Product performance verification report

Q-Bot

15 July 2022

Energy Saving Trust
Version number 02

energy saving trust

ENERGY SAVING TRUST

PRODUCT PERFORMANCE VERIFICATION REPORT

Client: Q-Bot Ltd

Address: Block G, Riverside Business Centre, Wandsworth, SW18 4UQ, UK

This report constitutes an evaluation of the performance of insulation applied under suspended timber floors by a remotely operated robotic device manufactured by the client:

Q-Bot

hereinafter referred to as **the Insulation Solution.**

Energy Saving Trust, Energy Saving Trust Wales, 33 Cathedral Road, Cardiff CF11 9HB

energy saving trust

Contents

1. Background

Q-Bot requested product performance verification from Energy Saving Trust, based on the evidence submitted as well as Energy Saving Trust modelling, including:

- Confirmation of energy savings provided by their Insulation Solution
- The impact on property EPC rating following installation
- The financial cost per point of EPC rating improvement

2. Product description

Q-Bot has developed a solution for the insulation of suspended timber floors. A remotely operated robotic device applies spray-foam insulation to the underside of the floor, resulting in a reduction in heat loss through the floor and a barrier to cold air draughts.

The robot enters the underfloor cavity via an access hatch, removing the need to uplift flooring as in a traditional floor insulation application.

Q-Bot trained installers inspect the floor and underfloor cavity to determine suitability.

The robot is controlled remotely, spraying the underside of the floorboards between the joists to the desired thickness in the case of suspended timber floor construction, or the underside of solid concrete floors in solid floor construction.

The insulation is a hydrofluorocarbon (HFC) based closed-cell spray polyurethane foam, developed and certified for floor insulation.

3. Supporting evidence

Q-Bot supplied certification and data collected from properties before and after real, in-situ application of the Insulation Solution in support of the claims. The documents provided and reviewed are as follows:

1. British Board of Agrément Certificate 17/5440
2. Q-Bot 100 Properties Abb_Database

3.1.1. Evidence A

Reference	British Board of Agrément Certificate 17/5440
Date	11 July 2017
Laboratory name	British Board of Agrément
Laboratory address	Bucknalls Lane Watford Hertfordshire WD25 9BA
Laboratory accreditation and date	ISO 17025:2005 16 November 2018
Test standards	BS EN ISO 5250:2011 Annexes D and F BRE Report BR 443:2006 BS EN ISO 14315-1:2013 BS EN ISO 1995-1-1:2004 BS EN ISO 6946:2007 BRE Report BR 262:2002

Evidence A publishes the results of several tests examining the Insulation Solution's performance. The insulation was applied, following Q-Bot guidelines, to a suspended timber floor constructed for testing purposes. Note that this certificate does not review the SprayBot, computer control interface, spray gun, hoses, connections, pumps, or power supply required to apply the Insulation Solution. The report reviews the energy efficiency effects of insulation on typical properties with suspended timber floors.

3.1.1.1. Thermal performance

Thermal performance was calculated as per BS EN ISO 6964:2007 [1]and used thermal conductivity data made available in Q-Bot's Declaration of Performance. As U-values vary with material thickness and floor geometry, a range of insulation thicknesses between and under joists (mm) are provided below in relation to the perimeter/area (P/A) ratio and design U-value ($W \cdot m^{-2} \cdot K^{-1}$).

[1] N.B. ISO 69461:2007 has been superseded by procedure ISO 6964:2017; however, the previous standard still demonstrates evidence in support of appropriate calculation. Therefore, Energy Saving Trust has accepted results to the 2007 standard.

P/A ratio	Design U value ((W·m^{-2}·K^{-1})				
	0.13	0.15	0.20	0.22	0.25
0.2	150 between 10 under	130 between 0 under	80 between 0 under	70 between 0 under	50 between 0 under
0.4	150 between 30 under	150 between 10 under	110 between 0 under	95 between 0 under	80 between 0 under
0.6	150 between 40 under	150 between 15 under	120 between 0 under	105 between 0 under	90 between 0 under
0.8	150 between 45 under	150 between 20 under	125 between 0 under	110 between 0 under	95 between 0 under
1.0	150 between 45 under	150 between 20 under	125 between 0 under	115 between 0 under	100 between 0 under

3.1.2. Evidence B

Reference	Q-Bot 100 Properties
Date	08 June 2022
Laboratory name	n/a
Laboratory address	n/a
Laboratory accreditation and date	n/a
Test standards	n/a

Evidence B reports the SAP scoring of 100 properties before and after application of the Insulation Solution. The data surveys several property archetypes built during a range of periods, with floor spaces between 16m^2 and 103m^2. It included air permeability improvement scores post install, U-values calculated to ISO 13370:2017 standard and RdSAP assessments. The data also included installation costs, updated to reflect current quotes (versus at point of installation).

Domestic Energy Assessors employed by an external organisation carried out most assessments; however, some assessments were by Q-Bot employed Domestic Energy Assessors.

4. Product performance

Energy Saving Trust modelled “before” and “after” scenarios using our BREDEM SAP-based energy model, the Dynamic Engine (DE). Energy Saving Trust uses the model widely through our work, including government reporting and consumer advice, to generate insulation and heating savings.

The model generates energy saving scenarios for a range of property archetypes, representative of the GB housing stock.

DE includes an inference engine generating typical building and heating system characteristics for a range of archetypes. These typical characteristics were used all parameters except U-values and air tightness values, which were selected from measured values supplied in Evidence B for both before and after scenarios. DE generates energy consumption, fuel costs, CO_2e emissions and SAP scores for each archetype, pre- and post-insulation installation.

This process produces robust and realistic energy saving claims for the purposes of consumer guidance when marketing the Insulation Solution. Selected archetypes represent each of the following property types:

- Ground floor flat
- Mid terrace
- End terrace
- Semi-detached bungalow
- Detached bungalow
- Semi-detached house
- Detached house

Subtracting the modelled energy use of a dwelling after application from the modelled annual energy use before the Insulation Solution is applied produces the annual savings as illustrated in the following results table:

Table 1 Annual savings from the Insulation Solution

Bedrooms	Property	Heating system	Energy (kWh)	Financial (£)	Carbon (kg CO2e)	SAP improvement	Cost per SAP point
3	Semi-detached house	Electric	1730	£490.00	400	5	£650.00
3	Semi-detached house	Gas	1780	£130.00	385	3	£1,080.00
3	Semi-detached house	LPG	1780	£280.00	430	4	£810.00
3	Semi-detached house	Oil	1650	£200.00	490	3	£1,080.00
3	Semi-detached house	Solid fuel	2430	£150.00	965	4	£810.00
3	Semi-detached bungalow	Electric	4030	£1,130.00	930	9	£330.00
3	Semi-detached bungalow	Gas	3990	£290.00	855	6	£490.00

3	Semi-detached bungalow	LPG	3990	£620.00	955	7	£420.00
3	Semi-detached bungalow	Oil	3690	£440.00	1100	7	£420.00
3	Semi-detached bungalow	Solid fuel	5470	£350.00	2175	8	£370.00
3	Mid Terrace	Electric	1710	£480.00	395	5	£560.00
3	Mid Terrace	Gas	1900	£140.00	410	3	£930.00
3	Mid Terrace	LPG	1900	£290.00	455	5	£560.00
3	Mid Terrace	Oil	1760	£210.00	525	4	£700.00
3	Mid Terrace	Solid fuel	2550	£160.00	1015	4	£700.00
2	Ground floor flat	Electric	3410	£960.00	790	12	£230.00
2	Ground floor flat	Gas	3730	£270.00	800	6	£470.00
2	Ground floor flat	LPG	3730	£580.00	895	10	£280.00
2	Ground floor flat	Oil	3590	£420.00	1070	10	£280.00
2	Ground floor flat	Solid fuel	4470	£280.00	1775	8	£350.00
3	End Terraced	Electric	2280	£640.00	530	6	£460.00
3	End Terraced	Gas	2320	£170.00	500	4	£680.00
3	End Terraced	LPG	2320	£360.00	555	4	£680.00
3	End Terraced	Oil	2150	£250.00	640	5	£550.00
3	End Terraced	Solid fuel	3170	£200.00	1260	5	£550.00
4	Detached house	Electric	3390	£950.00	785	6	£710.00
4	Detached house	Gas	3080	£230.00	660	5	£850.00
4	Detached house	LPG	3080	£480.00	740	5	£850.00
4	Detached house	Oil	2850	£340.00	850	5	£850.00
4	Detached house	Solid fuel	3860	£250.00	1535	6	£710.00
3	Detached bungalow	Electric	4690	£1,320.00	1085	11	£290.00
3	Detached bungalow	Gas	4690	£350.00	1005	7	£460.00
3	Detached bungalow	LPG	4690	£730.00	1125	8	£410.00
3	Detached bungalow	Oil	4340	£510.00	1295	8	£410.00
3	Detached bungalow	Solid fuel	6420	£410.00	2550	8	£410.00

5. Evidence review

This section summarises the findings from the evidence submitted and their relevance in supporting the claims made by Q-Bot about the Insulation Solution.

5.1.1. Evidence A

The British Board of Agrément Certificate report demonstrated that Q-Bot could be successfully deployed for insulating suspended timber ground floors without the requirement of lifting the entire flooring structure, either through a hatch or a vent to the underfloor cavity.

Highlighted in this report were the criteria required for the application to be successful. These criteria include:

- the airspace void under the floor must be at least 150mm deep
- the airspace void must be ventilated
- the insulation must not obscure any ventilation grills or other ventilation ducts
- the system should only be deployed by trained and approved Q-Bot certificate holders

Achieving determined U-values is met by varying thicknesses of insulation required, and this was calculated over a number of perimeter to area (P/A) ratios. The actual floor construction and floor finish will influence the depth of insulation required to achieve the desired U-value, and therefore the depths of insulation reported may vary to the in-situ decision.

Additionally, the report identified that the product can contribute to maintaining the continuity of thermal insulation at junctions with other elements and minimise thermal bridges and air infiltration.

5.1.2. Evidence B

The Q-Bot 100 Properties Abb Database report demonstrated the modelled in-situ results from a range of housing types. All the properties generated a rise in SAP score, further supporting accepted evidence that insulating flooring improves a home’s energy efficiency.

This data set provided the U-values, air permeability and cost data for the energy reduction, cost reduction and SAP score calculations.

U-values were calculated from measured in-situ parameters according to ISO 6946:2007 and ISO 13370, rather than being based on RdSAP defaults. Air permeability values were based on actual measured pressure test values rather than RdSAP defaults. The U-values and air permeability rates used both indicated increased energy savings compared to those suggested by the default values.

5.1.3. Product performance review

The results of Energy Saving Trust Dynamic Engine modelling demonstrated increases in SAP scores after insulation application evidence in all modelled property

archetypes. This result further supports the well-established position in that floor insulation improves the energy efficiency of buildings.

Estimated annual energy savings, CO2e savings and annual fuel bill savings were modelled and the results are available in Section 4. Product performance. Every property type demonstrates savings across these categories.

Installation costs provided in Evidence B for cost per SAP point were calculated. The results varied from £230 per SAP point to £1080 per SAP point, with a median value of £550 per SAP point.

6. Review of quality assurance documentation

6.1.1. Calculation quality

U-value calculations followed the standard methods:

- ISO 13370:2017 Thermal performance of buildings – Heat transfer via the ground – Calculation

  methods; and,

- ISO 6946:20072 Building components and building elements – Thermal resistance and thermal

  transmittance – Calculation methods.

ISO 13370:2017 provides methods of calculation of heat transfer coefficients and heat flow rates for building elements in thermal contact with the ground, including slab-on-ground floors, suspended floors and basements. It applies to building elements, or parts of them, below a horizontal plane in the bounding walls of the building situated at the level of the inside floor surface, for slab-on-ground floors, suspended floors and unheated basements; and at the level of the external ground surface for heated basements.

ISO 13370:2017 includes calculation of the steady-state part of the heat transfer (the annual average rate of heat flow) and the part due to annual periodic variations in temperature (the seasonal variations of the heat flow rate about the annual average).

ISO 6946:2007 provides the method of calculation of the thermal resistance and thermal transmittance of building components and building elements. The calculation method is based on the appropriate design thermal conductivities or design thermal resistances of the materials and products for the application concerned. The method applies to components and elements consisting of thermally homogeneous layers.

ISO 6946:2007 also provides an approximate method that can be used for elements containing inhomogeneous layers, including the effect of metal fasteners, by means of a correction term.

These are commonly accepted standards for U-value determination and present quality assurance for the numbers obtained.

Air permeability calculations followed standard method promoted by the Air Tightness Testing and Measurement Association (ATTMA), Technical Standard L1 Measuring Permeability of Building Envelopes (Dwellings) October 2010 Issue. Its principles are based on BS EN 13829:2001 Thermal Performance of Buildings – Determination of air permeability of buildings – Fan pressurisation method.

This is a commonly accepted calculation protocol for air leakage determination and present quality assurance for the numbers obtained.

6.1.2. Quality management standards

The BBA has awarded a BBA Agrément Certificate to Q-Bot, after assessing against UK Building Regulations and classifying the Insulation Solution as fit-for-purpose. This Certificate acts as Q-Bot's quality assurance document and supports their claims that the product is certified as suitable for their specific intended use.

This has been confirmed by submission of BBA Agrément Certificate 17/5440.

Certificate number	British Board of Agrement Certificate 17/5440
Date of Issue	11 July 2017
Date of Expiry	n/a
Accrediting Body	British Board of Agrement Bucknalls Lane Watford Hertfordshire WD25 9BA

Note that this certificate does not review the SprayBot, computer control interface, spray gun, hoses, connections, pumps, or power supply required to apply the Insulation Solution.

BBA reviewed with Q-Bot:

- the quality control procedures and product testing to be undertaken
- the quality control operated over batches of incoming materials
- the production process and verified that it is in accordance with the documented process
- the process for management of nonconformities
- that equipment has been properly tested and calibrated

Q-Bot manage a monitoring and evaluation programme to verifying that these quality procedures are followed and quality maintained.

Energy Saving Trust is satisfied that Q-Bot follows a rigorous quality management process.

7. Conclusions and verification of performance claims

Insulating flooring is a well-established method of reducing heat loss. Installing floor insulation, however, can often prove highly disruptive to householders as the existing flooring is removed, insulation fitted, and the flooring re-laid. Q-Bot have developed technology that aims to reduce the level of disruption householders face by removing the need to uplift the entire floor covering.

Their installers perform diagnostics tests to vet the householder's underfloor space for suitability, including the provision of adequate ventilation.

For properties that do meet the suitability criteria, applying floor insulation via Q-Bot could reduce heat loss of the building, saving on energy bills and improve the building's SAP score.

All statements are correct as of July 2022 and valid for 12 months, subject to the terms and conditions of the *Energy Saving Trust Verification Licence Agreement.*

Claim

Insulating suspended timber flooring can reduce the building's heat loss, reducing energy demand and lowering fuel bills.

Caveat

The physical characteristics of the insulation materials and building construction materials, the depth the insulation is applied, as well as occupant behaviour will determine the extent of which the insulation could reduce energy demand.

As with all insulation, due caution should be exercised as adequate ventilation is required to prevent issues from moisture build up.

Explanation

Insulating floors will reduce heat loss, improving the level of thermal comfort that may result in a reduction of energy demand, lowering fuel bills. All insulation works by slowing the movement of heat as it moves from warm areas to cooler areas. Floor insulation may additionally prevent draughts entering the property through floorboards.

Claim

Insulating your floor with Q-Bot could typically save you around £190 a year in a gas heated home.

Caveat

Based on a weighted average of different property types, a typical heating system and a gas price of 7.4p/kWh. Actual savings will depend on various factors, including the size of your home.

Explanation

Based on modelled energy demand before and after floor insulation for a typical home and household. This is based on the flooring element achieving a specified U-value, and variations will exist in practice. The physical characteristics of the building and heating system, the depth of insulation applied, as well as occupant behaviour, will determine the extent to which the insulation will save money.

Claim

Insulating your floor with Q-Bot could typically save you around £430 a year in an electrically heated home.

Caveat

Based on a weighted average of different property types, a typical storage heating system and an off-peak electricity price of 16.7p/kWh. Actual savings will depend on various factors, including the size of your home.

Explanation

Based on modelled energy demand before and after floor insulation for a typical home and household. This is based on the flooring element achieving a specified U-value, and variations will exist in practice. The physical characteristic of the building and heating system, the depth of insulation applied, as well as occupant behaviour will determine the extent to which the insulation will save money.

Claim

If you live in a gas-heated 3 bedroom detached bungalow, insulating your floor with Q-Both could typically save you around £350 a year.[2]

Caveat

Based on a typical property and heating system and a gas price of 7.4p/kWh. Actual savings will depend on various factors, including the size of your home.

Explanation

Based on modelled energy demand before and after floor insulation for a typical home and household This is based on the flooring element achieving a specified U-value, and variations will exist in practice.

The physical characteristics of the building and heating system, the depth of insulation applied, as well as occupant behaviour will determine the extent to which the insulation will save money.

Claim

Insulating your floor with Q-Bot could increase your SAP score, costing between £540 and £830 per point.

[2] This statement may be modified for other property types and fuel types using the figures from Table 1.

Caveat

Based on a weighted average of different property types and typical heating system. Actual SAP improvement and cost will depend on various factors, including the size of your home.

Explanation

The Standard Assessment Procedure, or SAP, is the methodology used to assess the energy efficiency of homes. The SAP score is a key element of the property's Energy Performance Certificate (EPC), with a SAP rating of "A" being a highly energy efficient home and "G" being a poorly insulated home. An improvement in SAP score is a measure of the improvement in the building's energy efficiency. The cost per SAP point has been determined by modelling before and after scenarios of application of the Insulation.

Calculated using a BREEAM based SAP model for before and after SAP score scenarios, based on average housing stock. Installation costs provided by Q-Bot. The building's physical characteristics and heating system will influence the actual SAP score achieved and may be different to those modelled.