

- Description no insulation
- U-Value 3,181 W/(m²K)
- Installation date: 2015
- Next replacement:
- Other:

4.3.2 External walls

- Description 20 cm. EPS with graphitte
- U-Value 0,142 W/(m²K)
- Installation date: 2015
- Condition:
- Next replacement:
- Other:

4.3.3 Windows

- Description new PVC windows
- U-Value 0,8 W/(m²K)
- Installation date: 2025
- Condition:
- Next replacement:
- Other:

4.3.4 Roof / Top floor ceiling

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

4.3.5 Heating

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

4.4 Description of Building components – block D

4.4.1 Floor slab

- Description 10 cm. XPS
- U-Value 0,302 W/(m²K)
- Installation date: 2015
- Condition:
- Next replacement:
- Other:

4.4.2 External walls

- Description 20 cm. EPS with graphitte
- U-Value 0,14 W/(m²K)
- Installation date: 2015
- Condition:
- Next replacement:
- Other:

4.4.3 External ground walls

- Description 15 cm multipor
- U-Value 0,271 W/(m²K)
- Installation date: 2015
- Condition:
- Next replacement:
- Other:

4.4.4 Windows

- Description new PVC windows
- U-Value 0,8 W/(m²K)
- Installation date: 2030
- Condition:

- Next replacement:
- Other:

4.4.5 Roof / Top floor ceiling

- Description 30 sm. XPS
- U-Value 0,113
- Installation date: 2015
- Condition:
- Next replacement:
- Other:

4.4.6 Heating

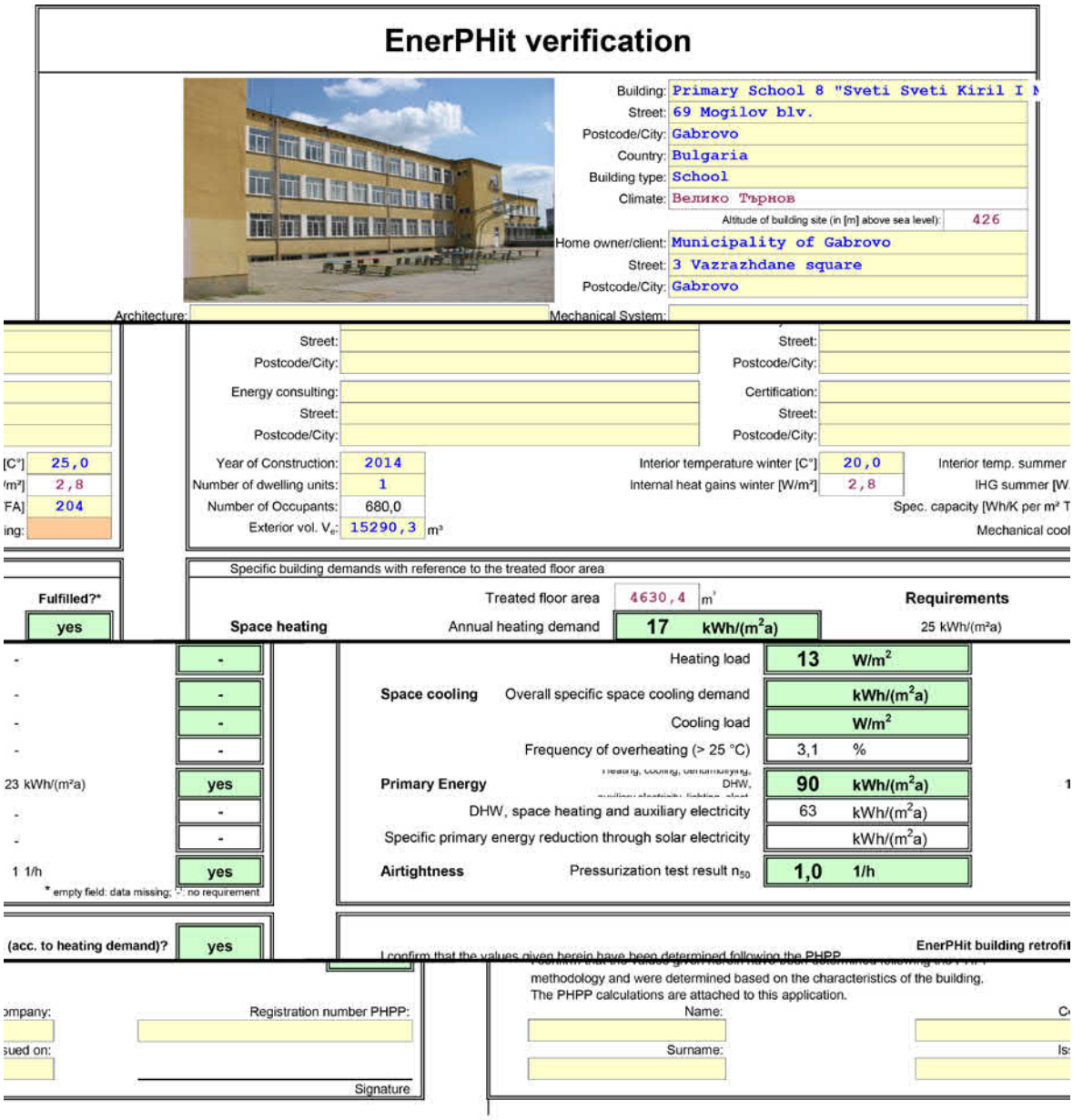
- Description
- Efficiency:
- Installation date:
- Condition:
- Next replacement:
- Other:

4.5 Energy efficiency of the refurbished building

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

- Modelled specific heating demand:
  Blocks A,B C 17,3 kWh/(m^{2}a) ; Block D-18,4 kWh/(m^{2}a)
- Modelled specific cooling demand / overheating frequency:
  Blocks A,B C 3,1%, Block D-7,3%
- Modelled specific primary energy demand:
  Blocks A,B C 80,5 kWh/(m^{2}a), Block D-116,2 kWh/(m^{2}a)

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.



EnerPHit verification

Building: Primary School 8 "Sveti Sveti Kiril I
Street: 69 Mogilov blv.
Postcode/City: Gabrovo
Country: Bulgaria
Building type: School
Climate: Велико Търнов
Altitude of building site (in [m] above sea level): 426
Home owner/client: Municipality of Gabrovo
Street: 3 Vazrazhdane square
Postcode/City: Gabrovo
Architecture:
Mechanical System:
Street:
Postcode/City:
Energy consulting:
Street:
Postcode/City:
Certification:
Street:
Postcode/City:
[C°] 25,0
m²] 2,8
FA] 204
ing:
Year of Construction: 2014
Number of dwelling units: 1
Number of Occupants: 680,0
Exterior vol. V_e: 15290,3 m³
Interior temperature winter [C°] 20,0
Internal heat gains winter [W/m²] 2,8
Interior temp. summer
IHG summer [W
Spec. capacity [Wh/K per m²
Mechanical cool

Specific building demands with reference to the treated floor area

Treated floor area 4630,4 m²

Fulfilled?*			Requirements
yes	Space heating	Annual heating demand 17 kWh/(m²a)	25 kWh/(m²a)
-		Heating load 13 W/m²	
-	Space cooling	Overall specific space cooling demand kWh/(m²a)	
-		Cooling load W/m²	
-		Frequency of overheating (> 25 °C) 3,1 %	
23 kWh/(m²a) yes	Primary Energy	DHW, 90 kWh/(m²a)	
-		DHW, space heating and auxiliary electricity 63 kWh/(m²a)	
-		Specific primary energy reduction through solar electricity kWh/(m²a)	
1 1/h yes	Airtightness	Pressurization test result n_{50} 1,0 1/h	

* empty field: data missing; -: no requirement

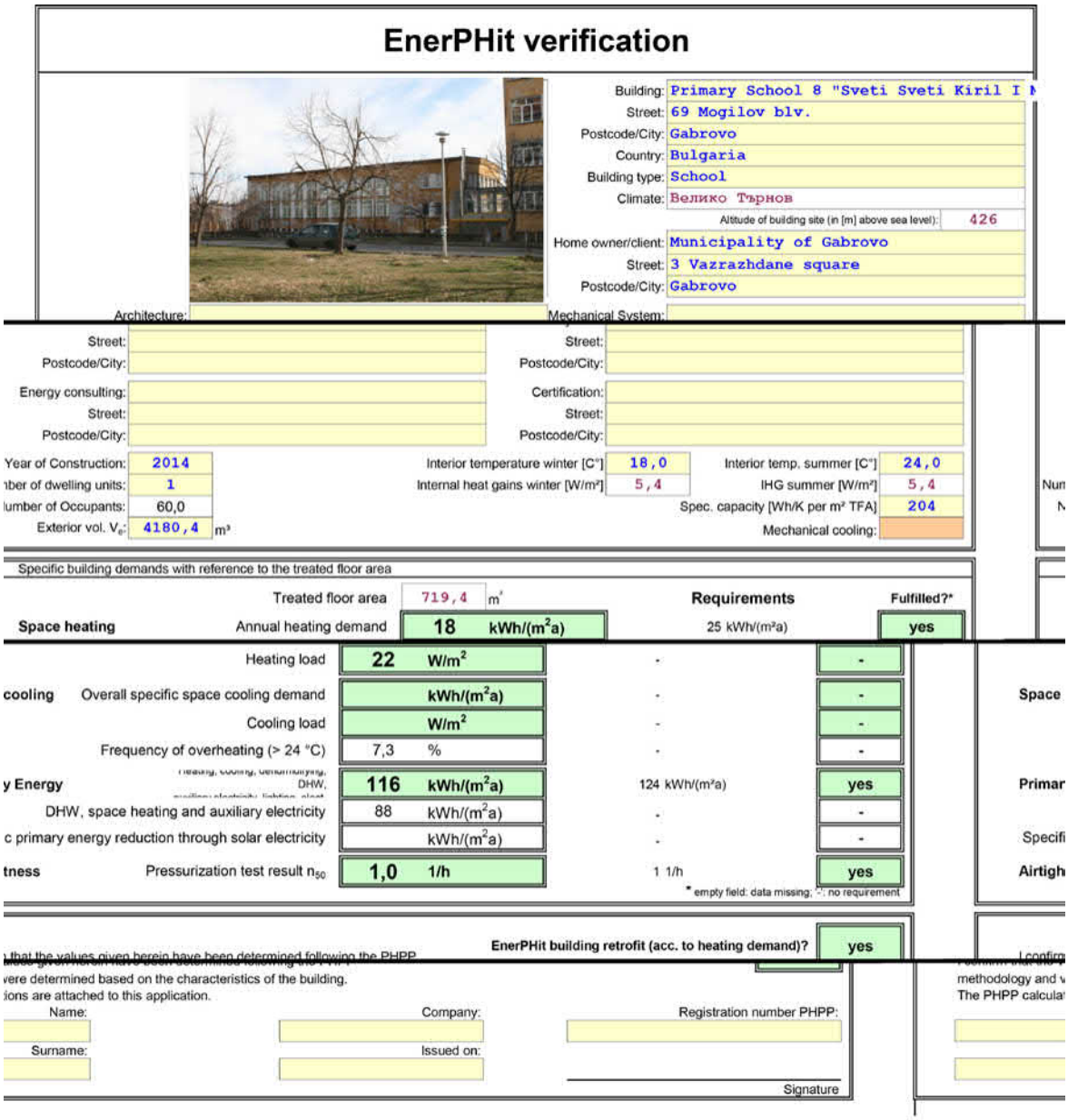
(acc. to heating demand)? yes

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.

EnerPHit building retrofit

ompany:
Registration number PHPP:
Name:
sued on:
Surname:
Signature

Figure 19: Specific energy efficiency values of the completed project modelled with PHPP 9 Beta, Blocks A,B,C



EnerPHit verification

Building: Primary School 8 "Sveti Sveti Kiril I M
Street: 69 Mogilov blv.
Postcode/City: Gabrovo
Country: Bulgaria
Building type: School
Climate: Велико Търнов
Altitude of building site (in [m] above sea level): 426
Home owner/client: Municipality of Gabrovo
Street: 3 Vazrazhdane square
Postcode/City: Gabrovo
Architecture:
Mechanical System:
Street:
Postcode/City:
Energy consulting:
Street:
Postcode/City:
Certification:
Street:
Postcode/City:
Year of Construction: 2014
Interior temperature winter [C°] 18,0
Interior temp. summer [C°] 24,0
Internal heat gains winter [W/m²] 5,4
IHG summer [W/m²] 5,4
Spec. capacity [Wh/K per m² TFA] 204
Exterior vol. V_e: 4180,4 m³
Mechanical cooling:

Specific building demands with reference to the treated floor area

				Requirements	Fulfilled?*
	Treated floor area	719,4	m²		
Space heating	Annual heating demand	18	kWh/(m²a)	25 kWh/(m²a)	yes
	Heating load	22	W/m²	-	-
cooling	Overall specific space cooling demand		kWh/(m²a)	-	-
	Cooling load		W/m²	-	-
	Frequency of overheating (> 24 °C)	7,3	%	-	-
y Energy	DHW,	116	kWh/(m²a)	124 kWh/(m²a)	yes
	DHW, space heating and auxiliary electricity	88	kWh/(m²a)	-	-
c primary energy reduction through solar electricity			kWh/(m²a)	-	-
tness	Pressurization test result n_{50}	1,0	1/h	1 1/h	yes

* empty field: data missing, "-": no requirement

EnerPHit building retrofit (acc. to heating demand)? yes

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

I confirm
methodology and
The PHPP calcula

Figure 20: Specific energy efficiency values of the completed project modelled with PHPP 9 Beta, Block D

4.6 Pictures / Drawings

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

To be completed on later stage.

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 21: Pictures / drawings of evaluated PV system

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 Blocks A,B,C:

According to the national standards for this building specific energy demand for heating and ventilation is 59,3 kWh/m^{2}a (PHPP)/ 33,0 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 4 h^{-1}, windows ventilation.

General description Block D-Gym:

According to the national standards for this building specific energy demand for heating and ventilation is 93,7 kWh/m^{2}a (PHPP)/ 33,0 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 4 h^{-1}, windows ventilation.

6.2 Efficiency results comparison table blocks A,B,C

	Existing building	National regulations	EnerPHit standard	Differences [%]
Space heat demand [kWh/(m^2/a)]	142,4	56,8	17,3	28%
Primary energy demand [kWh/(m^2/a)]	233,5	115,6	89,9	11%
Heat Load [W/m^2]	66,3	32,1	13,0	29%

Figure 22: Comparison of efficiency results for Blocks A, B,C

6.3 Efficiency results comparison table block D-Gym

	Existing building	National regulations	EnerPHit standard	Differences [%]
Space heat demand [kWh/(m^2/a)]	228,4	85,8	18,5	29%
Primary energy demand [kWh/(m^2/a)]	411,8	217,5	116,2	25%
Heat Load [W/m^2]	123,0	60,1	22,1	31%

Figure 23: Comparison of efficiency results for block D-Gym

6.4 Building envelope comparison table blocks A,B,C

	Existing building	National regulations	EnerPHit standard	Differences [%]
Airtightness Pressure test n50 [1/h]	4	3	1	75%
Building envelope				
Floor Slab [W/(m²K)]	2,937	0,450	2,597	
Walls to ground [W/(m²K)]	2,622	0,600	0,180	16%
Walls [W/(m²K)]	1,295	0,350	0,143	16%
Roof / Attic ceilings [W/(m²K)]	1,551	0,280	0,126	10%
Windows [W/(m²K)]	2,7	1,7	0,8	33%
Doors [W/(m²K)]	2,25	2,2	1,4	36%
Thermal bridging ΔU[W/(m²K)]				

Figure 24: Comparison of building envelope components for blocks A,B,C

6.5 Building envelope comparison table block D-Gym

	Existing building	National regulations	EnerPHit standard	Differences [%]
Airtightness Pressure test n50 [1/h]	4	3	1	50%
Building envelope				
Floor Slab [W/(m²K)]	3,181	0,450	0,302	5%
Walls to ground [W/(m²K)]	2,865	0,600	0,271	11%
Walls [W/(m²K)]	1,206	0,350	0,141	17%
Roof / Attic ceilings [W/(m²K)]	2,260	0,280	0,113	7%
Windows [W/(m²K)]	2,7	1,7	0,8	33%
Doors [W/(m²K)]	2,25	2,2	1,4	36%

Thermal bridging ΔU[W/(m²K)]				

Figure 25: Comparison of building envelope components for block D-Gym

6.6 Building equipment comparison table blocks A,B,C

	Existing building	National regulations	EnerPHit standard	Differences [%]
Ventilation	**Natural**	**Natural**	**Mechanical**	
HR Efficiency [%]			81%	
Electric efficiency [Wh/m³]			0,40	
Ducting				
Heating	**Boiler**	**Boiler**	**Boiler**	
Energy source	Gas	Gas	Gas	
Performance ratio of heat generation [%]	112 %	112 %	112 %	
Thermal output kW	1000 (whole building)	1000 (whole building)	1000 (whole building)	
Insulation of pipes	60	60	60	
Domestic hot water	**-**	**Boiler**	**Boiler**	
Energy source	-	Gas	Gas	
Performance ratio of heat generation [%]	-	116 %	116 %	
Thermal output kW				
Insulation of pipes				
Cooling	**-**	**-**	**-**	
Energy source				
Performance ratio of cooling generation [%]				

Thermal output kW				
Insulation of pipes				

Figure 26: Comparison of building equipment for Blocks A,B,C

6.7 Building equipment comparison table block D - Gym

	Existing building	National regulations	EnerPHit standard	Differences [%]
Ventilation	**Natural**	**Natural**		
HR Efficiency [%]			81%	
Electric efficiency [Wh/m³]			0,40	
Ducting				
Heating	**Boiler**	**Boiler**	**Boiler**	
Energy source	Gas	Gas	Gas	
Performance ratio of heat generation [%]	111 %	111 %	111 %	
Thermal output kW	1000 (whole building)	1000 (whole building)	1000 (whole building)	
Insulation of pipes	60	60	60	
Domestic hot water	**-**	**Boiler**	**Boiler**	
-Energy source	-	Gas	Gas	
Performance ratio of heat generation [%]	-	116 %	116 %	
Thermal output kW				
Insulation of pipes				
Cooling	**-**	**-**	**-**	
Energy source				
Performance ratio of cooling generation [%]				

Thermal output kW				
Insulation of pipes				

Figure 27: Comparison of building equipment for Block D-Gym

6.8 RES implementation comparison table blocks A,B,C

	Existing building	National regulations	EnerPHit standard	Differences [%]
Renewables	None	None	2,6 kWh/yr. solar heating collectors for Domestic hot water (kitchen + toilet)	

Figure 28: Comparison of RES implementation for Blocks A,B,C

6.9 RES implementation comparison table block D - Gym

	Existing building	National regulations	EnerPHit standard	Differences [%]
Renewables	None	None	10,1 kWh/yr. solar heating collectors for Domestic hot water (kitchen + toilet)	

Figure 29: Comparison of RES implementation for Block D - Gym

6.10 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 %.