D3.5_Report on step-by-step retrofitting building case studies

Project: CS03 - Hotel Restaurant Valcanover

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
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Project Duration	1 April 2013 – 31 March 2016 (36 Months)

Deliverable No.	D3.5
Dissemination Level	PU
Work Package	WP3_Practical Implementation
Lead beneficiary	04_MosArt
Contributing beneficiary(ies)	02_ZEPHIR
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Date	24 10 2014
File Name	EuroPHit_D3.5_CS03_Hotel_Restaurant_Valcanover.doc

Table of Contents

Abstract 6
1 General Project description 7
1.1 Motivation 7
1.2 Existing Building 7
1.3 Refurbishment steps 7
1.3.1 Retrofit steps within EuroPHit 7
1.3.2 Further retrofit steps 7
1.4 EnerPHit standard 8
1.5 Pictures 9
2 Existing building 10
2.1 General description 10
2.1.1 Building data 10
2.1.2 Client 10
2.2 Envelope of the existing Building 10
2.2.1 Floor slab 10
2.2.2 External walls 10
2.2.3 Windows 11
2.2.4 Roof / Top floor ceiling 11
2.3 Technical equipment of the existing building 11
2.3.1 Heating 11
2.3.2 Domestic hot water 11
2.3.3 Ventilation 12
2.4 Energy efficiency of the existing building 12
2.4.1 Modelled efficiency parameters 12
2.4.2 Available consumption parameters 12
2.5 Pictures / Drawings 14
3 Retrofit steps 17
3.1 Overall refurbishment Plan 17
3.1.1 Retrofit steps: 17
3.1.2 Efficiency Improvements 18
3.2 Retrofit steps within EuroPHit 18
3.2.1 Retrofit step 1: 18
3.2.2 New ventilation component (ventilation unit) 19
3.3 Future retrofit Steps 22
3.3.1 Retrofit step 2: 22
3.3.2 Retrofit step 3: 25
3.3.3 New ventilation component (ventilation unit) 25
3.3.4 Retrofit step 4: 28

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3.3.5 New ventilation component (ventilation unit) 28
3.4 Pictures / Drawings 30
4 Completion of step-by-step refurbishment to EnerPHit standard including RES 33
4.1 General description 33
4.2 Retrofit steps carried out 33
4.2.1 Building data 33
4.2.2 Client 33
4.3 Description of Building components 34
4.3.1 Floor slab 34
4.3.2 External walls 34
4.3.3 Windows 34
4.3.4 Roof / Top floor ceiling 34
4.4 Technical equipment of the refurbished building 35
4.4.1 Heating 35
4.4.2 Domestic hot water 35
4.4.3 Ventilation 35
4.5 Energy efficiency of the refurbished building 36
4.5.1 Modelled efficiency parameters 36
4.6 Pictures / Drawings 38
5 Refurbishment to the current National Standards 40
5.1 General Description 40
5.2 Efficiency results comparison table 40
5.3 Building envelope comparison table 40
5.4 Building equipment comparison table 41
5.5 RES implementation comparison table 42
6 Monitoring 42
7 Conclusions 46

List of tables and figures

Figure 1: The existing building [ZEPHIR, 2013] 6
Figure 2: Pictures of the existing building. Top: north view. Bottom: south view. [ZEPHIR, 2013] 9
Figure 3: Specific energy efficiency values of the existing building modelled with PHPP 9 Beta 13
Figure 4: Aerial view of Hotel Restaurant Valcanover [Bing Maps, 2013]. 14
Figure 5: Existing double glazed (left) and single glazed (right) windows [ZEPHIR 2013]. 14
Figure 6: Roof of the existing building [ZEPHIR 2013]. 15
Figure 7: Ground floor plan, existing building. 15
Figure 8: First floor plan, existing building. 16
Figure 9: Second floor plan, existing building. 16

Figure 10: Overview refurbishment steps 17
Figure 11: Overview energy efficiency improvement according to the overall refurbishment plan 18
Figure 12: Specific energy efficiency values after step 1. 21
Figure 13: Specific energy efficiency values step 2. 24
Figure 14: Specific energy efficiency values after step 3. 27
Figure 15: Specific energy efficiency values after measures within EuroPHit 29
Figure 16: Ground floor plan of the refurbished building. 30
Figure 17: First floor plan of the refurbished building. 30
Figure 18: Second floor plan of the refurbished building. 31
Figure 19: Attic floor plan of the refurbished building. 31
Figure 20: North-East elevation of the refurbished building. 31
Figure 21: South-West elevation of the refurbished building. 32
Figure 22: PHPP9 beta Variant sheet with the planned retrofit steps. 33
Figure 23: Specific energy efficiency values of the completed project modelled with PHPP 9 Beta 37
Figure 24: Rendering of the west view of the refurbished building. 38
Figure 25: Rendering of the North-East view of the refurbished building. 38
Figure 26: Rendering of the South view of the refurbished building. 39
Figure 27: Comparison of efficiency results 40
Figure 28: Comparison of building envelope components 40
Figure 29: Comparison of building envelope components 41
Figure 30: Comparison of building envelope components 42
Figure 31: The open-source Arduino platform. 42
Figure 32: Arduino can receive input from sensors, controlling external actuators and send teal time data via internet. 43
Figure 33: Typical error curve DS18B20 temperature sensor 43
Figure 34: Sketch of the location of the three detectors. One outside the building and two inside. 44
Figure 35: Sample plot of the results extracted from the three sensors (blue line: dressing room, green line: dining room, red line: external). Top panel: air temperature. Bottom panel: relative humidity. 44
Figure 36: Monthly natural gas consumptions of the existing building for 2013 (red) and 2014 (light red) 45
Figure 37: Monthly electricity consumptions of the existing building for 2013 (blue) and 2014 (light blue). 46

Abstract

This report provides provides an overview of the retrofit steps of a step-by-step refurbishment to EnerPHit standard to be undertaken for the project Hotel-Restaurant Valcanover.

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 refurbishing the existing building according to the Passivhaus principles. The thermal protection of all the dissipating surfaces will be improved by adding an external insulation. The airtightness of the building will be realized taking care of implementing a continuous layer without interruptions. The existing windows will be replaced with triple glazed windows with insulated frames. Furthermore the building will also be enlarged adding two new volumes and using Passivhaus suitable components. From the point of view of the building services we will install four different ventilation units with heat recovery and we will replace the existing gas boiler with a more efficient heat generator: a water-water heat pump. We will add photovoltaic panels on the roof.

Figure 1: The existing building [ZEPHIR, 2013]

1 General Project description

1.1 Motivation

The running costs of the building are, at present, extremely high and the living comfort is very low. For these reasons, during the coldest months of the year, the hotel and the restaurant are usually closed. The owners are interested in the Passivhaus standard to reduce the running costs of the building as much as possible and increase the living comfort to the highest standards. Moreover they also believe that the visibility of the Hotel-Restaurant can benefit significantly from being the first building in Italy refurbished to the EnerPHit standard using a step by step approach.

1.2 Existing Building

The existing building is a three-storey building with three main destinations of use: restaurant, hotel and residential. The building was constructed in 1928 and later it was enlarged and refurbished in 1994 and 2008. The main body of the building, which is the oldest part, is a limestone construction. Most of the windows are single glazed and with uninsulated wooden frames. The newer extension is a brickwork construction and the windows have wooden frames with no insulation and double glazing. The timber roof is in precarious conditions and needs to be replaced as soon as possible. At present the envelope of the building has mainly no insulation. The restaurant is currently located at the ground floor, the residential part at the 1st floor while the hotel extends to the 1st and 2nd floors.

1.3 Refurbishment steps

1.3.1 Retrofit steps within EuroPHit

The all building will be retrofitted according to the Passivhaus principles with the target to reach the EnerPHit certification following a step-by-step approach. The refurbishment plan includes the dismantling of some parts of the building and the realization of some new extensions. In particular the restaurant at the ground floor will be enlarged and redesigned. The *2nd* floor will be demolished and rebuilt with a larger treated floor area. All the new parts of the building will be realized entirely with cross laminated timber (xlam). We plan also to rearrange the internal spaces in order to make them more functional. The *1st* floor of the building will be fully devoted to the hotel while the *2nd* floor will contain a residential part, composed by two different dwelling units, and a little apartment which is part of the hotel. We also planned a little solarium and a terrace on the roof.

Within the end of the EuroPHit project we will demolish and rebuild the second floor, thus replacing the precarious roof. In rebuilding the floor we will use Passivhaus components for all the elements of the thermal envelope and also for the building services.

1.3.2 Further retrofit steps

The future steps that have to be undertaken after the end of the EuroPHit project are the realization of the extension at the ground floor and the refurbishment of the existing parts of the ground and of the first floor. These have to be renovated both from the point of view of the building envelope and of the building services. As regards the building envelope, a new insulation layer will be added to all the opaque components, the existing windows will be replaced and a new airtight layer will be implemented. As regards the building services a new ventilation system with heat recovery will be installed, the existing heat generator will be replaced and PV panels will be added on the roof.

1.4 EnerPHit standard

The EnerPHit standard will be reached after the end of the project when the last step of the refurbishment plan will be completed.

1.5 Pictures

Figure 2: Pictures of the existing building. Top: north view. Bottom: south view. [ZEPHIR, 2013]

2 Existing building

2.1 General description

The existing building has a rather compact shape, the A/V ratio is 0.47 and the treated floor area is 584.61 m^2. The main challenges of the project are the poor orientation of the building and of the windows, the thermal bridge at the external wall-basement connection and the limitation/removal of the internal heating loads of the restaurant, especially in summer. Another challenge is the fact that the building contains three different destination of use that needs to be refurbished in different steps. At the same time some old parts of the building will be demolished and some new extensions will be built.

2.1.1 Building data

Construction Time	:	1928
Last retrofit	:	2008
Building use	:	restaurant, hotel, residential
General condition	:	
Occupancy	:	one dwelling unit (1st floor), restaurant with 100 seats (ground floor), hotel with 15 double rooms (1st and 2nd floors).
Treated floor Area	:	584.61
Other	:	

2.1.2 Client

Name / Company	:	Maria Biasi and Monica Valcanover
Address	:	Via di Mezzolago 1, I-38057 Pergine Valsugana (TN)
Email	:	albergo.valcanover@virgiglio.it
Other	:	

2.2 Envelope of the existing Building

2.2.1 Floor slab

Description	:	Concrete slab
U-Value [W/(m²K)]	:	2.806 W/m^2K
Installation date	:	1928
Condition	:	Good
Next replacement	:	
Other	:	

2.2.2 External walls

Description	:	Masonry construction
U-Value [W/(m²K)]	:	1.44 W/m^2K (average)
Installation date	:	1928, 1980, 1994, 2008

Condition	:	Good
Next replacement	:	2015
Other	:	

2.2.3 Windows

Description	:	Double glazed and single glazed windows with wooden frame
U-Value [W/(m²K)]	:	3.088 W/m^2K (average)
Installation date	:	1928, 1980, 1994, 2008
Condition	:	Poor
Next replacement	:	2015
Other	:	

2.2.4 Roof / Top floor ceiling

Description	:	Lightweight timber construction
U-Value [W/(m²K)]	:	1.917 W/m^2K
Installation date	:	1928
Condition	:	End of lifecycle
Next replacement	:	2015
Other	:	

2.3 Technical equipment of the existing building

2.3.1 Heating

Description	:	Gas Boiler
Performance ratio of heat generation [%]	:	n.a.
Installation date	:	2004
Condition	:	Good
Next replacement	:	
Other	:	

2.3.2 Domestic hot water

Description	:	Gas Boiler
Performance ratio of heat generation [%]	:	n.a.
Installation date	:	2004
Condition	:	Good
Next replacement	:	

Other :

2.3.3 Ventilation

Description : Natural

HR Efficiency[%] :

El.Efficiency [Wh/m³]

Installation date :

Condition :

Next replacement :

Other

2.4 Energy efficiency of the existing building

The energy efficiency properties of the existing building were calculated with the use of the PHPP 9 (Passive House Planning Package) and the results prove that the energy performance of the building is very poor due mainly to the lack of insulation in the thermal envelope and the low level of airtightness of the building.

2.4.1 Modelled efficiency parameters

PHPP: specific heating demand [kWh/(m²K)]	:	268.8
PHPP: specific cooling demand | Overheating frequency [kWh/(m²K) | %]	:	3.5
PHPP: specific primary energy demand [kWh/(m²K)]	:	867.9

2.4.2 Available consumption parameters

Annual Gas/Oil consumption | bills [kWh/a | €]	:	about 9000 €/a (hotel and restaurant) + about 3000 €/a (residential)
Annual Electricity consumption | bills [kWh/a | €]	:	about 20000 €/a
Other	:	

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.

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EnerPHit verification

Building:	Hotel Restaurant Valcanover
Street:	
Postcode/City:	
Country:	Italy
Building type:	Masonry construction
Climate:	Pergine
Altitude of building site (in [m] above sea level):	459
Home owner/client:	
Street:	
Postcode/City:	

Architecture:		Mechanical System:	
Street:		Street:	
Postcode/City:		Postcode/City:	
Energy consulting:	ZEPHIR	Certification:	
Street:		Street:	
Postcode/City:	Pergine Valsugana	Postcode/City:	

Year of Construction:	1928	Interior temperature winter [C°]	20.0	Interior temp. summer [C°]	25.0
Number of dwelling units:	1	Internal heat gains winter [W/m²]	9.4	IHG summer [W/m²]	9.9
Number of Occupants:	37.0			Spec. capacity [Wh/K per m² TFA]	204
Exterior vol. V_e:	2948.8 m³			Mechanical cooling:	x

Specific building demands with reference to the treated floor area

				Requirements	Fulfilled?*
	Treated floor area	584.6	m²		
Space heating	Annual heating demand	**269**	kWh/(m²a)	25 kWh/(m²a)	**no**
	Heating load	**128**	W/m²	-	-
Space cooling	Overall specific space cooling demand	**4**	kWh/(m²a)	-	-
	Cooling load	**13**	W/m²	-	-
	Frequency of overheating (> 25 °C)		%	-	-
Primary Energy	Heating, cooling, dehumidifying, DHW,	**868**	kWh/(m²a)	425 kWh/(m²a)	**no**
	DHW, space heating and auxiliary electricity	445	kWh/(m²a)	-	-
	Specific primary energy reduction through solar electricity		kWh/(m²a)	-	-
Airtightness	Pressurization test result n_{50}	**10.0**	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.

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

Figure 3: Specific energy efficiency values of the existing building modelled with PHPP 9 Beta

2.5 Pictures / Drawings

These pictures or drawings illustrate the existing building.

Figure 4: Aerial view of Hotel Restaurant Valcanover [Bing Maps, 2013].

Figure 5: Existing double glazed (left) and single glazed (right) windows [ZEPHIR 2013].

Figure 6: Roof of the existing building [ZEPHIR 2013].

Floor Plans of the existing building.

Figure 7: Ground floor plan, existing building.

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Figure 8: First floor plan, existing building.

Figure 9: Second floor plan, existing building.

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3 Retrofit steps

3.1 Overall refurbishment Plan

3.1.1 Retrofit steps:

The building will be probably refurbished in four different steps. A detailed plan of the different steps with a detailed time schedule has not been developed so far. Here we present a preliminary plan of the possible steps.

The building will not only be refurbished, some parts will also be demolished and some new extension will be realized. In particular the second floor will be demolished and reconstructed with a larger treated floor area. Also at the ground level a new extension will be constructed in order to increase the area devoted to the restaurant. All the new parts of the building will be realized using cross laminated timber.

Step	Year	Measure	Specific Heating Demand	Specific Primary Energy Demand	Additional Specific Renewable Energy Gains
0	2008	Existing	269 kWh/m^2a	868 kWh/m^2a	
1	2015	Demolition and reconstruction of the second floor of the building	98.2 kWh/m^2a	n.a.	
2	2016	Realization of the extension of the ground level and insulation of all the external walls	31.2 kWh/m^2a	n.a.	
3	2017	Energy retrofitting of the existing part of the ground level (windows, airtightness, ventilation, floor slab insulation)	27.5 kWh/m^2a	n.a.	
4	2018	Energy retrofitting of the existing part of the first level (windows, airtightness, ventilation)	17.8 kWh/m^2a	n.a.	

Figure 10: Overview refurbishment steps

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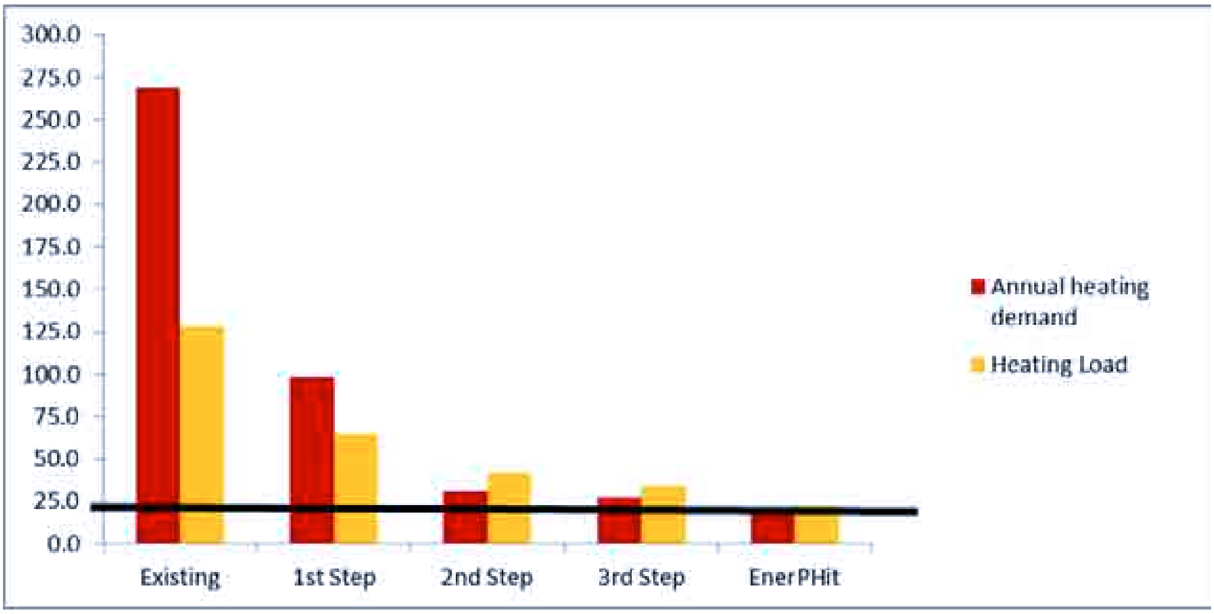
3.1.2 Efficiency Improvements



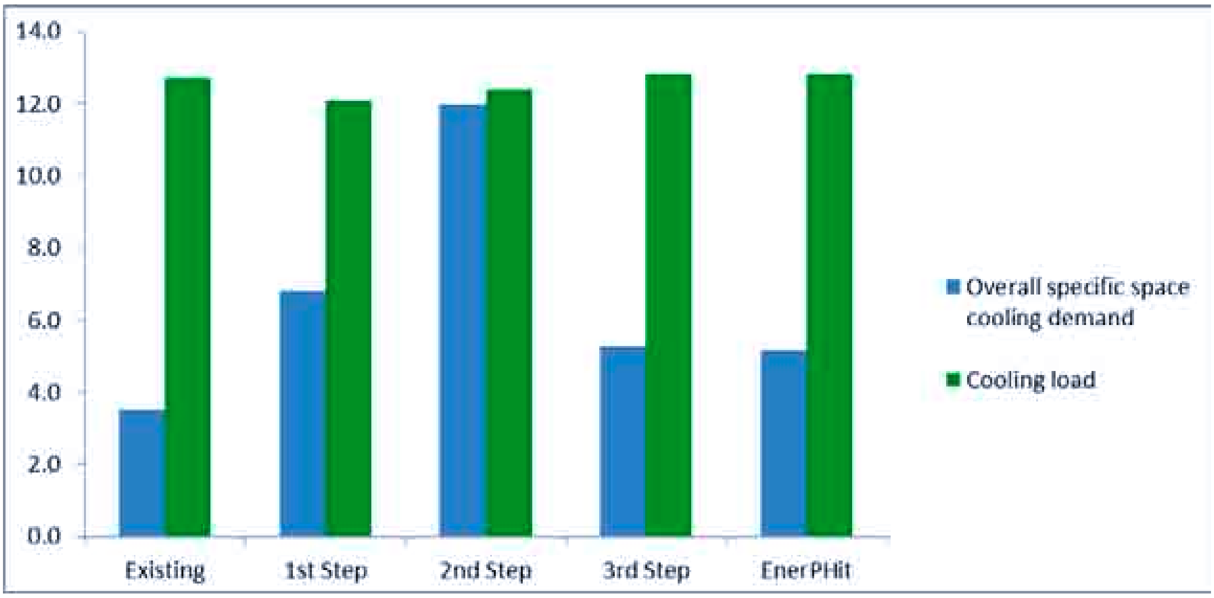


Figure 11: Overview energy efficiency improvement according to the overall refurbishment plan

3.2 Retrofit steps within EuroPHit

3.2.1 Retrofit step 1:

Demolition and reconstruction of the second level of the building with a larger treated floor area. The new external walls will be realized with cross laminated timber and external EPS insulation. The new windows will be timber/aluminium windows with insulated frame and triple glazing. The destination of use of the reconstructed level will be residential with two dwelling units. Two ventilation units with heat recovery will be installed, one for each apartment.

Start date	:	Winter 2015
Completion date	:	Spring 2016
Budget	:	€ 281500
PHPP: specific heating demand [kWh/(m²K)]	:	98.2
PHPP: specific cooling demand | Overheating frequency [kWh/(m²K) | %]	:	6.8
PHPP: specific primary energy demand [kWh/(m²K)]	:	

3.2.1.1 New Envelope component (new external walls)

Description	:	XLAM with external EPS insulation and internal mineral wool insulation
U-Value [W/(m²K)]	:	0.115
Installation date	:	2015
Condition	:	Good
Next replacement	:	2075
Other	:	

3.2.1.2 New Envelope component (top floor ceiling)

Description	:	wood-concrete slab + XPS insulation
U-Value [W/(m²K)]	:	0.11
Installation date	:	2015
Condition	:	Good
Next replacement	:	2075
Other	:	

3.2.1.3 New Envelope component (windows)

Description	:	Aluminium clad timber frame triple glazed windows
U-Value [W/(m²K)]	:	0.95
Installation date	:	2015
Condition	:	Good
Next replacement	:	2045
Other	:	

3.2.2 New ventilation component (ventilation unit)

Description	:	2 Ventilation units with heat recovery
HR Efficiency[%]	:	90%
El.Efficiency [Wh/m³]	:	0.42

Installation date	:	2015
Condition	:	Good
Next replacement	:	2040
Other	:	

EnerPHit verification

Building:	Hotel Restaurant Valcanover
Street:	
Postcode/City:	
Country:	Italy
Building type:	Masonry construction
Climate:	Pergine
Altitude of building site (in [m] above sea level):	459
Home owner/client:	
Street:	
Postcode/City:	

Architecture:		Mechanical System:	
Street:		Street:	
Postcode/City:		Postcode/City:	
Energy consulting:	ZEPHIR	Certification:	
Street:		Street:	
Postcode/City:	Pergine Valsugana	Postcode/City:	

Year of Construction:	1928	Interior temperature winter [C°]	20.0	Interior temp. summer [C°]	25.0
Number of dwelling units:	1	Internal heat gains winter [W/m²]	9.4	IHG summer [W/m²]	9.9
Number of Occupants:	37.0			Spec. capacity [Wh/K per m² TFA]	204
Exterior vol. V_e:	3018.9 m³			Mechanical cooling:	x

Specific building demands with reference to the treated floor area

		Value	Unit	Requirements	Fulfilled?*
	Treated floor area	635.8	m²		
Space heating	Annual heating demand	98	kWh/(m²a)	25 kWh/(m²a)	no
	Heating load	65	W/m²	-	-
Space cooling	Overall specific space cooling demand	7	kWh/(m²a)	-	-
	Cooling load	12	W/m²	-	-
	Frequency of overheating (> 25 °C)		%	-	-
Primary Energy	Heating, cooling, dehumidifying, DHW,		kWh/(m²a)	220 kWh/(m²a)	
	DHW, space heating and auxiliary electricity		kWh/(m²a)	-	-
	Specific primary energy reduction through solar electricity		kWh/(m²a)	-	-
Airtightness	Pressurization test result n_{50}	7.1	1/h	1 1/h	no

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

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 (acc. to heating demand)?

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

Figure 12: Specific energy efficiency values after step 1.

3.3 Future retrofit Steps

3.3.1 Retrofit step 2:

Realization of the extension of the ground floor and thermal insulation of the existing walls of the thermal envelope.

Start date	:	Winter 2016
Completion date	:	
Budget	:	
PHPP: specific heating demand [kWh/(m²K)]	:	31.2
PHPP: specific cooling demand | Overheating frequency [kWh/(m²K) | %]	:	12.0
PHPP: specific primary energy demand [kWh/(m²K)]	:	

3.3.1.1 New Envelope component (new external walls)

Description	:	XLAM with external EPS insulation and internal mineral wool insulation
U-Value [W/(m²K)]	:	0.115
Installation date	:	2016
Condition	:	Good
Next replacement	:	2075
Other	:	

3.3.1.2 New Envelope component (insulation existing walls)

Description	:	external EPS insulation
U-Value [W/(m²K)]	:	0.18
Installation date	:	2016
Condition	:	Good
Next replacement	:	2075
Other	:	

3.3.1.3 New Envelope component (floor slab)

Description	:	concrete slab + XPS insulation
U-Value [W/(m²K)]	:	0.184
Installation date	:	2016
Condition	:	Good
Next replacement	:	2075
Other	:	

3.3.1.4 New Envelope component (windows)

Description	:	Aluminium clad timber frame triple glazed windows
U-Value [W/(m²K)]	:	0.95
Installation date	:	2016
Condition	:	Good
Next replacement	:	2045
Other	:	

EnerPHit verification

Building:	Hotel Restaurant Valcanover
Street:	
Postcode/City:	
Country:	Italy
Building type:	Masonry construction
Climate:	Pergine
Altitude of building site (in [m] above sea level):	459
Home owner/client:	
Street:	
Postcode/City:	

Architecture:		Mechanical System:	
Street:		Street:	
Postcode/City:		Postcode/City:	
Energy consulting:	ZEPHIR	Certification:	
Street:		Street:	
Postcode/City:	Pergine Valsugana	Postcode/City:	

Year of Construction:	1928	Interior temperature winter [C°]	20.0	Interior temp. summer [C°]	25.0
Number of dwelling units:	1	Internal heat gains winter [W/m²]	9.4	IHG summer [W/m²]	9.9
Number of Occupants:	37.0			Spec. capacity [Wh/K per m² TFA]	204
Exterior vol. V_e:	3281.5 m³			Mechanical cooling:	x

Specific building demands with reference to the treated floor area

				Requirements	Fulfilled?*
	Treated floor area	723.4	m²		
Space heating	Annual heating demand	**31**	**kWh/(m²a)**	25 kWh/(m²a)	**no**
	Heating load	**42**	**W/m²**	-	**-**
Space cooling	Overall specific space cooling demand	**12**	**kWh/(m²a)**	-	**-**
	Cooling load	**12**	**W/m²**	-	**-**
	Frequency of overheating (> 25 °C)		%	-	**-**
Primary Energy	Heating, cooling, dehumidifying, DHW,		**kWh/(m²a)**	139 kWh/(m²a)	
	DHW, space heating and auxiliary electricity		kWh/(m²a)	-	**-**
	Specific primary energy reduction through solar electricity		kWh/(m²a)	-	**-**
Airtightness	Pressurization test result n_{50}	**7.1**	**1/h**	1 1/h	**no**

* 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 PHPP methodology and were determined based on the characteristics of the building. The PHPP calculations are attached to this application.

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

Figure 13: Specific energy efficiency values step 2.

3.3.2 Retrofit step 3:

Retrofitting of the existing part of the ground level. This includes installation of new windows, realization of an airtightness layer, insulation of the existing floor slab and installation of a ventilation unit with heat recovery and replacement of the heat generator.

Start date	:	Winter 2017
Completion date	:	
Budget	:	-
PHPP: specific heating demand [kWh/(m²K)]	:	27.5
PHPP: specific cooling demand | Overheating frequency [kWh/(m²K) | %]	:	5.3
PHPP: specific primary energy demand [kWh/(m²K)]	:	-

3.3.2.1 New Envelope component (windows)

Description	:	Aluminium clad timber frame triple glazed windows
U-Value [W/(m²K)]	:	0.95
Installation date	:	2017
Condition	:	Good
Next replacement	:	2045
Other	:	

3.3.2.2 New Envelope component (floor slab)

Description	:	XPS insulation
U-Value [W/(m²K)]	:	0.212
Installation date	:	2017
Condition	:	Good
Next replacement	:	2075
Other	:	

3.3.3 New ventilation component (ventilation unit)

Description	:	Ventilation unit with heat recovery
HR Efficiency[%]	:	80%
El.Efficiency [Wh/m³]	:	0.37
Installation date	:	2017
Condition	:	Good
Next replacement	:	2040

Other	:	

3.3.3.1 New heating component

Description	:	Water-water heat Pump
Performance ratio of heat generation [%]	:	-
Installation date	:	2017
Condition	:	Good
Next replacement	:	2045
Other	:	

EnerPHit verification

Building:	Hotel Restaurant Valcanover
Street:	
Postcode/City:	
Country:	Italy
Building type:	Masonry construction
Climate:	Pergine
Altitude of building site (in [m] above sea level):	459
Home owner/client:	
Street:	
Postcode/City:	
Architecture:	
Street:	
Postcode/City:	
Mechanical System:	
Street:	
Postcode/City:	
Energy consulting:	ZEPHIR
Street:	
Postcode/City:	Pergine Valsugana
Certification:	
Street:	
Postcode/City:	

Year of Construction:	1928	Interior temperature winter [C°]	20.0	Interior temp. summer [C°]	25.0
Number of dwelling units:	1	Internal heat gains winter [W/m²]	9.4	IHG summer [W/m²]	9.9
Number of Occupants:	37.0			Spec. capacity [Wh/K per m² TFA]	204
Exterior vol. V_e:	3281.5 m³			Mechanical cooling:	x

Specific building demands with reference to the treated floor area

		Value	Unit	Requirements	Fulfilled?*
	Treated floor area	723.4	m²		
Space heating	Annual heating demand	**27**	**kWh/(m²a)**	25 kWh/(m²a)	**no**
	Heating load	**34**	**W/m²**	-	**-**
Space cooling	Overall specific space cooling demand	**5**	**kWh/(m²a)**	-	**-**
	Cooling load	**13**	**W/m²**	-	**-**
	Frequency of overheating (> 25 °C)		%	-	**-**
Primary Energy	Heating, cooling, dehumidifying, DHW,		**kWh/(m²a)**	135 kWh/(m²a)	
	DHW, space heating and auxiliary electricity		kWh/(m²a)	-	**-**
	Specific primary energy reduction through solar electricity		kWh/(m²a)	-	**-**
Airtightness	Pressurization test result n_{50}	**3.9**	**1/h**	1 1/h	**no**

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

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 (acc. to heating demand)?

Name: | Company: | Registration number PHPP:

Surname: | Issued on:

Signature

Figure 14: Specific energy efficiency values after step 3.

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

3.3.4 Retrofit step 4:

Retrofitting of the existing part of the first level. This includes installation of new windows, realization of an airtightness layer, installation of a ventilation unit with heat recovery.

Start date	:	Winter 2018
Completion date	:	-
Budget	:	-
PHPP: specific heating demand [kWh/(m²K)]	:	17.8
PHPP: specific cooling demand | Overheating frequency [kWh/(m²K) | %]	:	3.5
PHPP: specific primary energy demand [kWh/(m²K)]	:	

3.3.4.1 New Envelope component (windows)

Description	:	Aluminium clad timber frame triple glazed windows
U-Value [W/(m²K)]	:	0.95
Installation date	:	2018
Condition	:	Good
Next replacement	:	2045
Other	:	

3.3.5 New ventilation component (ventilation unit)

Description	:	Ventilation unit with heat recovery
HR Efficiency[%]	:	80%
El.Efficiency [Wh/m³]	:	0.45
Installation date	:	2018
Condition	:	2040
Next replacement	:	
Other	:	

EnerPHit verification

Building:	Hotel Restaurant Valcanover
Street:	
Postcode/City:	
Country:	Italy
Building type:	Masonry construction
Climate:	Pergine
Altitude of building site (in [m] above sea level):	459
Home owner/client:	
Street:	
Postcode/City:	

Architecture:		Mechanical System:	
Street:		Street:	
Postcode/City:		Postcode/City:	
Energy consulting:	ZEPHIR	Certification:	
Street:		Street:	
Postcode/City:	Pergine Valsugana	Postcode/City:	

Year of Construction:	1928	Interior temperature winter [C°]	20.0	Interior temp. summer [C°]	25.0
Number of dwelling units:	1	Internal heat gains winter [W/m²]	9.4	IHG summer [W/m²]	9.9
Number of Occupants:	37.0			Spec. capacity [Wh/K per m² TFA]	204
Exterior vol. V_e:	3281.5 m³			Mechanical cooling:	x

Specific building demands with reference to the treated floor area

				Requirements	Fulfilled?*
	Treated floor area	723.4	m²		
Space heating	Annual heating demand	18	kWh/(m²a)	25 kWh/(m²a)	yes
	Heating load	22	W/m²	-	-
Space cooling	Overall specific space cooling demand	5	kWh/(m²a)	-	-
	Cooling load	13	W/m²	-	-
	Frequency of overheating (> 25 °C)		%	-	-
Primary Energy	Heating, cooling, dehumidifying, DHW,		kWh/(m²a)	123 kWh/(m²a)	
	DHW, space heating and auxiliary electricity		kWh/(m²a)	-	-
	Specific primary energy reduction through solar electricity		kWh/(m²a)	-	-
Airtightness	Pressurization test result n_{50}	1.0	1/h	1 1/h	yes

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

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 (acc. to heating demand)?

Name: Company: Registration number PHPP:

Surname: Issued on:

Signature

Figure 15: Specific energy efficiency values after measures within EuroPHit

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

3.4 Pictures / Drawings

Floor Plans after the end of the retrofit process.

Figure 16: Ground floor plan of the refurbished building.

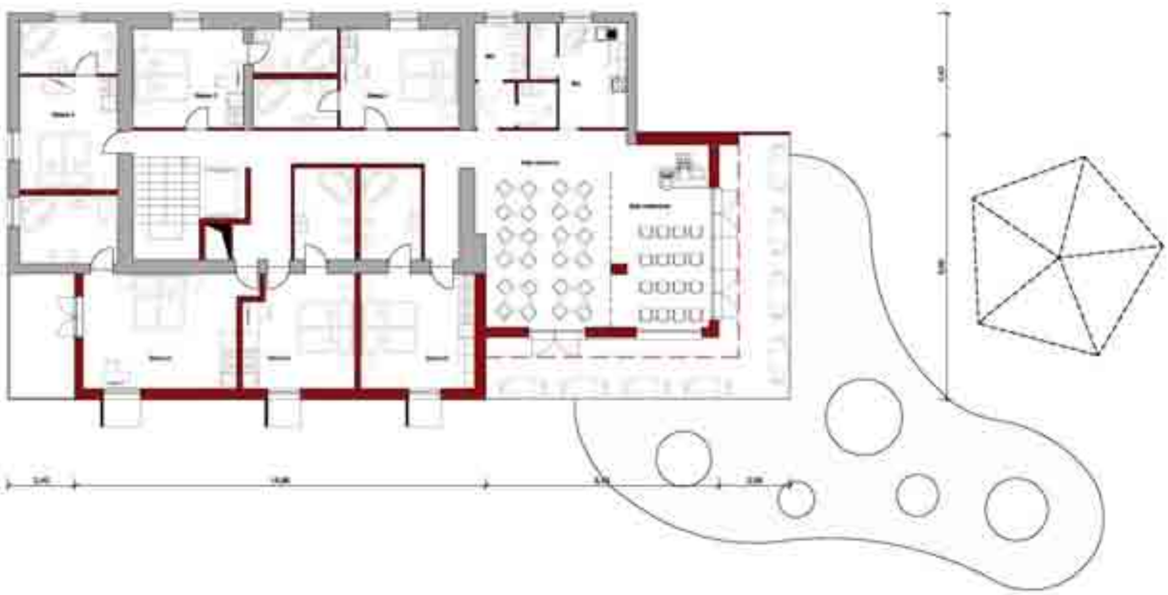


Figure 17: First floor plan of the refurbished building.

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

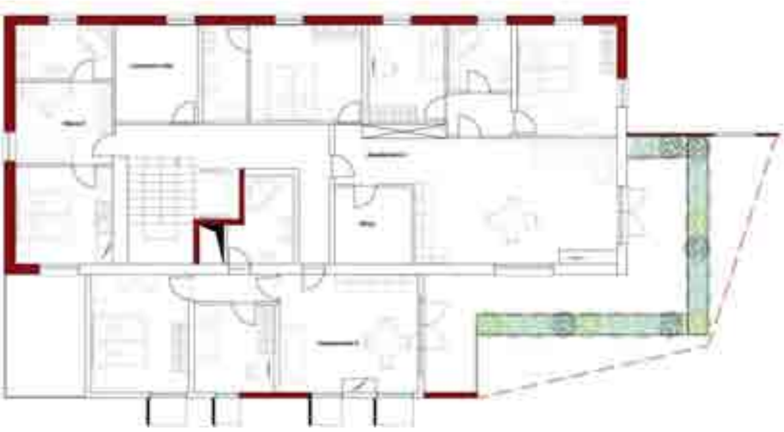


Figure 18: Second floor plan of the refurbished building.

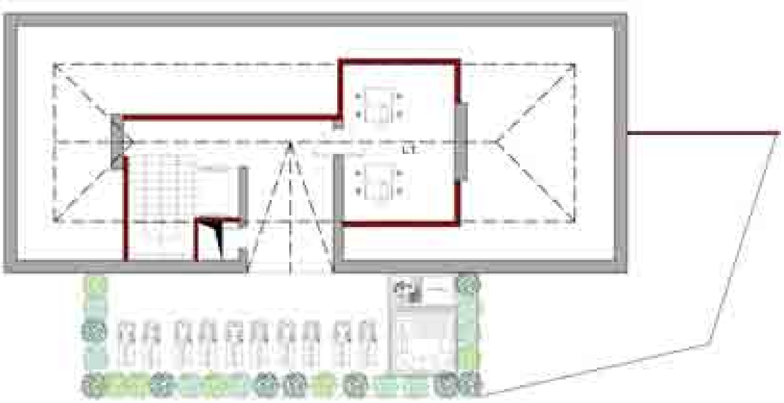


Figure 19: Attic floor plan of the refurbished building.

Elevetions after the end of the retrofit process.

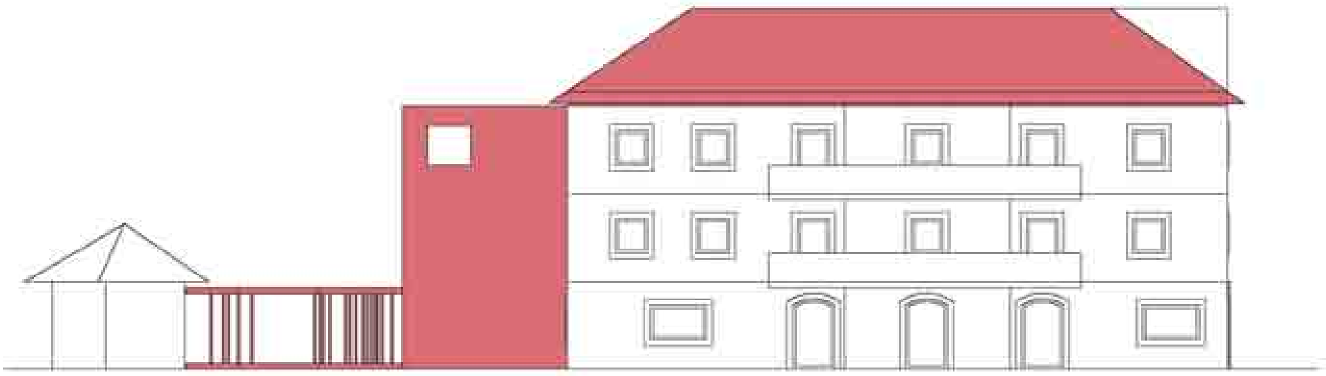


Figure 20: North-East elevation of the refurbished building.

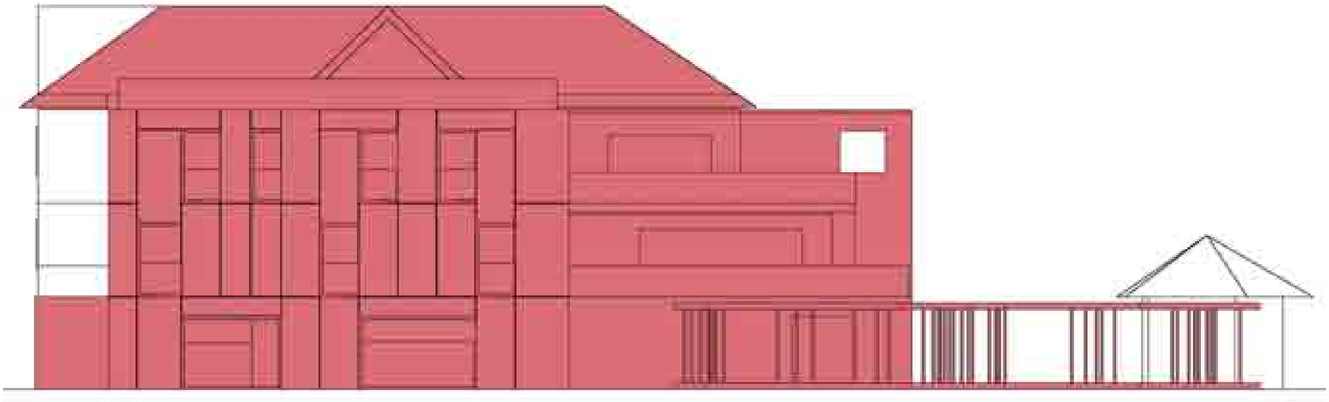


Figure 21: South-West elevation of the refurbished building.

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

4.1 General description

The proposed refurbishment plan reaches the EnerPHit standard at the last step when all the parts of the building will be renovated. The large improvement that can be achieved with this refurbishment plan is possible mainly due to the improvement of the envelope of the building as regards the thermal protection and the airtightness. The ventilation system gives the possibility to provide fresh air to the building without dissipating large amounts of energy.

4.2 Retrofit steps carried out

The following

EnerPHit planning: CALCULATION OF VARIANTS

select active variants >>		Active: 5-3rd Step (Airitgness/Windows Ground Floor - VentialtionRestaurant -Basment Insulation)	Exsisting	4th step (Final state)	1st Step (Roof-Extension/Airightness/Windows/Ve	2nd Step (Windows/Airtightness/Extension Ground	3rd Step (Airitgtness/Windows Ground Floor -
Results	**Units**	5	1	2	3	4	5
Annual heating demand	kwh/(m²a)	17.8	268.8	98.2	31.2	31.6	17.8
Heating Load	W/m²	22.4	128.0	64.9	42.2	35.4	22.4
Overall specific space cooling demand	kwh/(m²a)	5.1	3.5	6.8	12.0	5.3	5.1
Cooling load	W/m²	12.9	12.7	12.1	12.4	12.9	12.9
Frequency of overheating	%						
Total primary energy demand	kwh/(m²a)		867.9				
Certifiable as EnerPHit building retrofit (acc. to heating demand)?	yes / no		no				

Figure 22: PHPP9 beta Variant sheet with the planned retrofit steps.

4.2.1 Building data

Construction Time	:	2015-2020
Last retrofit	:	2020
Building use	:	residential, hotel, restaurant
General condition	:	
Occupancy	:	2 dwelling unit (2nd floor), restaurant with 60 seats (ground floor), hotel with 7 double rooms (1st floor).
Treated floor Area	:	723.4 m²
Other	:	

4.2.2 Client

Name / Company	:	Maria Biasi and Monica Valcanover
Address	:	Via di Mezzolago 1, I-38057 Pergine Valsugana (TN)
Email	:	albergo.valcanover@virgiglio.it

Other	:		

4.3 Description of Building components

4.3.1 Floor slab

Description	:	Existing floor slab	New floor slab
U-Value [W/(m²K)]	:	0.221	0.184
Installation date	:	2016 / 2017	
Condition	:	Good	
Next replacement	:	2075	
Other	:		

4.3.2 External walls

Description	:	Existing walls	New walls
U-Value [W/(m²K)]	:	0.193 - 0.171	0.115
Installation date	:	2015 / 2016	
Condition	:	Good	
Next replacement	:	2075	
Other	:		

4.3.3 Windows

Description	:	New windows
U-Value [W/(m²K)]	:	0.95
Installation date	:	2015 / 2016 / 2017 / 2018
Condition	:	Good
Next replacement	:	2045
Other	:	

4.3.4 Roof / Top floor ceiling

Description	:	New Ceiling Last Floor
U-Value [W/(m²K)]	:	0.110
Installation date	:	2015
Condition	:	Good
Next replacement	:	2075
Other	:	

4.4 Technical equipment of the refurbished building

4.4.1 Heating

Description	:	Water-water Heat Pump
Performance ratio of heat generation [%]	:	n.a.
Installation date	:	2017
Condition	:	Good
Next replacement	:	2045
Other	:	

4.4.2 Domestic hot water

Description	:	Water-water Heat Pump
Performance ratio of heat generation [%]	:	n.a.
Installation date	:	2017
Condition	:	Good
Next replacement	:	2045
Other	:	

4.4.3 Ventilation

Description	:	4 Ventilation units with heat recovery
HR Efficiency[%]	:	80 - 90 - 91 - 80
El.Efficiency [Wh/m³]		0.37 – 0.42 – 0.42 – 0.45
Installation date	:	2015 / 2017 / 2018
Condition	:	Good
Next replacement	:	2040
Other	:	

4.5 Energy efficiency of the refurbished building

The last step of the proposed retrofit process reaches the EnerPHit standard. The PHPP calculation performed provides the following results.

4.5.1 Modelled efficiency parameters

PHPP: specific heating demand [kWh/(m²K)] : 17.8

PHPP: specific cooling demand | : 5.1

PHPP: specific primary energy demand [kWh/(m²K)] : n.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:	Hotel Restaurant Valcanover
Street:	
Postcode/City:	
Country:	Italy
Building type:	Masonry construction
Climate:	Pergine
Altitude of building site (in [m] above sea level):	459
Home owner/client:	
Street:	
Postcode/City:	

Architecture:		Mechanical System:	
Street:		Street:	
Postcode/City:		Postcode/City:	
Energy consulting:	ZEPHIR	Certification:	
Street:		Street:	
Postcode/City:	Pergine Valsugana	Postcode/City:	

Year of Construction:	1928	Interior temperature winter [C°]	20.0	Interior temp. summer [C°]	25.0
Number of dwelling units:	1	Internal heat gains winter [W/m²]	9.4	IHG summer [W/m²]	9.9
Number of Occupants:	37.0			Spec. capacity [Wh/K per m² TFA]	204
Exterior vol. V_e:	3281.5 m³			Mechanical cooling:	x

Specific building demands with reference to the treated floor area

			Requirements	Fulfilled?*
	Treated floor area	723.4 m²		
Space heating	Annual heating demand	18 kWh/(m²a)	25 kWh/(m²a)	yes
	Heating load	22 W/m²	-	-
Space cooling	Overall specific space cooling demand	5 kWh/(m²a)	-	-
	Cooling load	13 W/m²	-	-
	Frequency of overheating (> 25 °C)	%	-	-
Primary Energy	Heating, cooling, dehumidifying, DHW,	kWh/(m²a)	123 kWh/(m²a)	
	DHW, space heating and auxiliary electricity	kWh/(m²a)	-	-
	Specific primary energy reduction through solar electricity	kWh/(m²a)	-	-
Airtightness	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)?

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.

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

Figure 23: Specific energy efficiency values of the completed project modelled with PHPP 9 Beta

4.6 Pictures / Drawings

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

Figure 24: Rendering of the west view of the refurbished building.

Figure 25: Rendering of the North-East view of the refurbished building.

Figure 26: Rendering of the South view of the refurbished building.

5 Refurbishment to the current National Standards

5.1 General Description

The Italian building regulation imposes to improve the thermal quality of the components of the thermal envelope setting a limiting U-value which changes depending on the climate zone of the location under consideration. Unluckily the U-values are not ambitious enough and are far from being those required for a Nearly Zero Energy Building - Passivhaus. In addition the Italian regulation does not impose any requirement as regards the ventilation concept and the airtightness, compromising the living comfort of buildings and in some cases also their structural integrity. The reduction of the heating demand and of the primary energy demand is not the priority of the Italian legislation and often energy efficiency is implemented only with the addition of renewables.

5.2 Efficiency results comparison table

	Existing building	National regulations	EnerPHit standard	Differences [%]
Space heat demand [kWh/(m^2/a)]	269	-	17.8	-
Primary energydemand [kWh/(m^2/a)]	-	-.	-	-
Heat Load [W/m^2]	128	-	22	

Figure 27: Comparison of efficiency results

5.3 Building envelope comparison table

	Existing building	National regulations	EnerPHit standard	Differences [%]
Airtightness Pressure test n50 [1/h]	10	-	1	-
Building envelope				**-**
Floor Slab [W/(m²K)]	2.8	0.32	0.22 / 0.18	36%
Walls to ground [W/(m²K)]	1.4	0.33	0.19 / 0.17 / 0.16	47%
Walls [W/(m²K)]	1.4	0.33	0.19 / 0.17 / 0.16	47%
Roof / Attic ceilings [W/(m²K)]	1.9	0.29	0.11	62%
Windows [W/(m²K)]	3.1	2	0.95	53%
Thermal bridging ΔU[W/(m²K)]	-	-	< 0.01 W/mK (if economically convenient)	

Figure 28: Comparison of building envelope components

5.4 Building equipment comparison table

	Existing building	National regulations	EnerPHit standard	Differences [%]
Ventilation	**Natural**	**Natural**	**Zehnder comfoair**	
HR Efficiency [%]	-	-	84	-
Electric efficiency [Wh/m³]	-	-	0,29	-
Ducting	-	-	cold ducts in warm region need to be insulated with at least 100 mm	-
Heating	**Boiler**	**Bolier**	**Heat pump**	
Energy source	Natural Gas	Natural Gas	Electricity	
Performance ratio of heat generation [%]	-		-	
Thermal output kW	-		-	
Insulation of pipes	-		-	
Domestic hot water	**Bolier**	**Bolier**	**Heat pump**	
Energy source	Natural Gas	Natural Gas	Electricity	
Performance ratio of heat generation [%]	-	-	-	
Thermal output kW	-	-	--	
Cooling	**Bolier**	**Bolier**	**Heat pump**	
Energy source	Natural Gas	Natural Gas	Electricity	
Performance ratio of cooling generation [%]	-	-	-	
Thermal output kW	-	-	-	

Figure 29: Comparison of building envelope components

5.5 RES implementation comparison table

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

Figure 30: Comparison of building envelope components

6 Monitoring

The monitoring concept which has been implemented for the project Hotel-Restaurant Valcanover had three main goals:

1. Monitor the internal climatic parameters in order to have information on the living comfort
2. Provide information on the energy consumption
3. Be as cost-effective as possible

In order to archive these goals we have chosen to develop low-cost sensors together with the company Tecnosi s.r.l. The developed sensors are based on an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software which is called Arduino.

Figure 31: The open-source Arduino platform.

Arduino has the possibility to sense the environment receiving input from sensors, affect its surrounding by controlling different kind of actuators and send real time data via internet.

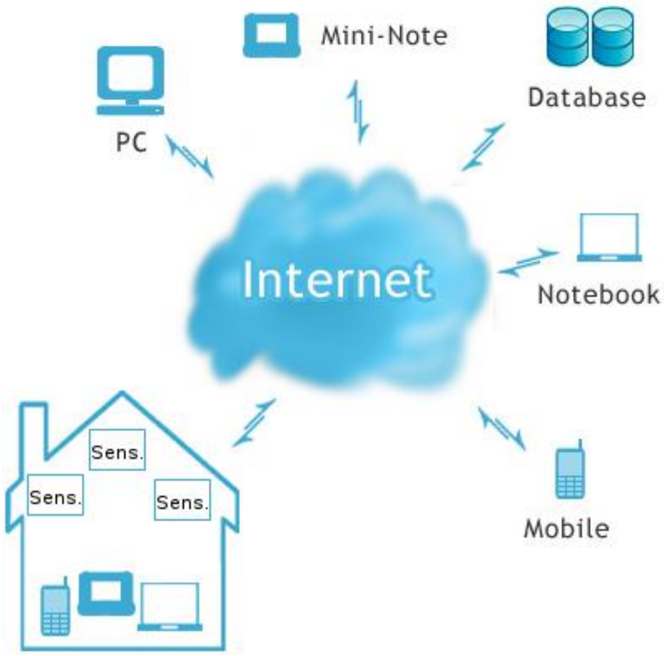


Figure 32: Arduino can receive input from sensors, controlling external actuators and send real time data via internet.

In our specific case the Arduino platform has been connected with two input sensors (temperature and relative humidity) and with the internet network through a Wi-Fi client. This gave us the possibility to monitor air temperature and relative humidity and send real time data to an online server. In principle this concept can also be extended adding more sensors such as CO_2 detectors, VOC detectors and so on.

For this monitoring project the following two sensors were used:

1. Temperature: Dallas DS18B20 with an operating temperature range from -55°C to 125°C. See Figure 33 for the sensor typical error curve.

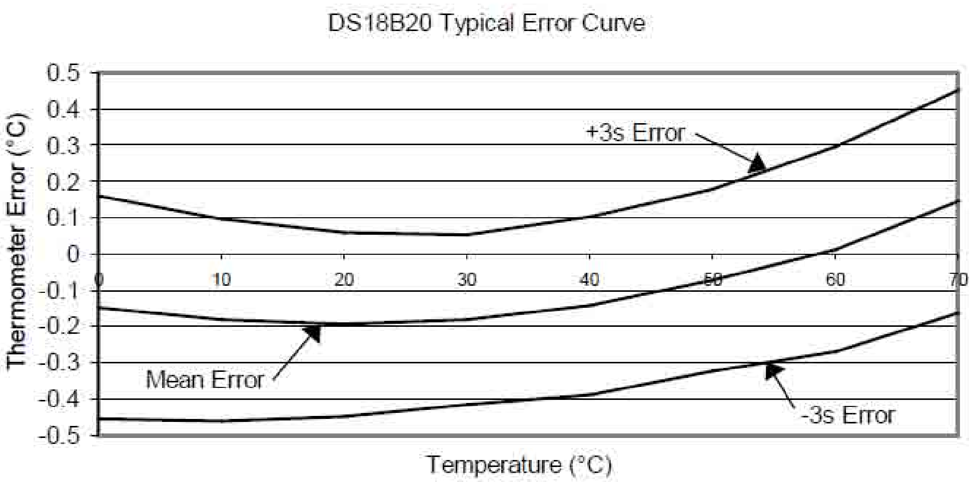


Figure 33: Typical error curve DS18B20 temperature sensor

2. Relative humidity: Honeywell HIH-4000 humidity sensor with an accuracy of ±2.5% RH. Every sensor comes with individual calibration data used to calculate the output with the best accuracy.

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Three detectors have been placed in the building in strategic areas each measuring temperature and relative humidity. In particular one sensor has been placed outside the building in order to get precise information on the microclimatic conditions in the area surrounding the building site. The two other sensors have been placed inside the building: one in the dining room of the restaurant, which is the area with the highest internal heat loads and one in the dressing room at the first floor, which provides information on the surface temperature in one of the most unfavourable rooms. Every sensor was connected through a Wi-Fi client to a Wi-Fi network to send collected data to an Internet server.

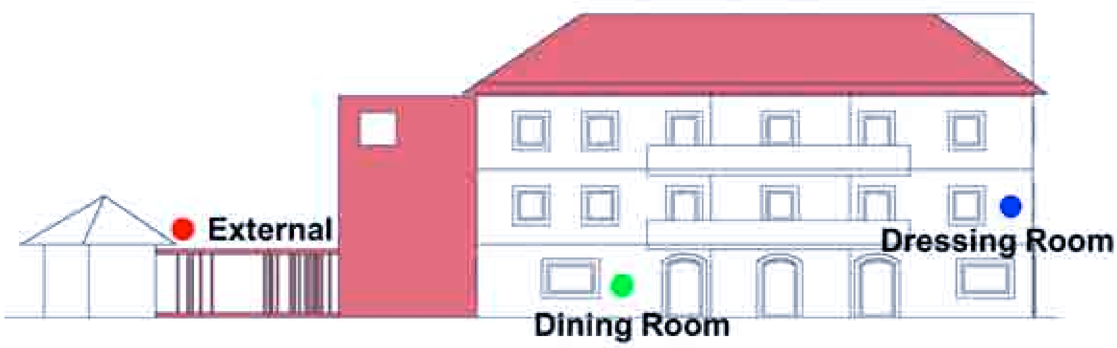

Figure 34: Sketch of the location of the three detectors. One outside the building and two inside.

In the graph below we show a sample plot of the results that we obtain from the three detectors.

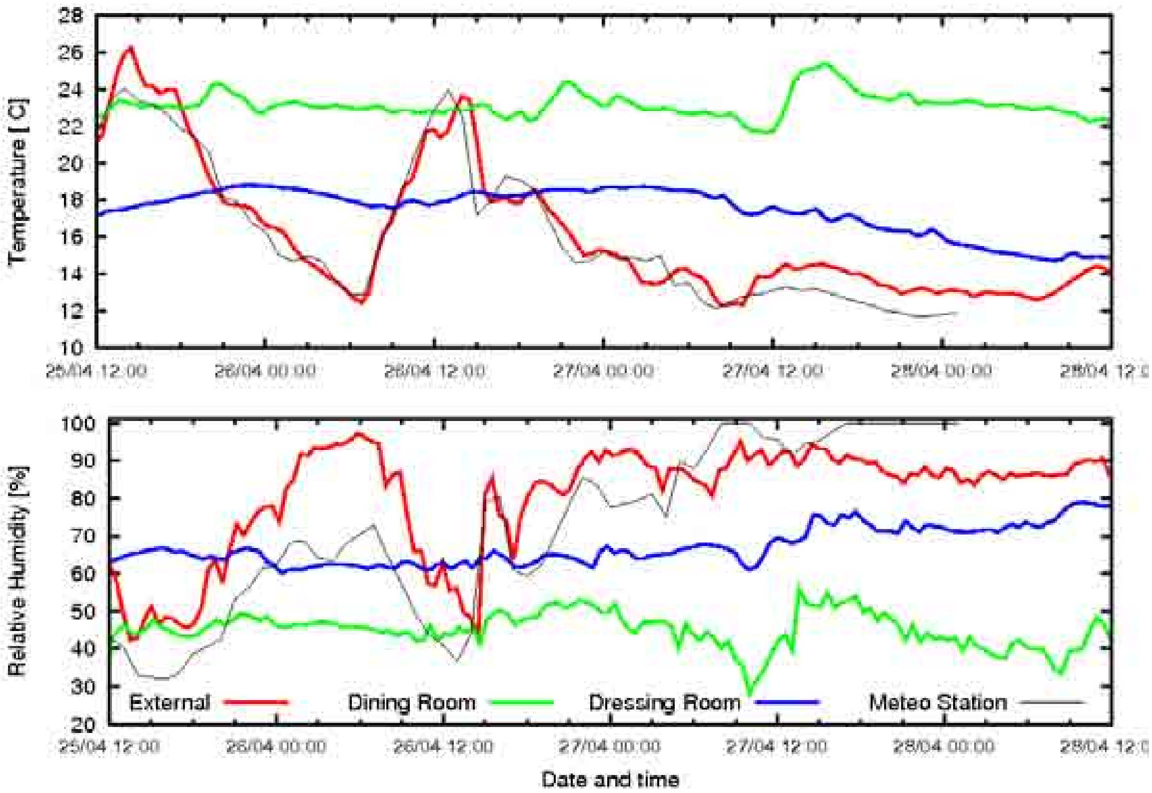

Figure 35: Sample plot of the results extracted from the three sensors (blue line: dressing room, green line: dining room, red line: external). Top panel: air temperature. Bottom panel: relative humidity.

In general we have extracted the following information from the monitoring activity:

- The time constant of the building is extremely low and therefore the climatic parameters quickly respond to the external climatic condition. As a result even short periods with low temperatures result in high energy consumptions for space heating.
- The surface temperature can become extremely low even on opaque components. This results in absence of comfort and eventually it could lead also to mould formation or even condensation.
- The relative humidity in the dining room is too high. To guarantee living comfort it should be in the range 30 - 50%, while from the measured data we have relative humidifies outside this range. This demonstrates that a ventilation concept based on natural ventilation is not enough. It is therefore important to install in the refurbished building a mechanical ventilation system with heat recovery.
- The presence of high internal heat loads in summer in the restaurant area leads to overheating. This suggests the use of a cooling system and of an adequate summer ventilation strategy.

In addition to the measurement of the internal climatic parameters we have also monitored the energy consumptions using gas and electricity meters readings. From these parameters we have extracted the natural gas and the electricity consumptions of the existing buildings.

We have done this analysis for the years 2013 and 2014. In the graph below we show the monthly energy consumptions of the existing building for the natural gas. This includes heating, cooking and domestic hot water.

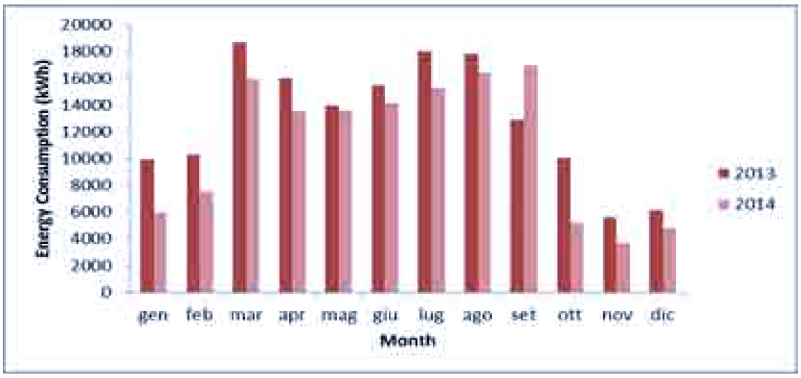

Figure 36: Monthly natural gas consumptions of the existing building for 2013 (red) and 2014 (light red)

The total yearly natural gas consumptions are summarized in the following table:

Year	Natural Gas Consumption kWh/a
2013	154977.7
2014	133181.5

Here we show the monthly electricity consumptions of the existing building.

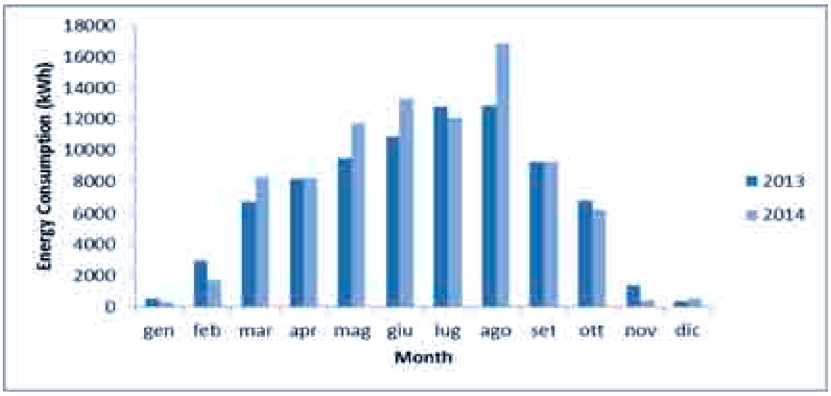

Figure 37: Monthly electricity consumptions of the existing building for 2013 (blue) and 2014 (light blue).

The total yearly electricity consumptions are summarized in the following table:

Year	Electricity Consumption kWh/a
2013	82175
2014	88920

In general the energy consumptions are lower during the winter because the hotel-restaurant is closed. The restaurant is typically open between March and September.

We can conclude that as regards both energy consumptions and living comfort there is a huge improvement potential. It makes therefore sense to apply the Passivhaus principles aiming to the EnerPHit standard.

7 Conclusions

The first step of the overall refurbishment plan has not been implemented within the project period since the owner decided to postpone/cancel the refurbishment works.

We have got this information from the design team in summer 2015 after a negative evaluation of a first project proposal presented to the municipality in mid-June. This project proposal have been the result of a long and intense effort of the design team that have been trying to fulfil a large number of requirements imposed by the building owner and has been working on several variants before coming to a final proposal.

The presented project has been rejected because exceeding the maximum volumetric extension allowed by the local building regulation. The design team was aware of this issue but have decided to present the project to the municipality anyway mainly for two reasons:

1. The extension that caused the rejection of the project was strongly requested by the owner. Without this extension the owner would have not undertaken the refurbishment anyway.
2. They intended to use a volumetric bonus for energy efficient building that is given on a project specific basis and whose applicability is evaluated from time to time

Unluckily in this case the volumetric bonus has not been given and the project has been rejected.

Anyway this project and its design phase have been useful and interesting in order to investigate possible approaches to a step-by-step retrofit process. In addition during the preparation of the overall refurbishment plan we have been testing and learning how to use the new design tool, PHPP9, and its variant calculation.