NW Bicester

An application for the exemplar phase of the
NW Bicester Eco Development proposals submitted by
P3Eco (Bicester) Limited **and the** A2Dominion Group

Daylight and Sunlight Analysis

Hyder

P3Eco Ltd

a2dominion

Hyder Consulting (UK) Limited
2212959
29 Bressenden Place
London SW1E 5DZ
United Kingdom
Tel: +44 (0)20 3014 9000
Fax: +44 (0)20
www.hyderconsulting.com

Bicester Eco-Town, Oxfordshire

Overshadowing and Daylighting Study

Author	R. Real	
Checker	M. Nague	
Approver	R. Cruz	

Report No 6505-UA001881-03

Date 20th June 2011

This report has been prepared for P3 Eco Ltd, A2 Dominion in accordance with the terms and conditions of appointment for Overshadowing and Daylighting Study dated 18-10-10. Hyder Consulting (UK) Limited (2212959) cannot accept any responsibility for any use of or reliance on the contents of this report by any third party.

CONTENTS

1 SUMMARY

The consensus is that for planning purposes, the daylight levels to the plots are adequate for typical housing design. The dwelling units have achieved the minimum average daylight levels when referring to the British standards for daylight.

Adjacent dwelling units do not cast large shadows unto neighbouring plots. For some portion of the winter months, there may be overshadowing to the ground floor living room by buildings opposite. This scenario is only for a short period of time at the end of a day when electric lighting will shortly be required.

Shadow cast will be experienced on the roofs of the adjoining houses as expected during the winter season. However, the effect is insignificant on solar panels on the basis of solar flux intensity and the period of time when the shadow is being experienced. For the rest of the year the roofs are clear of localised shadows and the potential for solar harvesting is high especially for the roofs facing south.

2 INTRODUCTION

Hyder Consulting UK Ltd was appointed to undertake overshadowing and daylighting works to the Exemplar site of the Bicester Eco-Town development on 18th October 2010. The daylighting and overshadowing studies included within this report have been formulated on the basis of the information supplied by the project architect. All models created and analysed are for option 1 of Eco-Town Exemplar scheme only.

2.1 Standards

The following standards and good practice guides have been used for the study:

Type	Description
BS 8206-2 (2008)	Lighting for Buildings Part 2: Code of practice for daylighting
BRE Report 209	Site layout planning for daylight and sunlight; A guide to good practice
CE292	Energy efficiency and the code for sustainable homes; Levels 5 & 6

Table.1 – Applied standards and good practice

2.2 3D Modelling

3D models have been constructed for the exemplar site based on the dwelling types provided by the project architect. At this stage, there are currently ten types of dwelling identified to the scheme, which are as follows:

Type	Description
01	*a) 2 Bed Private Terrace*
	b) 2 Bed Social Detached
	c) 3 Bed Private Terrace
	d) 3 Bed Social Detached
	e) 4 Bed Private Terrace
	f) 5 Bed Private Detached
03	*a) 2 Bed Private*
	b) 2 Bed Social
	c) 3 Bed Private
	d) 3 Bed Social
	a) 4 Bed Private
	b) 4 Bed Social
05	*c) 2 Bed Private*
	d) 2 Bed Social
	e) 3 Bed Private
	f) 3 Bed Social
	g) 4 Bed Private
	h) 5 Bed Private
07	*a) F1_B_F*
	b) F2_B_F
	c) F3 and F4
	d) F5_B_F
08	*a) 2 Bed Bungalow_B1&B2*
	b) 2 Bed Bungalow_B5
	c) 2 Bed Bungalow_B16&B7
	d) 2 Bed Bungalow_B3&B4
E1	*a) 2 Bed Private*
	b) 3 Bed Private
	c) 3 Bed Social
	d) 4 Bed Private
	e) 5 Bed Private
E2	*a) 2 Bed Private*
	b) 2 Bed Social
	c) 3 Bed Private
	d) 5 Bed Private

Table.2 – Dwelling Types

All models for dwelling types were created in accordance with the drawing presented by the architect as follows.

1. Site Layout Plan; providing a proposed master planning layout for the dwelling types. This has been used as a template for the overshadowing study

2. Building Elevations; providing the scope of typical window sizes and placements for the building front elevations.

3. Floor Plan Layouts; providing indication of the space planning to the building plots.

For the purpose of this study, building types have been modelled in Google SketchUp for ease of creation and manipulation. The selection of SketchUp was primarily due to the surfaced based nature of its cad engine, which has been found to translate geometry into the selected environmental program with the highest level of accuracy, particularly in comparison to other modelling methods such as Autodesk Revit Architecture or other standard *.dxf or *.xml imports. Recent developments between the software packages in the form of a GUI plug-in have also strengthened the flexibility and accuracy of model translation. Baseline models were constructed for each of the building templates described in table.1 (with the exception of Type 05). These models were then exported to the environmental analysis software for addition of the reflectance and transmittance variables (see section 2.2). Habitable spaces were translated as bound rooms within the environmental analysis software, with occupiable areas extending from finished floor level to underside of ceiling. Intermediate floors and roof spaces were also created within the model geometry but have not been included within the analysis areas.

2.2.1 Assumptions made

In the absence of relevant data or information, the following assumptions have been made in order to expedite modelling works and analysis;

1. All internal doors have been assumed as 900mm wide x 2100mm high to comply with building regulations.
2. For dwellings, the current cladding is not yet designed in detail, with external wall thicknesses proposed as 350mm thick and internal walls 100mm thick block or metal stud. The works being undertaken do not have any thermal transmittance requirements and so statement of U-Values is not included. As such all external and internal walls are assumed as fully opaque.
3. The glazing to the dwellings has been applied as per the specification in Table.3 in order to meet the target U-values in line with CSH level 5 dwellings. This configuration is influenced by reference data supplied within CE292 (refer to appendices) and also research within current sustainable buildings such as the PassiveHaus by Eco2h2o which denotes a specification of triple glazing with a krypton gas fill to the glazing cavities. These values in turn are indicative of the transmittance and reflectance values required for daylight calculation.
4. Neutral colours and finishes have been selected for the internal and external building surfaces such as white emulsion on render or crème carpets in order to calculate internal daylighting factors. The reflectance and transmittance properties of these finished are stated in Table.4.

Description	***Process***		***Thick***
1. Pilkington Suncool	*Toughened*		*6mm*
2. Cavity	*Krypton fill (90%)*		*16mm*
3. Pilkington Optifloat	*Annealed*		*6mm*
4. Cavity	*Krypton fill (90%)*		*16mm*
5. Pilkington Optilam	*Laminated*		*6.4mm*
U-Value	*U*	*0.80*	*W/m^{2}k*
Light Transmission	*LT*	*62*	*%*
	UV	*1*	*%*
Light Resistance Out	*LR Out*	*13*	*%*
Light Resistance In	*LR In*	*17*	*%*
Energy Transmitted	*ET*	*32*	*%*
Energy Reflected	*ER*	*29*	*%*
Energy Absorbed	*EA*	*39*	*%*
Total Transmittance	*g*	*39*	
Shading Coefficient	*SC*	*0.45*	

Table.3 – Typical Glazing Specification

Material	***LR In***	***LR Out***	***LT***
Carpet: Light Colour	*45*	*0*	*0*
External Wall; Light Grey Brick	*40*	*40*	*0*
Internal Wall; Plaster, White Emulsion	*80*	*80*	*0*
Door; Light Oak Timber	*25*	*25*	*0*
Ceiling; Plaster, White Emulsion	*80*	*80*	*0*

Roof; Slate / Timber	*70*	*10*	*0*

Table.4 – Materials Reflectance Properties

2.3 Environmental Analysis

For overshadowing and daylighting analysis, the housing types were imported from Google SketchUp into IES Virtual Environment. All geometrical elements were identified as either opaque or transparent, with no translucent materials applied at this stage. Window perimeter frames have been created within the models to accurately represent the intended areas of glazing coverage. The geographical location of the buildings was set as for Oxford, with local CIBSE DSY weather data for Brize Norton applied, being the nearest site for reference data.

Particular relevance has been placed on calculation of Average Daylight Factors (ADF) that are required within BS-8206 as requirement for planning. Vertical Sky Components (VSC) and Annual Probable Sunlight Hours (APSH) have not been included as they are used primarily for guidance under the BRE Report 209 which does not constitute the basis for planning application

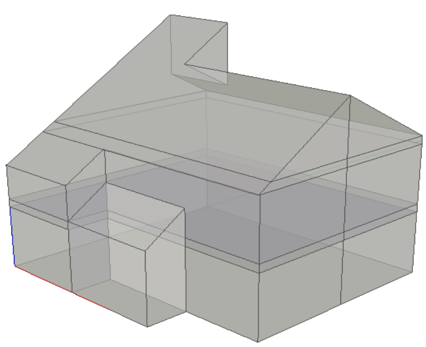


Fig.1 – Typical SketchUp Model (Type 10)

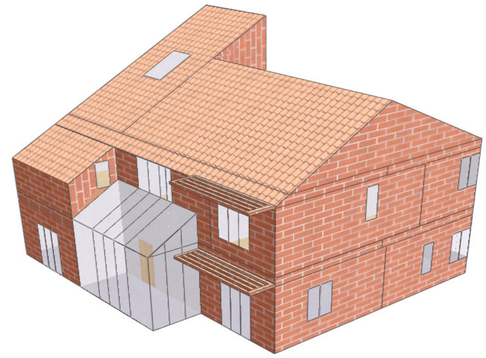


Fig.2 – Typical IES Model (Type 10)

2.3.1 Overshadowing Study

For the overshadowing study, all building types modelled and imported were applied to sample areas of the site location plan in order to populate typical areas. The models were then subject to Suncast analysis to track solar patterns and account for any localised shading impacts from surrounding buildings. Images were captured for particular areas of interest, with results stated in section 3.1.

2.3.2 Daylighting Study

Building types were analysed individually, with multiple cases investigated for the varying orientations of the building types, indicated by placement on the site layout plan provided by the project architect. IES FlucsPro software was then used to establish daylighting factors within building plots. Daylighting calculations were made for a midseason day of 21st March at midday, with a CIE standard overcast sky applied to all calculations to allow an onerous case for the internal lighting levels. Contour plots were taken for the ground and first floor areas of the proposed buildings, with a working plane of 850mm above finished floor, being the standard as stated in BRE Report 209 (see fig.3). A maintenance factor for the glazing of 0.9 was assumed allowing for clean vertical glazing.

Methods proposed within the British Standard for daylighting (BS8206-2) indicate that daylight factors within properties should be no lesser than the values stated in Table.4 below for adequate task lighting in dwelling. Methods described by the BRE in Report 209 (P.J Littlefair, 1998) however state that for a predominantly day lit appearance, calculated daylight factors should ideally be 5% or more if there is to be no additional supplemented daylighting, with lesser factors requiring assistance from electric lighting to create suitable conditions.

Room Type	***Min. Average DF***
Bedrooms	*1%*
Living Rooms	*1.5%*
Kitchens	*2%*

Table.5 – Daylight Factors by British Standard

Given the high level of passive design imposed upon the proposed properties, investigation was made into mapping daylight factors against lower and upper limits of 2% and 5% accordingly to represent the effectiveness of the orientation of the building plots. An indication of this output can be seen in fig.4 overleaf; further results for these daylight factors are stated in section 3.2.

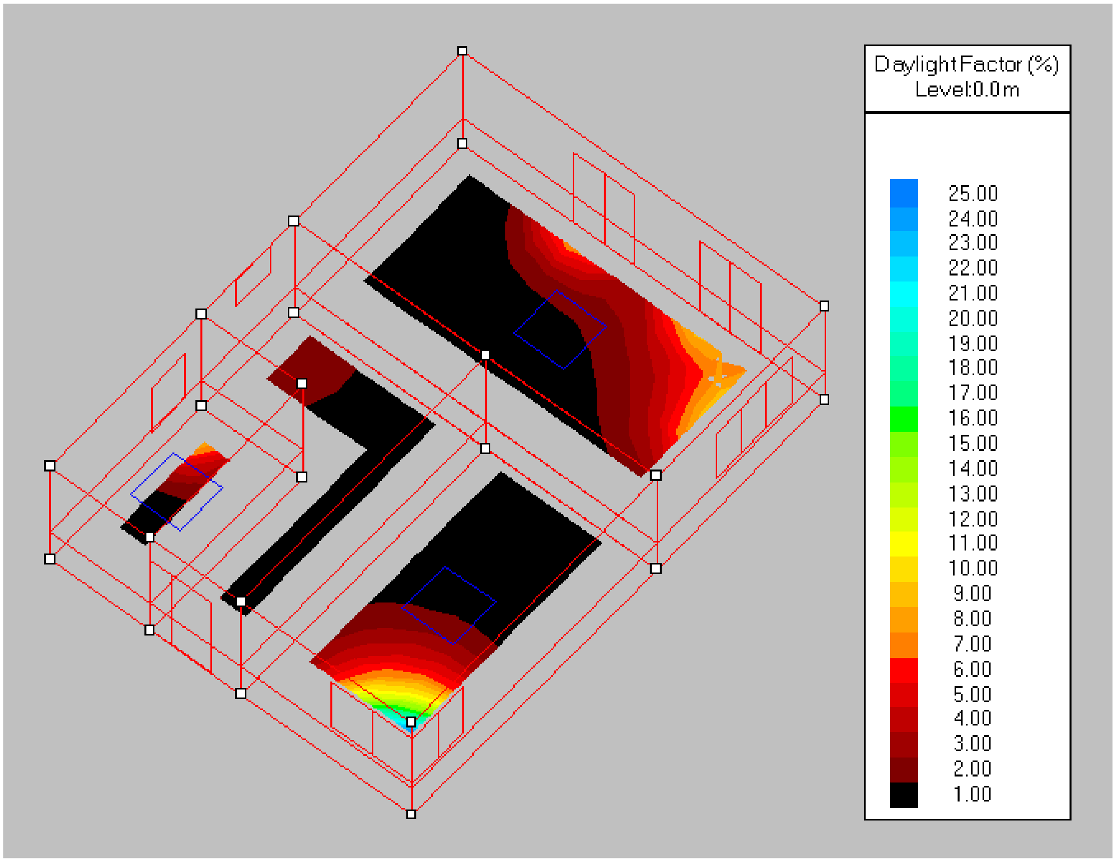


Fig.3 – Typical Daylighting Factor Contour Map

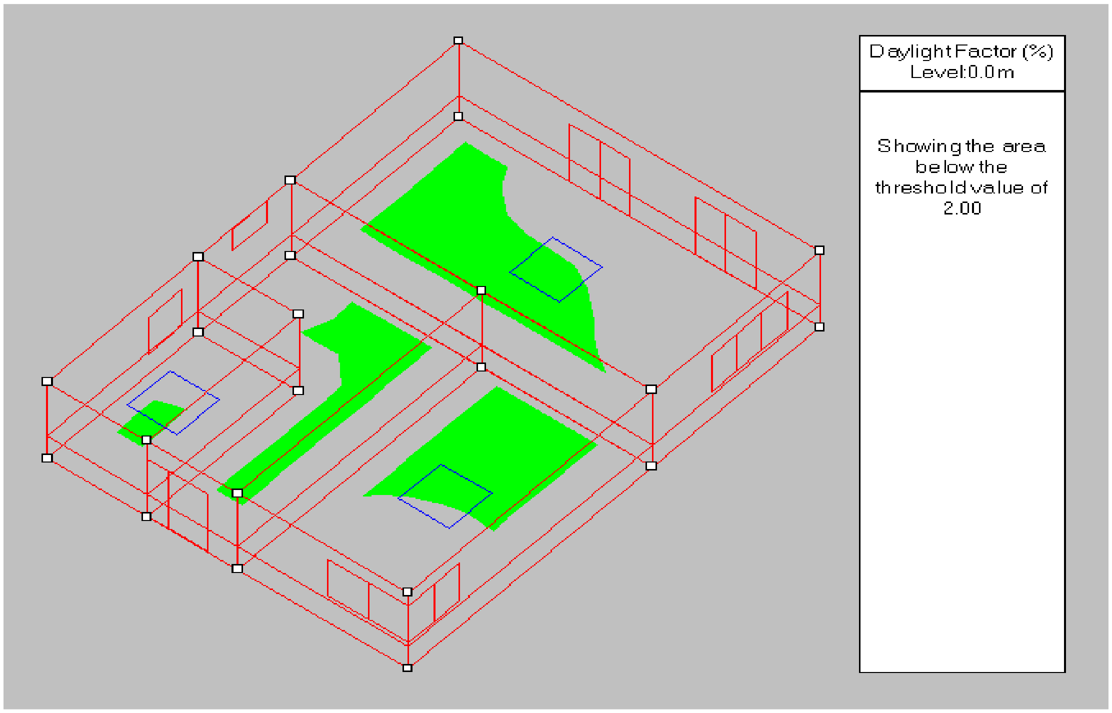


Fig.4 – Typical indication of areas below 2% Daylight Factor

3 RESULTS

3.1 Overshadowing Study

Fig.5 – Exemplar Site Layout Plan

As indicated previously in section 2.3.1, all building types modelled and imported were applied to sample areas of the site location plan in order to populate typical areas. The proposed site was split into four zones for further analysis; these areas have been denoted as zones 1 to 4 respectively, indicated in fig.5 above.

The models were then subject to Suncast analysis to track solar patterns and account for any localised shading impacts from surrounding buildings. For the purposes of this report, shadows were recorded for a typical winter day as an onerous case, where elongated shadows are more likely to extend to adjacent building plots. In this case the design day is 15th January for a typical CIBSE design year.

Suncast Images were captured for particular areas of interest and have been entered into the report for investigation of any possible issues (figs. 6 to 17 respectively). All Suncast images, along with some recorded videos for cast shadows, will be made available to the clients design team for further inspection. The configuration of the houses should still be valid and the results yielded for the overshadowing and daylighting studies will remain unchanged, particularly with regards to orientation of the dwelling types.

In the winter months, houses with adjoining models are partially casting shadows unto neighbouring roofs, which is expected, as the shadows produced during this season are considerably long. This is only for about three hours and the effect will be insignificant for solar harvesting on the basis of solar flux intensity. For the rest of the year the roofs are clear of shadows and the provisions for the solar panels will be beneficial in particular to the roofs section facing south, where the largest solar flux intensity is expected.

Fig.6 – Zone 1 - Critical Suncast

Fig.7 – Zone 2 - Critical Suncast

Fig.8 – Zone 3 - Critical Suncast

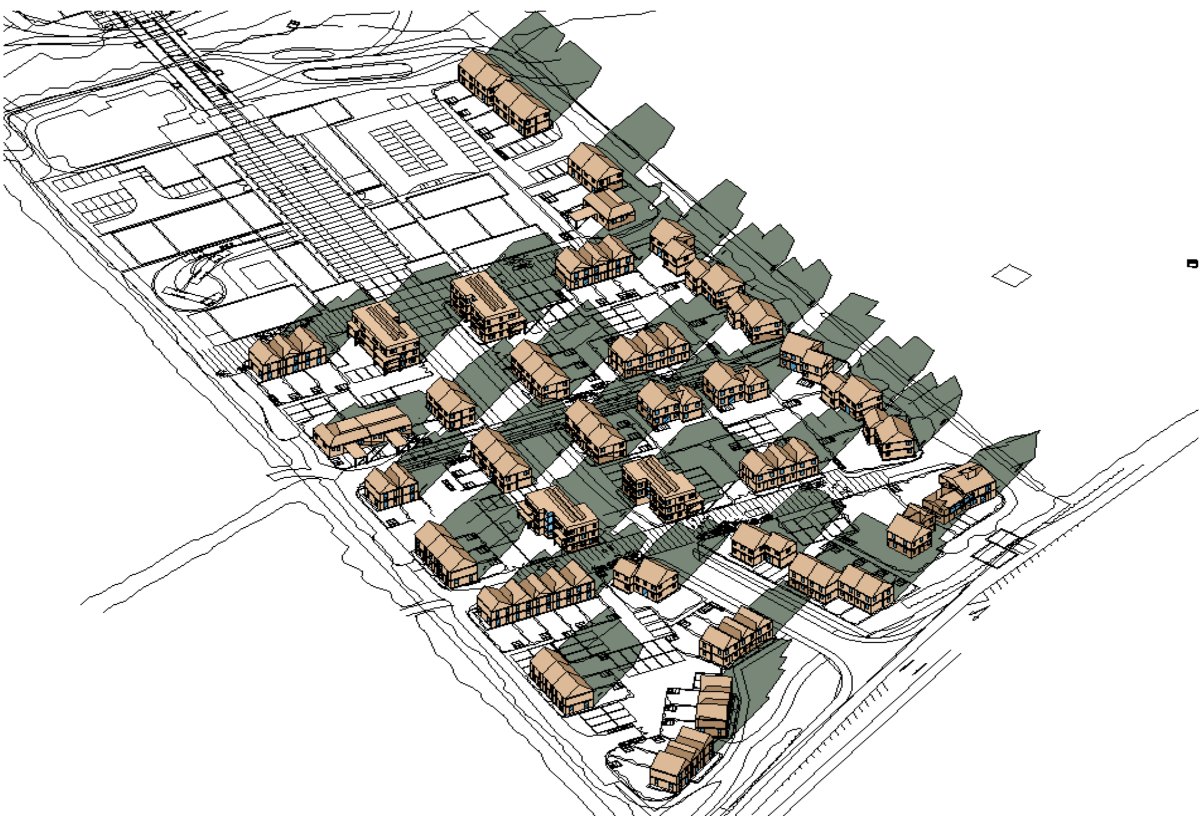


Fig.9 – Zone 4 - Critical Suncast

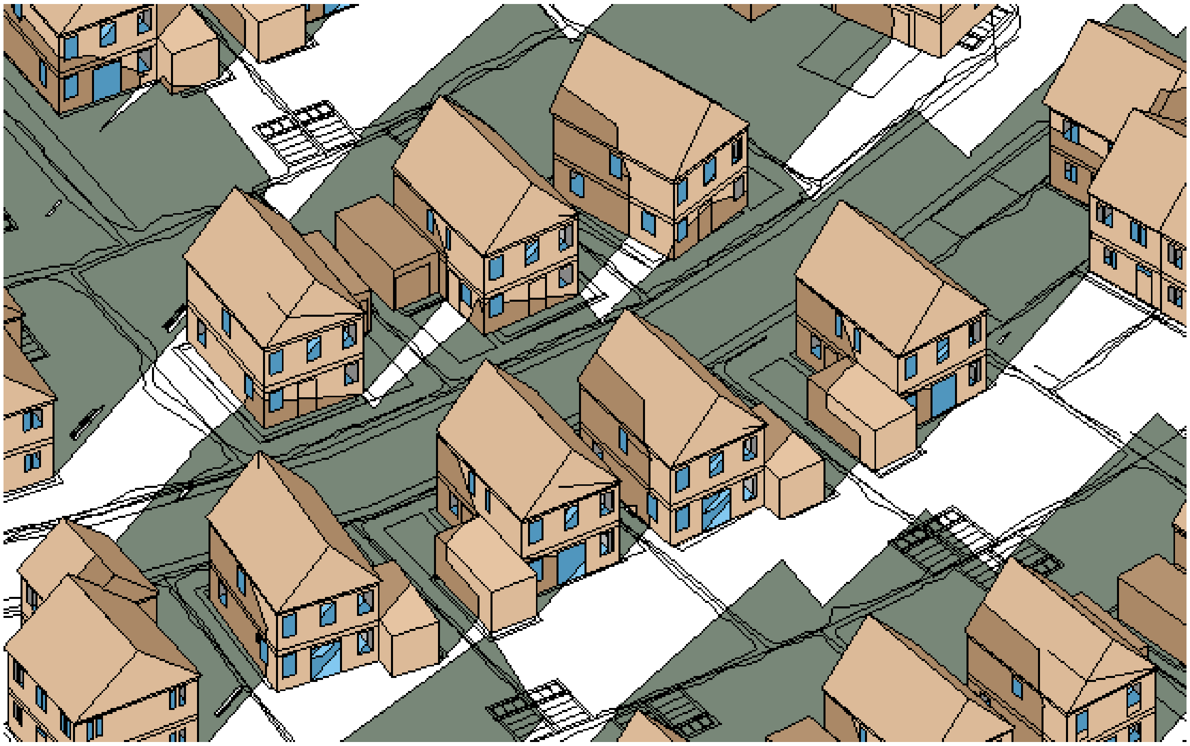


Fig.10 – Zone 1a - Critical Suncast

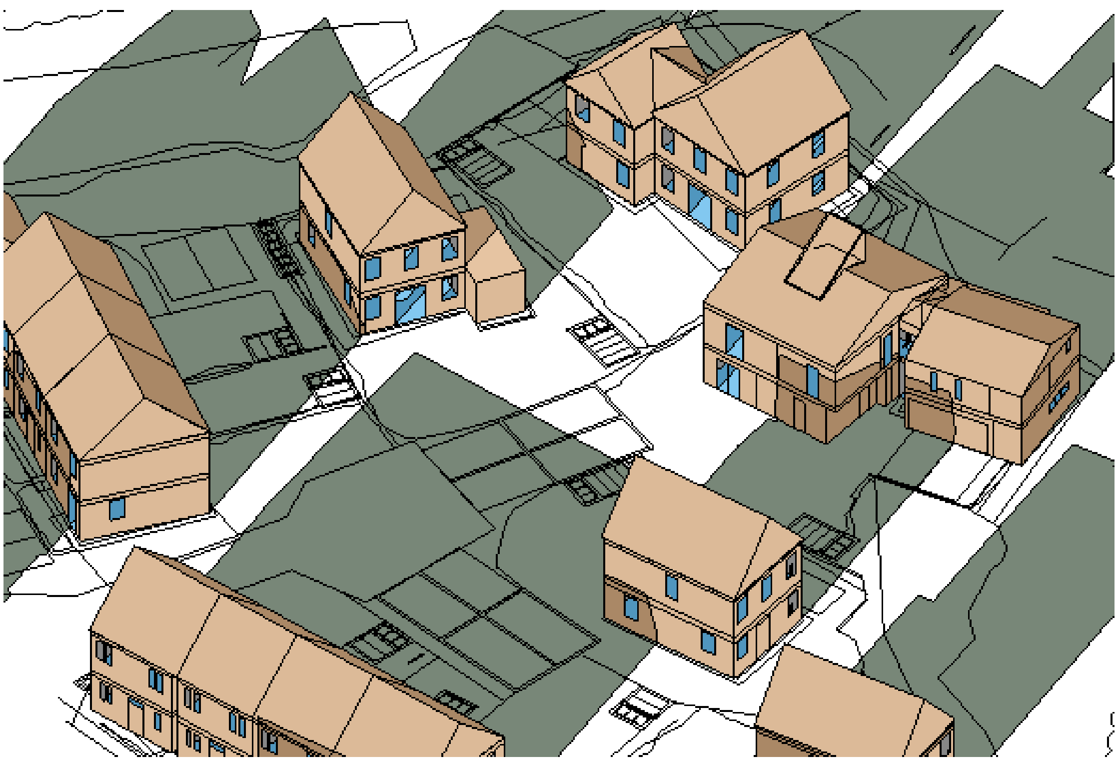


Fig.11 – Zone 1b - Critical Suncast

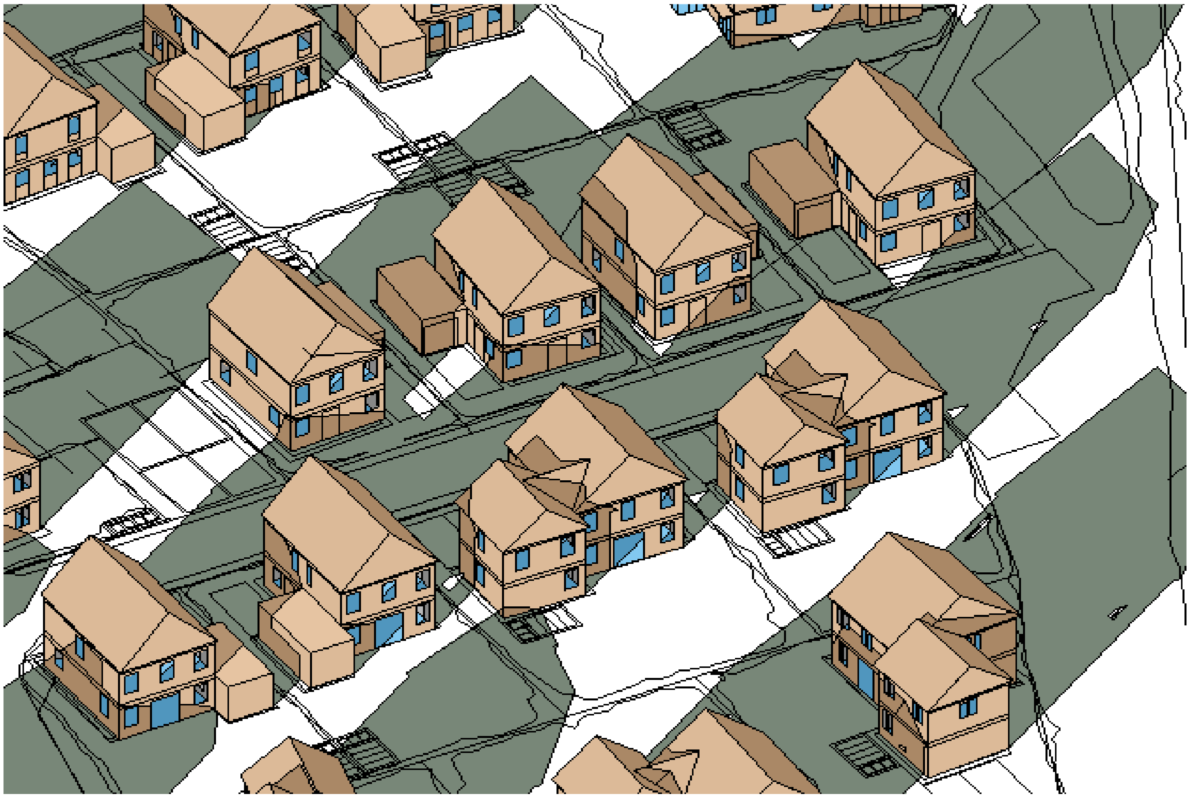


Fig.12 – Zone 2a - Critical Suncast

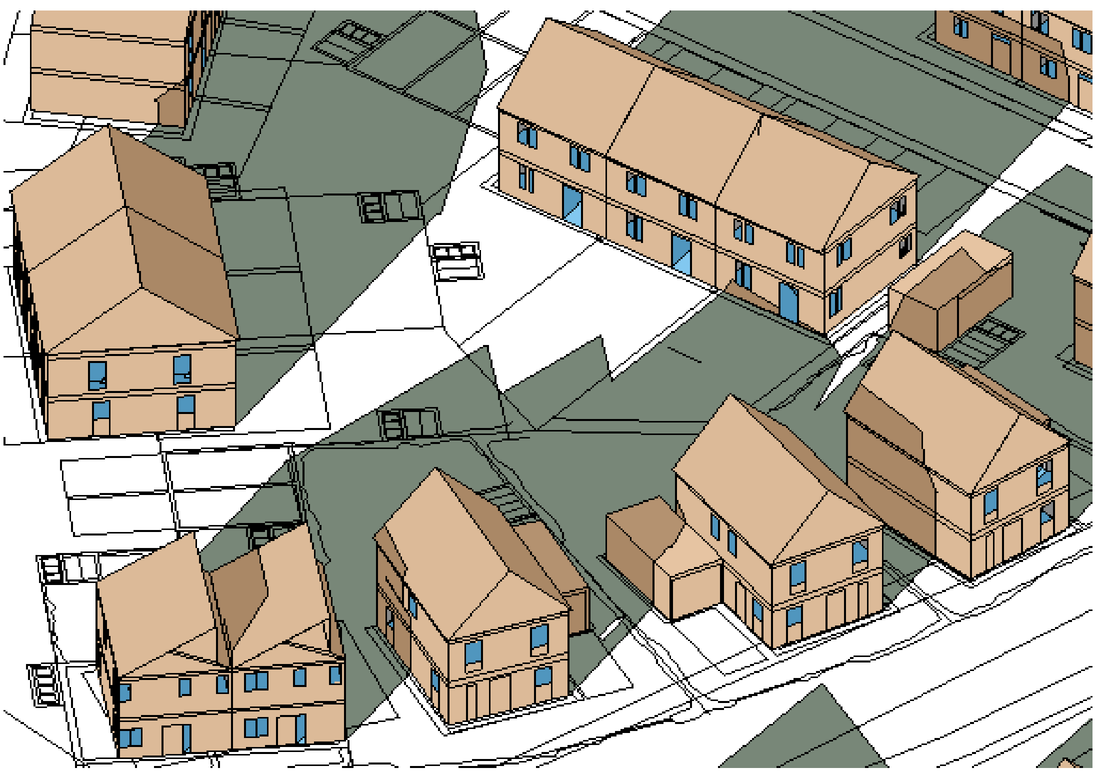


Fig.13 – Zone 2b - Critical Suncast

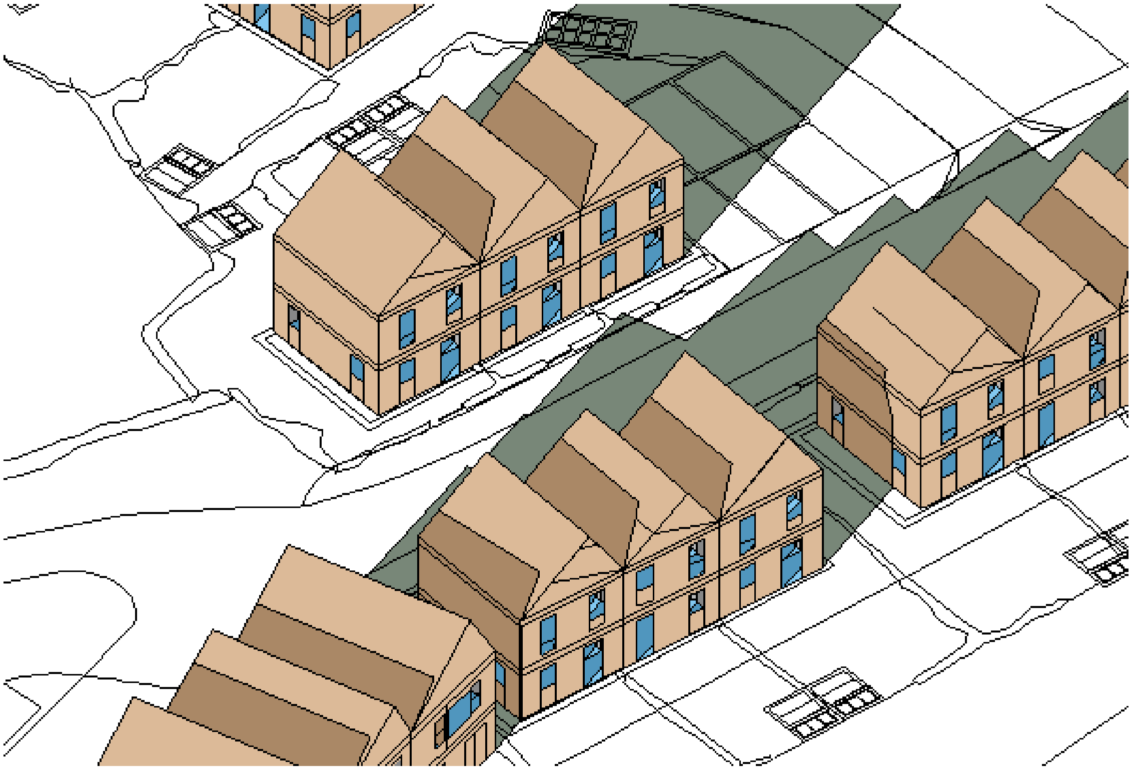


Fig.14 – Zone 3a - Critical Suncast

Fig.15 – Zone 3b - Critical Suncast

Fig.16 – Zone 4a - Critical Suncast

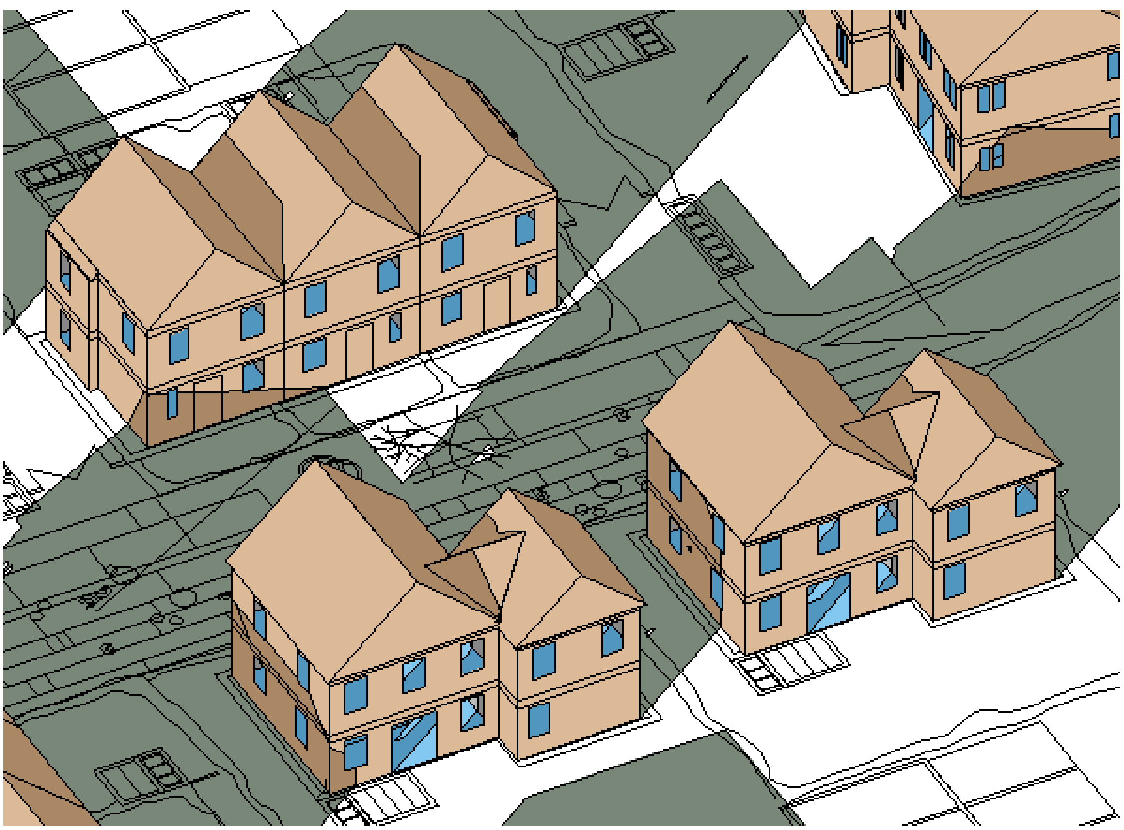


Fig.17 – Zone 4b - Critical Suncast

3.2 Daylighting Study

The following section contains a summary of daylighting conditions for each dwelling type for their respective orientations, as dictated by the site layout plan. The quality of the internal lighting has been noted for daylight factors for the upper and lower limits of 5% and 2% as noted inspection 2.3.2. For more detailed information on the Lux levels for the dwelling room types, along with colour contour charts, please refer to the appendices documents accompanying this report.

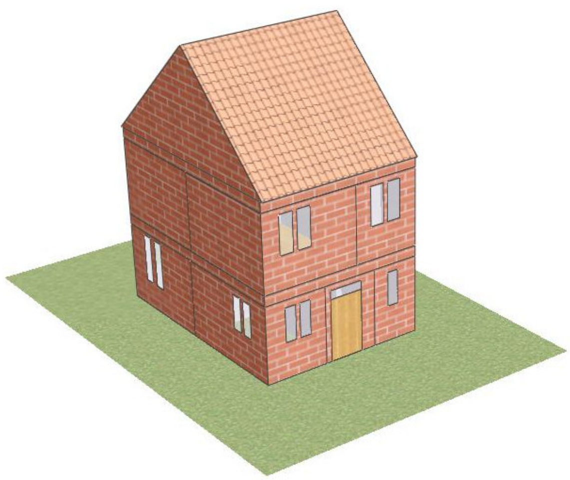


Fig.18 – Dwelling Type 1-a

Orientation	***Floor***	***Quality @ 2%***	***Quality @ 5%***
n/a	*Ground*	*Good*	*Average*
n/a	*1st*	*Good*	*Average*

Table.6 – Type 1-a Daylight Summary

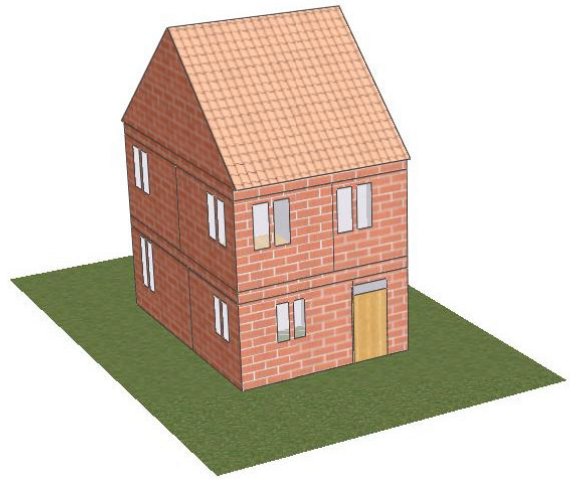


Fig.19 - Dwelling Type 1-b

Orientation	***Floor***	***Quality @ 2%***	***Quality @ 5%***
n/a	*Ground*	*Good*	*Average*
n/a	*1st*	*Good*	*Good*

Table.7 – Type 1-b Daylight Summary

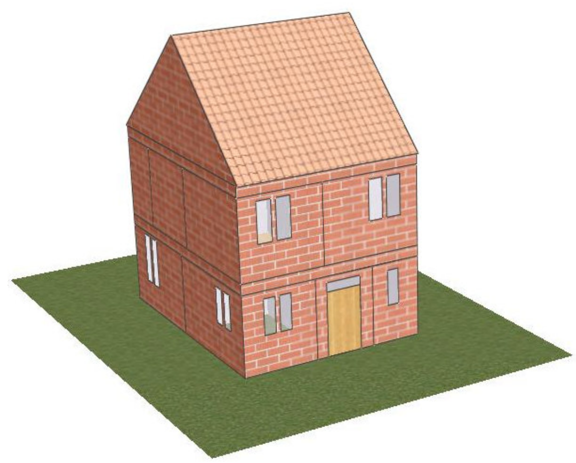


Fig.20 – Dwelling Type 1-c

Orientation	***Floor***	***Quality @ 2%***	***Quality @ 5%***
n/a	*Ground*	*Good*	*Average*
n/a	*1st*	*Good*	*Good*

Table.8 – Type 1-c Daylight Summary

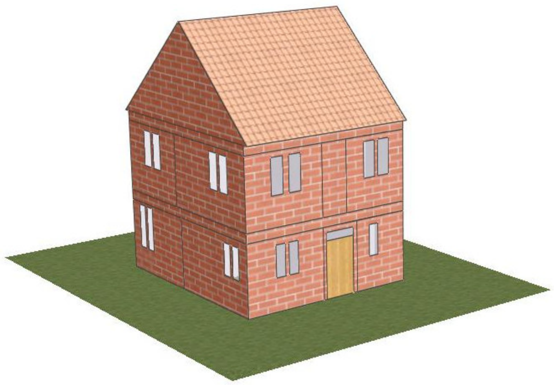


Fig.21 - Dwelling Type 1-d

Orientation	Floor	Quality @ 2%	Quality @ 5%
n/a	Ground	Good	Average
n/a	1st	Good	Good

Table.9 – Type 1-d Daylight Summary

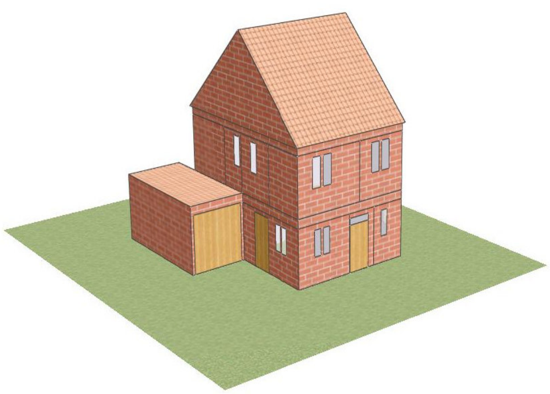


Fig.22 - Dwelling Type 1-e

Orientation	Floor	Quality @ 2%	Quality @ 5%
n/a	Ground	Good	Average
n/a	1st	Good	Average

Table.10 – Type 1-e Daylight Summary

Fig.23 - Dwelling Type 1-f

Orientation	Floor	Quality @ 2%	Quality @ 5%
n/a	Ground	Good	Average
n/a	1st	Good	Good

Table.11 – Type 1-f Daylight Summary

Fig.24 - Dwelling Type 3-a

Orientation	Floor	Quality @ 2%	Quality @ 5%
n/a	Ground	Good	Good
n/a	1st	Good	Good

Table.12 – Type 3-a Daylight Summary

Fig.25 - Dwelling Type 3-b

Orientation	Floor	Quality @ 2%	Quality @ 5%
n/a	Ground	Good	Average
n/a	1st	Good	Average

Table.13 – Type 3-b Daylight Summary

Fig.27 - Dwelling Type 3-d

Orientation	Floor	Quality @ 2%	Quality @ 5%
n/a	Ground	Good	Average
n/a	1st	Good	Average

Table.15 – Type 3-d Daylight Summary

Fig.26 - Dwelling Type 3-c

Orientation	Floor	Quality @ 2%	Quality @ 5%
n/a	Ground	Good	Average
n/a	1st	Good	Good

Table.14 – Type 3-c Daylight Summary

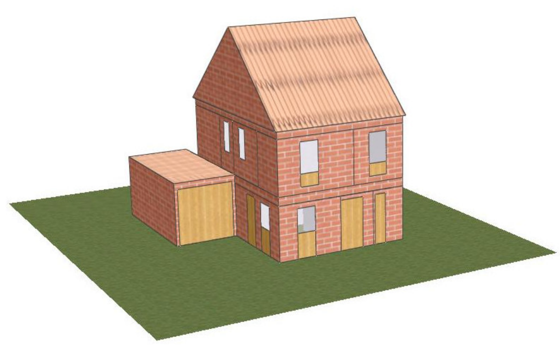


Fig.28 - Dwelling Type 3-e

Orientation	Floor	Quality @ 2%	Quality @ 5%
n/a	Ground	Good	Average
n/a	1st	Good	Good

Table.16 – Type 3-e Daylight Summary

Fig.29 - Dwelling Type 3-f

Orientation	Floor	Quality @ 2%	Quality @ 5%
n/a	Ground	Good	Average
n/a	1st	Good	Average

Table.17 – Type 3-f Daylight Summary

Fig.31 - Dwelling Type 5-b

Orientation	Floor	Quality @ 2%	Quality @ 5%
n/a	Ground	Good	Average
n/a	1st	Good	Average

Table.19 – Type 5-b Daylight Summary

Fig.30 - Dwelling Type 5-a

Orientation	Floor	Quality @ 2%	Quality @ 5%
n/a	Ground	Good	Good
n/a	1st	Good	Average

Table.18 – Type 5-a Daylight Summary

Fig.32 - Dwelling Type 5-c

Orientation	Floor	Quality @ 2%	Quality @ 5%
n/a	Ground	Good	Average
n/a	1st	Good	Good

Table.20 – Type 5-c Daylight Summary

Fig.33 - Dwelling Type 5-d

Orientation	Floor	Quality @ 2%	Quality @ 5%
n/a	Ground	Good	Average
n/a	1st	Good	Average

Table.21 – Type 5-d Daylight Summary

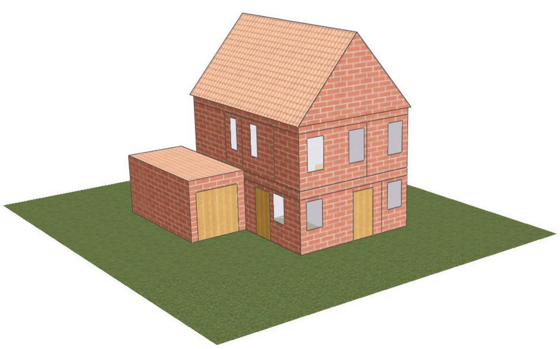


Fig.34 - Dwelling Type 5-e

Orientation	Floor	Quality @ 2%	Quality @ 5%
n/a	Ground	Good	Good
n/a	1st	Good	Good

Table.22 – Type 5-e Daylight Summary

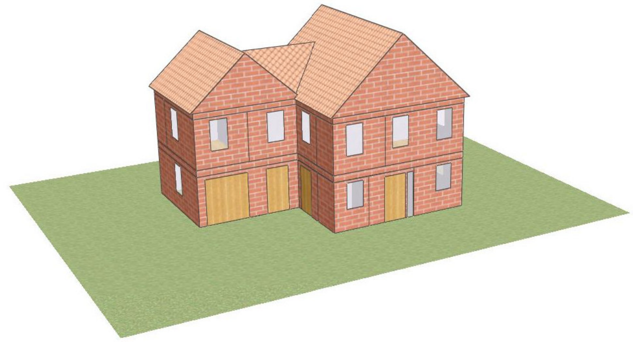


Fig.35 - Dwelling Type 5-f

Orientation	Floor	Quality @ 2%	Quality @ 5%
n/a	Ground	Good	Good
n/a	1st	Good	Average

Table.23 – Type 5-f Daylight Summary

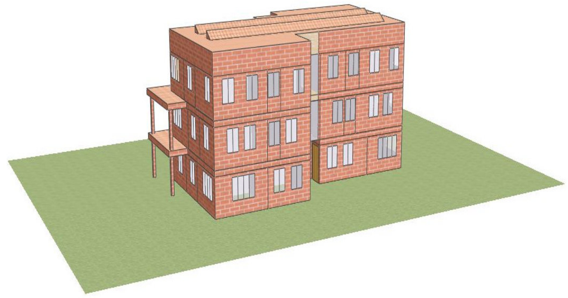


Fig.36 - Dwelling Type 7-a

Orientation	Floor	Quality @ 2%	Quality @ 5%
n/a	Ground	Good	Average
n/a	1st	Good	Average

Table.24 – Type 7-a Daylight Summary

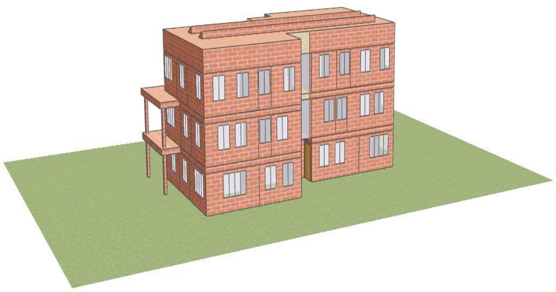


Fig.37 - Dwelling Type 7-b

Orientation	*Floor*	*Quality @ 2%*	*Quality @ 5%*
n/a	*Ground*	*Good*	*Average*
n/a	*1st*	*Good*	*Average*

Table.25 – Type 7-b Daylight Summary

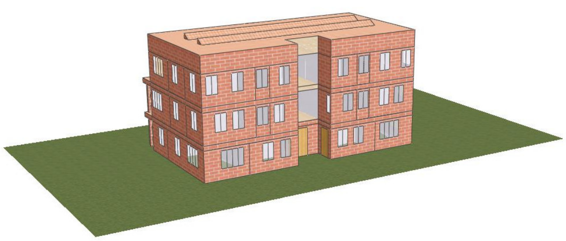


Fig.38 - Dwelling Type 7-c

Orientation	*Floor*	*Quality @ 2%*	*Quality @ 5%*
n/a	*Ground*	*Good*	*Average*
n/a	*1st*	*Good*	*Average*

Table.26 – Type 7-c Daylight Summary

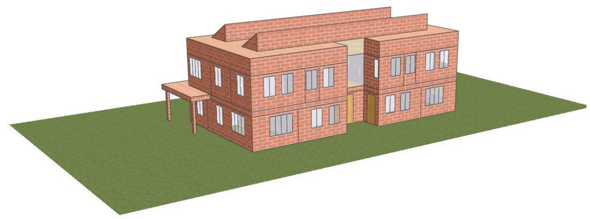


Fig.39 - Dwelling Type 7-d

Orientation	*Floor*	*Quality @ 2%*	*Quality @ 5%*
n/a	*Ground*	*Good*	*Average*
n/a	*1st*	*Good*	*Average*

Table.27 – Type 7-d Daylight Summary

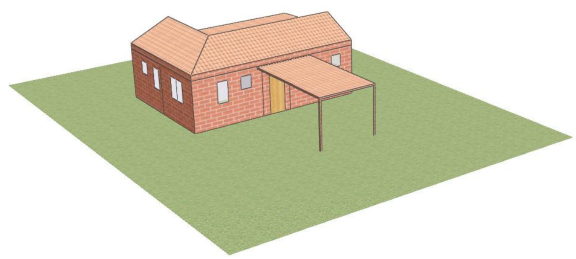


Fig.40 - Dwelling Type 8-a

Orientation	*Floor*	*Quality @ 2%*	*Quality @ 5%*
n/a	*Ground*	*Good*	*Average*
-	-	-	-

Table.28 – Type 8-a Daylight Summary

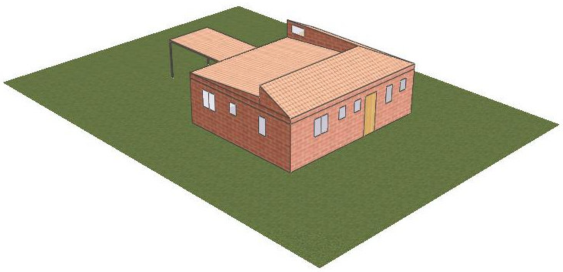


Fig.41 - Dwelling Type 8-b

Orientation	Floor	Quality @ 2%	Quality @ 5%
n/a	Ground	Good	Average
-	-	-	-

Table.29 – Type 8-b Daylight Summary

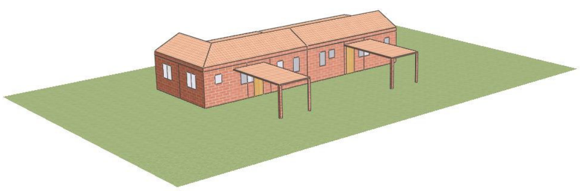


Fig.42 - Dwelling Type 8-c

Orientation	Floor	Quality @ 2%	Quality @ 5%
n/a	Ground	Good	Average
-	-	-	-

Table.30 – Type 8-c Daylight Summary

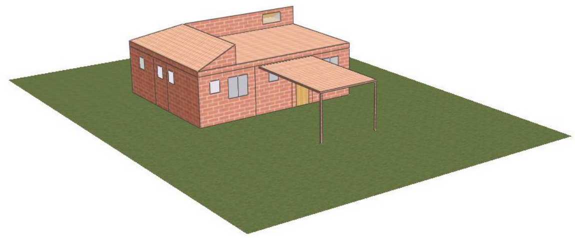


Fig.43 - Dwelling Type 8-d

Orientation	Floor	Quality @ 2%	Quality @ 5%
n/a	Ground	Good	Poor
-	-	-	-

Table.31 – Type 8-d Daylight Summary

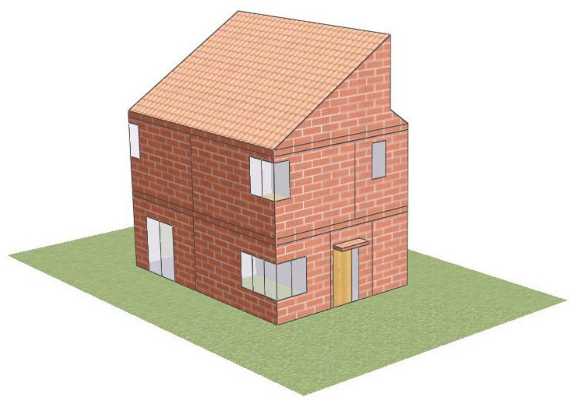


Fig.44 - Dwelling Type E1-a

Orientation	Floor	Quality @ 2%	Quality @ 5%
n/a	Ground	Good	Average
n/a	1st	Good	Average

Table.32 – Type E1-a Daylight Summary

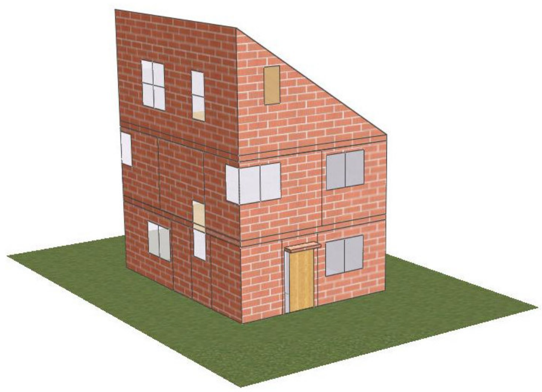


Fig.45 - Dwelling Type E1-b

Orientation	*Floor*	*Quality @ 2%*	*Quality @ 5%*
n/a	*Ground*	*Good*	*Average*
n/a	*1st*	*Good*	*Average*

Table.33 – Type E1-b Daylight Summary

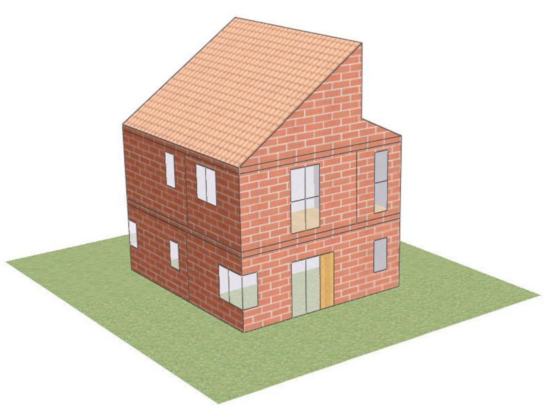


Fig.46 - Dwelling Type E1-c

Orientation	*Floor*	*Quality @ 2%*	*Quality @ 5%*
n/a	*Ground*	*Good*	*Average*
n/a	*1st*	*Good*	*Average*

Table.34 – Type E1-c Daylight Summary

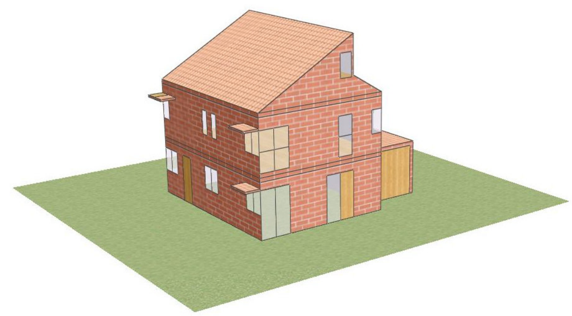


Fig.47 - Dwelling Type E1-d

Orientation	*Floor*	*Quality @ 2%*	*Quality @ 5%*
n/a	*Ground*	*Good*	*Average*
n/a	*1st*	*Good*	*Average*

Table.35 – Type E1-d Daylight Summary

Fig.48 - Dwelling Type E1-e

Orientation	*Floor*	*Quality @ 2%*	*Quality @ 5%*
n/a	*Ground*	*Average*	*Poor*

n/a	1st	Good	Average

Table.36 – Type E1-e Daylight Summary

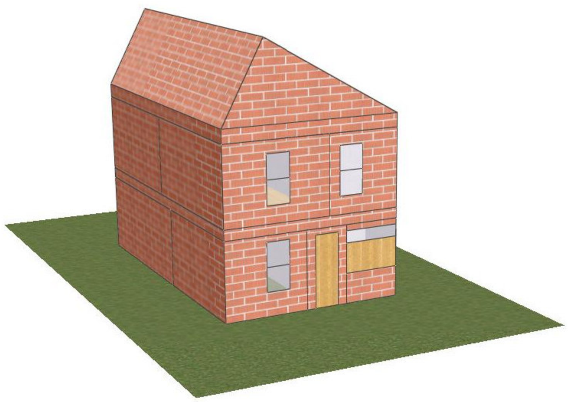


Fig.49 - Dwelling Type E2-a

Orientation	Floor	Quality @ 2%	Quality @ 5%
n/a	Ground	Average	Poor
n/a	1st	Good	Average

Table.37 – Type E2-a Daylight Summary

Fig.50 - Dwelling Type E2-b

Orientation	Floor	Quality @ 2%	Quality @ 5%
n/a	Ground	Average	Poor
n/a	1st	Average	Poor

Table.38 – Type E2-b Daylight Summary

Fig.51 - Dwelling Type E2-c

Orientation	Floor	Quality @ 2%	Quality @ 5%
n/a	Ground	Average	Poor
n/a	1st	Good	Average

Table.39 – Type E2-c Daylight Summary

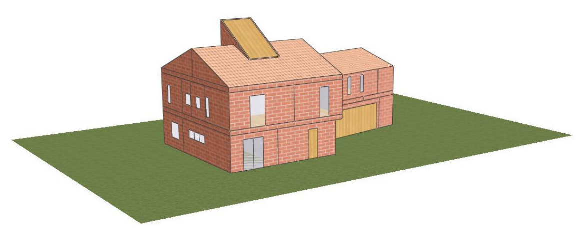


Fig.52 - Dwelling Type E2-d

Orientation	Floor	Quality @ 2%	Quality @ 5%
n/a	Ground	Average	Poor

n/a	*1st*	*Good*	*Average*

Table.40 – Type E2-d Daylight Summary

4 CONCLUSION;

Overshadowing;

With respect to any overshadowing risk, the proposed housing types appear well spaced apart, with adjacent dwellings not casting large shadows onto neighbouring plots. This scenario will provide a reasonable degree of living environment to the neighbouring plots in terms of sunlight, privacy and environmental quality. For some portions of the winter months there may be some overshadowing to ground floor livings rooms by buildings opposite. However, this is likely to be for short periods at the end of the day when electric lighting will shortly be required.

In the winter months, houses with adjoining models are partially casting shadows unto neighbouring roofs, which is expected, as the shadows produced during this season are considerably long. This is only for about three hours and the effect will be insignificant for solar harvesting on the basis of solar flux intensity. For the rest of the year the roofs are clear of shadows and the provisions for the solar panels will be beneficial in particular to the roofs section facing south, where the largest solar flux intensity is expected.

DAYLIGHTING;

The consensus is that for planning purposes, the light levels to the plots are adequate for typical housing design. The lower limit Daylight Factor of 2% actually provides the onerous case for dwellings when referring to the British standard for daylighting, with lower requirements for bedrooms and living rooms during the daytime periods when natural light will be available. The results forecast are also for midseason overcast cases and so internal lighting conditions will typically be of better quality for a greater portion of the year.

The level of the natural illumination entering the space is the result of actual building geometry and window openings within the dwelling units. Window openings increase the natural light directly entering through the window and the reflected light coming from the internal surfaces.

Upon reviewing the results for the upper 5% Daylight Factor limits, the levels are generally good and average, while some dwelling areas have poor daylight conditions. House model that have achieved good and average level can reduce energy, since electrical lighting will not be required in daytime except for specific task that require high level of illumination. Artificial lighting will generally be required in house model that achieved poor result to supplement the appropriate level of illumination within the space. For most of the dwelling spaces, the average daylight level between 2% and 5% is achievable with the current geometrical shapes. However, improvements to light levels to the ground floor corridors may be increased by introductions of glazed fan lights and fixed lights to the surround of the entrances. Patio or French doors may also be considered to the rear of some dwellings, which may further increase the lighting levels to living rooms or kitchen areas.

Any improvements to increase the daylight levels will need to consider how the design limits the solar gains and prevent unwanted heat build-up, given the highly insulated nature of the intended building fabric. Internal glare into the dwelling spaces will also need to be considered, and so alteration of window glazing should considered carefully against thermal and visual comfort.

5 APPENDICES:

The following information has been obtained from the Energy Saving Trust document CE292 for CSH level 5 and 6 dwellings. The fabric U-values contained within have been used formulate a template for the building fabric used within the daylighting study.

Detached house (104m²) scenarios

		Typical building regulations scenario	Energy Saving Trust 100% and zero carbon solutions							
			Gas boiler with solar water heating		Biomass boiler		Heat pump		Communal gas CHP	
			100%	Zero carbon	100%	Zero carbon	100%	Zero carbon	100%	Zero carbon
Fabric U-values W/m²K	Roof	0.15	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
	Walls	0.30	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
	Ground floor	0.20	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
	Windows	1.90	0.80	0.70	0.80	0.70	0.80	0.70	0.80	0.70
	Doors	2.00	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
	y-value	0.08 (accredited)	0.04		0.04		0.04		0.04	
Ventilation	Airtightness m³/(hr.m²)	7.0	3.0		3.0		3.0		3.0	
	Mechanical Ventilation	Extractor fans	MVHR 85% efficiency, 1W /(l.s) specific fan power		MVHR 85% efficiency, 1W /(l.s) specific fan power		MVHR 85% efficiency, 1W /(l.s) specific fan power		MVHR 85% efficiency, 1W /(l.s) specific fan power	
Heating	Boiler	Gas condensing 90%, boiler interlock	Gas condensing 90%, boiler interlock		Wood pellet, independent boiler 86%		Electric ground to water heat pump		Gas CHP, 75%	
	Controls	Programmer, room thermostat, thermostatic radiator valves	Programmer, room thermostat, thermostatic radiator valves, weather or load compensator		Programmer, room thermostat, thermostatic radiator valves		Programmer and at least 2 room thermostats		Flat rate charging, programmer, room thermostat and thermostatic radiator valves	
	Water heating	160 litre cylinder, 50mm insulation	160 litre cylinder, 80mm insulation		160 litre cylinder, 80mm insulation		160 litre cylinder, 80mm insulation		160 litre cylinder, 80mm insulation	
	Secondary heating	Electric heaters	Electric	n/a	Electric	n/a	Electric	n/a	Electric	n/a
Renewables	Solar water heating	n/a	Solar water heating 4m²		n/a		n/a		Solar water heating 4m²	
	Photovoltaic (kWp)	n/a	2.90	5.30	1.75	3.95	3.60	5.95	2.90	5.35
Lighting		30%	100%		100%		100%		100%	
CO_2 100% (Level 5)	TER	23.76	23.76		23.76		33.73*		23.76	
	DER	23.46	-0.12		-0.20		-0.10		-0.19	
	Improvement	**1.3%**	**100.00%**		**101.00%**		**100.00%**		**101.00%**	
CO_2 Level 6 only	**Actual emissions**		-1.65		-2.22		-1.82		-1.42	
	Level 6 offset		12.24		12.24		12.24		12.24	
	Final DER		-10.59		-10.02		-10.42		-10.82	
Energy efficiency rating		80 (C)	97 (A)	112 (A)	85 (B)	95 (A)	102 (A)	114 (A)	101 (A)	112 (A)
Environmental impact rating		79 (C)	99 (A)	112 (A)	102 (B)	112 (A)	102 (A)	112 (A)	101 (A)	112 (A)
Running costs (£/yr)		263	69	-107	210	98	4	-124	27	-108

*Here the TER has changed because the heating fuel for this option has different fuel factor in the building regulations

Fig.27 – CE292 Target for Detached Houses

Semi-detached house (89m²) scenarios

			Typical building regulations scenario	Energy Saving Trust 100% and zero carbon solutions							
				Gas boiler with solar water heating		Biomass boiler		Heat pump		Communal gas CHP	
				100%	Zero carbon	100%	Zero carbon	100%	Zero carbon	100%	Zero carbon
Fabric U-values W/m²K		Roof	0.15	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
		Walls	0.25	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
		Ground floor	0.25	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
		Windows	1.90	0.80	0.70	0.80	0.70	0.80	0.70	0.80	0.70
		Doors	2.00	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
		y-value	0.08 (accredited)	0.04		0.04		0.04		0.04	
Ventilation		Airtightness $m^3/(hr.m^2)$	7.0	3.0		3.0		3.0		3.0	
		Mechanical Ventilation	Extractor fans	MVHR 85% efficiency, 1W /(l.s) specific fan power		MVHR 85% efficiency, 1W /(l.s) specific fan power		MVHR 85% efficiency, 1W /(l.s) specific fan power		MVHR 85% efficiency, 1W /(l.s) specific fan power	
Heating		Boiler	Gas condensing 90%, boiler interlock	Gas condensing 90%, boiler interlock		Wood pellet, independent boiler 86%		Electric ground to water heat pump		Gas CHP, 75%	
		Controls	Programmer, room thermostat, thermostatic radiator valves	Programmer, room thermostat, thermostatic radiator valves, weather or load compensator		Programmer, room thermostat, thermostatic radiator valves		Programmer and at least 2 room thermostats		Flat rate charging, programmer, room thermostat and thermostatic radiator valves	
		Water heating	160 litre cylinder, 50mm insulation	160 litre cylinder, 80mm insulation		160 litre cylinder, 80mm insulation		160 litre cylinder, 80mm insulation		160 litre cylinder, 80mm insulation	
		Secondary heating	Electric heaters	Electric	n/a	Electric	n/a	Electric	n/a	Electric	n/a
Renewables		Solar water heating	n/a	Solar water heating 4m²		n/a		n/a		Solar water heating 4m²	
		Photovoltaic (kWp)	n/a	2.75	5.25	1.60	4.20	2.40	5.00	2.50	5.10
Lighting			30%	100%		100%		100%		100%	
CO_2	100% (Level 5)	TER	23.00	23.00		23.00		32.60*		23.00	
		DER	22.69	-0.19		-0.01		-0.03		-0.17	
		Improvement	**1.3%**	**101.00%**		**100.00%**		**101.00%**		**101.00%**	
	Level 6 only	**Actual emissions**		-1.68		-1.31		-1.28		-1.38	
		Level 6 offset		13.46		13.46		13.46		13.46	
		Final DER		-11.78		-12.15		-12.18		-12.08	
Energy efficiency rating				101 (A)	113	94 (A)	106	97 (A)	109	100 (A)	112
Environmental impact rating				102 (A)	112	101 (A)	112	101 (A)	112	101 (A)	112
Running costs (£/yr)				21	-98	99	-23	60	-64	32	-89

*Here the TER has changed because the heating fuel for this option has different fuel factor in the building regulations

Fig.28– CE292 Target for Semi-Detached Houses

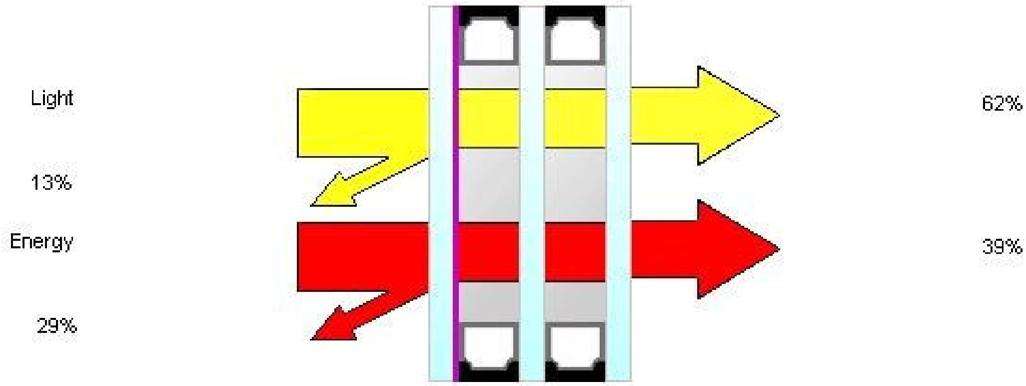
Mid-terrace house ($79m^2$) scenarios

			Typical building regulations scenario	Energy Saving Trust 100% and zero carbon solutions							
				Gas boiler with solar water heating		Biomass boiler		Heat pump		Communal gas CHP	
				100%	Zero carbon	100%	Zero carbon	100%	Zero carbon	100%	Zero carbon
Fabric U-values $W/m^2.K$		Roof	0.15	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
		Walls	0.30	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
		Ground floor	0.20	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
		Windows	1.90	0.80	0.70	0.80	0.70	0.80	0.70	0.80	0.70
		Doors	2.00	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
		y-value	0.08 (accredited)	0.04		0.04		0.04		0.04	
Ventilation		Airtightness $m^3/(hr.m^2)$	7.0	3.0		3.0		3.0		3.0	
		Mechanical Ventilation	Extractor fans	MVHR 85% efficiency, 1W /(l.s) specific fan power		MVHR 85% efficiency, 1W /(l.s) specific fan power		MVHR 85% efficiency, 1W /(l.s) specific fan power		MVHR 85% efficiency, 1W /(l.s) specific fan power	
Heating		Boiler	Gas condensing 90%, boiler interlock	Gas condensing 90%, boiler interlock		Wood pellet, independent boiler 86%		Electric ground to water heat pump		Gas CHP, 75%	
		Controls	Programmer, room thermostat, thermostatic radiator valves	Programmer, room thermostat, thermostatic radiator valves, weather or load compensator		Programmer, room thermostat, thermostatic radiator valves		Programmer and at least 2 room thermostats		Flat rate charging, programmer, room thermostat and thermostatic radiator valves	
		Water heating	140 litre cylinder, 50mm insulation	160 litre cylinder, 80mm insulation		160 litre cylinder, 80mm insulation		160 litre cylinder, 80mm insulation		160 litre cylinder, 80mm insulation	
		Secondary heating	Electric heaters	Electric	n/a	Electric	n/a	Electric	n/a	Electric	n/a
Renewables		Solar water heating	n/a	$4m^2$		n/a		n/a		$4m^2$	
		Photovoltaic (kWp)	n/a	2.35	4.75	1.45	3.75	2.25	4.65	2.25	4.65
Lighting			30%	100%		100%		100%		100%	
CO_2	100% (Level 5)	TER	21.32	21.32		21.32		30.13*		21.32	
		DER	21.04	-0.18		-0.18		-0.16		-0.19	
		Improvement	**1.3%**	**101.00%**		**101.00%**		**101.00%**		**101.00%**	
	Level 6 only	**Actual emissions**		-1.66		-1.97		-1.47		-1.47	
		Level 6 offset		14.28		14.28		14.28		14.28	
		Final DER		-12.62		-12.31		-12.81		-12.81	
Energy efficiency rating				101 (A)	113 (A)	88 (B)	99 (A)	97 (A)	109 (A)	101 (A)	113 (A)
Environmental impact rating				101 (A)	113 (A)	102	112 (A)	101 (A)	112 (A)	101 (A)	113 (A)
Running costs (£/yr)				24	-87	163	53	58	-57	28	-87

*Here the TER has changed because the heating fuel for this option has different fuel factor in the building regulations

Fig.29 – CE292 Target for Mid-Terrace Houses

PILKINGTON
NSG Group Flat Glass Business



Description

Position	Product	Process	Thickness (nominal) mm	Weight kg/m^2
Glass 1	Pilkington Suncool 70/40	Toughened	6	15
Cavity 1	Krypton (90%)		16	
Glass 2	Pilkington Optifloat Clear	Annealed	6	15
Cavity 2	Krypton (90%)		16	
Glass 3	Pilkington Optilam Clear	Laminated	6.4	15
Product Code	6C(74)-16Kr-6-16Kr-6.4L		50.4	46

Performance

Light		
Transmittance	LT	62%
	UV %	1%
Reflectance Out	LR out	13%
Reflectance In	LR in	17%

Energy		
Direct Transmittance	ET	32%
Reflectance	ER	29%
Absorptance	EA	39%
Total Transmittance	g	39%
Shading Coefficient Total		0.45
Shading Coefficient Shortwave		0.36

Sound Reduction	R_w dB (C;C_{tr})	NPD
Thermal Transmittance	W/m^{2}K	0.8

Performance Code	
U-value/Light/Energy	0.8 / 62 / 39

The values of some of characteristics are displayed as NPD. This stands for No Performance Determined.

Fig.30 – Typical Triple IGU to meet CSH Level 5 requirements