

Building Typology Brochure Ireland

A detailed study on the energy performance of typical Irish dwellings



May 2012





















www.building-typology.eu









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Introduction

The aim of the Intelligent Energy Europe TABULA project (2009-2012) is to create a building typology in each of the member states participating in the project. In the case of Ireland, the building typology aims to identify the most common residential building types and to provide relevant building energy information for each type that will be of use to home owners and building professionals alike.

At the beginning of the project, a quick survey showed that very limited typology data was available in the participating member countries. (The participating countries are Germany, France, Italy, Denmark, Sweden, Belgium, Poland, Austria, Czech Republic, Greece, Slovenia, Ireland and Bulgaria).

Information on TABULA is being made available to energy consultants and the general public via two key channels, namely through (1) the TABULA building typology webtool and (2) brochures for each participating country giving an overview of the energy performance of typical buildings and the possible energy savings by refurbishment measures. The webtool analysis is based on a common EU methodology defined for the TABULA project whereas the energy analysis within the brochures is based on the Irish national Building Energy Rating (BER) method known as Dwelling Energy Assessment Procedure (DEAP). (BER is more often referred to as EPC or energy performance certificate in Europe).

This document contains details of the brochures created for 30 Irish residential building types within TABULA. Individual double-sided A4 brochures are available separately for each building type.

The following introductory sections provide some useful information relating to the structure of this new Irish typology and the brochure content.

Creation of the Irish Building Typology

30 typical Irish house & apartment types identified by the Irish TABULA project team are included in the Irish TABULA brochure. The typical Irish residential buildings were selected primarily by assessing the ranges of construction types and age bands with the Irish national Building Energy Rating method (DEAP) and examining data sources such as the Irish Census and the Sustainable Energy Authority of Ireland's (SEAI's) national BER database.

Within the Irish TABULA project, 5 distinct Irish construction age bands were identified based on changes to building regulations that would significantly affect the energy performance of dwellings. Draft Building Regulations were first introduced in Ireland in 1976 and there were revisions in 1981 (draft also), leading to full Building Regulations in 1991 with subsequent revisions in 1997, 2002, 2005, 2008 and 2011. Allowing for the transition interval between the commencement date for new regulations and the completion of the construction process, dwelling built two years after the introduction of the new regulations are considered to meet the new regulations. (This approach is consistent with the DEAP method). Hence, there were no building standards applying to dwellings built before 1977.

The 5 construction age bands selected for the Irish TABULA typology are shown in Table 1 overleaf. The first age band contains dwellings built in the 1800s, some built in the 1920s, 1950s and 1970s etc.. While the different styles will be further classified in TABULA, as none of these buildings had any insulation installed when constructed, they all fall within the same construction age band.

Table 1: Irish Construction Age Bands

Construction Year Class	Code
1800-1977	1
1978-1982	2
1983-1993	3
1994-2004	4
2005-onwards	5

The 30 Irish dwelling types are spread across these 5 age bands. They include both detached, semi-detached and terraced houses plus one pre 1977 apartment with a range of building wall types including stone, mass concrete, solid brick, hollow block, cavity and timber frame with insulation levels varying from none to 2005 standards.

Construction Details

The individual brochures for the 30 dwelling types are shown in this document. For each building type, sectional drawings and sketches are provided to illustrate many of the typical wall and roof constructions for both the original state and the refurbished state. These sectional drawings and sketches should provide homeowners, in particular, with some basic information relating to their dwelling that will enable them engage fully with potential refurbishment projects.

For example the roof and wall construction for type 8, a mass concrete terraced house, are shown in figures 1 and 2 below.

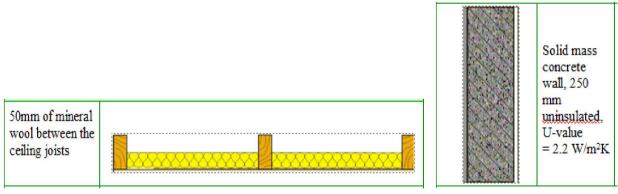


Figure 1

Figure 2

Characteristics of Typical Irish Buildings

When determining the energy related characteristics of a house built in the 1930s, the challenge for the project team was to estimate what would be the typical energy performance of such a building. When it was constructed, it would have had single glazed windows, no wall, roof or floor insulation and no central heating. When the TABULA project started in 2009, there was very limited information available to the project team on the levels of refurbishment of Irish buildings.

The Irish National Survey of Housing Quality report (2001-2002) published by the Economic & Social Research Institute (ESRI), based on a survey of 40,000 Irish dwellings, is the most comprehensive report available on Irish dwellings and contains much useful information. However, it did not contain sufficiently detailed information for adaptation into TABULA.

Thus, the Irish TABULA team used its extensive surveying experience of Irish dwellings to draw conclusions on how to determine the current state of typical older buildings. In determining the energy characteristics of older dwellings, the approach adopted was to assume that all older dwellings will have had modest energy upgrades only in keeping with general societal modifications to dwellings. For example, it was assumed that a house built in the 1940s will have had roughly 50mm of roof insulation installed during the 1970s and that it will have had an oil or gas central heating system with minimal heating controls installed at the same time. This approach was adopted for all 30 typical Irish buildings.

The existing conditions for all building types are listed in each of the individual brochures.

Refurbishment Analysis for each Dwelling Type

As well as indentifying these national house types, two stages of refurbishment of each dwelling type are examined in TABULA. Data on the 2 stages of retrofit are contained in each of the 30 brochures.

Each member state involved in TABULA was given the freedom to define its own refurbishment measures.

The first stage of refurbishment for Irish dwellings is broadly based on the SEAI Better Energy Homes (BEH) standard for roof and wall insulation and heating system upgrades. The Stage 1 refurbishment also includes measures which are not part of the SEAI BEH standard but which would be recommended for comprehensive refurbishment of existing buildings, namely the replacement of uninsulated wooden floors, the replacement of windows and the provision of spray foam cylinder insulation. The Stage 1 refurbishment measures are listed in Table 1 below.

Stage 1 Measures	Upgrade Standards
Roof U-Value	0.13W/m ² K
Flat roofs	$0.22 \text{ W/m}^2\text{K}$
Wall U-Value	$0.27 \text{ W/m}^2\text{K}$
Wooden Floor (replace)	0.25 W/m ² K
Windows U-Value	$2 W/m^2K$
Doors (PVC)	$2 W/m^2K$
Space heat generator efficiency	90% gas, 90% oil
Water heat generator efficiency	90% gas, 90% oil
Heating controls	Full zone control
Cylinder Insulation	50mm, spray foam

Table 2: Stage 1 Refurbishment

The second stage of refurbishment is for a more advanced level of refurbishment. The measures for the stage 2 refurbishment are detailed in table 3 below. The U values for flat roofs, walls and windows have been reduced broadly to match the stop-gap or area-weighted average values within 2011 building regulations standards (Technical Guidance Document Part L) and renewable technologies are included for water heating and space heating. (Obviously, the range of renewable technologies available is far wider than those included in table 3 and different solutions would be recommended for individual houses.)

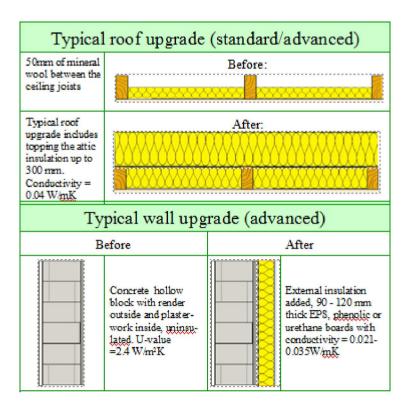
Stage 2 Measures	Upgrade Standards
Roof U-Value	0.13 W/m2K
Flat roof	0.2 W/m ² K
Wall U-Value	0.21 W/m ² K
Windows U-Value	1.3 W/m ² K
Doors (PVC)	2 W/m²K
Space heat generator efficiency	Heat pump: 380% min air, 400% ground
Water heat generator efficiency	Heat pump: 380% min air, 400% ground
Plus Solar thermal (4m ² to 6m ²)	40% contribution of total energy (10% electric immersion)
Heating controls	Full zone control
Cylinder Insulation	50mm, spray foam
Mechanical Heat Recovery Ventilation	90% minimum efficiency

Table 3: Stage 2 Refurbishment

The impact of the refurbishment measures are shown in each of the individual dwelling brochures in terms of reductions in primary energy use, carbon dioxide emissions and the corresponding BER grade (i.e. A to G rating band). The impact of each individual measure is shown separately to show the likely results from partial upgrades.

An example from house type 11 is shown in figure 3 below.

Figure 3: Building Fabric Upgrade Steps



For each dwelling type, the cost of the recommended measures is shown as well the associated payback periods. The cost of measures are full costs and do not include any possible grants that may be available. The costs used are average industry costs gathered from a short survey of market prices in 2011. It was decided to use payback periods and not to include actual yearly running costs as the former can vary with regular energy price movements and make the brochure appear less relevant. The payback information can give a better impression of the value for money aspect of particular refurbishment measures.

The relevant table showing estimated costs and payback time for house type 10 is shown in table 4 below.

Estimated costs and payback time**						
Measure	Estimated costs	Payback (y)				
Step 1	€ 750	3.4				
Step 2	€ 5,800	15.6				
Step 3	€ 6,650	32.9				
Step 4	€ 11,100	28.9				
Total:	€ 24,300	20.6				

 Table 4: Estimated costs & payback time for Type 10

Note that in the case of dwelling type 14, the pre 1977 apartment, a different approach was adopted for refurbishment analysis. Two variants on the main heating system were used, namely a gas boiler and an electric storage heating system. Standard refurbishment details for both heating systems are contained in the brochure for this dwelling type only.

It is worth noting that all running costs and payback periods are based on energy use predicted by the DEAP calculation. Research data from other TABULA partners indicates that, for older and poorly (say G) rated house types, actual energy consumption is typically 50% of that predicted by BER calculation methods. Thus, the payback periods in Table 4 may be longer than estimated.

Summary of BER Calculation Results

The improvement in BER scores for the 30 dwelling types are shown in Table 5.

Stage 1 measures improve the BER scores to a range between C1 and B2. The stage 2 measures improved the BER ratings to a range between B3 and A3.

no	Age Band:	House type	Current State	Stage 1	Stage 2
1	1900-1977	SFH.01.Gen	G	B3	B1
2	1900-1977	TH.01.Gen	G	B3	B1
3	1900-1977	SFH.01.Stone	G	C1	B1
4	1900-1977	TH.01.Stone	G	C1	B2
5	1900-1977	SFH.01.225SB	G	C1	B3
6	1900-1977	TH.01.225SB	G	B3	B1
7	1900-1977	SFH.01.325SB	G	B2	B1
8	1900-1977	TH.01.325SB	G	C1	B2
9	1900-1977	SFH.01.MassConc	G	C1	B3
10	1900-1977	TH.01.MassConc	F	B2	B1
11	1900-1977	SFH.01.Hblock	G	B3	B1
12	1900-1977	TH.01.HBlockFBF	G	B3	B1

Table 5: BER Results Summary

		TH.01.HBlockH			
13	1900-1977	BF	G	B2	B1
14	1900-1977	AB.01.Gen	G	B3 (Var 1)	C1 (Var 2)
14	1978-1982	SFH.02.Gen	E2	B3	B1
15	1978-1982	TH.02.Gen	E1	B2	B1
16	1978-1982	SFH.02.Hblock	E1	B3	B1
17	1978-1982	TH.02.Hblock	E2	B2	B1
18	1983-1993	SFH.03.Gen	E1	B3	B2
19	1983-1993	TH.03.Gen	D2	B3	B2
20	1983-1993	SFH.03.Hblock	D1	B2	B1
21	1983-1993	TH.03.Hblock	D2	B2	A3
22	1994-2004	SFH.04.Gen	D2	C1	B3
23	1994-2004	TH.04.Gen	C2	B2	B1
24	1994-2004	SFH.04.Tframe	C3	B3	B2
25	1994-2004	TH.04.Tframe	C3	B3	B2
26	2005-onw	SFH.05.Gen	C1	B2	B1
27	2005-onw	TH.05.Gen	B3	B2	B1
28	2005-onw	SFH.05.Tframe	C1	B2	B1
29	2005-onw	TH.05.Tframe	B2	B2	B1

Comparison of TABULA BER Calculations to average BER Rating Values on SEAI NAS

SEAI provided data from the National Administration System in October 2011 on the 225,000 BER (EPC) certificates that had been published for existing dwellings at that stage. This enabled a comparison to be made between the TABULA-based primary energy values (in kWh/m2/year) for each of the 29 house types within the Irish building typology and the average primary energy values (in kWh/m2/year) for those same house types extracted from the Irish BER (EPC) database. (The pre 1977 apartment is not included in the table below). Table 6 shows the primary energy values for the 29 Irish house types created for TABULA along with the average primary energy value for each of these 29 house types derived from the EPC database in October 2011.

TABULA House type	TABULA Typi- cal Primary En- ergy Value (kWh/m2/a)	EPC Average Primary Energy Value (kWh/ m2/a)	Variation	Variation as % of TABULA typical Primary Energy Value	
SFH.01.Gen	483.85	365.91	117.94	24%	
TH.01.Gen	489.08	314.14	174.94	36%	
SFH.01.Stone	618.18	440.14	178.04	29%	
TH.01.Stone	607.41	410.36	197.05	32%	
SFH.01.225SB	634.04	443.34	190.70	30%	
TH.01.225SB	463.56	390.24	73.32	16%	
SFH.01.325SB	453.53	383.00	70.53	16%	
TH.01.325SB	631.70	381.47	250.23	40%	

Table 6: TABULA & EPC Primary Energy Comparisons

SFH.01.MassConc	656.59	507.00	149.59	23%
TH.01.MassConc	398.14	364.00	34.14	9%
SFH.01.Hblock	549.40	398.18	151.22	28%
TH.01.HBlockFBF	499.43	333.92	165.51	33%
TH.01.HBlockHBF	456.75	333.92	165.51	33%
SFH.02.Gen	365.73	237.96	127.77	35%
TH.02.Gen	317.67	262.15	55.52	17%
SFH.02.Hblock	321.72	258.70	63.02	20%
TH.02.Hblock	346.16	270.13	76.03	22%
SFH.03.Gen	302.52	271.60	30.92	10%
TH.03.Gen	293.97	260.88	33.09	11%
SFH.03.Hblock	250.87	232.27	18.60	7%
TH.03.Hblock	265.12	267.16	-2.04	-1%
SFH.04.Gen	292.27	244.87	47.40	16%
TH.04.Gen	179.55	227.11	-47.56	-26%
SFH.04.Tframe	214.70	265.98	-51.28	-24%
TH.04.Tframe	203.99	220.44	-16.45	-8%
SFH.05.Gen	171.12	162.20	8.92	5%
TH.05.Gen	149.74	167.26	-17.52	-12%
SFH.05.Tframe	162.37	147.36	15.01	9%
TH.05.Tframe	123.21	154.26	-31.05	-25%

It is notable that the for the pre1977 house types, the average primary energy values from the NAS database are about 30% lower than the values for the TABULA house type.

This difference is due to several factors including:

- * the EPC database includes EPCs for many dwellings that have been retrofitted with energy upgrades. (In order to avail of grants from the Government for refurbishment works, post works EPCs are required.) Thus, many of the EPCs for the old dwellings will have better primary energy values than typical buildings of this age would have.
- * each TABULA house type is based on a selected fuel type. The EPC average includes all fuel types.

For the years 2007-2011, approximately 180,000 Irish dwellings have had refurbishment measures installed under SEAI's energy efficiency programmes. Approximately 50% of these dwellings will have had EPCs published based on the post works primary energy values.

The chart in figure4 shows the range of published BER scores for a Type 11 house, a pre 1978 terraced hollow block wall house. It is interesting to note that many of these dwellings have B, C and D ratings indicating that these properties will have already had some refurbishment measures carried under the current energy efficiency schemes. It is notable that there is a spike in published BER certificates at the D1, D2 grades and a falling off thereafter . It is also interesting to note that within the brochure for type 11, that the standard refurbishment of the building fabric brings the TABULA dwelling from a G to a D1 rating.

This pattern showing a spike of published BER numbers at D1, D2 was consistent for all thirteen pre 1977 dwelling types.

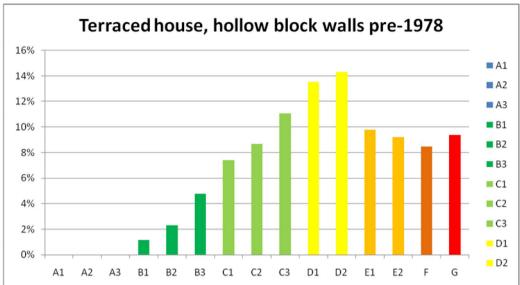


Figure 4: Analysis of Type 11 BER Scores from NAS, October 2011

Observations

The development of this suite of brochures of typical Irish dwellings will hopefully act as a useful information source both Irish householders and building professionals.

The National Energy Efficiency Action Plan 2009 -2020 (NEEAP) includes the aim to retrofit 1 million residential buildings in Ireland with energy efficient measures by 2020. The Stage 1 and Stage 2 refurbishment measures outlined in the TABULA brochures broadly cover the spectrum of works needed for the Irish housing stock.

The Irish TABULA project hopes that this brochure will make a positive contribution to the long term goal of retrofitting 1 million Irish dwellings by making the subject more accessible and more easily understood by a wider audience, most particularly, the Irish home-owners.



1. Detached House, stone walls, pre-1978



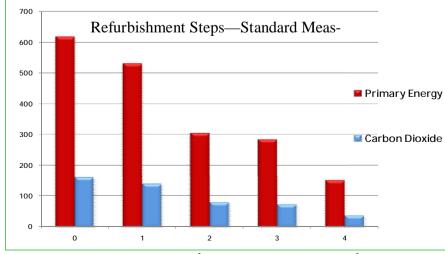


Description: Stone walls were common up to the 1930s in rural areas/ towns. Walls can be 300mm to 400mm thick. The type of stone will influence the insulation options as not all stone wall types are suited for additional insulation.

	Building elements :	Insulation	U - value		
Walls	Valls Solid stone None		2.1		
Roofs	Pitched, insulation between joists	50 mm	0.68		
Floors	Solid	none	0.65		
Windows	Single glazed, wooden frame	n.a.	4.8		
Doors Solid timber		none	3.0		
Heati	ng systems characteristics:	Fuel	Efficiency		
Primary	Central heating boiler, pipework uninsulated	Heating oil (kerosene)	65%		
Secondary Open fire in grate		Coal	30%		
Hot water	bt water From primary heating system. Electric immersion used in Summer.				
Cylinder	Uninsulated, no cylinder thermostat.				
Controls	Programmer only				

	Refurbishment steps — standard					Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating
0	⁰ Building fabric upgrade steps: Expected U-values					159 (actual state)	G
1	Roof insulation and standard package*	Add 250 mm of mineral wool between and over the ceiling joists 0.13		0.13	531	138	G
2	Wall insulation	Add	External insulation or internal drylining. Thickness of the insulation: 70-100 mm	0.27	306	79	E1
3	Windows and Doors	Replace	Replace Double glazed, low-e windows, air filled, 16mm gap Wooden/PVC doors, insulated 2.0			73	D2
	Systems upgrade:						
4	Space and water heat- ing system and con- trols	Replace	Condensing boiler 90% efficient, two separated heating time and thermostatic control, independent water heatin Hot water cylinder insulated with 50 mm spray foam.	151	37	C1	

*also includes draughtstripping, 80mm lagging jacket for HW cylinder and low energy bulbs.



Estimated costs and payback time**					
Measure	Estimated costs		Payback (y)		
Step 1	€ 1,060		1.5		
Step 2	€ 18,600		8.8		
Step 3	€ 4,225		Step 3 € 4,225		19.9
Step 4	€ 3,500		2.9		
Total:	€ 27,385		6.5		
Standar	d upgrade	su	mmary		
Consumption of primary energy reduced by:			67 kWh/m²/y		
Emission of carbon dioxide reduced by:			$22 \text{ kg CO}_2/\text{m}^2/\text{y}$		

Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y

	Typical roof upg	rade (st	andard	/advanced)			-	Heatir	ng sys	stem ı	ıpgra	.de	
	m of mineral letween the		Before:			Feature	:	S	tandar	tandard		Advanced	
	ng joists			×××××××××××		Heat genera	ntor	Regula boiler	ar condensing Gre		Groun	Ground source heat pu	
ipgr	cal roof ade includes ing the attic	mm	After:			Efficiency: 90%		90%			400%		
nsul	ation up to mm.			Fuel:		Heatin	g oil		Electri	city			
0.04	ductivity = W/mK.					SH Control type:	s	Full zo	one cont	rol	Full zo	one control	
	Typical wall upgr	ade (sta	andard			Hot water	7) -		y heatii			y heating sy	
Before				After		source (HW	():				lar thermal j ing 50% of] d		
Solid stone wall, uninsulated U-value = 2.1 W/m ² K		uninsulated U-value added, EPS, urethane or phenolic boards,			HW Cylinder:		120 litt insulat	re, facto ed	ory		re combined ctory insulat		
					HW Controls type:		Time a static	and ther	mo-	Time a	and thermost	tatic	
	TE	The second se	TE			Ventilation	•	Natura	al		MVHR, 90% efficient		
	Ref	urbish	ment s	teps — advan	ice	d				energy n/m²/y		on Dioxide $CO_2/m^2/y$	Energ Rating
)	Building fabric upgrade steps:					-	ected alues	618 (actual state)		159 (actual state)		G	
	Roof insulation and standard package*	Add	250 mm o joist	f mineral wool between a	nd o	over the ceiling	(0.13	5	31	138		G
2	Wall insulation	Add	External v	vall insulation. Thickness:	: 90-	-150 mm	(0.21	2	98		77	D2
4	Windows and Doors	Replace	Triple glaz	zed, argon filled, low-e wi	indo	ows and doors		1.3	2	73	70		D2
_		Sys	tems up	grade:									
	Space and water heat- ing system and con- trols	Replace	with time thermal pa	ource heat pump 400% effi and thermostatic control, i unels providing 50% of ho der. Mechanical ventilatio	inde ot wa	ependent water h ater demand wit	neating h coml	, solar bined		95		23	B1
∗ pa	ckage also includes draughtstrij	oping, 80mn	n lagging jao	eket for HW cylinder and	low	energy bulbs.	I	Estima	ited c	osts a	nd pa	ayback ti	me*;
70	00 1						٦	Measu	ıre	Estima	ted cos	ts Paybacl	с (y)
60	Refurbishi	nent Ste	eps—Ad	vanced Measures	<u>s</u>			Step	1	€	1,060	1	.5
								Step	2	€ 20,40		9	0.3
50					Ene	nergy Used		Step 3		€£	€ 5,600		3.5
40	400							Step 4		€1	6,100	9	9.6
30	00				Carbon Dioxide			Tota	l:	€4	3,220	9	.6
20								Ad	vance	ed up	grade	e summa	ry
10								onsumpt gy reduc		orimary	en-	523 kWł	n/m²/y
	0 1 2	:	3	4 5	1			mission (on dio	xide	136 kgCC	$D_2/m^2/y$

Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y

**Note: 1. Costs are indicative only, based on typical prices (2011). 2. Measures analysed are one of many options, especially for the renewable heating systems.

Analysis conducted in association with IHER Energy Services, www.iher.ie

reduced by:





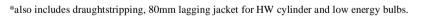


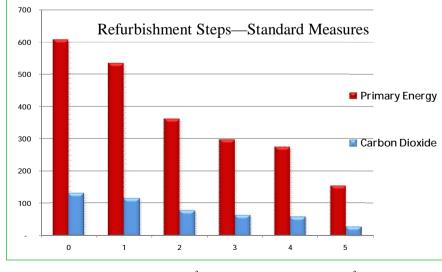
Description: Stone walls were common up to the 1930s in rural towns. Walls can be 300-400mm thick. These thicker walls have good thermal mass properties and help retain heat. The type of stone will influence the insulation options.

	Building elements :	Insulation	U - value
Walls	Solid stone	None	2.1
Roofs	Pitched, insulation between joists	50 mm	0.68
Floors	Solid floor Suspended floor	None None	0.73 0.8
Windows	Single glazed, wooden frame	n.a.	4.8
Doors	Solid timber	none	3.0
Heatiı	ng systems characteristics:	Fuel	Efficiency
Primary	Central heating boiler, pipework uninsulated	Mains gas	65%

Secondary	Open fire in grate	Coal	30%							
Hot water	From primary heating system. Electric immers	rom primary heating system. Electric immersion used in Summer.								
Cylinder	Uninsulated, no cylinder thermostat.									
Controls	Programmer only									

	Ref	urbishi	ment steps — standard		Prim. energy kWh/m ² /y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating
0	Bu	ilding fa	bric upgrade steps:	Expected607U-values(actual state)		129 (actual state)	G
1	Roof insulation and standard package*	Add	250 mm of mineral wool between and over the ceiling joists	0.13	534	114	G
2	Wall insulation	Add	External insulation or internal drylining. Thickness of the insulation: 70-100 mm	0.27	363	77	E2
3	Flat roof insulation	Add	Insulation boards, rigid urethane/phenolic (100-110mm)	0.22	298	64	D2
4	Windows and Doors	Replace	Double glazed, low-e windows, air filled, 16mm gap PVC/Timber doors, insulated	2.0	275	59	D2
		System	s upgrade:	-	• •		
5	Space and water heat- ing system and con- trols	g system and con- time and thermostatic control, independent water heating . Hot water cylinder insulated with 50 mm spray foam.				30	C1





Estimated costs and payback time** Estimated costs Payback (y) Measure € 665 Step 1 1.7 Step 2 € 13,700 18.9 € 3,400 12.5 Step 3 Step 4 € 3,600 37.5 Step 5 € 3,000 5.1 **Total:** € 24,500 11.8

Standard upgrade	e summary
Consumption of primary energy reduced by:	452 kWh/m²/y
Emission of carbon dioxide reduced by:	99 kg CO ₂ /m ² /y

Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y

	Typical roof up	grade (st	tandard/advanced)		-	Heati	ng syste	m up	ograde	
	m of mineral l between		Before:	Feature	e:	S	Standard		Advan	ced
	ng joists			Heat genera	ator	-	Regular condensing boiler		ir source heat	pump
upgr	ical roof rade includes bing the attic		After:	Efficiency:		90%		38	380%	
insu 300	lation up to mm. ductivity =			Fuel:		Mains	sgas	El	lectricity	
	W/mK	arada (s	tandard/advanced)	SH Control type:			one control	Fı	ull zone contro	ol
	Before	igrade (s	After	Hot water source (HW	/):	Prima systen	ry heating		rimary heating nd solar therm	
					,	-)		pr	roviding 50% emand	
	Solid stone uninsulated U-value = 2		External insulation added, EPS, urethane or phenolic boards,	HW Cylind	-		120 litre, factory insulated		200 litre combined cyli der, factory insulated	
			conductivity = 0.021 - 0.031 W/mK	HW Contro type:	ols	Time static	and thermo-	- Ti	ime and therm	ostatic
			Ventilation	•	Natur	al	М	IVHR, 90% et	ficient	
	R	efurbish	ment steps — advanc	ed			Prim. ener kWh/m ² /		Carbon Dioxid kgCO ₂ /m ² /y	e Energy Rating
0	⁰ Building fabric upgrade steps:				Expected U-values (607 (actual sta	te)	129 (actual state)	G
1	Roof insulation and standard package*	Add	250 mm of mineral wool between an joist	d over the ceiling	0	.13	534		114	G
2	Wall insulation	Add	External wall insulation. Thickness :	90-150 mm	0	.21	363		77	E2
3	Flat roof	Add	Insulation boards, rigid urethane/phe (100-110mm)	nolic	0	.22	298		64	D2
4	Windows and Doors	Replace	Insulated PVC/wooden doors, Triple glazed, argon filled, low-e wir	ndows		2.0 1.3	273		58	D2
5	Suspended floor	Replace	Suspended floor replaced, insulation between the floor joists, 70-100mm	boards added	0	.25	266		57	D2
		Sys	stems upgrade:							
6	Space and water hea ing system and con- trols	t- Replace	Air source heat pump 380% efficient with time and thermostatic control, in thermal panels providing 50% of hot HW cylinder. Mechanical ventilation	ndependent water l water demand wit	neating h coml	, solar oined	115		27	B2
_		stripping, 80mn	n lagging jacket for HW cylinder and lo	ow energy bulbs.		Esti	mated cos	sts and	d payback t	ime**
70		shment Ste	eps—Advanced Measures	-		Meas	ure Esti	mated c	costs Payba	ck (y)
60					_	Step		€ 66		1.7
50	00					Step Step		€ 15,1 € 3,4		20.8
40	00		H EN	ergy Used	\vdash	Step		€ 3,4		45.6
30	00		E Ca	rbon Dioxide		Step		€ 1,1		35.8
20	00			-		Step	6	€11,1	100	18.7
10						Tota	վ։	€ 36,1	155	18.7
				1				10	pgrade summary	
	0 1 Primary Energ	2 3	23 4 5 6 Carbon Dioxide emissions: kg/m ² /y		by	Consumption of primary energy reduced 492 kV by:			kWh/m ² /y	
442.							carbon diox		ŗ	kgCO ₂ /m ² /y
**N	ote: 1. Costs are indicative	only, based on t	typical prices (2011). 2. Measures analy	ysed are one of ma	ny opti	ions, espe	cially for the r	enewabl	he neating system	S.





3. Bungalow, solid brick walls, pre-1978





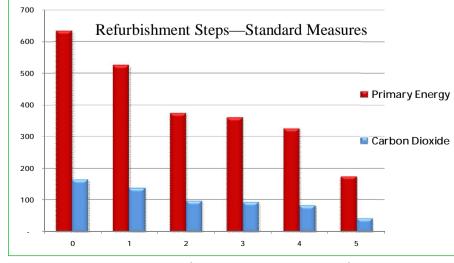
	Building elements :	Insulation	U - value	
Walls	Solid brick, 225 mm	None	2.1	
Roofs	Pitched, insulation between joists Flat roof over the kitchen	50 mm none	0.68 2.3	
Floors	Solid floor	none	0.84	
Windows	Single glazed, wooden frame	n.a.	4.8	
Doors	Solid timber doors half glazed back doors	None None	3.0 3.9	
Heatir	ng systems characteristics:	Fuel	Efficiency	
Primary	Central heating boiler, pipework uninsulated	Heating oil	65%	
Secondary	Open fire in grate	Coal	30%	
Hot water	From primary heating system. Electric immersi	ion used in Sum	ner.	
Cylinder	Uninsulated, no cylinder thermostat.			
Controls	Programmer only			

Description

One-off bungalow with uninsulated solid brick walls. Most likely found in outer parts of towns and in rural areas. Often extended to rear. Ideally suited for external wall insulation.

	Refurbishment steps — standardPrim. energy kWh/m²/yCarbon Dioxide kgCO2/m²/yEner Ratin									
0	Bu	ilding fa	bric upgrade steps:	Expected U-values	634 (actual state)	162 (actual state)	G			
1	Roof insulation and standard package*	Add	250 mm of mineral wool between and over the ceiling joists	0.13	526	136	G			
2	Wall insulation	Add	External wall insulation. Thickness of the boards: 70-100 mm	0.27	375	96	E2			
3	Flat roof insulation	Add	Insulation boards, rigid urethane/phenolic (100-110mm)	0.22		92	E2			
4	Windows and Doors	Replace	Double glazed, low-e windows, air filled, 16mm gap PVC/Timber doors, insulated	2.0	326	83	E1			
		System	s upgrade:							
5	Space and water heat- ing system and con- trols	Replace	Condensing boiler 90% efficient, two separated heating time and thermostatic control, independent water heatin Hot water cylinder insulated with 50 mm spray foam.	174	43	C1				

*also includes draughtstripping, 80mm lagging jacket for HW cylinder and low energy bulbs.



Estimated costs and payback time**

Measure

Estimated costs Payback (y)

			J (J)		
Step 1	€ 1,350		1.9		
Step 2	€ 11,940		10.9		
Step 3	€ 830		7.5		
Step 4	€ 5,250		21.1		
Step 5	€ 3,500		3.3		
Total:	€ 22,900		7.1		
Standar	d upgrade	e su	mmary		
Consumption of pergy reduced by:	primary en-	460 kWh/m²/y			
Emission of carbon dioxide 119 kg CO₂/m reduced by:					

Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y

	Typical r	oof upgr	ade (s	tandard	/advanced)	_]	Heati	ng sys	stem u	ıpgrade	•	
	m of mineral l between the			Before:	_	Feature	:	S	Standard		Advance		ed
	ng joists					Heat genera			Regular condensing boiler		Air source heat pump		ump
upgr	ical roof ade includes	mmm	mm	After:		Efficiency:		90%			380%		
nsul 300	ing the attic lation up to mm.				Fu			Heatin	ng oil		Electricit	у	
	ductivity = W/mK	11				SH Control type:	SH Controls Full zon type:			trol	Full zone	control	
	Typical w Bef		ade (st	andard/	(advanced) After	Hot water source (HW):		Primary heating		ng	Primary h		
		ore):	system	11		and solar providing demand		
Solid brick wall 225 mm, uninsulated, U-value = 2.1 W/m ² K			External insulation added, EPS, urethane or phenolic boards,		HW Cylind	ins HW Controls Tim		120 litre, factory insulated Time and thermo- static		200 litre combined cyl der, factory insulated Time and thermostatic			
				conductivity = 0.021 - 0.031 W/mK								static	
					_	Ventilation	:	Natur	al		MVHR, 90% efficient		cient
	<u>+</u>	Refu	ırbish	ment s	teps — advan	ced		1	Prim. e kWh		Carbon I kgCO ₂	-	Energy Rating
)		Building fabr			grade steps:		-	Expected U-values (634 (actual state)		162 (actual state)	
l	Roof insulat standard pa		Add	250 mm o joist	f mineral wool between a	nd over the ceiling	0	.13	52	26	13	6	G
2	Wall insulat	tion	Add	External w	vall insulation. Thickness	: 90-150 mm	0	.21	37	70	95	5	E2
3	Flat roof		Add	Insulation (100-110n	boards, rigid urethane/ph nm)	enolic	0	.22	35	55	91	l	E2
4	Windows an	nd Doors	Replace		PVC/wooden doors, zed, argon filled, low-e wi	ndows		2.0 3	31	16	81	l	E1
			Sys	stems up	grade:								
5	Space and w ing system a trols		Replace	with time thermal pa	heat pump 380% efficier and thermostatic control, unels providing 50% of he der. Mechanical ventilation	independent water l t water demand wit	neating h comb	solar solar	13	32	31	l	B3
* pa	ckage also includ	les draughtstrip	ping, 80m	m lagging jac	ket for HW cylinder and	low energy bulbs.	E	Estim	ated c	osts a	nd pay	back t	ime*
70	00					_		Meas	ure	Estima	ted costs	Paybao	ck (y)
60		Refurbishr	nent Ste	eps—Ad	vanced Measures	5		Step	1	€	1,340		1.9
								Step			3,130		10.5
50	00				P	- rimary Energy		Step			830		7.5
40	00			-				Step 4 Step 5			7,000		24.8
30	00	_			C.	arbon Dioxide					1,100		7.6
20	00	_		_		_		Tota			3,400		9
10	00					_		onsump	tion of p	-	grade s en-	umma 502 kV	
-	0	1	2	3	4 5	-	Er	nission	ced by: of carbo	on dio	xide	131 kg($CO_2/m^2/$
			Wh /		de emissions: kg/m ² /y		re	duced b	w.				









Description

Solid brick fronted house with solid block walls to side and rear. Very common in older parts of Dublin, Limerick, Cork, etc. Built in the early 1900s and up to the 1940s. Suspended timber floors fitted in most of the property.

	Building elements :	Insulation	U - value					
Walls	Solid brick, 225 mm, partially semi-exposed	none none	2.1 1.38					
Roofs	Pitched, insulation between joists	50 mm none	0.68					
Floors	Suspended timber floor Solid floor	none none	0.69 0.79					
Windows	Single glazed, wooden frame Single glazed, metal frame	n.a. n.a.	4.8 5.7					
Doors	Solid wooden Wooden, half glazed	None none	3 3.9					
Heatir	ng systems characteristics:	Fuel	Efficiency					
Primary	Central heating boiler, pipework uninsulated	Mains gas	65%					
Secondary	Open fire in grate	Smokeless	30%					
Hot water From primary heating system. Electric immersion used in Summer. Cylinder Insulated with lagging jacket 25mm, no cylinder thermostat.								
Controls	Programmer only							

	Ref	urbish	ment steps — standard		Prim. energy kWh/m ² /y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating
0	Bu	ilding fa	bric upgrade steps:	Expected U-values	464 (actual state)	99 (actual state)	G
1	Roof insulation and standard package*	Add	250 mm of mineral wool between and over the ceiling joists	0.13	418	89	F
2	Wall insulation	Add	82.5 mm of internal wall insulation+ vapour control layer.	0.27	282	60	D2
3	Windows and Doors	Replace	Double glazed, low-e windows, air filled, 16mm gap PVC/Timber frame doors.	2.0	250	53	D1
		System	s upgrade:				
4	Space and water heat- ing system and con- trols	Replace	Condensing boiler 90% efficient, two separated heating time and thermostatic control, independent water heating Hot water cylinder insulated with 50 mm spray foam.	125	24	В3	

*also includes draughtstripping, 80mm lagging jacket for HW cylinder and low energy bulbs.



Estimated costs and payback time**							
Measure	Estimated co	sts	Payback (y)				
Step 1	€ 1,330		3.9				
Step 2	€ 10,560		12.3				
Step 3	€ 6,230		31.1				
Step 4	€ 3,000		3.5				
Total:	€ 21,120		9.3				
Standar	d upgrade	e su	mmary				
Consumption of pergy reduced by:	3	339 kWh/m²/y					
Emission of carbo reduced by:	7:	5 kg CO ₂ /m ² /y					

Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y

	or upgra		andard/advanced)		ł	Heati	ng sys	tem i	upgrade		
50mm of mineral vool between the		-	Before:	Feature	e:	5	Standar	d	Advanced		ed
ceiling joists				Heat genera	ator	r Regular condensing boiler		nsing	Air source heat pu		ump
Typical roof pgrade includes	ade includes					90%			380%		
opping the attic nsulation up to 800 mm.				Fuel:		Mains	s gas		Electricity	/	
Conductivity = 0.04 W/mK				SH Control	s	Full z	one cont	rol	Full zone	control	
• 1	10	de (sta	andard/advanced)	Hot water			ry heatir	ıg	Primary h		
Before After				source (HW	/):	syster	n		and solar providing		
Solid	brick wall 22	25	Internal insulation			1001			demand		1 1.
U-val			added, urethane or phenolic boards,	HW Cylind	er:	120 li insula	tre, facto ited	ory	200 litre c der, factor		
= 2.1	W/m ² K		conductivity = 0.021 - 0.025 W/mK	HW Contro	ols		and ther	mo-	Time and	thermo	static
				type: Ventilation	•	static Natur	ลไ		MVHR, 8	8-90%	efficier
					•	I atur					
	Refur	bishi	nent steps — advand	ced			Prim. er kWh/		Carbon E kgCO ₂ /		Energ Rating
	Build	ding fa	bric upgrade steps:		Expected 464 U-values (actual state)			99 (actual state)		G	
Roof insulation standard packa		Add	250 mm of mineral wool between ar joist	nd over the ceiling	0.	.13 41		8	89		F
Wall insulation	1	Add	82.5 mm of internal wall insulation+ layer.	- vapour control	0.	.27	27 282		60		D2
Windows and I	Doors	Add	Insulated PVC/wooden doors, Triple glazed, argon filled, low-e windows			2.0 3	24	6	52		D1
Suspended floo	or ¹	Replace	Insulate the suspended wooden floor phenolic/urethane boards	r with 70-100mm	0.	.25	22	6	48		C3
		Sys	tems upgrade:		-				•		•
Space and wate ing system and trols		Replace	Air source heat pump 380% efficien with time and thermostatic control, i thermal panels providing 50% of ho HW cylinder. Mechanical ventilation	ndependent water l t water demand wit	neating, h comb	solar solar	93	3	22		B1
package also includes of	lraughtstrippi	ng, 80mm	lagging jacket for HW cylinder and l	low energy bulbs.	E	Estim	ated c	osts a	and payl	back	time*
500 450 Re	furbishm	ent Ste	eps—Advanced Measures	 S		Meas	sure	Estima	ated costs	Payba	ck (y)
400			1			Step			1,330		3.9
350				Step			10,560		12.3		
300		Primary Energy					,		36.9 18.4		
250				Step			13,100		18.8		
200				Carbon Dioxide		Tota			35,470		15.8
100									grade si		
50				 [onsump	otion of p leed by:	-	<u> </u>	371 kW	-
0	1	2	3 4 5		En	nission	of carbo	n dio	oxide 7	7 kgC0	$D_2/m^2/y$
Primary	Energy: kWl	h/m²/y, Ca	arbon Dioxide emissions: kg/m ² /y		rec	duced b	by:				

**Note: 1. Costs are indicative only, based on typical prices (2011). 2. Measures analysed are one of many options, especially for the renewable heating systems.







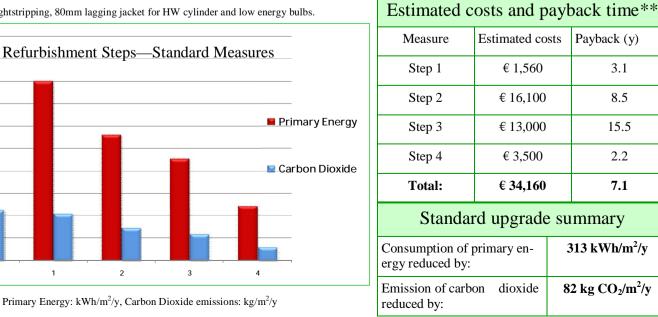


Description: Larger detached solid brick house typically found in larger towns and cities from 1900s to 1940s. Normally brick to front and block walls to side and rear. Internal dry-lining suitable for front with external wall insulation to side and rear.

	Building elements :	Insulation	U - value
Walls	Solid brick, 325 mm	none	1.64
Roofs	Pitched, insulation between joists	50 mm	0.68
Floors	Solid floor	none	0.73
Windows	Single glazed, metal frame	n.a.	5.7
Doors	Solid wood	none	3.0
Heatir	ng systems characteristics:	Fuel	Efficiency
Primary	Central heating boiler, pipework uninsulated	Heating oil	65%
Secondary	Open fire in grate	Coal	30%
Hot water	From primary heating system. Electric immersi	on used in Sumr	ner.
Cylinder	Insulated with lagging jacket 125mm, no cylind	ler thermostat.	
Controls	Programmer only		

	Ref	urbish		Prim. energy kWh/m ² /y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating		
0	Building fabric upgrade steps:			Expected U-values	436 (actual state)	112 (actual state)	F	
1	Roof insulation and standard package*	Add	250 mm of mineral wool between and over the ceiling joists	0.13	401	104	F	
2	Wall insulation	Add	Internal drylining. 77.5 mm phenolic / urethane boards	0.27	281	72	D2	
3	Windows and Doors	Replace	Double glazed, low-e windows, air filled, 16mm gap Insulated doors	2.0	228	59	D1	
	Systems upgrade:							
4	Space and water heat- ing system and con- trols	Replace	Condensing boiler 90% efficient, two separated heating time and thermostatic control, independent water heatin Hot water cylinder insulated with 50 mm spray foam.		123	30	B2	

*also includes draughtstripping, 80mm lagging jacket for HW cylinder and low energy bulbs.



Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y

	Typical roof	upgrad	e (sta	andard	advanced)		1	heati	ng sys	iem i	upgrade	ŧ	
vool	m of mineral l between the]	Before:		Feature	:	Standard		d	Advanced		ed
ceilii	ng joists					Heat genera	ator	Regul boiler	ar conde	ensing	Ground source heat pu		eat pump
ıpgr	prical roof After:				Efficiency:		90%			400%			
nsul	ing the attic lation up to mm.		<u>XXX</u>			Fuel:		Heatin	ng oil		Electricit	y	
	ductivity = W/mK					SH Control type:	s	Full z	one cont	rol	Full zone	e control	
	Typical wall	ıpgrade	e (sta			Hot water source (HW	<i>.</i>		ry heatir	ıg	Primary l and solar		
Before After				source (II w):	syster	11		providing demand				
	Solid bri mm, unin U-value	ck wall 325 isulated,		Internal insulation added, (on dabs or timber battens)- urethane or phenolic boards, conductivity = 0.021 - 0.025 W/mK		HW Cylind	er:	120 li insula	tre, facto ted	ory	200 litre der, facto		
	= 2.1 W/	m ² K				HW Contro type:	ls		and ther	mo-	Time and	•	
						Ventilation	:	Natur	al		MVHR,	90% effi	cient
		Refurb	oishr	nent st	eps — advan	ced			Prim. e kWh/		Carbon kgCO	-	Energy Rating
)		Buildi	ng fa	bric upg	rade steps:		-	values (actual state			112 (actual state)		F
	Roof insulation an standard package	iu	Add	250 mm of joist	mineral wool between a	and over the ceiling		13	3 401		104		F
2	Wall insulation	ł	Add	Internal drylining. 77.5 mm phenolic / urethane boards			0.	27 281		72		D2	
;	Windows and Do	ors Re	place		VC/wooden doors, ed, argon filled, low-E w	ndows		.0 .3	222		57		C3
			Syst	tems upg	grade:				<u> </u>				<u> </u>
	Space and water l ing system and co trols	leat	place	zones with solar therm	rce heat pump 400% eff time and thermostatic cc al panels providing 50% cylinder. Mechanical ver	ontrol, independent of hot water demar	water he	eating, com-	8	8	2	1	B1
pa	ckage also includes drau	ghtstripping	, 80mm	lagging jacl	ket for HW cylinder and	low energy bulbs.	E	Estim	ated c	osts a	and pay	back	time*
50	Refur	hishmen	nt Ste	ns—Adv	vanced Measures	 }		Meas	sure	Estima	ated costs	Payba	ck (y)
								Step) 1	€	1,560		3.1
350								Step	o 2	€ 1	16,100		8.5
250						Primary Energy			Step 3		13,025		13.7
						Carbon Dioxide		Step 4			18,100		7.9
	50							Tota			48,785		8.66
1!							Co		dvance		grade s		ary /h/m²/y
1(50								ced by:			C 10 H 11	

TABULA





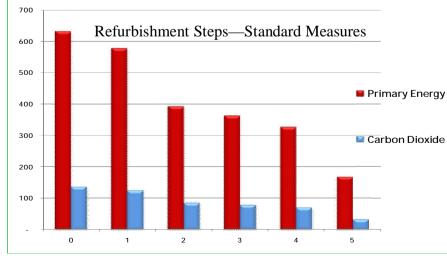
Description

Typical redbrick house found in Dublin, Cork, Limerick etc from late 1800s up to 1930s. Often includes a flat roof extension to rear. Suited to a mix of internal and external wall insulation. Suspended timber floors are common that can be retrofitted with insulation.

	Building elements :	Insulation	U - value			
Walls	Solid brick, 325 mm	none	1.64			
Roofs	Pitched, insulation between joists	50 mm	0.68			
Floors	Suspended timber floor Solid floor (kitchen)	none none	0.69 0.79			
Windows	Single glazed, wooden frame Single glazed, metal frame	n.a. n.a.	4.8 5.7			
Doors	Solid timber	none	3.0			
Heatir	ng systems characteristics:	Fuel	Efficiency			
Primary	Central heating boiler, pipework uninsulated	Mains gas	65%			
Secondary	Open fire in grate	Smokeless	30%			
Hot water	Hot water From primary heating system. Electric immersion used in Summer.					
Cylinder	Insulated with 25mm lagging jacket, no cylinde	er thermostat.				
Controls	Programmer only					

	Ref	urbish	ment steps — standard		Prim. energy kWh/m ² /y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating	
0	Building fabric upgrade steps:			Expected U-values	632 (actual state)	134 (actual state)	G	
1	Roof insulation and standard package*	Add	250 mm of mineral wool between and over the ceiling joists	0.13	577	123	G	
2	Wall insulation	Add	Internal drylining. 77.5 mm phenolic boards, extension walls externally insulated.	0.27	393	83	F	
3	Flat roof	Add	Flat roof drylined or externally insulated	0.22	363	77	E2	
4	Windows and Doors	Replace	Double glazed, low-e windows, air filled, 16mm gap Insulated doors	2.0	328	70	E1	
	Systems upgrade:							
5	Space and water heat- ing system and con- trols	Replace	Condensing boiler 90% efficient, two separated heating time and thermostatic control, independent water heatin Hot water cylinder insulated with 50 mm spray foam.	169	32	C1		

*also includes draughtstripping, 80mm lagging jacket for HW cylinder and low energy bulbs.



Estimated costs and payback time**							
Measure	Estimated costs	Payback (y)					
Step 1	€ 1,140	4.4					
Step 2	€ 12,900	17.4					
Step 3	€ 1,230	10.1					
Step 4	€ 4,600	32.8					
Step 5	€ 3,000	4.3					
Total:	€ 22,870	11.7					
Standard upgrade summary							

dioxide

463 kWh/m²/y

102 kg CO₂/m²/y

Consumption of primary en-

ergy reduced by:

reduced by:

Emission of carbon

Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y

	Typical roof upg	grade (s	tandard	/advanced)			Heati	ng sys	tem ı	upgrade	,	
	m of mineral l between the		Before:		Featu	re:	S	Standar	d	А	dvance	ed
	ng joists			×*************************************	Heat gen	erator	Regular condensing boiler		Air source heat pu		ump	
upgi	ical roof rade includes	mm	After:		Efficiency	7 :	90%			380%		
nsu	ing the attic lation up to mm.				Fuel:		Mains	s gas		Electricity	y	
	ductivity = $\frac{M}{2}$				SH Contr type:	ols	Full z	one cont	rol	Full zone	control	
	Typical wall upg	rade (si	tandard/	,	Hot wate			ry heatir	ıg	Primary h		
Before After			source (H	W):	system	n		and solar providing demand				
	Solid brick wa mm, uninsulate U-value	E CONTRACTOR OF CONTRACTOR OFO		Internal insulation added, (on dabs or timber battens)-	HW Cylin	nder:	120 li insula	tre, facto ted	ory	200 litre c der, factor		
	$= 2.1 \text{ W/m}^2\text{K}$			urethane or phenolic boards, conductivity = 0.021 - 0.025	HW Cont type:	rols	Time static	and ther	mo-	Time and	thermos	static
			W/mK		Ventilatio	n:	Natur	al		MVHR, 9	0% effi	cient
	Ref	[°] urbish	ment st	teps — advan	ced			Prim. er kWh/		Carbon I kgCO ₂ /	-	Energy Rating
)	В	uilding f	fabric upg	grade steps:		-	bected 632 values (actual sta			134 (actual state)		G
l	Roof insulation and standard package*	Add	250 mm of joists	f mineral wool between a	nd over the ceilir	g ().13	0.13 577		123		G
2	Wall insulation	Add	urethane b	Internal drylining. 77.5 oards external insulation 100 -	•).27).21	• / -		83		F
3	Flat roof	Add	Flat roof d	rylined or externally insu	lated	(0.22		1	77	1	E2
ł	Suspended floor	Add	Insulation	boards between the floor	joists, 70-100 m	n ().25	34	0	72		D2
5	Windows and Doors	Replace		Insulated PVC/wooden doors, Triple glazed, argon filled, low-e windows			2.0 1.3			64		D2
		Sy	stems up	grade:						• •		
5	Space and water heat- ing system and con- trols	Replace	with time a thermal pa	heat pump, 380% efficie and thermostatic control, nels providing 50% of he ler. Mechanical ventilatio	independent wat	er heating with com	g, solar bined	12	4	30)	B2
' pa	ckage also includes draughtstr	ipping, 80m	m lagging jac	ket for HW cylinder and	low energy bulb		Esti	mated	costs a	and payb	ack tin	ne**
70	Refurbish	ment St	ens Ad	vanced Measure			Meas	ure	Estimate	ed costs	Payback	: (y)
60			cps—nu		<u> </u>		Step	1	€	1,140		4.4
500							Step 2 €			20,620		27.6
400					Primary Energ	у –	Step			,		10.1
							Step			1,650 6,100		19.2 38.0
3	200				Carbon Dioxide		Step 5 Step 6			€ 6,100 € 11,100		19.6
5				_		Total:		€	41,840		15.6	
							Advanced upgrade summary			/		
20										0		
20		2	3 4	5 6				on of prima	ary energ	y	508 kW	h/m²/y







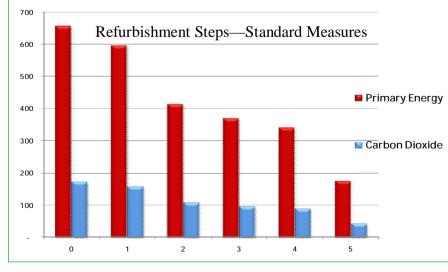
Description

This house type very common in rural areas and towns in 1940s and 1950s. Mass concrete walls have good thermal mass and is suited for external insulation. Flat roof often in kitchen annex.

	Building elements :	Insulation	U - value					
Walls	Solid mass concrete	none	2.2					
Roofs	Pitched, insulation between joists Flat roof (kitchen)	50 mm none	0.68 2.3					
Floors	Solid floor	none	0.84					
Windows	Single glazed, wooden frame	n.a.	4.8					
Doors	Solid timber (back door)	none	3.0					
Heati	ng systems characteristics:	Fuel	Efficiency					
Primary	Central heating boiler, pipework uninsulated	Heating oil	65%					
Secondary	Open fire in grate	Coal	30%					
Hot water	From primary heating system. Electric immers	From primary heating system. Electric immersion used in Summer.						
Cylinder	Insulated with loose jacket, 25mm, no cylinder	thermostat						
Controls	Programmer only							

	Ref	urbish		Prim. energy kWh/m ² /y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating		
0	Building fabric upgrade steps:			Expected U-values	657 (actual state)	171 (actual state)	G	
1	Roof insulation and standard package*	Add	250 mm of mineral wool between and over the ceiling joists	0.13	596	156	G	
2	Wall insulation	Add	External wall insulation. Thickness: 70-100 mm	0.27	414	107	F	
3	Flat roof	Add	Flat roof drylined or externally insulated, 80-110 mm	0.22	369	96	E2	
4	Windows and Doors	Replace	Double glazed, low-e windows, air filled, 16mm gap Insulated doors	2.0	341	88	E2	
	Systems upgrade:							
5	Space and water heat- ing system and con- trols	Replace	Condensing boiler 90% efficient, two separated heating time and thermostatic control, independent water heatin Hot water cylinder insulated with 50 mm spray foam.	174	43	C1		

*also includes draughtstripping, 80mm lagging jacket for HW cylinder and low energy bulbs.



Estimated costs and payback time**							
Measure	Estimated costs	Payback (y)					
Step 1	€ 1,670	7.7					
Step 2	€ 15,800	9.3					
Step 3	€ 2,700	6.6					
Step 4	€ 5,230	19.8					
Step 5	€ 3,000	2.0					
Total:	€ 28,400	7.0					
Standard	l upgrade su	nmary**					
Consumption of pergy reduced by:	primary en-	483 kWh/m²/y					
Emission of carbo reduced by:	on dioxide 1	28 kg CO ₂ /m ² /y					

Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y

	Typical roof upg	rade (st	andard/	advanced)			Heatir	ng system	upgr	ade	
	m of mineral between the		Before:		Feature	e:	St	tandard		Advan	ced
	ng joists				Heat genera	ator	Regula boiler	r condensing	g Grou	nd source	neat pump
upgr	cal roof ade includes	mm	After:		Efficiency:		90%		400%)	
	ing the attic ation up to mm.				Fuel:		Heatin	g oil	Elect	ricity	
0.04	luctivity = W/mK				SH Control type:	s	Full zo	ne control	Full 2	zone contro	ol
	Typical wall upg	ade (st			Hot water		Primar	y heating	Prima	ary heating	system
	Before			After	source (HW	/) :	system			olar therm ding 50% nd	
	Solid mass con- wall, 250 mm uninsulated,	rete		External insulation added, EPS, urethane or phenolic boards,	e		120 lita insulate	re, factory ed		itre combinactory insu	
	U-value = $2.2 \text{ W/m}^2\text{K}$			conductivity = 0.021 - 0.031 W/mK	HW Contro type:	Controls Time a static		nd thermo-	Time	and therm	ostatic
					Ventilation	:	Natura	1	MVH	MVHR, 90% efficien	
	Ref	urbish	ment st	teps — advan	ced			Prim. energ kWh/m ² /y		bon Dioxi gCO ₂ /m ² /y	
0	Βι	uilding fa	abric upg	rade steps:		Expected 657 U-values (actual state		e) (actual state)		G	
	Roof insulation and standard package*	Add	250 mm of joists	mineral wool between ar	nd over the ceiling	C).13	596		156	G
2	Wall insulation	Add	External wa	ll insulation, Thickness:	90-150 mm	C).21	407		106	F
3	Flat roof	Add	Flat roof dr	ylined or externally insul	ated	C).22	363		94	E2
4	Windows and Doors	Replace		VC/wooden doors ed, argon filled, low-e wi	ndows		2.0 1.3	331		85	E1
		Sys	tems upg	grade:				<u>.</u>			
	Space and water heat- ing system and con- trols	Replace	with time as thermal par	rce heat pump, 400% eff nd thermostatic control, i tels providing 50% of ho er. Mechanical ventilation	independent water I t water demand wit	neating. h comb	, solar bined	128		30	В
* pa	ckage also includes draughtstri	pping, 80mn	n lagging jack	et for HW cylinder and l	low energy bulbs.	Ε	Estima	ted costs	and p	ayback	time**
70							Measu	re Estir	nated co	osts Payb	ack (y)
60		ment Ste	eps—Adv	anced Measures			Step	1	€ 1,670		7.7
50	0						Step		17,400		9.9
				🖬 F	Primary Energy		Step		2,700		6.6
40	0			_			Step -		€ 7,450		24.7
30	0				Carbon Dioxide		Step : Total		e 16,100 e 45,320		7.9 9.6
20	0							anced up			
10	0							ion of prima	•	1	Wh/m ² /y
-	0 1	2	3	4 5				•	lioxide	141 kg	$CO_2/m^2/y$





8. Terraced house, mass concrete, pre-1978





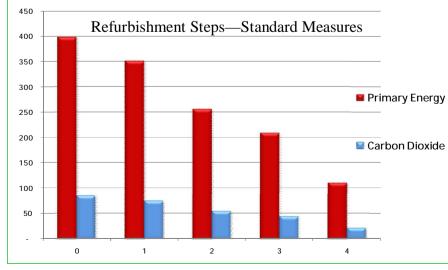
Description

Terraced house, very common in Dublin in 1930s and 1940s. Originally built by Dublin Corporation with mass concrete walls and solid floors. This house type is an ideal candidate for external wall insulation as space is limited internally.

	Building elements :	Insulation	U - value
Walls	Solid mass concrete	none	2.2
Roofs	Pitched, insulation between joists	50 mm	0.68
Floors	Solid floor	none	0.61
Windows	Single glazed, metal frame	n.a.	5.7
Doors	Solid wooden	none	3.0
Heatir	ng systems characteristics:	Fuel	Efficiency
Primary	Central heating boiler, pipework uninsulated	Mains gas	65%
Secondary	Open fire in grate	Smokeless	30%
Hot water	From primary heating system. Electric immersi	on used in Sumr	ner.
Cylinder	Insulated with loose jacket, 25mm, no cylinder	thermostat	
Controls	Programmer only		

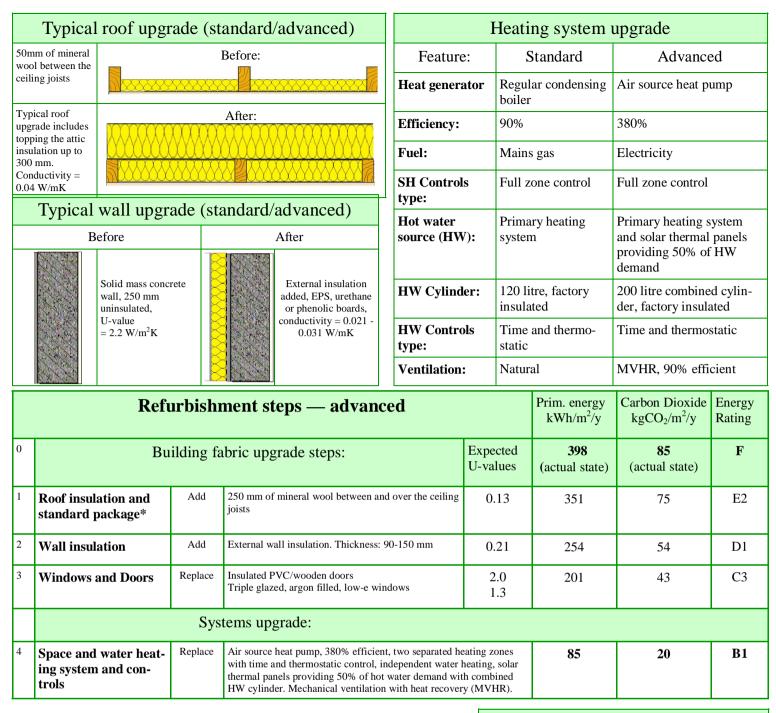
_							
	Ref	urbish		Prim. energy kWh/m ² /y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating	
0	Bu	ilding fa	bric upgrade steps:	Expected U-values	398 (actual state)	85 (actual state)	F
1	Roof insulation and standard package*	Add	250 mm of mineral wool between and over the ceiling joists	0.13	351	75	E2
2	Wall insulation	Add	External wall insulation. Thickness: 70-100 mm	0.27	257	55	D1
3	Windows and Doors	Replace	Double glazed, low-e windows, air filled, 16mm gap Insulated doors	2.0	209	44	C3
	Systems upgrade:						
4	Space and water heat- ing system and con- trols	Replace	Condensing boiler 90% efficient, two separated heating time and thermostatic control, independent water heatin Hot water cylinder insulated with 50 mm spray foam.		112	22	B2

*also includes draughtstripping, 80mm lagging jacket for HW cylinder and low energy bulbs.

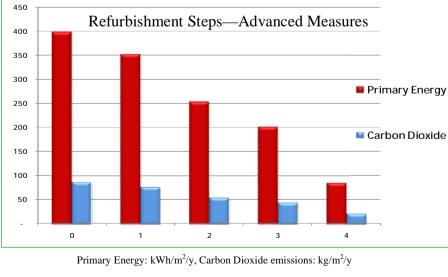


Estimated c	osts and pa	yback time**
Measure	Estimated cost	s Payback (y)
Step 1	€ 750	3.4
Step 2	€ 5,280	14.6
Step 3	€ 4,930	27.2
Step 4	€ 3,000	7.1
Total:	€ 13,960	11.8
Standar	d upgrade	summary
Consumption of pergy reduced by:	286 kWh/m²/y	
Emission of carbo reduced by:	$63 \text{ kg CO}_2/\text{m}^2/\text{y}$	

Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y



* package also includes draughtstripping, 80mm lagging jacket for HW cylinder and low energy bulbs.



Estimated costs and payback time**						
Measure	Estimated costs	Payback (y)				
Step 1	€ 750	3.4				
Step 2	€ 5,800	15.6				
Step 3	€ 6,650	32.9				
Step 4	€ 11,100	28.9				
Total:	20.6					
Advanced upgrade summary						
Consumption of primary en- 313 kWh/m²/y						

 $65 \text{ kg CO}_2/\text{m}^2/\text{y}$

ergy reduced by:

reduced by:

Emission of carbon dioxide

**Note: 1. Costs are indicative only, based on typical prices (2011). 2. Measures analysed are one of many options, especially for the renewable heating systems.



9. Bungalow, hollow block, pre-1978





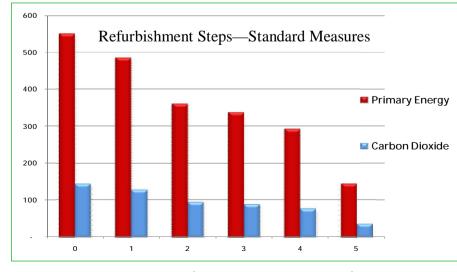
	Building elements :	Insulation	U - value		
Walls	Concrete hollow block	none	2.4		
Roofs	Main roof insulated on ceiling Flat roof over the extension	50mm none	0.68 2.3		
Floors	Suspended wooden floor, unsealed	none	0.69		
Windows	Single glazed, wooden frame Single glazed, metal frame	n.a. n.a.	4.8 5.7		
Doors	Solid timber doors	none	3.0		
Heati	ng systems characteristics:	Fuel	Efficiency		
Primary	Central heating boiler, pipework uninsulated.	Heating oil	65%		
Secondary	Open fire in grate	Smokeless	30%		
Hot water	From primary heating system. Electric immersi	ion heater is used	l in summer.		
Cylinder Insulated with 25mm thick loose jacket, no thermostat					
Controls Time clock only					

Description

1950s detached bungalow with uninsulated 9 inch (225mm) hollow block walls, uninsulated suspended timber floors and a standard pitched roof insulated at ceiling level between the attic joists. This house type is located in the Dublin and east coast areas in particular.

	Ref	urbish		Prim. energy kWh/m²/y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating	
0	Bu	ilding fa	bric upgrade steps:	Expected U-values	549 (actual state)	142 (actual state)	G
1	Roof insulation and standard package*	Add	250 mm mineral wool between and over the ceiling joists.	0.13	485	126	G
2	Wall insulation	Add	70-100 mm external insulation, main and extension walls (phenolic/urethane/EPS)	0.24-0.27	360	93	E2
3	Flat roof insulation	Add	External insulation or drylining boards (urethane/ phenolic) , 100-110 mm	0.22	337	87	E1
4	Windows and Doors	Replace	Double glazed low-e windows, air filled, 16mm gap, Insulated doors.	2.0	292	75	D2
	Systems upgrade:						
5	Space and water heat- ing system and con- trols	Replace	Condensing boiler 90% efficient, two separated heating time and thermostatic control, independent water heating Hot water cylinder insulated with 50 mm spray foam.		143	35	В3

*also includes draughtstripping, 80mm lagging jacket for HW cylinder and low energy bulbs.



Estimated costs and payback time**

Measure	Estimated cost	ts	Payback (y)		
Step 1	€ 2,360		3.1		
Step 2	€ 13,050		8.5		
Step 3	€ 1,900		6.7		
Step 4	€ 9,150		p 4 € 9,150		16.5
Step 5	€ 3,500		2.0		
Total:	€ 29,960		6.1		
Standar	d upgrade	su	mmary		
Consumption of pergy reduced by:	primary en-	4	06 kWh/m²/y		
Emission of carbo reduced by:	on dioxide	10	07 kgCO ₂ /m ² /y		

Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y

	Typical	roof upgi	rade (st	andard/	advanced)]	Heatir	ng syster	n u	ipgrade	;	
	m of mineral l between the			Before:	_	Feature	e:	S	tandard		Α	dvance	d
	ng joists					Heat genera	ator	Regula boiler	r condensir	ıg	Ground so	ource hea	at pump
upgi	ical roof rade includes			After:	0000000000	Efficiency:		90%			400%		
nsu	ving the attic lation up to mm.					Fuel:		Heatin	g oil		Electricity	ý	
	ductivity = W/mK					SH Control type:	S	Full zo	ne control		Full zone compensa	,	load
	-	vpical wall	upgra			Hot water	. `		y heating		Primary h		
	B	efore	Fore After source (HW): sy		system			and solar providing demand					
		Concrete hollow block with render outside and plas	er		External insulation added, 70 - 120 mm thick EPS, phenolic	HW Cylinder: HW Controls type:		120 litt insulat	re, factory ed		200 litre c der, factor		
		work inside, uninsulated. U-v =2.4 W/m ² K	value		or urethane boards with conductivity = 0.021-0.035 W/mK			Time a static	nd thermo-	,	Time and	thermos	tatic
						Ventilation	:	Natura	Natural		MVHR, 90% efficie		eient
		Ref	urbish	ment st	teps — advanc	ced			Prim. ener kWh/m ²		Carbon kgCO		Energ Rating
)		Bu	Building fabric				fabric upgrade steps:				1 (actual	42 state)	G
l	Roof insu standard		Add	250 mm mi joists.	neral wool between and o	ver the ceiling	0	0.13	485	5 126		26	G
2	Wall insu	ation	Add	External wa	all insulation. Thickness: 9	90-150 mm	0	0.21 356		356 92		2	E2
3	Flat roof i	nsulation	Add	External ure	ethane/phenolic insulation	, 100-110 mm	0	.22	333		8	6	E1
4	Windows	and Doors	Replace	Triple glaze Insulated do	ed, argon filled low-e wind pors.	dows,		1.3 2.0	283		7	3	D2
5	Floors		Add	Add insulat	ion between the floor jois	ts 70-100mm	0	0.25	239		6	1	D1
			Sys	tems upg	grade:								
5	Space and ing systen trols	water heat- and con-	Replace	with time an thermal pan	rce heat pump 400% effic nd thermostatic control, in hels providing 50% of hot er. Mechanical ventilation	dependent water l water demand wit	neating, h comb	, solar ined	89		2	1	B1
* pa	ckage also inc	ludes draughtstrip	oping, 80mm	lagging jack	tet for HW cylinder and lo	ow energy bulbs.		Estir	nated cos	ts a	nd payb	ack tim	ne**
60	00 00							Measu	re Esti	mate	d costs	Payback	(y)
E.		Refurbishr	nent Ste	ps—Adv	vanced Measures			Step 2			2,360 4,400		3.1 9.1
50								Step 2			1,900		6.6
40	oo				# P	 Primary Energy		Step 4	4	€ 1	2,400	2	20.0
30	oo							Step :			5,800		2.8
					📕 🖬 C	Carbon Dioxide		Step o Tota			8,100 5.960		9.2 9.8
20								ŀ	Advanced	up	grade su		
1(00								n of primary er			460 kWl	
								· · c	carbon dioxi	4			$D_2/m^2/y$

Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y

**Note: 1. Costs are indicative only, based on typical prices (2011). 2. Measures analysed are one of many options, especially for the renewable heating systems.

TABULA





	Building elements :	Insulation	U - value			
Walls	Hollow block (gable and rear) Cavity wall (front)	none none	2.4 1.78			
Roofs	Pitched, insulation between joists	50 mm	0.68			
Floors	Solid	none	0.79			
Windows	Single glazed, metal frame	n.a.	5.7			
Doors	Single glazed, metal frame	none	5.7			
Heati	ng systems characteristics:	Fuel	Efficiency			
Primary	Central heating boiler, pipework uninsulated	Heating oil	65%			
Secondary	Open fire in grate	Smokeless	30%			
Hot water	From primary heating system. Electric immers	ion used in Sum	ner.			
Cylinder	linder Insulated with lagging jacket 25mm thick, no cylinder thermostat.					
Controls	Programmer only					

Description

Semi-detached house with a brick-cavity-block front wall and hollow block walls to side & rear. All walls would be uninsulated. This construction was common from the 1950s up to the end of the 1970s in Dublin and along the East Coast but can be found in Cork too.

	Ref	urbish		Prim. energy kWh/m ² /y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating	
0	Bu	ilding fa	bric upgrade steps:	Expected U-values	499 (actual state)	129 (actual state)	G
1	Roof insulation and standard package*	Add	250 mm of mineral wool between and over the ceiling joists	0.13	458	119	G
2	Wall insulation	Add	Gable and rear– internal drylining, 82.5 mm urethane/ phenolic boards Front - cavity fill, 60mm	0.27 0.48	308	79	E1
3	Windows and Doors	Replace	Double glazed, low-e windows, air filled, 16mm gap Insulated doors.	2.0	242	62	D1
	Systems upgrade:						
4	Space and water heat- ing system and con- trols	Replace	Condensing boiler 90% efficient, two separated heating time and thermostatic control, independent water heatin Hot water cylinder insulated with 50 mm spray foam.	128	31	B3	

*also includes draughtstripping, 80mm lagging jacket for HW cylinder and low energy bulbs.



Estimated costs and payback time**

Measure	Estimated co	sts	Payback (y)			
Step 1	€ 1,280		3.3			
Step 2	€ 7,400		4.7			
Step 3	€ 9,430		13.8			
Step 4	€ 3,500		3.1			
Total:	€ 21,610		5.7			
Standar	Standard upgrade summary					
Consumption of primary en- 371 kWh/m ² /y						

dioxide

 $98 \text{ kg CO}_2/\text{m}^2/\text{y}$

ergy reduced by:

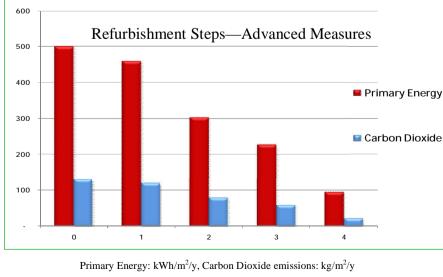
reduced by:

Emission of carbon

Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y

	Typical	l roof upgr	ade (s	tandard	/advanced)			Heati	ng system	upgrade	
	Omm of mineral gool between the eiling joists			Before:		Feat	Feature: S		Standard	Advanced	
ceilin			Heat ger		erator	or Regular condensing boiler		Air source heat pump			
upgra	Fypical roof Ipgrade includes		After:		Efficienc	Efficiency: 90%			380%		
opping the attic nsulation up to 300 mm.				Fuel:	Fuel: Heatin		ng oil	Electricity			
	nductivity = 14 W/mK			SH Co type:		ontrols Full zone control		cone control	Full zone control		
	Tyj	pical wall	upgrad	le (adva	anced)	Hot wate	r	Prim	ary heating	Primary heating s	system
Before Concrete hollow block with render outside and plaster- work inside, uninsulated. U-value =2.4 W/m²K				After			system		and solar thermal panels providing 50% of HW demand		
		block with rende	render		External insulation added, 90 - 120 mm thick EPS, phenolic			120 li insula	tre, factory ated	200 litre combined cylir der, factory insulated	
		lated. U-value	-value		or urethane boards with conductivity = 0.021-0.035W/mK	HW Controls Time static		and thermo-	Time and thermostatic MVHR, 90% efficient		
						Ventilation: Natur		al			
		Refu	ırbish	ment s	teps — advan	ced			Prim. energy kWh/m ² /y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating
)	Building fabric upgrade steps:				-	ected values	499 (actual state)	129 (actual state)	G		
		of insulation and adard package* Add 250 mm of mineral wool between and over the ceiling joists		ng	0.13	458	119	G			
2 '	Wall insulation Add Gable and rear- external insulation, Front - cavity fill, 60mm		90-150 mm		0.21 0.48	303	78	E1			
3 7	Windows	and Doors	Add		PVC/wooden doors zed, argon filled, low-e wi	ndows		2.0 1.3	228	58	D1
			Sys	stems up	grade:						
i	-	l water heat- 1 and con-	Replace	Air source heat pump 380% efficient, two separated with time and thermostatic control, independent wat thermal panels providing 50% of hot water demand HW cylinder. Mechanical ventilation with heat reco		er heatin with com	g, solar ibined	94	22	B1	





Estimated costs and payback time**

Measure	Estimated co	sts	Payback (y)		
Step 1	€ 1,280		3.3		
Step 2	€ 12,800		6.4		
Step 3	€ 13,050		30.6		
Step 4	€ 13,100		8.7		
Total:	€ 40,230		9.3		
Advanced upgrade summary					
Consumption of primary energy reduced by:			05 kWh/m²/y		

Emission of carbon dioxide

reduced by:

107 kgCO₂/m²/y

**Note: 1. Costs are indicative only, based on typical prices (2011). 2. Measures analysed are one of many options, especially for the renewable heating systems.









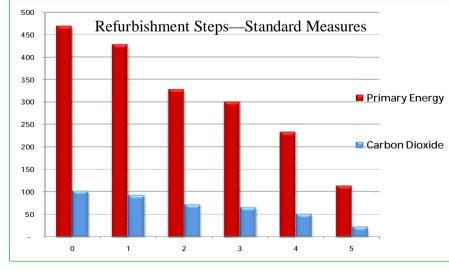
Description

Mid terrace house with half brick front. Very common in Dublin in 1950s and 1960s. Small 50mm cavity behind brick wall with 9 inch (225mm) hollow block walls elsewhere. Uninsulated exposed floor above the garage. Suspended timber floors.

	Building elements :	Insulation	U - value			
Walls	Hollow block (up front, rear and extension) Cavity wall (lower front)	none none	2.4 1.78			
Roofs	Pitched, insulation between joists	50 mm	0.68			
Floors	Suspended floor Exposed floor (over the garage)	none none	0.54 1.2			
Windows	Single glazed, metal frame	n.a.	5.7			
Doors	Single glazed, metal frame	none	5.7			
Heatiı	ng systems characteristics:	Fuel	Efficiency			
Primary	Central heating boiler, pipework uninsulated	Mains gas	65%			
Secondary	Open fire in grate	Smokeless	30%			
Hot water	ner.					
Cylinder	Insulated with lagging jacket 25mm thick, no cylinder thermostat.					
Controls	Programmer only					

	Refurbishment steps — standard					Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating
0	Building fabric upgrade steps:		Expected U-values	468 (actual state)	100 (actual state)	G	
1	Roof insulation and standard package*	Add	250 mm of mineral wool between and over the ceiling joists	0.13	428	91	F
2	Wall insulation	Add	Hollow block walls– internal drylining, 82.5 mm urethane/phenolic boards Front - cavity fill, 60mm	0.27 0.48	328	70	E1
3	Flat roof and floor over the garage	Add	Phenolic / urethane drylining boards, 70-100 mm	0.22	301	64	E1
4	Windows and Doors	Replace	Double glazed, low-e windows and doors, air filled, 16mm gap	2.0	233	50	D1
	Systems upgrade:						
5	Space and water heat- ing system and con- trols	Replace	Condensing boiler 90% efficient, two separated heating zones with time and thermostatic control, independent water heating . Hot water cylinder insulated with 50 mm spray foam.		114	22	B2

*also includes draughtstripping, 80mm lagging jacket for HW cylinder and low energy bulbs.



Estimated costs and payback time**					
Measure	Estimated cos	ts Payback (y)			
Step 1	€ 1,360	4.4			
Step 2	€ 6,400	10.2			
Step 3	€ 2,200	12.5			
Step 4	€ 11,400	26.6			
Step 5	€ 3,000	3.7			
Total:	€ 24,360	10.3			
Standard upgrade summary					
Consumption of pergy reduced by:	354 kWh/m²/y				
Emission of carb reduced by:	78 kg CO ₂ /m ² /y				

Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y

	Typical	roof upgi	ade (standard	/advanced)]	Heati	ng sys	stem u	upgrade	e			
	nm of mineral of between the			Before:			Feature	:	S	Standar	d	А	dvance	ed		
	ing joists		*****			ŀ	Heat generatorRegular conde boilerEfficiency:90%		ensing	g Air source heat pump		ump				
upg	pical roof rade includes	YYYYYY	mm	After:		F			90%			380%				
nsu	ping the attic lation up to mm.					Fuel:			Mains	s gas		Electricit	у			
	nductivity = 4 W/mK						SH Control	s	Full z	one con	trol	Full zone	control			
		ical wall	upgra	de (adva			Hot water		Prima	ry heati	ng	Primary h				
	Be	efore	After		s	source (HW	') :	syster	n		and solar thermal par providing 50% of HV demand					
		Concrete hollow block with rende outside and plas	er		External insulation added, 90 - 120 mm thick EPS, phenolic	I	HW Cylinde HW Control type:		HW Cylinde		120 li insula	tre, facto ited	ory	200 litre der, facto		
		work inside, uni lated. U-value = 2.4 W/m ² K	nsu-		or urethane boards with conductivity = 0.021-0.035 W/mK				Time static	and thermo-		Time and thermost		static		
						۲	Ventilation	:	Natur	al		MVHR, 9	90% effi	cient		
		Refu	urbisl	hment s	teps — advan	ced	1			Prim. e kWh		Carbon I kgCO ₂	-	Energy Rating		
D		Bu	ilding	fabric up	grade steps:			Expe U-va		40 (actual		10 (actual	-	G		
l	Roof insula standard p		Add	250 mm o joist	f mineral wool between a	nd ov	ver the ceiling	0	.13	428		9.	1	F		
2	Wall insula	ation	Add	All walls:	external insulation. Thick	kness	90-150 mm	0.21 325		25	69		E1			
3	Flat roof an over the ga		Add	Phenolic /	urethane drylining boards	s, 70-	-100 mm	0	0.22 297		63	3	D2			
4	Windows a	and Doors	Replace		PVC/wooden doors, eed, argon filled, low-e wi	indow	VS		2.0 1.3	21	9	47	7	C3		
5	Suspended	floor	Add	70-100 mi joists	n of insulation boards bet	tween	veen the floor 0.25		20)3	43	3	C3			
			S	ystems up	grade:							-		-		
5	Space and ing system trols	water heat- and con-	Replace	with time thermal pa	heat pump 380% efficien and thermostatic control, nels providing 50% of ho ler. Mechanical ventilatio	indep ot wat	bendent water h ter demand with	eating,	, solar vined	7	7	18	3	B 1		
* pa	ackage also inclu	ides draughtstrip	oping, 80r	nm lagging jac	ket for HW cylinder and	low e	energy bulbs.	, [Esti	mated	costs a	and payb	ack tin	ne**		
	500	Refurbishn	nent St	ens—Adv	vanced Measures				Meas	ure	Estimate	ed costs	Payback	(y)		
	00					<u> </u>			Step			1,360		4.4		
	50								Step			12,200 2,220		18,7 12.6		
3	:00		 	_	📟 F	<u>Pri</u> ma	ary Energy		Step Step			16,000		32.7		
2	250	_							Step			3,630		36.4		
2	200				——————————————————————————————————————	Carbo	on Dioxide		Step			13,100		18.9		
1	50								Tota	մ։	€4	48,510		20		
1	00									Advan	ced ur	grade su	immarv	V		
	50 - 0	1	2	3 4	5 6					on of prim	-	-	391 kW			
					de emissions: kg/m ² /y				nission o ced by:	f carbon	dioxide r	e-	82 kgCC	$D_2/m^2/y$		
			. ,	n typical price	0.00			uu	<i>oy</i> .							

Analysis conducted in association with IHER Energy Services, www.iher.ie





12. Detached Bungalow, cavity walls pre-1978





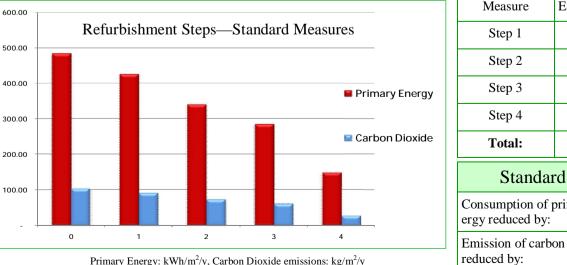
Description: Very common house construction in most of rural Ireland during 1960s and 1970s. Typically has 100mm empty cavity in walls that can be pumped with insulation beads.

	Building elements :	Insulation	U - value
Walls	Empty cavity walls	none	1.78
Roofs	Pitched, insulation between joists	50 mm	0.68
Floors	Suspended timber floor	none	0.65
Windows	Single glazed, metal frame	n.a.	5.7
Doors	Single glazed, metal frame	n.a.	5.7
Heatir	ng systems characteristics:	Fuel	Efficiency
Primary	Central heating boiler, pipework uninsulated	Mains gas	65%

Primary	Central heating boiler, pipework uninsulated	Mains gas	65%			
Secondary	Open fire in grate	Solid, smoke- less	30%			
Hot water	From primary heating system. Electric immers	ion used in sumn	ner			
Cylinder	Pr No thermostat, insulated with 25mm lagging jacket					
Controls Time clock only						

	Ref	Prim. energy kWh/m ² /y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating			
0	Building fabric upgrade steps:				483 (actual state)	102 (actual state)	G
1	Roof insulation and standard package*	Add	250 mm mineral wool between and over the ceiling joists	0.13	425	90	F
2	Wall insulation	Add	100mm cavity filled with beads.	0.32	340	72	E2
3	Windows and Doors	Replace	Double glazed, low-e windows, air filled, 16mm gap Insulated Doors	2.0	286	60	D2
	Systems upgrade:						
4	Space and water heat- ing system and con- trols	Replace	Condensing boiler 90% efficient, two separated heating time and thermostatic control, independent water heati Hot water cylinder insulated with 50 mm spray foam.	0	149	28	В3

*also includes draughtstripping, 80mm lagging jacket for HW cylinder and low energy bulbs.



Estimated	costs	and	nav	vhack	time**
Louinateu	COSIS	anu	pa	your	time

Measure	Estimated cos	sts Payback (y)			
Step 1	€1,600	2.9			
Step 2	€900	1.1			
Step 3	€9,425	16.9			
Step 4	€3,000	2.2			
Total:	€14,925	4.5			
Standard upgrade summary					
Consumption of j ergy reduced by:	334 kWh/m²/y				

dioxide

74 kg CO₂/m²/y

Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y

	Typical	l roof upgi	ade (s	tandard/	advanced)			Heati	ng sys	stem u	upgrade		
	m of mineral between			Before:		Feature	e:	S	Standar	ď	A	dvance	ed
	ng joists						Regular condensing boiler		ensing	g Air source heat pump		ump	
pgra	cal roof ade includes			Efficiency:		90%			380%				
nsula	ing the attic ation up to mm.					Fuel:		Mains	s gas		Electricity		
	luctivity = W/mK					SH Control type:	s	Full z	one con	trol	Full zone	control	
	Ту	pical wall	l upgra	de (stan	dard)	Hot water		Prima	ry heati	ng	Primary h	eating s	system
	B	efore			After	source (HW	/) :	system	•	C	and solar providing demand	thermal	panels
		Empty cavity wa brick or block -c - block. U-value	avity		100 mm cavity filled with beads, conduc- tivity = 0.33 W/mK	HW Cylind	er:	120 li insula	tre, facto ited	ory	200 litre combined der, factory insulat		
		$= 1.78 \text{ W/m}^2\text{K}$				HW Contro type:	ols	Time static	and ther	mo-	Time and	thermo	static
						Ventilation	:	Natur	al		MVHR, 9	0% effi	cient
		Refu	ırbish	ment st	eps — advanc	ed			Prim. e kWh		Carbon D kgCO ₂ /		Energ Rating
)		Bu	ilding f	abric upg	rade steps:			ected alues		83 l state)	10 (actual		G
	Roof insul standard		Add	250 mm mi joists	neral wool between and o	ver the ceiling	0).13	42	25	90		F
2	Wall insul	ation	Add	2	s filled with beads with co ll insulation	ombination of	0	0.21	33	34	70		E1
1	Windows	and Doors	Replace	Triple glaz	ed, low-e windows, argon	ı filled		1.3	27	71	57		D2
ŀ	Floors		Add	Insulation b	oards between the floor jo	oists	0.25 226		26	47		D1	
			Sy	stems upg	grade:						·		
	Space and ing system trols	water heat- and con-	Replace	with time an thermal pan	heat pump 380% efficient nd thermostatic control, ir els providing 50% of hot r. Mechanical ventilation	ndependent water h water demand wit	neating h comb	, solar bined	9	8	23		B1
pac	kage also incl	udes draughtstrip	ping, 80mr	n lagging jack	et for HW cylinder and lo	ow energy bulbs.	F	Estim	ated c	osts a	and payl	oack t	time*
600.	.00							Meas	ure	Estima	ted costs	Paybao	ck (y)
500.	.00	Refurbishr	ment St	eps—Adv	vanced Measures			Step	0 1	€	1,600		2.9
		-						Step			1,500		12.3
400.	.00				# F	Primary Energy		Step			3,050		20.5
300.	.00							Step			2,750		6.0
				Carbon Dioxide		Step 5		€11,100			7.8		

Advanced upgrade summary

Consumption of primary energy reduced by:	385 kWh/m²/y
Emission of carbon dioxide reduced by:	80 kg CO ₂ /m ² /y

Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y

3

2

**Note: 1. Costs are indicative only, based on typical prices (2011). 2. Measures analysed are one of many options, especially for the renewable heating systems.

5

4

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1



100.00

0







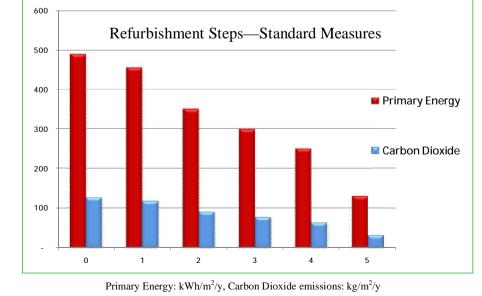
	Building elements :	Insulation	U - value
Walls	300 mm cavity walls	None	1.78
Roofs	Main roof insulated on ceiling Flat roof over the extension	50mm Flat roof - 0	0.68 2.3
Floors	Ground solid concrete floor	None	0.79
Windows	Single glazed, wooden frame	n.a.	4.8
Doors	Solid timber doors	none	3.0
Heati	ng systems characteristics:	Fuel	Efficiency
Heatin Primary	ng systems characteristics: Central heating boiler, pipework uninsulated.	Fuel Heating oil	Efficiency 65%
			-
Primary	Central heating boiler, pipework uninsulated.	Heating oil Solid, smoke- less	65% 30%
Primary Secondary	Central heating boiler, pipework uninsulated. Open fire in grate	Heating oil Solid, smoke- less ion heater is used	65% 30%

Description

1970s end of terrace/ semi-detached house with 12 inch (300mm) cavity walls containing a 100mm empty cavity. This house type has uninsulated solid floors and a standard pitched roof insulated at ceiling level between the attic joists. Most likely found in north, west & south of Ireland.

	Ref	urbish		Prim. energy kWh/m ² /y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating		
0	Building fabric upgrade steps:				489 (actual state)	126 (actual state)	G	
1	Roof insulation and standard package*	Add	250 mm mineral wool between and over the ceiling joists.	0.13	455	118	G	
2	Wall insulation	Add	100 mm cavity fill (beads)	0.32	352	91	E2	
3	Flat roof insulation	Add	110 mm rigid urethane/phenolic boards	0.22	301	77	E1	
4	Windows and Doors	Replace	Double glazed low-e windows, air filled, 16mm gap, PVC/wooden doors, insulated.	2.0	251	64	D1	
	Systems upgrade:							
5	Space and water heat- ing system and con- trols	time and thermostatic control, independent water heating . Hot water cylinder insulated with 50 mm spray foam.				32	B3	

*also includes draughtstripping, 80mm lagging jacket for HW cylinder and low energy bulbs.



Estimated costs and payback time**

Measure	Estimated costs	Payback (y)
Step 1	€ 780	2.6
Step 2	€ 990	0.9
Step 3	€ 3,400	6.7
Step 4	€ 9,750	19.1
Step 5	€ 3,000	2.6
Total:	€ 17,920	5.1

Standard upgrade	e summary
Consumption of primary energy reduced by:	358 kWh/m²/y
Emission of carbon dioxide reduced by:	94 kgCO ₂ /m ² /y

50	m of mineral	roof upgi	(1	ng sys	1	10		
woo	l between ng joists			Before:		Feature			Standard		Advance		
						Heat genera	erator Regula boiler				Air source heat pump		ump
upgi	ical roof rade includes	mmmm	$\gamma\gamma\gamma\gamma$	After:		Efficiency: 90%		380		380%			
insu	bing the attic lation up to mm.					Fuel:		Heati	ng oil		Electrici	ty	
	ductivity = W/mK	MUUUUU					s	Full z	one cont		Full zone		, load
	Ту	pical wall	l upgı	rade (stand	dard)	type: Hot water		Primar		ng	Primary	heating s	system
	B	efore		After		source (HW):		: system			and solar thermal p providing 50% of H demand		
outer brick and		Empty cavity wa outer brick and i block with plast	ick and inner with the beads		Empty cavity filled with the beads through the number	HW Cylinde		er: 120 litre, factory insulated		2	200 litre der, facto		
		work, uninsulated. U-value = 1.78 W/m ² K		HW Contro type:	ols	Time static	and ther	mo-	Time and thermostat		static		
					up to 0.033 W/mK	Ventilation	:	Natur	al		MVHR,	90% effi	cient
Refurbishment steps — advar						ed			Prim. e kWh		Carbon kgCO	-	Energy Rating
0		Building fabric upgrade steps:						Expected U-values (a				26 l state)	G
1		Add 250 mm mineral wool between and o joists.			ver the ceiling	0.	.13	45	55 118		18	G	
2	Wall insul	ation	Add	Cavity fill w drylining (50	ith combination of extern 0-80 mm)	nal insulation or	0.	.21	34	14	8	8	E2
3	Flat roof i	nsulation	Add	110 mm rigi	d urethane/phenolic board	ds	0.	.22	29	93	7	5	D2
4	Windows	and Doors	Replac		Triple glazed low-e windows, argon filled, 16mm gap. PVC or wooden doors.			1.3 233 2.0		33	59		D1
			S	ystems upg	rade:								
5	Space and ing system trols	water heat- and con-	Replac	with time an thermal pane	d thermostatic control, in	dependent water I water demand wit	93 ependent water heating, solar vater demand with combined with heat recovery (MVHP)			3	2	2	B1
* pa	ckage also incl	udes draughtstrip	ping, 80r	mm lagging jacke	et for HW cylinder and lo	w energy bulbs.	E	Estim	ated c	osts a	nd pay	back t	ime**
6	00					_] —	Meas			ted costs	Payba	
		Refurbishr	nent S	Steps—Adv	anced Measures			Step) 1	€	780		2.6
5	00	_				_		Step	02	€ 1	2,500		11.0
4	00					_		Step	03	€ 3	3,400		6.6
					🖬 Pi	rimary Energy		Step) 4	€1	3,500	2	22.5
300			_		Step 5		€1	1,100		7.3			
200 C				arbon Dioxide -		Tota	al:	€4	1,280	1	10.1		
								A	dvanc	ed up	grade s	summa	ary
10	00					_			otion of p iced by:	orimary			h/m²/y
	0	1	2	3	4 5	Emissio			hission of carbon dioxide uced by:		xide	e 104 kgCO ₂ /m ² /y	
	Р	rimary Energy: k	Wh/m ² /y	. Carbon Dioxide	e emissions: kg/m ² /y		100	auccu l	-y.				

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ABULA 14. Top floor apartment, solid brick / concrete wall, pre 1978



U - value

Insulation



Walls	Front wall and stairwells: mass concrete Rear wall: 325mm solid brick		none none	2.2 1.64						
Roofs	Flat roof, concrete slab		none	2.3						
Windows	Single glazed, wooden frame		n.a. 4.8							
Doors	Solid timber		none	3.0						
Heating systems characteristics:										
Feature:	Variant 1-gas heating	Vai	Variant 2 -electric heating							
Heating	Gas boiler, 68% efficient	Elect	ric storage heate	rs						
Hot water	From the gas boiler, immersion heater supplementary in summer	Electric immersion heater								
Controls	Programmer only	Manual charge control								
Cylinder	Insulated with 25 1	Insulated with 25 mm lagging jacket								

Building elements :

Description

600

Top floor flat of 1940s block of flats in Dublin city centre. This flat has both mass concrete walls facing the courtyard with 325mm solid brick walls facing the street. It has a flat concrete roof. External insulation would be the optimum solution if the block was upgraded as a single project.

	Refurbishm	ent ste	eps — variant 1 (gas heating)		Prim. energy kWh/m ² /y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating					
0	Bui	lding fa	bric upgrade steps:	Expected U-values	522 (actual state)	99 (actual state)	G					
1	Basic measures Add 100% Draughtstripping, Replacing all bulbs with CFLs, Installing 80 mm lagging jacket on the cylinder n.a				490	92	G					
2	Wall insulation	Add	Internal drylining. 52.5 mm thick phenolic /urethane boards	0.5	430	81	F					
3	Roof insulation	Add	Internal drylining. 52.5 mm thick phenolic /urethane boards	0.5	272	52	D2					
4	Windows and Doors	Replace	Double glazed, low-e windows, air filled, 16mm gap Insulated solid doors	1.6 2.0	239	46	D1					
		System	s upgrade:									
5	Space and water heat- ing system and controls	Replace	Condensing boiler 90% efficient with room thermostat independent water heating. Hot water cylinder insulate mm spray foam.	149	28	B3						
	Estimated costs and payback time											



Estimated of	costs and pa	yback time*
Measure	Estimated costs	Payback (y)
Step 1	€ 140	1.4
Step 2	€ 1,625	12.3
Step 3	€ 2,990	8.7
Step 4	€ 2,450	33.8
Step 5	€ 3,000	12.4
Total:	€ 10,205	11.5
Standa	rd upgrade s	summary
Consumption of gergy reduced by:	primary en-	373 kWh/m ² /y
Emission of carb	on dioxide	71 kg CO ₂ /m ² /y

reduced by:

Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y

		Туріса	l roof u	upgrade	;				Heati	ng sys	tem uj	pgrade	,	
Con	crete slab,		a da anticipa da anticipa da com	Before:			Feature	:	Var	iant 1–	–gas	Varia	nt 2—	electric
	sulated						Heat genera- tor		Regular condensing boiler		sing	Air to a	Air to air heat pump	
boar	rnal drylining ds fixed to ceiling	dang bir gen generger sig varjatiopa	en sede dedenterio per transmissi dante:	After:			Efficiency:		90%			360%		
Con	ductivity]	Fuel:		Mains g	gas		Electric	rity	
= 0.023 W/mK Typical wall u		ıpgrade	pgrade		SH Controls type:		Programmer, Room thermostat, TRV's			Time an zone co	-	erature		
	Be	efore			After		Hot water		Primary	y heating	system	Electric	e immer	sion
					!	source (HW	/):							
	Solid brick wall 32 mm, uninsulated, U-value			added, (on dabs or timber battens)-]	•		96 litre, factory insulated			96 litre factory	,	ed
$= 2.1 \text{ W/m}^2\text{K}$				urethane or phenolic boards, conductivity = 0.021 - 0.025		HW Contro type:	ols		-day programmer, Cylinder thermostat		7-day programmer, Cylinder thermostat			
W/mK			w/mk		Ventilation	:	Natural		Natural	_				
	Ref	furbishm	ent ste	ps—va	riant 2 (elect	ric	heating)	<u> </u>	Prim. er kWh/		Carbon I kgCO ₂ /	-	Energy Rating
⁰ Building fabric upgrade steps:							Expected U-values (ac		2 16 state) (actual		66 state)	G		
1	Basic meas	sures	Add	Replacing a	ghtstripping, all bulbs with CFLs, 0 mm lagging jacket on	the c	cylinder	:	n.a. 7		-2	160		G
2	Wall insula	ation	Add	Internal dry boards	lining. 52.5 mm thick pl	heno	lic /urethane		0.5	62	.8	13	5	G
3	Roof insula	ation	Add	Internal dry boards	lining. 52.5 mm thick pl	heno	lic /urethane		0.5		1	76	j	E2
4	Windows a	and Doors	Replace	Double glazed, low-e windows, air filled, 16mm gap Insulated solid doors			1.6 2.0			7 64		D2		
			Sys	stems upg	grade:									
5	Space and ing system trols	water heat- and con-	Replace	for each roo	om.		-	ividual temperature controls 156 d by the immersion heater.		6	34	ļ	C1	
90	00	Defentio	1	Lange V					Estin	nated c	costs a	nd pay	back	time*
80	00	Refurbis	nment S	steps—v					Meas	sure	Estimate	ed costs	Payba	ck (y)
70	00								Step			140		1.9
60	00					Prir	mary Energy		Step			,625		7.6
50	00						2 03		Step			,990		5.8
400					Car	bon Dioxide		Step Step			,450 ,300		24.1 22	
300						Tota			,500 1,505		10.4			
20									А	dvance			umm	arv
10	_					1			Consum	tion of p	orimary	ograde summary 616 kWh/m²/y		
	0 Pr	1 imary Energy: k	2 Wh/m²/y, C	3 arbon Dioxic	4 5 le emissions: kg/m ² /y			_ _ E		of carbo	on dioxi	de 1	32 kgC	$O_2/m^2/y$

*Note: 1. Costs are indicative only, based on typical prices (2011). 2. Measures analysed are one of many options, especially for the renewable heating systems.

Analysis conducted in association with IHER Energy Services, www.iher.ie









	Building elements :	Insulation	U - value
Walls	300 mm cavity walls, partially filled	15-25 mm	1.1
Roofs	Pitched, insulation between joists	100 mm	0.4
Floors	Solid	10-15 mm	0.64
Windows	Double glazed, metal frame, 6mm gap	n.a.	3.7
Doors	Solid timber	none	3.0

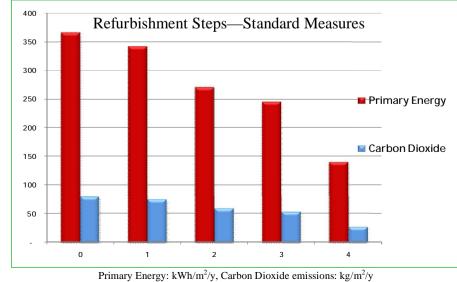
Heatir	ng systems characteristics:	Fuel	Efficiency							
Primary	Central heating boiler, pipework uninsulated.	Mains gas	70%							
Secondary	Open fire in grate	Smokeless	30%							
Hot water	From primary heating system. Electric immers	ion heater is used	l in summer.							
Cylinder	Insulated with loose jacket, 35 mm thick, no the	hermostat								
Controls	Time clock only									

Description

Red-brick fronted detached house with cavity wall construction, i.e. wall contains a 100mm cavity part-filled with a 50mm insulation board. More commonly found outside of Dublin and neighbouring counties.

	Ref	urbish		Prim. energy kWh/m ² /y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating						
0	Bu	ilding fa	Expected U-values	366 (actual state)	79 (actual state)	E2						
1	Roof insulation and standard package*			341	73	E2						
2	Wall insulation Add 50-80 mm of remaining cavity filled with beads		0.41 (for 50mm)	270	58	D2						
3	Windows and Doors	Replace	Double glazed low-e windows, air filled, 16mm gap. Insulated PVC/wooden doors.	2.0	245	52	D1					
	Systems upgrade:											
4	Space and water heating system and controls	Replace	Condensing boiler 90% efficient, two separated heating time and thermostatic control, independent water heatin Hot water cylinder insulated with 50 mm spray foam.	140	27	B3						

*also includes draughtstripping, 80mm lagging jacket for DHW cylinder and low energy bulbs.



Estimated costs and payback time**								
Measure	Estimated costs	Payback (y)						
Step 1	€ 830	4.3						
Step 2	€ 1,600	3.8						
Step 3	€ 8,200	55.6						
Step 4	€ 3,000	4.5						
Total:	€ 13,630	9.5						

Standard upgrade summary								
Consumption of primary energy reduced by:	226 kWh/m²/y							
Emission of carbon dioxide reduced by:	52 kgCO ₂ /m ² /y							

	Typical	l roof upgi	ade (s	tandard/a	advanced)			Heati	ng sys	tem u	upgrade		
	nm of min- wool be-		YYYYY	Before:		Feature	e:	S	Standar	d	Advance		ed
joists						Heat generator			Regular condensing boiler		Ground source heat		at pump
upgra	cal roof ade includes			After:		Efficiency: 90		90%			400%		
	ng the attic ation up to nm					Fuel:		Mains	s gas		Electricity	1	
Cond	luctivity = W/mK					SH Control type:	s	Full z	one cont	rol	Full zone compensa		load
	Typical wall upgrade (standard)				dard)	Hot water		Prima	ry heatir	ng	Primary h		vstem
	B	efore			After		source (HW):		system		and solar thermal pa providing 50% of H demand		panels
Cavity walls, ou brick and inner b with plasterwork		olock		Remaining cavity filled with the beads through the number	HW Cylind	ler:	120 li insula	tre, facto ted	ory	200 litre combined cy der, factory insulated			
	partially insulated U-value =1.1 W/m ² K				of holes drilled in the outer brickwork. Conductivity of beads up to 0.033 W/mK			Time static	and thermo-		Time and thermostati		static
						Ventilation	entilation: Natura		al		MVHR, 9	0% effi	cient
	Refurbishment steps — advance					ed			Prim. e kWh/		Carbon D kgCO ₂ /	-	Energy Rating
0		Bu	ilding f	abric upgi	rade steps:			pected values	3 (actual	66 state)	79 (actual s		E2
	Roof insul standard j		Add	200 mm min	neral wool over the existin	ng insulation.		0.13 341		· · · · · ·	73		E2
2	Wall insul	ation	Add	50-80 mm of remaining cavity filled with beads, with combination of drylining (front) and external wall insulation (sides and rear). Thickness: 50-100 mm		external wall		0.21	0.21 248		53		D1
3	Windows	and Doors	Replace		Triple glazed low-e windows, argon filled, 16mm gap Insulated doors.			1.3 2.0			43		C3
			Sy	stems upg	rade:				<u>.</u>		<u>.</u>		
4 Space and water heat- ing system and con- trols Replace Ground source heat pump 400%, tw time and thermostatic control, independ mal panels providing 50% of hot wat cylinder. Mechanical ventilation with					rmostatic control, indeper providing 50% of hot wate	ndent water heatin er demand with co	ng, so ombin	lar ther- ied HW	9	2	22		B1
-	-	udes draughtstrip	ping, 80mi	m lagging jacke	et for DHW cylinder and	low energy bulbs.		Estim	ated c	osts a	and payl	back t	ime**
Refurbishment Steps—Advanced Measures					_		Meas	ure	Estima	ited costs	Paybac	ck (y)	
300					_		Step	Step 1 €		830		4.3	
						imany Engra		Step	02	€2	20,100		37.1
20						rimary Energy		Step 3		€ 11,050		4	59.2

Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y

2

3

**Note: 1. Costs are indicative only, based on typical prices (2011). 2. Measures analysed are one of many options, especially for the renewable heating systems.

4

Analysis conducted in association with IHER Energy Services, www.iher.ie

1



📰 Carbon Dioxide

Step 4

Total:

ergy reduced by:

reduced by:

Emission of carbon

Consumption of primary en-

€ 18,100

€ 50,080

Advanced upgrade summary

dioxide

30.8

33.2

274 kWh/m²/y

57 kgCO₂/m²/y

200

150

100

50

0







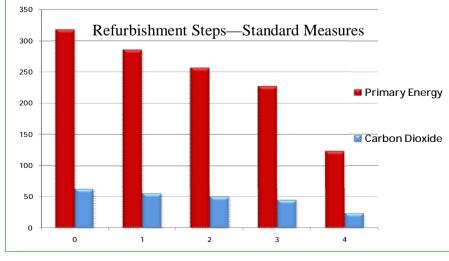
Description

Terraced house with cavity walls containing 25mm insulation boards. This one was found in Dublin but it could be anywhere in Ireland. This house is a perfect candidate for cavity wall insulation. Solid floors were standard for this period and so floor insulation options are limited.

	Building elements :	Insulation	U - value
Walls	300 mm cavity walls, partially filled	15-25 mm	1.1
Roofs	Pitched, insulation between joists	100 mm	0.4
Floors	Solid	10-15 mm	0.64
Windows	Double glazed, metal frame, 6mm gap	n.a.	3.7
Doors	Double glazed, metal frame, 6mm gap	none	3.0
Heatin	ng systems characteristics:	Fuel	Efficiency
Primary	Central heating boiler, pipework uninsulated.	Mains gas	70%
Secondary	Gas fire, coal effect	Mains gas	20%
Hot water	From primary heating system. Electric immersi	ion heater is used	l in summer.
Cylinder	Insulated with loose jacket, 35 mm thick, no th	nermostat	
Controls	Time clock only		

	Ref	Prim. energy kWh/m ² /y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating			
0	⁰ Building fabric upgrade steps:			Expected U-values	318 (actual state)	62 (actual state)	E1
1	Roof insulation and standard package*	Add	200 mm mineral wool over the existing insulation. 0.13		286	55	D2
2	Wall insulation	Add	50-80 mm of remaining cavity filled with beads	50-80 mm of remaining cavity filled with beads 0.41 (for 50mm)		50	D1
3	Windows and Doors	Replace	Double glazed low-e windows, air filled, 16mm gap, Insulated doors	2.0	227	44	D1
	Systems upgrade:						
4	Space and water heat- ing system and controls	Replace	Condensing boiler 90% efficient, two separated heating time and thermostatic control, independent water heati Hot water cylinder insulated with 50 mm spray foam.		124	24	B2

*also includes draughtstripping, 80mm lagging jacket for DHW cylinder and low energy bulbs.

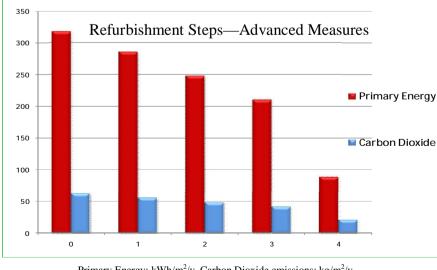


Estimated costs and payback time**

Measure	Estimated cos	sts Payback (y)
Step 1	€ 620	3.8
Step 2	€ 460	3.9
Step 3	€ 5,850	18.3
Step 4	€ 3,000	11.4
Total:	€ 9,930	11.5
Standar	d upgrade	summary
Consumption of pergy reduced by:	194 kWh/m²/y	
Emission of carbored by:	38 kgCO ₂ /m ² /y	

Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y

	Typical	roof upgr	ade (st	andard/a	advanced)		ł	Heati	ng system u	upgrade	
	mm of min- wool]	Before:		Feature	e:	S	tandard	Advance	ed
betw ceili	veen the ng joists	een the				Heat genera	ator	Regul boiler	ar condensing	Air source heat p	ump
upgr	ical roof ade includes ing the attic		00000	After:		Efficiency:		90%		380%	
insul 300	lation up to mm.					Fuel:		Mains	gas	Electricity	
	ductivity 04 W/mK					SH Control type:	s	Full z	one control	Full zone control, compensation	load
	Typ	pical wall	upgrad	de (stand	dard)	Hot water		Drimo	ry heating	-	vetom
	Be	fore			After	source (HW	V):	systen		Primary heating system and solar thermal pane providing 50% of HW demand	
		Cavity walls, out brick and inner b with plasterwork	olock		Remaining cavity filled with the beads through the number	HW Controls		120 litre, factory insulated		200 litre combined cylinder, factory insulate	
	1 🛛 📲	partially insulate U-value =1.1 W/m ² K			of holes drilled in the outer brickwork. Conductivity of beads up to 0.033 W/mK						Time and thermos
							:	Natur	al	MVHR, 90% effi	cient
		Refu	ırbishı	nent ste	eps — advanc	ed			Prim. energy kWh/m ² /y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating
0		Bu	ilding fa	bric upgr	ade steps:		Expe U-val		318 (actual state)	62 (actual state)	E1
1	Roof insula standard pa		Add	200 mm min	eral wool over the existing	ng insulation.	0.	13	286	55	D2
2	Wall insula	ition	Add	combination	f remaining cavity filled of drylining (front) and e ear). Thickness: 50-100 n	external wall		248	48	D1	
3	B Windows and Doors Replace Triple glazed low-e windows and door 16mm gap.		ors, argon filled,	1	.3	210	41	C3			
	Systems upgrade:										
4	Space and v ing system controls		Replace	with time an thermal pane	eat pump 380% efficient, d thermostatic control, in els providing 50% of hot r. Mechanical ventilation	dependent water l water demand wit	heating, th comb	solar ined	89	21	B1
* pa	package also includes draughtstripping, 80mm lagging jacket for DHW cylinder and low energy bulbs. Estimated costs and payback time**										



Estimated costs and payback time**					
Measure	Estimated co	sts	Payback (y)		
Step 1	€ 620		3.8		
Step 2	€ 4,720		31.2		
Step 3	€ 8,100		54.1		
Step 4	€ 11,100		27.0		
Total:	€ 24,540		28.1		
Advance	ed upgrad	e st	ummary		
Consumption of penergy reduced b	2	29 kWh/m²/y			
Emission of carbo reduced by:	4	1 kgCO ₂ /m ² /y			

Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y









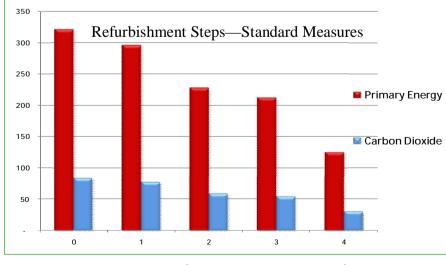
D	•	. •
Desc	rın	t10n
	чr	ci O II

Detached house with hollow block walls. These walls would be dry-lined internally with perhaps 25mm of insulation board on timber battens or else 50mm of fibre insulation may be placed between the battens.

	Building elements :	Insulation	U - value				
Walls	Concrete hollow block, drylined	25-50 mm	1.1				
Roofs	Pitched, insulation between joists	100 mm	0.4				
Floors	Solid	10-15 mm	0.64				
Windows	Double glazed, metal frame, 6mm gap	n.a.	3.7				
Doors	Double glazed, metal frame, 6mm gap	none	3.0				
Heatiı	ng systems characteristics:	Fuel	Efficiency				
Primary	Central heating boiler, pipework uninsulated.	Heating oil	75%				
Secondary	Open fire in grate	Solid multi- fuel	30%				
Hot water	Hot water From primary heating system. Electric immersion heater is used in summer						
Cylinder Insulated with loose jacket, 35 mm thick, no thermostat							
Controls	Time clock only						

	Refurbishment steps — standardPrim. energy kWh/m²/yCarbon Dioxide kgCO2/m²/yEnergy Rating							
			Expected U-values	322 (actual state)	83 (actual state)	E1		
1	Roof insulation and standard package*	Add	200 mm mineral wool over the existing insulation.	296	77	D2		
2	Wall insulation	Replace insulation	Walls re-drylined with 82.5mm phenolic/urethane boards.	0.27	228	59	D1	
3	Windows and Doors	Replace	Double glazed low-e windows and doors, air filled, 16mm gap	2.0	212	55	C3	
	Systems upgrade:							
4	Space and water heat- ing system and con- trols	Replace	Condensing boiler 90% efficient, two separated heating time and thermostatic control, independent water heating Hot water cylinder insulated with 50 mm spray foam.		126	31	В3	

*also includes draughtstripping, 80mm lagging jacket for DHW cylinder and low energy bulbs.



Estimated costs and payback time**					
Measure	Estimated co	sts	Payback (y)		
Step 1	€ 1,060			3.9	
Step 2	€ 14,780		1	7.3	
Step 3	€ 6,250		11.9		
Step 4	€ 3,500			5.0	
Total:	€ 25,590		1	0.9	
Standar	rd upgrade	e su	mmai	ry	
Consumption of p energy reduced b	1	.96 kW	h/m²/y		
Emission of carbored by:	5	2 kgCC	$D_2/m^2/y$		

Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y

	Typical	l roof upg	rade (s	standard/a	advanced)			Heati	ng syste	mι	ıpgrade		
	nm of min- vool be-		YYYYY	Before:		Featur	e:	S	tandard		A	dvance	ed
oists						Heat gener	ator	Regul boiler	ar condensi	ng	ng Ground source heat pu		eat pump
ipgra	cal roof ide includes		0000	After:	After:			90%			400%		
	ng the attic ation up to					Fuel:		Heatir	ng oil		Electricity	7	
Cond	uctivity = W/mK					SH Contro type:	ls	Full z	one control		Full zone compensa		load
		pical wall	upgra			Hot water			ry heating		Primary h		
B		efore	B		After	source (HV	V):			and solar thermal par providing 50% of HV demand			
A MOOOD		Concrete hollow block walls, dry insulation betwe	lined en		External wall insula- tion added, urethane, phenolic or EPS	HW Cylind	der:	120 lit insula	tre, factory ted		200 litre c der, factor		
KOCOCOC		the timber batter U-value =1.1 W/m ² K	ns,		boards, thickness: 80-120mm, conductivity = type:		ols	Time static			thermostatic		
10000X			MXXX		0.021—0.031 W/mK	Ventilation	1:	Natura	al		MVHR, 9	0% effi	cient
		Ref	urbish	nment ste	eps — advanc	ed			Prim. ener kWh/m ²		Carbon D kgCO ₂ /		Energy Rating
)		Bu	ilding f	fabric upgr	ade steps:		Exp -val	ected U ues	322 (actual sta	ate)	83 (actual s		E1
	Roof insul standard j		Add	200 mm min	eral wool over the existin	ng insulation.		0.13	296		77		D2
2 7	Wall insul	ation	Add	Walls insulat insulation bo	ted externally with 80-12 bards	0 mm thick		0.21	223		57		C3
3 7	Windows	and Doors	Replace	Triple glazed 16mm gap	l low-e windows and doo	ors, argon filled,		1.3	204		52		C3
			Sy	stems upg	rade:		·						<u> </u>
]	Space and heating sy controls		Replace	with time and thermal pane	ce heat pump 400% effic d thermostatic control, in els providing 50% of hot . Mechanical ventilation	dependent water water demand wi	heatin th con	ig, solar nbined	92		22		B1
* pac	kage also inc	ludes draughtstrij	pping, 80m	nm lagging jacke	et for DHW cylinder and	low energy bulbs	3.	Estim	ated cost	ts a	nd payl	oack t	time*
350)							Meas	ure Est	tima	ted costs	Paybac	ck (y)
300	,	Refurbish	ment St	teps—Adv	anced Measures			Step	1	€	1,060		3.9
250								Step	2	€ 1	9,800	2	21.5
					🗯 Pri	mary Energy		Step	3	€8	3,250	2	34.7
200					Ston	4	£ 1	8 100		11.8			

Primary Energy: $kWh/m^2/y$, Carbon Dioxide emissions: $kg/m^2/y$

2

3

**Note: 1. Costs are indicative only, based on typical prices (2011). 2. Measures analysed are one of many options, especially for the renewable heating systems.

4

Analysis conducted in association with IHER Energy Services, www.iher.ie

1



Carbon Dioxide

Step 4

Total:

Consumption of primary

Emission of carbon dioxide

energy reduced by:

reduced by:

€ 18,100

€ 47,210

Advanced upgrade summary

11.8

12.2

230 kWh/m²/y

55 kgCO₂/m²/y

150

100

50

0





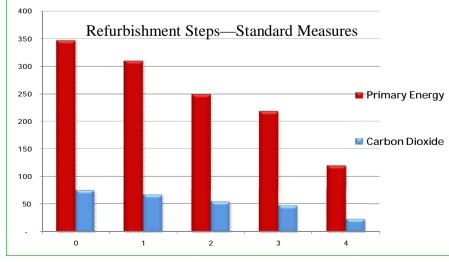


Description: Mid or end of terrace house commonly built in Dublin with a red-brick front with a small cavity behind it on the ground floor and 9 inch hollow block walls elsewhere. Insulation first appeared in 1978 and these walls would typically be drylined with 25mm polystyrene board or with 50mm of insulation fibre between battens.

	Building elements :	Insulation	U - value		
Walls	Concrete hollow block, drylined	15-25 mm	1.1		
Roofs	Pitched, insulation between joists	100 mm	0.4		
Floors	Solid	10-15 mm	0.57		
Windows	Double glazed, metal frame, 6mm gap	n.a.	3.7		
Doors	Double glazed, metal frame, 6mm gap (front) Solid wood (kitchen door)	n.a. none	3.7 3.0		
Heatiı	ng systems characteristics:	Fuel	Efficiency		
Primary	Central heating boiler, pipework uninsulated.	Mains gas	70%		
Secondary	Open fire in grate	Solid multi- fuel	30%		
Hot water From primary heating system. Electric immersion heater is used in a					
Cylinder Insulated with loose jacket, 35 mm thick, no thermostat.					
Controls	Programmer.				

	Ref	urbish		Prim. energy kWh/m²/y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating	
0	Bunding fabric upgrade steps.			Expected U-values	346 (actual state)	74 (actual state)	E2
1	Roof insulation and standard package*	Add	200 mm mineral wool over the existing insulation. 0.13		310	66	E1
2	Wall insulation	Replace insulation	Walls re-drylined with 82.5mm phenolic/urethane boards.			53	D1
3	Windows and Doors	Replace	Double glazed low-e windows, air filled, 16mm gap Insulated doors.	2.0	218	46	C3
	Systems upgrade:						
4	Space and water heat- ing system and con- trols	Replace	Condensing boiler 90% efficient, two separated heating time and thermostatic control, independent water heati Hot water cylinder insulated with 50 mm spray foam.		120	23	B2

*also includes draughtstripping, 80mm lagging jacket for DHW cylinder and low energy bulbs.



Estimated costs and payback time**

Measure	Estimated cos	sts Payback (y)
Step 1	€ 680	3.8
Step 2	€ 6,160	25.9
Step 3	€ 7,200	59.6
Step 4	€ 3,000	6.8
Total:	€ 17,040	17.5
Standa	d upgrade	summary
Consumption of p energy reduced b	226 kWh/m²/y	
Emission of carbo reduced by:	51 kgCO ₂ /m ² /y	

Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y

	Typical	roof upgi	ade (s	tandard/	advanced)]	Heati	ng sys	tem ı	upgrade		
	nm of min- vool be-			Before:		Feature	e:	5	Standar	d	A	dvance	ed
oists		<u>ND00000</u>				Heat genera	ator	Regul boiler	ar conde	ensing	Air source	e heat p	ump
ipgra	cal roof ide includes	YYYYYYY	YYYYY	After:	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	Efficiency:		90%			380%		
nsula 800 n						Fuel:		Mains	s gas		Electricity	1	ump ystem panels HW d cylin- ted cient Energy Rating E1 D1 C3 E1 D1 C3 E1 D1 C3 E1 D1 C3 Static E1 D1 C3 C3 C3 C3 C3 C3 C3 C3 C3 C3 C3 C3 C3
	uctivity 04 W/mK	<u> </u>			<u></u>	SH Control type:	s	Full z	one cont	rol	Full zone	control	
		pical wall	upgra			Hot water			ry heatir	ng	Primary h		
Before Concrete hollow block walls, drylined insulation between the timber battens, U-value =1.1 W/m ² K		B		After	source (HW	/):	syster	n		and solar providing demand		panels	
		block walls, dry insulation betwe	lined en		External wall insula- tion added, urethane, phenolic or EPS	HW Cylind	er: 120 litre, factory insulated		ory	200 litre combined c der, factory insulated			
		U-value	ns,		boards, thickness: 80-120mm, conductivity	HW Contro type:	ols	Time and thermo-		mo-	Time and thermostati		static
					= 0.021—0.031 W/mK	Ventilation	:	Natur	al		MVHR, 9	0% effi	cient
		Refu	urbish	ment st	eps — advanc	ed			Prim. er kWh/		Carbon E kgCO ₂ /		
Building fabric upgrade steps:				rade steps:			ected alues	34 (actual		74 (actual		E2	
	Roof insula standard p		Add	200 mm min	neral wool over the existi	ng insulation.	0	.13	31	0	66		E1
	Wall insul	ation	Add	Walls insulation be	ted externally with 80-12 pards	20 mm thick	0	.21	24	4	52		D1
	Windows a	and Doors	Replace	1 0	d low-e windows, argon n doors, insulated	filled, 16mm gap		1.3 2.0	21	3	45		C3
			Sy	stems upg	rade:				<u> </u>				
:	Space and ing system controls	water heat- and	Replace	with time ar thermal pan	eat pump 380% efficient ad thermostatic control, in els providing 50% of hot r. Mechanical ventilation	dependent water l water demand wit	neating h coml	, solar bined	8	8	21		B1
pac	kage also incl	udes draughtstrip	oping, 80m	n lagging jack	et for DHW cylinder and	low energy bulbs.	F	Estim	ated co	osts a	and payl	back t	time*
400)	D (1'1		A 1	1.5.6	-		Meas	sure	Estima	ited costs	Paybao	ck (y)
350)	Refurbishr	nent St	eps—Adv	anced Measures	-		Step) 1	€	680		3.8
300)					_		Step	o 2	€	8,260		32.3
250					🖬 Pr	imary Energy		Step	o 3	€	9,350	-	76.9
200						-		Step	o 4	€ 1	1,100	,	26.5
150					Ca	rbon Dioxide		Tota	al:	€ 2	29,390		30.2
100						-		A	dvance	ed up	grade si	umma	ary
50						-			otion of p educed by		2	258 kW	h/m²/y
-	0	1		2	3 4			mission duced b	of carbo	on dic	oxide 5	3 kgC0	$D_2/m^2/y$







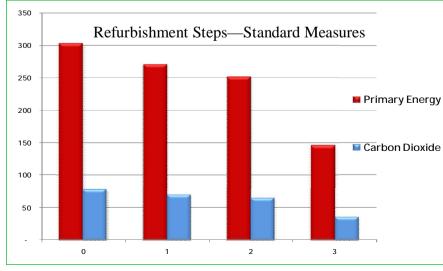
	Building elements :	Insulation	U - value			
Walls	Cavity walls, partially filled	25-50 mm	0.6			
Roofs	Pitched, insulation between joists	100 mm	0.4			
Floors	Solid	10-15 mm	0.57			
Windows	indows Double glazed, wooden frame, 6 mm gap		3.1			
Doors Solid wooden		none	3.0			
Heating systems characteristics: Fuel Efficience						
Heati	ng systems characteristics:	Fuel	Efficiency			
Heatin Primary	ng systems characteristics: Central heating boiler, pipework uninsulated.	Fuel Heating oil	Efficiency 75%			
			•			
Primary	Central heating boiler, pipework uninsulated.	Heating oil Coal	75%			
Primary Secondary	Central heating boiler, pipework uninsulated. Open fire in grate	Heating oil Coal ion heater is used	75%			

Description

Very typical rural bungalow from the 1980s. 50mm of polystyrene wall insulation was normally fitted during construction. The part-filled cavity can be full-filled by pumping in additional insulation beads.

	Ref	urbish		Prim. energy kWh/m ² /y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating			
0	Building fabric upgrade steps: Expecte U-value				303 (actual state)	78 (actual state)	E1		
1	Roof insulation and standard package*	Add	200 mm mineral wool over the existing insulation.	0.13	271	70	D2		
2	Wall insulation	Add	Remaining cavity (50mm) filled with insulation beads	0.27	252	65	E1		
	Systems upgrade:								
3	Space and water heating system and controlsReplaceCondensing boiler 90% efficient, two separated heating zones with time and thermostatic control, independent water heating.			-	146	36	B3		

*also includes draughtstripping, 80mm lagging jacket for DHW cylinder and low energy bulbs.



Estimated costs and payback time**

Measure	Estimated costs		Payback (y)		
Step 1	€ 1,940		5.3		
Step 2	€ 1,270		5.2		
Step 3	€ 3,500		tep 3 € 3,500		2.8
Total	€ 6,710		3.6		
Standa	rd upgrade	su	mmary		
Consumption of penergy reduced b	1	57 kWh/m²/y			
Emission of carbored by:	4	2 kgCO ₂ /m ² /y			

Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y

		root upgi	rade (s	standard	(advanced)		1	Heati	ng sys	tem i	ıpgrade		
	mm of min- wool be-			Before:		Feature	e:	S	Standar	d	A	dvance	ed
oist						Heat genera	ator	Regul boiler	ar conde	ensing	Ground so	ource he	eat pump
ıpgı	cal roof ade includes		0000	After:		Efficiency:		90%			400%		
nsu 300	ing the attic ation up to mm.					Fuel:		Heati	ng oil		Electricity	7	
	ductivity = W/mK	<u>MD00000</u>				SH Control type:	S	Full z	one cont	rol	Full zone	control	
		pical wal	lupgra	ade (star		Hot water	T)		ry heatir	ng	Primary h		
	Be	efore			After	source (HW):		system			and solar thermal pane providing 50% of HW demand		
Cavity walls, p filled with insu boards, 25-50 r thick. U-value =0.6 W/m ² K		ation		Remaining cavity filled with insulation beads, conductivity	lation Hw Cylinder: 120 f		120 litre, factory		200 litre combined cy der, factory insulated				
				=0.033 W/mK	HW Contro type:	ols	Time static	and ther	mo-	Time and	Time and thermostatic		
						Ventilation	:	Natur	al		MVHR, 9	0% effi	cient
		Ref	urbish	ment st	eps — advanc	ed			Prim. e kWh/		Carbon D kgCO ₂ /	-	Energy Rating
)		Bu	ilding	fabric upg	grade steps:		Expe U-va		3 (actual	03 state)	78 (actual		E1
l	Roof insula standard p		Add	200 mm m	ineral wool over the existi	ng insulation.	0.	.13	27	'1	70		D2
2	Wall insula	ation	Add	beads, wall	cavity (50mm) filled with s insulated internally with ethane drylining boards		0.	.21	24	2	62		D1
			Sy	stems up	grade:						<u> </u>		
3	Space and heating sys controls		Replace	time and th mal panels	urce heat pump 400%, two ermostatic control, indepe providing 50% of hot wat lechanical ventilation with	endent water heating er demand with co	ng, sola mbinec	r ther-	11	.0	26		B2
ра	ckage also inclu	ıdes draughtstrij	oping, 80m	m lagging jac	ket for DHW cylinder and	low energy bulbs	E	Estim	ated co	osts a	ind payl	oack t	ime*
35		Defeation			1	_		Meas	ure	Estima	ted costs	Paybac	ck (y)
30		Refurbishi		eps—Adv	vanced Measures	_		Step) 1	€	1,940		5.3
25					= P	rimary Energy		Step	02	€ 1	1,400	2	30.9
20						arban Diavida		Step	3	€ 1	8,100		9.8
10						arbon Dioxide		Tota	al:	€ 3	51,440	1	12.2
5	0					_				-	grade si		
						_		Consumption of primary energy reduced by:				193 kWh/m²/y	
	0		1	2	3								$D_2/m^2/y$

Analysis conducted in association with IHER Energy Services, www.iher.ie







U - value

Insulation



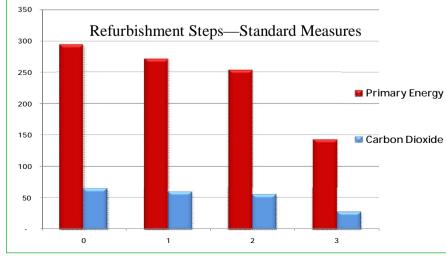
Building elements : 25-50 mm Walls Cavity walls, partially filled 0.6 Pitched, insulation between joists 100 mm 0.4 Roofs Solid 10-15 mm 0.64 Floors Double glazed, PVC frame, 6 mm gap 3.1 n.a Windows Solid wooden none 3.0 Doors Fuel Efficiency Heating systems characteristics: Central heating boiler, pipework uninsulated. Mains gas 75% **Primary** Smokeless 30% Open fire in grate Secondary From primary heating system. Electric immersion heater is used in summer. Hot water Insulated, loose jacket 35mm, no cylinder thermostat. Cylinder Programmer. Controls

Description

Semi-detached house with part-filled cavity walls and solid floors. The part-filled cavity can be full-filled by pumping in additional insulation beads. This house type is common throughout Ireland during the 1980s.

	Ref	urbish		Prim. energy kWh/m ² /y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating	
0	Building fabric upgrade steps: Expe- U-val				294 (actual state)	63 (actual state)	D2
1	Roof insulation and standard package*	Add	200 mm mineral wool over the existing insulation.	0.13	271	58	D2
2	Wall insulation	Add	Remaining cavity (50mm) filled with insulation beads	0.27	253	54	D1
		System	s upgrade:				
3	Space and water heating system and controls	Replace	Condensing boiler 90% efficient, two separated heating time and thermostatic control, independent water heatin Hot water cylinder insulated with 50 mm spray foam.	143	27	B3	

*also includes draughtstripping, 80mm lagging jacket for DHW cylinder and low energy bulbs.

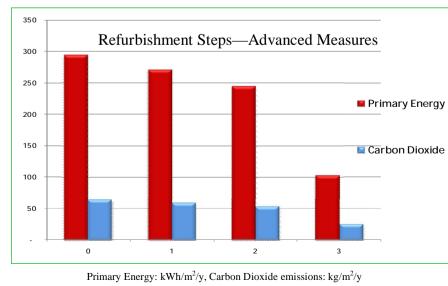


Estimated c	costs and p	ayback time**
Measure	Estimated cos	ts Payback (y)
Step 1	5.4	
Step 2	€ 870	10.6
Step 3	€ 3,000	5.3
Total:	€ 4,630	5.9
Standa	rd upgrade	summary
Consumption of energy reduced b	151 kWh/m²/y	
Emission of carb reduced by:	36 kgCO ₂ /m ² /y	

Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y

	Typical roof upg	ade (st	andard/a	advanced)		ŀ	Ieati	ng system u	upgrade	
	mm of min- wool be-		Before:		Feature	e:	S	Standard	Advance	ed
joist					Heat genera		Regul boiler	ar condensing	Air source heat pump 380%	
upgi	ical roof rade includes ping the attic		After:		Efficiency:		90%			
insu 300	lation up to mm.				Fuel: Mains		s gas	Electricity		
	nductivity = <u>14 W/mK</u> There is a 1 area 11 area area do (a doce no co d)				SH Control type:	s	Full z	one control	Full zone control	
	Typical wall	upgrac	le (adva	nced)	Hot water		Prima	ry heating	Primary heating s	ystem
	Before			After	source (HW	V):	system	n	and solar thermal panels providing 50% of HW demand	
	Cavity walls, pa filled with insul boards, 25-50 m	ation _		Remaining cavity filled with insulation beads, conductivity				200 litre combined cylin- der, factory insulated		
	thick. U-value $= 0.6 \text{ W/m}^2\text{K}$			= 0.033 W/mK			and thermo-	Time and thermostatic		
					Ventilation	:	Natur	al	MVHR, 90% efficient	
	Refu	urbishi	ment ste	eps — advanc	ed			Prim. energy kWh/m ² /y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating
0	Bu	ilding fa	abric upgr	ade steps:		Expec U-val		294 (actual state)	63 (actual state)	D2
1	Roof insulation and standard package*	Add	200 mm min	eral wool over the existi	ng insulation.	0.	13	271	58	D2
2	Wall insulation	Add	beads, walls	avity (50mm) filled with insulated internally with e drylining boards		0.1	21	244	53	D1
		Sys	tems upg	rade:						
3	Space and water heating system and controls	Replace	and thermost panels provide	eat pump 380% two sepa tatic control, independen ding 50% of hot water de ical ventilation with heat	t water heating, so mand with combi	olar theri ned HW	mal	103	25	B2

* package also includes draughtstripping, 80mm lagging jacket for DHW cylinder and low energy bulbs.



Estimated costs and payback time**								
Measure	Estimated cos	ts	Payback (y)					
Step 1	€ 760		5.4					
Step 2	€ 7,800		64.5					
Step 3	€ 13,100		24.7					
Total:	€ 21,660		27.4					
Advance	ed upgrade	e su	ımmary					
Consumption of p energy reduced by		1	91 kWh/m²/y					
Emission of carbon dioxide 38 kgCO₂/m²/y reduced by:								

**Note: 1. Costs are indicative only, based on typical prices (2011). 2. Measures analysed are one of many options, especially for the renewable heating systems.

Analysis conducted in association with IHER Energy Services, www.iher.ie



21. Detached bungalow, hollow block walls, 1983-1993





Description

This house was found in Dublin and had hollow block walls with internal dry-lining. If it was located outside Dublin, cavity wall construction would be more likely. The room in the roof at first floor level would have had modest fibre insulation at the time of construction and could be much improved.

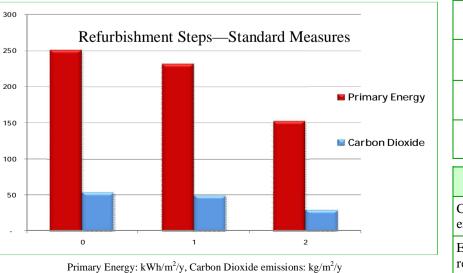
	Building elements :	Insulation	U - value
Walls	Concrete hollow block	25-50 mm	0.6
Roofs	Pitched, insulation between joists Insulation between rafters	100 mm 100 mm	0.4 0.4
Floors	Solid	10-15 mm	0.64
Windows	Double glazed, PVC frame, 6 mm gap	n.a	3.1
Doors	Solid wooden	none	3.0
Heati	ng systems characteristics:	Fuel	Efficiency
Heatii Primary	ng systems characteristics: Central heating boiler, pipework uninsulated.	Fuel Mains gas	Efficiency 75%
Primary	Central heating boiler, pipework uninsulated.	Mains gas Smokeless	75% 30%
Primary Secondary	Central heating boiler, pipework uninsulated. Open fire in grate	Mains gas Smokeless ion heater is used	75% 30%

	Ref		Prim. energy kWh/m ² /y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating		
0	Bu	ilding fa	bric upgrade steps:	Expected U-values	251 (actual state)	54 (actual state)	D1
1	Roof insulation and standard package*	Add	200 mm mineral wool over the existing insulation.	0.13	232	49	D1

Walls are insulated, but the thickness of the insulation is below the current standards. One of the possible measures is re-drylining or installing external wall insulation to achieve a U-value of 0.27 W/m²/K. Usually, when the walls are uninsulated, the payback time for installing external wall insulation is around 10-15 years. But in this case, where the walls are partially insulated, the payback time would be around 80 years. Therefore it is not recommended on economic grounds. Replacement of double glazed windows to achieve current standards is also possible, but due to long payback times, this step is not generally recommended either.

Systems upgrade:								
2 Space and water heating system and controls Repla	Condensing boiler 90% efficient, two separated heating zones with time and thermostatic control, independent water heating. Hot water cylinder insulated with 50 mm spray foam.	153	29	C1				

*also includes draughtstripping, 80mm lagging jacket for DHW cylinder and low energy bulbs.

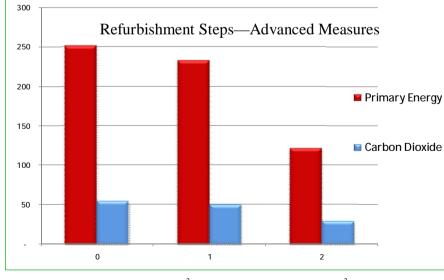


Estimated costs and payback time**						
Measure	Estimated costs	Payback (y)				
Step 1	€ 1,020	5.8				
Step 2	€ 3,000	5.6				
Total: € 4,020 5.6						
Standard upgrade summary						

Standard upgrade summary					
Consumption of primary energy reduced by:	98 kWh/m²/y				
Emission of carbon dioxide reduced by:	25 kgCO ₂ /m ² /y				

	Typical	roof upgr	ade (st	andard/advanced)		He	eati	ng system ı	ıpgrade	
	mm of min- wool be-			Before:	Feature	e:	S	Standard Advance		ed
twee joist	tween ceiling joists		Heat genera	erator Regular condensing boiler		ar condensing	Air source heat pump			
upg	Typical roof After: P0%			380%						
insu 300	bing the attic lation up to mm. ductivity =				Fuel:	Ν	Mains	gas	Electricity	
	W/mK	Muuu			SH Control type:	s F	Full zo	one control	Full zone control	
	Typical wall construction			Primary heating s						
Concrete hollow block, insulated		ck, insulated			ysten		and solar thermal panels providing 50% of HW demand			
			25-50m wooden	bollow block, internally drylined. n thick insulation between the battens, 12.5 mm thick plaster- U value = 0.6 W/m ² K	HW Cylinder: 120 litt insulat			200 litre combined cylin- der, factory insulated		
			boards. O value – 0.0 w/m K		HW Contro type:		Time and thermo- static		Time and thermostatic	
					Ventilation	n: Natural		al	MVHR, 90% efficient	
	Refurbishment steps — advanced		Prim. energy kWh/m ² /y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating					
0		Bu	ilding fa	bric upgrade steps:		Expecte U-value		251 (actual state)	54 (actual state)	D1
1	Roof insula standard p		Add	200 mm mineral wool over th insulation.	e existing	0.13	3	232	49	D1
	Systems upgrade:				-					
2	-	Space and water heat- ing system and con- trolsAir source heat pump 380% efficient, two separated heating zones with time and thermostatic control, inde- pendent water heating, solar thermal panels providing 50% of hot water demand with combined HW cylinder. Mechanical ventilation with heat recovery (MVHR).		122	29	B2				

* package also includes draughtstripping, 80mm lagging jacket for DHW cylinder and low energy bulbs.



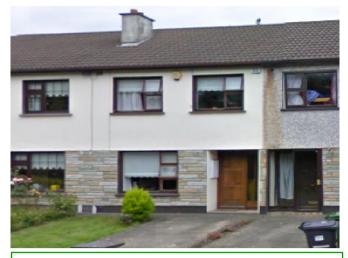
Estimated costs and payback time**				
Measure	Estimated costs		Payback (y)	
Step 1	€ 1,020		5.8	
Step 2	€ 13,100		31.0	
Total:	€ 14,120		23.6	
Advanc	ed upgrade	e su	ımmary	
Consumption of p energy reduced b	1	29 kWh/m²/y		
Emission of carbo reduced by:	2	5 kgCO ₂ /m ² /y		

Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y









Description

Very typical house built in Dublin and east coast area during the 1980s with hollow block walls that were dry-lined internally with 50mm of fibre insulation between wooden battens fixed to the walls. See notes on wall insulation options below. Solid floors are common with this house type.

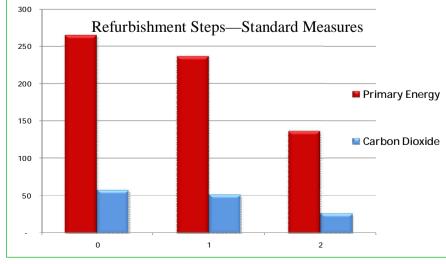
	Building elements :	Insulation	U - value
Walls	Concrete hollow block with internal dry- lining	25-50 mm	0.6
Roofs	Roofs Pitched, insulation between joists		0.4
Floors Solid		10-15 mm	0.48
Windows Double glazed, metal frame, 12 mm gap		n.a	3.4
Doors Solid wooden		none	3.0
Heati	ng systems characteristics:	Fuel	Efficiency
Heatii Primary	ng systems characteristics: Central heating boiler, pipework uninsulated.	Fuel Mains gas	Efficiency 75%
Primary	Central heating boiler, pipework uninsulated.	Mains gas Smokeless	75%
Primary Secondary	Central heating boiler, pipework uninsulated. Open fire in grate	Mains gas Smokeless ion heater is used	75%

	Refurbishment steps — standard				Prim. energy kWh/m ² /y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating
0	Building fabric upgrade steps: Expected U-values		-	265 (actual state)	57 (actual state)	D2	
1	Roof insulation and standard package*	Add	200 mm mineral wool over the existing insulation.	0.13	237	51	D1

Walls are insulated, but the thickness of the insulation is below the current standards. One of the possible measures is re-drylining or installing external wall insulation to achieve a U-value of $0.27 \text{ W/m}^2/\text{K}$. Usually, when the walls are uninsulated, the payback time for installing external wall insulation is around 10-15 years. But in this case, where the walls are partially insulated, the payback time would be around 80 years. Therefore it is not recommended on economic grounds. Replacement of double glazed windows to achieve current standards is also possible, but due to long payback times, it is not recommended either.

System	s upgrade:			
2 Space and water heating system and controls Replace	Condensing boiler 90% efficient, two separated heating zones with time and thermostatic control, independent water heating. Hot water cylinder insulated with 50 mm spray foam.	136	26	B3

*also includes draughtstripping, 80mm lagging jacket for DHW cylinder and low energy bulbs.



Estimated costs and payback time**							
Measure	Estimated costs	Payback (y)					
Step 1	€ 570	4.7					
Step 2	€ 3,000	7.6					
Total: € 3,570 6.9							

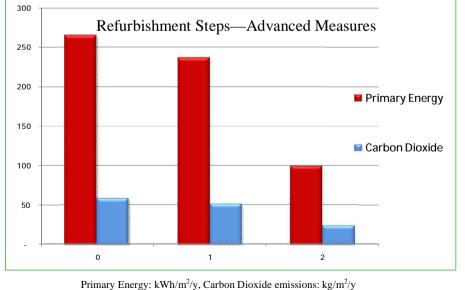
Standard upgrade summary					
Consumption of primary energy reduced by:	129 kWh/m²/y				
Emission of carbon dioxide reduced by:	31 kgCO ₂ /m ² /y				

Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y

	Typical	roof upgi	ade (st	andard/advanced)]	Heati	ng system i	upgrade	
	mm of min- wool be-			Standard	Advanced					
joist	en ceiling ts Heat generator Regul		Regular condensing boiler		Air source heat pump					
upg	vical roof rade includes bing the attic		00000	After:	Efficiency:		90%		380%	
insu	ilation up to mm.				Fuel:		Mains	s gas	Electricity	
	ductivity = 4 W/mK				SH Control	ls	Full z	one control	Full zone control	
	Concrete hollow block, insulated source (HW): system Concrete hollow block, internally drylined. 25-50mm thick insulation between the wooden battens, 12.5 mm thick plaster-boards. U value = 0.6 W/m ² K HW Cylinder: 120 litt insulation		nstruction			Prima	ry heating	Primary heating s	system	
			W): system an pr		and solar thermal panels providing 50% of HW demand					
			25-50mm thick insulation between the wooden battens, 12.5 mm thick plaster-		HW Cylinder: 120 lit		tre, factory ted	200 litre combined cylin- der, factory insulated		
								and thermo-	Time and thermostatic	
	×				Ventilation: Natura		al	MVHR, 90% efficient		
		Refu	ırbishı	nent steps — advanc	ed			Prim. energy kWh/m ² /y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating
0		Bu	ilding fa	bric upgrade steps:		Expe U-va		265 (actual state)	57 (actual state)	D2
1	Roof insula standard p			.13	237	51	D2			
			Sys	tems upgrade:						
2	Space and heating sys controls		Replace	Air source heat pump 380% e heating zones with time and th pendent water heating, solar t 50% of hot water demand with Mechanical ventilation with h	hermostatic co hermal panels h combined H	ntrol, provic W cyl	inde- ding inder.	100	24	B1

* package also includes draughtstripping, 80mm lagging jacket for DHW cylinder and low energy bulbs.

Estimated costs and payback time**



	1 5	
Measure	Estimated costs	Payback (y)
Step 1	€ 570	4.7
Step 2	€ 11,100	28.2
Total:	€ 11,670	22.6

Advanced upgrade summary					
Consumption of primary energy reduced by:	165 kWh/m²/y				
Emission of carbon dioxide reduced by:	33 kgCO ₂ /m ² /y				









	Building elements :	Insulation	U - value
Walls	Cavity walls, partially filled	50 mm	0.55
Roofs	Pitched, insulation between joists	150 mm	0.41
Floors	Solid	20-30mm	0.26
Windows	Double glazed, PVC/wood, 12 mm gap	n.a	2.8
Doors	Solid wooden	none	3
		1	
Heati	ng systems characteristics:	Fuel	Efficiency
Heatin Primary	ng systems characteristics: Central heating boiler, pipework uninsulated.	Fuel Heating oil	Efficiency 75%
			-
Primary	Central heating boiler, pipework uninsulated.	Heating oil Smokeless	75%
Primary Secondary	Central heating boiler, pipework uninsulated. Open fire in grate	Heating oil Smokeless controls,.	75%

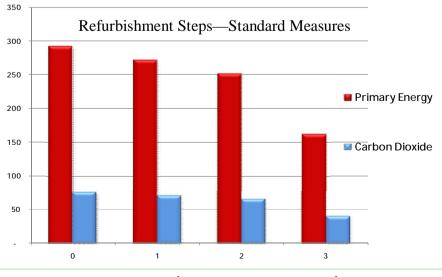
Description

Semi-detached bungalow with cavity walls part-filled with 50mm polystyrene insulation boards. The part-filled cavity can be full-filled by pumping in additional insulation beads. The solid floor was insulated at the time of construction.

	Ref	Prim. energy kWh/m²/y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating			
0	Building fabric upgrade steps:				292 (actual state)	75 (actual state)	D2
1	Roof insulation and standard package*	Add	150 mm of mineral wool over the existing insulation	0.13	271	70	D2
2	Wall insulation	Add Remaining cavity filled with insulation beads.		0.32	251	65	D1
		System	is upgrade:				
3	Space and water heating system and controls	Replace	ondensing boiler 90% efficient, two separated heating ones with time and thermostatic control, independent ater heating. ot water cylinder insulated with 50 mm spray foam.		162	40	C1

.

*also includes draughtstripping, 80mm lagging jacket for DHW cylinder and low energy bulbs.



Estimated costs and payback time**								
Measure	Estimated costs	s Payback (y)						
Step 1	€ 1,030	8.5						
Step 2	€ 800	6.0						
Step 2	€ 3,500	5.9						
Total:	€ 5,330	6.3						
Standar	d upgrade s	summary						
Consumption of penergy reduced b		130 kWh/m²/y						
Emission of carbored by:	on dioxide	35 kgCO ₂ /m ² /y						

Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y

	Typical	roof upgr	ade (st	andard/	advanced)]	Heat	ing system	upgrade	
eral	mm of min- wool be-	Before: Feature:		Before:		Before:			Standard	Advanced	
twee joist	en ceiling ts				<u> </u>	Heat gener	rator	Regu boile	llar condensing r	Air source heat pump	
upgi	ical roof rade includes bing the attic	YYYYYYY	~~~~~	After:		Efficiency	:	90%		380%	
insu 300	lation up to mm.					Fuel:		Heat	ing oil	Electricity	
	ductivity = 4 W/mK		6666666			SH Contro type:	ols	Full	zone control	Full zone contro	1
	Тур	pical wall	upgrac	le (adva	nced)	Hot water		Prim	ary heating	Primary heating	system
	Be	efore			After	source (HV	W):	syste	m	and solar therma providing 50% of demand	
		Cavity walls, pa filled with insula boards, 50 mm t	sulation filled with insulation beads, conductivity		HW Cylinder: 120 li insula		itre, factory ated	200 litre combined cylin- der, factory insulated			
		U-value =0.55 W/m ² K		=0.033 W/mK		HW Contr type:	ols	Time static	e and thermo-	Time and thermo	ostatic
						Ventilation: Natura		ral	MVHR, 90% eff	ficient	
		Refu	ırbishr	nent ste	eps — advance	ed			Prim. energy kWh/m ² /y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating
0		Bui	ilding fa	bric upgr	ade steps:		Expec U-valu		292 (actual state)	75 (actual state)	D2
1	Roof insula standard p		Add	150 mm ing insula	of mineral wool over tion.	r the exist-	0.1	13	271	70	D2
2	Wall insula	ation	Add	Remainin beads.	g cavity filled with i	nsulation	0.3	32	251	65	D1
			Sys	tems upg	rade:						
2	Space and heating sys controls		Replace	zones wit water hea hot water	e heat pump 380% tw h time and thermosta ting, solar thermal p demand with combi ventilation with heat	atic control, in anels providin ned HW cylin	ndepen ng 50% nder. N	dent of	124	29	B2

* package also includes draughtstripping, 80mm lagging jacket for DHW cylinder and low energy bulbs.

Estimated costs and payback time** 350 Measure Estimated costs Payback (y) Refurbishment Steps—Advanced Measures 300 Step 1 € 1,030 8.5 250 Step 2 € 800 6.0 Energy 200 Step 3 € 11,100 11.2 150 📓 Carbon Dioxide € 12,930 Total: 10.4 100 Advanced upgrade summary 50 168 kWh/m²/y Consumption of primary energy reduced by: 0 1 2 3 Emission of carbon dioxide 46 kgCO₂/m²/y reduced by: Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y





24. Terraced House, cavity walls, 1994-2004





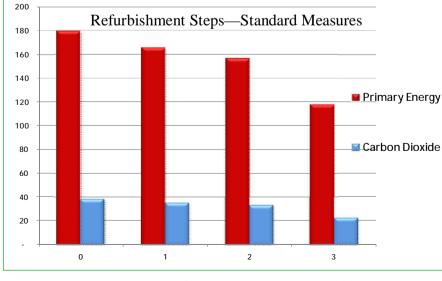
	Building elements :	Insulation	U - value
Walls	Cavity walls, partially filled	50 mm	0.55
Roofs	Pitched, insulation between joists	150 mm	0.36
Floors	Solid	20-30mm	0.26
Windows	Double glazed, PVC/wood, 12 mm gap	Not applicable	2.8
Doors	Solid wooden	none	3
Heati	ng systems characteristics:	Fuel	Efficiency
Heatin Primary	ng systems characteristics: Central heating boiler, pipework uninsulated.	Fuel Heating oil	Efficiency 80%
Primary	Central heating boiler, pipework uninsulated.	Heating oil Smokeless	80%
Primary Secondary	Central heating boiler, pipework uninsulated. Open fire in grate From primary heating system. Independent tim	Heating oil Smokeless a control of spa	80%

Description

Mid terrace house with part-filled cavity walls. The partfilled cavity can be full-filled by pumping in additional insulation beads. The floors were insulated during construction.

	Ref	Prim. energy kWh/m ² /y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating					
0	Building fabric upgrade steps:			Expected U-values	180 (actual state)	38 (actual state)	C2		
1	Roof insulation and standard package*	Add	150 mm of mineral wool over the existing insulation	0.13	166	35	C1		
2	Wall insulation	Add	Remaining cavity filled with insulation beads.	0.32	157	33	C1		
	Systems upgrade:								
3	Space and water heating system and controls	Replace	Condensing boiler 90% efficient, additional zone	heating	118	23	B2		

*also includes draughtstripping, 80mm lagging jacket for DHW cylinder and low energy bulbs.

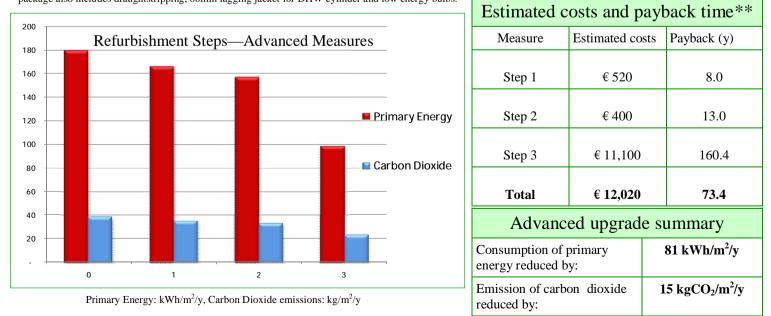


Estimated costs and payback time**							
Measure	Estimated cost	ts Payback (y)					
Step 1	€ 520	8.0					
Step 2	€ 400	13.0					
Step 2	€ 2,050	16.7					
Total:	€ 2,970	13.6					
Standar	d upgrade	summary					
Consumption of penergy reduced b		62 kWh/m²/y					
Emission of carbored by:	on dioxide	15 kgCO ₂ /m ² /y					

Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y

	Typical r	oof upgr	ade (st	andard/	advanced)		I	Heat	ing system	upgrade	
	mm of min- wool be-			Before:		Featur	Feature: Sta		Standard	Advanc	ed
twee joist	en ceiling ts					Heat gene	rator	Regu boile	llar condensing	Air source heat	pump
upg	vical roof rade includes bing the attic		20000	After:	00000000	Efficiency	:	90%		380%	
insu 300	lation up to mm.					Fuel:		Heat	ing oil	Electricity	
	aductivity = 4 W/mK					SH Contro type:	ols	Full	zone control	Full zone contro	1
		Typica	l wall ı	ıpgrade		Hot water		Prim	ary heating	Primary heating	system
	Bef	ore			After	source (H	W):	syste		and solar therma providing 50% of demand	
_	fi b	avity walls, pa lled with insula oards, 50 mm t	ation		Remaining cavity filled with insulation beads, conductivity =			120 I insul	itre, factory ated	200 litre combined cylin der, factory insulated	
		-value 0.55 W/m ² K		0.033 W/mK		HW ControlsTimetype:static		e and thermo-	Time and thermostatic		
						Ventilation: Natur		ral	MVHR, 90% efficient		
		Refu	ırbishn	nent ste	eps — advance	ed			Prim. energy kWh/m ² /y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating
0		Bui	ilding fa	bric upgr	ade steps:		Expec U-valı		180 (actual state)	38 (actual state)	C2
1	Roof insulat standard pa		Add	150 mm ing insula	of mineral wool over tion.	r the exist-	0.1	3	166	35	C1
2	Wall insulat	ion	Add	Remainin beads.	g cavity filled with i	insulation	0.3	32	157	33	C1
	Systems upgrade:										
3	Space and w heating syst controls		Replace	heating ze dependen ing 50% o	Air source heat pump 380% efficient, two separated eating zones with time and thermostatic control, in- ependent water heating, solar thermal panels provid- ng 50% of hot water demand with combined HW ylinder. Mechanical ventilation with heat recovery				99	23	B1

* package also includes draughtstripping, 80mm lagging jacket for DHW cylinder and low energy bulbs.



**Note: 1. Costs are indicative only, based on typical prices (2011). 2. Measures analysed are one of many options, especially for the renewable heating systems.

Analysis conducted in association with IHER Energy Services, www.iher.ie









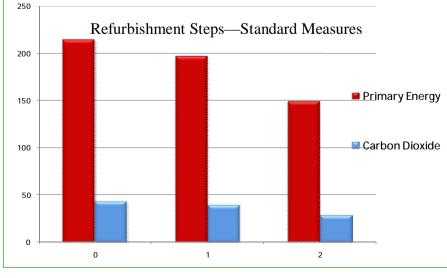
	Building elements :	Insulation	U - value
Walls	Timber frame	50 –100 mm	0.55
Roofs	Pitched, insulation between joists	150 mm	0.26
Floors	Solid	20-30mm	0.41
Windows	Double glazed, wood/PVC frame, 12 mm gap	n.a	2.8
Doors	Solid wooden	none	3.0
Heati	ng systems characteristics:	Fuel	Efficiency
Heatin Primary	ng systems characteristics: Central heating boiler, primary pipework uninsulated.	Fuel Gas	Efficiency 80%
	Central heating boiler, primary pipework		
Primary	Central heating boiler, primary pipework uninsulated.	Gas	80%
Primary Secondary	Central heating boiler, primary pipework uninsulated. Electric heaters	Gas Electricity controls,.	80%

Description

Timber frame construction started to become increasingly popular in the late 1990s and has made up more than 10% of the market from 2000 onwards. Apart from adding additional roof insulation, the focus for retrofit would be on upgrading the space & water heating systems.

	Ref	Prim. energy kWh/m²/y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating			
0	Building fabric upgrade steps:				215 (actual state)	43 (actual state)	C3
1	Roof insulation and standard package*Add150 mm of mineral wool over the existing insulation				197	39	C2
		System	s upgrade:	-			
3	Space and water Replace Condensing gas boiler 90% efficient, additional space heating system and controls Replace Condensing gas boiler 90% efficient, additional space				150	29	B3

*also includes draughtstripping, 80mm lagging jacket for DHW cylinder and low energy bulbs.



Estimated costs and payback time**								
Measure	Estimated costs	Payback (y)						
Step 1	€ 950	8.6						
Step 2	€ 2,060	7.6						
Total:	€ 3,010	7.9						

Estimated agets and marshaply times **

Standard upgrade	e summary
Consumption of primary energy reduced by:	65 kWh/m²/y
Emission of carbon dioxide reduced by:	14 kgCO ₂ /m ² /y

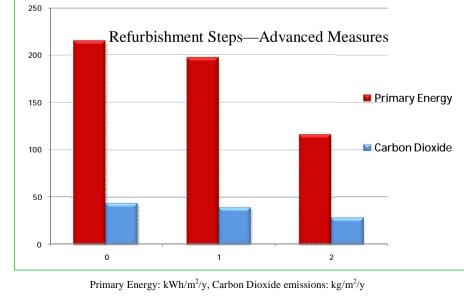
Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y

Typical	roof upgra	de (standard/advanced)]	Heating system	upgrade
150 mm of min- eral wool be-	Before:		Feature:	Standard	Advanced
tween ceiling joists			Heat generator	Regular condensing boiler	Air source heat pump
Typical roof upgrade includes topping the attic		After:	Efficiency:	90%	380%
insulation up to 300 mm.	n up to		Fuel:	Mains gas	Electricity
Conductivity = 0.04 W/mK	Conductivity = 0.04 W/mK			Full zone control	Full zone control
	Typical wa	all construction	type: Hot water	Primary heating	Primary heating system
	Tim	iber frame	source (HW):	system	and solar thermal panels providing 50% of HW demand
	Timber frame wall with the outer brickwork and ventilated drainage cavity. Insulation between the studs. U-value = 0.55 W/m ² K		HW Cylinder:	120 litre, factory insulated	200 litre combined cylin- der, factory insulated
			HW Controls type:	Time and thermo- static	Time and thermostatic
			Ventilation:	Natural	MVHR, 90% efficient

	Refurbishment steps — advanced				Prim. energy kWh/m ² /y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating
0				Expected U-values	215 (actual state)	43 (actual state)	С3
1	Roof insulation and standard package*	Add	150 mm of mineral wool over the exist- ing insulation.	0.13	197	39	C2
		Sys	tems upgrade:				
2	Space and water heating system and controls			117	28	B2	

* package also includes draughtstripping, 80mm lagging jacket for DHW cylinder and low energy bulbs.

Estimated costs and payback time**



Measure	Estimated costs	Payback (y)
Stop 1	€ 950	8.6
Step 1	£ 950	8.0
Step 2	€ 11,100	50.6
Step 2	€ 11,100	50.0
Total:	€ 12,050	36.5
Totali	• 12,000	0000

Advanced upgrade summary					
Consumption of primary energy reduced by:	98 kWh/m²/y				
Emission of carbon dioxide reduced by:	15 kgCO ₂ /m ² /y				





26. End of terrace house, timber frame, 1994-2004





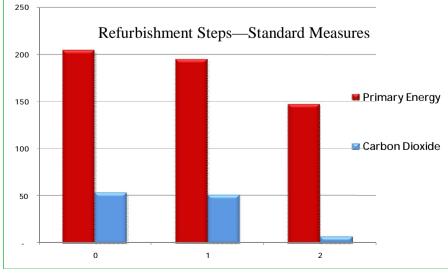
Description

Timber frame construction started to become increasingly popular in the late 1990s and has made up more than 10% of the market from 2000 onwards. Apart from adding additional roof insulation, the focus for retrofit would be on upgrading the space & water heating systems.

	Building elements :	Insulation	U - value
Walls	Timber frame	50 –100 mm	0.55
Roofs	Pitched, insulation between joists	150 mm	0.26
Floors	Solid	20-30mm	0.41
Windows	Double glazed, wood/PVC frame, 12 mm gap	n.a	2.8
Doors	Solid wooden	none	3.0
Heati	ng systems characteristics:	Fuel	Efficiency
Heatin Primary	ng systems characteristics: Central heating boiler, primary pipework uninsulated.	Fuel Heating oil	Efficiency 80%
	Central heating boiler, primary pipework		
Primary	Central heating boiler, primary pipework uninsulated.	Heating oil Coal	80%
Primary Secondary	Central heating boiler, primary pipework uninsulated. Open fire in grate	Heating oil Coal controls.	80%

	Refurbishment steps — standard				Prim. energy kWh/m²/y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating
0	Building fabric upgrade steps: Expected U-values			204 (actual state)	53 (actual state)	C3	
1	Roof insulation and standard package*	Add	150 mm of mineral wool over the existing insulation	0.13	194	50	C2
	Systems upgrade:						
2	2 Space and water heating system and controls Replace Wood pellet boiler 90% efficient, additional space heat- ing zone, secondary heating removed		147	7	B3		

*also includes draughtstripping, 80mm lagging jacket for DHW cylinder and low energy bulbs.



Estimated costs and payback time**					
Measure	Estimated costs	Payback (y)			
Step 1	€ 570	11.4			
Step 2	€ 7,500	38.9			
Total:	€ 8,070	33.2			
Standar	d upgrade s	ummary			
Consumption of penergy reduced b	•	57 kWh/m²/y			
Emission of carbo reduced by:	on dioxide	46 kgCO ₂ /m ² /y			

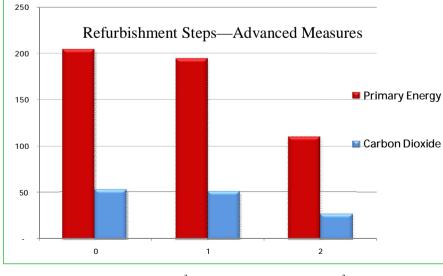
Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y

Typical	roof upgra	de (standard/advanced)	Heating system upgrade		
150 mm of min- eral wool be- tween ceiling	be- be- ling oof ncludes ne attic nup to		Feature:	Standard	Advanced
joists Typical roof			Heat generator	Regular condensing boiler	Air source heat pump
upgrade includes topping the attic			Efficiency:	90%	380%
insulation up to 300 mm. Conductivity =			Fuel:	Wood pellets	Electricity
0.04 W/mK				Full zone control	Full zone control
	Typical wall construction Timber frame Tiber frame		type: Hot water source (HW):	Primary heating system	Primary heating system and solar thermal panels providing 50% of HW demand
	Timber frame wall with the outer brickwork and ventilated drainage cavity. Insulation between the studs. U-value = 0.55 W/m ² K	HW Cylinder:	120 litre, factory insulated	200 litre combined cylin- der, factory insulated	
		HW Controls type:	Time and thermo- static	Time and thermostatic	
			Ventilation:	Natural	MVHR, 90% efficient

	Refurbishment steps — advanced				Prim. energy kWh/m ² /y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating
0	Building fabric upgrade steps: Expected U-values			204 (actual state)	53 (actual state)	C3	
1	Roof insulation and standard package*	Add	150 mm of mineral wool over the exist- ing insulation.	0.13	194	50	C2
	Systems upgrade:						
2	Space and water heating system and controls	e ·		110	26	B2	

* package also includes draughtstripping, 80mm lagging jacket for DHW cylinder and low energy bulbs.

Estimated costs and payback time**



Measure	Estimated cos	ts Payback (y)				
Step 1	€ 570	11.4				
Step 2	€ 11,100	63.5				
Total:	€ 11,670	51.9				
Advanc	ed upgrade	e summary				
Consumption of p energy reduced b		94 kWh/m²/y				
Emission of carbored by:	on dioxide	27 kgCO ₂ /m ² /y				

Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y





27. Detached house, cavity walls, 2005 - onwards





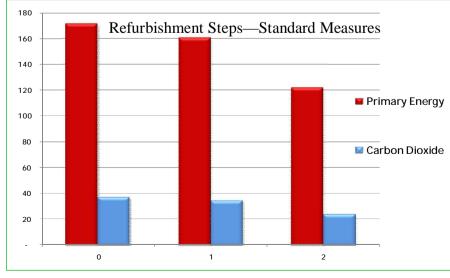
	Building elements :	Insulation	U - value
Walls	Cavity walls, partially filled	50-70 mm	0.37
Roofs	Pitched, insulation between joists	200 mm	0.2
Floors Solid		40-80 mm	0.25
Windows	Double glazed, Low-E, wood/PVC frame, 16 mm gap	n.a.	2.0
Doors	Solid wooden	none	3.0
Heati	ng systems characteristics:	Fuel	Efficiency
Heatii Primary	ng systems characteristics: Central heating boiler, primary pipework insulated.	Fuel Mains gas	Efficiency 80%
	Central heating boiler, primary pipework		
Primary	Central heating boiler, primary pipework insulated.	Mains gas Smokeless	80%
Primary Secondary	Central heating boiler, primary pipework insulated. Open fire in grate	Mains gas Smokeless	80%

Description

The cavity walls of this house are well insulated with U values as low as $0.27 \text{ W/m}^2\text{K}$ and the floors are well insulated. Apart from adding additional roof insulation, the focus for retrofit would be on upgrading the space & water heating systems.

	Refurbishment steps — standard				Prim. energy kWh/m ² /y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating
0	Building fabric upgrade steps: Expected U-values			171 (actual state)	37 (actual state)	C1	
1	Roof insulation and standard package*	Add	100 mm of mineral wool over the existing insulation	0.13	160	34	C1
		System	s upgrade:				
3	Space and water heating system and controls	Add/ replace	Gas condensing boiler 90% efficient, addition heating zone, secondary heating removed	onal space	122	23	B2

*also includes draughtstripping (if not present), 80mm lagging jacket for DHW cylinder (if insulation is not present) and low energy bulbs.



Estimated costs and payback time								
Measure	sts	Payback (y)						
Step 1	€ 540		6.4					
Step 2	€ 2,200		11.7					
Total:	€ 2,740		10					
Standar	rd upgrade	e su	mmary					
Consumption of pergy reduced by:	,	49 kWh/m²/y						
Emission of carbored by:	1	4 kgCO ₂ /m ² /y						

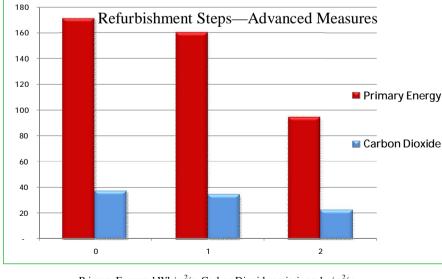
Estimated costs and payback time**

Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y

	Typical roof	upgra	de (st	andard/advanced)		H	Heati	ng system u	ıpgrade	
	mm of min- wool be-			Before:	Featur	re:	S	tandard	Advanced	
	tween ceiling joists				Heat generator Regula boiler		ar condensing	Air source heat pump		
upgi	Typical roof upgrade includes topping the attic				Efficiency	:	90%		380%	
insu	lation up to mm.				Fuel:		Mains	Gas	Electricity	
	ductivity = MX W/mK				SH Contro type:	ols	Full z	one control	Full zone control	
	Typical wall construction						Prima	ry heating	Primary heating system	
	Cavity walls, partially filled				source (H	W):	systen	ı	and solar thermal providing 50% of demand	panels
	the expanded poly			walls, partially filled with banded polystyrene boards, $e = 0.37 \text{ W/m}^2\text{K}$	HW Cylinder:		120 litre, factory insulated		200 litre combined cylin- der, factory insulated	
			U-valu	e = 0.37 w/m K	HW Controls type:Time a staticVentilation:Natura		Time and thermo- static		Time and thermostatic MVHR, 90% efficient	
							ıl			
		Refu	rbishr	nent steps — advanc	ed			Prim. energy kWh/m ² /y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating
0		Build	ling fa	bric upgrade steps:		Expec -value		171 (actual state)	37 (actual state)	C1
1	1 Roof insulation and standard package* Add 100 mm of mineral wool ov ing insulation.			100 mm of mineral wool over ing insulation.	the exist-	0.	13	160	34	C1
Systems upgrade:										
2	2 Space and water heating system and controls Replace Replace Replace Air source heat pump 380% efficient, two separated heating zones with time and thermostatic control, inde- pendent water heating, solar thermal panels providing 50% of hot water demand with combined HW cylinder. Mechanical ventilation with heat recovery (MVHR).					inde- ling Inder.	95	23	B1	

* package also includes draughtstripping, 80mm lagging jacket for DHW cylinder and low energy bulbs.

Estimated costs and payback time**



Measure	Estimated co	sts Payback (y)							
Step 1	€ 540	6.4							
Step 2	€ 13,100	87.9							
Total:	€ 13,640	58.3							
Advanced upgrade summary									
Consumption of primary en- 76 kWh/m²/y									

onsumption of prin gy reduced by:	76 kWh/m²/y	
nission of carbon duced by:	dioxide	14 kgCO ₂ /m ² /y

Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y



TABULA





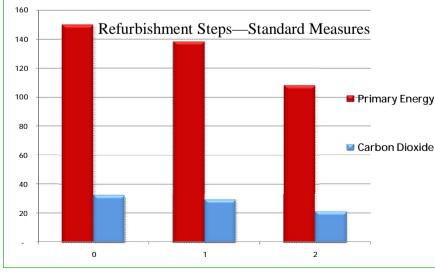
Insulation U - value **Building elements :** 50-70 mm Cavity walls, partially filled 0.37 Walls 200 mm 0.2 Pitched, insulation between joists Roofs Solid concrete 40-80 mm 0.26 Floors Double glazed, Low-E, wood/PVC frame, 16 2.0 n.a. Windows mm gap Solid wooden 3.0 Doors none Fuel Efficiency Heating systems characteristics: Central heating boiler, primary pipework Mains gas 80% Primary insulated. Secondary Open fire in grate Smokeless 30% From primary heating system. Separated time controls. Hot water Factory insulated, 35mm spray foam, cylinder thermostat Cylinder Separated timers for SH and DHW, room thermostat, TRVs Controls

Description

The cavity walls of this house are well insulated with U values as low as $0.27 \text{ W/m}^2/\text{K}$ and the floors are well insulated. Apart from adding additional roof insulation, the focus for retrofit would be on upgrading the space & water heating systems.

	Ref	Prim. energy kWh/m ² /y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating			
0	Building fabric upgrade steps: Expected U-values					32 (actual state)	B3
1	Roof insulation and standard package*Add100 mm of mineral wool over the existing insulation0.13				138	29	В3
		System	s upgrade:				
3	3 Space and water heating system and controls Add/ replace Gas condensing boiler 90% efficient, additional space heating zone, secondary heating removed				108	21	B2

*also includes draughtstripping (if not present), 80mm lagging jacket for DHW cylinder (if insulation is not present) and low energy bulbs.



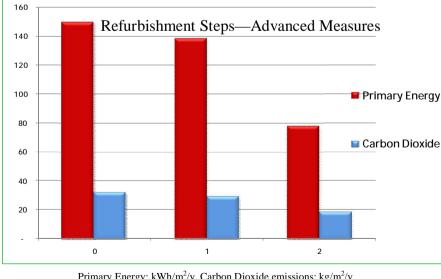
Estimated costs and payback time**								
Measure	sts	Payback (y)						
Step 1		5.7						
Step 2	€ 2,200		14.2					
Total:	€ 2,760		10.9					
Standar	d upgrade	su	mmary					
Consumption of penergy reduced b	•		42 kWh/m²/y					
Emission of carbo reduced by:	on dioxide	1	1 kgCO ₂ /m ² /y					

Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y

	Typical roof	upgra	de (sta	andard/advanced)		I	Heat	ing system	upgrade	
	mm of min- wool be-	YYYYY]	Before:	Featur	re:		Standard	Advanced	
twe the	tween and above the ceiling joists				Heat generator Regul boiler		lar condensing	Air source heat pump		
upg	Typical roof After:				Efficiency		90%		380%	
insu 300	topping the attic insulation up to 300 mm.				Fuel:		Mair	ns Gas	Electricity	
	ductivity =				SH Contro type:	ols	Full	zone control	Full zone control	
	• 1			struction	Hot water			ary heating	Primary heating	
	Cavity walls, partially filled				source:		syste	2111	and solar thermal panels providing 50% of HW demand	
	Cavity walls, partially filled with expanded polystyrene boards, U-value = 0.37 W/m ² K		HW Cylinder: 1201		litre, factory ated	200 litre combined cylin- der, factory insulated				
		$\overline{\mathbf{U}}$				Time statio	e and thermo-	Time and thermostatic		
					Ventilation: Natural		MVHR, 90% efficient			
]	Refur	bishn	ient steps — advance	ed			Prim. energy kWh/m ² /y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating
0		Build	ling fal	oric upgrade steps:		Expec U-valu		150 (actual state)	32 (actual state)	B3
1	Roof insulation a standard package		Add	100 mm of mineral wool over ing insulation.	the exist-	0.1	13	138	29	B3
	Systems upgrade:									
2 Space and water heating system and controls Replace Air source heat pump 380% efficiency heating zones with time and therm dependent water heating, solar the ing 50% of hot water demand with cylinder. Mechanical ventilation with (MVHR).				ermostatic c thermal pan with combin	ontrol, els pro ed HW	in- vid-	78	19	B1	

* package also includes draughtstripping, 80mm lagging jacket for DHW cylinder (if not present) and low energy bulbs.

Estimated costs and payback time**



Measure	Estimated co	sts	Payback (y)
Step 1	€ 560		5.7
Step 2	€ 13,100		76.5
Total:	€ 13,660		50.8
Advanc	ed upgrad	e su	ımmary
Consumption of penergy reduced b	7	72 kWh/m²/y	
Emission of carb reduced by:	1	3 kgCO ₂ /m ² /y	

Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y







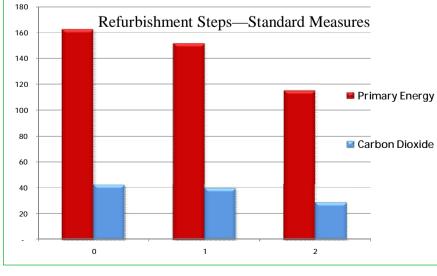
Description

Timber frame construction accounted for more than 10% of the new house market from 2000 onwards. The walls are well insulated with U values as low as $0.27 \text{ W/m}^2\text{K}$ and the floors are well insulated. Apart from adding additional roof insulation, the focus for retrofit would be on upgrading the space & water heating systems.

	Building elements :	Insulation	U - value
Walls	Timber frame	100 mm	0.37
Roofs	Pitched, insulation between joists	200 mm	0.2
Floors	Solid concrete	40-80 mm	0.34
Windows	Double glazed, Low-E, wood/PVC frame, 16 mm gap	n.a.	2.0
Doors	Solid wooden	none	3.0
Heati	ng systems characteristics:	Fuel	Efficiency
Heatin Primary	ng systems characteristics: Central heating boiler, primary pipework insulated.	Fuel Heating oil	Efficiency 80%
	Central heating boiler, primary pipework		
Primary	Central heating boiler, primary pipework insulated.	Heating oil Smokeless	80%
Primary Secondary	Central heating boiler, primary pipework insulated. Open fire in grate	Heating oil Smokeless controls.	80%

	Ref	urbishi	Prim. energy kWh/m ² /y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating		
0	Building fabric upgrade steps: Expected U-values (42 (actual state)	C1
1	Roof insulation and standard package*Add100 mm of mineral wool over the existing insulation0.13				152	39	C1
		System	s upgrade:	- -			<u>.</u>
2	Space and water heating system and controls	Add / Replace	Condensing boiler 90% efficient, additional zone, secondary heating removed.	heating	115	28	B2

*also includes draughtstripping (if not present), 80mm lagging jacket for DHW cylinder (if insulation is not present) and low energy bulbs.



Estimated costs and payback time							
Measure	Estimated costs	Payback (y)					
Step 1	€ 800	6.7					
Step 2	€ 2,700	5.5					
Total:	€ 3,500	5.8					
Standa	rd upgrade s	ummary					
Consumption of energy reduced		47 kWh/m²/y					
Emission of carbon dioxide $14 \text{ kgCO}_2/\text{m}^2/\text{y}$							

reduced by:

Estimated costs and payback time**

Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y

	Typical	roof upgr	ade (st	andard/advanced)		ŀ	Heat	ing system	upgrade	
	mm of min- wool be-	NYYYYYY	YYYYY	Before:	Featur	re:		Standard	Advanced	
the	tween and above the ceiling joists			Heat gene	rator	tor Regular condensing boiler		Air source heat pump		
upg	Typical roof After:				Efficiency	:	90%		380%	
insu	opping the attic nsulation up to 300 mm.				Fuel:		Heat	ing oil	Electricity	
	ductivity = 4 W/mK	<u> 2000000</u>			SH Contro	ols	Full	zone control	Full zone contro	1
	Typical wall construction				type: Hot water		Prim	ary heating	Primary heating	system
	Contraction of	Tim	ber frame	wall	source (H		syste		and solar thermal panels providing 50% of HW	
									demand	
				r frame wall with the outer ork and ventilated drainage			120 litre, factory insulated		200 litre combined cylin der, factory insulated	
			cavity.	Insulation between the studs. $e = 0.37 \text{ W/m}^2\text{K}$			Time and thermo- static		Time and thermostatic	
					Ventilation	Ventilation: Natural		MVHR, 90% efficient		
		Refu	rbishn	nent steps — advance	ed			Prim. energy kWh/m²/y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating
0		Bui	lding fa	bric upgrade steps:		Expect U-valu		162 (actual state)	42 (actual state)	C1
1	1 Roof insulation and standard package* Add 100 mm of mineral wool over ing insulation.			100 mm of mineral wool over ing insulation.	r the exist-	0.1	3	152	39	C1
Systems upgrade:										
2	2 Space and water heating system and controls Replace/ add Air source heat pump 380% efficient, with time and thermostatic control, in thermal panels providing 50% of hot HW cylinder. Mechanical ventilation					r heating, vith combi	solar ined	85	20	B1

* package also includes draughtstripping, 80mm lagging jacket for DHW cylinder (if not present) and low energy bulbs.

Refurbishment Steps—Advanced Measures

Estimated costs and payback time** Measure Estimated costs Payback (y) Step 1 € 800 6.7 Step 2 € 18,100 16.6 Total: € 18,900 15.6

Advanced upgrade summary

Consumption of primary energy reduced by:	77 kWh/m²/y				
Emission of carbon dioxide reduced by:	22 kgCO ₂ /m ² /y				

Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y

1

**Note: 1. Costs are indicative only, based on typical prices (2011). 2. Measures analysed are one of many options, especially for the renewable heating systems.

2

Analysis conducted in association with IHER Energy Services, www.iher.ie

0



🗯 Primary Energy

Carbon Dioxide

180

160 140

120

100

80

60

40 20



30. Semi detached house, timber frame, 2005 - onwards





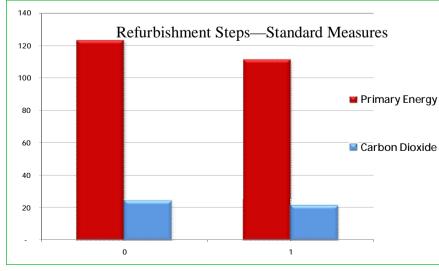
Description

The walls of this timber frame house are well insulated with U values as low as $0.27 \text{ W/m}^2\text{K}$ and the floors are well insulated. Apart from adding additional roof insulation, the focus for retrofit would be on upgrading the space & water heating systems.

	Building elements :	Insulation	U - value
Walls	Timber frame	100 mm	0.37
Roofs	Pitched, insulation between joists	200 mm	0.2
Floors	Solid concrete	40-80 mm	0.25
Windows	Double glazed, Low-E, wood/PVC frame, 16 mm gap	n.a.	2.0
Doors	Solid wooden	none	3.0
Heati	ng systems characteristics:	Fuel	Efficiency
Heatin Primary	ng systems characteristics: Central heating boiler, primary pipework insulated.	Fuel Mains gas	Efficiency 90%
	Central heating boiler, primary pipework		
Primary	Central heating boiler, primary pipework insulated.	Mains gas	90%
Primary Secondary	Central heating boiler, primary pipework insulated. None.	Mains gas	90%

	Refurbishment steps — standard			Prim. energy kWh/m²/y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating
0	⁰ Building fabric upgrade steps: Expected U-values		123 (actual state)	24 (actual state)	B2	
1	Roof insulation and standard package*Add100 mm of mineral wool over the existing insulation0.13		111	21	B2	
	Systems upgrade:					
2	2 Space and water heating system and controls n.a. Heating system meets all current requirements		n.a.	n.a	n.a.	

*also includes draughtstripping (if not present), 80mm lagging jacket for DHW cylinder (if insulation is not present) and low energy bulbs.



Estimated costs and payback time**					
Measure	Estimated costs	Payback (y)			
Stop 1	€ 500	6.0			
Step 1	£ 300	0.0			
T () () () () () () () () () (
Total:	€ 500	6.0			

Standard upgrade summary			
Consumption of primary energy reduced by:	12 kWh/m²/y		
Emission of carbon dioxide reduced by:	3 kgCO ₂ /m ² /y		

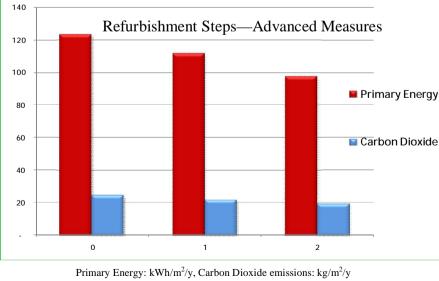
Primary Energy: kWh/m²/y, Carbon Dioxide emissions: kg/m²/y

Typical roo	of upgrade (standard/advanced)	Heating system upgrade			
200 mm of min- eral wool be-	wool be- en and above		Standard	Advanced	
tween and above the ceiling joists			n.a.	n.a.	
toping the attic insulation up to 300 mm. Conductivity = 0.04 W/mK		Efficiency:	n.a.	n.a.	
		Fuel:	n.a.	n.a.	
		SH Controls type:	n.a.	n.a.	
Typical wall construction		Hot water	n.a.	Primary heating system	
Timber frame wall		source (HW):		and solar thermal panels providing 50% of HW demand	
	Timber frame wall with the outer brickwork and ventilated drainage cavity. Insulation between the studs. U-value = $0.37 \text{ W/m}^2\text{K}$	HW Cylinder:	n.a.	n.a.	
		HW Controls type:	n.a.	n.a.	
		Ventilation:	n.a.	n.a.	

	Refurbishment steps — advanced			Prim. energy kWh/m ² /y	Carbon Dioxide kgCO ₂ /m ² /y	Energy Rating
0	Building fabric upgrade steps: Expected U-values			123 (actual state)	24 (actual state)	B2
1	Roof insulation and standard package*Add100 mm of mineral wool over the exist- ing insulation.0.13		111	21	B2	
	Systems upgrade:					
2	Space and water heating system and controlsReplace/ addSolar thermal panels providing 50% of hot water de- mand		98	19	B1	

* package also includes draughtstripping, 80mm lagging jacket for DHW cylinder (if not present) and low

Estimated costs and payback time**



Estimated costs and payouek time				
Measure	Estimated costs	Payback (y)		
Step 1	€ 500	6.0		
Step 2	€ 3000	47.4		
Total:	€ 3500	23.8		

Advanced upgrade summary				
Consumption of primary energy reduced by:	25 kWh/m²/y			
Emission of carbon dioxide reduced by:	5 kgCO ₂ /m²/y			

**Note: 1. Costs are indicative only, based on typical prices (2011). 2. Measures analysed are one of many options, especially for the renewable heating systems.

Analysis conducted in association with IHER Energy Services, www.iher.ie



A

Air Source Heat Pump They draw their heat from the ambient environment, that is, from the air, from water, or from the ground. By compressing and decompressing liquids circulating within the heat pump system, they can be used to transfer heat from the environment into a dwelling. Heat is circulated inside the dwelling either via warmed water in radiator s or underfloor distribution networks, or by warmed air being pushed into the dwelling.

С

Cavity Wall A wall constructed in two separate thicknesses with an air space between; provides thermal insulation.

Condensing Boiler recovers and utilises the heat that would otherwise be lost up the flue thus increasing its efficiency compared to a non-condensing boiler

D

DEAP (Dwelling Energy Assessment Procedure) The Irish official method for calculating and rating the energy performance of dwellings

Draught-Stripping Draught stripping products are strips that are fixed around windows, interior and exterior doors, and loft hatches to reduce draughts

Dry Lining The application of an insulation layer (in most cases) and plasterboard layer to the internal surface of an exposed wall.

Ε

Electric Immersion An electrical heating element, usually thermostatically controlled, for heating the liquid in which it is immersed, especially as a fixture in a domestic hot-water tank.

F

Fibre Insulation This insulation normally in the form of mineral glass fibre or rock wool is used between joists or rafters in roof construction or between timber studs in wall constructions.

G

Gable The part of a wall that encloses the end of a pitched roof

Н

Hollow-block A 9 inch masonry block containing hollowed sections.

HW controls water heating controls such as cylinder thermostat.

L

Insulation Beads Polystyrene beads designed for pumping into cavity wall constructions. The beads are normally bound by glue to enhance performance and prevent movement or spillage if the wall is broken open for any reason.

J

Joists A length of timber or steel supporting part of the structure of a building, typically arranged in parallel series to support a floor or ceiling

L

Lagging Jacket An insulation covering for a hot water cylinder or cold water storage tank located in an attic space

Μ

Methodology A body of practices, procedures and rules used by those who work in a discipline or engage in an inquiry; a set of working methods

Mineral Wool is made from molten glass, stone or slag that is spun into a fibre-like structure. Inorganic rock or slag is the main components (typically *98%*) of stone wool. The remaining *2%* organic content is generally a thermosetting resin binder (an adhesive) and a little oil.

R

Retrofit To install or fit (a device or system, for example) for use in or on an existing structure, especially an older dwelling

S

Sectional Drawing Relating to or based upon a section (i.e. as if cut through by an intersecting plane); "a sectional view"; "sectional drawings"

SH controls space heating controls such as room thermostat, programmer etc

Societal Of or relating to the structure, organization, or functioning of society

Т

Timber Battens Horizontal or vertical timber sections or strips are fixed to walls or to pitched roofs to which rigid insulation boards or plasterboards are mechanically fixed.

TRV (Thermostatic Radiator Valve) A self-regulating valve fitted to hot water heating system radiators. The TRV contains a bellows that will close the valve on a rise in air temperature in the room, stopping the flow of heating water to the heat emitter. The TRV has a number of settings that can be used to set the desired air temperature in each room.

Typology The study or systematic classification of types that have characteristics or traits in common.

U

Urethane

Urethane insulation is a building product used to prevent air transfer through the exterior walls of a home. It is comprised of polymer chains connected by organic compounds known as carbonates, or urethanes. The terms *urethane* and *polyurethane* are used interchangeably when it comes to most applications, including insulation.

U-Value (Thermal Transmittance) Is the rate of transfer of heat (in watts) through one square metre of a structure divided by the difference in temperature across the structure. It is expressed in watts per square metre per Kelvin, or W/m²K. Well-insulated parts of a building have a low thermal transmittance whereas poorly-insulated parts of a building have a low thermal transmittance whereas poorly-insulated parts of a building have a low thermal transmittance whereas poorly-insulated parts of a building have a low thermal transmittance whereas poorly-insulated parts of a building have a low thermal transmittance whereas poorly-insulated parts of a building have a low thermal transmittance whereas poorly-insulated parts of a building have a low thermal transmittance whereas poorly-insulated parts of a building have a low thermal transmittance whereas poorly-insulated parts of a building have a low thermal transmittance whereas poorly-insulated parts of a building have a low thermal transmittance whereas poorly-insulated parts of a building have a low thermal transmittance whereas poorly-insulated parts of a building have a low thermal transmittance whereas poorly-insulated parts of a building have a low thermal transmittance whereas poorly-insulated parts of a building have a low thermal transmittance whereas poorly-insulated parts of a building have a low thermal transmittance whereas poorly-insulated parts of a building have a low thermal transmittance whereas poorly-insulated parts of a building have a low thermal transmittance whereas poorly-insulated parts of a building have a low thermal transmittance whereas poorly-insulated parts of a building have a low thermal transmittance whereas poorly-insulated parts of a building have a low thermal transmittance whereas poorly-insulated parts of a building have a low thermal transmittance whereas poorly-insulated parts of a building have a low thermal transmittance whereas poorly-insulated parts of a building have a low thermal transmittance whereas poorly-i

W

Wood Pellet Boiler Wood pellets are a type of wood fuel, generally made from compacted sawdust or other wastes from sawmilling and other wood products manufacture. High-efficiency wood pellet boilers have been developed in recent years, typically offering combustion efficiencies of over 85%.