POST GRADUATE CERTIFICATE DT774 - 2017 - One-off house in Parsonstown, Co. Kildare - Anne Madaire D15127525

Summary of dwelling specification and dimensions. 3 No. options to achieve compliance with EU 2016/1318 were considered.

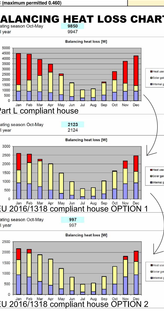
Cost optimal option

	PART L COMPLIANCE	EU 2016/1318COMPLIANCE OPTION 1	EU 2016/1318COMPLIANCE OPTION 2	EU 2016/1318COMPLIANCE OPTION 3
Dwelling dimensions:				
Ground floor area:	166.2m2	166.2m2	168.53m2	168.53m2
height (area-weighted average):	3m	3m	3m	3m
First floor area (area-weighted average):	40.8m2	43.8m2	43.8m2	43.8m2
height:	2.2m+2	2.2m+2	2.2m+2	2.2m+2
Living area:	40.23m2	34.75m2	34.75m2	34.75m2
Total floor area:	213m2	210m2	210m2	210m2
Living area percentage:	18.88%	16.50%	16.50%	16.50%
Ventilation losses:				
Chimney:	0	0	0	0
Open flues:	0	0	0	0
draught lobby:	0	1	0	0
intermittent and passive vents:	3	3	3	3
air permeability test m³/h.m²) @50 Pascals pressurisation	5	0.6	0.6	0.6
Index sheltered	0	0	0	0
ventilation method	whole-house extract ventilation	MHRV 91% efficiency	MHRV 91% efficiency	MHRV 88% efficiency
Building elements				
Fabric Heat Loss:				
Ground floor: W/m²K				
150mm solid concrete slab insulation below 50mm screed)	0.14	0.14	0.14	0.14
Pitched roof: W/m²K				
150mm MW between rafters + 50m PIR to underside)	0.16	0.16	0	0
Pitched roof:W/m²K				
150mm MW between rafters + 60m PIR above rafters)	0	0	0.144	0.144
Flat roof W/m²K				
120mm paratroofi insulation + 50mm mineral wool)	0.16	0.16	0.18	0.18
Wall type 1:-external wall:W/m²K				
130mm full fill cavity insulation + 50mm PIR internally)	0.17	0.17	0	0
Wall type 1:-external wall:W/m²K				
180mm EPS external insulation + 50mm mineral internally)	0	0	0.149	0.149
Wall type 2:-internal wall, room in roof:W/m²K (same u value as pitched roof)	0.16	0.16	0.144	0.144
timber door:W/m²K	1.4	1.4	1.4	1.4
Thermal bridge factor (Y factor):-W/m²K	0.15	0.08	0.024	0.024
Windows / glazing:				
Alu-clad timber windows: W/m²K	1.2	0.82	0.82	0.82
Windows manufacturer:	Nordan Windows	Sofitor 200 Energy	Sofitor 200 Energy	Sofitor 200 Energy
Water heating				
hot storage:-litres	300	300	300	
Manufacturer's declared loss factor	2.352	2.352	2.352	1.17
solar water heating system	yes	yes	no	no
solar water heating area	4.1 m2	4.1 m2	0 m2	0 m2
Heating Systems:				
Primary heat source:	Joule samsung heat pump 179% efficiency	Joule samsung heat pump 480% efficiency	Joule samsung heat pump 456% efficiency	Direct electric radiation 100% efficiency
Heating Systems:	underfloor heating	underfloor heating	low temp rad	
	Low temp rad	Low temp rad		
	none, no backboiler			
Secondary heat source:	**60% efficiency**	**none**	**none**	**none**
				Nilan Compact MHRV
Main water heating system:	Joule samsung heat pump 188% efficiency	Joule samsung heat pump 188% efficiency	Joule samsung heat pump 188% efficiency	**heat pump heat pump 150% efficiency**
Renewables	**4No. PV Panels 5W roof** delivering 892kWh/y	**7No. PV Panels 5W roof** delivering 1250kWh/y	**4No. PV Panels 5W roof** delivering 1250kWh/y	
Results	**Delivered energy**	**Delivered energy**	**Delivered energy**	**Delivered energy**
Space heating - main	1,541.00	329.00	217.00	1,339.00
Space heating - secondary	1,641.00	0.00	0.00	0.00
Water heating - main	1,500.00	1,486.00	2,174.00	1,786.00
Water heating - supplementary	0.00	0.00	0.00	0.00
Pumps, fans, etc	795.00	903.00	838.00	779.00
Light and lights	1,000.00	1,000.00	1,000.00	1,000.00
CHP input (for combined heating systems only)	0.00	0.00	0.00	0.00
CHP electrical output (individual heating system only)	0.00	0.00	0.00	0.00
Type 1	0.00	682.00	1,544.00	1,784.00
Type 2	0.00	0.00	0.00	0.00
Type 3	0.00	0.00	0.00	0.00
Total	**6,478.00**	**3,777.00**	**2,834.00**	**2,928.00**
per m² floor area	30.40	17.98	13.50	13.94
Building Energy Rating	**A3**	**A2**	**A2**	**A2**
kWh/m2y	**58.47**	**28.93**	**23.23**	**30.20**
EPC (maximum permitted 0.400)	**0.37**	**0.18**	**0.18**	**0.19**
CPC (maximum permitted 0.460)	**0.40**	**0.18**	**0.18**	**0.19**

DWELLING DIMENSIONS

Artistic view from south orientation

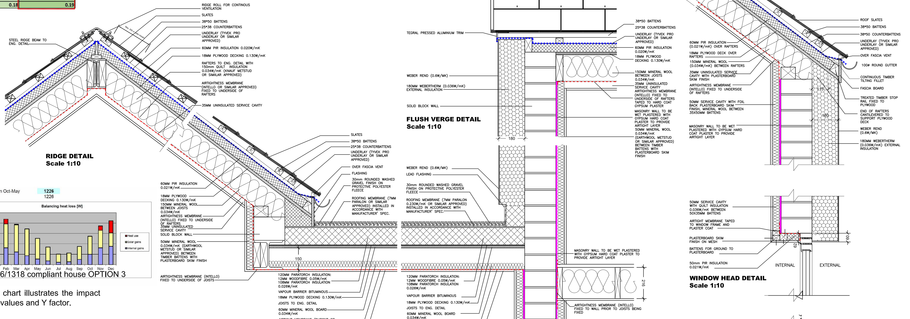
BALANCING HEAT LOSS CHART



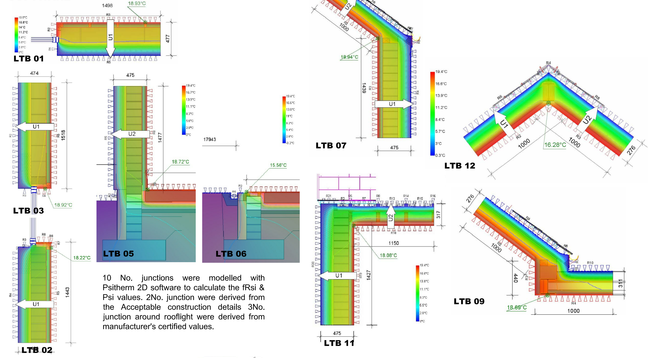
EU 2016/1318 compliant house OPTION 3

The comparison of the chart illustrates the impact of ventilation system, u-values and Y factor.

BUILDING FABRIC



THERMAL BRIDGE ASSESSMENT WITH PSITHERM 2D SOFTWARE



10 No. junctions were modelled with Psitherm 2D software to calculate the fRsi & Psi values. 2No. junction were derived from the Acceptable construction details 3No. junction around rooflight were derived from manufacturer's certified values.

Detail 06/T05 - Option 1 cavity wall
fRsi = 0.90 > 0.75
Psi value = 0.14614 W/mK

Detail Flat roof- external/internal wall
fRsi = 0.96 > 0.75
Psi value = 0.04195 W/mK

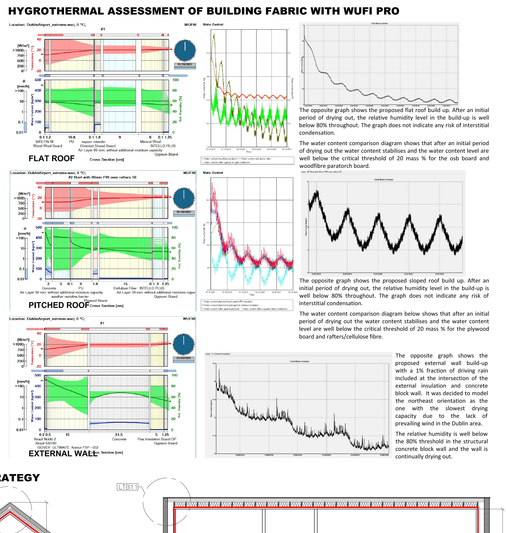
Note:
At the early stage of the project (Part L compliant scheme), the external walls were specified as cavity walls, consisting of 130mm full-filled cavity with graphite bead and PIR insulated plasterboard internally.
However, when the above detail was compared with a similar detail with wall consisting of block on flat with external insulation it was clearly apparent that the external insulation was a detail providing much lower psi value and better fRsi value.
After the above detail was modelled in psi-therm software it was decided to specify the Nzeb compliant house with block on flat and external insulation.

Y FACTOR CALCULATIONS

Thermal Bridging Calculation — Version 1.0

Item Number	Table	Junction Detail	Description	Target U-Value(W/m²K)	Psi Value (W/mK)	Length (m)	Calculated Value PsiL (W/mK)
1	Custom Junction	Custom Junction	1.7X Window jamb	Custom Junction	-0.006	8.512	-1.890
2	Custom Junction	Custom Junction	1.7X Window sill	Custom Junction	0.170	10.540	2.046
3	Custom Junction	Custom Junction	1.7X window / door head	Custom Junction	0.012	8.000	0.090
4	Section 5 - External Insulation	5.10.1 Corner	4.1External corner	U = 0.15 (Ind) U = 0.18 (Rec) U = 0.15	0.078	-0.800	1.037
5	Custom Junction	Custom Junction	5.1.7R wall to ground junction	Custom Junction	0.836	24.000	5.030
6	Custom Junction	Custom Junction	4.1.7R door threshold	Custom Junction	0.802	2.000	0.602
7	Custom Junction	Custom Junction	3.1.7R roof/wall junction eaves	Custom Junction	0.548	41.500	5.602
8	Custom Junction	Custom Junction	6.1.7R flat roof/wall to internal wall junction	Custom Junction	0.845	1.500	0.268
9	Custom Junction	Custom Junction	2.1.7R flat roof/ parapet junction detail	Custom Junction	0.070	1.710	0.451
10	Section 5 - External Insulation	5.10.7A Roof - Parapet	10.1.7R flat roof / wall parapet	U = 0.15 (Ind) U = 0.18 (Rec) U = 0.15	0.275	4.500	2.866
11	Custom Junction	Custom Junction	11.1.7R verge wall / roof junction	Custom Junction	0.001	41.000	2.007
12	Custom Junction	Custom Junction	12.1.7R Ridge inland Roof	Custom Junction	0.007	14.000	1.018
13	Custom Junction	Custom Junction	13.1.7R rooflight kerbs Frame Jnct	Custom Junction	0.000	1.400	0.234
14	Custom Junction	Custom Junction	14.1.7R rooflight kerbs Frame Jnct	Custom Junction	0.000	1.400	0.000
15	Custom Junction	Custom Junction	15.1.7R rooflight kerbs Frame Jnct	Custom Junction	0.000	1.400	0.000

HYGROTHERMAL ASSESSMENT OF BUILDING FABRIC WITH WUFI PRO



The opposite graph shows the proposed flat roof build up. After an initial period of drying out, the relative humidity level in the build-up is well below 80% throughout. The graph does not indicate any risk of interstitial condensation.

The water content comparison diagram shows that after an initial period of drying out the water content stabilises and the water content level are well below the critical threshold of 20 mass % for the osb board and woodfibre paratorch board.

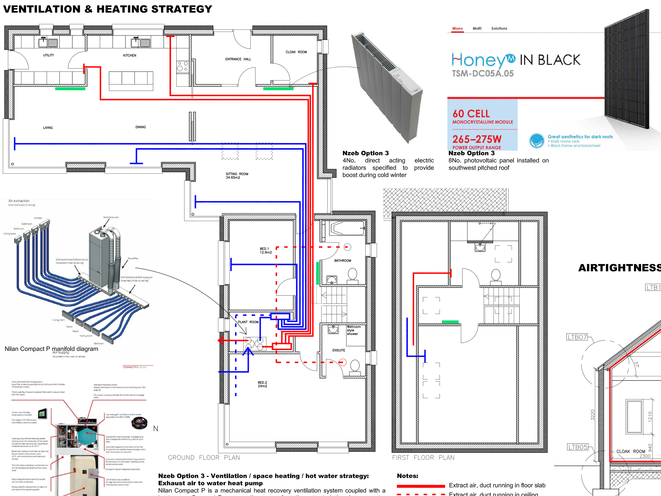
The opposite graph shows the proposed sloped roof build up. After an initial period of drying out, the relative humidity level in the build-up is well below 80% throughout. The graph does not indicate any risk of interstitial condensation.

The water content comparison diagram below shows that after an initial period of drying out the water content stabilises and the water content level are well below the critical threshold of 20 mass % for the plywood board and rafters/cellulose fibre.

The opposite graph shows the proposed external wall build-up with a 1% fraction of drying rain included at the intersection of the external insulation and concrete block wall. It was decided to model the northeast orientation as the one with the slowest drying capacity due to the lack of prevailing wind in the Dublin area.

The relative humidity is well below the 80% threshold in the structural concrete block wall and the wall is continually drying out.

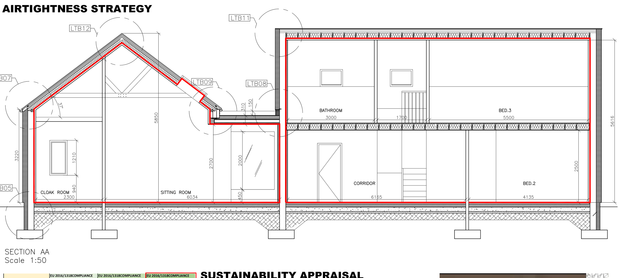
VENTILATION & HEATING STRATEGY



Nzeb Option 3 - Ventilation / space heating / hot water strategy:
Exhaust air to water heat pump
Nilan Compact P is a mechanical heat recovery ventilation system coupled with a heat pump. Compact P recovers the energy from the extracted air using a counter flow heat exchanger to pre-heat incoming fresh air. The remaining energy that is not utilised by the counter flow heat exchanger is used by the heat pump to produce hot water.
In addition 4No. direct acting electric radiators are specified to boost the space heating during teh couple of weeks when extra heat may be required.

Notes:
- Extract air, duct running in floor slab
- Extract air, duct running in ceiling
- Supply air, duct running in floor slab
- Supply air, duct running in ceiling
- Direct acting electric radiator

AIRTIGHTNESS STRATEGY



COST APPRAISAL - ASSESSING COST OPTIMALITY

Results & Sensitivity Analysis
3 options to achieve the Nzeb standard were appraised against the Part L compliant scheme which can be summarised as follows:
Option1: same building fabric as Part L scheme, 4No. types of technology
Option 2: enhanced building fabric, 3No. Types of technology
Option 3: enhanced building fabric, 2No. Types of technology

From the LCC calculations it appears that with current accepted financial parameters none of the Nzeb options are cost optimal against the Part L compliant scheme. However when carrying out a sensitivity analysis the results are as follows:
Option 3 is cost optimal with a discount rate ≤3.2% as option 1 relies heavily on fabric which is a long term investment and pay back period in particular maintenance cost
Option 1 is cost optimal with a high fuel inflation ≥ 5.7% as option 1 has the lowest energy cost
Option 3 is cost optimal with a general inflation ≥ 6% as option 1 relies on long term investment in its capital cost
Option 2 is not cost optimal in any of the scenarios analysed

Conclusion
As it is unlikely that fuel inflation is going to rise steeply due to political commitment to reduce energy dependency, it is highly unlikely that fuel inflation would ever reach 5.7% and therefore it is deemed that option 1 is not the most cost optimal nzeb option.
On the other hand, option 3 could be cost optimal if discount rate could be maintained low to improve the affordability of capital investment in building fabric.
Also the argument could be made for incentive to invest in good thermal efficiency fabric rather than technology as a more secure future proof investment which would not be affected by fuel inflation nor general inflation.
However, option 3 requires an additional capital investment of €23,949.35 + Vat as opposed to Option 1 which only requires an additional €16,123.56 + Vat. It would be interesting to see whether incentives could be made through financial institution for example when applying for a mortgage that the financial institution would take cost appraisal analysis similar to this one before granting a mortgage. This would improve affordability of high quality building fabric as opposed to a "quick fix" nzeb solution relying heavily on technology.

	PART L COMPLIANCE	EU 2016/1318COMPLIANCE OPTION 1	EU 2016/1318COMPLIANCE OPTION 2	EU 2016/1318COMPLIANCE OPTION 3
Ventilation :-				
whole house extraction ventcm	5,010.00	-	-	-
Paul Novus MVHR 91% efficient	-	6,474.00	6,474.00	-
Nilan compact P MVHR without air to water heat pump 88% efficiency	-	-	-	9,700.00
Heating System:-				
Primary heat source:-				
Air to water heat pump: Generation 5 Samsung Mono HP(Ltd) capacity & scop: exact ptions9.9kW power input 3kW + 3kW buffer tank(Ltd) Ground floor: 35mm pipe @ 150mm centres & 8mm pipe @ 75mm centres	6,597.00	6,597.00	6,597.00	-
Joule samsung heat pump	2,725.74	2,725.74	2,725.74	-
All rooms heated and installation of heating equipment: low temperature radiators 1.5 kW/hr	585.46	585.46	1,169.92	-
Electric towel rad: 0.7kW/hr towel rad in bathroom, ensuite & shower room	600.00	600.00	600.00	-
Extra pump electric radiators - cost included with gas radiators	-	-	-	-
Secondary heat source:-				
Joule & fuel stove with no backboiler	1,500.00	-	-	-
Joule of building chimney	1,276.00	-	-	-
Water heating system				
Joule samsung heat pump: Generation 5 Samsung Mono HP(Ltd) capacity & scop: exact ptions9.9kW power input 3kW + 3kW buffer tank(Ltd) 300 litre hot water cylinder	-	-	-	-
Joule samsung heat pump	1,951.79	1,951.79	-	-
Solar water heating system: Navitor 2X 2No. PowerTub plate collectors 4.1m2	2,025.78	2,025.78	0.00	0.00
Total capital cost	**27,474.78**	**43,159.76**	**19,567.66**	**43,159.76**
Fabric cost:-				
Fabric cost (Ground floor, Walls, Roof, Windows and Doors)	-	-	-	-
Fabric cost for roof identical on all options:-				
Roof type 1:-external wall:W/m²K				
130mm full fill cavity insulation + 50mm PIR internally)	0.17	0.17	0.149	0.149
Roof type 1:-external wall:W/m²K	26,528.00	26,528.00	-	-
180mm EPS external insulation + 50mm mineral internally)	-	-	1,365.45	1,365.45
Concrete block on flat roof with external insulation	26,528.00	26,528.00	850.00	850.00
Velux roofwindows (Ground floor)	-	-	1,365.45	1,365.45
Velux roofwindows (First floor)	-	-	850.00	850.00
Velux roofwindows (Ground floor)	-	-	10,725.76	10,725.76
Velux roofwindows (First floor)	-	-	25,634.49	25,634.49
Velux roofwindows 60 spare for blinds to work in junction to comply	-	-	-	-
Pre-reduced lintels - cost £20.00 per linear metre	-	500.00	-	-
Extra EPS insulation below ground, including insulation to cavity wall below ground level	-	-	1,478.52	1,478.52
Extra wall and foundation battens, plasterboard skim finish and 450 detail	-	-	3,707.02	3,707.02
Total capital cost	**53,056.00**	**53,028.00**	**45,627.69**	**45,627.69**
Windows / glazing				
double glazing timber windows	21,500.00	-	-	-
triple glazing timber windows	-	15,050.00	15,050.00	15,050.00
Total capital cost	**21,500.00**	**15,050.00**	**15,050.00**	**15,050.00**
Total cost 30Yrs	**101,701.45**	**111,233.36**	**79,245.35**	**103,837.45**
Part L compliant option = 0 - cost differential on building fabric	**0.00**	**15,531.91**	**(22,456.10)**	**(2,063.91)**

Cost optimal option

	PART L COMPLIANCE	EU 2016/1318COMPLIANCE OPTION 1	EU 2016/1318COMPLIANCE OPTION 2	EU 2016/1318COMPLIANCE OPTION 3
Discounted cost 30Yrs				
Discount rate = 3.2%				
Ventilation :-				
whole house extraction ventcm	3,010.00	-	-	-
Paul Novus MVHR 91% efficient	-	3,474.00	3,474.00	-
Nilan compact P MVHR without air to water heat pump 88% efficiency	-	-	-	5,700.00
Heating System:-				
Primary heat source:-				
Air to water heat pump: Generation 5 Samsung Mono HP(Ltd) capacity & scop: exact ptions9.9kW power input 3kW + 3kW buffer tank(Ltd) Ground floor: 35mm pipe @ 150mm centres & 8mm pipe @ 75mm centres	3,777.74	3,777.74	3,777.74	-
Joule samsung heat pump	1,563.00	1,563.00	1,563.00	-
All rooms heated and installation of heating equipment: low temperature radiators 1.5 kW/hr	335.46	335.46	670.92	-
Electric towel rad: 0.7kW/hr towel rad in bathroom, ensuite & shower room	344.00	344.00	344.00	-
Extra pump electric radiators - cost included with gas radiators	-	-	-	-
Secondary heat source:-				
Joule & fuel stove with no backboiler	860.00	-	-	-
Joule of building chimney	732.00	-	-	-
Water heating system				
Joule samsung heat pump: Generation 5 Samsung Mono HP(Ltd) capacity & scop: exact ptions9.9kW power input 3kW + 3kW buffer tank(Ltd) 300 litre hot water cylinder	-	-	-	-
Joule samsung heat pump	1,118.79	1,118.79	-	-
Solar water heating system: Navitor 2X 2No. PowerTub plate collectors 4.1m2	1,161.39	1,161.39	0.00	0.00
Total capital cost	**15,676.39**	**12,123.79**	**10,332.66**	**5,700.00**
Fabric cost:-				
Fabric cost (Ground floor, Walls, Roof, Windows and Doors)	-	-	-	-
Fabric cost for roof identical on all options:-				
Roof type 1:-external wall:W/m²K				
130mm full fill cavity insulation + 50mm PIR internally)	0.17	0.17	0.149	0.149
Roof type 1:-external wall:W/m²K	15,202.00	15,202.00	-	-
180mm EPS external insulation + 50mm mineral internally)	-	-	782.60	782.60
Concrete block on flat roof with external insulation	15,202.00	15,202.00	487.00	487.00
Velux roofwindows (Ground floor)	-	-	782.60	782.60
Velux roofwindows (First floor)	-	-	487.00	487.00
Velux roofwindows (Ground floor)	-	-	6,145.00	6,145.00
Velux roofwindows (First floor)	-	-	14,685.71	14,685.71
Total capital cost	**30,404.00**	**30,404.00**	**23,369.91**	**23,369.91**
Windows / glazing				
double glazing timber windows	12,320.00	-	-	-
triple glazing timber windows	-	8,623.00	8,623.00	8,623.00
Total capital cost	**12,320.00**	**8,623.00**	**8,623.00**	**8,623.00**
Total cost 30Yrs	**58,400.39**	**51,150.79**	**42,325.57**	**37,692.91**
Part L compliant option = 0 - cost differential on building fabric	**0.00**	**(7,249.60)**	**(16,074.82)**	**(20,707.48)**

Cost optimal option

SUSTAINABILITY APPRAISAL

PARKS AND OPEN SPACES

ASSESSMENT OF PROJECT LOCATION

The Water Calculator
http://www.thewatercalculator.org.uk
Congratulations
Parsonstown House
You are within your target maximum consumption (3 litres per person per day)
Your consumption calculation
Calculation summary

Installation type	Unit of measure	Capacity / Flow rate	Use factor	Fixed use	Litres / person / day
WCs (single flush)	Flush volume (litres)	4.00	3	15.47	
Showerheads (non-low flow)	Average effective flushing volume (litres)	9.5	0.5		
Taps (non-kitchen/utility rooms)	Flow rate (litres / minute)	3.2	1.08	1.08	8.64
Bath (average size pressure)	Volume to overflow (litres)	180	0.15	5	32.4
Shower (cubic size pressure)	Flow rate (litres / minute)	2.3	4.07	0	10.68
Kitchen/utility room tap(s)	Flow rate (litres / minute)	3.2	0.58	0.58	4.72
Washing machine	Litres / kg dry load	6.17	2.1	0	17.36

ASSESSMENT OF WATER CONSUMPTION

HPI - Home Performance Index

PROJECT	Parsonstown House
DATE	09/05/2017
ADDRESS	Parsonstown, Celbridge, Co. Kildare
OVERALL SCORE	59%
	SILVER

ASSESSMENT OF DAYLIGHT FACTOR

Dublin Institute of Technology
Institiúid Teicneolaíochta Átha Cliath
D I T

POST GRADUATE CERTIFICATE DT774 - 2017 - One-off house in Parsonstown, Co. Kildare - Anne Madaire D15127525