Keep It Simple Stupid (KISS) Retrofit



Keeping Retrofit Simple

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Introduction

Retrofit is a complex business – far from simple! However, there are some key decisions that can be made that make it a lot simpler.

KISS Retrofit is an attempt to strip back retrofit to its bare bones and try to reconstruct it in a meaningful and simplistic manner that will allow the industry to wipe the dirty slate clean and start again in a considered, logical, realistic and achievable manner.

There is a backdrop of realism that we must take onboard from now on.

Firstly, the biggest issue here is that we are NOT going to meet any target for retrofitting all the UK's building stock by 2050. Simple. To think that we can safely retrofit 29 million homes by 2050 (= c. 3,300 homes per day for the next 24 years) is just Stupid. It is not realistic and if we attempt it with haste and an eye for 'affordability' we shall just make a hash of it.

Secondly, we must consider the longevity of materials and systems that we are currently using. Retrofitting buildings with materials that have 30-year life expectancy just means that we must do all this again in 30 years' time, but this time it will mean removing the old worn / failed materials and then replacing them all, this is more costly than the work we are doing now. This is therefore a ticking time bomb if we continue using the same materials and energy efficiency measures that we do now. We must start using materials that are permanent. Simple.

Retrofitting correctly and with an eye to the permanent is expensive, but it is cheaper than having to do it all over again every 20-30 years. To plan on retrofitting indefinitely with temporary products is stupid.

Thirdly, retrofit occurs in the real world, not on a computer spreadsheet or programme. Using theoretical modelling and a large dose of assumptions (e.g. EPCs) with arbitrary targets (MEES) based on this flawed methodology is stupid. We must change to assessing each property individually and ascertaining the. Surely, it is simpler to aim for achievable real world informed targets for each property to make them as 'best' as

they can be.

Fourthly, we already have the tools available to us to undertake retrofit correctly. PAS2035 demands that we act in the best interests of the owner and the public good (the property) by using a risk based whole house approach. We just need to use this process as it was designed rather than using arbitrary single focus targets. We must also consider the intended outcomes of the owner. Available options may provide very different outcomes. For example, installation of a heat pump may radically reduce carbon emissions but not necessarily costs, so if the owner wants to cut costs this may not be a recommended measure.

The ‘new’ KISS approach may not facilitate the ‘desired’ 85% reduction in CO2 from the built environment sector that Governments think should deliver, but chasing these targets will just increase the relative costs and CO2 associated with retrofit if we get it wrong. The reality is that the only way of reducing the UK’s carbon footprint to meet our carbon targets is to focus on consumption and consumerism, the energy supply network and other industrial / transportation sectors where massive savings are achievable. Housing / built environment will never reach 85% carbon savings. This document will not address how these sectors might achieve enhanced goals or indeed how a revolution over consumerism might succeed, the focus of KISS Retrofit is on how to facilitate the built environment sector contributing as much as safely possible to the climate emergency without causing un-necessary harm to occupants and the housing stock of the UK.

A new philosophy

If we accept that retrofitting the UK housing stock needs to be more nuanced than now, then we need to change our existing philosophy and start to work on different priorities.

From a wider societal point of view, KISS Retrofit believes that we need to steer our focus away from just Carbon savings / Energy efficiency / Fuel Poverty. The blinkered focus on them, that we have had over the past 15 years or so, has led to repeated failures, poor health, cost overruns, etc. You only have to look at the levels of CWI extraction, EWI removal, mould and damp, fuel poverty entrapment to realise that we need a fundamental change in approach.

KISS Retrofit believes that whilst Carbon savings / Energy efficiency / Fuel Poverty are vitally important, we are better served by focusing on wider priorities of Health and Nature protection because if we get these other priorities right, then Carbon savings / Energy efficiency / Fuel poverty solutions will naturally flow from them.

Work with nature rather than against it.

Nature is home to the most powerful forces in the world, so we must respect it and work with it. For example, rather than trying to keep water out of a building, accept that water will get in and work out how to cope with this and adapt accordingly.

Respect Global Ecosystem resilience.

Natural resources are finite, so we must focus on renewable resources and using them in a manner that preserves them rather than constantly depleting them. Doing things once rather than having a system that constantly demands renewing every 20-30 years.

Focus on moisture and health not energy / carbon savings.

It is moisture that both ruins homes and threatens occupiers' health. Long term we must preserve our existing housing stock, so ensuring that the house is free from mould, damp and rot is vital. Removing the root cause of mould / damp then helps to keep the occupants healthy.

Think about summer and winter.

We must ensure that our houses are fit for purpose all year round. Cool in the summer and warm in the winter. Using thermal mass in a building can help keep a building cool in the summer as well as providing a store of latent heat in the winter. So, don't de-couple the thermal mass of your walls and floors by using layers of stratified insulation.

Think maintenance.

Unless our buildings are easy to run and maintain they will gradually fall into disrepair and this then leads to more resources being consumed over time.

Think long term.

Doing retrofit repeatedly only increases the carbon and cost associated with it. If we use proven materials that can be easily repaired and maintained, rather than needing replacement, it reduces the long-term effects. If we use proven materials that are permanent fixes or that can be repaired maintained rather than needing replacement it reduces the long-term effects.

Aim for realistic and achievable energy savings.

Aiming for theoretical maximum thermal performance increases risk. Pushing the fabric hard in terms of improving thermal performance radically increases risks associated with thermal bridging, thermal by-pass and moisture management. So, aim for achievable improvements that will allow Energy Efficiency Measures (EEM) to work in harmony with the existing building.

Use appropriate materials.

Using compatible materials that work with your existing building lowers risk significantly. So, make sure you use low risk materials and systems.

Use technology wisely.

Technology can create as many problems as it solves. Use automated systems where possible that help regulate internal conditions, so, for example, install relative humidity-controlled ventilation rather than relying on manual controls.

Install appropriate technology.

The construction industry is full of ‘boys’ toys’. Keep things simple and focus on real life issues rather than the latest tech.

Install technology correctly.

Technology associated with retrofit needs to be designed, installed and commissioned properly. So, use reputable companies with higher qualifications so that technology does deliver all its promises. E.g. Use Heat Geek approved installers for heat pumps.

Contract with individual companies for system installation.

Systems might involve several trades, but if you employ different contractors for each of them you have no single point of contract for any maintenance / warranty issues. So, use one firm to undertake all the required steps for system installation.

Use local, low carbon materials when possible.

Using local and natural materials lowers the embodied carbon associated with retrofitting. However, these still need to be the right materials for your improvements.

Focus on existing / recognised trades.

Retrofit can require really specialist trades / knowledge, but if we can use simple solutions / materials then it is relatively quick and easy to upskill an existing set of tradespeople rather than having to create brand new training systems.

Create honest retrofits.

Improvements to homes must be clear and interpretable. If we cover up issues by using membranes and masks of various descriptions we can no longer ‘read’ buildings with any certainty. Using materials that allow the building to be understood in terms of moisture and warmth allows us to make informed decisions in suitable time. Hiding problems can lead to unpredictable and catastrophic failure, so we must be able to easily interpret out homes.

Work with real data, not spreadsheet derivatives.

We need to start using data collected from site rather than based on computer generated standardised data. This helps to reflect how people and buildings perform in the real world rather than the hypothetical one.

Real world factors trump in-principle designs.

Buildings are not as square and perfect as they might appear on a computer screen or in a design programme. Walls are not straight and smooth, windows do not fit perfectly etc. We need to have solutions that can adjust on site to the inconvenient reality of buildings.

Avoid designing in weak points.

Solutions are only as good as their weakest point. It only takes a silicon seal to fail for a whole EWI project to be compromised. So, we need to design in permanent design solutions rather than relying on short-term patches.

Respect the intended outcomes of the owner.

The retrofit must be fit for purpose and hence the wishes of the owner must sit at the core of the specified work. This might involve giving the owner advice on the overall societal aims of retrofitting homes.

All these principles rely on us having an exceptional understanding of the building and how it is used. The new British Standard BS40104 is therefore vital to utilise when assessing any home. Similarly, we must use risk based procedural guides like PAS2035 and 2038 so that solutions are based in the whole building house approach.

These documents are not tick box exercises but fundamentally represent a seismic shift in how to approach retrofit. One of the key factors that underpins PAS2035 is that the Retrofit Co-ordinator (who is effectively a Project Manager for the retrofit) MUST represent the interests of the owner AND the public good. This means that the Retrofit co-ordinator must do what is right both for the owner and the property, we are only temporary custodians of property after all.

Adaptation / mitigation for future climates

The point of retrofit is to adapt our buildings for a lower carbon future. This future is ultimately unpredictable, but we can expect that certain key features are associated with it, including:

1. a focus on electricity as a primary fuel generated from renewable sources,
2. there will be a need to reduce embodied carbon as part of the global response to climate change,
3. weather patterns will change (in the UK this is expected to bring more severe storms, warmer wetter winters and summers interspersed with longer periods of hot and dry weather; see: https://weather.metoffice.gov.uk/climate-change/climate-change-in-the-uk)
4. skills and knowledge will have to increase regarding new products and innovations within the industry, but the development of these can be glacial
5. long term maintenance of properties will continue to be largely ignored

If we are to get retrofit right for the future, then we need to keep it simple and not be stupid! This starts from accepting these key features and creating solutions that address them.

So, any solutions that we utilise in retrofit should be:

1. Encouraging the use of electricity as a source of energy, both in terms of heating and building services. Encouraging local generation of renewable energy.
2. Use low carbon materials that are from renewable sources and are easily recycled.
3. Fit for both warmer and colder climates and are extreme weather tolerant / resistant.
4. Easy to use, install and maintain and build on existing knowledge / skills that are available in the construction industry
5. Permanent solutions so that maintenance is minimised or at least simple.

Existing Retrofit tools

PAS2035/2038

The way that we retrofit buildings therefore must be sympathetic to predicted climate change. This suggests that any holistic solutions need to embrace a new way of looking at them. PAS2035 and PAS2038 provide the foundations for this whole building approach, but they are still focused on energy efficiency. Indeed, PAS2035 and PAS2038 are entitled:

- PAS2035:2023 Retrofitting dwellings for improved energy efficiency
- PAS2038:2021 Retrofitting non-domestic buildings for improved energy efficiency

The philosophy behind PAS2035 and 2038 was always about ensuring that energy efficiency was not addressed in isolation. This blinkered view had led the industry to a range of catastrophic retrofit projects under schemes like CERT and CESP where we had taken a crude fabric first approach that relied upon insulating elements of building in isolation rather than spending time and resources ensuring that the project as a whole was completed in a joined up, risk assessed and ultimately more sustainable manner.

The industry though has been slow to react to the demands of PAS. Inertia within the construction industry comes from all quarters. Assessments have been accomplished by upskilling Domestic Energy Assessors (DEA) via a 10-hour long CPD, Co-ordination functions have been largely replaced by tick box computer programmes adapted from failed past energy efficiency systems. Enforcement has been difficult due to the lack of skilled evaluators and the pace of change that the Government wishes to see within the sector. The basic proviso has been on the status quo in terms of methodology and thought processes. ‘How can we tick the boxes whilst not changing what we do?’.

The system is held back by many systemic issues including testing regimes for products and systems, specifications that rely on these basic tests, design and modelling skills for building professionals that are still 2D in their scope, training and qualifications. There is also a low respect for the construction industry that has led it to be under performing in terms of attracting new entrants into the market.

The development of new tools and approved systems to help drive change has also been slow. In 2026 we are still using crude rdSAP calculations.

Spreadsheets told the industry what to do, but not how to do it. Energy Performance Certificate headline metrics (energy running costs) were used to make decisions on the most cost-effective interventions. The issues with this are now better known by the industry but still entrenched in some sections of industry. The drive for better EPC ratings is still at the heart of many organisations and Government thinking.

ECO, MEES and other funding / compliance systems have relied on EPCs for metrics despite our greater appreciation of risks. PAS 2035 has been designed as a foil against

this drive for ratings, trying to ensure that we make designs based on the wider whole buildings approach that takes other key factors into account, notably moisture. It is after all moisture management that is the key to success or failure.

The assessment of the building is the key starting point in this journey towards making (or at least mapping out) the building to be as good as it can be. A keen understanding of building pathology and building physics, combined with the acknowledgement of the social, economic and technical pressures on the building allows a designer to create a sustainable pathway for it.

The management of moisture should therefore in theory 'trump' energy efficiency as we must ensure that any plans will success or at least have a minimal risk of failure. PAS2035 and 2038 are quite clear that solutions need to be at least into the medium / long term (hence the Medium-Term Improvement Plans running to 2050) and this means that we need to think about buildings in terms of their past, present and future. This was eloquently put into the BSI White Paper on Moisture (May and Sanders) in terms of the 4 'C's.

PAS2035 and 2038 were quite specific on certain items when it comes to retrofit, so any KISS solutions need to address these. The main pointers were:

1. Fabric First
2. Focus on interfaces, corners, edges, junctions

Fabric first is a concept that makes absolute sense, but of course it can be over-ridden when required. This is a risk-based decision, so if there is likely to be an issue associated with fabric works, EWI or IWI for example, it may be more prudent to spend any investment in low-risk service improvement, like PV panels, rather than high risk insulation. KISS would certainly support this argument, but again the fabric first approach can work if the fabric is not being stretched to breaking point. The use of 'threshold' values in Part L of the Approved Documents can be a key consideration when it comes to risk management. Fabric first could and should be applied first, especially when an informed designer / specifier uses the tools and leeway afforded to them via regulations.

Section 5.6 in PAS2035:2023 states that the process must "concentrate on the interfaces". It says that 'retrofit projects often go wrong because of poor attention to the corners, junctions and edges of building elements (where insulation and air barriers should be continuous) and the interfaces between the building fabric, the building services and the occupants.' With this being a key fundamental risk in retrofit, surely, it is vital that we have solutions that reduce the risks associated with corners, junctions and edges.

It has been observed that most retrofit work in the UK involves creating more junctions and edges rather than reducing them. This is because we conventionally use board-based insulation for both EWI and IWI. These boards are generally 'butted' together, and this creates an imperfect junction / joint in the wall. These junctions are either left as is or sealed with some expanding foam. So, we are building inherent risks into our properties by introducing even more potential failure points. Board based solutions also create additional issues in terms of interfaces as the substate that they are placed upon are never perfectly flat and so we are creating voids behind the boards. These voids are not allowed according to all the manufacturer's data . Installation requirements are very precisely set out by suppliers and being applied onto a flat, even surface is one of the key factors identified.

The differences between manufacturers' installation and on-site practices can be very wide ranging. This is partially driven by the fact that products / materials are tested in laboratory conditions that have very little to do with real world situations and that designs are completed on computers and drawing desks where all walls and building elements all join perfectly where walls are flat, windows perfectly sealed into place etc. The reality, of course, is that on site practices and situations are far from perfect, Walls are uneven, require drips to be removed, etc. Are these things done in a computer perfect manner and smoothed off to create an even surface? Of course not, so square, fixed depth boards do not fit perfectly onto existing walls. This then creates voids, jointing issues, poor seals etc. This diversion away from the manufacturers' specifications is just ignored by the industry. It accepts that onsite conditions will prevent the insulation from being installed to the required specification / standards demanded by the manufacturer. So, who is responsible? The manufacturer will say that they specified that the boards were installed onto a regularised surface etc, the designer will state they also specified that the products were to be installed to the manufacturer's specifications and requirements. The contractor will say that they didn't have the resources / money / skills to make all the surfaces perfectly flat etc and this will also be true because if they had priced in getting the walls to be perfect prior to installation they would have priced themselves out of the work, so the whole system just accepts that the quality of the work will be below what could have been achieved. This performance gap is well known in the construction / housing industry.

The situation stated above can be seen replicated in many an inquiry, Grenfell for one. Things not being done properly due to systemic failings. These can be at any stage, research, testing, procurement, funding, specification, design, installation, commissioning. It is imperative therefore that risk is put centre stage. Using low risk systems and materials can only reduce the performance gap, reduce risk of failure, reduce risk of future issues, …

BS40104:2025 Retrofit assessment for domestic dwellings. Code of practice

This is a new British Standard that seeks to ensure that we assess and hence start to

understand buildings better.

Current skill requirements for retrofit assessments are very poor. The entire system relies on ‘upskilled’ Domestic Energy Assessors to collate the data. A Retrofit Assessor therefore has undertaken a weeklong Level 3 course to become a DEA and then undertaken c. 10 hours of relevant CPD. Of course, RA’s will gain more knowledge as they progress in the industry, but the required 10 hours of CPD a year is not adequate to create a bank of truly knowledgeable assessors.

To fully understand buildings fully we really need trained and competent building surveyors. However, this is unlikely to happen, so we need to look at how we can upskill the existing workforce so that we can make informed decisions. BS40104 attempts to do this by setting out the requirements of an assessment.

The simple solution therefore is to ensure that any retrofit assessments follow BS40104.

BS40101:2022 Building performance evaluation of occupied and operational buildings. Specification

Whilst this does not automatically affect the assessment process or indeed the options available, it does guide the intended outcomes of any work. Good post occupancy evaluations allow us to learn from our interventions and assess their efficacy. BS40101 emphasizes the use of real-world data rather than the predicted data. So having an evaluation system that is grounded in reality can only help us with specifying interventions that work.

The simple solution therefore is to ensure that any retrofit evaluations follow BS40101 and then use the results to assess retrofit solutions.

BS7613:2013 Guide to the conservation of historic buildings

Understanding ‘traditional / historic buildings’ is vital in a country where c. 30% of all the building stock is of traditional build. This document is useful in determining the appropriate EEMs for retrofitting of traditional buildings, but too many associate it with ‘historic’ buildings, i.e. protected buildings. The contents though need to be better known across the industry, along with the guidance provided by Historic England in terms of ‘Special Considerations’ that are referenced in the building regulations.

BS7913 is referenced in PAS2035:2023 and recommends its use in terms of assessing significance, but also, it has important guidance in terms of how to undertake retrofit / improvements to traditionally built structures. KISS Retrofit effectively follows the ethos and guidance in BS7913.

The only thing that is missing from these documents in terms of ‘significance’ is that they are very objective. This works in terms of accepted long-term societal appreciation of a building’s significance, however, there is no allowance for what the current owners might deem to be significant. KISS Retrofit feels that this is an essential element of decision making as it may be contentious for the owner is certain recommendations are made via a Retrofit Co-ordinator that they might feel are counter to their sensitivities about the building.

Building regulations

Most of the decisions that are made about buildings are done so via reference to the building regulations and their Approved Documents (AD). There are interactions between the various ADs and these need to be recognised, but there are real world issues that might affect the implementation of some of the recommendations / requirements.

The ADs need to be well known by any RC and Retrofit Designer (RD) as there may be circumstances where compromises are required or where implementation may be impractical. This then takes confidence in knowledge of underpinning building physics to ensure that incorrect / high risk measures are not undertaken without the necessary risk analysis.

Part L

Part L has been the focus of much of the retrofit work in the UK as it deals with the thermal efficiency of the building. There tends to be a strict adherence to the headline requirements rather than an interpretation of the whole document. The most critical issues here are the differences between traditional and conventional types of buildings, and the requirements for retained and replaced building elements.

Section 0 states clearly:

Exemptions for historic and traditional buildings

0.8

Work to the following types of dwellings does not need to comply fully with the energy efficiency requirements where to do so would unacceptably alter the dwelling’s character or appearance.

Those listed in accordance with section 1 of the Planning (Listed Buildings and Conservation Areas) Act 1990.

Those in a conservation area designated in accordance with section 69 of the Planning (Listed Buildings and Conservation Areas) Act 1990.
Those included in the schedule of monuments maintained under section 1 of the Ancient Monuments and Archaeological Areas Act 1979.
0.9
Work to a dwelling in paragraph 0.8 must comply with the energy efficiency requirements where this would not unacceptably alter the dwelling's character or appearance. The work should comply with standards in this approved document to the extent that it is reasonably practicable.

Historic and traditional dwellings where special considerations apply
0.10
In addition, special considerations apply to works to the following three classes of non-exempt existing buildings:
of architectural and historic interest and are referred to as a material consideration in a local authority's development plan or local development framework; or
of architectural and historic interest and are within national parks, areas of outstanding natural beauty, registered historic parks and gardens, registered battlefields, the curtilages of scheduled monuments, and world heritage sites; or
of traditional construction with permeable fabric that both absorbs and readily allows the evaporation of moisture.

0.11
Work to such buildings is required to comply with the energy efficiency requirements as far as is reasonably practicable. In considering what is reasonably practicable, the work should not unacceptably alter or mar the character of the building or increase the risk of long-term deterioration of the building's fabric or fittings.

0.12
Additional guidance on how to implement specific energy efficiency measures is available in Historic England's Energy Efficiency and Historic Buildings: Application of Part L of the Building Regulations to Historic and Traditionally Constructed Buildings (2017).

These exemptions / special considerations are vital to understand when dealing with retrofit as moisture is the main factor that we need to address to manage risk effectively.

The issue of retained and replacement measures is dealt with in two main tables (from AD Part L Dwellings 2022 Conservation of fuel and power (Wales)):

Table 4.1 Worst acceptable fabric performance values Maximum U-value W/(m2.K)

Element type	In new dwellings	In existing dwellings
Roofs	0.13	0.13
Wall - Dwelling Houses	0.18	0.18
Wall - Flats	0.21	0.21
Floor	0.15	0.15
Party wall	0.20	0.20
Swimming pool basin	0.25	0.25
Window or roof window	1.4	1.4 or minimum WER Band B
Roof-light	2.2	2.2
Doors:	1.4	1.4 or minimum DER
>60% internal face glazed All other doors	1.4	Band C 1.4 or minimum DER Band B
Air Permeability	8.0 m3/ (h·m2)@50Pa or 1.57m3/(h·m2)@4Pa	N/A

Table 11.1: Standards for retained fabric elements

Elements	(a) Maximum U-values for retained fabric	(b) Limiting U-values for retained fabric
Walls - cavity insulation	0.55	0.70
Walls - internal or external insulation	0.30	0.70
Floors	0.25	0.70
Pitched roofs - insulation at ceiling level	0.1c	0.35
Pitched roofs - insulation between the rafters	0.1c	0.35
Flat roofs or roofs with integral insulation	0.1c	0.35

11.7

Retained thermal elements should be upgraded to achieve or better U-values set out in column (a) of Table 11.1.

11.8

Where the U-value set out in column (a) of Table 11.1 is not economically, functionally or technically feasible, the thermal element should be upgraded to as close to the maximum U-value as is practicably possible. Generally, the U-value of the thermal element should not be worse than the limiting U-values set out in column (b) of Table 11.1 to minimise the risk of surface condensation and mould growth.

The AD is quite clear on the requirements, but we need to be sure in our choices as to what is economically, functionally or technically feasible. Referring to the 'Limiting U Values for retained fabric' can be useful when addressing the issues around pushing the fabric too hard.

Part F

Part F has recently been updated and like all ADs it does tend to work on worse case scenarios. However, with retrofit work it does provide clear guidance in terms of which EEMs affect airtightness and hence the need for enhanced ventilation.

There are numerous issues that complicate decision making. Having definitions for an airtight property is useful, but then it insists on having certain ventilation types if the building is airtight, but you won't necessarily know whether the building meets this standard until the work is done. There isn't too much of an issue with the extractors here, it is more the size / location of background ventilation (normally trickle vents). Windows will have been specified and installed before the pressure testing is done, but then it is difficult to change the trickle ventilation infrastructure without interfering with warranties etc.

The simplest thing is to assume that you will have an airtight house and hence install a constant ventilation strategy (dMEV or cMEV) with the appropriate size and location of trickle vents and through ventilation (door undercuts). However, this can be difficult when having to achieve the whole house ventilation rates when you don't have sufficient extractors to easily provide the required flow rates. For example, a large four bed house with one bathroom may only have 2 extractors with a required whole house flow rate of 37l/s, so each one should be running at c. 19l/s constantly. This has sound, draught, and energy consumption implications.

If windows aren't being changed then you will be inheriting the trickle vents provision. This might be zero, 8,000mm2 in each window, or something in between. It might be possible to remove trickles but installing them might be impossible due to a lack of width / depth in the window frame. So, again it is important to gather all the information from the assessment so that an informed choice / decision can be made.

Part F should not be used as a proxy way of dealing with 'damp'. Damp comes from a variety of sources, most common being penetrating damp, and ventilation will not solve this issue. Part F should work well with condensation issues, but even here it cannot solve all issues, for example where fixtures and fitting are hard up against external walls.

Part C

Part C is problematic in terms of how the industry thinks about moisture movement. Whereas Part L looks at 'traditional' buildings that are 'breathable / permeable' in nature, Part C defines 'historic buildings' differently and in a much more limited sense.

Historic buildings

Material change of use or alterations to existing buildings may include work on historic buildings. Historic buildings include:

- *listed buildings;*
- *buildings situated in conservation areas;*
- *buildings which are of architectural and historical interest and which are referred to as a material consideration in a local authority's development plan;*
- *buildings of architectural and historical interest within national parks, areas of outstanding natural beauty and world heritage sites.*

The need to conserve the special characteristics of such historic buildings needs to be recognised. In such work, the aim should be to improve resistance to contaminants and moisture where it is practically possible, always provided that the work does not prejudice the character of the historic building or increase the risk of long-term deterioration to the building fabric or fittings. In arriving at an appropriate balance between historic building conservation and improving resistance to contaminants and moisture it would be appropriate to consider the advice of the local planning authority's

conservation officer.

[1] refers the reader to BS7913.

This inconsistency is problematic as it goes onto describe ways that solid walls should be treated in terms of moisture resistance.

Solid walls are treated as though they must be protected from penetrating and 'rising' damp via implied impermeable materials.

5.2 states:

Walls should:

(c) resist the penetration of precipitation to components of the structure that might be damaged by moisture; and

(d) resist the penetration of precipitation to the inside of the building;

…

Use of the term 'resist' is misleading as it implies that moisture must be kept out of the building rather than using permeable materials to allow the building to both wet and dry naturally.

The simple thing to do is to change the wording so that **Historic buildings** changes to **Historic and traditional buildings** and that an additional definition of *(e) buildings of traditional construction with permeable fabric that both absorbs and readily allows the evaporation of moisture* is added.

This then allows traditional buildings to be addressed via BS7913 as per the recommendations within that document.

Part O

Whilst Part O is currently only for new builds, there is learning for retrofit of existing houses too.

The key issues for overheating in existing homes must be tied into thermal mass as well as issues around shading and ventilation. Cooling should be avoided as this just adds to the running costs and carbon footprint of a property.

Thermal mass can be kept and added by suitable design decisions and material choices.

Welsh Housing Quality Standard (WHQS) 2023

The WHQS 2023 states that properties must be:

- *structurally stable and free from disrepair*
- *free from damp*
- *affordable to heat and have minimal environmental impact*

There is a 'requirement' for a minimum rating of SAP 92. *UNLESS the installation of measures to achieve SAP 92 are not physically practical*, also the *carbon emissions from homes must be minimised (minimum of EIR 92) UNLESS the measures are not physically practical*.

This element needs to be taken in the context that a landlord's whole stock must achieve carbon emissions equivalent to an EIR 92; homes with a low EIR could be balanced by more efficient homes or other defined carbon balancing measures.

The standard also states that *fabric measures must be considered primarily and planned where possible*. *All installation of measures must also comply with current version of 'PAS2035 Retrofitting Dwellings for Improved Energy Efficiency'*.

KISS Retrofit therefore is compatible with the WHQS requirements as it is targeting fabric measures and the avoidance of moisture problems. The SAP and EIR demands can also be accommodated; however, this does place additional strain on properties where better scores are achievable in order to attain the stock level targets (assuming that this will be enforced).

Welsh Development Quality Requirements 2021

The WDQR asks for consideration for *reducing upfront and embodied carbon,.. when undertaking refurbishment*.' KISS Retrofit supports this aim by the recommendation for using natural products whenever possible. Lime as a binder is also significantly lower

in carbon emissions than cement, so its use will naturally help to reduce overall CO_2 emissions.

Decent Homes Standard (England)

In a similar vein to the WHQS the DHS standard in England has minimum requirements that fit into the KISS agenda. A home must be:

- *free of the most dangerous hazards*
- *in a reasonable state of repair*
- *provide thermal comfort*
- *free of damp and mould*

KISS's focus on the long-term risk and moisture issues that face properties means that it should guide RSLs towards sustainable solutions.

Awaabs Law

Awaabs law come into effect in 2025 and it requires RSLs to address issues around mould quickly and effectively. There are minimal timescales within which organisations have to act to alleviate damp and mould issues, see Figure 1

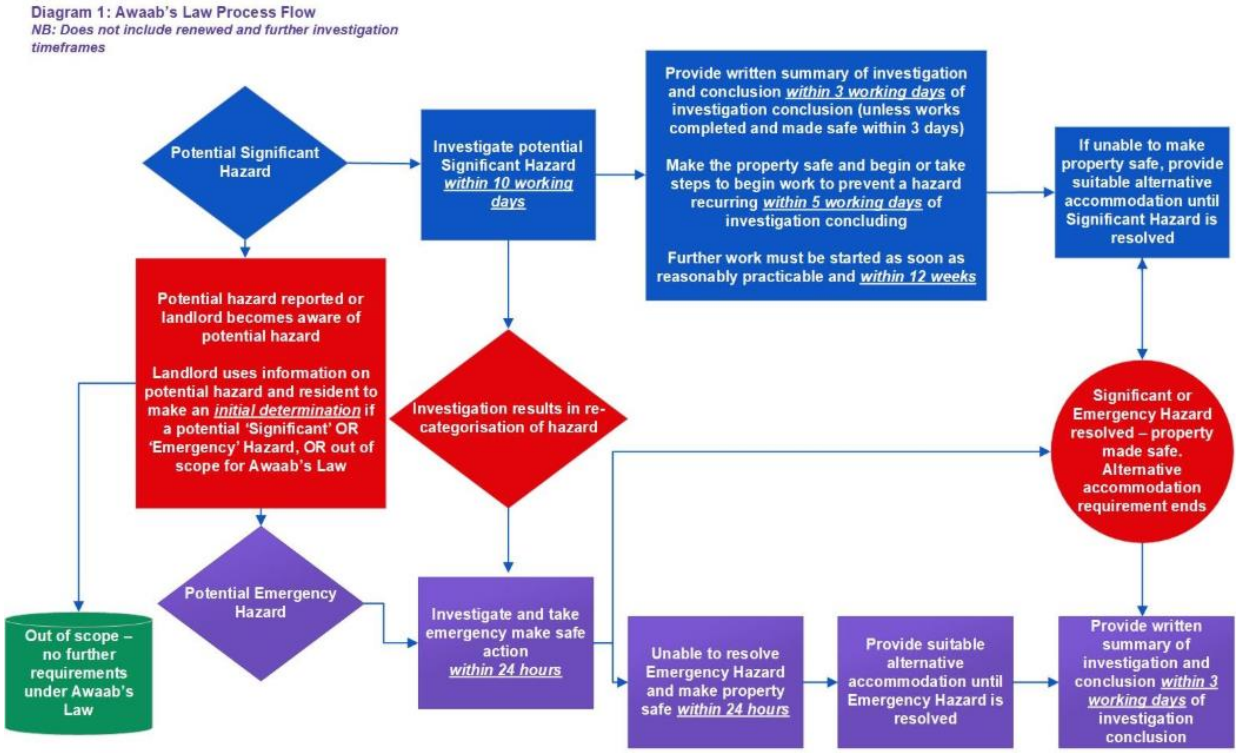

Figure 1

Avoiding the need for these tight timescales and the costs associated with them suggests that dealing with mould and damp will become increasingly important. Hard wiring in solutions via KISS Retrofit methodologies should therefore save costs in both the short and long term.

Accredited / Approved Systems

The use of approved systems / certified details can be problematic in terms of choosing EEMs for properties. This is because they are approved for all situations and this is generally accepted without question by building control, specifiers etc. These give a false sense of security as the system / material is pre-approved.

The industry needs to stop and think here, if it wants to use simple measures off the shelf then they need to be focused on the 'lowest common denominator' principle rather than 'typical / standardised / hypothetical' scenario.

These types of systems often stem from the use of Part C and resistance to moisture arguments. So EWI and IWI systems like EPS and mineral wool are approved because they have water resistant coverings. The belief that you can keep rainwater out of a building permanently just by having waterproof coatings has been disproved repeatedly, yet the idea that it's possible persists. This is due to following 'perfect' drawings that don't have the issues / faults / mess that exist in the real world.

It would be great to have ‘approved systems’, BUT they need to be driven by experience in the real world, combined with better understanding of traditional buildings. This then would create a series of EEM interventions that are based on the lowest common denominator and hence would automatically manage the risks associated with the work.

The 4 ‘C’s

This concept is well known to Retrofit Co-ordinators and stems from a BSI publication called *Moisture in buildings: an integrated approach to risk assessment and guidance*. See: https://sdfoundation.org.uk/downloads/BSI-White-Paper-Moisture-In-Buildings.PDF. In this publication that came out in 2017 the authors produced a key principle called the 4 ‘C’s. The 4 ‘C’s are:

- Context
- Coherence
- Capacity
- Caution

In brief the principles are:

- Understand the context of the building and the building project and ensure compatibility of the design with this context
- Ensure coherence in approach and detailing.
- Build in capacity in the design and construction phase for mistakes, uncertainties and future challenges.
- Ensure that caution is taken in the use, maintenance and after care phase where there are ongoing requirements of care and uncertainty of outcomes.

The 4 ‘C’s are interpreted here as:

- Building pathology – understanding the buildings history and its part in the built and natural environment. (The past, how the building got here and what surrounds it)
- The plan for making the building more ‘energy efficient’ and the management of

risk associated with these changes. (The details of the here and now, and how we get safely to a better place)

- The physical changes in our climate that are expected and the ability of the building to cope with this. (The future climate)
- The maintenance requirements of the building in the future and how to ensure that it is easy to keep in good condition. (The future viability of the building)
-

If we are to have risk managed retrofits as per the PAS's we also need to address the future as well as the past and the here and now. The industry is currently struggling just with the first two. We are frantically training people to understand building pathology and physics so that we can create the correct designs to the existing building (The Context and the Coherence) but few are spending time addressing Capacity and Caution.

Some projects are starting to address Capacity in terms of installing over-sized rainwater goods as standard practice, but few are addressing the risks of overheating or flood risk.

The 'Caution'ary approach requires the industry to think about items like pre-installing ducting for future heat pump installations or thinking about repairs / damage to EWI, any fitting issues associated with changing windows and doors (given their lower life expectancy compared to that of the EWI), access to services that might be buried under insulation, etc.

The 'Caution'ary approach also implies that it is advisory to allow the building to 'talk to us' in an open and honest way so that if anything fails that this is visible to the owners rather than being hidden behind layers of finishes. This can be vital when we start to think about moisture. Within many modern retrofit solutions, we create layers of waterproofing membranes / finishes that effectively hide the problems away – this is in fact symptomatic of the industries' approach to moisture for years – drylining being the most obvious example. Hiding problems just causes more problems in the future and there is an implied desire within PAS to keep buildings honest so that risk can be managed. Surely, it is better to know that there is a problem that needs solving, rather than cover it over and ignore it until the catastrophic failure occurs. This will naturally bring higher costs, more disruption, additional carbon emissions etc.

This is important given that many organisations are viewing current retrofit practices as a long-term solution that won't require any maintenance soon. Retrofit is quickly becoming a fit and forget practice as we are consumed by the over-bearing figures of properties that 'require' retrofitting. The focus is on getting work done and then moving onto the next rather than reviewing work and ensuring that the investments made will stand the test of time.

The ethos of fit and forget is also prevalent in the services that are involved in modern retrofit practices. Large, expensive items like heat pumps are often installed, not commissioned properly, and then expected to provide the savings (either in carbon or cost) that the SAP spreadsheet predicted. Of course, without correct specification, installation, commissioning and maintenance, any piece of equipment can go wrong. Putting things right, if they do fail, can be expensive business. Also trying to find people to service and undertake repairs can be difficult and expensive. These factors do not tend to be in the forefront of designers / specifiers minds. It is all too easy to focus on the predicted benefits and savings that technology and equipment can, in theory, deliver.

This section shows that there are many factors / guidance / regulations that impact on retrofit and how it might be conducted. Making sense of all of this and keeping it simple can, therefore, be a bit of a task! This is why there is a need to take the lessons from the past, review what has worked and what hasn't and then precis all of this down for the industry to have a simple set of EEMs, materials, techniques, technology that is low risk, simple to install, use and maintain. Only then can we really start to raise the pace of change and start to move forward with any confidence in the mass retrofit of housing in the UK.

Things that stand in the way

The conservative industry

The construction industry is notoriously conservative in its approach. Doing things the same way as it always has, especially when looking at the RMI market. Fathers hand done skills and knowledge so their children, the supply industry caters for the majority rather than the ‘specialist’, and construction training focuses on new build and the skills associated with that.

However, where things can be made, cheaper, quicker and easier, the industry tends to adopt these products readily. Multi-foil insulation and foiled backed insulation boards, for example, are widely used. These are quick and easy products to install and so they get used everywhere, including in many wrong places.

Any KISS based solutions therefore must mirror this and be quick, easy and ideally cheaper to install.

Commercial interests

No doubt it is in the interests of any industry to provide cheap goods that are designed to fail. KISS is the absolute opposite of this in terms of longevity and hence quality and costs. However, to maintain such EEMs, there is a need for maintenance tools, equipment and products. A slow re-focusing on maintenance should placate the move to more permanent solutions.

Government policy and its infatuation with climate change

This is a huge obstacle as the Government has signed up to large-scale reductions in CO2 emissions in the fight against climate change. The metrics are such that they focus on arbitrary targets using poorly designed metrics that do not consider the CO2 bubble that is created by retrofit. They only look at in-use carbon. This is a huge issue but also one that is quite convenient for the industry / Government. If it only focuses on the CO2 post retrofit, rather than the whole process of retrofit then it can pat itself on

the back and think that it has done a good job, even if getting there makes the situation worse and this is then compounded by having to do it all again in a couple of decades.

There must be a step change in the understanding of CO2 emissions from each sector, and this means taking the entire process into account.

The Green lobby

Holding the Government to account and ensuring it's on track to keep its commitments is the green lobby. However, these groups are not retrofit specialists. They do not understand the practical issues nor generally the wider embodied carbon issue. The field is dominated by fuel poverty and environmental groups that are looking at headline figures generated by the Government and these are fundamentally based on flawed metrics like EPCs.

Groups are pressing to increase the rate of progress towards EPC C ratings etc, without understanding the wider risks and consequences of this drive.
We must educate these pressure groups to understand the ramifications of getting things wrong and the hidden CO2 associated with the process.

Boys' Toys

The industry has always loved 'boys' toys' and retrofit is no different. We wax lyrical about technological innovations and seem to see them as the panacea for retrofit in the future. Some new high-end technology will suddenly provide a one size fits all solution. It is doubtful whether this will ever happen and certainly there will be unintended consequences, including inertia and kicking the ball down the road in terms of the application of tried and tested solutions.

With the 'boys toys' approach holding a series of unknown implications, most of which will be based around increased cost, complexity and ineffectiveness, due to skills / installation / design issues, there is an argument for an innovative approach to retrofit. One that is based around simplicity, applicability and low risk. Therefore, the KISS solutions should be dressed up as the latest thing so that decision makers are

encouraged to adopt it.

Costs

Doing things right can cost more, so it is important that this is addressed head on. New materials and ways of doing things do not necessarily have to be more expensive, indeed if they are much more expensive, they will not be adopted.

This can be countered by employing different financial incentives, company models etc.

Mortgage and home insurance companies should be engaged to promote the use of permanent, honest and low carbon solutions for properties so that the owners (owner occupiers, social landlords and private landlords) can choose the right solutions over the cheaper but flawed alternatives. This type of system already exists where Governments insist on the use of PAS2035 for funded projects. Other schemes like Green Homes Wales can lead the way too.

House vs Home

There is reluctance to spend money on property when it is a stepping stone property where people are planning on only spending a couple of years before ‘upgrading’. There is a belief that cosmetically improving a property will increase its value, so there is a natural incentive to cover over issues, hide faults and generally ‘pull the wool over the eyes’ of the next purchaser.

This trend is difficult to break unless there are informed buyers in the market. Education is therefore an essential element of the KISS approach as buyers need to be aware of issues like dry-lining, the smell of fresh paint, the existence of injected damp proof courses, the orientation of the building and any faults in the outer walls etc. If we can drive down offers for buildings that have obviously been beautified for sale rather than being honest then maybe the practice will slowly die out.

The KISS Approach

Keep It Simple Stupid (KISS) Retrofit is all about taking the risk out of retrofit so that a palette of achievable measures can be created that apply to all properties. The desire to have a small palette to work from is that it keeps skills training simple and allows for companies to provide a high quality / interchangeable set of services that can be rolled out at scale across the whole of the UK.

The vision to have a palette of measures for all housing is based around the fact that at present there are wide range of factors that mean that we need bespoke solutions to all properties. This slows down installation and adds to the costs of design and installation when there are various nuances that can mean the difference between success and failure.

The rationale that underpins this approach is that of ‘lowest common denominator’ and is a key principle that underpin the KISS retrofit approach.

Lowest common denominator

The risks associated with older solid walls are seen as being greater than those associated with cavity walled structures*. However, if one has a single zone of solid wall within the property then applying a single solution that is designed for moisture closed walls is higher risk. It appears to good practice to design for and install retrofit systems that are appropriate for the riskiest element of the structure. In the case of walls, KISS would recommend that any traditionally built structure should form the basis of any decision making for the rest of the property.

Housing pathology tells us that houses are not static entities. Buildings are constantly changing in terms of design, materials, layouts, decoration, occupation etc. A house built in 1880’s will probably have been extended over time, using varied materials, different wall and roof types, kitchens will have been introduced, bathrooms moved into the property, electrics installed, re-rendered, knocked through etc. So, if it is decided to take a single approach to fabric improvements then it is vital that the most ‘delicate’ / highest risk areas are catered for. If this then means that more modern

areas of the property are slightly less efficient that would be possible to use other materials, then this is the price for keeping it simple and just using one material solution. For example, putting EPS insulation over a solid wall and a cavity wall will have a higher risk than using an insulating lime render over the whole structure. Swapping between materials so that each section of wall / roof / floor is 'optimised' in terms of thermal performance, just increases the risks associated with jointing, thermal expansion co-efficient of materials, …. KISS would say, just use the 'safe' material and if this delivers 5% less efficiency overall then so be it. The savings would still be significant (say 70-80% savings) and so the risk of additional expense later by having to deal with failures of joints etc would far outweigh the additional 5% a year savings, given that this will be the difference between say 70-75% reduction in heat loss through the building fabric.

KISS also recognises that many properties that the industry regards as being simple (e.g. cavity walled properties) are far from it. Many cavities (up until 1970's/ 80's) would be created using brick or block closers in cavity wall construction. This effectively creates solid walled properties at the openings. Openings are one of the riskier areas of retrofit specification. They are both an edge and a junction in materials. These are high risk areas. With the walls being solid at this point, it suggests that we should indeed treat them as solid walls. With the material used being a brick or a block, this then creates a 'breathable' solid wall at this point. Some openings will have physical DPCs built into them, but many will not and hence the risk increases. So, if we have a breathable solid wall then we should be looking to use appropriately breathable materials for the insulation layer. This is, of course, not done by the industry.

System built properties are a case in their own right as there are numerous variations on a theme regarding the condition issues that they face. However, they do require specialist attention, but the idea behind lowest common denominator can equally be applied to them.

We need to be able to solve underpinning faults, but if we cannot see them then the issues can become chronic and ultimately acute.

Single palette of measures

PAS2035 correctly reminds us that all buildings are different, even those in a terrace or estate. Time, fashion and enhanced expectations have meant that each house has been subjected to a range of modifications. Understanding how these changes have affected the building dynamics is key to lowering risk. Some of these changes are fundamental, others more seemingly cosmetic.

Older solid walled buildings have been subjected to more change, partially due to time, but also significant changes in lifestyles and expectations. Gone are the external privies, the coal fires, the sash windows etc. and in there are showers, central heating and uPVC double glazed windows and doors. This has had a fundamental impact on the moisture and thermal performance and pressures on the building fabric.

The public demand that buildings adapt to the new demands of modern living. We want all buildings to provide us with the basics (shelter, warmth and security) but we also want the bells of whistles of technology with plenty of plug sockets, heat pumps, electric car chargers, the internet of things etc.

So, any retrofits need to be capable of coping with the provision of modern technology. This includes the simple issue of installing heat pumps. This might appear to be obvious, but so many retrofits are made with EWI / IWI that carries a 25-year warranty. Interfere with any of the systems (like drilling a hole through it to connect your heat pump) and your warranty is invalidated. The same issue applies to IWI where many systems rely on VCL and various other membranes. Puncture through these and it can cause no end of moisture and airtightness related issues.

Do contractors know about how to re-seal hidden membranes, how it is checked, enforced etc when the puncture point will be concealed from view?

Modern materials too have changed the fabric’s ability to work as originally built. Moisture movement is compromised by using cement renders, gypsum plasters, replacement concrete floors, etc and so there is a fundamental choice between working with what is currently there or changing it back to its original functionality. Sometimes the changeover to ‘moisture closed’ systems works and there are no damp

or mould issues, but many problems concerned with water are chronic and so there is no guarantee that a system that appears dry and healthy now will last into the future. This is a risk issue. Sometimes it is better to leave things alone when then are working and sometimes it is better to reset the building back to its original state. This is a difficult and vital call for retrofit co-ordinators and designers to make.

The lowest risk would appear to be re-instating the original functionality and using compatible materials to improve this base fabric. Using more modern materials (like EPS) over the top of cement rendered traditional houses is certainly cheaper in the short term but may prove to be more expensive both in terms of money, resources, carbon and time in the long run.

One of the major considerations when specifying materials and systems for retrofit is that of building pathology. Buildings have changed over time. This applies not only to materials, functionality etc, as stated above, but also extensions to properties. An 1890's terrace house, may well have a 1960's double height extension with 2000's single storey extension. The combinations are endless. The key problems are walls and floors.

KISS and building elements

Walls:

Intro:

Past extensions and the resulting impact on building pathology means there are potentially several distinct types of walls in a single dwelling. In the case above this would mean solid walls to the original, uninsulated cavities to the first extension and then insulated cavities to the latter one.

According to PAS these different building elements should / could have different interventions. A moisture open solution to the original building, a cavity wall insulation with EWI for the 1960's and EWI for the 2000's (or even no EWI at all depending on the U value of the wall). A particular property might be suitable for installing all these different solutions, but care needs to be taken between the interfaces of each. With large scale retrofit we need to have simple solutions that can be applied to all ages and types of a building's elements.

KISS retrofit's basic additional principles for walls:

Sacrificial materials and layers

Walls are commonly made up of different layers of material. Solid walls especially have traditionally been covered with renders, these may have been applied to the windward walls only to give the added protection required against the wind driven rain, or over the whole of the property. Modern walls also use render either to protect more porous blockwork or to cover external insulation or for aesthetic purposes.

The idea of sacrificial layering is to have different, less 'valuable' materials / structures that take the brunt of the weather to protect the more valuable main wall structure. In solid walls this translates into the main wall, made of bricks, stones etc, being

protected by a ‘weaker’ render layer which in turn is protected by an even weaker finish / coating. This requires that each layer can be repaired / removed as needed to maintain this protective system. With each layer being cheaper to replace than the one below it creates a system whereby if the upper coat is maintained then it protects the layer below and so on. So, with regular and routine maintenance it should be possible for a wall to remain in excellent condition for decades / centuries. This approach is supported by Historic England advice (see https://historicengland.org.uk/advice/technical-advice/flooding-and-historic-buildings/repair-and-emergency-works/repair/)

On traditional walls this would involve having the stone / brick wall protected by a lime-based render and then this in turn protected by a limewash. If the limewash is not replenished, then the render will slowly start to degrade until eventually the main wall is exposed to the elements and this then will suffer at the hands of the weather. The principle being that if the limewash is ‘topped up’ as required then this protects the render and this in turn protects the main wall. Limewash will chemically dissolve over time due to its alkaline nature compared to the acidic nature of rain, so replacement will naturally have to take place. However, solid walls should only require minimal effort and costs to remain in good condition when using this type of system.

With limewash being cheap the longevity of walls should be very cost effective in terms of retrofit if the right materials are used.

Many renders are seen as being water proofing layers, so this is interpreted by the mainstream industry as needing to be watertight. This brings us onto the next principle.

Gradations in porosity

Solid and cavity walls need to be more porous on the external face. Cavity walls were designed so that the external leaf could get wet, but any water that penetrated through the half brick thick wall would then run down the inside of the cavity and into the ground. Solid walls too were more porous to the outside when originally built. Mortar (either via pointing or render) was lime based and more porous than the stone / brick

that it sat next to. This meant that water passed more easily through the mortar / render thus keeping the more costly bricks and stone drier, thus reducing risk of failure via spalling / weathering / cavity wall tie failure.

Filling cavity walls becomes less risky when the external is rendered with a moisture open material. This is because when using CWI, the wall effectively becomes a solid wall, but the moisture is principally focused on the outer leaf, which is where it is easier to manage. If the cavity gets wet then there is no ventilation to dry it, so it becomes more important to draw the water out of the 100mm outer brick so that the cavity remains dry and the wall ties too.

Part C of the building regulations, and a whole host of other reasons, meant that we are replacing this system of more porous top layers with less porous ones as we strive towards ‘water tightness’ in the walls. This, as many have discovered to their cost, is not the best solution. Watertight walls made of brittle cement render especially those with added water proofing agents often trap water within the walls rather than keeping it out. This is down to the fact that water has a knack of getting into structures whatever you do – via failed window seals, poor installation of renders, poor mixes, thermal movement cracks, ….

Having a system that is progressively more porous from the main wall structure to the outside facilitates drying of the wall, thus ‘perversely’, or at least ‘non intuitively’ the more porous the external finishes the drier the wall in terms of the ‘long-run’.

Porosity of renders and mortars is a nonlinear issue as porosity can be measured in several ways. The construction industry only looks at vapour resistance. This of course is a major problem as most moisture affecting buildings comes in liquid form. Rain is much more of a risk in terms of volumes of water than condensation. However, there is no measure for how materials cope with liquid water. How they cope is an interesting question, do they use capillary action, diffusion or chemical / physical resistance? What levels of liquid moisture can they hold, how quickly is it transferred through the material, how is this affected by wind, sun, temperature and pressure differentials etc? None of these key issues is measured or covered by the construction industry. However, the issue of wind driven rain is well known and there is an underpinning thought that the higher the index the more watertight a structure should be. However,

with the principle of higher porosity to the outer elements of a wall then the higher the WDR index then the protective finish should be more porous.

The principle underpinning the requirement for higher porosity is this: when the most exposed finish is saturated then it will shed water as it cannot hold any more. The layers below will take on some of this water as they too are porous, but they do have greater resistance, so the outer finish is encouraged to allow the water to run down the surface to the ground and away. In practical terms this translates to limewash being the outer surface that gets saturated first because of its thin nature.

The next layer in order of both sacrificial layers and porosity is that of a lime render. Here it is important to make the render porous and to use diffusion to be able to spread the water out so that it can dry easily when the rain stops and the wind and sun creates evaporation within the structure and on the surface. The key factor here is then the aggregate that provides ¾ of the mass of the render. Conventionally the industry uses sand, but this is not, in itself, porous. Moisture must travel around the sand particles as it cannot flow through them. This creates capillary flow in the material rather than diffusion. Diffusion can only occur where the whole of the render material is porous and to a similar degree. Thus, the use of a limestone rich aggregate is much more appropriate for a lime render. This matching of materials within the main render structure allows it to work as one rather than in a conflicting manner.

This thicker render layer then works in partnership with the limewash finish (which has cured into being a thin layer of limestone) to keep the main wall dry.

The main wall is then a variety of material (brick, stone etc) that is more resistant to moisture, so any liquid moisture is encouraged to remain in the outer layers of the wall. Lime and limestone are happy to be wet and to dry and hence provide a long-term protective layer for the main wall. The key, as stated above, is to maintain the initial outer protective layer of limewash to the walls.

Maintenance of limewash on older walls has conventionally been seen as a major issue as limewash is predicted, by the mainstream industry, to require re-painting every few years. However, this is because it has been twinned with sand-based mortars rather than limestone-based ones. With moisture being concentrated in the

lime of the render it places more pressure on the limewash and there is poorer adhesion to sand than there is to limestone. So, by changing the render mix away from sand to a higher proportion of limestone in the aggregate the limewash will adhere better, work in partnership with the limestone in the render and hence last longer. A limewash finish on a limestone-based render would be expected to last around 10-15 between coats. This puts it on a par with modern paints, but it is a lot cheaper.

Wall honesty

As mentioned in the three ‘C’s element of Caution, the honesty of walls is important as it allows us to diagnose and manage walls in the longer term. If it possible to read the functionality and health of a wall by easy observation, then any issues can be identified and rectified quickly and easily. In the past we have covered over problems with easy to apply ‘solutions’ like dry lining. This hides the wall away from view and will facilitate an ‘easy fix’ in terms of making over the problem, but it, of course, does not solve the underpinning fault. Using wet render and plaster systems that are applied ‘on the hard’ creates a continual path for moisture and links the fortunes of each material in the wall structure together, so that if one wall element is suffering then it shows through to one of the elevations internal or external).

This is especially true when looking at external retrofit measures like EWI. EWI must take the brunt of the weather – wind driven rain, frost and thermal expansion issues. The way that solid walls perform is so radically different from modern cavity walls in terms of their moisture and thermal characteristics that expecting the more modern materials, like cement, to be dependable in the long term is not sensible in terms of risk. Materials that are moisture closed and hence likely to lock water in behind them if there is some sort of surface failure, should not be used over the top of moisture open materials. The BSI White Paper of Moisture from 2017 was quite clear that moisture open materials should be used when working on moisture open structures. PAS2035 and PAS2038 are also clear in terms of maintaining a hygrothermal balance within walls and other building elements.

EWI systems on cavity walls might seem to be sensible as they are ‘moisture closed’ (note that many walls are solid at the openings). However, by covering over the wall you are also covering any signs that might appear linked to wall tie failure. If the walls

are damp / get wet then the wall ties are likely to fail, but if you cannot see the linear cracking then this potentially grave issue will go un-noticed. Using a lime render therefore keeps the wall both dry and visible.

Wall systems must be robust enough against accident damage and / or at least be easily repaired if damage does occur. Board based solutions use standard renders like cement and silicon, but these are brittle especially when set over the softer insulation layer. This leaves them at the mercy of puncture and compression-based incidents – like footballs, cricket balls, bikes etc. Repairing damaged sections is also difficult as it requires cutting out sections, adhering them back on, taping them and then re-applying render and finishes. Getting a good finish on this type of repair is difficult. The longer terms risks therefore of damage, poor repairs, or lack thereof mean that board-based solutions may be higher.

Moisture open materials can sit over the top of most materials and so their use continuing over from any moisture open traditionally built walls over to conventionally built cavities holds negligible risk.

The main argument for using higher performing board-based materials is that they return ‘better’ in-use energy savings. This appears, of course, a major plus point to them. The ‘war’ on climate change does seem to imply that we should always reach for a more ‘efficient solution’. This doctrine is slowly being challenged in terms of overall benefits. There are a wide number of factors including issues of cost, embodied carbon, performance gaps etc, however one of the most powerful has recently come from the DEEP project. This Leeds Beckett University led research project, which was funded by UK Government, is pointing towards other factors like target U values.

However, with moisture open wet render systems being able to deliver the safe levels identified in the research (U of around 0.8 which closely matches the ‘threshold value’ in the building regulations of 0.7) it appears as though the lower risk, approach of wet render systems is appropriate for addressing climate change safely.

The higher U value of the Leeds Beckett research is associated with the issue of thermal bridging that occurs in retrofit, so again wet render should be better at removing these risks as it can go around corners and into reveals more readily than

boards. The issues around eaves and verges can also be addressed more easily as there a natural ability to ‘feather in’ render to different depths as the situation allows. So, where space is tight due to roof lines, lack of soffits etc then there is a way of reducing the thickness of the render and hence decreasing its insulating capacity so that it still provides some protection and thermal improvement, but without the added costs associated with extending rooflines, reducing window sizes, replacement windows etc. This ability to removed large ‘enabling costs’ for retrofit is a major benefit. Verge detailing especially may only marginally compromise thermal performance due to a small requirement to feather any render out by 20-30mm over the distance between the roof line and the internal ceiling line.

* Many earlier cavity walls used bricks and blocks to form openings (windows and doors). This forms a solid wall at an intersection of the dwelling / building. PAS tells us that we need to be very careful at these corners, junctions and edges (see 5.6 Concentrate on the interfaces), so if we have a solid wall that is potentially moisture open at the openings the idea of reducing risk should mean that moisture open solutions are applicable here too. Given that EWI and IWI systems also create corners, junctions and edges at this very point (thus making it the highest risk area) that real care is taken to minimise the risk. This may involve using varied materials and non-board-based insulation (as it is the very nature of boards that they require sealing, accurate jointing and are weakest at these corners).

KISS and wall trades

The focus of KISS is of course on simplicity, but this should not be confused with ease. Most the issues addressed above appear to be simple, but this can only be achieved if there is a workforce capable of delivering them.

Most works described in the sections above are core skills of the existing construction industry but just done differently. This is best described and illustrated by looking at wet render and plaster systems for walls.

The existing industry trains people to plaster and render on the hard (i.e. against the main walls as compared to just applying finishing plaster to boards), therefore the skills

are there within the mainstream colleges and industry, just that most jobs currently are completed using thin coats on board-based systems rather than thicker layers of plaster/ render.

Insulating plasters and renders are of course lightweight by their very nature. They rely on aggregates that trap air inside them and hence they are naturally different to apply as they don't have the mass that drags them down. Applying thicker coats is therefore easier than it might at first appear to someone who is used to sand based renders and gypsum plasters. Experience has shown that experienced plasterers and renderers have no problem in applying these unconventional materials as the processes that surround them are well known to them – mixing, dampening walls, levelling etc. The differences experienced are therefore quite minimal. However, there is one issue that needs to be explored in more detail for external work and that is application.

Pumping / harling application

Harling is the traditional style of application for renders, but this has been forgotten in the modern marketplace. Most smaller jobs now will be trowelled on whilst larger works may well use a pump, and it is from this that we need to take some lessons. The fundamental reason for this is adhesion. Many rendering jobs fail due to poor mixes and poor application – walls not dampened enough, or too much for example. Another key factor is how well adhered to the wall the material is when it is applied, imagine a snowball: If you smear a snowball onto a wall, it might stick or it might fall off straight away, but if you throw a snowball at a wall then it may well be there for weeks.

This idea of throwing is of course illustrated by the old technique of harling. Harling was developed by industry over centuries, and it is an important skill to be resurrected, albeit in a modern way. This is where learning from the larger scale pumping of renders is important. Pumping insulating renders onto walls will help with adhesion thus allowing for thicker layers to be applied in one sweep.

There are other little key areas that also need to be addressed that are not skill based, but are nevertheless important for a successful outcome of application, these include:

Not creating joints at corners.

We tend to visualize applying renders to a wall rather than a whole house, this leads us to stop at ends of walls, corners etc. Here we might also install a bead to create a straight edge etc., but corners and edges are the riskier places on a wall. Winds travel faster around corners and hence they are colder and more at risk from frost damage etc. Also, if we put a joint in at the edge / corner we are more likely to get water ingress here and this then makes the detail even riskier in the long term. So, it is an easy fix to get into the habit of not stopping at a corner or edge, rather go around it with the same layer of material so that it creates a consistent, continuous structure that is free from any break.

This might encourage the creation of smoother rounded edges and corners rather than the sharp edges that we currently see in buildings. This changes the aesthetics a little of properties, but the gains in removing junctions and corners are important to achieve, as per PAS2035:2023 Section 5.6.

Use appropriate materials including fixings.

When using lime-based materials on walls it is important to remember that steel will rust unless it is deeply embedded into the mix. Using zinc covered steel is not sufficient for a long-term solution. Zinc is easier scratched off during rendering and the use of zinc nails is destined to fail as their very application will remove their protective coating. So, alternatives are required where beads or other support structures are required for the successful application of a rendering system. It is suggested that stainless steel or plastic beads are more appropriate, but these need to be installed using stainless steel or plastic fixings.

Ideally beads are not used for applications as there is probably no need for them given that the render will be applied around and over corners rather than using a bead to create a corner. It is important that PAS2035 guidance is followed as much as possible to remove corner and junction risks, after all this was the basis of the choice of an insulating render over boards in the first place.

Rendering is an area where the industry has competence and a supply of skilled labour, but there is a need for ‘upskilling’ in terms of application requirements of unconventional

products. This is probably best addressed by the industry using manufacturers and suppliers to provide onsite training for tradespeople to become ‘registered installers’ of their systems / products. This is a common technique used cross industry to build their trade base of qualified installers.

KISS recommendations for wall insulation

Solid walls

- Use an insulating lime render for EWI
- Use an insulating lime plaster for IWI

Cavity walls

- Use bonded bead CWI in combination with an insulating lime render
- Use IWI with no cavity wall insulation

System solid walls

- Use an insulating lime render for EWI

Floors

Floors can be one of the most difficult and disruptive elements of a building to retrofit. Solid floors are addressed when the property is empty, this is due to the amount of material required to be moved and replaced as part of the process. Suspended wooden floors can be thermally improved more easily but there are health and safety issues associated with any work to a floor. The two main floor types require different approaches, but understanding the base pathology of the building is important as the starting point.

When and how solid floors were constructed is important to ascertain and assess. This is because many replacement concrete floors were done when there was scant regard for the holistic operation of houses. The main factors that were ignored when concrete floors are introduced into existing houses were: ventilation and damp.

Replacement concrete floors in individual rooms can easily cut off ventilation paths for the other suspended floors in the property. Very few new concrete floors were poured with integral ventilation routes (via ducting) to serve the remaining suspended floors. This has meant that many houses have suspended wooden floors to one room, but no cross ventilation to serve them. This in turn creates a much higher risk of floor failure due to damp and rot within the joists. So, an assessment of the ventilation paths (or lack of) is important to ascertain when planning floor improvements. Remedial works should be undertaken as part of any new retrofit works to re-instate missing or degraded factors like ventilation.

Replacement concrete floors are installed using large sheets of damp proof membranes laid into the floor space and then filled with concrete. The DPM was very rarely tied into any existing or new DPC, they were typically just loosely laid up against the internal and external walls and cut at ground level once the floor had been laid. This meant that any moisture under the floor can no longer travel up through the main body of the floor area, instead any moisture is transferred to the edges of the walls. This commonly bypasses any DPC in the internal wall structure and may also do the same in the main walls. This issue is compounded where DPCs are missing in buildings. It should be noted that DPCs should be in all houses after 1875, so those built prior to this and those that were just not built to up to the appropriate requirements may well suffer more from not having a DPC to protect the walls from this new ground moisture being transferred into them.

Replacement concrete floors are often associated with this type of rising damp. Curing this is difficult. DPCs can be injected or laid into the walls if they are brick, but stone walls are notorious to 'damp proof' effectively. Brick walls are also likely to require stripping of plaster and re-plastering if using a damp proof injection. A physical DPC is the best solution, but this is more complex, costly and disruptive.

Suspended wooden floors

Suspended wooden floors can be easy to insulate, but each one needs to be assessed and retrofitted individually. Careful attention should be given to ventilation and its adequacy. Older properties often have one or two vents to the front of the property and then one to the rear, but this would not meet current building standards. It is important to introduce higher levels of ventilation if possible and try to meet current regulations. Making sure that ventilation routes are clear is also important. Often sleeper walls have been blocked by debris or occasionally replaced with solid walls when internal work has been undertaken in the past. Honeycomb sleeper walls allow for air to circulate across the whole of the width of the room rather than relying on single ventilation points. This is important to maintain as 'stagnant' air pockets should be avoided, and these can be created by poor airflow.

It is also important to remember that an insulated floor will lose airspace under it, so some thought needs to be taken to ensure that sufficient space is allowed for airflow.
If a suspended floor's ventilation is blocked due to an adjoining solid floor or similar it is important to re-introduce the airflow / circulation. This may be done in a variety of ways – new ducting through the solid floor or via pumped ventilation. This is a site-specific decision, but the key is to ensure that the underfloor space is sufficiently vented to reduce the risk associated with damp and rot.

The joists of the floor also require close inspection to make sure that they are in good condition. Any rot or decay will need to be treated and ideally any joists that are embedded into the walls are decoupled from them. This can be done by using stainless steel hangers and fixings, sleeper walls etc.

Once the floor has been hard wired for ventilation and moisture management requirements then it can be retrofitted with insulation. There are various guides for this,

but it is suggested that as a rule wood fibre insulation is used for any areas that are not in contact with external walls. This is because wood fibre and wood have similar moisture characteristics and hence any moisture will be equally spread throughout the structure. Insulation that touches potentially damp external walls will need to be rot and waterproof. The insulation at the edges of the floor is important as this is where most heat is lost.

With the structure being well vented from underneath it is important that the floor is draught proof. The use of membranes / draught proofing or board-based materials to prevent thermal bypass is therefore important. This is especially true around the perimeter of the floor. Careful choices are required to ensure that a draught proof solution is created around the edge of the floor. The use of long-life tapes is recommended as once the floor has been finished it is unlikely to be accessed and maintained on a regular basis.

Solid floors

Solid floors in principle can be insulated from above or below. Of course, insulating from below requires the whole floor to be removed and re-laid. If undertaking this it may be important to ensure that the replacement structure is vapour permeable. A vapour permeable floor should be used where there is risk associated with damp floors and where the re-instatement of a suspended floor is not an option.

Vapour permeable flooring has been associated with a limecrete floor, however the issue around how to facilitate vapour permeable only flooring is open to debate.

Insulating above the floor can be complicated in terms of access and design. Raising the floor height has implications for stairwells, window and door heights, fixtures and fittings etc. So, it is important that any intervention is carefully thought through and any design / access issues are addressed at the concept stage.

The compressive strength of any solution is also important. Floors need to be stable and take a lot of weight, sometimes this weight can be very focused and hence a high compressive strength is necessary to avoid damage / contortion.

Generally keeping the depth of the insulation as low as possible is recommended. Therefore, using products like aerogels in association with rigid flooring boards is seen as the predominate way forward, although using rigid phenolic boards will also provide a satisfactory level of insulation for their thickness.

KISS recommendations for floor insulation

Suspended wooden floors

- Breathable mineral insulation around perimeter
- Breathable natural insulation materials between joists

Suspended non-timber floors

- Non-biodegradable insulation

Solid floors

- Breathable insulated limecrete floor if replacing suspended wooden floors
- Aerogel or phenolic insulation if above non-breathable floor

Loft

Intro:

There is no special requirement for ‘alternative’ solutions for insulating loft spaces. The installation of insulation on joists is standard and has no need for anything out of the ordinary per se. There are natural insulation options that perform in similar ways to standard mineral wool, glass fibre style insulations. Hemp, flax and sheep’s wool etc. have lower embodied energy associated with them, but they do tend to be more costly.

Standard practice and consequences:

There are of course issues that need to be emphasised in terms of best practice like, eaves vents, correct loft ventilation rates, use of downlighting protectors, draught proofing around loft hatches etc, but these are already ‘requirements’ / best practice.

Modern insulation boards used in rafters are more complex as they start to rely on airtight membranes and correct ventilation. The attachment of membranes is particularly worrisome as tapes need to be capable of providing airtightness between very different types of materials like bricks, blocks, rough cut sawn timbers, etc. This may well require doing additional work that will add to the costs of any work. Creating surfaces against which tapes can stand a chance of long-term effectiveness is an issue. There are materials out there that are quick drying and create suitable surfaces for tapes, but they are not widely used.

All boards also need to be taped together to ensure that thermal bypass does not occur. This is becoming more customary practice but still seems to be done at the behest of informed customers or quality installers.

These factors are also affected by others like purge ventilation. So, there is an overall advantage in having good cross flow purge ventilation combined with high decrement value insulation, especially on any south or west facing roof structure.

KISS recommendations for loft insulation

The only other factor where there is little knowledge that could improve the overall success of a retrofit is that of ‘decrement values’ in insulation materials / systems. Effectively these are thermal mass in insulation. The main objective here is to both slow heat transference but also to have some heat absorption too. Higher levels of heat absorption in higher density materials lie wood fibre boards means that peak heat in the day is reduced as the materials are lowering heat in two ways, their thermal conductivity and their thermal absorption. This has the effect of lowering the overall temperature in these roof structures, but also by increasing the relative heat in the night. This can work two ways in terms of real life, having a cooler space during the day can be useful when using the space for working, but having a warmer space at night might not suit sleeping preferences.

At joist level

- Natural insulations

Rafter level

- Woodfibre insulation

Doors and windows

Intro:

There is little to distinguish between recognised best practice and KISS retrofit in terms of the replacement of doors and windows. However, it is important to be sensitive to the aesthetics and history of existing units both within the building and its' immediate built environment / street scene. Windows especially represent the 'eyes' of the building and it can make a fundamental change in the look and feel of the property if inappropriate windows are installed.

There is a fundamental choice between installing new windows and doors and repairing the existing ones. There is good advice on windows that can be found at Historic England: https://historicengland.org.uk/images-books/publications/traditional-windows-care-repair-upgrading/heag039-traditional-windows-revfeb17/ although this is being revised as of August 2026.

Repairing single glazed windows and doors is a lower embodied carbon choice, but within a lifetime of a unit, having a double glazed may repay its' embodied carbon with in-use carbon savings. The payback period in terms of carbon is c. 20 years, but in terms of financial payback the figure tends to be closer to 60-100 years. Given that PVCu framed windows are estimated to last for 20 years both the carbon and costs seem to indicate that replacing windows is not viable. So, windows are replaced for other reasons, notably: fashion, window salespeople, public perception that it is a carbon and cost saving measure, but also typically due to a lack of maintenance – worn hardware, blown double glazed units.

With buildings being a heterogeneous blend of materials and ages, it is very common to have a mix of windows in a property. Some might be single glazed, others wooden, some fitted from the outside, others from the inside. It is vital therefore that experienced, competent and qualified window installers are employed. It is also important that the same people are used to both measure and install the windows and doors. Measurements may vary depending on how the element is to be fixed.

Doors and windows may also be installed alongside other EEM, for example EWI. This might involve moving the position of the window in the wall into the insulation layer. It is essential that these types of decisions are made early on so that the appropriate type of window, fixing and measurements can be determined.

Windows are also used to provide most background ventilation in the property via the use of trickle vents. Depending on the ventilation strategy to be employed in the building this might change the specification of the windows. This is important to be specific about as each window might have a different requirement. For example, having a constant ventilation system requires that only habitable rooms have trickle vents, so there will be a blend of specifications for the manufacturer, and they are not used to this. Each job in the past tends to be all trickle vents or none, so having individual windows requiring different solutions needs to be managed carefully.

Ventilation systems could also involve the specification of non-standard vents. For example, having a Demand Controlled Ventilation system requires that specialist trickle vents that are ‘paired’ with the extractors are installed. So, this may mean that the manufacturer of the window must work with new ventilation companies to get the right trickle ventilation specification. These subtle changes can cause no end of confusion and delay in a market that is defined by set supply chains and ways of working.

Frame sizes change between suppliers. Triple glazing tends to require more robust framing to support the weight of the glazing and so tends to be wider. PVCu tends to be weaker than wood or metal frames, so again they tend to be wider. Frame size is important both for the look of the property, but also for determining where trickle vents might be located (or not) in terms of the junction between the frame and the superstructure.

Frame size might also be important in terms of whether there is insulation to be installed in the window / door reveals. Reveals are a weak point where thermal bridging may occur. Ensuring that the reveals are insulated to prevent thermal bridging and the associated mould etc means that the size of the window might be adjusted to accommodate, or that the reveals are enlarged (e.g. this may be via removal of existing renders). Wider framing might facilitate the installation of reveal insulation.

Consideration must be given to opening of the windows. Typically, in the UK we have outward opening windows. This is due to the weather and historical window technology. In the past, before rubber seals we relied on the physical shape of the windows and frames to keep out the wind and rain. With modern seals units like inward opening tilt and turn are available. These tend to be easier to maintain and clean but are more complex in terms of their hardware and seals. Stability within the frames of these types of units is thus very important. Wooden and metal frames are more rigid than PVCu and hence tend to be recommended for these types of units.

Maintenance on windows and doors is typically poor, so many units are replaced because the hardware has failed. It is important therefore to provide ease of maintenance for windows. This is where superior quality inward opening units are advantageous as once opened the mechanism is very accessible to work on. The framing hardware on external opening units is naturally better accessed from outside. This can create issues when above the ground floor.

Standard practice and consequences:

The most common solution is to install PVCu framed windows with double glazing. Windows and doors are measured to the edges that are visible, rather than the actual frame size. This is to ensure that fitting is easy and that the windows will indeed fit into the opening. These are secured in place using a combination of brackets and screws with expanding foam to fill the void. Windows also tend to come with all trickle vents or none.

None of these practices are truly sustainable. uPVC is not easily repairable, windows surrounded by perishable solid foam are not good in the long term and an unthought through ventilation system can complicate the strategy.

KISS retrofit recommendations:

The above shows that there are multiple factors in the installation of windows and doors. Time needs to be spent planning, designing, specifying and installing windows and doors. Owners need to spend time with a competent designer and window / door

installer making sure that the options for doors and windows are well understood and decided upon with an open mind.

Using stable engineered wood reduces the embodied carbon of the windows / doors and facilitates repair and maintenance if required.

Superior quality hardware should also last for the lifetime of the frames if maintained (lubricated) regularly.

If there is an issue with noise into the property, for example being on a busy road, then it is possible to specify acoustic glass rather than standard glazing. Acoustic glass is a glazing unit made of 6mm and 4mm thick glass rather than two sheets of 4mm. This helps to stop resonance between the sheets. Overall acoustic glazing will provide a similar acoustic performance to that of triple glazing, but of course at a lower cost and weight.

It is important to use window grade silicon when sealing between frames and the main wall structure. This is because it has a higher degree of flexibility and thus facilitates more thermal expansion differential between common materials like uPVC and bricks. This stops the seal from failing for longer. Check seals regularly as this can be a source of rainwater penetration.

Roofs

Roofs come in a wide variety of formats, materials and styles so it is always important to assess the significance of the roof and be sensitive both to the aesthetics and history of the building and the immediate built environment / street scene.

Pitched roofs

Intro:

The main issue for any KISS retrofit is whether the roof is going to suitable for the installation of solar systems (PV or thermal). PV especially has a lifespan of over 20 years, and most require an adequate roof for at least 25 years.

Standard practice and consequences:

Most roofs coverings are chosen via a combination of design, aesthetics and cost. Where cost is the primary driver, it may involve making poor decisions in terms of weight. Tiles compared to slates can be much heavier and this can place undue stress on the roof structure. This must be avoided otherwise it can lead to roof deformation and failure.

KISS retrofit recommendations:

Use materials that are in keeping with the area, which are suitable for the underlying roof structure, and that provide easy fixings for solar energy generation. Ensure that the main structure and covering are in a good state of repair with at least 30-50 years expected lifespan.

Ensure that appropriate ventilation is installed as per BS5250:2021 Management of moisture in buildings. Code of practice.

Flat roofs

Intro:

Flat roofs are typically over wet rooms (bathrooms, kitchens etc) to the rear of properties. This means that there are at risk of condensation issues as many have uninsulated or poorly insulated structures.

Standard practice and consequences:

The most obvious way of dealing with this is to install insulation in between the rafters, but this creates a cold roof and unless it is fitting with a continuous and correctly specified vapour control layer (VCL) will increase the risk of condensation under the roof, and this can lead to rot and mould.

KISS retrofit recommendations:

Remove the existing roof and replace it with a warm roof structure that meets current building regulation requirements.

Ensure that appropriate ventilation is installed as per BS5250:2021 Management of moisture in buildings. Code of practice.

Rainwater systems

Intro:

Guttering is a key factor in helping guarantee success in any retrofit. Guttering should be easy to get right, but again there is a little lack of forward thinking in the industry. With a changing climate there is greater risk associated with inadequate rainwater goods. Winters are predicted to be wetter and there is a presumption that more extreme weather evens (storms etc) are to become more common. So, any retrofit should assess the suitability of the rainwater goods.

Standard practice and consequences:

The standard way of dealing with guttering is to install the cheapest plastic system. These tend to be the smallest width with the cheapest brackets and joints.
These plastic systems expand and contract with temperature and hence can easily twist, break seals and fail.

KISS retrofit recommendations:

First, it is important to assess:

- Routes and area of roofs being served by the system
- Guttering width and capacity
- Downpipe diameter and capacity
- Type of guttering (material)
- Support for the system (distance between brackets)
- Connections between each element
- Flow issues in terms of gradient, focusing of flow into sensitive roof areas, etc.
- Potential storage of rainwater for domestic purposes

Based on this assessment it may be that the entire system needs to be redesigned / installed. It is probable though that at the very minimum it is necessary to:

- Install high-capacity guttering
- Change joints to ensure that they are correctly sealed (the rubber seals have a finite lifespan)
- Install additional brackets to support the guttering
- Install rainwater butts to provide storage and ability to slow storm water.

Ventilation

Intro:

It is vital that both the building and the occupants have adequate ventilation. Structural ventilation requirements are covered by BS5250:2021 and Part C of the building regulations. Internal ventilation is set out in Part F of the building regulations.

Structural ventilation

Intro:

Structural ventilation is vital to reduce the risks to the building fabric associated with condensation. Condensation can occur on surfaces and within structures (interstitial condensation) and both need to be avoided.

Whilst ventilation is important, we must also be mindful of creating other risk factors like thermal bridging and rainwater penetration.

Standard practice and consequences:

Most professional contractors will follow the requirements / specifications associated with ventilation. However, it is recognising the need for ventilation. Roofs are generally well done, but it is when floors / external groundworks are undertaken that issues arise.

Suspended floor ventilation is essential but can often be compromised. For example, when paths around buildings are re-laid, vents are blocked or reduced in size due to the raised path work. Replacement solid floors in individual rooms are notorious for blocking ventilation routes for the other rooms' floor vents. So, it is common to find that one reception room has a solid floor and the other has a bouncy suspended wooden floor. Extensions to the front / rear of buildings are typically made with solid floor bases and again the existing suspended floor vents are not extended through this new floor, just blocked off by it.

KISS retrofit recommendations:

Keeping good levels of ventilation in suspended wooden floors is vital for their long-term structural health. It is essential that appropriate levels of ventilation are introduced / re-introduced so that the floor does not decay due to excessive moisture driven by poor ventilation. This may not be easy to achieve, especially where the altered design of the building prohibits easy ventilation routes to be introduced, e.g. terraces with replacement solid floors or solid floor rear extensions / conservatories.

Roofs are better served by the existing industry but can lack ventilation if they were re-roofed a couple of decades ago. The assessment of ventilation is important both from inside and outside, as occasionally the existing vents may not align. For example, having ridge vents and either no eave vents or felt vents.

Occupancy ventilation

Intro:

Part F is the dominant force when looking at internal air quality and required ventilation rates. However, PAS2035 is also important as it brings in additional key factors. The main one being the identification of any issues. Part F is prescriptive, whereas PAS2035 Annexe C focuses on the practical evidence of mould or condensation. If there are any signs, then the ventilation is deemed to require upgrading.

It is important that we recognise that many instances of mould and damp are due to structural issues. Therefore, we cannot treat these with ventilation only, they need to be cured at source.

Standard practice and consequences:

Ventilation is often used as a cure-all for damp, and this is a major mistake. Ventilation is good for sorting condensation (if it has no structural thermal bridging cause), but only if the ventilation systems work. The RMI construction sector is principally driven by price rather

than effectiveness and so tends to install the cheapest Part F ‘compliant’ models. These are not tested afterwards, and controls are not well considered or discussed with clients. Ducting tends to be flexible, sealed with tape and left in a tangle. This of course leads to the systems not working well or being loud and hence underused.

KISS retrofit recommendations:

Ventilation needs to work to a strategy, so this requires planning and the installation of the correct supportive equipment.

Ideally whichever strategy is employed the system should be effective (and this requires testing that it is performing as expected), easy to control (ideally with relative humidity controls), well ducted (with a maximum of one 90-degree bend and via rigid ductwork), sealed (using long term tape or appropriate brackets) and quiet. These types of systems are naturally more expensive in terms of extractor units, but much of the cost is in labour and so it is a false economy to install cheap units as they will be short lived and ineffective. They will therefore not provide the required ventilation, nor will they save money as the replacement costs will outweigh any initial savings.

Heating systems

Intro:

There is an overall travel in the UK towards electrifying heat to cut carbon emissions. This is a wise move as fossil fuels are finite, whilst electricity can be generated from renewable sources. Whilst there is a clear carbon argument in terms of turning to electricity as a power source it only makes sense when you use heat pump technology. Using storage heaters and electric panel heating does not provide the carbon savings that the Government seeks.

Electricity, though, is c. 4 times the price of gas / oil / LPG in terms of pence per kWh, so getting the equation right to avoid putting people into fuel poverty is vital.

Heating source efficiency is classified using bench tests and these do not reflect the real world. Condensing boilers are rated at 90% efficient; however, they will not reach this is the home. Similarly heat pumps are rated at c. 350%, and it is vital to ensure that they do reach this 'average' over the year (measured in Seasonal Co-efficient of Performance – SCoP) otherwise the costs of running them will higher than the original boiler. SCoP of heat pumps is affected by numerous factors and so it is vital that all of them are recognised and appropriate decisions taken to maximise this.

The type and size of property that requires heating will have an impact on the best type of heating system for it. This is based around several factors, including: the initial capital costs of replacing the heating system, the space available in the house, the demand for heat, the preferences of the client and the requirements for hot water. This is not a one size that fits all scenario.

Boilers

Gas, LPG and oil boilers represent antiquated technology in an age where carbon efficiency is as important as cost. However, there will be a long legacy associated with the technology and fuels.

The move towards electric heating is set and will continue to pick up pace as pressure grows on carbon targets.

Heat delivery systems

An issue with heat pumps is that their SCoP is improved by having an efficient low temperature delivery system. This means providing a system where the lowest possible temperature is achieved in terms of reducing the heat pump's output. Underfloor heating (UFH) is ideal as it is effectively a very large radiator. But the floor needs to be insulated for this to be effective. UFH does have the advantage of creating a heat profile that focuses warmth on the feet, and this physiologically means that the overall internal temperature can be lower as humans feel warmer if their feet are warm.

For most people, the issue will be the need to replace existing radiators with higher output models (larger) and to have wider bore pipework, ideally 15mm rather than the more common 12mm or microbore pipework. Changing over to a more efficient delivery system adds capital costs, so it needs to be borne in mind when investigating the installation of a heat pump.

Some systems use warm air as the delivery system. This is possible and there is a move towards air-to-air heat pumps as they provide coolness in the summer months. Overheating is an issue and so it may be important for a particular house to think about the use of cooling as part of its retrofit.

DHW

Hot water is required all year around and so any system needs to be able to provide this. This factor is important when looking at air-to-air heat pumps as they do not supply hot water, so alternative means of heating water would be required with this type of heating system.

There is an argument for where it is better to have a combination or conventional boiler. Combination systems provide water on demand, whilst conventional systems have a hot water tank. Both systems have pros and cons, however as a rule of thumb

it is recommended for a conventional tank-based system when the property has 3 or more bedrooms.
The heat source has an influence in terms of system that might be used. For example, heat pumps require the use of a hot water tank.

There are independent ways of heating water even if you have removed an old boiler. Electric boilers are common in small flats where there is no mains gas. These ‘point of use’ systems are like combination boilers as they do not store water, but this means they are very energy intensive whilst in use. Immersion heaters in hot water tanks can be used in lieu of boiler generated heat. Whilst these require a lot of energy, it can be much less intense as they heat the water up over a longer period. These can also take advantage of time of use tariffs.

A compromise type of system can be seen with ‘change state heating’. These use salts to store up energy (like the immersion heater) and then release the heat when required (like the combination / electric boiler).

Heat pumps

Heat pumps are the future of heating in the UK, but there are distinct types of heat pumps, and each has its pros and cons.

In principle they all work in the same way. They take heat from a medium (air, water, ground) by using super cooled coolants that are exposed to this external source of warmth, compressing the coolant to release heat, transferring this heat to the internal system via a heat exchanger, then expanding the coolant to reduce its temperature down before being pumped out again. The cycle repeats.

The key issue is the difference between the temperature of the coolant and the external source of heat. The lower this difference the more efficient the heat pump. So having a lower internal temperature or a higher external temperature alters the Co-efficient of Performance (CoP). The better the CoP the lower the running costs. The CoP over the full year gives you the seasonal average, SCoP.

Lower efficiency, of heat pumps, is linked to the production of hot water as this needs to be heated to c. 60 degrees centigrade occasionally for legionella prevention. Heat pumps are around 150% efficient when heating up water to these temperatures. As mentioned, there is a need for a hot water tank for most systems, so there needs to be space identified for one.

The 350% seems too good to be true. It stems from the relationship between the energy required to run the heat pump and the amount of heat that is provided. For every 1 kWh of electricity that is inputted into the heat pump there is 3.5kWh of heat produced.

With electricity costing circa four times more than gas per kWh, the SCoP needs to be c. 350% just to break even compared with an existing gas boiler. This is because a fossil fuelled boiler is only 90% efficient (in the laboratory). This factor may be tempered by using specialist tariffs for heat pumps. In the drive towards more time conscious use of electricity via smart meters and the desire to increase grid capacity via improved flexibility of demand, there are opportunities to reduce unit costs significantly. Careful use of tariffs (and potentially battery storage too) can radically reduce running costs and therefore avoid the risks of fuel poverty.

One kWh of electricity has a carbon footprint of c. 0.177 and gas c. 0.202 (2026 figures), so being able to produce the same amount of heat from 1kWh of electricity compared to 3.5kWh of gas means that the carbon footprint of heat pumps is radically lower than gas. Hence the push to install them! A word of caution. Heat pumps are 'boys' toys' and so one needs to be careful that a lot of unnecessary controls etc are not installed alongside the standard system. In heat pump world, less is generally more.

The last general comment is that it is vital that the heating and hot water systems are looked at holistically and installed by competent professionals. This means getting the same company to design, specify, install and commission the system. This means that you have one point of contact if there are any issues and that the system should all be installed correctly in an integrated manner.

Cooling

It is possible to specify heat pumps to cool as well as heat the building. Reversible heat pumps do exist, but it would need to be specified prior to any design / installation.

ASHP

Air source heat pumps are by far the most common. The only major issue that is not covered in the sections above it that there are some restrictions in terms of noise that can restrict the location of the external unit.

If you live in a coastal area, it is worth asking about a coastal-protected variant.

GSHP

Ground source heat pumps can be fuelled via extensive ground loops or via boreholes. So, you don't necessarily require large gardens or open spaces for GSHP. GSHP are more efficient than air source as they have a more stable heat source. Air

temperatures vary significantly during the diurnal period, whereas the ground is more constant.

Air to Air HP

Air to Air heat pumps are cheaper than ASHP and GSHP, but they are less efficient and they do not support hot water systems. They can cool in the summer, and noise levels need to be considered. This can be key in terms of bedrooms as these are the rooms that are best cooled in heatwaves (to make sleep easier) but also require quiet models.

Renewable energy

Intro:

Renewable energy is key to cutting carbon emissions and cutting costs. Individual systems are not the most efficient in terms of global carbon and costs, but they can facilitate homeowners reaping some benefits in terms of reduced energy costs, carbon savings and energy security*.

* Batteries can supply energy during power cuts, but they need to be specific models that have this capability.

The most common forms of renewable energy are solar PV, solar thermal and micro wind. The generation of electricity is the dominate force in the market due to its higher unit cost. Generating electricity is attractive because it is a very versatile, easy to manage and measure energy. It can be used for powering our electricity demands at home, for storing for later use and for heating water.

Renewable heat generation tends to be more efficient than electricity generation, but it is used to offset heat demand, and this has been historically cheap per kWh (via gas, oil etc), so the financial savings are less.

Solar PV

PV is the most versatile and low maintenance form of renewable energy generation for homeowners. Most PV is installed via permitted development rights on rooftops.

This section will not go into any details of systems but there are some key factors that make it easier to understand in terms of how it works that are important when assessing viability etc. For this it is easier to use an example. This basic scenario will be based on a typical 4kWp array with a 10kWh battery into a 3-bed house (with OFGEM typical usage of c. 3,000kWh per annum for a property with non-electric heating and c. 7,000kWh with a heat pump). On paper the array (assuming south facing @ 30-degree angle with no shading in the southern half of the UK) will produce

c. 3,700kWh of electricity during the year.

The consumption for a non-electricity heated household will be c. 8kWh per day.

The consumption for an electricity heated household will be c. 19Wh per day, but this will be focused on the heating months, so consumption in winter will be much higher. A typical profile is shown in Figure 2.

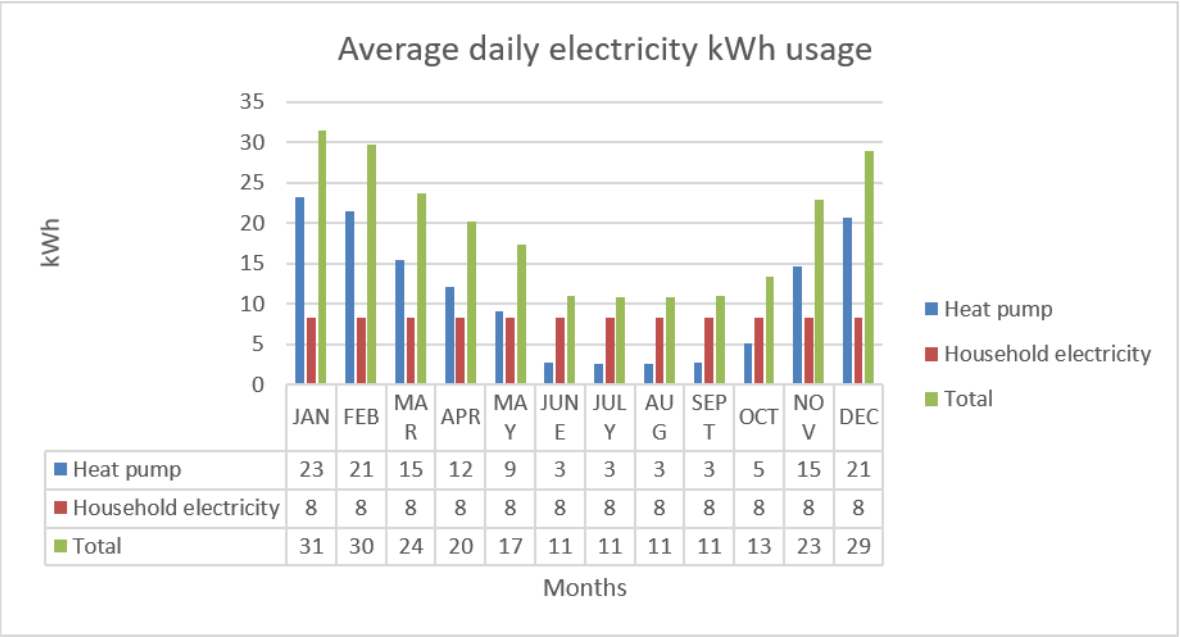

Figure 2

Key factors:

- PV generates c. 4.5 x the kWp figure per day during May-July
- PV generates c. 1 x the kWp figure per day during December-February
- PV generates c. 2/3 x the kWp figure per day during the rest of the year

See Figure 4

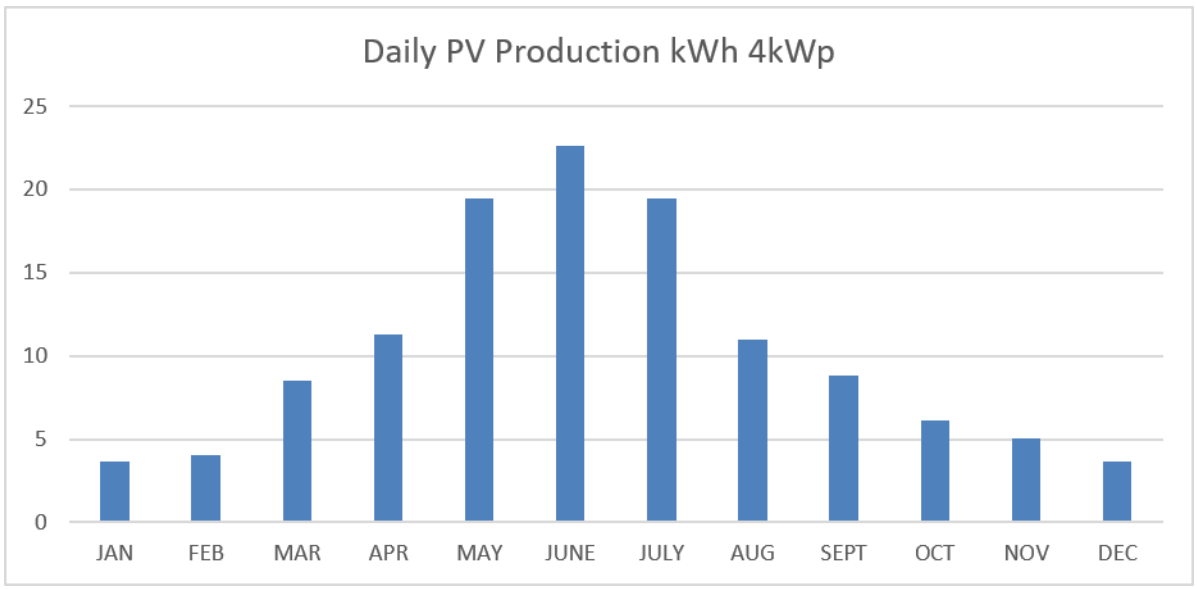

Figure 3

Combining demand and PV production for a non-electricity heated home and an ASHP heated home are shown below in Figure 3 and Figure 4.

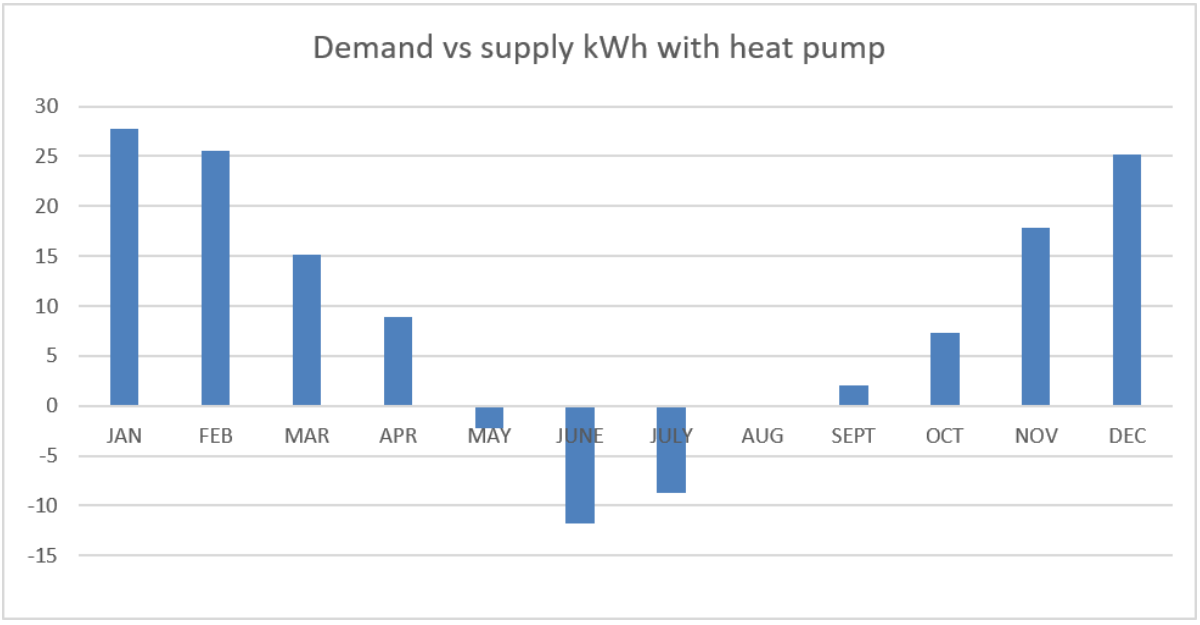

Figure 4

This situation is important as ASHP and PV are often sold together with the promise that the PV will provide the energy for the ASHP. Figure 3 clearly shows that this is not the case. The PV is good though at powering the ASHP to provide for hot water in the summer periods.

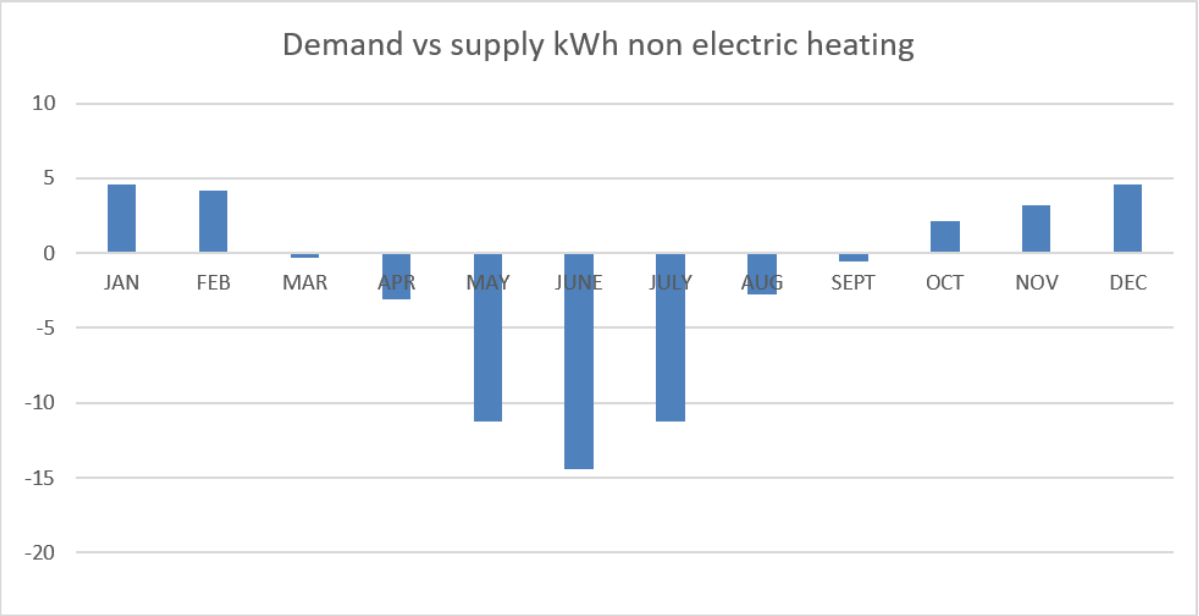

Figure 5

Orientation and roof angles for PVs are crucial elements that impact on time and volume of production. Figure 5 below shows the relationship between these factors for south Wales. The X-axis is orientation from south moving from the left (directly south) to the right (north). The Y-axis is roof orientation, moving from the bottom (vertical) to the top (horizontal).

The green shading shows the optimum situation, roughly 30-degree angle with a south facing direction. If this is taken to be 100%, then when we are looking at east or west facing production drops to c. 80% and north is c. 53%. North facing therefore does produce some energy, this is due to the focus on energy production in the summer when the north facing roof will get sun from its higher azimuth, its wider path and the longer days. Winter production will be negligible for the opposite reasons.

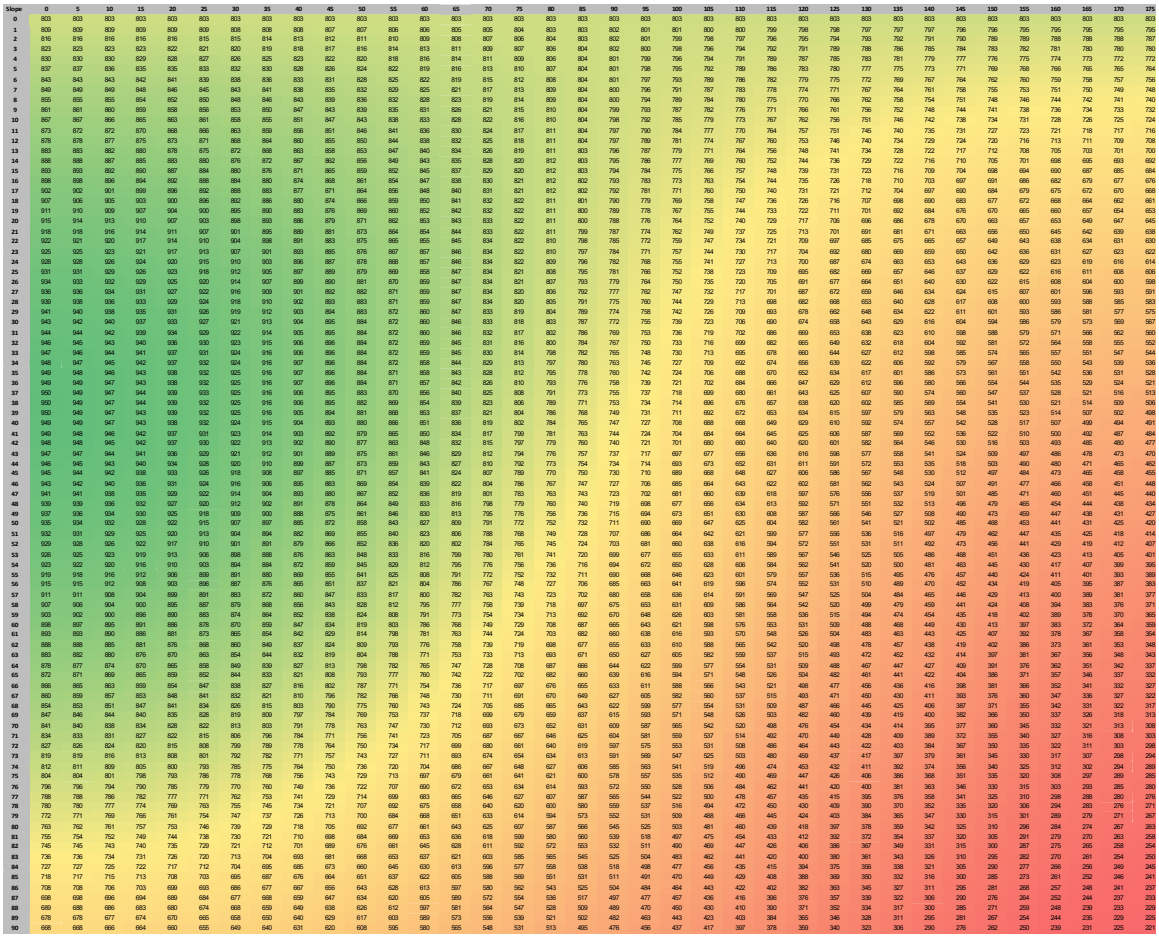

Figure 6

PV has many peripheral factors that sit alongside, the most notable are:

1. Battery storage
2. Smart Export Guarantee
3. Time of Use tariffs
4. Distribution Network Operator (DNO) permission

Battery storage

Battery storage is typically 2 x kWp of the array, so a 4kWp array will have an 8kWh battery associated with it. Batteries do decay over time and so here a 10kWh would seem more appropriate for the long term.

Batteries will be storing any excess generation during the peak production hours ready for use when the sun goes down / demand increases above supply. We can see that a

typical consumption of 8kWh per day can be serviced for most of the year via a 4kWp array combined with a 10kWh battery. See Figure 4.
This same set up will not fuel a heat pump. However, careful use of a larger battery pack can help to fuel a heat pump in the winter if it has been combined with a suitable time of use tariff. Topping up the battery during the cheap periods and using it to power the heat pump during the peak demand times can radically cut costs. This does however assume that the time of use tariffs are here to stay. There are also the increased capital costs of the battery to factor in.

Battery technology has restrictions. They can only charge and discharge at certain rates. Most batteries will charge and discharge at c. 5/6 kW, so if you have high demand equipment e.g. car chargers, electric showers etc then the battery may not provide all the power for such uses. Batteries can be configured to provide more power, but you will need to discuss this with the installer.

Smart Export Guarantee

SEG is a new market for the selling of exported electrical energy back to the grid. Any new electric based renewable energy generation installation should have an export meter included to measure the export of any excess energy that isn't used in the home. For information on SEG see https://www.ofgem.gov.uk/environmental-and-social-schemes/smart-export-guarantee-seg.

The price that you get for exported energy is set by the market and it is poor. However, supply companies want your business and some therefore often offer better rates to their customers.

It is unlikely that exporting your energy will contribute much to the financial viability of any installation, due to the poor rates. However, maximising the return is recommended, with the caveat that good SEGs might incur a higher import cost, so a balancing act is required.

Time of Use (ToU) tariffs

ToU tariffs are becoming more widely available for domestic users. These tariffs are

designed to encourage use of electricity when demand and embodied carbon is low. This means that cheaper energy is available at nighttime, often around 25% of the cost of peak energy.

ToU tariffs usually have a slightly higher peak tariff compared to flat tariffs that most providers supply. So, there is a need to shift demand away from peak demand and into the off-peak times. This is often best accomplished by using batteries that can store up the cheaper energy for peak time use. This is another major factor in specifying a larger battery than would typically be done.

Many companies have specialist options for ASHP and there are many dynamic tariffs available from companies that facilitate the buying and selling of energy at different times of the day. It is worth spending some time investigating the options available to you. ToU tariffs, though, are dependent on a smart meter as it needs to measure usage in half-hourly sections.

Distribution Network Operator (DNO) permission

The connection between a domestic PV / renewable energy generation system and the grid is determined by a combination of permitted rights and the local DNO. A household is allowed to have 3.68kWp of generation power per phase of electricity that enters the property. Houses are predominately single phase and with the minor losses associated with the equipment this is interpreted as a 4kWp allowance. Installing a larger array would require permission from the DNO. This is a straightforward process that the installer undertakes, although there is a fee for this.

Arrays above the 4kWp may have restrictions placed upon them. This will depend on individual circumstances as it will be determined by wider factors in the local area, e.g. the existence of a solar or wind farm on the same network.

Larger arrays therefore may not be able to export as much energy as they would wish due to these restrictions.

Summary

Whilst many of the solutions are simple and can be applied to most properties it is essential that the whole house is assessed and understood. Only with good and comprehensive information collected by competent assessors can sound decisions / recommendations be made.

Retrofit Co-ordinators must focus on the core principles of PAS2035:2023 to act in the best interests of the owner and the property (public good). This means that the solutions must reflect the intended outcomes of the owners / occupiers and manage the risk associated with the EEMs. This may mean that the building does not meet the arbitrary Government / Building Regulations targets, but that it is the best it can be. It is vital that we aim for this ‘best it can be’, otherwise we are storing up potential problems for the future that will, no doubt, result in more disruption and global carbon emissions.

Limiting the number of solutions to a smaller range of low risk, low carbon, permanent and maintainable energy efficiency measures should allow the industry to ramp of the scale of retrofit in the UK. This will reduce the embodied carbon footprint, the in-use carbon, but also importantly the longer-term need for carbon-based resources.

The main problematic issue of fabric retrofit is insulating walls. Floors, doors, windows, and lofts are relatively straight forward with current knowledge, practices and available materials. If we are to embrace the opportunities associated with using the lowest common denominator and a small palette of measures, then it is vital that the industry moves towards using a lime based insulating version of EWI for solid walls and a hybrid of CWI and the same EWI for cavity walls. This solution provides all the long-term advantages associated with low risk, low carbon, permanence and easy maintenance.

The changes required for adopting a lime based EWI system within the existing construction industry should be relatively simple in terms of transferable skills and labour availability via CPD and talk-box talks.

Retrofitting ‘services’ is very well served by the current industry if it is done well. The direction of travel with PV arrays and heat pumps all make sense in terms of the

electrification of our homes and the supply for that energy. The main concern is the quality of the process, but this can be achieved via the appropriate use of recognised certification: e.g. Heat Geek training for heat pump installers; and good education for homeowners e.g. PV only on southerly orientated roofs.

Overall Retrofit needs to get back on track via RA's providing more accurate assessments, RC's focusing on risk and making the property 'as good as it can be', a more focused set of simple solutions based on risk for Retrofit Installers.