Folkestone & Hythe District Council | Homes England

EXISTING BUILDINGS

September 2023 | Rev E

Levitt Bernstein People.Design | Introba | Etude

Foreword and Acknowledgments

Foreword from F&HDC to be added

The Folkestone & Hythe District Council Net Zero Toolkit for Retrofit has been developed in close collaboration with the District Council, Otterpool Park LLP, Homes England and Kent County Council.

We are very grateful to the following individuals for their time, leadership, contributions and comments.

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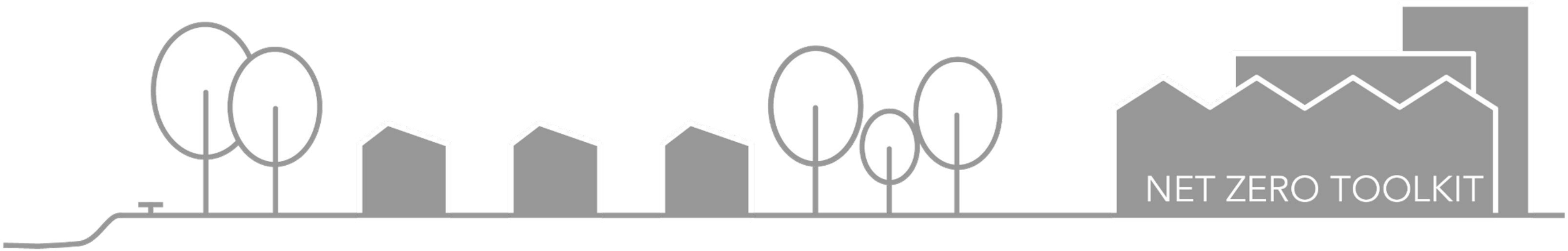
The Folkestone & Hythe District Council Net Zero Toolkit

The Folkestone & Hythe District Council Net Zero Toolkit comprises of four parts, each consisting of a separate document.



This document

Part 1

Decarbonising buildings – Strategic objectives

This part is 6 pages long and aimed at Councillors, officers and other key stakeholders involved in the formation and adoption of the Net Zero Toolkit.

It lays the foundations for the Toolkit documents by explaining legal climate change requirements and policy context. It also explain the "whys" for being ambitious with Net Zero Carbon new buildings.

Part 2

New buildings

This part is 60 pages long and aimed at developers (small and large), architects, consultants, planning officers.

Its main aim is to communicate how new developments that are consistent with climate change objectives can be designed and constructed. It covers both domestic and non-domestic developments and includes useful 'one pagers'.

Part 3

Retrofit

This part is 40 pages long and aimed at F&H District Council as it focuses mainly on the Council's own stock.

It seeks to communicate the importance of retrofit, explain which key improvements need to be made in a simple way.

It also signposts useful guidance on retrofit.

Part 4

Planning policy recommendations

This part is 20 pages long and aimed at F&H District Council's Planning department.

It provides clear policy recommendations for the Council to consider for the next Local Plan update.

Contents

1 CONTEXT

This chapter provides the background context of the current Climate Emergency and why action must be taken now. This begins with assessing Folkestone & Hythe's existing building stock to understand where improvements need to be made.

Context | Why?

There is overwhelming scientific consensus that significant climate change is happening. The sixth assessment report from the Intergovernmental Panel on Climate Change (IPCC AR6) released in February 2022, is a "dire warning about the consequences of inaction," said Hoesung Lee, Chair of the IPCC. It concludes that . "Any further delay in concerted global action will miss a brief and rapidly closing window to secure a liveable future."

The Paris Agreement, 2015

The Paris Agreement is a legally binding international treaty on climate change with the aim of limiting global warming to well below 2°C, preferably to 1.5°C, compared to pre-industrial levels.

UK's commitment to Net Zero Carbon

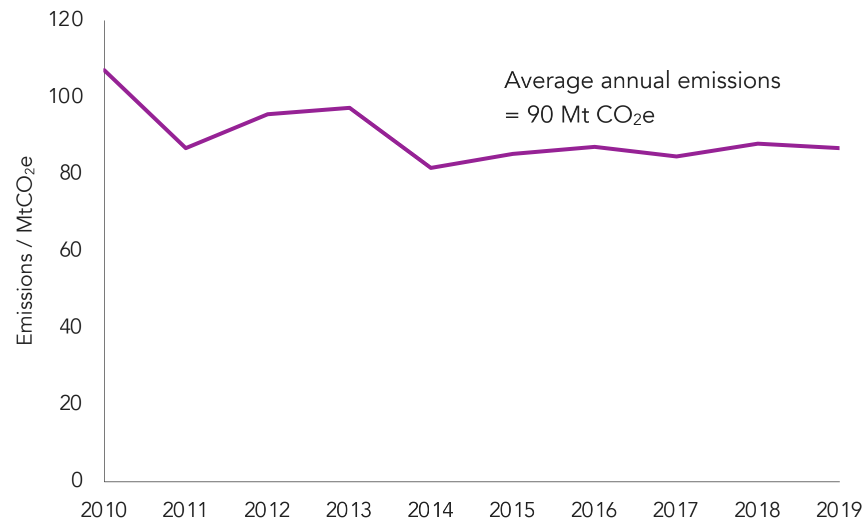
The UK has voluntarily bound its Paris Agreement target of being net zero carbon by 2050 in law through the Climate Change Act 2008 (amended in 2019). A Net Zero Strategy produced in 2021 set out the decarbonisation pathways for all sectors to reach net zero emissions by 2050.

Folkestone & Hythe's District Council (F&HDC)

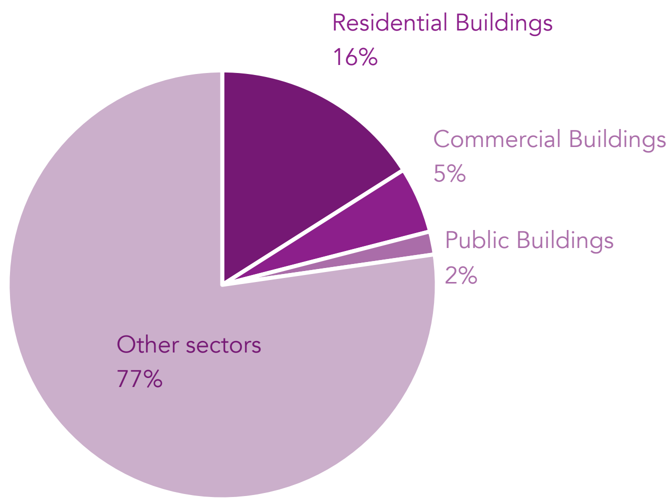
The Council declared a Climate and Ecological Emergency in July 2019 and is committed to reduce its estate and operations to zero net carbon by 2030. The Council needs to stay within a maximum cumulative CO_2 emissions budget of 3.1 million tonnes for the period 2020-2100 with emissions cut averaging 13.3% year on year.

Buildings

Emissions from buildings emanate mostly from heating, with an annual average of 90 Mt CO_2e. 77% of these emissions emanate from the domestic stock, equivalent to 16% of national emissions. If the net zero carbon target is to be met, the energy demand of the existing building stock needs to reduce significantly.



Total annual emissions (direct and indirect) from UK buildings. 2010 to 2019 (adapted from UKCC Progress Report to Parliament, June 2020).



UK CO_2e emissions, 2020 – includes direct emissions only (adapted from Final UK Greenhouse Gas Emissions National Statistics: 1990 to 2020).

Context | The crucial importance of moving away from gas

Carbon emissions of the existing UK housing stock

There are approximately 28 million households in the UK, of which approximately 86% use natural gas boilers. Similarly, about 84% of households in F&HDC uses gas as the main heating fuel. Gas boilers emit around 240 g of CO_2 for every kWh of energy that is delivered to the home. The average UK home uses12.5 MWh/year for heating and hot water which results in an annual emission of 2.6 tonnes of CO_2. To minimise carbon emissions and maximise energy performance, all households will need to be decarbonise by 2050.

Decarbonising the grid

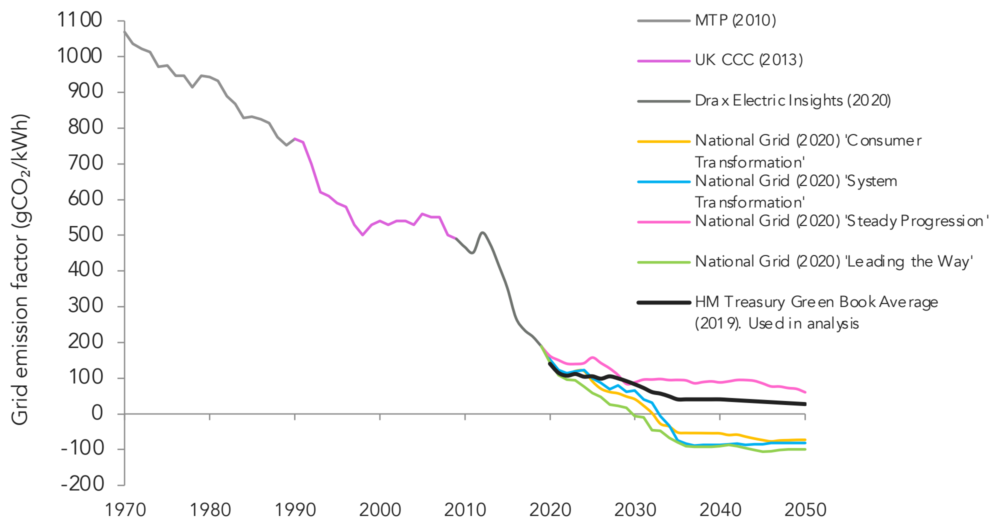
The role of gas power stations is changing from bulk electricity production to balancing out variations in wind and solar output. Moreover, the rapid changes in UK's power system are shifting the goal posts for clean heating with coal phase-out, growth of renewables, such as wind, solar and biomass as well as increasing carbon prices and demand reduction.

For the first time, the average carbon intensity of UK's electricity fell below that of gas in 2019, making electric heating the lower carbon option. The carbon intensity of electricity will continue to fall as more renewable energy is fed into the grid. It further emphasises why electrification of heat is commonly considered as one of the main priorities of decarbonisation.

Eliminating the use of fossil fuel-based systems

New gas or oil boilers should not be installed in existing homes and as from 2025, the use of fossils fuels for heating will be banned in new dwellings.

However, electricity is currently more expensive than natural gas. It is, therefore, crucial to improve the energy efficiency of dwellings to reduce energy consumption, for example by increasing insulation roofs, walls and floors.



Long-term variations in emission factor of grid electricity show the rapid historical reduction in emission factors *© Etude based on data from Market Transformation Programme, UK Committee on Climate Change, Drax, National Grid and HM Treasury.*

Note: *The National Grid Future Emissions Scenarios (FES) show that if the power sector removes CO_2 from the atmosphere by the growth of biomass and captures it when it is used in power stations, it could be carbon negative. This would rely on the use of Bioenergy with Carbon Capture and Storage (BECCS). Carbon Capture and Storage is a process in different steps: CO_2 produced is captured, transported away and isolated from the atmosphere in long-term storage in geological formations or for use in industrial processes). When more carbon is removed from the atmosphere and stored by a process than is emitted into the atmosphere, emissions are negative. BECCS features prominently in three of the four scenarios modelled in FES.*

Context | Towards Net Zero

Putting homes on the right track towards Net Zero

There are currently about 28 million homes in England, which would need to have some form of retrofit by 2050. By that time, an additional six million homes would have been built. Thus, 80% of the homes that will exist in 2050 have already been built. However, as the new build standards still do not align with net zero, even the homes being built currently will need to be retrofitted by 2050. Retrofit is, therefore, critical in supporting the transition to net zero.

Additionally, Part 2 of the Net Zero Toolkit - New Build, outlines the targets required to avoid the need to retrofit new build homes in the future.

Retrofit and the hierarchal approach

Retrofit refers to the upgrading of the home to both mitigate against climate change while ensuring that the dwelling is well adapted to the changing climate.

For a retrofit to be net zero compliant, the following hierarchy should be followed in addition to not having any gas or oil boiler.

1 - Energy efficiency

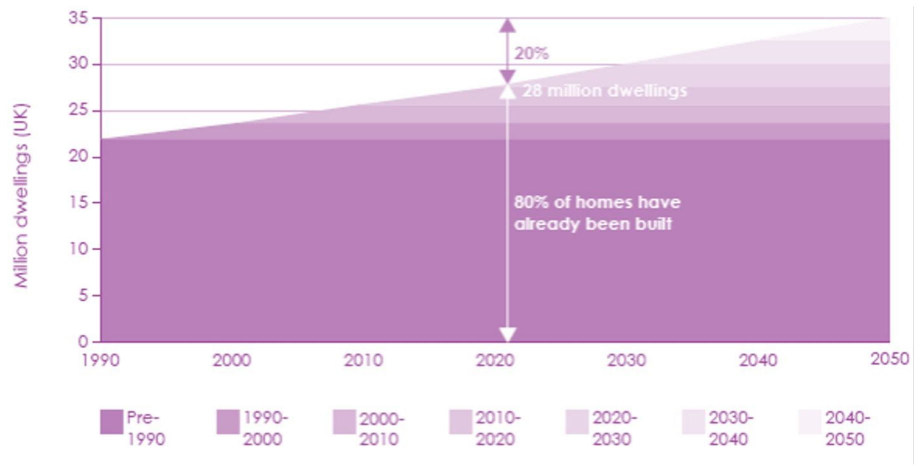
Buildings use energy for heating, hot water, ventilation, lighting, cooking and appliances. The efficient use of energy reduces carbon emissions and running costs. Using a fabric first approach, space heating demand and Energy Use Intensity should be reduced as far as is practicable.

2 - Low carbon heat

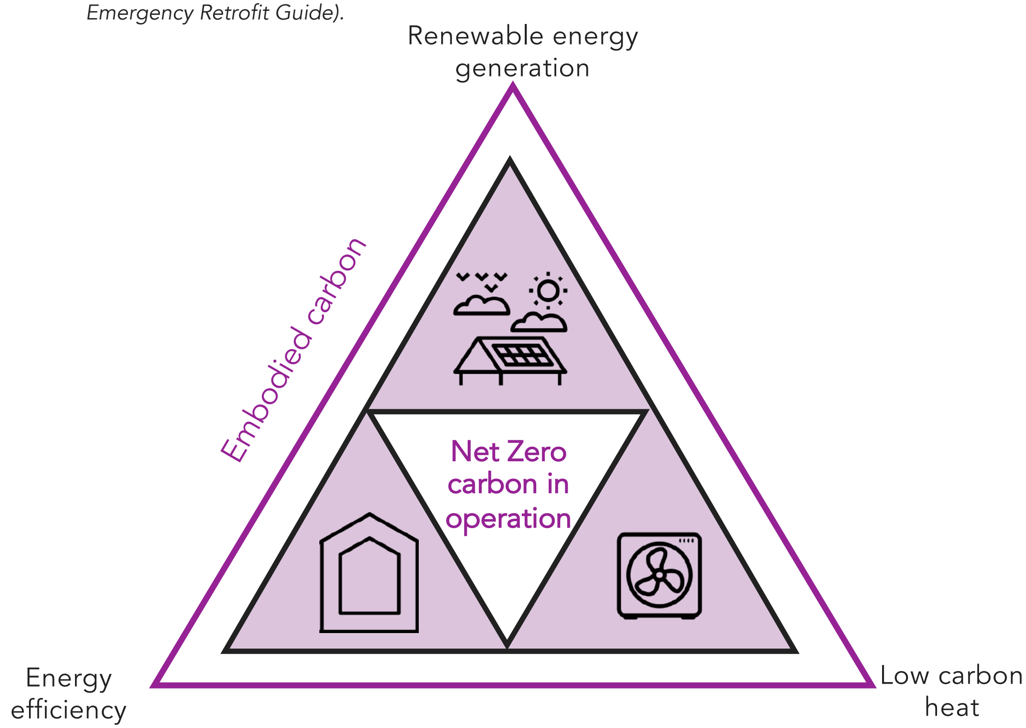
Existing buildings need to transition away from gas and oil as soon as possible. Heat pumps offer an excellent way of transitioning to electric heating whilst reducing the electrical load on the grid as they are up to three times as efficient as turning electricity into heat.

3 - Renewable energy generation

Renewable energy should be generated on-site, wherever it is feasible but not at the detriment of the above two strategies. The roofs of existing homes should be utilised for PV panels, to support the increased demand for renewable energy.



Millions of dwellings built in the UK pre-1990 to 2050. Demolition is not considered as there's an insignificant mount of domestic demolition that is replaced (Adapted from LETI Climate Emergency Retrofit Guide).



Hierarchical approach to be followed for an operational net zero carbon home.

Context | The benefits of Retrofit

Retrofit not only responds to the imperative of climate change but also provides several value-added benefits.

1. Fuel poverty. One in ten households in England is considered to be in fuel poverty. There is, expectedly, a strong correlation between inefficient homes and fuel poverty as 88% of all fuel poor households have an EPC band D or below. As the energy performance of Folkestone & Hythe's housing stock is similar to the average UK home with an EPC rating of D, retrofitting this housing stock will result in lower energy bills of the residents.

2. Reduced energy bills. Inefficient homes suffer from high operating costs. Upgrading all UK homes to EPC band C could provide annual energy cost savings of £7.5 billion.

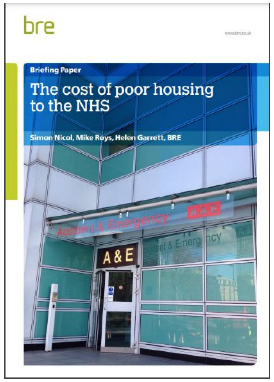
3. Improved health and wellbeing. Poor quality homes can have a detrimental impact on our health. The International Energy Agency and the Organisation for Economic Co-operation and Development suggest health improvements might account for 75% of the overall value of improving the energy efficiency of buildings. Improving the energy efficiency of homes whilst ensuring proper ventilation improves indoor air quality. Additionally, reducing the number of fossil fuel boilers significantly reduce the emission of various pollutants, such as nitrous oxides.

4. Local growth. Decarbonisation will support clean local growth across the country through the creation of jobs. Installing energy efficiency measures and new heating systems will rely on local supply chains and businesses. It is reported that a retrofit programme could result in 500,000 new jobs by 2030 with a £309bn boost to the economy (Construction Leadership Council, Greening our Existing homes, National Retrofit Strategy).

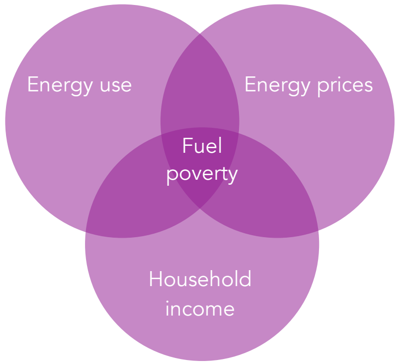
5. Increased property value. Energy efficient properties typically have a higher property value than less efficient ones.

Increased property value

Energy efficient properties typically have a higher property value than less efficient ones. Properties with an EPC C rating were worth around 5% more than those currently at EPC D rating.



The BRE estimated that poor quality housing costs the NHS approximately £1.4 billion in avoidable treatments.



The dwelling's energy use is one of the three key factors contributing to fuel poverty. Net Zero Carbon buildings would help to reduce it, contributing to the sustainable reduction in fuel poverty in Newham

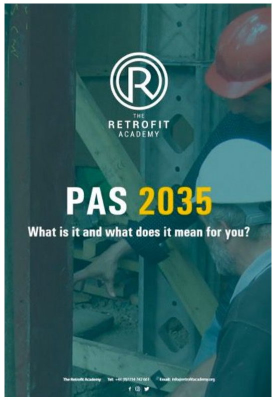
Context | PAS 2035

PAS (Publicly Available Specification) 2035 is the UK's first retrofit standard for a 'whole house' or 'whole building' retrofit. It is concerned with assessing domestic dwellings for energy retrofit. This involves identifying areas where improvements can be made and specifying and designing the relevant improvement measures. It is also concerned with the monitoring of domestic retrofit projects.

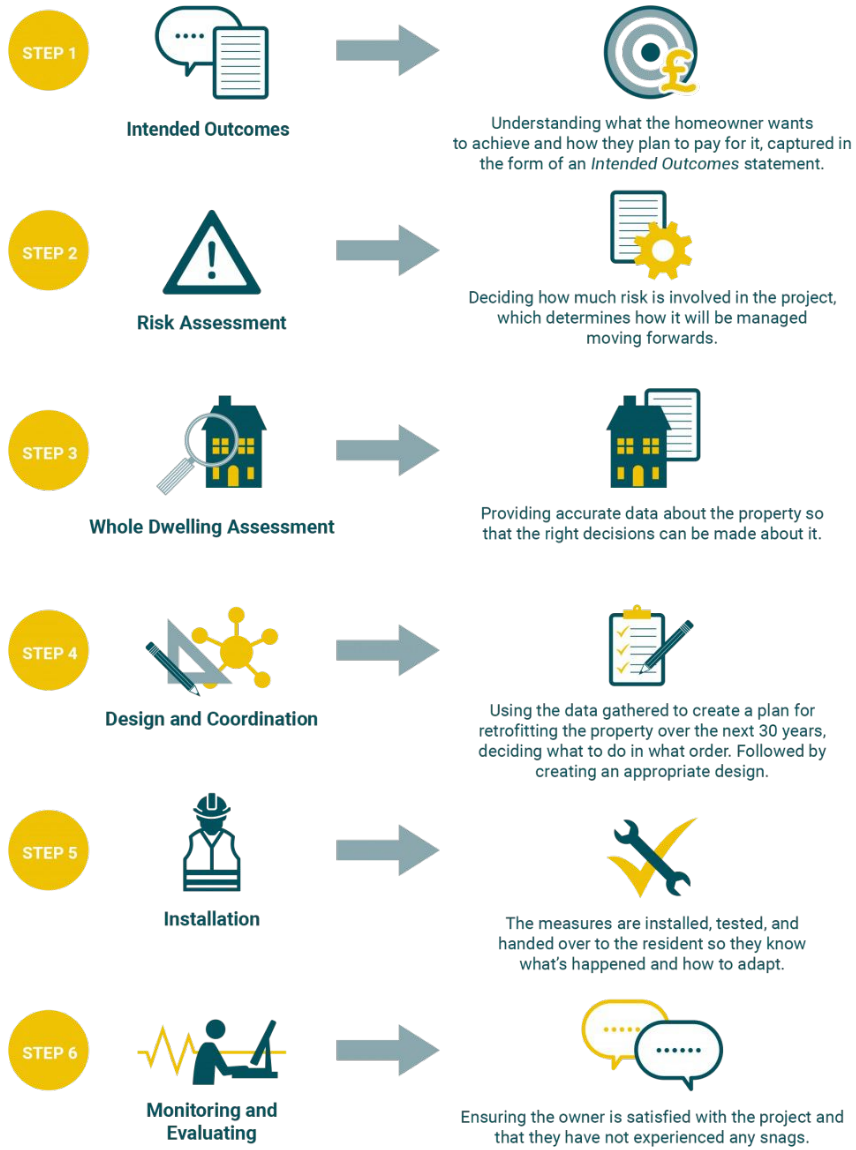
PAS 2035 follows two core principles:

1. A **'fabric first'** approach to reduce the heat demand of a building as much as possible and to ensure newly airtight homes are well ventilated and avoid issues with damp and humidity.
2. A **'whole house'** approach to ensure retrofit plans for homes consider improvements to the fabric, services and renewable energy generation in a coherent way to minimise both risks and carbon emissions.

PAS 2035 is to be used in conjunction with PAS 2030: 2019, which sets out the standards required for installing Energy Efficiency Measures (EEM). Compliance with PAS 2035 and PAS 2030 is mandatory for all companies installing EEMs, including domestic retrofit, as from 30th June 2021. Firms participating in Green Homes Grant and Local Authority Delivery Phase 1 schemes are exempted until the end of October 2021.



PAS 2035 requires an accredited Retrofit Coordinator to be appointed who will take responsibility for demonstrating compliance with the PAS 2035 standard. This is a relatively new role and different projects require input from different retrofit specialist depending on the risk category. The Retrofit Coordinator identifies whether the project falls into a low, medium or high high-risk category and advises on appropriate steps to minimise risk.



PAS 2035 recommended six steps on a quality assured retrofit project.

Context | EnerPHit

The Passivhaus EnerPHit retrofit standard provides an Independent Construction Standard and route to providing a retrofit certification closely aligned with Passivhaus standards.

There are two routes to demonstrating compliance with the EnerPHit standard:

1. **Building Component Method:** Target fabric performance U-values, building colours and ventilation standards are to be met. The targets vary depending on the climate zone of the building;
2. **Energy Demand Method**: Target maximum heating demand figures are to be met depending on the climate zone of the building.

The majority of the UK is within the 'Cool-temperate' climate with some locations in the south of England in the 'Warm-temperate' climate zone within PHPP. This would need to be defined by an appointed Passivhaus Designer on which climate would be most relevant for each building

The standard suggests that significant energy savings can be made of between 75-90% in existing buildings with the following measures proving effective:

- Improved thermal insulation
- Reduction of thermal bridges
- Considerably improved air tightness
- Use of high quality windows
- Ventilation with highly efficient heat recovery
- Efficient heat generation
- Use of renewable energy sources

Passivhaus windows and systems are recommendable for EnerPHit.

Compliance with the standard is demonstrated by PHPP modelling and is independently verified by a Passivhaus Certifier.

Where exemplar levels of retrofit are being targeted, modelling in PHPP can be undertaken and quality assurance is to be achieved through an independent QA process.

The range of routes to compliance make this widely applicable in the UK, this can be used to meet LETI exemplar targets and for projects following the PAS 2035 methodology.

EnerPHit may not be applicable to all buildings but could be used for exemplar retrofits.

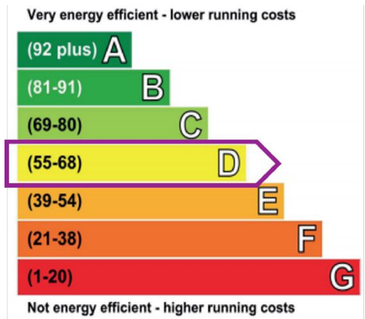
Context | Existing Housing Stock

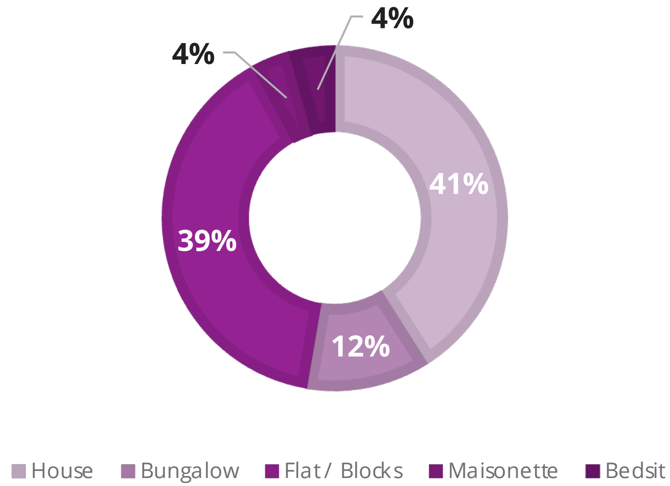
It was reported that 8,721 dwellings in Kent are second homes, mostly concentrated in coastal districts, which include Folkestone & Hythe. As of 31 March 2020, the number of dwellings in the district amount to 52,728. The vast majority, 89%, of the housing stock in Folkestone & Hythe is owned by the private sector. F&HDC owns about 6% of the housing stock. Social housing dwelling stock consists of Local Authority dwellings and Private Registered Providers (PRPs, such as Housing Associations) stock (Kent Housing Stock, Statistical Bulletin, October 2021).

The breakdown of the stock owned by F&HDC by dwelling type is as follows, with houses and flats making up most of the stock.

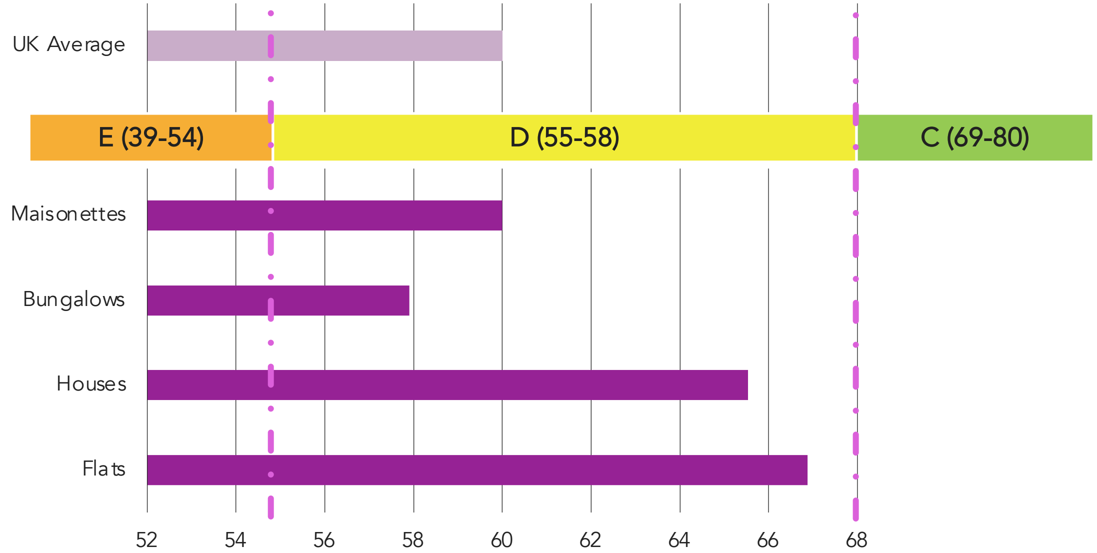
- House – 41%
- Bungalow – 12%
- Flat / Block – 39%
- Maisonette – 4%
- Bedsit – 4%

The average energy performance of the existing housing stock is similar to the average UK home with an EPC rating of D. Flats are the least energy efficient with a rating of 66.9, followed closely by houses.





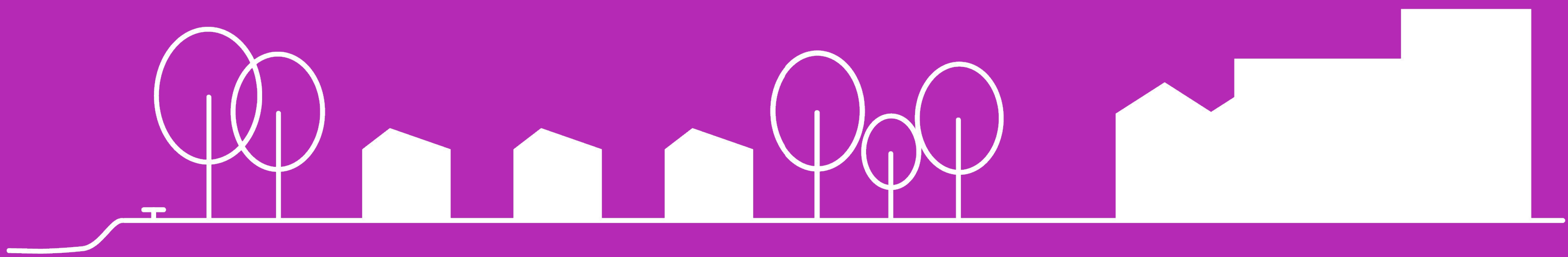
The breakdown of the housing stock owned by F&HDC by archetype (Stock Condition Survey, F&HDC). Houses and flats form a majority of the stock.



The energy performance of all housing within the Folkestone & Hythe District Council area is similar to the average UK home with an EPC rating of D.

2 RETROFIT ROADMAP

This chapter outlines the steps required to carry out a retrofit on an existing building. This covers opportunities and constraints around building fabric upgrades, heating systems, ventilation systems and renewable energy generation.



Retrofit Roadmap I Best practice checklist

	✓	✗
General	• Plan a Whole House building retrofit • Keep a Building Renovation Passport to log any changes made during the retrofit and this could be passed to future homeowners/tenants	• Do not plan to carry out a phase of retrofit without consideration to the impacts this may have on phases of the retrofit in the future
Energy efficiency	• Start with a fabric first approach • Install external insulation as this will offer higher benefits rather than internal insulation, if the façade is not constrained • Install MVHR wherever possible • Address air tightness as a priority	• Do not add internal insulation without assessing the possibility of adding external insulation. Internal insulation will increase moisture risk if not done correctly
Low carbon heat	• Install heat pumps for space and water heating wherever feasible	• Do not install gas or oil boilers • Do not replace gas boilers with direct electric heating unless fabric can be upgraded to best practice levels (LETI best practice targets are shown on the Retrofit Toolkit Summary One Page Design Guide)
Renewable generation	• Maximise on the addition of PV area on the roof of your property following the retrofit of your fabric and systems	• Do not install ground mounted PV arrays in lieu of roof mounted ones

Retrofit Roadmap | Developing a plan

What is a Retrofit Plan?

A Retrofit Plan might also be called a Whole House Plan or be a part of a Building Renovation Passport. Building Renovation Passports are emerging in other countries and are being considered in the UK as a way of formally recording information about a building that can be shared publicly, or between owners in a digital building logbook. This would also include predicted energy performance and actual energy consumption.

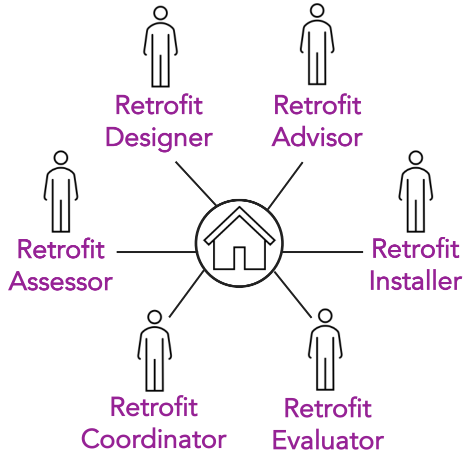
How a Retrofit Plan benefits the whole building approach

There are many technical constraints that affect the Retrofit Plan, like the existing construction, the number of people living in the building, the time they spend there and the budget available to do a full or gradual retrofit. Therefore, a Retrofit Plan is needed to follow a whole building approach.

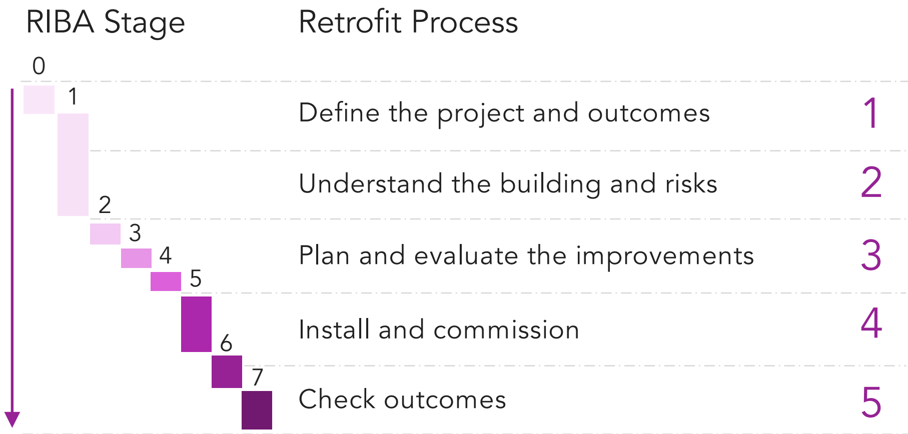
What should a Retrofit Plan cover?

1. Set out key building information, constraints, risks and opportunities
2. Set out the key works proposed along with related strategies and details
    - Maintenance items that need to be resolved
    - Ventilation strategy for each phase
    - Insulation and airtightness strategy
    - Window and door upgrade strategy
    - Critical junction between upgraded fabric elements that will need to be designed
3. Set out the sequence of work
4. Be appropriate in its level of detail and intervention for the building size, context, use, owner and occupants, scope of work and heritage value
5. Include a plan for monitoring and reporting energy consumption
6. Record in a way that can be handed over to future owners

Building renovation passport



Retrofit planning roles. Source: PAS2035



The Retrofit process across the RIBA stages (LETI, Climate Emergency Retrofit Guide)

Retrofit Roadmap | Building Fabric

Improvement to the building fabric helps to reduce space heating demand and improve energy efficiency. Key measures to improve the building fabric include:

Changing single glazed windows to triple glazed windows

Windows can lose more than ten times more heat compared to a well insulated external wall. Care should be given to avoid any risk of condensation and to improve airtightness.

Insulating walls

External insulation is thermally effective. It does not reduce internal space and does not cause disruption to the residents. If internal insulation is considered, breathable materials should be used, and combustible products should be carefully assessed.

Insulating floors and roofs

Floor to ceiling heights should be considered when insulating floors as it may require raising floor level. Therefore, potential impacts on steps at entrances, door heights and consistent staircase levels should be deliberated carefully.

Reducing thermal and air leakage

It is crucial to identify thermal bridges. Insulation, doors and windows that help keep heat in should all connect without insulation depth reducing by more than a third. Where thermal bridges cannot be avoided, the distance that heat must flow to escape the structure should be increased.

A key consideration in retrofit is managing moisture risk and minimising risk of warm humid indoor air coming into contact with cold surfaces. It may be necessary to combine traditional building practices with modern airtightness products, such as tapes, primers, membranes and parge coats.

	LETI best practice retrofit targets	LETI exemplar retrofit targets
Space Heating Demand	50 kWh/m²/yr	25 kWh/m²/yr
Energy Use Intensity	50 kWh/m²/yr	40 kWh/m²/yr

Key performance indicators based on LETI best practice and exemplar retrofit targets.

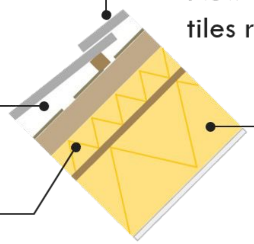
Having the same target for Space Heating Demand and EUI drives more towards high efficiency electric-driven low carbon solutions.

Retrofit Roadmap | Building Fabric - Houses

Specific advice for houses

1. Roof insulation

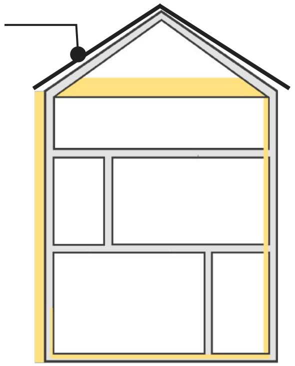
If an unheated attic space is present, a simple approach consists of insulating the floor of the attic space. If possible, existing water services and tanks in the roof void should be relocated; if not they should be insulated. If a heated and habitable loft is required, insulation can be added between rafters and an insulated sheathing board can be applied over the rafters. Fabric improvements should be considered in conjunction with any loft extension works.



It is worth noting that such an approach entails changing the roof line and ridge height. Therefore, a planning application should be submitted to carry out any works.

2. Wall insulation

Where external wall insulation meets the roof, extending the eaves to cover the additional wall thickness should be considered. It should be ensured that ventilation is maintained or added at the eaves.



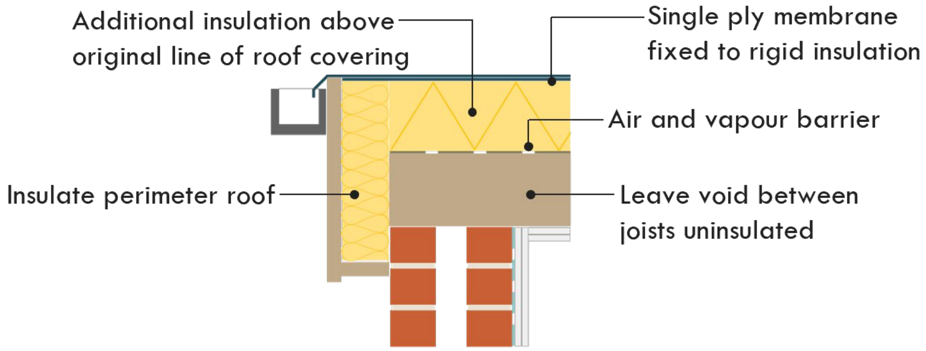
It may be beneficial to consider a hybrid approach e.g. internal insulation at the front to retain the architectural features of the front façade and external insulation at the rear. The roof eaves have been extended to cover the additional wall thickness.

Retrofit Roadmap | Building Fabric - Flats

Specific advice for Flats

1. Flat roof insulation

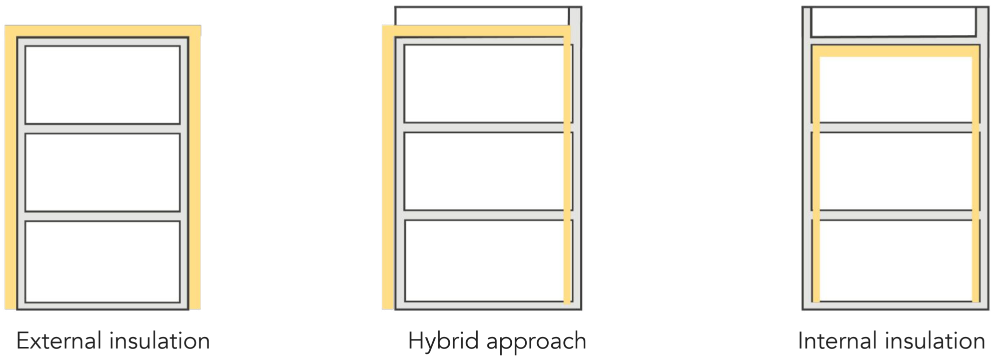
The easiest way to insulate a flat roof is to have the insulation sit over the top of the existing roof deck. Although, it provides better thermal performance, it adds height to the building.



External roof insulation would be possible if a whole block of flat is retrofitted rather than a single unit

2. Wall insulation

The type of wall insulation that would be appropriate depends on whether a flat or a whole block of flats are being retrofitted. Internal insulation would be appropriate for a single unit instead of external insulation as the unit's façade remains visually unaltered.



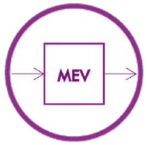
Three types of possible insulation that can be applied. The parapet is being shown in the hybrid and internal insulation options.

Retrofit Roadmap | Ventilation

Existing buildings in the UK are generally leaky and naturally ventilated,
leading to discomfort, poor air quality and large energy demands. Insulation, airtightness and new windows are often considered important, but they generally should not be done without the retrofit of a controlled ventilation system. Therefore, ventilation is a critical part of retrofit as it

- improves air quality;
- reduces condensation; and
- minimises moisture risk.

Different systems of ventilation



Mechanical Ventilation with Heat Recovery (MVHR)	Mechanical Extract Ventilation (MEV)
MVHR provides a whole house approach to improve air quality.	MEV provides no heat recovery and is focused to bathrooms and kitchen only.
Extracts air from wet spaces and supplies fresh air into living rooms and bedrooms.	Extracts air from kitchens and bathrooms.
Circulation of fresh air whilst recovering heat from inside.	Supplied air comes from trickle vents, usually within window frames in living rooms and bedrooms.

MVHR

✔
- Reduces space heating demand
- Heat recovery saves more than 10x the amount of electricity needed to run the fans.
- Savings made on space heating usually offset the running costs of ventilation.
- No cold draughts as supplied air is warm.
- Supplied air is filtered, providing clean and fresh air.
- No external air vents in habitable rooms, minimising external noise.

✘
- MVHRs run constantly; demand control is not included.
- High capital costs and invasive to retrofit.
- Complex systems which require expert design and commissioning to ensure correct operation.
- Filters need to be changed every 6 months.
- Requires a good level of airtightness.

MEV

✔
- Requires smaller space and ductwork connections.
- Enough ventilation to suppress condensation.

✘
- No heat recovery and is, therefore, less energy efficient.
- Prone to draughts.

Key requirements for a good MVHR system

<2 m	<0.85 W/l/s	>90%	>25 mm	PH
Distance from external wall	Specific fan power	Heat recovery	Thickness of duct insulation	PassivHaus Certification

Retrofit Roadmap I Ventilation

MVHR

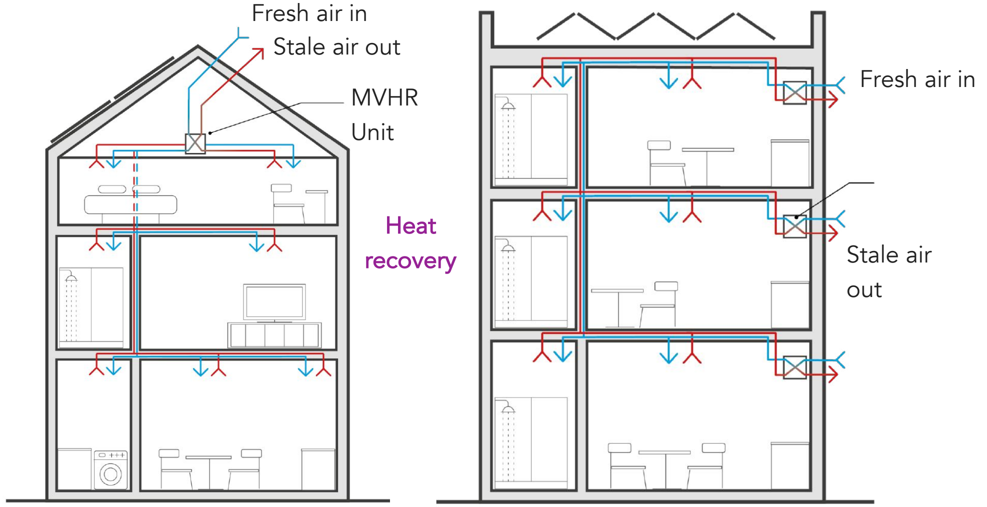
Unit Location

Key requirements:

- Near an outside wall or roof
- Accessible for maintenance
- Not in a bedroom or quiet place

Good locations:

- Above the hot water tank
- At the end of a row of kitchen cupboards
- Store cupboard
- Heated porch space
- Heated loft space



MVHR layout in a house and flat.

MEV

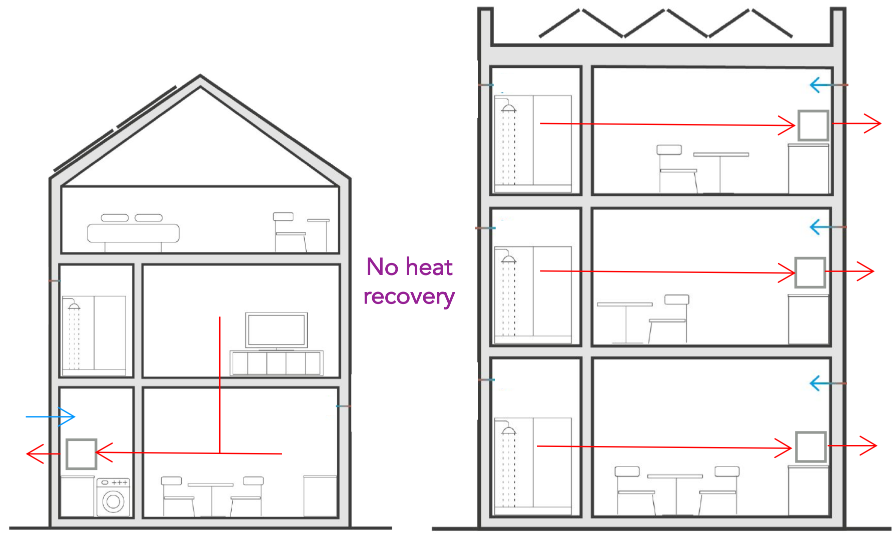
Unit Location

Key requirements:

- Near an outside wall or roof
- Accessible for maintenance
- Not in a bedroom or quiet place

Good locations:

- Above the hot water tank
- At the end of a row of kitchen cupboards
- Store cupboard
- Heating porch space
- Heating loft space
- Above a washing machine



MEV layout in a house and flat.

Ducts – Guidelines all systems

Internal Ducts

- Enough room for ducts to pass freely
- Enough room for acoustic attenuation where needed
- Route to rise between floors
- Route to each room for supply and extract
- Minimise duct bends

External Ducts

- Short as possible
- Insulated 20-50mm thick with vapour proof insulation
- Rigid ducting only (Use pre-insulated rigid foam ducts for easiest install)

Retrofit Roadmap I Heat pumps

The electricity grid has decarbonised and will continue to decarbonise, thus the most likely low carbon heat source for now and the future is electricity. This is done most efficiently, and has lower running costs, when using heat pumps.

Most homes with a heat demand below 100kWh/m^2/yr. will be suitable for a heat pump, unless there is not sufficient space.

Heat pump technologies

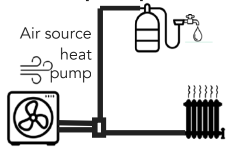
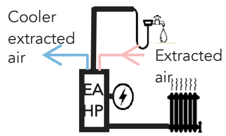
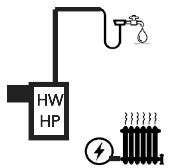
There are lots of different types of heat pumps, broadly in two categories, individual heat pumps and communal heat pumps. They run on electricity but are far more efficient at generating heat than conventional systems and therefore require less energy. Unlike gas and oil boilers, heat pumps tend to deliver heat at lower temperatures over much longer period.

It is important to note that heat pumps run best at lower temperatures (around 35-45ºC degrees) this means that radiators may need to be slightly larger to emit the same amount of heat as a traditional radiator.

It is important to ensure the following actions are considered when designing your heat pump strategy:

- Heat pumps must be sized correctly to meet the heating and hot water load.
- Heat pumps need to be placed outside the home. If permitted development rights cannot be used, a planning application may be required with a noise report.
- Choose a heat pump with a refrigerant that has a low Global Warming Potential (GWP) - Propane is currently market best practice.
- Minimise external pipe lengths to reduce the heat losses from distribution.
- Choose a heat pump with a high efficiency (often referred to as the Coefficient of Performance or COP).

What are the different types of heat pumps?

Heat Pump	Space heating?	Domestic hot water?	Description
Monoblock or split (air source) heat pump 	✓	✓	This heat pump is highly efficient and works with radiators, underfloor hearing and domestic hot water generation. These heat pumps require space for indoor and/or outdoor units.
Exhaust air heat pump 	✓ Provides some level of heating by heating air that is circulated through the home	✓	An exhaust air heat pump (compact unit) combined a heat pump and a MVHR. Some products can only meet the heat demand in smaller dwellings and/or dwellings with a space heating demand <15kWh/m^2/year.
Integrated domestic hot water heat pump 	✗ Heating must be provided by direct electric (DE)	✓	This is a heat pump integrated into a hot water store (i.e. hot water heat pump). They require space for a hot water store. Heating is delivered through direct electric panel radiators.

Retrofit Roadmap I Direct electric

Direct electric

Direct electric heating systems use electric energy without any supporting mechanisms such as heat pumps e.g. an electric panel heater. Electric heating and hot water systems can be attractive due to their simplicity and typically lower capital cost when compared to a wet system. However, the building will be significantly more expensive to run compared to a heat pump, as the cost of gas is cheaper than electricity, and heat pumps are more efficient.

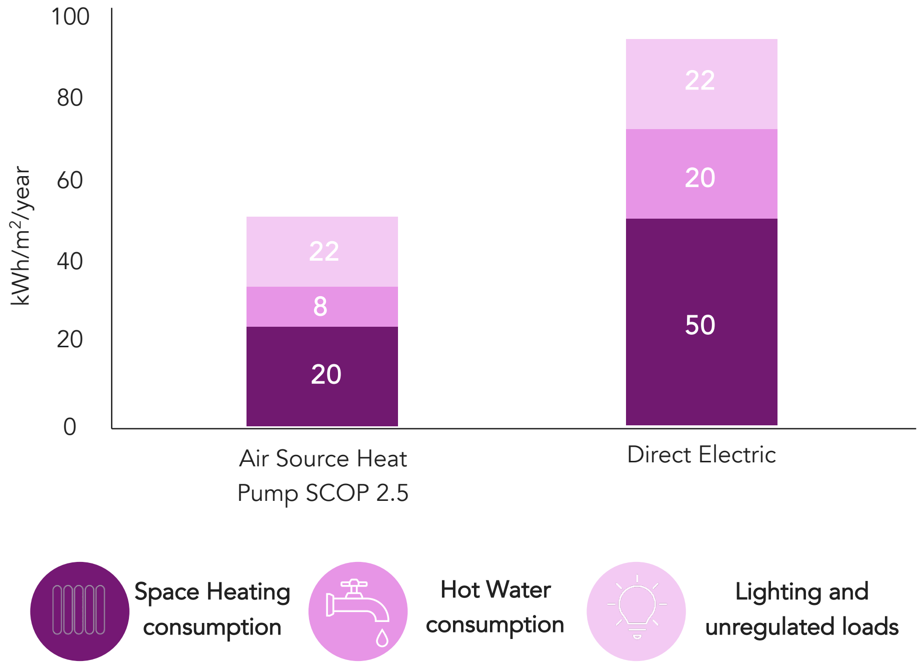
Direct electric also results in higher peak electricity demand and so requires far more electricity to be generated, putting pressure on the capacity for renewable power generation. The use of storage heaters can help to mitigate both these factors, but, in general direct electric should only be considered where heat pumps are not feasible and where the heat demand is very low.

Potential risk Direct electric heating can lead to very high heating bills, it is important to begin with improving the building fabric to reduce the heat demand of the dwelling.

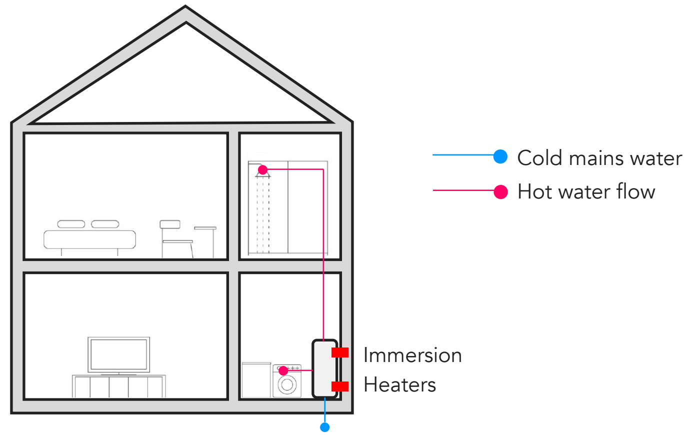
- Simplicity and easy to install
- Lower capital cost than a heat pump
- Lower embodied carbon than a heat pump

- Higher energy bills for occupants
- Requires increased electricity grid due to high peak electricity demand
- Lower efficiency than a heat pump

Advantages and disadvantages of direct electric systems



Comparison of EUI of an air source heat pump versus direct electric for the same dwelling. Source:LETI



Example layout of a direct electric hot water cylinder

Retrofit Roadmap I Which heating strategy is right for me?

Highest

Carbon savings from system

Lowest

Retrofit the home such that the heat demand is as low as possible, as this reduces carbon emissions and fuel bills.

Best practice fabric performance values can be found on the Retrofit Toolkit One Page Design Guides.

Is there enough internal space for a cylinder, external space for a condenser unit and budget to install a heat pump?

Yes → Install a mono block or split (air source) heat pump

No → Is the Space Heating Demand <100kWh/m² /yr?

Is there enough internal space for a cylinder and heat pump condenser unit and budget to install a heat pump?

Yes → Install an EAHP (+DE)

Install an integrated DHW HP (+DE)

No → Is the Space Heating Demand <40kWh/m²/yr?

Yes → Direct Electric

No → Carry out additional fabric improvements

In the case that the existing heating strategy is electric, then keeping this as direct electric is permissible as it will not negatively impact bills

Retrofit Roadmap | Domestic Hot Water Generation

As we look towards a net zero future, it is clear that the ways in which we heat and provide hot water for our homes will need to change. Water efficiency is about reducing our use of mains water and the effect our homes have on water resources. In very low energy buildings, the energy required for hot water can exceed the amount of energy required for space heating.

A method of electrifying hot water generation is to install heat pumps. Most heat pumps will also need a hot water tank to provide hot water so there will be a requirement for additional space in smaller dwellings.

Potential risk Low and zero carbon technologies may need different size hot water tanks, operating at different temperatures and with different size pipes. Poor planning can lead to abortive work, missed opportunities and additional costs in the future

Reduce flow rates

The AECB water standards (opposite) provide clear guidance on sensible flow rates for showers and taps in low energy buildings.

Reduce distribution Losses

All pipework must be insulated. Pipe lengths should be as short as possible and pipe diameters as small as possible.

Insulate to minimise losses from hot water tanks

The standby losses of hot water tanks are highly variable and can have a significant impact on overall energy use. Target a hot water tank heat loss of less than 1 kWh/day equivalent to 0.75 W/K

Install waste water heat recovery systems in shower drains

A simple technology that recovers heat from hot water as it is drained. Vertical systems can recover up to 60% of heat with more common horizontal ones recovering 25-40%.

Consider water recycling

This is the process of treating waste water and reusing it. It can't be used for large portions of potable water use.

25 kWh/m²/yr

Domestic Hot Water Demand

1.5 W/K

Storage Tank Insulation

DHW Targets: LETI best practice and exemplar retrofit targets

Appliance /Fitting	AECB Best Practice Standard
Showers	6 to 8 l/min measured at installation. Mixer to have separate control of flow and temperature although this can be achieved with a single lever with 2 degrees of freedom (lift to increase flow, rotate to alter temperature). All mixers to have clear indication of hot and cold, and with hot tap or lever position to the left where relevant.
Basin taps	4 to 6 l/min measured at installation (per pillar tap or per mixer outlet). All mixers to have clear indication of hot and cold with hot tap or lever position to the left.
Kitchen sink taps	4 to 6 l/min measured at installation (per pillar tap or per mixer outlet). All mixers to have clear indication of hot and cold with hot tap or lever position to the left.
WCs	≤ 6 l full flush when flushed with the water supply connected. All domestic installations to be dual flush. All valve-flush (as opposed to siphon mechanism). WCs to be fitted with an easily accessible, quarter turn isolating valve with a hand-operated lever. Where a valve-flush WC is installed, the Home User Guide must include information on testing for leaks and subsequent repair.
Baths	≤ 180 litres measured to the centre line of overflow without allowing for the displacement of a person. Note that some product catalogues subtract the volume of an average bather. A shower must also be available. If this is over the bath then it must be suitable for stand-up showering with a suitable screen or curtain.
Showers	6 to 8 l/min measured at installation. Mixer to have separate control of flow and temperature although this can be achieved with a single lever with 2 degrees of freedom (lift to increase flow, rotate to alter temperature). All mixers to have clear indication of hot and cold, and with hot tap or lever position to the left where relevant.

AECB Water Standard

Retrofit Roadmap I Renewable Energy Generation

Solar PVs

The Climate Change Committee forecast that the UK solar electricity generation requires 85 GW by 2050.

Panel layout

It is important to establish the right conditions to maximise solar power generation. The ideal panel angle in the UK is between 30 and 40 degrees. The further we move from the optimum angle, the less is the solar output. Additionally, at an angle of 12 degrees or less, the panel is not able to self-clean itself. Therefore, dirt accumulates and the output falls.

Appropriate technology

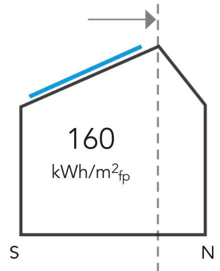
Key points to take into consideration are:

- Specify high efficiency monocrystalline silicon solar panels from a reputable manufacturer (minimum of 450W).
- Choose a panel with a linear power output warranty.
- Specify microinverters or DC optimisers.

High efficiency monocrystalline silicon solar panels can deliver excellent levels of efficiency while maintaining their performance over several decades. The advances in the technology are progressing rapidly and power outputs from commercially available panels are steadily increasing.

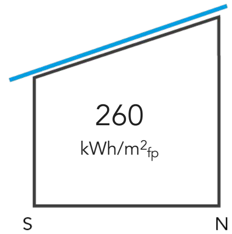
Benefits

Residents of individual homes will naturally benefit from the free electricity
generated by the PV panels but it is not always straightforward for residents in flats or blocks of flats. The free electricity generated can be used to power communal spaces. The Council also benefits from this measure as it demonstrates commitment to decarbonising its stock.



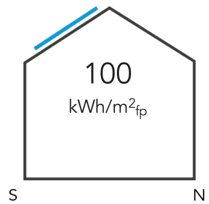
North South

Asymmetric pitch roof with a majority south facing roof



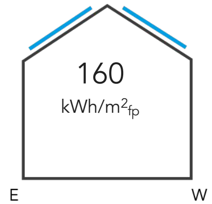
North South

Mono pitch roof with a majority south facing roof



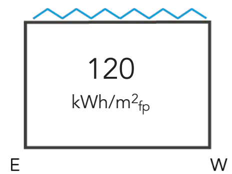
North South

Pitch roof with a south facing roof. North pitch installation isn't recommended due to minimal radiation



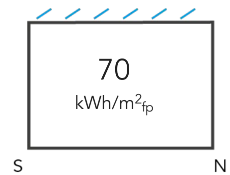
East West

Pitch roof with a majority east/west facing roof. Equal amount of solar radiation can captured in both the first and second halves of the day



East West

Flat roof with an east/west concertina solar panels array prevents inter-row shading



East West

Flat roof with an angled south solar panels array

Considerations should be given to maximising the density of PV panels for optimal electricity generation. Panel density and arrangement depends on the roof form and orientation. How well the roof space is utilised can be expressed in kWh generated per m² of building footprint (kWh/m²fp).

Retrofit Roadmap | Beyond energy and adaptation to future climate change scenarios

Sustainable design goes beyond energy and carbon. It's important we design and build developments that operate within planetary boundaries, create healthy, happy environments for people, and support the wider natural environment on which we all depend. The principles of these strategies are closely linked with the New Build Toolkit.

Embodied Carbon

Embodied Carbon refers to the greenhouse gas emissions associated with the:

A - Manufacture, transport and construction – the upfront carbon;

B - Repair, maintenance and replacement – the in-use carbon; and the

C - Deconstruction – the end of life carbon.

Select products with a low embodied carbon impact when undergoing a retrofit. Use Environmental Product Declarations (EPDs) to assess this, where available.

Circular Economy

Retrofitting the existing building stock strongly aligns with the three key principles of Circular Economy:

- Wherever possible, eliminate waste and pollution.
- Maintain the use of products and materials for as long as possible.
- Restore natural systems

The reuse of existing buildings should always be the priority as it is prolonging the life cycle of a built asset.

Ecology

Enhancing biodiversity benefits occupants, the larger community, and the economy, as well as species and habitats. The following strategies should be followed for existing buildings:

- Use and protection of existing flora fauna and trees.
- Select diverse native species of planting on landscaping areas around the existing building. This encourages creating habitats in the landscaping.

Flooding

A key impact of climate change will be an increase in the frequency and severity of flood events. For Folkestone and Hythe being on the coast makes it vulnerable to flooding and has issues of nutrient loss and contamination of the environment.

- **Slow the flow** – through planting hedgerows, trees, buffer strips.
- **Store water** – through rainwater harvesting, green roofs, permeable paving, bioretention systems (e.g. rain gardens), trees, etc.
- **Increase infiltration** – through improving soil structure, creating permeable surfaces.
- **SuDs should be utilised on every site,** considered at every scale and designed in from the beginning of a project. Control the flow of water on-site through the use of Sustainable Urban Drainage Systems (SuDS).

Overheating

Overheating in buildings is becoming an increasing threat to occupants' health and wellbeing, particularly for vulnerable people. All developments should set out clear measures to reduce overheating. For existing buildings, this includes selecting a **g-value** (the solar factor indicating how much heat is transmitted from the sun) for glass of around 0.5 where possible, when replacing windows. Also, appropriate **external solar shading** should be provided. South façades should have horizontal shading over the window and the west façade should ideally have efficient movable shading e.g. shutters. Do not rely on internal blinds – these can be ineffective.

Sustainable Transport

Sustainable transport for existing building involves reducing environmental impact of the journeys that have to be made by both encouraging active transport (cycling and walking).

Retrofit Roadmap I Appliances, white goods and lighting

Energy efficient appliances & lighting

Appliances and white goods can use significant amounts of energy in a building. When retrofitting and replacing existing appliances, high efficiency appliances are recommended to limit total energy consumption and minimise overheating risk from waste energy given off as heat (i.e. A++ or A+++). Provision of clothes drying lines can help to avoid the use of tumble dryers. Generally, free-standing appliances can achieve better performance than integrated devices and their use is encouraged wherever this is possible although their compliance with the overall design needs also to be considered.

Lighting efficacy is also a key way to reduce energy in individual homes. Light fittings should be as low energy as possible, e.g. LEDs and occupancy sensors and daylight dimming should be specified in communal areas where appropriate.

When replacing cooking appliances, induction hobs and all electric cooking should be prioritised.

Induction hob and all electric cooking

High-rated (A+++) washing machine

Waste water heat recovery

A well-designed wastewater heat recovery (WWHR) system can typically extract between 20% and 55% of the heat from outgoing waste water, using it to pre-heat incoming cold water. They are primarily applicable to showers, which create a simultaneous balanced flow of warm waste water and incoming cold water, permitting heat exchange to occur. For dwellings where showers are the main form of bathing, they are likely to account for around 70-80% of hot water use.

For very low energy buildings, hot water can exceed demand for space heating and therefore WWHR represents a significant opportunity to reduce overall energy consumption.

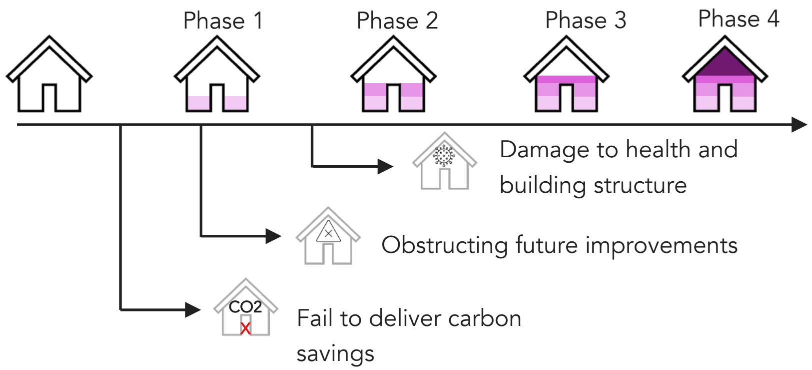
Although WWHR units are far easier to install for new housing, this does not mean they cannot be installed as part of retrofit. As long as there is access to the pipework serving the shower and suitable pipework lengths, a unit can be installed. This technology is well-suited to social housing as it requires little maintenance.

Waste water heat recovery examples from left to right: Horizontal – underneath bath or shower tray

Retrofit Roadmap | Potential risks

Minimising Risks

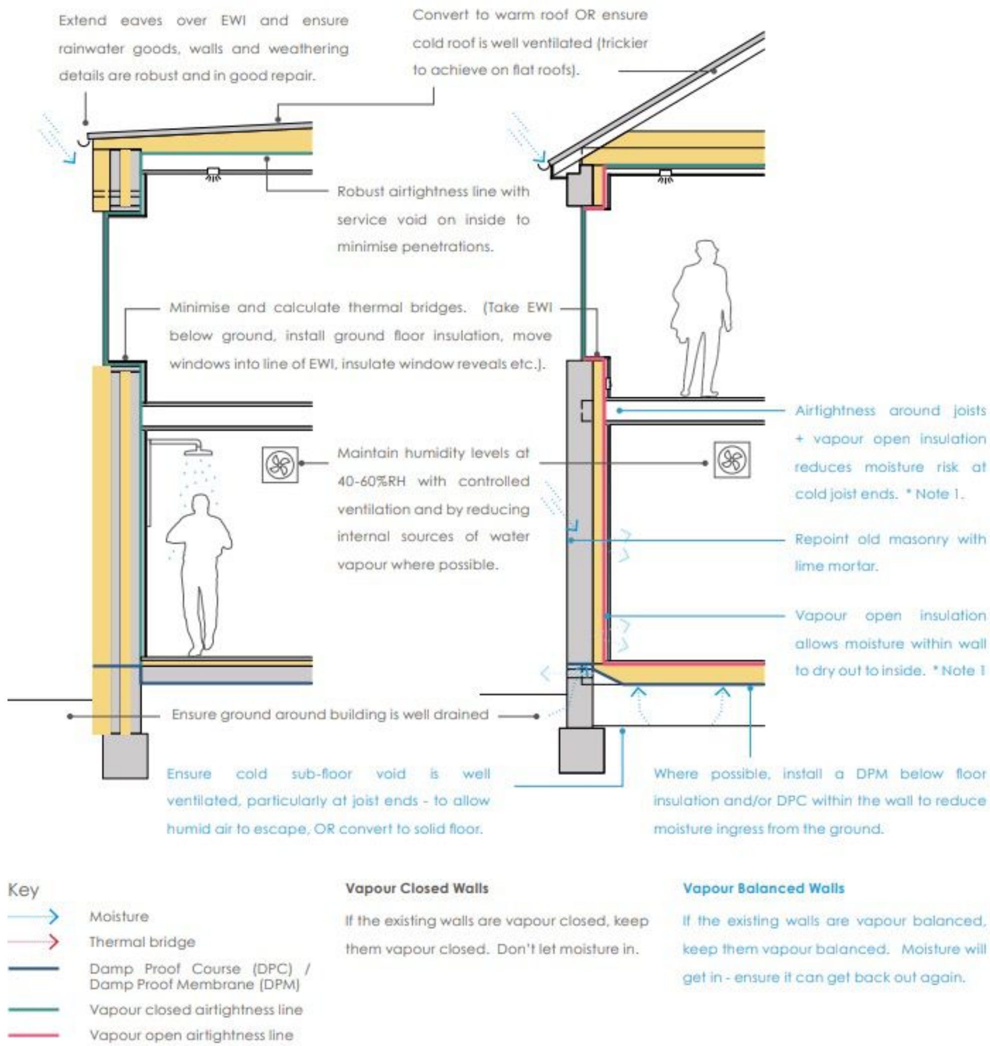
A Whole House Approach minimises risks as the work is phased, meaning interventions can be designed to work together to deliver the most benefit as effectively as possible. Risks of a piecemeal approach include failing to deliver the energy and carbon savings predicted, obstructing future improvements that prevent the full benefits from being realised and potential damage to occupant health.



Moisture

When retrofitting existing buildings, a few key principles must be followed to avoid exacerbating or introducing moisture problems. The risks of retrofit can be overcome with sensible design and well-executed construction. Some key rules are:

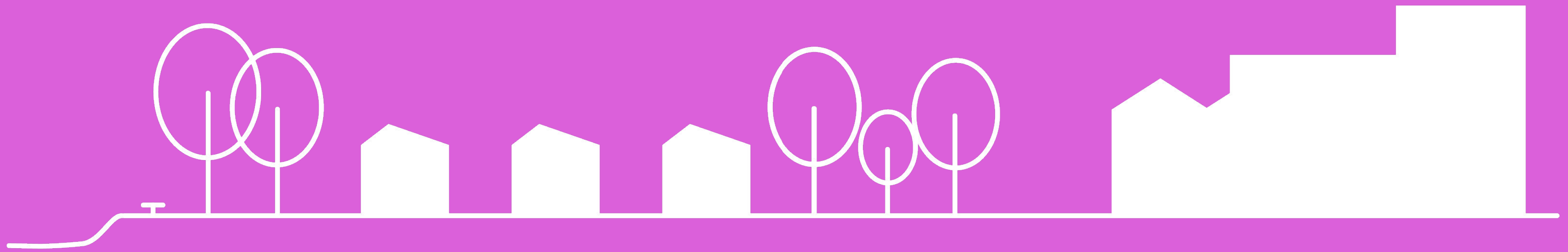
- **No insulation without ventilation.** As you add insulation you are also likely to increase airtightness. This means less air moving through the building. You can counter this with opening windows and extract fans, but ideally by fitting a whole-house ventilation system like MVHR.
- **External insulation is best.** Internal insulation means your external walls become cold and there is therefore a risk of condensation if the warm internal air reaches a cold surface. External insulation is preferred, but if internal insulation cannot be avoided, vapour open insulation (such as wood fibre) should be used. It is chemically fixed to the inside surface thus reducing the risk of condensation.



Best practice retrofit reduces moisture risks. Source: LETI

3 ONE PAGE DESIGN GUIDES

This chapter presents two One Page Design Guides tailored to a typical flat and house typology. The summary page covers the main requirements to retrofit existing homes to a good standard. An additional two pages outline the steps required to carry out a retrofit on two existing homes within Folkestone & Hythe.



Retrofit Toolkit Summary – Flat Typology

Improve fabric efficiency (1)

Add insulation to improve fabric efficiency and replace windows and doors. The following values reference LETI's unconstrained best practice values.

Roof

Cold or warm/flat roof

- U-Value 0.12 W/m^2.K

Windows and doors

Window

- U – Value 1.00 W/m^2.K

Door

- U – Value 0.80 W/m^2.K

Walls and floor

External walls

- U – Value 0.18 W/m^2.K

Suspended timber floor

- U-Value 0.18 W/m^2.K

Solid uninsulated floor

- U-Value 0.15 W/m^2.K

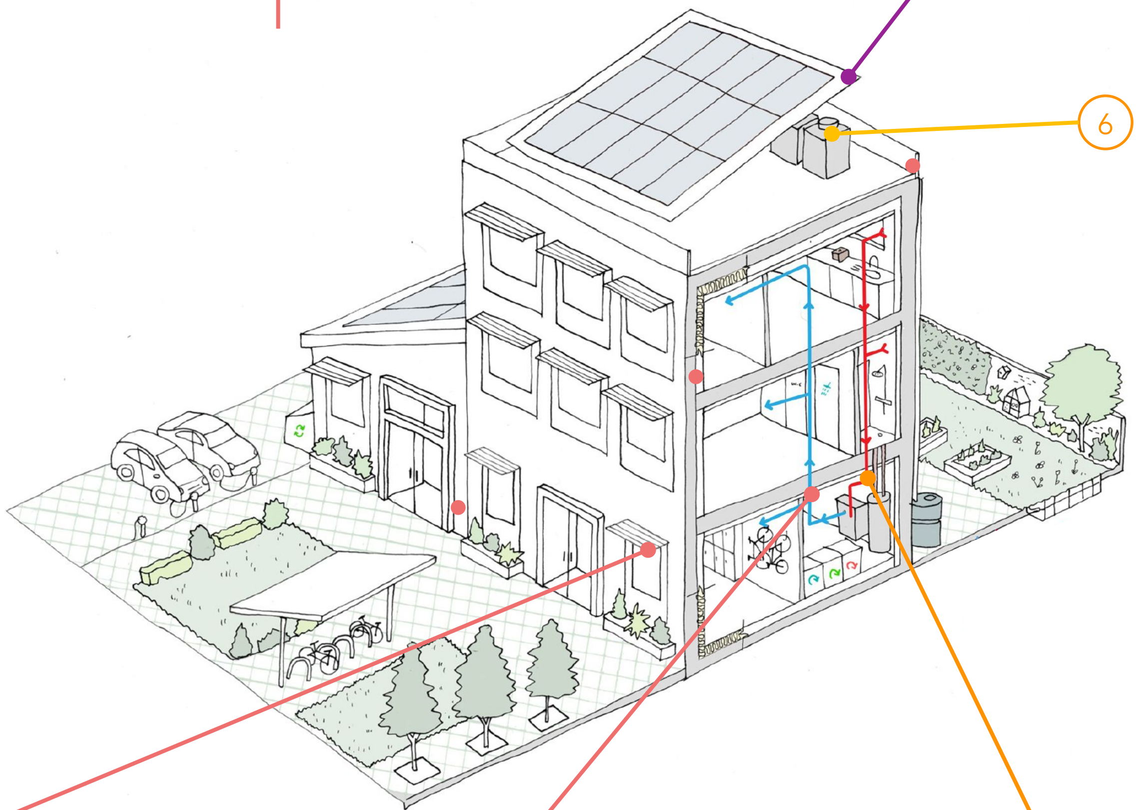
Airtightness and Thermal Bridging (2)

Improve the airtightness of the building fabric to meet 2 m^3/h/m^2 at 50Pa. Draught proof the dwelling and seal existing chimneys and vents.

Thermal bridging should be mitigated.

Renewables (7)

Generate on-site renewable electricity using available roof space (photovoltaics). Meet a minimum of 40% of roof area.



Heating System (6)

Replace the existing gas or oil heating system with a heat pump. Adding a heat pump can significantly improve efficiency. As the exposed external area can be quite small for a flat, the space heating demand can be quite low making direct electric a viable option, specifically if the LETI best practice or exemplar targets are achieved.

Shading (3)

Add external shading to reduce overheating risks. Prioritise overhang shading to all south windows and include shutters or similar on west facing facades.

Ventilation (4)

Ensure that there is adequate ventilation installed to avoid moisture risk. An MVHR (Mechanical Ventilation with Heat Recovery) system is ideal (90% efficiency).

Hot Water (5)

Increase tank insulation or replace to meet 1.5 W/K

Ensure 90% of pipework is insulated

Install low flow fittings to meet 16 l/person/day for shower demands and 9 l/person/day for all other demands.

Retrofit Toolkit Summary – House Typology

Improve fabric efficiency (1)

Add insulation to improve fabric efficiency and replace windows and doors. The following values reference LETI's unconstrained best practice values.

Roof

Cold or warm/flat roof

- U-Value 0.12 W/m^2.K

Windows and doors

Window

- U – Value 1.00 W/m^2.K

Door

- U – Value 0.80 W/m^2.K

Walls and floor

External walls

- U – Value 0.18 W/m^2.K

Suspended timber floor

- U-Value 0.18 W/m^2.K

Solid uninsulated floor

- U-Value 0.15 W/m^2.K

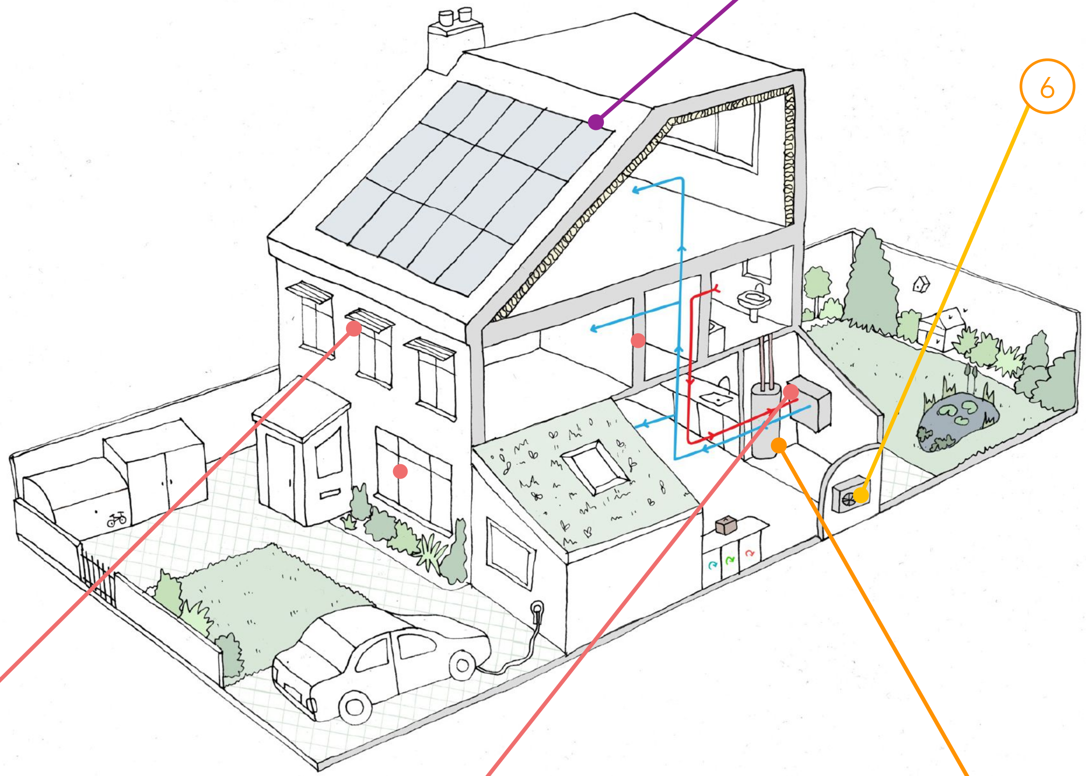
Airtightness and Thermal Bridging (2)

Improve the airtightness of the building fabric to meet 2 m^3/h/m^2 at 50Pa. Draught proof the dwelling and seal existing chimneys and vents.

Thermal bridging should be mitigated.

(7) Renewables

Generate on-site renewable electricity using available roof space (photovoltaics). Meet a minimum of 40% of roof area.



(6) Heating System

Replace the existing gas or oil heating system. Adding a heat pump can significantly improve efficiency. As houses typically have sufficient external space, a monoblock or split heat pump should be considered in the first instance.

Shading (3)

Add external shading to reduce overheating risks. Prioritise overhang shading to all south windows and include shutters or similar on west facing facades.

Ventilation (4)

Ensure that there is adequate ventilation installed to avoid moisture risk. An MVHR (Mechanical Ventilation with Heat Recovery) system is ideal (90% efficiency).

Hot Water (5)

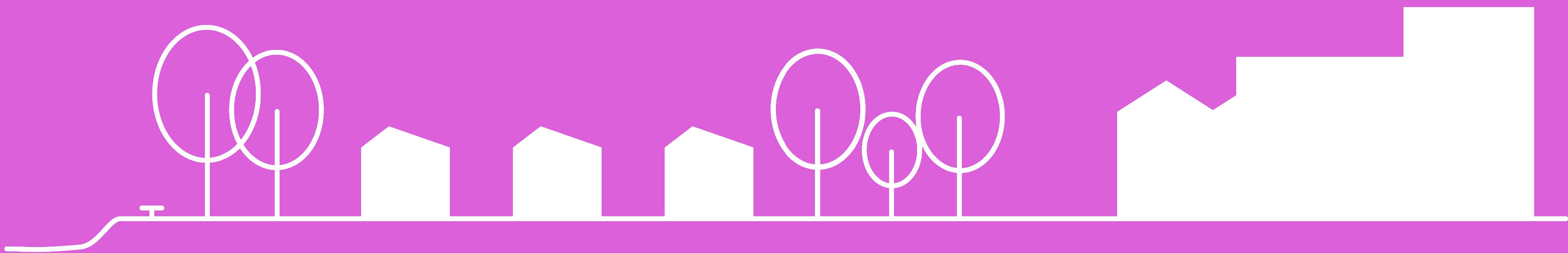
Increase tank insulation or replace to meet 1.5 W/K

Ensure 90% of pipework is insulated

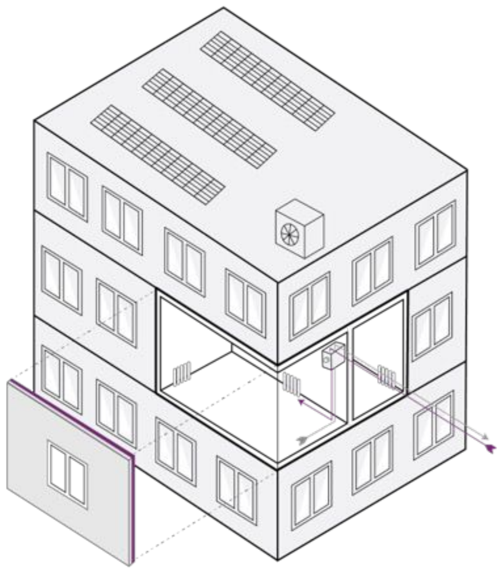
Install low flow fittings to meet 16 l/person/day for shower demands and 9 l/person/day for all other demands.

3 Case Studies – Existing Properties

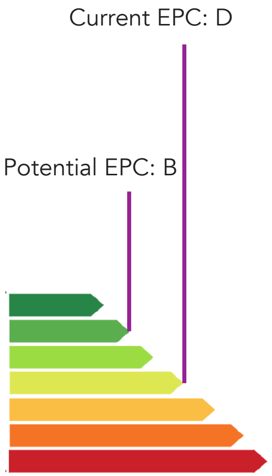
This chapter presents the energy performance of two typical dwelling typologies in the Folkestone & Hythe District Council Area and retrofit recommendations based on existing EPC data.



Retrofit Roadmap | Folkestone & Hythe's existing housing stock – Top-floor flat



Top-floor flat – Floor area: 43m² ; Property age: 1976.



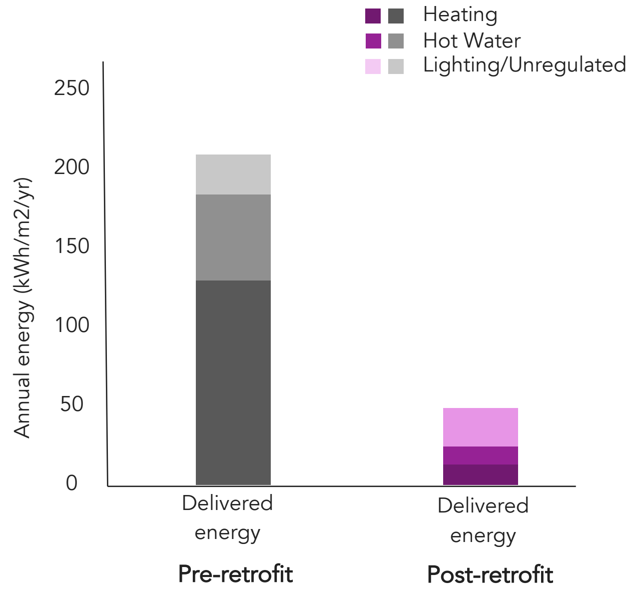
EPC Rating

20 kWh/m²/yr
Space Heating Demand

50 kWh/m²/yr
Energy Use Intensity

Total energy demand *includes space heating demand, hot water demand and the electricity required for lights, ventilation and plug loads.*

Delivered energy *is the amount of energy required by the building, called energy consumption.*



LETI best practice unconstrained retrofit targets and energy reduction results based on a typical UK flat.

Existing features of property

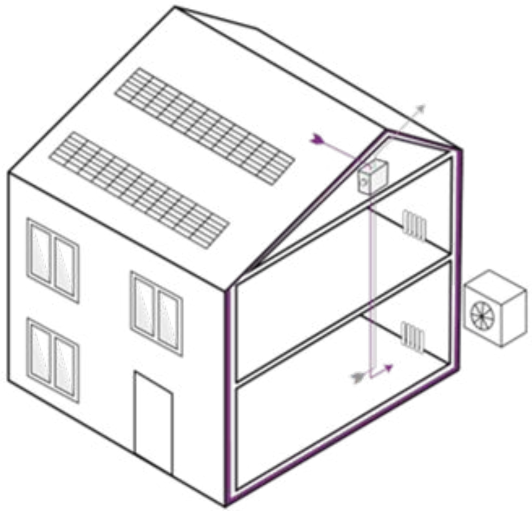
	Feature	Description	Rating
Fabric	Wall	Cavity wall, partial insulation	Average
	Roof	Pitched, 100 mm loft insulation	Average
	Window	Fully doubled glazed	Average
	Floor	Another dwelling below	-
Systems	Main heating	Room heaters, electric	Very poor
	Hot water	Electric immersion	Very poor
	Lighting	Low energy lighting in 14% of fixed outlets	Poor
	Ventilation	Natural	-

Retrofit Recommendations

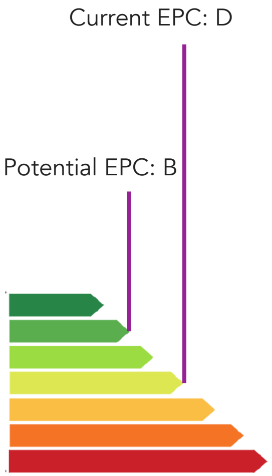
- Add insulation to meet best practice values. U-value between 0.18-0.30 W/m²K
- Install MVHR system (this should be done in conjunction with increased insulation to reduce moisture risk)
- If fabric efficiency measures bring space heating demand to below 40 kWh/m²/yr, electric heaters are permissible to be used. Otherwise, refer to page 20.
- Replace double-glazed windows triple glazing
- Draught-proof and seal the dwelling to reduce air leakage
- Install PV on the roof to cover at least 40% of the available roof Area
- Upgrade all lighting to low-energy fittings throughout the dwelling

Information is provided by F&HDC.

Retrofit Roadmap | Folkestone & Hythe's existing housing stock – Mid-terrace house



Mid terrace house – Floor area: 60m² ; Property age: 1925.



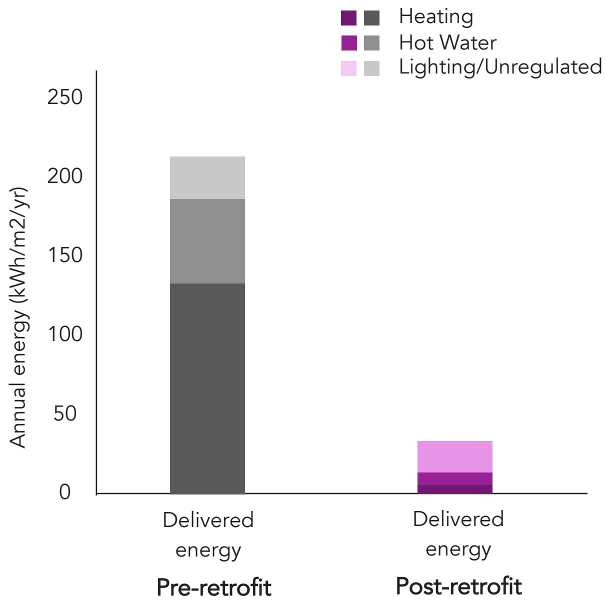
EPC Rating

20 kWh/m²/yr
Space Heating Demand

50 kWh/m²/yr
Energy Use Intensity

Total energy demand *includes space heating demand, hot water demand and the electricity required for lights, ventilation and plug loads.*

Delivered energy *is the amount of energy required by the building, called energy consumption.*



LETI exemplar retrofit targets and energy reduction results based on a typical mid-terrace house.

Existing features of property

	Feature	Description	Rating
Fabric	Wall	Cavity wall, no insulation	Poor
	Roof	Pitched, 100 mm loft insulation	Average
	Window	Fully doubled glazed	Average
	Floor	Suspended, no insulation	-
Systems	Main heating	Boiler and radiators, mains gas	Good
	Hot water	Main system	Good
	Lighting	No low energy lighting	Very poor
	Ventilation	Natural	-

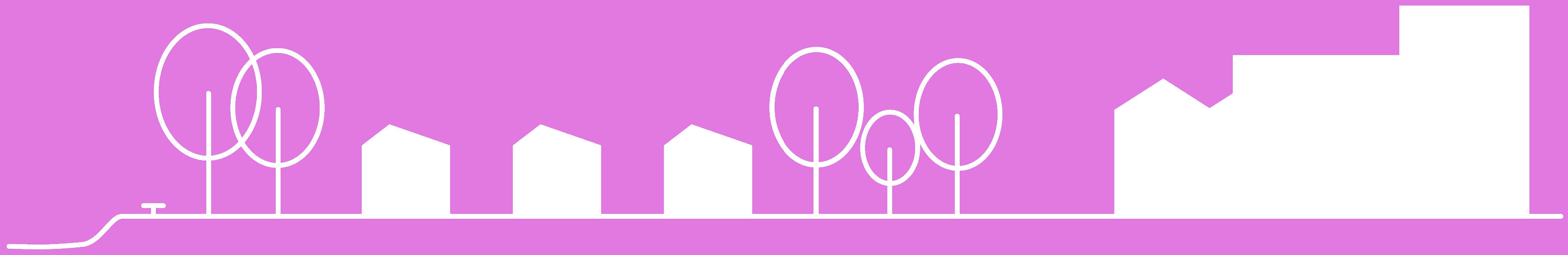
Retrofit Recommendations

- Add insulation to meet best practice values. U-value between 0.18-0.30 W/m²K
- Install MVHR system (this should be done in conjunction with increased insulation to reduce moisture risk)
- Replace the gas boiler with a heat pump
- Replace double-glazed windows triple glazing
- Draught-proof and seal the dwelling to reduce air leakage
- Install PV on the roof to cover at least 40% of the available roof area
- Upgrade all lighting to low-energy fittings throughout the dwelling

Information is provided by F&HDC.

4 RETROFIT COSTS

This chapter dives deeper into the costs associated with different measures of retrofit and how this relates to their energy impact.



Retrofit costs, benefits and funding

How much will my retrofit cost?

Retrofit costs depend hugely on the baseline building's characteristics and condition. A rough guide for an average semi-detached home is £5-15k for a shallow retrofit which, if starting with a poor baseline, could save around 30% in carbon emissions, through to £45-55k for a deep retrofit which would include significantly improving the building fabric, changing the heating system to a heat pump and fitting roof mounted solar PVs (*Net Zero Carbon Toolkit*). This level of retrofit could achieve an 80-90% reduction in carbon emissions – particularly in the future as the heat pump makes use of a lower carbon grid.

Seeing retrofit as an additional cost to maintenance?

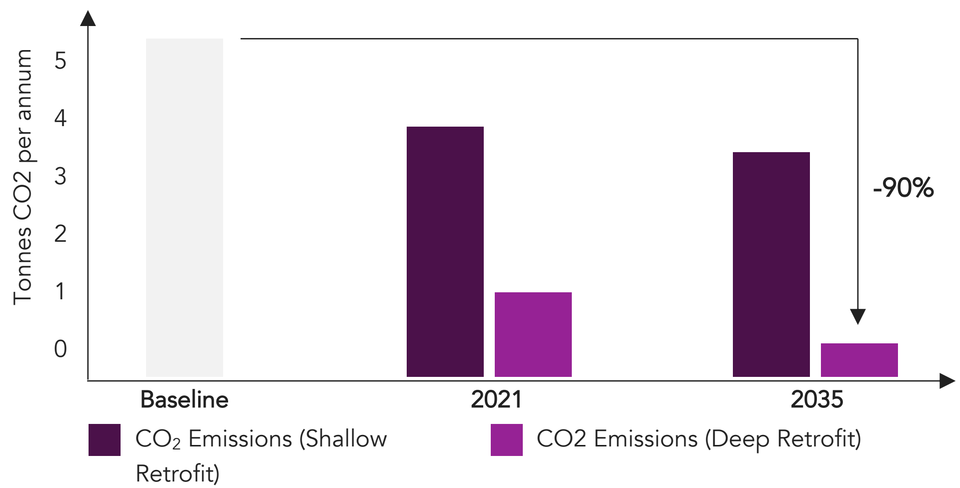
It is important to consider whether a measure is best undertaken as part of a planned or required maintenance activity. For example, rerendering a wall would be an ideal time to apply external insulation and would mean the actual extra costs are just the insulation material and labour to secure the insulation to the wall, because the scaffolding and rendering costs are already accounted for.

Cost related benefits

- **Reducing fuel bills alongside carbon emissions.** In 2018, one in ten households in England were considered to be in fuel poverty. There is, unsurprisingly, a strong correlation between inefficient homes and fuel poverty with 88% of all fuel poor households living in properties with a Band D EPC or below. As the energy performance of Folkestone & Hythe's housing stock is similar to the average UK home with an EPC rating of D, retrofitting this housing stock will result in lower energy bills of the residents.
- **Health and wellbeing.** As a result of the improved living conditions there will be lower health-care costs because occupants live in healthier buildings with good air quality and thermal comfort.

Financial barriers to retrofit for social housing

1. **Limited funds**
   New construction, retrofit of existing stock and building safety improvements compete for council budgets
2. **High upfront costs**
   Both councils and housing associations have large portfolios
3. **Long term financing**
   Short term government grant programs make it difficult to develop long term plans and finance models



CO_2 reductions for an unrenovated 90m² semi-detached dwelling

Retrofit costs

This page outlines indicative costs associated with various retrofit measures related to energy efficiency upgrades, improving systems and adding renewable generation. This has been sorted in ascending order showing the lowest to highest cost implication.

The cost figures represent indicative retrofit costs for an unrenovated 90m^2 semi-detached dwelling.

Although this figure provides costs associated with different measures, it is critical to have completed a plan for the whole house, even if you are doing just a small piece of work. A retrofit plan should be prepared before commencing any retrofit works.

Measures	Cost (£)	Impact on energy efficiency	Difficulty
Fit 100% low energy lighting	20		
Increase hot water tank insulation by 50mm	50		
Fit new time and temperature control on heating system	150		
Loft Insulation – add 400mm	500		
Insulate all heating and hot water pipework	500		
Cavity wall insulation – 50mm	600		
Upgrading to double or triple half glazed doors	1,500 – 2,000		
Floor insulation – between & below suspended timber	1,500		
100% draught proofing – improve airtightness	2,000		
Photovoltaic panels, 3kWp array, 21m^2 area	6,500		
Upgrading to double or triple glazed windows	7,000 – 8,400		
Fit mechanical ventilation and heat recovery (MVHR)	7,000		
Main heating – Air source heat pump and new HW tank	9,000		
External wall insulation – 160mm, expanded polystyrene	11,000		
Miscellaneous and enabling works	5,000		
Total	Approximately £ 53,000		

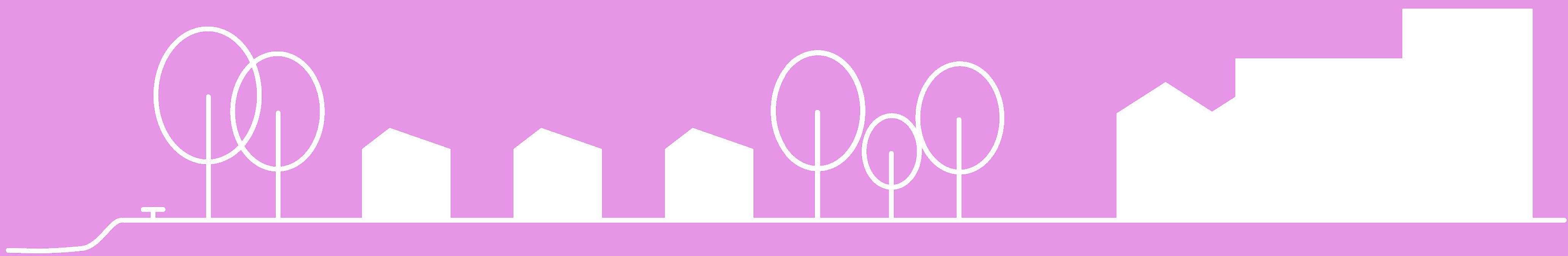
KEY

(red)	*High Cost*	*Low Impact*	*Difficult*
(yellow)	*Med Cost*	*Med Impact*	*Medium*
(green)	*Low Cost*	*High Impact*	*Easy*

Indicative cost of retrofit (Source: Net Zero Carbon Toolkit)

5 CASE STUDIES

This chapter provides details on national case studies of retrofit in the UK.



Case studies

Haddington Way, Aylesbury – Mid-terrace house; mid-1990

Pre-retrofit

- Insulated cavity walls with face brick exterior
- Suspended concrete beam and block ground floor
- Double glazed windows
- Pitched tiled roof enclosing both loft room and cold attic spaces.
- Air tightness of 13 $m^3/m^2/hr@50Pa$
- Space heating – electric storage system
- Hot water – dual immersion cylinder
- Natural ventilation

Post-retrofit

- Internal wall insulation with 40mm Spacetherm PP; U-value=0.23 $W/m^2.K$.
- Ground floor insulation with 75mm Kingspan Kooltherm K3; U-value=0.17 $W/m^2.K$.
- Argon filled, ultra-low-e double glazed window; U-value=1.10-1.24 $W/m^2.K$.
- Door insulation; ; U-value=1.6 $W/m^2.K$.
- Roof insulation at rafter level with 150mm Celotex.
- Air tightness of 5 $m^3/m^2/hr@50Pa$; measures include wrapping of joist ends and sealing of window reveals with Pro-Clima Tescon tape.
- Space heating – exhaust air heat pump and direct electric
- Hot water - exhaust air heat pump
- 9 m^2 PV panels

41 $kWh/m^2/yr$
Space Heating Demand

40 $kWh/m^2/yr$
Energy Use Intensity

Wilmcote House, Portsmouth – Three blocks of flats; 1960's

Pre-retrofit

- Concrete wall panels with little insulation.
- Inefficient double-glazed windows.
- Old electric storage heaters.
- Residents experienced fuel poverty as per feedback.
- Space heating demand: 188 $kWh/m^2/yr$

Post-retrofit

- External insulation of walls and roof with 300mm non-combustible mineral wool insulation.
- Triple-glazed windows.
- Individual MVHR units in each flat.

23 $kWh/m^2/yr$
Space Heating Demand

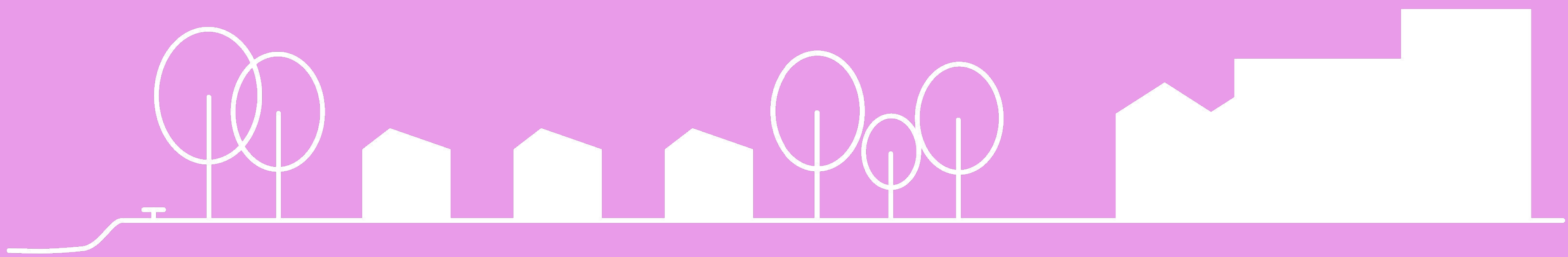
EPH
EnerPHit Standard

At the time of completion, it was the largest residential EnerPHit delivered with residents in occupation in the world.

Source: LETI Climate Emergency Retrofit Guide

6 FURTHER GUIDANCE AND ADVICE

This chapter provides further guidance and advice for architects, contractors, including some additional detail on product selection.



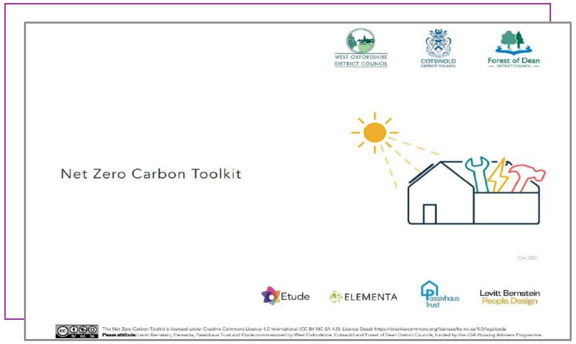
Further guidance & advice | Guidance documents

LETI Climate Emergency Retrofit Guide, 2021

LETI's Climate Emergency Retrofit Guide shows how we can retrofit our homes to make them fit for the future and support the UK's Net Zero targets. This document defines energy use targets for existing homes and provide practical guidance on how to achieve them.

The guide is useful for architects, engineers, Local Authorities, social landlords, energy professionals, contractors and clients looking for guidance about best practice retrofit.

Net Zero Toolkit Retrofit Part, 2021



Three councils have partnered in the production of a Net Zero Carbon Toolkit: a practical and easy-to-navigate guide on how to plan your Net Zero housing project. Whether you are a small or medium-size house builder, an architect, a self-builder or a consultant advising clients, this Toolkit will help you.

People Powered Retrofit. 2021

People Powered Retrofit is an organization that has a knowledge base to help you deliver your retrofit project. It's structured like an end-to-end service, which offers assistance in making key decisions, co-ordinating contractor procurement, overseeing retrofit works quality assurance and offering impartial, expert advice and hand-holding throughout.

Households Declare, 2019

Households Declare is a campaign by ACAN! (The Architects Climate Action Network!) This campaign was launched to highlight the extent of the problem of emissions from homes in the UK and to put pressure on our elected representatives to do something about it.

Further guidance & advice | Architects & Consultants

This page provides a summary of all the technical aspects of retrofit that require additional attention from Architects.

Architects should take a holistic approach. They should assess the building fabric and services but also understand its occupants and their behavioural impacts. All of this should take into account a building's situation (just as any new-build design would) with regard to orientation, sunlight, and wind and rain exposure.

This 'whole house' approach mirrors the thorough guidance published by LETI and endorsed by the RIBA in the Climate Emergency Retrofit Guide.

Survey of the existing building

Start with a comprehensive survey of the existing building, he urged, and evaluate any inappropriate works that have been undertaken in the past. This survey should, in particular, look for any such alterations that have created a vapour barrier. A moisture risk assessment is essential. This should examine both internal and external moisture loads and understand how a building is transmitting moisture in all its forms.

Thermal bridging, airtightness and ventilation

Avoiding gaps that allow thermal bridging becomes more important with higher levels of insulation. The impact of thermal bridging is disproportionate: the more you insulate, the bigger the impact becomes.

The goal for the architect should be to identify a continuous airtight barrier while sticking to the principle that in a moisture-open assembly, the airtight layer should still be vapour permeable.

Ventilation also becomes more important as airtightness and insulation levels are improved and will require careful assessment.

Adding insulation into a house. Source: RIBA

Further guidance & advice | Contractors

For more information:
West Oxfordshire Net Zero Carbon Toolkit

This section summarises the requirements during construction in order to ensure that the airtightness target can be achieved.

Managing the airtightness risk

It is possible to robustly manage the risk of achieving the airtightness requirement on site. The contractor should take responsibility for delivering the airtightness and propose a robust strategy.

The importance of interim leak testing

A phased leak testing strategy is recommended. Each dwelling should be tested for air leaks after retrofitting the building fabric. This should occur before the air barrier is covered or closed up.

✓ All air barrier parts should be installed and open to visual inspection.

✓ Using a blower door fan to negatively pressure areas undergoing internal investigation or positively pressurise areas for external investigation.

✓ Carrying out investigation on the air barrier side of the construction (internal for most of the building.)

✓ Using thermographic camera equipment, smoke pens, or feeling the joints to identify any air leaks.

✓ Remedying any leaks. no leaks in the external fabric can be detected with reasonable effort.

Heat pumps

The commissioning of a heat pump is very similar to the commissioning of a boiler.

✓ Ensure the system is watertight – complete a standard test, first with pressurised air, then with water.

✓ Ensure the fuel source is safe – in this case check the electrical test certificate is in place.

✓ Ensure the unit is functioning correctly – check the flow volume and temperature (ideally at varying external air temperatures)

✓ Ensure the water pressure is inline with manufacturers recommendations.

✓ Ensure the user is trained – make sure any alarms are being generated correctly and that the user understands what protocols to follow for each alarm option.

MVHR systems

The following items should be checked on MVHR units:

✓ Check filters are clean

✓ Inspect ductwork for any air leaks and seal where appropriate.

✓ Check that the ductwork is clean at the terminals

✓ Set the fan speed and balance the supply and extract flow rates

✓ Ensure the supply and extract rates to each grille are operating at the design air flow

✓ If there is a boost function make sure that this works correctly

✓ Ensure the user understands how to use and maintain the MVHR

Further guidance & advice | Products

For more information:
West Oxfordshire Net Zero Carbon Toolkit

Windows

Key selection criteria

- Glazing U-value - This is an indication of the ability of the glazing itself to retain heat. For double glazing, this should be 1.3 W/m^{2}K or lower. For triple glazing you should expect 0.6 W/m^{2}K or lower.
- Generally, it is best to avoid metal frames unless they have a dedicated thermal break. Timber frames offer good levels of performance and are a good option in most cases and can be clad in aluminium if required.

Doors

Key selection criteria

- U-value – A U-value of 0.8 W/m^{2}K should be used as a guideline.

Insulation

Key selection criteria

- 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 a pre-1919 building.
- Thickness – The thickness should be considered to ensure it achieves the required U-value and aligns with building setting out. For external walls, it is important to ensure that the products used to support insulation are available in the length 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.
- Embodied carbon – The amount of carbon dioxide equivalent emissions generated when producing the insulation material should be considered.

Product examples (Source: Internorm, Green Building Store, Knauf Insulation, Paul Heat Recovery, Zehnder)

Mechanical Ventilation Heat Recovery (MVHR) Units

Key selection criteria

- Air volume flow rate (litres per second) – This must be high enough to meet requirements in Part F of the building regulations, and to mitigate overheating risk.
- Pressure drop (pascals) – This is how much pressure the MVHR can overcome and will influence your ductwork design.
- Noise rating (dB) – In a utility space NR35-40 may be appropriate, however if it is near living space or sleep accommodation NR25 or lower should be targeted.
- Specific Fan Power (Watts per litre per second) – This is critical to the energy efficiency of the ventilation system. A value of 0.9 or lower is recommended.
- Heat recovery efficiency (%) – This defines how much heat can be recovered from the exhaust air. For best practice a minimum of 90% efficient should be targeted.
- Certification – Choose an MVHR unit that is Passivhaus certified to ensure quality and performance

Heat pumps

Key selection criteria

- Maximum heating capacity (kW) - Heat pumps are given output ratings in kilowatts (kW) which represent how powerful a heat pump is. They should be sized according to the peak heating demand. Max heating capacity tends to range from 4 kW-16 kW.
- Minimum heating capacity (kW) - A good heat pump has adequate turn-down to perform well during low-load conditions as well as peak conditions
- Coefficient of Performance, CoP – This represents the efficiency of a heat pump. For example, if a heat pump produces 4 kWh of usable heat for a home and requires 1 kWh of electricity to do so, it has a COP of 4.
- Seasonal Coefficient of Performance, SCoP - This is an average coefficient of performance taken across the entire heating system, and the main metric used to define the performance of a heat pump