

Retrofit guide

Non-traditional archetypes

June 2025



**HEAT
PUMP
READY**



Department for
Energy Security
& Net Zero

Part of the Net Zero Innovation Portfolio

HEAT
PUMP
READY

R.J.BARWICK

energie
sprong
uk

“Heat Pump Ready” is an up to £60 million programme funded by the **Department of Energy Security and Net Zero** looking to accelerate the domestic uptake of heat pumps in the UK that supports 45 innovative projects.

This “innovation in heat pump technology programme” is divided into three streams of activity:

1. **High density deployment projects** supporting the installation of heat pumps at scale in selected local areas, over a short period of time.
2. **Optimised solutions development projects** supporting the development of new tools, technologies and business models that overcome barriers to heat pump deployment
3. **Trial support and learning** fostering collaboration and knowledge sharing across the supported projects, undertaking evaluation activities, and disseminating learnings and best practice to the wider heat pump market and associated sectors.

This retrofit guidance has been produced as part of one of the stream two “optimised solutions development

projects”. The project theme is the retrofit of “hard to treat” non-traditional house types, of which some 1.5 million dwellings were built in the UK 1918–1975.

The partners involved are:

- > Project Lead: **RJ Barwick**
- > Principal Partner: **Energiesprong UK**
- > Social Landlord Partners:
 - > Wolverhampton Homes
 - > Clarion Housing Group
 - > West Kent Housing Association
 - > Gravesham Borough Council

This advice document is developed by **Studio Partington**, supported by **CBG Consultants** and **Melius Homes**, who have provided their expertise on assessment of the homes’ energy performance and retrofit costs respectively. Acknowledgement is given to Gardner Stewart Architects (GSA) and Structerm Ltd. who have shared details of example retrofit projects.

RJ Barwick and Energiesprong UK are grateful to the Department of Energy Security and Net Zero and all partners and professional advisors involved in this initiative.



How to use this guide

It is easy to navigate between the different sections of this guide. Please use the links at the top of the page to explore this guide like a website. A “return to contents >” button is also available to the right-hand side.

Section 1 is a brief summary of what is covered and key findings in this report.

Section 2 introduces non-traditional homes, Heat Pump Ready, archotyping, the Energiesprong approach, the team behind the report and retrofit considerations.

Section 3 includes a summary of the characteristics of each of the four archetypes to help with identification and segmentation of building stock.

Section 4 includes information about the retrofits, including building fabric improvement measures, building services upgrades and renewable energy generation. It also includes “before and after” visual guides to retrofit solutions for each archetype and common variations, showing the key retrofit measures that are possible to make homes comfortable, desirable and on track to net zero in 2050.

Section 5 summarises lessons learned from the “real life” delivered projects which are included in this guidance document.

Whilst every care has been taken to confirm the accuracy of the information within this document, every home is unique and may have been constructed differently from available materials and changed over time. The contents of this document are subject to change and may not remain accurate over time. Independent assessment and advice from individuals and organisations with competence in retrofit (as a combination of skills, knowledge, experience and behaviours) should be sought before commencing works.

Neither Studio Partington, RJ Barwick or Energiesprong UK shall be held responsible for any errors or omissions within the document, nor accept any liability whatsoever for any losses arising from the use of this document, reliance on the information contained within it, nor for any consequential loss arising from the application of the document, except to the extent this would be prohibited by law or regulation.

Contents

1. Executive summary	4
2. Introduction	5
Heat pump ready	6
Why archetype?	6
Energiesprong explained	7
Who is behind the report?	8
Meet the team	9
Retrofit considerations	10
3. The archetypes	11
Wimpey No-fines 2-storey: typical condition	12
Wimpey No-fines 3-storey: typical condition	13
BISF: typical condition	14
Cornish Unit: typical condition	15
Bryant Low Rise (cross wall): typical condition	16
Cross wall (Nottingham): typical condition	17
Cross wall (Hammersmith & Fulham): typical condition	18
4. The retrofits	19
Section 4 introduction	20
Potential improvements	21
Wimpey No-fines 2-storey retrofit 1: “fabric first” (SHDF)	22
Wimpey No-fines 2-storey retrofit 2: renewables “top up”	23
Wimpey No-fines 3-storey retrofit 1: renewables “top up”	24
Wimpey No-fines 3-storey retrofit 2: deep retrofit	25
BISF retrofit 1: ‘fabric first’	26
BISF retrofit 2: renewables ‘top up’	27
Cornish Unit retrofit 1: decarbonise first	28
Cornish Unit retrofit 2: medium-term fabric	29
Bryant Low Rise retrofit 1: ‘fabric first’ (SHDF)	30
Bryant Low Rise retrofit 2: renewables ‘top up’	31
Cross wall (Nottingham) deep retrofit	32
Cross wall (Hammersmith & Fulham) deep retrofit	33
Summary of energy performance assessment	34
5. Delivery insights	35

1.

Executive summary

1

Why archetype? Identifying archetypes and template retrofit solutions will allow local authorities and housing associations to aggregate demand, establish stable supply chain relationships and retrofit at scale. This retrofit guidance covers four archetypes (> 368,000 homes) summarising typology and variations; typical construction and condition; watch points; efficiency improvements and decarbonisation; repairs and maintenance; typical construction costs; pre and post retrofit energy performance and estimated energy bills.

The results of this analysis show the balance to be struck between capital expenditure; residents' energy bills; energy performance; demand reduction through building fabric improvements; decarbonisation of building services; disruption to residents; retrofit “in one go” or staged retrofit. Once retrofitted, house form and position (mid-terrace versus poor performing end-of-terrace or semidetached) are shown to have more impact on performance than construction method or material. Additionally, contingency is needed for structural repairs or discovery of hazardous materials (e.g., asbestos) which can increase construction cost.

We hope this retrofit guidance will benefit local authorities, housing associations, architects, retrofit designers and contractors and provide a starting point for commissioning projects and project specific retrofit design.

2.

Introduction

2

1.5 million non-traditional “homes for heroes” were built (in the UK 1918–1975) to address a severe shortage of skilled labour and building materials, and meet persistent demand for new housing. Today, Local Authorities and Housing Associations own these non-traditional homes at or nearing the end of their 60-year design life. This provides an opportunity to accelerate retrofit at scale through archotyping.

This guidance summarises learning from two “heat pump ready” pilot retrofit schemes, for Clarion Housing Group in Snodland, Kent and for Wolverhampton Homes. Both schemes retrofit Wimpey No-fines homes, an example of historic non-traditional construction designed to be low-cost and “quick to build” without needing skilled bricklayers.

In addition, this report identifies and provides template retrofit solutions for three further common non-traditional housing archetypes: British Iron & Steel Federation (BISF), Cornish Unit and

examples of cross wall construction. The selection of archetypes is based on lessons learned from the delivery of Energiesprong UK projects, to cover a range of construction materials and methods and those archetypes built in large numbers. More than 368,000 of these four archetypes were built, although not all remain in the social sector. It is hoped that further archetypes can be added in future to build a library of template solutions.

Important note

This document will hopefully provide a helpful starting point for landlords and design teams. However, the words and information provided should not be construed as specific professional advice for individual properties or segments of housing stock. When landlords decide to undertake retrofit work, they should employ a design team of competent professionals and develop a specific retrofit plan for each property, mindful that every home and every family is different.

Heat pump ready

RJ Barwick and Energiesprong UK responded in partnership with the support of social landlords to the Heat Pump Ready Programme. Their project focused on reducing retrofit costs through non-traditional housing template solutions based on two pilot deep retrofit schemes in Wolverhampton and Kent.

The Heat Pump Ready Programme supports the development and deployment of solutions needed to accelerate high-density, cost-effective installation of domestic heat pumps. Heat pumps are a key solution for

decarbonising homes and will be critical for meeting the UK's commitment to achieve Net Zero by 2050. Heat Pump Ready forms part of Department for Business, Energy & Industrial Strategy's £1 billion Net Zero Innovation Portfolio, which aims to accelerate the commercialisation of innovative clean energy technologies and processes through the 2020s and 2030s.

There are 45 Heat Pump Ready projects, each one selected on their approach to the challenges they are trying to overcome, and the solutions they propose.

Why archetype?

Archotyping is a well-used and powerful tool to understand or segment a building stock. This document will help with identifying archetypes and those designing retrofit interventions based on archetypes to achieve good quality results based on measured performance.

Archotyping can enable an increase in the pace, ease and quality of retrofitting in many ways, including:

- > Providing an accessible start to planning retrofit projects.
- > Allowing portfolio holders to quickly understand their stock.
- > Enabling research, planning and procurement collaboration between portfolio holders with shared archetypes.
- > Taking existing stock model data and making it tangible by unveiling patterns in the visual, volumetric and qualitative.

- > Providing an accessible route for those without access to, or the ability to interpret, large quantities of data at an aggregate level.
- > Enabling the de-risking of projects, by identifying common risks in different building types up-front.
- > Allowing retrofit projects to be aggregated based on similar building types or buildings with similar retrofit plans.
- > Providing householders with initial information on what might be right for their home, beyond recommendations in an EPC.
- > Informing supply chain forecasting.
- > Storing knowledge and lessons-learned on an archetype-by-archetype basis: increasing quality and optimising cost.

Source: National Retrofit Hub,
Archotyping for retrofit: Best practice methodology

Energiesprong explained

Energiesprong UK's (ESUK) mission is for every UK home to be comfortable, affordable, desirable and fit for 2050 net-zero standards.

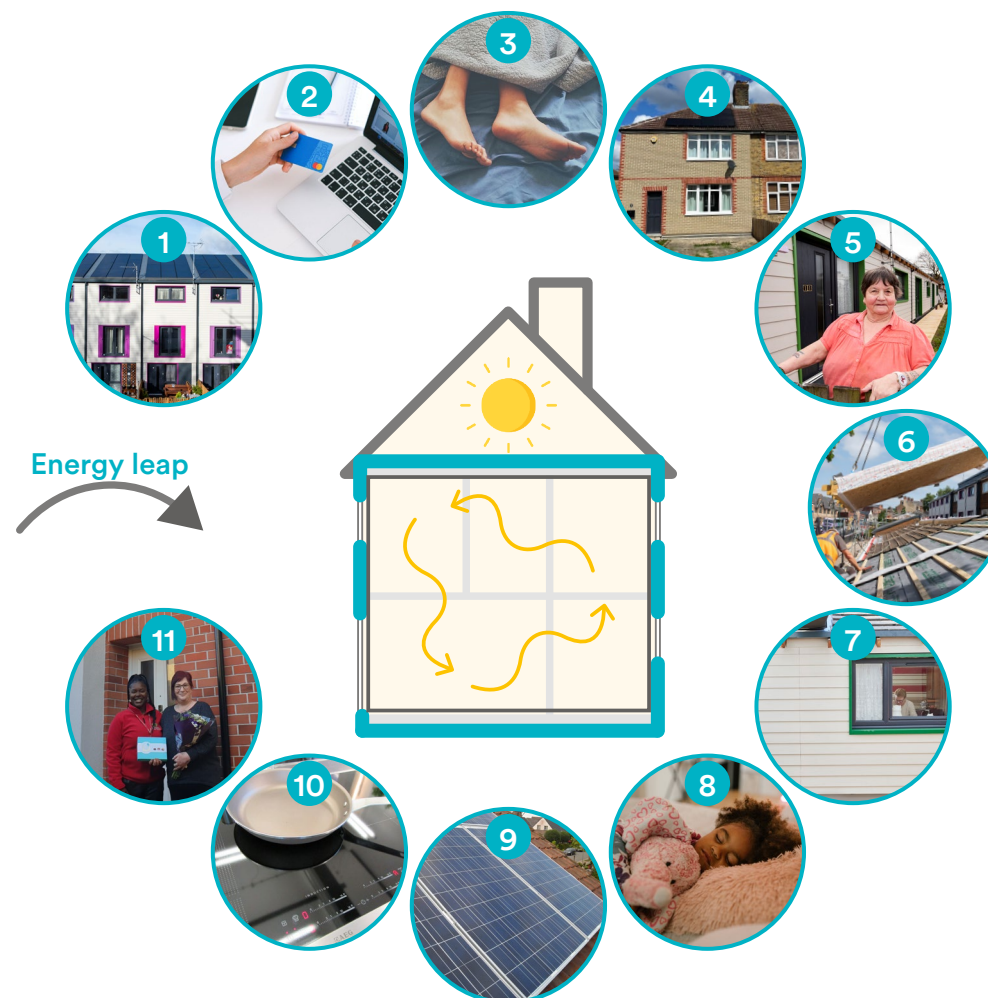
Inspired and informed by a decade of testing the Dutch Energiesprong ("Energy Leap") model in the UK market, Energiesprong UK supports partners to use this approach. It also works to catalyse the industry change required to unlock "outcome-led retrofit" at scale – high-quality, cost-effective, performance-guaranteed.

An outcome-led retrofit approach transforms hard-to-heat, cold and draughty homes with high carbon emissions into desirable, warm, affordable homes that are cosy in winter and cool in summer heatwaves.

Super-insulated prefabricated facades maximise energy-efficiency, while renewable technologies ensure the home generates as much energy as the occupier needs.

Following retrofit, homes are more comfortable – winter temperatures typically improved from ~15°C average pre-retrofit to above 20°C post-retrofit – and risks of damp, mould and overheating are mitigated/can be managed, improving health and wellbeing of residents.

Residents are financially better off than before, even including Comfort Plan™ payments, and are protected from volatile energy prices, having predictable bills across the year, minimising the risk of fuel poverty.



1. Whole house deep retrofit, all in one go, or in stages.
2. Residents pay less than before.
3. Affordable heating, hot water, and electricity.
4. Increased kerb appeal.
5. A Comfort Plan™ gives certainty over performance.
6. Insulated walls, roofs, and floors.
7. New windows and external doors.
8. Mechanical ventilation.
9. Renewable energy.
10. Gas supply removed.
11. Help from Energiesprong UK.

Who is behind the report?

RJ Barwick (project lead) is a longstanding construction and renovation specialist, which over the last five years has become a leading “whole house” retrofit Construction Manager and Project Lead. RJ Barwick focus on three key activities: retrofit leadership, project coordination and construction management.

RJ Barwick supports Energiesprong UK on some of their Greater London deep retrofit initiatives, ranging from low-rise housing to mid-rise multi-tenure schemes. RJ Barwick are also project lead on new build affordable housing schemes, most recently, 50 homes for Raven Housing Group and currently 106 low energy homes for West Kent Housing Association.

Through his membership of the CIOB, Director, Richard Barwick is a “client-side” Chartered Construction Manager, and Provisional Principal Contractor (Building Safety Act) “Category A – All Buildings including Higher Risk Buildings”. Richard is also a retrofit project Risk Management specialist through a separate trading division, Coombs and Partners (www.coombsandpartners.co.uk).

Energiesprong UK (principal partner) is a non-profit organisation that works to catalyse outcome-led home retrofit at scale. Energiesprong UK is a team of independent retrofit experts that collaborates with partners to create new approaches for home energy refurbishment at scale.

Energiesprong UK work with local authorities, housing providers, building firms and the supply chain to:

- Develop and test innovative retrofit strategies, models and tools
- Aid the delivery of innovative schemes to upgrade homes; and
- Inspire sector change by showcasing real-life examples of transformation.

Energiesprong UK support local authorities and social landlords to develop and deliver outcome-led retrofit projects, including managing large-scale, multi-stakeholder, collaborative programmes. This ranges from project development, grant applications and defining strategies through to archetype-based stock assessment, procurement advice, delivery, tenant engagement and ongoing performance monitoring.

Studio Partington (architect and retrofit designer) have over 20 years’ experience delivering successful new build and retrofit housing across the UK. In 2017 Studio Partington designed the UK’s first Energiesprong retrofit pilot for Nottingham City Council. The completed project, delivered by Melius Homes, has retrofitted over 200 homes while residents remain at home using modern methods of construction.

This year Studio Partington have completed retrofits of a 1930s apartment building in a South London conservation area (SHDF) and Wimpey No-fines Energiesprong retrofit in Wolverhampton, both under PAS 2035. Key clients include Camden Council, City of London (listed Golden Lane Estate), Islington Council, Joseph Rowntree Housing Trust, Lewisham Council and Wolverhampton Homes.

Many of Studio Partington’s projects are at the forefront of sustainable design with a particular interest in making homes that are comfortable, welcoming, secure and run economically and simply. Studio Partington’s technical knowledge is underpinned by research and writing for BSI Group, Future Homes Hub and NHBC.

Melius Homes (solution provider and contractor) retrofit and build sustainable places that enhance people’s wellbeing, protect the planet for future generations and offer an essential alternative to traditional methods of construction. Melius Homes believe that meeting the challenges of sustainable development requires long-term, creative partnership.

Melius Homes undertake whole-house retrofit, providing a new structural envelope and new energy systems built in a systematic and controlled way, with much of the fabrication undertaken in an enclosed factory environment. In conjunction with the new envelope and energy system, full internal refurbishment works can be undertaken. This approach is especially suitable for post-war, non-traditional system built housing.

Using the Energiesprong principles developed in the Netherlands, Melius Homes are able to assure the performance of the home and offer an energy performance guarantee.

Meet the team



Richard Barwick
Director
RJ Barwick Ltd

I am excited to take part in Heat Pump Ready to develop heat pump technology for “hard to treat” residential properties, and measure performance in a “true to life” environment.



Emily Braham
Strategy and operations director
Energiesprong UK

I use my experience of delivering some of the UK’s largest and most innovative retrofit projects to help us achieve our ambitious mission of scaling the market, so every home is fit for 2050.



Dr. Zack Gill
Net zero technical analyst
Energiesprong UK

I drive continual improvement of the innovative Energiesprong approach by aiding our projects to meet or exceed(!) their performance targets and deliver “people first” retrofit.



Jon Warren
Innovation and policy director
Energiesprong UK

I help lead the Energiesprong team to ensure we have the greatest impact in making millions of homes ready for 2050.



Adam Cornish
Director
Studio Partington

I use my design and construction experience to champion outcome-led retrofit and deliver comfortable and healthy homes for residents.



Suzanne Davenport
Associate
Studio Partington

I am an advocate of listening and co-design, adaptation and reuse, robust low energy design for life, and space for nature and wellbeing.



Robert Lambe
Managing director
Melius Homes

I believe in developing long-term relationships and working with like-minded people who are determined to make a positive difference.



Zahid Ashraf
Associate
CBG Consultants

I use over 15 years’ experience and lead CBG’s sustainability team to produce energy models for a wide range of commercial and domestic buildings.

Whole house retrofit involves:

1. Any maintenance undermining thermal performance

2. Appropriate ventilation to tackle any damp or mould

Followed by:

- Install solar panels to generate renewable energy
- Insulation (including windows and doors) and improved airtightness
- More efficient (and gas-free) heating, hot water and lighting

Retrofit considerations

- > Identify any maintenance and determine reasons for any damp (e.g. leaks and insufficient ventilation).
- > How can continuous ventilation best be provided? Decentralised is least intrusive. Centralised can include heat recovery.
- > How many solar panels can be accommodated? Consider orientation, chimneys/vents, overshadowing from trees.
- > Is the loft adequately ventilated? Can insulation be extended over the wall plate?
- > How far the eaves/verge extend can determine external wall insulation (EWI) thickness. Eaves and/or verge can be extended but this will increase cost.
- > Are there existing canopies, porches, bin stores, external gas/electricity meters, satellite dishes, security alarms, rainwater down pipes etc. that need to be removed/re-provided to allow for EWI installation?
- > Do gulley drains need to be moved out?
- > Can walls be insulated below damp-proof course? Are there any steps or paving?
- > Fix windows in line of insulation for best performance.
- > Specify new windows with low u-value and adequate trickle ventilation. Consider lower g-value if overheating is an issue.
- > Replace doors for better performance and security.
- > Assess psi-value where insulation is not continuous to check condensation risk.
- > Assess impacts of – and on – neighbouring houses not being retrofitted.
- > Can ground floor finishes be upgraded to improve comfort?
- > Is there sufficient space inside for air source heat pump hot water cylinder (larger than standard).

3.

The archetypes

Section 3 summarises the characteristics of each of the four non-traditional housing archetypes covered in this guidance to help with identification and segmentation of local authority and housing association building stock.

Wimpey No-fines, British Iron & Steel Federation (BISF), Cornish Unit and cross wall construction archetypes are covered in detail summarising typology and variations; typical construction and condition; and watch points based on experience of retrofitting these archetypes by the people and organisations behind this report.

Wimpey No-fines 2-storey: typical condition



Historic photograph from George Wimpey & Co. Ltd. publication: two-bedroom semidetached Wimpey No-fines house type built at Farnborough, Hampshire

Basic typology

What is no-fines? Cast in situ concrete without fine aggregates/sand allowing for faster construction

Construction: In-situ concrete

Number built: 300,000 1940s–1970s

House types: 2- and 3-storey semi and terraced houses. Also, bungalows and flats up to 5 storeys

Typical construction

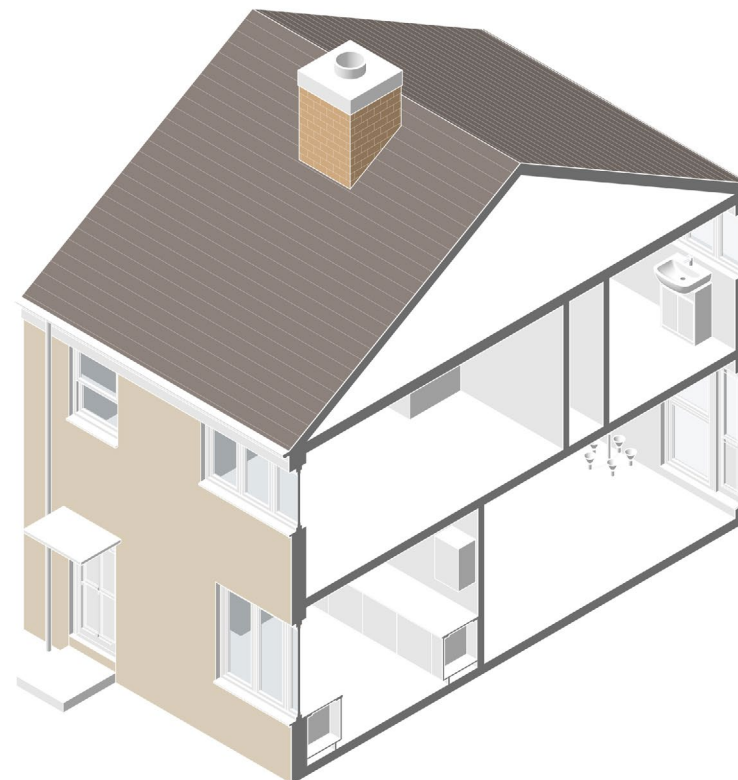
Foundations: Concrete strip

Wall type:

- Rendered no-fines concrete (8–12" depending on age)
- Dense reinforced concrete (RC) eaves beam
- Precast RC lintels above ground floor doors and windows
- Dry lined or plastered inside

Floor type: Solid concrete

Roof type: Gable or hipped timber rafters, purlins and tiles



- > **Uninsulated solid concrete walls** with significant heat loss. Fixing “pull out” tests are needed. Concrete mix quality can vary house-to-house
- > Possible disrepair, damp and mould
- > Insufficient extract ventilation. Intermittent fans may not be working
- > Inadequately insulated loft and leaky, uninsulated loft access hatch
- > Windows and doors, old replacements with poor performing double glazing, seals and no trickle vents
- > Cold, uninsulated solid concrete ground floor
- > Gas boiler for heating and hot water
- > Some traditional high-energy consuming lamps remaining

Note, bold text indicates features unique to this archetype

Wimpey No-fines 3-storey: typical condition



Example project: Wolverhampton Homes' four-bedroom terraced Wimpey No-fines houses in Wolverhampton before retrofit (a previous retrofit has been undertaken)

Basic typology

What is no-fines? Cast in situ concrete without sand that could be built quickly by less skilled workers

Construction: In-situ concrete

Number built: 300,000 1940s–1970s

House types: 2- and 3-storey semi and terraced houses.

Also, bungalows and flats up to 5 storeys

Typical construction

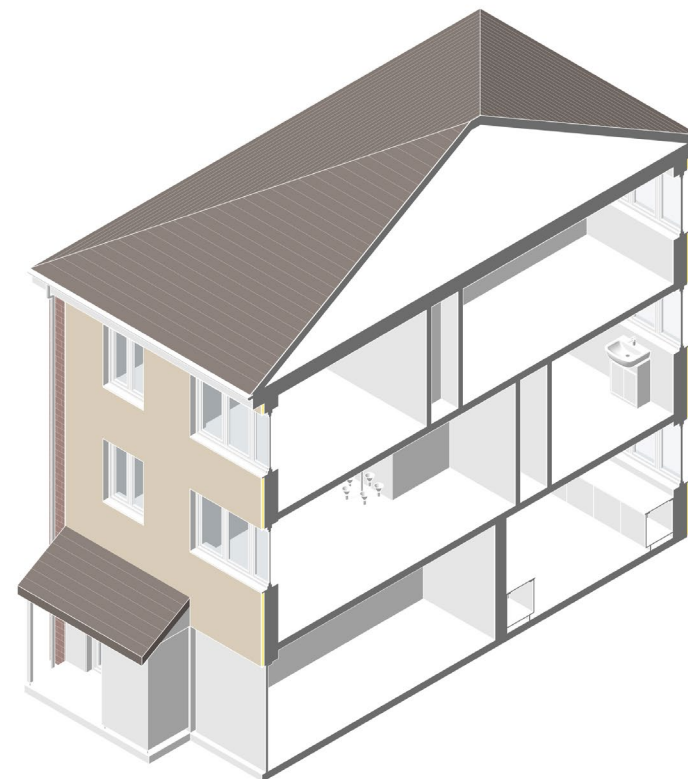
Foundations: Concrete strip

Wall type:

- Rendered no-fines concrete (8–12" depending on age)
- Dense RC eaves beam
- Precast RC lintels above ground floor doors and windows
- Dry lined or plastered inside

Floor type: Solid concrete

Roof type: Gable or hipped timber rafters, purlins and tiles



- > **Inefficient form** (high form factor, the heat loss area divided by floor area) particularly end-of-terraces
- > **Cold integral garage** undermines thermal envelope
- > **Uninsulated solid concrete walls** with significant heat loss. Fixing “pull out” tests are needed. Concrete mix quality can vary house-to-house
- > Possible disrepair, damp and mould
- > Insufficient extract ventilation. Intermittent fans may not be working
- > Inadequately insulated loft and leaky, uninsulated loft access hatch
- > Windows and doors, likely to be old replacements with poor performing double glazing, seals and no trickle vents
- > Cold, uninsulated solid concrete ground floor
- > Gas boiler for heating and hot water
- > Some traditional high-energy consuming lamps remaining

Note, bold text indicates features unique to this archetype

BISF: typical condition



Contemporary photograph: BISF semidetached houses in London Borough of Redbridge; the lefthand semi is in original condition apart from newer porch, doors and windows

Basic typology

Design developed from 1944

by sponsors British Iron & Steel Federation and architect Frederick Gibberd and engineer Donovan Lee

Construction: Steel frame and steel clad

Number built: 35,000 1944–1950

House types: only 2-storey semidetached (some terraces) less variants than other non-trads

Note: Some houses have attached outbuildings

Typical construction type A1

Foundations: Concrete strip with brick plinth

Frame: Rolled steel channel columns (at 3' 6" centres)

Wall type:

Ground floor: rendered metal mesh over columns, plasterboard inside
First floor: Rolled steel angle cladding rails support profiled steel sheets (projects over ground floor)

Ground floor type: Solid concrete with perimeter downstand

Roof type: Asbestos cement profiled sheets on steel purlins



- > **Structural steel may need repair**
- > **Asbestos** cement profiled sheets roof covering
- > **Poor airtightness**
- > **Walls with minimal/degraded insulation** and significant heat loss, particularly metal clad first floor. Existing cladding can be retained untreated behind EWI
- > Possible disrepair, damp and mould
- > Insufficient extract ventilation. Intermittent fans may not be working
- > Inadequately insulated loft and leaky, uninsulated loft access hatch
- > Windows and doors, likely to be old replacements with poor performing double glazing, seals and no trickle vents
- > Cold, uninsulated solid concrete ground floor
- > Gas boiler for heating and hot water
- > Some traditional high-energy consuming lamps remaining

Note, bold text indicates features unique to this archetype

Cornish Unit: typical condition



Contemporary photograph: semidetached houses with distinctive mansard roofs in Darfield, South Yorkshire, © Steve Fareham

Basic typology

Designated defective under Housing Act 1985. Cracking, carbonation and chloride in precast RC columns, cracking of first floor ring beams. Suitable for repair and refurbishment

Construction: Precast concrete

Number built: 30,000 1946–1960s

House types: 2-storey semidetached with mansard (type I) or pitched gable/hipped roof (type II) as well as terraces. The system was also used for flats up to 4-storeys

Typical construction type I

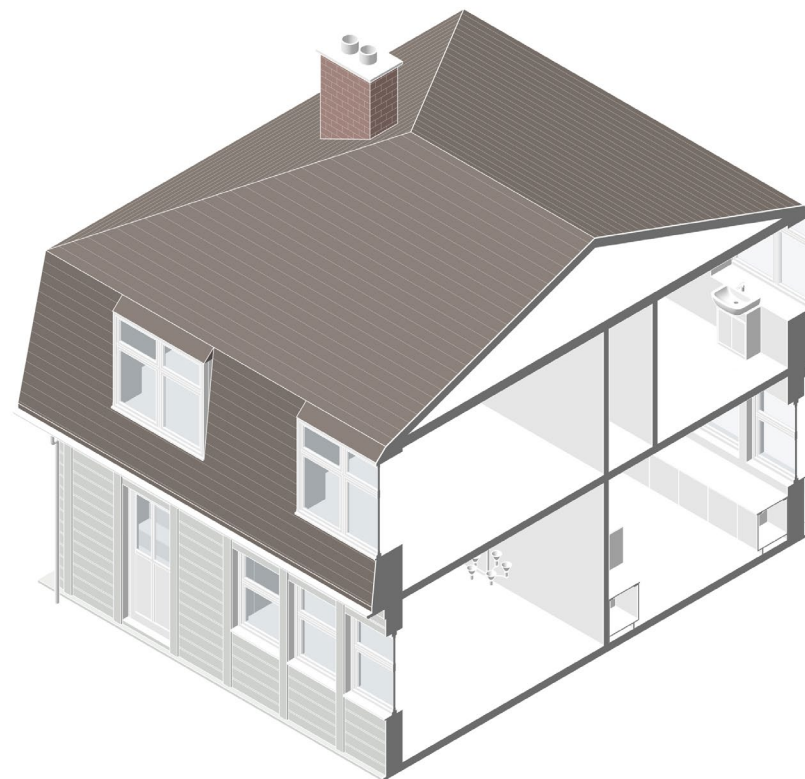
Foundations: Concrete strip footings with blockwork plinth and precast concrete plinth units rebated to set out precast RC columns

Wall type:

- Grooved precast RC columns, steel tie rods, double skin of precast concrete panels, radiused/square corners
- Precast ring beam at first floor

Ground floor type: Solid concrete

Roof type: Timber mansard that envelopes the first floor, bituminous felt and concrete tiles, asbestos cement slates or cedar shingles



- > **Designated defective**, inherent faults in the precast concrete construction
- > **Remedial structural works needed** (if not already completed)
- > **Potential asbestos** cement slates roof covering
- > **Significant cold bridging through columns**
- > **Concrete walls with little/no insulation** and significant heat loss
- > **Inefficient form mansard roof** timber frame with minimal/degraded insulation
- > Possible disrepair, damp and mould
- > Insufficient extract ventilation. Intermittent fans may not be working
- > Windows and doors, likely to be old replacements with poor performing double glazing, seals and no trickle vents
- > Cold, uninsulated solid concrete ground floor
- > Gas boiler for heating and hot water
- > Some traditional high-energy consuming lamps remaining

Note, bold text indicates features unique to this archetype

Bryant Low Rise (cross wall): typical condition



Example project: Birmingham City Council terraced Bryant Low Rise cross wall houses in Birmingham before retrofit

Basic typology

Designed and manufactured by Bryant & Sons Ltd

Construction: Precast concrete and timber frame

Number built: 3,000 1964–1970s

House types: 2-storey semidetached and terraced houses. Shallow pitch gable roof. Brick gable wall. Also used for flats

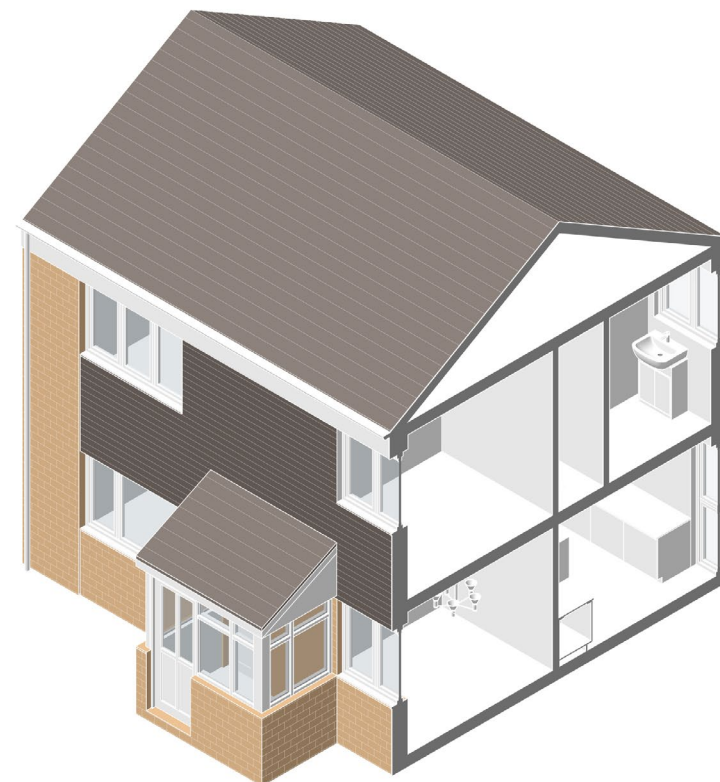
Typical construction system 4

Foundations: 4" concrete raft with perimeter downstand

Wall type:

- Insulated timber frame panels sheathed with plywood, clad with brick, tiles and/or timber boarding
- Lined with plywood inside
- Rolled steel joist at first floor
- Gable: brick, cavity, precast concrete panels, loadbearing timber frame panels

Roof type: Prefabricated timber trusses, bituminous felt and concrete tiles. Glass insulation quilt



- > **Front porches and attached outbuildings**
- > **Timber infill front and rear walls** external wall insulation (EWI) will require additional support
- > Possible disrepair, damp and mould
- > Insufficient extract ventilation. Intermittent fans may not be working
- > Inadequately insulated loft and leaky, uninsulated loft access hatch
- > Windows and doors, likely to be old replacements with poor performing double glazing, seals and no trickle vents
- > Cold, uninsulated solid concrete ground floor
- > Gas boiler for heating and hot water
- > Some traditional high-energy consuming lamps remaining

Note, bold text indicates features unique to this archetype

Cross wall (Nottingham): typical condition



Example project: Nottingham City Council's terraced cross wall houses in Nottingham before retrofit, the houses are next to flats and bungalows of similar construction

Basic typology

Not a recognised non-traditional system but is typical of similar concrete crosswall low rise systems

Designed and manufactured by William Moss & Sons Ltd

Construction: Precast concrete and timber frame

Period built: 1960s

House types: 3-storey terraced houses with terraced bungalows opposite. Ground floor to rear only, undercroft beneath oversailing first floor. Split pitch gable roof. Brick gable wall. Also used for 2-storey flats

Typical construction

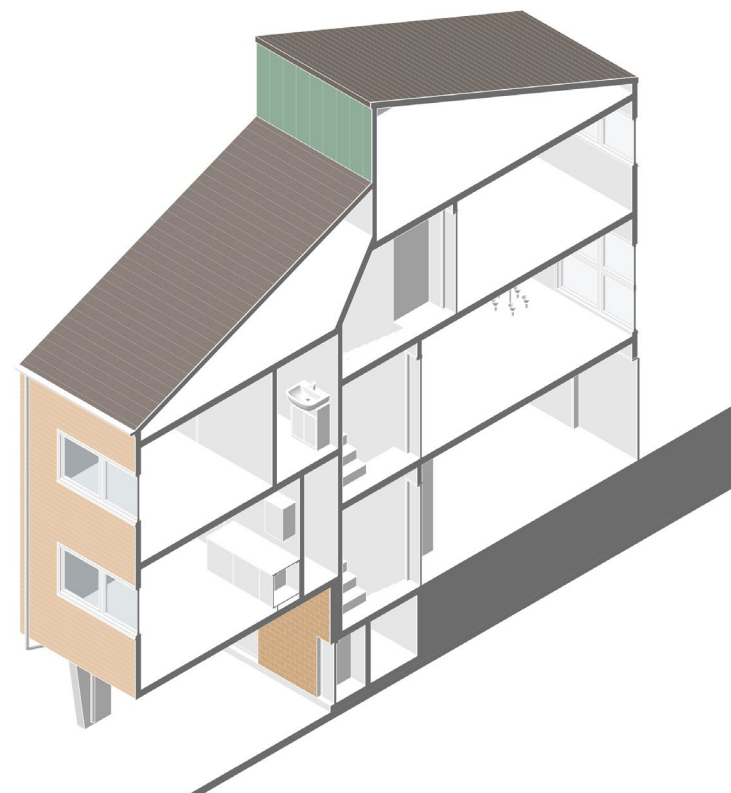
Foundations: concrete strip

Cross wall construction:

- Segmental large panel concrete cross walls (front to rear)
- First floor precast concrete
- Interconnecting concrete beams at roof level

Wall type: Brickwork tied to concrete, concrete panels with a textured finish or timber framing supporting tile hanging or timber boarding

Roof type: Conventional tiles on trussed rafters. Two opposing mono-pitched trusses supported on a central concrete beam



- > **Inefficient form with undercroft and split roof** (high form factor, the heat loss area divided by floor area) particularly end-of-terraces
- > **Cold integral garage** undermines thermal envelope
- > Possible disrepair, damp and mould
- > Insufficient extract ventilation. Intermittent fans may not be working
- > Inadequately insulated loft and leaky, uninsulated loft access hatch
- > Windows and doors, likely to be old replacements with poor performing double glazing, seals and no trickle vents
- > Cold, uninsulated solid concrete ground floor
- > Gas boiler for heating and hot water
- > Some traditional high-energy consuming lamps remaining

Note, bold text indicates features unique to this archetype

Cross wall (Hammersmith & Fulham): typical condition



Example project: Hammersmith & Fulham Council's terraced houses in Fulham before retrofit

Basic typology

Construction: Traditional masonry construction with tile cladding to front and rear elevations

Period built: 1970s

House types: 3-storey terraced houses

Typical construction

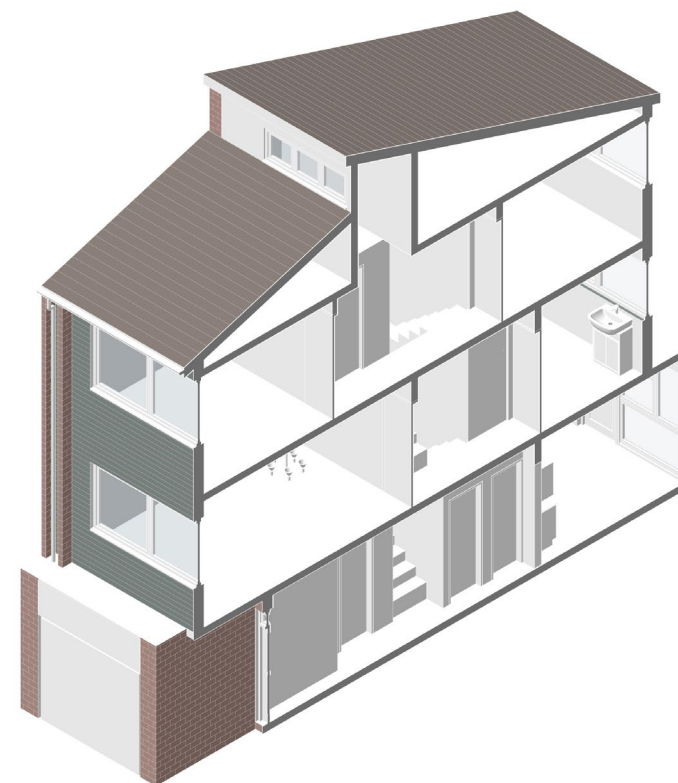
Foundations: concrete strip

Wall type:

- Front and rear: 140mm thick blockwork with timber battens, insulation and a tile cladding
- Gable: 265 mm thick brickwork and blockwork cavity wall

Ground floor type: 300 mm thick cast-in-situ concrete suspended slab

Roof type: Pitched, tiled roof supported by a regular arrangement of traditional timber rafters



- > **Inefficient form with projecting ground floor and split roof** (high form factor, the heat loss area divided by floor area) particularly end-of-terraces
- > **Cold integral garage** undermines thermal envelope
- > Possible disrepair, damp and mould
- > Insufficient extract ventilation. Intermittent fans may not be working
- > Inadequately insulated loft and leaky, uninsulated loft access hatch
- > Windows and doors, likely to be old replacements with poor performing double glazing, seals and no trickle vents
- > Cold, uninsulated solid concrete ground floor
- > Gas boiler for heating and hot water
- > Some traditional high-energy consuming lamps remaining

Note, bold text indicates features unique to this archetype

4.

The retrofits

Section 4 summarises suggested retrofits (as well as alternative options and staged retrofits) for each non-traditional archetype included in this guidance showing the key retrofit measures that are possible to make homes comfortable, desirable and on track to net zero in 2050.

A summary of energy efficiency improvements/ measures (building fabric improvements, building services upgrades and renewable energy generation), typical construction costs (for 10 properties of the same archetype) and energy performance assessments is included. Note, cost and performance information is indicative and not based on example retrofit projects.

Section 4 introduction

The following pages summarise potential retrofit solutions for each non-traditional archetype included in this guidance. Note, whilst photographs of example completed retrofit projects show what can be achieved for each archetype, the cost and performance information presented is indicative and not based on real case study projects.

An annotated diagram summarises the energy efficiency improvements/measures which can be undertaken for each archetype. These diagrams are overlaid with typical construction costs indicating the overall cost of retrofitting each archetype and costs for individual improvements. Costs are based on notional projects to retrofit 10 properties of the same archetype. Note, retrofit works can be undertaken in stages, however, there will be additional management and contingency costs and the first retrofit needs to be properly considered and designed to enable the second retrofit.

This is presented alongside a summary

of energy performance assessment for each archetype which compares the typical or “as found” condition (generally as built with some improvements) with the energy performance of the retrofitted property, retrofit options, or staged retrofit. The energy performance assessment tests the impact of archetype size and form, typical construction, position (mid-terrace, semidetached or end-of-terrace), deep retrofit versus staged retrofit and the order of staged retrofit (fabric first or decarbonise first).

For this retrofit guidance the home’s energy performance was estimated through the UK government’s Standard Assessment Procedure (SAP) using SAP 10.2. The summary covers Energy Performance Certificate (EPC) rating, air permeability, space heating demand, dwelling emission rate (DER) as well as estimating gas and regulated electricity costs/energy bills.

See explanations to the right for help understanding the information presented in this section.

U-values measure how effective a particular section of construction (like a wall, roof or window) is as an insulator. The units of measurement are $\text{W/m}^2\text{K}$. The better-insulated a construction is, the lower the U-value will be.

G-values measure how much solar energy is transmitted through windows. G-value is a scale 0–1. A high g-value of 1 represents full transmittance of the sun’s energy.

An **EPC** assesses a property’s energy efficiency on a scale from A (most efficient) to G (least efficient), with higher ratings indicating lower energy consumption and costs.

Air permeability is the volume of air that escapes per m^2 of external surface area, at 50 Pascals of pressure. Airtightness is important for many reasons, including reducing heat loss, improving comfort and protecting the building fabric.

Space heating demand is the amount of thermal energy that needs to be provided to the space to achieve a desired temperature, typically measured in kilowatt-hours per square meter per year ($\text{kWh/m}^2/\text{yr}$). This is dependent on many factors including fabric heat loss, ventilation and infiltration heat loss and thermal mass.

DER is the estimated carbon dioxide (CO_2) emissions per m^2 per year ($\text{KgCO}_2/\text{m}^2/\text{year}$) for the dwelling as designed. Carbon dioxide

in the atmosphere warms the planet, causing climate change.

Air permeability of $9 \text{ m}^3/\text{m}^2\cdot\text{h}$ is assumed as we wanted to test performance without the complexity of achieving very airtight conditions in retrofitted non-traditional homes. If higher (better) airtightness is achieved, then performance would be expected to improve although care must always be taken to select and install an appropriate ventilation system.

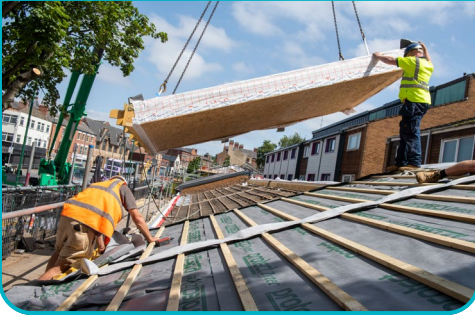
Estimated electricity and gas cost per year is based on the Ofgem energy price cap between 1 April and 30 June 2025. The energy price cap is the maximum amount energy suppliers can charge you for each unit of energy and standing charge if you’re on a standard variable tariff.

Electricity cost per year is for regulated electricity, which is the energy consumed by a building, and it’s controlled, fixed services and systems, including heating, hot water, ventilation, fans, pumps and lighting.

For improvement options with solar panels, fifty per cent self-consumption is assumed, i.e., half of the electricity produced by the solar panels is consumed by the household. An export rate of 4p/kWh has been assumed for electricity generated by solar panels and exported to the grid. Note, export rates do vary between energy suppliers and can be up to 15p/kWh.

Potential improvements

Well insulated – walls, roofs, floors, windows, and external doors



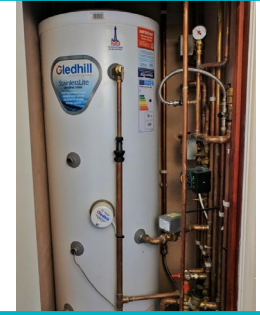
Mechanical ventilation – continuous air supply and removal of stale air



Heat pump – runs on clean electricity, provides all heating and hot water



Hot water cylinder – including back-up immersion



New windows and doors – more airtight and better insulating versions



Solar panels – generate free electricity from the sun



Electric cooking – efficient and safe induction hob



Unobtrusive monitoring – to check performance



Wimpey No-fines 2-storey retrofit 1: “fabric first” (SHDF)



Example project: terraced Wimpey No-fines houses in Snodland, Kent after SHDF retrofit plus decarbonisation (see overleaf) for Clarion Housing

Performance pre retrofit

Mid-terrace:

As built/some improvements

EPC rating: 69 C

Air permeability: 15 (default)

Space heating demand: 111

Dwelling emission rate (DER): 36

Electricity: £330 per year

Gas: £1046 per year

End-of-terrace:

EPC rating: 63 D

Air permeability: 15 (default)

Space heating demand: 154

Dwelling emission rate (DER): 47

Electricity: £330 per year

Gas: £1311 per year

Performance post retrofit 1

Mid-terrace:

Retrofit 1: “fabric first” (SHDF)

EPC rating: 78 C

Air permeability: 9 (target)

Space heating demand: 57

Dwelling emission rate (DER): 24

Electricity: £339 per year

Gas: £708 per year

End-of-terrace:

EPC rating: 75 C

Air permeability: 9 (target)

Space heating demand: 75

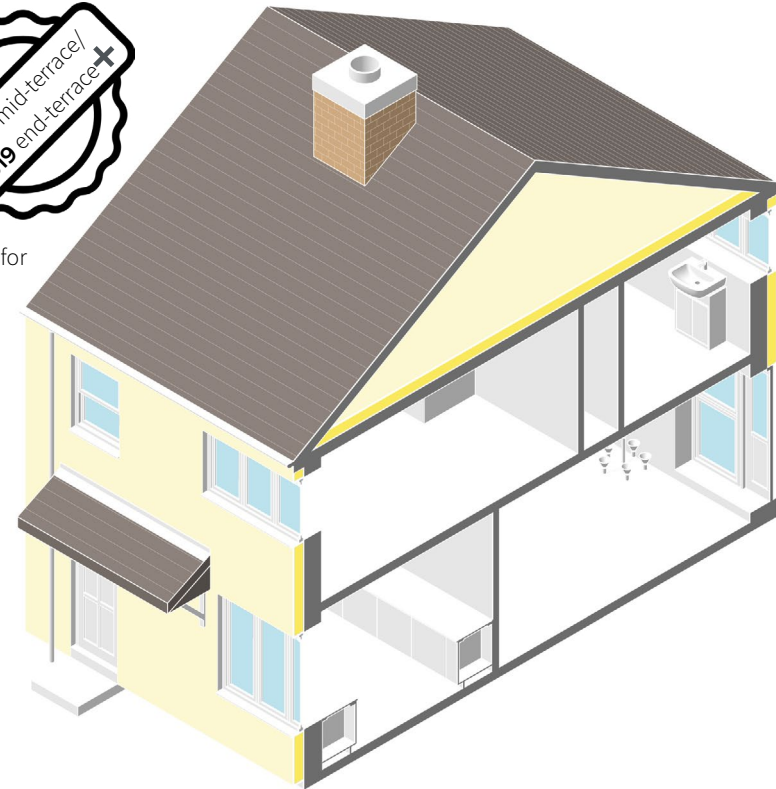
Dwelling emission rate (DER): 28

Electricity: £339 per year

Gas: £818 per year



+ Costs for retrofit 1



- > Decentralised continuous mechanical extract ventilation to kitchens and bathrooms, sufficient trickle vents in windows and door undercuts
- > External wall insulation (EWI): render on 120 mm mineral wool insulation above damp proof course (DPC); 80 mm expanded polystyrene (EPS) insulation below DPC
- > Insulate/top-up loft insulation to 400 mm, maintain ventilation gap at eaves, extend insulation over the wall plate if possible
- > Install insulated and airtight loft access hatch
- > New UPVC windows and doors: 1.4 u-value, 0.72 g-value
- > Airtightness tape around new windows and doors

Note, project cost includes management and contingency. Costs are indicative/normalised for comparison and not based on example projects

Wimpey No-fines 2-storey retrofit 2: renewables “top up”

Performance pre retrofit

Mid-terrace:

As built/some improvements

EPC rating: 69 C

Air permeability: 15 (default)

Space heating demand: 111

Dwelling emission rate (DER): 36

Electricity: £330 per year

Gas: £1046 per year

End-of-terrace:

EPC rating: 63 D

Air permeability: 15 (default)

Space heating demand: 154

Dwelling emission rate (DER): 47

Electricity: £330 per year

Gas: £1311 per year

Performance post retrofit 2

Mid-terrace:

Retrofit 2: renewables “top up”

EPC rating: 87 B

Air permeability: 9 (target)

Space heating demand: 56

Dwelling emission rate (DER): 3

Electricity: £900 per year

Gas: NA

End-of-terrace:

EPC rating: 83 B

Air permeability: 9 (target)

Space heating demand: 74

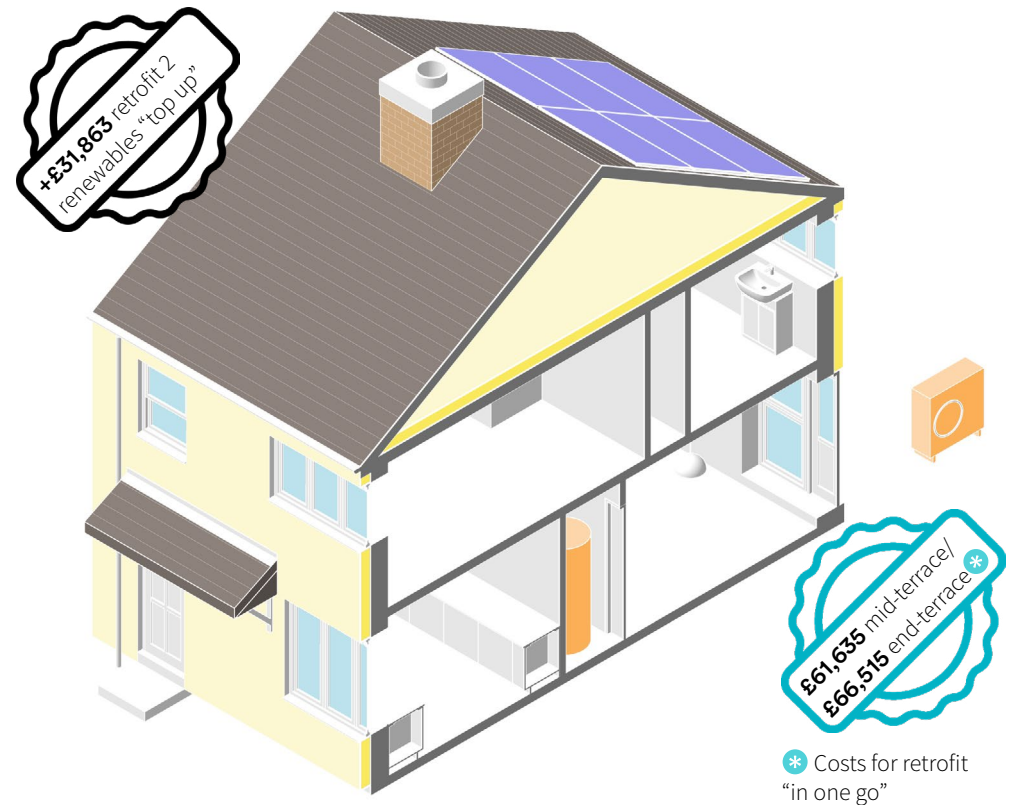
Dwelling emission rate (DER): 4

Electricity: £1042 per year

Gas: NA

Orientation (north, east, south and southeast) was assessed for Wimpey No-fines 2 storey mid-terrace, finding that orientation has less impact than house type/ form or position (mid- or end-of-terrace). For the typical pre-retrofit condition space heating demand varied between 110–111 depending on orientation. For retrofit 2: renewable top up space heating demand varied between 54–56 depending on orientation.

Sensitivity analysis of Wimpey No-fines 2 storey end-of-terrace showed that an **air permeability of 5 m³/m²·h** improved retrofit 1: “fabric first” (SHDF) EPC rating by one point to 76 C and reduced space heating demand by 10 to 65 kWh/m²/yr saving £58 per year. Retrofit 2: renewables “top up” worsened EPC rating by two points to 85 B and reduced space heating demand by 9 to 65 kWh/m²/yr saving £70 per year.



In addition to the fabric measures outlined on the previous page:

- > Solar panels: 8 panels/3.5 kWp (kilowatt peak)
- > Battery: 5.8 kWh
- > Air-to-water monobloc heat pump: 5kW, using refrigerant R290
- > Un-vented hot water cylinder: 150 litres with 3kW immersion

Note, project cost includes management and contingency. Costs are indicative/ normalised for comparison and not based on example projects

Wimpey No-fines 3-storey retrofit 1: renewables “top up”

Performance pre retrofit

End-of-terrace:

Previous retrofit

EPC rating: 73 C

Air permeability: 11 (tested)

Space heating demand: 93

Dwelling emission rate (DER): 29

Electricity: £360 per year

Gas: £1347 per year

Performance post retrofit 1

End-of-terrace:

Retrofit 1: Renewables “top up”

EPC rating: 74 C

Air permeability: 11 (tested)

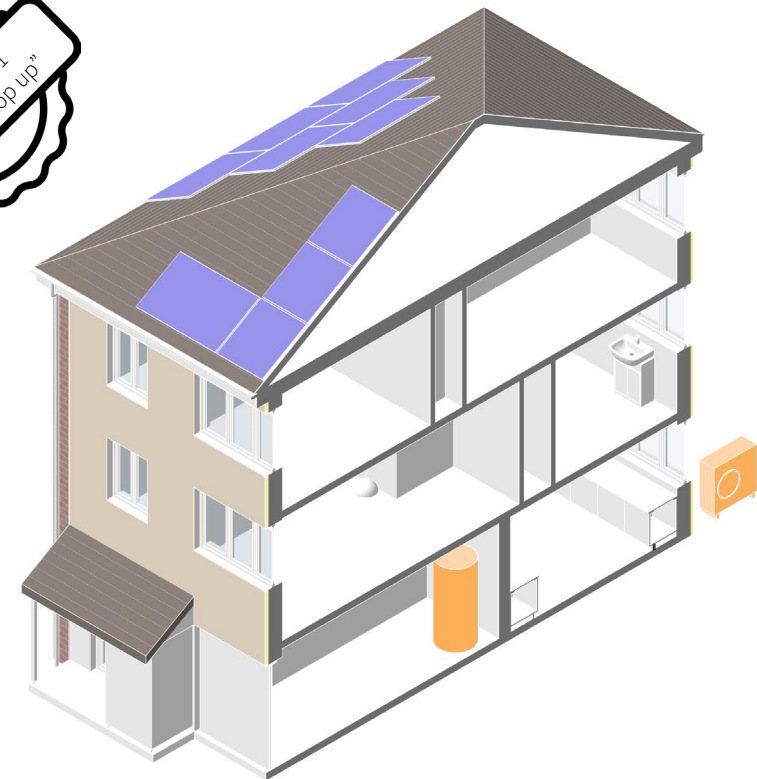
Space heating demand: 101*

Dwelling emission rate (DER): 5

Electricity: £1775 per year

Gas: NA

* Post-retrofit space heating demand increases slightly due to SAP's treatment of heat gain from ASHP's compared to traditional gas combi boilers



Renewables “top up” to previous retrofit:

- > Decentralised continuous mechanical extract ventilation to kitchens and bathrooms, demand-controlled trickle vents in windows and door undercuts
- > Solar panels: 10 panels/4.4 kWp
- > Battery: 5.8 kWh
- > Air-to-water monobloc heat pump: 5kW, using refrigerant R290
- > Un-vented hot water cylinder: 210 litres with 3kW immersion

Note, project cost includes management and contingency. Costs are indicative/normalised for comparison and not based on example projects

Wimpey No-fines 3-storey retrofit 2: deep retrofit



Example project: four-bedroom terraced Wimpey No-fines houses in Wolverhampton after retrofit for Wolverhampton Homes (10 homes were upgraded)

Performance pre retrofit

End-of-terrace:

Previous retrofit

EPC rating: 73 C

Air permeability: 11 (tested)

Space heating demand: 93

Dwelling emission rate (DER): 29

Electricity: £360 per year

Gas: £1347 per year

Performance post retrofit 2

End-of-terrace:

Retrofit 2: deep retrofit

EPC rating: 83 B

Air permeability: 9 (target)

Space heating demand: 69

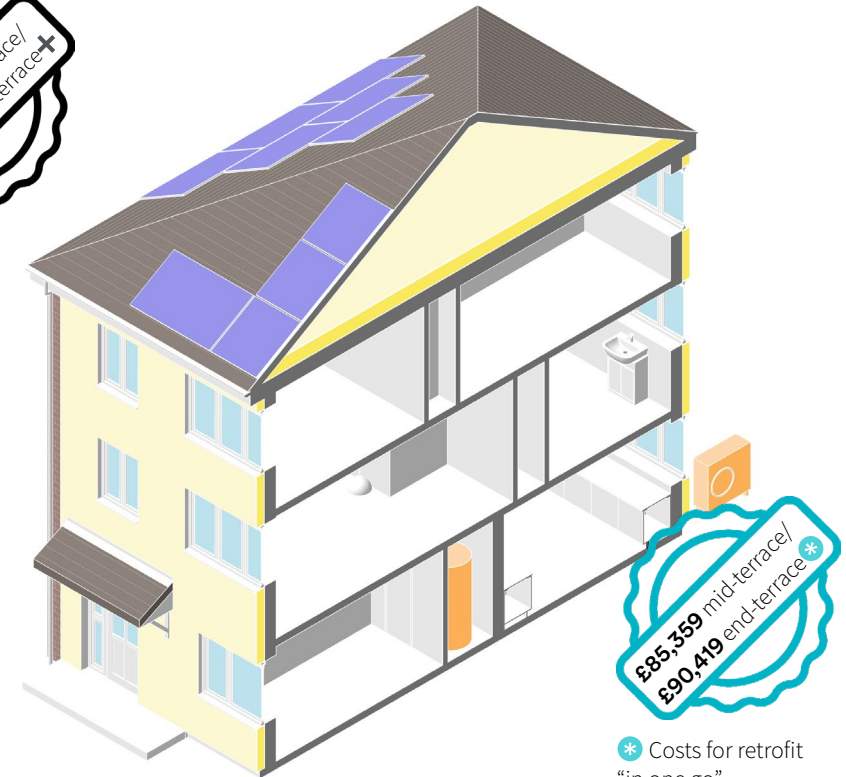
Dwelling emission rate (DER): 6

Electricity: £1350 per year

Gas: NA



+ Costs for retrofit 2



* Costs for retrofit "in one go"

In addition to the renewables and services upgrades outlined on the previous page:

- > EWI to front and rear walls: render on 160 mm mineral wool insulation above DPC, 100 mm Extruded Polystyrene (XPS) insulation from ground to DPC
- > Cavity wall insulation (CWI) to end wall: 60 mm polyurethane foam insulation
- > Integral garages converted to be part of the house with new window and wall below window, insulated party wall (100 mm mineral wool insulation) and ground floor
- > Insulate/top-up loft insulation to 400 mm, maintain ventilation gap at eaves, extend insulation over the wall plate if possible, install insulated and airtight loft access hatch
- > New UPVC windows and doors: 1.3/1.2 u-value, 0.72 g-value
- > New windows and doors installed with airtightness tape and aligned with wall insulation

Note, project cost includes management and contingency. Costs are indicative/normalised for comparison and not based on example projects

BISF retrofit 1: 'fabric first'



Example project: semidetached BISF houses in Preston after fabric retrofit by Struchterm Ltd. for Community Gateway Association (70 homes were upgraded)

Performance pre retrofit

Semidetached:

As built/some improvements

EPC rating: 61 D

Air permeability: 20 (assumed)

Space heating demand: 167

Dwelling emission rate (DER): 49

Electricity: £331 per year

Gas: £1498 per year

Performance post retrofit 1

Semidetached:

Retrofit 1: "fabric first"

EPC rating: 76 C

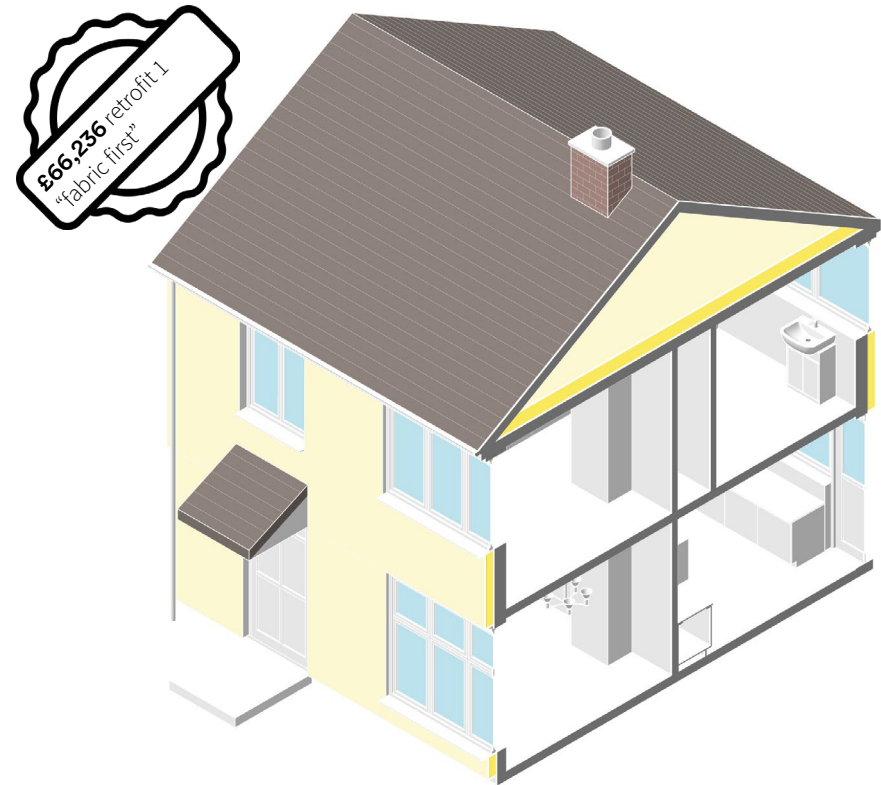
Air permeability: 9 (target)

Space heating demand: 69

Dwelling emission rate (DER): 26

Electricity: £340 per year

Gas: £835 per year



- > Repairs to steel frame
- > Decentralised continuous mechanical extract ventilation to kitchens and bathrooms, sufficient trickle vents in windows and door undercuts
- > Structural EWI: render on 80 mm EPS insulation above and below DPC
- > Insulate/top-up loft insulation to 400 mm, maintain ventilation gap at eaves, extend insulation over the wall plate if possible, install insulated and airtight loft access hatch
- > New UPVC windows and doors: 1.3 u-value, 0.72 g-value
- > Airtightness tape around windows and doors

Note, project cost includes management and contingency. Costs are indicative/normalised for comparison and not based on example projects

BISF retrofit 2: renewables ‘top up’

Performance pre retrofit

Semidetached:

As built/some improvements

EPC rating: 61 D

Air permeability: 20 (assumed)

Space heating demand: 167

Dwelling emission rate (DER): 49

Electricity: £331 per year

Gas: £1498 per year

Performance post retrofit 2

Semidetached:

Retrofit 2: renewables “top up”

EPC rating: 83 B

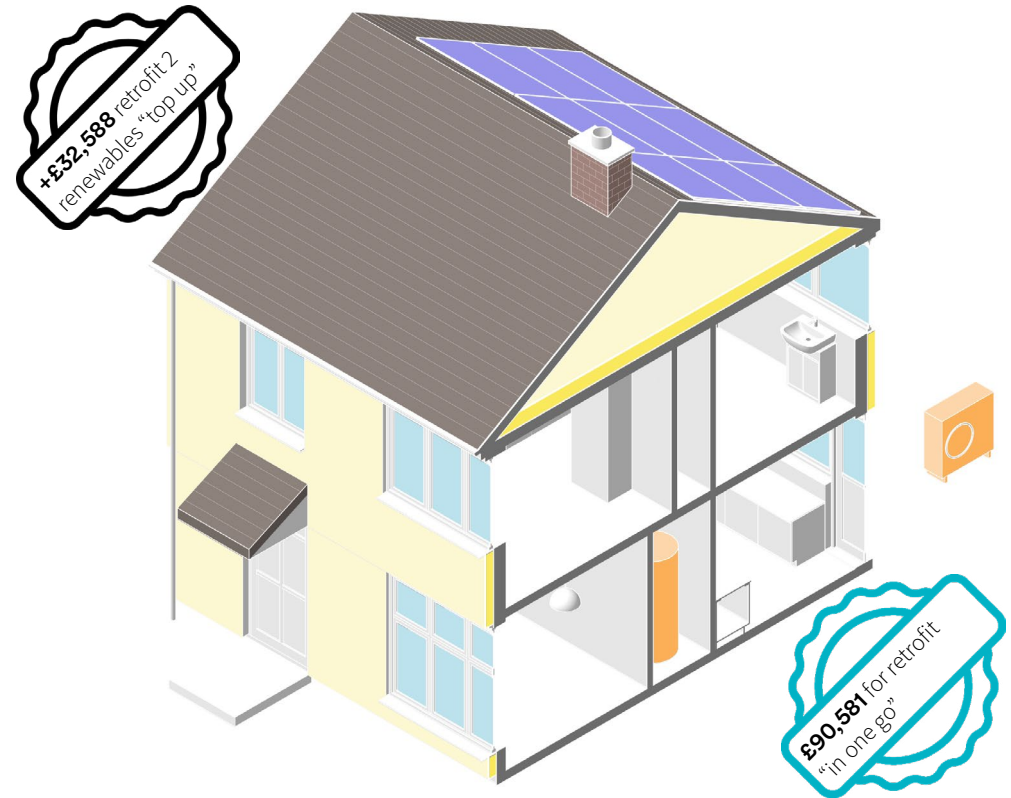
Air permeability: 9 (target)

Space heating demand: 72

Dwelling emission rate (DER): 4

Electricity: £1037 per year

Gas: NA



In addition to the repairs and fabric measures outlined on the previous page:

- > Solar panels: 8 panels/3.5 kWp (kilowatt peak)
- > Battery: 5.8 kWh
- > Air-to-water monobloc heat pump: 5kW, using refrigerant R290
- > Un-vented hot water cylinder: 150 litres with 3kW immersion

Note, project cost includes management and contingency. Costs are indicative/normalised for comparison and not based on example projects

Cornish Unit retrofit 1: decarbonise first

Performance pre retrofit

Semidetached:

As built/some improvements

EPC rating: 56 D

Air permeability: 15 (default)

Space heating demand: 200

Dwelling emission rate (DER): 57

Electricity: £330 per year

Gas: £1708 per year

Performance post retrofit 1

Semidetached:

Retrofit 1: decarbonise first

EPC rating: 34 F

Air permeability: 15 (default)

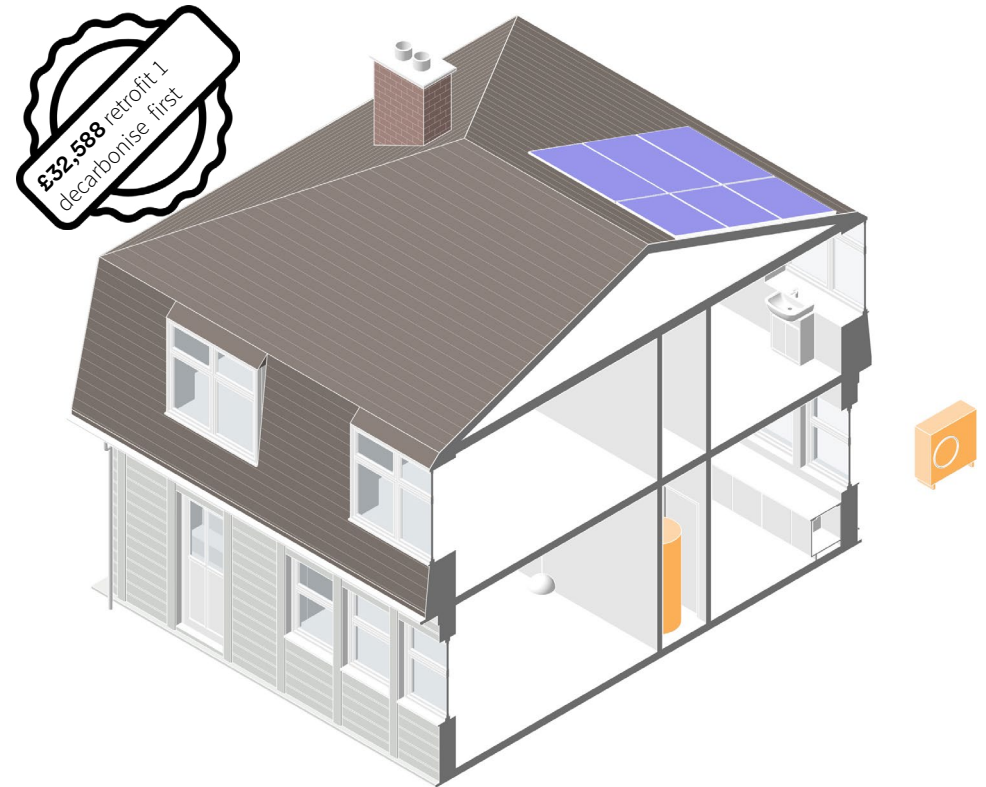
Space heating demand: 250*

Dwelling emission rate (DER): 17

Electricity: £2941 per year

Gas: NA

* Post-retrofit space heating demand increases slightly due to SAP's treatment of heat gain from ASHP's compared to traditional gas combi boilers



- > Decentralised continuous mechanical extract ventilation to kitchens and bathrooms, sufficient trickle vents in windows and door undercuts
- > Solar panels: 8 panels/3.5 kWp (kilowatt peak)
- > Battery: 5.8 kWh
- > Air-to-water monobloc heat pump: 5kW, using refrigerant R290
- > Un-vented hot water cylinder: 150 litres with 3kW immersion

Note, project cost includes management and contingency. Costs are indicative/normalised for comparison and not based on example projects

Cornish Unit retrofit 2: medium-term fabric



Example project: semidetached Cornish Unit houses in Birmingham after fabric retrofit by Structherm Ltd. for Birmingham City Council (64 homes were upgraded)

Performance pre retrofit

Semidetached:

As built/some improvements

EPC rating: 56 D

Air permeability: 15 (default)

Space heating demand: 200

Dwelling emission rate (DER): 57

Electricity: £330 per year

Gas: £1708 per year

Performance post retrofit 2

Semidetached:

Retrofit 2: medium-term fabric

EPC rating: 71 C

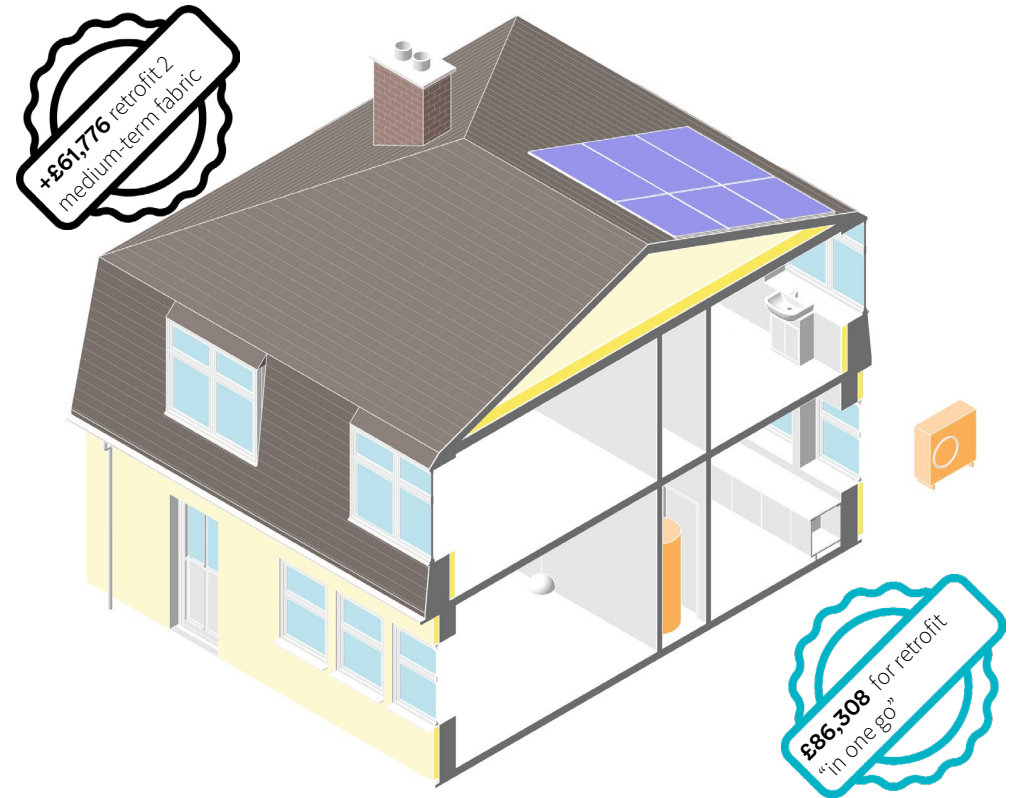
Air permeability: 9 (target)

Space heating demand: 123

Dwelling emission rate (DER): 7

Electricity: £1492 per year

Gas: NA



- > Localised concrete repair: breaking out damaged areas, treatment of exposed reinforcement and patch repair with a concrete repair product
- > Structural EWI ground floor: render on 80 mm EPS insulation above and below DPC
- > Internal wall insulation (IWI) first floor/mansard: 80 mm rigid Polyisocyanurate (PIR) insulation between rafters plus 38 mm insulated plasterboard
- > Insulate/top-up loft insulation to 400 mm
- > Install insulated and airtight loft access hatch
- > New UPVC windows and doors: 1.3 u-value, 0.72 g-value
- > Airtightness tape around windows and doors

Note, project cost includes management and contingency. Costs are indicative/normalised for comparison and not based on example projects

Bryant Low Rise retrofit 1: 'fabric first' (SHDF)

Performance pre retrofit

Mid-terrace:

As built/some improvements

EPC rating: 67 D

Air permeability: 15 (default)

Space heating demand: 130

Dwelling emission rate (DER): 41

Electricity: £324 per year

Gas: £1143 per year

Performance post retrofit 1

Mid-terrace:

Retrofit 1: "fabric first"

EPC rating: 76 C

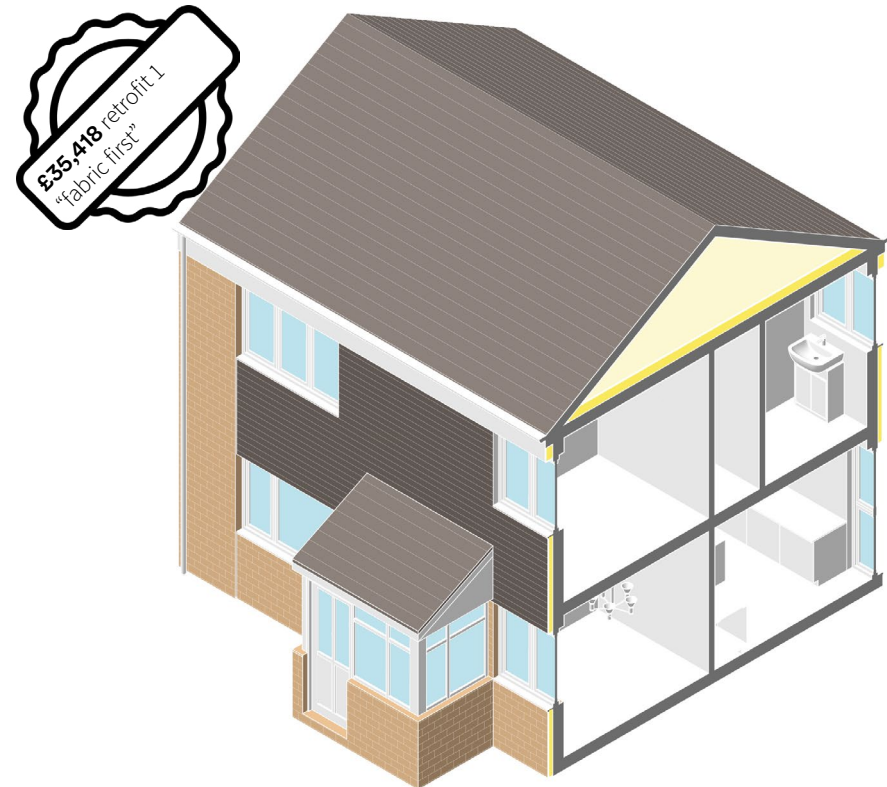
Air permeability: 9 (target)

Space heating demand: 68

Dwelling emission rate (DER): 26

Electricity: £334 per year

Gas: £766 per year



- > Bracing to roof and joists
- > Treatment of porches and rear extensions
- > Decentralised continuous mechanical extract ventilation to kitchens and bathrooms, sufficient trickle vents in windows and door undercuts
- > CWI to gable walls and brick piers: 60 mm polyurethane foam insulation
- > CWI to infill timber construction between studs
- > Insulate/top-up loft insulation to 400 mm, maintain ventilation gap at eaves, extend insulation over the wall plate if possible
- > Install insulated and airtight loft access hatch
- > New UPVC windows and doors: 1.4 u-value, 0.72 g-value
- > Airtightness tape around windows and doors

Note, project cost includes management and contingency. Costs are indicative/normalised for comparison and not based on example projects

Bryant Low Rise retrofit 2: renewables ‘top up’



Example project: terraced Bryant Low Rise cross wall houses in Birmingham after retrofit to EPC B for Birmingham City Council (10 homes were upgraded)

Performance pre retrofit

Mid-terrace:

As built/some improvements

EPC rating: 67 D

Air permeability: 15 (default)

Space heating demand: 130

Dwelling emission rate (DER): 41

Electricity: £324 per year

Gas: £1143 per year

Performance post retrofit 2

Mid-terrace:

Retrofit 2: renewables “top up”

EPC rating: 85 B

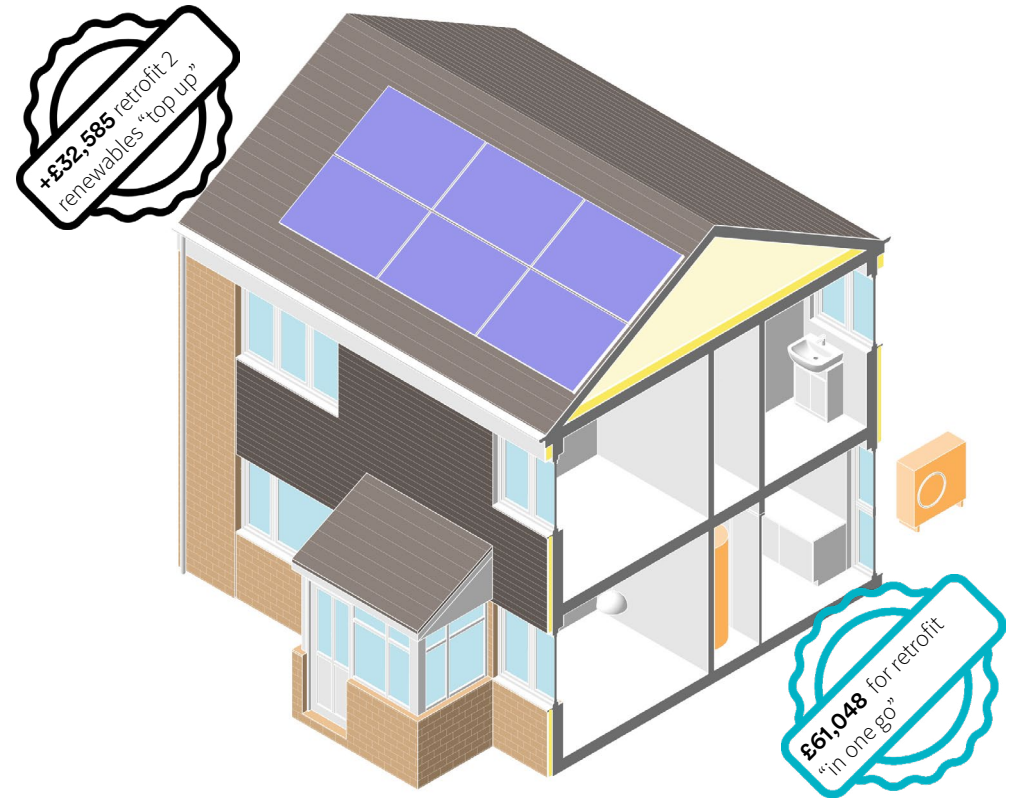
Air permeability: 9 (target)

Space heating demand: 67

Dwelling emission rate (DER): 4

Electricity: £964 per year

Gas: NA



In addition to the fabric measures outlined on the previous page:

- > Solar panels: 8 panels/3.5 kWp (kilowatt peak)
- > Battery: 5.8 kWh
- > Air-to-water monobloc heat pump: 5kW, using refrigerant R290
- > Un-vented hot water cylinder: 150 litres with 3kW immersion

Note, project cost includes management and contingency. Costs are indicative/normalised for comparison and not based on example projects

Cross wall (Nottingham) deep retrofit



Example project: terraced cross wall houses in Nottingham after deep retrofit for Nottingham City Council (144 homes were upgraded, 1st Energiesprong project in the UK)

Performance pre retrofit

Mid-terrace:

As built/some improvements

EPC rating: 69 C

Air permeability: 15 (default)

Space heating demand: 110

Dwelling emission rate (DER): 36

Electricity: £318 per year

Gas: £1272 per year

Performance post retrofit 1

Mid-terrace:

Retrofit 1: deep retrofit

EPC rating: 90 B

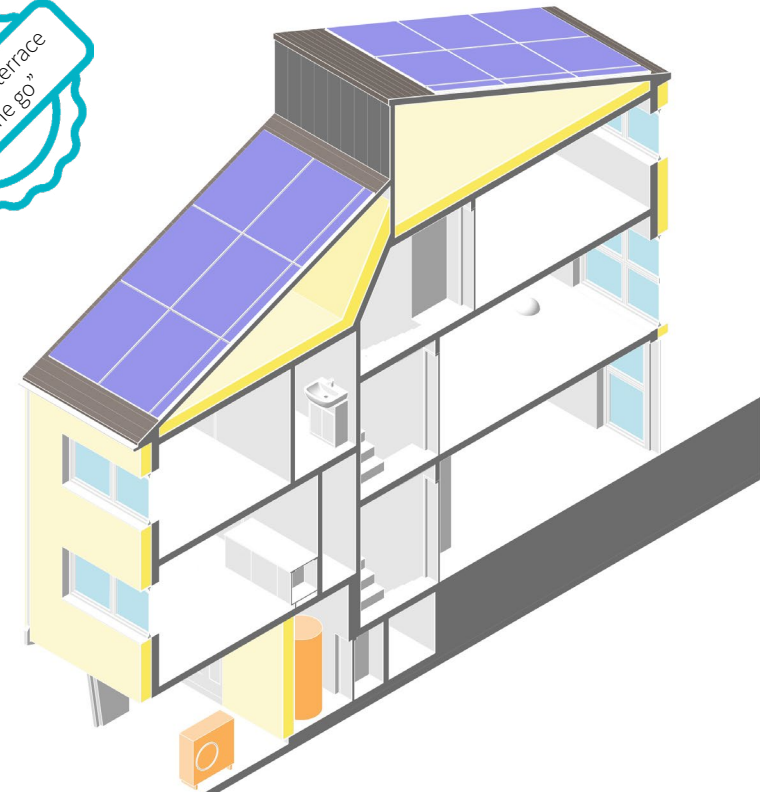
Air permeability: 9 (target)

Space heating demand: 55

Dwelling emission rate (DER): 2

Electricity: £850 per year

Gas: NA



- > Demand-controlled centralised continuous ventilation
- > Prefabricated insulated wall panels to front and rear walls: 220 mm
- > Insulated concrete foundation: 50 mm EPS insulation from 300 mm below ground
- > Integral garages converted to be part of the house with new window, entrance doors and wall panel, insulated party wall (100 mm mineral wool insulation) and ground floor
- > Insulate/top-up loft insulation to 400 mm, maintain ventilation gap at eaves, extend insulation over the wall plate if possible. Install insulated and airtight loft access hatch
- > New UPVC windows and doors: 1.3/1.2 u-value, 0.72 g-value
- > New windows and doors factory-installed within insulated panels with airtightness tape
- > Solar panels: 18 panels/6.0 kWp
- > Battery: 4.8 kWh
- > Air-to-water monobloc heat pump: 5kW, using refrigerant R290
- > Un-vented hot water cylinder: 150 litres with 3kW immersion

Note, project cost includes management and contingency. Costs are indicative/normalised for comparison and not based on example projects

Cross wall (Hammersmith & Fulham) deep retrofit



Example project: terraced houses in Fulham during deep retrofit for Hammersmith & Fulham Council © Gardner Stewart Architects

Performance pre retrofit

End-of-terrace:

As built/some improvements

EPC rating: 61 D

Air permeability: 15 (default)

Space heating demand: 160

Dwelling emission rate (DER): 45

Electricity: £356 per year

Gas: £2002 per year

Performance post retrofit 1

End-of-terrace:

Retrofit 1: deep retrofit

EPC rating: 71 C

Air permeability: 5 (target)

Space heating demand: 86

Dwelling emission rate (DER): 5

Electricity: £1714 per year

Gas: NA

£103,706 end-terrace retrofit "in one go"



- > Decentralised continuous mechanical extract ventilation to kitchens and bathrooms, sufficient trickle vents in windows and door undercuts
- > Prefabricated insulated wall panels to front and rear walls: 328 mm
- > 200x 600 mm XPS insulation below DPC
- > CWI to gable wall: 60 mm mineral wool insulation
- > Integral garages converted to be part of the house with new window, entrance doors and wall panel, insulated party wall (100 mm mineral wool insulation) and ground floor
- > Insulate/top-up loft insulation to 400 mm, maintain ventilation gap at eaves, extend insulation over the wall plate if possible
- > New triple-glazed UPVC windows and doors: 1.0 u-value, 0.72 g-value
- > Solar panels: 12 panels/5.2 kWp
- > Air-to-water monobloc heat pump: 5kW, using refrigerant R290
- > Un-vented hot water cylinder: 200 litres

Note, project cost includes management and contingency. Costs are indicative/normalised for comparison and not based on example projects

Summary of energy performance assessment

Archetype	Wimpey No-fines 2 storey	Wimpey No-fines 2 storey	Wimpey No-fines 3 storey	BISF	Cornish Unit	Bryant Low Rise	Cross wall (Nottingham)	Cross wall (Hammersmith & Fulham)
Position	Mid-terrace	End-of-terrace	End-of-terrace	Semidetached	Semidetached	Mid-terrace	Mid-terrace	End-of-terrace
Typical condition	As built/some improvements	As built/some improvements	Previous retrofit	As built/some improvements	As built/some improvements	As built/some improvements	As built/some improvements	As built/some improvements
Retrofit 1	"Fabric first" (SHDF)	Fabric first (SHDF)	Renewables top up	Fabric first	Decarbonise first	Fabric first	Deep retrofit	Deep retrofit
Retrofit 2	Renewables "top up"	Renewables top up	Deep retrofit	Renewables top up	Medium-term fabric	Renewables top up	NA	NA
Retrofit 3	Renewables "top up" solar panels and battery only	NA	NA	NA	NA	NA	NA	NA

Energy performance								
Pre-retrofit								
EPC rating	69C	63D	73C	61D	56D	67D	69C	61D
Air permeability	15 (default)	15 (default)	11 (tested)	20 (assumed)	15 (default)	15 (default)	15 (default)	15 (default)
Space heating demand	111	154	93	167	200	130	110	160
DER	36	47	29	49	57	41	36	45
Electricity (£ per year)	330	330	360	331	330	324	318	356
Gas (£ per year)	1,046	1,311	1,347	1,498	1,708	1,143	1,272	2,002

Post retrofit 1								
EPC rating	78C	75C	74C	76C	34F	76C	90B	71C
Air permeability	9	9	11	9	15 (default)	9	9	5
Space heating demand	57	75	101	69	250	68	55	86
DER	24	28	5	26	17	26	2	5
Electricity (£ per year)	339	339	1,775	340	2,941	334	850	1,714
Gas (£ per year)	708	818	NA	835	NA	766	NA	NA

Post retrofit 2						
EPC rating	87B	83B	83B	83B	71C	85B
Air permeability	9	9	9	9	9	9
Space heating demand	56	74	69	72	123	67
DER	3	4	6	4	7	4
Electricity (£ per year)	900	1,042	1,350	1,073	1,492	964
Gas (£ per year)	NA	NA	NA	NA	NA	NA

5.

Delivery insights

- > Getting resident engagement right throughout the lifecycle of the project is important for successful outcomes.
- > Retrofit can be undertaken while residents carry on living in their homes (sometimes residents need to go out for a few hours if craning over cannot be avoided).
- > Retrofit works can be “all in one go” or staged. Note, staged retrofit is more expensive due to additional management and contingency costs. Also, the first retrofit needs to be properly considered and designed to enable the second stage.
- > Actual building performance should be measured (in Winter) and energy bills and resident surveys obtained before retrofit to inform the retrofit design.
- > Despite the benefits of archotyping, there will be variances between homes and every family is different.
- > Retrofit design is about finding the sweet spot between performance improvement, cost (both construction and impact on resident bills) and disruption.
- > Garage conversions provide space for building services and extra space benefitting residents.
- > Attention is drawn to detailing/insulating below DPC, at eaves and corners, next to cold neighbours and fixing windows and doors (ideally in line with wall insulation).
- > Location of batteries should consider fire risk, see BSI, **PAS 63100 Electrical installations. Protection against fire of battery energy storage systems for use in dwellings. Specification.**
- > Gas disconnection is critical to programme.
- > Cost contingency is required for outstanding repairs and maintenance works and discovery of structural defects (such as corrosion to steel or precast concrete, or strengthening of roof trusses), asbestos or other hazardous materials, or failure of fixing “pull out” tests.
- > Costs evolve. Early Energiesprong UK projects included significant cost for sensors to monitor performance. Now, heat pumps etc. include onboard monitoring.
- > Retrofit cost can be recovered over time and reinvested in future retrofits through the Comfort Plan charge, which residents pay in lieu of a gas bill.

If you are commissioning a project or need help with project-specific retrofit design, please do get in touch with the people and organisations behind this report:

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