

Retrofit Archetypes

A thermal image of a two-story house with a gabled roof. The house is rendered in a color gradient from blue (cooler) to red (warmer). The roof is mostly blue, while the walls and windows are in shades of yellow and red, indicating heat loss. A window on the right side has a flower box. A small air conditioning unit is visible on the lower left wall. The background shows another house and some trees.

Background

This presentation is part of the Energy Efficiency Supply Chain (EESC) project that Southern Uplands Partnership managed for Scottish Borders Council during 2021-2025. The same team undertook the related LHEES Community Retrofit Pilot project in 2024 and this presentation is adapted from that work. The project brief called for:

“Identification of potential pockets where property archetype, existing heating types, energy ratings and higher energy use may suit a small focussed retrofit project, and where the demographics may indicate that owner occupiers could be open to such a scheme.”

Note: this presentation looks specifically at Retrofit Archetypes for energy efficiency measures, the role of Decarbonising Heat as part of the retrofit process is covered by a separate presentation.

LHEES

LHEES (Local Heat & Energy Efficiency Strategies) was introduced by the Scottish Government in 2022. It places an obligation on all Local Authorities to prepare a strategy for decarbonising heat in buildings across their local area, with 6 categories to be considered:

1. Off-gas grid buildings
2. On-gas grid buildings
3. Heat networks
4. Poor building energy efficiency
5. Poor building energy efficiency as a driver for fuel poverty
6. Mixed-tenure, mixed-use and historic buildings

LHEES also has categories for when a building is ‘heat pump ready’:

0. Heat pump already installed
1. Could be installed with no changes
2. Could be installed with modest improvement of energy efficiency
3. Requires major improvements

Retrofit Archetypes

As part of the **Net Zero** transition every house needs to be made more energy efficient.

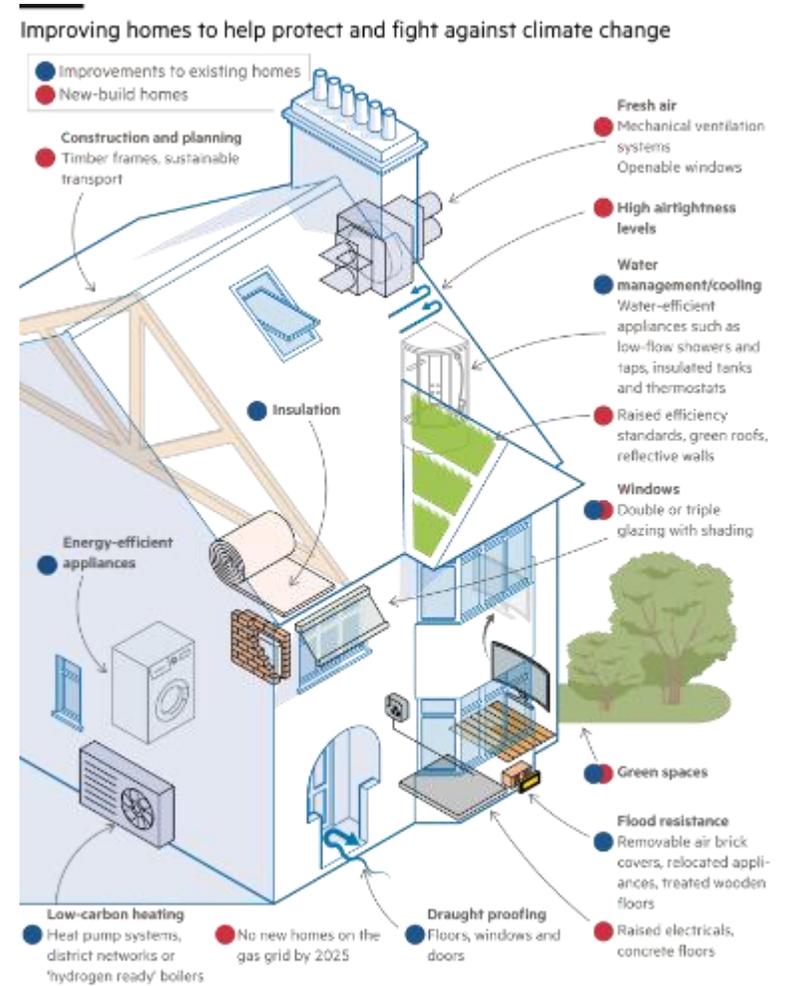
- **Retrofit** is the design and building process to make that happen for an individual house. It will involve a range of typical construction
- **Measures** (e.g. insulation, double-glazing, heat pumps) appropriate to each house.
- **Archetypes** is a way of grouping houses with similar characteristics (e.g. age, wall construction, layout) where the same Measures are likely to be appropriate.

Net Zero

Net Zero means cutting Carbon emissions to a very small amount, the balance able to be stored by nature or through technology solutions.

The main thing we have to do to reach Net Zero is stop burning fossil fuels wherever possible and use Renewable Energy instead, but that task will be easier if we use energy more efficiently and reduce overall energy demand.

Home heating + electricity is directly responsible for 20% of UK carbon emissions so Retrofitting our houses is essential to reach Net Zero.



Graphic: Ian Bolt Sources: The Committee on Climate Change; CEB FT research © FT

<https://www.ft.com/content/cf668430-fee8-45d4-982c-4b2996186879>

Retrofit

Retrofit refers to any work on an existing building to improve its energy efficiency, including:

- making them easier to heat or cool to reduce energy demand
- able to maintain thermal comfort levels for longer
- replacing fossil fuels with renewable energy (e.g. Decarbonised Heat)

The Retrofit process should also deliver broader benefits:

- improved internal air quality
- resilience to extreme weather events e.g. high winds or flooding.



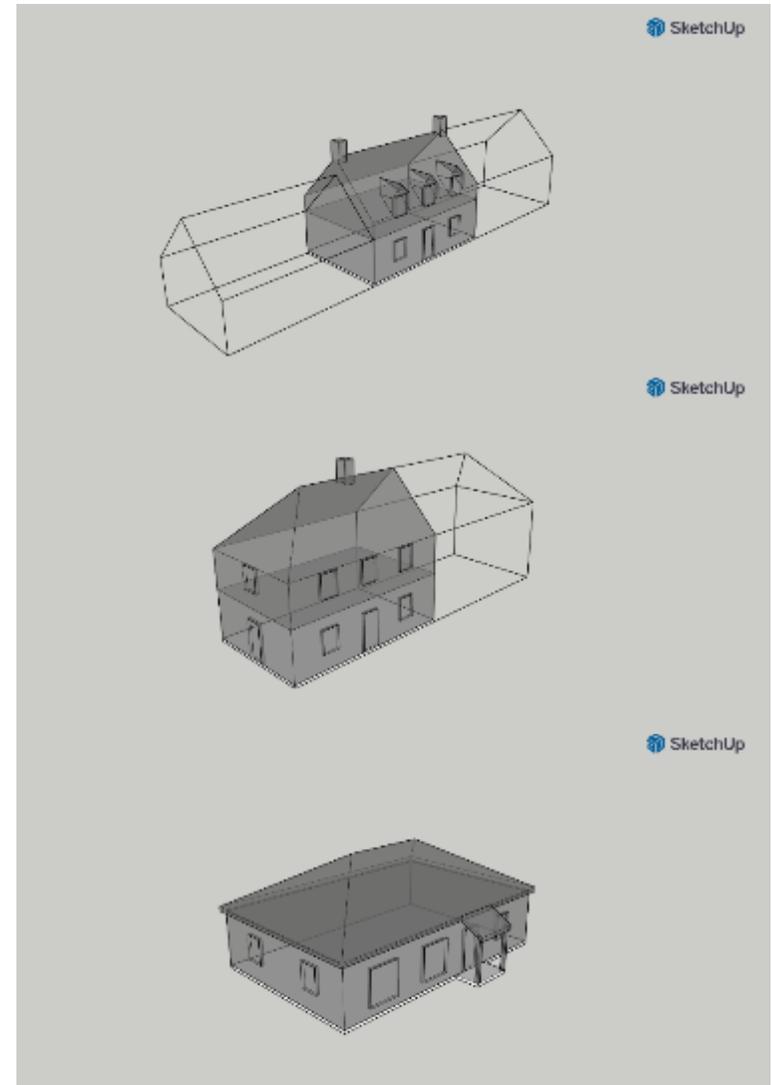
<https://www.thepebbletrust.org/sustainable-renovation-guide/>

Archetypes

Archetypes categorise buildings based on key aspects of their construction that will affect which retrofit Measures are relevant. Typical characteristics are:

- property age
- wall construction
- built form and layout
- number of storeys

The definition of Archetypes is about the building fabric, not the building services (i.e. heating/energy systems), although they will be included as part of the Retrofit process.



Measures

Retrofit **Measures** include a wide range of works that can be grouped as:

- **Insulation:** floor, wall and roof insulation, thermal bridges
- **Ventilation:** windows + doors, extract fan systems, airtightness
- **Building Fabric:** condition, dampness, vulnerability to extreme weather or environmental changes
- **Energy:** heating/cooling systems, energy generation + storage, controls



Defining Archetypes

Defining Archetypes is not an exact science, it's just about grouping houses with common features that will influence retrofit measures.

- **Age:** most important threshold is pre or post-1919 when building regulations introduced, with later groups based on dates when regulations upgraded (1950, 1984, 1992, 2002).
- **Wall Construction:** most important for determining appropriate insulation measures > solid wall (pre-1919), cavity wall (masonry or timber), steel, concrete, non-standard.
- **Roof Construction:** for pitched roofs any attic/room-in-roof spaces are more complex to insulate than an open loft, and flat roofs have very different requirements (warm v cool roof).
- **Built Form:** key distinction is detached/semi-detached/terraced/apartment as that determines extent of external wall area.
- **Number of Storeys:** this is important to determine what works are practical as working at height can significantly increase costs.

Defining Archetypes

Various organisations are trying to formalise the Archetype definition process, such as a current project by University of Edinburgh with the local Housing Associations (which includes Coding for wall types):

Example of Common Archetypes in Scotland

Archetype	Most Common External Wall KEY Archetypes	Coding	Sub-Categorisation Guidance within KEY Archetypes
1	Pre1919 sandstone house (solid)	SW - SS - 1	Variation of finishes room side
2	Pre1919 sandstone tenement flat (solid)	SW - SS - 2	Variation of finishes room side and overall wall depth
3	Pre1919 granite stone (solid)	SW - GS - 1	Variation of finishes room side
4A to 4E	Timber frame based (block or brick outer leaf)	CW - TF - A	90mm mineral wool insulation (inner leaf)
	Timber frame based (block or brick outer leaf)	CW - TF - B	rigid foam insulation (inner leaf)
	Timber frame based (block or brick outer leaf)	CW - TF - C	expanding foam (inner leaf) - note different types
	Timber frame based (block or brick outer leaf)	CW - TF - D	140mm mineral wool insulation (inner leaf)
	Timber frame based (block or brick outer leaf)	CW - TF - E	Other - e.g. SIPS inner leaf
5	Brick full depth (solid)	SW - B - 1	Variation of finishes room side and outer leaf
6A to 6D	Masonry & block cavity wall	CW - MB - A	Brick outer skin - dense block inner skin
	Masonry & block cavity wall	CW - MB - B	Block & render outer skin - dense block inner skin
	Masonry & block cavity wall	CW - MB - C	Block & render outer skin - LWA block inner skin
	Masonry & block cavity wall	CW - MB - D	Block & render outer skin - Aircrete block inner skin
7	Steel frame (block or brick outer leaf)	CW - SF - 1	Mineral wool insulation (inner leaf)

https://www.pure.ed.ac.uk/ws/portalfiles/portal/418122863/Archetype_approach_workshop_review_final-3_full.pdf

Defining Archetypes

There is debate about how useful Archetypes are in guiding retrofit, especially relying on the date of construction as a starting point.

- Building regulations apply at date of application, not construction, even if the house is not built until many years later.
- Quality of construction can be a much bigger determinant of performance e.g. insulation has little value if poorly installed
- Deteriorated fabric condition can seriously compromise thermal performance e.g. dampness in walls, windows that don't seal shut
- Site microclimate will affect thermal performance even if houses are identical e.g. exposure to winds, rainfall, temperature variations

Archetypes are useful for high level planning by government and industry, and give homeowners a guide to what measures to consider, but it's important that each house is assessed individually to allow for unique aspects e.g. alterations, condition, occupancy patterns.

Archetypes + Property Tenure

Property tenure (i.e. ownership) is classified into three categories:

- Housing Association
- Privately Rented
- Owner Occupied

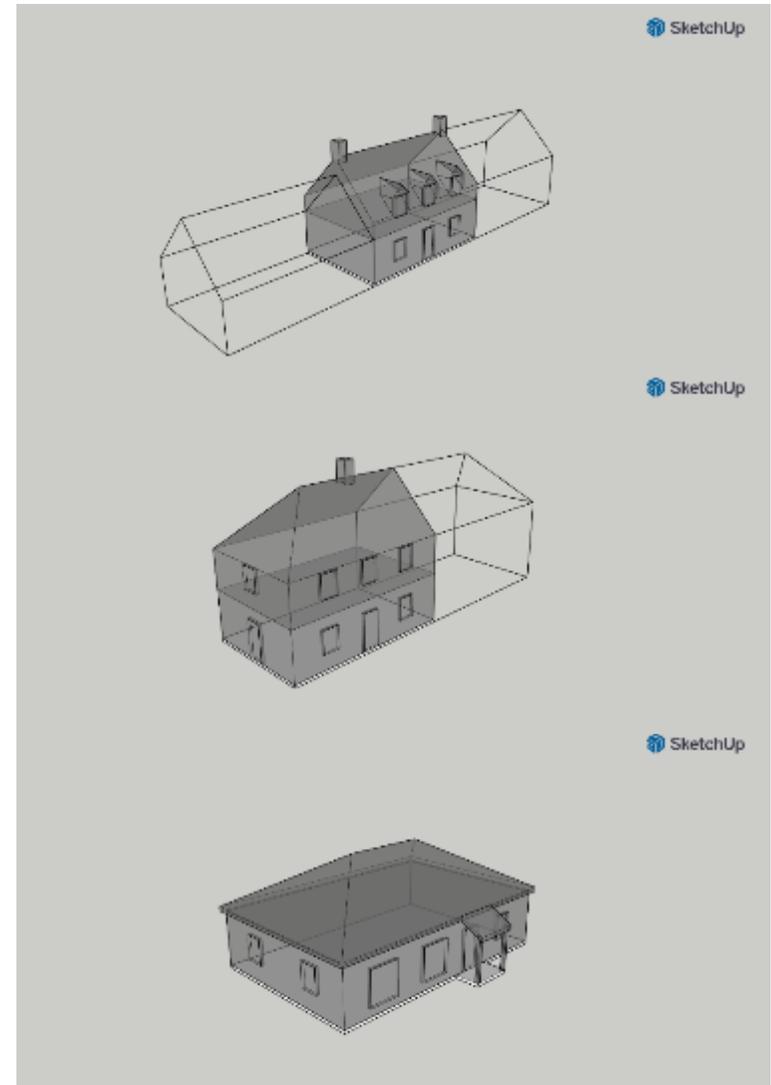
Whilst the same **Archetypes** are valid across all these categories, the way the **Retrofit** process is managed will be different. For Owner Occupied private homes, each household will make their own choice about what **Measures** to do, as and when they see fit. These decisions will be driven by a wide range of motivations:

- Ability and willingness to invest
- Response to media and marketing
- Whether the level of disruption is manageable in daily life
- Occupancy patterns and behaviours
- Health and lifestyle factors
- Experiences of neighbours and family

Archetypes

Archetypes can be defined in numerous ways, but for the pilot project in Swinton we found the majority of houses could be grouped into 3 types, and these will apply to a large proportion of houses in the region.

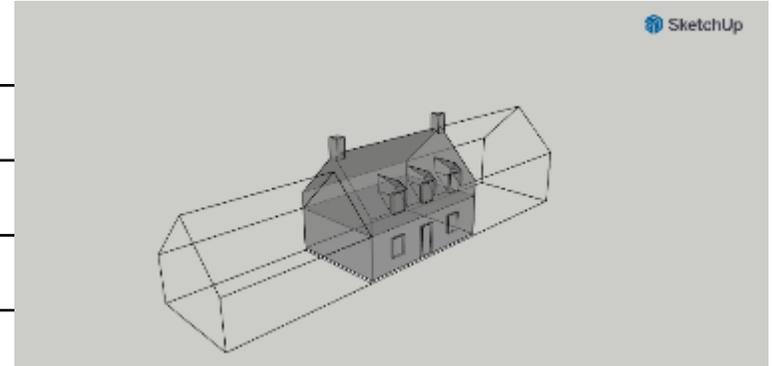
- 1. A. Traditional terrace house**
B. Traditional detached house
solid wall, stone, room-in-roof
- 2. Post-War semi-detached house**
cavity wall, brick
- 3. Modern detached house**
timber frame wall



Archetype 1A. Traditional row house

Typical characteristics

Age	Pre-1919
Walls	Solid stone
Roof	Timber frame, dormers
Floor	Suspended, some solid
Windows	Original timber single glazed or UPVC double glazed replacements
Built form	Attached row houses, some with attics
Storeys	1 or 1½



Archetype 1A. Traditional row house

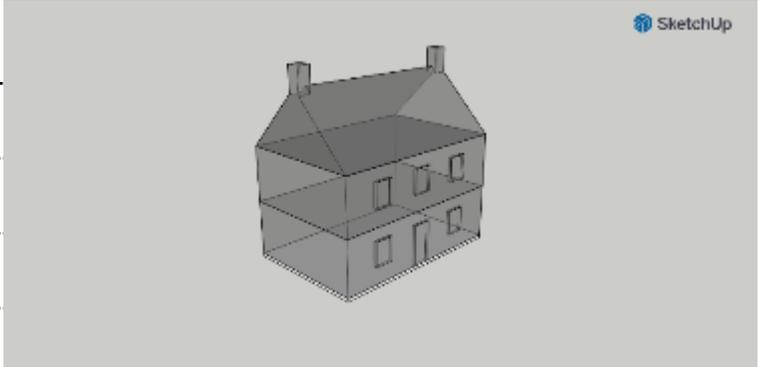
Building Fabric Measures

Walls	External wall insulation (rear only) (Solid Wall Insulation)	Exposed stone to street facade should be kept.
	Internal wall insulation (Solid Wall Insulation)	Solid stone walls need to be able to “breathe” which means any internal insulation must be hygroscopic (can absorb and release water).
Roof	Loft insulation	Top up to 350mm min.
	Room-in-roof insulation	Insulate coombs and dwarf walls.
Floor	Suspended floor insulation	Insulate from above, or below if accessible.
	Solid floor insulation	If height is restricted consider replacing floor in full, or use thermal underlay as a minimum.
Windows	A-rated glazing	New double or triple-glazed windows or upgrade existing windows, including heritage glazing.
	Insulate reveals	If there are no original shutters or linings, consider insulating reveals of all openings.
Doors	New insulated door	New insulated door or refurbish existing door.
Ventilation	Whole house ventilation strategy	Ensure adequate extract ventilation and compensatory ventilation.
	Airtightness	Improve airtightness of fabric where possible.

Archetype 1B. Traditional detached house

Typical characteristics

Age	Pre-1919
Walls	Solid stone
Roof	Timber frame
Floor	Suspended, some solid
Windows	Original timber single glazed
Built form	Detached houses
Storeys	2 or 2½



Archetype 1B. Traditional detached house

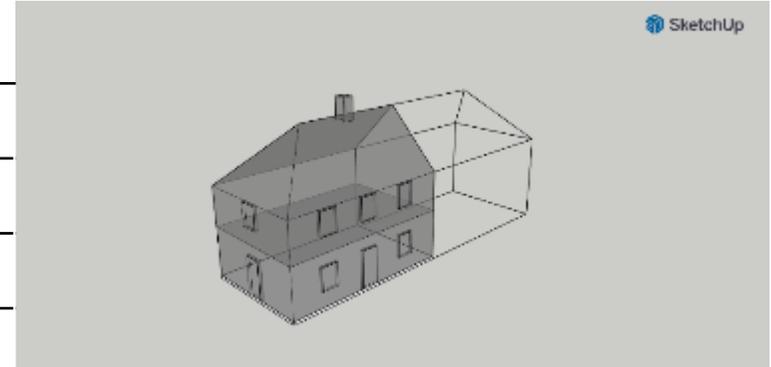
Building Fabric Measures

Walls	External wall insulation (rear + side) (Solid Wall Insulation)	Exposed stone to street facade and other decorative stone features should be kept.
	Internal wall insulation (Solid Wall Insulation)	Solid stone walls need to be able to “breathe” which means any internal insulation must be hygroscopic (can absorb and release water). Avoid disrupting cornices or decorative wall features.
Roof	Loft insulation	Top up to 350mm min.
	Room-in-roof insulation	Insulate coombs and dwarf walls and gable end walls.
Floor	Suspended floor insulation	Insulate from above, or below if accessible.
	Solid floor insulation	If height is restricted consider replacing floor in full, or use thermal underlay as a minimum.
Windows	A-rated glazing	New double or triple-glazed windows or upgrade existing windows, including heritage glazing.
	Insulate reveals	If there are no original shutters or linings, consider insulating reveals of all openings.
Doors	New insulated door	New insulated door or refurbish existing door.
Ventilation	Whole house ventilation strategy	Ensure adequate extract ventilation and compensatory ventilation.
	Airtightness	Improve airtightness of fabric where possible.

Archetype 2. Post-war semi-detached house

Typical characteristics

Age	1950-1983
Walls	Brick cavity
Roof	Timber frame
Floor	Suspended
Windows	UPVC double glazed replacements
Built form	Semi-detached houses
Storeys	2



Archetype 2. Post-war semi-detached house

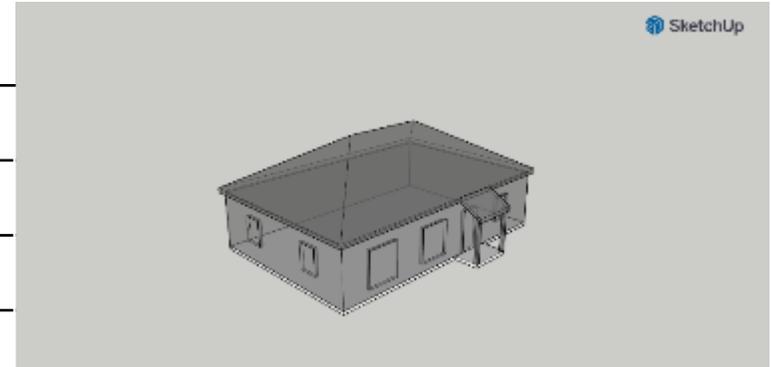
Building Fabric Measures

Walls	Cavity wall insulation	Ensure cavity is suitable for insulation.
	External wall insulation	Liaise with owners of attached house.
	Internal wall insulation	Alternative to the above but will reduce floor area.
Roof	Loft insulation	Top up to 350mm min.
Floor	Suspended floor insulation	If height is restricted consider replacing floor in full, or use thermal underlay as a minimum.
Windows	A-rated glazing	New double or triple-glazed windows or upgrade existing windows.
Doors	New insulated door	Plain doors perform better but glazed doors may be preferred to allow daylight in entry.
Ventilation	Whole house ventilation strategy	Ensure adequate extract ventilation and compensatory ventilation.
	Airtightness	Improve airtightness of fabric where possible.

Archetype 3. Modern detached house

Typical characteristics

Age	1992-2002
Walls	Brick veneer, timber frame
Roof	Timber frame, dormers
Floor	Suspended floor
Windows	UPVC double glazed
Built form	Detached houses
Storeys	1, 1½ or 2



Archetype 3. Modern detached house

Building Fabric Measures

Walls	Cavity wall insulation	Cavities with timber frame houses are best left clear.
	Internal wall insulation	Consider upgrading insulation within the timber to minimise reduction of floor area.
Roof	Loft insulation	Top up to 350mm min.
	Room-in-roof insulation	Insulate coombs and dwarf walls and gable end walls.
Floor	Suspended floor insulation	Insulate from above, or below if accessible.
Windows	A-rated glazing	New double or triple-glazed windows or upgrade existing windows.
Doors	New insulated door	Check rating of existing door.
Ventilation	Whole house ventilation strategy	Ensure adequate extract ventilation and compensatory ventilation.
	Airtightness	Improve airtightness of fabric where possible.

Does your house match these Archetypes?

1A. + 1B.

Traditional row or detached house

Age	Pre-1919
Walls	Solid stone
Roof	Timber frame, dormers
Floor	Suspended, some solid
Windows	Original timber single glazed or UPVC double glazed replacements
Built form	Attached row houses, some with attics
Storeys	Row house 1 or 1½ Detached house 2 or 2½

2.

Post-war semi-detached house

Age	1950-1983
Walls	Brick cavity
Roof	Timber frame
Floor	Suspended
Windows	UPVC double glazed replacements
Built form	Semi-detached houses
Storeys	2

3.

Modern detached house

Age	1992-2002
Walls	Brick veneer, timber frame
Roof	Timber frame, dormers
Floor	Suspended floor
Windows	UPVC double glazed
Built form	Detached houses
Storeys	1, 1½ or 2

Does your house match these Archetypes?

Remember, Archetypes are not an exact science and you may need to dig deeper to figure out where your house fits.

- **Age:** this is a pointer to what sort of construction you can expect, but buildings may have been altered so much it's almost irrelevant.
- **Wall, Floor and Roof:** most important distinction is whether these are solid and you need to allow the fabric to “breathe” or if they have cavities (gaps or voids) that keep the inner fabric dry.
- **Windows:** these will often have been replaced already, but just because they have it doesn't mean they perform well.
- **Built Form:** key distinction is detached/semi-detached/terraced/apartment as that determines external wall area.
- **Number of Storeys:** this doesn't fundamentally affect the archetype but is helpful to determine what works are practical.

Retrofit Process

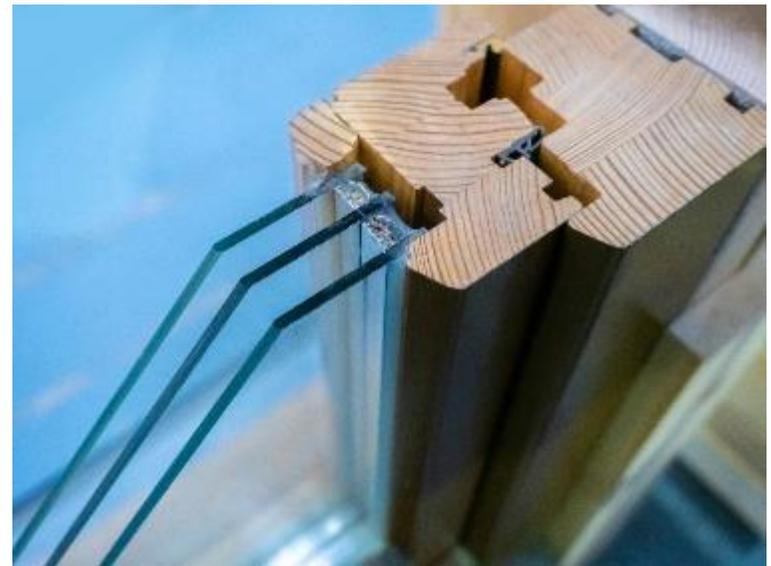
The Retrofit process includes two separate but linked tasks:

- 1. Energy Efficiency:** use less energy > increase insulation > Retrofit (Fabric First) > building works (measures) > individual house > Archetype classifications
- 2. Decarbonised Heat:** replace fossil fuels with renewables > heat pump (Electrify Everything) > individual house or heat network (range of fuel options) > clusters of houses > whole community

Fabric First

Fabric First means reducing energy demand as much as possible in the first instance, before deciding what heating/energy systems should be installed. This includes:

- insulation to walls/floor/roof
- windows + doors
- ventilation + airtightness
- fabric repairs



Decarbonised Heat

Decarbonising Heat means removing any fossil fuel heating system (oil, gas, coal) and installing a system that has nil or minimal carbon emissions. These could include:

- Heat pumps (air/ground/water source)
- Electric storage or instantaneous heat
- Solar thermal
- Heat storage devices
- Biomass (regenerative timber source)
- Heat Networks (shared systems)



Whole House Approach

It is important that all parts of the retrofit process are coordinated to optimise energy efficiency and avoid unintended negative consequences. That is why a ‘whole house’ approach is preferred. The retrofit industry is guided by PAS 2035, a framework for the energy retrofit of domestic buildings. It details best practice for how a ‘whole house’ approach is delivered, including:

- Occupants and end users
- Each home individually
- Oversight of assessment, design, delivery and use



Whole House Survey

The first part of the retrofit process is to survey the existing house to better understand its construction and services. Building surveys can be done at different levels of detail, from a simple visual inspection through to opening up parts of the fabric to check what insulation has been installed.

Surveys can also include non-intrusive tests, such as Thermal Imaging and Airtightness tests, which help to identify and locate where heat is leaking from.



Community + Place

Community-based retrofit is not just about the practicalities of energy efficiency and decarbonisation, but part of a broader programme of:

- Placemaking: collaborative process for communities to shape the public realm to maximise shared value.
- Regeneration: supporting the reestablishment of local services and economic opportunities.
- Resilience: the ability to adapt and grow following adversity, in this context around climate change.



maps.nls.uk/view/74426551



coldstreamhistorysociety.co.uk/general/villages/



facebook.com/SwintonVillageEvents/photos/

Measures

The types of building work that Retrofit involves are often referred to as ‘measures’. Following are explanations of the most common measures that you will find referenced in Archetype guidelines, individual house surveys, and EPC certificates. We have grouped them into three categories:

- **Insulation**
walls, floor + roof
- **Ventilation**
windows, doors + ventilation
- **Energy**
heat + electricity

Recommendations for improvement

The measures below will improve the energy and environmental performance of this dwelling. The performance ratings after improvements listed below are cumulative; that is, they assume the improvements have been installed in the order that they appear in the table. Further information about the recommended measures and other simple actions to take today to save money is available from the Home Energy Scotland hotline which can be contacted on 0909 909 2292. Before carrying out work, make sure that the appropriate permissions are obtained, where necessary. This may include permission from a landlord (if you are a tenant) or the need to get a Building Warrant for certain types of work.

Recommended measures	Indicative cost	Typical saving per year	Rating after improvement	
			Energy	Environment
1 Room-in-roof insulation	£1,500 - £2,700	£480	E 45	E 41
2 Cavity wall insulation	£800 - £1,600	£193	E 52	E 47
3 Floor insulation (solid floor)	£4,000 - £6,000	£139	D 57	E 51
4 Upgrade heating controls	£300 - £400	£88	D 60	E 54
5 Condensing boiler	£2,200 - £3,000	£247	C 69	D 65
6 Solar water heating	£4,000 - £6,000	£43	C 71	D 68
7 Replace single glazed windows with low-E double glazed windows	£3,300 - £8,500	£30	C 72	C 69
8 Solar photovoltaic panels, 2.5 kWp	£3,500 - £5,500	£303	C 79	C 78

Alternative measures

There are alternative improvement measures which you could also consider for your home. It would be advisable to seek further advice and illustration of the benefits and costs of such measures.

- External insulation with cavity wall insulation

Measures: Insulation

Thermal insulation is any material that blocks the movement of heat. To make our homes more energy efficient we need to increase the amount of insulation of the building envelope: the walls, floor and roof. Every little bit helps to improve the overall performance of the house. Insulation is part of the ‘fabric first’ approach.

Wall

- Cavity Wall Insulation
- External Wall Insulation
- Internal Wall Insulation

Floor

- Solid Floor Insulation
- Suspended Floor Insulate
- Thermal Underlay

Roof

- Flat Roof Insulation
- Loft Insulation
- Room-in-roof Insulation

Thermal Bridging

- Insulation cold bridges



Measures: Wall Insulation

Cavity Wall Insulation

Many cavity walls can be insulated by injecting insulation material into the cavity. A specialist company will drill holes in the outside walls, inject insulation through the holes and then seal them. The insulation material is usually mineral wool or polystyrene beads.

[Source: Energy Saving Trust](#)

Cavity walls have separate inner and outer skins of brick or block with a ventilated gap between. Filling the cavity must be done in a way that maintains the ventilation and does not allow moisture to cross the gap. There have been problems with cavity wall insulation methods in the past, but current practices are considered appropriate.



Measures: Wall Insulation

External Wall Insulation

External wall insulation involves fixing a layer of insulation material to the outside of the wall, then covering it with a special type of render or with cladding. The finish can be smooth, textured, painted, tiled, panelled, pebble-dashed, or finished with brick slips.

[Source: Energy Saving Trust](#)

If walls are already rendered or painted the new finish can be made to match, but any exposed stone or brick will be concealed. If the appearance of the facade to the street can't be changed, side and back walls only can be done.



Measures: Wall Insulation

Internal Wall Insulation

Internal wall insulation is done by fitting rigid insulation boards to the wall, or by building a stud wall filled with insulation material such as mineral wool fibre.

[Source: Energy Saving Trust](#)

Internal wall insulation can be fitted to cavity brick walls or timber framed walls. IWI will reduce the floor area by the thickness of the insulation, and may impinge on historic cornices or decorative wall finishes.



Measures: Wall Insulation

Solid Wall Insulation

Solid walls can be insulated, either from the inside or the outside. This will cost more than insulating a standard cavity wall, but the savings on your heating bills will be bigger too.

[Source: Energy Saving Trust](#)

If walls are solid masonry (stone or brick with no gaps) any insulation, whether External or Internal, must ensure the building can still “breathe” and allow the movement of moisture. So the insulation material must be hygroscopic (typically natural materials like wood fibre) or it must be fitted clear of the wall surface leaving a void for airflow. There are also thermal plasters which can boost performance. Importantly, if the walls are constantly wet their thermal performance will suffer, so check the condition of the building fabric and make any repairs.



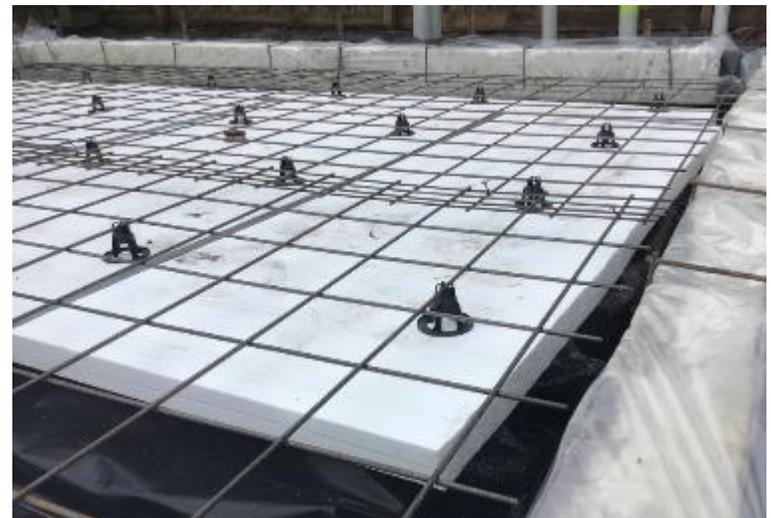
Measures: Floor Insulation

Solid Floor Insulation

Rigid insulation can be laid on top of an existing solid floor, with new flooring placed over it. This will raise the level of the floor so doors will need to be trimmed shorter. If solid floors need to be replaced in full, rigid insulation foam can be fitted either above or below the concrete.

[Source: Energy Saving Trust](#)

Solid floors are the hardest item to insulate. There are slim-profile but high-performance insulation materials where even 20-40mm can significantly improve energy efficiency, but you may lose another 40-60mm in height for a screed and floor coverings on top of this. If the floor is in poor condition it is worth considering replacing it in full. Whilst that is very disruptive it does provide the best long term outcome, and means underfloor heating can be added.



Measures: Floor Insulation

Suspended Floor Insulation

The most effective way to insulate a suspended floor and improve its airtightness is to retrofit insulation between the floor joists. This usually involves lifting the floorboards. If the floor is accessible from below (basement or crawl space) insulation can be fitted from underneath.

[Source: Ecological Building Systems](#)

Stopping draughts can be just as useful as the added insulation for improving the energy efficiency of suspended floors. Ventilation of the subfloor space has to be maintained so air vents etc. must not be blocked. Work can be coordinated with installing new pipes for radiators, or underfloor heating can be fitted on trays between the joists.



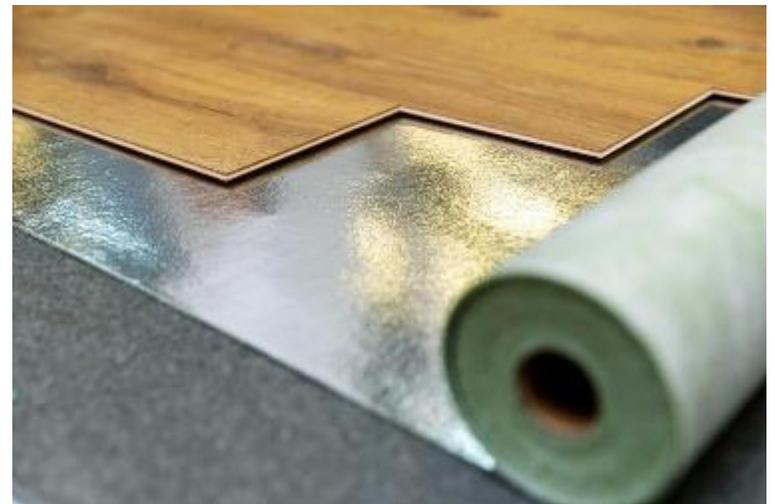
Measures: Floor Insulation

Thermal Underlay

Thermal underlay is a type of underlay for carpets or engineered timber floors. Aside from offering all the usual benefits of underlay, its primary job is to create an insulating barrier between the subfloor and your carpeting.

[Source: Simply Underlay](#)

When more substantial insulation on either a solid or suspended floor is not possible, a thermal underlay can make a worthwhile contribution to insulation levels. Products range from 3-15mm in thickness so have minimal impact on door heights etc.



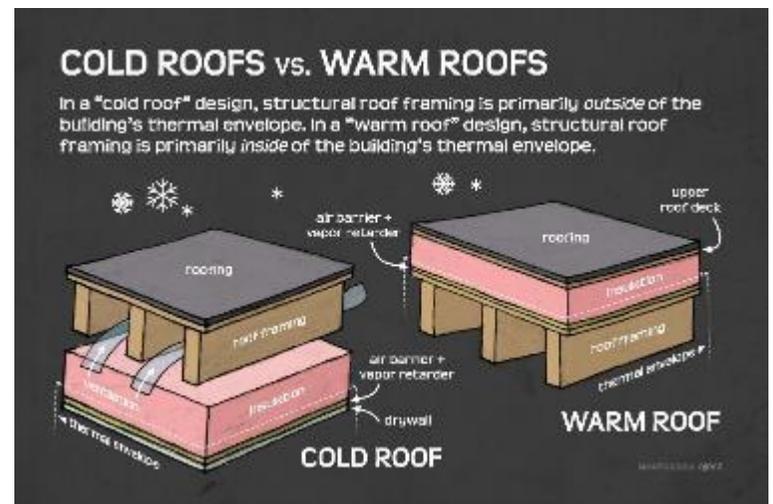
Measures: Roof Insulation

Flat Roof Insulation

Flat roofs are best insulated from above. A layer of rigid insulation board can be added with a new weatherproof layer on top. This is best done when the roof covering needs replacing anyway. It is possible to insulate a flat roof from underneath, but this can lead to condensation problems if not completed correctly.

[Source: Energy Saving Trust](#)

Uninsulated flat roofs are one of the biggest sources of heat loss. If insulation is placed directly under the weatherproof layer it is called a 'warm roof' because the timber roof frame is fully within the heated envelope. It is called a 'cold roof' if the insulation is fitted between or below the roof joists, leaving the frame partially outside the heated envelope, and a ventilation gap must be left to disperse any condensation.



Measures: Roof Insulation

Loft Insulation

A quarter of heat is lost through the roof in an uninsulated home. If your loft is easy to access and has no damp or condensation problems, it should be easy to insulate. If you plan to use the loft for storage, you can raise the level of the floor, making sure you don't squash the mineral wool when you fit the floor boards.

[Source: Energy Saving Trust](#)

Even if your house has some loft insulation already you can probably install more, with 350mm commonly recommended. That means it will have to be laid on top of the ceiling joists, not just between them. If these extra layers get squashed it reduces their insulation value. Adding a small area of raised flooring for maintenance access is helpful, even if you don't plan to use the whole loft area for storage.



Measures: Roof Insulation

Room-in-roof Insulation

If you use your attic space for rooms, you need to make sure all walls and ceilings between heated and unheated spaces are insulated. Sloping ceilings (coombs) can be insulated in the same way as a flat roof ('warm' or 'cold'). Vertical walls can be insulated in the same way. Flat ceilings can be insulated like a standard loft. Make sure you insulate all round dormers.

[Source: Energy Saving Trust](#)

Attic rooms are one of the trickiest areas to insulate because you need to use different methods for the different parts. Coombs and dormers are a big sources of heat loss because there is so little separation between the inside and outside. Coombs are typically a 'cold roof' and maintaining a ventilation gap is critical, which also requires vents at the eaves and ridge.



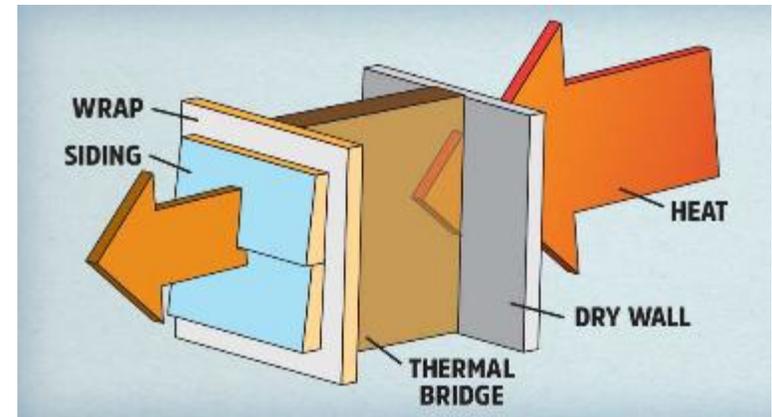
Measures: Insulation Cold Bridges

Thermal bridging

Thermal bridging is an increasingly recognised problem when insulating older buildings. A thermal bridge results when the inside and the outside are directly connected by elements that are more thermally conductive e.g. screws or timber joists passing through insulation layer. Where thermal bridging occurs, condensation is a major concern and the overall thermal performance of the building is reduced.

[Source: Greenspec](#)

The higher the level of insulation, the greater the risk for concentrated areas of condensation at any cold bridge. Window reveals are a major concern, also wall/ceiling junctions. Providing a continuous layer of insulation across the structural frame is a simple way to avoid this.



Measures: Ventilation

Good ventilation is essential for indoor air quality and to prevent mould, but it's also important for ventilation to be controlled so that our houses don't leak heat. Windows and doors have always been the main way we control ventilation, but to boost energy efficiency we need to improve their performance and consider other ventilation options. Ventilation is also part of the 'fabric first' approach.

Windows

- A-rated glazing
- Heritage glazing
- Secondary glazing
- Refurbish existing windows
- Window shutters
- Insulate reveals

Doors

- New insulated doors
- Refurbish existing doors

Ventilation

- Airtightness
- Condensation

- Whole house ventilation
- Heat recovery ventilation



Measures: Windows

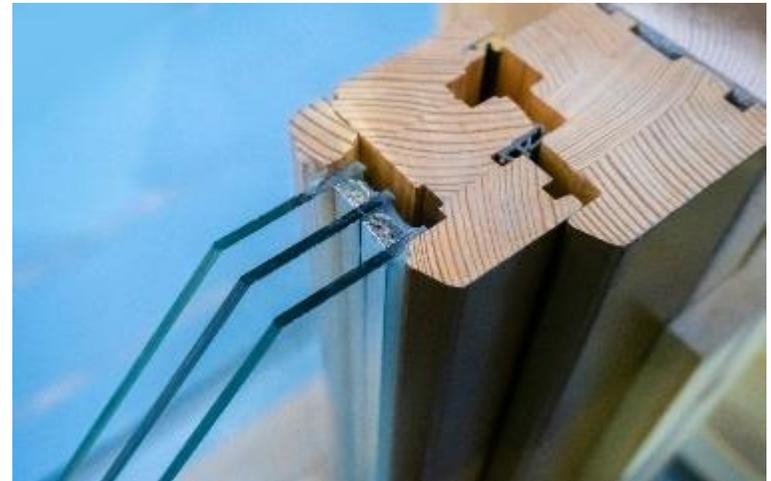
A-rated glazing

Energy efficient windows are made of 2 or 3 glass panes with air gaps sealed in a single unit, surrounded by a frame made from UPVC, wood, or other material. Window manufacturers show energy efficiency using a rating from A++ to E.

[Source: Energy Saving Trust](#)

Old double-glazed units (U=2.5)* perform half as well as newer units (U=1.2) and triple-glazed is better again (U=0.8), that's why some level of window upgrade is almost always recommended to improve energy efficiency. Overall window performance is affected by the type of frame, how tightly openings seal, and various special treatments to the glass and glazing unit, all of which can be adjusted to achieve an A-rating.

* U-value is a measure of how effective a material is an insulator, the lower the number the better the performance. The figures quoted are typical but will vary.



Measures: Windows

Heritage glazing

The windows of a historic building are important in defining its character. Double-glazing may be acceptable where the new windows will match the original, or where it can be incorporated within the original joinery.

[Source: Historic Environment Scotland](#)

There is debate about the merit of replacing traditional single-glazed windows, whether for energy efficiency or aesthetics, but options are available. ‘Slim Profile’ double-glazed units have a very narrow air gap which mean they can be fitted in existing timber frames, but still perform well ($U=1.5$)*. ‘Vacuum Glazing’ is even thinner, where the glass panes are separated by tiny beads and the air gap is vacuum sealed ($U=0.7$).

* U-value is a measure of how effective a material is an insulator, the lower the number the better the performance. The figures quoted are typical but will vary.



Measures: Windows

Secondary glazing

Internal secondary glazing can reduce heat loss by 60% and has the advantage of leaving the original window untouched. Normally comprises glass in thin aluminium or timber frames set on the internal window framing. Care is needed to allow ease of use for both opening and cleaning.

[Source: Historic Environment Scotland](#)

Secondary glazing is a cost effective option for improving energy efficiency, especially if the existing windows* are in good repair and it would be a 'waste' to replace them, or if they have unusual shapes and details that would be difficult to replicate. Panes are simple and quick to install, creating minimal disruption. They can also improve acoustic insulation in noisy areas.

* Secondary glazing can also be suitable for rooflights.



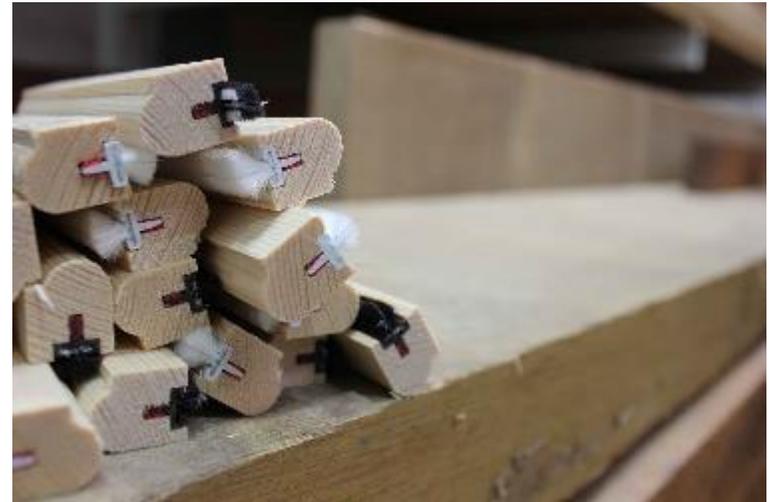
Measures: Windows

Refurbish existing windows

Repaired and adapted, older windows can be as energy efficient as new ones. Repairs usually cost less, and it is more environmentally sustainable to repair than to replace.

[Source: Historic England](#)

Provided the frame is still in good condition, most windows can be refurbished to improve their energy efficiency. This applies to better quality UPVC windows as well as traditional timber windows. Works can include: replacing seals and making sure opening sashes close tightly; upgrading the glazing units (see previous slides) and; making sure there are no gaps around the edges of the window frame and wall.



Measures: Windows

Window shutters

Interior shutters add a layer of insulation to cold windows. Edinburgh World Heritage Trust used thermal imaging cameras to show the most effective ways to avoid heat loss. Reinstating shutters is a cost-effective solution if closed tightly at night and when the room is not in use.

[Source: The Shutter Shack](#)

Shutters are a simple and traditional way to manage heat flow around windows: opened wide when the sun is shining for heat gain, closed tight at night to keep the heat in. Joiners can get old shutters working again, and make repairs if they are warped or have gaps. Insulation of the concealed side is sometimes possible, with thin-profile products such as 'Aerogel' blanket.



Measures: Windows + Doors

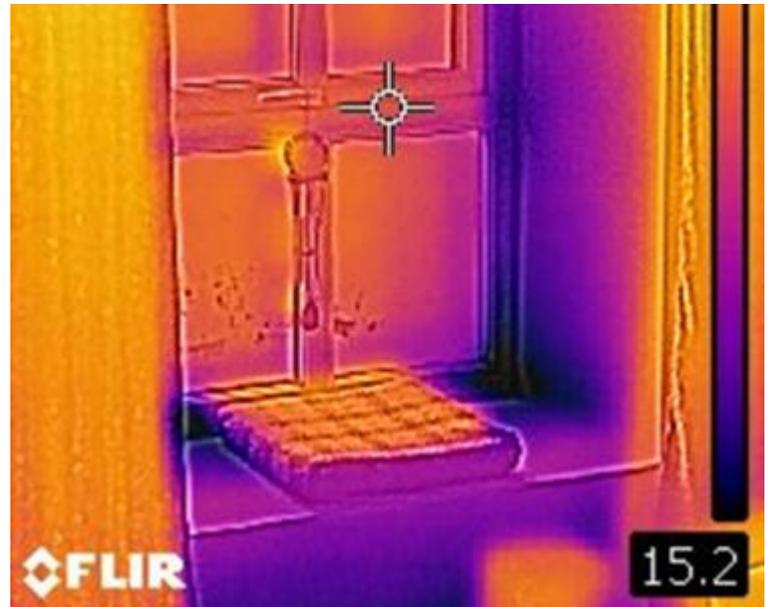
Insulate reveals

Where the wall is very thin, heat is able to leak around the window frames. This is very typical of solid walled buildings, and is the cause of common mould and mildew patches around windows. The best way to prevent heat loss in window reveals is to insulate them.

[Source: Heritage House](#)



This includes the top, bottom and sides of door and window openings. The thicker the wall, the more reveal is exposed, the greater the heat loss. Modern building regulations require reveals to be insulated and similar methods can be used in existing buildings. Methods include: insulation-backed plasterboard; fitting thin-profile products such as 'Aerogel' blanket behind joinery; using an insulating plaster (lime-based).



Measures: Doors

New insulated doors

Like any other part of the home, doors can be insulated and draught-proofed to prevent heat escaping. New external doors now generally contain integrated insulation to reduce heat loss and an effective draught-proofing system.

[Source: Energy Saving Trust](#)

Most new doors are not solid timber but made of 'composite' construction with a variety of materials, including an insulated core. Whether timber or composite, they will have integrated seals on all sides to prevent draughts. Plain doors perform best ($U=1.0$)* but doors with double or triple-glazing are available ($U=1.4$).

* U-value is a measure of how effective a material is an insulator, the lower the number the better the performance. The figures quoted are typical but will vary.



Measures: Doors

Refurbish existing doors

Draught-proofing external doors can stop a lot of heat from escaping, and won't cost you much. Internal doors also need draught-proofing if they lead to a room you don't normally heat.

[Source: Energy Saving Trust](#)

Similar to windows, the performance of doors can be significantly improved with tight-fitting seals arounds all edges. It also helps to remove or provide airtight covers for letter slots and keyholes. On traditional panelled doors, thin-profile insulation such as 'Aerogel' blanket can be fitted on the internal face of panels (because the panels are generally thinner than the main body) without changing the external appearance.



Measures: Ventilation

Airtightness

Airtightness is aimed at stopping uncontrolled movement of air by closing gaps and cracks in the building fabric, in windows and doors, or around cables and pipes, through which warm air can escape and cold air get in.

[Source: Homebuilding & Renovating](#)

Airtightness goes beyond draught-proofing, it's about minimising gaps in every part of the fabric. Behind skirting boards and cornices, the edges of window and door frames, around power sockets or cables, all are common points of failure. Even a skim coat of plaster on walls and ceilings can help. Airtightness is measured using 'blower door' and 'smoke pen' tests. Old houses tend to be very leaky testing at 15 'air-changes' or higher, while new homes typically test at 5 - 7. The highly efficient Passivhaus standard requires 1 or lower.



Measures: Ventilation

Condensation

After adding a warm layer of insulation to your home, moisture from daily household activities (bathing, drying clothes, cooking, and breathing) is now trapped inside. This excess moisture could cause condensation in any cooler area which has potential to lead to mould and health problems. To avoid this, you should install effective ventilation to allow your home to breathe.

[Source: Changeworks](#)

Increased risk of condensation and mould is the downside of better insulation and airtightness, the importance of which is often overlooked during the retrofit process. It is exacerbated by many modern building materials that don't 'breathe' (allow the free passage of moisture). Traditional solid-walled buildings were designed to allow moisture movement so need special care.



Measures: Ventilation

Whole house ventilation

A whole house ventilation system may include intermittent extract fans, mechanical ventilation with heat recovery, combined with background ventilators. These systems ensure extraction of moist air and supply of fresh air, crucial for maintaining indoor air quality and preventing condensation after energy efficiency retrofits.

[Source: Airflow quoting PAS2035 Ventilation Assessment](#)

Making sure there is adequate ventilation can involve simple measures: ‘intermittent extract fans’ means cooker hoods and bathroom fans; ‘background ventilators’ means trickle vents or windows that can be cracked open. Good cross ventilation, including high-level windows or rooflights to vent hot air, help to ‘purge’ stale air overnight and prevent overheating. The point is this needs to be planned, it doesn’t just happen.



Measures: Ventilation

Heat recovery ventilation

Heat recovery ventilation extracts stale humid air from 'wet' rooms (bathrooms, kitchen, utility) and passes it over a heat exchanger that recovers 80% of the heat. Another duct draws fresh air from outside, filters it, then passes it over the heat exchanger, to supply warmed fresh air to living areas and bedrooms.

[Source: Homebuilding & Renovating](#)

This mechanical ventilation system is often used in buildings with very high levels of airtightness (e.g. Passivhaus) where natural ventilation is not adequate to ensure air quality, and to maximise energy efficiency, but it can be used in any house. It has added benefits of distributing heat evenly through all rooms, stopping mustiness, filtering pollutants and pollens, and allowing windows to stay closed in noisy locations.



Measures: Energy

Alongside ‘fabric first’ measures we need to overhaul our energy systems, making sure we use energy as efficiently as possible and decarbonising energy supply. The way we use energy in our homes is still largely derived from the expansion of the national electricity grid and the introduction of gas or oil boilers in the 1950s & 60s, but that is now rapidly changing with modern technology and renewable energy.

Renewable energy

- Renewable electricity
- Decarbonised heat

Energy management

- Heating controls + insulation
- A-rated light fittings + appliances
- Energy tariffs

More detail about heating options are provided in a separate presentation:
[Decarbonising Heat](#)



Measures: Renewable Energy

Renewable electricity

If you generate renewable electricity at home, you can use it to power electrical appliances, or even an electric vehicle. This lowers the amount of electricity you import and pay for. Combining renewable energy with energy storage means you make more use of the energy you generate.

[Source: Energy Saving Trust](#)

For many households, ‘electrify everything’ will be the best approach: heat pumps, induction cookers, electric vehicles, all require electricity. Solar panels can make a major contribution to that energy use, especially if the system includes a battery to store electricity generated during the day for use at night. Solar panels are often on the house roof but can be on outbuilding roofs or ground based frames. A standard single-phase grid connection can take up to 4kW generation.



Measures: Renewable Energy

Decarbonised heat

Heating is central to our lives. We rely on it for comfort, cooking and washing. It is the biggest reason we consume energy in our society. Less than 5% of home heating is currently low carbon.

[Source: Energy Systems Catapult](#)

Heat pumps will be the obvious choice for many houses, especially if it can be connected to existing central heating radiators, but there are alternatives. Smaller well-insulated houses could use electric storage heaters, whilst larger older 'leaky' houses might be better with a biomass boiler. There are also 'heat batteries' or 'solar thermal' panels that can help with hot water supply. At the community level, Heat Networks are expected to be used in 20% of UK houses by 2050 with heat supplied from a local energy centre via underground pipes.



Measures: Energy Management

Heating controls + insulation

Heating controls includes timers, thermostats, plumbing and electronic components. They help manage when the heating should be on and what temperature rooms should be. Heating controls are improving all the time, but research shows that few people understand their controls.

[Source: Energy Saving Trust](#)

Even if you are not replacing the current heating system it may be worth updating controls, and learning how to use them: just turning down the central heating flow temperature can make a big difference. Modern systems allow a higher level of control, including responsive to the weather and remote operation. Meanwhile, better insulation of hot water cylinders and pipes ensures heat is not wasted, which will reduce energy demand.



Measures: Energy Management

A-rated light fittings + appliances

Energy efficient lighting helps lower electricity bills and carbon dioxide emissions, all without reducing the quality of light in our homes. You can also use sensors or timers on external lights, so they are only on when they need to be.

[Source: Energy Saving Trust](#)

Even if you are not upgrading the insulation of your house, you can reduce energy use by installing light fittings and appliances with high energy efficiency ratings. For lighting that simply means swapping incandescent bulbs for LED, though sometimes the fitting is best replaced. For cooking, install an induction hob and fan-forced or microwave oven. Even within those products there is a wide range of efficiency levels so check the rating labels.



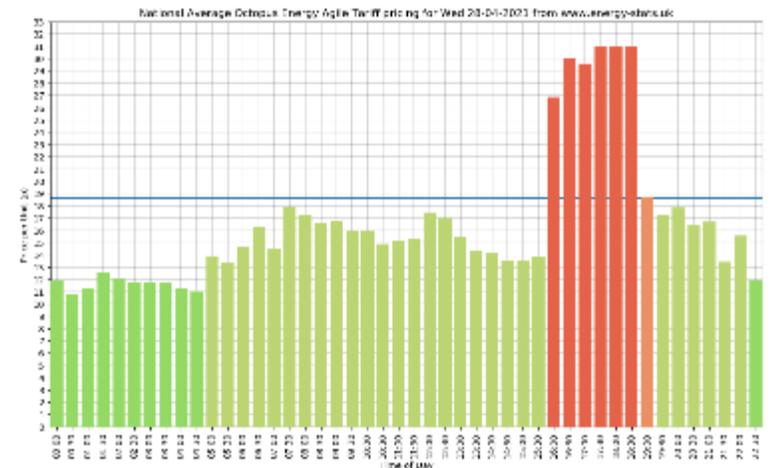
Measures: Energy Management

Energy tariffs

The biggest savings for people with heat pumps can be made by switching to a time-of-use-tariff or a heat-pump-tariff. Your savings will come more quickly if you're using a dedicated tariff.

[Source: WHICH magazine](#)

Because we are changing the way we use energy it makes sense we reconsider how we pay for it. Heat pumps should be left running 24/7, electric vehicle charging is best done in the middle of the night, but solar panels will be generating most on a hot summer day. Does someone have a health condition that needs a constant high temperature, or do you travel for work and are rarely home? Energy companies are starting to offer deals aligned with these different customer needs. The right tariff can significantly reduce the payback period for some measures.



Retrofit Process

Q. Balance between Fabric First v Decarbonising Heat?

- Fabric First: greater upfront £ + more disruptive but reduces whole life costs + enhances resilience.
- Decarbonising Heat: simpler process + immediate CO2 reduction but no guarantee for future energy £.

A. The balance will vary for every house.

- Do whatever energy efficiency improvements you can manage and afford even if your house is classed as ‘heat pump ready’ as this will always reduce your total energy demand and ongoing bills.
- Don’t forget ventilation which may already be compromised.
- Don’t forget any repairs needed to the building fabric.
- Heat pumps are becoming the default to replace gas and oil boilers but they will not be the best option for every house e.g. is a local Heat Network likely.
- Consider energy use in the house as a whole e.g. will improving airtightness make enough difference to reduce peak demand on the heating system, or plan to install solar panels + battery to help power a heat pump.

Thanks

During the course of this project, we have consulted with various organisations, government agencies and businesses, and have engaged with many different communities across the region. We would like to take this opportunity to thank them all for their invaluable advice, assistance and encouragement.

We hope you find this presentation helpful to understand what the retrofit process is about and how it might apply to your home.

Glossary

- LHEES** Local Heat and Energy Efficiency Strategy, the Scottish Government policy that requires all Local Authorities to develop a strategy for decarbonising buildings in their area.
- Net Zero** Cutting carbon emissions to a small amount of residual emissions that can be absorbed by nature, or Carbon Capture and Storage (CCS), leaving zero change in atmospheric levels.
- Retrofit** Where new features and technologies are added to existing buildings. To achieve Net Zero that means anything that will make buildings more energy efficient or climate resilient through measures such as better insulation and installing renewable energy equipment.
- Passivhaus** Certification scheme for buildings that provide very high levels of energy efficiency through things like insulation and airtightness. This can reduce the need for space heating to the extent that a conventional heating system is not needed.
- Airtightness** A measure of how well sealed the building fabric is. Airtightness is measured by how many air changes per hour occur when all doors and windows are closed.
- Blower Door** The Blower Door test is a way to measure airtightness. A fan is temporarily fitted across an external door opening and sucks air from the house, with the fan rate adjusted until incoming and outgoing air flow is balanced.
- Smoke Pen** This is a small pen-like device that burns a wick to release smoke (similar to an incense stick). This is used during an Airtightness test to locate points of air leakage.
- Thermal Image** Special cameras can be used to identify the location and level of heat loss from building fabric. The test has to be done during cold weather with the house heating system on in all rooms to create a heat differential with the outside, and is done at dusk or early evening.

Useful links

- For information about the Scottish Borders Local Heat and Energy Efficiency Strategy and Delivery Plan please visit: scotborders.gov.uk/lhees
- To view information and guidance on community engagement provided by Scottish Borders Council please go to: scotborders.gov.uk/say/community-engagement or email the team at communityengagement@scotborders.gov.uk
- South of Scotland Enterprise (SOSE) provide a range of services for enterprising communities, see: southofscotlandenterprise.com/community
- Scotland's Heat Network Fund overview and guidance for communities, see: gov.scot/publications/heat-network-fund-application-guidance/
- Heat in Buildings Strategy, see: gov.scot/publications/heat-buildings-strategy-achieving-net-zero-emissions-scotlands-buildings/
- Home Energy Scotland (HES) energy and funding advice for homeowners: homeenergyscotland.org
- Business Energy Scotland (BES) offers business support: businessenergyscotland.org
- Local Energy Scotland (CARES) provides support for community schemes: localenergy.scot
- LETI is one of many organisations across Scotland and the UK producing guidelines for Retrofitting houses: leti.uk/retrofit

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***This project has been funded by UK Government
through the UK Shared Prosperity Fund***



**Funded by
UK Government**

