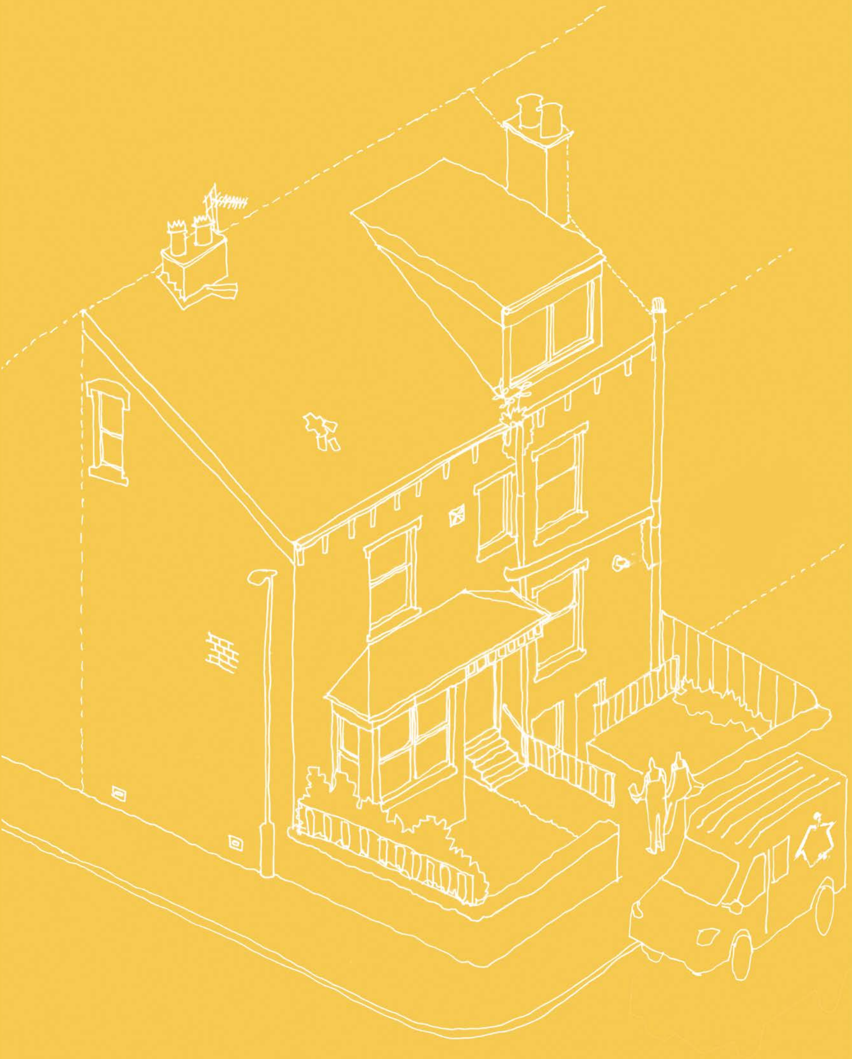
The Canopy Guide to Retrofit



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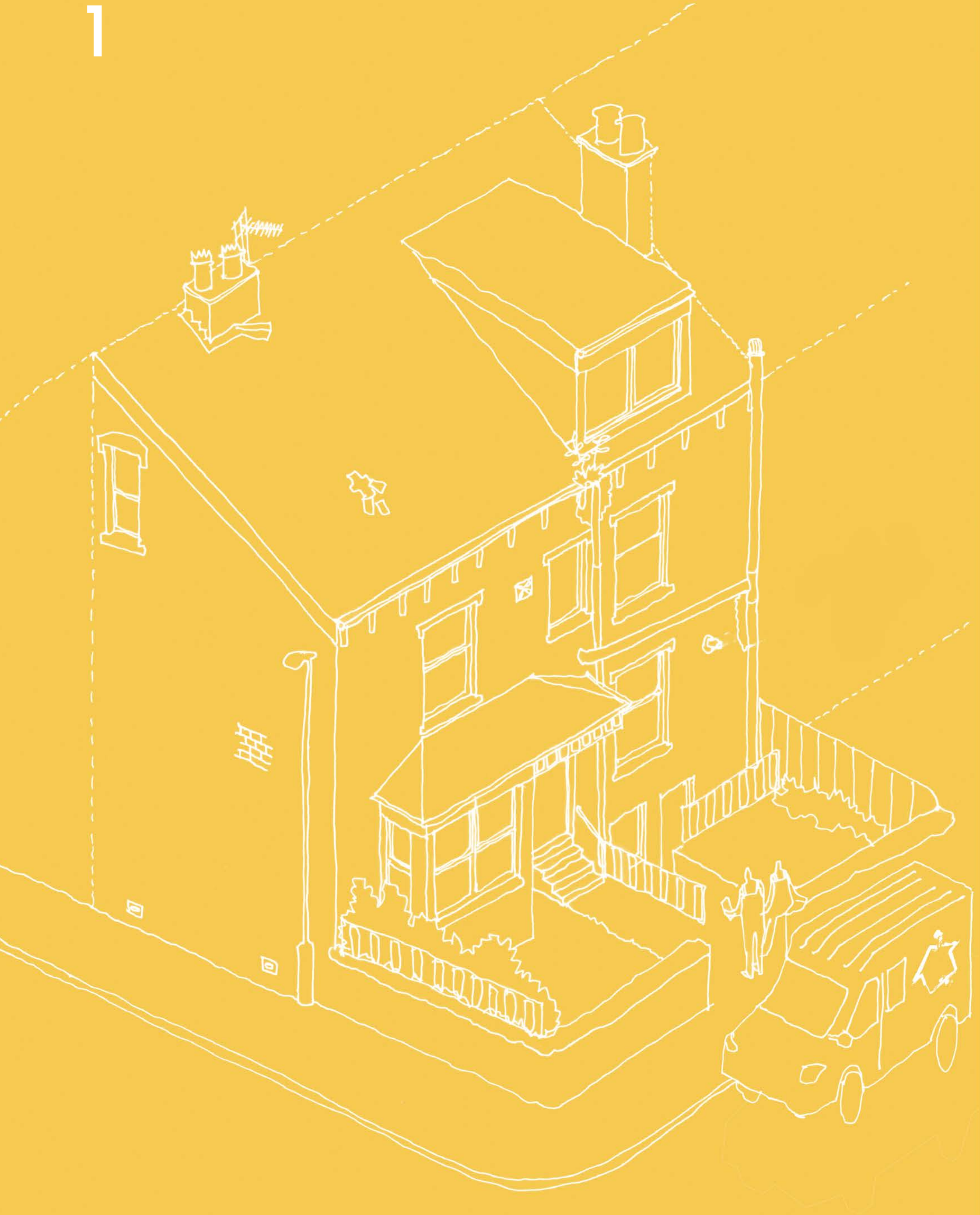

1 The Canopy Approach to Retrofit

Site workers and volunteers painting the exterior of a retrofitted house.

Canopy works with volunteers to retrofit empty homes to a high standard using sustainable materials such as wood fibre, hemp and lime. The healthy, energy-efficient homes we create are used to accommodate people in severe housing need, who become part of the volunteering team before they move in.

Reducing our carbon footprint

Canopy aims to reduce the amount of energy – including embodied energy – required to power its homes, offices and operations.

Using resources wisely

Through careful procurement and robust recycling, Canopy aims to consume fewer resources and produce less waste and pollution.

Encouraging positive behaviour

Canopy aims to encourage its staff, tenants, volunteers and contractors to use less energy, reduce their fuel bills, consume fewer resources and produce less waste. It supports them in doing this and encourages positive behaviour change.

Equity and local economy

Canopy brings together many individuals from different communities in the local area, including people from different age groups and with differing abilities. Canopy facilitates an opportunity for people from different backgrounds to interact and learn from each other's experiences and skills. There is a real need for projects like Canopy that can pull different strands of the community together and overcome ignorance and prejudice.

Health and happiness

Prioritising natural materials that are more pleasant to work with helps to ensure that Canopy sites are happy and healthy places to volunteer and work.

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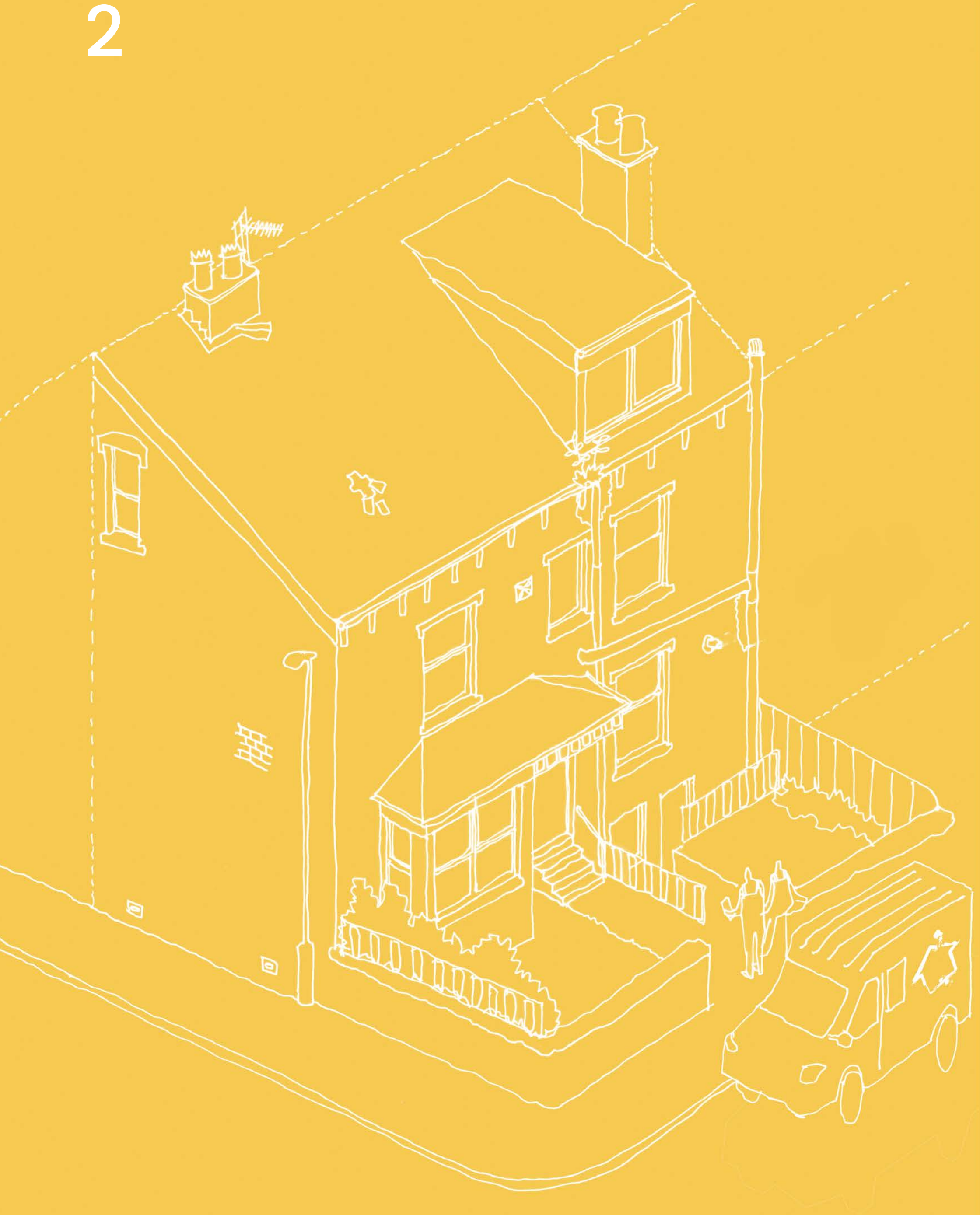


Canopy Houses

Archival photographs of back-to-backs in Leeds.
Source: leodis.net / Leeds Libraries

Canopy's houses are located in the inner suburbs of Leeds; Burley, Beeston and Harehills.

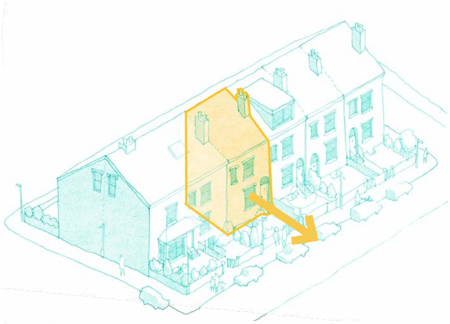
They are mostly back-to-backs; a type of terraced house with a shared wall to the rear, as well as either side, and with the front door and all windows facing onto the street.

Back-to-backs were built in vast numbers from the mid-19th Century, to replace earlier slum housing that had been thrown up to house workers pouring into cities as the Industrial Revolution took hold.

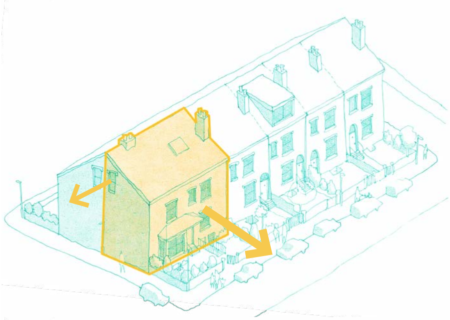
In other industrial cities, back-to-back housing stock was entirely demolished during post-war development; in Birmingham, the last remaining back-to-backs are now a Grade II listed heritage attraction, run by the National Trust!

Leeds took a different approach, and today has 19,500 back-to-back houses still providing homes to a varied and diverse population.

Canopy owns 81 properties which more or less fall into four categories;



Standard back-to-back, as described on the previous page



End-terrace back-to-back with two external walls rather than just one.

Room-in-roof back-to-back, with or without a dormer.

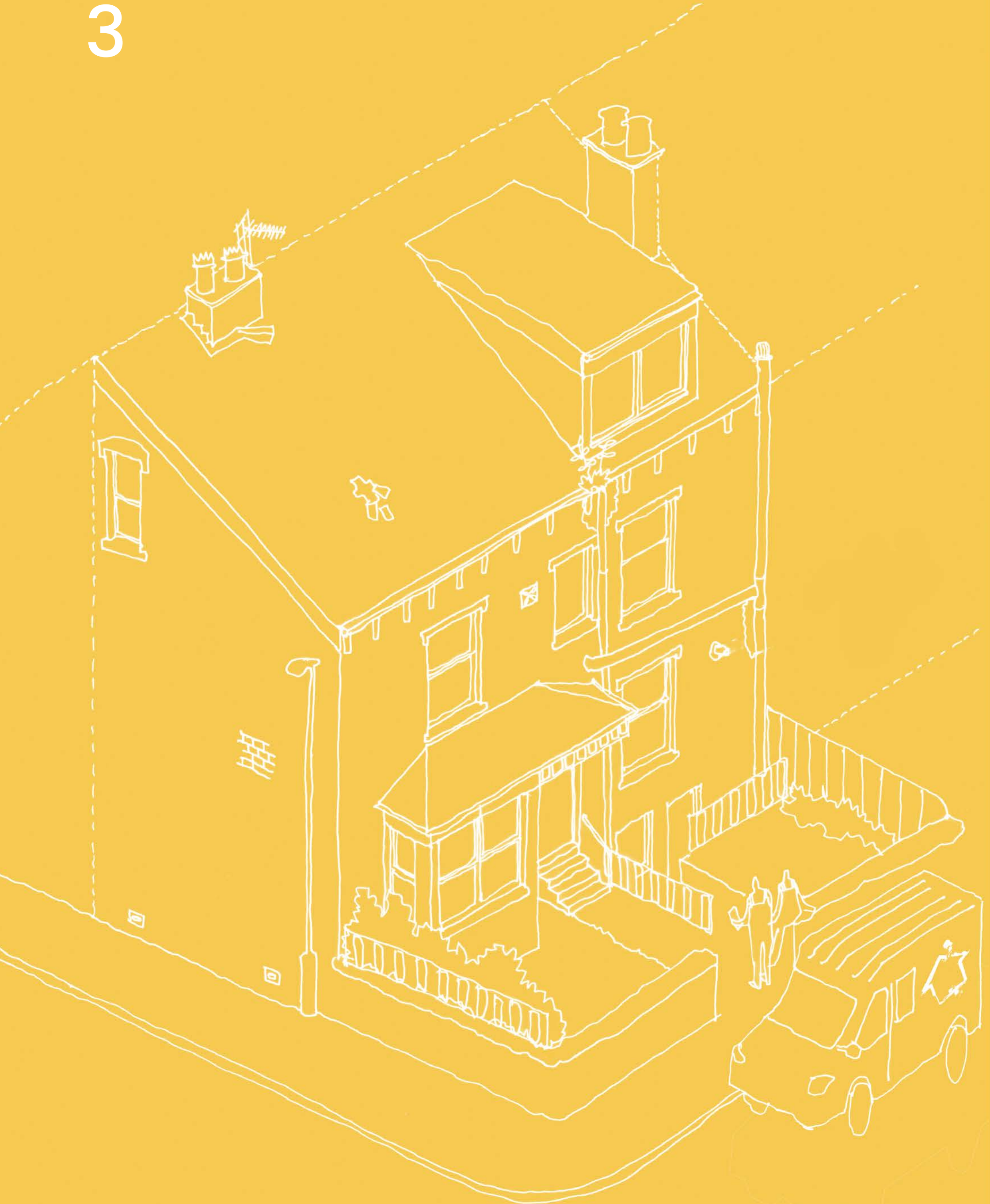
Through-terrace with a front and rear elevation. This type is often two standard back-to-backs that have been knocked together to form a larger home.

Although there is a lot of variation in the design of back-to-back houses, these are characteristic features;

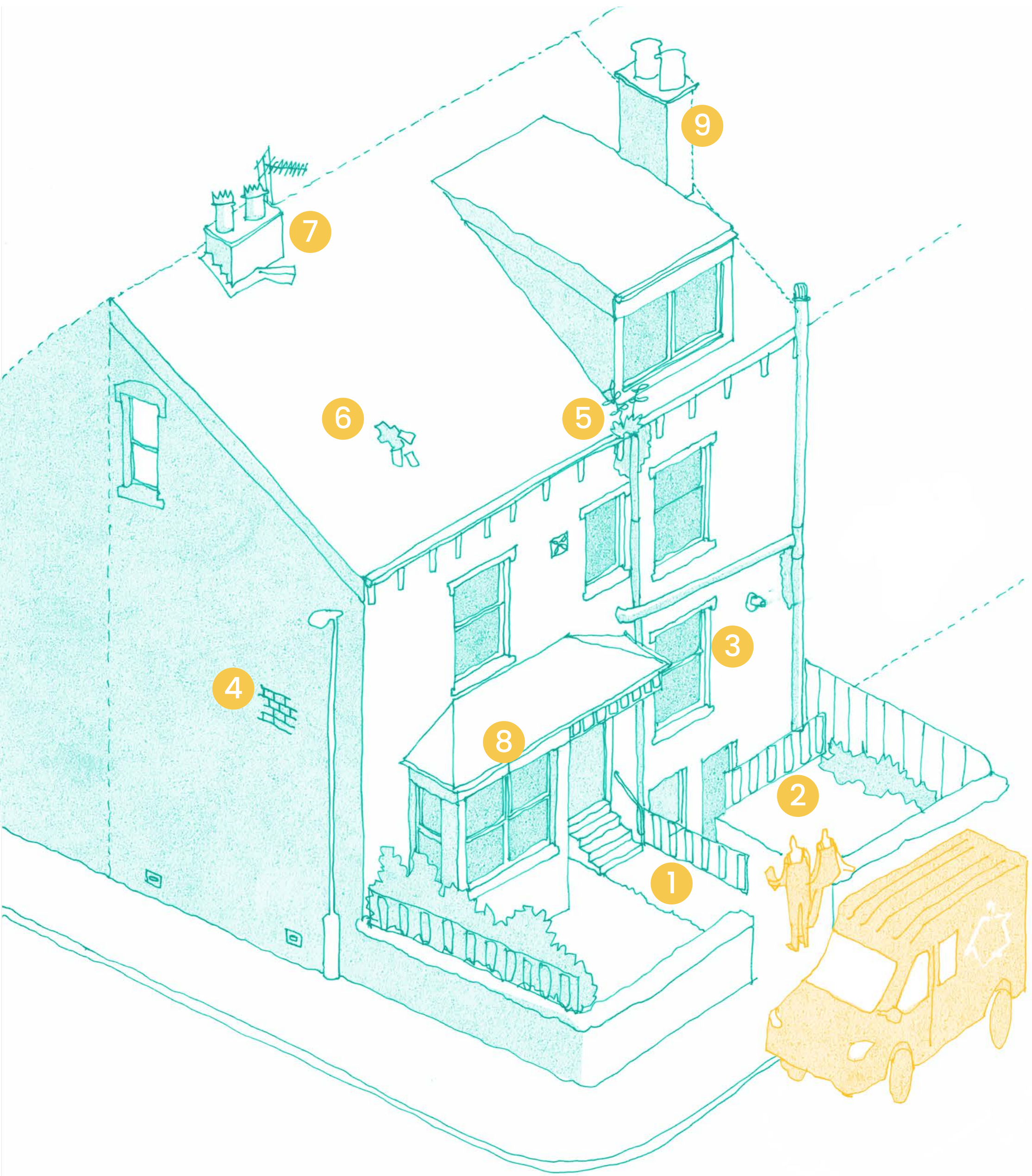
- built in red brick; a smooth external leaf and rougher internal leaf with no cavity.
- timber roof structure with slates. These have sometimes been replaced with concrete tiles that can cause the roof joists to bow.
- original timber sash windows largely replaced with uPVC frames of varying quality.
- suspended timber floors,
- often have a relatively large front garden, although some are accessed directly off the street.

The National Retrofit Hub's *Pattern Book* for Flat-fronted Victorian Terraced House has lots of information relevant to back-to-back housing.

3 Assessing a Property



Canopy homes are empty when the retrofit works are undertaken. When assessing the state of a property, start with the outside of the building. Ideally this would be in person, but there is a lot you can tell from a 'desktop survey' using Street View - just make sure it's up-to-date! You're looking for maintenance issues and hints of structural issues and defects.



Assessing a property from the exterior.

1. Access to the property. Can you easily park outside? Are there any obstructions that might prevent certain retrofit measures e.g. a lamp post against the wall that would get in the way of external wall insulation.

2. Outside space. Does the property have a front garden? A back yard? Do they need clearing? Can they accomodate a skip?

3. Windows & doors. Are they in a good state of repair? See the Windows chapter to learn more about assessing the condition of uPVC windows.

4. Are there any cracks in walls, or areas where the mortar has fallen away?

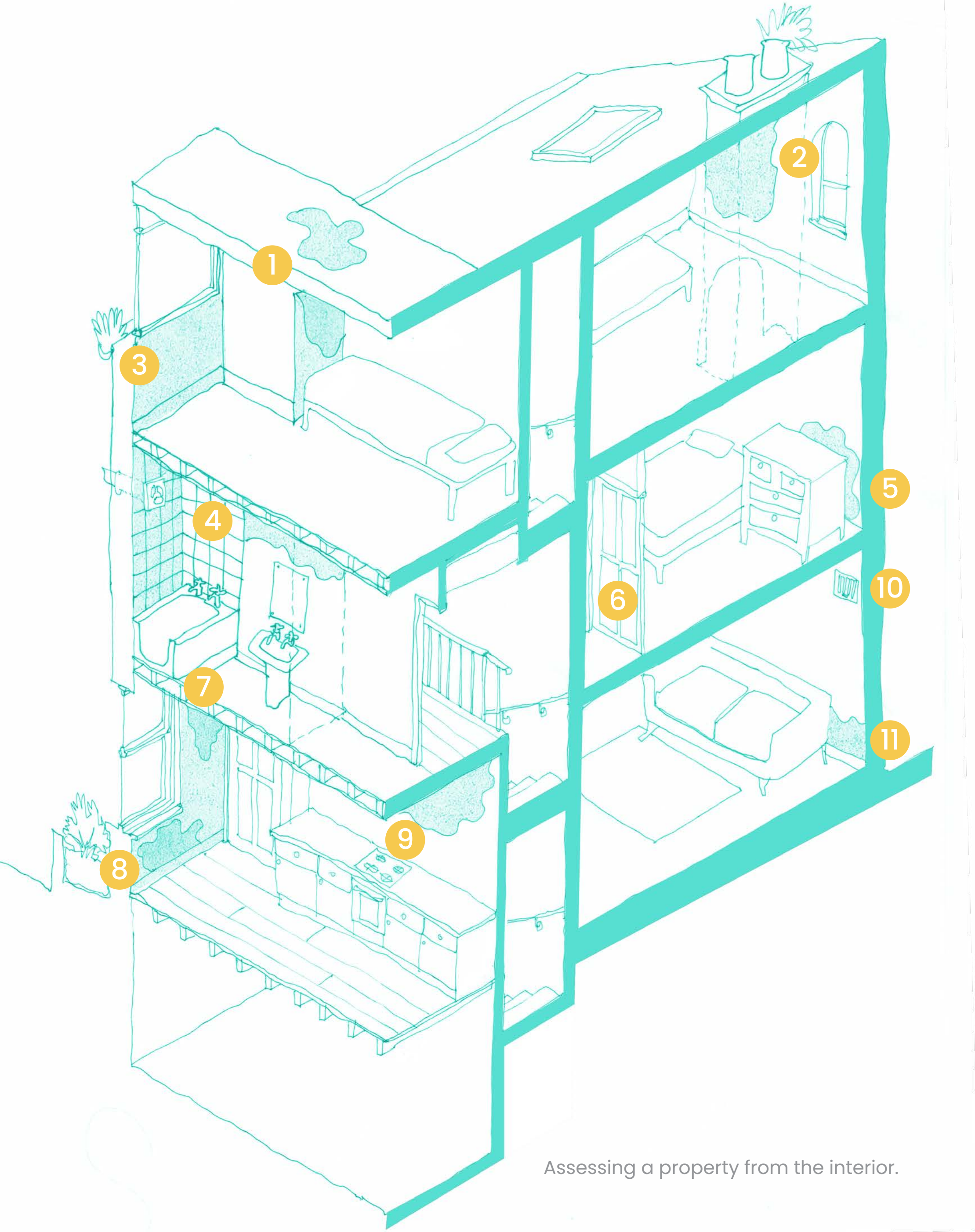
5. Are there any indications of blocked or leaking gutters, downpipes or soil pipes?

6. Have any of the roof tiles slipped?

7. Can you see dislodged or missing flashing around the chimneys / dormers?

8. Identify any non-standard details that require special attention during the retrofit works e.g. a bay window.

9. Are the chimney pots capped?



Assessing a property from the interior.

Once inside the property, you are looking for issues with the building fabric and areas of damp that correlate with the external issues, or reveal new ones. There are lots of different causes of damp that can be associated with the building and the way people are living in it.

1. Damp patches on the underside of the roof suggest a leak.
2. Chimney stacks are weak spots for moisture penetration.
3. Blocked or leaking gutters can overflow and saturate the walls.
4. In the bathroom & kitchen, mould is usually a sign of inadequate ventilation.
5. Mould behind furniture suggests inadequate ventilation.
6. Check that internal doors have a 10mm gap at the bottom to allow air to circulate between rooms.
7. Damp patches on ceilings and walls can suggest an internal leaking pipe.
8. Planters built up against the house are often mistaken for rising damp.
9. Inadequate extraction in the kitchen.
10. Blocked air vents or air bricks.
11. Previous retrofit works that have changed the building fabric e.g. where concrete has replaced earth and stone flags or previously installed roof insulation that might be retained or need to be replaced.
12. Air tightness. e.g draughts around windows - see air tightness section.

Right - a bathroom with a faulty extract fan - the cold surfaces - the external wall and ceiling are covered in black mould.

Left - water ingress on chimney breast suggests missing flashing where the stack meets the roof tiles.

Right - you can see where furniture was pushed against the cold external walls in this bedroom with inadequate ventilation.

Left - the ceiling has fallen in this kitchen, which is positioned below the bathroom. This suggests a leaking pipe.

Moisture Ingress

Canopy houses are constructed from two layers of brick; an outer layer that you see from the street, and an inner layer covered by plaster and internal finishes; either paint or wallpaper.

They do not have cavities, which were introduced in the early 20th century to prevent moisture in the external atmosphere - rain! - from making it's way through the wall and reaching the internal face. This is known as 'penetrating damp'.

If the exterior of the house is not well maintained, there is a risk of damp and mould on the interior surfaces.

There are many situations that can cause penetrating damp including;

- blocked gutters,
- gaps in mortar
- slipped roof tiles
- a leaking flat roof,
- gaps around windows,
- a breached or defective damp proof course.

Indoor Moisture Generation

Breathing, cooking, washing up, showering and drying clothes all create moisture in the internal atmosphere of our homes.

Without suitable ventilation, this moisture condenses on cold surfaces creating the perfect conditions for black mould growth.

Victorian houses are built from materials that absorb & release moisture from the air, whereas modern construction materials generally aim to be impenetrable to moisture.

Problems can arise when modern construction materials are used to retrofit old houses, changing the way the building fabric functions in the process. Moisture can get trapped within the building fabric and cause rot and mould.

PAS 2035:2023 Retrofitting Dwellings provides guidelines for retrofitting dwellings to improve energy efficiency and includes guidance on how to undertake a Retrofit Assessment.

Monitoring for Condensation, Damp & Mould

Purrmetrix provided monitors to Canopy free of charge for the ERS project. Purrmetrix have years of experience in monitoring housing performance for retrofit and repair. Using their sensors and web platform, they help social housing landlords deliver the right retrofit and repairs, where they are most needed.

Mould is a hard problem for landlords – it has serious impact on tenants' health but it can be difficult to identify the causes, leaving landlords struggling to find the right solution.

Monitoring and measuring the humidity in a home gives landlords vital information on why the problem is occurring. There are many ways to capture data on humidity, this is a short introduction on how this can be done.

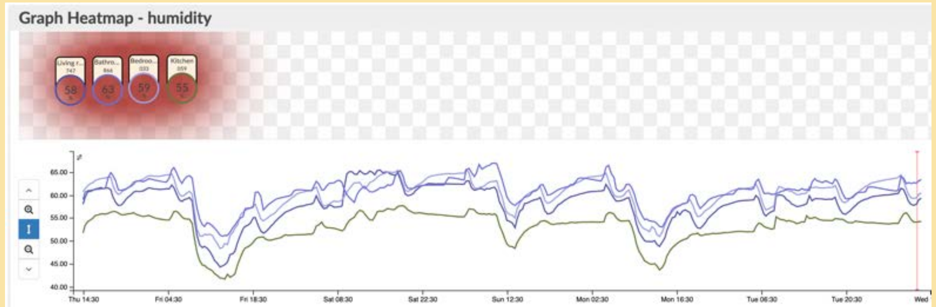
When to monitor
Some rented homes already have monitoring solutions installed – smart thermostats or other built in sensors - although a single point of measurement cannot give detailed picture for a home. Landlords rely on complaints or inspection to highlight issues – this is the point where monitoring can help.

How monitoring works
Monitoring uses sensors in the home to capture data on relative humidity (RH), temperature and air quality. Solutions can be permanent hardwired installations, data recorders (which store data for later pick up) or temporary battery powered sensors sending data back live.

By looking at when and where RH peaks it's possible to understand a lot more about why the problems might be happening. With two to three weeks of data from a home landlords – and tenants - can build a picture of what is going wrong and agree a plan of action.

Continuing the monitoring and sharing the data after the fixes go in help tenants and landlords understand what is working.

Turning data into information
Most sensors will present the data as a simple graph:



A week of RH data from four rooms in Property X

More sophisticated platforms can provide a benchmark for condensation risk, show how many hours the home is heated, and indicate what times and locations are peak risk. Some can even give indications of ventilation rates in the property.

The same RH / temperature data turned into information

This information makes it simpler to identify potential causes and discuss what might help.

Monitoring choices and guidelines

The best solutions fit smoothly into your process for identifying and investigating mould complaints, and deliver good quality, robust information so you can rely on the solution.

Questions worth asking for any monitoring solution:

- How many points of measurement? Mould can often start as a localised problem in one place but spread around the home. Measurement of multiple spaces is helpful to understand the risk around the house
- Can we share the data with tenants? Successful solutions for mould need landlords and tenants to work together to manage conditions in the home. Sharing the information from monitoring helps build agreement on when and where problems occur before discussing how they might be fixed
- How much help does the platform give you in understanding the data? Simple graphs are helpful but may make it hard to see small improvements or patterns of behaviour in the home. Turning data into measurements that are understandable and provide useful information is a powerful step forward
- How easy is it to set up and reuse? The easier it is to install the kit, the more opportunities there will be to use it. The simplest solutions can be installed with minimal training by anyone making a site visit, or even by the tenants themselves. Some monitoring kits, such as Purrmetrix, can easily be recycled from site to site.

Get started with monitoring

Monitoring is a powerful new tool in combatting condensation and mould problems. Our top tips for getting the most from it:

- Be clear on how you intend to take action on mould and at what point monitoring can be useful
- Think about who your users are and the opportunities for installation
- Consider carefully the quality of the data that you are getting – where it comes from, the frequency and how you can add other information
- Use data and information as a talking point with tenants, to build a joint action plan on what can be done
- Protect data privacy with clear GDPR policies and consents

For support in using data for your damp and mould strategy, contact us on info@purrmetrix.com

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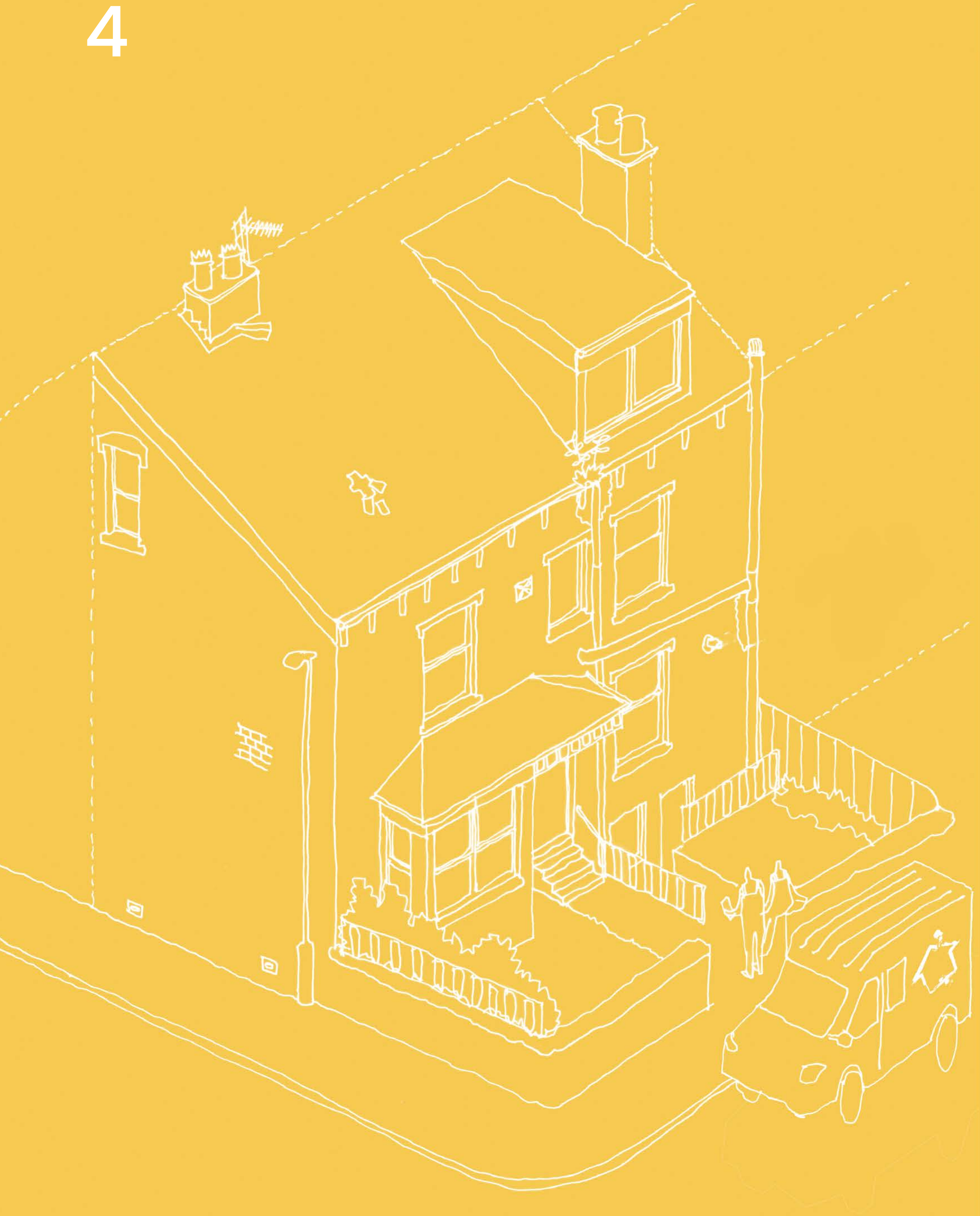

Fabric First

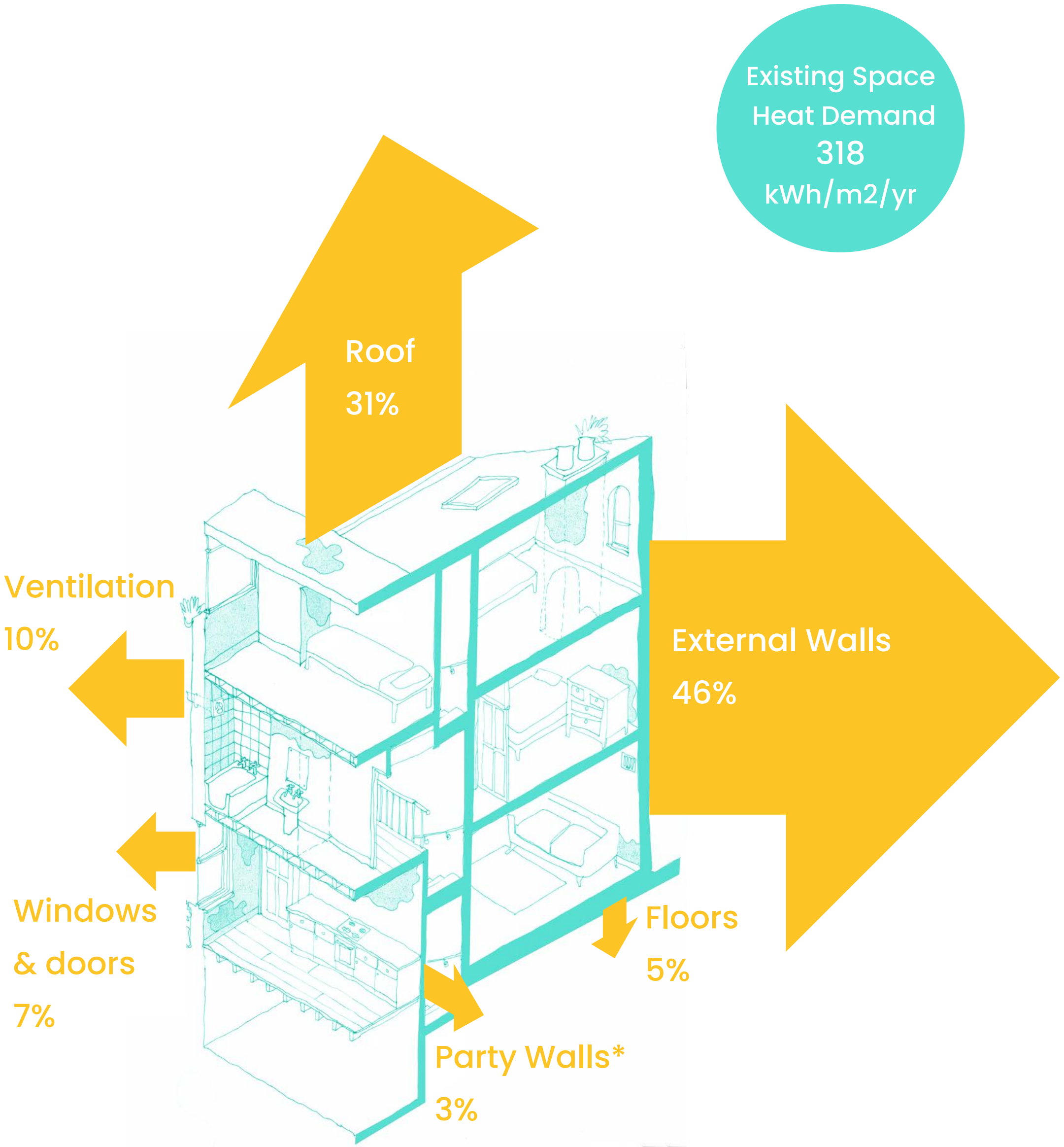

Diagram describing where heat energy is lost through the built fabric of a Canopy house prior to retrofit.

Canopy takes a 'Fabric First' approach to retrofit; maximising the environmental performance of the building fabric - the walls, floors, roof, windows and doors - to minimise the in-use energy demand.

Fabric First

'Fabric First' retrofit measures have a longer lifespan than technological solutions that save or generate energy - solar panels, etc. - and tend to be more cost effective.

As Canopy uses predominantly natural materials, the embodied carbon of the retrofit measures is low.

A 'fabric first' approach means that Canopy's tenants benefit from the house's reduced operating costs.

Embodied Carbon & Renewables

Renewables have a part to play in decarbonising our housing stock. As the national grid rapidly decarbonises, on-site renewables should only be installed where there are clear benefits.

Solar panels take a lot of energy to produce and are difficult to recycle. They are most effective when the energy they produce can be stored and used on site.

'Back to brick'

Often, when Canopy renovates a property, some retrofit measures will have already been installed, either by Canopy or a previous owner.

Sometimes these have been installed effectively - e.g. mineral wool for suspended floor insulation - but more often they're ineffective, causing more issues than they're solving.

Usually, Canopy will take a property 'back to brick' to undertake what is known as a 'deep' or 'whole house' retrofit. This process is as messy and disruptive as it sounds.

Target Space Heat Demand 50 kWh/m2/yr

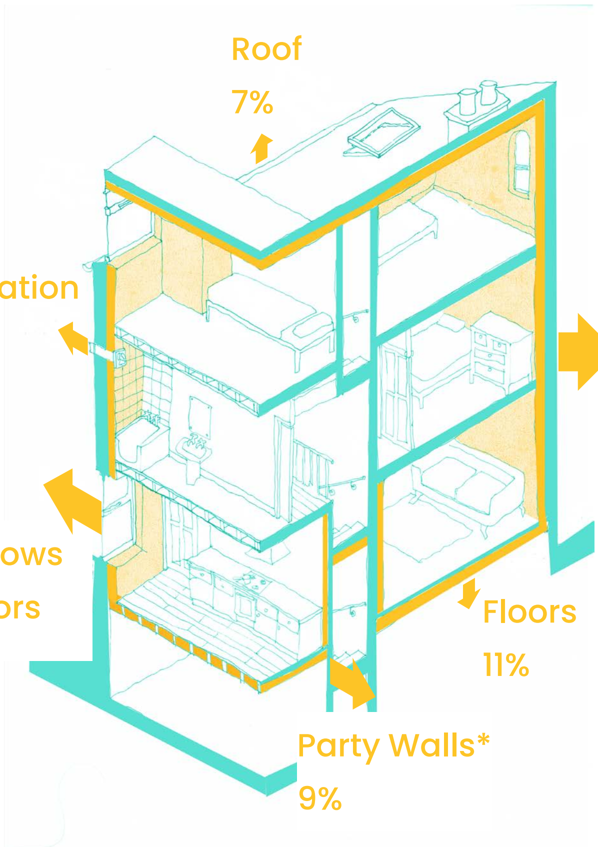

Diagram describing where heat energy is lost through the built fabric of a Canopy house after retrofit.

Party walls

The diagram on the previous page illustrates the results of a digital energy model of an existing Canopy house.

Canopy's approach to retrofit addresses all of the areas where heat is being lost except party walls.

It's difficult to accurately model heat loss through party walls, because the results differ greatly depending on whether the neighbouring property is kept warm or not.

Canopy properties have a greater area of party wall than a standard terrace, a semi or detached house. This means that the amount of heat lost through the party walls effects the overall energy model significantly.

Retrofit Standards

Canopy aims to retrofit homes to meet the Association of Environmentally Conscious Builders' (AECB) CarbonLite Retrofit Standard. The standard sets out specific criterea to meet for space heating, cooling and air tightness.

The Performance Gap

A building's energy performance in use is often significantly worse than what we anticipate at the design stage.

This discrepancy between design intent and actual operational energy use is referred to as the 'performance gap'.

It's not only Canopy volunteers that are learning on site; a lot of the tradespeople are working on a deep retrofit with natural materials for the first time. This is a great opportunity to provide on-the-job training but can mean that the performance gap is greater than expected.

Site monitoring and air tightness testing at key stages of the retrofit are vital to ensure that we're meeting the AECB criteria - see the Airtightness chapter for more information.

The requirements for meeting the *AECB CarbonLite Retrofit Standard* are detailed on the AECB website.

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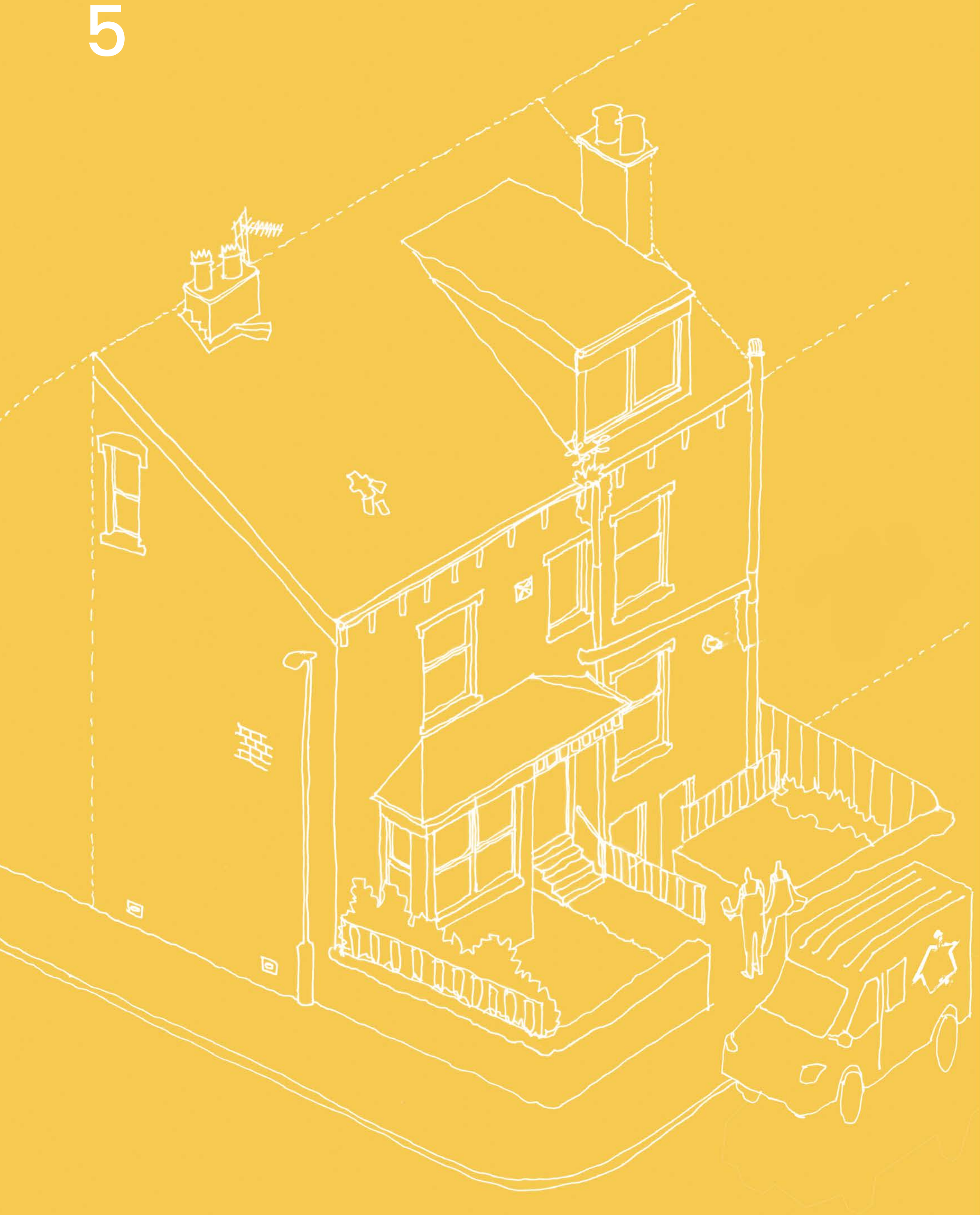


Natural Materials

Site workers and volunteers fixing the woodfibre insulation to the interior walls of a bay window.

'Natural materials' is a term for to construction materials that can be found in nature and used with relatively minimal processing.

What are 'Natural Materials'?

Whilst they're not all strictly 'natural', they tend to have low embodied carbon associated with their production, either because the raw materials have been grown, absorbing carbon from the atmosphere in the process - timber, hemp, straw. - or because the carbon emissions emitted throughout the life cycle of the material are low e.g. stone, earth, clay, etc.

There are other construction materials that are naturally occurring but require energy intensive extraction and processing and as such are no longer thought of as 'natural materials'.

Canopy prioritises the use of natural materials wherever possible and, in particular, uses woodfibre insulation in place of foam or mineral wool insulation.

There are a number of reasons for this;

- low embodied carbon,
- do not rely on extraction of fossil fuels for their production,
- less dangerous / unpleasant to work with,
- Vapour-open (see Moisture section)
- Wood fibre insulation has more thermal mass meaning it can play a part in preventing overheating in hot summers.
- Health and well-being of tenants VOCs;
- Hygroscopic - it can help to control humidity.

The Sustainable Traditional Buildings Alliance's report; *The Use of Natural Insulation Materials in Retrofit* explores the energy and carbon characteristics of natural materials, their moisture handling characteristics, and the regulatory context.

Top - Woodfibre Insulation

Above - Hempfibre Insulation

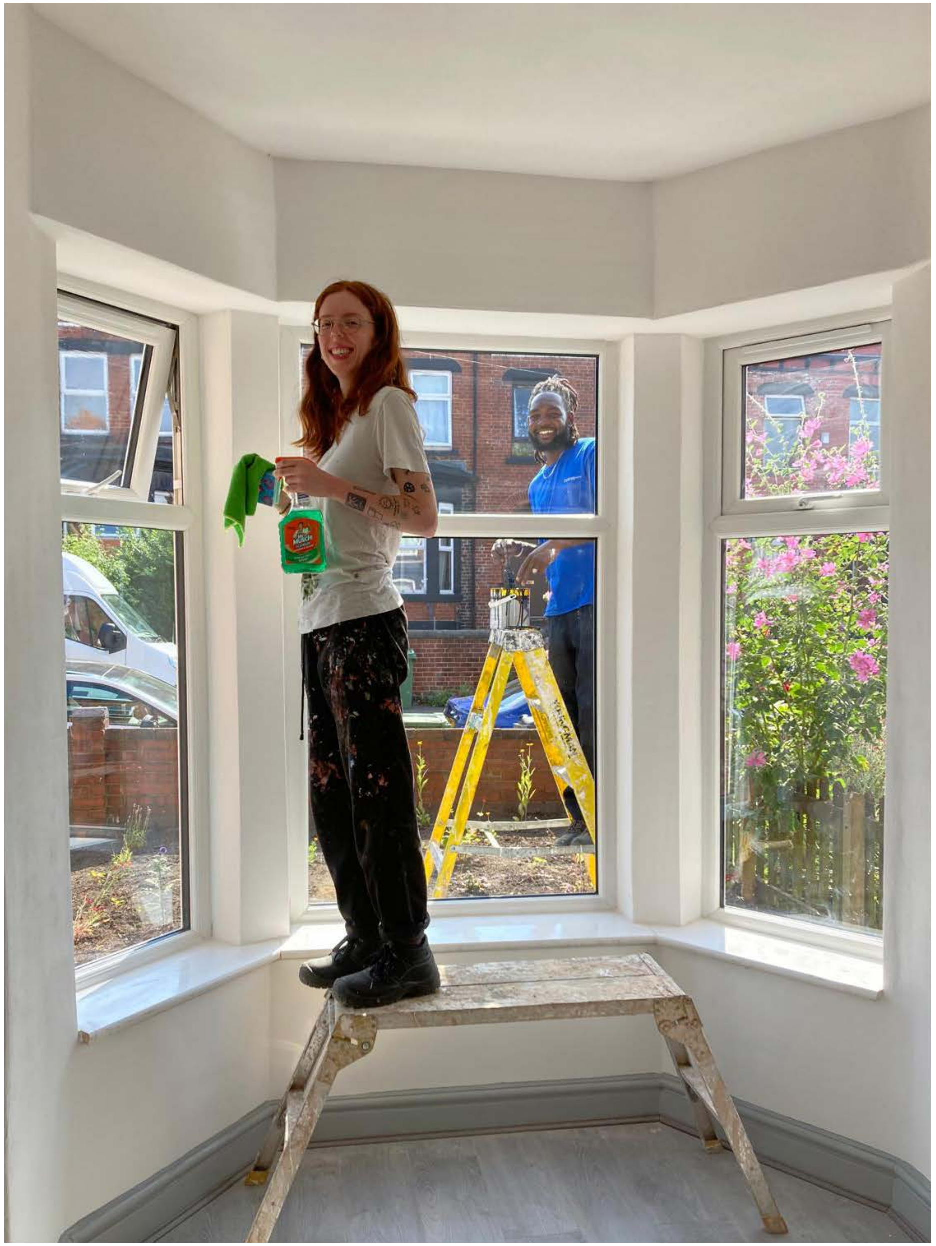
Right - Sheepswool Insulation.

Bio-based insulation trials as part of the Energy Redress Project.

Canopy has been using woodfibre insulation with lime plaster to retrofit external walls for a number of years. It's good for the houses, for the site workers and volunteers and for the planet.

As part of the Energy Redress Project, we were keen to explore the use of different types of bio-based insulation systems. In the table below, we've summarised the advantages and disadvantages of the three we've either used or are considering using.

Insulation Type	Advantages	Disadvantages
Rigid Woodfibre	• high percentage of waste material & mainly made from renewable resources • sequesters CO2 during tree growth • relatively simple detailing, lime plaster directly onto insulation forms air tightness layer.	• Polyester binder and fire retardant. • Imported into UK, adding to embodied carbon
Hempfibre	• renewable material • sequesters CO2 during plant growth • grown in Yorkshire! (but processed in Scotland.)	• Polyester binder and fire retardant. • Fertiliser use during plant growth. • more complex to install, requires timber frame support and an air tightness membrane.
Sheepswool	• a waste product from renewable sources • sequesters CO2 during animal growth • sourced and processed in Yorkshire!	• Polyester binder and fire retardant. • pesticides used during animal growth • green house gas released during animal growth. • more complex to install, requires timber frame support and an air tightness membrane.



Volunteers finishing up a bay window that has been insulated, lime plastered and painted with vapour-open paint.

Lime

For external walls, Canopy uses lime plasters and mortars, in place of cement and gypsum.

Lime is a material produced by crushing and then heating limestone.

The reasons for using lime over cement externally and gypsum internally are as follows;

- It is vapour-open (see Moisture section) so suited to use with natural materials.
- Lower embodied carbon; lime needs to be heated to 900ºC, whereas cement production requires temperatures of around 1400ºC.
- It continues to absorb CO_2 from the atmosphere as it cures, which helps to offset the carbon emitted during its production,
- It is consistent with the original materials used in the construction of Canopy houses.

Paint

It is important to ensure that vapour-open paint is used on insulated walls. Like the woodfibre insulation and lime, the paint allows moisture to pass through and evaporate from the surface.

The paint is the final layer of the retrofit measure to be installed.

If the vapour-open retrofit measures were covered with a vinyl or acrylic-based paint, it will seal in the moisture within the solid walls and lead to problems with damp and mould.

Paints often contain plastics derived from petrochemicals that have a negative impact on our health and the environment. Vapour-open paints tend to be made using only natural minerals and pigments.

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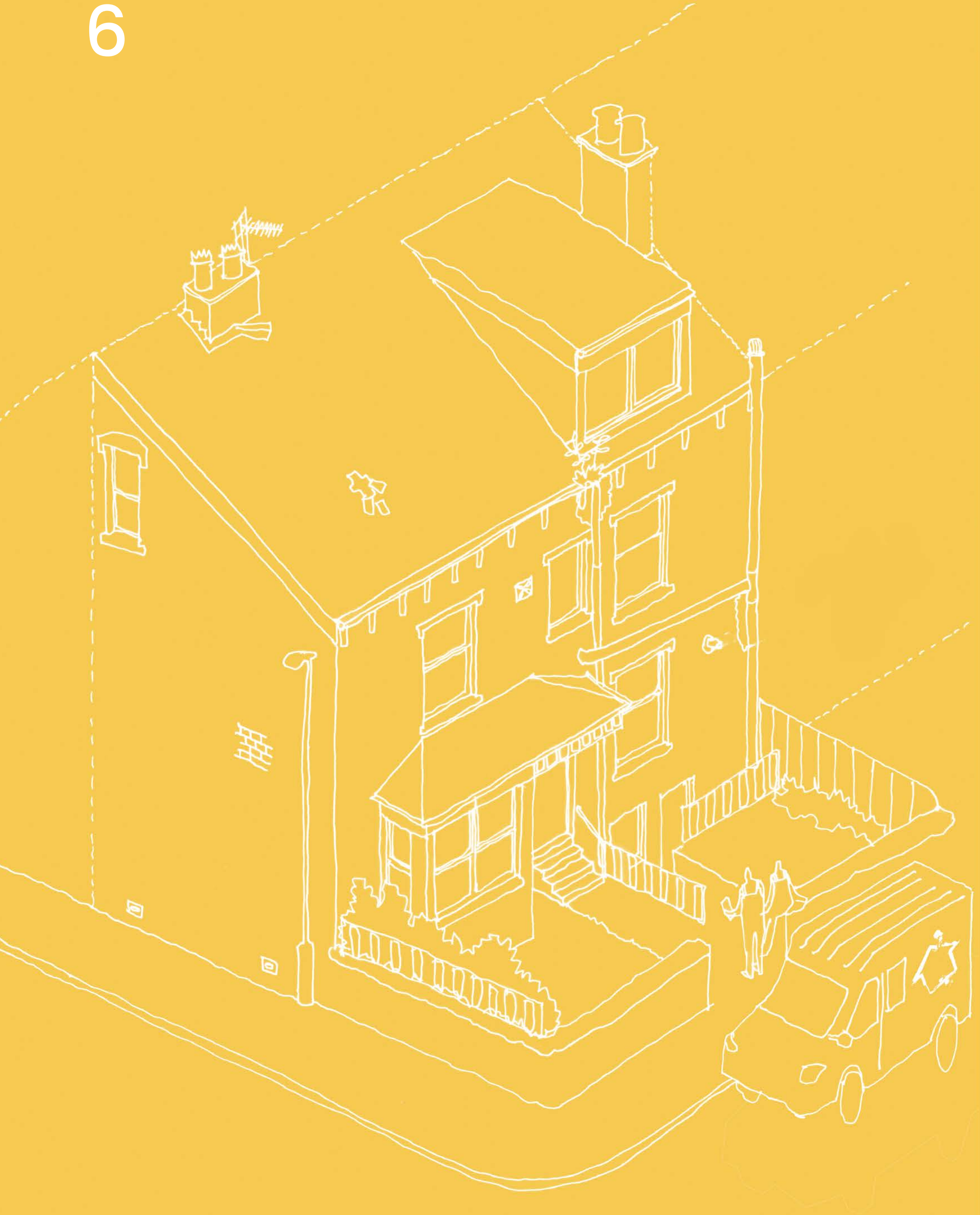
Heating & Hot Water



How we heat our homes has changed considerably over the lifespan of an average back-to-back. The changes in heating and hot water systems have also required changes to the building fabric.

Coal Fires

Canopy houses were mostly built in the late 19th and early 20th Century. They were designed to be heated by coal fires, with a fireplace in every room. These fires also provided hot water, boiled in kettles and poured directly into tin baths. Heating a house with coal fire was not only highly inefficient - most of the heat generated went straight up the chimney - it also was incredibly polluting. From the 1970s onwards, gas central heating replaced coal fires.

Gas & Electricity

These days almost all houses have a gas boiler and radiators, but change is afoot again. In the UK, we've committed to reach net-zero carbon emissions by 2050 and this means we need to stop burning fossil fuels to heat our homes and start using renewable electricity.

Heat Pumps

The alternative to gas central heating in most cases is a Heat Pump.

Heat pumps are systems powered by electricity that extract heat from the external atmosphere and 'pump' it indoors. The system works in the same way that fridges and freezers stay cold. Heat pumps are much more efficient than electric boilers, that use electricity to generate heat directly.

Heat pumps require outside space - a yard or a garden - which not all Canopy houses have. Where possible, Canopy has begun to install heat pumps into retrofitted homes. For properties with no outside space, the 'Fabric First' approach to retrofit ensures that the demand for fossil fuels is as low as possible.

An outdoor coil unit installed in the back garden of a 'through terrace'.
A large space is required internally for the hot water tank.

A significant consideration during the Energy Redress Project has been whether heat pumps are suitable for low income households, when electricity is more expensive than gas.

Heat pumps are most efficient when they're operating around the clock - heating the house to a constant temperature. Canopy tenants often only heat there houses for short bursts of time when it's particularly cold.

Data from the first house that had a heat pump installed as part of the ERS has shown that heating and hot water supplied by the heat pump in a retrofitted house is still more expensive than gas - although the house that the tenants moved into was larger than the house they lived in previously & they did like to keep the house very warm.

Switching to a 'smart heat pump' tariff did reduce the cost.

A diagram showing how district heating connects up an entire neighbourhood with insulated pipes supplying heat.

District Heat Networks

District heat delivers heat through insulated pipes from a central energy source, providing space heating and hot water to buildings connected to the network.

Whilst Canopy has begun to install heat pumps in properties where feasible, there are significant barriers to this type of heating system in dense, urban housing.

Urban housing often has no outside space suitable for the external unit, and insufficient internal space for a hot water tank.

District heating is common in northern Mainland Europe and would be a more appropriate way to supply renewable and low-carbon heat to back-to-back neighbourhoods.

Although there would be disruption to connect up neighbourhoods, we've just undergone a similar process across the country to connect up fibre broadband.

District heating is flexible because the energy source can be switched, without having to change the heating system in individual homes.

District heating can recycle heat produced from electricity generation or industrial processes and use this to heat homes.

In addition to the community retrofit programme, Canopy is exploring a new project to focus on heating, hot water, energy generation and fuel poverty.

Many of Canopy's tenants are on low income and struggle to afford their bills, often creating debts on their prepayment meters.

Tenants in extreme fuel poverty prefer prepayment meters and prefer to be able to not use energy to avoid debt.
We have concerns that a short term, stop start approach to Air Source Heat pump heating systems

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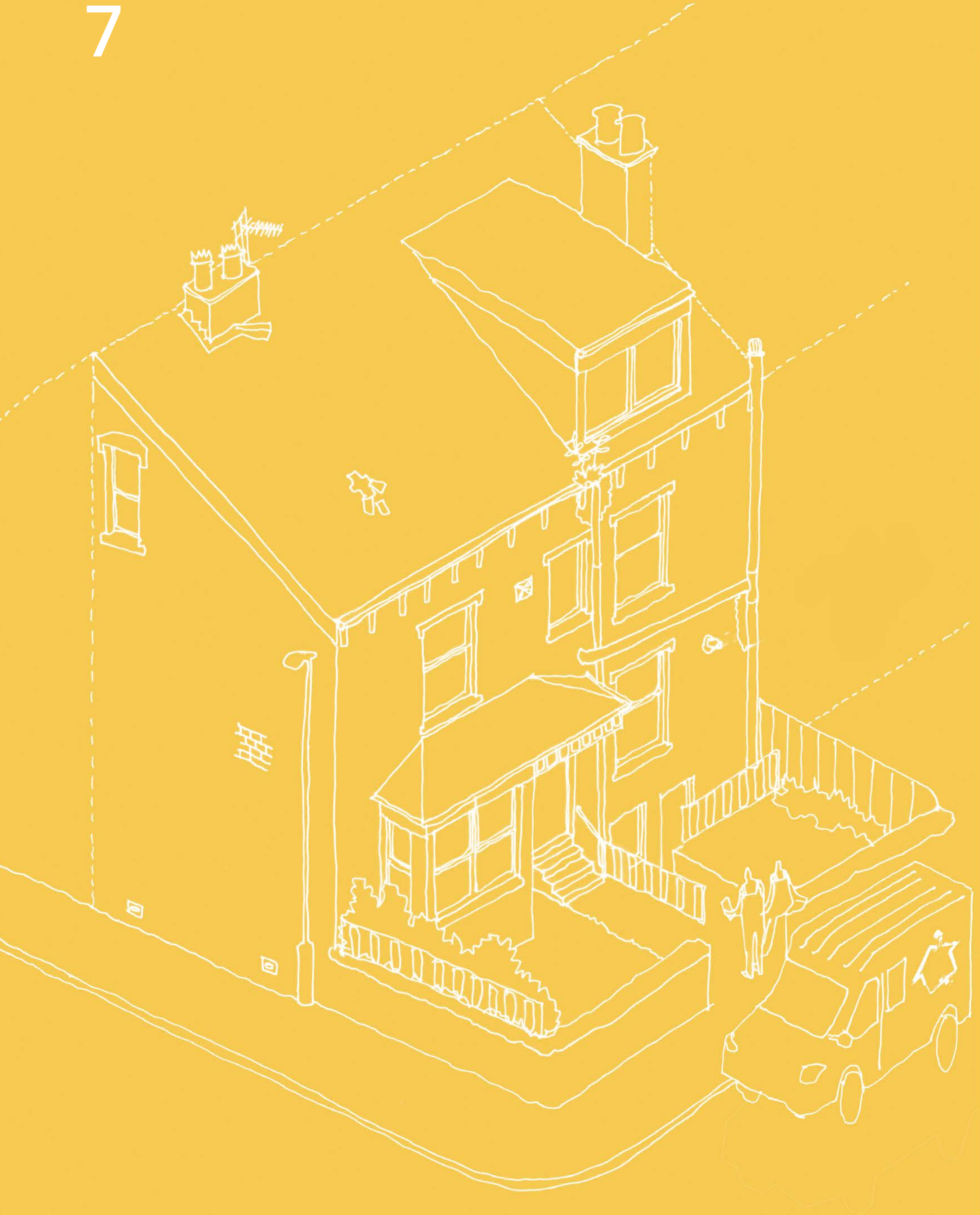
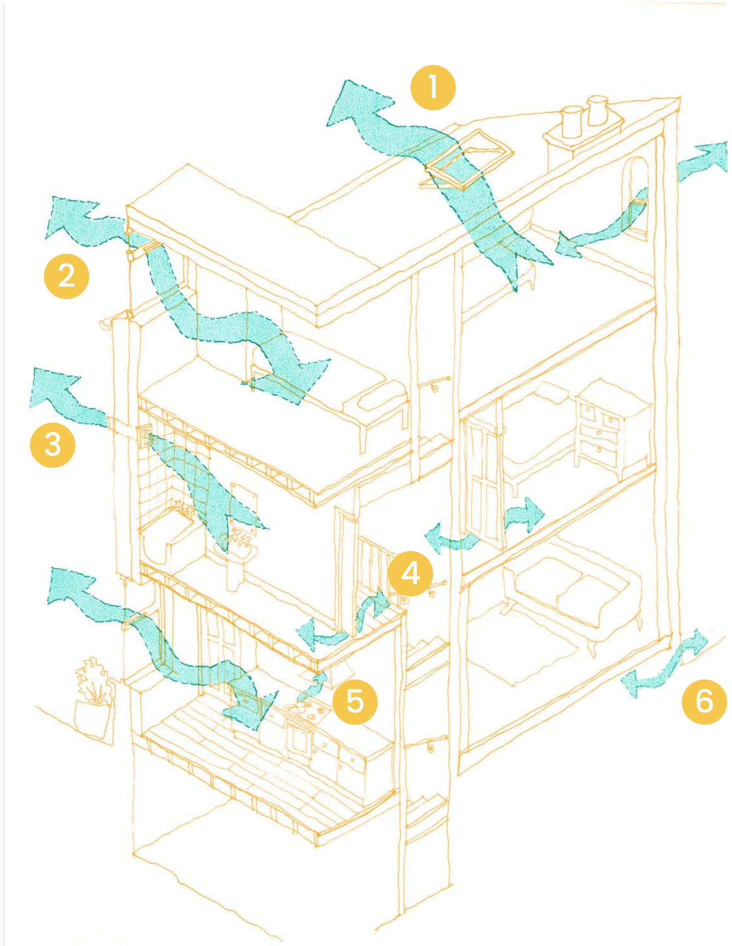


Air Tightness & Ventilation



1. Purge Ventilation - opening a window.
2. Trickle vents - gaps in the window frame providing a constant source of fresh air.
3. Mechanical extract fan in bathroom.
4. Internal door undercuts.
5. Kitchen extract hood
6. Sub-floor ventilation.

Different types of 'controlled ventilation' in retrofitted house.

With fires burning in every room, it was also necessary to have lots of fresh air entering the house. Sash windows, gaps in suspended timber floors and air bricks ensured that adequate levels of oxygen were maintained. Nowadays we refer to this as 'uncontrolled ventilation'.

Air Tightness

Airtightness is a measure of uncontrolled movement of air into and out of a building.

When retrofitting a property Canopy are aiming to make the 'building fabric' - the walls, floors, windows, doors and roof - airtight, so that there are no unwanted draughts. This is achieved through a combination of insulation, membranes, tapes and a thick layer of lime plaster

Canopy site workers nominate an 'Air Tightness Champion', whose responsibility it is to check the air tightness works are being installed correctly on site.

Ventilation

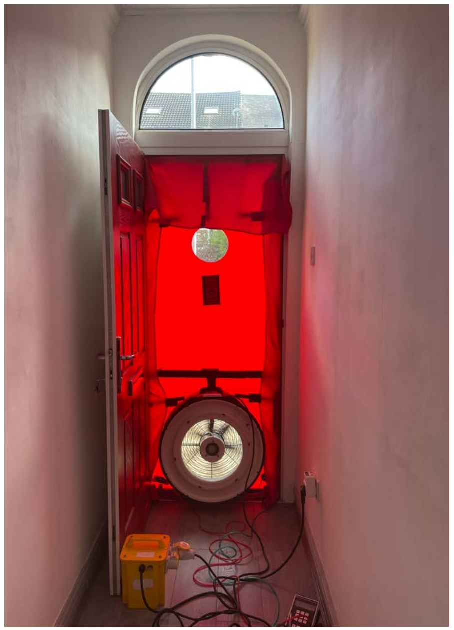
Canopy houses follow a ventilation strategy set out in the Building Regulations Approved Document F.

Extract ventilation is installed in the kitchen and bathrooms, where water vapour or pollutants are likely to be released. We use a what is known as a 'decentralised MVHR'; a Mechanical Extract Ventilator with Heat Recovery.

This is supplemented by 'background ventilation'; trickle vents in windows, and 'purge ventilation'; the ability to open a window to let out stale air. These are explained in more detail in the Window section.

Mechanical Ventilation with Heat Recovery

In the past, Canopy has installed whole house MVHR systems with good results. We would like to again, but they're unfortunately around £8.5K to install, which is beyond the budget of a typical Canopy retrofit.



Top - The blower door kit installed within the front door of Regent Terrace.
Above - Using thermal imaging to understand where air is entering the house.
Right - Interior view of the blower door kit.

Airtightness testing of properties as part of the Energy Redress Project.

We identified a number of houses that were to be retrofitted as part of the Energy Redress Project - and also represented standard 'types' of Canopy houses - to undertake airtightness testing at key milestones during the retrofit process.

Ideally testing takes place three times during the retrofit process;

1. Before any works take place, as part of the assessment of the existing house, to establish a baseline.

2. Once all the air-tightness measures have been installed, but before finishing touches and decoration, to test their effectiveness.

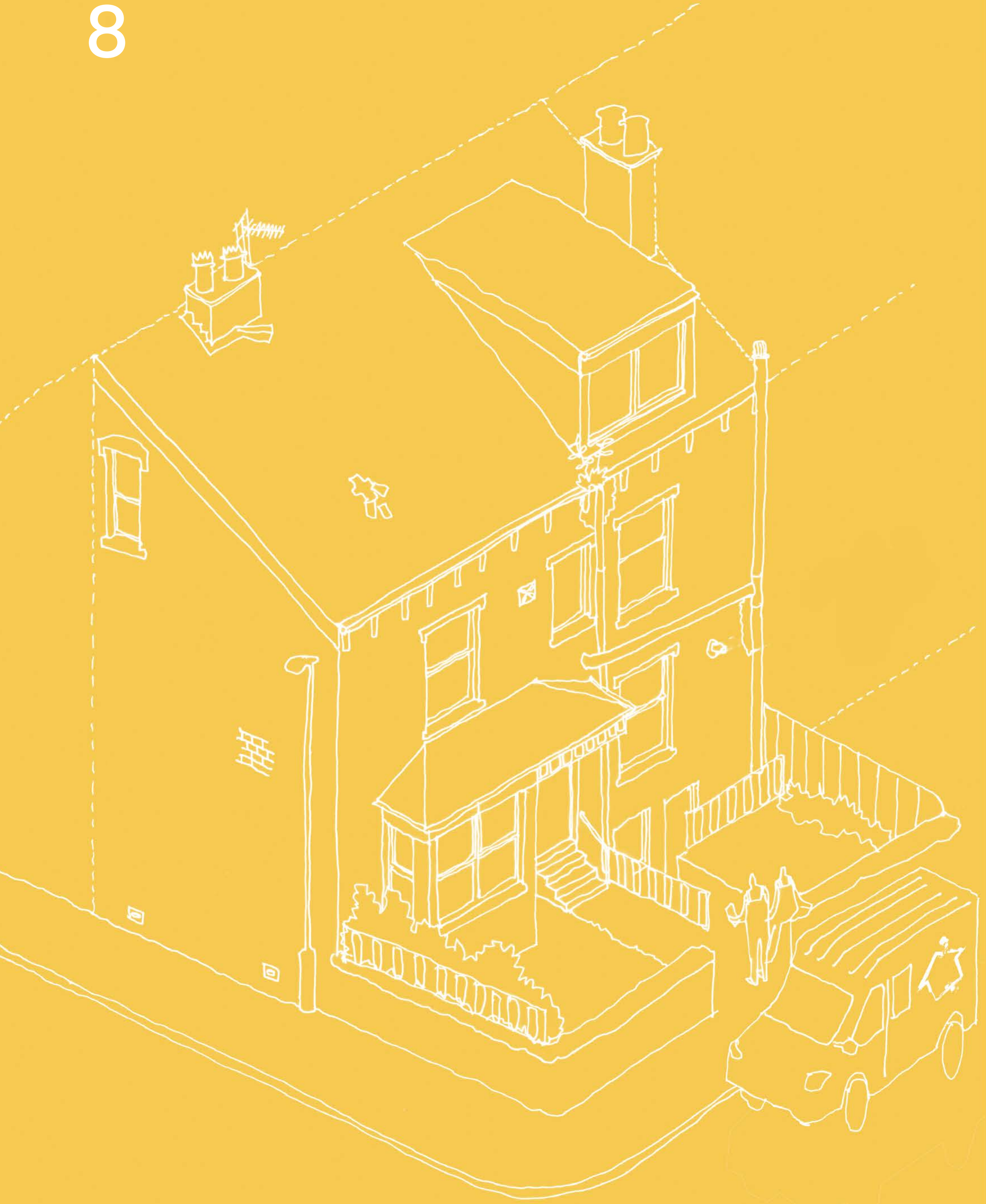
3. On completion of the retrofit, to understand the effectiveness of the measures.

A blower door kit is fixed to the front door. This is a fan that creates a pressurized internal atmosphere.

Canopy volunteers and staff then use thermal imaging cameras and smoke pens to identify 'leaky' areas of building fabric. In early tests, we found that service penetrations in the bathroom and kitchen were a particular problem area, and started using air tight grommets on site.

Whilst we've had some success at achieving targets, Canopy has struggled to consistently meet the levels of airtightness that have been targeted on the Energy Redress Project. We suspect this is down to the fact that there is a greater surface area of untreated party wall than in a typical house.

8



Windows

Replacement uPVC windows in a retrofitted house.

Window Frames

Canopy houses tend to have uPVC (plastic) window frames, which have a lifespan of 20-30 years.

uPVC frames are difficult to recycle, so it's important to assess whether windows really need replacing as part of a whole house retrofit. What to look out for;

- draughts around the frames mean the seals have failed. Use a smoke pencil draught detector during an air tightness test to assess the seals.
- condensation or white dust inside the sealed double glazing unit means the sealant has failed. You may be able to replace the glazing, without replacing the frames.
- the frames are cracked or yellowing.
- the windows won't open or close properly. This means the frames have failed. They may be able to be fixed or may need replacing.
- noise from outside can be heard when the window is closed.

Double or triple glazing?

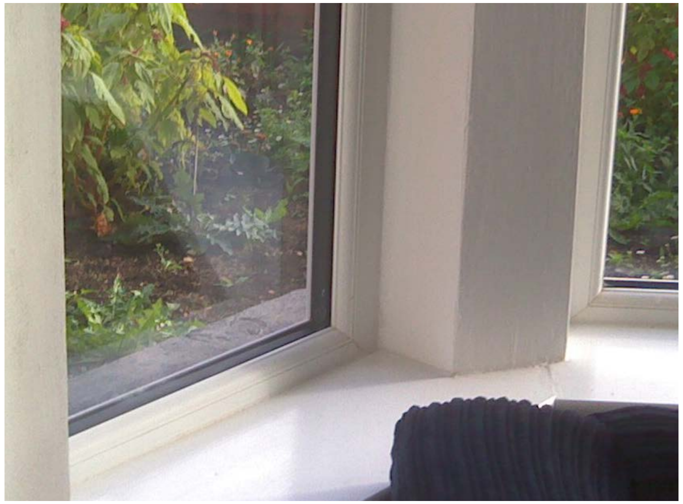
Canopy houses are usually double glazed. Triple glazing is about 50% more energy efficient than double glazing, and around 20% more expensive.

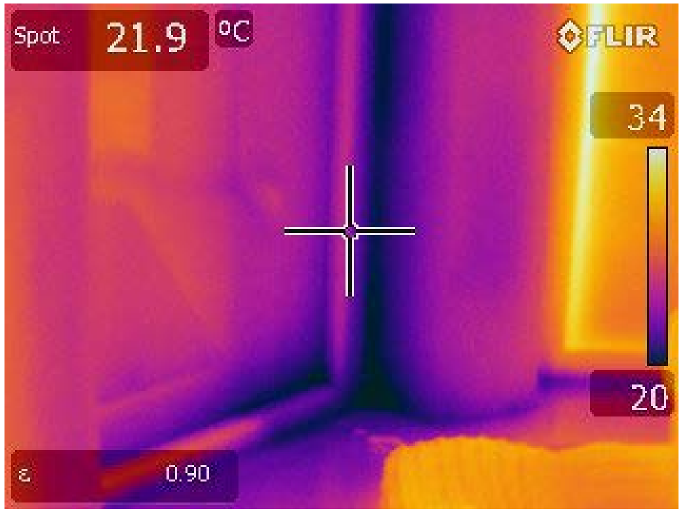
Ventilation

Canopy houses are usually 'single aspect'; all the windows and doors face in a single direction onto the street.

This means they do not benefit from 'cross-ventilation'; where the difference in air pressure between the front and back of a building draws air through from one side to the other. This means it is all the more important to ensure that ventilation is appropriate designed.

A trickle vent is a slit within a window frame that ensures a small amount of constant airflow from the outside to the inside of the house, removing excess moisture from the air that can otherwise cause mould. Although trickle vents can be closed, they are designed to be left open at all times. They should be positioned at the top of a window frame to reduce cold draughts.





Images of a retrofitted bay window from a thermal imaging camera, showing the temperature difference across the reveal board.

Even with newly fitted double glazing, air leakage around and conduction through the frames is a significant source of heat loss. It is therefore sensible to simplify the window frames so that there is only one opening casement, although this needs to be balanced against opening requirements for purge ventilation.

Purge ventilation is the ability to open a window or door to quickly remove odours, fumes or water vapour. It can also be used to quickly cool a room down.

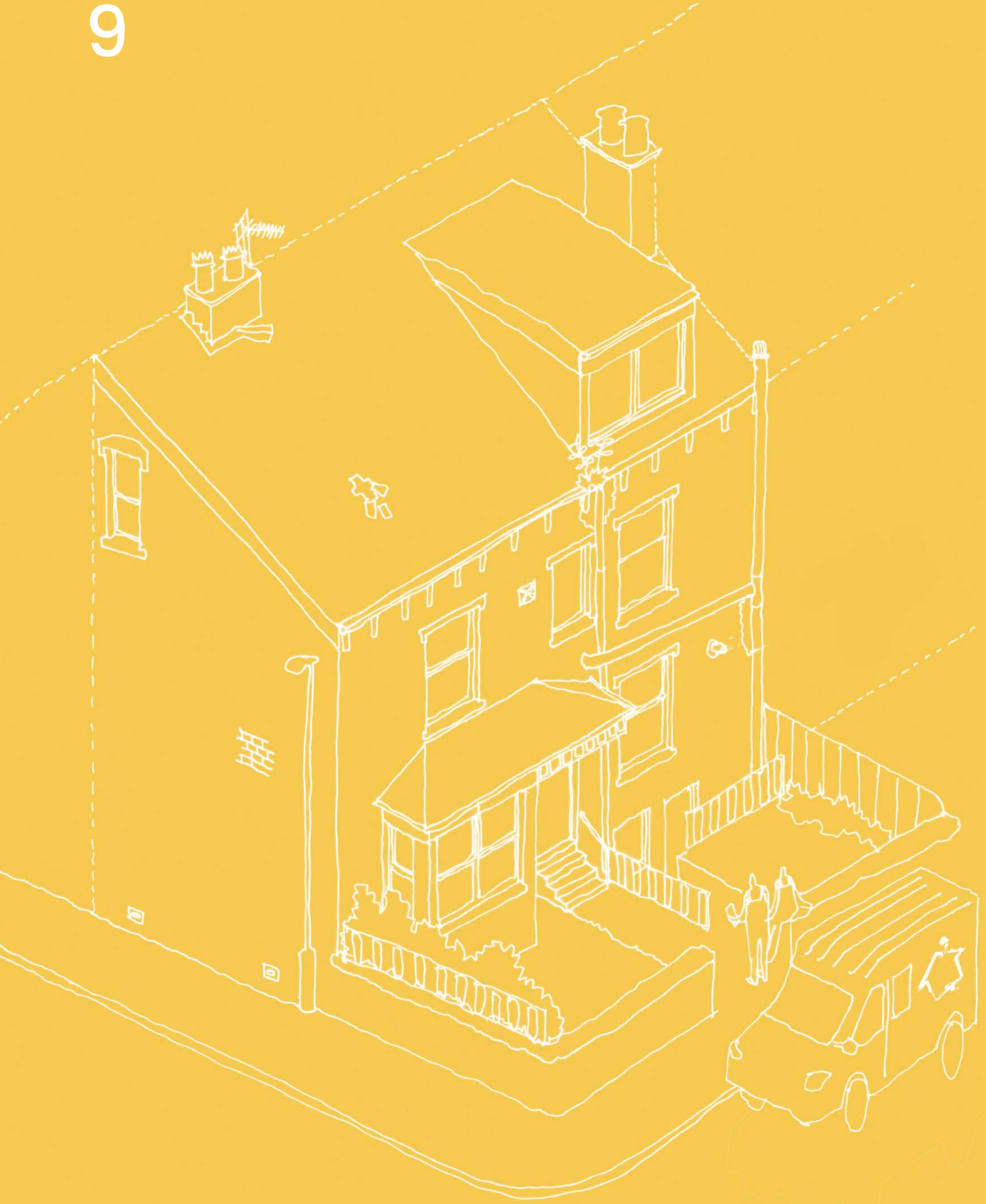
The size of the opening required relates to the area of the room and how far the window can open. Requirements are set out in the Building Regulations Approved Document F: Volume 1: Dwellings.

It also important to consider whether the window is needed as a means of escape in the case of a fire, see Approved Document B1.

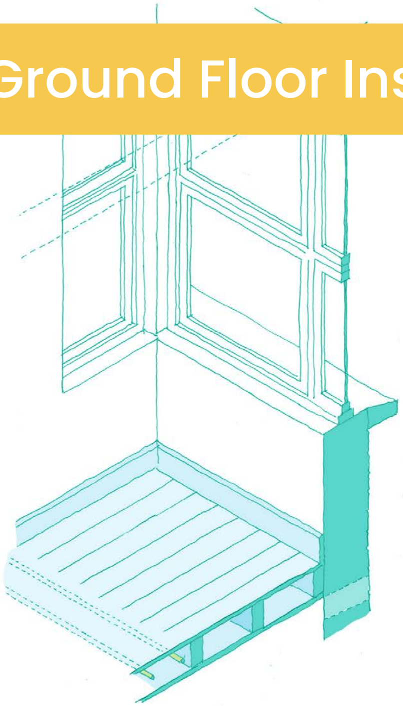
The Building Regulations *Approved Documents* set out requirements to ensure that windows are designed to be safe and energy efficient.

9

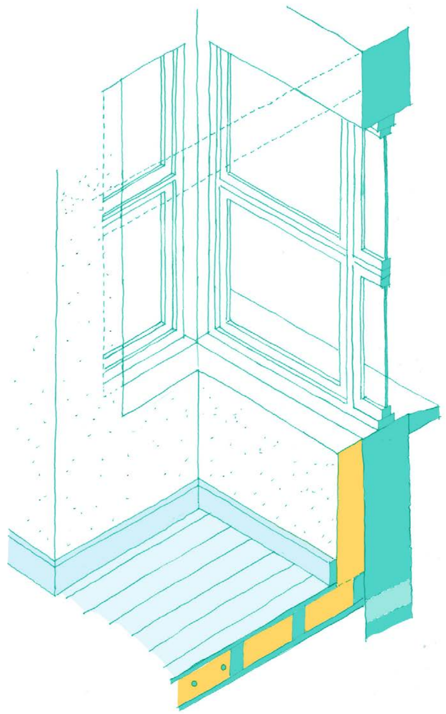
Step-by-step Retrofit Measures



Ground Floor Insulation



Before installation



After installation

Key

- Insulation
- Timber
- Membrane
- Tape
- Plaster

Canopy houses generally have suspended timber floors, often with a cellar beneath at least part of the house.

Ventilation beneath the timber floorboards and joists prevent the wood from rotting, but also results in unwelcome draughts.

Insulating the ground floor of the house can improve comfort and reduce heat loss significantly.

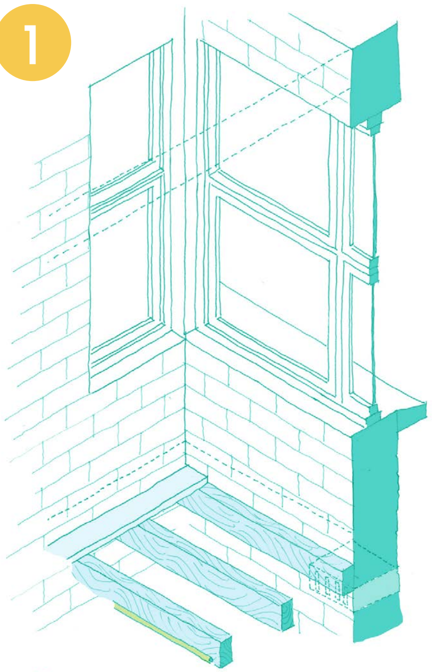
Where there is a cellar, insulation and an air tightness membrane can be installed from below, without disturbing the floorboards and finishes.

If there is no cellar, the floorboards can be carefully lifted and reused after the insulation has been installed.

Top - Canopy volunteers installing a 'wind-tight' membrane'.

The Ecological Building Systems website features a thorough technical guide; *A Best Practice Approach To Insulating Suspended Timber Floors.*

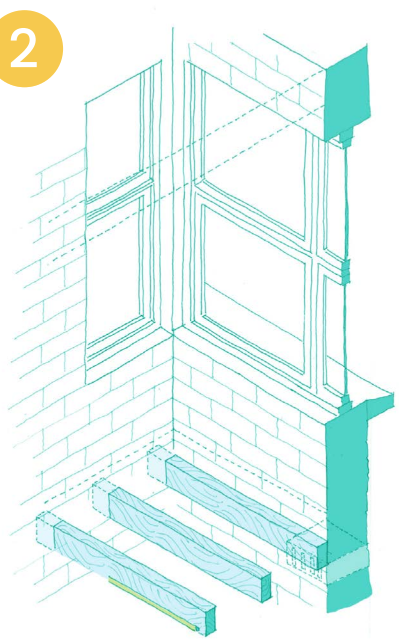
1



Lift any existing floor finishes and assess the boards for re-use. If they can be carefully lifted you should be able to reuse them.

Remove any gypsum plaster and cement mortar from the walls.

2

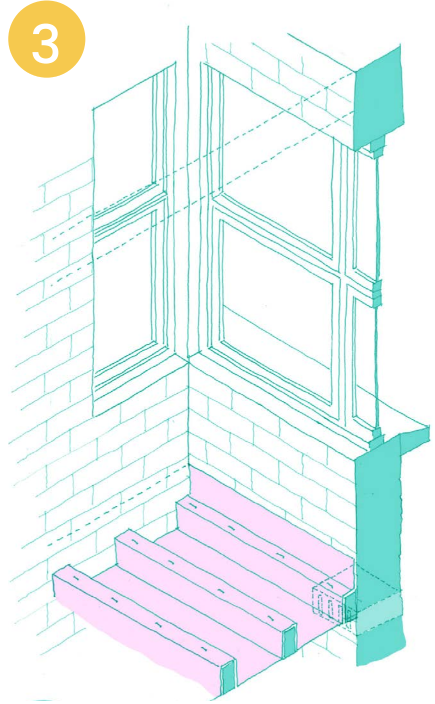


Check the joists for decay and replace where required.

Remove any nails from the joists.

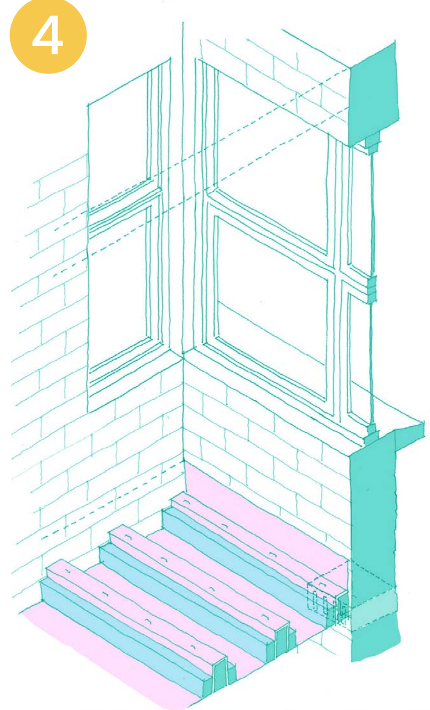
Check for air bricks and ensure that the insulation will not block the air flow.

3



Lay the ‘windtight’ breather membrane over the joists, leaving enough at the edges of the room to tape to the walls, behind the skirting board.

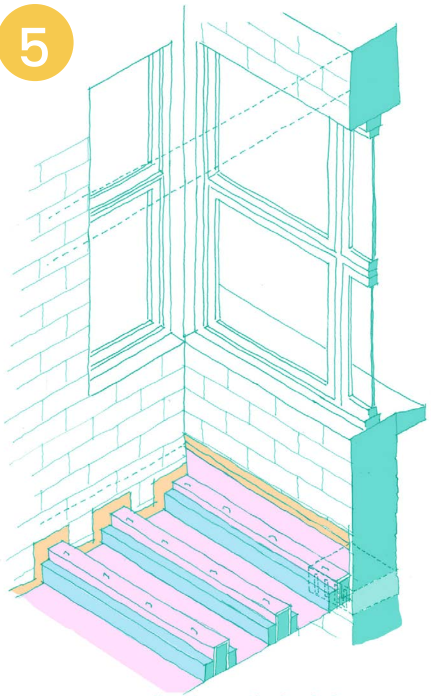
4



Screw timber battens along the base of the joist, to create an even channel between each joist.

Staple the membrane in place.

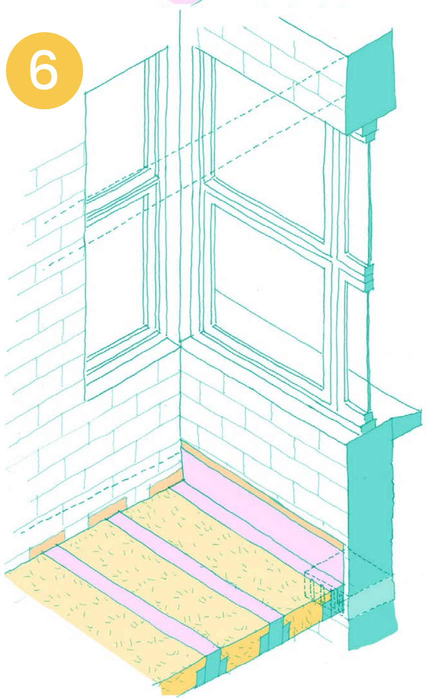
5



Carefully tape the membrane along all the edges and joints using an appropriate air tightness tape.

Pay particular attention to the seals where the joist penetrates through the wall.

6

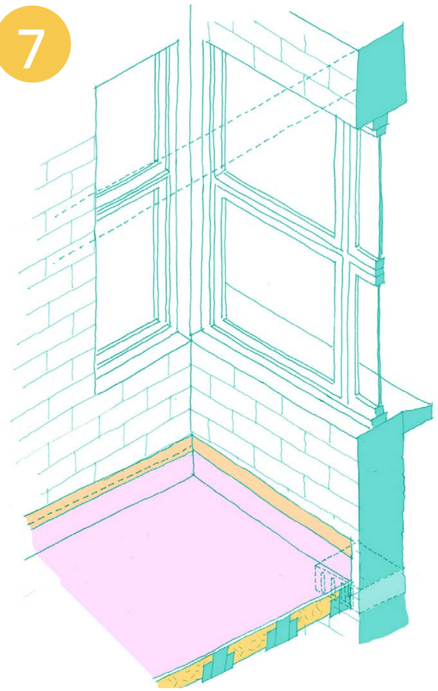


Fit the insulation in between joists.

If using a roll of insulation (e.g. sheepswool, mineral wool) ensure that the insulation will not be compressed by the floorboards.

If using a rigid board or semi-rigid batt (e.g. woodfibre, hempfibre) ensure that the insulation fits snugly between the joists. Fill any gaps.

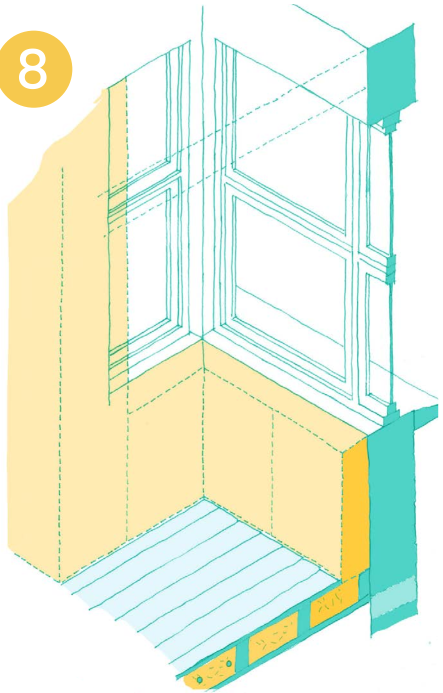
7



Lay the vapour control layer over the floor joists and insulation and tape the edges to the wall.

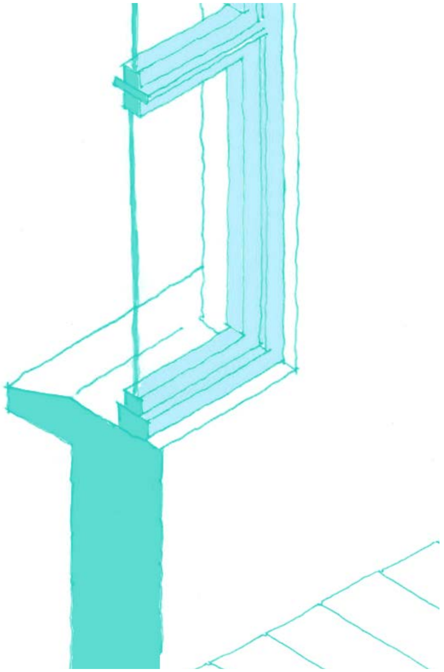
If using tongue and groove chipboard as a sub floor, this should be sufficient at stopping warm moist air entering the floor structure. You will still need to tape the edges and joints.

8

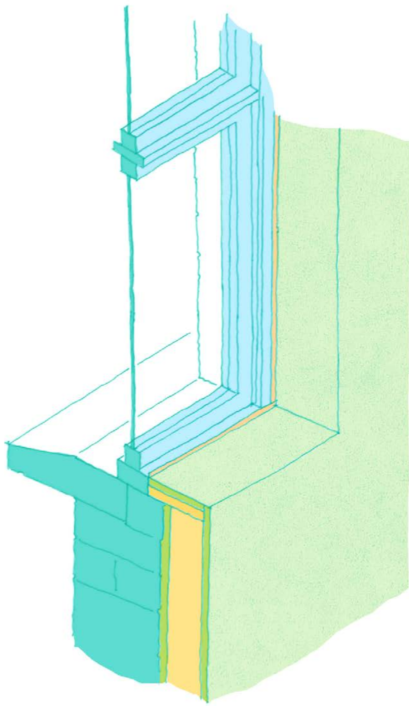


Relay the floorboards. They will need to be cut back at the external walls if you are planning to install internal wall insulation as part of the retrofit works.

Walls & Windows Insulation



Before installation



After installation

Key
- Insulation
- Timber
- Membrane
- Tape
- Plaster

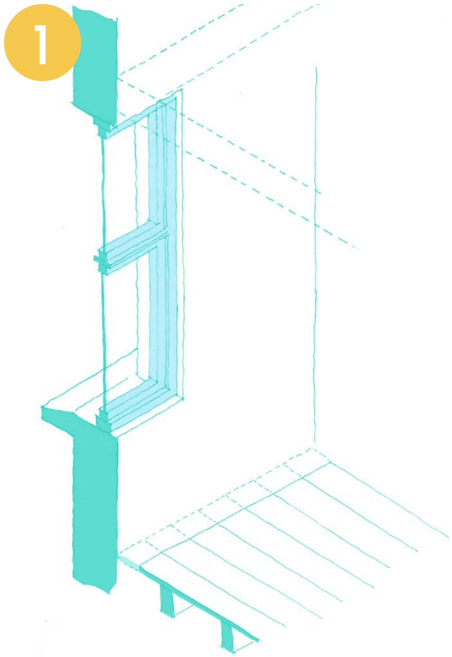
Canopy prioritises internal wall insulation (IWI) because it is more sympathetic to the character of the terraced elevations of the back-to backs.

IWI also avoids situations in which staff and volunteers are required to work at height.

It involves slightly more risk in relation to moisture management, as well as added complexity in achieving airtight building fabric, than insulation applied to the external face of a wall.

Canopy has been using woodfibre insulation fixed directly to the wall, which then can be lime plastered directly. Whilst this is a relatively simple 'build-up' of materials it can be difficult to fix the insulation in place and the lime plaster needs

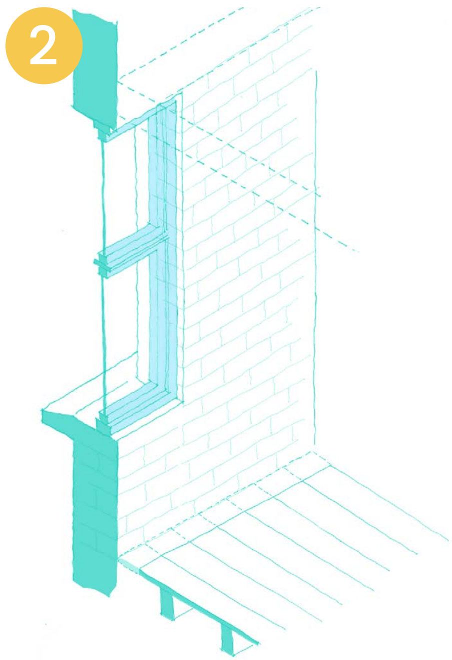
Top - Canopy volunteers removing mineral wool insulation.to install a 'wind-tight' membrane. The insulation was set aside and relaid once the membrane was installed.



Remove the skirting boards and cut back the floorboards to ensure that the insulation is able to run continuously up the internal face of the external wall.

There should not be a break between the ground floor ceiling and the first floor floorboards.

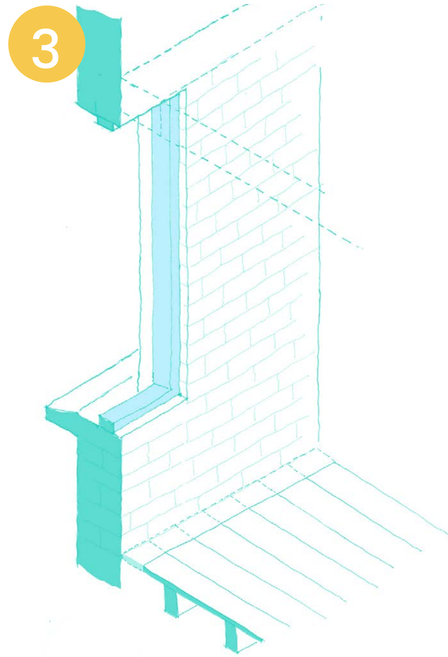
Where timber stud walls meet the external facade these should be cut back too.



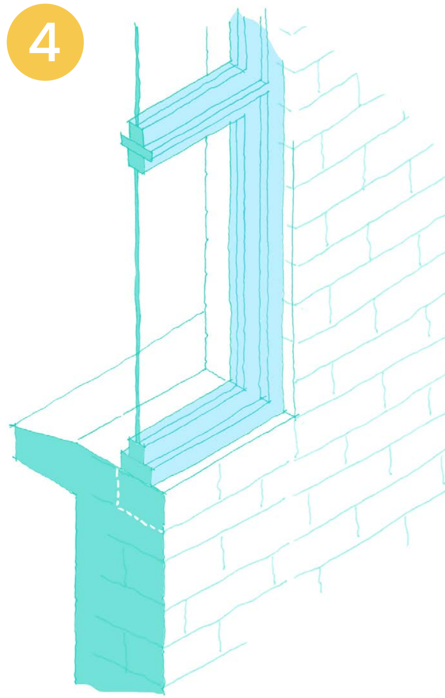
Remove any gypsum plaster (pink, smooth hard surfaces) and patch with lime plaster.

OR

If the plaster is falling from the wall, remove all the plaster, taking the wall 'back-to-brick'.

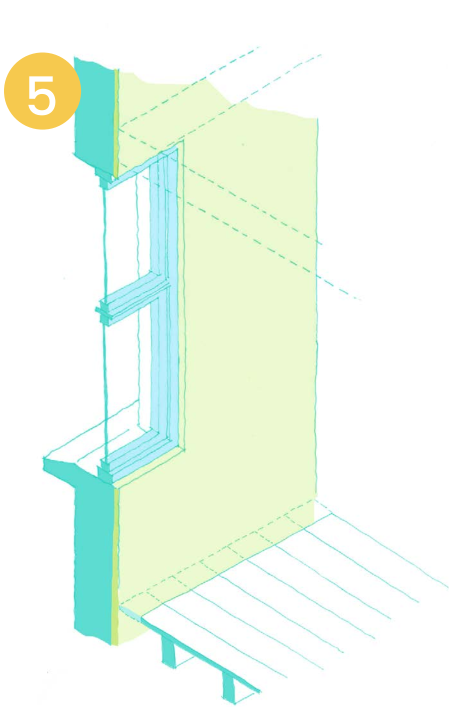


If replacing the window, remove the old frame.

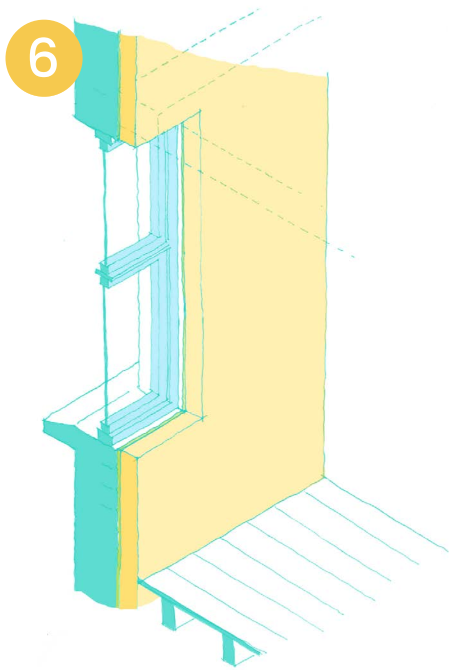


Ensure the new window frame is positioned in line with the internal brick leaf, to minimise thermal bridging around the window reveal.

It is important to communicate this to the window fitter, who may have other ideas!



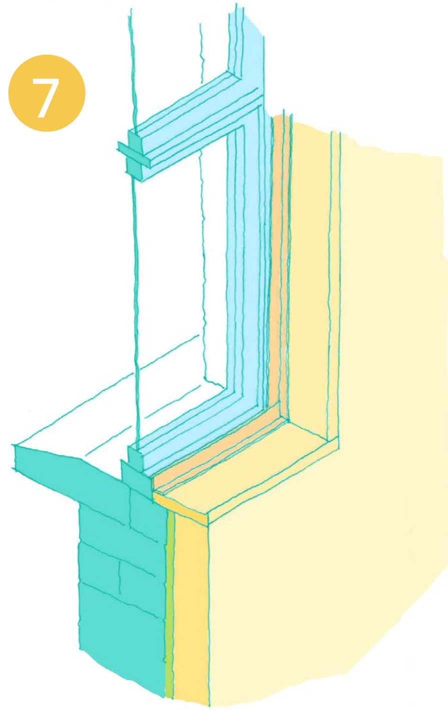
Apply a 'parge coat' of lime plaster to brick wall. This helps with airtightness and creates a smooth surface to fix the woodfibre insulation to.



Fix the insulation to the walls using insulated masonry fixings. The thicker the insulation, the trickier it is to get fixings in the correct position.

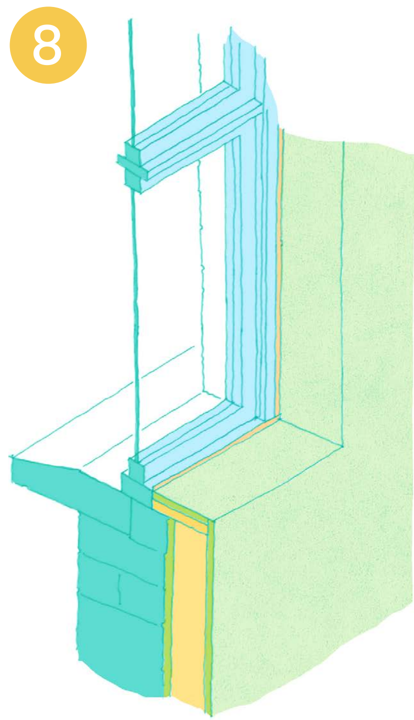
For more information on the appropriate thickness of insulation, see the section on insulation thicknesses overleaf.

It is worth considering how blinds and curtains will be installed at this stage too - you will likely need to fix a timber pattress as you cannot fix directly into the insulation.



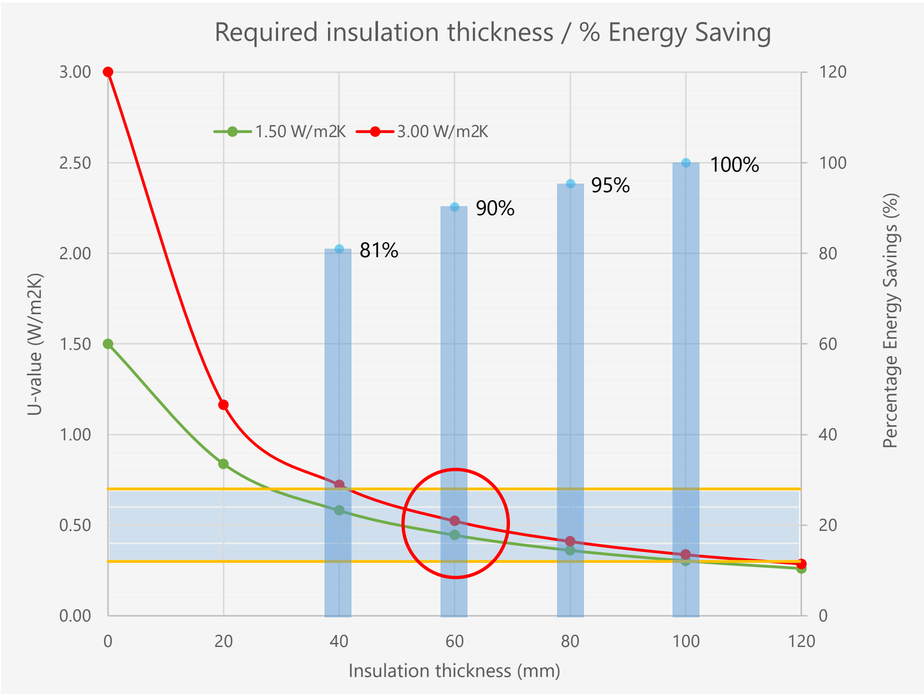
Fix the reveal board around the window reveal. This is a thinner piece of woodfibre that minimies thermal bridging around the window reveal.

Carefully tape the reveal board to the window frame using a plasterable airtightness tape.



Lime plaster directly onto the insulation and into the window reveal, covering the airtightness tape.

The lime plaster should also cover the taped membrane beneath the insulation in the floor.



Graph showing energy savings for different thicknesses of woodfibre internal wall insulation.
Source: STEICO Presentation (see bibliography)

Thickness of Internal Wall Insulation as part of the Energy Redress Project.

Our starting point was a thickness of 120mm woodfibre insulation, to fully comply with the Building Regulations.

The Building Regulations require retrofitted walls to have a thermal performance of 0.30W/m2K for walls but also gives a 'threshold value' of 0.70W/m2K.

What this means in practice is that the higher value has to be met, the lower value should be aimed for. If you are not reaching 0.30W/m2K there needs to be a compelling argument in support of your approach.

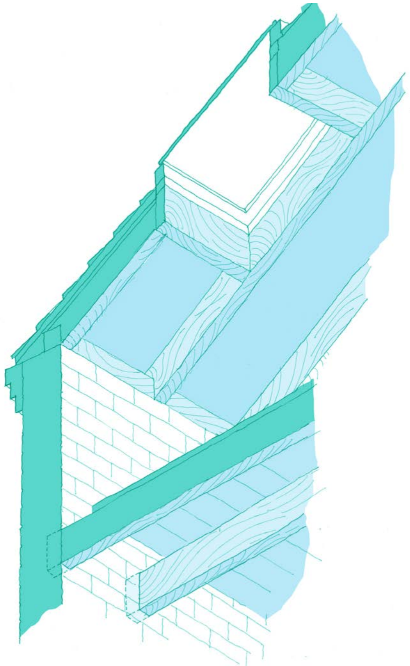
Woodfibre insulation manufacturer STEICO's own research suggests that an internal wall insulation thickness of 60mm is optimum.

Through testing different insulation thicknesses on site, Canopy found that the thicker the insulation the more difficult it is to fix to the walls. Whilst rooms in back-to-back houses are generally quite spacious, installing 100mm+ thick insulation begins to create issues with the internal layouts.

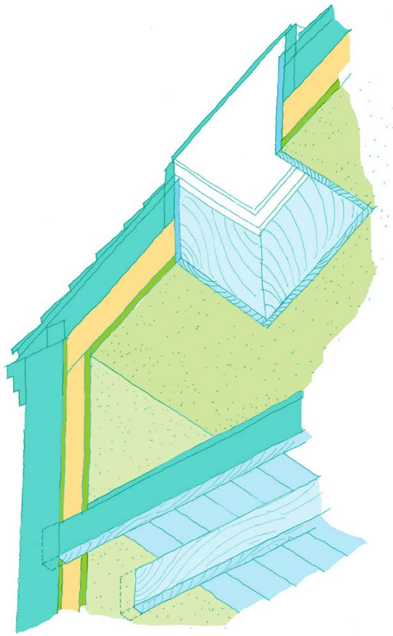
Canopy has settled on 80mm thick woodfibre insulation, balancing ease of installation, space requirements and energy savings.

Steico's research; *The retrofit solution and looking beyond U-values,* explains why 60mm of insulation can be seen as a 'sweet spot'.

Eaves + Rooflight Insulation



Before installation



After installation

Key
- Insulation
- Timber
- Membrane
- Tape
- Plaster

Around 30% of heat is lost through an uninsulated roof in a back-to-back house, so it's important to get the approach to insulation right.

Attic rooms often have restricted ceiling heights. This has to be taken into account when considering how to design and specify the retrofit measures.

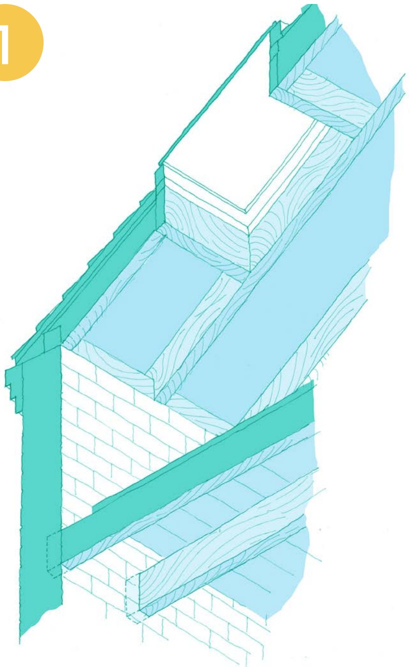
Canopy's preferred approach, shown in the diagrams overleaf, is to continue the same build up as used for the IWI; fixing woodfibre insulation to the timber roof joists and finishing with a thick layer of lime plaster as an airtight layer.

This keeps things simple when ordering materials and minimises the need to consider how different systems of insulation and airtightness join.

The weight and thickness of this system can often mean it's not practical. Alternative approaches are discussed at the end of this section.

Top - Canopy volunteers installing roof insulation.

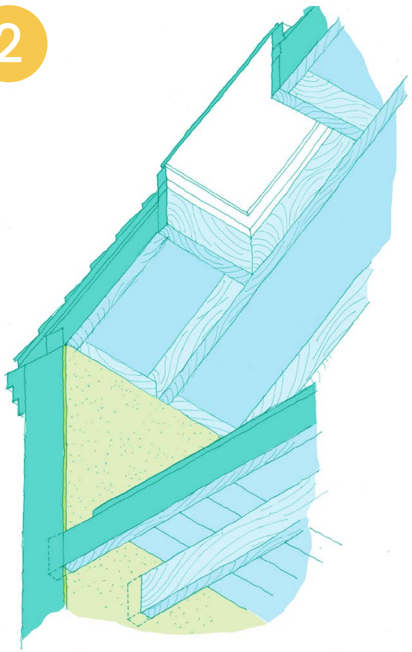
1



Strip back existing plasterboard or lath and plaster to reveal the roof rafters.

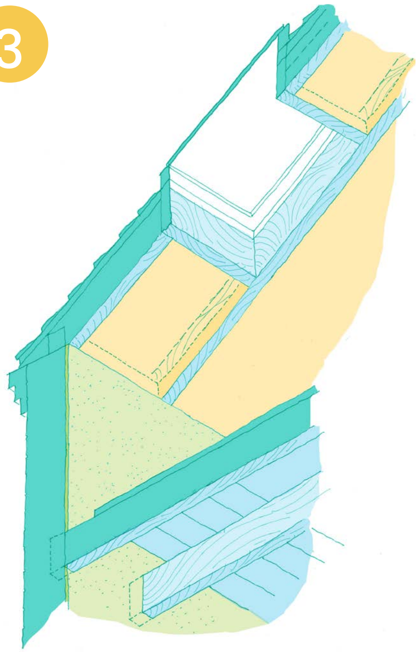
The internal wall insulation should be completed as in the staged process for the internal wall insulation. The internal wall insulation should continue all the way up the wall to meet roof rafters at the eaves.

2



Apply a 'parge coat' of lime plaster to brick wall. This helps with airtightness and creates a smooth surface to fix the woodfibre insulation to.

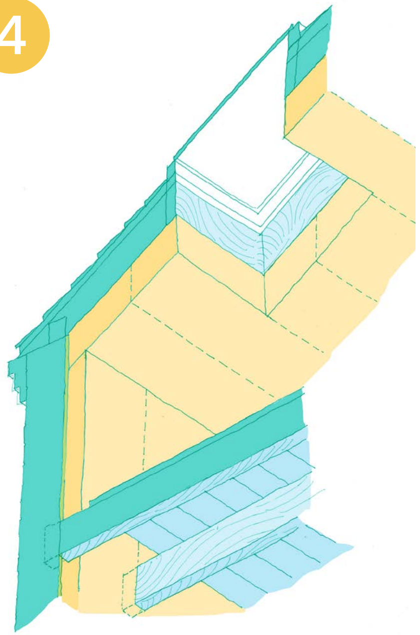
3



Cut the insulation batts so that they can be push-fitted in between rafters.

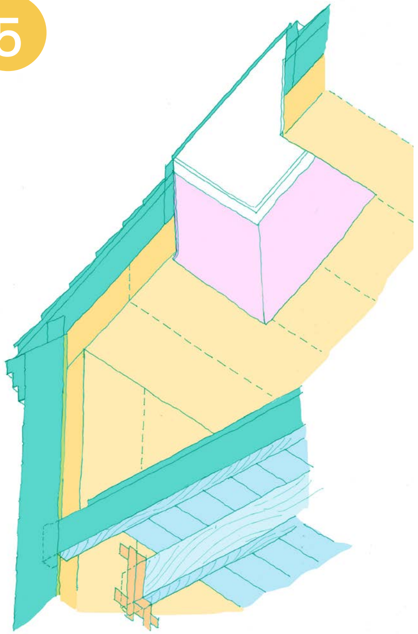
Ensure that the depth of insulation fitted between the rafters maintains at least a 25mm ventilation gap beneath the underside of the tiles or underlay.

4



Fix the rigid insulation to the underside of the rafters. Fill any gaps with offcuts.

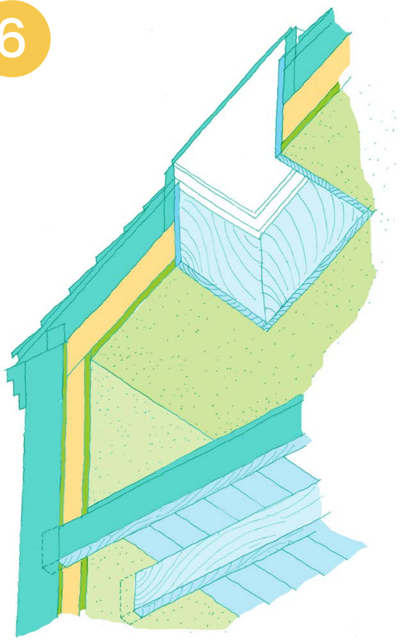
5



Install airtightness tapes and membranes, if using. Whether you are installing an airtight membrane will depend on how you plastering. If you are using plasterboard and skim, you will need an airtightness membrane between the insulation and plasterboard.

In the diagram, the joist penetrations are sealed with airtightness tapes and a 'collar' is installed around the rooflight reveal.

6



Lime plaster is applied directly to the woodfibre insulation and acts as the airtight layer.

Types of Roof Insulation installed and considered as part of the Energy Redress Project.

Canopy have trialled various different approaches to insulating roofs with benefits and drawbacks to each.

The original timber structure holding up the roof is sized to support slates/tiles, batons, lath and plaster.

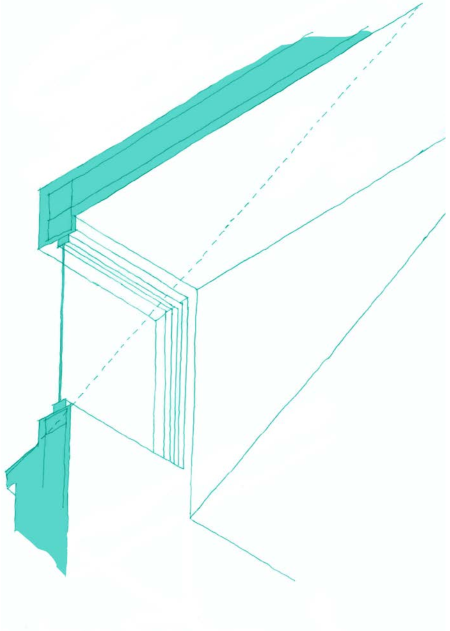
Woodfibre insulation and lime plaster are heavy materials that, in most cases, require the roof structure to be strengthened prior to fixing the insulation. This is not always practical or viable.

Where head-height is a problem, Canopy has chosen to prioritise natural materials over thermal performance; reducing the thickness of natural insulation, rather than switching to fossil-fuel based insulation.

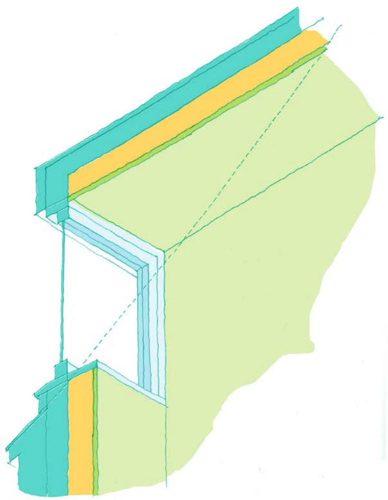
If this is still too heavy for the existing roof structure, we will swithc to flexible natural insulation e.g. hempfibre.

Whilst Canopy tries to avoid fossil fuel based insulation wherever possible, it's superior thermal performance, lightness and thinness when compared to natural materials does sometimes make it the best option for the roof insulation in spaces with restricted head height or floor area.

Dormer Insulation



Before installation



After installation

Key

- Insulation
- Timber
- Membrane
- Tape
- Plaster

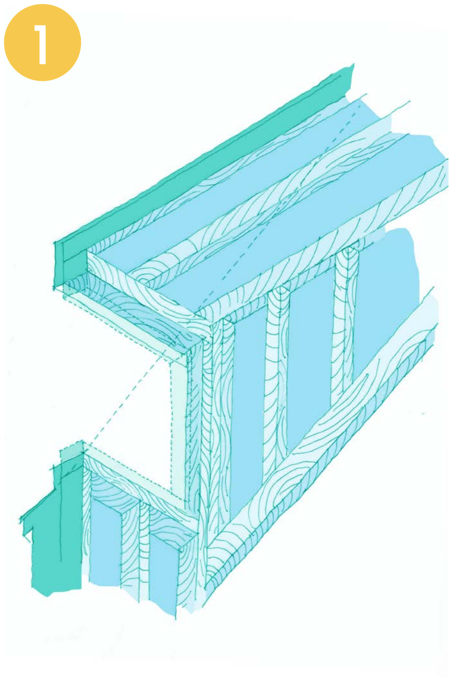
Dormers are often poorly constructed and insulated resulting in rooms that are very cold in winter and too hot in summer.

When insulating a dormer, an important first step is to understand how much additional load the structure can take. This will inform what type of insulation you use.

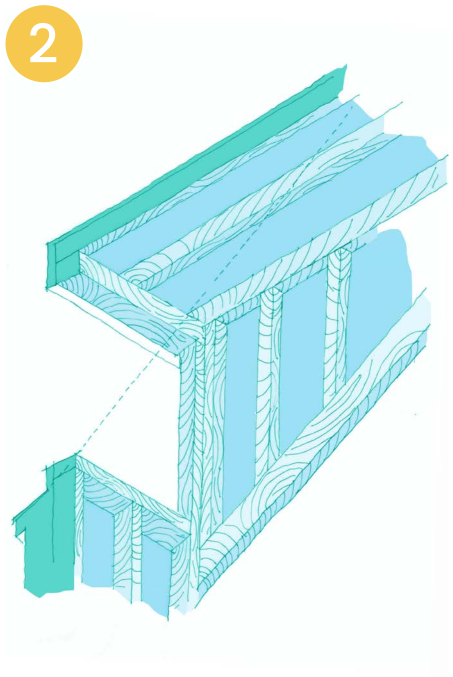
As with the roof, where the structure is strong enough, Canopy will use woodfibre and lime plaster. Where it is not, we will switch to a lighter natural insulation.

If replacing the windows, ensure that the replacement window frames are resized to allow for an appropriate thickness of insulation to the dormer cheeks.

Dormer windows are often oversized for the rooms, so consider reducing the size further to minimise overheating in the summer.

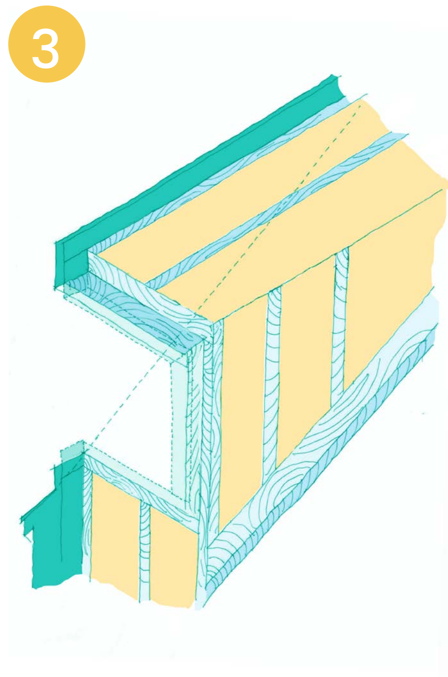


Strip back existing plasterboard or lath and plaster to reveal the dormer framing.



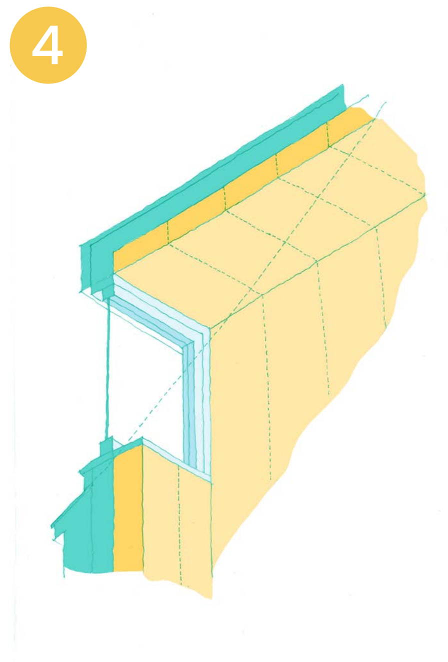
If replacing the windows, ensure that the additional depth of insulation in the roof and the dormer cheeks are allowed for when sizing the replacement window. The replacement window will need to be smaller than the existing one.

It is worth considering how blinds and curtains will be installed at this stage too.



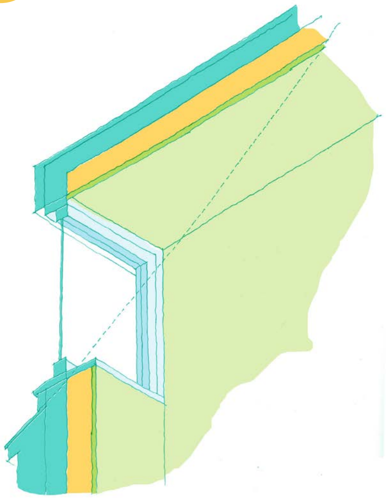
Cut the insulation batts so that they can be push-fitted in between dormer framing.

Ensure that the depth of insulation fitted between the framing maintains at least a 25mm ventilation gap beneath the underside of the underlay.



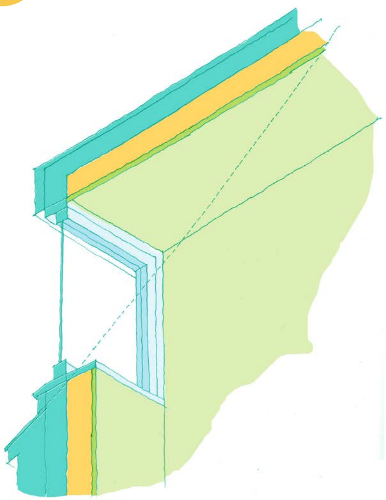
Fix the rigid insulation to the inside of the dormer framing. Fill any gaps with offcuts.

5



Carefully tape the window frame to the insulation using a plasterable airtightness tape.

6



Lime plaster is applied directly to the woodfibre insulation and acts as the airtight layer.

Canopy volunteers fitting and taping an air tight membrane in a dormer roof.

Produced with funding from the
Energy Redress Scheme.

Text : Editional Studio
Graphics Editional Studio
Diagrams: Editional Studio
Photographs: Editional Studio / Canopy