D3.9_Overall Refurbishment Plan

DRAFT

CS02

School, RosMuc

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

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Abstract

This overall refurbishment plan provides an overview of the retrofit steps of a step-by-step refurbishment to EnerPHit standard to be undertaken for the project School in RosMuc.

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 through a sequence of refurbishment steps between 2014 and 2018. The proposed development, in essence, comprises a step-by-step expansion, retrofit and enclosure of open space that includes by default the elimination of many existing external walls by their becoming internal.

Figure 1: Areal view [MosArt, 2013]

1 General Project description

1.1 Motivation

There are currently Grants available to refurbish public building in Ireland, in particular schools. The Client is taking this opportunity to go one step more and achieve the EnerPHit Standard for this School.

1.2 Existing Building

The existing building complex comprises three detached single-storey buildings formed around a central play yard. The largest, Main Building to the west, was constructed of solid block in 1945, an extension to the north and contiguous Metalwork Block was constructed of block cavity in 1960 and Classroom/Office to the east was also constructed of block cavity but in 1990. The floors are of poured concrete and roofs of pitched timber trusses. Ventilation is natural, using opening window sections. An oil-fired central heating system with radiators provides heating.

1.3 Refurbishment steps

1.3.1 Retrofit steps within EuroPHit

The initial works comprise an extension to Passive House Standard of four classrooms followed by circulation lobbies connecting the classrooms to the existing structures. EnerPHit works include a part refurbished roof to Main Building and a complete refurbished roof to Metalworks Block. Between 2015-2016 Main Building, Metalworks Block and Classroom/Office will each be refurbished in respect of walls (external insulation), windows and roofs. The oil-fired central heating system will be replaced with a high efficiency condensing gas boiler with new radiators throughout the buildings.

1.3.2 Further retrofit steps

It is expected that by or before 2018 the Central Space, currently the play yard will be roofed over and have an insulated floor installed. Airtightness will be achieved primarily during the process of fitting of new doors and replacement of windows with those of higher performance. As a direct consequence of these works, a mechanical ventilation heat recovery (MVHR) system will be installed throughout the school.

1.4 EnerPHit standard

The final retrofit step to EnerPHit standard will be the enclosure of the current play yard that is to be built to Passive House standards. At this point the School will be formed by one single airtight block mechanically ventilated with high efficiency MVHR (s).

1.5 Drawings

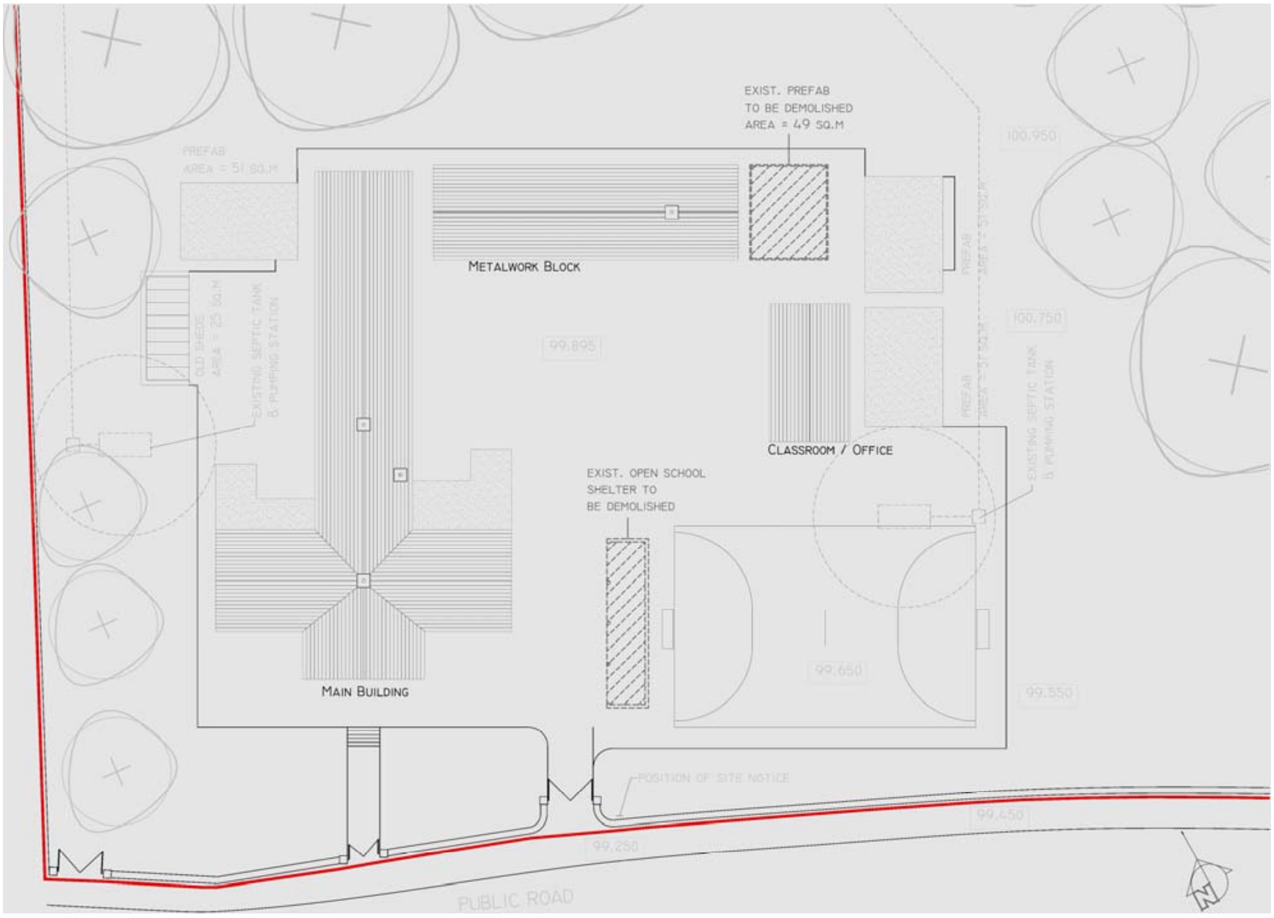

Figure 2: Existing site plan – not to scale [MosArt, 2013]

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Figure 3: Existing elevations – not to scale [MosArt, 2013]

2 Existing building

2.1 General description

The site is currently made up of three permanent buildings ranging in age from 100 years, to 60 years to 50 years. The buildings are unconnected, so rendering the thermal envelope inefficient through an extremely poor compactness ratio (huge surface area – bearing in mind these three blocks being exposed to the elements of the Atlantic Ocean). Approval has already been obtained for roof works for the engineering building and the boys toilet block, as well as for four additional general classrooms. It is expected to get approval for a Disability Access toilet facility. We have applied for the external insulation of these three existing buildings under the summer works scheme (Irish Government Grants). Current investigations are being conducted as to whether we could convert to Gas for the heating system. As an integral aspect of the deep retrofit strategy to dramatically reduce energy requirements in space heating demand, we intend to create a more compact building form by eliminating the space between these three isolated building. Accordingly, this space will be incorporated into the thermal envelope, so eliminating also certain energy inefficient external walls and this will be achieved by roofing the space and insulating the yard (as it currently is). An initial step towards this is the positioning of four new classrooms (for which planning permission is underway) so as to facilitate this. It is also hoped either this year or in the near future to replace all windows and external doors with those of higher performance as well as the remaining roofs.

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2.1.1 Building data

Construction Time : 1945, 1960

Last retrofit : 1990

Building use : School

General condition : Good

Occupancy : 3 Blocks – 6 classrooms

Treated floor Area : 579.5sqm

Other:

2.1.2 Client

Name / Company : Vocational Educational Committee (VEC)

Address : Department of Education and Skills, Marlborough Street, Dublin 1, Ireland

Email : info@etbi.ie

2.2 Envelope of existing building

2.2.1 Floor slab

Description : poured concrete construction

U-Value [W/(m²K)] : 3.85

Installation date : 1945, 1960

Condition : Good

Next replacement : 2015

Other :

2.2.2 External walls

Description : solid block, cavity wall

U-Value [W/(m²K)] : 2.2, 0.44

Installation date : 1945, 1960

Condition : Good

Next replacement : 2015

Other :

2.2.3 Windows

Description : double glazed, PVC frame

U-Value [W/(m²K)] : 2

Installation date : 1990

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Condition : Good
Next replacement : 2015
Other:

2.2.4 Roof / Top floor ceiling

Description : timber frame, insulated on the flat
U-Value [W/(m²K)] : 0.7
Installation date : 1945, 1960
Condition : Medium
Next replacement : 2015
Other :

2.3 Technical equipment of the existing building

2.3.1 Heating

Description : Oil Boiler
Performance ratio of
heat generation [%] :
Installation date : 1960
Condition : Medium
Next replacement : 2015
Other :

2.3.2 Domestic hot water

Description : Oil Boiler
Performance ratio of heat generation [%] :
Installation date : 1960
Condition : Medium
Next replacement : 2015
Other :

2.3.3 Ventilation

Description : Natural ventilation
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 buildings were calculated with the use of the PHPP (Passive House Planning Package) and the results prove that the energy performance of the buildings is very poor due mainly to the lack of insulation in the thermal envelope. The following results are average calculation between the three blocks

2.4.1 Modelled efficiency parameters

PHPP: specific heating demand [kWh/(m²K)]	:	316
PHPP: specific cooling demand | Overheating frequency [kWh/(m²K) | %]	:	
PHPP: specific primary energy demand [kWh/(m²K)]	:	418

2.4.2 Available consumption parameters

Annual Gas/Oil consumption | bills [kWh/a | €]	:	Not available at the moment
Annual Electricity consumption | bills [kWh/a | €]	:	Not available at the moment
Other	:	

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

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EuroPHit

EnerPHit verification

Building:	Gairmscoil Na Bpiaisach-Main Building
Street:	Rosmuc, Galway
Postcode/City:	Galway
Country:	Ireland
Building type:	School
Climate:	[IE] - Birr
Altitude of building site (in [m] above sea level):	-
Home owner/client:	VEC
Street:	
Postcode/City:	

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

ar of Construction:	1945	Interior temperature winter [C°]	19.0	Interior temp. summer [C°]	25.0
r of dwelling units:	1	Internal heat gains winter [W/m²]	2.8	IHG summer [W/m²]	2.8
ber of Occupants:	11.0			Spec. capacity [Wh/K per m² TFA]	132
Exterior vol. V_e:	1709.3 m³			Mechanical cooling:	

Specific building demands with reference to the treated floor area

				Requirements	Fulfilled?*
	Treated floor area	383.7	m²		
Space heating	Annual heating demand	**316**	**kWh/(m²a)**	25 kWh/(m²a)	**no**
	Heating load	**102**	**W/m²**	-	**-**
Space cooling	Overall specific space cooling demand		**kWh/(m²a)**	-	**-**
	Cooling load		**W/m²**	-	**-**
	Frequency of overheating (> 25 °C)	0.0	%	-	-
Primary Energy	Heating, cooling, dehumidifying, DHW,	**418**	**kWh/(m²a)**	481 kWh/(m²a)	**yes**
	DHW, space heating and auxiliary electricity	399	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

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

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MosArt

2.5 Pictures / Drawings

These pictures illustrate the existing building.

Figure 6: Main Building view from the South

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Figure 7: Metalwork Block view from the yard

Figure 8: View of the Classroom/Office West facade

Figure 9: View of the Main Building East facade

3 Retrofit steps

3.1 Overall refurbishment Plan

3.1.1 Retrofit steps:

The upgrading works will be initiated in 2014 and it is likely that they will be completed before 2018, depending on funding made available from the Department of Education and Skills as well as other national sources. The timeframe for the step-by-step works is provided below, allowing for some degree of flexibility in respect of monies being made available.

Step No.	Year	Measures	Specific Heating Demand	Specific Primary Energy Demand
-	1945 - 1960	Existing Buildings	316	418
1	2015	New Roof to Main Building & Metalwork Block, 4 new Classrooms	*150*	*280*
2	2016	External walls refurbished to all existing buildings and new roof to Classroom/Office. New Classrooms Built.	*115*	*250*
3	2016	Replacement of windows & doors	*93*	*220*
4	2016	Airtightness to 1 air changes per hour @ 50 Pa & MHRV installed	51	115
5	2016	Condensing Gas Boiler & new radiators installed	51	98
6	2018	Enclosure of central space to Passive House standard	18	55

Figure 10: Overview refurbishment steps (the results in italic are estimated – to be confirmed)

3.1.2 Efficiency Improvements

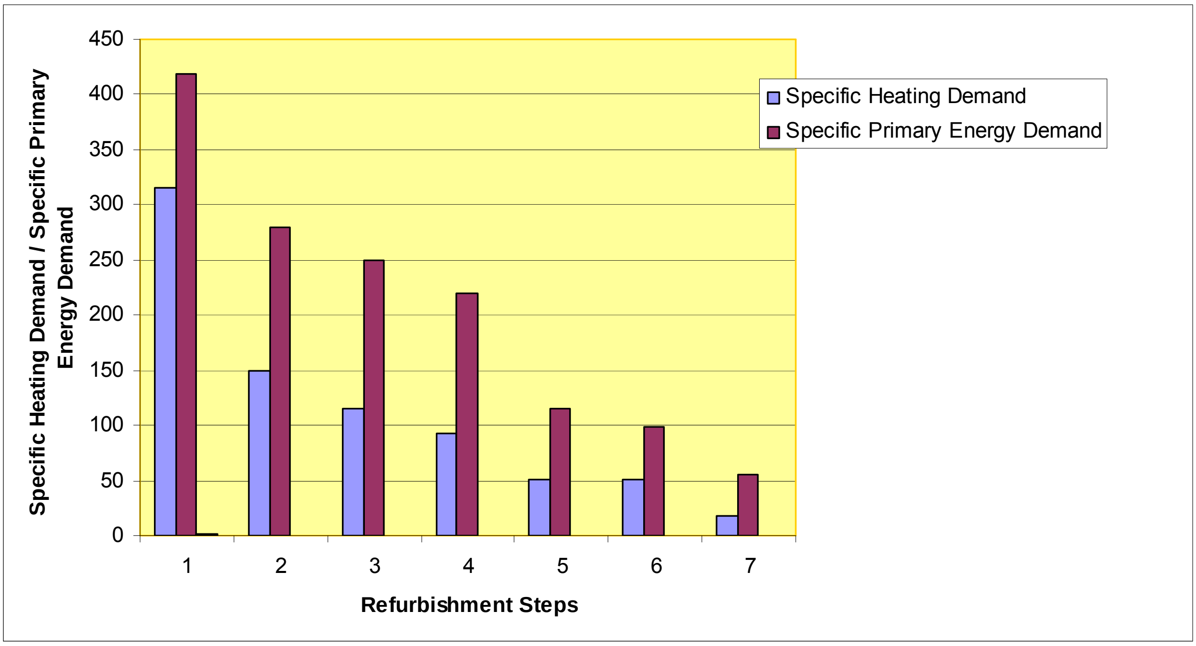

Figure 11: Overview energy efficiency improvement according to the overall refurbishment plan

3.2 Retrofit steps within EuroPHit

3.2.1 Retrofit step 1:

New Roof to Main Building & Metalwork Block, 4 new Classrooms.

Start date	:	Summer 2015
Completion date	:	Summer 2015
Budget	:	
PHPP: specific heating demand [kWh/(m²K)]	:	150
PHPP: specific cooling demand | Overheating frequency [kWh/(m²K) | %]	:	
PHPP: specific primary energy demand [kWh/(m²K)]	:	280

3.2.1.1 New Envelope component

Description	:	300 mm of mineral wool insulation on ceiling joists
U-Value [W/(m²K)]	:	0.1
Installation date	:	Summer 2015
Condition	:	
Next replacement	:	
Other	:	

3.2.2 Retrofit step 2:

External walls refurbished to all existing buildings and new roof to Classroom/Office. New Classroom built to Passive House standard.

Start date	:	Summer 2016
Completion date	:	Summer 2016
Budget	:	
PHPP: specific heating demand [kWh/(m²K)]	:	115
PHPP: specific cooling demand | Overheating frequency [kWh/(m²K) | %]	:	
PHPP: specific primary energy demand [kWh/(m²K)]	:	250

3.2.2.1 New Envelope component

Description	:	200 mm of EPS insulation on external walls

U-Value [W/(m²K)]	:	0.1
Installation date	:	Summer 2016
Condition	:	
Next replacement	:	
Other	:	

3.2.3 Retrofit step 3:

Replacement of all windows and doors.

Start date	:	Autumn 2016
Completion date	:	Winter 2016
Budget	:	
PHPP: specific heating demand [kWh/(m²K)]	:	93
PHPP: specific cooling demand | Overheating frequency [kWh/(m²K) | %]	:	
PHPP: specific primary energy demand [kWh/(m²K)]	:	220

3.2.3.1 New envelope component

Description	:	Replacement of windows and doors
U-Value [W/(m²K)]	:	0.1
Installation date	:	Autumn 2016
Condition	:	
Next replacement	:	
Other	:	

3.2.4 Retrofit step 4:

Improvement of the air tightness to 1 air changes @ 50 Pa and MHRV installation.

Start date	:	Autumn 2016
Completion date	:	Winter 2016
Budget	:	
PHPP: specific heating demand [kWh/(m²K)]	:	51
PHPP: specific cooling demand | Overheating frequency [kWh/(m²K) | %]	:	
PHPP: specific primary energy demand [kWh/(m²K)]	:	115

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3.2.5 New ventilation component

Description	:	MHRV units installed in each school building (model not yet confirmed)
HR Efficiency[%]	:	85
El.Efficiency [Wh/m³]	:	0.42
Installation date	:	Autumn 2016
Condition	:	
Next replacement	:	
Other	:	

3.2.6 Retrofit step 5:

Condensing gas boiler installation to heat up new radiators installed throughout the school buildings.

Start date	:	Winter 2016
Completion date	:	Winter 2016
Budget	:	
PHPP: specific heating demand [kWh/(m²K)]	:	51
PHPP: specific cooling demand | Overheating frequency [kWh/(m²K) | %]	:	
PHPP: specific primary energy demand [kWh/(m²K)]	:	98

3.2.6.1 New heating component

Description	:	Condensing gas boiler and new radiators throughout
Performance ratio of heat generation [%]	:	90
Installation date	:	Winter 2016
Condition	:	
Next replacement	:	
Other	:	

EnerPHit verification

Building:	Gairmscoil Na Bpiaisach-Main Building
Street:	Rosmuc, Galway
Postcode/City:	Galway
Country:	Ireland
Building type:	School
Climate:	[IE] - Birr
Altitude of building site (in [m] above sea level):	-
Home owner/client:	VEC
Street:	
Postcode/City:	

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

ar of Construction:	1945	Interior temperature winter [C°]	19.0	Interior temp. summer [C°]	25.0
r of dwelling units:	1	Internal heat gains winter [W/m²]	2.8	IHG summer [W/m²]	2.8
ber of Occupants:	11.0			Spec. capacity [Wh/K per m² TFA]	132
Exterior vol. V_e:	1709.3 m³			Mechanical cooling:	

Specific building demands with reference to the treated floor area

			Requirements	Fulfilled?*
	Treated floor area	383.7 m²		
Space heating	Annual heating demand	76 kWh/(m²a)	25 kWh/(m²a)	no
	Heating load	25 W/m²	-	-
Space cooling	Overall specific space cooling demand	kWh/(m²a)	-	-
	Cooling load	W/m²	-	-
	Frequency of overheating (> 25 °C)	0.0 %	-	-
Primary Energy	Heating, cooling, dehumidifying, DHW,	129 kWh/(m²a)	193 kWh/(m²a)	yes
	DHW, space heating and auxiliary electricity	110 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

Figure 12: Specific energy efficiency values after measures within EuroPHit

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3.3 Future retrofit Steps

3.3.1 Retrofit step 6:

Enclosure of central space to Passive House standard, improving the air to volume ratio of the overall school complex.

Start date	:	2018
Completion date	:	2018
Budget	:	
PHPP: specific heating demand [kWh/(m²K)]	:	18
PHPP: specific cooling demand | Overheating frequency [kWh/(m²K) | %]	:	
PHPP: specific primary energy demand [kWh/(m²K)]	:	55

3.4 Pictures / Drawings

These pictures or drawings illustrate the retrofit process.

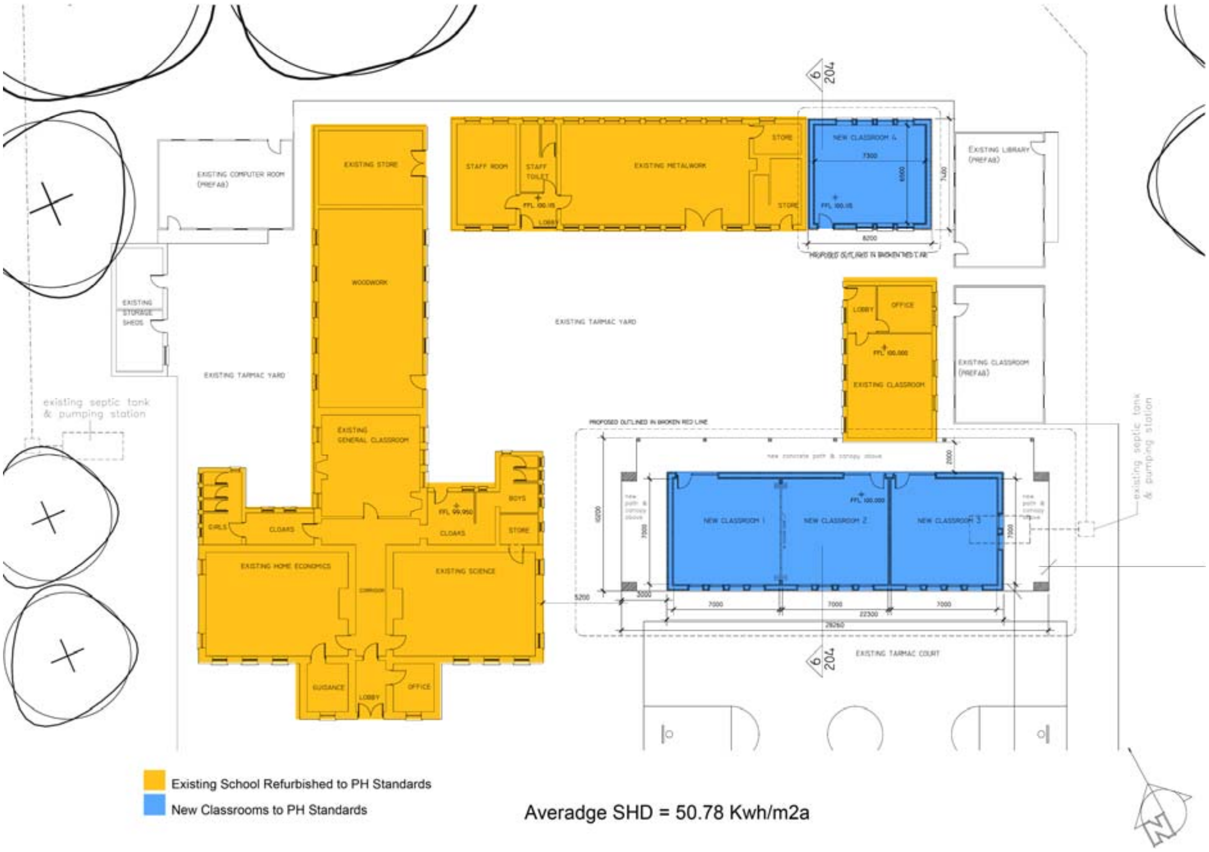

Figure 13: Floor plan illustrating the existing buildings in orange and the extensions in blue- not to scale [MosArt, 2014]

Figure 14: Floor plan illustrating new central atrium enclosing all buildings into one block - not to scale [MosArt, 2014]

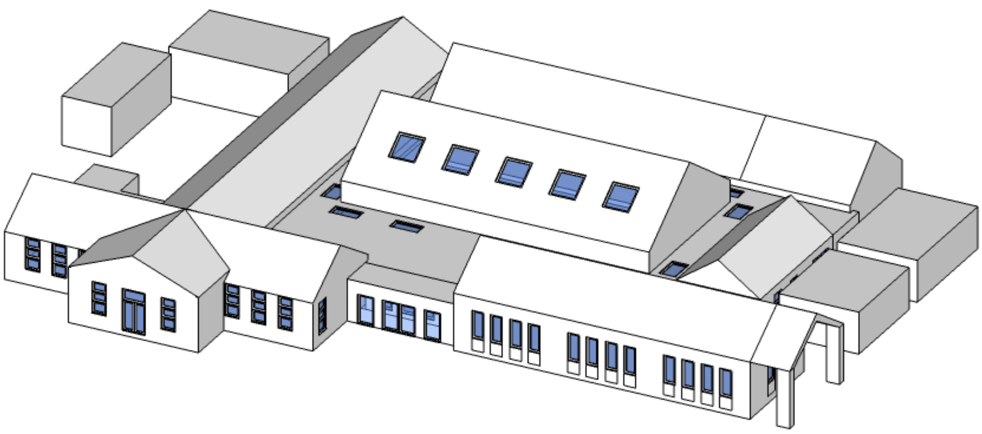

Figure 15: 3D view – sketchup PHPP tool [MosArt, 2014]

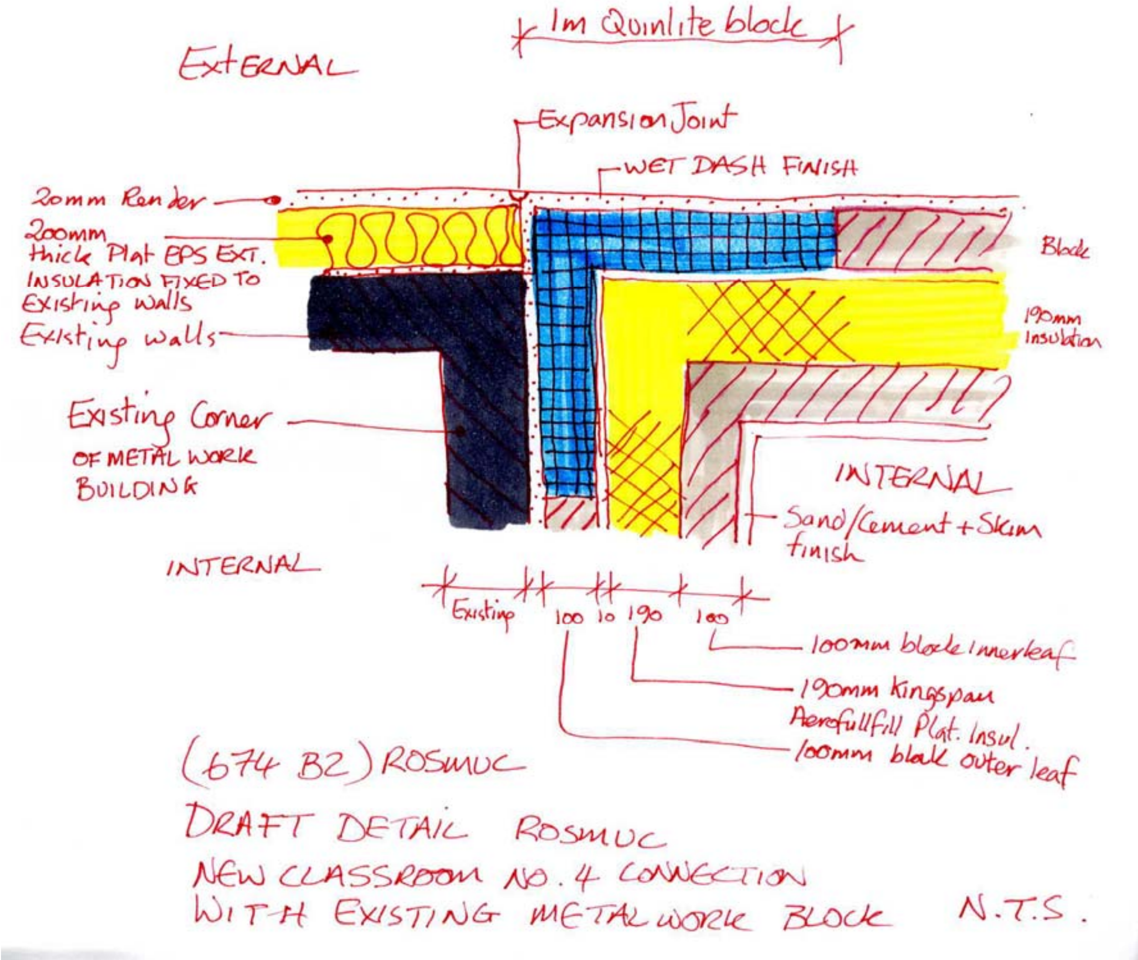

Figure 16: Detail of new classroom extension wall connection to existing wall in plan - not to scale [MosArt, 2014]

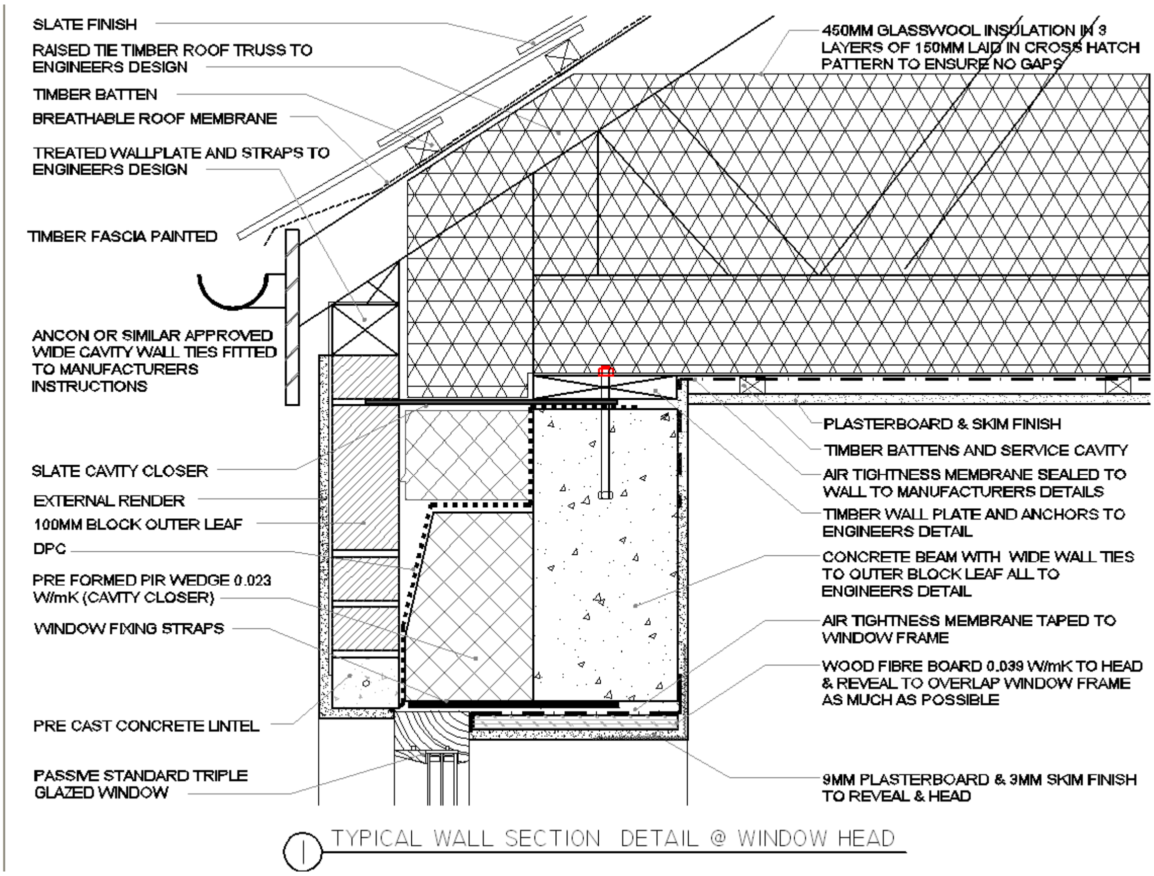

Figure 17: Typical eave to wall section detail at window head - not to scale [Paul Dillon Architects, 2014]

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

4.1 General description

The proposed refurbishment plan is achieving the EnerPHit standard. The great improvement of this project's energy performance is due to all different steps outlined above but also due to careful analysis and development of thermal bridge free and airtight details throughout the building envelop.

4.2 Retrofit steps carried out

The following figures present the chosen efficiency improvement steps expected to be carried out after completion of the overall refurbishment plan within the EuroPHit project (April 2016):

Passive House planning: CALCULATION OF VARIANTS

Results	Units	Active: 1-Existing (select active variants >>)	Existing Classroom/Office Block	Proposed Classroom/Office Block			
		1	1	2	3	4	5
Annual heating demand	kwh/(m²a)	253.4	253.4	56.3			
Heating Load	W/m²	83.5	83.5	19.6	2.7		
Overall specific space cooling demand	kwh/(m²a)						
Cooling load	W/m²						
Frequency of overheating	%	0.0	0.0	0.0			
Total primary energy demand	kwh/(m²a)	468.1	468.1	244.2			
Certifiable as Passive House?	yes / no	no	no	no			
<< User defined	Units	Link	Link	Link	Link		
Input variables	Units	Value	1	2	3	4	5

Figure 18: PHPP9 beta [PHI 2013] Variant sheet with the retrofit steps carried out for the Classroom/Office block.

EnerPHit planning: CALCULATION OF VARIANTS

Results	Units	Active: 2-Proposed (select active variants >>)	Existing Main Building	Proposed Main Building		
		2	1	2	3	4
Annual heating demand	kwh/(m²a)	76.2	316.2	76.2		
Heating Load	W/m²	24.7	101.6	24.7		
Overall specific space cooling demand	kwh/(m²a)					
Cooling load	W/m²					
Frequency of overheating	%	0.0	0.0	0.0		
Total primary energy demand	kwh/(m²a)	129.2	400.4	129.2		
Certifiable as EnerPHit building retrofit (acc. to heating demand)?	yes / no	no	no	no		
<< User defined	Units	Link	Link	Link	Link	
Input variables	Units	Value	1	2	3	4

Figure 19: PHPP9 beta [PHI 2013] Variant sheet with the retrofit steps carried out for the Main Building.

4.2.1 Building data

Construction Time	:	Winter 2018
Last retrofit	:	1990
Building use	:	School
General condition	:	Good
Occupancy	:	4 blocks united with a central space - 9 classrooms
Treated floor Area	:	1184.7
Other	:	

4.2.2 Client

Name / Company	:	Vocational Educational Committee (VEC)
Address	:	Department of Education and Skills, Marlborough Street, Dublin 1, Ireland
Email	:	info@etbi.ie
Other	:	

4.3 Description of Building components

4.3.1 Floor slab

Description	:	Existing floor slab	New floor slab
U-Value [W/(m²K)]	:	3.85	0.1
Installation date	:		2016 / 2018
Condition	:	Good	
Next replacement	:		
Other	:		

4.3.2 External walls

Description	:	External insulated with 200 mm EPS
U-Value [W/(m²K)]	:	0.1
Installation date	:	Winter 2016
Condition	:	Good
Next replacement	:	
Other	:	

4.3.3 Windows

Description	:	Passive House certified windows
U-Value [W/(m²K)]	:	0.8
Installation date	:	Winter 2016
Condition	:	
Next replacement	:	
Other	:	

4.3.4 Roof / Top floor ceiling

Description	:	300 mm mineral wool
U-Value [W/(m²K)]	:	0.1
Installation date	:	2015 / 2016
Condition	:	Good
Next replacement	:	
Other	:	

4.4 Technical equipment of the refurbished building

4.4.1 Heating

Description	:	Condensing gas boiler connected to new radiators throughout
Performance ratio of heat generation [%]	:	90
Installation date	:	Winter 2016
Condition	:	
Next replacement	:	
Other	:	

4.4.2 Domestic hot water

Description	:	Condensing gas boiler connected to a DHW tank
Performance ratio of heat generation [%]	:	90
Installation date	:	Winter 2016
Condition	:	
Next replacement	:	

Other :

4.4.3 Ventilation

Description	:	MHRV units installed in each school building (model not yet confirmed)
HR Efficiency[%]	:	85
El.Efficiency [Wh/m³]		
Installation date	:	0.42
Condition	:	
Next replacement	:	
Other	:	

4.5 Energy efficiency of the refurbished building

The refurbishment of this building is aiming to achieve the EnerPHit standard. The PHPP model carried out with the data submitted so far by the client is the following.

4.5.1 Modelled efficiency parameters

PHPP: specific heating demand [kWh/(m²K)]	:	18
PHPP: specific cooling demand | Overheating frequency [kWh/(m²K) | %]	:	
PHPP: specific primary energy demand [kWh/(m²K)]	:	55

For an overview of the energy efficiency of the completed step-by-step refurbishment, see the verification spreadsheet of the PHPP 8 version [PHI 2013] on the next page.

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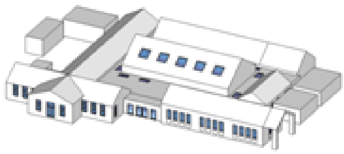
EnerPHit verification



Building:	Gairmscoil Na Bpiaisach-Proposal
Street:	Rosmuc, Galway
Postcode / City:	Galway
Country:	Ireland
Building type:	School
Climate:	[IE] - Birr — Altitude of building site (in [m] above sea level): -
Home owner / Client:	VEC
Street:	
Postcode/City:	
Architecture:	
Street:	
Postcode / City:	
Mechanical system:	
Street:	
Postcode / City:	

Year of construction:	2018		Interior temperature winter:	19.0	°C	Enclosed volume V, m³:	6834.6
No. of dwelling units:	1		Interior temperature summer:	25.0	°C	Mechanical cooling:	
No. of occupants:	33.8		Internal heat sources winter:	2.8	W/m²		
Spec. capacity:	132	Wh/K per m² TFA	Ditto summer:	2.8	W/m²		

Specific building demands with reference to the treated floor area

				Requirements	Fulfilled?*
	Treated floor area	1184.7	m²		
Space heating	Heating demand	18	kWh/(m²a)	25 kWh/(m²a)	yes
	Heating load	11	W/m²	-	-
Space cooling	Overall specif. space cooling demand		kWh/(m²a)	-	-
	Cooling load		W/m²	-	-
	Frequency of overheating (> 25 °C)	0.1	%	-	-
Primary energy	Heating, cooling, dehumidification, DHW, auxiliary electricity, lighting, electrical appliances	56	kWh/(m²a)	124 kWh/(m²a)	yes
	DHW, space heating and auxiliary electricity	56	kWh/(m²a)	-	-
	Specific primary energy reduction through solar electricity		kWh/(m²a)	-	-
Airtightness	Pressurization test result n_{50}	0.6	1/h	1 1/h	yes

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

EnerPHit building retrofit (according to heating demand)?	yes

Figure 20: Specific energy efficiency values of the completed project modelled with PHPP

4.6 Pictures / Drawings

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

Figure 2: Pictures / drawings of the completed retrofit (not yet available)

5 RES Strategy / PV potential Evaluation

5.1 Inhabitant's comfort and location concept

Onyx Solar will study in the following pages, the integration of photovoltaic technology on the School Refurbishment project located in Rosmuc (Ireland).

BIPV integration will be analyzed as a multifunctional added value where, in addition to the electrical generation, the system could provide passive bioclimatic properties as thermal inner comfort -since most of the UV and infrared radiation from the sun will be harvested by the silicon-based material (solar filter effect)-, natural sunscreen and the highly modern appearance.

The location is a key issue in order to consider the best solutions for this intervention. Into these parameters, there are critical factors that must be taken into account to move ahead. These critical factors include climate and microclimate features, geographical conditions (latitude, longitude, altitude above sea level, orientation) and building orientation.

Location	
Country	
Region	
Latitude	
Longitude	
Altitude	
Time Zone	

Table 1: Location parameters

	Global Irradiation	Diffuse Irradiation	Average temperature
	kWh/m^2	kWh/m^2	°C
January			
February			
March			
April			
May			
June			
July			
August			
September			
October			
November			
December			
Year			

Table 1: Microclimate conditions

Rosmuc shows annual irradiation of --- kWh/m^2. The average annual temperature is --- °C. The elevation above sea level is ---m. These climatic and geographic parameters, and the specific location of the building –latitude, longitude, altitude above sea level, orientation- were critical facts when selecting the technology to be implemented.

It is mandatory to point out that it has not been considered the effects of shadows or components of diffuse radiation and albedo in this approach. Therefore, a detailed analysis of production taking into account these critical factors should be done in subsequent stages of the analysis.

5.2 Evaluation of potential BIPV systems

The best option for this building is the integration on the roof, taking advantage of this area directly exposed to the sun. PV tilted traditional panels could be a good intervention, but due to aesthetic criteria, the proposal is based on the superposition of the panels with a black back sheet parallel to the existing roof. Thus, the visual impact from the street remains unchanged.

Furthermore, the application of insulating material between the PV glass and the existing roof, can help to avoid thermal losses and to increase the inner comfort.

The roof superposition would be located on all the available area. The scheme of the PV integration is shown below:

Figure 3: Rooftop and south façade view

Pending: other roofs

The description of the components composing the PV ventilated system is included below:

5.3 Production estimation

A preliminary estimation of PV energy generation can be determined for the proposed solutions by means of implementing simulation tools, where key site location factors as climatic parameters (latitude, longitude, altitude above sea level, orientation) and BIPV system characteristics (tilted angle, azimuth etc.) are considered to establish the final solution energy performance.

The graphic draws a comparison between Peak Power and Energy yield for the different options of PV integration.

Considering the data of energy mixing in ------ (country name) according to the International Energy Agency, where a ratio of ---- Kg CO2 / KWh is found, it can be extracted the following emissions of CO_2 per year that would be prevented for each option proposed:[1]

PV type	opaque m-c	*other roofs*	*other roofs*
Location	roof	pending	pending
Installed PV area [m²]	165,54	pending	pending
Installed peak power [kWp]	24,48	pending	pending
Annual RES gains [kWh]	22708	pending	pending
CO2 emissions prevented	pending	pending	pending

Pending: other roofs

The installation consists of 102 glasses, with an active surface of 165,54 sqm and a total power installed of 24,48 kWp.

6 Refurbishment to the current National Standards

6.1 General Description

The Irish building regulations are very much concerned with the Primary Energy consumption of a refurbished or new building. The targets for the thermal envelope improvements are still very low, and in regard to the airtight level, there is no ambition at all. Unfortunately the Heat demand is not at all a priority for the current regulations; the big priority is the investment on the Renewables and new heating (more efficient) systems.

[1] CO_2 emissions from fossil fuels consumed for electricity generation, in both electricity-only and combined heat and power plants, divided by output of electricity generated from all fossil and non-fossil sources. Both main activity producers and auto producers have been included in the calculation.

Source: CO2 EMISSIONS FROM FUEL COMBUSTION Highlights (2013 Edition), INTERNATIONAL ENERGY AGENCY

6.2 Efficiency results comparison table

	Existing building	National regulations	EnerPHit standard	Differences [%]
Space heat demand [kWh/(m²/a)]	316	87	18	22
Primary energydemand [kWh/(m²/a)]	418	166	55	27
Heat Load [W/m²]	-	42	11	-

Figure 21: Comparison of efficiency results

6.3 Building envelope comparison table

	Existing building	National regulations	EnerPHit standard	Differences [%]
Airtightness Pressure test n50 [1/h]	10.0	-	1.0	100
Building envelope				
Floor Slab [W/(m²K)]	2.49	0.25	0.12	5
Walls to ground [W/(m²K)]	-	-	-	
Walls [W/(m²K)]	2.2	0.27	0.12	5
Roof / Attic ceilings [W/(m²K)]	0.37	0.16	0.1	16
Windows [W/(m²K)]	2.75	2.2	0.8	50
Doors [W/(m²K)]	5	2.2	0.8	28
Thermal bridging ΔU[W/(m²K)]	-	-	-	-

Figure 22: Comparison of building envelope components

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6.4 Building equipment comparison table

	Existing building	National regulations	EnerPHit standard	Differences [%]
Ventilation	**Natural**	**Natural**	**Zehnder comfoair**	
HR Efficiency [%]			85	
Electric efficiency [Wh/m³]			0,42	
Ducting				
Heating	**Boiler**	**Boiler**	**Boiler**	
Energy source	Oil	-	Gas	
Performance ratio of heat generation [%]	na	-	90	
Thermal output kW	na	-	na	
Insulation of pipes	na	-	na	
Domestic hot water	**Gas**	**-**	**Boiler**	
Energy source	Oil	-	Gas	
Performance ratio of heat generation [%]	na	-	90	
Thermal output kW	na	-	na	
Insulation of pipes	na	-	na	

Figure 23: Comparison of building equipment

6.5 RES implementation comparison table

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

Figure 24: Comparison of Renewables installed

6.6 Conclusions

The Irish Building Regulations clearly prioritise the primary energy demand of a refurbished building over its thermal envelope/airtightness improvements. The overall results for a refurbished building under the Irish regulations are clearly way over the EnerPHit standard. This is a case for the need of a significant improvement on the Irish regulation. These regulations are due to be revised in 2015.