The importance of standards for safe energy retrofit

A BSI white paper

bsi.

By Royal Charter

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Overview

This White Paper explains the background to the development of new standards for energy retrofit of buildings in the domestic and non-domestic sectors of the UK building stock.

It explains why the development of new standards was considered necessary in order to manage risks to buildings and occupants and became the focus of three key recommendations of the Each Home Counts Review.

Those recommendations resulted in the development of the BSI Retrofit Standards Framework and of two overarching retrofit standards: PAS 2035, *Retrofitting dwellings for improved energy efficiency - Specification and guidance* and PAS 2038, *Retrofitting non-domestic buildings for energy efficiency - Specification*.

The scope of the BSI Retrofit Standards Framework and its role in bringing all the relevant standards to bear on retrofit projects is explained. The two overarching standards are essentially best practice process standards focused on managing risks to buildings and to the health of occupants, rather than on energy performance standards; the processes they promote are reviewed. The benefits of adopting the Framework and standards are covered, and plans for their future development are discussed. Finally, some conclusions are offered about the way forward for retrofit standards.

Introduction

Retrofitting existing buildings to improve their energy efficiency, and to 'decarbonize' them, is one of the key challenges presented by climate change. If we do not retrofit, we will not achieve our national and international targets for the elimination of greenhouse gas emissions, and the consequences are likely to be catastrophic (Vince, 2023).

The challenge is immense: in the UK there are over 27 million dwellings, and in England and Wales there are over two million non-domestic premises. Most of these buildings will have to be retrofitted, because none of the options for decarbonizing building services (e.g. using heat pumps powered by zero-carbon electricity) can cope with the current level of energy demand (HM Government, 2021). An average reduction in demand of between 40% and 70% will be necessary (Eyre and Oreszczyn, 2022), so much better insulation and airtightness are needed. Consequently, during the next three decades we must deliver at least five building retrofit projects every working minute, on average.

The cost of retrofitting existing buildings in the UK is likely to be of the order of £1 trillion, and it must be done well—there is neither the time nor the money to get it wrong and do it all again. But retrofit is risky: ill-considered retrofit, carried out without understanding of the risks, with poor knowledge of building physics and with poor attention to detail, can result in interstitial condensation (i.e. condensation within the construction) leading to rot, corrosion and dangerous deterioration. Poor retrofit also leads to poor internal air quality, surface condensation and mould growth, leading to serious health risks, especially for vulnerable people: the elderly, the very young and those susceptible to respiratory illnesses.

To assist with the retrofit process, and to establish robust processes for managing risks, the British Standards Institution (BSI) has collaborated with Government and the retrofit industry to develop the BSI Retrofit Standards Framework. This document explains the background to the Framework and its three main components, the Publicly Available Specifications PAS 2035, PAS 2030 and PAS 2038. It also explains the benefits of using the standards and plans for their future development.

Background

The UK construction industry came late to retrofit for energy efficiency.

Pioneers (mostly members of the Association for Environment Conscious Building motivated by the need for sustainability) explored the technical implications of domestic retrofit during the 1980s and 1990s, and some of their experience was embedded in the Housing Energy Best Practice Programme Good Practice Guide Energy efficient refurbishment of existing housing (HEEBPP, 2001, 2003, 2007). Then, between 2009 and 2014 the Technology Strategy Board (now Innovate UK) ran the Retrofit for the Future programme of 86 deep retrofit projects involving 115 houses owned by housing associations. The projects were extensively monitored and evaluated (Barrett-Duckett et al, 2014). The Retrofit for the Future programme identified many technical risks (mostly moisture-related) associated with domestic retrofit, as well as the critical role of ventilation in ensuring safe internal air quality when dwellings are insulated or their airtightness is improved. These risks should not be underestimated: at least two occupants of homes in the Retrofit for the Future programme were hospitalised as a consequence of poor internal air quality resulting from insulation without adequate ventilation.

Learning from Retrofit for the Future was consolidated by the EU-funded Centre of Refurbishment Excellence (CoRE), where it was embedded in a training programme for the new role of 'Retrofit Coordinator'. The Sustainable Traditional Buildings Alliance (STBA) was set up and received Government funding to research and promote responsible retrofit of traditionally constructed buildings; and the UK Centre for Moisture in Buildings (UKCMB, now housed at University College London) was established to research moisture risks in buildings and disseminate guidance. The Code of Practice for managing moisture in buildings (BSI, 2021) was extensively updated. Domestic retrofit guidance was also published by the Construction Products Association (Rickaby et al, 2010, 2014) and by the Institute for Sustainability (Rickaby et al, 2011), amongst others. In all this work, the importance of managing technical risks to buildings and serious health risks to occupants was emphasized.

In parallel, a series of UK Government programmes targeted fuel poverty by using funding from energy suppliers (the 'Supplier Obligation') to install insulation and efficient heating in homes. These programmes culminated in the Carbon Emissions Reduction Target (CERT) and the Community Energy Saving Programme (CESP), which were attempts at scaling up but were replaced by the Energy Company Obligation (ECO) in 2011. Also in 2011, the Government launched the Green Deal, a programme intended to widen the take-up of domestic retrofit through the provision of loans by commercial 'Green Deal Providers', which would be repaid by levies on households' electricity bills. The Green Deal subsequently failed, but one lasting consequence was the 'de-professionalization' of domestic retrofit: surveyors, architects and engineers were omitted from retrofit processes because their critical contributions were not recognized, and they were considered too expensive, even though they were the people who had learned how to manage retrofit risks from Retrofit for the Future and from CoRE.

A community of installers of energy efficiency measures grew up around the funded retrofit programmes. Installation companies usually focused on just one or two measures, and because they were funded by the energy companies, they often took little notice of the occupants of the homes they worked on, nor of the characteristics of the buildings themselves. Installers assessed dwellings and the

eligibility of households, then installed their usual measures. Installers typically had no professional training and limited understanding of building physics; they were consequently poorly equipped to identify and manage retrofit risks.

A culture of poor work emerged around this independently funded, measures-based approach to retrofit. Little or no attention was paid to the needs of occupants, to identifying the most appropriate measures to improve homes towards 'zero carbon' by 2050, to managing moisture risks or to installing adequate ventilation. Consequently, Government received thousands of complaints about retrofit failures where the improvements were either inappropriate or poorly installed, including several high-profile large-scale failures, e.g. in Preston, Hull, Middlesborough and North and South Wales, as well as two in Scotland. Most of these failures involved damage to homes and serious risks to occupants' health, but many have still not been remediated. An important lesson learned from them is that remediation of poor retrofit takes a long time and costs several times more than it would have cost to do the original work properly. Damage to occupants' health is very difficult to repair, and sometimes fatal. It has been argued that the poor culture in the retrofit industry was a significant factor in the Grenfell Tower tragedy in 2017 (Apps, 2022).

In response to fears about 'cowboy installers' exploiting ECO and the Green Deal, Government sponsored Publicly Available Specification (PAS) 2030 in 2011. PAS 2030 identified minimum installation competencies, good-practice standards and processes, and established a network of measures-based certification bodies to accredit competent installers. Certification bodies were funded by levies on installers. However, PAS 2030 was quickly and widely criticised as unfit for purpose, and was updated in 2014, 2017, 2019 and 2023. The 2017 update introduced requirements for design, for minimizing thermal bridges, and for upgrading ventilation when insulating or improving airtightness.

Several retrofit failures involved external solid wall insulation (EWI), so Government commissioned a review of EWI by Peter Hansford, the Chief Construction Advisor (Hansford, 2015). Supported by BRE, this review made several recommendations, but also suggested that technical problems, lack of skills and poor workmanship were not confined to EWI but pervaded the whole measures-based, funded retrofit industry. This prompted two Government departments to commission the Chief Executive of BRE (formerly the Building Research Establishment), Peter Bonfield, to conduct an independent review of consumer advice, protection, standards and enforcement for energy efficiency and renewable

energy. This review became known as the Each Home Counts review, and involved hundreds of industry professionals and academics working voluntarily in several parallel work-streams for eighteen months. The report (Bonfield, 2016) proposed a 'quality mark' for domestic retrofit, a code of conduct for the industry, a customer charter, development of a comprehensive overarching standards framework and certification of retrofit assessors, designers and installers by approved certification bodies (which was already happening under PAS 2030). There were 27 recommendations altogether, and an Each Home Counts Implementation Board was established and worked for nearly three years to embed them in the industry.

The retrofit quality mark was established as TrustMark, which adopted the code of conduct and customer charter developed under Each Home Counts. TrustMark's role is to monitor retrofit quality and enforce standards in order to reassure householders and Government about the quality of work carried out on homes. TrustMark is funded by levies on installers' certification bodies and by fees for lodging records of retrofit projects in its data warehouse. The data warehouse is used to track retrofit work and to support risk assessments aimed at identifying problematic measures or installers. TrustMark also requires insurance-backed guarantees to be applied to some retrofit measures; this is a way of transferring some risk away from householders, landlords and installers, towards insurers.

A key theme of the Each Home Counts review was the importance of managing retrofit risks by moving away from incremental, measures-based programmes towards 'whole-dwelling' retrofit involving coherent packages of improvement measures embracing the building fabric, ventilation, other building services such as heating, hot water and lighting, and renewable energy systems. This approach initiated an uncomfortable direction of travel for an industry largely made up of small, specialist companies set up and funded to install single measures. To promote the new whole-dwelling approach, which is intended to apply to retrofit in all domestic sectors, Government has initially required funded retrofit programmes to adhere to 'scheme rules' developed by TrustMark.

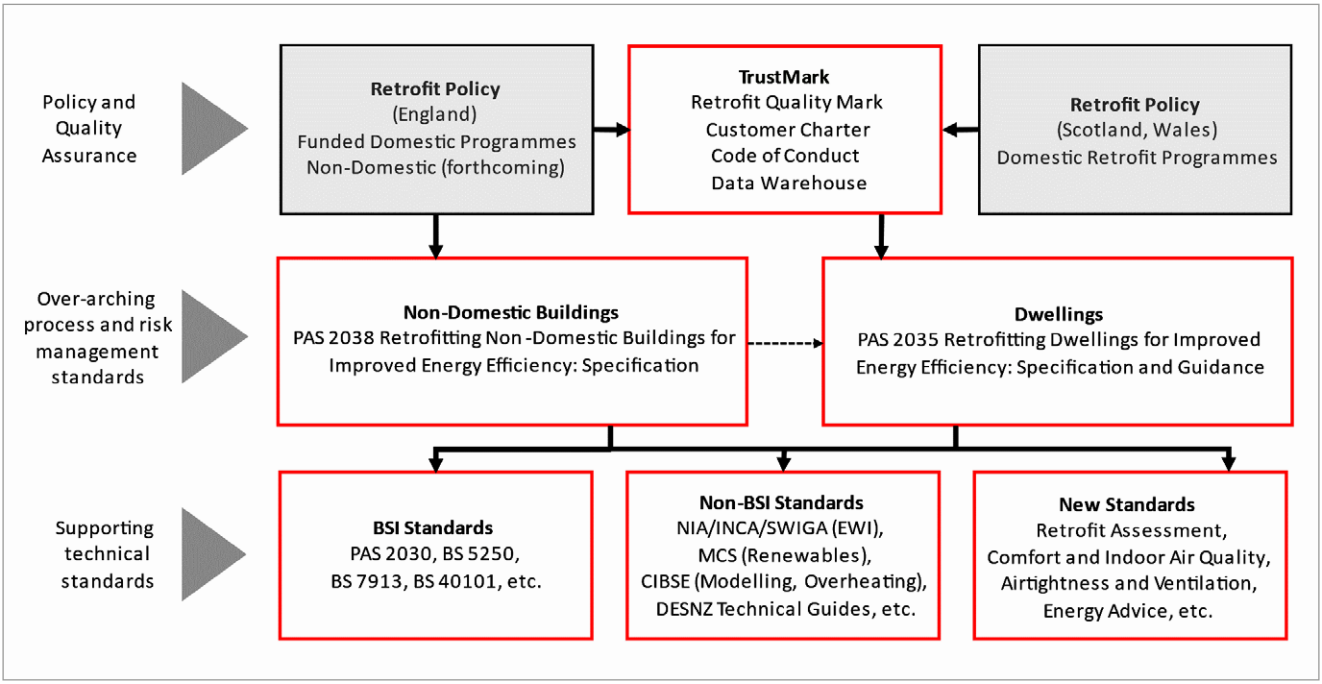
The BSI retrofit standards framework

Three of the recommendations of the Each Home Counts review relate to technical standards:

- **Recommendation 8** Develop an overarching standards framework for the end-to-end delivery of retrofit of energy efficiency and renewable energy measures, building on existing standards and make it freely available (under licence) to all those installing under the new Framework.
- **Recommendation 9** Establish a Retrofit Standards Task Group to address the UK's standards needs in the retrofit sector in the broadest sense, i.e. including formal and non-formal standard solutions, as appropriate in the short and long-term.
- **Recommendation 10** Commission a research project to map existing formal and informal standards to shape and deliver a standards development programme for retrofit.

Implementation of these recommendations was entrusted to the BSI Retrofit Standards Task Group (RSTG), which carried out research and established the BSI Retrofit Standards Framework to support the Each Home Counts quality mark. The RSTG is an advisory group of approximately 20 technical experts, supplemented by representatives of TrustMark, Government and the devolved administrations.

Figure 1: The BSI Retrofit Standards Framework



The BSI Retrofit Standards Framework is shown diagrammatically in Figure 1. The top row of the diagram shows the quality assurance features (in the red box) that emerged from the Each Home Counts review: the TrustMark quality mark supported by the Code of Conduct for retrofit installers and the Customer Charter that tells householders and landlords what they should (and should not) expect from the retrofit industry.

The middle row of the diagram shows the two overarching retrofit process standards: PAS 2035 for domestic retrofit and PAS 2038 for non-domestic retrofit[1]. The two PASs are discussed below.

The bottom row of the diagram shows examples of the range of BSI and non-BSI standards that are referred to by PAS 2035 and PAS 2038, with which they require compliance. Also shown (in the right-hand box) are new retrofit standards developed by the RSTG and BSI's Retrofit Committee CB 401, which form part of the Framework.

The point of the Framework is that when third-party funded domestic retrofit programmes are required by funding bodies to be subject to the TrustMark quality mark, TrustMark applies 'scheme rules' requiring the work to comply with PAS 2035, *Retrofitting dwellings for improved energy efficiency – Specification and guidance*. Not only Government but also any organization promoting or funding domestic retrofit (e.g. a devolved administration, local authority or housing association) can adopt PAS 2035 and require compliance. Similarly, any organization promoting or funding non-domestic retrofit can adopt PAS 2038 and require compliance. Both PAS 2035 and PAS 2038 refer to and require compliance with a range of other standards that form part of the Framework, so the adoption of either brings the full range of relevant best practice standards to bear. Thus the Framework provides a comprehensive basis for quality retrofit in which buildings and their occupants are protected against known risks.

[1] *PAS 2038 did not arise from the Each Home Counts review – it was added later at Government request*

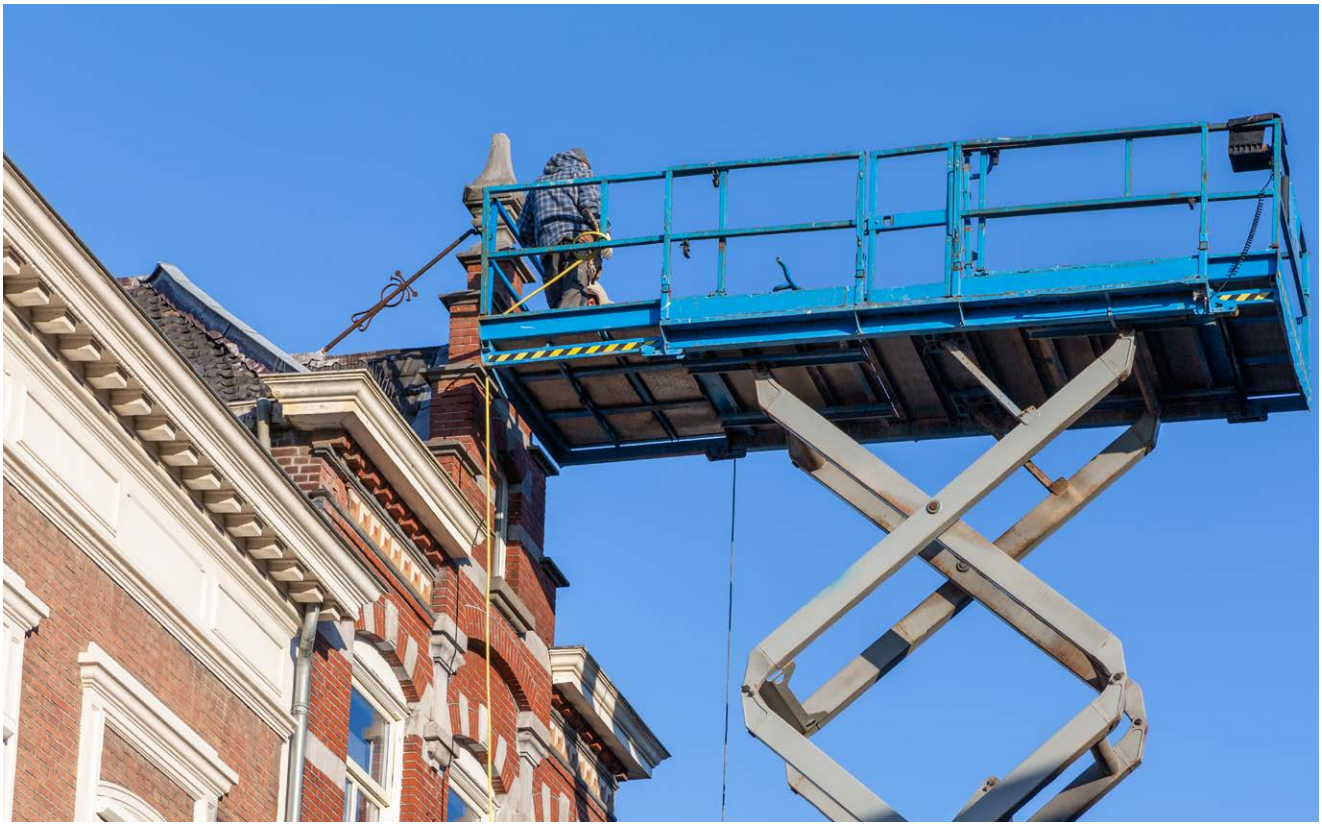
Overarching Retrofit Standards

The two overarching standards in the BSI Retrofit Standards Framework are the domestic standard PAS 2035 and the non-domestic standard PAS 2038.

In addition, PAS 2030 Specification for the installation of energy efficiency measures in existing dwellings is referred to by both standards. PAS 2035 and PAS 2030 are 'locked together' because the installation of retrofit designs compliant with PAS 2035 must comply with PAS 2030, and installers working to PAS 2030 may only install retrofit designs compliant with PAS 2035. PAS 2035 and PAS 2030 may therefore be seen as two interlocked parts of a single standard.

Domestic Retrofit

For domestic retrofit, PAS 2035 requires adoption of a robust process that is designed to allow identification and management of technical risks, promote quality outcomes and protect both homes and the health of their occupants against unintended consequences. The process must be overseen by a qualified Retrofit Coordinator, who is a retrofit professional trained to understand all aspects of retrofit and how they interact, and to manage retrofit risks. Essentially, Retrofit Coordinators 'know what good retrofit looks like', and their role is to protect the interests of their clients and the public. An important recommendation of PAS 2035 is that in order to avoid conflicts of interest Retrofit Coordinators should be employed by householders or landlords, not by retrofit contractors or installers.



The key elements of the PAS 2035 compliant retrofit process are:

- **A whole-dwelling retrofit assessment** to provide a comprehensive understanding of the existing dwelling. Where the building is traditionally constructed or protected, an assessment of its historical, architectural, industrial or cultural significance is required, in accordance with BS 7913:2013.
- **An improvement option evaluation** to identify the improvements needed to bring the dwelling to 'net zero carbon' (or a similar performance standard) by 2050, and to determine which options are the most effective and appropriate.
- **A medium-term improvement plan** to establish a staged retrofit process that will bring the dwelling from its current condition to the intended outcomes. This recognizes that most owner occupiers and landlords cannot afford to undertake deep retrofits of their homes all at once. The medium-term improvement plan also allows landlords to align retrofit projects with their asset management and investment plans.
- Preparation of a **design and specification** of the initial stage(s) of the proposed retrofit by a suitably qualified Retrofit Designer (typically an architect, an architectural technologist, a surveyor or an engineer, leading a team of specialists). When insulation or airtightness measures are included, the adequacy of the existing ventilation system (if any) is required to be assessed, and if it is found to be inadequate the system must be upgraded. The design must also include provision for minimizing thermal bridging (which leads to condensation and mould growth) and eliminating thermal by-pass at corners, junctions and edges of the building envelope, for managing interactions between improvement measures, and for minimizing the risk of overheating.
- **Installation, testing, commissioning and handover** of improvements in accordance with the design and specification and compliant with PAS 2030 or (in the case of renewable energy technologies) with the Microgeneration Certification Scheme (MCS) standards.
- The **delivery of energy advice** to householders and landlords at the inception of each project, after the improvement option evaluation (in order to agree intended outcomes), when the design is complete and after handover (to ensure that occupants know how to make best use of the improved dwelling).
- **Evaluation** of every completed retrofit project to confirm that intended outcomes have been achieved, and to investigate and remediate any unintended consequences.

PAS 2035 also specifies minimum qualifications for retrofit professionals: the Retrofit Coordinator, Retrofit Assessor, Retrofit Designer and Retrofit Evaluator. Additional qualifications are required for retrofit professionals working on traditionally constructed or protected buildings. PAS 2030 and the MCS standards specify minimum certified competencies for installers of retrofit measures.

Non-Domestic Retrofit

For non-domestic retrofit, PAS 2038 requires adoption of a similar, robust process that is designed to allow identification and management of technical risks and promote quality outcomes. However, the non-domestic building stock is much less homogenous than the domestic stock, so the process must cope with retrofit of a huge variety of

buildings ranging in scale from corner shops to The Shard, and with so-called 'base buildings' (e.g. office blocks and shopping centres) that accommodate multiple activities in different tenancies. Non-domestic retrofit is typically undertaken in conjunction with broader refurbishment, and usually involves building professionals such as surveyors, architects and engineers.

The PAS 2038 process is designed to allow identification and management of technical risks, promote quality outcomes and protect against unintended consequences. The process must be overseen by an appropriately experienced 'Retrofit Lead Professional' selected from the project team.

The key elements of this process are:

- **A retrofit assessment** to provide a comprehensive understanding of the existing building. Where the building is traditionally constructed or protected, an assessment of its historical, architectural, industrial or cultural significance is also required, in accordance with BS 7913:2013.
- **An improvement option evaluation** to identify the improvements needed to bring the building to 'net zero carbon' (or a similar performance standard) by 2050, and to determine which options are the most effective and appropriate. Where significance is found, proposed retrofit measures must be the subject of a Heritage Impact Assessment in accordance with BS EN 16883:2017.
- **Agreement of intended outcomes** of the project, and development of a medium-term improvement plan to establish a staged retrofit process that will bring the building from its current condition to the intended outcomes.
- **Preparation of a design and specification** of the initial stage(s) of the proposed retrofit. Typically, this will involve a 'Lead Designer' coordinating the work of specialists specifying improvements to the building fabric and various building services.
- **Acquisition of the necessary statutory approvals**, e.g. planning permission and approval under the Building Regulations.
- **Retrofit work on site** including installation of measures in accordance with the design and specification and compliant with PAS 2030 or (in the case of renewable energy technologies) with the Microgeneration Certification Scheme (MCS) standards.
- **Testing, commissioning and handover** of all the installed building improvements and systems in accordance with PAS 2030 or (in the case of renewable energy technologies) with the Microgeneration Certification Scheme (MCS) standards.
- **Evaluation** of every completed retrofit project to confirm that intended outcomes have been achieved, and to investigate (and if necessary, remediate) any unintended consequences.

PAS 2038 also specifies that the professional team must be suitably qualified. Additional qualifications are required for retrofit professionals working on traditionally constructed or protected buildings.

In order to deal with the complexity of the non-domestic stock, PAS 2038 includes options for assessing the energy performance of the building as existing and as proposed (for the improvement option evaluation); a range of simulation models may be used. Another option is the use of the RIBA/CIBSE/BSRIA 'Soft Landings' project management process that aims to secure intended outcomes, especially with respect to building performance.

PAS 2038 also includes additional requirements for buildings over 1000 m^2 in floor area. These include: the estimation of 'whole life' greenhouse gas emissions for improvement options and packages; the provision or updating of a building logbook; and fine-tuning of building systems and controls shortly after the improved building has been occupied.

Finally, small non-domestic retrofit projects, involving buildings that are not more than 500 m^2 in floor area and have simple domestic construction and simple building services (heating, hot water, ventilation and lighting) may comply with PAS 2035 instead of PAS 2038. This provision is aimed particularly at non-domestic premises in converted dwellings.

Benefits of the retrofit standards

The benefits of using the retrofit standards in the BSI Retrofit Standards Framework include:

- Provision of robust processes to minimize retrofit risks to building owners, occupiers, designers and installers. Most retrofit risks are moisture-related and have time-consuming and expensive consequences if they are not well managed. PAS 2035 and PAS 2038 are designed to help project teams manage risks and to protect buildings and their occupants' health against the unintended consequences of poor retrofit.
- Professionalization of retrofit, which is a new type of work involving new materials, new products, new systems and new processes, and requiring new skills. The capacity of the retrofit industry is inadequate and not yet well-founded on the proven techniques developed by pioneers. PAS 2035, PAS 2038 and the other standards in the Framework define good practice.
- Identification of routes to zero carbon. Every building is unique, and the paths to zero carbon are many and varied. The retrofit assessments, improvement option evaluations and medium-term improvement plans required by PAS 2035 and PAS 2038 raise clients' expectations, identify a stream of retrofit work for the industry, and help us to discern and follow appropriate retrofit paths.
- Explicit definition of intended project outcomes, and holding retrofit project teams to account by evaluating delivery. PAS 2035 and PAS 2038 discourage project teams from following usual, lazy or inappropriate practice resulting in under-performance or unintended consequences. We have insufficient time and resources to deliver poor retrofit and then go around again putting it right.
- Restoration and maintenance of the confidence of clients (i.e. building owners, occupants and funding bodies) and Government in an industry that has not performed well in recent years and that has developed a reputation for poor work that deters clients from initiating essential retrofit projects.
- Continuous improvement, through the regular addition of new standards to the Retrofit Standards Framework, annual updating of PAS 2035 and regular updating of PAS 2038 in the light of experience, new knowledge and new technical developments.

These benefits apply as much to the retrofitting of single dwellings by homeowners looking for security by 'getting it right' as they do to large scale housing retrofit by landlords, under their asset management and investment programmes.

Next Steps

The BSI Retrofit Standards Task Group and BSI Committee CB/401 continue to propose and develop new standards to be added to the Retrofit Standards Framework.

Some of these standards will embrace new topics such as internal environmental quality; others will replace sections of PAS 2035 or PAS 2038 with more detailed and up-to-date requirements than could be accommodated in the original versions. A standard for Building Performance Evaluation, BS 40101:2022, has already been added to the Framework with a view to replacing the relevant clauses of PAS 2035 and PAS 2038.

Compliance with PAS 2035 is currently only required by government-funded energy efficiency schemes focused on fuel poverty, i.e. the Energy Company Obligation (ECO), the Local Authority Delivery Scheme (LADS) and the Social Housing Decarbonisation Fund (SHDF). The application of PAS 2035 may be extended to other funding schemes targeted on different housing sectors, for example the Great British Insulation Scheme and the Home Upgrade Grant (HUG). PAS 2035 is intended to apply to retrofit work beyond the funded schemes, and there is scope for encouraging housing organizations to adopt PAS 2035 for work that they finance themselves, and for encouraging lenders to make compliance a condition of funding in the owner-occupied sector.

If we are to meet our climate change zero carbon targets, large scale retrofit programmes will be essential. Retrofit delivered under the SHDF funding scheme is providing valuable lessons about how the PAS 2035 process can be scaled up and to some extent automated to deliver more retrofit projects quickly. Several consultancies working on SHDF projects are developing digitalised versions of some parts of the PAS 2035 process, including assessments, improvement option evaluation,

standard retrofit specifications and retrofit construction details templates, many of which are likely to be incorporated into future revisions of PAS 2035. The challenge will be to preserve retrofit quality as these techniques are used to deliver retrofit at scale; some early PAS 2035 software developed by installers' bodies 'dumbed down' the PAS 2035 process to minimize the challenges it presents, rather than enhancing it and making it more efficient.

To date, PAS 2038 has only been used by a few architects working on historic or protected non-domestic buildings. The Department for Energy Security and Net Zero (DESNZ) is developing policies to promote retrofit of non-domestic buildings, which PAS 2038 will support and have to respond to. The non-domestic building stock is not exempt from the retrofit challenge, so we can expect to see more versions of PAS 2038 in the future, as the industry gains experience with it.

Conclusions

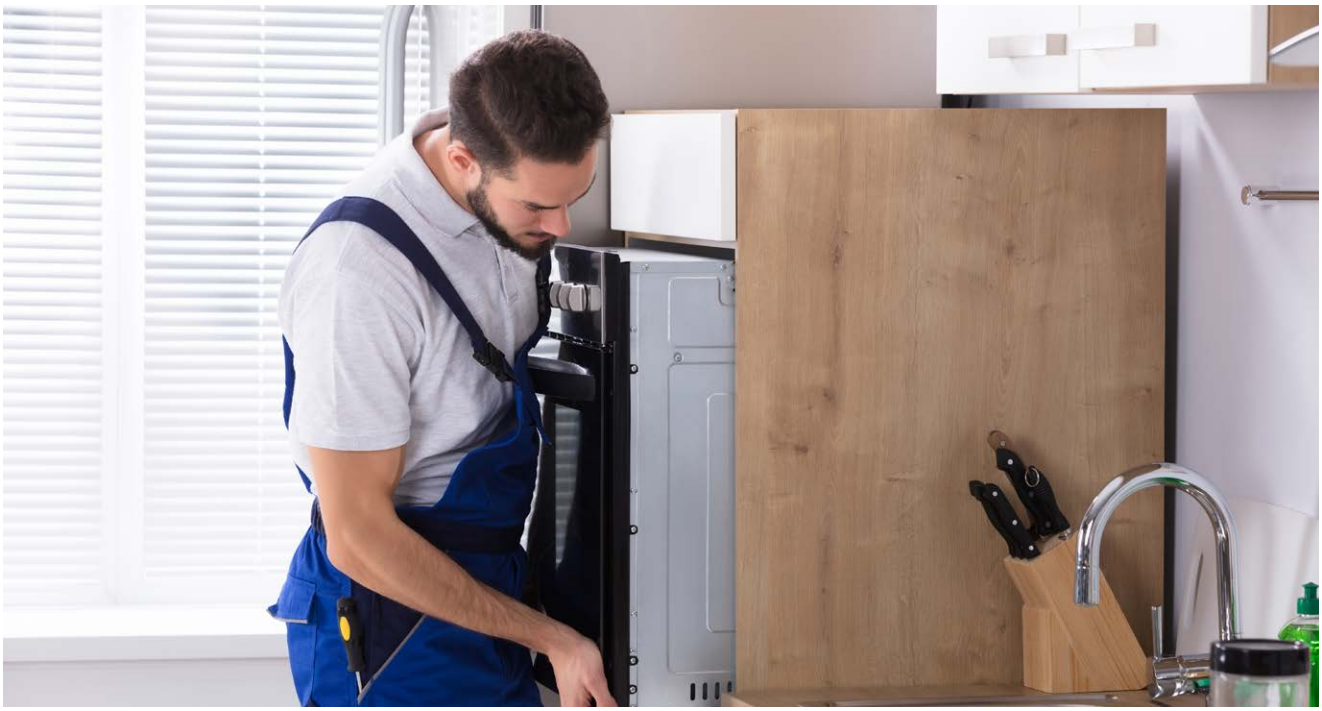
The BSI Retrofit Standards Framework, PAS 2035 and PAS 2038 are children of the Each Home Counts review.

They are intended to change the culture of the retrofit industry, which had become unprofessional and careless about risks to people's homes and their health. They are also part of the response to the challenge of climate change, and intended to support building retrofit at scale, as we move towards a zero-carbon built environment.

The importance of professional input to retrofit cannot be over-emphasized. The skills of trained professional surveyors, architects and engineers are essential to effective, safe retrofit. Both PAS 2035 and PAS 2038 require professional contributions to retrofit projects. In the non-domestic sector PAS 2038 focuses the role of building professionals on retrofit, and in the domestic sector the new profession of Retrofit Coordinator is intended to facilitate and coordinate professional inputs. Retrofit is too risky be left to untrained and unskilled installer organizations with little or no understanding of building physics or of risk assessment and risk management.

However, installer skills are also critical, and huge growth in the number of skilled retrofit contractors and installers is essential. The installer competencies required by PAS 2030 must be maintained and expanded as the retrofit industry grows and new technologies are introduced, so new means of managing those skills need to be developed—possibly by putting some parts of PAS 2030 online.

The biggest challenge is to deliver safe energy retrofit programmes for all buildings, in which risks to performance outcomes and risks to the health and safety of occupants are properly managed. Foremost amongst those risks are fire, and the health risks associated with moisture and mould.



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4 Funding and Procurement for Low Carbon Retrofit Projects
5. Managing Low Carbon Retrofit Projects
6 Improving the Building Fabric
7 Improving the Building Services
8 Green Retrofit: Materials, Waste, Water and Maintenance
9 Living in a Low Carbon Home
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Dr Peter Rickaby originally qualified as an architect and has over forty years of experience as an energy and sustainability consultant, mostly in social housing and retrofit. He contributed to the Retrofit for the Future programme, was a Fellow of the Centre of Refurbishment Excellence, and a member of the Implementation Board for the Each Home Counts Review, where he was co-lead on technical standards. He chaired the BSI Retrofit Standards Task Group for five years and was the Technical Author of the original editions of PAS 2035 and PAS 2038. Peter is an Honorary Senior Research Fellow at University College London, where he helps to run the UK Centre for Moisture in Buildings. He is also a consultant to Savills, working on retrofit processes for large-scale PAS 2035 compliant projects funded by the Social Housing Decarbonisation Fund.

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