

DUBLIN SCHOOL OF ARCHITECTURE DT774 PG CERTIFICATE IN DIGITAL ANALYSIS & ENERGY RETROFIT ARCH1280 NZEB PROJECT: RESIDENTIAL DWELLING 2017

PAUL KOPIK D16126509 NZEB HOUSE DESIGN, KENT, UK Part L (2011) (Base case)

EU 2016/1318

Delivered

Energy kWh/y

216

0 2671

0

729

1014

0

0

-2163

0 0

2466

11.4

33.7 kWh/m2

A1

24.87

0.00

24000.00

3100.00

2880.00

2400.00

4490.00

2500.00

2400.00

2500.00

€44,270.00

Delivered

Energy

kWh/y

4318

2798

327

978

0

-481

0

7940

36.6

13.7 kWh/m2y

A2

44.35

4000.0

30000.0

4500.0

3840.0

3040.0

300.0

6600.0

€ 52,280.00

€ 8,010.00

Cost Ontimality Assessment								Delivered		Fuel Type		SEAL	Costs	Annual	Repair & M	aintenance	Costs			Initial Capital Investment Costs						
						Estimated Ener	av costs					Unit		NZEB	NZEB			PA								
COSL OPTIN	Idli	ιy	H22	6221116	IIL			5)	Energy k	Wh/y			Costs								Fabric	Air Tightness 0.05 = 1	ac/h @ 50	Pa (extra	cost)	
•							NZEB								Solar Th	hermal syste	m	100.00			Fabric	Air Tightness $0.35 = 7$	ac/h @ 50	Pa		
SIMPLE LCCA CALCULATION SHEE	т		LCCA Study:	Comparative Life C	ycle Cost	ts for 3 Alternatives									Window	v & door seal	s - cleaning	100.00			Fabric	Windows Alu-Clad Dou	ble glazed			
							Main space heat	ing		216	E	lectric	0.2306	6 49.8	MVHR f	filters		30.00			Fabric	Windows Alu-Clad Trip	le glazed			
Inputs & PV Formulae:							Secondary space	e heating		0				0.0	00			230.00			Renewab	les Solar PV - 2 panels sys	stem + inst	all		
						Main water heati	ng		2671	E	lectric	0.2306	615.9	3						Renewab	les Solar PV - 9 panels sys	stem + inst	all			
Length of Study (years)		30	vrs	Energy Cost (C	(A noite	€ 923	Pumps, fans			729	E	lectric	0.2306	6 168.1	1 Replace	ement Cost	S				Renewab	les Solar Thermal 6 46 so	m Panels	+ install 60	0 tubes	
Replacement Period (years)		20	yrs	Energy Cost (C	ption B)	€ 1,068	Energy for lightin	g		1014	E	lectric	0.2306	6 233.8	33				Service	e	Renewab	les Solar Thermal 8 46 sq	m Panels	+ install 80	0 tubes	
Discount Rate (as decimal)	lecimal) 0.050 Energy Cost (Option C)				Total units 4630		4630					NZEB	NZEB		Life Years Cost PA			Systems	stems Solar DHW Tank 300L includes solar station Rotex							
General Inflation Rate (as decimal)		0.020					То	tal Costs	5					1067.6	8						Systems	Solar DHW Tank 500L	includes s	olar station	n Rotex	
Fuel Escalation Rate (as decimal)		0.040		SPV* (residua	I) [0.419108222									Electric	Radiators		130.00	10	13.00	Systems	Space Heating: Boiler	oil (Keros	ene)	THOLOX	
Residual Value Option A (as decimal))	0.70		SPV* (replace	ment)	0.560037946									Window	v & door seal	s - replace	2400.00	15	160.00	Systems	Space Heating: Electric	radiators	x 2 + insta	dl	
Residual Value Option B (as decimal)	0.70		UPV* 1 (Repai	r Costs)	19.75032045									Solar no	ot water pane	els	3200.00	20	160.00	Systems	Space Heating: Oil stor	age tank (hunded) n	ining & con	r has
Residual Value Option C (as decimal)			UPV* 2 (Fuel (osts)	25.95329975									Solar D	V pariels		800	5	45.00	Systems	Ventilation: Aereco - D	emand Co	ntrol Ventil	lation	5. Duo
															Solar wa	ater numn		450	20	22.50	Systems	Ventilation: MVHP Cor	fo ducting	system + i	install	
																		-00	20	560 50	Systems	Space Heating: wet rac	listor CH e	system	mətan	
Life Cycle Cost Calculation:	Initial Co	osts +	(Replaceme	nt Cost x SPV replac	ement) +	(Annual Repair Cost	x UPV 1) +	(Annual E	Energy Costs	x UPV 2) -	- Res	sidual Value	Total LCC (N	IPV)	Replace	ement Perio	d (Years)		20	11210.00	Systems	Space fleating, wet fac	iator on s	ystem		
															replac							Differential Cost bet	voon Par	1 2011 8	NZER	
ALTERNATIVE A	€	44,270	€	14,637	0.560	€ 225	19.7503	€	923	25.953	3€	12,988	€	67,868	OPTION A LCC	C					-	Differential Cost bet	veenran	20110	NZED	
ALTERNATIVE B	€	52,280	€	11,210	0.560	€ 230	19.7503	€	1,068	25.953	3€	15,338	€	75,473	OPTION C LCC	C <u>-€</u>	7,604.87	NET SAVIN	NGS FROM	ALTERNATIVE A						
ALTERNATIVE C					0 560		19 7503	ŧ	-	25 953	3 €		£	- (c €	67,867,87	NET SAVIN	NGS FROM	A ALTERNATIVE A	_	DEAP Results				
					0.200		22.7200	-		20.000							01,001101					Space Heating - main				
																						Space Heating - secon	darv			
																					_	Water Heating - main	aary			
																						Water Heating - supple	mentary			
																						Pumps fans etc	memory			
Present Value Formulae in Excel (Fro	m SCSI Guid	le to Life	Cycle Costing	2013):																	_	Energy for lighting				
																					_	CHP input (individual b	eating syst	ems only)		
																					_	CHP electrical output (i	ndividual h	eating sve	stem only)	
3.4 Single Present Value Mo	dified (SF	PV*)						Escalation														Type 1	numuuan	icating sys	stem only)	
								cocaración														Type 2				
The SPV* factor is similar to the SPV calcul allows for the incorporation of escalation	(e) into the ca	previously	, except SPV*			n		n 🕨 Stu	tudy Period		The	a SDV/* formula e	shown above could	lba [-111 - 0/11	1.:110.						Type 2				
used when the cost today is known (or est	imated) and a	relevant e	escalation rate		+ e		[1+ é]	· _			writ	tten into an exce	el cell as follows;		-((1+e)/(1+1))					_	Total				
is applied over a certain period of time to e	stimate the ful	iture cost o	of the building		+ i		$\overline{1+i}$	Inte	erest rate/Discount	rate											_	2 8				
component. The formulae allows for the es	calation and d	discounting	g factors to be	L ·			L														_	per m ² floor area				
incorporated in the same calculation.			· · · ·							1											_	Renewable energy con	tribution a	s equivalei	nt therm.	
																					_	Building Energy Rating				
																						kWh/m2y				
																						EPC (MPEPC 0.400)				
3.5 Uniform Present Value Mo	odified (UF	PV^)																			_	CPC (MPCPC 0.460)				
The UPV* calculation is similar to the UPV original amount is escalated on a yearly b	/ calculation c	outlined pr	reviously. The proportionally	r :	+ e 1 ⁿ		The UPV* formula a	above could t	be written into a	an excel cell as foll	llows;										olar gains					
throughout the building life cycle. An exam	ple of this is e	energy cos	sts which can	1	+ i			-	10 110											-	lonth	Jan	Feb	Mar	Apr	N
be reasonably estimated in today's costs. A	pplying an esc	calation rat	e (e) to energy		7				=(1-((1+e	e)/(1+i))^n)	/ (((1	l+i)/(1+e))	-1)								rientation					
costs on a yearly basis over the life cycle an	nd discounting	g (i) the cos	ts will provide	$\frac{1+1}{1+1}$	- 1 - 1			_			-										orth	0.00	0.00	0.00	0.00	0.
you with a cumulative PV cost.																					E/NW	0.00	0.00	0.00	0.00	0.
																					E/W	1.50	3.00	5.15	7.65	9.
																										-

Outcome

It would appear that the Part L design is overdesigned regarding energy performance and is consuming less energy than if it was designed to just meet the Part L 2011 parameters. The LTB calculations from modelling in PsiTherm also confirmed the low Y factor and resultant higher efficiency thermal envelope. The client's insistence of the use of Durisol for the walls and the same performance of the floor & roofs for both designs have resulted in good energy efficiency. The NZEB space heating requirement is almost negligable. However, it is noted that the carbon allowances are much less in the NZEB than in the part L 2011 designs. Part L CO2 emissions are 2325 kg/y versus 1166 kg/y for NZEB. Sensitivity analysis of fuel escalation has not proved significant. The NZEB house is not cost optimal although it is my preferred option regarding it's robustness against the volatility in the fossil fuel oil economy.

Ventilation Design

Ventilation design is achieved using a Paul Novus 300 MVHR system with Comfo Air semi-rigid ducting & system and to comply with TGD Part F (2009). TGD F requires 0.3 litres per second per square metre of floor area and equates to 234 m3/h.









DEAP NZEB Heat Use & Result Bar Chart



The Brief

To demonstrate compliance with Irish Building regulations at the level of design and assigned certifiers as defined under the current BCAR regulatory architecture.

Two standards of building energy performance are explored: Full compliance with part L (2011) and compliance with EU 2016/1318

The 8 essential NZEB skills defined by DIT for the delivery of successful NZEB projects are

- 1. Geometry / Form-Factor Optimisation
- 2. Overheating
- Condensation Risk Analysis 3.
- Cost Optimality Assessment 4.
- 5. Thermal Bridge Calculation
- 6. Ventilation design
- 7. Air tightness Design
- 8. U-value & Heat Loss

Geometry / Form Factor Optimisation

The design began as a two storey compact building approximately square on plan. The shape evolved into a form of "H" shape to enable more southern aspect walls to include southern glazing both for insolation & view to southerly seascape. The roof shape massing evolved to reduce the bold massing in the urban landscape as well as to provide south sloping surfaces for the incorporation of solar panels. The middle flat roof section is a green roof and this is to also act as a surface water attenuation sponge. All roof rainwater is directed to a 300 L tank in the ground. DEAP (NZEB) Heat Loss Parameter (HLP) = 0.57

Overheating

There are windows to the South, East & West. The major view is South & the building uses the passive house method to gain heat from the sun. Shading is provided to the South elevation by a large eaves overhang & horizontal shading external louvers above the ground floor windows. Vertical external timber louvers are provided to the East & West elevation obscure windows (timber clad walls area). The DEAP summer sheet analysis indicates that the Threshold Internal Temperature is an acceptable 21 degrees centigrade with some window ventilation. Generally the building uses a MVHR balanced whole house ventilation system with summer bypass.



Natural slate roo "Del Carmen" 500x250 at 25 d

All parapet & verge trir zink Anthracite grey m

Gutters & RWP are zi

Windows are AluCla RAL 7016 Anthracit Grey triple glazed T

Galv. Handrail, window planter & sun shade support

33.8 cr

А

0, **5***P*

107.215

50.115

4.28

Timber cladding to face of oriels coloured "Seagrass"

Orac P5 Corinthian pi 2885 high

White render

FFL

North Elevation



GL (varies



West Elevation







Section 1:50



Condensation Risk assessment - WUFI

This risk analysis was undertaken using WUFI software to analyse the flat roof of the NZEB house.





WUFI: flat roof RH. Mineral wool outer layer at 10mm internally of the Pavatex sarking board. Refer monitor positions.

Result: The RH approaches equilibrium after one year. At equilibrium the RH fluctuates between 30% & 80% and does not cause concern. At this colder part of the insulation (more external) it is obvious that the RH increases with the drop in temperature. RH at 80% at this location does not cause concern.

Thermal Bridge Calculation & Condensation Risk Assessment fRsi - PsiTherm

The following diagrams below indicate a Psi value & fRsi thermal models for the eaves adjacent detail.





Air-tightness & Wind-tightness Design

The wind-tightness is achieved by using Pavatex sarking board to manufacturers instructions. Pavatex is used externally of any timber frame components in roof or walls. Pavatex also insulates the timber and is modelled successfully in WUFI.

Durisol block external face is rendered with Parex external render system to BBA certificate. Air-tightness internally is achieved using Intello products for ceilings, and joints. Internal finishes of external walls are 18mm gypsum wet plaster system bonded with Intello Contega SL tape at junctions and frames where necessary. All services penetrations are to be sealed with Intello products.

