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AEROSEAL

Air Tightness Review

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CONTENTS

1.0 INTRODUCTION

This document provides a study of the effect of air tightness on typical UK dwellings and the knock-on effect this can have on the required building fabric performance in order to meet Part L of building regulations. Additionally, the effects of changing the air tightness on the carbon emissions of dwellings were assessed using different inputs.

Air tightness is an integral part of modern building design and significantly effects the control of heat loss in dwellings, which can undo the effects of highly insulated walls and glazing etc. As such controlling air tightness allows a building designer more control and design flexibility when designing the building fabric.

The results of the study show how the use of Aeroseal to create more airtight dwellings can help reduce construction costs and increase design flexibility through reducing the insulation requirements of the building façade. Increasing the air tightness also reduces carbon emissions produced by the dwellings.

2.0 METHODOLOGY

All assessments within this study have been carried out as per *'Approved Document L1 2021 Conservation of Fuel and Power in dwellings'*, which sets minimum energy efficiency and fabric efficiency standards for all domestic buildings.

Changes were made to the air tightness values for each building type to establish what the maximum U-values were required to achieve Part L compliance. Building ventilation, heating and lighting inputs are considered to be typical of new build dwellings and remain consistent throughout the assessments.

5 dwelling types have been assessed as part of the study so to give representation of typical UK housing stock. The assessed dwelling types include; a 1 bed flat, a 3 bed flat, a 3 bed terraced house, a 3 bed semi-detached house and a 4 bed detached house.

3.0 SUMMARY OF RESULTS

The table and graph below show that changing the air tightness of dwellings has a significant impact on their efficiency and can lead to large differences in their carbon emissions. Increasing the air tightness from 8m^3/h.m^2@50Pa to the Passivhaus standard, can reduce carbon emissions by around 30%. This can lead to significant savings in heating and cooling costs for the occupier, as well as reduce the environmental impact of the home.

		Dwelling Primary Energy Rate (kWh/m^2/yr)				Carbon Emissions per m^2 (kgCO_2/m^2/yr)			
Air Tightness m3/h.m2 @ 50Pa		8	5	3	0.6 ACH^{-1} (Passivhaus)	8	5	3	0.6 ACH^{-1} (Passivhaus)
Dwelling Type	1B2P Flat	68.52	62.90	60.23	57.25	6.47	5.92	5.65	5.35
	3B5P Flat	58.29	52.69	49.07	45.53	5.52	4.97	4.61	4.26
	3B5P Mid Terrace	42.29	40.00	39.15	39.15	4.04	3.81	3.73	3.73
	3B5P Semi Detached	49.15	44.68	44.01	43.71	4.44	4.00	3.93	3.90
	4B6P Detached	38.23	34.09	30.95	27.48	3.66	3.25	2.94	2.60

Table 3.1 Normalised Primary Energy Rates and Carbon Emissions Across Different Dwelling Types and Air Tightness Values.

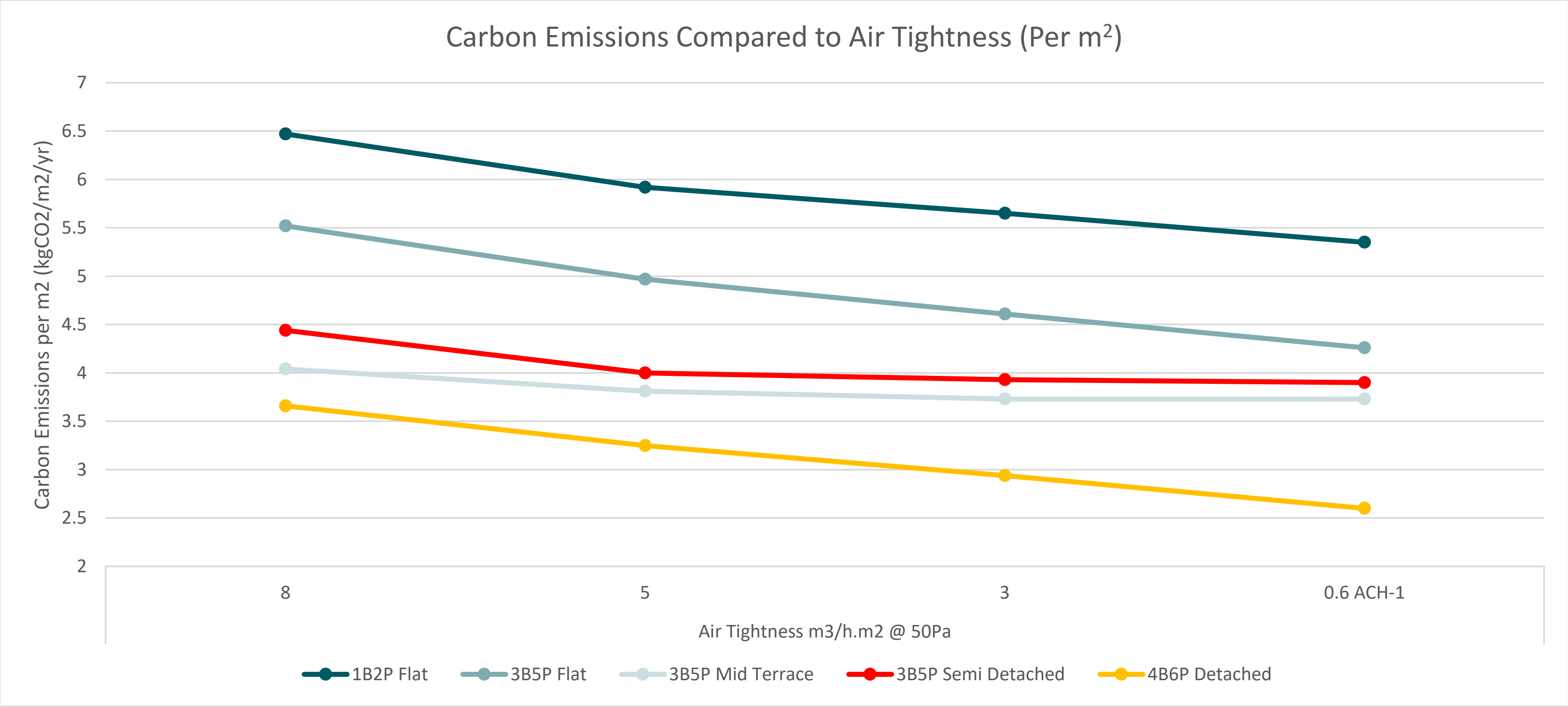

Figure 3.1 Graph Depicting the Normalised Carbon Emissions for Each Dwelling Type Across Different Air Tightness Values.

The table and graph to the right show the total carbon emissions per dwelling types, where a similar pattern to table and figure 3.1; that an increased air tightness reduces the carbon emissions of each dwelling. Since these values have not been normalised as before (i.e. per m^2), it can clearly be seen the larger dwellings have higher emissions.

		Dwelling Primary Energy Total (MWh/yr)				Total Carbon Emissions (t/yr)			
Air Tightness m3/h.m2 @ 50Pa		8	5	3	0.6 ACH^{-1} (Passivhaus)	8	5	3	0.6 ACH^{-1} (Passivhaus)
Dwelling Type	1B2P Flat	3.43	3.15	3.01	2.86	0.29	0.27	0.27	0.26
	3B5P Flat	5.10	4.61	4.29	3.98	0.43	0.4	0.38	0.35
	3B5P Mid Terrace	5.75	5.44	5.32	5.32	0.47	0.45	0.45	0.44
	3B5P Semi Detached	2.25	2.05	2.01	2.00	0.35	0.33	0.33	0.32
	4B6P Detached	13.27	11.83	10.74	9.54	1.12	1.00	0.92	0.84

Table 3.2 Total Dwelling Primary Energy and Carbon Emissions Per Dwelling Type

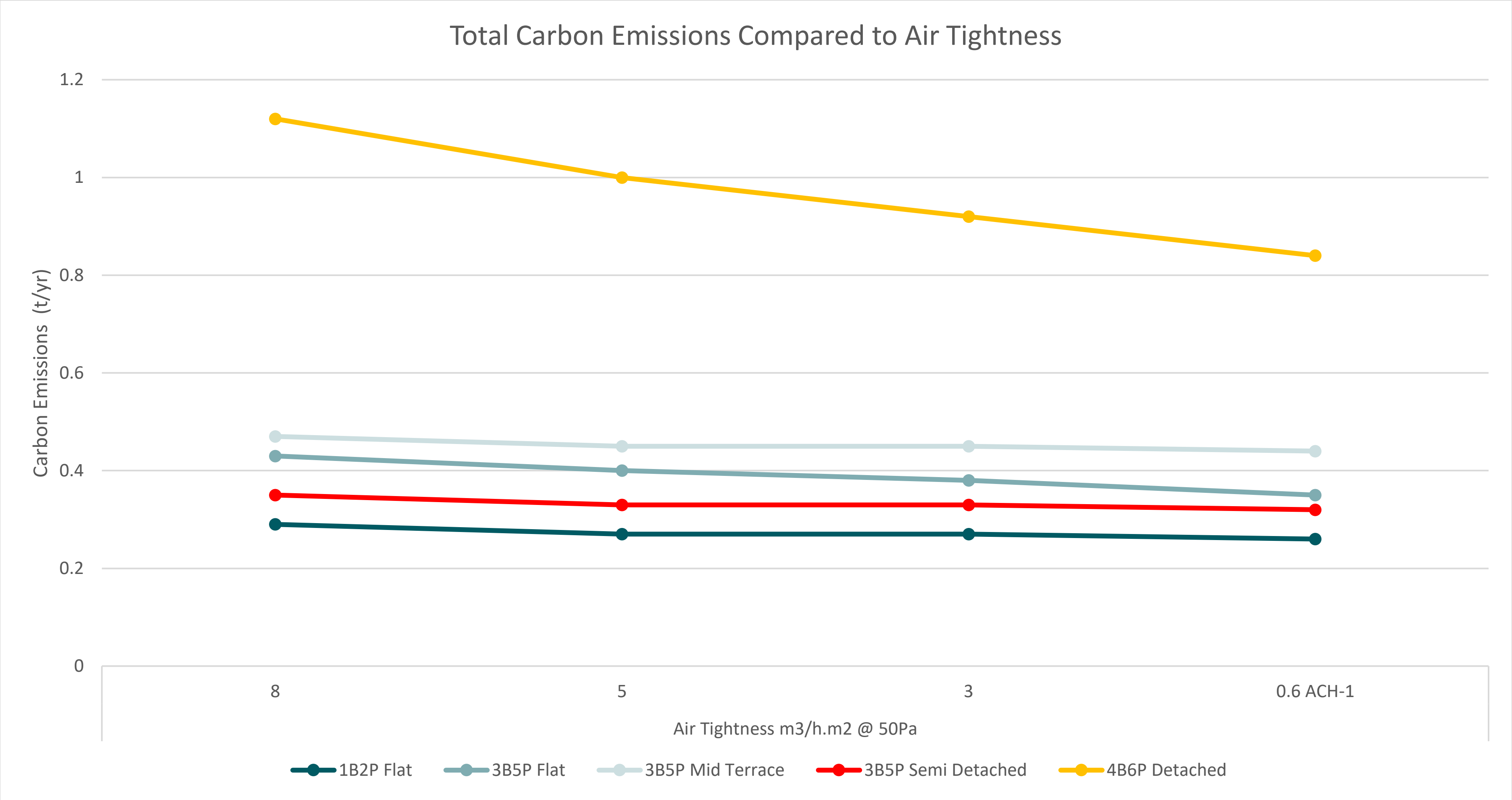

Figure 3.2 Graph Depicting The Total Carbon Emissions For Each Dwelling Type Across Different Air Tightness Values.

The table to the right provides a summary of the results for a 3 bedroom semi-detached house, in which it shows that U-values can change by up to 50% depending on the air tightness target of the dwelling. The required glazing performance can change from triple glazing (up to 1.10 W/m.K) at an air tightness value of 5 or higher but can be reduced to double glazing for an air tightness of 3 or lower, which results in significant cost savings.

	Air Tightness Performance			
	8 $m^3/h.m^2$ @ 50Pa	5 $m^3/h.m^2$ @ 50Pa	3 $m^3/h.m^2$ @ 50Pa	0.6 ACH^{-1} @ 50Pa (Passivhaus)
External Wall U-Value (W/m.K)	0.13	0.16	0.17	0.18
Floor Construction U-Value (W/m.K)	0.09	0.10	0.10	0.12
Roof Construction U-Value (W/m.K)	0.09	0.10	0.10	0.11
Glazing U-Value (W/m.K)	0.90	1.10	1.30	1.40
Thermal Bridging	As per Part L notional values			
Ventilation System	MVHR (85% Efficiency)			
Heating System	Air Source Heat Pump (SCOP 3.48)			
Hot Water System	Air Source Heat Pump (SCOP 3.48)			
Hot Water Tank	200 litre tank, loss 1.8 kWh/day			
Lighting	Low energy lighting throughout			
Fabric Energy Demand ($kWh/m^2/yr$)	36.3 $kWh/m^2/yr$			
Total Fabric Energy Demand (kWh/yr)	3340 kWh/yr			
Betterment Above Part L Energy Limit	1%			
Carbon Emissions per m^2 ($kgCO_2/m^2/yr$)	4.3 $kgCO_2/m^2/yr$			
Total Carbon Emissions ($kgCO_2/yr$)	396 $kgCO_2/yr$			
Betterment Above Part L Carbon Limit	58%			

Table 3.3: Minimum requirements for Part L compliance for a typical semi-detached house

4.0 TYPICAL CONSTRUCTIONS

To understand the benefits of the relaxation in U-value requirements due to air tightness performance, the table opposite provides typical constructions for walls, floors, and roofs for different U-values.

As shown opposite, the U-value change of 0.13 to 0.18 for a wall can result in a reduction of insulation of 80mm for a typical masonry wall, which can save valuable floor area. Alternative constructions such as SFS, which needs more insulation due to thermal bridging, will result in even larger reductions in insulation thicknesses across the different air tightness values.

Glazing

As stated previously, the U-value requirement for glazing will determine whether it needs to be double or triple glazing, which can result in increased cost and also practical issues due to the extra weight of the units.

For residential applications, double glazing can achieve a U-value between 1.2 - 1.3 W/m^{2}K, and triple glazing will be needed for U-values of 1.1 W/m^{2}K or lower.

	U-Value Target, W/m^{2}K		
	0.13	0.16	0.18
Masonry Wall Construction	• Plaster (3 mm) • Plasterboard (12.5 mm) • Plaster dabs (15 mm) • Medium Dense Blockwork (100 mm) • Cavity Insulation 0.035 W/m.K (240mm) • Unventilated cavity (50 mm) • Brick (102 mm)	• Plaster (3 mm) • Plasterboard (12.5 mm) • Plaster dabs (15 mm) • Medium Dense Blockwork (100 mm) • Cavity Insulation 0.035 W/m.K (200mm) • Unventilated cavity (50 mm) • Brick (102 mm)	• Plaster (3 mm) • Plasterboard (12.5 mm) • Plaster dabs (15 mm) • Medium Dense Blockwork (100 mm) • Cavity Insulation 0.035 W/m.K (160mm) • Unventilated cavity (50 mm) • Brick (102 mm)

Table 4.1: Wall constructions for various U-values

	U-Value Target		
	0.09	0.10	0.11
Pitched Roof with insulated ceiling	• Plasterboard (12.5 mm) • Mineral wool insulation between rafters 0.035 W/m.K (100 mm) • Mineral wool insulation 0.035 W/m.K (300mm) • Roof space • Roof tiles	• Plasterboard (12.5 mm) • Mineral wool insulation between rafters 0.035 W/m.K (100 mm) • Mineral wool insulation 0.035 W/m.K (250mm) • Roof space • Roof tiles	• Plasterboard (12.5 mm) • Mineral wool insulation between rafters 0.035 W/m.K (100 mm) • Mineral wool insulation 0.035 W/m.K (220mm) • Roof space • Roof tiles

Table 4.2: Roof constructions for various U-values

	U-Value Target		
	0.09	0.10	0.12
Insulated Ground Floor Slab	• Screed (75mm) • Vapour control layer • PIR Insulation 0.022 W/m.K (220mm) • DPM • Concrete (200mm)	• Screed (75mm) • Vapour control layer • PIR Insulation 0.022 W/m.K (200mm) • DPM • Concrete (200mm)	• Screed (75mm) • Vapour control layer • PIR Insulation 0.022 W/m.K (175mm) • DPM • Concrete (200mm)

Table 4.3: Floor constructions for various U-values

5.0 DIFFERENT HOUSING TYPES

The table opposite provides a summary of U-values required across the 5 different house types across different air tightness values.

As shown, the U-values required remain largely consistent across the different dwelling types, in which the increment in U-values are the same when reviewing different air tightness targets.

As to be expected, the Passivhaus air tightness target allows for the most design flexibility in regard to building fabric, where double glazing can be adopted with reduced insulation to walls, floors, and ceilings.

Of course, achieving the stringent Passivhaus air tightness target can also provide the opportunity to design low carbon buildings through the combination of high levels of insulation, excellent air tightness and the use of efficient building services alongside renewable energy technologies.

Maximum U-Values Needed for Part L Compliance					
		Air Tightness Value			
		Part L Maximum 8 $m^3/h.m^2$@50Pa	Part L Notional Value 5 $m^3/h.m^2$@50Pa	'Good' UK Target 3 $m^3/h.m^2$@50Pa	Passivhaus (0.6 ACH^{-1}@50Pa)
1B2P Flat	Wall U-Value	0.13	0.16	0.18	0.19
	Floor U-Value	0.10	0.11	0.115	0.12
	Roof U-Value	0.09	0.10	0.11	0.12
	Glazing U-Value	1.00	1.10	1.30	1.40
3B5P Flat	Wall U-Value	0.13	0.16	0.16	0.18
	Floor U-Value	0.09	0.12	0.12	0.12
	Roof U-Value	0.09	0.12	0.12	0.12
	Glazing U-Value	0.90	1.00	1.30	1.30
3B5P Mid Terrace House	Wall U-Value	0.13	0.16	0.16	0.18
	Floor U-Value	0.09	0.12	0.12	0.13
	Roof U-Value	0.09	0.12	0.12	0.12
	Glazing U-Value	0.90	1.10	1.30	1.30
3B5P Semi-Detached House	Wall U-Value	0.13	0.16	0.16	0.18
	Floor U-Value	0.09	0.10	0.10	0.12
	Roof U-Value	0.09	0.10	0.10	0.11
	Glazing U-Value	0.90	1.10	1.30	1.40
4B6P Detached House	Wall U-Value	0.13	0.16	0.16	0.17
	Floor U-Value	0.10	0.11	0.11	0.12
	Roof U-Value	0.09	0.10	0.11	0.11
	Glazing U-Value	0.9	1.10	1.30	1.40

Table 5.1: Typical increase in U-values for different air tightness values for various dwelling types

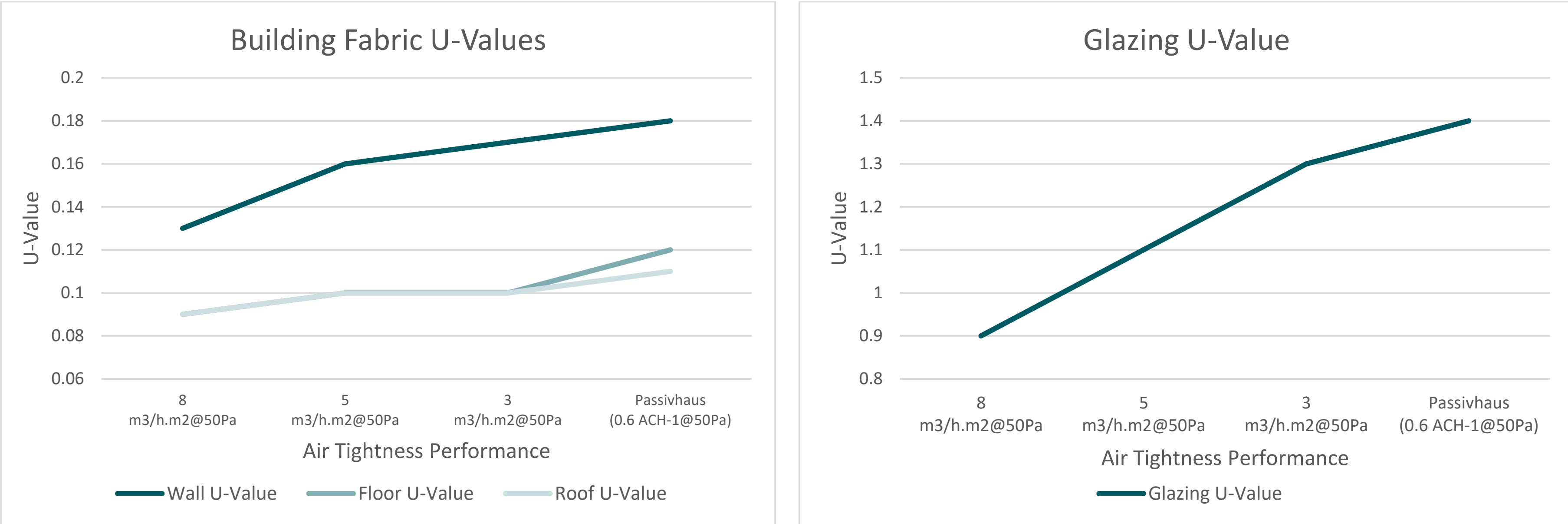

Figure 5.1: Typical increase in U-values for different air tightness values (3B5P semi-detached house)