Supplementary information: Appendix B SBEM retrofit option modelling

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Appendix B: SBEM Retrofit option modelling

The details and results of each retrofit option applied to each of the case studies are set out in the tables below.

CS1 Retrofit modelling

Table 1: CS1 SBEM Retrofit Options and impact

Description	Version Name	Modelled as	Energy Use total in kWh	Energy impact from baseline in kWh	Energy Use kWh/m2/yr	Energy impact from baseline
Baseline	Case Study 1 SBEM		43,480		228	
Thermal Curtains to all windows based on u-values from (Wood et al., 2009)	Case study 1.1TC	Reduction for single glazed sashes (SGS) 4.3 -2.5W/m²K. On secondary glazing (SG) 1.8 - 1.7W/m²K. On single glazing with shutters 1.7 - 1.6W/m²K. Double glazing (DG) 2.739 - 2.5W/m²K	43,415	65	227.66	0.44 kWh/m2 = 0.2% Overall reduction
Interior Shutters to all windows based on u-values from (Wood et al., 2009)	Case study 1.2IS	Reduction for SGS 4.3 - 1.8W/m²K. SG 1.8 - 1.6W/m²K. DG 2.7 - 1.8W/m²K	43,323	157	227.18	0.82kWh/m2 = 0.4%
Secondary glazing to single glazed windows based on (Wood et al., 2009)	Case study 1.3SG	Reduction for SGS 4.3 - 1.8W/m²K	43,480	0	228	0

Secondary glazing (where not already) and curtains based on (Wood et al., 2009)	Case study 1.4SGC	SGS and SG to 1.7W/m²K. Single with shutters to 1.6W/m²K. DG to 2.5W/m²K	43,415	65	227.66	0.44 kWh/m2 = 0.2% Overall reduction
Floor insulation (suspended floor) based on (Currie et al., 2013)	Case study 1.5FI	Reduction for suspended floors 2.3 - 0.7W/m²K	42,743	737	224.14	3.86kWh/m2 = 1.7%
Wall hangings to sitting room walls experimental test based on u-value for wood lining effect in (Rye & Scott, 2012)	Case study 1.6WH	1 external wall in each reception room reduced 1.4 - 1.2W/m²K	43,224	256	226.66	1.44kWh/m2 = 0.6%
No heating to bedrooms	Case study 1.7NHB	N/A Bedrooms not currently heated.				
Door retrofitting with 10mm aerogel blanket based on (Currie et al., 2013)	Case study 1.8ID	Reduced 3 - 0.9W/m²K	43,224	256	226.66	1.44kWh/m2 = 0.6%
Double glazing in line with current building regulations (HM Government, 2018)	Case study 1.9DG	All windows to 1.6W/m²K in line with current building regulations	43,205	275	226.56	1.44kWh =0.6%
Heating system improvement based on modern oil boiler from Product Characteristics database (BRE, 2020)	Case study 1.10HSI	Improve boiler efficiency 65% - 83.1%	39,006	4,474	204.54	23.46kWh =10.3%
Additional loft insulation based on SBEM library values for different thicknesses	Case study 1.11LI	Improve loft insulation. 100mm – 250mm (0.42 - 0.16W/m²K)	42,488	992	222.8	5.2kWh = 2.3%
Air infiltration improvement informed by (Rye et al., 2012)	Case study 1.12ACH	From 12 to 8	42,393	87	222.3	5.7kWh/m2 = 2.5%
Combination of measures, Interior shutters to all windows, Floor insulation, wall hangings, heating system improvement. door retrofitted, additional loft insulation and improved air infiltration	Case Study 1RetroCombi	As above	34,128	9,352kWh	178.96	49kWh = 21.5%

CS5 Retrofit modelling

Table 2: CS5 SBEM retrofit options and impact

Description	Version Name	Modelled as	Energy Use total	Energy impact from baseline in kWh	Energy Use kWh/m2/yr	Energy impact from baseline
Baseline	Case Study 5 SBEM		23,196kWh		191.7	
Thermal Curtains to all windows based on u-values from (Wood et al., 2009)	Case study 5.1TC	Reduction for SGS 4.3 - 2.5W/m²K. SG 1.8 - 1.7W/m²K	22,041kWh	1,155kWh	182.31	9.39 kWh/m2 = 5% Overall reduction
Interior Shutters to all windows based on u-values from (Wood et al., 2009)	Case study 5.2IS	Reduction for SGS 4.3 -1.8W/m²K. SG 1.8 - 1.6W/m²K	21,561kWh	1,635kWh	178.34	13.36kWh/m2 = 7%

Secondary glazing to single glazed windows based on (Wood et al., 2009)	Case study 5.3SG	Reduction for SGS 4.3 - 1.8W/m²K	21,922kWh	1,274kWh	181.32	10.38kWh/m2 = 5.4%
Secondary glazing (where not already) and curtains based on (Wood et al., 2009)	Case study 5.4SGC	All windows to 1.7W/m²K	21,793kWh	1,403kWh	180.26	11.44kWh/m2 = 6%
Floor insulation (suspended floor) based on (Currie et al., 2013)	Case study 5.5FI	Reduction for suspended floors 2.3 - 0.7W/m²K	22,839kWh	357kWh	188.91	2.79kWh/m2 = 1.5%
Wall hangings to sitting room walls experimental test based on u-value for wood lining effect in (Rye & Scott, 2012)	Case study 5.6WH	Experimental test 1external wall in each reception room reduced 1.2 - 1W/m²K	22,884kWh	312kWh	189.28	2.42kWh/m2 = 1.3%
No heating to bedrooms. Adjusted by not modelling bedrooms as unheated.	Case study 5.7NHB	Model 3 bedrooms as unheated spaces.	18,951kWh	4,245kWh	156.75	34.95kWh/m2 = 18%
Door retrofitting with 10mm aerogel blanket based on (Currie et al., 2013)	Case study 5.8ID	Reduced 3 - 0.9W/m²K	22,875kWh	321kWh	189.21	2.49kWh/m2 = 1.3%
Double glazing in line with current building regulations (HM Government, 2018)	Case study 5.9DG	All windows to 1.6W/m²K in line with current building regulations	21,665kWh	1,531kWh	179.2	12.5kWh 6.5%
Additional loft insulation based on SBEM library values for different thicknesses	Case study 5.10LI	Improve loft insulation in main roof. 150mm - 250mm (0.29 0.16W/m²K)	22,925kWh	271kWh	189.62	2.04 = 1.1%
Air infiltration improvement informed by (Rye et al., 2012)	Case study 5.12ACH	From 12ACH - 8ACH	22,362	834	184.96	6.74kWh/m2 = 3.5%
Combination of measures, Interior shutters to all windows, Floor insulation, wall hangings, heating system improvement. door retrofitted, additional loft insulation and improved air infiltration	Case Study 5RetroCombi	As above	16,309	6,887kWh	134.9	56.8kWh = 29.6%

CS14 Retrofit modelling

Table 3: CS14 SBEM retrofit options and impact

Description	Version Name	Modelled as	Energy Use total	Energy impact from baseline in kWh	Energy Use kWh/m2/yr	Energy impact from baseline
Baseline	Case Study 14v1 SBEM		23,763kWh		150.4kWh	
Thermal Curtains to all windows based on u-values from (Wood et al., 2009)	CS14.1TC	Reduction SGS 4.3 - 2.5W/m²K . Shuttered window 1.8 - 1.6W/m²K	23,068	695	146	4.4kWh/m2 = 2.9% Overall reduction
Interior Shutters to all windows based on u-values from (Wood et al., 2009)	Case study 14.2IS	Reduction for SGS 4.3 -1.8W/m²K	22,878	885	144.8	5.6kWh/m2 = 3.7%
Secondary glazing to single glazed windows based on (Wood et al., 2009)	Case study 14.3SG	Reduction for SGS 4.3 - 1.8W/m²K	22,878	885	144.8	5.6kWh/m2 = 3.7%
Secondary glazing (where not already) and	Case study 14.4SGC	All windows to 1.7W/m²K	22,815	948	144.4	6kWh/m2 = 4%

curtains based on (Wood et al., 2009)						
Floor insulation (suspended floor) based on (Currie et al., 2013)	Case study 14.5FI	Reduction for suspended floors 2.3 - 0.7W/m²K	21,283	2,480	134.7	15.7kWh/m2 = 10.4%
Wall hangings to sitting room walls experimental test based on u-value for wood lining effect in (Rye & Scott, 2012)	Case study 14.6WH	Experimental test 1external wall in each reception room reduced 1.1 – 0.9W/m²K	23,542	221	149	1.4kWh/m2 = 0.9%
No heating to bedrooms. Adjusted by not modelling bedrooms as unheated.	Case study 14.7NHB	Model 2 bedrooms as unheated spaces (master bedroom already unheated.	21,124	2,639	133.7	16.7kWh/m2 = 11%
Door retrofitting with 10mm aerogel blanket based on (Currie et al., 2013)	Case study 14.8ID	Reduced 3 - 0.9W/m²K	23,447	316	148.4	2kWh/m2 = 1.3%
Double glazing in line with current building regulations (HM Government, 2018)	Case study 14.9DG	All windows to 1.6W/m²K in line with current building regulations. Including roof lights, from 3.124W/m²K)	22,594	1,169	143	7.4kWh 4.9%
Additional loft insulation based on SBEM library values for different thicknesses	Case study 14.10LI	Improve loft insulation in main roof. 150mm - 250mm (0.29 0.16W/m²K)	23,605	158	149.4	1 = 0.7%
Air infiltration improvement informed by (Rye et al., 2012)	Case study 14.12ACH	From 13ACH to 9ACH	23,087	676	146.12	4.3kWh/m2 = 2.9%
Combination of measures, Interior shutters to all windows, Floor insulation, wall hangings, heating system improvement. door retrofitted, additional loft insulation and improved air infiltration	Case Study 14RetroCombi	As above	16,938	6,825	107.2	43.2kWh = 28.7%

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