Passive House
Project Documentation

Semi-detached house with new extension and refurbished to the EnerPHit standard, Dublin Ireland

Passive house designer	Ann-Marie Fallon (formally of Joseph Little Architects)
Year of construction	2011-2012
See also www.passivehouse-database.org	Project ID 2515

This semi-detached house was for a private client in Blackrock County Dublin Ireland. The existing house had been constructed in the 1960's and very little refurbishment had occurred before the project started on site in 2011. The house is two storeys and includes a side and rear extension (and was certified under the old EnerPHit criteria). The construction type was a mixture of masonry with external wall insulation and timber frame as the focus for the client was also on a low carbon extension to the Passivhaus standard and therefore was included within the envelope

Special features: gravity fed rain water harvesting

U Value exterior walls (mixture of types)	0.12-0.14 W/(m2K)	**PHPP Annual heating demand**	**17 kWh/(m2a)**
U Value roof (pitched)	0.12 W/(m2K)		
U Value roof (flat)	0.13 W/(m2K)	PHPP Primary electric demand	109 kWh(m2a)
U Value windows	1.04 W/(m2k)		
Heat recovery	92%	Pressure test n50	$1.0h^{-1}$

Abstract

The project was for a retired client who set a demanding brief to create a low energy low carbon building with water conservation features which she was heaviliy influenced by whilst working for an aid agency in Africa throughout her career. The initial energy concept was to create a low carbon refurbishment and extension. However in July 2011 the first ‘EnerPHit’ standard was launched and the client agreed that this was the best way to deliver the building, using low carbon materials where possible.

New living and dining space was provided via a single storey extension to the rear. The two storey north facing side extension then provided utility and services spaces on the ground floor, and a master bed room ensuite and walk in wardrobe on the first floor.

The extension was to be low carbon timber frame in construction. Due to budget constraints uPVC Passivhaus certified windows were used, but every effort was made in the extension to use diffusion open hygroscopic materials and timber constituted products where possible.

The existing building required EPS external wall insulation for high performance requirements. The whole attic space (including the extension) was sprayed with Warmcell insulation.

The project took some time to reach the required n50 air pressure test of $1.0h^{-1}$ or lower. This will be discussed in more detail further on.

The refurbished dwelling and extension was the first EnerPHit residential building in Ireland to be completed, and estimated to be the 5th building in the world to be competed to the EnerPHit standard when it was finished in May 2012.

Photos

The photos below describe the house in its existing state in 2007 and the finished refurbishment and extension in 2012.

2007

2012

Fig 1 photos of Monkstown EnerPHit before and after (real photos not computer renders)

Construction description

The existing building envelope is externally insulated with EPS and internally insulated with an insulated PIR plasterboard. The new timber frame is an open panel construction with wood fibre external insulation. The attic is insulated with 400mm of cellulose insulation. The existing suspended timber floor slab was removed and replaced with 300mm EPS insulation that also covers the floor slab of the new extension.

Floor plans

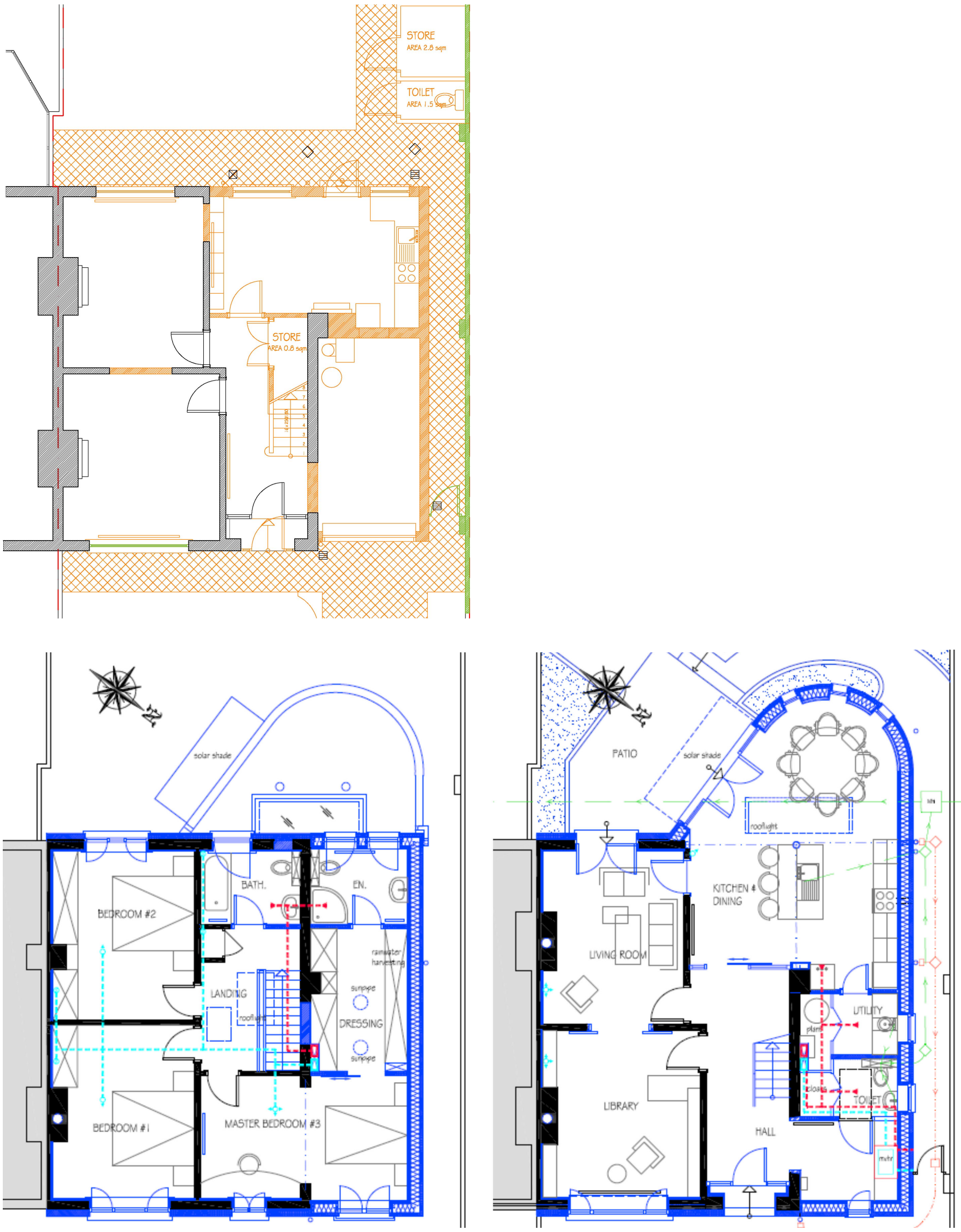

Fig 2,3 & 4 existing ground floor plan showing demolished areas (orange) and proposed floor plan (blue)

Cross section of the implementation plan

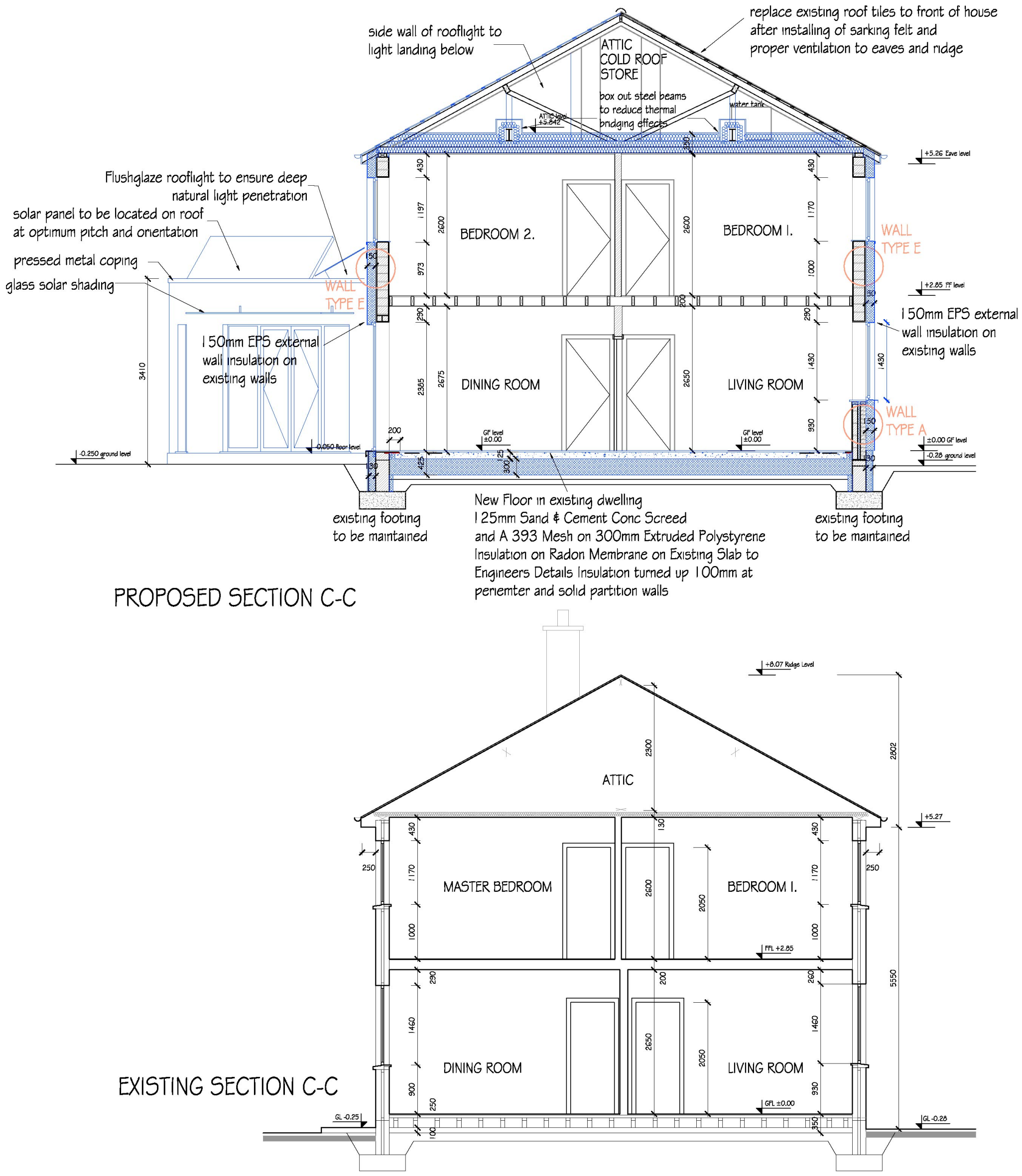

Fig 5 cross section through extension of building

This section shows the concept of how the existing fabric was dealt with thermally, and shows the existing building fabric as it was.

Construction details floor/ground connection

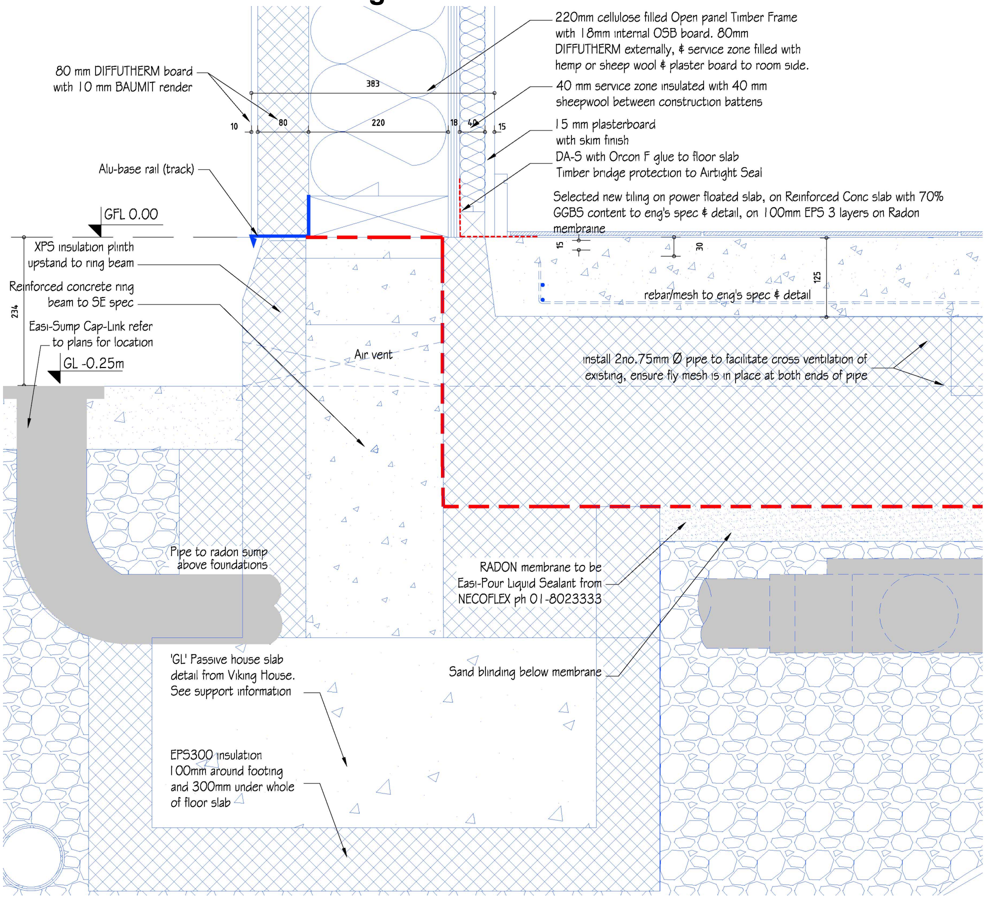

Fig 6 details hybrid insulated raft footing detail

Construction details wall

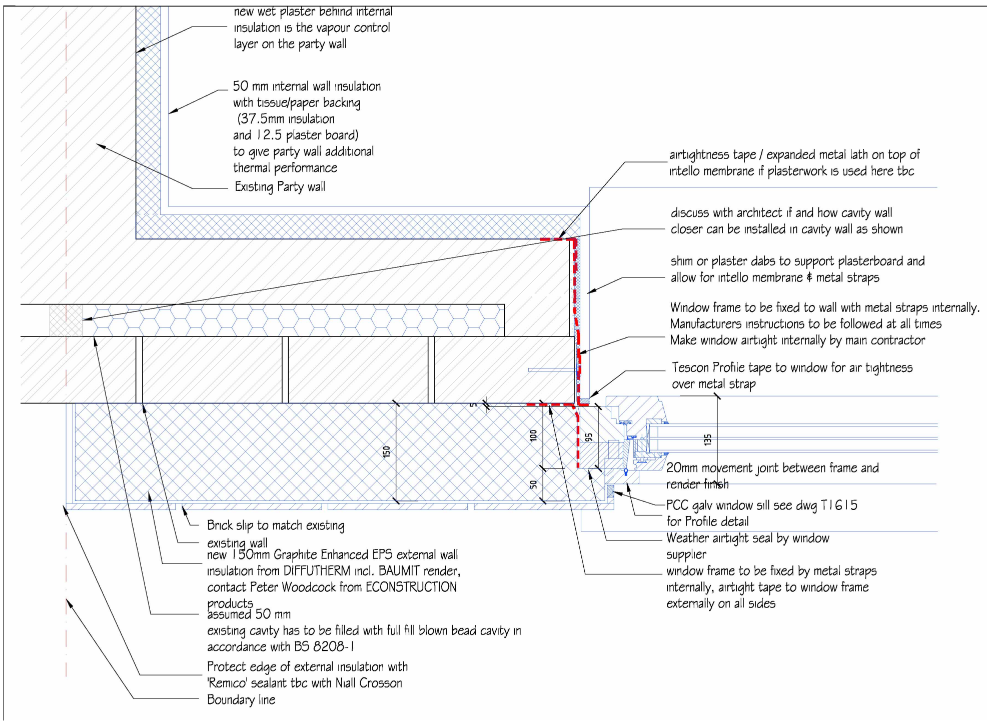

Fig 7 details existing wall insulated externally, cavity filled, & lined with insulated plasterboard

Construction details ceiling

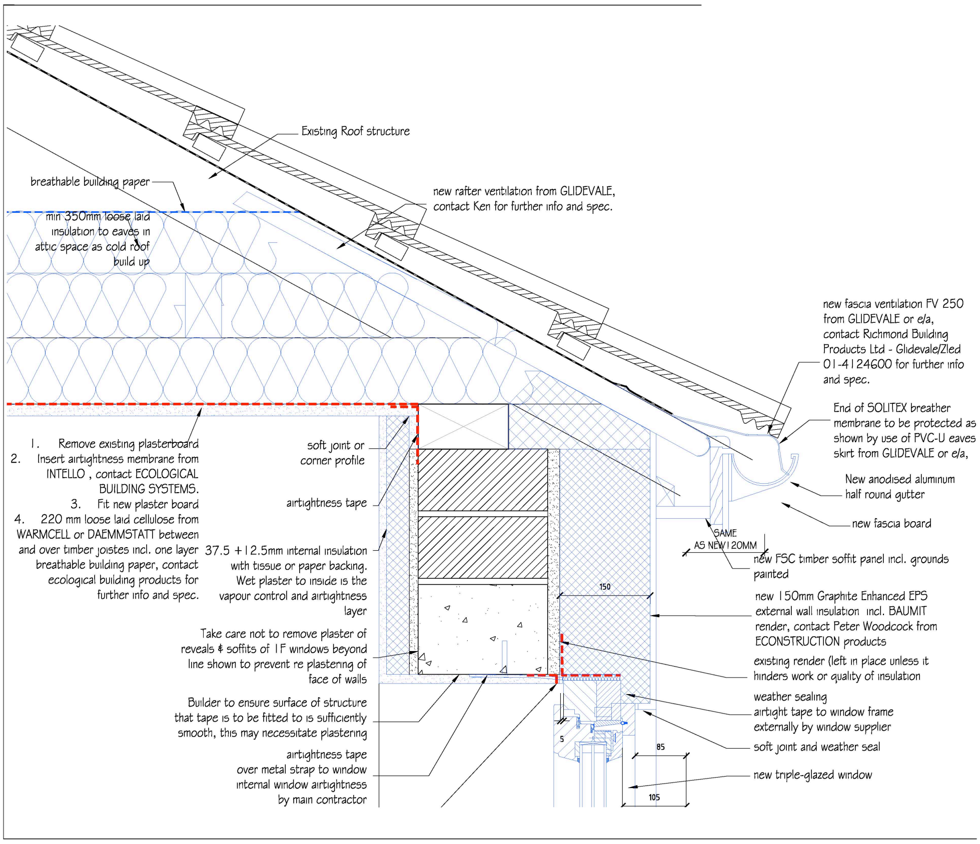

Fig 8 detail of existing roof and wall connection with new ceiling and wall insulation

Construction details window openings

Munster Joinery uPVC futureproof windows were used for the building. The glazing was Saint Gobain with a g-value of 0.61 and a U-Value of 0.55 W/(m2k). The frame U Value varied from 0.917 W/(m2k) for openable to 0.895 W/(m2k) for fixed. The insulation in all areas sits in the external insulation plane with the appropriate air tightness taping applied according to whether it is wet plaster or OSB-3.

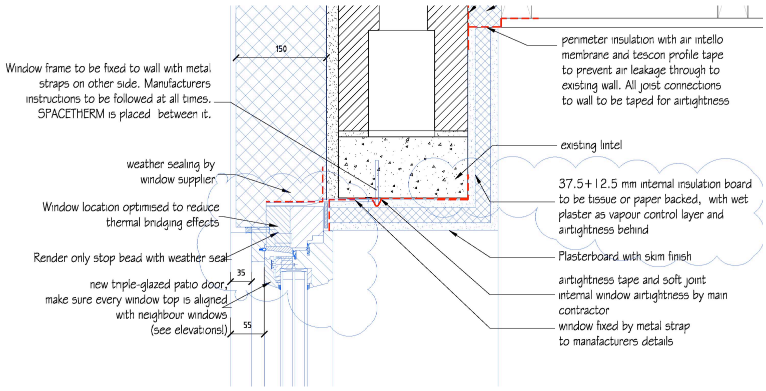

Fig 9 window head detail showing window in plane of insulation

Fig 10 showing window timber frame with Diffutherm insulation, and the adjacent EPS graphite insulation on the existing wall (movement joint in between)

Description of the air tight envelope

The air tightness envelope was a mixture of many materials due to the masonry and timber frame elements of the house.

Existing building	
Floor	New concrete slab with Proclima DA-S membrane to wall
Walls	Wet plaster and Pro Clima fleece air tightness tapes
Ceiling	Intello Plus membrane with Tescon tape
Opening connections	ProClima Tescon tape and other tapes to create air tight window and door connections
Extension	
Floor	New concrete slab with Proclima DA-S membrane to wall
Walls	OSB-3 board with Remmers* Induline water based primer over, and ProClima Tescon tape over connections
Ceiling	Intello Plus membrane with Tescon tape
Opening connections	ProClima Tescon tape and other tapes to create air tight window and door connections

*The OSB-3 was found to be leaky in the very first test. The whole of the OSB layer was subsequently coated in a vapour permeable priming coat from Remmers called Induline. Several tests and diagnostic remedial works were required to achieve the air tightness as illustrated below, showing the improvement over eight formal tests.

Greenbuild were the independent company who carried out the testing. During de-pressurisation the n50 value was $0.8855h^{-1}$ and pressurization produced an n50 value of $0.9715h^{-1}$. The averaged final result was an n50 $0.960h^{-1}$.

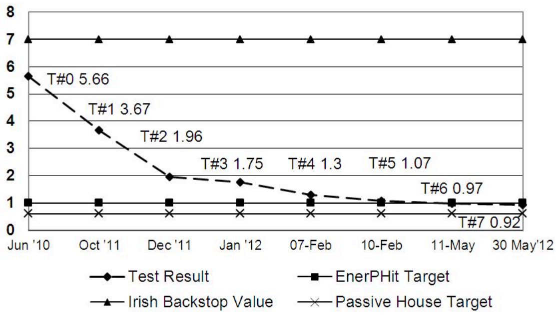

Fig 11 graph showing frequency and results of air pressure testing

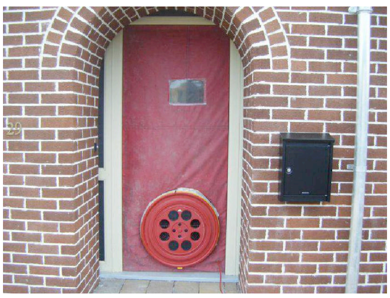

Fig 12 testing unit at entrance door

Fig 13 sealing with Proclima tape where Cellulose was blown into stud wall.

Result @50Pa	Flow m³/h	Air changes (n50)	Permeability $m^3/(hr.m^2)$ (q50)
Averaged Result	361.0	0.9285	0.960

Comparison of Air Permeability Result ($m^3/(hr.m^2)$)

Industry Standards	Best Practise <3	Good Practise 3-7	Average 7-10	Poor >10
Your Result	0.960			

Fig 14 excerpt from final air pressure test report

Ventilation

The ventilation unit is a PAUL Focus 200 with a design air flow rate of 160m3/hr and an electrical fan efficiency of 0.24 Wh/m2. The specific heat recovery of the unit is 92%. The ventilation unit also supplied air heating. The unit was fitted with a electrical post heating coil to supply heated air to the supply rooms. Towel rads and radiators were used in some areas to back up the air heating. The ducting is Lindab rigid circular ducting, which had 100mm foil wrapped mineral wool on its intake and exhaust primary ducts to the unit. The supply duct for air heating was then insulated in 25mm foil wrapped mineral wool. The distribution of the ventilation was through ceiling mounted diffusers for both extract and supply. The extracted rooms were kept close together. The transfer zones were the ground floor and first floor hallways.

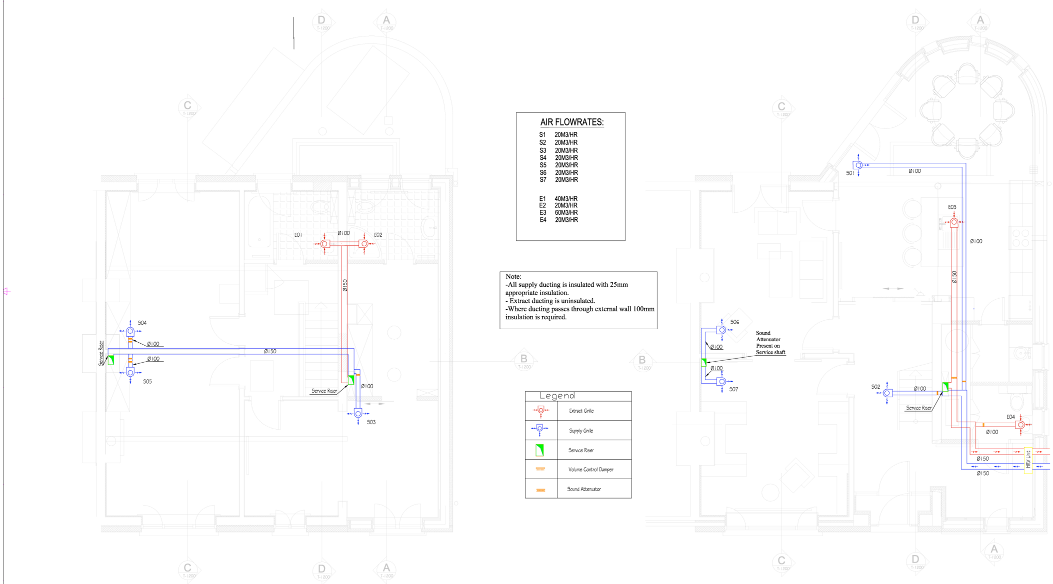

Fig 15 layout of ductwork and MVHR unit location, supply rooms in blue, extract rooms in red



Fig 16,17,18 photo of installation of ductwork and MVHR unit before completion, and insulation of air heating supply duct after completion

Heat supply

The main heating supply was mains gas to a small modulating gas boiler (1.9-12kW modulating). Domestic hot water was also supplemented by solar heating.

Brief report on the important PHPP results

The building was certified on annual heating demand being 17 kWh/(m2a) so less than 25 kWh/(m2a), rather than being certified by components only. The target value of 1.0h-1 or lower was difficult to achieve and took time and cost in the construction programme to achieve.

Building characteristics:	Achieved		Required	
Annual specific space heating demand	17 kWh/(m²a)	≤	25 kWh/(m²a)	✓
Annual specific primary energy demand[2] for heating, DHW, ventilation and all other electric appliances for standard use	109 kWh/(m²a)	≤	122 kWh/(m²a)	✓
Airtightness of building envelope n_{50} as per test result	1.0 h^{-1}	≤	1.0 h^{-1}	✓
Mean value of individual building component thermal protection :				
Exterior insulation to ambient Thermal transmittance (U-value)	0.12 W/(m²K)	≤	0.15 W/(m²K)	-[1]
Exterior insulation to ground[2] Thermal transmittance (U-value)	0.10 W/(m²K)	≤	0.19 W/(m²K)	-[3]
Interior insulation to ambient Thermal transmittance (U-value)	0.53 W/(m²K)	≤	0.35 W/(m²K)	-[1]
Interior insulation to ground Thermal transmittance (U-value)	W/(m²K)	≤	0.61 W/(m²K)	-[1]
Thermal bridges Δ_U Building envelope (window installation excluded)	0.06 W/(m²K)	No limiting value		
Windows Thermal transmittance $U_{w,installed}$	1.04 W/(m²K)	≤	0.85 W/(m²K)	-[1]
Exterior doors Thermal transmittance $U_{w,installed}$	W/(m²K)	≤	0.80 W/(m²K)	-[1]
Ventilation unit Effective efficiency of heat recovery	92 %	≥	75 %	-[1]

[1]Limiting value is not relevant [2]Limiting value differs for each building [3]The requirements can not be met (exception applies)

Certification criteria met? Selection of the evalulation method		
	Space heating demand	✓
	Component quality	

issued:
Darmstadt, 08.10.2012

Wolfgang Feist
Dr. Wolfgang Feist

Fig 19 summary of verification results in EnerPHit certificate

Construction cost

The build cost for both the refurbishment of the existing building to EnerPHit and the extension designed to Passivhaus standard was €262,851. The table below shows the breakdown and costs per metre squared.

Monkstown project costs	EnerPHit retrofit (incl. changes)	PH Extension	Total ex VAT @ 13.5%
Areas (m²)	102.5	58.4	160.9
Total cost	141,753	121,098	262,851
Cost per sqm	1,383	2,074	1,634

Fig 20 graph of areas and costs in euros

Architectural design

The intention of the architect was to bring the building into the garden so that the living and kitchen space to the rear opened up better to the sunny south aspect. The character and appearance of the front elevation had to remain similar to the street context of semi-detached houses.

Building services planning

The PHPP heating load worksheet confirmed heating by air was not sufficient on its own to heat the house. The air heating element on the MVHR was backed up by radiators to a small modulating gas boiler heating the primary rooms where required.

There was 4m2 of solar panels feeding the insulated cylinder and this contributed to 70% of the useful heat required for domestic hot water.

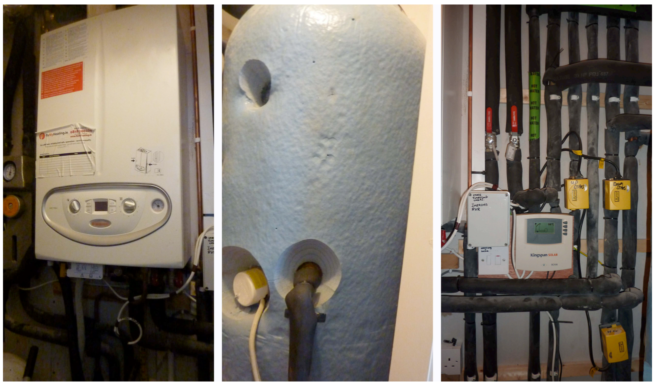

Fig 21 showing modulating boiler 100mm insulated cylinder and insulated pipework

Structural physics and analysis

We had to deal with a 3D thermal bridge where the building corner was removed to make the extension on the rear elevation (see fig 2 & 4). This was solved with foamglass insulation and a structural fixing through to the slab below the steel column.

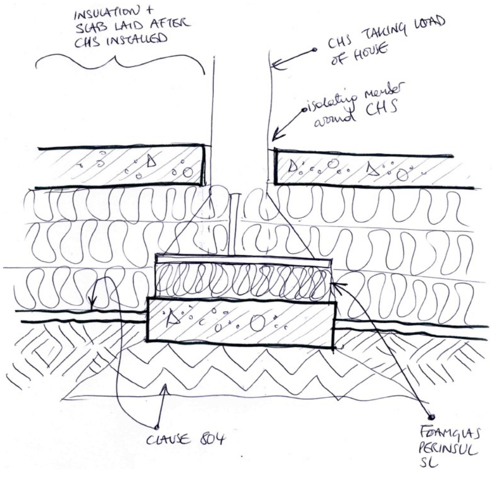

Fig 22 sketch detail of 3D thermal bridge

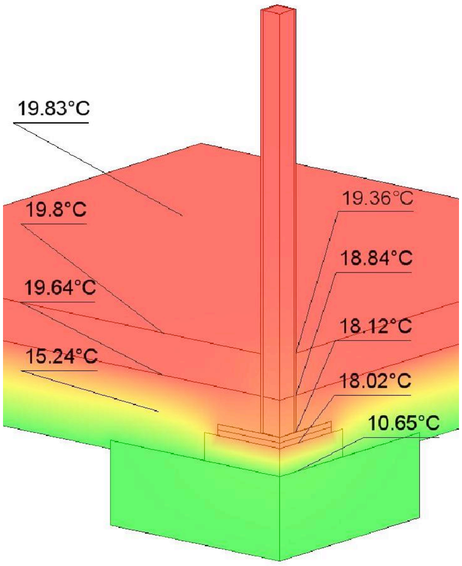

Fig 23 3D thermal bridge temperature strata for junction detail

End user feedback

The clients' thermal comfort temperature is higher than 20 degrees Celsius it is more like 23 degrees Celsius. The client is also living on her own in a large house and so not as much internal heat gains to rely on.

Thermal imaging

A comparison image between the adjacent semi detached building is shown below showing the huge improvement in heat loss in the building envelope but a little heat loss around the window pane areas.

Fig 24 thermal image overlay of photo elevation showing temperature differences

Data logging

Some data logging was carried out for a short time in the spring of 2012 when the client moved back in of two areas the bathroom and the kitchen both on the south elevation (bathroom on first floor). This showed that temperatures in the living room area could fluctuate up to 30 degrees Celsius at times. The steady state calculation in the PHPP had shown a risk of less than 3% overheating but in reality this may have been more. Unfortunately the data logger broke down and this is all the logging to date that has been made available on the project.

Post occupancy monitoring temperature

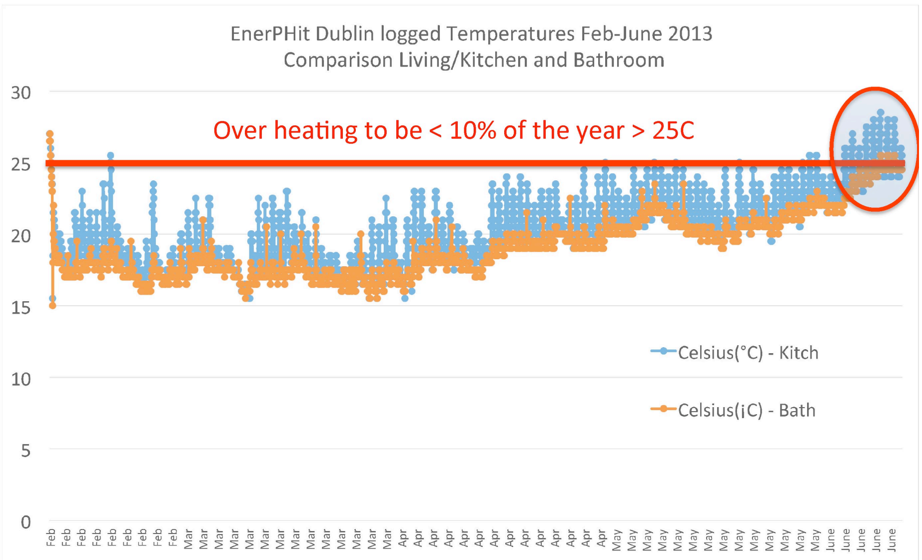

Fig 25 data logging from kitchen and bathroom Feb-June 2012

Publications and studies

December 2012	Magazine feature as energy PHPP consultant in article for EnerPHit Dublin for Passive House Plus magazine
April 2013	Green Residential Building Award for Irelands first EnerPHit building Dublin
April 2013	Co-preseneter with Joseph Little, International Passivhaus Conference Frankfurt
Paper:	*'Retrofitting Irelands First EnerPHit House: Issues, Challenges, Solutions'*