Assessment of the potential improvements in energy efficiency due to various internal wall insulation options for solid brick external walls.

Revised in accordance with the new lower "price cap" introduced by government from October 2002

This report describes the analysis of the potential heating cost savings and improvement to SAP energy efficiency ratings following the application of various internal wall insulation products to a typical semi-detached house with solid 9" brick external walls. This updates previous analysis to use the recently released SAP 10.2 software and to account for the significant increases in energy tariffs in 2022.

Three typical property types have been assessed as before, all with similar fabric characteristics but with different heating systems (which are the primary factor in determining the energy rating band). The property in energy rating band D is heated by a condensing gas boiler. If the heating system is assumed to be electric storage heaters, the energy rating fell to band F using SAP 2012 but is now Band G using SAP 10.2. (Energy ratings for electrically heated properties are significantly lower in SAP 10.2 due to greater increases in electricity tariffs compared to mains gas tariffs.

The details of the property type used for the energy model are as follows:

- Two storey pre 1919 semi-detached house with 9" solid brick walls
- Total floor area 104.8m^2, 4.9m x 6.9m plus 3.0m x 6.2m rear extension for each storey, 2.7m floor to ceiling height in the main part and 2.3m in the rear extension each storey. This gives a gross external wall area of 120.9m^2 (or net 99.5m^2 after allowing for windows/doors as below).
- Ground floor to front part suspended timber sealed and uninsulated (U-value 0.60 W/m^{2}K) and solid to rear part (U-value 0.71 W/m^{2}K).
- External walls uninsulated solid brick construction, assumed U-value = 2.1 W/m^{2}K.
- Party walls assumed solid (U-value 0.0 W/m^{2}K)
- Roof assumed to have good insulation between joists (U-value 0.16 W/m^{2}K).
- The windows are upvc framed and double glazed installed post 2002 (U-value assumed 2.0 W/m^{2}K).
- Two external doors – one solid timber, one half glazed timber frame
- Total area of windows and doors 21.37m^2, assumed front facing East
- All windows and doors draught sealed, plus a draught lobby at the front entrance
- Thermal mass parameter = 'Medium'
- Living area 24.42m^2
- y-value 0.20 W/m^{2}K based on SAP 10.2 default value (previously 0.15 W/m^{2}K in SAP 2012)
- Natural ventilation, no air permeability entered, draught lobby, no extract fans, no open flue or chimney
- Space heating – mains gas condensing combi boiler and radiators (no secondary heating) or modern (slimline) electric storage heaters with manual charge control and secondary heating by on-peak electric convector heaters.
- Hot water from the combi boiler or in the case of electric heating, a standard size hot water cylinder with dual immersion heaters and a 50mm tank jacket.
- 100% low energy lights

These are all the same as before apart from the more pessimistic default for thermal bridging in SAP 10.2

The third property type is a smaller semi-detached house (66.2m^2 rather than 104.8m^2), which was included since the size of the property will be a significant factor in the savings achieved. This is also assumed to be heated by electric storage heaters. The energy rating is better than the larger house due to the more compact form and is in Band F using SAP 10.2.

Energy tariffs assumed are as follows:

	Gas p/kWh	On peak electricity p/kWh	Off peak electricity p/kWh
As used for EPCs (updated July 2022 but based on average over the last 3 years)	3.74	23.68	9.99
April 2022 'price cap' set by OFGEM	7.00	28.00	11.81*
New October 2022 'price cap' set by government	10.30	34.00	14.34*

*It has not been possible to confirm the average off peak electricity tariff under the 'price cap' regime so it is assumed to be the same ratio to the on peak rate as applied to the July 2022 tariffs used for EPCs.

Five scenarios have been modelled as follows:

1. Uninsulated solid single-brick wall with plaster internally, assuming brick conductivity of 0.77 W/mK as quoted by BRE for brick outer leaf – calculated U-value 2.1 W/m^{2}K
2. As above but assuming brick conductivity of 0.56 W/mK as quoted by BRE for brick inner leaf, assuming wall is dry following application of 'Stormdry' – calculated U-value 1.71 W/m^{2}K. (This is also now the default U-value for solid brick walls in RdSAP)
3. Internal wall insulation using calcium silicate board: 2mm cement adhesive - 25mm calcium silicate board @ 0.062 W/mK – plaster skim. This has a calculated U-value of 1.13 W/m^{2}K assuming a U-value of 2.1 W/m^{2}K for the original uninsulated solid wall.
4. Internal wall insulation using aerogel: 3mm polyurethane adhesive - 15mm Aerogel @ 0.015 W/mK - 3mm MgO Board – plaster skim. This has a calculated U-value of 0.82 W/m^{2}K assuming a U-value of 2.1 W/m^{2}K for the original uninsulated solid wall.
5. Internal wall insulation using VIP panels: 2mm polymer adhesive - 7mm VIP @ 0.007 W/mK - 3mm polymer adhesive - 3mm MgO Board – plaster skim. This has a calculated U-value of 0.66 W/m^{2}K assuming a U-value of 2.1 W/m^{2}K for the original uninsulated solid wall. (This does not take account of any edge effects where panels are joined).

The results are tabulated in Appendix A.

The following points should be borne in mind when interpreting the results:

- The estimated results do not include for any further reductions that might be achieved in practice due to reduced air leakage (which is likely to happen to some degree even if not intended) and/or reduced thermal bridging (which should be designed in).

- The default U-value used in RdSAP for solid brick walls is now 1.7 W/m^{2}K (reduced from 2.1 W/m^{2}K). This is following measurements of the U-values of solid brick walls in situ that have found a wide range of U-values in practice, with 2.1 W/m^{2}K being towards the top of the range and the median value being about 1.7 W/m^{2}K. This is considered to be primarily due to the presence of pockets of air within the "solid" wall construction. The consultation paper on this[1] argued that a median value is more appropriate for the production of Energy Performance Certificates on existing dwellings and therefore for RdSAP. A further reduction is under consideration for RdSAP 10, which is expected to be introduced in 2023. This does not necessarily mean that different values cannot be used where appropriate evidence is available.
- Note that all calculations assume 'standard occupancy conditions' (21^{o}C in the living room, 18^{o}C in the rest of the house, heating 9 hours per day). Given how high energy tariffs now are, it is very unlikely that many households will be able to afford to heat their home to this extent so actual fuel cost savings will be lower.
- None of the insulation options modelled are sufficient to improve the energy rating of the larger Band F/G house to Band E (as is now required for all private rented properties).
- Heating costs savings will also vary considerably for different property types.

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[1] Review of default U-values for existing buildings in SAP – SAP 2016 Consultation Paper: CONSP16

Appendix A – Summary of results on three house types

Tariffs as used for EPCs (updated July 2022 but based on average over the last 3 years)		**Band D house**			**Band F/G house**			**Smaller band F house**		
		SAP EER	**Heating cost**	**% saving**	**SAP EER**	**Heating cost**	**% saving**	**SAP EER**	**Heating cost**	**% saving**
Baseline - solid single brick wall	Wall U = 2.1	62 (D)	£732	-	11 (G)	£2,559	-	25 (F)	£1,364	-
With 'Stormdry' (dry solid wall)	Wall U = 1.71	65 (D)	£670	8.46%	16 (G)	£2,308	9.78%	29 (F)	£1,231	9.78%
With 25mm calcium silicate board IWI	Wall U = 1.13	68 (D)	£574	21.67%	24 (F)	£1,930	24.56%	36 (F)	£1,028	24.65%
With 10mm aerogel IWI	Wall U = 1.44	70 (C)	£519	29.10%	29 (F)	£1,723	32.65%	41 (E)	£917	32.77%
With 7mm vacuum insulated panel IWI	Wall U = 1.27	71 (C)	£490	33.07%	31 (F)	£1,615	36.89%	43 (E)	£859	37.03%

Tariffs based on April 2022 'price cap' set by OFGEM		**Band D house**			**Band F/G house**			**Smaller band F house**		
		SAP EER	**Heating cost**	**% saving**	**SAP EER**	**Heating cost**	**% saving**	**SAP EER**	**Heating cost**	**% saving**
Baseline - solid single brick wall	Wall U = 2.1	62 (D)	£1,370	-	11 (G)	£3,025	-	25 (F)	£1,613	-

With 'Stormdry' (dry solid wall)	Wall U = 1.71	65 (D)	£1,254	8.46%	16 (G)	£2,729	9.78%	29 (F)	£1,455	9.78%
With 25mm calcium silicate board IWI	Wall U = 1.13	68 (D)	£1,074	21.67%	24 (F)	£2,282	24.56%	36 (F)	£1,215	24.65%
With 10mm aerogel IWI	Wall U = 1.44	70 (C)	£972	29.10%	29 (F)	£2,037	32.65%	41 (E)	£1,084	32.77%
With 7mm vacuum insulated panel IWI	Wall U = 1.27	71 (C)	£917	33.07%	31 (F)	£1,909	36.89%	43 (E)	£1,016	37.03%

Tariffs based new Oct 2022 'price cap' set by government		**Band D house**			**Band F/G house**			**Smaller band F house**		
		SAP EER	**Heating cost**	**% saving**	**SAP EER**	**Heating cost**	**% saving**	**SAP EER**	**Heating cost**	**% saving**
Baseline - solid single brick wall	Wall U = 2.1	62 (D)	£2,017	-	11 (G)	£3,673	-	25 (F)	£1,958	-
With 'Stormdry' (dry solid wall)	Wall U = 1.71	65 (D)	£1,846	8.46%	16 (G)	£3,314	9.78%	29 (F)	£1,767	9.78%
With 25mm calcium silicate board IWI	Wall U = 1.13	68 (D)	£1,580	21.67%	24 (F)	£2,771	24.56%	36 (F)	£1,476	24.65%
With 10mm aerogel IWI	Wall U = 1.44	70 (C)	£1,430	29.10%	29 (F)	£2,474	32.65%	41 (E)	£1,317	32.77%

With 7mm vacuum insulated panel IWI	Wall U = 1.27	71 (C)	£1,350	33.07%	31 (F)	£2,318	36.89%	43 (E)	£1,233	37.03%