Part 2c

Modern house | A retrofit guide for residents

September 2024 | Rev R

Edwardes Square, Scarsdale and Abingdon Association (ESSA)

THE ROYAL BOROUGH OF KENSINGTON AND CHELSEA
Funded by RBKC NCIL

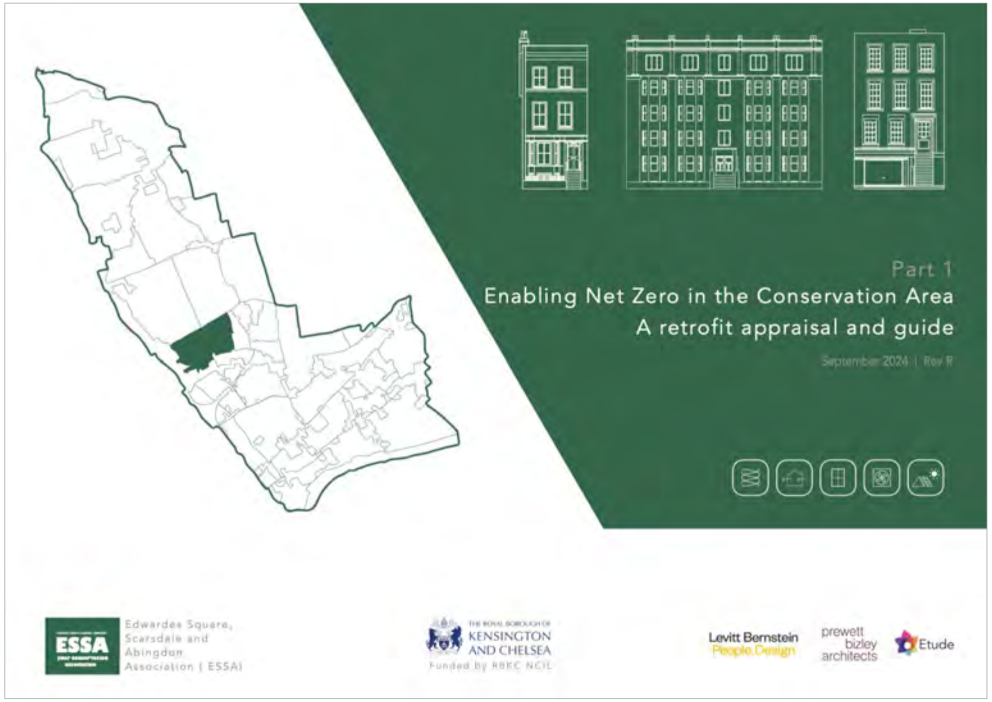
Levitt Bernstein People.Design
prewett bizley architects
Etude

Retrofit guidance developed for the ESSA Conservation Area

This guidance document is part of a suite of four documents developed by Levitt Bernstein, Prewett Bizley and Etude for the ESSA Conservation Area association. These documents have been developed in order to explain what retrofit means and how residents in the area can improve their homes while reducing its carbon emissions by more than 90%.

The ESSA conservation area association and the authors of these documents are very grateful for the support of the Royal Borough of Kensington and Chelsea.

__Important note:__ These documents will hopefully provide a helpful starting point for residents. However, the words and other content provided in these documents are not intended and should not be construed as specific professional advice for their homes. When residents decide to undertake any type of retrofit work to their homes, they should consult with an appropriately qualified building professional and develop a specific retrofit plan.



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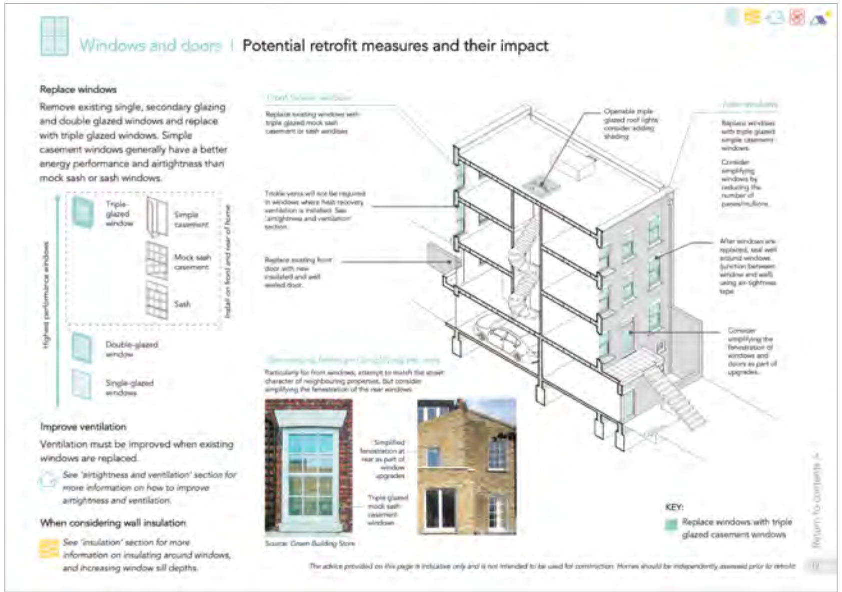
How to use this guide?

Simple graphical summary pages

Section 2.0 is a visual guide to retrofit solutions for the archetype. It will help you to understand, on a theme by theme basis, the key retrofit measures that are possible to improve your home and put it on track to Net Zero.

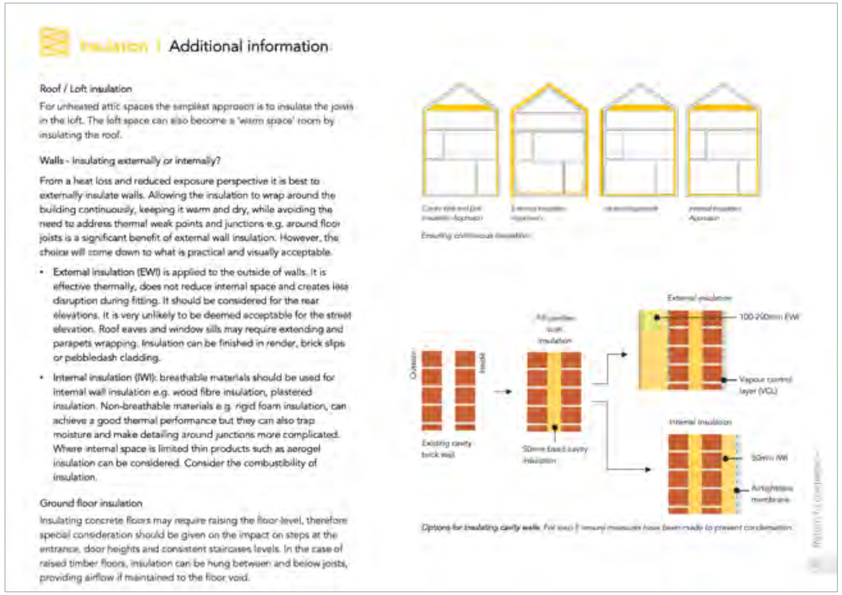


Summary page on windows (from Section 2.0) explaining which window improvements should be considered. Note the different approach to front and rear elevations.

Additional information

If you want to find out more about any of these measures, you can go to Section 3.0.

Further guidance and information is also signposted in Section 4.0.



Summary page on insulation (from Section 3.0) explaining the different approaches to insulation and how they can be applied to roofs/lofts, external walls and ground/basement floors.

Interactive navigation

It is easy to navigate between the different sections and pages of this report. Please use the links at the top and right hand side of the page to explore this guide like a website!

A return to contents button is also available >

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1.0

Introduction to retrofit and this guide for residents

Retrofitting our homes over the next 30 years is crucial to mitigate their impact on climate change and move away from fossil fuels. It will also help our homes to become better, more comfortable and healthier.

Before explaining what can be done in section 2.0, this section introduces the concept of retrofit and how this guide was designed to be useful to you.

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Why retrofit?

Decarbonising our homes is key to Net Zero

England currently has some 25 million homes. Between now and 2050 another six million new homes will be built. This means that 80% of the homes that will be present in 2050 have already been built.

If we are to successfully decarbonise housing, retrofitting is essential: we need to increase our homes' energy efficiency, change their gas or oil heating system for a low carbon heating system (e.g. heat pump) and generate more renewable energy on their roofs.

Reducing fuel bills alongside carbon emissions

Whilst decarbonising homes is important to mitigate climate change, it is not the only reason to retrofit. Much lower energy bills are possible. Retrofit will help avoid wasting money too.

Health and wellbeing

Improving the energy efficiency of a home is also likely to significantly increase thermal comfort (both in summer and in winter) and improve indoor air quality through better ventilation. This will have a positive impact on everybody, but especially small children, the elderly and those with respiratory conditions.

Better homes

All homes need regular maintenance and retrofitting will help with this. Poorly maintained windows, brickwork and roofs all represent weak points which retrofit will address.

Adding value to your home

It is likely that a poor energy efficiency rating or the use of a fossil fuel heating system will gradually impact a property value over the next few years. More positively, there is growing evidence that buyers are now ready to pay a premium for energy efficient, comfortable and low carbon homes.

Residents and organisations in the ESSA Conservation Area have a key role to play in putting their homes and buildings on track to Net Zero, and mitigate their impact on climate change

The United Kingdom is legally committed to achieve Net Zero by 2050. The Climate Change Committee provides useful supporting information on how this should be achieved (e.g. Future of Housing report, 2019). Other organisations promote the large scale retrofit of our homes in the next 20-30 years (e.g. Construction Leadership Council's Greening our existing homes publication)

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Introducing the retrofit measures

Energy efficiency

Our homes use energy for heating, hot water, ventilation, lighting, cooking and appliances. The efficient use of energy reduces running costs and carbon emissions. It also facilitates a transition to low carbon heating system, and it reduces a building's impact on the wider energy supply network by lowering demand.

Improving energy efficiency relies on the improvement or the replacement of windows with more efficient ones, a better level of insulation and airtightness for the building fabric and the integration of controlled ventilation, ideally with heat recovery, to ensure air quality and avoid condensation issues.

Low carbon heating

Low carbon sources of heat are an essential feature of Net Zero carbon buildings. Existing buildings need to start to undergo a complete transition away from fossil fuel heating, in particular gas boilers. The most likely solutions will use electrical heating systems, such as heat pump systems, electric radiators or storage heaters.

Gas hobs should also be replaced with cleaner lower carbon induction hobs.

Renewable energy generation

While the increasing proportion of renewable energy generation in the UK's electricity mix is one of the success stories in recent years, the roofs of buildings should be utilised to install solar photovoltaic panels (where possible) to contribute to an even greater generation of renewable energy. This will also directly benefit residents through lower energy bills.

Demand flexibility

With electricity being used more and more to meet heating demand and with more renewable electricity being generated locally, the ability of a dwelling to manage demand with more flexibility is becoming important.

Category	Example of retrofit measure
Windows	• Triple glazed casement windows • Triple glazed 'mock' sash windows • Evacuated glazing • Advanced secondary glazing • Double glazed casement windows • Double glazed sash windows
Airtightness & Ventilation	• Draughtproofing and airtightness • Mechanical extract ventilation • Mechanical supply and extract ventilation with heat recovery
Insulation	• Loft insulation • Cavity wall insulation • External wall insulation • Internal wall insulation • Ground/basement floor insulation
Low carbon heat	• Heat pumps • Direct electric heating • Hot water cylinder
Solar PVs	• Solar panels on roofs

Key potential retrofit measures generally used to improve energy efficiency, decarbonise heat, generate renewable energy on-site and use energy more flexibly.

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Making retrofit simpler through the use of archetypes

This document is for anyone living within the ESSA Conservation Area who is interested in making their home more energy efficient, less carbon intensive and more comfortable and healthy.

Which retrofit measure is right for my home?

The large number of potential retrofit measures can be overwhelming for residents. This is why this guide has been developed for three different archetypes (see adjacent diagrams).

We have identified and grouped together the solutions which are likely to be suitable for each archetype in order to provide residents with a useful starting point. Our associated analysis also shows the magnitude of change that these retrofit measures can make. It is written as far as possible in non technical language and aims to demystify what can feel like a daunting complex subject.

The three retrofit archetypes in the ESSA Conservation Area

ESSA identified three typologies within the Abingdon Ward, which were used to develop the retrofit archetypes and their associated retrofit templates. Although our work has been based on visits to specific dwellings (homeowners in the area have kindly opened their doors to us), it is important to note that these archetypes should be considered as 'typical'.

All homes are individual

While these archetypes cover the key differences that are found in the conservation area, it is not expected that they will match your home entirely of course. Each home is different due to its original design, its type of construction (e.g. solid wall or cavity wall), subsequent extensions and other alterations, the degree of repair/maintenance undertaken, its building services such as heating system and how it is occupied. Listed buildings also have specific constraints. It is therefore very important to consider this document as general guidance and to develop a specific retrofit plan for your home with building professionals.

Retrofit archetype 1

Victorian house archetype

Retrofit archetype 2

Mansion block archetype

Retrofit archetype 3

Modern house archetype

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Which retrofit archetype is the right starting point for your home?

The adjacent retrofit archetype map identifies which retrofit archetype is likely to be the closest match to the retrofit archetype for your home.

Retrofit archetype 1

Victorian house archetype and properties likely to require similar solutions to this archetype

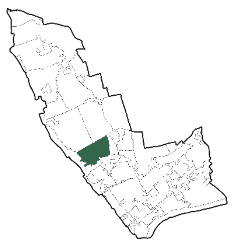
Retrofit archetype 2

Mansion block archetype and properties likely to require similar solutions to this archetype

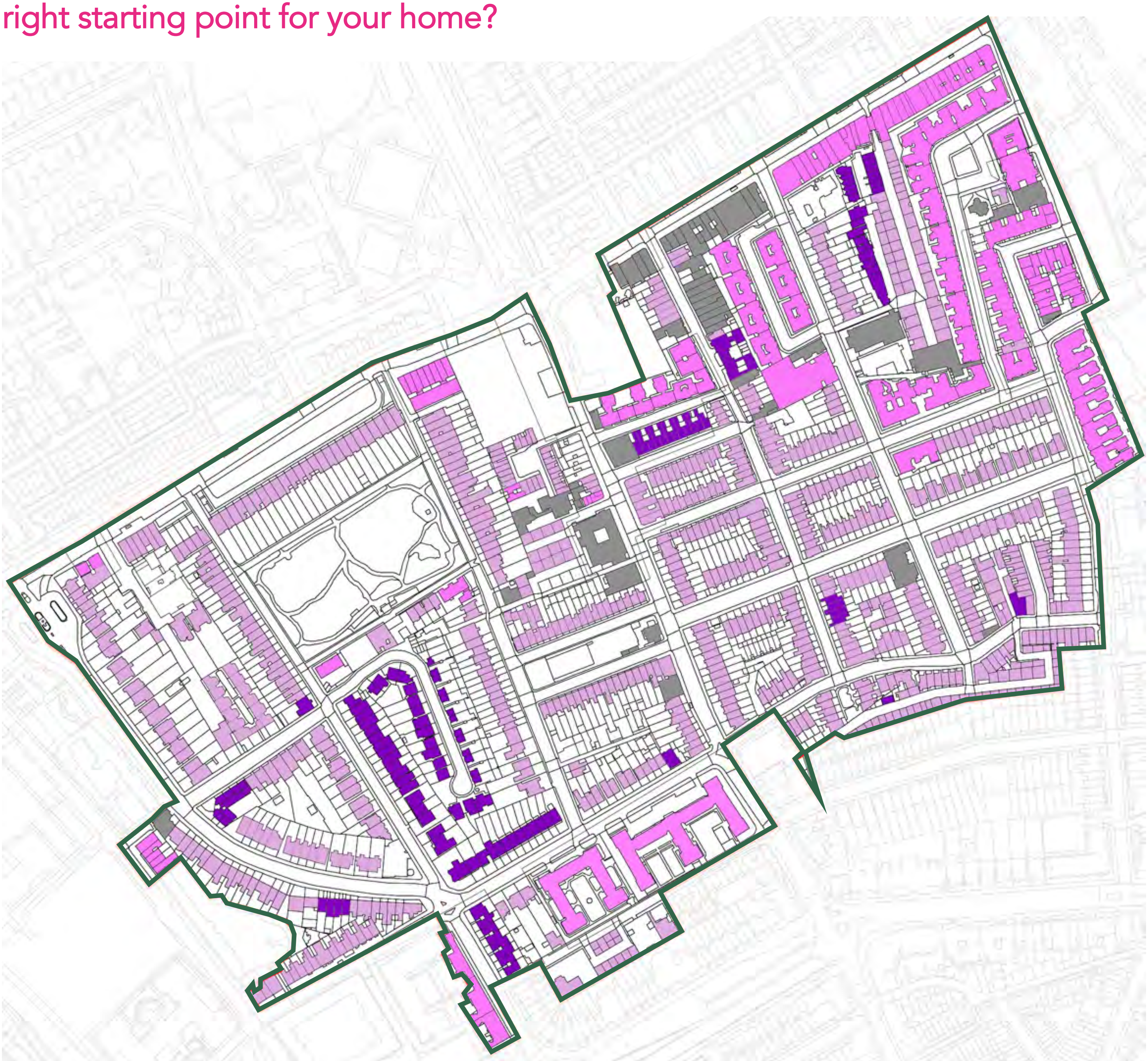
Retrofit archetype 3

Modern house archetype and properties likely to require similar solutions to this archetype

Non-residential



The ESSA Conservation Area in the Royal Borough of Kensington and Chelsea



The retrofit archetypes provided on this page are indicative only, based on best judgement. Homes should be independently assessed.

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Archetype 1 | Victorian house

A variety of characteristics and constraints are common to houses which form Archetype 1. This means that this archetype covers a range of different types of houses which may not look similar.

Residents are encouraged to use this guide as a starting point in understanding and planning their retrofit, rather than a prescriptive roadmap. The recommendations of this guide will have to be tailored to each house.

For example Pembroke Mews fall under Archetype 1 but the ground floor will require a different approach from other more typical Victorian houses in the area.

Lexham Mews

Pembroke Road

Warwick Gardens

Warwick Gardens - rear

Stratford Road

Earls Court Road - rear

Pembroke Mews

Pembroke Road

Abingdon Villas

Abingdon Road

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Archetype 2 | Mansion blocks

A variety of characteristics and constraints are common to blocks of flats which form Archetype 2, but this archetype covers a very wide range of different types of blocks of flats. As it can be seen from the images below, they do not share a similar appearance or style. They have been grouped into Archetype 2 as they are likely to require the same retrofit solutions.

Residents are encouraged to use this guide as a starting point in understanding and planning their retrofit, rather than a prescriptive roadmap. The recommendations of this guide will have to be tailored to each block of flats.

Pembroke Road

Pembroke Road

Pembroke Square

Pater Street

Wrights Lane

Wrights Lane

Cromwell Crescent

Abingdon Villas

Cheniston Gardens

Kensington High Street

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Archetype 3 | Modern house

A variety of characteristics and constraints are common to houses which form Archetype 3, which covers a wide range of different types of houses which may not look similar.

Residents are encouraged to use this guide as a starting point in understanding and planning their retrofit, rather than a prescriptive roadmap. The recommendations of this guide will have to be tailored to each house.

Cromwell Crescent

Pembroke Gardens

Warwick Gardens

Pembroke Gardens

Pembroke Road

Warwick Gardens

Cope Lane

Cope Lane - rear

Abingdon Road

Abingdon Road

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What is a whole house retrofit?

A whole house retrofit is a comprehensive plan for home improvements. Key issues such as air quality, damp, mould growth and ventilation are likely to be managed much more appropriately when retrofit is delivered as part of a structured plan instead of through a series of ad hoc interventions.

What are the main considerations?

It is now commonly agreed that retrofit should be done in a holistic manner which addresses the following key objectives:

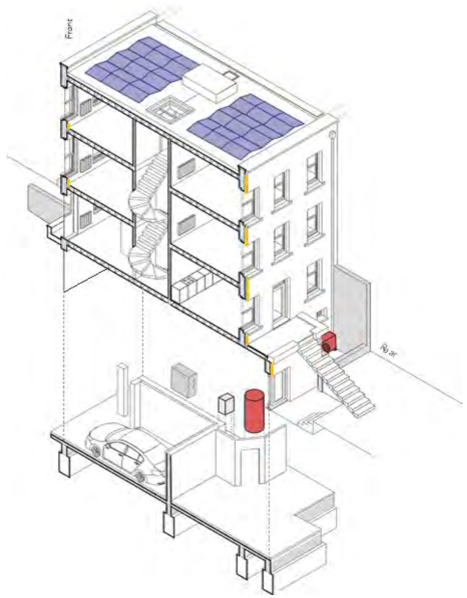
- Addressing existing building defects.
- Providing a continuous insulating layer.
- Developing a clear approach to interfaces, edges and junctions.
- Having a clear winter and summer ventilation approach.
- Providing a low carbon heating and hot water system.

What are the benefits?

The success of retrofit relies on ensuring improvements are undertaken in an organised, sensible order that complement each other and avoid unintended consequences. If you decide to develop a whole house retrofit plan for your home, you can expect to obtain an energy efficient and low carbon home that is in good repair, with very good ventilation and absence of damp.

Taking into account historic characteristics

A whole house retrofit needs to respond sensitively to historic characteristics. Not all measures may be appropriate in heritage terms in any given building.



Defining the end result instead of working out the next step of retrofit each time is one of the key objectives of a whole house retrofit plan.

It will help to maximise opportunities and reduce the risk of later improvements being made difficult by earlier work.

A whole house retrofit plan is a useful tool to prepare and provides a pragmatic and coherent way to deliver this ambition.

An example of a house fitted with various enhanced retrofit measures, including new double-glazed sash windows on the second floor, secondary glazing to the first and new double glazing into old frames on the ground.

Air tightness was implemented as part of the improvements, in this case along with window installation.

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How to start your journey

Delivering whole house retrofit, potentially in phases

Achieving all retrofit goals may take a number of different steps and they do not all have to be done at once, but it is very important to start with a map or 'pathway' of all the work that needs to be done. This is another benefit of the whole house retrofit plan.

A bespoke sequence of work

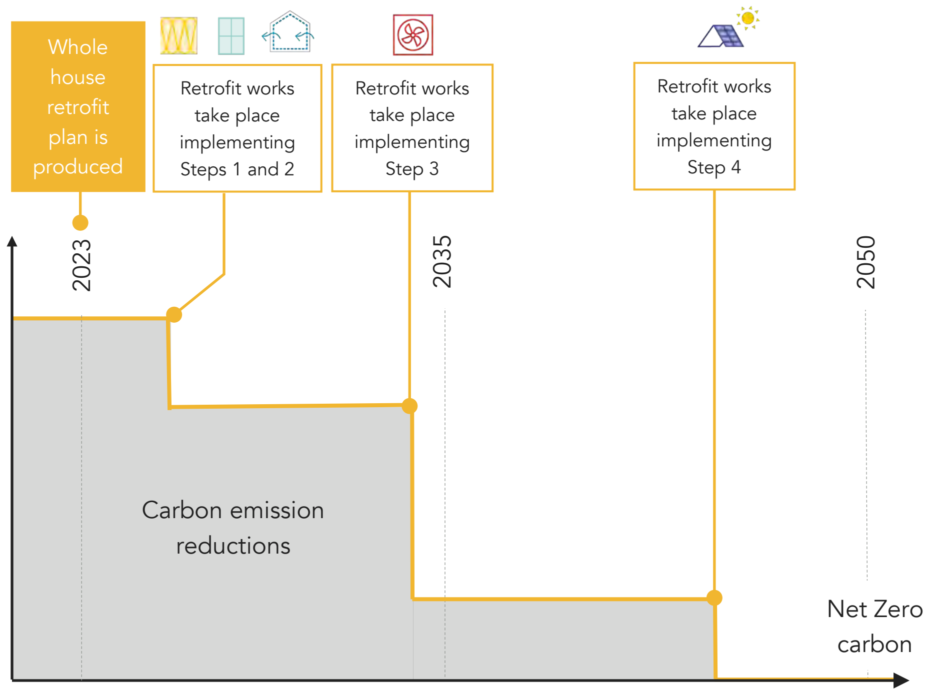
Each home is different, and each homeowner is unique, so each individual whole house retrofit plan will be bespoke. The steps needed may be similar, but the choices about what to do when may be influenced by financial, practical or maintenance considerations.

For instance, a busy family may want to do as much as possible at one time to avoid long term on-going work ongoing, but a couple on a fixed income may need to space the work out over a longer period to make it affordable. An equipment reaching the end of its life represents another example: if the boiler is very old and likely to fail, the heat pump work may be done earlier than where the boiler is fairly new.

Phasing improvements as part of coherent whole house plan

It may not be possible to implement all retrofit measures at once, but it is important to plan ahead so that packages of work are coherent and complementary. The preparation of a whole house plan is recommended to help in that planning. To lay it all out may seem quite daunting, but it helps to have thought about the bigger aims when planning each small part of the work, so you can check that what you do does not make it more difficult to do the next part.

Typical simple retrofit plan			Sequence factors	Cost considerations
	Step 1	Insulate loft	Needs to precede step 4	Grants may be available
	Step 2	Replace windows and improve ventilation	Ideally before step 3	High cost step so may not be afforded at the same time as step 3
	Step 3	Swap boiler for a heat pump	Ideally after step 2	High cost so may not be afforded at the same time as other measures
	Step 4	Install PV on the roof	After loft insulation is done	Smart meters should be installed at the same time to get access to the best tariffs



Note: the expected decarbonisation of the grid is not represented for simplicity but will also contribute to the reduction of carbon emissions over time.

Grasping the opportunity

A clear vision… with a pragmatic start

Planning the long term phased retrofit of your home may seem daunting but it does not have to be. The whole house retrofit plan is more about starting to see our homes and the work which they will require over time in a different way than about planning a long and disruptive journey.

Help and advice from retrofit professionals

The best way to plan the retrofit journey is to work with retrofit professionals. There is a range of help available from retrofit advisors, retrofit coordinators and architects with expertise in retrofit. These professionals will also be able to recommend the type of survey and energy audit you need to inform your retrofit plan.

Think about the work you need to do for maintenance

All homes need maintenance work from time to time, such as replacing a broken boiler or leaky windows, and we all carry out various improvement works when we can, such as upgrading a bathroom or replacing the kitchen. Each time you are considering this type of work, look at the overall plan and consider whether you can bring some part of it into the work at hand.

Grasping the opportunity

When considering the lifetime of a house, there are not many times when major improvements can be made. An extension is a fantastic opportunity to make a significant step towards Net Zero carbon and not locking in poor/high carbon decisions. If you are considering this type of work, please grasp the opportunity to see it as part of a whole house retrofit plan.

The importance of quality

Quality control is important at all stages of your retrofit, and the details of the product specified will be required for planning. PAS 2035 is a standard on how to conduct effective energy retrofits..

Maintenance item/ Trigger point	Retrofit measures to action or consider ☐ Critical (move away from fossil fuels) ☐ Desirable
Boiler replacement	• Replace with a heat pump system* (or direct electric heating if not feasible). No new gas boiler. • Plan improvements required to reduce the amount of heat needed to keep the home warm.
Cooking	• Replace gas cookers with an induction hob and all electric cooking. No more gas cooking. • Replace the cooker hood with one that works with the type of ventilation planned for the home.
Windows & door replacement	• Upgrade windows* with the best type available – this may be different for the windows at the back of the house and those facing the street. • Replace external doors* with ones that are insulated and that reduce draughts. • Make sure that windows* and doors* are installed with very good seals with the wall around them.
Roof repair (tiles, flat roof)	• Add more roof insulation and make sure any draughts are stopped. • Consider installing a PV system* to generate electricity.
External insulation	• If possible, install external wall insulation* – this may only be possible for some walls (e.g. rear elevation) • Upgrade windows* while there is access
Replastering wall or ceiling	• Add internal wall insulation to external walls where external insulation is not allowed while the room is cleared and before redecorating. • Check for draughts and seal any gaps
Electrical wiring	• Make sure there is spare capacity to allow for heat pump* or direct electric heating to be added. • Make sure there is spare capacity for electric car charging

** These measures are likely to require planning permission.*

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2.0

Modern house retrofit archetype: Key retrofit measures

The following pages summarise the likely weaknesses of this type of house and which retrofit measures are suitable to put it on track to Net Zero while improving comfort (temperature and noise) and air quality.

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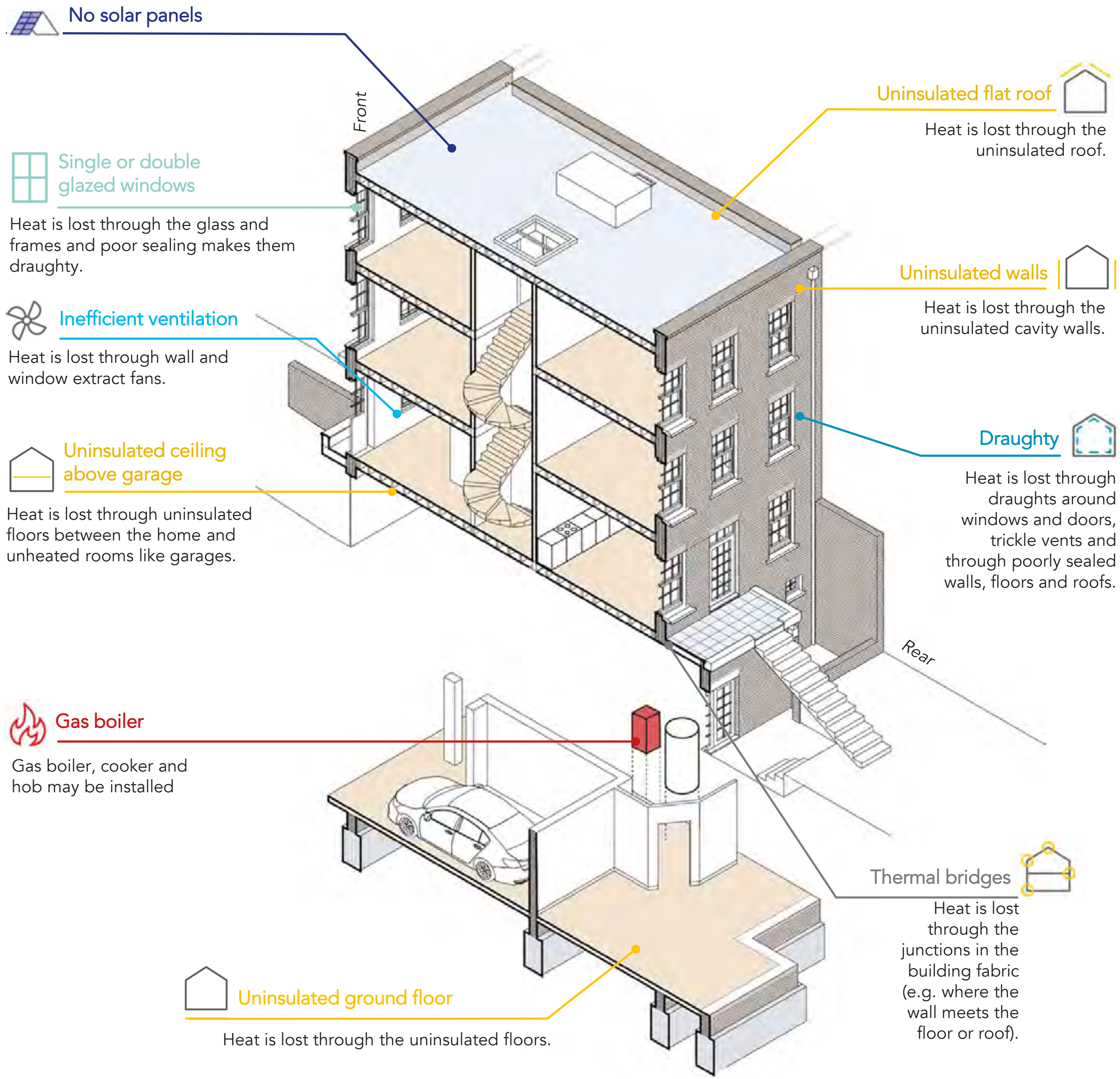
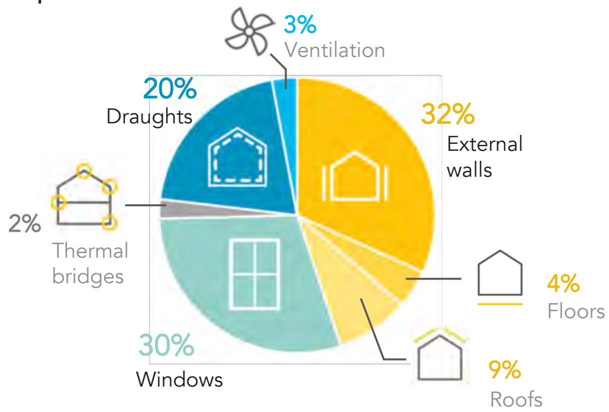
Existing modern terrace house and its weaknesses

Reasons to consider retrofit:

- The home can feel cold in winter with high heating bills, due to poor insulation, inefficient windows and draughts.
- Inefficient and poor ventilation leads to high humidity levels and a risk of condensation and mould growth on windows and walls.
- Gas is a fossil fuel and therefore not a green/clean source of energy. It also contributes to local air pollution.
- No renewable energy on-site – a missed opportunity to save money on energy bills and generate energy for use in the home.



Proportion of heat loss in the home:



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A better, healthier and more comfortable house on track to Net Zero

To put your house on track to achieve Net Zero, reduce energy bills and improve comfort, the following interventions are recommended:

Insulate the roof with 200-300 mm of insulation.

Insulate the ceiling and walls between garage and home.

Replace single and double glazed windows with the triple glazed simple casement windows (subject to conservation and planning constraints).

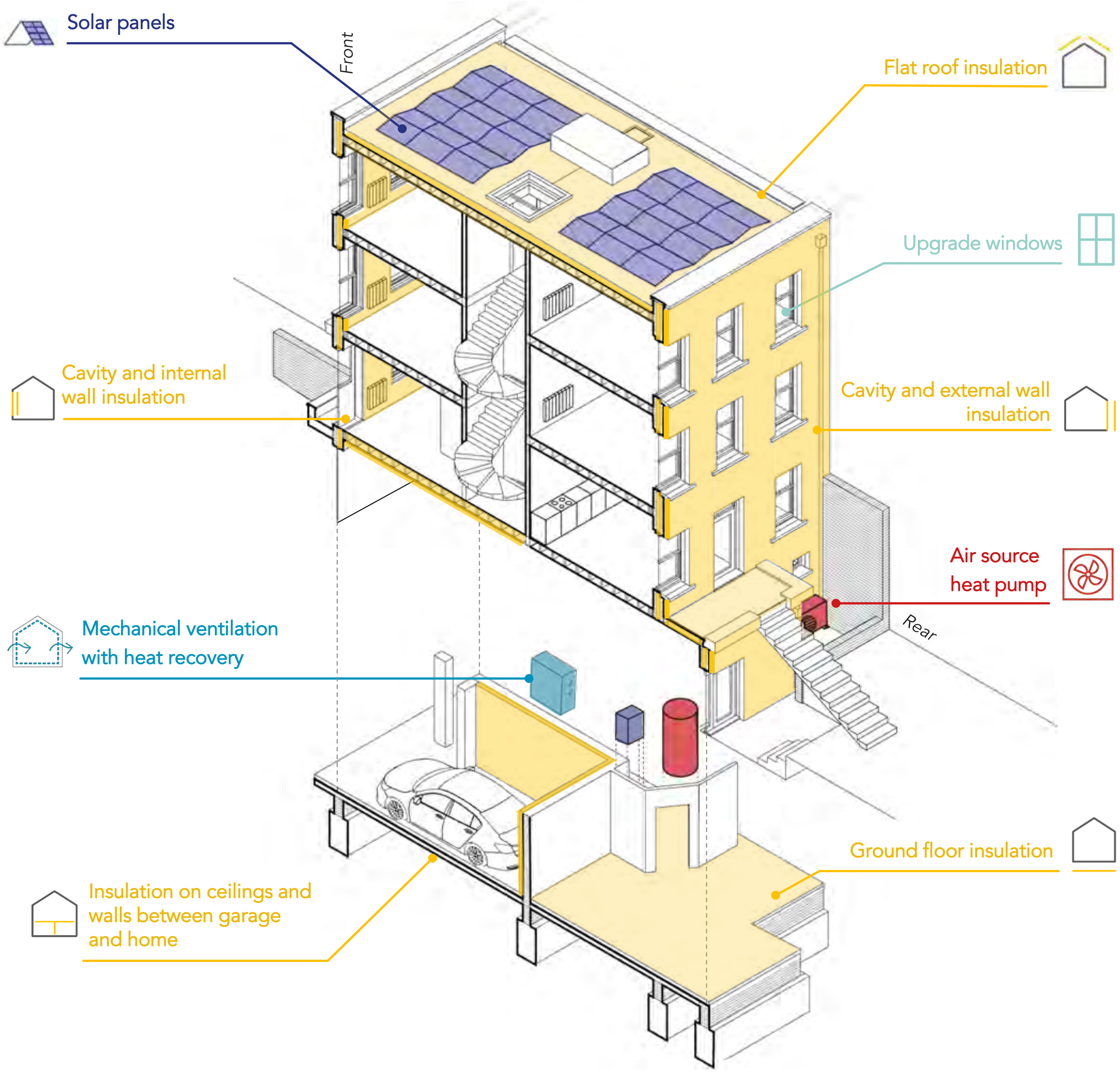
Reduce air leakage and introduce effective ventilation to ensure air quality.

Remove gas boiler and replace with a heat pump. Disconnect from the gas grid. Install an induction hob and electric cooker in the place of gas hobs and cookers.

Install solar photovoltaic panels on the roof to generate electricity. Carry out works as soon as roof access is available, as part of adding insulation or carrying out roof repairs.

Insulate walls to improve energy efficiency further. This is likely to require internal insulation at the front and external insulation at the back (where possible and subject to planning permission).

Ideally insulate the ground floor.



The advice provided on this page is indicative only and is not intended to be used for construction. Homes should be independently assessed prior to retrofit.

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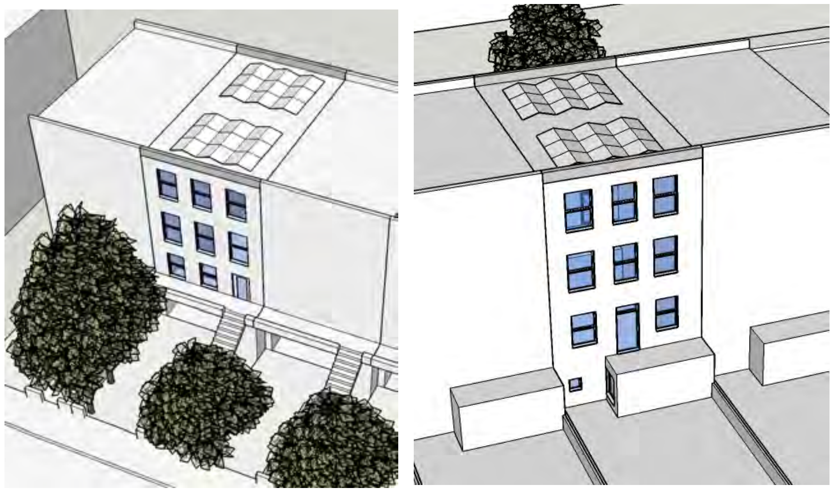
A better, healthier and more comfortable house on track to Net Zero | Numbers

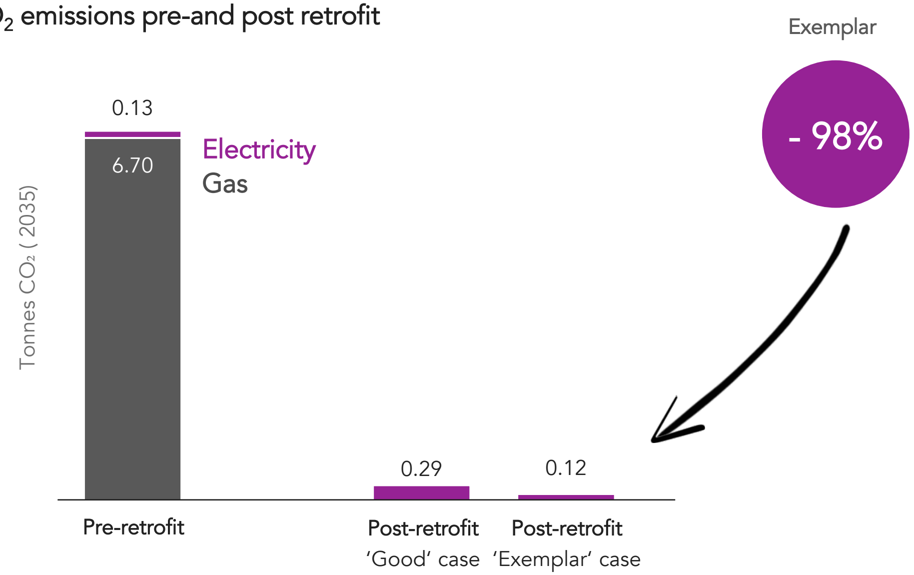
Retrofit can have a transformational impact:

- Energy use can be reduced by 80%.
- Solar panels on the roof can generate nearly two thirds of the total house annual energy use.
- Carbon emissions can be reduced down to nearly zero.
- The house can be disconnected from the gas grid, moving away from fossil fuels.
- Improved thermal comfort, healthier indoor environment and reduced overheating risk.
- The cost of retrofit is likely to be between £50,000 and £150,000.



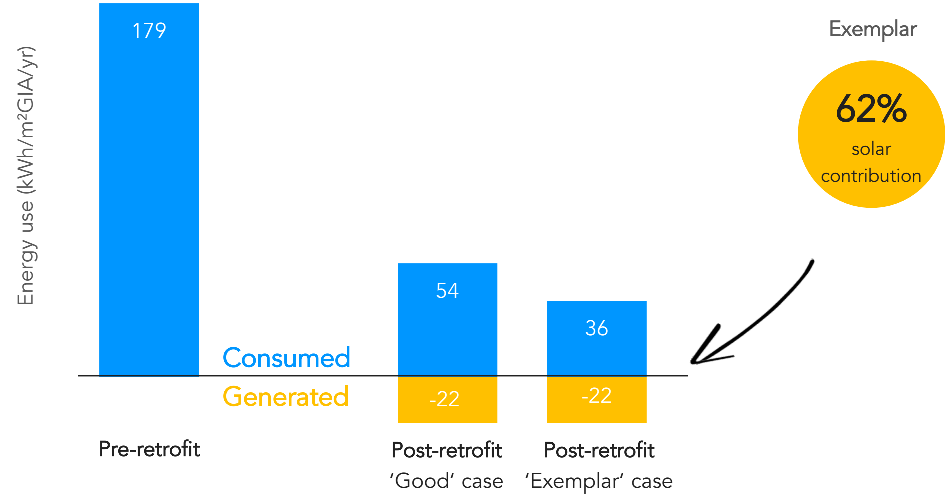
Screenshots of the energy model (DesignPH for PHPP). The energy model is instrumental is estimating what the house would need and how effective the various measures will be at reducing energy use, carbon emissions and costs

CO_2 emissions pre-and post retrofit



The reduction in energy use shown below combined with the move away from gas heating and the introduction of solar panels has a huge impact on the CO_2 emission savings.

Energy use pre- and post-retrofit



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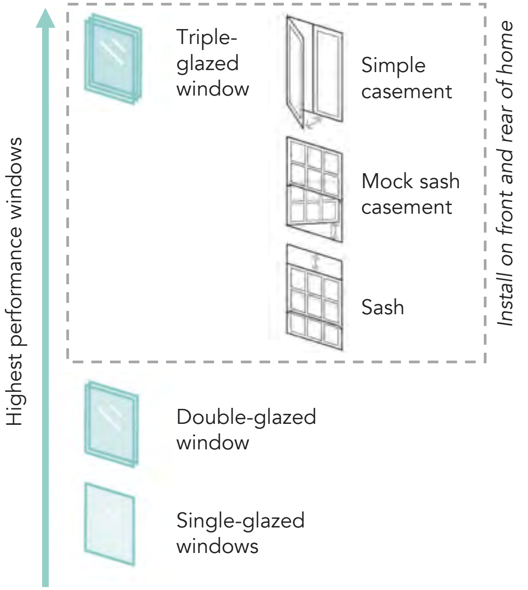
More on windows >

Replace windows

Remove existing single, secondary glazing and double glazed windows and replace with triple glazed windows in line with local character. Simple casement windows generally have a better energy performance and airtightness than mock sash or sash windows.



Improve ventilation

Ventilation must be improved when existing windows are replaced.

See 'airtightness and ventilation' section for more information on how to improve airtightness and ventilation.

When considering wall insulation

See 'insulation' section for more information on insulating around windows, and increasing window sill depths.

Front façade windows

Replace existing windows with triple glazed mock sash casement or sash windows.

Openable triple glazed roof lights - consider adding shading

Rear windows

Replace windows with triple glazed simple casement windows.

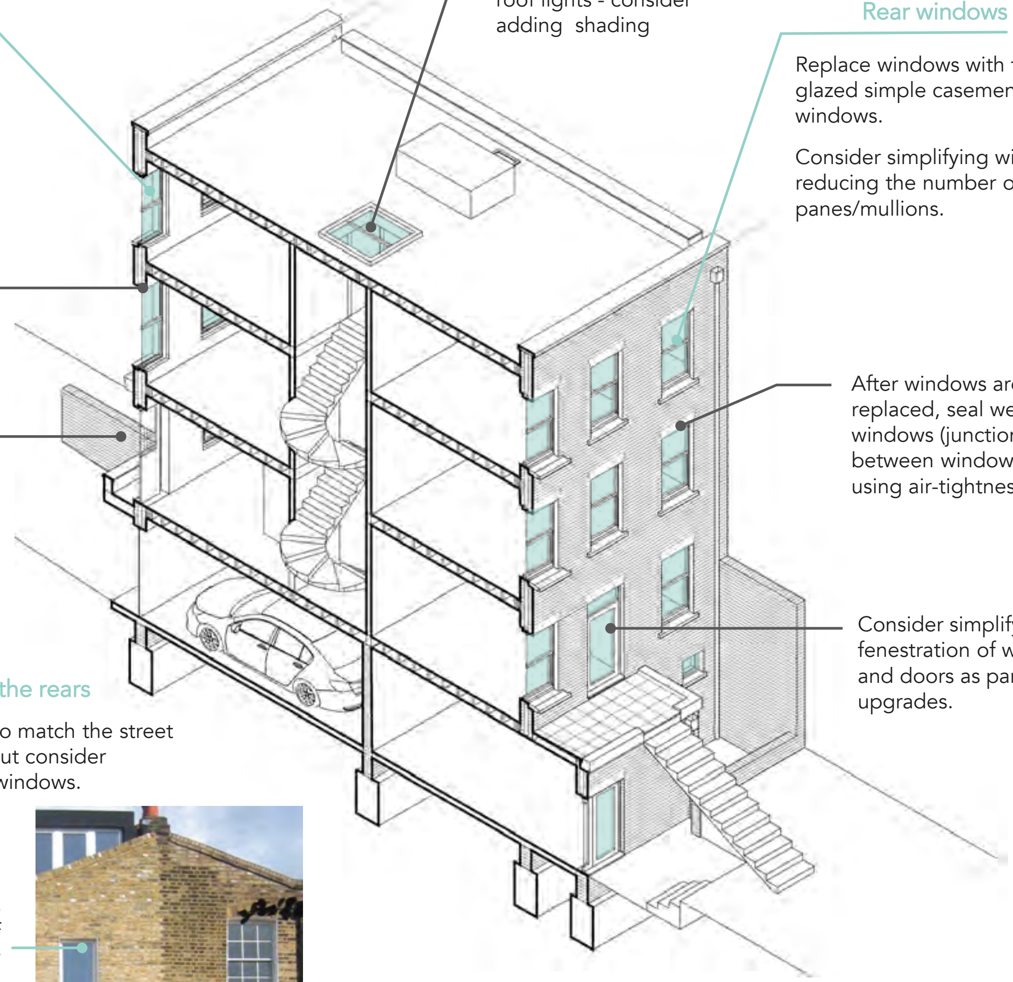
Consider simplifying windows by reducing the number of panes/mullions.

Trickle vents will not be required in windows where heat recovery ventilation is installed. See 'airtightness and ventilation' section.

Replace existing front door with new insulated and well sealed door.

After windows are replaced, seal well around windows (junction between window and wall) using air-tightness tape.

Consider simplifying the fenestration of windows and doors as part of upgrades.

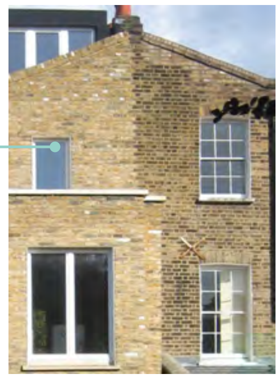


Harmonising fronts and simplifying the rears

Particularly for front windows, attempt to match the street character of neighbouring properties, but consider simplifying the fenestration of the rear windows.

Simplified fenestration at rear as part of window upgrades

Triple glazed mock sash casement windows



Source: Green Building Store

KEY:

Replace windows with triple glazed casement windows

The advice provided on this page is indicative only and is not intended to be used for construction. Homes should be independently assessed prior to retrofit.

More on insulation >

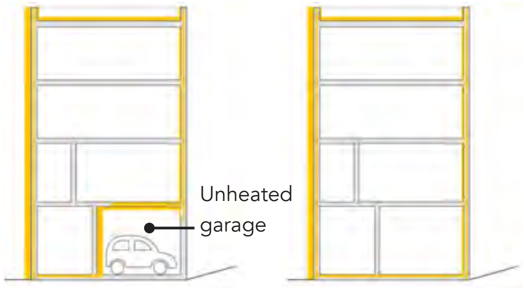
Insulation | Potential retrofit measures

Wrapping the home to keep it warm

The roof should be insulated first as part of repairs and waterproofing. Insulate easy to access areas such as wall and ceiling between garage and home.

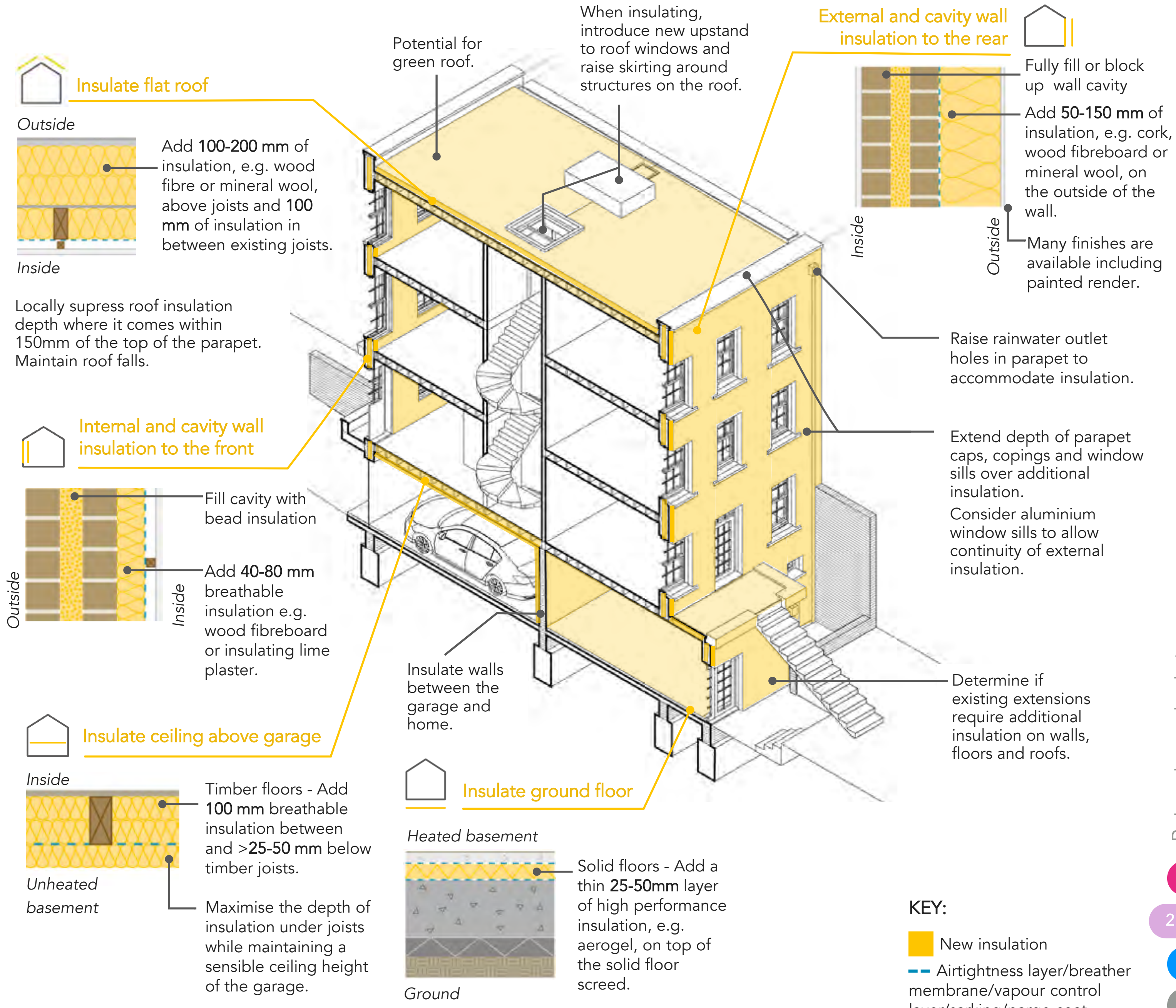
Wall insulation is likely to differ between the front and rear of the home. Consider installing internal wall insulation to fronts of homes and external wall insulation to the rear and end walls cognisant of local character (subject to planning permission). Insulate ground floors where possible.

The aim is to wrap the home continuously with insulation between floor, walls and roof with no breaks.



Practicality tips

- Asses the building for damp and remediate before installing wall insulation.
- Remove and refix copings, flashings, drainage and downpipes after installation of external roof and wall insulation.
- Re-point external brick work to prevent water ingress.
- Move and refit fitted furniture, radiators and plug sockets during the installation of internal wall insulation.



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Airtightness and ventilation | Potential retrofit measures

More on ventilation >

Well sealed

Begin by reducing draughts and heat loss by improving the airtightness of the home. Common areas of air leakage are around windows and doors, as well as from suspended timber floors and junctions between walls, floors and roofs.

Well ventilated

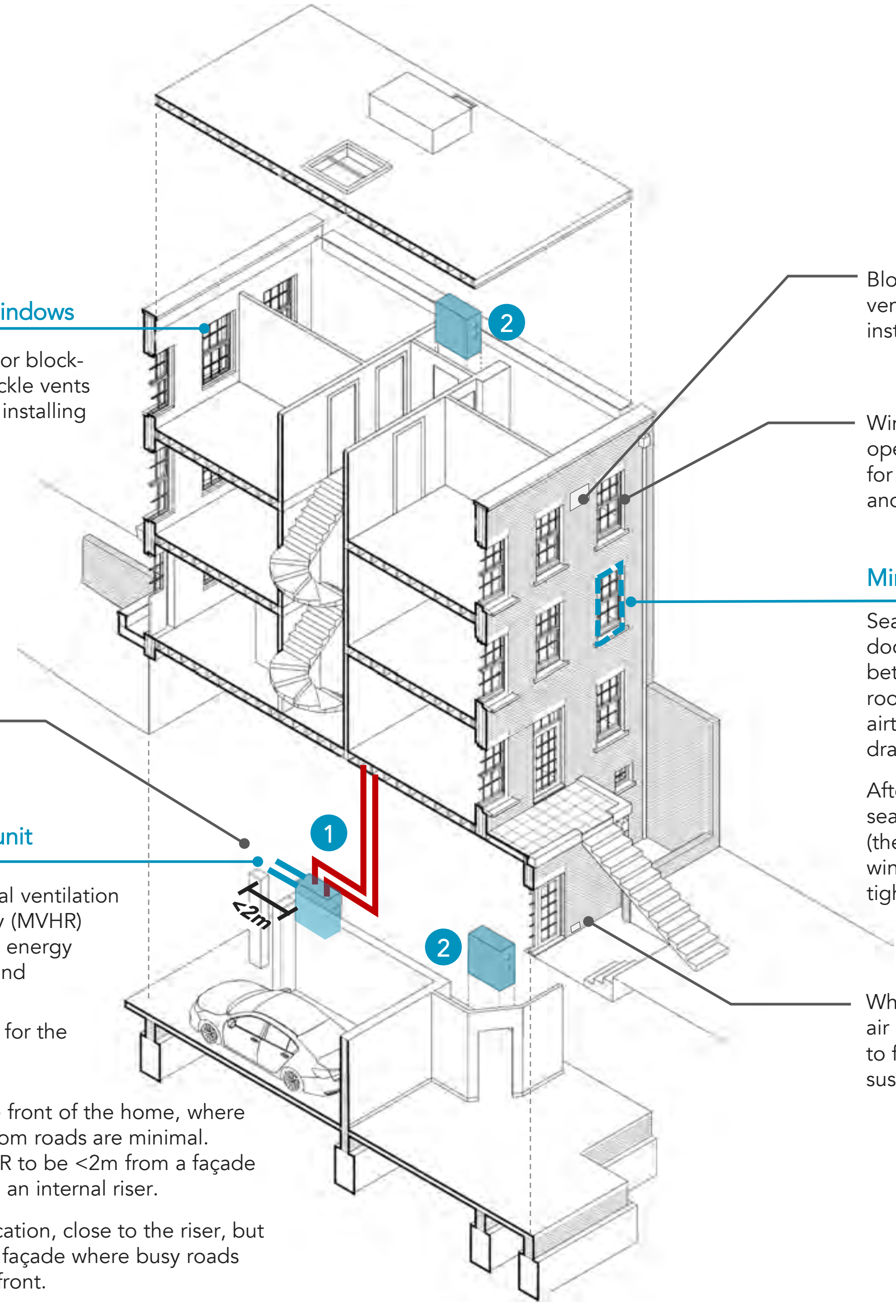
Once airtightness is improved install a mechanical ventilation with heat recovery (MVHR) system to provide a constant and stable background ventilation. MVHR has a positive effect on indoor air quality and reduces humidity levels.

Where adequate space for MVHR cannot be found, install continuous mechanical extract ventilation (MEV) with trickle vents instead.

Airtightness and background ventilation should be improved simultaneously to reduce condensation forming on internal surfaces and mould growth.

Considerations

- MVHR ducts should be insulated and airtight especially on fresh air intake or exhaust ducts.
- An MVHR system will performs more efficiently the better the airtightness of the home.
- Preferably avoid locating the MVHR in bedrooms, alternatively purchase a quiet MVHR.



Upgrade windows

Upgrade windows or block-up/seal existing trickle vents in windows before installing an MVHR.

Where possible, install the MVHR system within 2m of an external wall, to improve its efficiency.

MVHR unit

Install a mechanical ventilation with heat recovery (MVHR) system to provide energy efficient background ventilation.

Possible locations for the MVHR include:

1. Towards the front of the home, where pollutants from roads are minimal. Allows MVHR to be <2m from a façade and close to an internal riser.
2. A central location, close to the riser, but <2m from a façade where busy roads exist to the front.

Block up any existing ventilation grilles when installing an MVHR.

Windows can still be opened in warmer months for additional ventilation and a breeze.

Minimise draughts

Seal around windows and doors and junctions between walls, floors and roofs to improve airtightness and reduce draughts.

After windows are replaced, seal well around windows (the junction between window and wall) using air-tightness tape.

Where applicable retain air bricks and ventilation to floor voids of suspended floors.

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The advice provided on this page is indicative only and is not intended to be used for construction. Homes should be independently assessed prior to retrofit.

Low carbon heat/ heat from electricity | Potential retrofit measures

Heat pumps are the best option for low carbon buildings

Heat pumps are approximately three times more efficient than gas boilers. They use electricity to take heat from a source (most commonly air, but also possibly water or the ground), increase its temperature, and then move it to the hot water cylinder and radiators. Electricity used to run the heat pump can be provided from renewable energy sources such solar PV on the roof.

Considerations

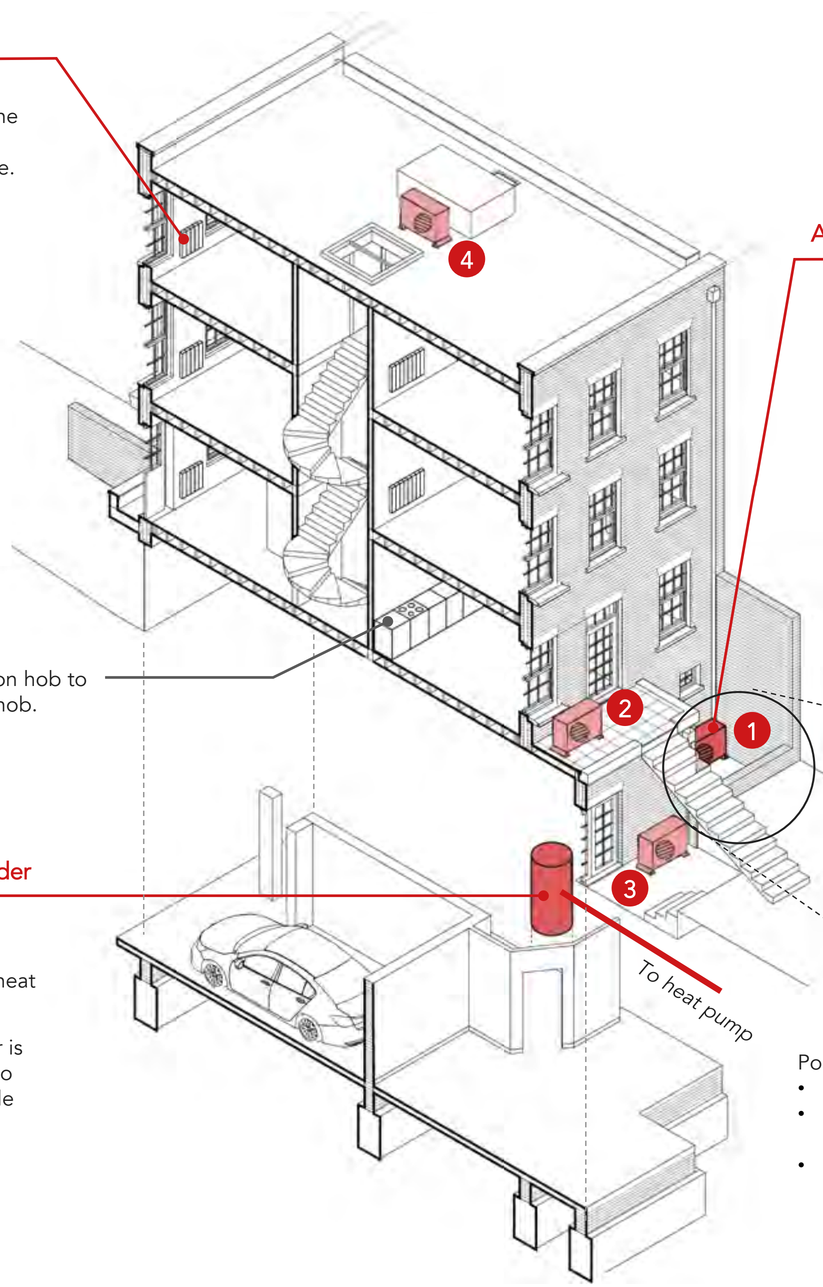
- The size of the heat pump will depend on the size of the home. Seek independent advice for location and size of heat pump.
- Position heat pumps to allow air flow around them.
- Heat pumps are not typically noisy, however, try to locate them away from bedroom windows, and be considerate of neighbours.
- Consider access for regular maintenance.

Practicality tips

- Heat pumps operate at lower temperatures than gas boilers, therefore, some radiators may need to be increased in size if other retrofit measures (such as insulation and window improvements) are not made.

Existing radiators

The existing radiators and pipework are connected to the new air source heat pump to provide heating to your home.



New induction hob to replace gas hob.

New hot water cylinder

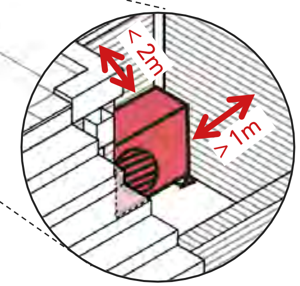
Replace the old hot water cylinder with a more efficient insulated one, suitable for a heat pump.

Ensure the hot water cylinder is located as close as possible to the heat pump, with a suitable pipework route in between.

Air source heat pump (ASHP)

Place the ASHP within 2m of the home to ensure efficiency. Possible locations for the ASHP include:

1. The lower ground rear terrace, mitigating noise problems and ensuring an easy access for maintenance
2. The roof of a rear extension (avoid clashes with windows)
3. The back garden
4. The main roof.



Position the heat pump:
- A maximum of 2m from the house
- At least 1m from the boundary of neighbouring houses
- Not facing any windows (yours or your neighbours')

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The advice provided on this page is indicative only and is not intended to be used for construction. Homes should be independently assessed prior to retrofit.

Solar PVs | Potential retrofit measures

Solar PVs will reduce your energy bills

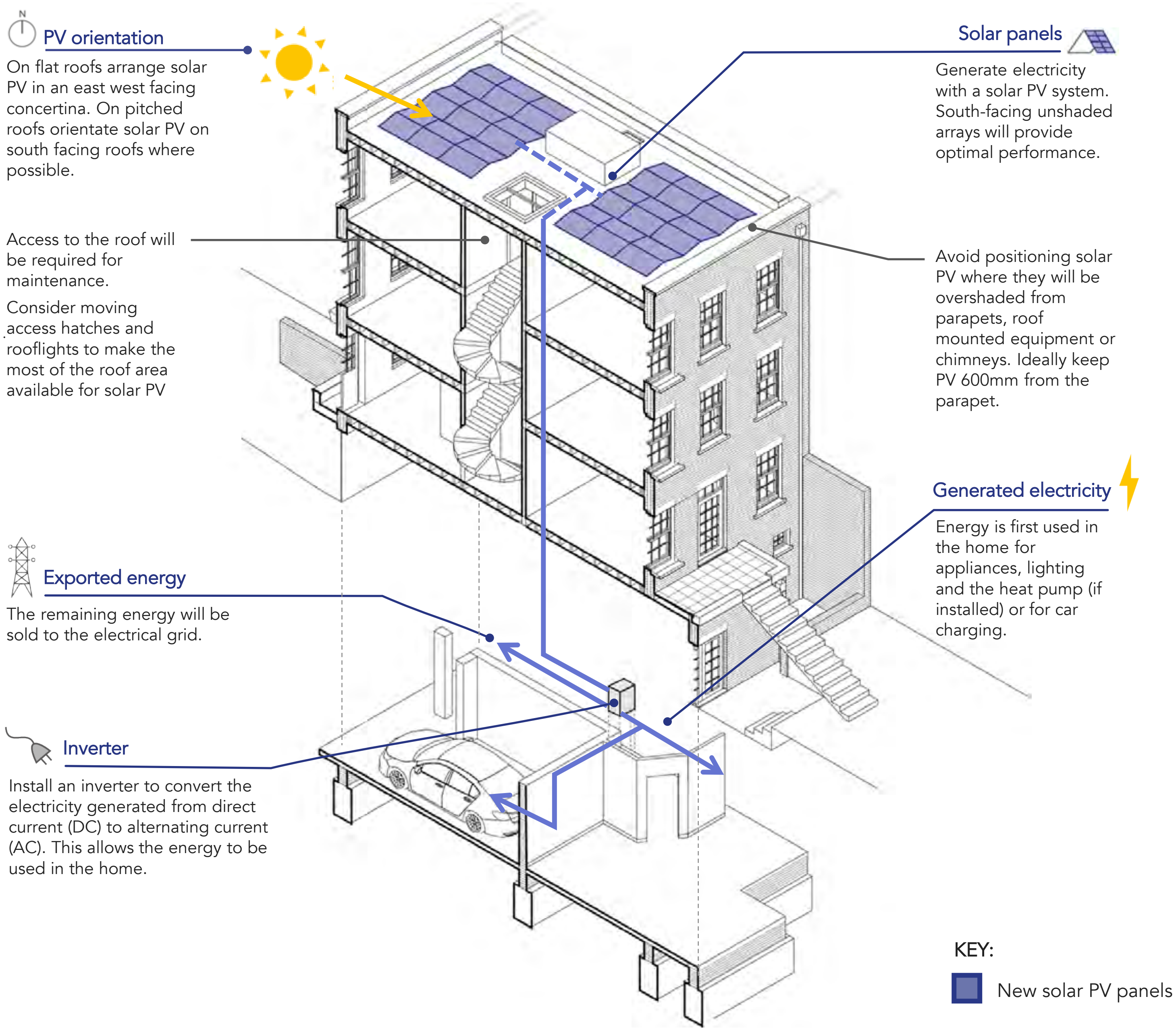
Solar photovoltaic (PV) panels generate 'free' electricity from the sun and can be installed on existing roofs. They are a simple, reliable and durable technology and homeowners benefit from a reduction in electricity bills.

Considerations

- Install PV as an east/west facing concertina on flat roofs. For pitched roofs south facing is a preference, but east and west facing roofs may be appropriate too.
- Confirm the roof can take the additional weight loadings and wind forces.
- The energy generated over the lifetime of a solar PV system based on the latest solar technology could be twice as high as the energy generated by a poorly specified system.

Practicality tips

- Avoid shading from existing objects on the roof, such as chimneys, parapets, equipment and overhanging trees. If partial shading is inevitable, install power optimisers to increase output and monitor individual panel's performance to be increased.
- Consider access to the roof and the solar PV panels for maintenance.
- Invest in a monitoring system to increase the reliability of the system. This will allow immediate identification of any issues.



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Cost

How much will it cost to retrofit?

It is notoriously challenging to provide an accurate assessment of the cost of retrofit. It depends obviously on the specific current building's characteristics and on which works are required.

Very importantly, it also depends on whether the 'energy' retrofit measures covered in this guide will be delivered on their own or whether they will be combined with other renovation and modernisation works.

A list of indicative costs for 'energy' retrofit measures is provided on this page. They are expressed per measure and should not be added together as they are based on different measures and units.

An indicative guide for all measures combined (covering the whole retrofit plan) for a **typical modern house of 221m^2 GIA** is **£80-120k for a 'good' retrofit**, through to £120-160k for an 'exemplar' retrofit. These can be delivered at the same time or over a long period, e.g. 10-20 years.

Contractor's overheads and profits, preliminaries costs, ancillary work, contingencies and design fees will all vary but also need to be taken into consideration, as well as planning fees, building control fees and, very importantly, VAT.

The cost of upgrading and future proofing the house

Improved comfort, health and lower fuel bills are all valuable and important outcomes of retrofit. For example, health and wellbeing is probably most improved by a Mechanical Ventilation with Heat Recovery (MVHR) system as this will dramatically improve indoor air quality and comfort. New windows will also significantly reduce noise coming from outside.

More generally, most retrofit costs can be considered as 'modernisation' costs. They will futureproof the house by making it a better and more sustainable.

Indicative costs of a range of retrofit measures

	Measures	Cost (low)	Cost (high)
Windows & doors	Triple glazed 'mock' sash (per m^2)	£1,300	£1,500
	Triple glazed single casement (per m^2)	£900	£1,300
	New entrance door (1 unit)	£1,600	£5,000
	Rooflight (per m^2)	£700	£1,000
Airtightness & ventilation	Improved draught proofing - New window sealing, filling cracks and taping junctions	£500	£1,000
	Mechanical ventilation system - MEV with associated ducts	£1,200	£2,800
	Mechanical ventilation with heat recovery - MVHR with associated ducts	£5,000	£10,000
Insulation	Front façade - 40-80mm internal insulation (47m^2)	£7,000	£20,000
	Rear façade - 100-200mm external wall insulation (84m^2)	£12,000	£27,000
	Flat roof - 200mm insulation (68m^2)	£3,500	£5,000
	Suspended floor - 100mm insulation (71 m^2)	£2,000	£5,000
	Solid floor - 25-50mm insulation (71m^2)	£8,000	£13,000
Low carbon heat	Air source heat pump and new hot water tank	£10,000	£13,000
	Fit new time and temperature control on heating system	£150	£250
Solar PV	Photovoltaic panels, 6.8 kWp array (15 panels)	£7,000	£11,000

The above cost estimate (Q3 2023) are only indicative estimates per house. A specific cost plan must be undertaken for each retrofit.

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Energy use and comfort pre- and post-retrofit

Energy use and space heating demand

The individual impact of each measure on the total energy consumed by the Post 1920's terraced house as well as on its predicted space heating demand are shown on the adjacent graphs. They have been calculated using PHPP, a predictive energy use modelling software.

- Loft insulation, replacement of windows, airtightness improvements and the integration of an efficient ventilation system (MVHR) have a decisive impact on space heating demand, facilitating the move away from a gas boiler towards a heat pump solution. The current radiators are likely to be enough for the heat pump to deliver the house’s heating requirements. In turn, this move helps to significantly reduce energy use and energy bills are likely to reduce, despite the higher cost of electricity.
- The final energy efficiency measures help to reduce energy (and running costs) further, improve comfort, and get to a point where nearly two thirds of the annual energy use can be generated by solar PVs on the roof.

Comfort

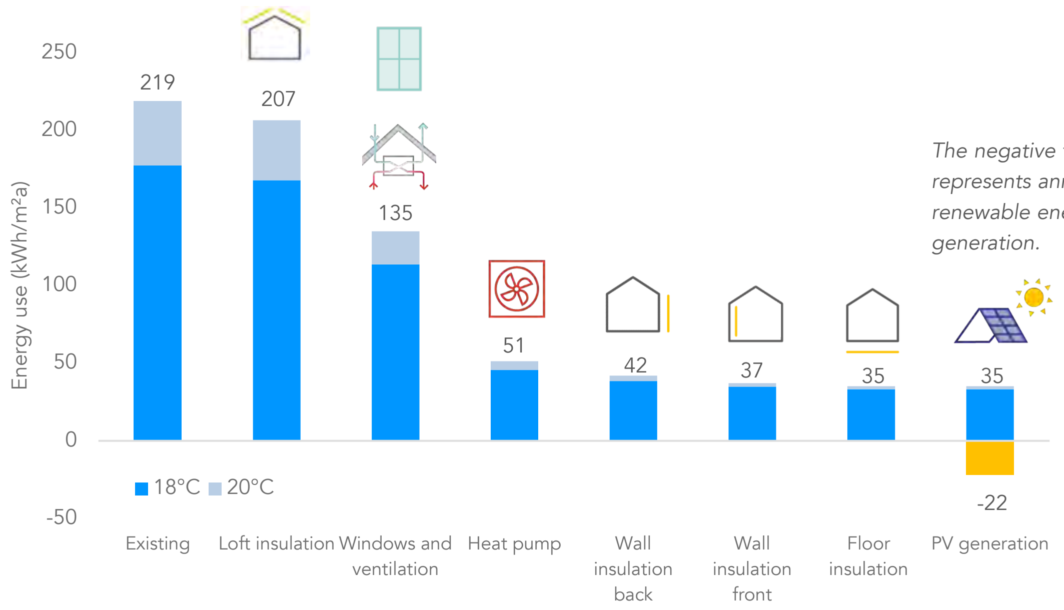
It is common for Post 1920's terraced house to be ‘under-heated’ as it can be difficult and/or costly to heat them to a more comfortable temperature. As energy efficiency improvements are installed, comfort is likely to increase as it becomes easier and cheaper to heat the house. Comfort will also become more consistent across the house.

This is why the adjacent graphs report energy use intensity and space heating demand at two different average temperatures.

Upgraded window specifications and improved ventilation will also improve indoor air quality and reduce noise pollution from outside.

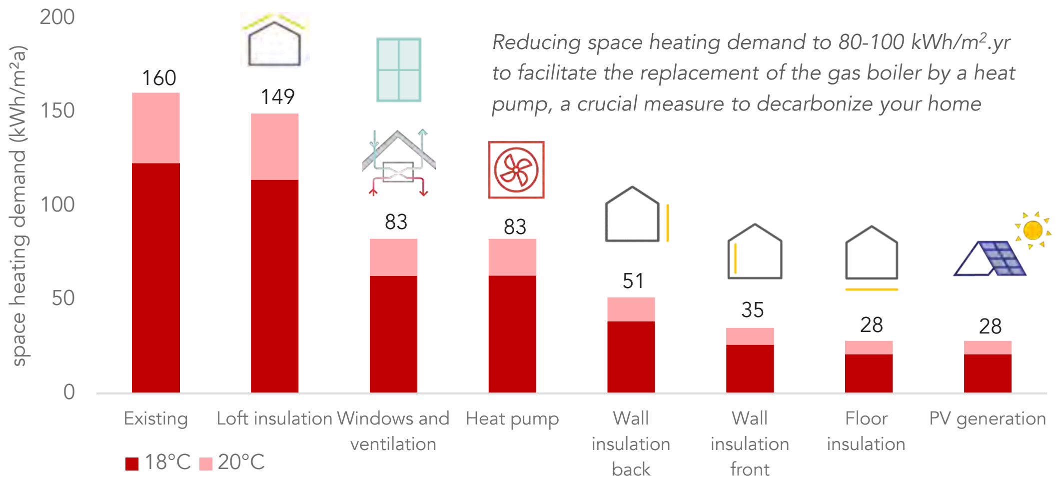
Energy use intensity for the Post 1920's terraced house

Impact of measures (exemplar retrofit)



Space heating demand for the Post 1920's terraced house

Impact of measures (exemplar retrofit)



How to approach your retrofit journey

Watch points

Carrying out any retrofit work should be done with care and a clear roadmap with the end goal and staging points along the way. As you develop your specific retrofit plan (probably with a professional) it is important to ensure that you:

- Identify any issues which are specific to the house.
- Are clear about whether the retrofit will be phased and consider appropriate sequencing.
- Consider building fabric and services together at once and ensure that they area adequately coordinated.
- Correct any existing defects at the start.
- Develop a robust 'moisture plan' (e.g. include ensuring all pipework is free of leaks) and take care that new materials are compatible with original ones particularly in the way they deal with moisture.
- Ensure that adequate ventilation is provided and the building is made less draughty and leaky.

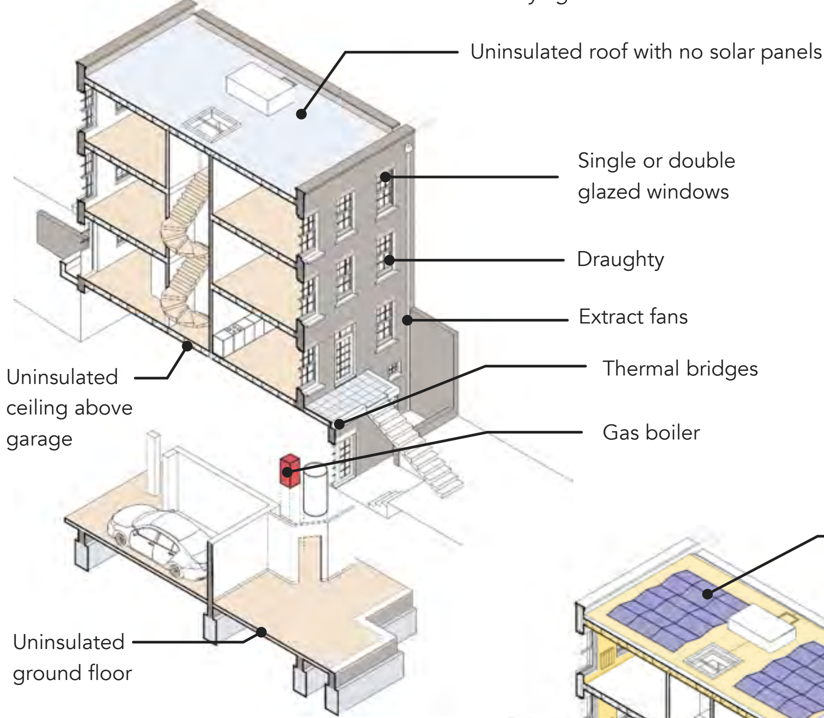
Develop a whole house plan before you start

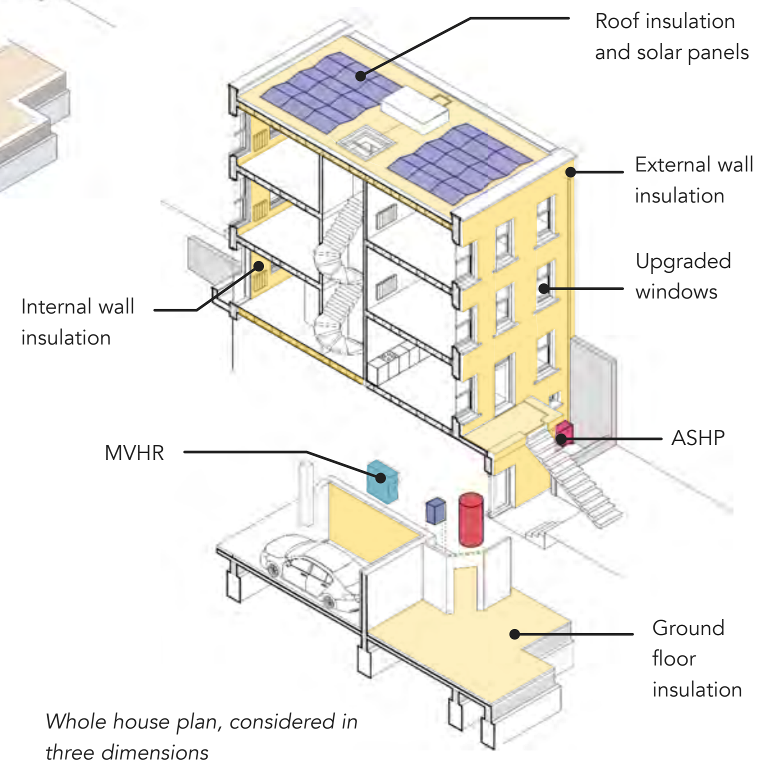
This should include all measures that are envisaged in the medium to long term, so that they can be planned in a coordinated manner. The drawings alongside shows how important it is to consider the measures in 3 dimensions.

The plan should ideally be underpinned by some energy use analysis of the current level of energy performance as well as an estimate for future use so that the project can be measured against a stated goal in due course. A pre-retrofit airtightness test and thermographic survey may also be useful.

If the project is carried out in stages then it is important to ensure that at each stage the risks are managed and the living environment is improved (e.g. air quality and moisture balance). A key to this is ensuring that as airtightness is improved, the ventilation system/approach is adequately considered and upgraded.

Identifying current issues





Whole house plan, considered in three dimensions

Work that can be done without planning permission

For buildings that are not listed, the following work does not need planning permission:

- Loft insulation
- Advanced secondary glazing
- Draught proofing
- Internally insulating walls (IWI)
- Central ventilation systems (extract or balanced ventilation with heat recovery can be installed but you may need permission for new grilles in the walls)
- Floor insulation

Work that can be done 'Permitted Development' (houses only)

(but you should check with the Council that what you want to do does comply with the rules for Permitted Development).

If you own and occupy a whole house that is not listed, the following can be done without formally applying for planning permission:

- Changing windows for ones that look identical to the old ones.
- Air source heat pumps if the location complies with a number of rules – *you need to check the details with the Council that what you intend to do is allowed.*
- Solar PV panels on the roof, if it is not visible from the public highway and does not protrude above the roof ridge line.

If you live in a flat, unfortunately there are currently no 'permitted development' rights, so the above work would require a planning application to be made*.

** An exception to this are solar panels in some instances. If an external change makes no material impact on the appearance of the building, then it does not constitute development, so there may be scope for some of the other changes to flats. It is recommended to check with the Council through RBKC's pre-application advice service.*

Permitted development and Certificates of Lawfulness (CoLs).

If you intend to carry out work that is allowed by Permitted Development rights, it is sometimes wise to obtain a Certificate of Lawfulness (CoL). The route for obtaining a CoL is very similar to planning permission, and if you make the application, the planning officers will review whether in their view the work that you want to do meets the rules for it to be considered to be 'permitted'. Having a CoL guards against misunderstandings on what is permitted and what is not. It is also useful to have on file when coming to sell the house, as it avoids uncertainties over whether home improvements have been carried out legally.

All other retrofit measures will require you to submit a planning permission

This will require a set of drawings to be submitted to the Council's planning department along with an explanation of how the design has been carried out in accordance with planning rules. For some applications, additional technical information may be needed and/or required by the Council.

If your building is listed (10% of buildings in the ESSA Conservation Area)

Any changes to the external appearance or internal layout of the building are likely to require listed building consent and, in many cases, the work will also require planning permission. A listed building application has to include an assessment of the historical significance of the house, and the impact on that significance that the proposals will have.

The application process for planning permission, listed building consent or a Certificate of Lawfulness

It is important to accompany proposals with drawings of what you want to do and a clear supporting statement. This statement might include:

- A description of how the building works now (before the work is done).
- Calculations showing the carbon savings the work will achieve.
- A plan showing that the work will be done thoughtfully in relation to your neighbours and the Conservation Area
- Images of the products you intend to use.

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Beyond energy and carbon, what other retrofit measures should be considered?

A retrofit may also be the opportunity to reduce the house's wider impact on the environment and contribute positively to the Council's efforts to make Kensington & Chelsea a more sustainable borough. This page introduces key environmental areas and suggests ideas for further consideration.

- **Water** is a precious resource and pressure on water supplies is increasing. Using less water is possible at a low cost and with no adverse impact.
- Alongside the reduction of building regulated emissions, **transport** represents a significant opportunity to achieve Net Zero.
- Although the options for improving **biodiversity** 'at home' may be limited, a retrofit may be the opportunity to consider how individual interventions can contribute to the Council's Biodiversity Action Plan.
- Better internal **waste** recycling storage facilities (recyclables, food waste) will contribute to better recycling. The retrofit process itself should also seek to minimise waste through the design, sourcing and selection of building and construction materials. And construction waste from the retrofit process should also be managed carefully during the retrofit itself, with options for local re-use explored.
- Upfront **embodied carbon** includes the carbon emissions associated with the extraction and processing of materials, energy use in the factories and transport. Retrofit will involve balancing the benefits of a retrofit measure with its embodied carbon.

Water

- Consider replacing your fittings (e.g. showerhead, taps) with more efficient fittings . The AECB water standards provides clear guidance on sensible flow rates.
- If you are replumbing your home, seek to reduce pipe distribution and insulate hot water pipes well.
- If you are updating your bathroom(s) or adding a new one, consider installing waste water heat recovery systems in shower drains - A simple technology that recovers heat from hot water as it is drained.
- Utilise rainwater collection for irrigating your garden.
- Utilise permeable surfaces in the garden wherever possible.

Transport

- Provide secure, easy to access cycle parking.
- Install an electric car charging point.
- Design in a space that can be used as a home office.

Biodiversity

- Select diverse native species of planting (incl. trees) in your garden

Waste

- Design kitchen and/or utility areas to include convenient, adequately sized recyclable and food waste storage.
- Consider options for re-use.

Embodied carbon

- If you think that a particular retrofit measure may have a limited impact in terms of operational carbon, while having a significant embodied carbon 'cost', do more research.

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Additional information

This section provides additional information on the retrofit measures summarised graphically in Section 2.0. Examples are also provided.

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Windows and doors | Additional information

Why are windows so important?

The sheer level of improvement that current glazing technology can now achieve, and the fact that all upgrade can take place with residents staying at home, make this fabric measure the most attractive and impactful from an energy saving perspective. The high window-to-wall ratio in the ESSA Conservation Area reinforces this conclusion.

Improving the windows will also deliver additional benefits to the residents such as better thermal comfort (the window pane will be warmer), less cold draughts and better acoustic insulation, making it a more attractive and likely proposition than other retrofit measures.

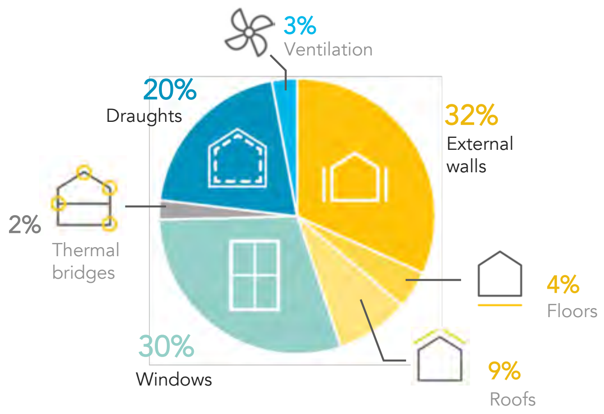
Finally, for many homes in the ESSA Conservation Area, an appropriate window upgrade can provide such a significant reduction in space heating demand that it will unlock the ability for a successful replacement of the existing gas boiler by a heat pump. This will enable a a move away from fossil fuel heating and a radical carbon emission reduction of more than 80%.

Wall insulation and floor insulation can take place in future steps.

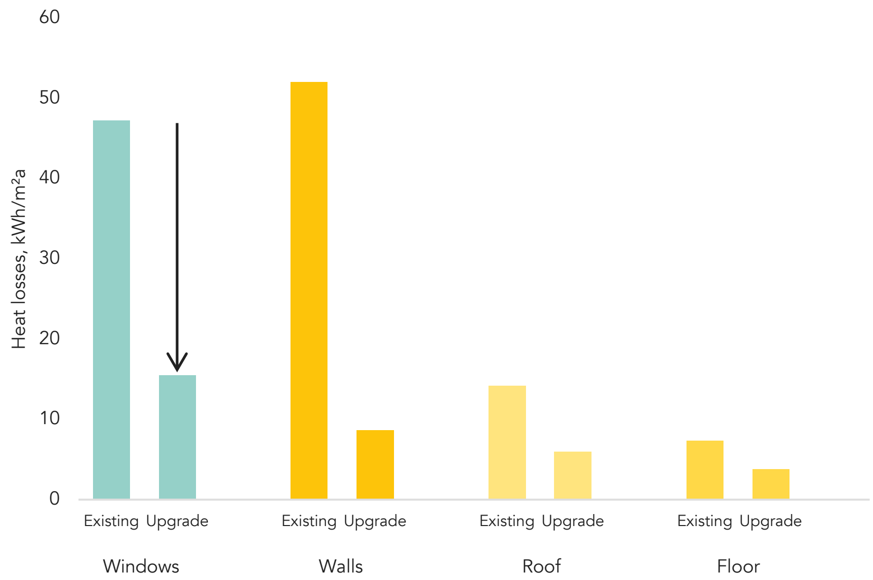
Window improvements: for a 'Best possible' approach

Altering windows is expensive and likely to only occur once every few decades, especially if embodied carbon is being considered, so it is crucial that changes are made with a view to optimising performance as much as possible but also meeting the statutory requirement to preserve or enhance the character or appearance of conservation areas. The bar is higher for listed buildings. A targeted energy performance with a U-value of 1.0 W/m².K is proposed. This can be achieved by the following available solutions: **triple glazing, best quality evacuated glazing, advanced secondary glazing.**

These solutions can deal with most of the windows within ESSA Conservation Area without affecting the special character of the area. Timber windows should be favoured. Aluminium windows may be acceptable at the rear. uPVC is not a sustainable material.



Windows represent a significant opportunity to reduce heat losses (30% in the case of the modern house)



Windows are also one of the biggest opportunities for improvement (see above comparison of U-value improvements from existing to ideals set out in this study by element).

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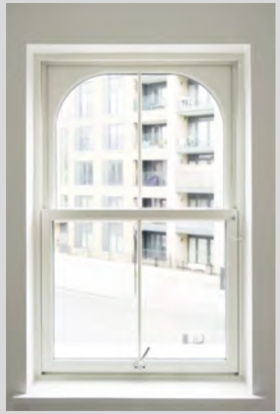
Windows and doors | Additional information

	Triple glazed casement	Triple glazed mock sash	Advanced secondary glazing	New evacuated glazing	Double glazed sash
					
Advantages	Very high thermal performance. Window is airtight and the frame is robust. The frame can be made relatively narrow.	Very high thermal performance. Window is airtight and the frame is robust.	Original window is preserved. Less disruptive installation process.	High thermal performance. Similar visual appearance to original window.	Average thermal performance. .
Disadvantages	Not applicable to all window upgrade scenarios, such as replacing original sashes on a front elevation.	Fake astragals become apparent when observed close-up.	Repairs are needed to make good the existing, which adds costs.	Frames are not thermally broken. Tend to be relatively expensive. Lead times can be length (limited supply chain).	Fake astragals become apparent when observed close-up.
Watch points	Fatter mid-rail, which will not be conspicuous on larger windows. These do not have a similar visual appearance to the original sliding sashes.	Fatter mid-rail, which will not be conspicuous on larger windows. These are mock sashes that function as inward-opening casements.	Ensure effective cleaning is possible. Ensure it allows adequate ventilation. Check it does not interfere with existing shutter boxes.	The windows open like a conventional sash window. The original astragals are altered to fit in the new glazing.	Fatter mid-rail, which will not be conspicuous on larger windows. Requires a deeper sash box to the original, affecting its relationship to the wall.
Heat loss coefficient U-value, W/m² **.yr** *(the lower the better)*	~ 0.8	~ 0.9	~ 1.0	~ 1.1	~ 1.6

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Windows and doors | Examples


Secondary glazing in front of historic stained glass


Casement advanced secondary system


Sliding sash and casement secondary glazing, built into the joinery of the shutter box, within a listed Georgian townhouse.


Evacuated glass sash windows within a conservation area


Double glazed sash window within a conservation area


Triple glazed mock sash window


Triple mock sash window (Bere:architects)


Triple glazed mock sash windows (PDP architects)


Triple glazed casement windows

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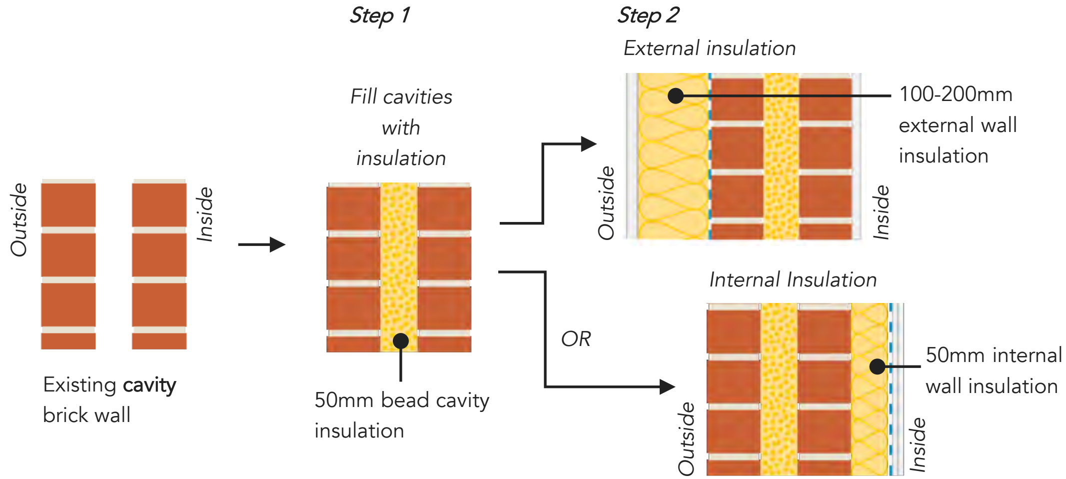
Insulation | Additional information

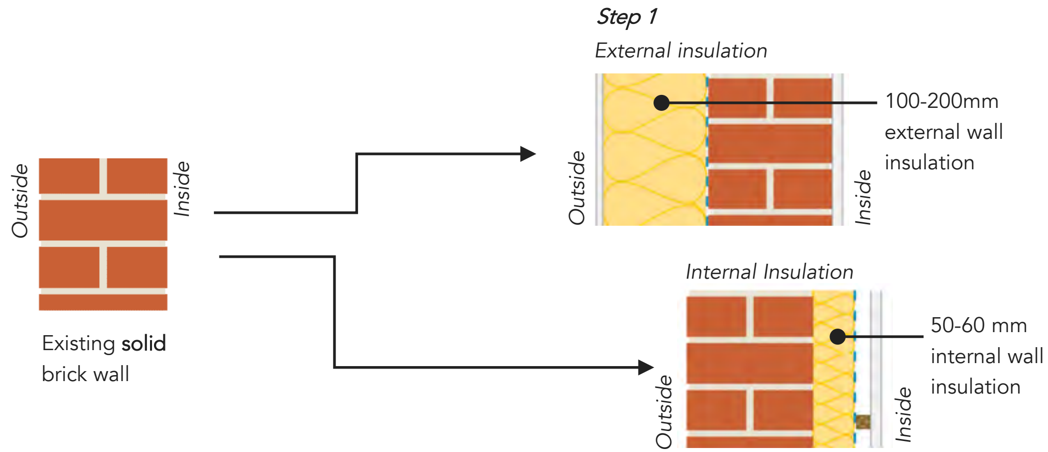
Walls - Insulating externally or internally?

From a heat loss and reduced exposure perspective it is best to externally insulate walls. Allowing the insulation to wrap around the building continuously, keeping it warm and dry, while avoiding the need to address thermal weak points and junctions (e.g. around floor joists) is a significant benefit of external wall insulation. However, the choice will come down to what is practical and visually acceptable.

- **Cavity wall insulation:** can be pumped from holes in the external brick course with little disruption to occupants. There is a moisture ingress risk associated with filling a cavity which is highly exposed, or if the cavity is significantly bridged, for example by a floor structure. This can potentially lead to cold spots in and on the surface of the structure, leading to condensation and moisture problems. One remedy is to externally insulate the structure. Appoint a suitability qualified surveyor and cavity wall specialist to determine the suitability for filling or blocking-up and the likely associated risks.
- **External insulation (EWI):** is applied to the outside of walls. It is effective thermally, does not reduce internal space and creates less disruption to residents during fitting. It should be considered for the rear elevations but would require planning permission. It is very unlikely to be deemed acceptable for the street elevation. Roof eaves and window sills may require extending to cover the insulation and parapets should be wrapped to reduce thermal bridging. Insulation can be finished in lime render, brick slips or pebbledash cladding.
- **Internal insulation (IWI):** breathable materials should be used for internal wall insulation e.g. wood fibre insulation, plastered insulation. Non-breathable materials e.g. rigid foam insulation, can achieve a good thermal performance but they can also trap moisture in the build-up and make detailing around junctions more complicated. Where internal space is limited thin products such as aerogel insulation can be considered. Consider the combustibility of insulation.



Options for insulating cavity walls. For step 1 ensure measures have been taken to prevent moisture entering or build-up in the cavity.



Options for insulating solid walls

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Insulation | Additional information

Roof / Loft insulation

Pitched roofs: For unheated attic spaces the simplest approach is to insulate the ceiling joists in the loft.

Where external wall insulation meets the roof consider extending eaves to cover the additional wall thickness. Also be sure to maintain or add ventilation at the eaves.

Consider fabric improvements in conjunction with any loft extension works. The loft space could become a 'warm space'/room, by insulating the roof at rafter level and applying a sheathing board over the rafters. Unless a reliable breather membrane is already in place, the roof tiles will require removal and refit to install a new breather membrane. This membrane is critical for partial protection against leaks and to prevent the insulation becoming moist, should condensation form on the underside of the tiles. Once the tiles have been removed, before refit, there is an opportunity to install insulation above the sheathing board. However, alignment with other building features, such as neighbouring roof lines should be reviewed before a decision is made to raise the roof line.

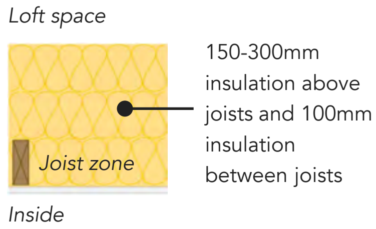
Ideally relocate existing water services and tanks in to the warm roof voids or insulate them.

Flat roofs: Where the home has a flat roof, insulation should be added on top of joists as part of re-roofing/waterproofing or maintenance cycles. Insulating between or below roof joists brings the greatest condensation and moisture risks to the roof structure, and should be avoided where possible. Ensure an adequate vapour control layer (VCL) is added to prevent interstitial condensation. Alignment with other building features, such as parapets, should be reviewed when raising the roof line.

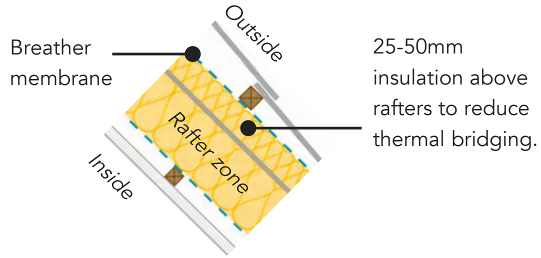
Ground floor insulation

Insulating concrete floors may require raising the floor-level, therefore special consideration should be given on the impact on steps at the entrance, door heights and consistent staircases levels. In the case of raised timber floors, insulation can be hung or sprayed between and below joists, providing airflow if maintained to ventilate the floor void.

Unheated attic spaces – *insulate between and above ceiling joists*

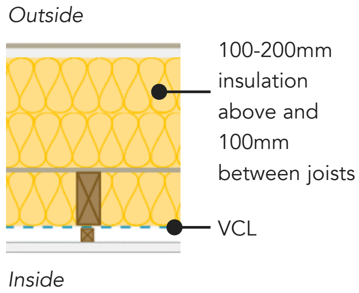


Heated attic spaces – *insulate above and between roof rafters*



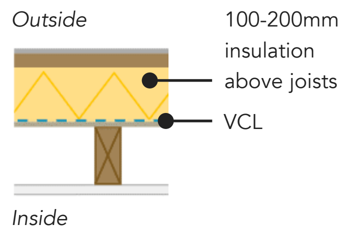
Options for insulating pitched roofs

Warm roof – *insulate above and between and roof joists*



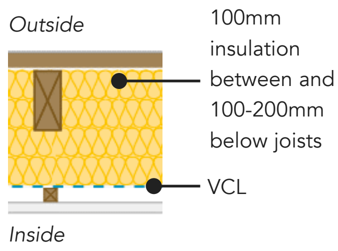
Access is required from above and below roof.

Warm roof – *insulate above roof joists*



Access is required from above roof.

Cold roof – *insulate between and below roof joists – avoid this method where possible*



Access is required from below roof.

This may be the only solution available for specific areas such as an inset balcony above a heated room.

Options for insulating flat roofs

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Insulation | Additional information

There are many types of insulation products. The following considerations should be made when selecting Insulation:

Area for use - Where the insulation be used (e.g. external wall, roof, floor).

Thermal conductivity - How much heat the material conducts. The lower the conductivity, the better performing the product.

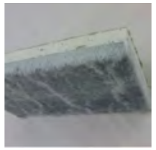
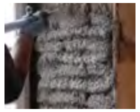
Moisture and air permeability - Some insulation products allow water vapor and/or air to pass through them, and some don't. It is important to understand their hygroscopic properties, particularly when retrofitting older homes to prevent moisture damage to existing structure.

Thickness - The thickness should be considered to ensure it keeps the home warm. For external walls, it is important to ensure that the products used to support insulation are available in the thickness required.

Physical properties - Insulation can be rigid or not, and there are advantages to both.

Fire rating - The building regulations associated with fire rating and insulation should be consulted to ensure safe and compliant products are used in the correct areas.

Compressive strength - Some insulation may require a degree of compressive strength, and this should be considered (usually floors or flat roofs).

										
Insulation type	Aerogel	Wood fibre board	Insulated lime plaster	Cork	Sheep's wool	Hempcrete	Mineral wool	Glass wool	EPS	PIR
Application *EWI = External Wall Insulation IWI = Internal Wall Insulation.*	IWI, roof and ground floor insulation	EWI, IWI	EWI, IWI	EWI, IWI, roof and ground floor insulation	IWI, roof insulation	EWI, IWI, roof and ground floor insulation	EWI, IWI, roof insulation	EWI, IWI, roof insulation	EWI, roof and ground floor insulation	Roof
Key component	Silica	Wood fibres	Lime, cork and clay plaster	Bark of the cork oak tree	Sheep's wool	Hemp mixed with lime-based binder	Mineral fibres	Recycled glass	Rigid plastic foam board Extruded polystyrene	Rigid plastic foam board Polyisocyan urate
Thermal conductivity	0.018-0.015 W/m.K	0.04-0.05 W/m.K	0.045 W/m.K	0.035-0.043 W/m.K	0.034-0.042 W/m.K	0.06-0.07 W/m.K	0.034-0.035 W/m.K	0.032-0.037 W/m.K	0.024-0.026 W/m.K	0.021-0.26 W/m.K
Vapour resistance/ breathability	Vapour open and breathable	Vapour open and breathable	Vapour open and breathable	Vapour open and breathable	Vapour open and breathable	Vapour open and breathable	Vapour open and non-breathable	Vapour open and non-breathable	Vapour closed and non-breathable	Vapour closed and non-breathable

Check with a professional and the manufacturer to determine which type of insulation best suits the application.

Insulation | Junctions and thermal bridges

Thermal bridges

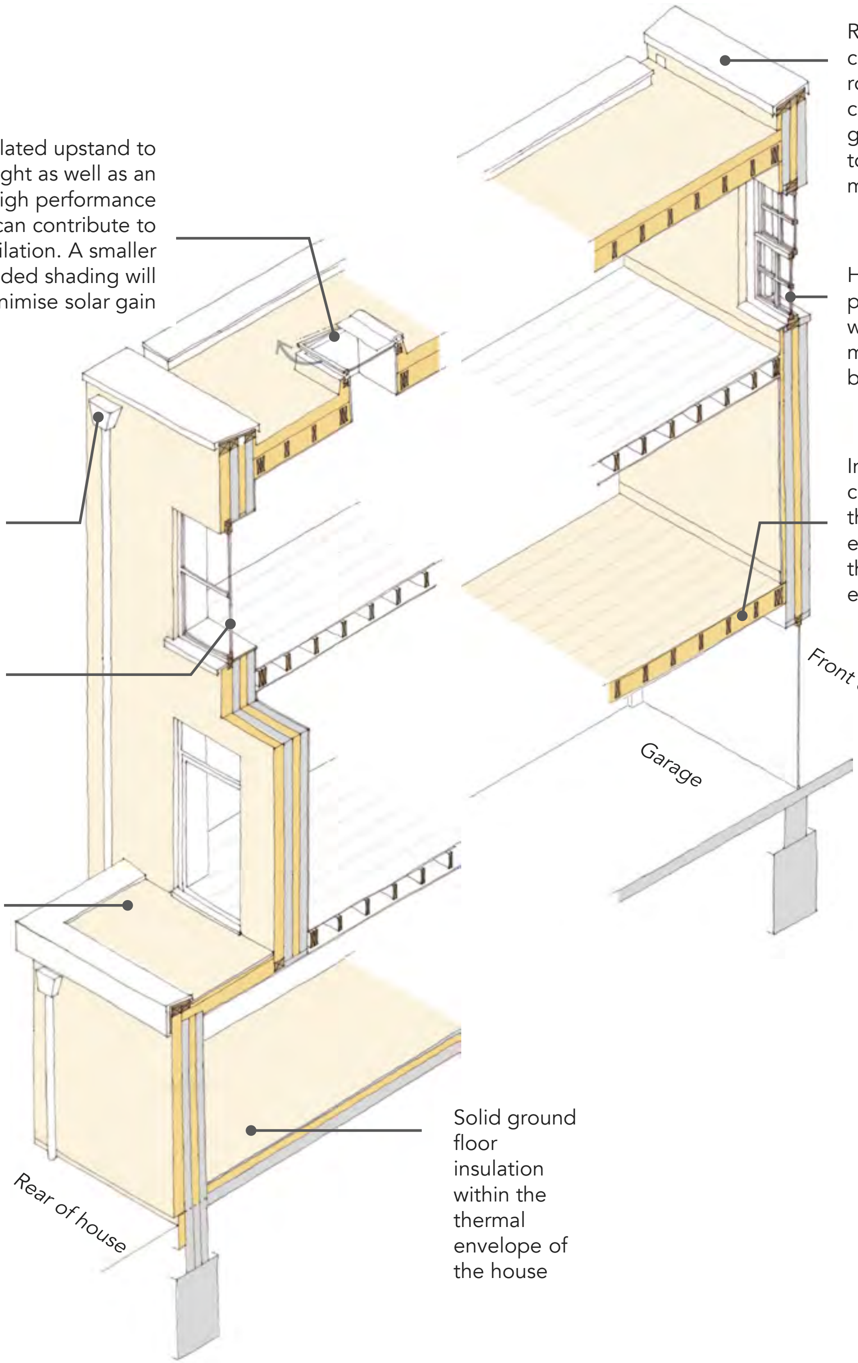
A thermal bridge, or cold bridge, is a location in the thermal envelope of a building through which heat flows easily. For example, a concrete lintel that interrupts the wall insulation layer would be considered a thermal bridge. Thermal bridges should be avoided as they increase heat loss, and can cause cold spots that lead to condensation.

Identifying thermal bridges

A good approach to retrofit is to sketch out a cross section drawing of the building to identify materials interrupting it or areas where something needs to be done to ensure continuity of insulation (e.g. wall to roof insulation). Different materials should be butt jointed, or overlap, ideally for a distance equivalent to the thickness of the insulating element. We strongly recommend engaging an architect or consultant who is able to produce a risk assessment and help design out condensation risk.

Roof and window to wall junction considerations

- Check the existing condition of the roof's structure (battens and rafters) and replace if rotten and damp.
- Check roof covering condition and replace and replicate tiles if are damaged and not weathered proof.
- Check the condition of the wall (including parapet wall) and re-point/ re-render brickwork if needed.
- Check the condition of the existing coping to ensure they are free from moisture defects and in good condition.
- Dispose any existing old insulation in the loft if not in a good condition (e.g. torn or damp).
- Make sure that roof/loft ventilation is improved and meets building regulations to avoid risk of condensation.



Flat roof to wall to ground junctions – front and rear of home, including front garage

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Insulation | Junctions and thermal bridges

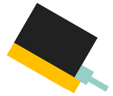
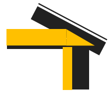
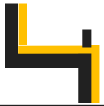
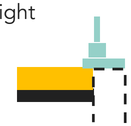
Key junctions and thermal bridges

These are places where significant amounts of heat can be lost around the sides of the new insulation and where condensation can form. There are a number of ways to make sure these thermal bridges are minimised or avoided. For example, insulation layers can be continuous around a junction, or installed with an overlap where continuity is not possible.

Windows should be installed centrally on the insulation line and the insulation should be overlapped with the window frame. Space should be allowed for the insulation that may be installed on an adjoining element at a later stage, and protection provided for the edges of the insulation left for the future connection. For example, roof eaves should be extended to plan for future external wall insulation, and parapet flashing should allow for the future connection between roof and wall insulation.

Fabric measures and insulation interactions

The table to the right shows examples of junctions that should be considered when installing insulation or new windows. The columns show the example measures, and the rows show potential insulation interactions between those and the adjacent elements. For example, when installing external wall insulation (EWI) there will be junctions at corners, at the roof and at the ground. Sometimes it is easy to wrap the insulation continuously at a junction (continuity or connection), and sometimes there will need to be an overlap or low conductivity structural product used to help reduce the heat loss through the junction.

	Fabric measure		
Insulation Interactions	External Wall Insulation	Internal Wall Insulation*	New Window
EWI	Connection 	Overlap 	Continuity 
IWI	Overlap 	Connection 	Continuity 
Rafter	Connection Protection 	Connection 	Continuity Drain-off 
Flat roof	Connection 	Overlap 	Continuity 
Loft	Connection Ventilation 	Connection Ventilation 	Continuity (loft hatch) 
Terrace	Connection Bridging Thresholds 	Overlap (double) 	Continuity Access 
Ground floor	Overlap 	Connection 	Continuity Access Height 

Indicative example fabric / insulation interactions.

**Moisture protection should always be considered for internally insulated structures*

Insulation | Examples


Townhouses within a conservation area in London. Add hoc render has been added to rear facades without disrupting the street scene.

Insulated ventilated timber floor using hydroscopic insulation and breathable membrane – source: Ecological Solutions


Exterior view of evacuated glazed sash windows in combination with internal wall insulation, in a conservation area in RBKC .


Wood fibre insulation panels fixed and taped with airtightness tape before plasterboard and batten lining


House façade after external wall installation


Cork granules visible in lime/cork plaster internal plaster insulation


Initial coats of lime/cork plaster being sprayed onto a masonry wall

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Airtightness | Additional information

What is airtightness?

Making a home more airtight is about eliminating or reducing the level or air leakage in order to retain heat and avoid letting it escape from the house through gaps and cracks, holes, splits and tears in the building envelope (i.e. walls, windows, floors and roof). It is important to note that an airtight dwelling it is not hermetically sealed, it just means that unintended air leakage is reduced to a minimum.

Why should airtightness be considered?

- The most important reason is to avoid losing heat, to reduce energy wastage and costs.
- Making a home airtight also means making it draught free: it improves comfort level.
- An airtight home also reduces external pollutants in the house, reducing the risk of allergies and other respiratory problems.
- Along with a suitable ventilation system, an airtight home will also help to protect the building fabric by reducing damp and the risk of condensation and mould.

How can I make my dwelling airtight?

Any retrofit plans of improvement should include an ambition to improve airtightness: a target should be set, specific improvements identified and airtightness should be measured at the end of retrofit.

The associated importance of controlled ventilation

The efforts to make your home more airtight must be combined with the introduction of controlled ventilation (see following page).

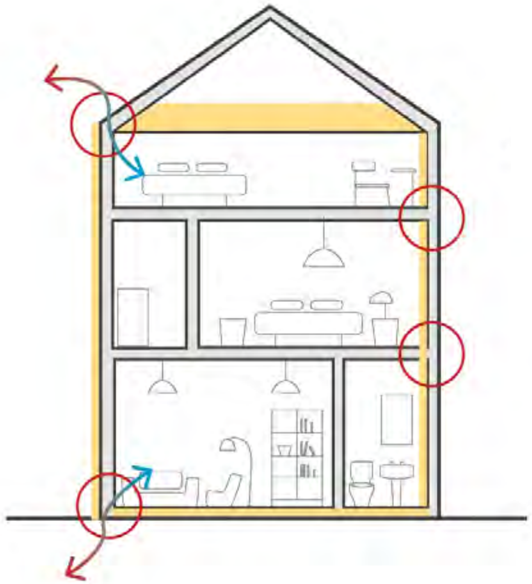

Diagram showing a few examples of potential air leakage points

A range of products are available to improve airtightness: specialist tapes, or specialised grommets that come in a range of sizes.

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Ventilation | Additional information

Why is it important?

Existing homes in the UK are often draughty, which is uncomfortable and increases the amount of heating needed. In most cases, they rely on 'natural ventilation' – opening windows - which is not very effective at making sure all parts of a home have good air movement. This can lead to condensation and then mould forming in some places. Reducing draughts is a very important part of improving energy efficiency, but it generally should not be done without the retrofit of a system to provide more controlled and effective ventilation.

What types of ventilation system could be used?

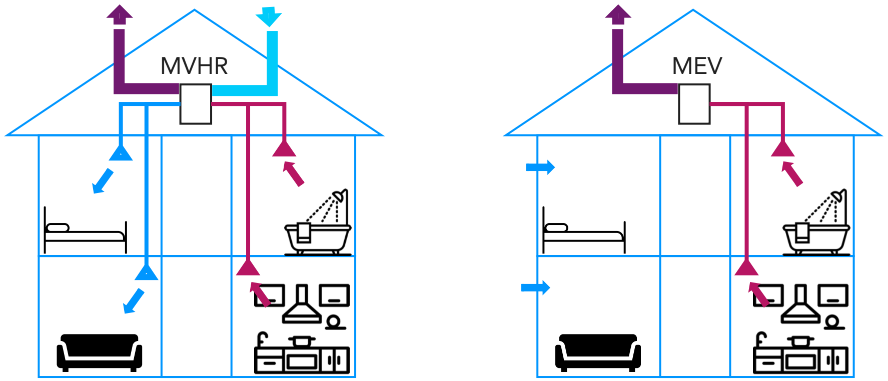
The most energy efficient way to provide controlled ventilation is Mechanical Ventilation with Heat Recovery (MVHR). The equipment circulates air using two small fans, and transfer heat from the air extracted from kitchens and bathrooms into fresh air to be supplied to living rooms and bedrooms.

In retrofit, it is not always possible to find a space for the MVHR unit and/or the associated ductwork to every room. In these cases, a compromise option is to use a system of mechanical extract only with trickle vents in the living and bedrooms to allow fresh air into the rooms. Demand controlled mechanical extract ventilation (dcMEV) is a suitable alternative, although it is less efficient than MVHR, so heating demands will be greater.

Installing and commissioning the system

To ensure the system works as planned, the system must be properly tested to ensure it is balanced, delivers the designed fresh air required and does not generate noise beyond what is expected.

MVHR units can be retrofitted into ceiling voids or wall mounted (© Will South) Ductwork has to be routed to every room. You will need a qualified installer and/or an MVHR manufacturer/supplier to calculate the fresh air required and to design the ventilation system for your home.



MVHR (left) requires more ductwork than dcMEV (right) so can be more challenging to fit into retrofit, but dcMEV is less energy efficient in most homes.

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Low carbon heat/ heat from electricity | Additional information

Types of heating

Electricity is the best energy source for low carbon heating. There are two main types of electric heating:

- **Heat pumps** use electricity to take heat from a source (air, water or the ground), increase its temperature, and then move it to where it is needed. Air source heat pumps are the most common form of heat pump especially in urban settings.
- **Direct electric** heating uses electricity to heat radiators, storage heaters or infra-red panels.

Hydrogen is sometimes talked about as a replacement for mains gas, but it is very unlikely that this will ever be a cost effective low carbon way to directly heat the majority of UK homes.

Biomass heating is burning wood or other plant material which is not suitable in urban areas because of its impact on local air quality.

Hot water

In some homes, especially smaller one, the energy required for hot water can exceed the amount of energy required for space heating. An energy efficient hot water system is therefore essential to ensure energy use remains low. Well insulated hot water storage is usually the best approach to allow heat pumps to work efficiently, to avoid having very large peaks of electricity demand from the National grid and to allow the storage of energy from PV systems during the day to use later in a cost-effective way.

Making a logical, low carbon choice

If an existing boiler needs to be replaced, heating alternatives which use electricity should be considered (see adjacent diagram). The specific type of heating to be used should be considered in a logical sequence, starting from the ones which are most efficient.

1 What type of heating do you have now?

A. A gas boiler that just serves your home

B. A gas boiler that serves other homes (e.g. all flats in your building)

C. Electric radiators or storage heaters

2 What sort of heating should you replace it with?

A. A heat pump that just serves your home

B. Either a heat pump that serves all the flats in your building or individual heat pumps, one for each flat, or (if not possible), direct electric heating

C. Modern electric radiators or storage heaters which work with smart meters and better controls.

3 For either case A or case B, how much outside space do you have?

I. A private garden or a flat roof with good access

- If you have a garden or a flat roof space that is suitable, use a 'monobloc' air source heat pump.
- If there is room for each flat to have its own heat pump close by, that is the best option. If not, then use one heat pump or group of heat pumps which serve the whole building.

II. None

- Consider a 'compact' heat pump indoor unit with ducts to outside.
- Consider a 'compact' heat pump indoor unit with ducts to outside in each flat

4 For case C

Modern electric heaters are more efficient than the old types, especially storage heaters, so it may be worth replacing your heaters with ones that can be controlled better. It is especially important for you to make improvements to the building fabric of your home, to save money on your bills.

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Low carbon heat/ heat from electricity | Examples

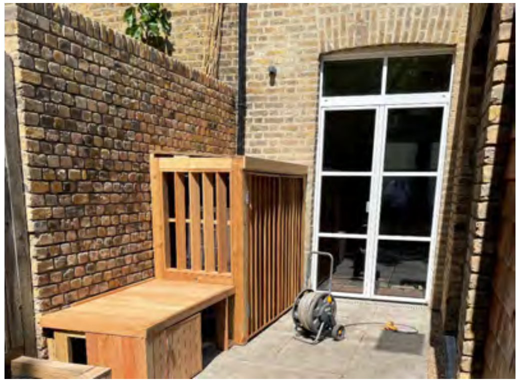
Deck mounted

Rear garden – ground mounted

Rear garden – ground mounted

Roof mounted

Bracket mounted



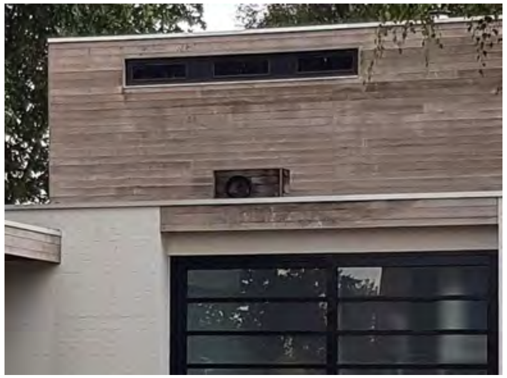
Boxed enclosure

Rear garden – ground mounted

Rear garden – ground mounted

Front garden – ground mounted

Wall mounted – wired enclosure



Wall mounted

Heat pump under a window and behind enclosure

Sources: @heatpumpchic and other homeowners' installations

Solar PVs | Additional information

Why considering solar PVs?

We need to increase solar energy generated in London to reduce carbon emissions and balance energy use. Many homes have a significant roof space and residents can directly benefit from this electricity.

Where to start?

Contacting a local MCS certified solar installer is a great first step to retrofitting a solar Photovoltaic (PV) system. They can assess your property, provide information on solar panels and inverters, and provide a quotation indicating how much energy the system will generate. Quotations typically also include financial analysis such as annual savings and simple payback period. Prices can vary substantially between installers though, so obtain several quotes.

Planning work

Scaffolding will typically need to be erected to install solar panels. Consider whether this could provide opportunities to carry out other retrofit work such as wall insulation, replacing windows, or tackling a thermal bridge between your wall and roof insulation. Standard solar scaffolds may not include working decks on intermediate floors, so if you do plan to do other work discuss it with your installer.

Getting up and running

Once your system is installed, you will need to get registered for the Smart Export Guarantee to receive payments for exported solar energy. Check [Solar Energy UK's](#) league table to find an energy supplier offering a competitive rate. Most schemes require an MCS certificate from the solar PV installer and a smart meter or export meter that can record the amount of energy you are supplying to the electricity grid.

Examples of photovoltaic panel precedents, clockwise from top left:

© Historic England, © Deege Solar © RBKC Solar together

Over a million homes in the UK already have solar panels, many of which have been retrofitted. Notify your building's insurance provider if you are having solar panels fitted to ensure they are covered and your policy remains valid. (Source: Alamy Stock Photo)

< Return to solar PV summary

Solar PVs | Additional information

Note: Solar panels on the front roof slopes of properties should be considered with care to minimise the effect on the character of the conservation area and may require planning permission.
Solar slates may be more acceptable than solar panels in such locations.


PV installation on a roof (house) as tile replacement


PV installation on a roof (house) over the tiles


PV installation on a roof (house) over the tiles


PV installation on a roof (house) as tile replacement


PV installation (rear elevation) over the tiles

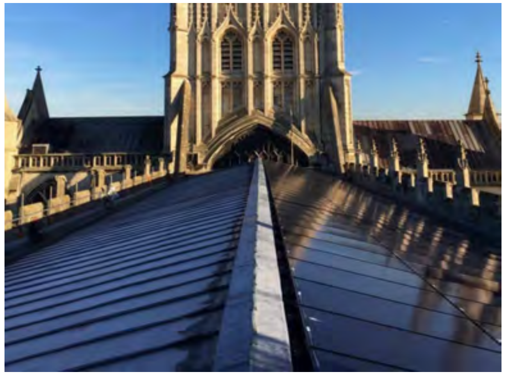

PV installation on a roof (house) – PV slates


PV installation on a roof (house) over the tiles


PV installation on a roof (house) over the tiles


PV installation on a roof (house) over the tiles


PV installation on a roof (house) over the tiles


PV installation at King's College, Cambridge


PV installation on a roof (house) over the tiles

Sources: Solar together, www.greenandheritage.uk, www.home-renewables-scotland.co.uk/

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Appendices

This final section includes:

- A glossary
- A list of guidance documents, reports and resources which can be used to further your understanding of retrofit

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Glossary

Air Source Heat Pumps (ASHP): An electric heating system that extracts ambient heat from external air to efficiently heat a dwelling.

Airtightness or air permeability rate: A measure of how much air naturally leaks out of or into a building, through gaps around doors, windows, cracks, etc. Usually measured in $m^3/m^2/hr$ @ 50Pa.

Building fabric: A term used to describe collectively the walls, roof, floor, windows and doors of a building.

Carbon budgets: A term used to qualify the remaining carbon emissions, or share of carbon emissions, that can be emitted before the amount of cumulative emissions exceeds a climate change target.

Carbon footprint: The amount of carbon emitted by a person or organisation in a given timeframe.

Carbon offsets: A way of balancing emissions in one area by reducing emissions in another or through carbon sequestration.

Climate resilience: Enabling a building, dwelling, geographical area or organisation to adapt to the changing climate.

CO_2: Carbon dioxide, a greenhouse gas.

Coefficient of Performance (CoP): A measure of efficiency usually used for heat pumps. The CoP is the amount of useful energy (heatig or cooling) produced from every unit electricity used, e.g. a heat pump with a CoP of 3 produces 3 kWh of heat for every 1 kWh of electricity it uses.

Communal heating system: A heating system serving several dwellings.

Energy efficiency: The relative amount of energy a building or system uses to achieve a certain aim (e.g. maintain a specific internal temperature).

Building fabric efficiency: A measure of how effective a building's fabric is at retaining heat.

kWh: Kilowatt hour, a measure of the amount of energy used or generated in one hour.

Leaky building: A building with a low level of air-tightness.

Mechanical Ventilation with Heat Recovery (MVHR): A type ventilation system that recovers heat from extracted air before it is vented outside the building and uses it to warm incoming fresh air.

Renewable energy: Energy produced from a renewable source e.g. wind or solar.

Retrofit: The introduction of new materials, products and technologies into an existing building to reduce its energy use and/or increase its renewable energy generation and/or reduce its carbon emissions.

Space heating demand: The amount of heat energy required to heat a space to the required temperature. Space heating demand is a good proxy for the building fabric efficiency and is usually expressed in $kWh/m^2/yr$.

Solar photovoltaic (PV): A form of renewable electricity generation from solar energy well suited to buildings and urban environments.

Thermal bridge: A point, line or area in a building's external envelope which loses more heat than its surroundings, i.e. a weak point from a heat transfer point of view.

Thermal line: The conceptual representation of where the building fabric insulating layer is. It is formed by the insulation in walls, roofs and floors as well as windows, rooflights and doors.

U-value: The metric used to quantify the rate of heat loss for different elements. The higher the U-value, the more heat the element will lose.

Waste Water Heat Recovery (WWHR): A proprietary system which uses heat from waste water and transfers it to the incoming cold water.

Resources and further reading

Sustainably retrofitting your home: Householders' guide to windows, Royal Borough of Kensington and Chelsea (2024)
https://www.rbkc.gov.uk/planning-and-building-control/planning-policy/sustainably-retrofitting-your-home

Transform your house into a low carbon sustainable home, EcoFurb (2020)
https://www.ecofurb.com

Retrofitting your home, Cambridge City Council (2022)
https://www.cambridge.gov.uk/media/11677/retrofitting-your-home-report-non-accessible-version.pdf

A guide to Retrofitting your home, Trust Mark (2021)
mar0004-retrofit-journey-brochure-a5-20pp-a-spreads.pdf

Individual how-to guides on retrofitting windows and heat pump, Westminster City Council (2022)
https://indd.adobe.com/view/b71d2927-183d-46b4-9f7d-ab4acbd7b052

Home for a Low Carbon Future, People Powered Retrofit (2019)
https://retrofit.coop

Adapting Historic Buildings for Energy and Carbon Efficiency, Historic England (2024)
https://historicengland.org.uk/images-books/publications/adapting-historic-buildings-energy-carbon-efficiency-advice-note-18/

London Energy Transformation Initiative (LETI) Climate Emergency Retrofit Guide, LETI (2021)
https://www.leti.uk/retrofit

Whole House Eco-Retrofit, Centre for Alternative Technology (2023)
https://cat.org.uk/info-resources/free-information-service/eco-renovation/eco-retrofit/

Sustainable Renovation: Improving homes for energy, health and environment, The Pebble Trust (2018)
https://static1.squarespace.com/static/5978a800bf629a80c569eef0/t/5beca5f021c67c2280e66de3/1542235691571/Guide+to+Domestic+Retrofit.pdf

Retrofitting existing homes: Guide for UK homeowners, Urbanist Architecture (2023)
https://urbanistarchitecture.co.uk/retrofitting-uk-houses/

Our guide to retrofitting: how to future proof your older home, The Modern House (2023)
https://www.themodernhouse.com/journal/thoughtful-living-retrofitting/

Retrofit Guide for Homeowners (ventilation), Aereco (2021)
https://www.aereco.co.uk/knowledge-centre/retrofit-guide-for-homeowners/

Retrofit Pattern Book, Greater Manchester Combined Authority, University of Salford and Red
https://retrofit.support

Other trusted sources for good information and advice about retrofit include:

AECB - Association for Environment Conscious Building
STBA - Sustainable Traditional Buildings Alliance
EH - English Heritage
HES - Historic Environment Scotland
The Green Register
The Retrofit Academy
Retrofit.Support website
UKCMB - the UK Centre for Moisture in Buildings

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