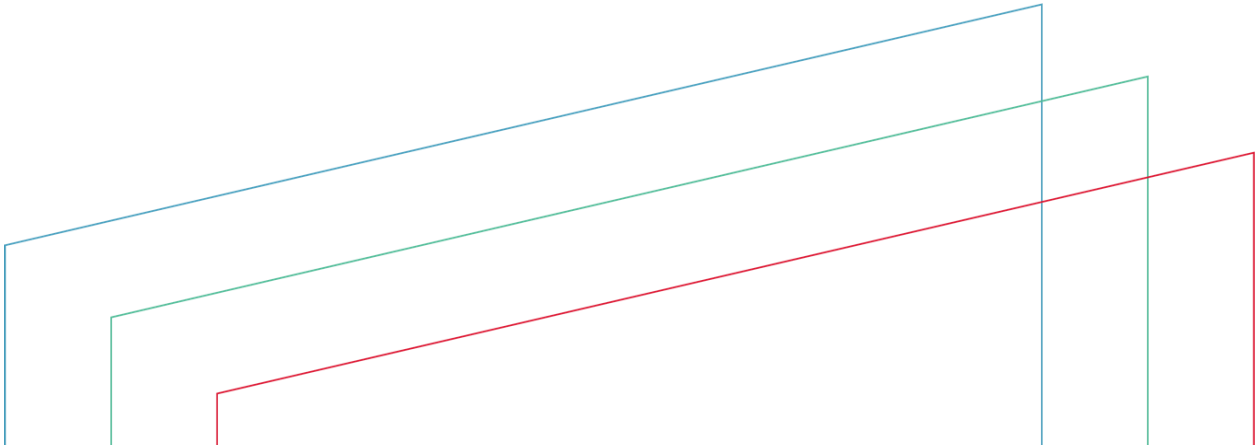
A COUNCIL-LED RESPONSE TO THE ENERGY AFFORDABILITY CRISIS

A street-level, rapid response retrofit strategy



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A STREET-LEVEL, RAPID RESPONSE RETROFITTING STRATEGY

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EXECUTIVE SUMMARY

The recent heat wave in the UK has driven home the urgency of tackling climate change while the high cost of living has deepened the crisis of fuel poverty. Action is urgently needed now to address these twin challenges and one of the most effective ways of doing so is upgrading our leaky and poor housing stock. Improving our homes brings a slew of benefits that include reducing energy bills and reliance on foreign powers, improving public health, and generating jobs and community wealth.

However, past retrofit programmes have consistently failed to deliver the much-needed scale, with roughly 16 million homes estimated to need some form of improvement to bring them to a reasonable standard (Energy Performance Certificate (EPC) C) by 2035. These programmes have failed in part due to the piecemeal nature of the offer to households, and the separation of financing from the wider renovation programme. Indeed, the fragmented and inconsistent nature of the grant funding environment has plagued the UK industry in recent years, with short-lived funding horizons and complexities surrounding eligibility and implementation leading to frustration within the construction industry and apathy from the wider public.

One approach, rooted in the local delivery aspect of retrofitting, is in starting from a few individual streets, estates, or neighbourhoods and working up to scale. The main benefits of such an approach are in the reduction of costs, driven by bulk procurement and delivery alongside the social effects of delivering neighbourhood-level transformative projects. Or in other words, the ‘keeping up with the Joneses’ phenomenon of seeking the lifestyle and benefits of one's neighbours.

Local authorities are already delivering retrofitting programmes at a small scale, often driven by government grants (such as the Local Authority Delivery (LAD) scheme) or through schemes such as the Energy Company Obligation. Competitive bidding processes have led to stretched councils with meagre resources investing in developing proposals that have a limited chance of success.

In this report, we highlight how the role of local authorities could be scaled up in implementing a ‘rapid-response’ retrofit programme that targets households that could benefit the most, through a street-by-street delivery. Such a programme could begin rolling out immediately, backed by the resources of local authorities and bolstered by support from the national government. Using a hypothetical local authority, we elaborate on how basic retrofitting measures that are typically cheap and energy saving such as loft and cavity insulation, draught-proofing, and smart heating controllers can be rolled out street by street across entire neighbourhoods. Bundled with free energy advice, the programme opens up the opportunity for more sophisticated and relatively expensive measures like heat pumps, and solid wall and floor insulation, based on a mix of financing options for the householder.

We estimate that for our chosen neighbourhood of 670 households, basic measures can be delivered at a highly reasonable cost of £580,000 while bringing annual savings of £158,000 in aggregate for the households. We believe several councils should be able to initiate this programme without necessarily waiting for central government intervention. If scaled up to all

the 94 neighbourhoods[a] in our chosen local authority, it would cost significantly higher at £54mn, which we believe ought to be supported by central government funding, alongside a mix of other financial measures that we elaborate on in this report.

The proposed delivery mechanism can be initiated within the existing capacity and resources of a typical council but scaling up from a few streets to the entire local authority cannot be done without establishing long-term infrastructure for delivery. We identify the following steps that we deem are essential in building the necessary institutional and operational capacity:

Establishing a retrofit taskforce and plan. Coordinating action on retrofit demands a staff team focused on the mission of achieving the retrofit task. This can be supported by a sub-regional group of stakeholders

2. **Choosing the areas for intervention.** We suggest working with the Lower Layer Super Output Area (LSOA) as the smallest unit to apply this approach, which on average has 650 homes within its boundary. However, in practice, the application of measures would be at an even smaller level of a street or an estate within the LSOA, to begin with.
3. **Assessing insulation and retrofitting measures against a set of criteria.** We present a set of headline criteria for assessing the prevailing insulation and retrofit measures in Section 3, including indicators such as cost, ease of installation, carbon-cutting, and cost-saving potential.
4. **Executing a public engagement strategy.** Section 4 details what a public engagement strategy could look like, communicating the benefits of insulation measures across different household types.
5. **Identifying a delivery model and business plan.** Local authorities have a variety of delivery and funding models to choose from. For ease and efficacy, we instead offer hypothetical examples. Section 5 highlights a few leading approaches that successful local authorities have deployed so far in the UK.
6. **Securing quality performance and customer assurance through evaluation.** Short-term benefits cannot just be delivered theoretically as households need to see a clear impact on their comfort and even their bills. A strong performance monitoring and evaluation framework will ensure households will be willing to possibly undertake more invasive measures in the future to secure greater benefits.

Local authorities, as trusted institutions, are well placed to deliver essential measures to households that need protection this winter and beyond. A typical household, facing annual energy bills of over £3,200 this October, could benefit from savings between £490 and £720. This can offer much-needed relief alongside the support measures that the government has announced so far.

We do not have to look further than Germany to understand the desperate measures that are being taken there to reduce gas consumption and the imperative is equally high in the UK to deliver emergency home improvement support to families in need this upcoming winter and beyond.

[a] Measured as a Lower Layer Super Output Area (LSOA), which on average has 650 homes within its boundary.

OVERVIEW OF THE ENERGY CRISIS

Households are struggling across the UK. The rise in inflation to a 40-year high is expected to see UK living standards fall at their fastest annual rate since the mid-1950s when modern records began.[1] As a result, come October, the bottom 75% of households will have seen the cost of living outpace their income since April 2021, on average.

The distribution, as well as the scale and immediacy of the income squeeze, will make it more acutely felt. The lowest-income tenth of households already spent over three times more as a proportion of their household expenditure on energy bills than richer households[2] before the cost of living crisis.

More recent analysis suggests that the poorest 10% of families will see energy costs increase by 6% (£724) of their disposable income, a 7.5 times larger rise than the 0.75% of disposable income rise for the richest 10% of families. Single parents, pensioners, and families with one or more people with disabilities are also likely to be the hardest hit.[3] For the poorest households, many of whom will have already tightened their belts as far as possible, the cost of living between April 2021 and October 2022 will have increased by over 10 percentage points faster than their incomes.[4]

The main drivers of high and rising inflation are the wholesale prices of gas and oil, which increased rapidly following the re-opening of the global economy and have increased sharply again since Russia invaded Ukraine.[5] In the UK, this has meant a sharp rise in fuel poverty with an estimated 6 million households, at least, categorised as such.[b]

While the Chancellor has primarily focused on cash handouts and the energy security strategy has focused on cleaning and diversifying UK's energy supply, very little has been done to improve the efficiency of Britain's housing stock, which is notoriously leaky and one of the coldest across Europe. With over 85% of households reliant on natural gas to keep warm, there is a desperate need to cut energy demand and clean our supply of heat, if we are to keep both bills and emissions low. In fact, the Climate Change Committee, in its latest progress report, has strongly criticised the government for its inaction around insulating homes and exposing us much more to the volatility of international gas prices.

According to the charity E3G, when the energy price cap rises again in October, the average household in a home with an Energy Performance Certificate (EPC) of D or below – over 15 million households in England – will pay an 'inefficiency penalty' of £916 more per year for adequate heating than those living in homes rated EPC C or better. Policy to address the energy efficiency of the residential housing stock is now limited to just one major flagship scheme called the Energy Company Obligation and yet a majority of below-average income households are not eligible for the scheme.

So, a deepening cost of living crisis, driven by soaring energy prices and exacerbated by a leaky housing stock has created a perfect storm of multiple, intersecting crises. It is evident that through this winter and beyond, the UK should deploy a strategy for retrofitting millions of homes, starting with the fuel poor, to push energy bills down immediately and permanently, while putting us back on track to meeting our net zero targets.

[b] The working definition of fuel poverty is any household residing in a dwelling that has an energy efficiency rating D or below and after energy costs, the residual income is below the poverty line.

WHAT A RAPID RESPONSE COULD LOOK LIKE

1. Establishing a retrofit taskforce and plan

One of the most binding constraints on councils is their limited staffing. To overcome this, the council should put together a retrofit taskforce, made up of local and regional government representatives, social landlords, building authorities, colleges, energy suppliers, industry experts, and investors. Significantly, the taskforce should be put together in partnership with a sub-regional group of councils with each dedicating resources and staff to underpin the function of the taskforce.

The taskforce should develop a delivery plan most suitable to the local housing stock, push forward a series of agreed actions, and maximise investment and public funding, particularly to support those least able to pay for retrofitting measures. Managing the retrofit scheme through a designated taskforce can ensure resources are used effectively, and that oversight is maintained across the whole project.

Funding is needed to establish the institutions needed to underpin the interventions outlined in the following sections. Part of the purpose of this taskforce is to draw on multiple organisational budgets to overcome this and enable the action detailed in this report.

Greater Manchester Combined Authority has a Buildings Retrofit Taskforce[6] to ensure the city-region's homes and buildings are fit for a zero-carbon future. The taskforce is chaired by the Mayor and uses the expertise and influence of its members to push forward a series of agreed actions and maximise investment and public funding.

2. Choosing the areas for intervention

Local authorities cannot address all homes within their boundaries at once. Given this, we suggest local leaders select priority neighbourhoods to undergo the retrofit process first, using a methodology that accounts for local **need** and **deliverability**. While there are many possible methods of selection, we suggest using data on fuel poverty (low income with low energy efficiency), housing type, tenure, and build period to select a neighbourhood to start with.

This can be done using Lower Layer Super Output Areas (LSOAs), which typically include approximately 650 homes each. We suggest that councils consolidate data on all the LSOAs within their boundaries and start by ranking neighbourhoods based on the prevalence of fuel poverty, prioritising those with above-average levels of fuel poverty. While the latest official data is from 2020, it may still be indicative of the relative scale of the issue by area, if not the absolute level.

Having identified the neighbourhoods with above-average fuel poverty levels, local leaders should then consider the energy efficiency of the properties. From here, the list of potential neighbourhoods can be reprioritised to only include those that have a high proportion of properties with an EPC rating of E or lower. The retrofitting scheme will ultimately need to address neighbourhoods with high levels of EPC D-rated properties too, but in the immediate term, we suggest focusing on those least-efficient neighbourhoods.

The resulting list leaves those neighbourhoods that have a high proportion of properties with the greatest **need**, and those that would stand to gain the most from a street-by-street retrofit campaign.

Next, the council must consider **deliverability**. To do so they should first consider housing tenure, prioritising LSOAs with a higher proportion of social and owner-occupied housing. These properties will be more easily influenced by current best practices than those in the private rented sector (PRS), where some of the mechanisms needed (eg green leases) require further development. As discussed in the final section, this is a clear area where central government can and should be doing more. Even without central government action, councils should be using landlord licensing to fund the enforcement of current minimum energy efficiency standards. This is discussed in Section 4.

Property type and build period can also be factored in. For example, more recently developed properties are more likely to have cavity walls than those built before 1920. Cavity wall insulation can be considerably cheaper than solid wall insulation (see Section 3 for more detail) making it more deliverable in the short term.

Councils should consider these measures of deliverability together and need to settle on a prioritised list of neighbourhoods, to begin with.

An illustrative case study

For illustrative purposes, we have gone through the same process for an English Unitary Authority and identified an LSOA for our council to begin its neighbourhood retrofit programme.

The selected LSOA includes 670 properties, 18% of these which are estimated to be fuel poor (~ 127 households). It's important to note that these are data published in 2022, but using underlying data from 2020 Latest estimates suggest that as of 1 April 2022, 26.7% of households are in fuel poverty, ie 13.5 percentage points above the rate of 13.2% indicated by the latest official data.[7]

Of the 670 properties, 54% are socially rented, while 34% are owner-occupied and 14% are privately rented. As these figures make clear, the proportion of socially rented homes is well above the England average of 17% with the inverse true of the owner-occupied segment (65%[8]). Most significantly for council action though, the proportion of housing that is not privately rented is high at over 85%.

The chosen LSOA has an above-average proportion[9] of semi-detached (41%) and terraced houses (37%) with lower numbers of flats or maisonettes (19%) and detached houses (3%).[c]

More than half the properties in the LSOA have an EPC rating of D (54%) while 28% have a rating of E or lower. Both of these figures were worse performing than the average for unitary authority as a whole.[10]

[c] The national averages for England are bungalow, 9%; flat/maisonette, 24%; terraced house, 26%; semi-detached house, 16%; unknown, 1%.

3. Assessing insulation and retrofitting measures

To map out a rapid response to the cost-of-living crisis, it is important to understand the energy efficiency measures best suited to delivering results in the short term. To understand this, we have assessed different measures against the criteria shown in Table 1.

Table 1. Criteria used in the assessment of energy efficiency measures

Criterion	Description
Cost	How much does it cost to purchase and install the measure?
Installation speed	How long does it take to install the measure?
Installation skills required	What qualifications, knowledge, or aptitudes must the installer have and are they easy to obtain?
Carbon-cutting potential	How much carbon could be cut by installing the measure?
Short-term cost-saving potential	By how much could household bills be reduced by installing the measure, ignoring the installation cost?

Table 2. Short-term suitability of home upgrade measures

Please refer to Appendix A for a full analysis of each measure, cost, and CO_2 savings.

Measure	Description	Short-term suitability (strong, medium, weak)
Loft insulation (0–270mm)	Standard loft insulation involves rolls of insulation being laid over the floor joists. Homes with an accessible loft (with no damp or condensation problems) are typically good candidates for loft insulation.	**Strong** – Loft insulation leads to good annual cost savings and carbon emissions savings for all property types. The payback time of installation costs is short (approximately 1–3 years) and the work can be done in a day. Qualification requirements are also relatively minimal.
Cavity wall insulation	Houses built post-1920s are likely to have cavity walls. There are made up of two walls with a gap in between, where the outer leaf is usually made of brick, and the inner layer of brick or concrete block.	**Strong** – Around 35% of heat loss from uninsulated homes is through walls, so this can be an impactful measure.[11] Installation time is short (can be done in a day) but immediate installer capacity is likely to be fixed in the very short term as people will likely need to undertake a 2-month course (which can be done online). The retrofit taskforce can work to put such training in place.
Floor insulation	Ground floors and floors above unheated spaces (such as garages) are a significant source of heat loss in homes. Both wooden and concrete floors can be insulated but suspended timber floors are typically most easily insulated.	**Medium** – This measure can be very expensive (up to £3,000 for detached houses), and cost savings are not significant. Installation can take 1–4 days. Carbon-cutting potential is also not hugely significant, with annual savings ranging from 120kg CO_2 emissions to 305kg for detached houses.
Solid wall insulation	Solid walls are susceptible to quick heat loss, as heat passes through solid materials faster than through cavities, with around 45% of a home's heat loss could be through solid	**Medium** – Solid wall properties are harder to insulate than cavity walls with insulation needing to be fitted to the inside or exterior of existing walls. Internal solid wall insulation options exist where space constraints are not a concern. External wall insulation costs are

	walls (according to the Energy Saving Trust). Properties built pre-1920s will likely have solid walls. The two traditional options are external wall insulation and internal wall insulation.	high and may not be possible within existing planning frameworks in conservation areas. It can potentially also lead to issues with dampness if done badly.
Double-glazed windows	On average 60% of heat is lost through the walls and loft combined. It makes sense, therefore, to insulate these areas, if possible, before replacing the windows or doors. Approximately 10% of the total heat loss from a typical house is through the windows. Double-glazed windows have two sheets of glass with a gap in between, to help reduce the heat lost.	**Medium** – Supply chains and installers are well established for this measure, but installation costs remain high. A set of A-rated windows for a semi-detached house will typically cost around £7,500. The savings are meaningful, but the payback period is not as quick as some of the strong suitability measures.
Energy-efficient external doors	External doors are another significant source of heat loss. Taken together with windows homes lose 10%–20% of their heat through these parts of the building envelope.	**Medium –** Like windows, supply chains and installers are well established for this measure, but installation costs remain high. A uPVC front door starts at £800, while timber doors start at £1,400 per door. The savings are expected to be meaningful, but the payback period is not as quick as some of the strong suitability measures.
Draught-proofing	Draught-proofing involves filling in gaps in a building, often open chimneys and gaps around windows and doors. It is one of the cheapest and most effective ways to save energy and money in any property type.	**Strong** – This is a cheap method, and the savings can be significant. Most draught-proofing measures do not require expertise to install and most properties are expected to benefit from draught-proofing, especially around windows and doors.[d]
Replacement boilers	Modern boilers are more efficient than older boilers because they recover more heat from the exhaust flue gas and use it to heat the central heating water. Heating and hot water can account for over 50% of a home's annual energy bills so an efficient boiler can dramatically affect this.	**Weak** – Heating and hot water is a huge chunk of energy bills, and a more efficient boiler system can make an impact, particularly for the most energy inefficient boiler ratings, particularly in semi-detached and detached houses. However, this can extend fossil fuel dependency and is not a medium or long-term solution. As part of the UK government's plan to reach net zero carbon emissions by 2050, fossil fuel heating systems will be phased out over time, starting with a ban on gas and oil boilers in new homes from 2025.

[d] This is especially true if you have single-glazed windows. Otherwise, draught-proofing is for homes with obvious draughts, for instance from an open chimney.

First-time central heating	Installing a central heating system in homes that do not currently have them can help to maintain a consistent temperature throughout a home compared to electric heaters.	**Weak** – The carbon-cutting and cost-saving potential is unclear, and it is relatively expensive (although grants are widely available). Most properties already have central heating installed. In terms of installation, only Gas Safe Registered heating engineers can install central heating systems.
Heat pumps	A heat pump uses electricity to capture heat from outside and move it into a home. It captures heat already present in the environment, so the system itself does not burn any fuel and therefore emits no carbon dioxide.	**Medium** – While installation costs are hefty, the cost and carbon-cutting potential are significant, even when replacing relatively new/A-rated boilers. The viability of this measure perhaps depends on the amount of funding available, as it is an expensive choice.
Solar panels (PV)	Solar electricity panels, also known as photovoltaics (PV), store and convert the sun's energy into electricity to be used in the home, enabling a property to generate its own renewable electricity.	**Medium** – The performance of these is highly dependent on solar irradiance, roof space, and its orientation but it does offer relatively significant cost and carbon emission savings.
Thermostatic radiator valves (TRVs)	Thermostatic radiator valves (TRVs) control the flow of hot water through the radiator they are fitted to. Programmable TRVs include the normal functionality of standard TRVs but with timing control as well. Some link to smart controllers.	**Strong** – TRVs are straightforward to install, affordable, and deliver high potential energy savings.
Smart heating control systems	Heating controls is a broad term covering timers, thermostats, and plumbing and electronic components, which help manage when the heating should be on and what temperature your rooms should be. Smart heating controls can link to your location (geo-fencing), learn heating habits, and be accessed through a smartphone app.	**Strong –** They are easy to install and the supply chain is well established. The cost and carbon-cutting potential are significant, and the measure is expected to have a short payback period.

In addition to the measures described it would also be a good opportunity for a retrofit coordinator to undertake an assessment of the property and provide advice on the appropriate measures to be installed. They could provide advice on the appropriate boiler settings, as many households currently have a poor understanding of how these settings

work. Such consultation is estimated to cost around £100 per property.[e] A more detailed whole-house assessment, as done by Retrofitworks, could cost roughly £350 per property. For this analysis, we have adopted the lower cost of a simple consultation.

An illustrative case study

In summary, our analysis indicates that, with things as they currently stand, there is a strong short-term investment case for loft insulation, cavity wall insulation, draught-proofing, TRVs, and smart heating control systems. Other measures are less clear-cut as detailed in Table 2 and summarised in Table 3.

Table 3. Summary of short-term suitability of home upgrade measures

Short-term suitability		
Strong	**Medium**	**Weak**
▪ Loft insulation (0–270mm) ▪ Cavity wall insulation ▪ Draught-proofing ▪ TRVs ▪ Smart heating control systems	▪ Solid wall insulation ▪ Floor insulation ▪ Solar panels (PV) ▪ Heat pumps ▪ Double-glazed windows ▪ External doors (not modelled[f])	▪ Replacement boilers ▪ First-time central heating

As detailed in the previous section, our LSOA is primarily made up of three types of housing: semi-detached (41%), terraced houses (37%), and flats or maisonettes (19%). This is presented in Table 4. Each of these types is almost entirely 1 to 3 bedrooms, so we assume this when presenting costs and bill savings.

Table 4. Housing type and size in chosen LSOA

	Number of properties
Semi-detached house (1–3 rooms)	270
Terraced house (1–3 rooms)	250
Flat-Maisonette (1–3 rooms)	130
Other	20
	670

If the local authority was to install all the measures classified as having strong suitability, we estimate that the investment required for addressing 97% of properties that fall into the three main housing types would be on average between £1,300 and £2,500 per property. As illustrated in

Table 5, the annual energy cost saving from the installation of the measures is estimated to be between £490 and £720.

[e] Parity Project via private communications.
[f] External doors have not been financially modelled, due to the lack of reliable cost-saving estimates.

Table 5. Cost estimates of 'strong' suitability measures, by house type, 2022 prices

Strong measures	Investment cost	Annual saving
Semi-detached house (1–3 rooms)	£2,405	£718
Terraced house (1–3 rooms)	£1,636	£545
Flat-Maisonette (1–3 rooms)	£1,397	£491

As shown in Table 6, the cost of ‘medium’ suitability measures ranges from £19,000 to £37,000, with associated annual cost savings ranging from £740 to £1,700. Detailed tables and assumptions are shown in Appendix B.

Table 6. Cost estimates of 'medium' suitability measures, by property type, 2022 prices

Medium measures	Investment cost	Annual saving
No solid wall insulation		
Semi-detached house (1–3 rooms)	£24,319	£868
Terraced house (1–3 rooms)	£20,694	£745
Flat-Maisonette (1–3 rooms)	£19,382	£741
With solid walls		
Semi-detached house (1–3 rooms)	£37,524	£1,691
Terraced house (1–3 rooms)	£33,710	£1,355
Flat-Maisonette (1–3 rooms)	£32,368	£1,282
Cost of advice	£100 per property	

Though high-level housing stock information is relatively easy to obtain, to effectively design a regional retrofit strategy for domestic buildings, regional and local governments must be able to establish more detailed profiles of their local housing stock and the socio-economic profile of their owners and occupiers. These figures are based on national estimates of costs and are meant only for illustrative purposes.

Before a council invests, it should properly estimate the scale of investment using the Housing Stock Energy Modelling, which can be used to assess the energy efficiency of domestic buildings and the investment required to improve it.

In our chosen neighbourhood, an estimated 39% of the properties were built pre-1919. We assume that all properties built pre-1919 have solid walls, with all others having cavity walls. We also make several assumptions about the take up of measures; these are detailed in Appendix B. Using these assumptions, we estimate that to install all ‘strong’ suitability measures across our three different property types would cost £580,000 in our chosen neighbourhood. As illustrated in the table below, these measures are estimated to generate an annual energy saving of £158,000.

Table 7. The estimated cost and savings associated with installing 'strong' and 'medium' suitability measures in 97% of the neighbourhood, 2022 prices

	Aggregate cost	Aggregate annual saving
Strong measures		
Semi-detached house (1–3 rooms)	£276,426	£73,511
Terraced house (1–3 rooms)	£174,283	£49,575
Flat-Maisonette (1–3 rooms)	£127,124	£34,418
	£577,833	**£157,503**
Cost of advice	£67,000	
Medium measures		
Semi-detached house (1–3 rooms)	£4,415,283	£169,032
Terraced house (1–3 rooms)	£3,970,413	£139,075
Flat-Maisonette (1–3 rooms)	£2,105,773	£57,190
	£10,491,468	£365,297
	£11,069,301	**£522,800**

We estimate that installing all ‘medium’ suitability measures across our three different property types would cost around £10.5m in our chosen neighbourhood. These measures are estimated to generate an annual energy saving of £365,000.

If this were scaled up across the 94 LSOAs in our local authority, such figures would translate into a cost of £54m for all strong measures, £630,000 for retrofit advice, and £986m for medium measures.

Table 7. Rough estimate of the costs and savings associated with installing 'strong' and 'medium' suitability across the local authority, 2022 prices

	Aggregate cost	Aggregate annual saving
Strong measures	£54,000,000	£15,000,000
Medium measures	£986,000,000	£34,000,000

4. Executing a public engagement strategy

Reaching net zero requires people to be fully engaged and empowered. Many of the urgent changes and decisions needed to drastically reduce emissions have a strong local dimension.

Local authorities should implement neighbourhood or community-based outreach and mobilisation, which can be critical in overcoming information barriers to retrofit. By **informing, consulting, involving, co-designing,** and **empowering**, local authorities can convey information on the benefits or processes of retrofit to potential home-retrofit

customers more effectively than traditional marketing approaches, by making use of trusted information channels like neighbourhood associations, faith groups, and others. Offering complementary add-on services can also drive take-up, as can successful engagement with community groups and local stakeholders.

In this section, we summarise recommendations and best practices for publicity and outreach elements of a local retrofit programme, with a focus on neighbourhood-based approaches.

Implementing a neighbourhood-based approach

Strong neighbourhood-based mobilisation and outreach can overcome information barriers, increase demand for retrofit, and position community-based organisations as key players in driving green economic development in their neighbourhoods. Evaluation of existing practices such as the Kirklees Warm Zone,[12] Transition Linlithgow, and Bristol Green Doors highlights three critical enablers of a successful localised model of retrofit delivery. These were **collaboration and coordination, a comprehensive approach,** and **consistent branding.**

Local authorities should adopt strategies such as neighbourhood canvassing campaigns, bringing in trained volunteers to alleviate concerns and provide information about retrofitting to those in the community interested. The case of Kirklees highlights that garnering broad-based support and join-up services through genuine public/private sector partnerships is key, as is building ongoing relationships in project management and procurement. Using consistent branding in direct marketing initiatives (ie press and radio coverage, features in local outlets, etc.) can make the campaign memorable and effective. Persistent communications (such as door knocking) can keep the campaign fresh in people's minds, while providing an opportunity to reassure or inform people about the nature and benefits of retrofit.[13] When led by the council (rather than an energy company), this can prevent people from feeling unduly pressurised to switch energy suppliers.

A council-led approach should focus on community presence and a personal approach. This should be tailored to reach target communities such as older residents, black and minority ethnic communities, and people who speak English as an additional language. Outreach efforts can and should also highlight the cost-savings attached to a neighbourhood-based approach such as in the case of Bristol Green Doors where treating properties simultaneously facilitated significant savings (approximately £500 in installation costs per household) by treating ten or more properties. All of the householders involved agreed they would not have partaken in the scheme without grant funding to offset expenses or the 'hand-holding' provided by Bristol Green Doors.

Engaging with community groups to drive up demand

Community groups can play the role of retrofit intermediaries, critically able to leverage high levels of trust to better overcome barriers to retrofit.[14] Careful engagement with existing community groups is critical for instilling a sense of ownership among residents. A community peer-led approach that builds on early adoption and integrates a local, social marketing approach to recruitment can be a more effective route to mass marketing local retrofit programmes than more top-down initiatives.[15] By identifying and supporting community champions and early adopters of retrofit, local authorities can strengthen local networks and secure long-term commitment to the initiative.

Engagement with social housing tenants

A report published by TPAS and Placeshapers (2021)[16] finds that a clear focus on cost-savings money as well as carbon-cutting is key to compellingly engaging with social housing tenants. Quantifying the exact cost-savings of measures allowed residents to confirm how much they were able to save on energy bills. Local authorities should also employ resident engagement experts to talk about the new carbon-efficient technologies in an accessible way, and ensure that front-facing staff members have suitable knowledge of green technology, so they can adequately respond to residents' questions and concerns.

Traditional marketing

INNOVATE's One-Stop Shop guide highlights the need for integrating traditional marketing methods and considerations into the process of retrofit. Property owners cannot be treated or targeted in the same way as owner-occupiers, so engagement with communication /marketing experts and market segmentation is key. Local authorities may not have in-house experts trained to tackle this issue. Local authorities should proactively engage homeowners and use targeted communication and marketing tools to reach the right groups (such as young families, elderly people, and low-income households) at the right moment.

Other practical considerations

A ward-by-ward approach can also help to better tailor communications about the scheme. Councillors can provide their input on which order the wards are visited according to poverty concerns, or even alternating the most affluent with the least affluent wards (as in the case of Kirklees). These can be balanced to distribute workloads between more rural or densely populated/urban wards, which require different resources.

Take-up and customer satisfaction can also be impacted by the street's housing stock and the number of harder-to-treat properties. This can partly be mitigated by making limitations clear to residents from the outset, and carefully choosing the area for delivery without shying away from targeting less affluent segments that may have harder-to-treat properties. Building trust among residents will require agreeing on expectations with homeowners and delivering in line with these, ensuring the accreditation of suppliers and fitters, and using robust and effective quality assurance frameworks informed by the PAS2035 standard. Local authorities could also use trusted community or cooperative-led intermediaries to facilitate work across properties, including tendering packages of homes and building a supply chain. Offering add-on services like free carbon monoxide detectors or safety checks during delivery of the scheme can also significantly increase uptake and boost the appeal of the scheme.

Engaging with the Private Rented Sector (PRS)

A local-authority-led retrofit programme, delivered street by street, should also prioritise the PRS. We expect landlords and tenants to be more amenable to interventions in their properties when limited to basic interventions that take a day or less, particularly when offered without any cost burden. In Section 6, we provide further detail on the state of the PRS and the predominant role of central government in providing the necessary finance and regulation in scaling up retrofit for this particular tenure. However, local authorities have a critical role in actively engaging landlords in communicating and encouraging them to align with the changing regulations on energy efficiency. Liverpool city council offers a useful case study of effective landlord licensing, driven by positive communication and engagement with

landlords, resulting in over 52,000 properties licensed over five years while identifying over 1,900 properties that needed home improvements.[17]

5. Identifying a delivery model and business plan

Local authorities have a variety of delivery and funding models to choose from. In this section, we sketch out the key aspects of an approach and apply them to our illustrative case study.

Financing retrofit

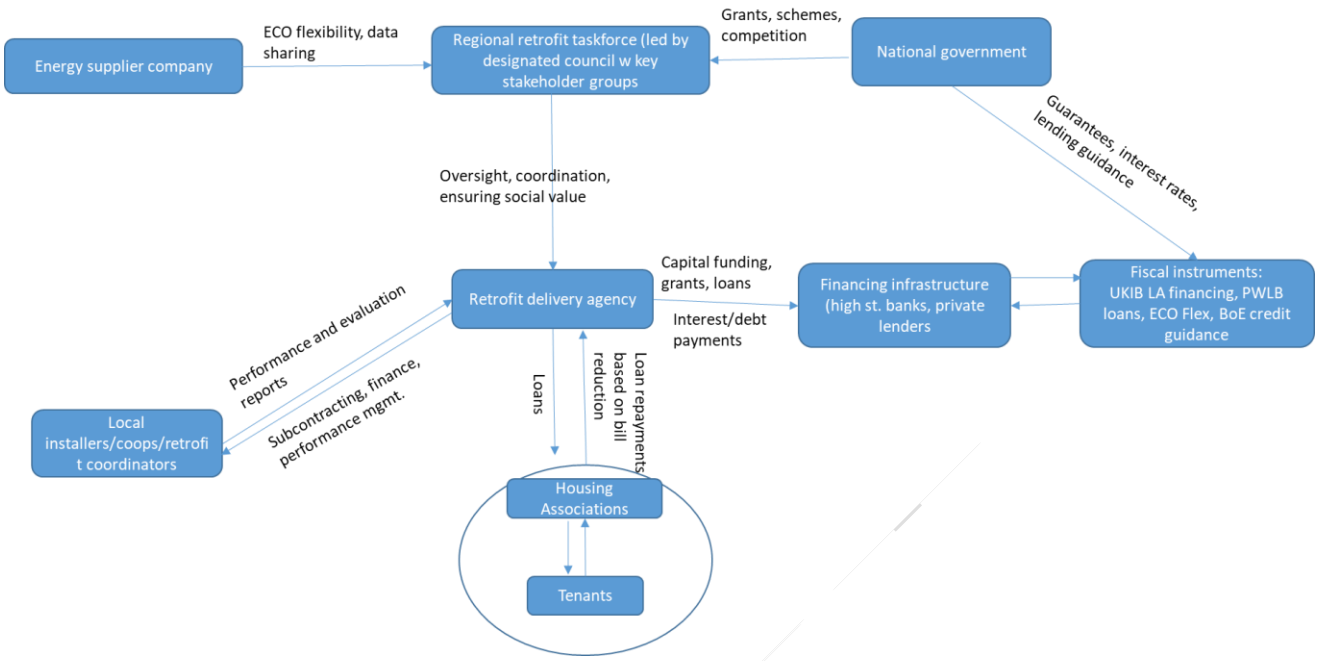
A blended approach

The measures we have identified as most appropriate for rapid action pay back relatively quickly and are typically well suited to debt finance. However, considering the emergency nature of our response strategy and the risk of low-income households laden with further debt while facing a significant squeeze on their income, we recommend councils deploy the most suitable measures through grants.

We are suggesting councils consider the following steps:

- Look to provide 'strong' suitability measures and free advice in the neighbourhoods where the need is highest, like the chosen LSOA in our hypothetical example.
- Work in partnership with other nearby councils to put together a central vehicle, such as a retrofit delivery agency as described in Figure 1, to facilitate the financing and delivery of retrofit. The vehicle would offer grant and low-interest debt financing to residents as relevant and applicable.
- The financing offer would be limited to the target area identified and made appropriate to different tenures. This would then be rolled out to other neighbourhoods using a blended approach of debt and grant financing of 'strong' suitability measures. New sources of finance, particularly through grants from central government, would be critical in achieving scale from one neighbourhood to the entire local authority and beyond.
- When using debt-financing instruments, we recommend households keep 50% energy savings, in other words, households only make debt repayments equivalent to 50% of the energy savings. This recognises that the entire programme would struggle to be financed by grant funding alone but considering the short payback periods, debt financing with high retention of savings will remain an attractive proposition for households.

Figure 1. A simple illustration of the institutional architecture and relationships to deliver a local-authority-led retrofit programme



A regional rapid retrofit taskforce is established to bring together key stakeholders from business, civil society, and government to chart out an early delivery roadmap and provide necessary oversight and coordination. A long-term retrofit programme will require a delivery body at its core that undertakes the roll-out of measures; subcontracts to local installers and supply chains; ensures quality and compliance with regulations; and offers finance to households, housing associations, and landlords. We identify a broad finance ecosystem that includes high street banks, private lenders, and the national government supplying fiscal support through a variety of instruments including low-interest loans, credit guidance to banks, and loan guarantees to name a few. Scaling up existing programmes where relevant, like the Energy Company Obligation, provides additional routes of finance.

Figure 1 is meant for illustrative purposes; a more detailed assessment of structure and options will be necessary, something the authors of this report have undertaken for the Welsh housing stock.[18]

An illustrative example of costs and savings

For a resident of a terraced house with cavity walls, the cost of installing strong suitability measures, and medium suitability measures is estimated to be £1,636 and £22,330, respectively, with associated annual expected energy savings of £545 and £745. The proportion of savings on investment reduces with medium and weak measures such as double glazing, which is an expensive measure for small gains. Measures such as heat pumps bring other significant benefits, such as a significant reduction in carbon emissions.

Where debt financing is applicable, we assume an interest rate of 2%, and that the household keeps 50% of energy cost savings and a 20-year loan term, then:

- If the household installed strong suitability measures in the early stages of the programme, the entire cost is covered through grants.
- If the household installed medium suitability measures, it could afford a £6,089 loan requiring a £14,605 grant.
- If the household installed strong and medium suitability measures, it could afford a £10,547 loan requiring a £11,783 grant.

Table 8. Illustrative example of maximum affordable loan and grant required assuming 2022 prices, 2% interest rate and a 20-year loan term

Terraced house (1–3 rooms)	Cost	Annual saving	Maximum loan affordable	Grant required
Strong measures	£1,636	£545	N/A	£1,636
Medium measures	£20,694	£745	£6,089	£14,605
Strong and medium measures	£22,330	£1,290	£10,547	£11,783

Please refer to Appendix C for detailed workings and estimates based on April 2021 energy prices.

In Section 3, we identified that the local authority will need to initially capitalise a financing vehicle with £11m to install strong and medium measures in one neighbourhood. In the following section, we identify a range of possible sources that the local authority can look to, in establishing the centralised financing facility. While these have useful potential, it is clear that central government needs to provide greater financial and wider support to scale up action on retrofit.

Retrofit delivery agency capitalisation

The funding sources will depend on the local authority and the tenure of the property but may include the following.

Table 10. Potential funding sources for retrofit

Funding source	OO	PRS	SH
Budgetary funds			
Housing Revenue Account (HRA). The HRA is intended to record expenditure and income on running a council's own housing stock and closely related services or facilities, and so would be appropriate to use to support retrofitting council-owned social housing. Its capacity is likely constrained.			✓
Repair, maintenance, and improvement budgets. The financial plans of social landlords will incorporate repair/maintenance and replacement costs, including new gas boilers and new roofs. This budget can be used to retrofit by creating a list of properties that require work over the next few years (such as boiler upgrades and roofing repairs) and reviewing whether energy-efficient measures can be installed at these stages.			✓
Local Authority Delivery (LAD) scheme. Councils may have already acquired LAD funding, which may or may not be possible to incorporate to support their wider rapid neighbourhood-based response. **LAD funding is targeted at low-income and low EPC-rated homes (those with Band E, F, or G)**	✓	✓	✓
Home Upgrade Grant (HUG). HUG is primarily targeted at those **off-grid** households and runs until 2025.	✓	✓	✓

ECO4 will run from 2022 until 2028 and provides support for upgrading fuel-poor homes and the homes of those unable to pay.	✓	✓	✓
Social Housing Decarbonisation Fund and Demonstrator is targeted at upgrading the social housing stock that is currently below EPC C.			✓
Regional and national finance			
Regional investment funds such as the Mayor of London's Energy Efficiency Fund (MEEF). MEEF is an investment fund established by the Greater London Authority (GLA) and managed by Amber Infrastructure. It offers unsecured/secured loans on terms to May 2038, with fixed interest rates that can be lower than the public works loan board.	✓	✓	✓
UK Municipal Bond Agency (UK MBA) provides long-term loans to local authorities of £250m or more.	✓	✓	✓
UK Infrastructure Bank is currently capitalised with £22bn and a mandate to scale up decarbonisation. The bank can initially support local authorities in developing financeable propositions for insulating their housing stock and subsequently offering government-guaranteed loans in delivering projects.	✓	✓	✓
Commercial financing			
Community Municipal Investments (CMIs). CMIs, such as those developed by Abundance Investments, make it possible for residents to directly invest in local authorities. CMIs are structured to match terms offered by the Public Works Loan Board (PWLB) and over similar borrowing periods, from 1 to 40 years. A donation feature can mean it's partly non-repayable capital. CMIs create a new opportunity for councils to communicate key messages regarding local net zero ambitions			✓
Sustainability Linked Bonds, such as those recently issued by Clarion Housing (£300m) and arranged by Natwest Markets, HSBC, and Santander, open up opportunities for low-interest rates and long-term capital to fund retrofit programmes. Long-term maturity possible (e.g. 30-year issuance)	✓	✓	✓
Sustainability Linked Loans (SLLs). Credit facilities are available for SLLs where the margin is linked to achieving certain key performance indicators.	✓	✓	✓
Green Investment Group (GIG; formally UK Green Investment Bank (GIB)). In 2012, the GIB was launched by the UK government to mobilise private finance into the green energy sector. It is unclear whether GIG has thus far invested in domestic retrofit programmes and to what extent this might be appropriate.	**?**	**?**	**?**

Underpinning mechanisms

To facilitate the flow of funding certain mechanisms will be needed.

Table 11. Potential mechanisms to support retrofit financing

Mechanisms to pay through energy savings	OO	PRS	SH
Energy Performance Contracts are the most common pay-for-performance mechanisms. They allow energy efficiency investments to be repaid through realised energy savings over time. Capital investment is paid for through an energy service company (ESCO) or a third-party financer. The building owner pays the ESCO from the operation energy savings over time. Under such an arrangement, the ESCO implements a project to deliver energy efficiency and uses the stream of income from the cost savings to repay the costs of the project, including the costs of the investment. Essentially the ESCO will not receive its payment unless the project delivers energy savings as expected. There are different ways of implementing this mechanism, including joint or wholly owned ventures.[19] Tenants can be guaranteed savings or savings can be shared.	✓	✓	✓
Energy Service Agreements (ESAs) are a variation on Energy Performance Contracts in which the ESA provider finances, installs, owns, and operates energy-efficient equipment in a building, and pays the utility	✓	✓	✓

bills. The building owner/manager pays the ESA provider back over time through service charge payments for actual realised savings. These payments are often set at, or slightly below, the customer's current utility bills, and appear as an operating expense (utility payments) on the building's balance sheet	
Green leases, with an Energy Alignment Clause enable landlords to recover the cost of a retrofit, based on the predicted energy savings, and minimise the landlord-tenant split incentive.	✓

Delivering retrofit

Accreditation

To undertake high-quality retrofit, councils should provide training for tradespeople, skills accreditation, and signpost residents to local, trusted tradespeople.[20]

Ensuring a high quality of service and provision within the sector is key, both to ensure standards are high and to protect consumers. Supplier accreditation is one method of safeguarding this. TrustMark, for example, has been established as the new quality mark within the retrofits standard framework, ensuring that users within the government-endorsed scheme must comply with the PAS 2035 when conducting any domestic retrofit work. This can provide quality assurance, and demonstrate to consumers that retrofit installers and workers have the requisite skills and knowledge needed to deliver best practices.[21]

Councils should engage with local/specialist platforms where retrofit installers and workers are recommended by word-of-mouth. Engaging with these platforms can enable the local authority to better signpost residents to tradespeople who hold TrustMark accreditation, and/or who have worked effectively on previous council retrofit projects. While there may be some reputational risk in directly recommending specific companies, local authorities can signpost to existing registration schemes and use a transparent and rigorous review process to provide less prescriptive recommendations. This could involve partnering with consumer websites, or establishing a TrustMark endorsement scheme (as laid out in the Retrofit London Housing Action Plan).

Local authorities must also build networks and collaboration between employers, colleges, and other providers, as well as local stakeholders to clearly articulate the skills needed in an area to undertake a street-by-street retrofit. Initiatives such as the government's Strategic Development Fund (SDF) can support further education (FE) providers in shaping their provision (including upskilling and reskilling) in response to skills needs. Areas can apply for up to £1.5m of capital funding and £1.25m of programme. However, the rollout of the scheme is limited so far, and funding is strictly time-bound – any slippage into the following financial year "will not be funded and is at the applicant's own risk".[22] More flexible initiatives are likely to be more impactful in building and maintaining longer-term capacity.

Procurement

Procurement is an essential feature of any retrofit programme, ensuring that the right resources are mobilised to deliver the relevant assessment and construction services for residents at a reasonable cost. Beyond these primary aims, there is potential for local and regional authorities to use procurement levers to significantly improve the economic and social impact of retrofit programmes, by steering and shaping retrofit sectors of the local economy. This additional impact may include setting high technical standards for work delivered and closing performance gaps, providing initiatives to improve the gender balance

of the construction workforce, taking measures to improve pay and conditions onsite, focusing on using local firms and workers, or phasing spending in a way that supports the growth of the local retrofit supply chain.

As with retrofit strategy more broadly, procurement could be tailored to the particular aims of the buyer. A procurement strategy that prioritises the reduction of emissions as soon as possible may cater to large, multinational suppliers who can deliver retrofit at scale and to certain technical standards. A more holistic approach may involve using procurement as a lever to create accessible jobs for local people, raise job quality and equality standards, and nurture a local supply chain, maximising the positive externalities of public expenditure on retrofit.

The scale and pace of the retrofit required to meet climate targets are likely to require repeated and ongoing procurement, meaning that arrangements like framework agreements and dynamic purchasing systems may be appropriate.

- In a **framework agreement,** the local authority grants a limited number of suppliers a place in the framework (via an initial competitive process) and an agreement is struck that sets the terms for how subsequent procurement will work. The local authority can then procure goods or services from these suppliers either via a mini-competition or by directly appointing a supplier ('calling off', which must adhere to procedures already specified in the framework agreement – there are several ways in which these procedures can work). Frameworks[23] are typically limited in duration to four years.

- A **dynamic purchasing system (DPS)** has similarities and differences to a framework. It is an entirely electronically based system and consists of two stages. First, all suppliers who apply and meet certain minimum criteria (via a pre-qualification questionnaire) must be given a place on the DPS. The DPS may be subdivided at the outset into categories in line with the types of goods or services being procured. Next, when the local authority is procuring goods or services, it must invite all suppliers on the DPS (or all suppliers within the relevant sub-category) to bid for the contract, which is awarded through a competitive process.[24]

These approaches have advantages and disadvantages in the context of the retrofit sectors.

- A framework selects a fixed number of suppliers in a limited initial period, while a DPS can continue adding new suppliers over time. Given that the sector will need to grow steadily over the coming years as a retrofit is scaled up, this feature of a DPS would remove the risk of locking out new small and medium enterprises (SMEs) and may be more appropriate where the public authority is trying to facilitate the development of a new local supply chain. However, in situations where the buyer is keen to secure social value commitments in the tendering process, the limited number of suppliers within a framework would allow for more focused engagement and relationship management.

- The ability to directly award work in a framework (which is not possible in a DPS) may be used to allocate retrofit spending across several suppliers to build the capacity of the supply chain. One such approach is a round robin, where consecutive pieces of work are offered to each supplier in turn.

- A framework can fix pricing in advance (as specified in the framework agreement), offering a more predictable cost to the buyer over several years compared with a DPS.

- Both approaches are less time-consuming for suppliers than individual tenders, as they only have to pass selection criteria once when joining. In both approaches, this selection stage typically focuses on standard criteria of suitability to pursue a professional activity, economic and financial standing, and technical and professional ability, as stipulated in the Public Contracts Regulations 2015.[25] At the later stage when work is tendered to suppliers via a mini competition, more ambitious criteria around social value can be added to each tender.

Recent work in the north-west of England illustrates the potential for a retrofit DPS to achieve improved social impact. The Local Energy North West Hub[26] commissioned not-for-profit procurement specialists Procure Plus to run a retrofit DPS and to work with suppliers to ensure entry-level jobs created are accessible to local people, especially those from marginalised demographic groups. This process includes taking referrals from the local community and voluntary groups, offering initial training and supporting people during their first six months of employment. The Liverpool City Region CA also worked separately with Procure Plus,[27] who have been able to deliver installation work while providing training and jobs for local people who were far from employment.

Efficiency North,[28] a group of non-profits set up by housing associations in Yorkshire and the Humber, is running its own 5-year DPS for retrofit. The group aims to add social value through several routes, with its procurement arm EN:Procure targeting at least one apprenticeship created for every £1m spent and engaging regularly with local SMEs, and via the group as a whole reinvesting any surplus into its charities, which focus on training and employment support.

The DPS approach[29] has been applied recently to the procurement of retrofit services by three of the five regional energy hubs, as a means of supporting and expediting retrofit by councils using LAD 2 funding. The Greater South East Energy Hub[30] has set up a DPS for installers of fabric efficiency measures, low-carbon heat, and micro-generation, which is managed by Cambridgeshire and Peterborough CA and can be used by all local authorities and social housing providers in their region. The Midlands Energy Hub has similarly set up two DPSs, managed by Nottingham City Council, for local authorities looking to procure installers and professional services.[31]

Frameworks have also been used extensively in the delivery of energy-efficiency building work. The GLA and Local Partnerships are currently operating the fourth iteration of the Re:Fit framework, which can be used by public bodies to procure guaranteed energy savings for their buildings (e.g. via greater energy efficiency or generation). Many of the companies on the Re:Fit framework list are very large multinational organisations.[32] The GLA's RE:NEW framework has operated in a similar way for home retrofit in London, with the potential to incorporate wider goals, such as job creation into the tendering process.[33]

Frameworks can be used to work towards more ambitious technical solutions for retrofit, as seen in the ongoing Innovation Partnership being run by the GLA.[34]. This new approach pairs construction firms with social landlords and provides initial funding of £30,000 per firm for the development of deep retrofit solutions to certain technical and cost-effectiveness standards. Following this initial research, prototyping, and piloting work, it is hoped that the

solutions[35] will be scaled up and any housing provider across the UK will be able to use the framework to procure deep retrofit from the suppliers on the list.[36]

Alternative delivery organisations
A potentially complementary approach to procurement is to utilise the strategic insourcing of services to deliver retrofitting functions. This could include direct labour organisations or arm's length construction companies:

- **A direct labour organisation (DLO)** involves bringing particular functions, often building maintenance and repairs, in-house. Historically, most housing providers – especially stock-owning councils – had DLOs, but they fell out of favour. Things have now changed with many social landlords bringing at least some functions in-house.[37] In the context of retrofit, this could be as involved as developing an entire low carbon construction organisation, directly employing tradespeople and the retrofit coordinators.

- An **arm's length construction (ALC) company**. This is an organisation wholly or partially owned by the council that delivers some of the supply-side functionality needed to retrofit the housing stock. The council can take inspiration from the example of Nottingham City Council, Leicester City Council, Glasgow City Council, and others who have established ALC organisations so that they are more directly able to deliver on strategic ambitions.

These approaches have advantages and disadvantages in the context of retrofit.

- Financial risks are borne by the council if operating a DLO, meaning the financing of retrofit would need to be clarified up front.

- ALC organisations potentially have greater flexibility to demand higher standards when procuring services. Not only can such organisations more proactively include women and ethnic minorities, but they can also offer greater opportunities for new entrants to the sector and more secure forms of employment, and build to higher standards. This is due to the greater flexibility they have in procurement. City Building, the joint-venture not-for-profit construction company owned by Glasgow City Council and Wheatley Housing Group, uses framework agreements to require its sub-contractors to provide good job quality for those delivering construction projects.[38] The framework specifies conditions such as the use of locally sourced materials, employment of apprentices and keeping Construction Skills Certification Scheme (CSCS) cards up to date.

Developing the supply chain

The skills and the workforce for low-energy construction activities must be in sufficient supply as they are needed to retrofit and construct buildings that require "near zero" energy, embed digital technologies, and minimise emissions from construction. To achieve a near zero built environment the number of appropriately trained net zero construction workers will need to rise rapidly.

Map the demand for labour for retrofit against supply and identify shortages
Local authorities should map the demand and supply of retrofit-related skills and combine this to map skills shortages related to low-energy construction.

Accreditation schemes for retrofit suppliers and subcontractors
The general quality of retrofit work in the UK is poor.[39] There is no entry-level barrier to work in the domestic retrofit market, anyone can advertise, and there is no formal qualification or skill level required. Addressing this could involve working with other local authorities to establish accreditation schemes and publish lists of local retrofit companies used by the council.

Develop a net zero construction skills strategy to address current skills gaps and achieve wider sectoral objectives
After the Retrofit Taskforce has mapped the demand for labour for retrofit against supply, it could implement a strategy for addressing existing skills gaps. The council could engage local businesses, colleges, and community groups throughout this process and build a plan that targets certain cohorts of the existing workforce – those with specific skill levels, for instance – for retraining to meet the need. The council could also promote its recommendations for inclusion within Local Plans.

Build confidence and set out expectations to incentivise retaining
To give potential suppliers the confidence to invest and retrain, the council could work with Registered Providers and other local authorities to lay out spending commitments and timelines. Any public communications could highlight the skills and qualifications that prospective contractors would need, for example being Trustmark registered. It could also require larger contractors to commit to not only employing the local workforce and SMEs but also training them to the required level

Training

Work with existing training schemes to develop local skills
The council could either partner with a current scheme provider to provide tradesperson training or set up a dedicated scheme provider to oversee training, marketing of trusted trades, and quality assurance on projects.
If the council was to strategically insource the retrofit operations, through the alternative delivery organisations noted, then it could take a more direct role in ensuring retraining is undertaken.

Create retrofit training centres
The council could work with the regional hubs and providers funded by the Adult Education Budget (AEB) to ensure suitable retrofit training is available locally.

Ambitiously utilise planning powers to support a net zero construction skills strategy
In major developments, the council can be made aware of job opportunities and apprenticeships through planning obligations so that local people from underrepresented social groups can be given the opportunity to fill these vacancies. The council could work with training providers, and contractors to embed these requirements into Employment and Skills Plans (ESPs) and Section 106 agreements (s106s).

Setting ambitious targets that require that women constitute 30% of the construction workforce as a whole, and at least 50% of trainees on certain developments, would help drive up female participation in the sector. The council could identify similar targets for ethnic minority participation.

What more could be done with central government support?

While local authorities have a vital role in improving the housing stock, they are severely limited by the lack of technical, regulatory and financial firepower to deliver on their potential. We identify a few non-exhaustive areas, where urgent intervention from the central government could unlock rapid progress on this agenda.

Regulation of the private rented sector

Around 20% of the UK's housing stock is within the PRS and governments over the years have failed to deliver effective retrofit solutions to this tenure. The latest figures estimate that roughly 60% of the PRS stock is below band C, houses that on average are paying an 'inefficiency penalty' of over £900 a year compared to more efficient homes. The Minimum Energy Efficiency Standards (MEES), which regulate the PRS, have had limited success largely owing to the lack of serious enforcement. The challenge of the split incentive is also cited as a major reason for lack of action where the benefits of investment by the landlord are not borne by them directly but instead by the tenants of the properties. However, this is changing as a recent study for the UK found that EPC Band D-rated homes received a premium of 10% on their sales compared to F- or G-rated homes – with landlords therefore able to recoup more than their investments through their eventual property sales.

A significant number of PRS homes were built pre-1940s and an estimated quarter of them are mid-terraced – factors that need to be considered when judging the necessary measures to be deployed. The path to net zero sees new MEES coming into force in the near future, where landlords will not be allowed to sell a property that is below band C from 1 April 2025 and neither can they let them from 2028. They are instead required to spend a minimum of £10,000 to upgrade properties to that standard.

Acknowledging the severe lack of enforcement of these regulations, the government has committed to spending a meagre £4.3m on 57 local authorities (out of 300 in England & Wales) to fund their engagement with landlords, energy advice providers, and tenants. With over 2.7m PRS households at or below EPC Band D, with at least a quarter of them in fuel poverty, all these homes will need upgrading within the next six years, requiring an urgent scale-up of the necessary local infrastructure both for enforcement and for installation of measures.

A local-authority-led retrofit programme, delivered street by street, should also prioritise the PRS sector. But scaling up measures will require some additional steps both by national and local governments:

1. A significant scale-up for resources for enforcement of MEES regulations, open to all councils with clear target-setting for identifying, engaging, enforcing, and monitoring retrofit measures in PRS properties.
2. Fiscal interventions that support landlords in easily accessing cheap finance. The recent cut to VAT is a welcome measure that can save a landlord hundreds of pounds but more needs to be done. Policies such as the Landlord Energy Saving Allowance, which offers an income tax credit on energy efficiency investments, could

be reintroduced. Local authorities should also extend their funding mechanisms, as described in our illustration in Section 5, to PRS properties.

3. Scale up public engagement and information through clear, effective communication targeting landlords while also providing free advice through home energy or retrofit advisors on the necessary measures, within the £10,000 cap, that landlords should undertake.
4. Central to driving enforcement is a national registry of landlords (currently less than 1 in 10 homes in the PRS are covered by any registration and licensing requirements) that can support the maintenance of high standards in the PRS. Local authorities, following successful examples such as the Liverpool city region, should proactively engage landlords in local licensing schemes.

Governance

The government's Net Zero Strategy highlighted the important role of local authorities in driving decarbonisation and established a new Local Net Zero Forum and renewed the network of low carbon or net zero hubs. The exact terms of reference of this new body are yet to be published but to avoid turning it into another talking shop, the government would do well to use this new forum to support local authorities, particularly those with fewer resources, in undertaking street-by-street retrofit programmes.

Finance

The role of finance is critical in unlocking the net zero ambition that hundreds of local authorities share. A pivotal public institution in providing finance is the UK Infrastructure Bank, which is currently capitalised with £22bn and a mandate to scale up decarbonisation. The bank can initially support local authorities in developing financeable propositions for insulating their housing stock and subsequently offering government-guaranteed loans in delivering projects, particularly the early strong measures, which are quick to install and have an immediate impact on bills. Furthermore, a success story over the last two years, albeit at a small scale, has been the roll-out of the LAD scheme where over 13,000 of the least efficient, low-income households have received a mix of insulation and low-carbon heating measures. The targeting of the scheme ensures those at the sharp end of the current cost of living crisis are receiving much-needed support on cutting their energy demand this winter. Scaling this scheme with a greater allocation of resources can ensure thousands more can benefit from a permanent reduction in their energy bills.

As identified in Section 5, central government has a major role in assisting local authorities and capitalising their retrofit delivery agencies. A powerful mechanism that can unlock billions is in moving the central bank to issue guidance to commercial and high street banks in offering zero or even negative interest loans for households and small businesses to undertake retrofit works.[40] Civil society groups, including NEF, have estimated the need for a cumulative investment of £11.7bn over the course of this current parliament, including grants for heat pumps, insulation measures, and the social housing decarbonisation fund.[41] An estimated £17.8bn of additional private finance can be mobilised with this scale of public investment, largely driven by the able-to-pay owner-occupiers, which is a sector that is currently ignored by policymakers.

Long-term capacity building and public engagement

Local authorities should be able to establish and strengthen long-term institutional capacity in understanding the technical, financial, and physical aspects of retrofitting buildings. This means a well-funded team of retrofit coordinators and advisors that can help households address their bespoke retrofitting needs. This is necessary, in particular, in the able-to-pay sector where the lack of trusted information is an equally significant barrier as the availability of finances. The CCC has recommended the government create a public energy advice service to provide households with guidance on decarbonising their homes. Such a provision in itself will not drive up demand, so we would argue that the central government should support the concurrent growth of the in-house capacity of trusted retrofit advisors within local authorities. This should include upskilling the existing workforce and creating new roles for the coordination and delivery of trusted and accurate advice.

APPENDIX A – ASSESSMENT OF MEASURES

Measure	Description	Costs	Installation speed and skills required	Cost-saving & carbon-cutting potential per year
Loft insulation (0–270mm)	Standard loft insulation involves rolls of insulation being laid over the floor joists. Homes with an accessible loft (with no damp or condensation problems) are typically good candidates for loft insulation.	Detached house – £680 Semi-detached house – £530 Mid-terrace house – £500 Detached bungalow – £690	Installation can be done in a day. Installers may need a Construction Skills Certification Scheme (CSCS) card or equivalent to train and work on a construction site.	Detached house: £580 and 1300kg CO_2 emissions[42] Semi-detached house: £255 and 600kg CO_2 emissions Mid-terrace house: £230 and 540kg CO_2 emissions Bungalow: £365 and 850kg CO^2 emissions
Floor insulation	Both wooden and concrete floors can be insulated. Typically, only the ground floor requires insulation, but any floors above unheated spaces (such as garages) may benefit from insulation.	Varies based on the size of the house and how easy it is to lift and replace the floorboards. https://householdquotes.co.uk/underfloor-insulation-costs/ The average floor insulation cost is estimated to be £1,400 outside of London.	Installation can be done in a day, depending on property size. Household Quotes estimates 1 day for small flats, 1-2 days for terraced houses, 2-3 days for semi-detached houses, and 3-4 days for detached houses. An NVQ in Insulation and Building Treatments is official recognition of the knowledge and skills needed to install insulation or carry out building maintenance work.	Detached house – £130 and 305kg CO_2 emissions Semi-detached house – £75 and 180kg CO_2 emissions Mid-terrace house – £50 and 120kg CO_2 emissions Bungalow – £115 and 270kg CO^2 emissions
Cavity wall insulation	Houses built post-1920s are likely to have cavity walls (made up of two walls with a gap in between, where the outer leaf is usually made of brick, and the inner layer of brick or concrete block).	Detached House – £2500 Semi-detached House – £1200 Mid-terrace house – £620 Detached Bungalow – £940 Mid-floor flat – £410	Installation can be done in a day. Must be a registered installer, possibly requiring specialist training such as Level 2 Insulation and Building Treatments (Construction), a Level 2 BTEC First Certificate or Diploma in Construction), or an NVQ Level 2 in Insulation and Building Treatments – Cold/Warm Roof Insulation course (for experienced roof and loft insulation installers).	Detached house: £480 and 1100kg CO_2 emissions Semi-detached house: £285 and 670kg CO_2 emissions Mid-terrace house: £180 and 425 kg CO_2 emissions Detached bungalow: £195 and 450kg CO_2 emissions Mid-floor flat: £145 and 335kg CO_2 emissions

Solid wall insulation	Solid walls are susceptible to quick heat loss, as heat passes through solid materials faster than through cavities. Around 45% of a home's heat loss could be through solid walls (according to the Energy Saving Trust). Properties built pre-1920s will likely have solid walls. The two traditional options are external wall insulation and internal wall insulation.	Cost varies depending on internal or external wall insulation. Typical installation costs are around £5,000–£9,000 for a three-bedroom semi-detached property, while a larger detached home could cost in the region of £8,000–£15,000.	Most External Wall Insulation (EWI) can be completed within 5–7 working days. Installers should be registered with an appropriate association, such as the Insulation Assurance Authority, and should offer a 25-year guarantee, such as from the Solid Wall Insulation Guarantee Agency (SWIGA).	Detached house: £650 and 1500kg CO_2 emissions Semi-detached house: £390 and 910kg CO_2 emissions Mid-terrace house: £245 and 580kg CO_2 emissions Bungalow: £260 and 610kg CO_2 emissions Mid-floor flat: £195 and 450kg CO_2 emissions
Double-glazed windows	Approximately 10% of the total heat loss from a typical house is through the windows. Double-glazed windows have two sheets of glass with a gap in between, usually about 16mm.	A set of A-rated windows for a semi-detached house will typically cost around £7,500.	If windows are installed by someone registered on an official competent person scheme, then they will provide you with a certificate that states that windows have been installed in line with the regulations. If not, then building control approval will be required before installation.	A-rated double-glazing to windows in an entirely single-glazed semi-detached gas-heated property, could save £145 a year and 335kg CO_2. Installing A++ rated double-glazed windows replacing single glazing, the savings could be up to £175 a year and 410kg CO_2.
Energy efficient front doors	Homes lose 10%–20% of their heat through windows and external doors.	Industry estimates: uPVC front door £800 including installation for A++ rated triple glazed. Composite door: £1,200–£1,500 Timber door: £1,400 – £2,000	Supply chains are well established.	No estimates available.
Draught-proofing	Draught-proofing involves filling in gaps in a building, often open chimneys and gaps around windows and doors. It is one of the cheapest and most effective ways to save energy and money in any type of building.	Approx. £225 for the whole house (professionally).	Can be installed DIY, greatly reducing installation costs.	Approximately £65 and 145 kg CO_2 a year for a typical gas-fuelled semi-detached property.

Replacement boilers (Combi, system, regular)[g]	Modern boilers are more efficient than older boilers because they recover more heat from the exhaust flue gas and use it to heat the central heating water. Heating and hot water accounts can account for over 50% of a home's annual energy bills. An efficient boiler can dramatically affect this. As part of the UK Government's plan to reach net zero carbon emissions by 2050, fossil fuel heating systems are likely to be phased out over time. This will start with a ban on gas and oil boilers in new homes from 2025.	Costs to replace a gas boiler are around £4,000, and £4,700 for oil boilers. Excluding installation, boilers themselves can cost around £500–£2,750, depending on the type (combi, system, or regular).	For gas and LPG boilers, the installer must be Gas Safe registered. For oil boilers, Energy Saving Trust recommends using an OFTEC registered installer.	Replacing an old gas boiler with a new A-rated condensing boiler with a programmer, room thermostat, and thermostatic radiator controls (TRVs): Bungalow (detached) Old boiler rating D: £170 G: £300 Detached house Old boiler rating D: £260 G: £580 Flat (mid-floor) Old boiler rating D: £80 G: £150 Semi-detached house Old boiler rating D: £215 G: £380 Mid-terrace house Old boiler rating D: £180 G: £325
First-time central heating	Installing a central heating system in homes that do not currently have them can help to maintain a consistent temperature throughout a home compared to electric heaters.	The cost of a new central heating system often falls between £3,500 and £5,000. But this will vary depending on several factors. Some grants are available to cover the costs, such as First Time Central Heating Grants (available to both homeowners and tenants in privately rented homes.)[h]	Installation time is generally 2–5 days (if two heating engineers are working on the job), but will take longer if the occupier is home during installation. Installers should be GDGC Accredited.	

[g] Combi boilers take water directly from mains and don't need a hot water cylinder. They are the cheapest option, and a strong choice for homes with 1-2 bathrooms and limited space, but not for larger homes. System boilers heat water directly from mains, but store in a cylinder – this means room is required for a cylinder. Regular boilers are space-consuming, but good choices for homes that use a lot of hot water at once.

[h] Tenants in council owned homes, in housing association homes and householders living in shared ownership homes do not qualify for First Time Central Heating Grants.

Heat pumps[i]	A heat pump uses electricity to capture heat from outside and move it into a home. As a heat pump captures heat that is already present in the environment, the system itself does not burn any fuel and therefore emits no carbon dioxide. Heat pumps are more efficient than other heating systems because the amount of heat they produce is more than the amount of electricity they use.	Installation of an air source pump, the most common type in the UK, can typically cost between £7,000 and £13,000.[j]	Heat pump installer capacity is limited and training support is badly needed to achieve existing UK government targets.	For an air source pump in an average 4-bed detached home Old (G-rated) gas boiler: £910 and 6,000kg CO_2 emissions. New (A-rated) gas boiler: £115 and 2900kg CO_2 emissions. Old electric storage heat pump: £1,900 and 3400kg CO_2 emissions. New electric storage heat pump: £1,000 and 2300kg CO_2 emissions. Old (G-rated) oil boiler: £2,200 and 8,500kg CO_2 emissions. New (A-rated) oil boiler: £600 and 4,600 kg CO_2 emissions. Old (G-rated) LPG boiler: £3,400 and 6,500kg CO_2 emissions. New (A-rated) LPG boiler: £1,400 and 3,400kg CO2 emissions.
Solar Panels/PV	Solar electricity panels, also known as photovoltaics (PV), store and convert the sun's energy into electricity to be used in the home, enabling a property to generate its own renewable electricity.	The estimated installation cost is £5,419.[k] Costs vary significantly based on property details, such as roof slope, shading, roof direction, installation size, etc., and can be upwards of £10,000.	Installation time is typically two days. However, lead-in and consultation time can take weeks.	Using the Solar Energy Calculator for a postcode in our LSOA: For a typical south-facing 3-bed house, the potential annual benefit could be £248 (potential fuel bill saving is £156/year, and potential payments from SEG is £92) and 644kg CO_2 emissions.

[i] Air source heat pumps are the most common in the UK. Ground source might be suitable if you have a garden or large outdoor space. Air-to-air systems are typically more common for small properties like flats or park homes.

[j] Air source heat pumps are the most common in the UK. Ground source might be suitable if you have a garden or large outdoor space. Air-to-air systems are typically more common for small properties like flats or park homes.

[k] For a post code in our LSOA with a 30-degree roof slope, modest shading, south-facing roof, and medium installation size for panels, as per Energy Savings Trust calculator.

Thermostatic radiator valves (TRVs)	Thermostatic radiator valves (TRVs) control the flow of hot water through the radiator to which they are fitted. Programmable TRVs include the normal functionality of standard TRVs but with timing control as well. Some link to smart controllers	TRVs cost about £30–£50 per radiator (including installation (assume one radiator per room excluding bathrooms, installed in all but one radiator)	TRVs are straightforward to install, with DIY installation common.	Around 80% of homes in the UK are heated by wet central heating systems with radiators. Significant savings are possible with TRVs with modelling and lab experiments suggesting that between 8% and 28% of energy costs can be saved. In our modelling, we have down-rated the lower bound of these estimates to account for a performance gap.
Smart heating control systems	Heating control is a broad term covering timers, thermostats, and plumbing and electronic components, which help manage when the heating should be on and what temperature your rooms should be. Smart heating controls can link to your location (geo-fencing), learn heating habits, and be accessed through a smartphone app.	Smart heating controls have an estimated cost of between £199 and £300	The supply chain is well established and installation is straightforward.	Evidence of savings of around 4.5%–10% (other higher claims also exist e.g. an estimated 10%–20% of energy bills) consumption.

APPENDIX B – DETAILED WORKINGS

Table B1 Detailed tables showing modelling and sources of costs and savings per property

Semi-detached house (1–3 rooms)				
No. of properties =	270		**Rationale and source**	
	Investment cost	Annual saving	Investment cost	Annual savings
Strong				
Loft insulation (0–270mm)	£530	£255	From Energy Savings Trust (EST), 2022: https://energysavingtrust.org.uk/advice/roof-and-loft-insulation/	From Energy Savings Trust(EST), 2022: https://energysavingtrust.org.uk/advice/roof-and-loft-insulation/
Cavity wall insulation	£1,200	£285	From EST, 2022: https://energysavingtrust.org.uk/advice/cavity-wall-insulation/	From EST, 2022: https://energysavingtrust.org.uk/advice/cavity-wall-insulation/
Draught-proofing	£225	£45	From EST, 2022 based on semi-detached for all housing types: https://energysavingtrust.org.uk/advice/draught-proofing/	From EST, 2022 based on semi-detached for all housing types: https://energysavingtrust.org.uk/advice/draught-proofing/
TRVs	£200	£85	The cost of installing TRVs is estimated to cost between £30 to £50 per TRV (we assume £40). To estimate the number of TRVs to be installed we estimate that there are 6 radiators (assuming 2 bedrooms, 2 halls, 1 kitchen, and 1 living) with TRVs fitted to all but one of the radiators, as is the norm. Cost source: https://heatingforce.co.uk/blog/radiator-installation-costs/	Computer modelling and lab estimates put the potential energy savings at 8%–28% of energy consumption: http://www.eubac.org/wp-content/uploads/2021/03/White_Paper_on_Room_Temperature_Controls_-_eu.bac_July_2017_FINAL.pdf. Research estimates a 40%+ performance gap between lab and real-life performance: https://www.sciencedirect.com/science/article/pii/S0378778821005375. We combined these figures: (1-performance gap) x % energy saving, to get an estimated saving as a share of consumption. This is then combined with average energy consumption and April 2022 prices to estimate a saving.

Smart heating control systems	£250	£48	Smart thermostats cost between £199 and £299. So we use a mid-point of £250. Source: https://www.cse.org.uk/advice/advice-and-support/central-heating-controls	Smart thermostats are estimated to save 4.5% of energy costs. We apply a 40% performance gap to this to get an estimated energy cost saving of 3%.
	£2,405	**£718**		
Medium				
Solid wall insulation	£12,000	£390	Solid wall insulation is estimated to cost between £10,000 and £14,000. We use a mid-point of £12,000. Source EST: https://energysavingtrust.org.uk/advice/solid-wall-insulation/	From EST, 2022:https://energysavingtrust.org.uk/advice/solid-wall-insulation/
Floor insulation	£1,400	£75	The average floor insulation cost is estimated to be £1,400 outside of London. Source, Checkatrade: https://www.checkatrade.com/blog/cost-guides/floor-insulation-cost/	From EST, 2022: https://energysavingtrust.org.uk/advice/floor-insulation/
Solar panels (PV)	£5,419	£248	From EST, 2022. Using a postcode from our chosen LSOA: https://energysavingtrust.org.uk/tool/solar-energy-calculator/	From EST, 2022. Using a postcode from our chosen LSOA: https://energysavingtrust.org.uk/tool/solar-energy-calculator/
Heat pump	£10,000	£400	From EST, 2022. https://energysavingtrust.org.uk/advice/air-source-heat-pumps/	Based on NEF's linear modelling of savings of a mid-point between a loss of £115 against an A-rated boiler and a saving of £910 against a G-rated boiler. This results in an estimated saving of approximately £400. Figures from the EST, 2022: https://energysavingtrust.org.uk/advice/air-source-heat-pumps/
Double-glazed windows	£7,500	£145	From EST, 2022: https://energysavingtrust.org.uk/advice/windows-and-doors/	From EST, 2022: https://energysavingtrust.org.uk/advice/windows-and-doors/
Medium with solid wall	**£36,319**	**£1,258**		
Medium no solid wall	**£24,319**	**£868**		
Strong and medium with solid wall	**£37,524**	**£1,691**		
Strong and medium with cavity wall	**£26,724**	**£1,586**		

Terraced house (1–3 rooms)				
No. of properties =	**250**		**Rationale and source**	
	Investment Cost	Annual saving	Investment cost	Annual savings
Strong				
Loft insulation (0–270mm)	£500	£230	From Energy Savings Trust(EST), 2022: https://energysavingtrust.org.uk/advice/roof-and-loft-insulation/	From Energy Savings Trust (EST), 2022: https://energysavingtrust.org.uk/advice/roof-and-loft-insulation/
Cavity wall insulation	£620	£180	From EST, 2022: https://energysavingtrust.org.uk/advice/cavity-wall-insulation/	From EST, 2022: https://energysavingtrust.org.uk/advice/cavity-wall-insulation/
Draught-proofing	£116	£28.42	Downgraded semi-detached estimate (from EST), using the ratio between cavity wall insulation costs and savings, between respective property types: https://energysavingtrust.org.uk/advice/draught-proofing/	Downgraded semi-detached estimate (from EST), using the ratio between cavity wall insulation costs and savings, between respective property types: https://energysavingtrust.org.uk/advice/draught-proofing/
TRVs	£150	£73	The cost of installing TRVs is estimated to cost between £30 to £50 per TRV (we assume £40). To estimate the number of TRVs to be installed we estimate that there are 6 radiators (assuming 2 bedrooms, 2 halls, 1 kitchen, and 1 living) with TRVs fitted to all but one of the radiators, as is the norm. Cost source: https://heatingforce.co.uk/blog/radiator-installation-costs/	Computer modelling and lab estimates put the potential energy savings at 8%–28% of energy consumption: http://www.eubac.org/wp-content/uploads/2021/03/White_Paper_on_Room_Temperature_Controls_-_eu.bac_July_2017_FINAL.pdf. Research estimates a 40%+ performance gap between lab and real-life performance: https://www.sciencedirect.com/science/article/pii/S0378778821005375. We combined these figures: (1-performance gap) x % energy saving, to get an estimated saving as a share of consumption. This is then combined with average energy consumption and April 2022 prices to estimate a saving
Smart heating control systems	£250	£34	Smart thermostats cost between £199 and £299. So we use a mid-point of £250. Source: https://www.cse.org.uk/advice/advice-and-support/central-heating-controls	Smart thermostats are estimated to save 4.5% of energy costs. We apply a 40% performance gap to this to get an estimated energy cost saving of 3%.
	£1,636	**£545**		

Medium				
Solid wall insulation	£12,000	£245	Solid wall insulation is estimated to cost between £10,000 and £14,000. We use a mid-point of £12,000. Source EST: https://energysavingtrust.org.uk/advice/solid-wall-insulation/	From EST, 2022:https://energysavingtrust.org.uk/advice/solid-wall-insulation/
Floor insulation	£1,400	£75	The average floor insulation cost is estimated to be £1,400 outside of London. Source, Checkatrade: https://www.checkatrade.com/blog/cost-guides/floor-insulation-cost/	From EST, 2022: https://energysavingtrust.org.uk/advice/floor-insulation/
Solar panels (PV)	£5,419	£248	From EST, 2022. Using a postcode from our chosen LSOA: https://energysavingtrust.org.uk/tool/solar-energy-calculator/	From EST, 2022. Using a postcode from our chosen LSOA: https://energysavingtrust.org.uk/tool/solar-energy-calculator/
Heat pump	£10,000	£400	From EST, 2022. https://energysavingtrust.org.uk/advice/air-source-heat-pumps/	Based on NEF's linear modelling of savings of a mid-point between a loss of £115 against an A-rated boiler and a saving of £910 against a G-rated boiler. This results in an estimated saving of approximately £400. Figures from the EST, 2022: https://energysavingtrust.org.uk/advice/air-source-heat-pumps/
Double-glazed windows	£3,875	£22	Downgraded semi-detached estimate (from EST), using the ratio between cavity wall insulation costs and savings, between respective property types: https://energysavingtrust.org.uk/advice/windows-and-doors/	From EST, 2022: https://energysavingtrust.org.uk/advice/windows-and-doors/
Medium with solid wall	**£32,694**	**£990**		
Medium no solid wall	**£20,694**	**£745**		
Strong and medium with solid wall	**£33,710**	**£1,355**		
Strong and medium with cavity wall	**£22,330**	**£1,290**		

Flat-Maisonette (1–3 rooms)			

No. of properties =	130		**Rationale and source**		
	Investment Cost	Annual saving	Investment cost	Annual savings	
Strong					
Loft insulation (0–270mm)	£500	£230	No relevant estimate so used terraced house estimates. From Energy Savings Trust (EST), 2022: https://energysavingtrust.org.uk/advice/roof-and-loft-insulation/	From Energy Savings Trust (EST), 2022: https://energysavingtrust.org.uk/advice/roof-and-loft-insulation/	
Cavity wall insulation	£410	£145	From EST, 2022: https://energysavingtrust.org.uk/advice/cavity-wall-insulation/	From EST, 2022: https://energysavingtrust.org.uk/advice/cavity-wall-insulation/	
Draught-proofing	£76.88	£23	Downgraded semi-detached estimate (from EST), using the ratio between cavity wall insulation costs and savings, between respective property types: https://energysavingtrust.org.uk/advice/draught-proofing/	Downgraded semi-detached estimate (from EST), using the ratio between cavity wall insulation costs and savings, between respective property types: https://energysavingtrust.org.uk/advice/draught-proofing/	
TRVs	£160	£60	The cost of installing TRVs is estimated to cost between £30 to £50 per TRV (we assume £40). To estimate the number of TRVs to be installed we estimate that there are 5 radiators (assuming 2 bedrooms, 1 hall, 1 kitchen, and 1 living) with TRVs fitted to all but one of the radiators, as is the norm. Cost source: https://heatingforce.co.uk/blog/radiator-installation-costs/	Computer modelling and lab estimates put the potential energy savings at 8%–28% of energy consumption: http://www.eubac.org/wp-content/uploads/2021/03/White_Paper_on_Room_Temperature_Controls_-_eu.bac_July_2017_FINAL.pdf. Research estimates a 40%+ performance gap between lab and real-life performance: https://www.sciencedirect.com/science/article/pii/S0378778821005375. We combined these figures: (1-performance gap) x % energy saving, to get an estimated saving as a share of consumption. This is then combined with average energy consumption and Apil 2022 prices to estimate a saving.	

Smart heating control systems	£250	£34	Smart thermostats cost between £199 and £299. So we use a mid-point of £250. Source: https://www.cse.org.uk/advice/advice-and-support/central-heating-controls	Smart thermostats are estimated to save 4.5% of energy costs. We apply a 40% performance gap to this to get an estimated energy cost saving of 3%.
	£1,397	**£491**		
Medium				
Solid wall insulation	£12,000	£195	Solid wall insulation is estimated to cost between £10,000 and £14,000. We use a mid-point of £12,000. Source EST: https://energysavingtrust.org.uk/advice/solid-wall-insulation/	From EST, 2022:https://energysavingtrust.org.uk/advice/solid-wall-insulation/
Floor insulation	£1,400	£75	The average floor insulation cost is estimated to be £1,400 outside of London. Source, Checkatrade: https://www.checkatrade.com/blog/cost-guides/floor-insulation-cost/	From EST, 2022: https://energysavingtrust.org.uk/advice/floor-insulation/
Solar Panels (PV)	£5,419	£248	From EST, 2022. Using a postcode from our chosen LSOA: https://energysavingtrust.org.uk/tool/solar-energy-calculator/	From EST, 2022. Using a postcode from our chosen LSOA: https://energysavingtrust.org.uk/tool/solar-energy-calculator/
Heat pump	£10,000	£400	From EST, 2022. https://energysavingtrust.org.uk/advice/air-source-heat-pumps/	Based on NEF's linear modelling of savings of a mid-point between a loss of £115 against an A-rated boiler and a saving of £910 against a G-rated boiler. This results in an estimated saving of approximately £400. Figures from the EST, 2022: https://energysavingtrust.org.uk/advice/air-source-heat-pumps/
Double-glazed windows	£2,563	£18	Downgraded semi-detached estimate (from EST), using the ratio between cavity wall insulation costs and savings, between respective property types: https://energysavingtrust.org.uk/advice/windows-and-doors/	From EST, 2022: https://energysavingtrust.org.uk/advice/windows-and-doors/
Medium with solid wall	**£31,382**	**£936**		
Medium no solid wall	**£19,382**	**£741**		
Strong and medium with solid wall	**£32,368**	**£1,282**		

Strong and medium with cavity wall	**£20,778**	**£1,232**

Table B2 Detailed tables showing the proportion of properties installing measures – semi-detached

Semi-detached house (1-3 rooms)			
	Proportion of homes assumed to install measures	**Rationale**	**Source**
Strong			
Loft insulation (0–270mm)	24%	22% of properties are estimated to need loft insulation from FOE analysis. Adjusting for the assumption that only 1 in 3 flats is on the top floor and so eligible means that the need is more concentrated in this housing type.	Friends of the Earth: https://policy.friendsoftheearth.uk/download/data-loft-and-cavity-wall-insulation
Cavity wall insulation	37%	41% of homes in our LSOA were built post-1919. Pre-1920 homes are likely to have been built with solid walls. We assume that 90% of this 41% of homes need solid wall insulation.	Council Tax data, ONS
Draught-proofing	80%	We assume 80% of homes need draught-proofing. This is a placeholder assumption.	N/A
TRVs	37%	An estimated 90% of UK households have central heating (EHS) and an estimated 41% of those (based on an EU-wide estimate, EU BAC) are in need of TRVs	English Housing Survey, 2020 (https://www.gov.uk/government/statistics/english-housing-survey-2020-to-2021-headline-report). EU BAC: http://www.eubac.org/wp-content/uploads/2021/03/White_Paper_on_Room_Temperature_Controls_-_eu.bac_July_2017_FINAL.pdf
Smart thermostat	80%	Conservative placeholder assumption	N/A
Medium			
Solid wall insulation	37%	39% of homes in our LSOA were built post-1919. Pre-1920 homes are likely to have been built with solid walls. We assume that 95% of this 39% of homes need solid wall insulation.	Council Tax data, ONS

Floor insulation	52%	- Only to be done on the ground floor of a house/ building - Properties built before the 1970s are likely to have suspended floors and would benefit most from under-floor insulation - Blackpool 007A has 86% properties built pre-1970 Owing to the complicated nature of the process and the potential for existing installation in those properties best suited we assume that insulation is only installed in 60% of this best-suited group.	Council Tax data, ONS
Solar panels (PV)	50%	Conservative placeholder assumption.	N/A
Heat pumps	75%	Assumed 75% take-up rate	N/A
Double-glazed windows	13%	English Housing Survey, 2020-21	N/A

Table 9 Detailed tables showing the proportion of properties installing measures – terraced

Terraced house (1–3 rooms)			
	Proportion of homes assumed to install measures	**Rationale**	**Source**
Strong			
Loft insulation (0–270mm)	24%	22% of properties are estimated to need loft insulation from FOE analysis. Adjusting for the assumption that only 1 in 3 flats is on the top floor and so eligible means that the need is more concentrated in this housing type.	Friends of the Earth: https://policy.friendsoftheearth.uk/download/data-loft-and-cavity-wall-insulation
Cavity wall insulation	37%	41% of homes in our LSOA were built post-1919. Pre-1920 homes are likely to have been built with solid walls. We assume that 90% of this 41% of homes need solid wall insulation.	Council Tax data, ONS

Draught-proofing	80%	We assume 80% of homes need draught-proofing. This is a placeholder assumption	
TRVs	37%	An estimated 90% of UK households have central heating (EHS) and an estimated 41% of those (based on an EU-wide estimate, EU BAC) are in need of TRVs	English Housing Survey, 2020 (https://www.gov.uk/government/statistics/english-housing-survey-2020-to-2021-headline-report). EU BAC: http://www.eubac.org/wp-content/uploads/2021/03/White_Paper_on_Room_Temperature_Controls_-_eu.bac_July_2017_FINAL.pdf
Smart thermostat	80%	Conservative placeholder assumption	N/A
Medium			
Solid wall insulation	37%	39% of homes in our LSOA were built post-1919. Pre-1920 homes are likely to have been built with solid walls. We assume that 95% of this 39% of homes need solid wall insulation.	Council Tax data, ONS
Floor insulation	52%	- Only to be done on the ground floor of a house/ building - Properties built before the 1970s are likely to have suspended floors and would benefit most from under-floor insulation - Blackpool 007A has 86% properties built pre-1970 Owing to the complicated nature of the process and the potential for existing installation in those properties best suited, we assume that insulation is only installed in 60% of this best-suited group.	Council Tax data, ONS

Solar panels (PV)	50%	Conservative placeholder assumption.	N/A
Heat pumps	75%	Assumed 75% take-up rate	N/A
Double-glazed windows	13%	English Housing Survey, 2020-21	N/A

Table 10 Detailed tables showing the proportion of properties installing measures – flat-maisonette

Flat-Maisonette (1–3 rooms)			
	Proportion of homes assumed to install measures	**Rationale**	**Source**
Strong			
Loft insulation (0–270mm)	7%	22% of properties are estimated to need loft insulation from FOE analysis. But assume that just 1 in 3 flats is on the top floor and so eligible means.	Friends of the Earth: https://policy.friendsoftheearth.uk/download/data-loft-and-cavity-wall-insulation
Cavity wall insulation	37%	41% of homes in our LSOA were built post-1919. Pre-1920 homes are likely to have been built with solid walls. We assume that 90% of this 41% of homes need solid wall insulation.	Council Tax data, ONS
Draught proofing	80%	We assume 80% of homes need draught-proofing. This is a placeholder assumption	N/A
TRVs	37%	An estimated 90% of UK households have central heating (EHS) and an estimated 41% of those (based on an EU-wide estimate, EU BAC) are in need of TRVs	English Housing Survey, 2020 (https://www.gov.uk/government/statistics/english-housing-survey-2020-to-2021-headline-report). EU BAC: http://www.eubac.org/wp-content/uploads/2021/03/White_Paper_on_Room_Temperature_Controls_-_eu.bac_July_2017_FINAL.pdf

Smart thermostat	80%	Conservative placeholder assumption	N/A
Medium			
Solid wall insulation	37%	39% of homes in our LSOA were built post-1919. Pre-1920 homes are likely to have been built with solid walls. We assume that 95% of this 39% of homes need solid wall insulation.	Council Tax data, ONS
Floor insulation	17%	Assume only 1 in 3 flats (assuming three flats per building on average) needs floor insulation	Adapted from other
Solar panels (PV)	17%	Assumed to be a third of the rate of other buildings, following earlier logic.	N/A
Heat pumps	25%	Assumed that 1 heat pump is installed per bloc, with a 75% take-up rate	N/A
Double-glazed windows	13%	English Housing Survey, 2020-21	N/A

APPENDIX C – DEBT MODELLING

Table C1. Detailed working of debt modelling of terraced house, April 2022 prices

Interest rate	2%
Proportion of savings kept	50%
Term of loan	20

Scenario	**Strong measures**
Max loan affordable	£ 4,458
Cost of measures	£ 1,636
Grant required	-£ 2,822

Year	**Remaining principal**	**Interest accrued**	**Annual estimated savings**	**Annual loan payback**
0	£ 1,636	£ 33	£ 545	£ 273
1	£ 1,396	£ 28	£ 545	£ 273
2	£ 1,152	£ 23	£ 545	£ 273
3	£ 902	£ 18	£ 545	£ 273
4	£ 647	£ 13	£ 545	£ 273
5	£ 388	£ 8	£ 545	£ 273
6	£ 123	£ 2	£ 545	£ 273
7	£ -	£ -	£ 545	£ 273
8	£ -	£ -	£ 545	£ 273
9	£ -	£ -	£ 545	£ 273
10	£ -	£ -	£ 545	£ 273
11	£ -	£ -	£ 545	£ 273
12	£ -	£ -	£ 545	£ 273
13	£ -	£ -	£ 545	£ 273
14	£ -	£ -	£ 545	£ 273
15	£ -	£ -	£ 545	£ 273
16	£ -	£ -	£ 545	£ 273

17	£ -	£ -	£ 545	£ 273
18	£ -	£ -	£ 545	£ 273
19	£ -	£ -	£ 545	£ 273
20	£ -	£ -	£ 545	£ 273
21	£ -	£ -	£ 545	£ 273
22	£ -	£ -	£ 545	£ 273
23	£ -	£ -	£ 545	£ 273
24	£ -	£ -	£ 545	£ 273
25	£ -	£ -	£ 545	£ 273

Scenario	**Medium measures**
Max loan affordable	£ 6,089
Cost of measures	£ 20,694
Grant required	£ 14,605

Year	**Remaining principal**	**Interest accrued**	**Annual estimated savings**	**Annual loan payback**
0	£ 6,089	£ 414	£ 745	£ 372
1	£ 6,130	£ 123	£ 745	£ 372
2	£ 5,881	£ 118	£ 745	£ 372
3	£ 5,626	£ 113	£ 745	£ 372
4	£ 5,366	£ 107	£ 745	£ 372
5	£ 5,101	£ 102	£ 745	£ 372
6	£ 4,831	£ 97	£ 745	£ 372
7	£ 4,555	£ 91	£ 745	£ 372
8	£ 4,274	£ 85	£ 745	£ 372
9	£ 3,987	£ 80	£ 745	£ 372
10	£ 3,694	£ 74	£ 745	£ 372
11	£ 3,395	£ 68	£ 745	£ 372
12	£ 3,091	£ 62	£ 745	£ 372
13	£ 2,780	£ 56	£ 745	£ 372
14	£ 2,464	£ 49	£ 745	£ 372

15	£ 2,141	£ 43	£ 745	£ 372
16	£ 1,811	£ 36	£ 745	£ 372
17	£ 1,475	£ 29	£ 745	£ 372
18	£ 1,132	£ 23	£ 745	£ 372
19	£ 782	£ 16	£ 745	£ 372
20	£ 426	£ 9	£ 745	£ 372
21	£ 62	£ 1	£ 745	£ 372
22	£ -	£ -	£ 745	£ 372
23	£ -	£ -	£ 745	£ 372
24	£ -	£ -	£ 745	£ 372
25	£ -	£ -	£ 745	£ 372

Scenario	**Strong and medium measures**
Max loan affordable	£ 10,547
Cost of measures	£ 22,330
Grant required	£ 11,783

Year	**Remaining principal**	**Interest accrued**	**Annual estimated savings**	**Annual loan payback**
0	£ 10,547	£ 447	£ 1,290	£ 645
1	£ 10,349	£ 207	£ 1,290	£ 645
2	£ 9,911	£ 198	£ 1,290	£ 645
3	£ 9,464	£ 189	£ 1,290	£ 645
4	£ 9,008	£ 180	£ 1,290	£ 645
5	£ 8,543	£ 171	£ 1,290	£ 645
6	£ 8,069	£ 161	£ 1,290	£ 645
7	£ 7,585	£ 152	£ 1,290	£ 645
8	£ 7,092	£ 142	£ 1,290	£ 645
9	£ 6,589	£ 132	£ 1,290	£ 645
10	£ 6,076	£ 122	£ 1,290	£ 645
11	£ 5,552	£ 111	£ 1,290	£ 645

12	£ 5,018	£ 100	£ 1,290	£ 645
13	£ 4,474	£ 89	£ 1,290	£ 645
14	£ 3,918	£ 78	£ 1,290	£ 645
15	£ 3,351	£ 67	£ 1,290	£ 645
16	£ 2,773	£ 55	£ 1,290	£ 645
17	£ 2,184	£ 44	£ 1,290	£ 645
18	£ 1,582	£ 32	£ 1,290	£ 645
19	£ 969	£ 19	£ 1,290	£ 645
20	£ 343	£ 7	£ 1,290	£ 645
21	£ -	£ -	£ 1,290	£ 645
22	£ -	£ -	£ 1,290	£ 645
23	£ -	£ -	£ 1,290	£ 645
24	£ -	£ -	£ 1,290	£ 645
25	£ -	£ -	£ 1,290	£ 645

Table 11 Detailed working of debt modelling of terraced House, April 2021 prices

Interest rate	**2%**
Proportion of savings kept	**50%**
Term of loan	**20**

Scenario	**Strong measures**
Max loan affordable	£ 2,574
Cost of measures	£ 1,636
Grant required	-£ 938

Year	Remaining principal	Interest accrued	Annual estimated savings	Annual loan payback
0	£ 1,636	£ 33	£ 315	£ 157
1	£ 1,512	£ 30	£ 315	£ 157
2	£ 1,384	£ 28	£ 315	£ 157
3	£ 1,255	£ 25	£ 315	£ 157
4	£ 1,122	£ 22	£ 315	£ 157

5	£ 987	£ 20	£ 315	£ 157	
6	£ 850	£ 17	£ 315	£ 157	
7	£ 709	£ 14	£ 315	£ 157	
8	£ 566	£ 11	£ 315	£ 157	
9	£ 420	£ 8	£ 315	£ 157	
10	£ 271	£ 5	£ 315	£ 157	
11	£ 119	£ 2	£ 315	£ 157	
12	£ -	£ -	£ 315	£ 157	
13	£ -	£ -	£ 315	£ 157	
14	£ -	£ -	£ 315	£ 157	
15	£ -	£ -	£ 315	£ 157	
16	£ -	£ -	£ 315	£ 157	
17	£ -	£ -	£ 315	£ 157	
18	£ -	£ -	£ 315	£ 157	
19	£ -	£ -	£ 315	£ 157	
20	£ -	£ -	£ 315	£ 157	
21	£ -	£ -	£ 315	£ 157	
22	£ -	£ -	£ 315	£ 157	
23	£ -	£ -	£ 315	£ 157	
24	£ -	£ -	£ 315	£ 157	
25	£ -	£ -	£ 315	£ 157	
Scenario	**Medium measures**				
Max loan affordable	£ 3,516				
Cost of measures	£ 20,694				
Grant required	£ 17,178				
Year	**Remaining principal**	**Interest accrued**	**Annual estimated savings**	**Annual loan payback**	
0	£ 3,516	£ 414	£ 430	£ 215	
1	£ 3,714	£ 74	£ 430	£ 215	
2	£ 3,574	£ 71	£ 430	£ 215	
3	£ 3,430	£ 69	£ 430	£ 215	

4	£ 3,284	£ 66	£ 430	£ 215
5	£ 3,134	£ 63	£ 430	£ 215
6	£ 2,982	£ 60	£ 430	£ 215
7	£ 2,827	£ 57	£ 430	£ 215
8	£ 2,668	£ 53	£ 430	£ 215
9	£ 2,507	£ 50	£ 430	£ 215
10	£ 2,342	£ 47	£ 430	£ 215
11	£ 2,174	£ 43	£ 430	£ 215
12	£ 2,002	£ 40	£ 430	£ 215
13	£ 1,827	£ 37	£ 430	£ 215
14	£ 1,649	£ 33	£ 430	£ 215
15	£ 1,467	£ 29	£ 430	£ 215
16	£ 1,281	£ 26	£ 430	£ 215
17	£ 1,092	£ 22	£ 430	£ 215
18	£ 899	£ 18	£ 430	£ 215
19	£ 701	£ 14	£ 430	£ 215
20	£ 501	£ 10	£ 430	£ 215
21	£ 296	£ 6	£ 430	£ 215
22	£ 86	£ 2	£ 430	£ 215
23	£ -	£ -	£ 430	£ 215
24	£ -	£ -	£ 430	£ 215
25	£ -	£ -	£ 430	£ 215

Scenario	Strong and medium measures
Max loan affordable	£ 6,090
Cost of measures	£ 22,330
Grant required	£ 16,241

Year	Remaining principal	Interest accrued	Annual estimated savings	Annual loan payback
0	£ 6,090	£ 447	£ 745	£ 372
1	£ 6,164	£ 123	£ 745	£ 372

2	£ 5,915	£ 118	£ 745	£ 372
3	£ 5,661	£ 113	£ 745	£ 372
4	£ 5,401	£ 108	£ 745	£ 372
5	£ 5,137	£ 103	£ 745	£ 372
6	£ 4,867	£ 97	£ 745	£ 372
7	£ 4,592	£ 92	£ 745	£ 372
8	£ 4,312	£ 86	£ 745	£ 372
9	£ 4,025	£ 81	£ 745	£ 372
10	£ 3,733	£ 75	£ 745	£ 372
11	£ 3,436	£ 69	£ 745	£ 372
12	£ 3,132	£ 63	£ 745	£ 372
13	£ 2,822	£ 56	£ 745	£ 372
14	£ 2,506	£ 50	£ 745	£ 372
15	£ 2,184	£ 44	£ 745	£ 372
16	£ 1,855	£ 37	£ 745	£ 372
17	£ 1,520	£ 30	£ 745	£ 372
18	£ 1,178	£ 24	£ 745	£ 372
19	£ 829	£ 17	£ 745	£ 372
20	£ 473	£ 9	£ 745	£ 372
21	£ 110	£ 2	£ 745	£ 372
22	£ -	£ -	£ 745	£ 372
23	£ -	£ -	£ 745	£ 372
24	£ -	£ -	£ 745	£ 372
25	£ -	£ -	£ 745	£ 372

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