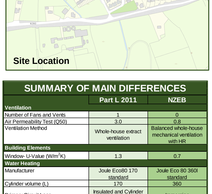
DUBLIN SCHOOL OF ARCHITECTURE
DT774 POSTGRADUATE CERTIFICATE IN ANALYSIS & ENERGY RETROFIT
2017 DESIGN PROJECT MULLINGAR, CO. WESTMEATH

DESCRIPTION OF PROJECT

The site is located to the west of Mullingar, Co. Westmeath. The project is to develop a new-build house design brief based on the projected energy performance characteristics required to achieve Part L and NZEB design compliance. The proposed NZEB standard is based on EU Commission Recommendation 2016/1318 for new single family house in the Oceanic climate zone of 15-30 kWh/(m²/yr) of net primary energy with, typically, 50-65 kWh/(m²/yr) of primary energy use covered by a maximum 35 kWh/(m²/yr) of on-site renewable sources.

This proposed NZEB dwelling is highly insulated. Therefore only four 0.5kW direct acting electrical heaters are proposed. DEAP normally uses the number of habitable rooms to decide the primary heating system. In the DEAP Manual if the design heat loss (DHL) is less than 3 kW, Section A3.2 of the Manual may not be realistic. For dwelling heat load, the maximum space heat demand is calculated by multiplying the heat loss coefficient by the required maximum temperature differential ΔT (usually -1 to 21°C).

The heat loss coefficient is the heat loss in W/K of the dwelling when accounting for fabric and ventilation losses. The heat loss coefficient is called the "Total Heat Loss" in the DEAP software building elements tab and includes heat lost through the dwelling fabric and ventilation heat loss. Therefore for this dwelling the Total Heat Loss is 60 W/K * 22°C (ΔT) = 1,320W or 1.3kW.



SUMMARY OF MAIN DIFFERENCES

	Part L 2011	NZEB
Ventilation		
Number of Fans and Vents	1	0
Air Permeability Test (Q50)	3.0	0.8
Ventilation Method	Whole-house extract ventilation	Balanced whole-house mechanical ventilation with HR
Building Elements		
Window- U-Value (W/m²K)	1.3	0.7
Water Heating		
Manufacturer	Joule Eco80 170 standard	Joule Eco 80 360 standard
Cylinder volume (L)	170	360
Primary Circuit Loss	Insulated and Cylinder Stat	Immersion
Distribution system loss and gains		
Heating System Control Category	Time and Temp with weather compensator & delayed start thermostat	Programmer
Heating System Responsiveness	Radiators	Direct acting
Central Heating Pump number	1	0
Gas Boiler Flue Fan	1	0
Energy Requirement-Space & Water Heating		
Main Space Heating	Gas Boiler	Direct acting
Water Heating	Gas Boiler	Immersion
Energy Requirement-Renewable and Energy Saving Technologies		
Number of PV panels		
Solar Thermal (Thermal kWhy)	N/A	Kingspan Solar HP 200

DEAP SPECIFICATION FOR KEY INPUT VALUES

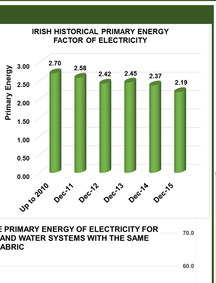
DEAP	Part L 2011	NZEB
Summary of systems	**Whole House Vent, Gas Boiler and PV**	**MVHR, Direct acting heating, Immersion with Solar Thermal and PV**
Electricity Factor	2.59	2.59
CO2 Emission Factors	**0.473**	**0.473**
Dimensions		
Ground Floor Area (m²)	66.63	66.63
Ground Floor Height	2.44	2.44
First Floor Area (m²)	59.38	59.38
First Floor Height	2.70	2.70
Living Area (m²)	20.10	20.10
Total Floor Area (m²)	126.01	126.01
Living Area Percentage	15.95	15.95
Ventilation		
Number of Chimneys	0	0
Number of Open Flues	0	0
Number of Fans and Vents	1	0
Draught Lobby	No	No
Air Permeability Test (Q50)	3.0	0.8
Sheltered Sides	4	4
Ventilation Method	Whole-house extract ventilation	Balanced whole-house mechanical ventilation with HR
Manufacturer	Vent-Axia Sentinel Multivent A	Vent Axia Kinetic Plus E
Building Elements		
Floor (MN²K)	**0.1**	**0.1**
Total Floor Area (m²)	66.63	66.63
Roofs (MW/K)	**0.1**	**0.1**
Total Roof Area (m²)	66.63	66.63
Wall (MW/K)	**0.14**	**0.14**
Total Wall Area (m²)	110.63	110.63
Doors (MW/K)	**1.4**	**1.4**
Total Door Area (m²)	4.24	4.24
Window- U-Value (W/m²K)	**1.3**	**0.7**
Manufacturer	TJ Grady Ltd. Elegance ZE2 PSK	Munster Joinery Futureproof Window
Total Window Area (m²)	17.98	17.98
Glazing Percentage (%)	14.27	14.27
Window- Solar Transmittance	0.71	0.61
Thermal Bridging Factor (W/m²K)	**0.0115**	**0.0115**
Water Heating		
Manufacturer	Joule Eco80 170 standard	Joule Eco 80 360 standard
Cylinder volume (L)	170	360
Dedicated solar storage	N/A	190
Declared loss Factor (kWh/day)	1.45	2.12
Cylinder Stat	Yes	Yes
Separate Time Control of HW	Yes	Yes
Primary Circuit Loss	Insulated and Cylinder Stat	Immersion
Lighting and Internal gains		
% of low energy fixed lighting	100	100
Net Space Heat Demand		
Thermal Mass Category	Med-High	Med-High
Distribution system loss and gains		
Heating System Control Category	Time and Temp with weather compensator & delayed start thermostat	Programmer
Heating System Responsiveness	Radiators	Direct acting
Central Heating Pump number	1	0
Central Heating Pump Consumption	130	0
Gas Boiler Flue Fan	1	0
Energy Requirement-Space Heating		
Main Space Heating	Gas Boiler	Direct acting
Manufacturer	Vokera Vision System 25S	Dimplex Q-Rad 0.5kW
Efficiency of Main Heating (%)	90.30	100
Efficiency Adjustment Factor	1.00	1.0
Efficiency of Secondary Heating (%)	N/A	N/A
Energy Requirement-Water Heating		
Water Heating	Gas Boiler	Immersion
Efficiency of Water Heating (%)	90.90	100
Efficiency Adjustment Factor	1.02	1.0
Energy Requirement-Renewable and Energy Saving Technologies		
Number of PV panels		
Manufacturer	Perlight Solar PLM-250MB	Perlight Solar PLM-270MB-60
	60	60
Pitch	30.0	30.0
PV (Electrical kWhy)	612.66	1102.68
Solar Thermal (Thermal kWhy)	N/A	1494
Manufacturer	N/A	Kingspan Solar HP 200
Total Part L renewable Contribution (kWhm²a)	12.2	33.6
Results DEAP 3.2.0		
Summary of systems	**Whole House Vent, Gas Boiler and PV**	**MVHR, Direct acting heating, Immersion with Solar Thermal and PV**
Energy Rating	**BER A3**	**BER A1**
Energy Value (kWhm²/yr)	55.3	24.92
CO_2 Emissions Indictor	10.47	5.38
EPC (2011-0-A0 & Amended 2011-0-A0)	0.34	0.175
EPC (2011-0-A0 & Amended 2011-0-A0)	0.375	0.169
Part L renewable Contribution (kWhm²a)	12.2	33.7
Results DEAP 3.2.0	**Primary energy kWhy**	**Primary energy kWhy**
Mains space heating	2074	230
Secondary Space heating	0	0
Main water heating	3834	2864
Supplementary water heating	0	0
Pumps, fans	564	621
Energy for lighting	1839	1839
Renewable	-1342	-2415

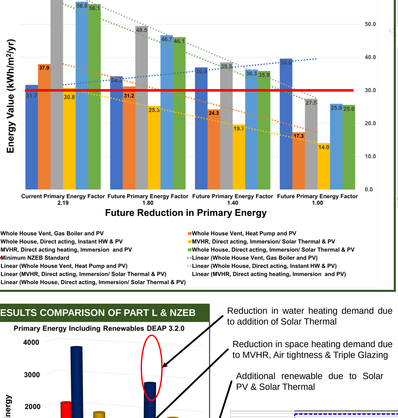
PROJECT RESEARCH

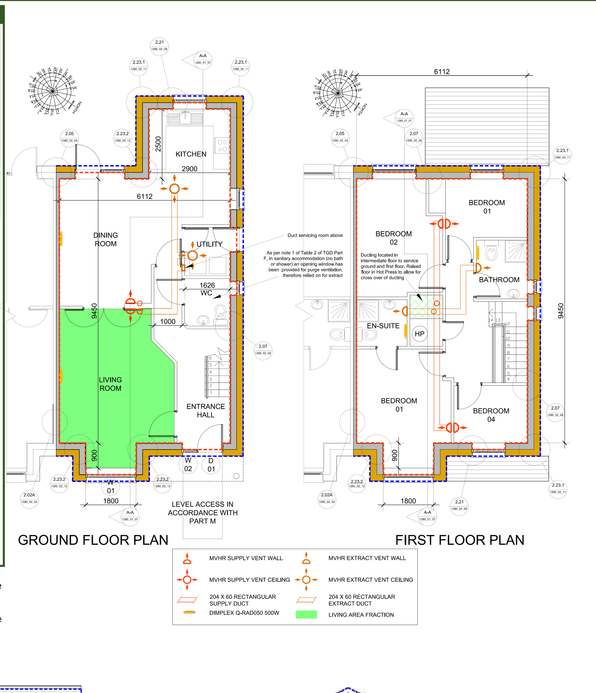
A study was undertaken on several different systems solutions to achieve compliance with the proposed NZEB standard. This study looked at the impact on compliance of the dwelling with future reductions in Primary Energy Factor of Electricity.

With the known reduction in this factor since 2010 as indicated in the chart to the right, a second chart below was produced to show the results for six systems options with four Primary Energy Factors.

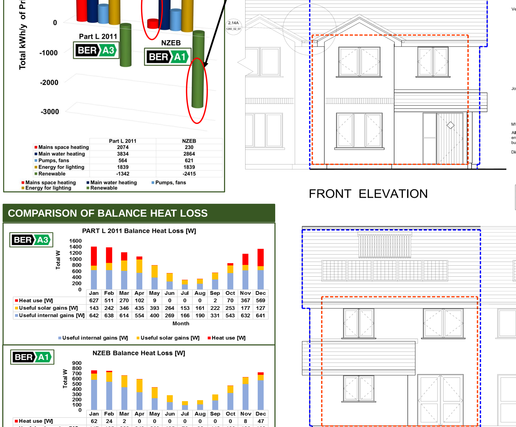
These four Primary Energy Factors used were 2.19, 1.80, 1.40 & 1.00. The chart shows the results for the project dwelling with the same fabric, but with changes to the systems. The result shows all systems, except of natural gas will eventually comply with a Primary Energy Factor of approximately 1.2.

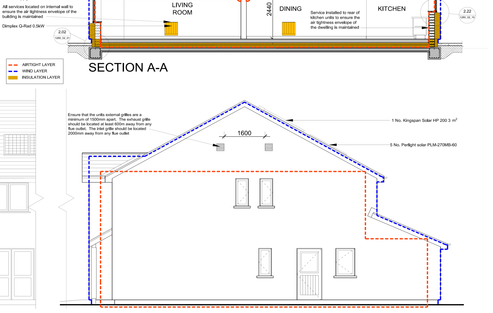




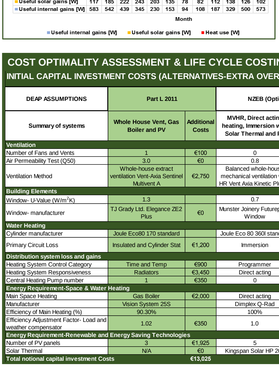


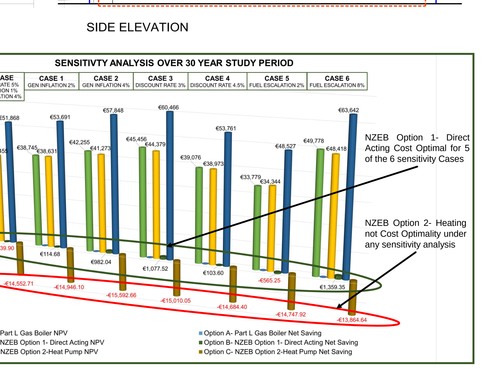
RESULTS COMPARISON OF PART L & NZEB





COMPARISON OF BALANCE HEAT LOSS



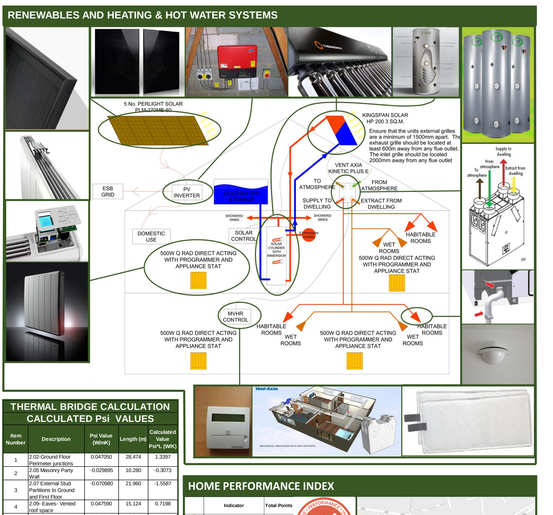


COST OPTIMALITY ASSESSMENT & LIFE CYCLE COSTINGS INVESTMENT APPRAISAL

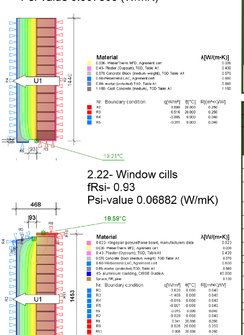
INITIAL CAPITAL INVESTMENT COSTS (ALTERNATIVES-EXTRA OVER RELATEDED COSTS)

DEAP ASSUMPTIONS	Part L 2011		NZEB (Option 1)		NZEB (Option 2)	
Summary of systems	**Whole House Vent, Gas Boiler and PV**	**Additional Costs**	**MVHR, Direct acting heating, Immersion with Solar Thermal and PV**	**Additional Costs**	**MVHR, Heat Pump and PV**	**Additional Costs**
Ventilation						
Number of Fans and Vents	1	€100	0	€0	0	€0
Air Permeability Test (Q50)	3.0	€0	0.8	€750	0.8	€750
Ventilation Method	Whole-house extract ventilation Vent-Axia Sentinel Multivent A	€2,750	Balanced whole-house mechanical ventilation with HR Vent Axia Kinetic Plus E	€4,500	Balanced whole-house mechanical ventilation with HR Vent Axia Kinetic Plus E	€4,500
Building Elements						
Window- U-Value (W/m²K)	1.3		0.7		0.7	
Window- manufacturer	TJ Grady Ltd. Elegance ZE'2 Plus	€0	Munster Joinery Futureproof Window	€1,300	Munster Joinery Futureproof Window	€1,300
Water Heating						
Cylinder manufacturer	Joule Eco80 170 standard		Joule Eco 80 360 standard		Joule Eco80 170 standard	
Primary Circuit Loss	Insulated and Cylinder Stat	€1,200	Immersion	€1,800	Insulated and Cylinder Stat	€1,200
Distribution system loss and gains						
Heating System Control Category	Time and Temp	€900	Programmer	€0	Time and Temp	€900
Heating System Responsiveness	Radiators	€3,450	Direct acting	€0	Radiators	€5,650
Central Heating Pump number	1	€350	0	€0	1	€350
Energy Requirement-Space & Water Heating						
Main Space Heating	Gas Boiler	€2,000	Direct acting	€1,800	Air to Water Heat Pump	€7,700
Manufacturer	Vision System 25S		Dimplex Q-Rad		Dimplex ABM	
Efficiency of Main Heating (%)	90.30%		100%		521%	
Efficiency Adjustment Factor- Load and weather compensator	1.02	€350	1.0	€0	1.0	€0
Energy Requirement-Renewable and Energy Saving Technologies						
Number of PV panels	3	€1,925	5	€2,875	4	€2,400
Solar Thermal	N/A	€0	Kingspan Solar HP 200	€2,700	N/A	€0
Total notional capital investment Costs		**€13,025**		**€15,525**		**€24,750**

RENEWABLES AND HEATING & HOT WATER SYSTEMS



2.09- Eaves Vented Roof Space fRsi- 0.92 Psi-value 0.04759 (W/mK)



THERMAL BRIDGE CALCULATION CALCULATED Psi VALUES

Item Number	Description	Psi Value (W/mK)	Length [m]	Calculated Value Psi's (W/K)
1	2.02-Ground Floor Perimeter junctions	0.047050	28.474	1.3397
2	2.05 Masonry Party Wall	-0.029895	10.280	-0.3073
3	2.07 External Stud Partitions to Ground and First Floor	-0.070980	21.960	-1.5587
4	2.09- Eaves- Vented roof space	0.047590	15.124	0.7198
5	2.14-Ground and First Floor Attic Floor Level	0.073340	16.250	1.1918
6	2.20- Window and Door lintels	0.007300	13.185	0.0963
7	2.21 Window and door jambs	0.006610	27.750	0.1696
8	2.22 Window cills	0.068820	13.185	0.9074
9	2.23-1 Ground and First Floor Corners	-0.031110	23.000	-0.7155
10	2.23-2 Inverted corners Ground and First Floor	-0.110660	12.720	-1.4076
11	2.24- Kitchen wall ceiling junctions	-0.011830	2.900	-0.0343
12	2.14a attic party wall	0.035870	9.450	0.3390
13	2.02A- Ground Floor Party Wall	0.044370	9.450	0.2934
14	5.03- Timber Stud Partition Head	0.000000	28.285	0.0000
Total Envelope Area containing Thermal Bridges (m2):				**265.1**
Calculating Y Factor for Thermal Bridging (W/m2K):				**0.0115**

THERMAL BRIDGE DEFAULT ACDs Psi VALUES

Item Number	Description	Psi Value (W/mK)	Length [m]	Calculated Value Psi's (W/K)
1	2.02-Ground Floor Perimeter junctions	0.247000	28.474	7.0331
2	2.05 Masonry Party Wall	0.033000	10.280	0.3392
3	2.07 External Stud Partitions to Ground and First Floor	0.000000	21.960	0.0000
4	2.09- Eaves- Vented roof space	0.074000	15.124	1.1192
5	2.14-Ground and First Floor Attic Floor Level	0.335000	16.250	5.4438
6	2.20- Window and Door lintels	0.098000	13.185	1.2921
7	2.21 Window and door jambs	0.091000	27.750	2.5253
8	2.22 Window cills	0.109000	13.185	1.4372
9	2.23-1 Ground and First Floor Corners	0.070000	23.000	1.6100
10	2.23-2 Invert corners Ground and First Floor	-0.096000	12.720	-1.2211
11	2.24- Kitchen wall ceiling junctions	-0.085800	2.900	-0.2488
12	2.14a attic party wall	0.450000	9.450	4.3281
13	2.02A- Ground Floor Party Wall	0.240000	9.450	2.2680
14	5.03- Timber Stud Partition Head	0.000000	28.285	0.0000
Total Envelope Area containing Thermal Bridges (m2):				**265.1**
Calculating Y Factor for Thermal Bridging (W/m2K)				**0.0978**

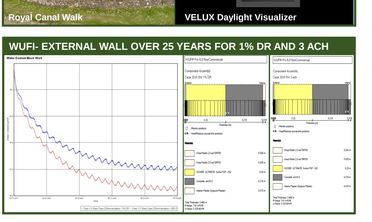
fRsi CALCULATION

Item Number	Description	fRsi	Temperature °C
1	2.02-Ground Floor Perimeter junctions	0.92	18.39
2	2.05 Masonry Party Wall	0.96	19.28
3	2.07 External Stud Partitions	0.96	19.28
4	2.09- Eaves- Vented roof space	0.92	18.46
5	2.14-Ground and First Floor Attic Floor	0.91	18.20
6	2.20- Window and Door lintels	0.96	19.21
7	2.21 Window and door jambs	0.96	19.13
8	2.22 Window cills	0.93	18.59
9	2.23-1 Ground and First Floor Corners	0.92	18.35
10	2.23-2 Invert corners Ground and First	0.96	19.29
11	2.24- Kitchen wall ceiling junctions	0.96	19.29
12	2.14a attic party wall	0.94	18.89

HOME PERFORMANCE INDEX

Indicator	Total Points
ENVIRONMENTAL CATEGORY	6.0
HEALTH AND WELLBEING CATEGORY	6.7
ECONOMIC CATEGORY	6.9
QUALITY ASSURANCE CATEGORY	8.1
SUSTAINABLE LOCATION	4.5
Home Performance Index	69%

WUFI- EXTERNAL WALL OVER 25 YEARS FOR 1% DR AND 3 ACH



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