City of London Corporation



City of London Corporation Housing NZ Action Plan

August 2021 | Rev J

CITY OF LONDON

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Contents

0.0
Executive Summary
p.3

1.0
Achieving Net Zero: Why and what?

Why
The context
p.10

2.0
Understanding the buildings and the right measures

Carbon performance
Resident engagement
Introducing archetypes
Which measures go where
p. 19

3.0
Housing Net Zero Action Plan templates
p. 35

4.0
Relating the Action Plan to the Climate Action Strategy

Carbon pathways to 2027 and 2040
p.51

5.0
Costs, funding & finance

Cost breakdowns
Potential sources of funding
p.58

6.0
Prioritisation & other recommendations

Prioritisation
Next Steps
p.66

7.0
Glossary
Appendices
p. 77

Executive Summary

The Climate Action Strategy and Housing

The City of London Corporation (CoL) owns 5,028 residential units, across 82 different buildings, across 14 estates. These 14 estates are currently responsible for 11.2 $ktCO_2$/yr (both landlord and tenant emissions).

The Corporation's Climate Action Strategy (CAS) commits to being net zero carbon by 2027 for the all Scope 1 and 2 emissions within the Corporation's control. For the housing stock, this encompasses all emissions associated with communal heating, lighting, lifts and any other landlord controlled energy. Currently, Scope 1 and 2 emissions from housing amount to 5 $ktCO_2$/yr.

The CAS also commits the Corporation to being net zero carbon by 2040 for all emissions, including Scope 3 emissions. For the housing stock, this encompasses all landlord emissions (Scope 1 and 2) plus emissions associated with energy that tenants and leaseholders consume in their properties. Scope 3 emissions from CoL's housing stock amount to 6.2 $ktCO_2$/yr.

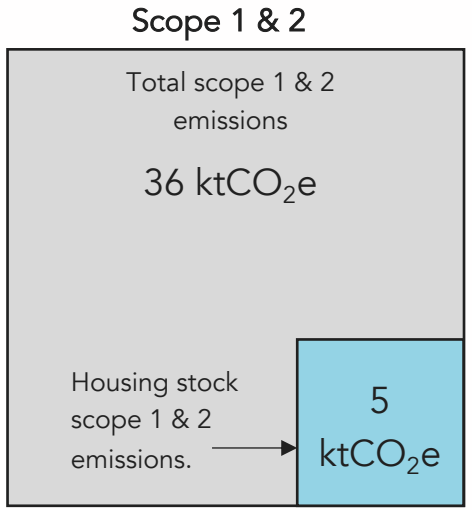
Achieving net zero carbon

Achieving the Corporation's net zero carbon targets will require large reductions in CO_2 emissions from its homes. The target does not require individual homes to be net zero carbon, rather the Corporation as a whole.

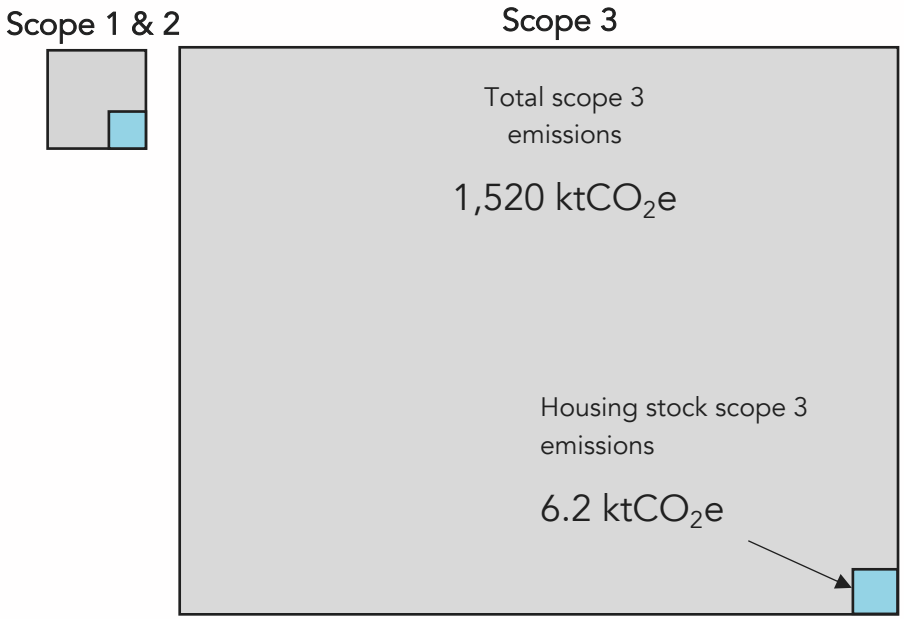
The Corporation owns land based assets which sequester 16 $ktCO_2$/yr (assessed by the University of Surrey) and wants to utilise this to balance emissions for the purposes of the Climate Action Plan targets.

In the scenarios discussed on the following pages, we have applied a proportional fraction of this sequestration to housing - 2.4 tCO_2/yr as at 2027. The Corporation could choose to apply more or less than this.

Due to these direct Greenhouse Gas Removals, the Climate Action Strategy (CAS) target can be met through a 59.2% reduction in CO_2 emissions from the baseline. This study seeks to understand the potential of housing to be consistent with this reduction.



Current scope 1 & 2 emissions for the City of London Corporation, showing proportion attributed to housing stock in blue.



Current scope 3 emissions for the City of London Corporation, showing proportion attributed to housing stock in blue. Scope 1 and 2 emissions shown for scale.

Executive Summary

Achieving the 2027 target for Scope 1 and 2 emissions

The key priorities for reducing scope 1 and 2 emissions (emissions associated with energy controlled by the Corporation) will be:

- Stop using gas for communal heating as soon as possible
- Install roof insulation early
- Install as many photovoltaics on the roofs as possible (at the same time, or after, roof insulation).
- Make communal lighting more efficient – upgrade to LED lighting and review lighting controls for each estate.
- Review controls of energy systems – is there scope to improve controls of communal heating systems?
- Review, and replace if necessary, insulation on pipework of communal heating systems.

We have modelled the impact of the above retrofit actions on energy and CO_2 emissions in two scenarios:

Scenario 1: As above apart from the new gas communal heating at Middlesex Street Estate and York Way Estate, which would remain in operation in 2027.

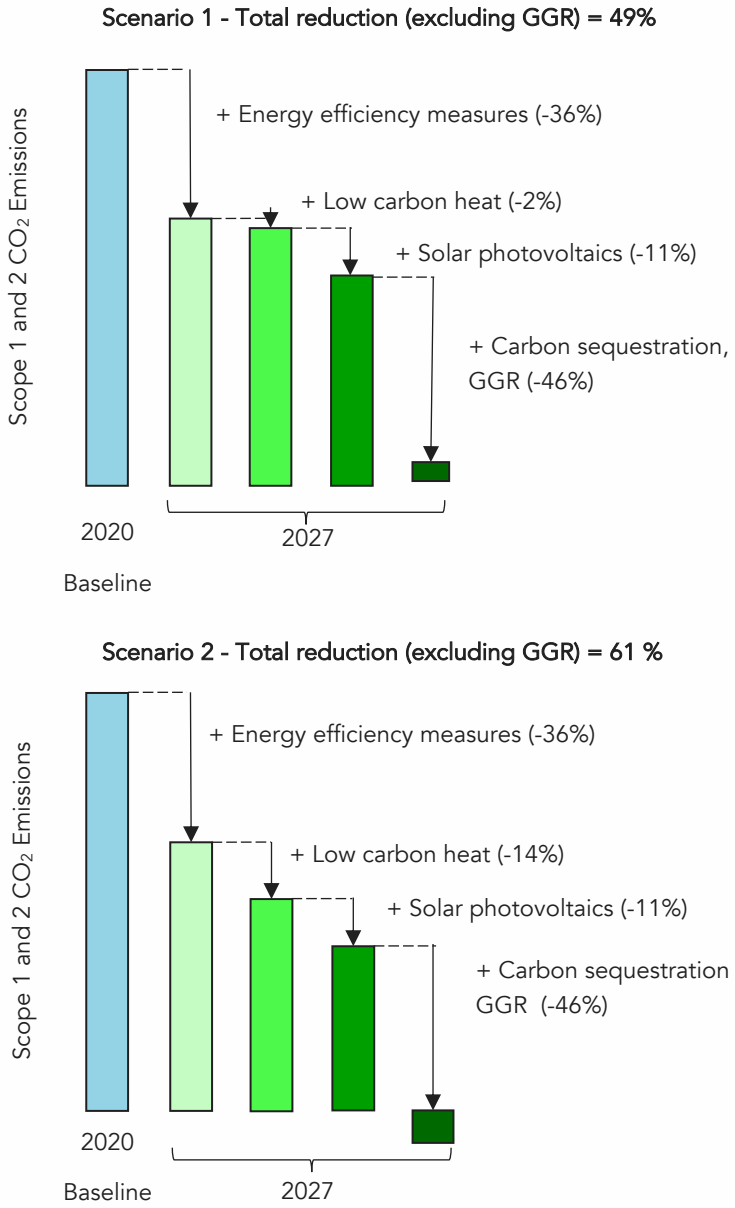
In this scenario, at 2027, a 49% reduction in emissions is achieved from the 2020 baseline, (including a 11% reduction attributable to the installation of solar photovoltaic panels on housing stock).

Scenario 2: As above – all gas communal heating replaced with communal Air Source Heat Pumps.

In this scenario, at 2027 a 61% reduction in emissions is achieved from the 2020 baseline, (including a 11% reduction attributable to the installation of solar photovoltaic panels on housing stock).

All remaining emissions are associated with imported grid electricity.

If we apply the direct greenhouse gas removals (GGR) from the Corporation's land based assets to scenario 2, the total emissions reduction is **107%** = carbon negative.



Scope 1 and 2 CO_2 emissions reduction strategies to 2027. Figures suggest emissions are carbon negative by 2027 only if all gas communal heating is changed to Air Source Heat Pumps by 2027.

Executive Summary

Achieving the 2040 target for Scope 1, 2 and 3 emissions

The key priorities for reducing Scope 3 emissions (from energy controlled by tenants, leaseholders and the Corporation) will build on the actions taken for Scope 1 and 2 emissions (landlord), and will be:

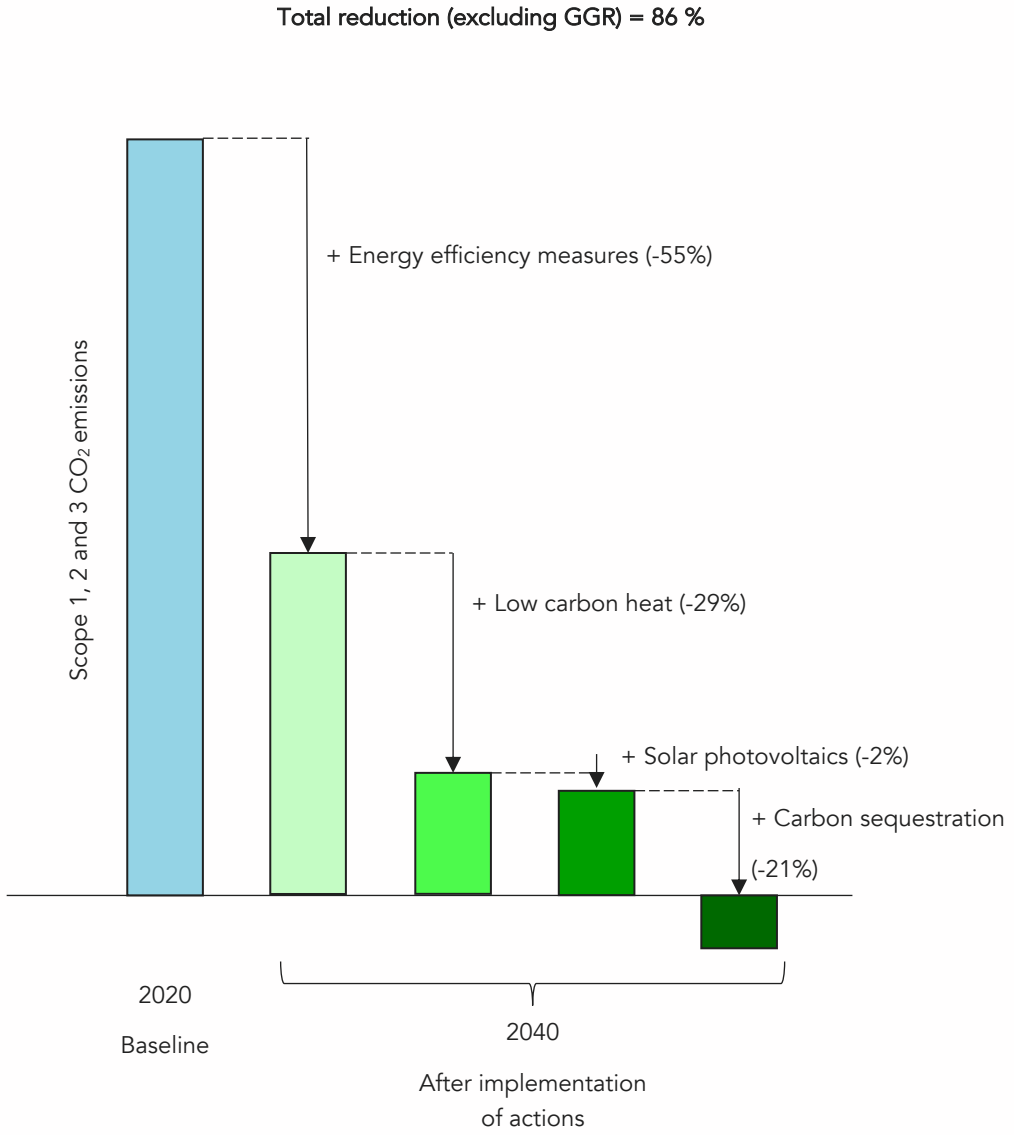
- Remove individual gas boilers in all properties and replace with low carbon heating alternatives.
- Improve the energy efficiency of the fabric of the buildings through:
  - Replacing windows with triple glazing,
  - Installing wall insulation where possible (the type will be dependant on the building),
  - Install roof insulation (where not already undertaken for 2027 target),
  - Improve air-tightness of homes to avoid unnecessary heat loss through leaky buildings,
  - Install floor insulation,
  - Improve ventilation – preferably through whole dwelling mechanical ventilation with heat recovery,
  - Install waste water heat recovery to showers and baths.

These measures apply both to existing and new build dwellings.

We have modelled the impact of the above retrofit actions, plus the actions to tackle Scope 1 and 2 emissions, on energy and CO_2 emissions. This includes future emissions from known new-build dwellings. Assuming all measures are undertaken, at 2040 14% of emissions remain (from the 2020 baseline). All remaining emissions are associated with imported grid electricity.

If we apply the direct greenhouse gas removals from the Corporation's land based assets, the net zero carbon target is achieved, with 107% emissions reduction – slightly carbon negative.

Should the Corporation target lower emissions reductions, we would recommend that land based sequestration isn't used to balance emissions from gas consumption.



Scope 1, 2 and 3 CO_2 emissions reduction strategy to 2040. Provisional figures suggest emissions are practicably carbon negative by 2040 (figures to be checked and verified).

Note: solar photovoltaics have an apparently small impact due to the low carbon intensity of the grid electricity they are offsetting. However, they do provide a vital contribution of renewable electricity to the grid upon which the total reductions rely.

Executive Summary

Actions for helping achieve the 2027 target for Scope 1 and 2 emissions

Action	By	Priority buildings / estates	Rationale
Stop using gas for heating as soon as possible  LOW CARBON HEAT	2026	All buildings – especially large estates: Middlesex Street Estate York Way Estate	It is acknowledged that the UK (and the rest of the world) needs to make a complete transition away from gas. If the Middlesex Street and York Way Estates remain on communal gas boilers, the Corporation's 2027 net zero carbon target will need to rely on increased emissions reductions from others sectors. **Co-benefits**: Large reduction in carbon emissions by 2027, benefitting the overall aim of the Climate Action Strategy.
Install hot water storage in individual units where heating systems are changed  DEMAND FLEXIBILITY	2026	All where heating is changed to low carbon heat sources	Hot water storage can be used to reduce peaks in heat system demand or to store energy by heating hot water when the grid has an oversupply to use later. This is particularly useful for dwellings using direct electric heating methods, to reduce heating bills and the peak load on the electricity network but is also useful where Heat Pumps are used. **Co-benefits**: Hot water storage allows the occupant to take advantage of cheap electricity if using a flexible tariff.
Install roof insulation early ENERGY EFFICIENCY	2026	Avondale Square Estate Holloway Estate York Way Estate Middlesex Street Estate	Roof insulation is an important (and often relatively simple) retrofit measure. It should be installed before, or at the same time as, photovoltaic panels. Some buildings have greater capacity for renewable energy generation. These should be prioritised and are listed here (left). **Co-benefits**: Reduced energy bills. Less risk of damp and mould, which can cause health problems for occupants.
Install as many photovoltaics on the roofs as possible (at the same time, or after, roof insulation).  RENEWABLE ENERGY	2026	Avondale Square Estate Holloway Estate York Way Estate Middlesex Street Estate	Photovoltaic panels produce renewable energy that displaces grid electricity and contributes to reducing its carbon intensity. Priority estates have been selected for their optimal roof space and consequently their significant renewable energy generation potential. **Benefits:** Can generate income and potentially reduce bills.

Actions for helping achieve the 2027 target for Scope 1 and 2 emissions (continued)

Action	By	Priority buildings / estates	Rationale
Make communal lighting more efficient – upgrade to LED lighting and review lighting controls for each estate. ENERGY EFFICIENCY	2026	Barbican Estate CoL Almshouses Gresham Almshouses	Some estates have large landlord electricity consumption relative to others (see left). **Co-benefits:** Reduced energy bills. Can be passed onto occupants.
Review controls of energy systems – is there scope to improve controls of communal heating systems. ENERGY EFFICIENCY	2026	Middlesex Street Estate York Way Estate Isleden House Estate	All communally heated estates (except Frobisher Crescent on the Barbican Estate) use approximately double the gas per dwelling compared with comparable homes on other estates which have individual heating systems. This indicates significant energy may be being lost in the distribution networks and poor controls, e.g. too high flow temperature or residents leaving heating on either when they are not on the premises or when they are but they open the windows rather than turn heating down/off. A number of residents right across the stock, and particularly at the Middlesex Street Estate, reported having to open their windows in winter to avoid overheating. Despite having triple glazing, the Middlesex Street Estate uses the most gas per dwelling of all communally heated estates, suggesting it has poor controls or high distribution heat loss or both. Large estate – 281 dwellings. York Way Estate is a large estate with 278 dwellings. 30-year old double glazing should also be changed as a priority. **Co-benefits**: Reduced energy bills. Improved occupant health and comfort through reduction in overheating.
Review, and replace if necessary, insulation on pipework of communal heating systems. ENERGY EFFICIENCY	2026	Middlesex Street Estate York Way Estate Isleden House Estate	

Actions for helping achieve the 2040 target for Scope 3 emissions

Action	By	Priority buildings / estates	Rationale
Continue to remove individual gas boilers in all properties and replace with low carbon heating alternatives and install hot water storage where there is none  LOW CARBON HEAT  DEMAND FLEXIBILITY	2032	All	All gas heating should be replaced by low carbon heating in all properties, as evidenced by the Housing London Retrofit Action Plan. Cumulative carbon emissions must be limited to stay within carbon budgets, therefore planning must start immediately to make all properties low carbon heat ready. Replacements should happen as soon as possible and should always include the installation of hot water storage wherever possible. **Co-benefits**: Improved local air quality. Improved health and safety through removal of gas connection and associated risks.
Replacing windows with triple glazing ENERGY EFFICIENCY	2032	All properties with single glazing or older, poor double glazing	Improved glazing has a big impact on heat loss and comfort. Cold, draughty windows were one of the biggest complaints from the resident engagement. The surface temperature of triple glazing remains warmer than single glazing, therefore the perceived temperature is higher and the internal air temperature can be lower to achieve the same 'comfort' perception, saving more on heating energy than the simple uplift in insulation achieves. **Co-benefits**: Improved comfort, lower energy bills. Reduces risk of damp and mould an associated health problems. Better acoustic performance.
Improve air-tightness of homes to avoid unnecessary heat loss through leaky buildings (infiltration) ENERGY EFFICIENCY	2032	All properties.	Consider not only around windows and window frames, but also doors, letterboxes, fire escapes, ventilation ducts and pipework entering the dwelling and also the main building envelope junctions especially roof eaves. Heat lost through air leakage can be very significant. **Co-benefits:** Improved comfort, lower energy bills and in combination with the introduction of improved mechanical ventilation (see next point), improved indoor air quality
Improve ventilation – preferably through whole dwelling mechanical ventilation with heat recovery (MVHR) ENERGY EFFICIENCY	2032	Any property that undergoes window upgrades.	Ventilation is important for air quality and removal of moisture build up in the air. Uncontrolled infiltration as described in the point above, can give the impression that a room is ventilated, but the quality of the air and the distribution of it is usually poor. Whole dwelling MVHR provides essential ventilation without the heat loss experienced through opening windows or "leaky" buildings. Windows can still be opened in the summer. **Co-benefits**: Improved comfort, improved indoor air quality, lower energy bills.

Actions for helping achieve the 2040 target for Scope 3 emissions (continued)

Action	By	Priority buildings / estates	Rationale
Installing wall insulation where possible (type dependant on building). ENERGY EFFICIENCY	2032	Properties with high ratio of external wall to internal area.	To achieve low levels of space heating demand, wall insulation may be necessary, especially on blocks with high external surface area relative to the internal floor area, such as top floor and ground floor flats, end flats and end of terrace houses and blocks with external 'deck' access. **Co-benefits:** Lower energy consumption (and bills), reduced risk of mould and damp and associated health problems.
Install roof insulation (where not already undertaken for 2027 target). ENERGY EFFICIENCY	2032	All	Uninsulated roofs can present comfort and heat loss problems, especially for top floor units. **Co-benefits:** Improved comfort. Reduced energy consumption (and bills) less risk of damp and mould and associated health problems.
Install floor insulation ENERGY EFFICIENCY	2038	All	Uninsulated floors can present comfort and heat loss problems, especially in ground floor units. **Co-benefits:** Improved comfort, less risk of damp and mould.
Install waste water heat recovery to showers and baths. ENERGY EFFICIENCY	2038	All	Hot water is often a substantial energy use in homes, and it becomes more significant as the fabric performance is improved. Measures to reduce hot water usage are difficult to introduce, especially in existing buildings. Recovering heat from the water going into the drains and using it to pre-heat cold water feeding hot water storage cylinders can have a useful impact on this hard-to-treat energy consumption. **Co-benefits:** Lower energy bills. Reduction in peak electricity demand.
Improved appliances ENERGY EFFICIENCY	2038	All	One of the key energy users in the Scope 3 emissions is the kitchen appliances that tenants use. A policy to encourage the selection of better performing appliances as and when old ones are replaced will help to reduce electricity consumption across the estate. **Co-benefits:** Lower energy bills. Reduction in peak electricity demand.

1.0 Achieving Net Zero

Why and how?

This section provides and overview of the context in which this net zero carbon action plan sits. It includes:

- Its relationship with the City of London Corporation's Climate Action Strategy and the London Retrofit Action Plan commissioned by London Councils.
- Core principles of low carbon retrofit
- The types of retrofit measures that might be required for the housing stock.
- Where our energy will come from in the future.

Why a net zero carbon action plan for housing?

This report presents an action plan for the retrofit of the City of London Corporation's (CoL) housing stock, in response to its net zero carbon targets outlined in the Climate Action Strategy.

The Corporation has committed to four overarching targets:

- Net zero by 2027 for the City Corporation's operations
- Net zero by 2040 for the City Corporation's full value chain
- Net zero by 2040 in the Square Mile.
- Climate resilience in its buildings, public spaces and infrastructure.

How the Net Zero by 2027 target relates to housing

Scope 1 emissions are all emissions associated with fossil fuels combusted by the Corporation (e.g. gas, petrol and diesel).

Scope 2 emissions are all emissions associated with electricity used directly by the Corporation.

Total Scope 1 and 2 emissions were assessed by ARUP to be 36 $ktCO_2e$ in 2018.

In the context of CoL's **housing** portfolio, scope 1 and 2 emissions include:

- Communal heating and hot water provided to homes
- Heating of community centres, estate offices, or other ancillary functions of the housing estates.
- Emissions associated with shared spaces such as lighting and lifts.
- We estimate Scope 1 and 2 emissions from **housing** to be **5 $ktCO_2e$** in 2020, representing 14% of the Corporation's total Scope 1 and 2 emissions.

Scope 1

Net zero carbon by 2027

Landlord controlled **gas**:

- Communal gas heating
- Gas heating of other estate premises

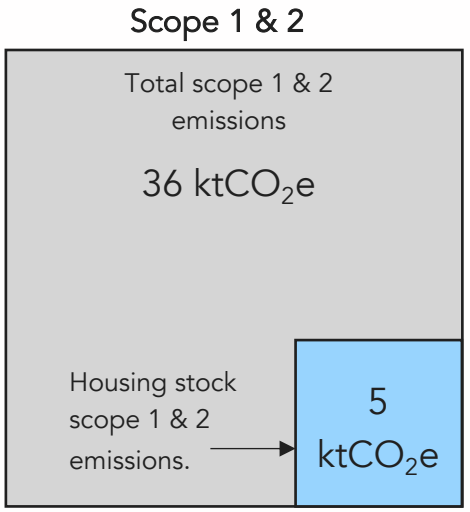
Scope 2

Net zero carbon by 2027

Landlord controlled **electricity**:

- Communal lighting
- Communal electric heating
- Lifts
- Other communal electricity

Scope 1 & 2 emissions in the context of this Housing Net Zero Action Plan



Current scope 1 & 2 emissions for the City of London Corporation, showing proportion attributed to housing stock in orange.

How the net zero by 2040 target affects housing

City of London Corporation also has a target of achieving net zero carbon for all its Scope 3 emissions by 2040.

Scope 3 emissions are all other emissions associated with the Corporation's activities or assets - e.g. purchased goods and services, business travel, commuting, waste, leased buildings (emissions from tenants or leaseholders fuel consumption) and financial investments.

Total Scope 3 emissions were assessed by ARUP to be 1,520 $ktCO_2e$ in 2018.

In the context of CoL's **housing** portfolio, scope 3 emissions include:

- Resident purchased energy for heating, hot water, lighting, appliances or any other energy used in the home (including both tenants and leaseholders).
- We estimate Scope 3 emissions from **housing** to be **6.2 $ktCO_2e$** in 2020, representing 0.5% of total scope 3 emissions.

Carbon accounting for the 2040 target

The Science Based Targets Initiative (SBTi) require only two thirds of Scope 3 emissions need be included in the net zero target committed to by the City of London Corporation. Emissions stated on this page do not include this reduction.

Our estimates of Scope 3 CO_2 emissions only include this reduction when explicitly stated for projected emissions in 2040.

Carbon sequestration

The City of London Corporation own land based assets that have been separately assessed* to sequester 16 $ktCO_2$ from the atmosphere every year. The Climate Action Strategy targets allow a proportion of this sequestration to be used as an offset to total operational Scope 1 and Scope 2 emissions.

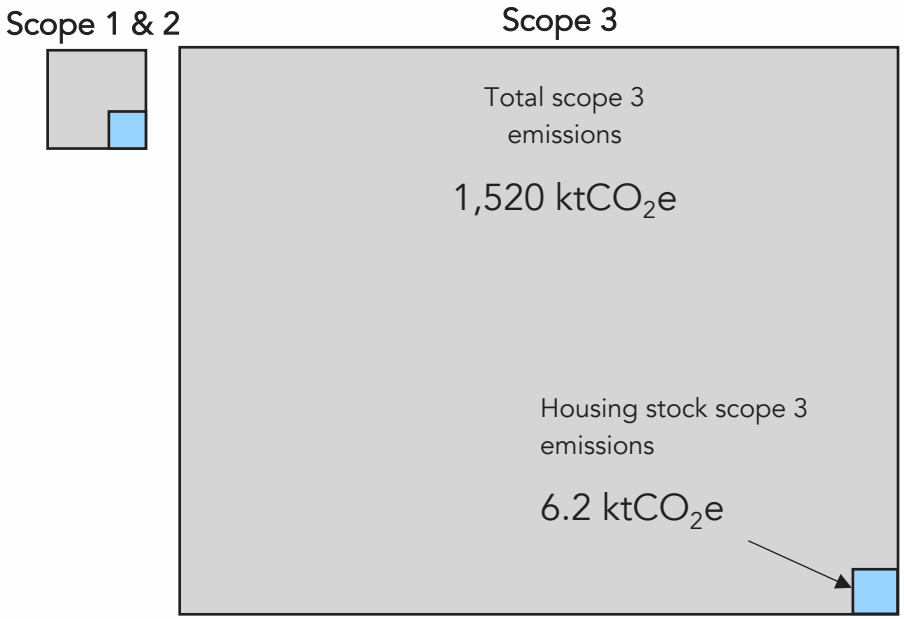
*Final Report WG5A - Sequestration Potential of the City of London's Open Spaces, 24 July 2020.

Scope 3 – Housing Zero carbon by 2040

Resident purchased **energy**:

- Gas or electric heating
- Lighting
- Appliances
- Cooking

Scope 3 emissions in the context of this Housing Net Zero Action Plan



Current scope 3 emissions for the City of London Corporation, showing proportion attributed to housing stock in orange. Scope 1 and 2 emissions shown for scale.

Link with the London Retrofit Housing Action Plan

The Retrofit London Housing Action Plan

The Retrofit London Housing Action Plan is a project funded by a combination of London Councils, the London Housing Directors' Group, Greater London Authority and LEDNet. It considers all housing in London, not just the housing stock managed by respective councils. It recommends nineteen actions and activities across four different themes:

- Technical: retrofit measures, packages and plans
- Delivery models, skills and supply chain
- Costs, finance and funding
- Engagement and communication

The Retrofit London Housing Action Plan provides information on current best practice in London and beyond and sets a number of principles which should underpin any retrofit action plan.

The two Action Plans are complementary

This Action Plan, specific to the City of London Corporation's housing stock, builds upon the technical recommendations within the Retrofit London Housing Action Plan. It is intended to be complementary to that report, and to be read alongside it.

The City of London Corporation is actively involved with the Retrofit London Housing Action Plan, therefore we have signposted its recommendations instead of repeating the relevant information. We recommend referring to it for wider context and higher level recommended actions.

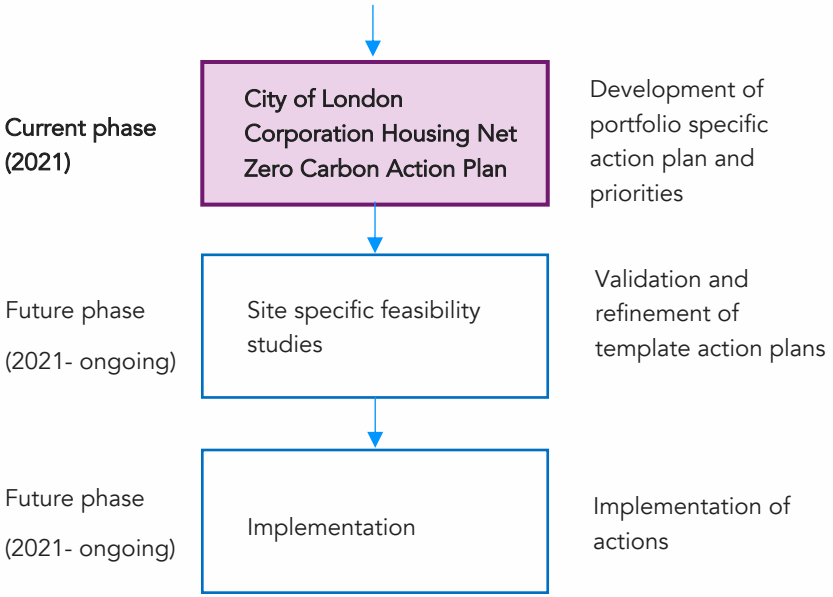
The wider context

The City of London Housing Net Zero Action Plan offers retrofit templates, or starting points, for six different archetypes which typify CoL's housing stock. These "template" action plans can be used as a starting point from which to build site specific feasibility studies and refined, detailed implementation plans.

Retrofit London Housing Action Plan

Draft completed (2021)

The Retrofit London Housing Action Plan is a 70-page report. It has been led by London Councils with input from the 32 London boroughs and the City of London.



The City of London Corporation Housing Net Zero Carbon Action Plan is an important step in the journey to zero carbon housing stock.

Link with the London Housing Retrofit Action Plan

Actions from the Retrofit London Housing Action Plan

This Housing Net Zero Action Plan for the City of London Corporation directly addresses nine of the nineteen actions recommended by the London Housing Retrofit Action Plan.

This Action Plan addresses, in part, all of the technical recommendations outlined in section 1 of the London Housing Retrofit Action Plan.

We have identified packages of energy efficiency measures, including ventilation strategies, and identified priority blocks and buildings to tackle. Specifications are suggested, but detailed feasibility studies and design packages will need to be created at a later stage.

Low carbon heat strategies applicable to archetypes are identified. Solar photovoltaic generation potential has been quantified.

Current maintenance and replacement programmes have been identified, and recommendations made to capitalise on these planned measures, some of which are already funded.

An approximate cost of retrofit for the housing portfolio has been identified, together with potential funding. The gap between funding and anticipated costs has been estimated.

The other ten actions from the London Housing Retrofit Action Plan are all very important to facilitate effective retrofit, and we recommend that the Corporation progresses all actions within it where possible.

	Retrofitting measures, packages and plans	
1	Improve the envelope of London's inefficient homes	☑
2	Develop a plan for retrofitting ventilation systems to improve health and air quality	☑
3	Electrify heat	☑
4	Deliver smart meters and demand flexibility (controls, storage) in retrofitted homes	☑
5	Increase solar energy generation on London homes	☑
6	Map out each building's journey towards lower energy costs and Net Zero	☑
	Delivery models, skills and supply chain	
7	Review current maintenance programmes and identify retrofit opportunities	☑
8	Facilitate procurement of materials and services at a larger scale	
9	Enable planning to facilitate low carbon retrofit, including in conservation areas	
10	Develop retrofit skills actively across London	
11	Set up a clear and consistent system to report and monitor progress (and success)	
	Costs, funding and finance	
12	Establish cost of retrofit, business case and funding gap for the different tenures	☑
13	Maximise capital finance for council owned stock (and eligible homes)	☑
14	Create a 'Finance for retrofit' taskforce with finance experts	
15	Support the owner occupier and PRS sectors to leverage private investment	
	Engagement and take-up	
16	Social housing: engage with tenants, leaseholders and other registered providers	
17	Engage with owner occupiers and the Private Rented Sector	
18	Lobby Central Government for more support, guidance and funding	
19	Continually develop and implement the Action Plan together	

Core principles of low carbon retrofit

Energy efficiency

Buildings use energy for heating, hot water, ventilation, lighting, cooking and appliances. The efficient use of energy reduces running costs and carbon emissions. It also reduces a building's impact on the wider energy supply network, which is also an important consideration. Improving energy efficiency relies on the replacement of windows with more efficient ones, a better level of insulation and airtightness for the building fabric and also controlled ventilation, ideally with heat recovery, to ensure air quality and avoid condensation issues.

Low carbon heating

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

Renewable energy generation

The roofs of buildings should be utilised as far as possible for photovoltaic panels which will generate renewable electricity.

Other key considerations

- **Demand flexibility:** with electricity being used more and more to meet heating demand and with more renewable electricity being generated locally, the ability of a dwelling to manage demand with more flexibility is becoming important.
- **Avoiding carbon offsets:** a sustainable Net Zero carbon strategy should not use carbon offsets to allow continued greenhouse gas emissions. The Climate Change Committee is clear that offsets should be reserved to 'hard-to-decarbonise' sectors such as aviation and agriculture. Offsets should therefore be avoided or considered only as a stepping stone. The Climate Action Strategy does not support the use of offsetting mechanisms other than including its own land based assets carbon sequestration potential.

Category	Measure
Energy efficiency	Double or triple-glazed windows
	Insulation (wall, roof, floor)
	Airtightness
	Ventilation (e.g. MVHR)
Low carbon heat and no more fossil fuels	Individual heat pumps
	Communal heat pumps
	Direct electric
Demand flexibility	Energy storage
	Smart energy controls
Renewable energy generation	Solar PVs

Summary of key retrofitting measures which the London Home Retrofit Action Plan should seek to deliver

Moving away from gas boilers is critical

Carbon budgets and cumulative carbon

The Climate Change Committee (CCC) have been very clear that the use of fossil fuels has to be eliminated in virtually all buildings by 2050.

A carbon budgets approach helps us to understand the impacts of the pace of change between now and 2050 and is imperative if we are to meet our obligations under the Paris Agreement in limiting global temperature rises to no more than 2C.

Carbon budgets take into account the effect of cumulative CO_2 emissions in the atmosphere. Cumulative emissions are proportional to global temperature rises. The Tyndall Centre for Climate Change has taken a Paris aligned global carbon budget and used it to derive a carbon budget for the UK and all the Local Authorities within it.

According to this analysis, London's remaining carbon budget is 204 $MtCO_2$. Meeting the budget must not rely on carbon offsets.

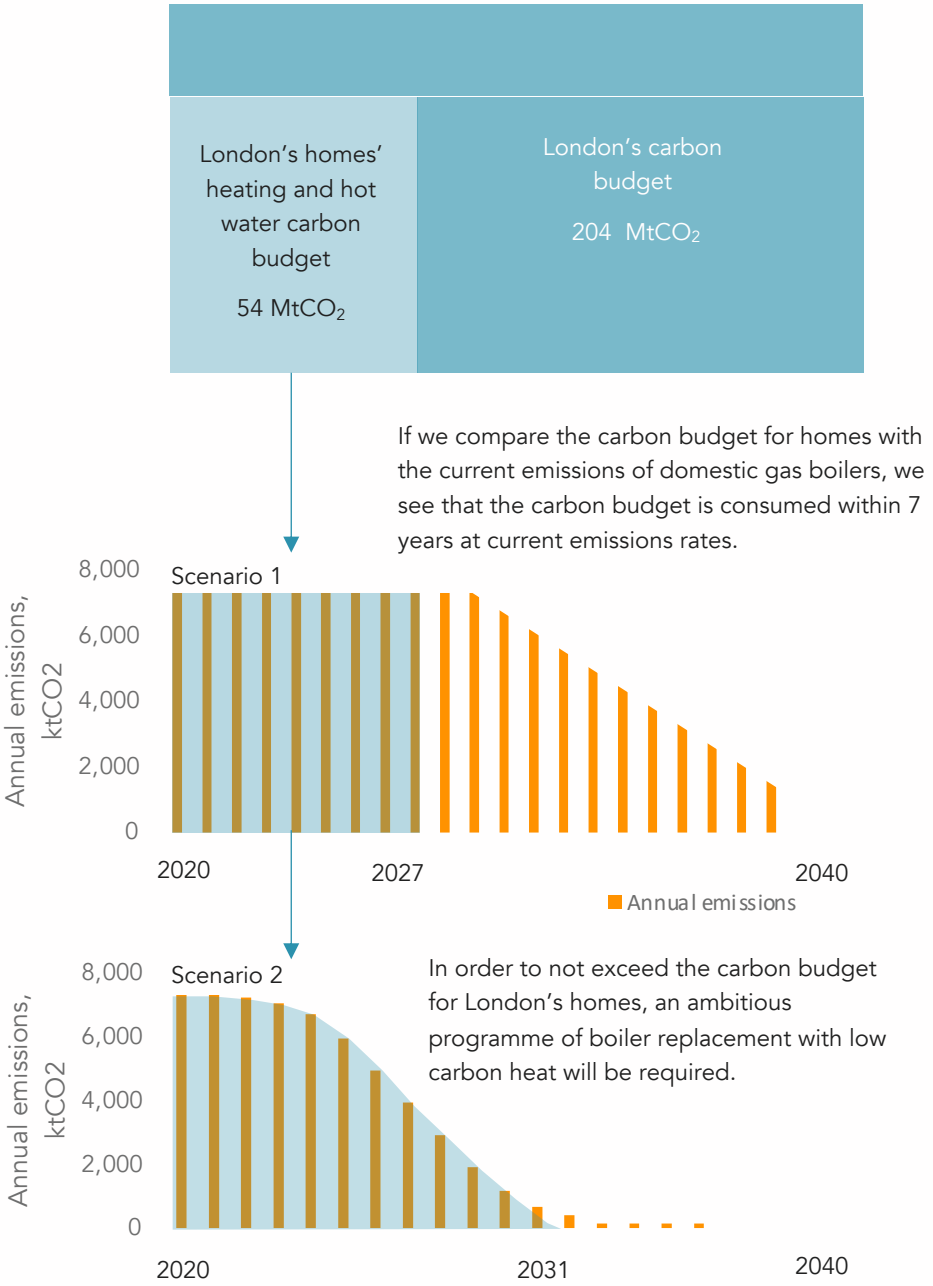
IEA – No new gas boilers from 2025

The International Energy Agency Net Zero report (2020) also states that all buildings must be zero carbon and that there should be no new gas boilers sold after 2025. This is an important message and signals clearly that the City of London Corporation should be preparing to enable all of their properties to switch to low carbon heat imminently.

What this means for CoL's housing stock

Net zero carbon for the City of London Corporation's own emissions by 2027 is the right target. This target will require CoL to replace all communal gas fired boilers with low carbon heat alternatives, such as heat pumps or other electric heating systems as soon as possible.

Concurrently, CoL should prepare their housing stock in order that each estate is ready for low carbon heat (e.g. through improving energy efficiency) and tenants and leaseholders should be provided with the information they need to make informed choices about when and how to make the swap.



The electricity revolution and infrastructure

Towards a decarbonised and smarter electricity system

The carbon content of electricity has fallen over the last few years. It is now three times less than 10 years ago and already lower than natural gas. It is forecasted to continue to reduce even further in the next 20-30 years. This underpins the current energy revolution and is why **electrification of transport and heat** is now seen as the best strategy to move away from fossil fuels.

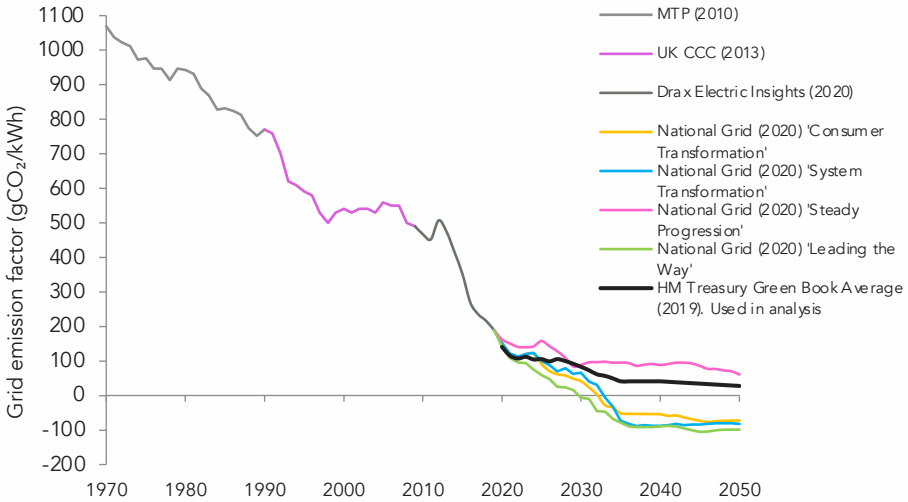
Infrastructure Upgrades are Required

In order for this revolution to be successful and as cost effective as possible, it is very important to reduce energy use, so that energy demand is not more than renewable and nuclear energy can generate in 2050. The power network locally also needs to be adapted to be able to accommodate both more load and also local generation from roof mounted PV arrays. UKPN, the local District Network Operator, are investing in the infrastructure to make it more suited to the developing needs, but they have to have a clear policy basis to demonstrate to Ofgem, the regulator, that the investments they make are supported by demand. Especially for the large sites, a clear statement of timescales and objectives will allow UKPN to plan the work necessary to make it possible.

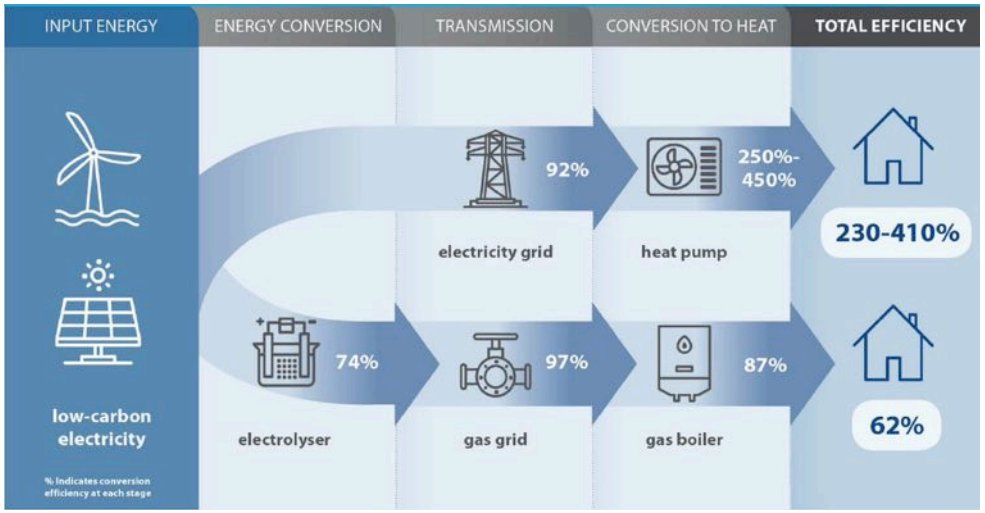
Demand also needs to be flexible, so that energy is used at times of high renewable energy generation. Energy storage (e.g. hot water tanks) and management (e.g. smart controls) as well as smart meters for Time of Use (ToU) variable electricity tariffs are therefore all likely to become increasingly important.

Hydrogen is unlikely to be a solution for heating homes

Hydrogen is not expected to be widely available at the domestic scale, certainly before 2030 and possibly not before 2050. There are remaining uncertainties about how it will be produced and stored, and the impact of these choices on overall energy use, carbon emissions and crucially, what the costs will be for consumers.



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



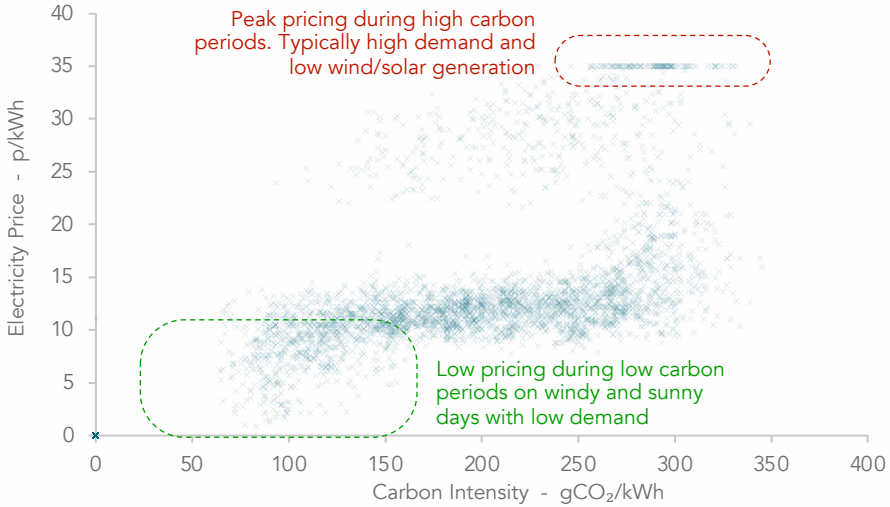
Relative heating efficiency – heat pumps vs electrolytic hydrogen boiler. From Committee on Climate Change Report, "Hydrogen in a Low Carbon Economy", 2018

Controls, smart meters and electricity demand flexibility

A sustainable electricity supply network.

The steep reduction in the carbon intensity of electricity in the UK has been achieved by significantly increasing the renewable energy contribution, especially from off-shore wind and solar. These intermittent, weather dependent sources have displaced high carbon, steady output coal fired power stations. For this process to continue and to be sustainable, it is necessary for the demand to be managed to match the supply in a way that wasn't previously necessary.

Energy prices fluctuate rapidly every day as supply goes up and demand goes down and vice versa. Time of Use tariffs have been commercially available for some years and are now becoming available to domestic customers. These tariffs track the energy price on an hourly or half hourly basis. If customers are able to reduce their use when prices are high (demand is outstripping supply) and increase it when they are low (oversupply on the grid), then customers can pay substantially less for their energy, on average.



Electricity costs: The carbon intensity and price of electricity vary depending on the balance between supply and demand. Chart shows price vs carbon intensity in London, at half hour intervals over 3 years from 2018 to 2021. Source www.energy-stats.uk/download-historical-pricing-data

Thermal stability & smart controls

Reducing the rate of heat loss from homes reduces the annual cost of heating and also makes it possible for the residents to utilise more effective 'Time of Use' fuel tariffs, such as Economy 7, by ensuring that when the heating is switched off, the home retains warmth for longer. Better controls and smart thermostats are essential (see image on the right), alongside clear information on how to use the new heating systems to achieve the best energy efficiency and lowest running costs.

Smart Buildings: Smart meters and smart thermostats are a way of unlocking the power of "agile" tariffs and demand side management to provide affordable low carbon heating. Used in combination with services such as If This Then That (IFTTT) they empower users to access cheap low carbon electricity, while helping the National Grid to balance the network.

The benefits of hot water storage

The facility to store energy, most simply as heat in domestic hot water cylinders, is also a crucial part of demand management strategies.

Batteries can also form part of demand management, and can be charged from the grid at times electricity is cheap, but the capital costs are relatively high, per unit of energy stored.

2.0 Understanding the buildings and choosing the right measures

This section looks at what we have learned about the City of London Corporation's housing stock. It also looks at how we have used this understanding to develop "archetypes" for the application of retrofit of energy efficiency measures, how we have determined the low carbon heating strategy, and our approach to determining renewable energy potential.

Simple overview of the City of London Corporation's housing stock

Number of units

The City of London Corporation is responsible for 5,028 homes across 82 buildings and 14 different estates, spread over a wide geographical area of London.

Building height

There are a wide variety of different buildings - 39 low rise (1-4 storeys), 19 mid rise (5-9 storeys), and 24 high rise (10+ storeys) of which there are 7 towers of 19+ storeys.

Building age

9 blocks are pre-1920, 7 are 1921-1945, 41 are 1945-1970, 22 are 1971-1991 and 2 are post 1991.

Special status

2,727 dwellings are within Grade II or II* listed buildings – predominantly across the Barbican and Golden Lane Estates, but also on the Sydenham Hill estate.

Leasehold and social rented

The units are a mixture of social rented, leasehold and a small proportion of freehold.

The majority of residents are tenants across the estates, with 20-50% of units owned by leaseholders. The Barbican Estate is almost entirely occupied by leaseholders.

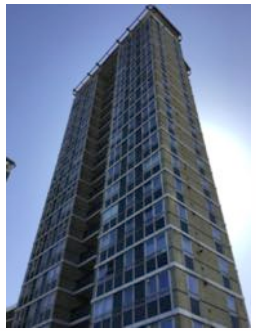
City of London Almshouses

Otto close

Lammas Green, Sydenham Hill Estate

Hatfield House, Golden Lane

Frobisher Crescent, Barbican Estate



Centre Points, Avondale Square Estate

The housing stock's carbon footprint

Total carbon emissions

We have utilised domestic gas and electricity data meter data from BEIS (aggregated by postcode for anonymity). Utilising this together with housing stock information we are able to estimate relative energy efficiency of different blocks. It also enables us to estimate Scope 3 CO_2 emissions, which are estimated to have been 6.2 $ktCO_2$ in 2020.

Space heating demands

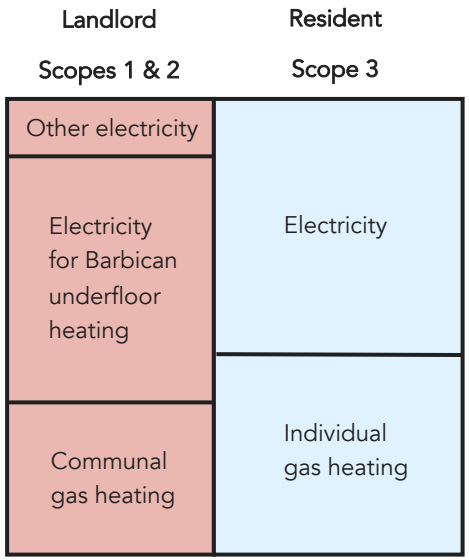
We have also used the above data to understand the average space heating demands of each home in each block. These are useful as they allow us to understand what decarbonisation measures will be suitable for each block. They also allow us to plot each block on the "The Retrofit Map" explained at the end of this section.

Landlord's emissions only

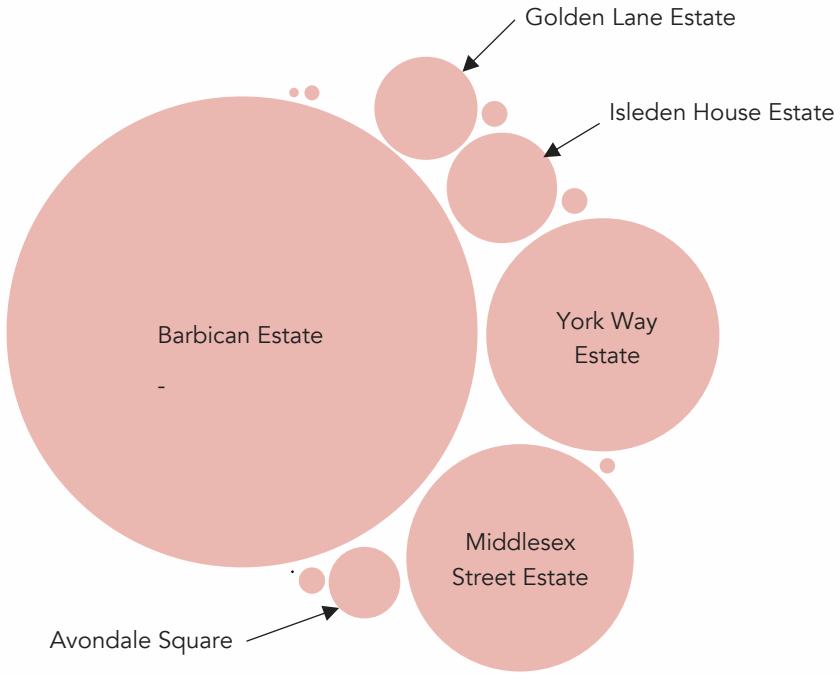
Utilising metered energy data given to us by the City of London Corporation for each estate for 2020, we could determine the following:

- Energy consumption of the Barbican's underfloor heating system for each block.
- Energy consumption of communally heated blocks, including Frobisher Crescent, York Way, Middlesex Street Estate and Isleden House (note that energy consumption data was not available for Horace Jones House or Twelve Acres House).
- Other electrical energy consumption including lighting of corridors and stairwells, lifts, pumps etc (note it was not possible to accurately disaggregate electrical energy consumption for different uses as labelling of meters was inconsistent).

We have determined the total Scope 1 and Scope 2 emissions in 2020 to be 5$ktCO_2$ (excluding non-residential energy uses on estates) and 5.3$ktCO_2$ including non-residential energy uses on estates.



Total stock emissions – scopes 1, 2 and 3.



Relative size of Scope 1 and 2 emissions for each estate, 2020. The largest Scope 1 and 2 emitters are communally heated estates and Golden Lane Estate (including leisure centre emissions).

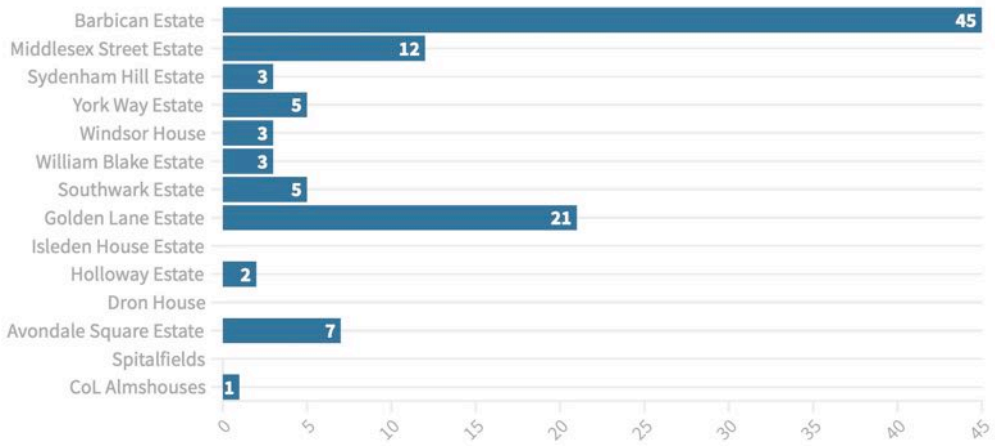
Listening to residents

Understanding the buildings through the residents eyes

In May 2021 we engaged with residents' to gain insights into the energy and comfort performance of the homes they live in.

Firstly, a questionnaire was circulated to all residents, in which people told us a bit about their building through carefully structured questions. Opportunities were also given for residents to write freely anything they wished to communicate (questionnaire outputs in the Appendices).

Subsequent to the questionnaire, we held workshops for residents with the same purpose of listening to residents to understand their buildings. Small group discussions took place centred around the themes of heating, energy efficiency, ventilation and renewable energy. A total of 23 people attended the workshops – 15 from the Barbican Estate and 8 from HRA estates.

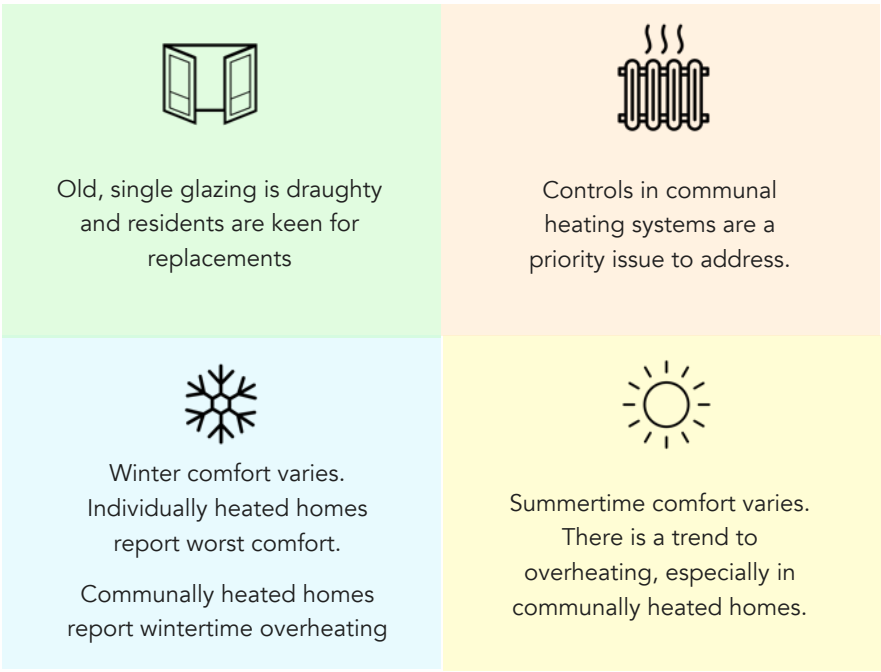


Number of responses to the energy and carbon questionnaire, by estate

Key insights from residents

- There was a strong interest from residents in moving away from gas to low carbon heating.
- Communally heated blocks appear to be getting enough heat, possibly too much. Most people said their homes were on the warm side and many open their windows in the winter to cool them down.
- Communally heated blocks most commonly complained of summertime overheating.
- Those blocks with individual heating tended to say it gets too cold in the winter, but it's comfortable in the summer.
- draughty, single glazed windows were unpopular with residents.
- Many residents also complained of doors being draughty.
- Homes with double or triple glazing performed better in winter.
- Ventilation is primarily through windows and trickle vents.

A more detailed write up of the engagement outputs can be found in the Appendices.



Key insights from residents

Simplifying the challenge: identifying archetypes

Archetypes based on construction type

When considering grouping blocks into archetypes, it was clear that there are numerous ways in which this could be done.

We opted for an archetype system based on how a building is constructed, which roughly corresponds to how it looks, and also corresponds with appropriate fabric retrofit measures.

Low carbon heating and renewables retrofit measures should be decided independent of the archetype on a case by case basis. We have detailed the decision process for these on the following pages.

Archetype Code

A short code for the archetypes has been used, with the following format:

[Elevation – Wall insulation location – roof insulation location]

Elevation

Trad - Traditional – Mostly solid or cavity wall, with discrete windows that can be replaced individually.

Mix - Combined / Mixed – Mostly composite wall/window elevations. Requires whole wall/window element to be replaced at the same time.

Wall insulation location

EWI - External wall insulation – Post 1920s buildings, non listed. Either on a traditional wall build up as rendered external insulation (Trad type), or as re-cladding with integrated windows (Mix type).

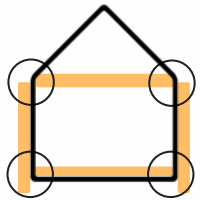
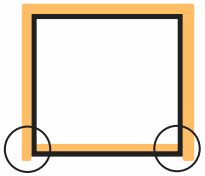
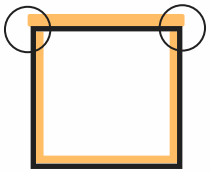
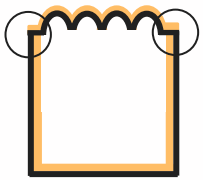
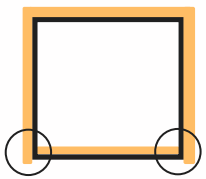
IWI - Internal wall insulation - Pre 1920s buildings or listed buildings.

Roof insulation

Loft – For pitched roofs with lofts. Most likely internal.

Flat – For flat roofs. Most likely external.

Barrel – For barrel roofs commonly found on the Barbican and Golden Lane Estates. External insulation if possible.

Archetype code	Example	Location of insulation
1. Trad – IWI - loft		
2. Trad – EWI – loft		
3. Trad – EWI - flat		
4. Mix – IWI - flat		
5. Mix – IWI – barrel		
6. Mix – EWI – flat		

The six archetypes. Circles indicate where insulation is discontinuous and attention needs to be paid to junctions between insulation and building fabric.

Fabric

Building fabric measures are important for both saving energy and carbon but also making buildings more resilient to future climate change.

Windows

The replacement of all single glazing to good double or, preferably to triple glazing (or a u-value less than 1.0 W/m2K), is a relatively easy first step for most home retrofit plans. Importantly, this measure can also deliver potentially significant CO_2 savings and may be sufficient to enable many homes to be 'heat pump ready', through energy savings and peak heat demand reduction.

Airtightness

Very good airtightness (target 2m^3/h/m^2 at 50Pa) can achieve a substantial improvement in overall space heating demand through minimising heat loss. Limiting draughts and the uncontrolled ingress of pollutants and noise from the outside improves indoor air quality and comfort.

Insulation

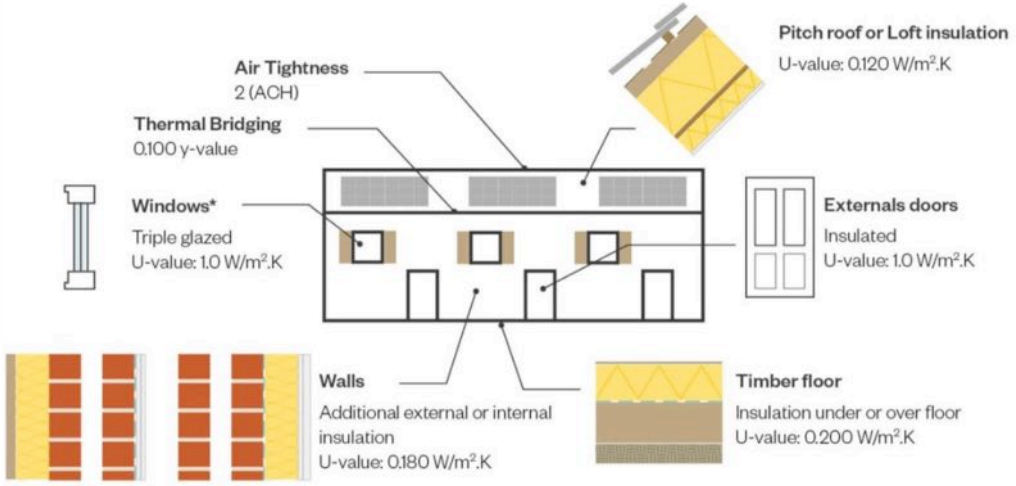
The simplest insulation upgrade is often at roof level, either increasing loft insulation or as part of routine roof maintenance work. Poor quality External Wall Insulation (EWI) installations across the UK, both technically and aesthetically, have seriously undermined confidence in this approach to improving the thermal performance of buildings but it is a vital element of retrofit work. Internal Wall Insulation (IWI) has less visual impact, so lower planning risk, than EWI but the impact on usable space and the degree of disruption required to tenants is far greater. Cavity wall insulation is possible where cavities exist.

EWI has to be designed with great care in relation to fire standards and building safety as well as moisture but there are many successful examples.

Ventilation

Concurrent with window replacement and air-tightness measures, ventilation should be upgraded to an energy efficient system with heat recovery. See the next page for more details on potential systems that could be used.

Replacement of windows is a key fabric efficiency measure. Single glazing should be replaced with double or triple glazing in every home.
Measures to improve air tightness and reduce draughts require attention to the details when fabric works are undertaken.



Fabric specifications recommended for refurbishment.

Ventilation

Ventilation

Changing the thermal performance of the fabric of a building needs to be carried out in conjunction with improvements in ventilation. This is because the "leakiness" of a building may be purging moist and stale air - albeit with uncontrolled heat loss and possible comfort issues. The risk of implementing air-tightness measures without additional ventilation is the creation of damp and mould. Proper ventilation maintains air quality, manages heat loss and reduces the risk of condensation and mould.

MVHR

In every case, Mechanical Ventilation with Heat Recovery (MVHR) should be the first choice to provide ventilation. This is a central system for each home, which extracts air from kitchens and bathrooms and supplies fresh air into living rooms and bedrooms. This system reduces draughts, and provides clean, fresh air to every room, without wasting valuable heat. It also is a key enabling technology for low carbon heating systems, because it reduces the peak heating loads and slows heat loss.

MEV

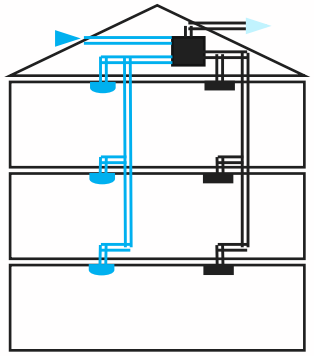
Where MVHR cannot be considered, for example if ceiling heights are particularly constrained and ductwork routes cannot be found, central mechanical extract ventilation (MEV) may be an alternative. This system is also an individual unit for each home which extracts air from kitchens and bathrooms. The supply air comes from trickle vents, usually within window frames, located in living rooms and bedrooms. This system is less energy efficient and more prone to draughts than MVHR, but does provide reasonable background ventilation to suppress condensation, etc.

Centralised Ventilation

Where there is no space and/or no route to outside air for ventilation within each home, particularly in high density housing with heritage status constraints that limit façade penetrations, a centralised system for the whole block can provide extract and potentially supply air from central fans located on the building roof.

MVHR units can be ceiling mounted, usually above bathroom or hallway ceilings, or wall mounted in utility cupboards or kitchen units.

MEV units have a single extract fan with multiple connections to extract air from each 'wet' room in a home with a single exhaust to outside. The units are a little smaller than MVHR with fewer duct connections so may fit where MVHR doesn't.



Centralised ventilation can provide either extract only or supply and extract with heat recovery.
There is a risk of 'cross talk' noise from one flat to the next so the acoustic design is critical.

Note: The introduction of any of the following mechanical ventilation strategies will not replace the need for opening windows to provide summer ventilation to control overheating – this would also be required in all cases. If opening windows are prohibited by external noise or air quality concerns, supplementary ventilation and cooling may be necessary

Choosing fabric and ventilation improvements

A holistic approach

Fabric and ventilation improvements should be considered together and executed simultaneously in order to reduce some of the risks associated with reduced ventilation, such as condensation and mould.

Whole house retrofits where multiple energy efficiency measures are installed as opposed to implementing individual measures have been found to be more effective in reducing energy consumption.

Windows

Replacing windows can bring multiple benefits. All single glazed and old double glazed windows should be replaced for all buildings, to improve energy efficiency and air tightness, reduce condensation and damp and reduce overheating risks.

Windows in some blocks have been replaced relatively recently, and do not need to be replaced again. Window replacements for a further nine blocks are programmed. The proposed specification should be reviewed to ensure the best possible performance is achieved in each case.

Wall insulation

For buildings constructed before 1920, Internal Wall Insulation is likely to be the best option to increase the energy efficiency of the building facade. This is because the facades are often complex, making high quality installation difficult, or architecturally interesting.

For more modern buildings, External Wall Insulation (EWI) may be possible, dependent on heritage status & the complexity of the façade.

Different strategies for EWI can be adopted, depending on the type of existing façade and the building's structural frame.

Air tightness

Better air-tightness is an important aspect of replacement window installation and should always be a key design consideration when this type of work is undertaken. Doors, letterboxes and other air-paths in the building fabric should also be assessed and addressed.

The decision process for fabric improvements

Windows

- ❑ Single glazed or old double glazed? → Replace.
- ❑ New double or triple glazing? → Spot check performance and air-tightness

Wall insulation

- ❑ Pre-1920s? → Internal wall insulation
- ❑ Complex façade? → Internal wall insulation
- ❑ Listed or conservation area? → Internal wall insulation.
- ❑ Simple external form? → External wall insulation
- ❑ Post-1920s → External wall insulation.

Air tightness

- ❑ draught proof all doors, letterboxes and leaky windows.

Ventilation

- ❑ Install mechanical ventilation with heat recovery (MVHR) in all dwellings where possible.
- ❑ Limited potential for intakes and extracts on façade? → consider centralised MVHR

Low Carbon Heating

System Choices

The replacement of gas boilers with other forms of heating which have a lower carbon intensity is a fundamental part of the net zero carbon objective. Electricity has a lower carbon intensity than natural gas, so is seen as the principal alternative energy source to replace gas boilers.

Heat Pumps

The most energy efficient electric heating systems utilise heat pumps. They can be employed for both individual and communal systems.

Air Source Heat Pumps usually have an external unit or units. Where there is space around a building, a Ground Source Heat Pump system could be utilised, using a communal group of boreholes and small heat pumps located inside each home. In buildings with a communal heating system, the gas boilers can be replaced with large central heat pumps.

In buildings where the heat demand is very high and difficult to reduce within the necessary timeframe, a hybrid arrangement where heat pumps are installed alongside existing gas boilers may provide an interim step to reduce carbon emissions with less impact on residents' energy bills. Correct controls are a crucial part of this type of system, to ensure emissions are reduced effectively.

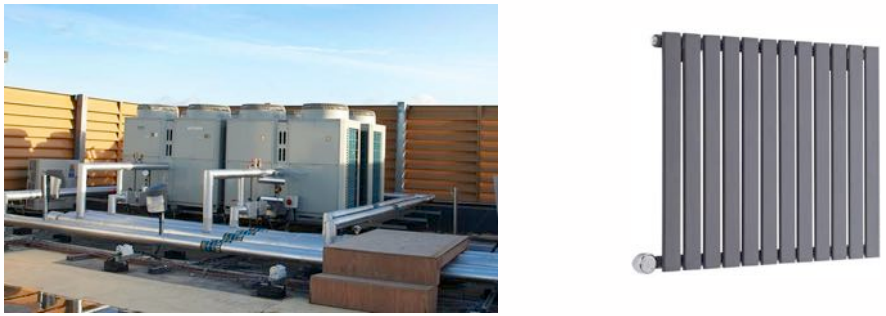
Direct electric heating

The simplest form of electric heating is 'direct', which uses heated elements in storage heaters, panel radiators and convectors, electric underfloor heating or electric boilers. In every case, this type of heating will use at least 2 or 3 times as much electricity as a comparable heat pump. Where fabric improvements are possible to reduce the heating demand to a point where direct electric heating is affordable for residents, it may be a good choice.

Heat Networks

District and communal heating systems currently generally use fossil fuel based heat sources - Combined Heat & Power (CHP) or gas boilers. In future, these systems should swap to low carbon heat sources.

An Air Source Heat Pump (left) with an external unit, gathering heat from the surrounding air. A Ground Source Heat Pump (right) gathers heat from the ground via boreholes.



Left: A centralised heat pump system on the roof of a building. Right: Direct electric heating can use wall mounted radiators, panels or underfloor heating

Criteria	Heat Pump Type	Standard	Best Practice
Space Heating CoP	ASHP	2.50	3.50
	Closed GSHP		4.50
	Open GSHP		5.50
Domestic Hot Water CoP	ASHP	2.0	2.50
	Closed GSHP		2.50
	Open GSHP		3.00

Standard and best practice Coefficient of Performance (CoP) efficiencies for different heat pumps.

Choosing the heat decarbonisation strategy

Consider the alternatives, in a logical order

If an existing boiler needs to be replaced, heating alternatives which use electricity should be considered, as set out in the adjacent process. The specific type of heat pump to be used should be considered in a logical sequence, starting from the ones which are most efficient, as follows:

- ❑ Individual heat pump with dedicated external unit
- ❑ Individual ground source heat pump system
- ❑ Individual heat pump connected to a communal heat pump system
- ❑ Individual heat interface unit connected to a communal heat pump system
- ❑ Exhaust air source heat pump
- ❑ Hot Water Heat Pump / Direct Electric

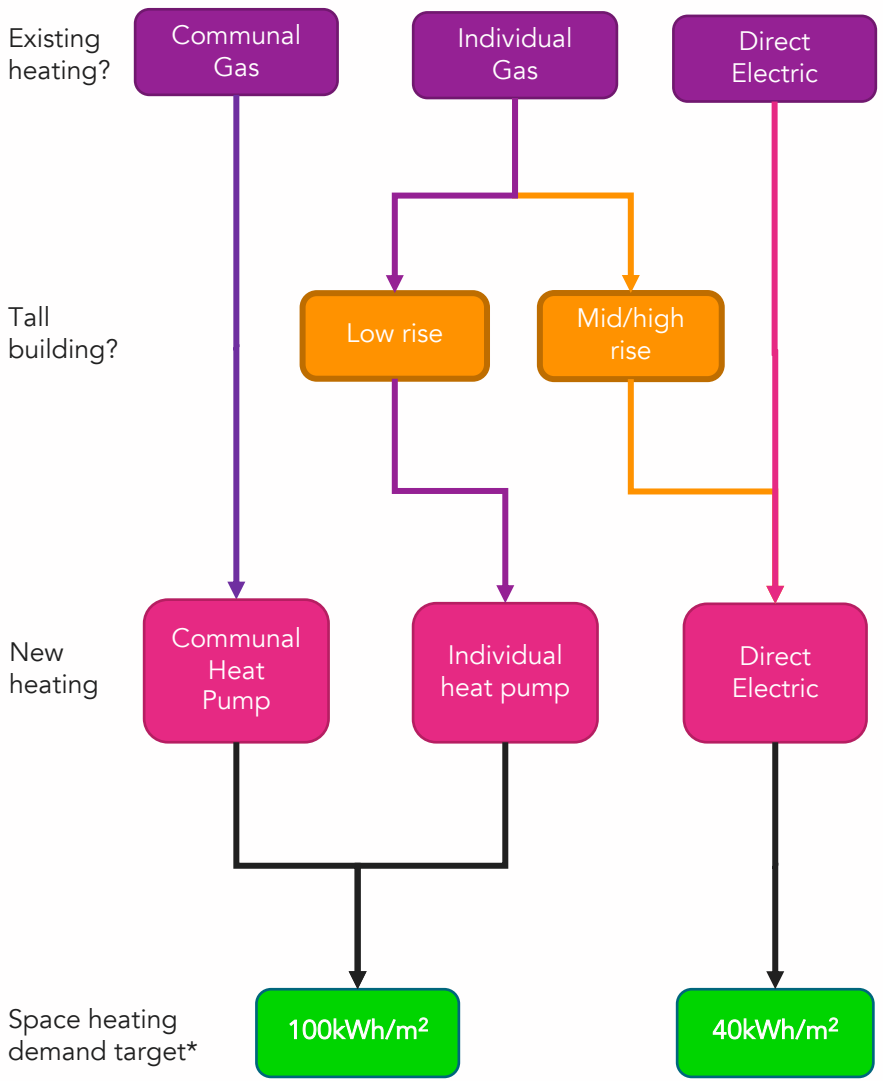
Enabling low carbon heat – set an appropriate space heating demand target

Simply swapping a heat pump to replace an existing gas boiler is generally seen as problematic for both economic and practical reasons. Principally:

- Heat pumps, to be efficient, operate at lower heating water temperatures than gas boilers. In order to enable an early switch to low carbon heat sources, reductions in energy demand may be required, sufficient to enable the home to be switched to a low carbon heat source without major works to the installed heating system.
- Electricity is, on average, more expensive than gas so a like for like replacement may lead to higher fuel bills. Energy efficiency improvements are important to enable the home to be switched to electricity-based heating without incurring additional annual heating costs for the residents. We therefore recommend minimum space heating demands of 100 kWh/m^2 for homes heated by a heat pump system, and 40 kWh/m^2 for homes heated directly by electricity.

Hot Water Storage

Hot water storage should always be part of all low carbon heat systems, if possible, to provide low cost, effective energy storage.



*Where space heating targets are unachievable in the short term, an interim step may be to use a hybrid heat pump while fabric improvement works are undertaken

Solar generation

Assess the potential extent of solar panels on site

Achieving a net zero energy balance in high density developments will rely upon finding space for as much renewable energy generation as possible.

Where fabric upgrades to roofs are required, these should be completed before PV panels are installed or, ideally, concurrently so the PV can be installed while access scaffolding etc is in place for the roof repair work.

Optimise the panel layout

Having established which sites have potential for PV to be installed, the best possible panel layout should be used to maximise the power generated. In many cases and especially where there are flat roofs, this may not be a traditional south facing array, but may be an east-west array installed in a concertina fashion, as explained in the figures on the right.

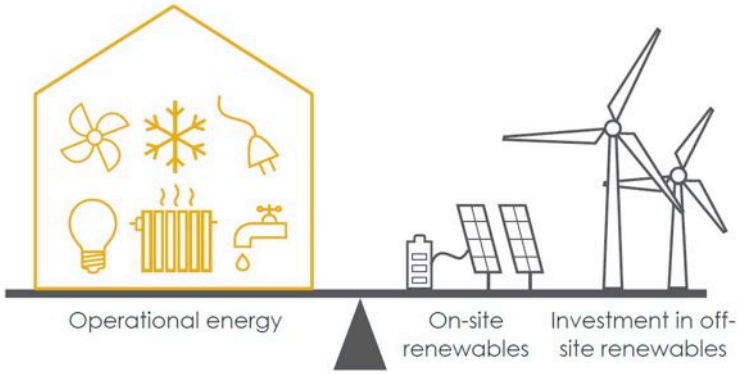
Use the best available technology

- Specify high efficiency monocrystalline silicon solar panels from a reputable manufacturer (min 360W)
- Choose a panel with a linear power output warranty
- Specify microinverters or DC optimisers

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

The power output warranty for a solar panel provides an indication of how it will perform over time. Higher performing solar panels have 'linear' warranties that guarantee higher levels of power production throughout the lifetime of the panel.

Module Level Power Electronics (MLPE) refer to technologies that manage power production individually for each solar panel. These can ensure each solar panel operates at its peak power output. There are two main MLPE options: microinverters or DC optimisers.



Net zero operational balance

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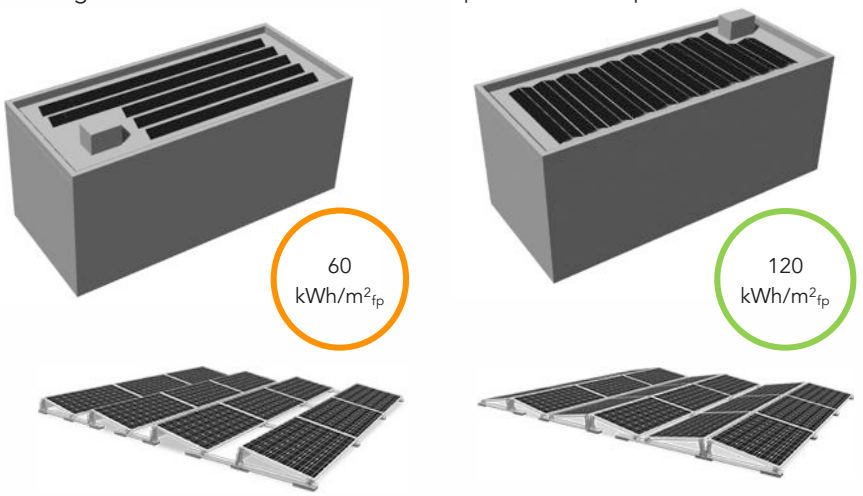
South facing array – panels need to be spaced apart to avoid inter-shading

East/west array – panels can be closer together so, overall, the array produces more power



The layout of PV panels has a significant impact on the power generated within a given roof space, especially on a flat roof

Determining the solar generation strategy

PV installations are relatively easy to plan for

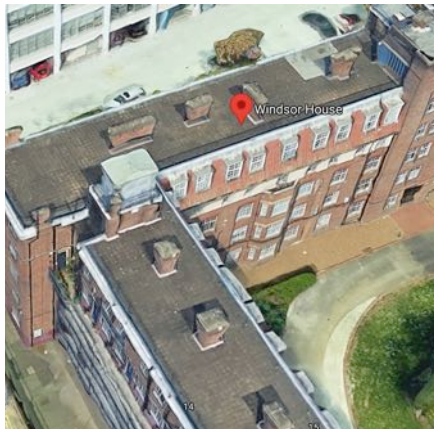
Photovoltaic panels are a versatile technology that can fit in a variety of locations, provided:

- ❑ the roof space is not overshaded
- ❑ Pitch roofs are oriented south, east or west.
- ❑ Roofs do not have lots of chimneys or roof plant obstructing clear area and casting shadows.

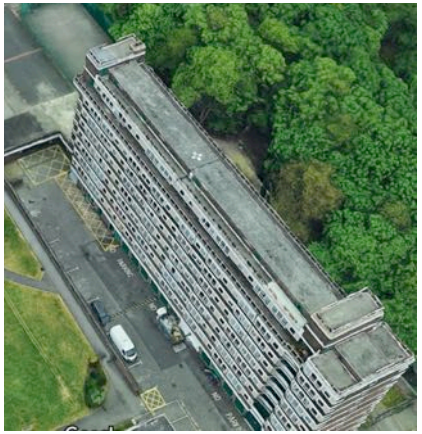
In our calculations for estimating potential output from photovoltaic panels, we have used a combination of: i) total area of roof, ii) % of roof area suitable for PV installation and iii) orientation.

Further analysis will be required by City of London Corporation to determine the suitability of particular roofs for PV installation:

- ❑ The roof can withstand the additional weight of a solar photovoltaic panel installation.
- ❑ A details overshading analysis should be completed.
- ❑ A detailed PV layout and output study should be undertaken.



Shading from chimneys may reduce output. Check.



Roof appears to be unobstructed and unshaded. Flat roof means PV can be oriented optimally.

Barrel roofs and listed status of these blocks at the Barbican estate mean PV is unlikely.

South facing portion of pitch roof is suitable for PV. Check overshading (Harman Close, Avondale Square Estate).

Appliances, white goods and lighting

Energy efficient appliances & lighting

Appliances and white goods can use significant amounts of energy in a building. While these items are mostly an individual choice for residents, where new build or major works are taking place some items can be designed in, and in other cases appropriate information and encouragement can be provided to residents.

High efficiency appliances are recommended to limit total energy consumption and minimise overheating risk from waste energy given off as heat (i.e. A++ or A+++). Provision of clothes drying lines can help to avoid the use of tumble dryers. Generally, free-standing appliances can achieve better performance than integrated devices and their use is encouraged wherever this is possible although their compliance with the overall design needs also to be considered. Lighting efficacy is also a key way to reduce energy in individual homes. Light fittings should be as low energy as possible, e.g. LEDs and occupancy sensors and daylight dimming should be specified in communal areas where appropriate.

Retractable clothes drying lines – could be located in the bathroom or a designated drying cupboard fitted with an extract

High-rated (A+++) washing machine

Waste water heat recovery

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

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

Waste water heat recovery examples from left to right: Horizontal – underneath bath or shower tray; Vertical – typically 2400mm long and mounts between floors; Compact – mounts below shower tray, lower efficiency.

The Retrofit Map

Each building is different

- Their current condition in terms of energy efficiency and heating system will be different.
- What can be done to improve them will vary and may be constrained by heritage and technical considerations.

We have used the adjacent Retrofit Map, developed for the Retrofit London Housing Action Plan, to enable the journey of buildings towards Net Zero to be summarised and understood. The Retrofit Map focuses on how to increase the level of energy efficiency with improvements to the fabric and ventilation system and how to decarbonise heat.

Ultimately, it is recommended that by 2040 (or earlier) all homes are moved to one of the green squares. The buildings which should be most urgently retrofitted will be in the red squares as they will be consuming most of the carbon budgets. However, we appreciate that other factors (e.g. maintenance schedules, replacement opportunities, fairness to residents) may influence the prioritisation.

Use of fossil fuels
Not compatible with Net Zero.
The heating system must be changed.

Low carbon heat but risk of high energy costs
A change of heating system may not be required but fabric, ventilation and system should be improved

Low carbon heat and sufficient level of energy efficiency
Compatible with Net Zero

High carbon → HEAT DECARBONISATION → Low carbon

FABRIC AND VENTILATION

	High carbon heat network	Individual gas boiler	Direct electrical heating	Low carbon heat network[1]	Heat pump system[2]
Heating demand <40 kWh/m^2.yr					
Heating demand <100 kWh/m^2.yr					
Heating demand <150 kWh/m^2.yr					
Heating demand >150 kWh/m^2.yr					

Low energy ↑ High energy

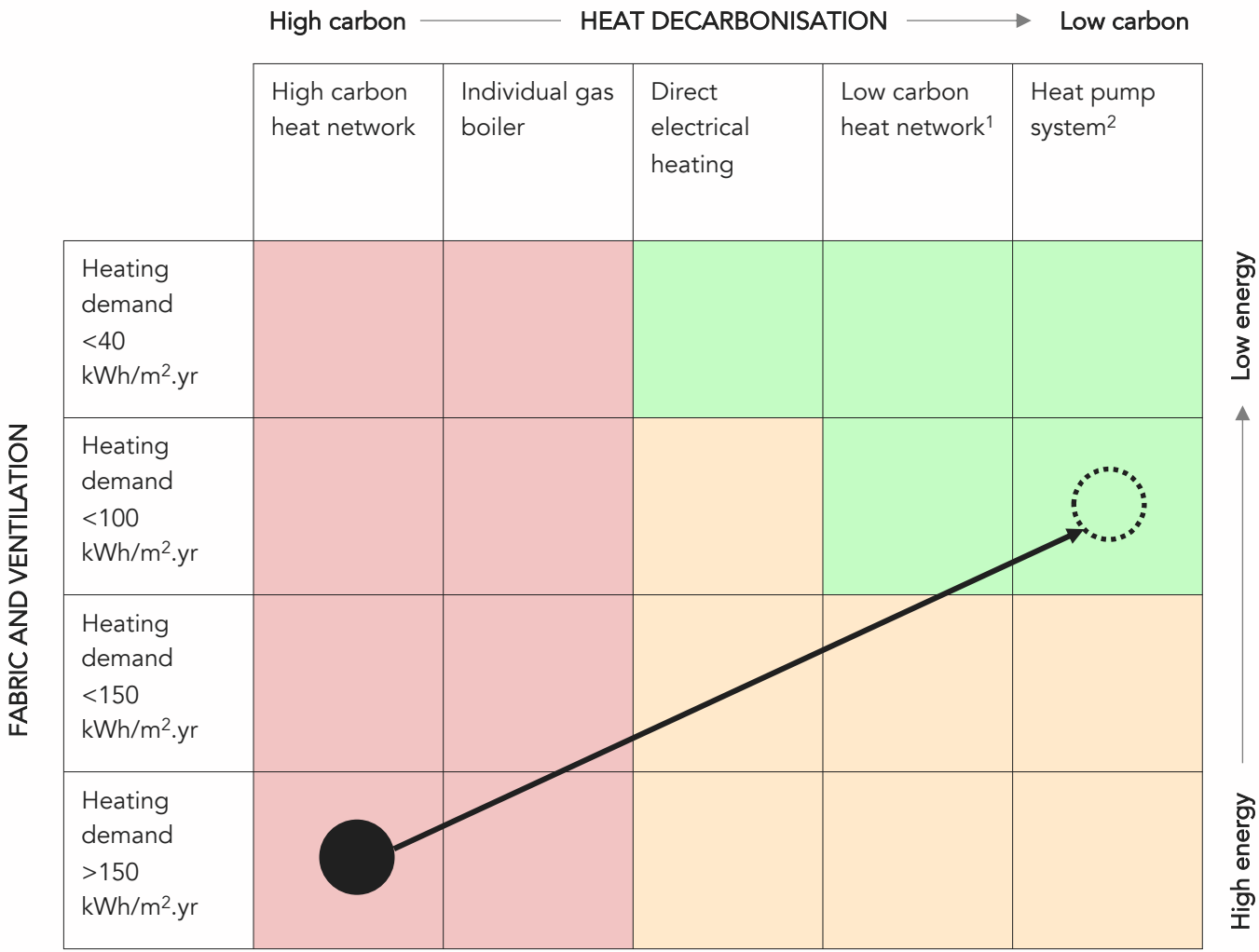
[1] A heat network would qualify as 'low carbon heat network' for the purpose of this Retrofit Map only if it would have a lower carbon content of heat (per kWh delivered) than direct electric heating. Any system using fossil fuels and/or with high distribution losses is unlikely to qualify.

[2] Could be an individual or building level heat pump with low distribution losses.

The Retrofit Map

Example 1

- Current situation: this building is very inefficient and is heated by a high carbon heat network.
- Changes required: it should be improved with works on building fabric and ventilation and a new communal heat pump system.



Use of fossil fuels
Not compatible with Net Zero.
The heating system must be changed.

Low carbon heat but risk of high energy costs
A change of heating system may not be required but fabric, ventilation and system should be improved

Low carbon heat and sufficient level of energy efficiency
Compatible with Net Zero

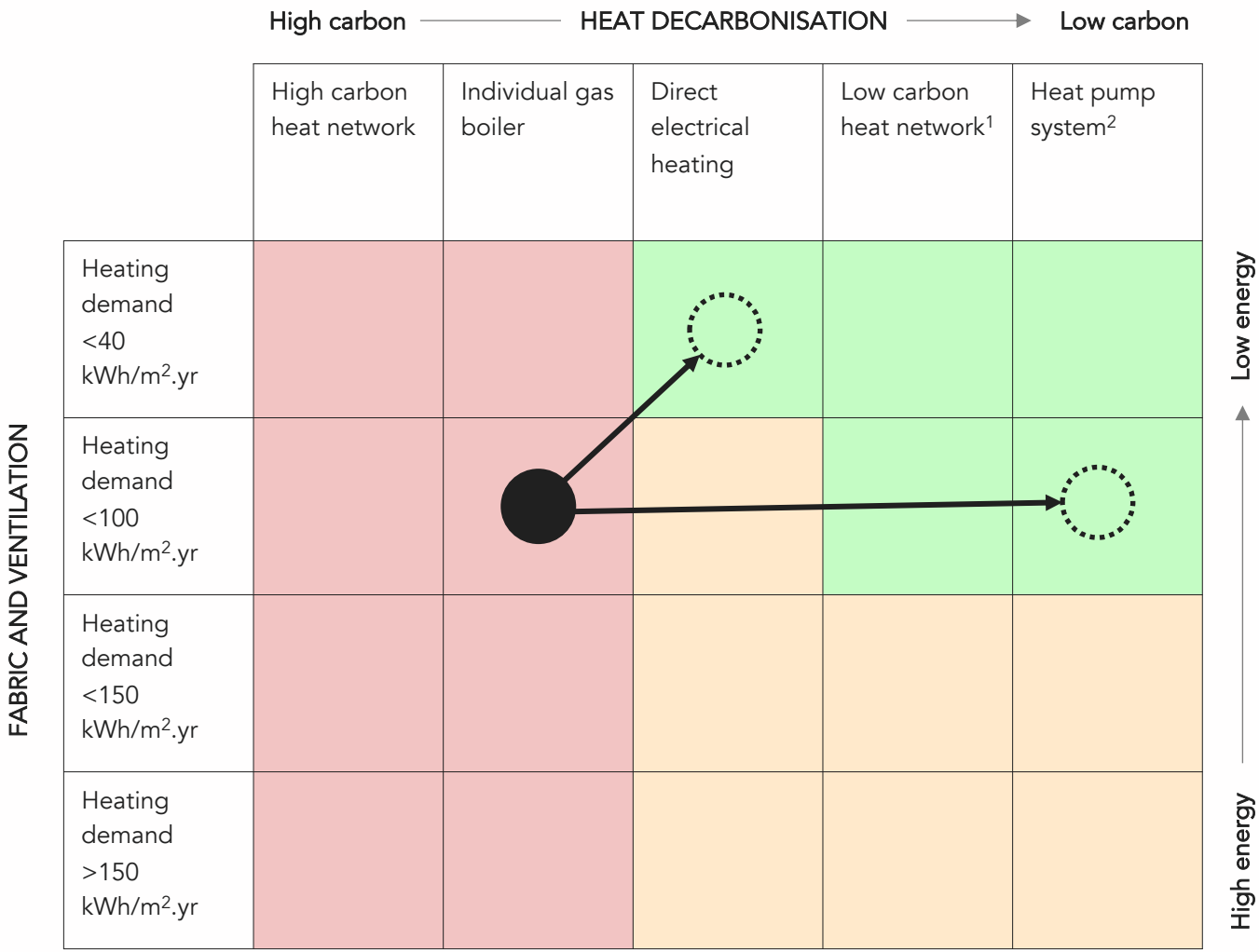
[1] A heat network would qualify as 'low carbon heat network' for the purpose of this matrix only if it would have a carbon content of heat (per kWh delivered) lower than direct electric heating. Any system using fossil fuels and/or with high distribution losses is unlikely to qualify.

[2] Could be an individual or building level heat pump with low distribution losses.

The Retrofit Map

Example 2

- Current situation: this building is relatively efficient and is heated by individual gas boilers.
- Changes required: if a heat pump system is feasible, it is possible that the change of heating system would be sufficient and would not lead to an increase in energy costs even with no fabric and ventilation improvements. However, if a heat pump system is not feasible and direct electric is the selected heating system, improvements to the building fabric and ventilation are recommended.



Use of fossil fuels
Not compatible with Net Zero.
The heating system must be changed.

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A change of heating system may not be required but fabric, ventilation and system should be improved

Low carbon heat and sufficient level of energy efficiency
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[1] A heat network would qualify as 'low carbon heat network' for the purpose of this matrix only if it would have a lower carbon content of heat (per kWh delivered) than direct electric heating. Any system using fossil fuels and/or with high distribution losses is unlikely to qualify.

[2] Could be an individual or building level heat pump with low distribution losses.

3.0 Housing Net Zero Action Plan templates

This section presents the retrofit action plan templates for the 6 different archetypes defined in Section 2.0.

The Net Zero Matrix: our assessment of each building

The diagram to the right describes the structure of the Net Zero Matrix, the tool we use to recommend measures for every building.

Archetyping

Firstly, metadata for buildings are assessed to sort the buildings into six archetypes according to features of the building fabric and potential for improvement.

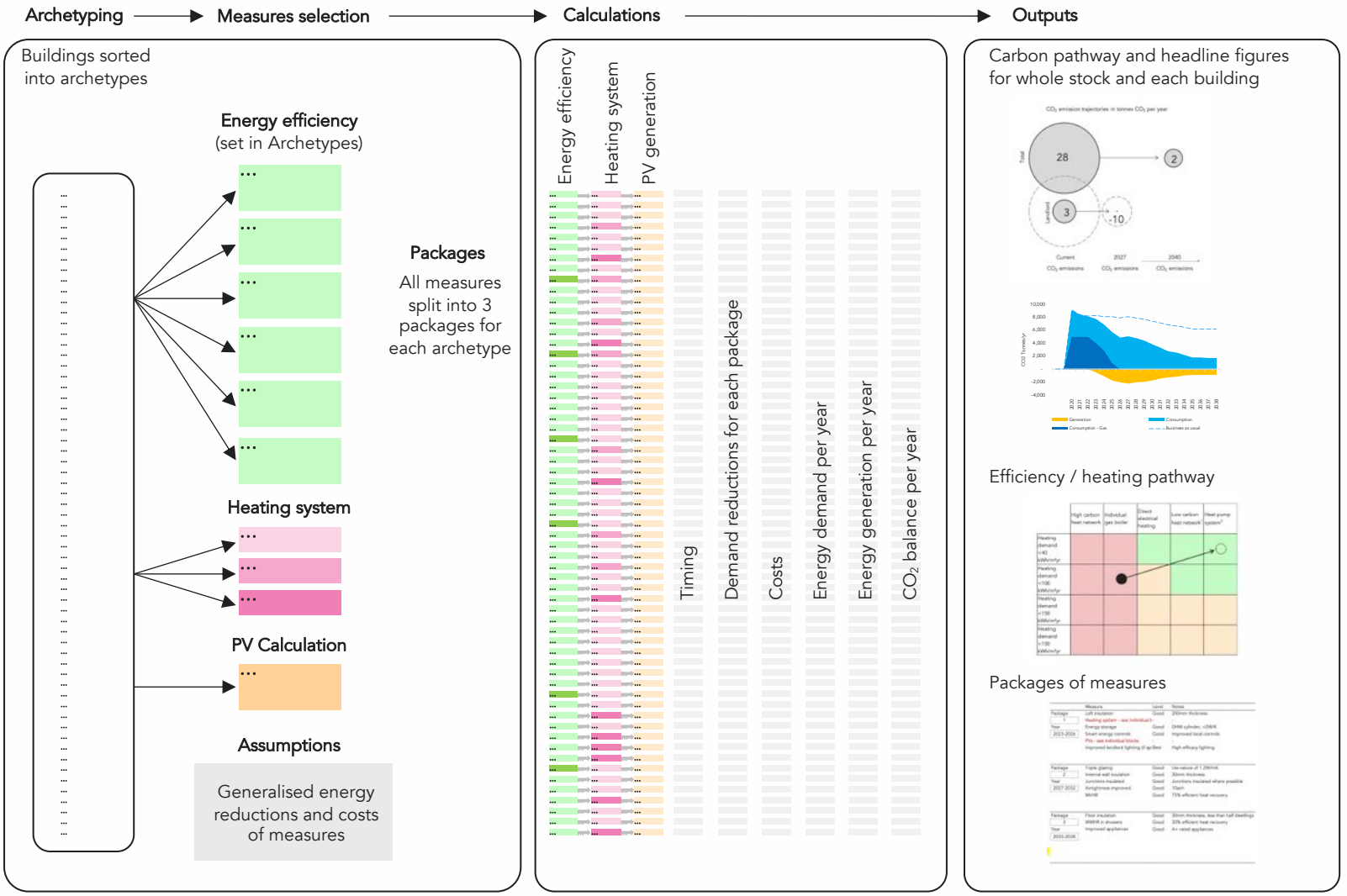
Measures selection & packages

Energy efficiency measures are selected for each Archetype. The most appropriate heating system is then determined by using the heating system decision tree. Next a PV assessment for each building gives approximate generation potential for each building.

The energy efficiency, heating and PV measures are then split into 3 packages for each archetype.

Calculations

During the calculation stage, dates are set for each of the 3 packages in each building. The percentage reduction in energy consumption is then predicted, which gives an energy and carbon trajectory to 2040 for scope 1-3 emissions, as well as a trajectory to 2027 for scope 1 & 2 emissions.



Net Zero Matrix structure (graphics reproduced at larger scale on following pages).

Simplifying the challenge: introducing the 6 archetypes

ARCHETYPE 1: Trad-IWI-Loft

e.g. City of London Almshouses

ARCHETYPE 2: Trad-EWI-Loft

e.g. Barnersbury House, Holloway Estate

ARCHETYPE 3: Trad-EWI-Flat

e.g. Collinson Court, Southwark Estate.

ARCHETYPE 4: Mix-IWI-Flat

e.g. Basterfield House

ARCHETYPE 5: Mix-IWI-Barrel

e.g. Bunyan Court, Barbican Estate

ARCHETYPE 6: Mix-EWI-Flat

e.g. Kinefold House, York Way

Considerations for each archetype

Risk factors and concurrent works

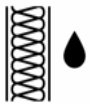
With any retrofit it's important to consider how works are designed, planned and executed in order not to incur unwanted unintended consequences such as the creation of mould and damp and the degradation of building fabric.

The figures to the right illustrate the main detailing considerations for each archetype, which are further described in the box below.

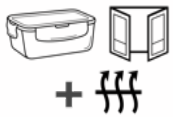
The key principles are to keep insulation lines continuous, ventilate properly, and consider moisture risk with internal insulation.

Insulation should be continuous. Pay attention to areas where there are breaks in insulation (see circles at junctions). These are risk areas for damp and mould.

Loft insulation: ensure adequate ventilation to loft / rafters

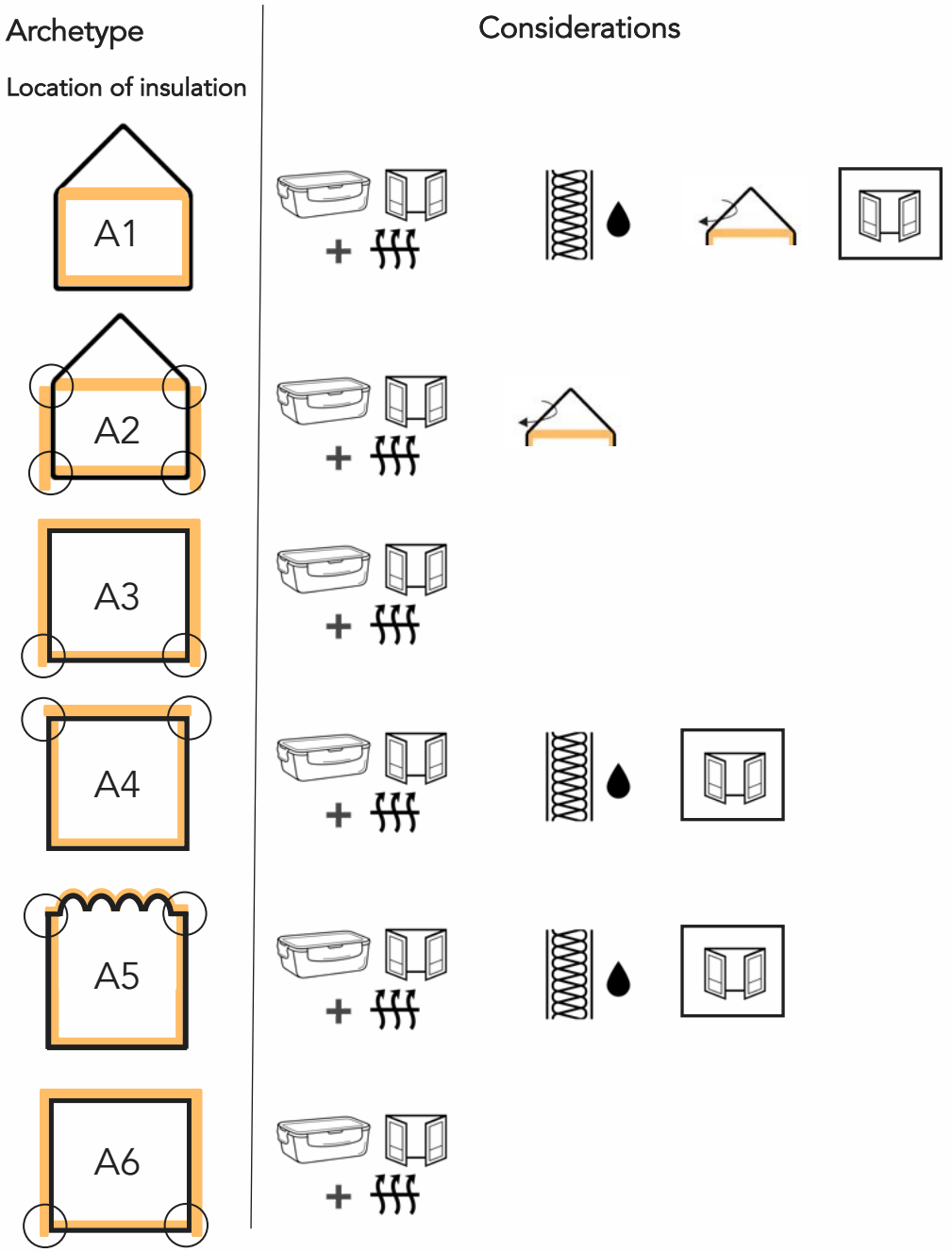


Internal wall insulation: assess moisture risk, use vapour open insulation and keep U-value high (>0.35W/m2K)



Windows / airtightness: ensure ventilation system assessed at same time or before

Specialist windows / heritage considerations



Archetype 1 (Trad-IWI-loft) | Characteristics and list of buildings

Key characteristics

Traditional façade, external wall insulation not likely to be possible.

Typically brick, heritage or complex façade.

Generally low-rise, two are 5 stories.

All have individual gas boilers. Eight have the potential for heat pumps, two are likely to require direct electric heating in the future.

All of the buildings (except Spitalfields) have a small amount of landlord energy.

List of buildings

- City of London Almshouses, Ferndale Road[1]
- Gresham Almshouses, Ferndale Road
- Lammas Green, Sydenham Hill Estate
- Commercial Street, Spitalfields
- Brushfield Street, Spitalfields
- Lamb Street, Spitalfields
- Lynton Mansions, William Blake Estate
- McAuley Close, William Blake Estate
- St James Mansions, William Blake Estate
- York House, William Blake Estate

Retrofit plan to Net Zero

1) Prioritise loft insulation, heating and DHW storage, energy controls, solar PV, any landlord lighting
2) Glazing, internal wall insulation, junctions, airtightness and MVHR
3) WWHR, improved appliances, floor insulation

[1] *Detailed on next page*


City of London Almshouses


Gresham Almshouses


Lammas Green


Commercial street


McAuley Close


Lynton Mansions

Images of some of the buildings

Archetype 1 (Trad-IWI-loft) | Example: proposed retrofit plan and carbon pathway

City of London Almshouses

Archetype A1

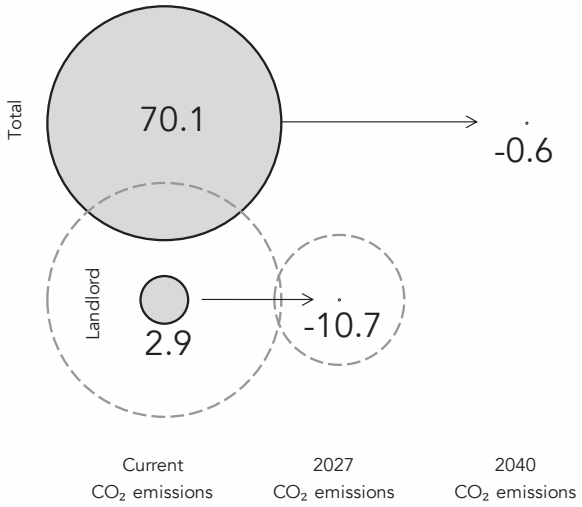
These buildings were built in 1884 and are in a conservation area, therefore the only option for insulating the walls will be internal wall insulation. We have assumed triple glazed heritage style windows (to be agreed with planning) and loft insulation.

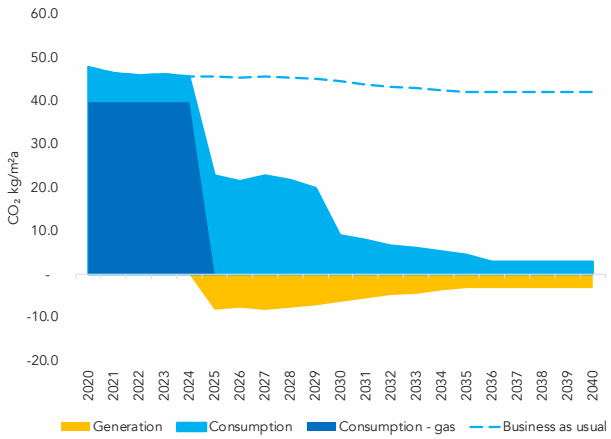
They are currently heated by individual gas boilers and we assume that heat pumps will be possible. Although the buildings are in a conservation area it may be possible to install solar PV on the Southwest facing roofs. We have also assumed small MVHR units can be installed in these dwelling.

There is a small amount of landlord energy from lighting which could be made more efficient and offset by the solar PV. These buildings could be net zero carbon by 2040 for scope 1,2 and 3 emissions.

Photograph of City of London Almshouses

CO_2 emission trajectories in tonnes CO_2 per year





Carbon balance for City of London Almshouses

Current and projected heating demand and system

	High carbon heat network	Individual gas boiler	Direct electrical heating	Low carbon heat network[1]	Heat pump system[2]
Heating demand <40 kWh/m²yr					
Heating demand <100 kWh/m²yr					
Heating demand <150 kWh/m²yr					
Heating demand >150 kWh/m²yr					

Use of fossil fuels
Not compatible with Net Zero. The heating system must be changed.

Low carbon heat but risk of high energy costs
A change of heating system may not be required but fabric, ventilation and system should be improved

Low carbon heat and sufficient level of energy efficiency
Compatible with Net Zero

[1] A heat network would qualify as 'low carbon heat network' for the purpose of this matrix only if it would have a lower carbon content of heat (per kWh delivered) than direct electric heating. Any system using fossil fuels and/or with high distribution losses is unlikely to qualify.

[2] Could be an individual or building level heat pump with low distribution losses.

	Measure	Level	Notes
Package 1	Loft insulation	Best	400mm thickness
	Individual HP	Best	SFP of 3+, Suitable if Heating demand <100kWh/m2a
Year 2023-2026	DHW tank	Best	DHW cylinder, <1W/K
	Smart energy controls	Best	Whole dwelling controls with zoning
	Solar PVs	Best	360Wp panels with microinverters
£842k	Improved com. lighting (if appl.)	Best	High efficacy lighting
	Improved lift (if appl.)	Best	N/A
Package 2	Triple glazing	Good	Uw-valuve of 1.2W/mK
	Internal wall insulation	Best	100mm thickness
Year 2027-2032	Junctions insulated	Best	Good connections possible: floor-wall and/or wall-roof
	Airtightness improved	Best	2ach
£1243k	MVHR	Best	90% efficient heat recovery
Package 3	Floor insulation	Good	30mm thickness, <half dwellings
	WWHR in showers	Best	50% efficient heat recovery
Year 2033-2038	Improved appliances	Best	A+++ rated appliances
£205k			

Breakdown of measures per package for City of London Almshouses

Extract of Matrix

Archetype 2 (Trad-EWI-loft) | Characteristics and list of buildings

Key characteristics

Simple façade, mostly brick and distinct windows, some older buildings included. Pitched roofs. All low rise (2-4 stories).

List of buildings

- Avondale House, Avondale Square Estate
- Harman Close, Avondale Square Estate
- Tevatree House, Avondale Square Estate
- Barnersbury House, Holloway Estate
- Bunning House, Holloway Estate
- Crayford House, Holloway Estate
- Fairweather House, Holloway Estate
- Hilton House, Holloway Estate
- McMoran House, Holloway Estate
- Whitby Court, Holloway Estate
- Isleden House, Prebend Street
- Great Suffolk Street, Southwark Estate
- Pakeman House, Southwark Estate
- **Otto Close,** Sydenham Hill Estate[1]

Retrofit plan to Net Zero

1) Prioritise loft insulation, external wall insulation and window replacements, MVHR, heating and DHW storage, solar PV, any landlord lighting
2) Floor insulation, junctions and airtightness
3) WWHR, improved appliances, energy controls

Images of some of the buildings

[1] *Detailed on next page*

Archetype 2 (Trad-EWI-loft) | Example: proposed retrofit plan and carbon pathway

Otto Close

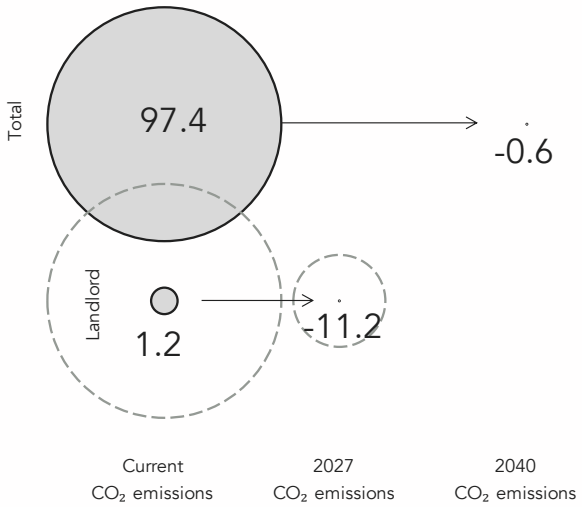
Archetype A2

These two story buildings were built in 1976 and are fairly simple brick construction. They would be suitable for external wall insulation, triple glazed windows and loft insulation.

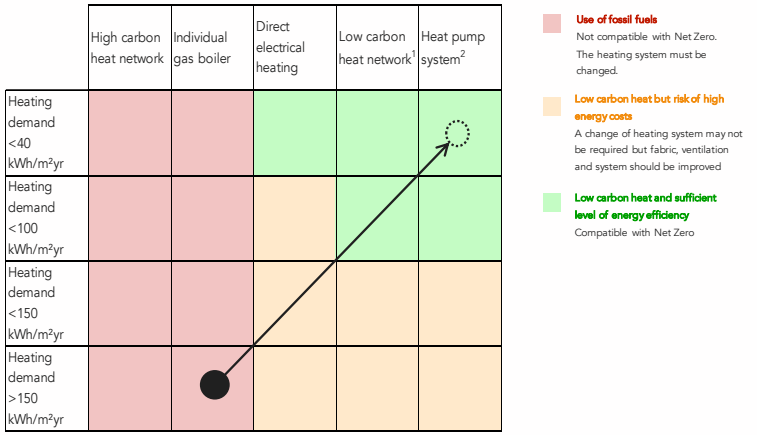
They are currently heated by individual gas boilers and we assume that heat pumps will be possible. It should also be possible to install MVHR units, as well as solar PV on the Southeast facing roofs.

There is a small amount of landlord energy from lighting, which could be made more efficient and offset by the solar PV. These buildings could offset approximately 60% of emissions from onsite renewable energy generation by 2040.

CO_2 emission trajectories in tonnes CO_2 per year



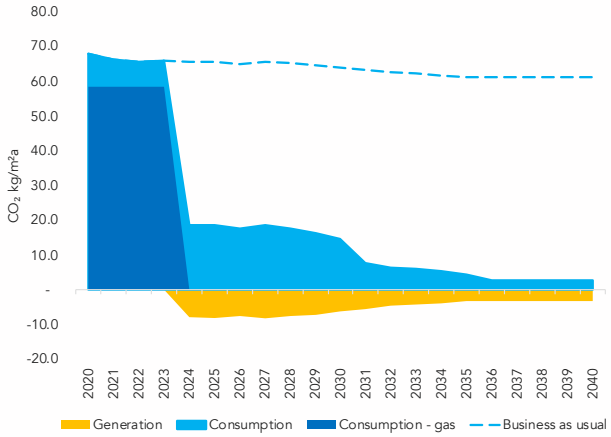
Current and projected heating demand and system



[1] A heat network would qualify as 'low carbon heat network' for the purpose of this matrix only if it would have a lower carbon content of heat (per kWh delivered) than direct electric heating. Any system using fossil fuels and/or with high distribution losses is unlikely to qualify.

[2] Could be an individual or building level heat pump with low distribution losses.

Photograph of Otto Close



Carbon balance for Otto Close

	Measure	Level	Notes
Package 1	Triple glazing	Good	Uw-valuve of 1.2W/mK
	External wall insulation	Best	200mm thickness
Year 2023-2026	Loft insulation	Best	400mm thickness
	MVHR	Best	90% efficient heat recovery
	Individual HP	Best	SFP of 3+, Suitable if Heating demand <100kWh/m2a
£1322k	DHW tank	Best	DHW cylinder, <1W/K
	Solar PVs	Best	360Wp panels with microinverters
	Improved com. lighting (if appl.)	Best	High efficacy lighting
Package 2	Floor insulation	Good	30mm thickness, <half dwellings
	Junctions insulated	Good	Junctions insulated where possible
Year 2027-2032	Airtightness improved	Best	2ach
£233k			
Package 3	WWHR in showers	Best	50% efficient heat recovery
	Improved appliances	Best	A+++ rated appliances
Year 2033-2038	Smart energy controls	Best	Whole dwelling controls with zoning
£45k			

Breakdown of measures per package for Otto Close

Extract of Matrix

Archetype 3 (Trad-EWI-flat) | Characteristics and list of buildings

Key characteristics

Simple façade, mostly brick and distinct windows, some older buildings included. Flat roof. 3-8 storeys.

List of buildings

- Eric Wilkins House, Avondale Square Estate
- George Elliston House, Avondale Square Estate
- Twelve Acres House, Avondale Square Estate
- Dron House
- Bazeley House, Southwark Estate
- **Collinson Court**, Southwark Estate[1]
- Horace Jones House, Southwark Estate
- Markstone House, Southwark Estate
- Stopher House, Southwark Estate
- Sumner Buildings, Southwark Estate
- Blake House, William Blake Estate
- Donnelly House, William Blake Estate
- Windsor House, Windsor House
- Petticoat Square, Middlesex Street Estate

Retrofit plan to Net Zero

1) Prioritise flat roof insulation, MVHR, heating and DHW storage, solar PV, any landlord lighting
2) Floor insulation, external wall insulation and window replacements, junctions and airtightness
3) WWHR, improved appliances, energy controls

Images of some of the buildings

[1] *Detailed on next page*

Archetype 3 (Trad-EWI-flat) | Example: proposed retrofit plan and carbon pathway

Collinson Court

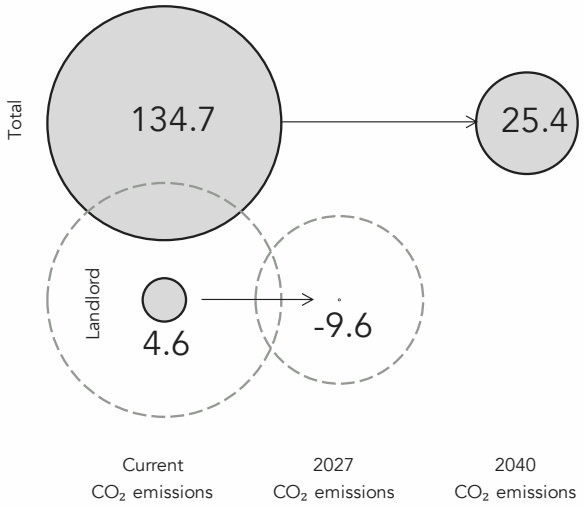
Archetype A3

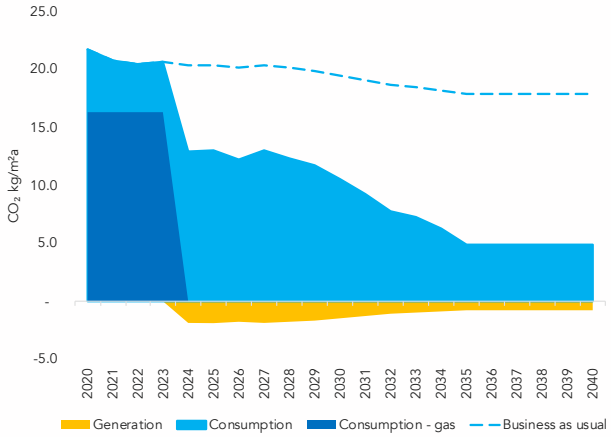
This block was built in 1957 and is fairly simple brick construction. It would be suitable for external wall insulation, triple glazed windows and flat roof insulation. It is currently heated by individual gas boilers. We recommend that these be replaced by direct electric during package 2, when the heating demand has been reduced by fabric improvement measures. It should also be possible to install MVHR units, as well as solar PV on some of the flat roof.

There is a small amount of landlord energy from lighting, which could be made more efficient and offset by the solar PV. This building could offset approximately 21% of emissions due to consumption from onsite renewable energy generation by 2040.

Photographs of Collinson Court

CO_2 emission trajectories in tonnes CO_2 per year





Carbon balance for Collinson Court

Current and projected heating demand and system

	High carbon heat network	Individual gas boiler	Direct electrical heating	Low carbon heat network[1]	Heat pump system[2]
Heating demand <40 kWh/m²yr					
Heating demand <100 kWh/m²yr					
Heating demand <150 kWh/m²yr					
Heating demand >150 kWh/m²yr					

Use of fossil fuels
Not compatible with Net Zero. The heating system must be changed.

Low carbon heat but risk of high energy costs
A change of heating system may not be required but fabric, ventilation and system should be improved

Low carbon heat and sufficient level of energy efficiency
Compatible with Net Zero

[1] A heat network would qualify as 'low carbon heat network' for the purpose of this matrix only if it would have a lower carbon content of heat (per kWh delivered) than direct electric heating. Any system using fossil fuels and/or with high distribution losses is unlikely to qualify.

[2] Could be an individual or building level heat pump with low distribution losses.

	Measure	Level	Notes
Package 1	Flat roof insulation	Best	250mm thickness
	MVHR	Best	90% efficient heat recovery
Year 2023-2026	Direct electric	Best	Suitable if Heating demand <40kWh/m2a
	DHW tank	Best	DHW cylinder, <1W/K
	Solar PVs	Best	360Wp panels with microinverters
£1182k	Improved com. lighting (if appl.)	Best	High efficacy lighting
	Improved lift (if appl.)	Best	High efficiency lift
Package 2	Triple glazing	Best	Uw-value of 0.8W/m2K
	Internal wall insulation	Best	100mm thickness
Year 2027-2032	Floor insulation	Good	30mm thickness, <half dwellings
	Junctions insulated	Best	Good connections possible: floor-wall and/or wall-roof
£2493k	Airtightness improved	Best	2ach
Package 3	WWHR in showers	Best	50% efficient heat recovery
	Improved appliances	Best	A+++ rated appliances
Year 2033-2038	Smart energy controls	Best	Whole dwelling controls with zoning
£108k			

Breakdown of measures per package for Collinson Court

Extract of Matrix

Archetype 4 (Mix-IWI-flat) | Characteristics and list of buildings

Key characteristics

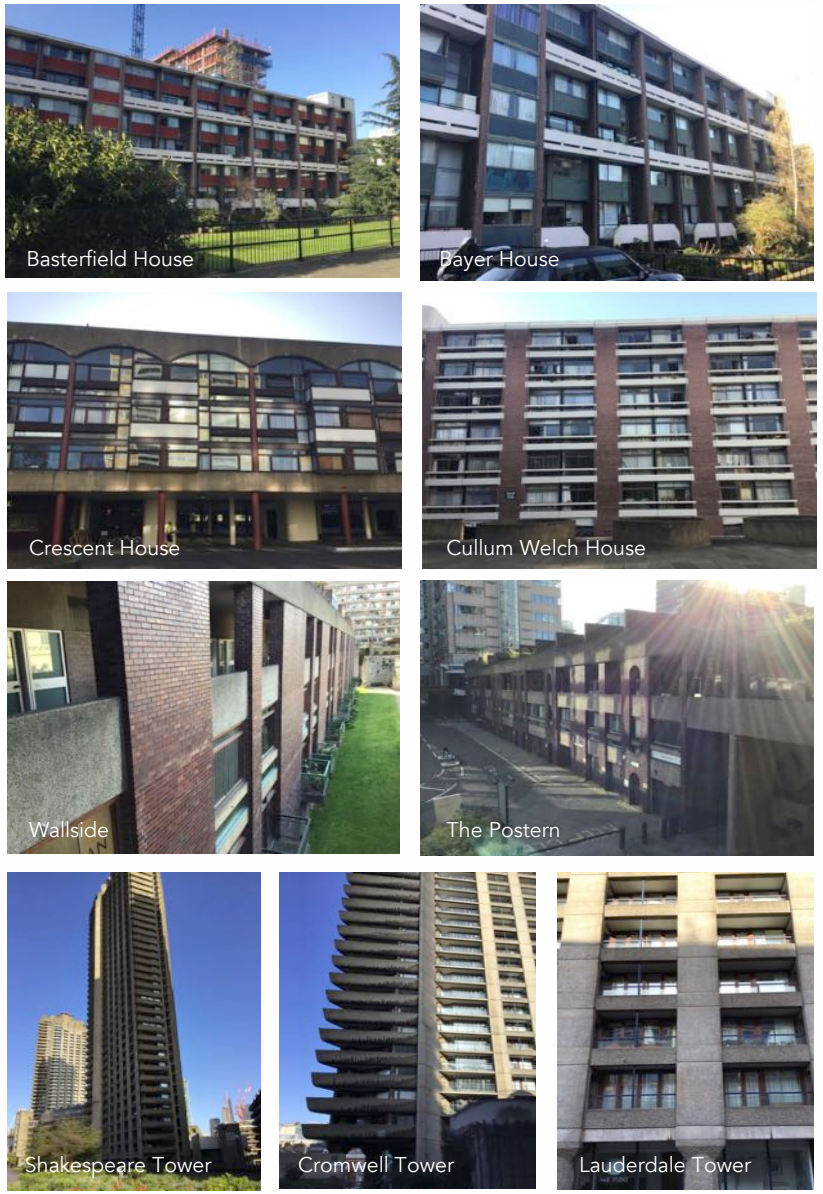
Complex façade, mixture of windows and panels, some brick/clad wall. Flat roof. Golden Lane and Barbican. Includes 3 towers. Typically listed or in a conservation area. Limited wall space for internal wall insulation.

List of buildings

- **Basterfield House**, Golden Lane Estate[1]
- Bayer House, Golden Lane Estate
- Bowater House, Golden Lane Estate
- Cullum Welch House, Golden Lane Estate
- Cuthbert Harrowing House, Golden Lane Estate
- Great Arthur House, Golden Lane Estate (Tower, curtain wall)
- Hatfield House, Golden Lane Estate
- Stanley Cohen House, Golden Lane Estate
- Cromwell Tower, Barbican Estate (Tower)
- Lauderdale Tower, Barbican Estate (Tower)
- Mountjoy House, Barbican Estate
- Shakespeare Tower, Barbican Estate (Tower)
- The Postern, Barbican Estate
- Wallside, Barbican Estate

Retrofit plan to Net Zero

1) Prioritise flat roof insulation, energy controls, heating and DHW storage, solar PV, any landlord lighting
2) Floor insulation, internal wall insulation (where possible) and window replacements (where possible – redesign of panelised systems may be appropriate in some cases), junctions and airtightness, MVHR
3) WWHR, improved appliances



Images of some of the buildings

[1] *Detailed on next page*

Archetype 4 (Mix-IWI-flat) | Example: Proposed retrofit plan and carbon pathway

Basterfield House

Archetype A4

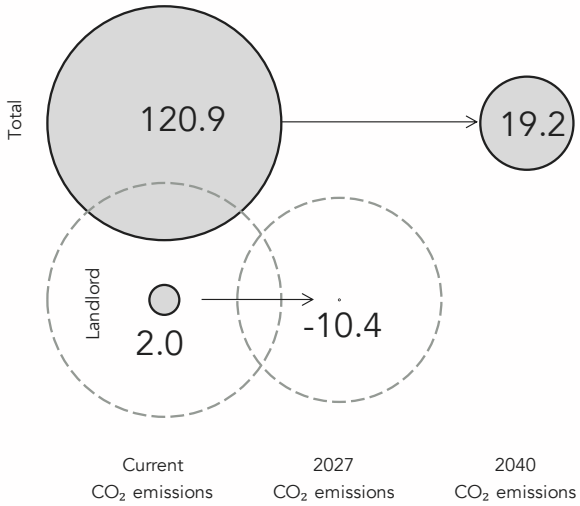
This four story block was built in 1957 and is Grade II Listed, making internal wall insulation necessary on areas of clear wall. The façades are fairly complex with a mixture of windows and panels on the main facade, the replacement strategy would need careful consideration but in principle triple glazed windows are possible. The roof is flat, which is suitable for insulating with PV panels on top.

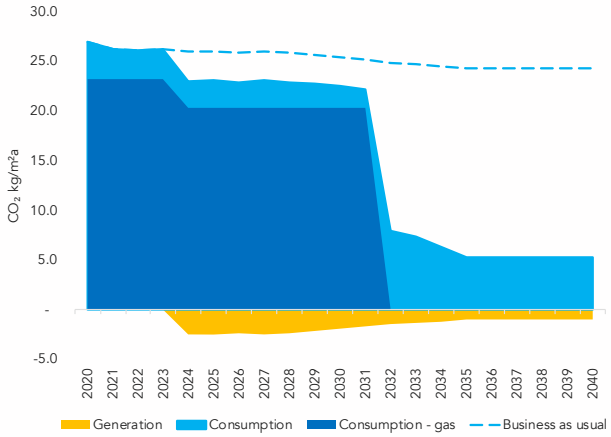
Heat pumps may be possible for this block but would need detailed assessment. Otherwise we recommend that the boilers are replaced by direct electric during package 2, when the heating demand has been reduced by fabric improvement measures. It should also be possible to install MVHR units.

There is a small amount of landlord energy from lighting, which could be made more efficient and offset by the solar PV. This building could offset approximately 23% of emissions due to consumption from onsite renewable energy generation by 2040.

Photograph of Basterfield House

CO_2 emission trajectories in tonnes CO_2 per year





Carbon balance for Basterfield House

Current and projected heating demand and system

	High carbon heat network	Individual gas boiler	Direct electrical heating	Low carbon heat network[1]	Heat pump system[2]
Heating demand <40 kWh/m²yr					
Heating demand <100 kWh/m²yr					
Heating demand <150 kWh/m²yr					
Heating demand >150 kWh/m²yr					

Use of fossil fuels
Not compatible with Net Zero. The heating system must be changed.

Low carbon heat but risk of high energy costs
A change of heating system may not be required but fabric, ventilation and system should be improved

Low carbon heat and sufficient level of energy efficiency
Compatible with Net Zero

[1] A heat network would qualify as 'low carbon heat network' for the purpose of this matrix only if it would have a lower carbon content of heat (per kWh delivered) than direct electric heating. Any system using fossil fuels and/or with high distribution losses is unlikely to qualify.

[2] Could be an individual or building level heat pump with low distribution losses.

Extract of Matrix

	Measure	Level	Notes
Package 1	Flat roof insulation	Best	250mm thickness
	Smart energy controls	Best	Whole dwelling controls with zoning
Year 2023-2026	Solar PVs	Best	360Wp panels with microinverters
	Improved com. lighting (if appl.)	Best	High efficacy lighting
£661k	Improved lift (if appl.)	Best	N/A
Package 2	Triple glazing	Good	Uw-valuve of 1.2W/mK
	Internal wall insulation	Good	30mm thickness
Year 2027-2032	Floor insulation	Good	30mm thickness, <half dwellings
	Junctions insulated	Good	Junctions insulated where possible
£1517k	Airtightness improved	Best	2ach
	Direct electric	Best	90% efficient heat recovery
Package 3	WWHR in showers	Best	50% efficient heat recovery
	Improved appliances	Good	A+ rated appliances
Year 2033-2038			
£108k			

Breakdown of measures per package for Basterfield House

Archetype 5 (Mix-IWI-barrel) | Characteristics and list of buildings

Key characteristics

Barbican Estate or Golden Lane Estate (Crescent House), complex façade, mostly more than 10 storeys, mixture of windows and panels, potentially some clear wall but likely to need to be internally insulated for heritage reasons. These buildings all have a barrel roof, partial roof insulation is possible.

List of buildings

- Andrews House, Barbican Estate
- Ben Jonson House, Barbican Estate
- Brandon Mews, Barbican Estate
- Breton House, Barbican Estate
- Bryer Court, Barbican Estate
- Bunyan Court, Barbican Estate
- **Crescent House**, Golden Lane Estate[1]
- Defoe House, Barbican Estate
- Frobisher Crescent, Barbican Estate
- Gilbert House, Barbican Estate
- John Trundle Court, Barbican Estate
- Lambert Jones Mews, Barbican Estate
- Seddon House, Barbican Estate
- Speed House, Barbican Estate
- Thomas More House, Barbican Estate
- Willoughby House, Barbican Estate

Retrofit plan to Net Zero

1) Prioritise barrel and flat roof insulation where possible, energy controls, heating and DHW storage, landlord lighting, PV if possible (less likely)
2) Floor insulation, IWI (small areas where possible), window replacements (where possible – redesign of panelised systems may be appropriate in some cases), junctions and airtightness, MVHR
3) WWHR, improved appliances

[1] *Detailed on next page*

Images of some of the buildings

Archetype 5 (Mix-IWI-barrel) | Example: Proposed retrofit plan and carbon pathway

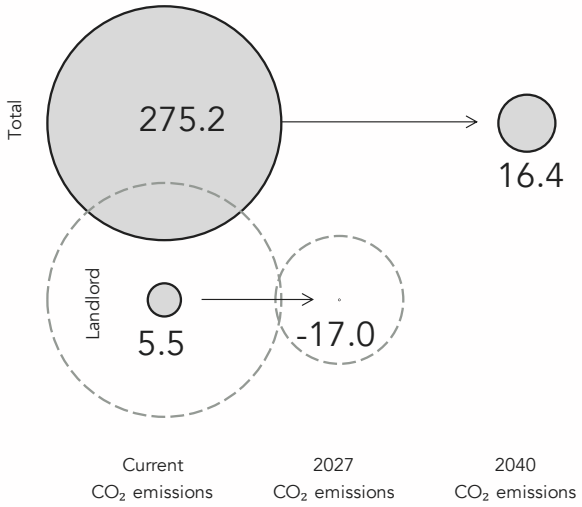
Crescent House

Archetype A5

This four story block was built in 1962 and is Grade II Listed, making internal wall insulation necessary on areas of clear wall. The façades are very complex with a mixture of windows and panels on the main facade, the replacement strategy would need careful consideration, triple glazed windows or equivalent may be possible. The roof is a low barrel profile which may be partially suitable for PV panels on the south facing portions. It should be possible to insulate this on top.

Heat pumps may be possible for this block but would need detailed assessment. It should also be possible to install MVHR units. There is a small amount of landlord energy from lighting, which could be made more efficient and offset by the solar PV. This building could offset approximately 23% of emissions due to consumption from onsite renewable energy generation by 2040.

CO_2 emission trajectories in tonnes CO_2 per year



Current and projected heating demand and system

	High carbon heat network	Individual gas boiler	Direct electrical heating	Low carbon heat network[1]	Heat pump system[2]
Heating demand <40 kWh/m²yr					
Heating demand <100 kWh/m²yr					
Heating demand <150 kWh/m²yr					
Heating demand >150 kWh/m²yr					

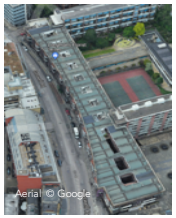
Use of fossil fuels
Not compatible with Net Zero. The heating system must be changed.

Low carbon heat but risk of high energy costs
A change of heating system may not be required but fabric, ventilation and system should be improved

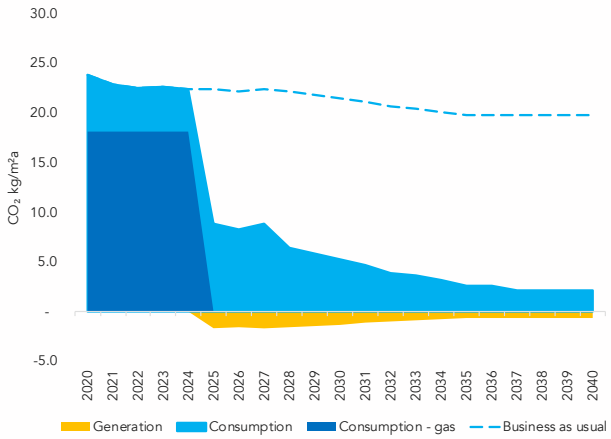
Low carbon heat and sufficient level of energy efficiency
Compatible with Net Zero

[1] A heat network would qualify as 'low carbon heat network' for the purpose of this matrix only if it would have a lower carbon content of heat (per kWh delivered) than direct electric heating. Any system using fossil fuels and/or with high distribution losses is unlikely to qualify.

[2] Could be an individual or building level heat pump with low distribution losses.



Photographs of Crescent House



Carbon balance for Crescent House

	Measure	Level	Notes
Package 1	Flat roof insulation	Good	100mm thickness
	Individual HP	Best	SFP of 3+, Suitable if Heating demand <100kWh/m2a
Year 2023-2026	DHW tank	Best	DHW cylinder, <1W/K
	Smart energy controls	Best	Whole dwelling controls with zoning
	Solar PVs	Best	360Wp panels with microinverters
£3457k	Improved com. lighting (if appl.)	Best	High efficacy lighting
	Improved lift (if appl.)	Best	N/A
Package 2	Triple glazing	Good	Uw-valuve of 1.2W/mK
	Junctions insulated	Good	Junctions insulated where possible
Year 2027-2032	Airtightness improved	Good	5ach
	MVHR	Best	90% efficient heat recovery
£1992k			
Package 3	WWHR in showers	Best	50% efficient heat recovery
	Improved appliances	Best	A+++ rated appliances
Year 2033-2038			
£453k			

Breakdown of measures per package for Crescent House

Extract of Matrix

Archetype 6 (Mix-EWI-flat) | Characteristics and list of buildings

Key characteristics

Complex façade, mixture of windows and panels, potentially some clear wall. These blocks have flat roofs and some potential for external wall insulation (EWI).

List of buildings

- Brettinghurst house, Avondale Square Estate
- Centre Point, Avondale Square Estate (Tower)
- East Point, Avondale Square Estate (Tower)
- West Point, Avondale Square Estate (Tower)
- Colechurch House, Avondale Square Estate (Tower)
- Proctor House, Avondale Square Estate (Tower)
- Tovy House, Avondale Square Estate (Tower)
- **Petticoat Tower**, Middlesex Street Estate (Tower)[1]
- Longland Court, Avondale Square Estate
- Kinefold House, York Way Estate
- Lambfold House, York Way Estate
- Penfields House, York Way Estate
- Shepherd House, York Way Estate

Retrofit plan to Net Zero

1) Prioritise flat roof insulation, heating and DHW storage, solar PV, any landlord lighting, energy controls
2) External wall insulation and window replacements (where possible – redesign of panelised systems in some cases), junctions, airtightness and MVHR
3) Floor insulation, WWHR, improved appliances


Longland Court

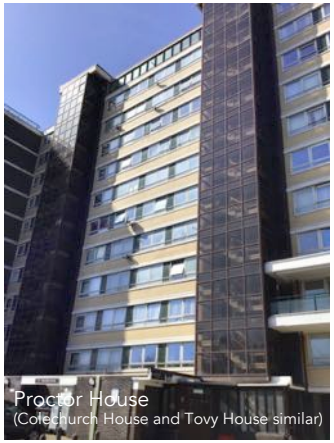

Brettinghurst house


West point / Centre point / East point © google


Kinefold House


West point
(East point and centre point identical)


Petticoat Tower


Proctor House
(Colechurch House and Tovy House similar)

Images of some of the buildings

[1] *Detailed on next page*

Archetype 6 (Mix-EWI-flat) | Example: Proposed retrofit plan and carbon pathway

Petticoat Tower

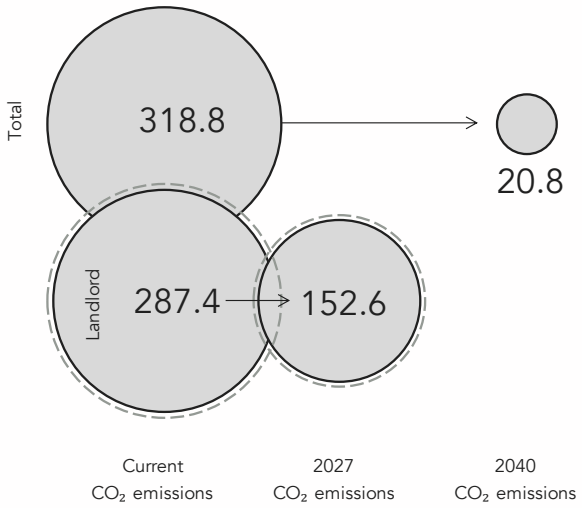
Archetype A6

This 23 storey tower was built in 1972. The windows have been replaced with triple glazing. The tower would be suitable for external wall insulation - particular attention should be paid to junctions with windows and the concrete panels surrounding the windows. Flat roof insulation is also recommended.

The block is currently heated by a communal gas boiler. We would recommend replacing this with a communal heat pump system as soon as possible. It should also be possible to install MVHR units, as well as a small amount of solar PV on the flat roof.

The landlord emissions include the communal boiler, lighting and lifts, which can be reduced significantly by a change in heating system by 2027.

CO_2 emission trajectories in tonnes CO_2 per year



Current and projected heating demand and system

	High carbon heat network	Individual gas boiler	Direct electrical heating	Low carbon heat network[1]	Heat pump system[2]
Heating demand <40 kWh/m²yr					
Heating demand <100 kWh/m²yr					
Heating demand <150 kWh/m²yr					
Heating demand >150 kWh/m²yr					

Use of fossil fuels
Not compatible with Net Zero. The heating system must be changed.

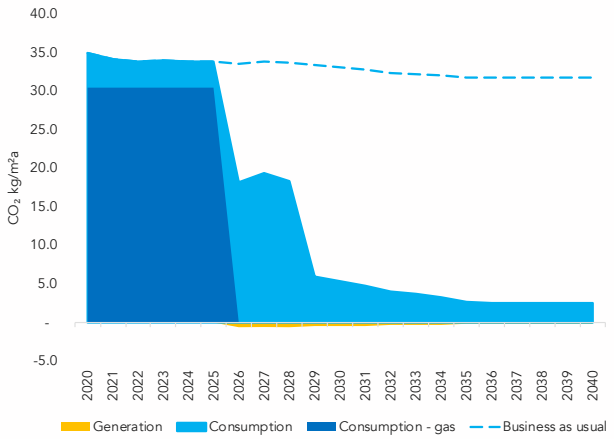
Low carbon heat but risk of high energy costs
A change of heating system may not be required but fabric, ventilation and system should be improved

Low carbon heat and sufficient level of energy efficiency
Compatible with Net Zero

[1] A heat network would qualify as 'low carbon heat network' for the purpose of this matrix only if it would have a lower carbon content of heat (per kWh delivered) than direct electric heating. Any system using fossil fuels and/or with high distribution losses is unlikely to qualify.

[2] Could be an individual or building level heat pump with low distribution losses.

Photograph of Petticoat Tower



Carbon balance for Petticoat Tower

	Measure	Level	Notes
Package 1	Flat roof insulation	Best	250mm thickness
	Communal heat pumps	Best	Using existing communal heat infrastructure
Year 2023-2026	DHW tank	Best	DHW cylinder, <1W/K
	Smart energy controls	Best	Whole dwelling controls with zoning
£1932k	Solar PVs	Best	360Wp panels with microinverters
	Improved com. lighting (if appl.)	Best	High efficacy lighting
	Improved lift (if appl.)	Best	High efficiency lift
Package 2	Triple glazing	Good	Uw-valuve of 1.2W/mK
	External wall insulation	Best	200mm thickness
Year 2027-2032	Junctions insulated	Best	Good connections possible: floor-wall and/or wall-roof
	Airtightness improved	Good	5ach
£2473k	MVHR	Best	90% efficient heat recovery
Package 3	Floor insulation	Good	30mm thickness, <half dwellings
	WWHR in showers	Best	50% efficient heat recovery
Year 2033-2038	Improved appliances	Best	A+++ rated appliances
£419k			

Breakdown of measures per package for Petticoat Tower

Extract of Matrix

4.0 Relating the action plan to the Climate Action Strategy

This section relates the retrofit plans and new build housing plans back to the Climate Action Strategy

Relating retrofit plans and new build strategy to the climate action strategy

Retrofit of housing

The bulk of this report relates to the 5,028 existing dwellings the City of London Corporation owns. The retrofit plans presented in the previous chapter map out carbon reduction strategies for six representative archetypes identified.

The following pages map out the expected combined carbon pathway of the Corporation's housing portfolio, against both the 2027 and 2040 Climate Action Strategy targets.

For the 2027 target we have mapped two scenarios:

Scenario 1) All actions in the retrofit plans take place but Middlesex Street Estate and York Way Estate remain on gas fired communal heating.

Scenario 2) All actions in the retrofit plans take place, including replacement of all communal gas boilers with low carbon heat alternatives.

New build

The City of London Corporation are adding to their housing portfolio through the construction of new housing estates.

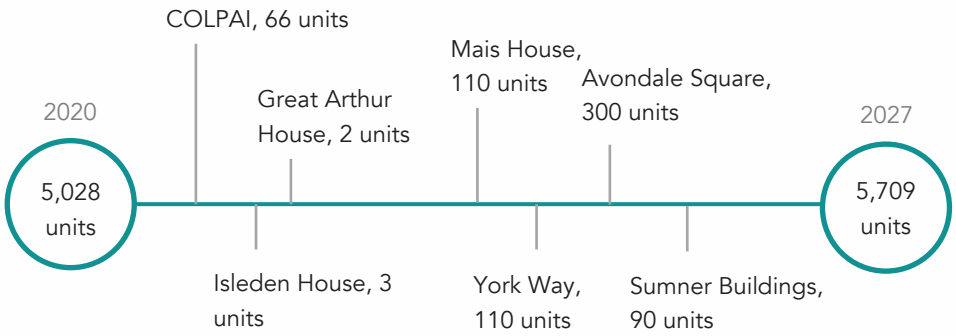
The estimated future carbon emissions of these new housing estates are included in our 2027 calculations, the first of which will be operational from 2022. As at 2027, the new build dwellings are expected to represent 12% of the stock (591 units) and 5% of the carbon emissions.

See the Appendices for information on the known new build housing, what was included in the calculations, and the assumptions made.

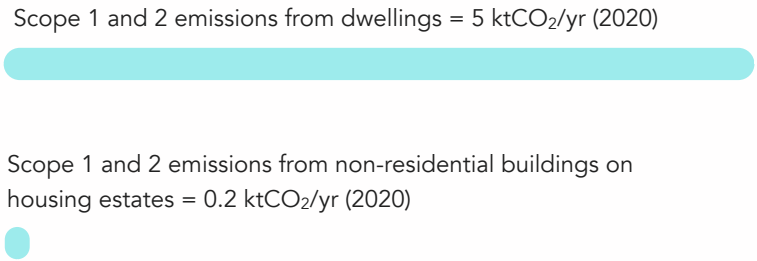
Non-domestic buildings on housing estates

Some of the estate have buildings with non-domestic uses, for example, estate offices, community centres, a leisure centre and library. The carbon emissions of these buildings are not included in our calculations as they are not housing.

For context, we have calculated the Scope 1 and 2 emissions from these buildings and compared them as a proportion of the estate's overall carbon emissions, see diagram on the right.



Timeline of known new-build programme for the City of London Housing portfolio



Scope 1 and 2 emissions from dwellings on residential estates and non-domestic buildings on residential estates, owned or managed by the City of London Corporation.

Summary of carbon emissions reduction potential by 2027

Achieving the 2027 target for Scope 1 and 2 emissions

We have modelled two scenarios to assess the carbon emissions reduction potential by 2027, of the Corporation's housing stock.

Approximately 1/3 of current Scope 1 and 2 emissions are from communal can heating of Middlesex Street Estate, York Way Estate, Isleden House and Frobisher Crescent.

While the ideal scenario would be to replace these communal gas boilers with low carbon alternatives, the two largest estates (Middlesex Street Estate and York Way Estate) are both in the process of having their communal heating systems replaced with new gas boilers. Therefore, we understand the Corporation may not be able to invest in replacement with low carbon heat alternatives.

We this in mind, we have tested two scenarios:

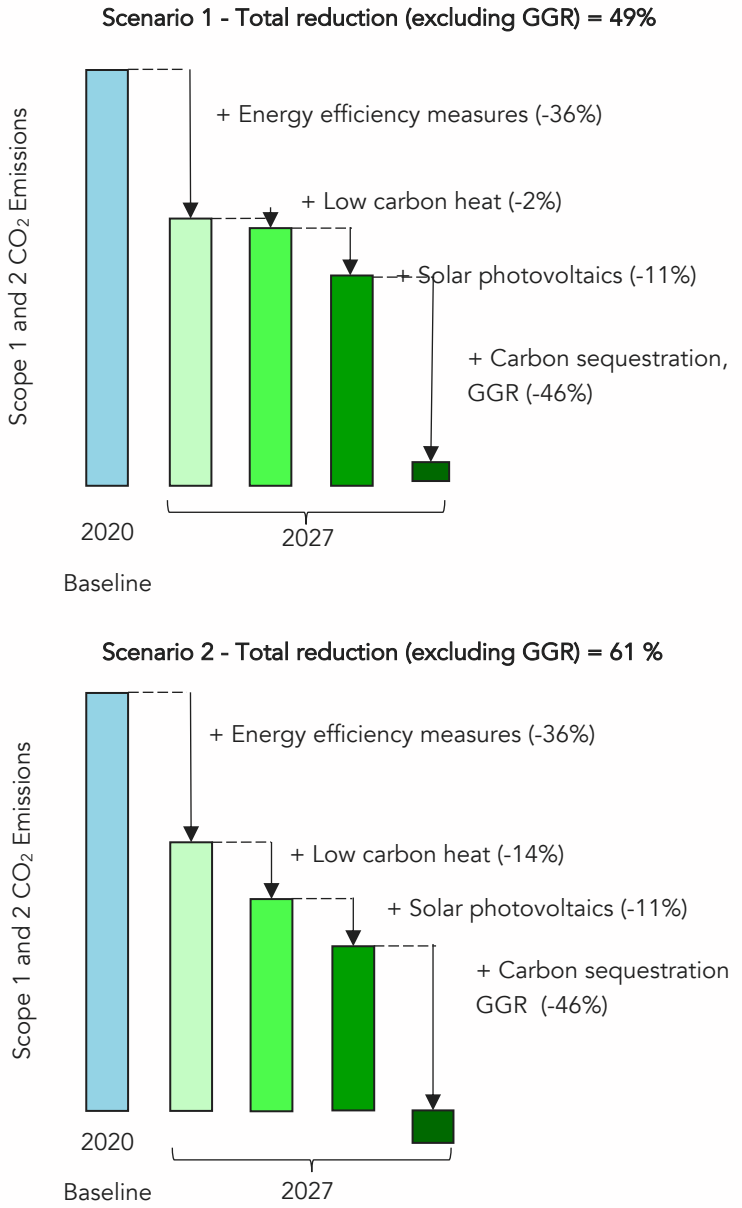
Scenario 1: As per retrofit plans, but gas communal heating remains for Middlesex Street Estate and York Way Estate

In this scenario, at 2027 a 49% reduction in emissions is achieved from the 2020 baseline. This is achieved through use of energy efficiency measures, replacement of communal gas boilers with low carbon heat (at Isleden House and Frobisher Crescent only), and the installation of photovoltaic panels on the roofs of all buildings across the estate (where roof area and shape permits).

Scenario 2: As per retrofit plans – all gas communal heating replaced with large scale Air Source Heat Pumps.

In this scenario, at 2027 a 61% reduction in emissions is achieved from the 2020 baseline. This is achieved through the same measures as scenario one, with the exception that all communal gas boilers are replaced with low carbon alternatives across all estates.

If we apply the proportionate direct greenhouse gas removals (GGR) from the Corporation's land based assets (described on page 13), a further 46% reduction may be applied to each scenario.



Scope 1 and 2 CO_2 emissions reduction strategies to 2027. Figures suggest emissions are carbon negative by 2027 only if all gas communal heating is changed to Air Source Heat Pumps by 2027.

Carbon pathway to 2027 for scope 1 and 2 emissions | Scenario 1

Scenario 1 achieves a 33% reduction from the CO_2 baseline

The graph to the right shows the carbon pathway for Scenario 1 for scope 1 and scope 2 emissions to 2027. The blue band represents emissions related to electricity consumption every year and the dark blue within it represents the emissions due to gas use. The yellow band below zero represents the emissions offset by generating renewable energy onsite.

Net emissions reductions from 2020 = 49% (i.e. 51% of emissions, or 2,554 tCO_2/yr, remain in 2027, due to emissions associated with grid electricity).

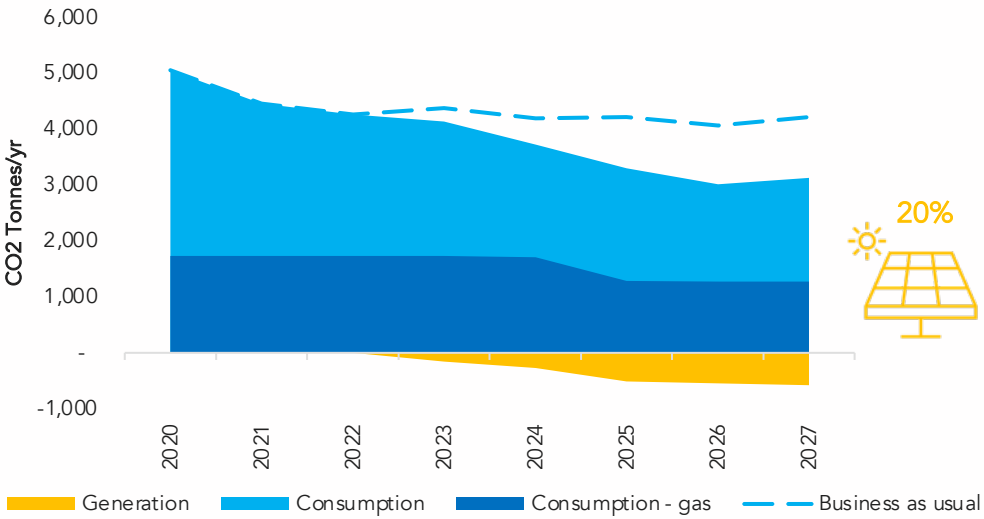
Key strategies

Key priorities for reducing scope 1 & 2 emissions in this Scenario will be:

- Stop using gas for communal heating as soon as possible (this Scenario assumes Middlesex Street and York Way Estate remain on gas communal heating.
- Install roof insulation early
- Install as much photovoltaics on the roofs as possible (at the same time, or after, roof insulation).
- Make communal lighting more efficient – upgrade to LED lighting and review lighting controls for each estate.
- Review controls of energy systems – is there scope to improve controls of communal heating systems?
- Review, and replace if necessary, insulation on pipework of communal heating systems.

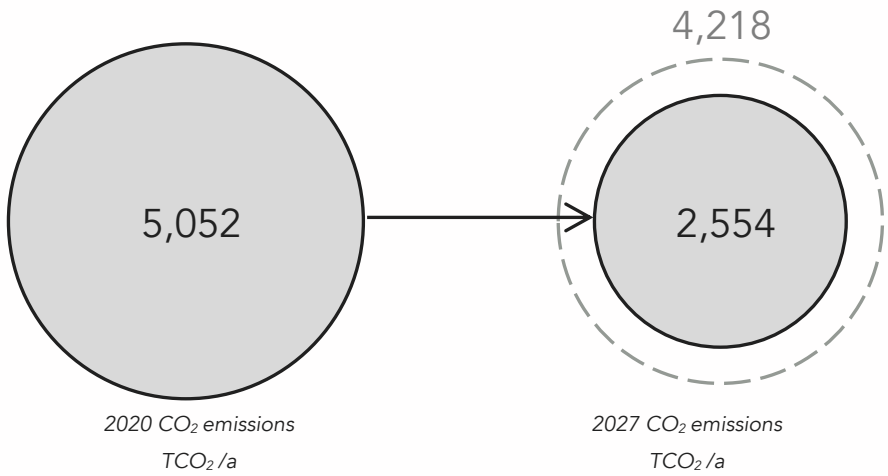
What happens if we carry on as usual?

The bubbles to the right show whole housing stock emissions in 2020 and potential emissions in 2027, including the offset from the solar generation on site. The dotted circle shows that expected emissions in a "Business As Usual" scenario (i.e. no improvements to the building fabric, heating systems and no solar PV installed on the roofs. The reduction in emissions in this case are attributed to grid electricity becoming less carbon intensive in future years.



Annual CO_2 emissions balance: Scope 1 & 2 emissions.

The icon to the right shows percentage emissions offset compared to emissions from consumption



Total scope 1 & 2 CO_2 emissions current and 2027. The combination of fabric measures, removal of gas and solar generation results in emissions reductions of 51% compared with 2020. The dotted line indicates 2027 emissions in a 'Business as usual' scenario where no retrofit action is taken.

Carbon pathway to 2027 for scope 1 and 2 emissions | Scenario 2

Scenario 2 achieves a 62% reduction from the CO_2 baseline

The graph to the right shows the carbon pathway for Scenario 2 for scope 1 and scope 2 emissions to 2027. The blue band represents emissions related to electricity consumption every year and the dark blue within it represents the emissions due to gas use. The yellow band below zero represents the emissions offset by generating renewable energy onsite.

Net emissions reductions from 2020 = 62% (i.e. 38% of emissions, or 1,986 tCO_2/yr, remain in 2027, due to emissions associated with grid electricity).

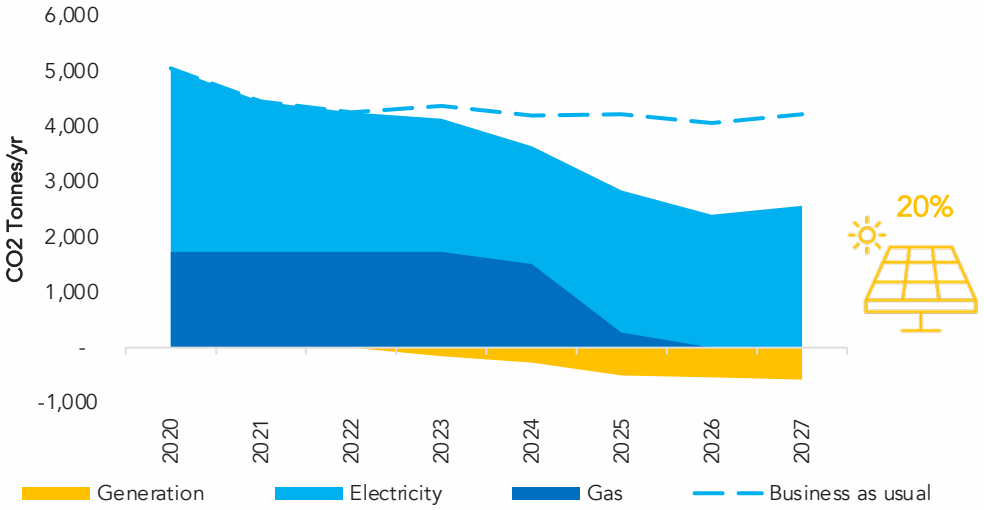
Key strategies

Key priorities for reducing scope 1 & 2 emissions in this Scenario will be:

- Stop using gas for communal heating on all estates as soon as possible
- Install roof insulation early
- Install as much photovoltaics on the roofs as possible (at the same time, or after, roof insulation).
- Make communal lighting more efficient – upgrade to LED lighting and review lighting controls for each estate.
- Review controls of energy systems – is there scope to improve controls of communal heating systems?
- Review, and replace if necessary, insulation on pipework of communal heating systems.

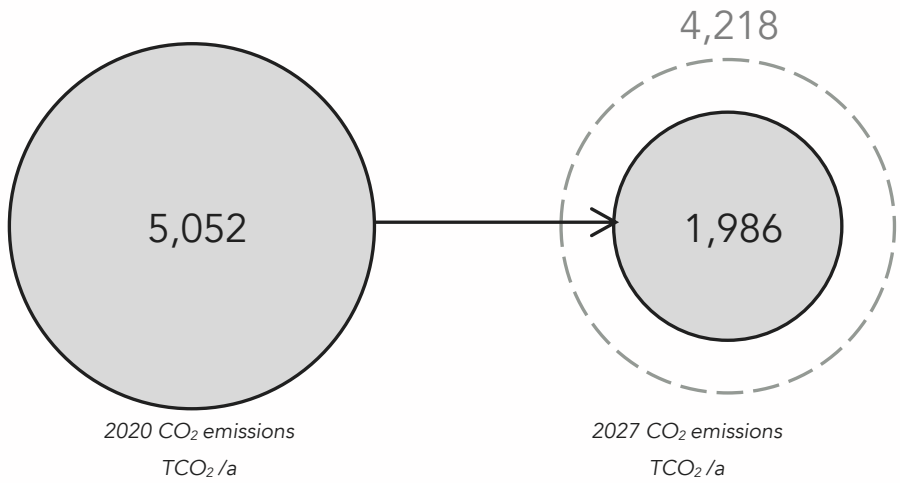
What happens if we carry on as usual?

The bubbles to the right show whole housing stock emissions in 2020 and potential emissions in 2027, including the offset from the solar generation on site. The dotted circle shows that expected emissions in a "Business As Usual" scenario (i.e. no improvements to the building fabric, heating systems and no solar PV installed on the roofs. The reduction in emissions in this case are attributed to grid electricity becoming less carbon intensive in future years.



Annual CO_2 emissions balance: Scope 1 & 2 emissions.

The icon to the right shows percentage emissions offset compared to emissions from consumption



Total scope 1 & 2 CO_2 emissions current and 2027. The combination of fabric measures, removal of gas and solar generation results in emissions reductions of 86% compared with 2020. The dotted line indicates 2027 emissions in a 'Business as usual' scenario where no retrofit action is taken.

Summary of carbon emissions reduction potential by 2040

Achieving the 2040 target for Scope 1, 2 and 3 emissions

Collectively, the measures outlined in the retrofit plans could achieve emissions reductions of approximately 86% from the 2020 baseline by 2040. This includes Scope 1, 2 & 3 emissions (from energy controlled by both the Corporation and by both tenants and leaseholders).

Key strategies modelled

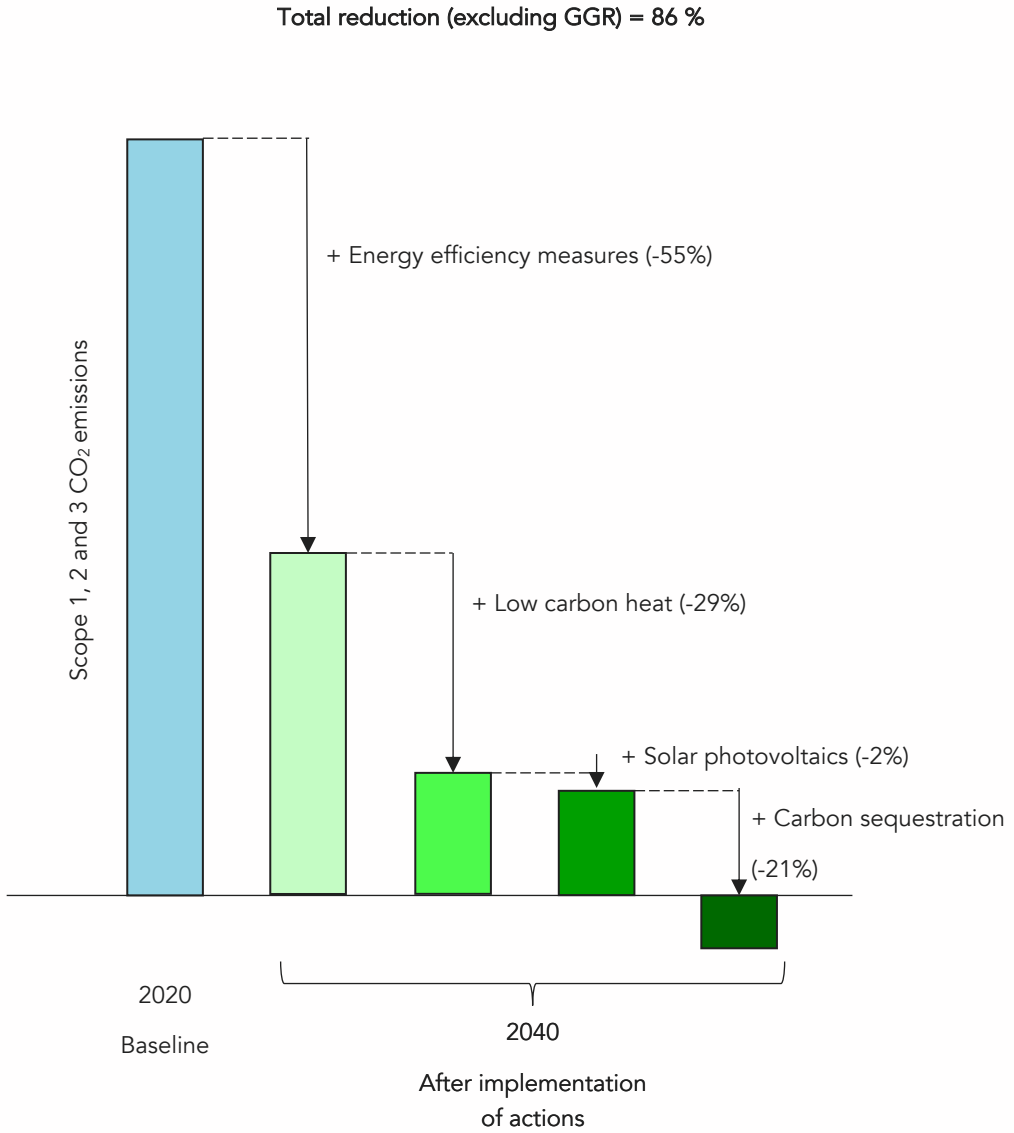
The key priorities for reducing scope 3 emissions (some of these will also reduce scope 1 and 2 emissions in communally heated blocks) will be:

- Remove individual gas boilers in all properties and replace with low carbon heating alternatives.
- Improve the energy efficiency of the fabric of the buildings through:
  - Replacing windows with triple glazing,
  - Installing wall insulation where possible
  - Install roof insulation (where not already undertaken)
  - Improve air-tightness of homes
  - Installation of floor insulation,
- Improve ventilation – preferably through whole dwelling mechanical ventilation with heat recovery,
- Install waste water heat recovery to showers and baths.

The approximate emissions reductions that could be achieved through utilising the above measures are illustrated in the graph on the right.

How far to go?

There is scope, within the carbon accounting protocol of the Climate Action Strategy, to choose not to go as far as the carbon emissions reductions suggested here. However, it is important to consider that a future of low carbon heat (a likely non-negotiable by 2040) will likely rely on energy efficiency to make it feasible. This should be factored into decisions relating to targets and ambition.



Scope 1, 2 and 3 CO_2 emissions reduction strategy to 2040. Provisional figures suggest emissions are practicably carbon negative by 2040 (figures to be checked and verified).

Note: solar photovoltaics have an apparently small impact due to the low carbon intensity of the grid electricity they are offsetting. However, the provide a vital contribution of renewable electricity to the grid.

Carbon pathway to 2040 for scope 1, 2 & 3 emissions

This pathway achieved an 86.5% reduction by 20240

The graph to the right shows the carbon pathway for the scope 1, 2 and 3 emissions to 2040. The blue band represents emissions related to electricity consumption and the dark blue within it represents the emissions due to gas use. The yellow band below zero represents the emissions offset by generating renewable energy onsite. This is enough to offset approximately 12% of the emissions due to consumption in 2040.

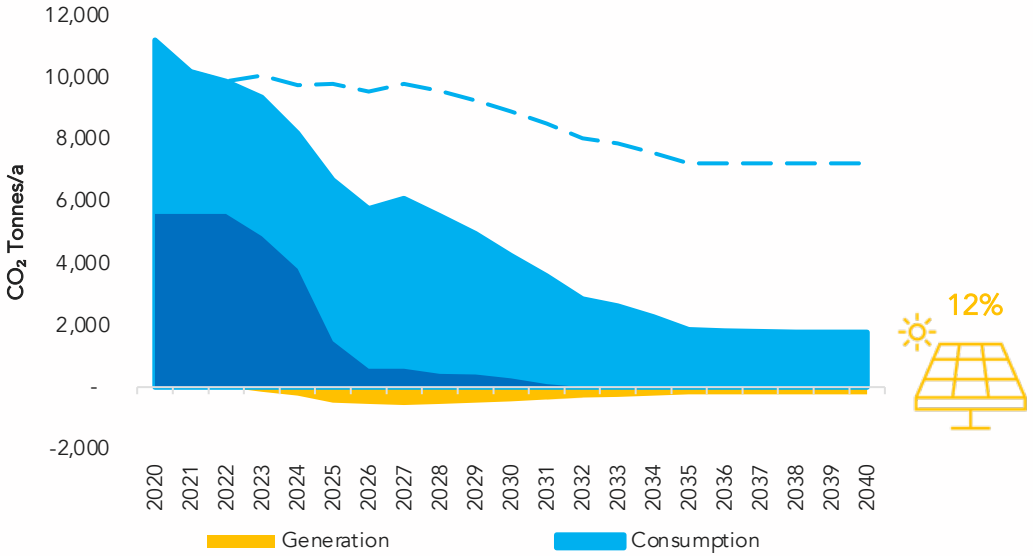
Our study shows that emissions we could achieve emissions reduction of 86.5% by 2040 (i.e. 13.5% of 2020 emissions including the offset from the solar generation on site). Remaining emissions are due to emissions from grid electricity – with electrical demand being greater than the maximum possible renewable energy generation onsite.

We have not factored in the potential carbon sequestration that the Corporation may wish to use from their land based assets. If this were to be applied in a proportional way to this pathway, net zero carbon for the housing portfolio would be achieved.

Our analysis is based on the best measures that we consider technically feasible for each estate. Different blocks present different challenges and opportunities, and each will require further site specific, detailed feasibility studies before determining the optimum approach.

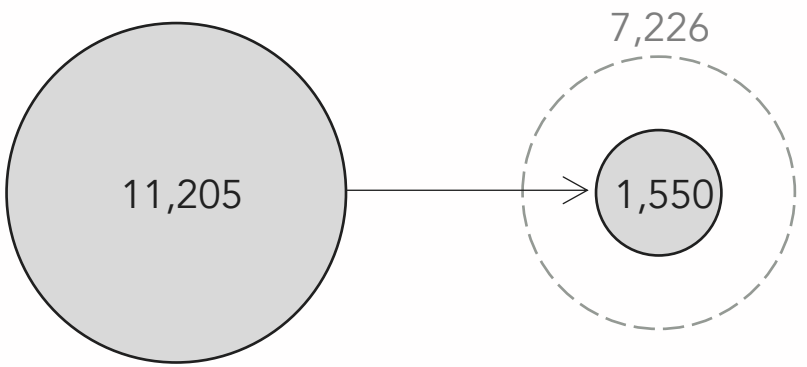
What happens if we carry on as usual?

The bubbles to the right show the baseline emissions in 2020 and potential emissions in 2040. The dotted circle represents BAU emissions (i.e. no improvements to the building fabric, heating systems and no solar PV installed on the roofs). In this case, emissions in 2040 would be 64% of 2020 emissions. The reductions would be due to expected reduction in the carbon intensity of grid electricity.



Annual CO_2 emissions balance: Scope 1, 2 and 3 emissions.

The icon to the right shows percentage emissions offset compared to emissions from consumption



2020 CO_2 emissions

TCO_2 /a

2040 CO_2 emissions

TCO_2 /a

Total Scope 1, 2 and 3 CO_2 emissions current and 2040. The combination of fabric measures, removal of gas and solar generation results in emissions reductions of 86.5% compared with 2020. The dotted line indicates 2040 emissions in a 'Business as usual' scenario where no retrofit action is taken (improvements are due to reduction in grid CO_2 emissions only.

5.0 Costs, funding and Finance

This section presents the results of the cost analysis undertaken. It also discusses opportunities within the current replacement and maintenance programme for undertaking retrofit works. Potential sources of funding are presented.

Costs per unit for net zero by 2027 (scope 1 and 2) and path to net zero 2040 (all emissions)

Costs per unit

The cost estimates below indicate the estimated cost of retrofitting existing housing to support the Corporation's net zero carbon targets for 2027 (scopes 1 & 2) and for 2040 (scope 3):

- 2027 – Average cost of £9,100 per property, with a range of £1,000 to £43,900 for labour and materials. (For communally heated properties this is an average cost of £15,200 per property, with a range of £9,700 to £41,900).

- 2040 – Average cost of £44,000 per property for labour and materials (with a range of £27,400 to £64,900).

Methodology

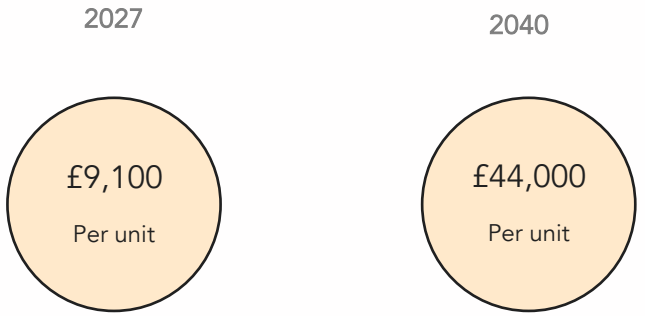
We have applied a cost per measure per unit figure to all measures applicable to each property, for both the "good" and the "best" versions of the technology/measure.

Cost per measure per unit figures are largely based on estimates from the work Parity Projects have produced for the London Retrofit Action Plan, which reference a mixture of unit sizes and conditions. Costs are based on labour and materials only and exclude for example, design fees, prelims, overheads and profit, enabling works, ancillaries etc). Currently cost estimates do not reflect cost uplifts that may be associated with listed buildings such as the Barbican or the Golden Lane Estate. This would likely affect cost of replacement windows and ventilation system costs.

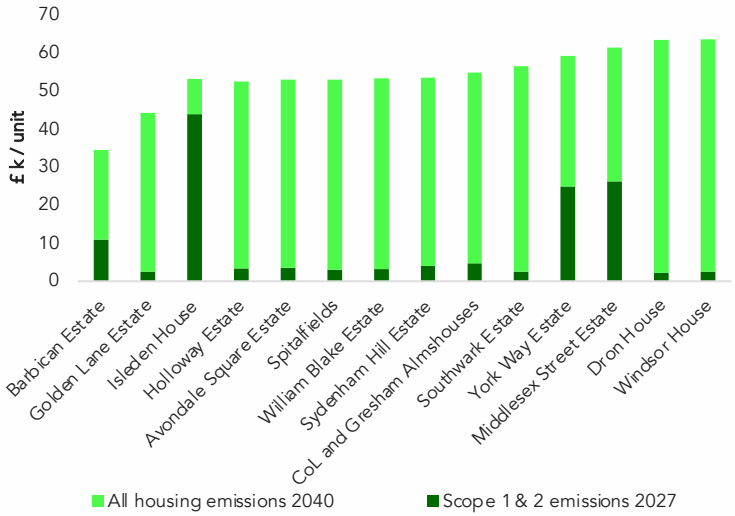
Cross checking with London Retrofit Action Plan

The Parity Projects analysis for the London Retrofit Action Plan gave two estimates (again, costs are based on labour and materials only):

- Interim target (EPC B): average cost per home £13,000, and
- Net zero target: average cost per home of £25,900 (with a range of £13,000 - £352,000).



Average cost of implementing net zero carbon action plans for housing, for 2027 and 2040.



Projected cost per unit, by estate

Note - Costs are based on sources that reference a mixture of unit sizes and conditions. Cost figures are budget costs, and need to be reviewed and adjusted for measures already installed, and for listed buildings.

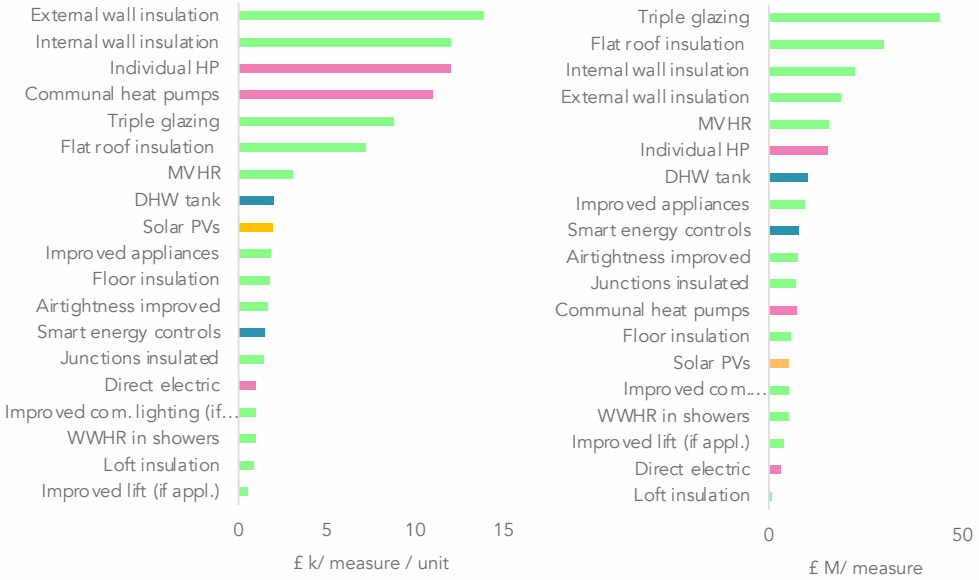
Costs breakdowns for the path to net zero 2040 (all emissions)

Costs per package and per measure type

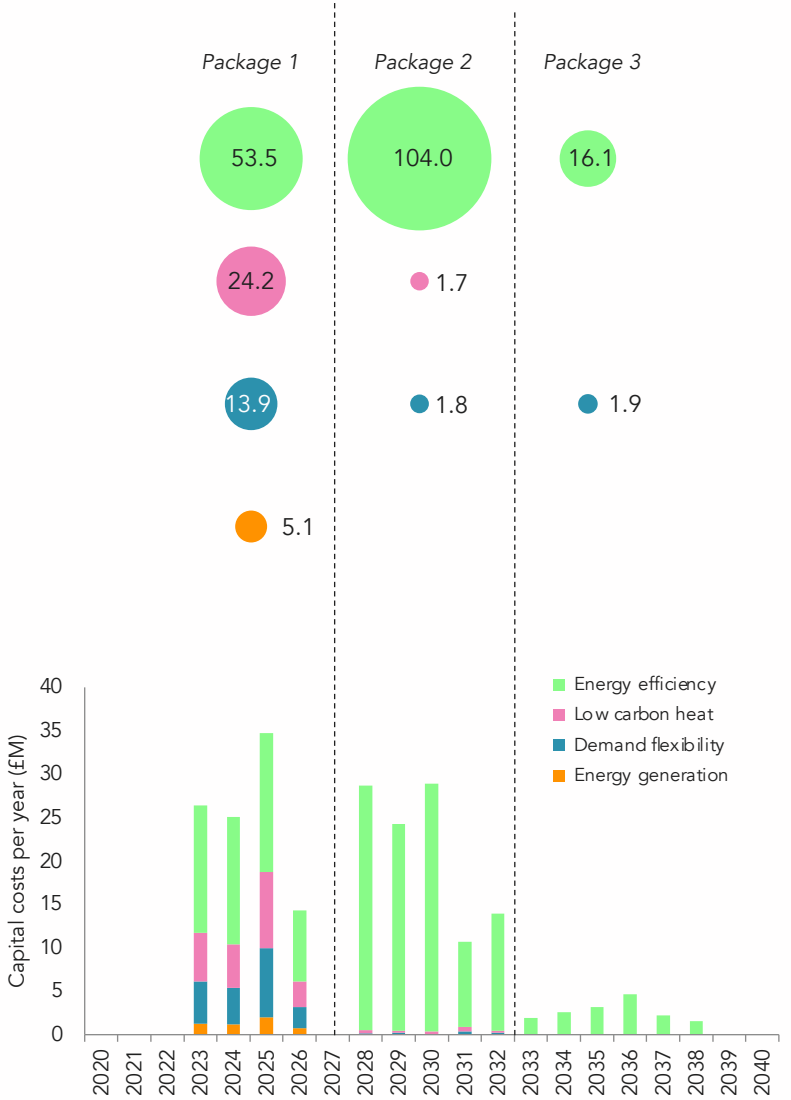
The figure to the right shows the cost breakdown over time. Top right shows the breakdown per package of works, and the years shown underneath give indicative amounts per year. This shows that most of the low carbon heat and demand flexibility and all of the energy generation measures are recommended to be installed before 2027, in package 1 (note package 1 impacts scope 1, 2 and 3 emissions due to the inclusion of fabric efficiency measures). Costs for measures that just include Scope 1 and 2 are detailed on page 65).

Costs per measure per unit

The figure below left indicates the cost per measure per unit (of units where the measure has been installed), and on the right total costs per measure to 2040. This indicates that wall insulation is the most expensive per unit but the glazing will be the most expensive overall. Low carbon heat measures are expensive per unit, but the total cost ranks lower as not all units are affected.



Projected costs by i) per measure per unit, and ii) per measure total across portfolio.



Projected costs per package and per measure type. Years within each package are indicative, and may be adjusted to match priorities and funding streams. Measured that should be tackled concurrently are noted in section 2.

Note - Costs are based on sources that reference a mixture of unit sizes and conditions. Cost figures are budget costs for labour and materials, and need to be reviewed and adjusted for measures already installed, and for listed buildings.

Cost benefits

Cost benefits

The retrofit measures recommended as part of this action plan are help reduce carbon emissions. Some measures cost more per tonne of carbon saved than others, but using a £/tonne CO_2 saved metric alone is not sufficient to decide which measures to prioritise over others.

We have not broken down energy efficiency into separate measures, since most measures should not be carried out in isolation (e.g. window replacement should always be carried out with improved ventilation). The goal is a whole house retrofit, a better means of prioritisation would be logical sequencing.

Energy efficiency and demand flexibility measures

Our calculations estimate that for every £1,000 spent on energy efficiency and demand flexibility, 40.5 kg of CO_2 will be saved.

Energy efficiency and demand flexibility deliver other benefits, including improved comfort, healthier indoor environment, reduced energy bills and greater resilience to climate change.

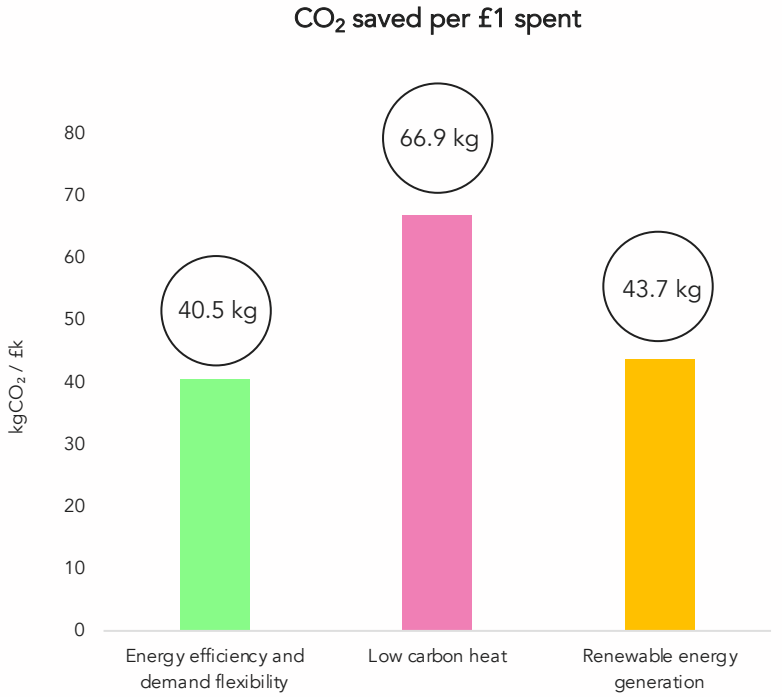
Removal of gas

Our calculations estimate that for every £1,000 spent on replacement of gas heating, 66.9 kg of CO_2 will be saved.

Renewable energy generation

Our calculations estimate that for every £1,000 spent on renewable energy, 43.7 kg of CO_2 will be saved.

Assessing the cost benefit of renewable energy in a £/tonneCO_2 metric is problematic. This is because the amount of CO_2 it offsets is directly related to the carbon intensity of electricity in the grid. With each year, the national grid's energy mix becomes less reliant on fossil fuels and the carbon intensity of electricity reduces. This is why the graph on page 54 shows a reduction in CO_2 savings from PV towards 2040. Local renewable energy generation is a necessary part of our future energy mix.



Projected kgCO_2 saved / offset for every £k spent on measures. The transition to low carbon heat is the most cost effective means of reducing carbon.

Energy efficiency and demand flexibility	Low carbon heat	Renewable energy generation
• Improved comfort • Improved indoor air quality • Reduced damp and mould • Better acoustic performance • Reduced energy bills • Greater resilience to climate change	• Improved local air quality • No gas safety issues	• Source of income / reduced energy bills • Contribution of local renewable electricity grid.

Co-benefits of energy efficiency, low carbon heat and renewable energy generation.

Current City of London Corporation climate change funding

A budget of £6m has been identified for the period 2021-2027 to contribute to the funding of low carbon retrofits outlined in this Action Plan.

Synergy with maintenance and replacement programme

The City of London Corporation is invests in their buildings through scheduled maintenance and replacement of building elements due for renewal, through ad-hoc replacement when elements fail, and through bringing homes up to the Decent Homes standard.

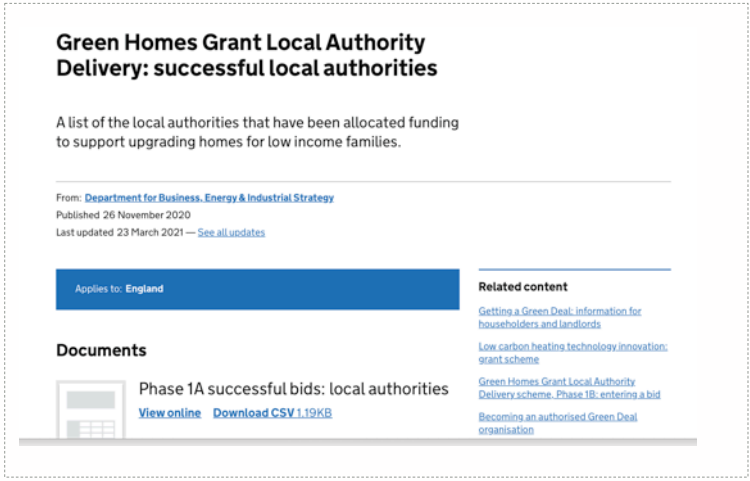
The funding for these works generally comes from rent collected from tenants and contributions from leaseholders.

There is lot of overlap between the measures that are recommended as part of this Retrofit Action Plan and measures carried out as part of standard maintenance and replacement works – e.g. replacement of windows and heating systems. If planned replacements are carried out with components of the right type and specification, cost efficiencies can be found and monies spent on planned maintenance and replacement will partially fund the Retrofit Action Plan.

Additionally, planned maintenance and replacement might present opportunities for applying energy efficiency measures at the same time as carrying out other works, and thereby share some of the fixed costs. For example, re-rendering a wall would be an ideal time to apply external insulation. The extra costs are just the insulation material and labour to secure the insulation to the wall.

Carbon offset fund

The City of London Corporation has access to monies collected through the City of London's carbon offset fund. It is estimated that £3.6 million will be available to spend on existing housing over the next 2-5 years. Since this fund is made up largely of developer contributions paid at the point of completion of new developments, estimating future funding from this source is difficult.



The Green Homes Grant Local Authority Delivery (LAD) scheme and the Social Housing Decarbonisation Fund currently provide financial assistance for retrofit and are both relevant for the City of London Corporation.

All buildings (example above of Eric Wilkins House) require regular maintenance and periodic replacement. Synergy between this programme and the Housing Net Zero Retrofit Action plan should be sought.

Opportunities in the current replacement and maintenance programme

Using allocated funds efficiently to 2027

The City of London Corporation currently has planned maintenance and replacement works planned that impact energy efficiency and energy supply. The works are funded across different estates for the period up to 2022 and are being planned for the period to 2027.

Funded works for the period to 2022 are listed in the table on the right – totalling a spend of approximately £46,040,000 over 2-4 years. Note – these figures are not directly comparable with our cost estimates as they represent total costs, and our estimates are based on labour and materials only). Also, the Corporation's spending on maintenance and replacement varies year on year.

We recommend that monies spent contribute efficiently to the zero carbon retrofit agenda. Specifically:

- that maintenance and replacement works carried out are consistent with a zero carbon specification (rather than a building regulations specification).
- For projects in design stage, planning stage, or tender stage, where there is scope, thermal performance specifications should brought in line with what we recommend in the action plan.

George Elliston and Eric Wilkins House

A sum of money has been allocated for the refurbishment of George Elliston House and Eric Wilkins House (£3,000,000). This is a great opportunity to retrofit these blocks for zero carbon, starting with the retrofit plan for Archetype 3. Our model predicts a cost of approximately £3,400,000 for the package of works (labour and materials) identified in the Action Plan.

Decent Homes

An additional £5.8 million has been identified for bringing homes up to the Decent Homes standard. Efficiencies could be found here – for example installing internal wall insulation when kitchens are replaced.

Current funding allocated through capital works programme

	Measure	Estate	Amount allocated
	Communal lighting	Avondale Square Estate - complete	£340,000
	Heating replacement and new communal heating	Golden Lane Estate	£14,000,000
	Window replacements	- Southwark Estate (Pakeman, Stopher and Sumner buildings) - William Blake Estate - Holloway Estate - Dron House (complete) - Windsor House - Sydenham Hill Estate - Golden Lane Estate (allocated funding unknown)	£21,000,000
	Roof repairs	(various estates)	£7,700,000
	Major refurbishment	George Elliston House Eric Wilkins House (both Avondale Square Estate)	£3,000,000
		Total	£46,040,000

Funding already allocated for works taking place 2020-2022 for replacement and maintenance measures directly related to energy performance.

Government funding

There are currently two Government grant schemes which could be used to help fund this Housing Retrofit Net Zero Action Plan.

- The **Green Homes Grant Local Authority Delivery Scheme (LAD)** is for Local Authorities to apply and is aimed at helping households with an income under £30,000. Parts 1A and 1B are now closed but Parts 2 is now open, and Part 3 is due to open soon.
- The **Social Housing Decarbonisation Fund** is for social landlords including Local Authorities. It is very significant, i.e. £3.8bn.
- Heat Networks Investment Project (HNIP) is a government funding programme aiming to increase the number of heat networks being built.
- **Sustainable Warmth Fund** will be available, but the majority of funds (90%) will go to privately owned and rented homes.

The **Green Homes Grant LAD** scheme and the **Social Housing Decarbonisation Fund** are both active and fairly recent Government schemes which the City of London Corporation could seek to benefit from in the near future. Although additional grant funding should be made available in the future, there is no certainty at this moment in time that it will be the case. **The Green Heat Network Fund (GHNF) Transition Scheme** supports the commercialisation of low-carbon heat network projects and is open to applications in July 2021. **The Sustainable Warmth competition** will be open to Local Authorities to help them improve the efficiency of low-income households.

Leveraging private finance

Under the 'Catalysing Green Finance' initiative the London Sustainable Development Commission are working with the Green Finance Institute to set up the London Future Finance Facility.

Community energy schemes may offer opportunities for private funding of measures such as renewables, that can offer a return on investment.

The Green Finance Institute's Coalition for the Energy Efficiency of Buildings and UKGBC's Accelerator Cities programme publishes Retrofit funding propositions earlier this year. The report also includes very useful references on page 13.

The Energiesprong approach (above the Nottingham scheme by Melius Homes) provides comfort improvements as well as energy cost savings for the residents. They use these benefits to fund the improvements over the long term.

Bringing it all together - headlines costs for Net Zero by 2027

Total cost for 2027 target – £46,000,000 (labour and materials)

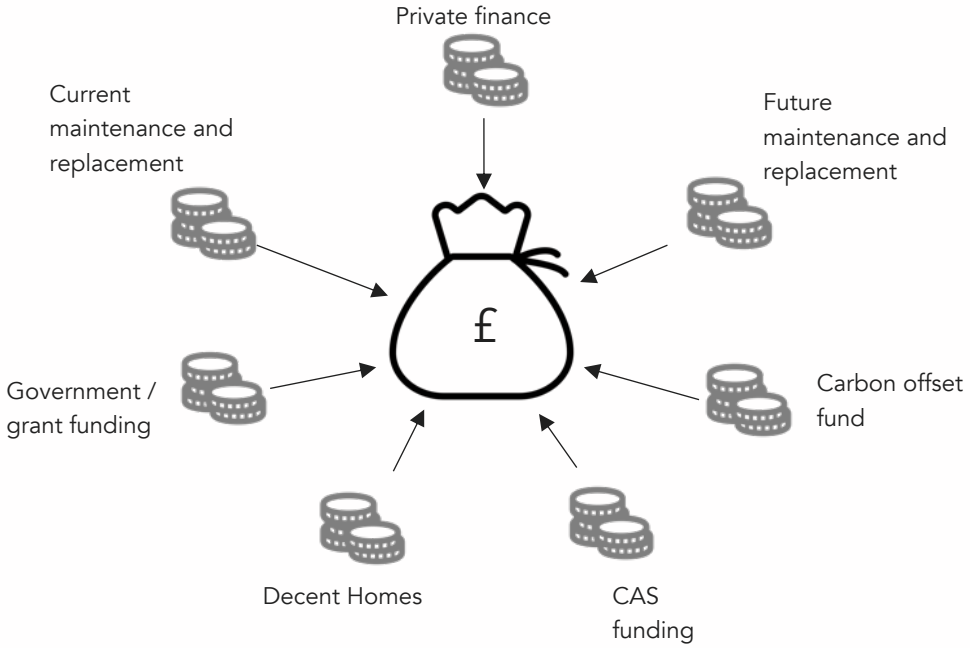
We estimate the cost of implementing the Scope 1 and 2 measures across the estates to be £46million for labour and materials (this covers communal heating replacement, photovoltaic panels, lifts and communal lighting). We recommend roof insulation is added to roofs at the same time as PV, at a further cost of approximately £21.6million.

When looking to understand how this could be funded, we have considered both the internal and external sources of funding discussed on previous pages. Funding estimates are expressed in ranges, which reflect the uncertainty surrounding the funding that could be secured:

- Maintenance and replacement (currently allocated) - £25 million (this reflects the monies allocated for heating system replacements at the Golden Lane Estate, the major refurb at George Elliston House and Eric Wilkins House, the roofing repairs at various estates and the lighting replacement at Avondale Square).
- Maintenance and replacement (future funding to 2027) - We have estimated, based on the spend 2020-2022, you may spend £4-16million (the Corporation should refine this if possible).
- Climate Action Strategy funding - £6-10million (as advised by the Corporation).
- City Corporation's carbon offset fund - £3.6million available over the next 2-5 years (as advised by the Corporation).
- Government grant funding - £1-10million (estimate based on upcoming government schemes. There is much uncertainty around how much will be available.

Total cost 2040 – £221,000,000 (labour and materials)

We estimate the cost of implementing the "Package 1, 2 and 3" measures across the estates (2021-2040) to be £221,000,000 for labour and materials.



Potential funding sources for measures

Notes on costs

Our cost estimates are based on cost per measure per unit figures derived from estimates from the work Parity Projects have produced for the London Retrofit Action Plan. As such, more detailed cost assessments should be carried out for each block or estate at more detailed design stages.

Costs are based on labour and materials only and exclude for example, design fees, prelims, overheads and profit, enabling works, ancillaries etc). Currently cost estimates do not reflect cost uplifts that may be associated with listed buildings such as the Barbican or the Golden Lane Estate. This would likely affect cost of replacement windows and ventilation system costs.

6.0
Prioritisation and other recommendations

This section includes recommendations for next steps and how to take things forward.

How to prioritise and what to start with

Prioritisation

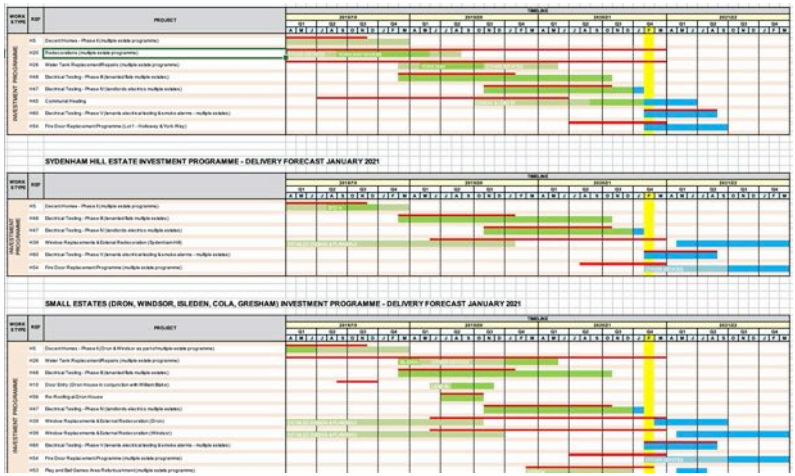
The scale of the retrofit challenge is significant. Over the next 19 years, most if not all of the 5,028 homes managed by the City of London Corporation will have to undergo some form of retrofit in order to put them on the right track towards Net Zero. The cost of doing this is also significant and is only partially funded at present so the question of prioritisation makes sense. Different logics can be followed, for example:

- The current **maintenance and replacement programme** could set the priorities both in terms of buildings to be addressed and type of work taking place. This would make sense as some heating systems or windows need replacing anyway.
- The biggest **carbon emitters** (per m^2 or total) could be addressed as a priority as reducing their emissions will help to save very significant amounts of cumulative emissions, even if they have a comparable goal.
- The issue of **fuel costs and fairness** could give priorities to the worst performing buildings in terms of energy costs: this would assist residents directly while helping the City of London Corporation to comply with current or future EPC obligations (e.g. EPC B or C by 2030).

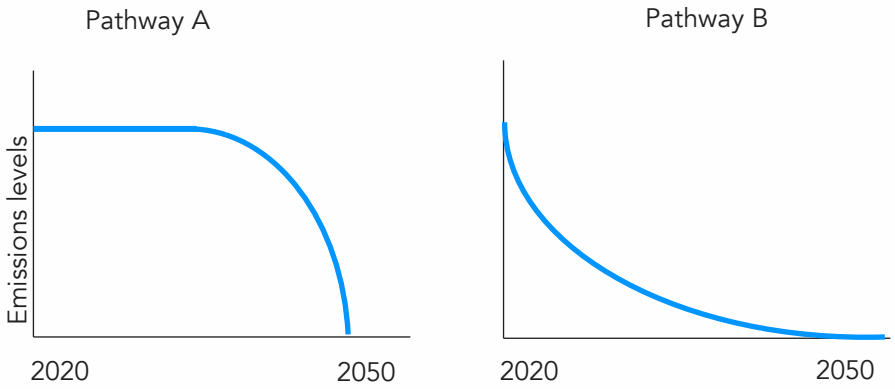
It is for the City of London Corporation to decide on the most suitable way to establish priorities. Whichever method is being selected what matters is that each intervention forms part of a well thought though, Net Zero compliant, long term renovation plan.

Getting started

It is also crucial to get started on this 19-year programme. Our recommendation would be to pick at least one the archetypes and use it to develop detailed whole house retrofit plans for each building. They will derive from the confrontation of the archetype's whole house retrofit plan template to specific constraints and opportunities for the building. And obviously, our recommendation would be to then pick the most natural candidate building and undertake design, consultation and retrofit works.



Extract of the maintenance replacement programme: it provides a natural priority for retrofit works.



Cumulative carbon is more critical than a target date for zero carbon: *Two emissions reductions pathways that achieve zero carbon emissions by 2050. Pathway A emits twice as much carbon as pathway B.*

Energy efficiency

The homes with the highest energy consumption

One way of prioritising energy efficiency measures is to identify the poorest performing homes.

This can be done indicatively through EPC data (not yet available) or through metered energy use data. Utilising a combination of the two may be the best approach.

We analysed tenant gas consumption through use of BEIS data (postcode statistics) and normalised it by the internal area of the units. From this we were able to ascertain an indicative space heating demand for each block (how much gas is consumed to heat each block on average and a reflection of fabric efficiency), in kWh/m_2/yr.

Our analysis shows the blocks listed to the right have relatively high space heating demand (above 100 kWh/m^2/yr) which is above the threshold we consider appropriate for low carbon heat. These blocks would be a logical prioritisation for energy efficiency measures over other blocks, particularly Holloway Estate (consistently low fabric efficiency), Sydenham Hill Estate, and Windsor House (selected as they have the most units).

Energy efficiency measures should be considered a priority over low carbon heat for these blocks, however, ideally whole house retrofit would be undertaken to include low carbon heat in addition. George Elliston and Eric Wilkins House are expected to undergo a full refurbishment in 2022. This is a great opportunity to retrofit these blocks for zero carbon, starting with the retrofit plan for Archetype 3.

Energy efficiency for the 2027 target

Some energy efficiency measures are suggested in Package 1 of our archetype retrofit plans. These primarily relate to the installation of roof insulation on blocks. This is because we recommend photovoltaic panels are installed on as many roofs as possible in Package 1 also, since this helps directly towards the 2027 target.

Block	Estate	Indicative space heating demand (kWh/m2/yr)	No. units
Barnersbury House	Holloway Estate	100+	18
Bunning House	Holloway Estate	100+	18
Fairweather House	Holloway Estate	100+	41
Hilton House	Holloway Estate	100+	24
McMoran House	Holloway Estate	100+	11
Whitby Court	Holloway Estate	150+	64
McAuley Close	William Blake Estate	150+	36
Lammas Green	Sydenham Hill Estate	100+	57
Otto Close	Sydenham Hill Estate	150+	30
City of London Almshouses	Ferndale Road	100+	43
Gresham Almshouses	Ferndale Road	100+	8
Colechurch House	Avondale Square Estate	100+	62
Tovy House	Avondale Square Estate	100+	52
Pakeman House	Southwark Estate	100+	56
Blake House	William Blake Estate	100+	48
Windsor House	Windsor House	100+	104

List of all blocks with the poorest fabric efficiency (as per our analysis), and above the threshold considered appropriate for low carbon heat. Priority could be given to the Holloway Estate, Sydenham Hill Estate and Windsor House (shaded in red), selected as the estates on the list with the most units.

Low carbon heat

Prioritisation

For the 2027 net zero carbon target, the Corporation may wish to prioritise the decarbonisation of communally heated blocs. This is discussed on pages 27 and 28.

For the 2040 target, all blocks and estates will need to have transitioned to low carbon heat, and the order in which they are tackled may depend on a variety of factors. One of which may be readiness for low carbon heat.

Some blocks may be ready for low-carbon heat now

Where our analysis indicates that space heating demand is low enough, it may be acceptable to prioritise the swap to low carbon heating systems over energy efficiency, and plan for energy efficiency measures to come later.

As per the logic set out on page 29, we recommend the minimum space heating demand acceptable for the use of heat pump systems is 100 kWh/m^2/yr, and the minimum space heating demand acceptable for the use of direct electric heating systems is 40 kWh/m^2/yr.

The blocks listed to the right all indicatively have space heating demands of less than 75 kWh/m^2/yr. They are grouped by storey height because storey height is a strong determinate of whether individual Air Source Heat Pumps would be suitable. Due to the indicative space heating demands being well below 100 kWh/m^2/yr, the blocks in Table A may well be suitable for Air Source Heat Pumps without needing any additional energy efficiency measures immediately.

The blocks in Table B are mid-rise, and may upon further investigation, prove suitable for communal heat pumps. If not, they will likely be suitable for direct electric heating with some energy efficiency measures.

The blocks in Table C are high-rise, and therefore unlikely to be suitable for a heat pump system. Additional energy efficiency measures are likely to make these properties suitable for direct electric heating systems.

Table A: Low-rise – may be suitable for individual Heat Pumps with no or minimal energy efficiency measures

Block	Estate	No storeys
Longland Court	Avondale Square Estate	4
Markstone House	Southwark Estate	4

Table B: Mid-rise – may be suitable for communal Heat Pumps with no or minimal energy efficiency measures

Block	Estate	No storeys
Collinson Court	Southwark Estate	8

Table C: High-rise – direct electric heating likely to be most suitable. Undertake all energy efficiency measures before installation

Block	Estate	No storeys
Centre Point	Avondale Square Estate	19
East Point	Avondale Square Estate	19
Eric Wilkins House	Avondale Square Estate	20
Proctor House	Avondale Square Estate	10
West Point	Avondale Square Estate	19
Great Arthur House	Golden Lane Estate	15

All the blocks listed above have an indicative space heating demand of less than 75kWh/m^2/yr.

Low carbon heat - Communal heating on HRA Estates

Gas communal heating must be phased out

Communal heating features at the HRA estates Middlesex Street Estate, York Way Estate, Isleden House and Frobisher Crescent (Barbican Estate). These communal heating systems all utilise gas fired boilers as the source of heating. Transitioning to low carbon heat will put the estates on a trajectory to achieving the Climate Action Strategy zero carbon targets.

The communal heating networks at Middlesex Street Estate and York Way Estate are currently being replaced with new gas boiler systems. If we model that these gas systems remain until 2027 at least, the remaining carbon emissions at that date are significant (see page 54).

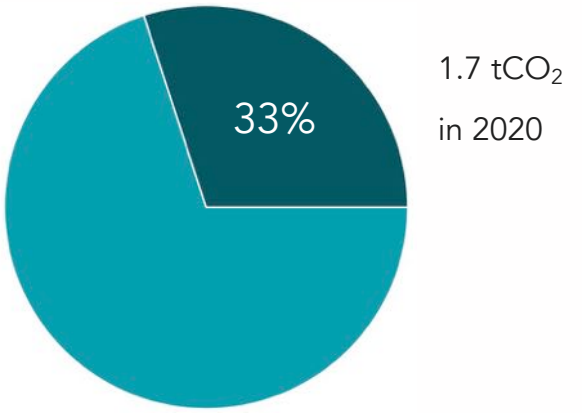
For the 2027 target of the Climate Action Strategy be achieved, the replacement of these systems would need to be paused, and design changes made so that large scale communal heat pump systems are installed instead. Without doing so, the zero carbon target for housing cannot be achieved.

Improve controls and heat loss

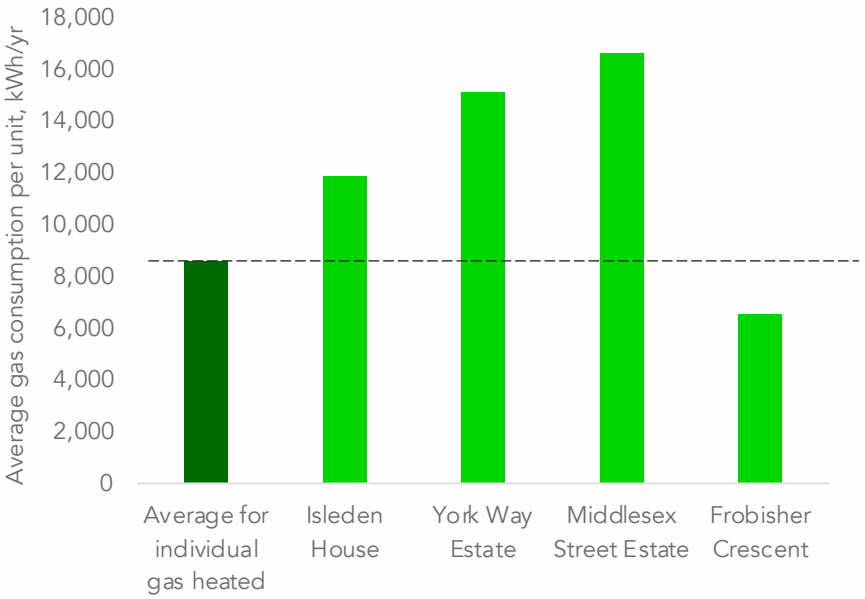
Our analysis shows that the communal heating systems consume approximately twice as much gas per dwelling than comparable individually heated units. This suggests that there are poor controls or high levels of heat loss in distribution. This should be investigated and improved.

Golden Lane Estate

There are plans to reinstate the Golden Lane Estate district heating system. We recommend that this is only done with low carbon heating systems, preferably at low temperature distribution to improve efficiency.



One third of the Corporation's housing Scope 1 & 2 emissions came from gas communal heating in 2020.



Three of the four gas communally heated estates use significantly more than the average consumption of individually gas heated units across the portfolio. Frobisher Crescent is the exception.

Low carbon heat - Communal Heating on the Barbican Estate

Barbican Estate

The majority of the Barbican Estate features electric underfloor communal heating. The associated emissions contribute to the City of London Corporation's Scope 2 emissions. Emissions were approximately 2.5 $ktCO_2$/yr in 2020 (49% of Scope 1 and 2 emissions from housing).

These emissions are set to drop year on year as the electricity grid decarbonises (see page 17). Therefore the Barbican Estate's heating system should remain.

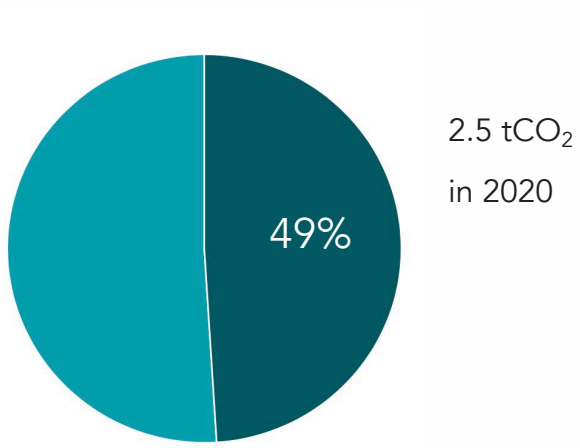
However, we understand from the experience of residents that the underfloor heating system may need optimising to ensure that electricity is used efficiently. Currently, many residents complain of too much heat in the winter (leading to open windows in mid-winter to cool flats), and not enough heat in shoulder seasons (spring and autumn). The residents have formed an Underfloor Heating Working Party which is looking in detail at how the controls can be optimised.

The issue is a complex one to solve. It's not entirely technical – there is also the problem of resident expectations and comfort and these vary greatly. A summary of conversations with the Underfloor Heating Working Party can be found in the Appendices, together with some recommendations.

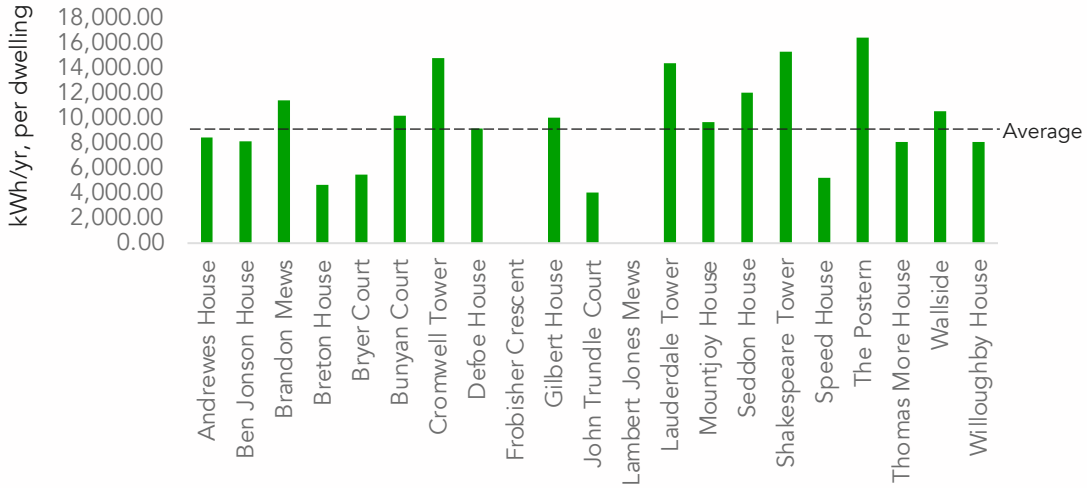
Investigate reasons for large variation in heating per dwelling

The graph on the right shows the metered electrical consumption, per dwelling, on a block by block basis at the Barbican. The range is large given that the controls are the same across every block. Further investigation of this might yield useful clues as to how to reduce energy consumption and emissions. For example obtaining reliable internal area data would allow normalisation for different sizes of flats.

It's possible that the metering system is not complete and is labelled incorrectly - this should also be investigated.



One half of the Corporation's housing Scope 1 & 2 emissions came from heating the Barbican in 2020.



Metered electrical consumption for underfloor heating across the Barbican Estate per dwelling. While the control system is the same across all blocks, consumption varies widely. Metering should be checked to ensure all heating is picked up.

Energy metering and data collection

Improve quality of metering and review regularly

A good level of energy metering, with the right amount of detail, can really help deliver efficient and cost effective strategies for carbon reduction.

We have used metered energy consumption from the Corporation to determine Scope 1 and 2 emissions for housing (landlord energy use).

Going forward, metering of landlord energy could be improved through greater consistency in meter labelling and clearer end-energy uses.

Good quality energy data is extremely useful. It allows us to:

- make useful comparisons of energy use before and after retrofit. If energy savings aren't as large as expected, reasons for this can be identified – has something not been commissioned properly? Is it being used incorrectly?
- Make useful comparisons between similar blocks and units. Are there any blocks with unusually high or low energy consumption? What could be going wrong (or right)?

For tenant energy consumption, BEIS gas and electricity by postcode statistics give annual average consumption by meter for a postcode. Given the size of the estates and blocks in the Corporation's housing portfolio, almost all estates have unique postcodes – sometimes multiple postcodes. This means data isn't muddied by consumption from non-relevant properties. Our analysis of the data from these datasets shows consistent energy consumption between similar blocks on a per meter basis, giving us confidence in these figures.

Energy metering is more useful that EPCs (Energy Performance Certificates) because it is based on actual energy consumed.

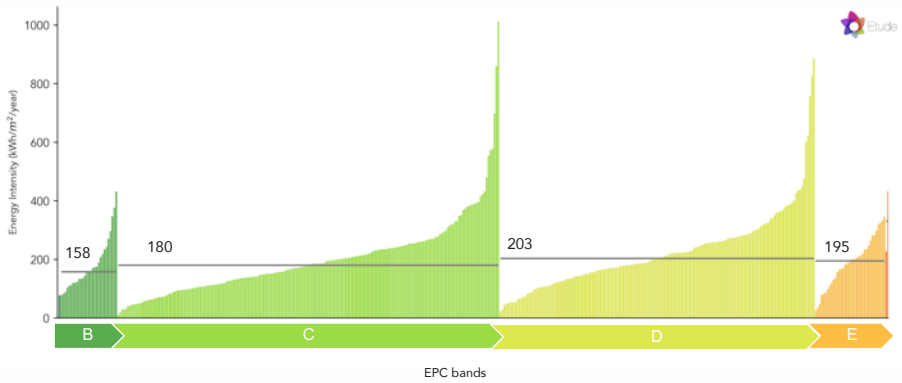
Additional recommendations regarding energy metering and data collection are suggested on the right.

Collecting residents' experiences

In addition to energy data, qualitative data from residents is helpful in identifying energy issues, and rectifying them.

- ❑ Compare landlord electricity consumption on Avondale Square Estate for 2021 and 2022 with 2019 and 2020, in order to assess effectiveness of LED lighting installation.
- ❑ Check Barbican underfloor heating meters – are they labelled correctly, are all supplies to underfloor heating included?
- ❑ Create a consistent, clear metering strategy per estate – or across all estates

Recommendations relating to energy metering and data collection



Distribution of metered energy use from 420 dwellings in London

This analysis of actual energy used in homes shows that improved EPC ratings are associated with some reduction in average energy use, but a limited one. For example, there is only a 22% reduction in total average energy use intensity from D- to B-ratings.

The mean total energy use in EPC band A is 161kWh/m²/yr, which is very high.*

Renewable energy

Prioritisation

Some estates appear to have a greater area of suitable roof space for photovoltaic panels and therefore a greater potential for renewable energy generation and associated carbon emissions reductions.

Estates and buildings which should be considered for photovoltaic panel installation as a priority include:

- **Avondale Square Estate -** The Avondale Square Estate is a large estate with buildings with strong potential for photovoltaic panels. For example, Colechurch House, Brettinghurst House, Tovy House and Proctor House all have large areas of flat, unobstructed roof space (see right). Longland Court has a lot of available flat roof space, but overshading from the towers (Centre Point, East Point and West Point) will need to be assessed.
- **York Way Estate -** Similar to the Avondale Square Estate, the York Way Estate has large areas of clear roof space.
- **Southwark Estate -** Collinson Court and Markstone House show particular potential.
- **Golden Lane Estate -** The Golden Lane Estate appears to have good potential for photovoltaic panels, especially Crescent House. It is Grade II listed estate (and Crescent House Grade II* listed). The listing will mean permission is required for panels, but it would be worth taking on the challenge.
- **Others -** Other estates with good potential for PV production include Middlesex Street Estate, Isleden House Estate, Windsor House, Lammas Green and Petticoat Square.

Note

The potential output from photovoltaic panels across the 82 buildings in the Corporation's portfolio have been estimated through a high level desk top study, and do not constitute detailed feasibility studies. These would be necessary to understand the true potential of each building.

Colechurch House, Tovy House and Proctor House on the Avondale Square Estate appear to have large, unobstructed roof areas suitable for photovoltaic panel installation.

	Potential annual output, MWh/yr
Avondale Square	1,000
Golden Lane	750
Southwark	650
Holloway	500
York Way Estate	450
Middlesex Street Estate	450

Estates with the largest renewable energy output potential. Renewable energy from photovoltaic panels can be used to power landlord electricity uses, directly offsetting grid electricity and associated carbon emissions.

Why a whole house retrofit plan for each building is crucial

A clear objective for each building, compliant with Net Zero

In order to achieve Net Zero, the approach to retrofit needs to anchor this objective as the end goal to be achieved by all buildings by 2040. Whole house plans specific to each building are likely to be both the most practical and successful way to set this target for each building, and ensure that it is compliant with the Net Zero carbon by 2040 commitment from the City of London Corporation.

A long term renovation plan

Successful retrofit relies on a structured process including adequate assessment, design, installation and monitoring as set out within PAS 2035. A long term renovation plan also enables to plan ahead so that packages of work are coherent and complementary, and avoid 'carbon lock-ins'. Opportunities can easily be identified (e.g. current maintenance and replacement programme, void properties) and retrofit costs minimised

The opportunity of a Building Digital Logbook

Alongside the long term renovation plan, a Building Digital Logbook should be developed to gather and retain all relevant information about the building. Together, they will what is referred to as the 'Building Renovation Passport' and should be accessible to tenants and leaseholders.

Step 1: developing whole house retrofit plan templates

Whole house plan templates created for the main archetypes would:

- Be useful at a **strategic level** by developing an understanding of the measures, costs, skills and supply chain needed over the next 20 years. This information could be used to help support and build capacity, lever finance and build a business plan for retrofit programmes.
- Be useful for **each individual building** as it would provide them with a template which can then easily be made specific to each building.

A long term, step-by-step renovation plan is the most practical approach to retrofit in order to achieve a long term objective compliant with Net Zero. The above image shows an example used in Germany iSFP

Core features of a building renovation passport

- Information on **the building's current condition and performance**, ideally supported by resident engagement.
- A **phased renovation plan** establishing a roadmap to the best possible carbon reduction.
- A **digital logbook** recording the works carried out and by whom, in-use performance data, and possibly drawings and additional information.

Next Steps

For 2027 target

- ❑ Develop plans for large scale roll out of photovoltaic panels across the estates' roofs. Most estates have good potential, but if priorities are sought the Corporation should prioritise installation at Avondale Square, Golden Lane, Southwark Estate, Holloway Estate, York Way Estate and Middlesex Street Estate since these have the greatest potential for energy generation.

- ❑ Simultaneously, plans for roof insulation across estates should be made with appropriate feasibility studies and permissions sought where appropriate (should be added before photovoltaic panels).

- ❑ Remove communal gas boilers and replace with low carbon alternatives where at all possible. This relates to Middlesex Street Estate, York Way Estate, Isleden House Estate and Frobisher Crescent (Barbican Estate).

- ❑ Where heating systems are installed, also install energy storage and smart controls to optimise use of low carbon heat.

- ❑ Review controls of communal heating systems at Middlesex Street Estate, York Way Estate and Isleden House Estate – all are consuming a large amount of gas per dwelling. For the same estates, review and improve insulation of distribution pipework. These measures should happen before fabric efficiency measures.

- ❑ Review controls of landlord lighting – internal and external. Are there lights on unnecessarily in daylight hours? Are there efficiencies that could be made to night time use? Priorities include the Barbican Estate and City of London and Gresham Almshouses.

- ❑ Replace inefficient lamps with LEDs.

For 2040 target

- ❑ Develop detailed whole house retrofit plans for Holloway Estate, Sydenham Hill Estate and Windsor House as a priority (along with the other blocks indicated on page 67).

- ❑ Consider early replacement of gas boilers with individual Air Source Heat Pumps for Longland Court (Avondale Square Estate) and Markstone House (Southwark Estate). Low metered energy consumption indicates a level of efficiency sufficient for heat pumps without an uplift in running costs.

- ❑ Consider early replacement of gas boilers with direct electric heating system for Collinson Court (Southwark Estate) in tandem with roof insulation. Based on low metered energy consumption, and windows already being replaced, external wall insulation could be a secondary measure without an uplift in running costs.

- ❑ Great Arthur House – complete window replacement, add energy storage and smart controls and replace gas boilers with direct electric heating.

- ❑ Roll out energy efficient measures at the Avondale Square Estate and install direct electric heating in all blocks except Longland Court and Twelve Acres House.

Next Steps, cont

General

- ❑ Utilise action plans for each archetype to create long term retrofit action plans for each estate or block.
- ❑ Develop ‘building logbooks’ for each building in the first instance (with a view to each dwelling) that records what measures have been undertaken and when, and includes details of the long term retrofit plans.
- ❑ Improve metering strategy and labelling of meters across all estates.
- ❑ Carry out at least an annual analysis of energy use across all blocks and estates and compare trends.
- ❑ Monitor effectiveness of retrofit measures by noting date of installation and any changes in energy use.
- ❑ Ensure no new build has gas communal heating.

Glossary

Air Source Heat Pumps (ASHP) – an electric heating system that gathers ambient heat from surroundings to efficiently heat a dwelling.

Air-tightness – A measure of how much air naturally leaks out of or into a building, through gaps around doors, windows, keyholes etc. Usually measured in $m^3/m^2/hr$ @ 50Pa.

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

Carbon budgets – a term used to state remaining carbon emissions, or share of carbon emissions, that can be emitted before the amount of cumulative emissions exceeds that aligned with a given atmospheric temperature change.

Carbon footprint – the amount of carbon emitted by a person or organisation in a given timeframe.

Carbon offsets – a way of balancing emissions in one area by reducing emissions in another or by sequestration of carbon*.

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

CO_2 – carbon dioxide, a greenhouse gas.

Coefficient of Performance (CoP) - a measure of efficiency usually used when describing heat pumps. The CoP is the amount of useful heat (or coolth) produces from every kilowatt of electricity used. E.g. a heat pump with a CoP of 3 produces 3 kW heat for every 1 kW of electricity it uses.

CoL - City of London Corporation

Communal heating system – a multi dwelling heating system.

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

Fabric Efficiency – a measure of how effective a building's fabric is at retaining heat or staying cool.

Greenhouse gas – a gas that retains heat in the atmosphere, e.g. carbon dioxide (CO_2).

ktCO_2 – kiloton of CO_2, a measure of the amount of carbon dioxide emitted or offset.

kWh – kilowatt hour, a measure of the amount of energy used or generated in one hour.

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

Mechanical Ventilation with Heat Recovery (MVHR) – a form of building ventilation that recovers heat from stale air before it is vented outside the building and uses it to warm incoming fresh air.

Net Zero Carbon – where the amount greenhouse gases emitted by an organisation are equivalent to the emissions either: i) sequestered or offset , ii) displaced by production of renewable energy.

Renewable energy – energy from a renewable source e.g. wind or solar.

Space heating demand (SHD) – the amount of heat energy required to heat a space. SHD is a reflection of building fabric efficiency and is usually expressed in $kWh/m^2/yr$.

Scope 1 emissions - emissions from the direct combustion of fossil fuels (e.g. gas, petrol and diesel)

Scope 2 emissions - emissions from the production of electricity

Scope 3 emissions - emissions from activities or assets not owned or controlled by the reporting organization, but that the organization indirectly impacts in its value chain e.g. purchased goods and services, business travel, commuting, waste, leased buildings (emissions from tenants or leaseholders fuel consumption) and financial investments.

***Sequestration** – the storing of carbon in land based assets.

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

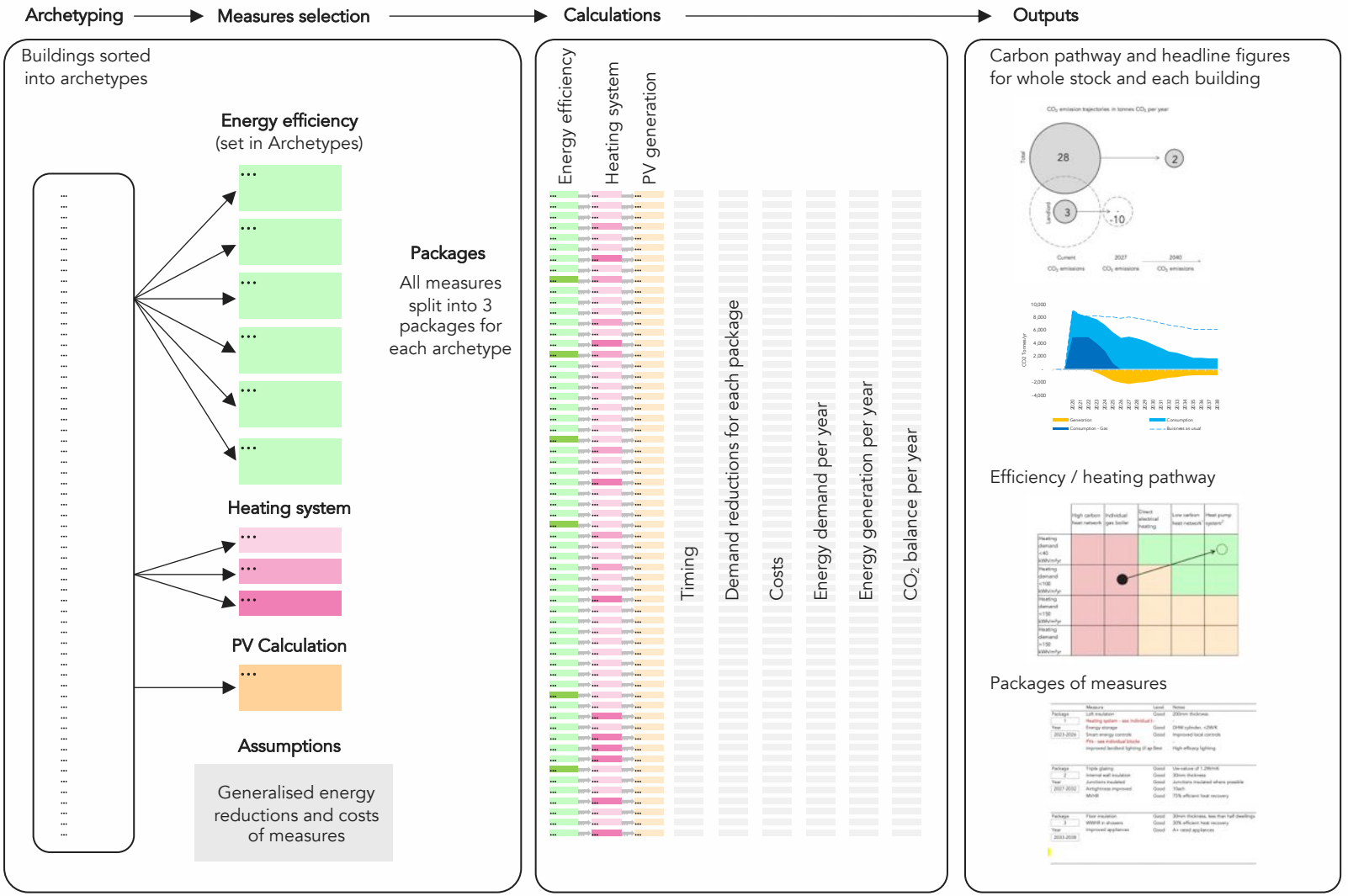
Waste Water Heat Recovery (WWHR) – A proprietary system fitted to the outlets from sinks, showers and baths, which collects heat from the waste water and transfers it to the cold water feeding a hot water store.

Whole House Retrofit – where a building is retrofitted for energy efficiency in an holistic manner, and many different fabric elements and systems are considered at once.

Key assumptions

The diagram to the right, introduced the structure of the Net Zero Matrix, the tool we used to recommend measures for every building and estimate costs for the action plan.

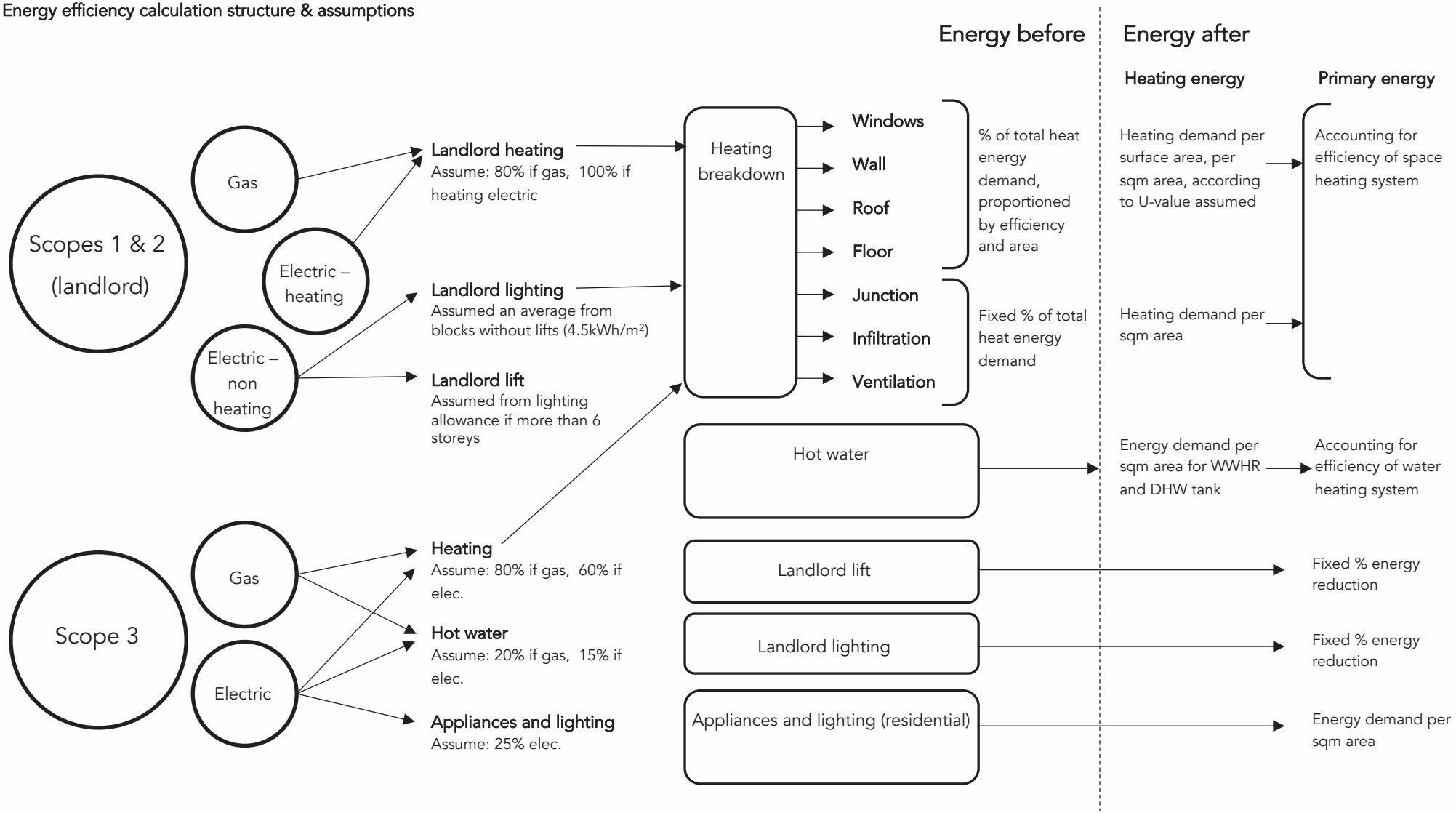
The following pages explain more about how the results were calculated and the assumptions used to generate them. This includes information on the energy efficiency calculation structure, energy efficiency assumptions and cost assumptions.



Net Zero Matrix structure (graphics reproduced at larger scale on following pages).

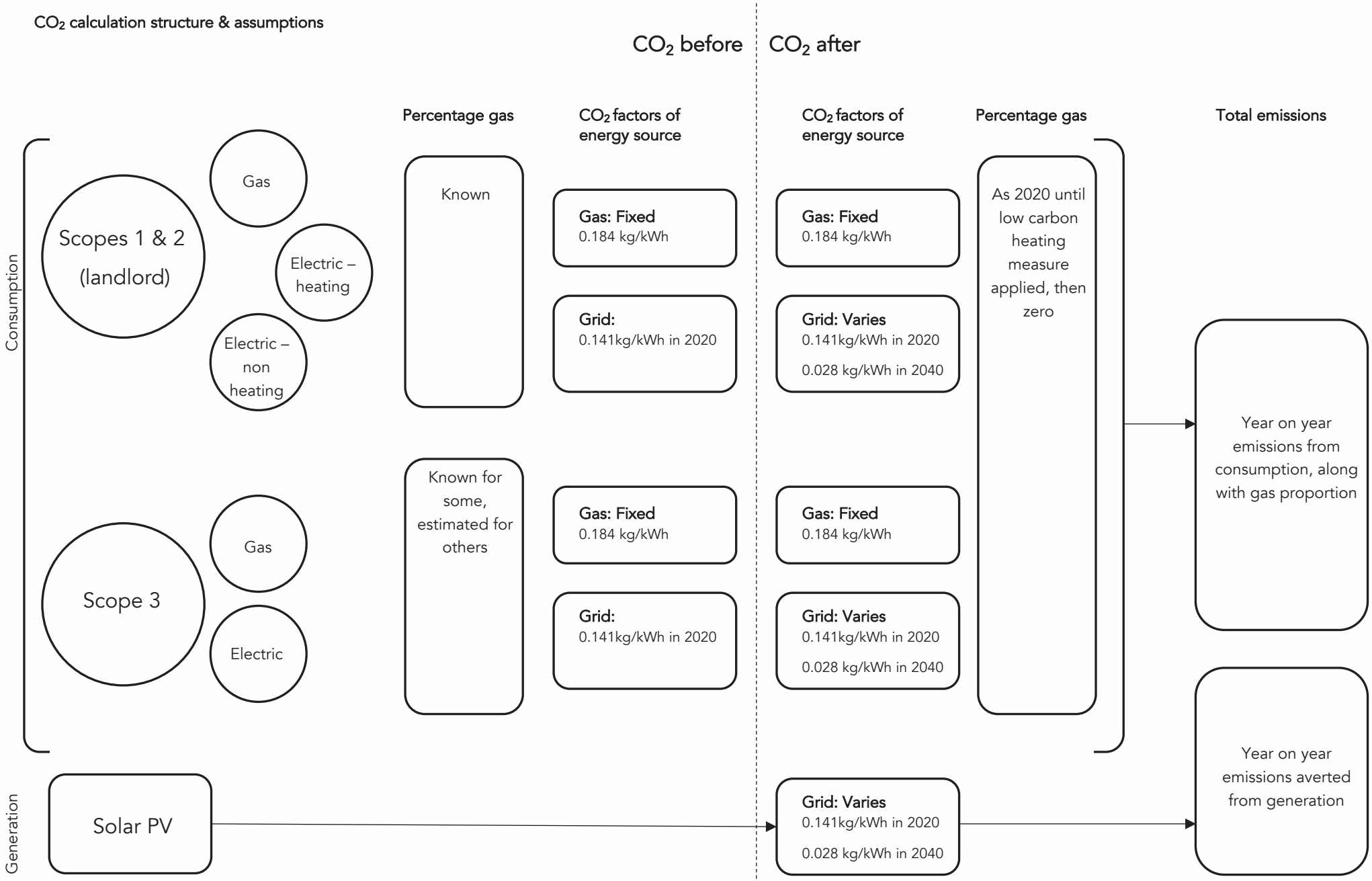
Key assumptions

Energy efficiency calculation structure & assumptions



Key assumptions

CO_2 calculation structure & assumptions



Key assumptions

Energy efficiency calculation detailed assumptions – This table gives the assumptions used to predict energy demand and generation

Energy use category	Energy use breakdown	Technology	Description		Before	After	
			Good	Best		Good	Best
					kWh/m²a/m²HLA, combined with % of current heating	*kWh/m²a / m²HLA*	
Space heating	Window glazing	Triple glazing	Uw-valuve of 1.2W/mK	Uw-value of 0.8W/m2K	0.047	0.029	0.022
	Wall insulation	Internal wall insulation	30mm thickness	100mm thickness	0.037	0.011	0.006
		External wall insulation	100mm thickness	200mm thickness	0.037	0.004	0.003
	Roof insulation	Flat roof insulation	100mm thickness	250mm thickness	0.037	0.004	0.003
	Floor insulation	Loft insulation	200mm thickness	400mm thickness	0.037	0.004	0.003
		Floor insulation	30mm thickness some dwellings	100mm thickness some dwellings	0.007	0.006	0.004
					% of current heat demand	*kWh/m2a*	
	Junctions	Junctions insulated	Junctions insulated where possible	Good connections possible	1.1%	6.3	4.2
	Airtightness	Airtightness improved	5ach	2ach	16.1%	28.8	11.6
	Ventilation	MVHR	75% efficient heat recovery	90% efficient heat recovery	11.0%	11.7	8.3
					% of energy demand		
Hot water	Hot water use	WWHR in showers	30% efficient heat recovery	50% efficient heat recovery	10.0%	11.5	9.0
	Hot water storage	DHW tank	DHW cylinder, <2W/K	DHW cylinder, <1W/K	10.0%	11.5	9.0
	Appliances, fans and pumps, lighting	Improved appliances	A+ rated appliances	A+++ rated appliances	12.5%	15.0	12.0
	Demand flexibility	Smart energy controls	Improved local controls	Whole dwelling controls with zoning	12.5%	15.0	12.0
					% of current lighting energy		
Landlord electricity	Landlord lighting	Improved com. lighting (if appl.)	N/A	High efficacy lighting	1.0	0.8	0.6
					% of current lift energy		
	Landlord lift	Improved lift (if appl.)	N/A	High efficiency lift	1.0	0.8	0.6
		No change			*SFP applied to heating energy*		
Low carbon heat and no more fossil fuels		Individual HP	SFP of 2+	SFP of 3+	N/A	N/A	2.8
		Communal heat pumps	Using existing communal heat infrastructure		N/A	N/A	2.8
		Direct electric			N/A	N/A	0.0
Renewable energy generation		Solar PVs	360Wp panels with microinverters			Wp per panel	
					N/A	N/A	360Wp

Key assumptions

Cost calculation assumptions

Energy use category	Energy use breakdown	Technology	Description			
			Good	Best	Good	Best
					Cost is £k per unit unless otherwise stated	
Space heating	Window glazing	Triple glazing	Uw-valuve of 1.2W/mK	Uw-value of 0.8W/m2K	8.1	12.2
	Wall insulation	Internal wall insulation	30mm thickness	100mm thickness	9.1	13.7
		External wall insulation	100mm thickness	200mm thickness	9.3	13.9
	Roof insulation	Flat roof insulation	100mm thickness	250mm thickness	5.3	7.9
		Loft insulation	200mm thickness	400mm thickness	0.6	0.9
	Floor insulation	Floor insulation	30mm thickness some dwellings	100mm thickness some dwellings	1.8	2.6
	Junctions	Junctions insulated	Junctions insulated where possible	Good connections possible	1.0	2.0
	Airtightness	Airtightness improved	5ach	2ach	1.0	2.0
	Ventilation	MVHR	75% efficient heat recovery	90% efficient heat recovery	2.1	3.1
Hot water	Hot water use	WWHR in showers	30% efficient heat recovery	50% efficient heat recovery		
	Hot water storage	DHW tank	DHW cylinder, <2W/K	DHW cylinder, <1W/K	0.5	1.0
	Appliances, fans and pumps, lighting	Improved appliances	A+ rated appliances	A+++ rated appliances	1.0	2.0
	Demand flexibility	Smart energy controls	Improved local controls	Whole dwelling controls with zoning	1.0	2.0
Landlord electricity	Landlord lighting	Improved com. lighting (if appl.)	N/A	High efficacy lighting	0.8	1.5
	Landlord lift	Improved lift (if appl.)	N/A	High efficiency lift	Per lift:	80.0
Low carbon heat and no more fossil fuels		Individual HP	SFP of 2+	SFP of 3+	6.0	12.0
		Communal heat pumps	Using existing communal heat infrastructure		5.0	11.0
		Direct electric			1.0	1.0
Renewable energy generation		Solar PVs			Cost per kWh/m2a	
			360Wp panels with microinverters		1.0 if <50kWh/m2a	0.8 If >50kWh/m2a

Communal Heating – Barbican Estate

Barbican Estate

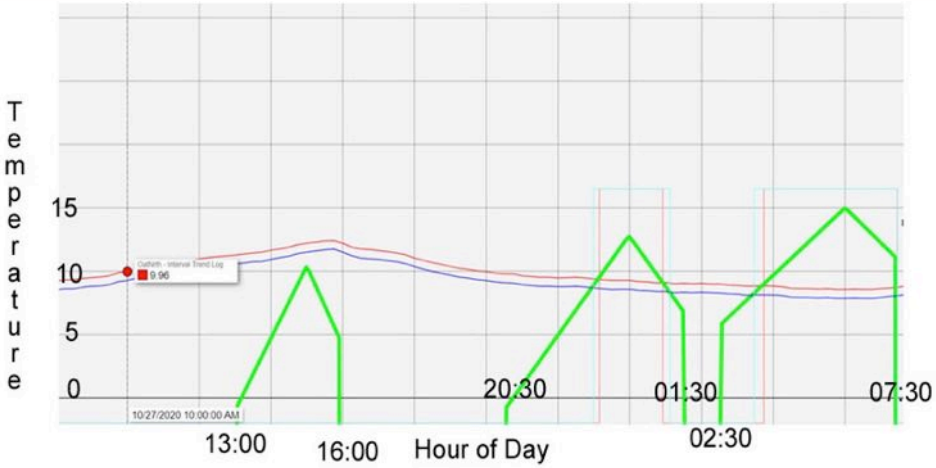
We understand from the experience of residents that the underfloor heating system may need optimising to ensure that electricity is used efficiently. Currently, many residents complain of too much heat in the winter (leading to open windows in mid-winter to cool flats), and not enough heat in shoulder seasons (spring and autumn). The residents have formed an Underfloor Heating Working Party which is looking in detail at how the controls can be optimised.

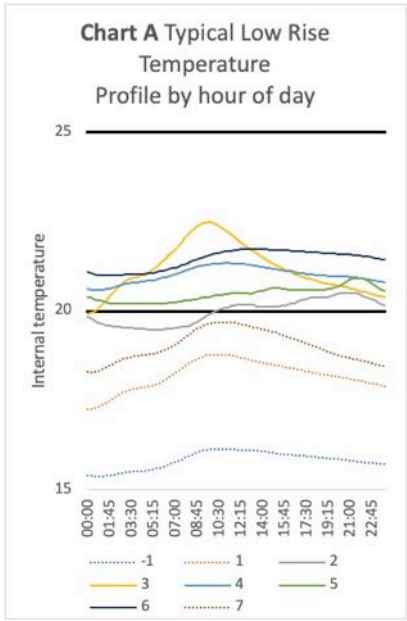
The issue is a complex one to solve. It's not entirely technical – there is also the problem of resident expectations and comfort and these vary greatly. A summary of conversations with the Underfloor Heating Working Party can be found in the Appendices, together with some recommendations.

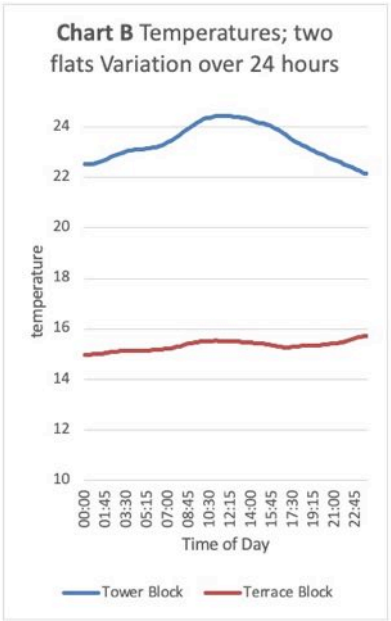
The most pragmatic solution to improving the control over how much heat is delivered to residents homes would be to deliver less heat through the communal heating system (and charge residents less) and install electric radiators in each unit that residents have easy, individual control over. However, an appropriate charging mechanism would need to be established. This could be through the Corporation itself – either a fixed charge (although this does not incentivise efficient behaviours) or through metering of electrical supplies to each unit. Alternatively, residents could have full control and pay bills to the utility companies themselves, although they would not benefit from the beneficial tariff the Corporation is understood to have secured.

Barbican underfloor heating system description

Barbican resident Ted Reilly has put tougher a very useful summary of the underfloor heating system at the Barbican Estate. Anyone wishing to understand this document better is encouraged to refer to this document entitled "Barbican Underfloor Heating System Description".







Extracts from "Barbican Underfloor Heating System Description" document provided by Ted Riley, Barbican resident.

Resident engagement

See following pages for:

- Barbican workshop 1
- HRA Estates workshop 1a
- HRA Estates workshop 1b
- Survey responses

Project	City of London Corporation - Housing Net Zero Action Plan
Workshop	Barbican Residents Workshop 1 - Understanding the buildings through the residents eyes.
Date	5th May 2021
Time	19:00 – 20:30
Venue	Online through Zoom
Attendees	Barbican residents - 15
	Etude (Anna MacKenzie, Thomas Lefevre, Kate Millen, Naomi Grint)
	Corporation of London (Graeme Low, Julia Makin, Lochlan MacDonald)
Duration	90 mins
Purpose	To understand the buildings through residents eyes.
Roles	Facilitator - Anna Presenter – Kate Break out room chairs – Thomas, Kate, Naomi

Stage	**Duration, mi**	**Time**	**Objective**	**Activity**	**Who**	**Resources**
1. Arrival	5	19:00	Time to arrive	- People arrive and settle	Anna	
2. Introduction	5	19:05	Intros	- Introduce the team (we are not CoL) - Introduce the purpose of the workshop - Establish ground rules - Present the agenda	Anna	
2. Scene setting	10	19:10	Set the scene Participants understand what the end-goal is for the building they live in.	- Who we are, what are we for (we are not CoL). - What we are doing – introduce the study - Why we are doing it - e.g. Climate Action Strategy. - What we want to achieve - what is net zero? - Describe the long term vision - Elaborate explaining the intermediate steps we need to get there.	Kate	Slides
4. Results of questionnaire	5	19:20			Anna	Slides
5. Group discussion	30	19:25	Residents share insights and ideas for improving the heating system.	- 30 mins: 3x Breakout rooms. Topic – Heating systems, energy efficiency, ventilation, controls. (discuss people's experiences and ideas for improvements)	Anna facilitate _____ Kate, Naomi, Thomas chair breakout rooms	Note taking spreadsheet
6. Group feedback	20	19:55		- 5 mins each: Return together to share thoughts – 1 volunteer from residents to report back and check our understanding with the attendees (5 mins each).	Anna facilitate _____ Kate, Naomi, Thomas present back	Note taking spreadsheet
7. Polls	5	20:15		- Priorities - what's the most important to deal with? -	Anna	Questions in chat Poll
8. Conclusion and next steps	5	20:20		- What we will do with the results - Next workshop	Anna	

9. AOB	5	20:25	Opportunity to ask questions and voice any other views		Anna	
Total	90					
NOTES						
Heating, Energy Efficiency, Ventilation						
Breakout room 1	cmd+ Enter for new line in cell					
Group 1 - permeabilty. Drafts - lack of control (too hot at night). Single and double glazing - mainly on road facing flats. Reverse fan light single glazing. Moisture in the air - down to 25% in some flats. People accept the background heating and dress accordingly, oil heaters commonly used. Colin and Sally - system is on the whole time - water tank is cycling constantly (hot water). Barbican - hot water can be turned off - immersion. West facing - can get very hot. Some residents have used films to reduce gain.						
Breakout room 2	cmd+ Enter for new line in cell					
Group 2 - Communal gas heating in Frobisher Crescent - review recent report. Interested in hearing ideas for changing heating system. Energy efficiency - opportuniutes around glazing, but it might be sufficient already. Heating system controls seem to be the thing to address - reducing energy wastage. Cost point - must not be a vanity project. Develop a climate change strategy for Barbican as exemplar.						
Breakout room 3	cmd+ Enter for new line in cell					
Group 3 - Overheating in both summer and winter. Dry air. Some residents can control summer overheating through blinds and ventilation. Orientation must be considered. Controls a big issue. How do adjacent flats impact other flats in terms of heating. Glazing - cost, how it works with climate change and overheating in the winter. Needs to be joined up.						
Glazing replacement.						
Case by case basis - can						
Modern building, stuck with cold bridges						
Focus on what's unique here						
Join up opportunities - recent study on changing pattern on transport. Vacant parking spaces for PV?						
Can deals be made with suppliers?						
Load patterns are unique. Surrounded by huge cooling loads neighbours.						
Wrap PV around barrel roofs.						
Can we utilise neighbouring solutions?						

What about non-domestic properties?					

Project	City of London Corporation - Housing Net Zero Action Plan
Workshop	HRA Residents Workshop 1 - Understanding the buildings through the residents eyes.
Date	Thu 6th May 2021
Time	19:00 – 20:30
Venue	Online through Zoom
Attendees	HRA residents - 2.
	Etude (Anna MacKenzie, Thomas Lefevre, Kate Millen, Naomi Grint)
	Corporation of London (tbc)
Duration	90 mins
Purpose	To understand the buildings through residents eyes.
Roles	Facilitator - Anna Presenter – Kate Break out room chairs – Thomas, Kate, Naomi

Stage	**Duration, mi**	**Time**	**Objective**	**Activity**	**Who**	**Resources**
1. Arrival	5	19:00	Time to arrive	- People arrive and settle	Anna	
2. Introduction	5	19:05	Intros	- Introduce the team (we are not CoL) - Introduce the purpose of the workshop - Establish ground rules - Present the agenda	Anna	
3. Who are the participants?	2	19:10		- Poll to see where people are from.	Anna	
2. Scene setting	10	19:12	Set the scene Participants understand what the end-goal is for the building they live in.	- Who we are, what are we for (we are not CoL). - What we are doing – introduce the study - Why we are doing it - e.g. Climate Action Strategy. - What we want to achieve - what is net zero? - Describe the long term vision - Elaborate explaining the intermediate steps we need to get there.	Kate	Slides
4. Results of questionnaire	3	19:22			Anna	Slides
5. Group discussion	30	19:25	Residents share insights and ideas for improving the heating system.	- 30 mins: 3x Breakout rooms. Topic – Heating systems, energy efficiency, ventilation, controls. (discuss people's experiences and ideas for improvements)	Anna facilitate _____ Kate, Naomi, Thomas chair breakout rooms	Note taking spreadsheet
6. Group feedback	20	19:55		- 5 mins each: Return together to share thoughts – 1 volunteer from residents to report back and check our understanding with the attendees (5 mins each).	Anna facilitate _____ Kate, Naomi, Thomas present back	Note taking spreadsheet
7. Polls	5	20:15		- Priorities - what's the most important to deal with? -	Anna	Questions in chat Poll
8. Conclusion and next steps	5	20:20		- What we will do with the results - Next workshop	Anna	

9. AOB	5	20:25	Opportunity to ask questions and voice any other views		Anna	
Total	90					
NOTES						
Will - hardly uses any heating. Doesn't need it. South facing on living room and bedroom side. Gas central heating doesn't come on at all. Electric shower. Uses a combi boiler to do the washing up. Uses an electric fire. Windows are solid. Trickle vents on the windows. Can shut all but hte bathroom, but then the air gets stale. Likes the way the street looks on the outside - would external insulation be ok or worthwhile? Might need to go a long way to get big improvements in energy efficiency. There are both tenants and leaseholders. Would need to consider the options re signing up to a communal system vs staying independant. Doesn't know where a big heat pump system would go. There is an airing cupboard type space. There's a deep boxed out riser space in the bathroom. Some people have taken this out. An old coal store.						
If we were going to do a lot of retrofit, a way to help overheating woudl be to install balconies outside full doors, to give shading (they face south-s-w) - decl access on northnorth east (ktichen and bathrooms). Bedrooms and living rooms face south. Would be interesting to know how it works - some upgrades woudl be communal.						
Hannah - Gas combi boiler is used most days. Heard that top floor gets colder. Interested in getting a heat pump to move away from gas. The block used to have Is there a weak point in energy efficiency? - draft comes in around the front door. Big windows at the bag. Flat room. Pram shed and garages next door. There has been a benefit in the window replacements. Ventilation in the kitchen - open the windows. Problems with condensation - yes on the 5th floor, lots of black mold. But no problem on 4th floor. On the same side of the building. Would there preference be direct electric + fabric improvements or heat pump ? - Upfront costs, running costs and disruption are all considerations. If there are beneifts, then increased running costs may be acceptable. Need to be clear about the postivies in teh package. How will people feel if they are payin						
Would defintiely be in favour of a green makeover. Petrol mowers and leaf blowers! Has been onvolved in community building and engagement - managing a garden patch by the garages. Communications can be frustrating. Golden Lane - lots of community building stuff. Really need to support community building so that they feel they are part of something.						

Project	City of London Corporation - Housing Net Zero Action Plan
Workshop	HRA Residents Workshop 1 - Understanding the buildings through the residents eyes.
Date	Wed 12th May 2021
Time	19:00 – 20:30
Venue	Online through Zoom
Attendees	HRA residents
	Etude (Anna MacKenzie, Thomas Lefevre, Kate Millen, Naomi Grint)
	Corporation of London (tbc)
Duration	90 mins
Purpose	To understand the buildings through residents eyes.
Roles	Facilitator - Anna Presenter – Naomi Break out room chairs – Thomas + Anna (GL) - Kate + Naomi (Others)

Stage	Duration, mi	Time	Objective	Activity	Who	Resources
1. Arrival	5	19:00	Time to arrive	- People arrive and settle	Anna	
2. Introduction	5	19:05	Intros	- Introduce the team (we are not CoL) - Introduce the purpose of the workshop - Establish ground rules - Present the agenda	Anna	
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2. Scene setting	10	19:12	Set the scene Participants understand what the end-goal is for the building they live in.	- Who we are, what are we for (we are not CoL). - What we are doing – introduce the study - Why we are doing it - e.g. Climate Action Strategy. - What we want to achieve - what is net zero? - Describe the long term vision - Elaborate explaining the intermediate steps we need to get there.	Naomi	Slides
4. Results of questionnaire	3	19:22			Anna	Slides
5. Group discussion	30	19:25	Residents share insights and ideas for improving the heating system.	- 30 mins: 3x Breakout rooms. Topic – Heating systems, energy efficiency, ventilation, controls. (discuss people's experiences and ideas for improvements)	Anna facilitate _____ Kate, Naomi, Thomas chair breakout rooms	Note taking spreadsheet
6. Group feedback	10	19:55		- 5 mins each: Return together to share thoughts – 1 volunteer from residents to report back and check our understanding with the attendees (5 mins each).	Anna facilitate _____ Kate, Naomi, Thomas present back	Note taking spreadsheet
7. Polls	10	20:05		- Priorities - what's the most important to deal with? -	Anna	Questions in chat Poll
8. Conclusion and next steps	5	20:15		- What we will do with the results - Next workshop	Anna	

9. AOB	5	20:20	Opportunity to ask questions and voice any other views		Anna	
Total	85					
NOTES						
Heating, Energy Efficiency, Ventilation						
Breakout room 1 - Golden Lane Estate		cmd+ Enter for new line in cell				
Dawn - windows. Hands are still cold and the hands are still cold. 75mm of foam glass is on the roofs. There are little windows around the top. THere are undercrofts on some flats, and that room is freezing in the winter. Uninsulated concrete slab. Alternate floors, there are timber floors. Projecting bays have some damp - cold bridges. Walkways to enter the front door. Ventilation - current ventilation is through the windows (there are holes at the bottom of the windows to let the condensations out. No ventilation fans in the bathrooms. Half the flats haven't had their roofs repaired/replaced for some time. Water is still coming in. A lot of the damp is from water ingress through the roof. End maisonette - uninsulated. Doors - they are solid but they leak air all the way around. Letter boxes are drafty too. Curtains in the large room are difficult to put in. Sue tried to get a smart meter, but they couldn't install one / they don't connect. Difficult for people to monitor their energy usage. Some blocks do have smart meters. 8.5m2 of single glazing. Two Basterfield properties - comparison of energy efficiency. Panel system walls on the south side of the blocks. On the north side, upper storey is panels. Under that think kinker block - insulation outside woudl eb difficult due to walkway. Kitchens very narrow. Heating - brand new combi boilers have just been put in. Boiler is coming on and off all day. Leaseholders individually fit their own. Sue has some electric underfloor heating she put in herself. Some boiler flues go out of windows. Shouldn't have to justify individual circumstances. Communal heating system being proposed for Cuthbert Harrowing and Crescent House. Look at Options Appraisal. Pipe routes - are they still there? It was more or less a steam system insulated with asbestos. Maybe use existing ducts but need to check asbestos.						
Breakout room 2	cmd+ Enter for new line in cell					

Breakout room 2 - "Others"	cmd+ Enter for new line in cell					
Horace Jones House and MSE both far too hot and struggling with overheating. Some ares of flat cold (Sandra). HJH uses electric heating (communal heating?). Can't leave windows open ebcause of wind or noise. Sandra - the big issue os replacing teh heating system with a fossil fuel system. Windows are triple glazed. The doors have been replaced - balcony doors have made a slight difference. The side panel was replaced. Horace Jones House has MVHR and winter gardens. Highly glazed facade. Some balonies but not above every day.						

Please select the estate in which you live.	Please select the block in which you live.	How many bedrooms does your home have?	Which of the below best describes your home?	Which best describes your house	Which floor are you on?	What's the main heating source in your home?	Communal system	Combi gas boiler	Immersion heater	Point-of-use heater (e.g. electric shower, hot tap etc)	Thermostat	Additional plug-in electric heaters	Additional gas heaters	Open windows when it's too warm in the winter	No control	Other	You selected "other". Please briefly describe other ways in which you control the temperature of your home.	How comfortable is your home in the winter?	How comfortable is your home in the summer?	Does your home suffer from damp?	Do you use your kitchen and bathroom ventilation?	Could you tell us why you don't use all or some of your ventilation fans?	Do you have broadband and wifi?	Would you be willing to share your energy bill data with us (anonymously)	If you would like us to	Use this space to add anything else you would like to say.
Avondale Square Estate	Brettinghurst House	1-bed	Flat		Ground/Low est floor	Own gas boiler		Combi gas boiler			Thermostat							3	5	No	Yes - bathroom only	Don't have ventilation in kitchen just open the windows	Yes	Maybe	k	
Avondale Square Estate	East Point	Studio	Flat		Top floor	Own gas boiler		Combi gas boiler							No control			1	8	Yes - a lot	Yes - bathroom only	Only have it in the bathroom	Yes	No		The windows are old. The rubber thing that put around it does nothing. Mould builds up on my windows weekly. There is a breeze even when closed. There is a breeze coming from the front door. They was charging me £50 per month for gas in a studio flat.
Avondale Square Estate	George Elliston House	3-bed	Flat		Middle floor	Own gas boiler		Combi gas boiler			Thermostat							1	8	Yes - a little	Yes - kitchen only	I don't have one in the bathroom and toilet	Yes	No		In my flat I have single glass old windows. In the winter it is very cold and we have paddles of water on the floor each morning. During windy weather the curtains "fly"- how bad those windows are! It is time to do something about it. We use a lot of gas to heat the flat and it is still too cold, not to mention the noise level...
Avondale Square Estate	Longland Court	3-bed	Flat		Middle floor	Own gas boiler				Point-of-use heater	Thermostat							3	8	Yes - a little	Yes - both		Yes	No		
Avondale Square Estate	Proctor House	Studio	Flat		Ground/Low est floor	Electric storage heater			Immersion			Additional plug-in electric heaters		Open windows when it's too warm in the winter				0	5	Yes - a little	No - we turn it off	I presume they were fitted when the recent works were done but I don't exactly know if I have them and I certainly don't know how to use them	Yes	Yes	n	I have had some mould in cupboards. In the past I have had a lot of trouble with water leaks from above. A few years ago the bathroom had to be replastered (I think is the word) and redecorated once it had dried out; I tend to worry that it might happen again.
Avondale Square Estate	Tovy House	2-bed	Flat		Top floor	Own gas boiler		Combi gas boiler			Thermostat							1	8	Yes - a lot	Yes - both		Yes	No		The windows and front doors need replacing in tovy house. In the winter the condensation is so bad I have to put towel along the window seal to soak up the water. The front doors have big gaps that let through alot of draught and we lose alot of our heat when the heating is on.
Avondale Square Estate	Tovy House	2-bed	Flat		Top floor	Own gas boiler		Combi gas boiler			Thermostat							2	8	Yes - a lot	Yes - both		Yes	No		The windows in my flat are rubbish they let to much draft and cold in and the front doors are not energy efficient. Double glazed windows and fire doors are required. These need to be updated.
Avondale Square Estate	Tovy House	2-bed	Flat		Ground/Low est floor	Own gas boiler		Combi gas boiler							No control			2	7	No	Yes - bathroom only	No ventilation on the kitchen. On the bathroom we open the window after every bath as there is not ventilation.	Broadband	Yes		I think CoL can do much more than just providing few recycling bins to help the environment. Normally recycling bins gets full by the end of the week and because the collection only happens about every fortnight, residents used other waste bins for recycling materials too.
Barbican Estate	Andrewes House	1-bed	Flat		Middle floor	Electric underfloor heating			Immersion						No control			3	5	No	Yes - both		Yes	Maybe		Residents should be made aware that stuck-open vents can be replaced and offered advice about draught-proofing. Both would help reduce unnecessary use of energy. Also, not everyone knows that underfloor heating 'trimmers' can be adjusted to provide more or less heat.
Barbican Estate	Andrewes House	2-bed	Flat		Middle floor	Electric underfloor heating			Immersion						No control			5	5	No	Yes - both		Yes	Yes	m	I have put both my email addresses in: Marydurcan@hotmail.com Mary.durcan@cityoflondon.gov.U.K. I would be interested in attending both workshops
Barbican Estate	Andrewes House	2-bed	Flat		Ground/Low est floor	Electric underfloor heating			Immersion						No control			5	5	No	Yes - both		Yes	Maybe	s	
Barbican Estate	Andrewes House	2-bed	Flat		Middle floor	Electric underfloor heating			Immersion					Open windows when it's too warm in the winter				7	5	No	Yes - both		Yes	Yes	w	xx
Barbican Estate	Andrewes House	1-bed	Flat		Ground/Low est floor	Electric underfloor heating			Immersion			Additional plug-in electric heaters			No control			3	5	No	Yes - both		Yes	Yes	a	
Barbican Estate	Ben Johnson House	1-bed	Maisonette		Middle floor	Communal heating			Immersion	Point-of-use heater		Additional plug-in electric heaters		Open windows when it's too warm in the winter	No control			4	6	No	Yes - both		Yes	No		When the new communal heating system was installed, why was it set to run in the same manner as before? Surely there are ways to make the communal heating more climate and user friendly? My heating bill in my 714 sq ft flat is more than a friend's 1023 sq ft flat in a block in Clerkenwell. Outrageous overcharging!
Barbican Estate	Brandon Mews	1-bed	House	Mid terrace		Electric underfloor heating			Immersion					Open windows when it's too warm in the winter	No control			7	8		Yes - both		Yes	No		Cannot select both workshops.
Barbican Estate	Breton House	Studio	Flat		Middle floor	Electric underfloor heating			Immersion			Additional plug-in electric heaters		Open windows when it's too warm in the winter												
Barbican Estate	Breton House	Studio	Flat		Middle floor	Electric underfloor heating			Immersion			Additional plug-in electric heaters		Open windows when it's too warm in the winter				1	8	No	Yes - bathroom only	Concerns over fire hazards.	Yes	Yes	fi	Although ours is a middle floor flat, three of its external walls are exposed including to the northern boundary of the block/estate.
Barbican Estate	Bunyan Court	1-bed	Flat		Middle floor	Electric underfloor heating				Point-of-use heater				Open windows when it's too warm in the winter				6	9	No	Yes - both		Yes	Maybe	ra	
Barbican Estate	Bunyan Court	2-bed	Maisonette		Top floor	Electric underfloor heating	Communal system					Additional plug-in electric heaters		Open windows when it's too warm in the winter	No control			5	7	No	Yes - both		Yes	Yes	e	
Barbican Estate	Cromwell Tower	4-bed	Flat		Middle floor	Electric storage heater	Communal system					Additional plug-in electric heaters		Open windows when it's too warm in the winter	No control			3	6	No	Yes - both		Yes	Yes	pa	
Barbican Estate	Cromwell Tower	3-bed	Flat		Middle floor	Electric underfloor heating	Communal system			Point-of-use heater					No control			3	5	No	No - we turn it off	We open the window in the kitchen. There's no ventilation in the bathroom.	Yes	Maybe	ly	Barbican Estate needs to find ways to insulate.
Barbican Estate	Cromwell Tower	3-bed	Flat		Middle floor	Communal heating			Immersion						No control			10	7	No	Yes - both		Yes	Yes	da	The Barbican communal heating system is grossly inefficient and renders many homes uncomfortable. At present I have to leave outside doors open across my flat day and night because otherwise it is much too hot. This is a terrible waste of energy.
Barbican Estate	Defoe House	1-bed	Flat		Middle floor	Electric underfloor heating			Immersion			Additional plug-in electric heaters		Open windows when it's too warm in the winter		Other	I use full length white reflective roller blinds to block out the sun on hot days and help keep the interior of the flat cool	3	5	No	Yes - both		Yes	Yes	s	I would be very interested if there was a way for a large group of residents to work together with CoL to upgrade the original barbican windows to make them much warmer and more energy efficient. I would be interested also to know if the barrel vault roof tops of the terrace blocks in the barbican could be fitted with solar panels, as I understand there are flexible/curved ones now that could perhaps be used without affecting the listed building roofline. Also could ground source heat pumps be installed under the residents' gardens?

Please select the estate in which you live.	Please select the block in which you live.	How many bedrooms does your home have?	Which of the below best describes your home?	Which best describes your house	Which floor are you on?	What's the main heating source in your home?	Communal system	Combi gas boiler	Immersion heater	Point-of-use heater (e.g. electric shower, hot tap etc)	Thermostat	Additional plug-in electric heaters	Additional gas heaters	Open windows when it's too warm in the winter	No control	Other	You selected "other". Please briefly describe other ways in which you control the temperature of your home.	How comfortable is your home in the winter?	How comfortable is your home in the summer?	Does your home suffer from damp?	Do you use your kitchen and bathroom ventilation?	Could you tell us why you don't use all or some of your ventilation fans?	Do you have broadband and wifi?	Would you be willing to share your energy bill data with us (anonymously)	If you would like to	Use this space to add anything else you would like to say.
Barbican Estate	Defoe House	1-bed	Flat		Top floor	Electric underfloor heating			Immersion						No control			4	6	No	Yes - kitchen only	There's a passive vent in the bathroom that doesn't work well. There's no other option	Yes	Yes	la	When it's chilly in the winter I need a space heater. But not all winter. It's especially cold in the flat when it is damp and overcast outside. It's only too warm for a few days in the summer. In future we may need air conditioning on the hottest days.
Barbican Estate	Defoe House	2-bed	Flat		Middle floor	Communal heating			Immersion			Additional plug-in electric heaters		Open windows when it's too warm in the winter				5	5	No	Yes - both		Yes	Yes	ta	
Barbican Estate	Defoe House	2-bed	Flat		Middle floor	Communal heating			Immersion			Additional plug-in electric heaters		Open windows when it's too warm in the winter				6	6	No	Yes - both		Yes	No		
Barbican Estate	Frobisher Crescent	3-bed	Flat		Middle floor	Communal heating	Communal system				Thermostat							6	6	No	Yes - both		Yes	Yes	m	
Barbican Estate	Frobisher Crescent	Studio	Flat		Middle floor	Communal heating			Immersion		Thermostat							5	6	No	Yes - both		Yes	Maybe		Yes i would like to attend both workshops
Barbican Estate	Frobisher Crescent	3-bed	Flat		Middle floor	Communal heating	Communal system				Thermostat	Additional plug-in electric heaters						5	5	No	Yes - both		Yes	No		
Barbican Estate	Gilbert House	3-bed	Flat		Top floor	Electric underfloor heating			Immersion			Additional plug-in electric heaters		Open windows when it's too warm in the winter				10	8	No	Yes - bathroom only	With all fans on the flat humidity is too low all the time. In winter it is often below 25% even with the kitchen extractor off. The open plan flat design means using a humidifier is not feasible. Also the air turnover is high & bringing more pollution into the flat.	Yes	Yes	w	Solar gain through the windows is a big problem in our flat during hot weather or when the winter underfloor heating is excessive. However, solar gain is very useful during cold weather in Spring, Autumn & Summer when there is no or inadequate communal heating. Outdoor shades would perhaps be the most effective. The underfloor heating is much too hot when the nights are cold & the days are relatively warm. It would be good to regulate the heating taking the next day's weather forecast into account. The lever operated window vent in the 7th floor domed bedroom is so high up it needs a ladder to teach it. This is obviously impractical. Bathroom heaters are very expensive to run as we have been told they must be run at 60 degrees because of Legionella.
Barbican Estate	Gilbert House	1-bed	Flat		Middle floor	Electric underfloor heating			Immersion	Point-of-use heater					No control			7	7	No	Yes - both		Yes	Yes	ja	Ok
Barbican Estate	Gilbert House	2-bed	Flat		Middle floor	Electric underfloor heating			Immersion			Additional plug-in electric heaters		Open windows when it's too warm in the winter				8	6	No	Yes - both		Yes	Yes	ba	I would be happy to pay more to have the electricity used for our communal underfloor heating be from renewable sources.
Barbican Estate	Hilton House	1-bed	Flat		Middle floor	Electric underfloor heating			Immersion					Open windows when it's too warm in the winter	No control			3	7	No	Yes - both		Yes	Maybe		I find the underfloor heating in the Barbican too hot overnight and too cold during the day (particularly by mid afternoon)
Barbican Estate	Lauderdale Tower	3-bed	Flat		Middle floor	Electric underfloor heating			Immersion			Additional plug-in electric heaters		Open windows when it's too warm in the winter	No control			3	8	Yes - a little	Yes - both		Yes	Maybe		There isn't a next button, people have to know to click the arrow next to the typeform blue bar
Barbican Estate	Petticoat Tower	3-bed	Flat		Middle floor	Communal heating	Communal system		Immersion		Thermostat							7	7	No	Yes - both		Yes	Yes	m	nothing at this stage
Barbican Estate	Seddon House	1-bed	Flat		Ground/Low est floor	Communal heating			Immersion			Additional plug-in electric heaters		Open windows when it's too warm in the winter				4	5	No	Yes - both		Yes	Yes	m	na
Barbican Estate	Seddon House	3-bed	Flat		Top floor	Electric underfloor heating			Immersion						No control			3	7	No	Yes - both		Yes	Yes	d	The estate must look at energy loss. All the heat is lost through old glazing. This should be replaced to improve efficiency and comfort. Long term solutions not short terms decisions
Barbican Estate	Seddon House	1-bed	Flat		Middle floor	Electric underfloor heating			Immersion			Additional plug-in electric heaters		Open windows when it's too warm in the winter				7	10	No	Yes - both		Yes	Yes	ja	
Barbican Estate	Seddon House	1-bed	Flat		Middle floor	Electric underfloor heating			Immersion						No control			5	5	Yes - a little	No - we turn it off	There are none	Broadband	No		Some of the questions clearly did not understand the estate.
Barbican Estate	Seddon House	1-bed	Flat		Middle floor	Electric underfloor heating			Immersion						No control			4	6	No	Yes - kitchen only	Because moths come into my flat via the ventilation system.	Yes	Yes	da	Many of the questions are ones which the Corporation as landlord will know the answers to already.
Barbican Estate	Shakespeare Tower	3-bed	Flat		Middle floor	Electric underfloor heating	Communal system			Point-of-use heater				Open windows when it's too warm in the winter				5	5	No	Yes - both		Yes	Yes	ly	
Barbican Estate	Shakespeare Tower	3-bed	Flat		Middle floor	Electric underfloor heating			Immersion						No control			5	5	No	Yes - both		Yes	Maybe	pe	
Barbican Estate	Shakespeare Tower	3-bed	Flat		Middle floor	Electric underfloor heating			Immersion					Open windows when it's too warm in the winter				8	7	No	Yes - both		Yes	Yes	ta	
Barbican Estate	Shakespeare Tower	2-bed	Flat		Middle floor	Electric underfloor heating			Immersion					Open windows when it's too warm in the winter	No control	Other	Underfloor heating trimmer	5	5	No	Yes - both		Yes	Yes	cl	
Barbican Estate	Shakespeare Tower	3-bed	Flat		Top floor	Electric underfloor heating			Immersion						No control			5	6	No	Yes - both		Yes	Maybe		
Barbican Estate	Shakespeare Tower	2-bed	Flat		Middle floor	Electric underfloor heating			Immersion						No control			5	8	No	Yes - both		Yes	Maybe		
Barbican Estate	Speed House	1-bed	Flat		Middle floor	Electric underfloor heating			Immersion					Open windows when it's too warm in the winter				9	5	No	Yes - both		Yes	No		
Barbican Estate	Speed House	2-bed	Flat		Middle floor	Electric underfloor heating			Immersion						No control			5	7	No	Yes - both		Yes	Maybe	bi	How about some solar heating for a start
Barbican Estate	Thomas More House	1-bed	Flat		Middle floor	Electric underfloor heating			Immersion						No control			7	8	No	Yes - both		Yes	Yes	m	
Barbican Estate	Thomas More House	Studio	Flat		Ground/Low est floor	Electric underfloor heating			Immersion					Open windows when it's too warm in the winter	No control			6	4	No	Yes - kitchen only	bathroom fan on all the time. Kitchen hob fan used for cooking on boost	Yes	Yes		

Please select the estate in which you live.	Please select the block in which you live.	How many bedrooms does your home have?	Which of the below best describes your home?	Which best describes your house	Which floor are you on?	What's the main heating source in your home?	Communal system	Combi gas boiler	Immersion heater	Point-of-use heater (e.g. electric shower, hot tap etc)	Thermostat	Additional plug-in electric heaters	Additional gas heaters	Open windows when it's too warm in the winter	No control	Other	You selected "other". Please briefly describe other ways in which you control the temperature of your home.	How comfortable is your home in the winter?	How comfortable is your home in the summer?	Does your home suffer from damp?	Do you use your kitchen and bathroom ventilation?	Could you tell us why you don't use all or some of your ventilation fans?	Do you have broadband and wifi?	Would you be willing to share your energy bill data with us (anonymously)	If you would like to say.	Use this space to add anything else you would like to say.
Barbican Estate	Thomas More House	2-bed	Flat		Ground/Lowest floor	Electric underfloor heating			Immersion			Additional plug-in electric heaters		Open windows when it's too warm in the winter				2	5	No	Yes - both		Yes	Maybe		The Barbican needs special analysis due to the block structure and centrally controlled underfloor heating
Barbican Estate	Thomas More House	1-bed	Flat		Middle floor	Electric underfloor heating			Immersion			Additional plug-in electric heaters		Open windows when it's too warm in the winter				5	5	No	Yes - both		Yes	No		'
Barbican Estate	Wallside	4-bed	House	Mid terrace		Electric underfloor heating			Immersion			Additional plug-in electric heaters		Open windows when it's too warm in the winter		Other	The house had its own trimmer which can turn the temperature of heating provided to the house up or down. Also I replaced the underfloor heating fuse board with permission from the BEO and can pull out fuses to turn the heating off if necessary. However there is no incentive to do so because the heating charges are charged by block, and not by the usage of the individual house.	3	3	No	Yes - both		Yes	No		I cannot attend the times of either workshop but you did not give an option for me to select that said that so I had not other choice but to select that I did not wish to attend. That is not correct. The Corporation has a responsibility to ensure that meetings and workshops are offered at different times of the day and not all in the evening to ensure they give everyone the opportunity to attend. This you have not done. Q11 and Q12 miss the point somewhat. Because there is no control and the heating is other on or off when it is very cold it is too cold and when the weather is very hot it is too cold. Both can happen in the summer and in the winter. Also because there is a lag when the heating kicks in if a very cold day is followed by a very hot day the heating will be full on and the windows have to be opened. Conversely if a hot day is followed by a cold day no heating will be generated and it will be freezing.
CoL Almshouses	39-44	1-bed	House	Mid terrace		Own gas boiler		Combi gas boiler			Thermostat							0	10	Yes - a lot	Yes - both		Yes	Yes	s	nothing else to say
Dron House	Dron House	1-bed	Flat		Top floor	Own gas boiler		Combi gas boiler			Thermostat							4	3	No	Yes - both		No internet	No		We have far too much ventilation, compared with modern standards and builds. This does have advantages re carbon monoxide + damp BUT it does cost more to heat flats..... Combi-boilers will be phased out. In the future you will have to consider other forms of heating. A reasonable 1/2-way stage is Combined Heat and Power generation, with a community heating scheme, but that still would use gas as the most likely fuel source. None-the-less, reduction in electricity transmission cuts energy use considerably. I would still like to see solar power + solar heating panels on the roof + thermal pile & ground-sourced heat pump..... Tho' I doubt if these would provide sufficient energy for the flats
Golden Lane Estate	Basterfield House	3-bed	Maisonette		Top floor	Own gas boiler		Combi gas boiler	Immersion		Thermostat							5	6	Yes - a lot	Yes - both		Yes	Maybe	d	Does HRA ESTATE residents include Leaseholders..
Golden Lane Estate	Basterfield House	2-bed	Maisonette		est floor	Own gas boiler		Combi gas boiler			Thermostat							1	9	No	No - we turn it off	There are none!	Yes	Yes	p	
Golden Lane Estate	Basterfield House	2-bed	Maisonette		Ground/Lowest floor	Own gas boiler		Combi gas boiler			Thermostat			Open windows when it's too warm in the winter				8	6	Yes - a little	Yes - both		Yes	Yes	a	
Golden Lane Estate	Bayer House	2-bed	Maisonette		Middle floor	Electric underfloor heating		Combi gas boiler			Thermostat							3	6	No	Yes - both		Yes	Maybe	n	
Golden Lane Estate	Bowater House	2-bed	Maisonette		Middle floor	Own gas boiler		Combi gas boiler			Thermostat							3	8	Yes - a little	Yes - both		Yes	Yes	c	Our flats leak heat and gas is becoming very expensive
Golden Lane Estate	Callum Welch House	4-bed	House	Detached		Electric underfloor heating			Immersion						No control			1	2	No	Yes - bathroom only	asdfs	Yes	Yes		
Golden Lane Estate	Crescent House	Studio	Flat		Top floor	Own gas boiler		Combi gas boiler			Thermostat			Open windows when it's too warm in the winter				4	8	Yes - a little	Yes - both		Yes	No		We have internally insulated the walls and ceilings in half of our flat and this has helped control the damp in those areas but the relative humidity in winter can be around 70%. We use a dehumidifier to get it down to around 60% and this extracts about 2-3 litres/day. We can't keep windows open as we face Goswell Road so there is high noise and pollution levels.
Golden Lane Estate	Crescent House	2-bed	Flat		Ground/Lowest floor	Own gas boiler		Combi gas boiler			Thermostat							0	4	Yes - a lot	Yes - both		Yes	Yes	e	We need windows from the flat changed in order to save on energy bills
Golden Lane Estate	Crescent House	1-bed	Flat		Top floor	Own gas boiler		Combi gas boiler			Thermostat	Additional plug-in electric heaters		Open windows when it's too warm in the winter				7	5	Yes - a little	Yes - both		Yes	Maybe	s	
Golden Lane Estate	Crescent House	Studio	Flat		Middle floor	Own gas boiler			Immersion		Thermostat							3	6	Yes - a lot	Yes - both		No internet	Yes	tr	The primary issue with crescent house is the lack of double glazing.
Golden Lane Estate	Cuthbert Harrowing House	3-bed	Maisonette		Top floor	Own gas boiler		Combi gas boiler			Thermostat	Additional plug-in electric heaters						1	2	Yes - a little	Yes - both		Yes	Maybe	d	
Golden Lane Estate	Cuthbert Harrowing House	2-bed	Flat		est floor	Own gas boiler		Combi gas boiler			Thermostat							3	5	Yes - a little	Yes - bathroom only	i dont have any	Yes	Maybe	m	not sure what the survey was for ?
Golden Lane Estate	Cuthbert Harrowing House	2-bed	Maisonette		Top floor	Own gas boiler		Combi gas boiler			Thermostat							2	5	Yes - a little	Yes - both		Yes	Yes	r	Double Glazing and roof insulation
Golden Lane Estate	Cuthbert Harrowing House	2-bed	Maisonette		est floor	Own gas boiler		Combi gas boiler			Thermostat							6	7	No						
Golden Lane Estate	Great Arthur House	1-bed	Flat		Ground/Lowest floor	Own gas boiler		Combi gas boiler			Thermostat			Open windows when it's too warm in the winter				2	8	Yes - a little	Yes - both		Yes	Yes	e	Nothing to add.
Golden Lane Estate	Great Arthur House	1-bed	Flat		Middle floor	Own gas boiler		Combi gas boiler			Thermostat			Open windows when it's too warm in the winter				3	8	No	No - we turn it off	Open windows instead	No internet	Yes	m	
Golden Lane Estate	Great Arthur House	1-bed	Flat		Middle floor	Own gas boiler		Combi gas boiler			Thermostat							7	4	Yes - a little	Yes - both		Yes	Yes	s	We all need to audit our energy use
Golden Lane Estate	Hatfield House	3-bed	Maisonette		Ground/Lowest floor	Own gas boiler		Combi gas boiler			Thermostat	Additional plug-in electric heaters						4	5	Yes - a little	Yes - both		Yes	Yes	a	
Golden Lane Estate	Hatfield House		Maisonette		est floor	Own gas boiler		Combi gas boiler			Thermostat							3	5	No	No - we turn it off	We don't have any	Yes	Yes	la	
Golden Lane Estate	Hatfield House	2-bed	Maisonette		Middle floor	Own gas boiler		Combi gas boiler			Thermostat							7	7	Yes - a little	Yes - both		Yes	Yes	p	
Golden Lane Estate	Hatfield House	2-bed	Maisonette		Ground/Lowest floor	Own gas boiler		Combi gas boiler			Thermostat	Additional plug-in electric heaters						2	5	No	No - we turn it off	I don't have a ventilation system I open the windows in the summer and the front door and kitchen window if I cook something with a lot of steam	Yes	Yes	s	I trust there will be a positive outcome to your research
Golden Lane Estate	Stanley Cohen House	2-bed	Flat		Middle floor	Own gas boiler		Combi gas boiler			Thermostat							2	9	Yes - a little	No - we turn it off	We do not have any	Yes	Yes	s	How many more years do we have to live in cold, noisy, dust ridden homes due to the corporation not double glazing our homes. We have rotting window frames, expensive fuel bills, damp, fungal spores and year after year we are fobbed off. Pointless survey after survey like these, costing how much? Shameful!!!!!!!
Holloway Estate	Crayford House	1-bed	Flat		Ground/Lowest floor	Own gas boiler		Combi gas boiler			Thermostat	Additional plug-in electric heaters						2	5	No	Yes - both		Yes	Yes	e	The draughty windows are a total disgrace. Why consult before fixing this serious problem You know about it please do something

Please select the estate in which you live.	Please select the block in which you live.	How many bedrooms does your home have?	Which of the below best describes your home?	Which best describes your house	Which floor are you on?	What's the main heating source in your home?	Communal system	Combi gas boiler	Immersion heater	Point-of-use heater (e.g. electric shower, hot tap etc)	Thermostat	Additional plug-in electric heaters	Additional gas heaters	Open windows when it's too warm in the winter	No control	Other	You selected "other". Please briefly describe other ways in which you control the temperature of your home.	How comfortable is your home in the winter?	How comfortable is your home in the summer?	Does your home suffer from damp?	Do you use your kitchen and bathroom ventilation?	Could you tell us why you don't use all or some of your ventilation fans?	Do you have broadband and wifi?	Would you be willing to share your energy bill data with us (anonymously)	If you give us y	Use this space to add anything else you would like to say.
Holloway Estate	Hilton House	1-bed	Flat		est floor	Own gas boiler		Combi gas boiler			Thermostat							0	3	Yes - a lot	Yes - both			Yes	b	I would like to participate and give ideas.
Middlesex Street Estate	Petticoat Square	3-bed	Maisonette		Middle floor	Communal heating	Communal system				Thermostat	Additional plug-in electric heaters		Open windows when it's too warm in the winter				5	7	No	Yes - bathroom only	I open window if cooking	Yes	Maybe	ia	New 35 system being installed soon will be fossil fuel at the start
Middlesex Street Estate	Petticoat Square	1-bed	Flat		Ground/Lowest floor	Communal heating	Communal system		Immersion		Thermostat							8	8	Yes - a little	Yes - both		Yes	Yes	b	CoL care not about their residents concerns
Middlesex Street Estate	Petticoat Square	2-bed	Flat		Middle floor	Communal heating	Communal system							Open windows when it's too warm in the winter	No control			7	7	No	Yes - both		Yes	Yes	a	No
Middlesex Street Estate	Petticoat Square	1-bed	Flat		Ground/Lowest floor	Own gas boiler		Combi gas boiler			Thermostat							3	9	Yes - a lot	Yes - both		Yes	Yes	fo	Maybe if we had new widows and wall insulation the flat would not be cold in the winter and Spring
Middlesex Street Estate	Petticoat Square	Studio	Flat		Top floor	Communal heating	Communal system								No control			10	8	No	Yes - both		Yes	No		
Middlesex Street Estate	Petticoat Square	3-bed	Maisonette		Middle floor	Communal heating	Communal system				Thermostat							4	8	Yes - a little	Yes - both		Yes	Yes	ju	
Middlesex Street Estate	Petticoat Tower	1-bed	Flat		Middle floor	Other	Communal system				Thermostat	Additional plug-in electric heaters						5	2	Yes - a little	Yes - kitchen only	Nothing is there,only a hole for ventilation but it does not work as i must be for the purpose.	Yes	Yes		They were planning to replace gas cooker to electric cooker thats very good idea as i believe.
Middlesex Street Estate	Petticoat Tower	2-bed	Maisonette		Ground/Lowest floor	Communal heating	Communal system				Thermostat							5	5	No	Yes - both		Yes	No		I am disappointed by the Corporation's unilateral decision to renew the Middlesex Street Estate's communal heating system via a purely fossil fuel powered solution. This new system is projected to remain in place for 35 years going forward.
Middlesex Street Estate	Petticoat Tower	1-bed	Flat		Middle floor	Communal heating	Communal system									Other	Thermostat Radiator valve	5	5	No	Yes - bathroom only	Too noisy	Yes	Yes		Both government and the City of London say that they want to reduce carbon emission, but they are in the process of installing a heating and hot water system in Middlesex Street Estate, that is gas fuelled contrary to the country's move away from fossil fuels. This system is predicted to last for next 35 years. Why weren't resident's views and general populations view about global warming taken into account? It is pointless to act concerned about these issues if you don't walk the walk.
Middlesex Street Estate	Petticoat Tower	1-bed	Flat		Middle floor	Communal heating	Communal system							Open windows when it's too warm in the winter		Other	Radiator thermostats	6	7	No	Yes - kitchen only	There is no working ventilation in the bathroom	Yes	Yes	s	MSE is currently having a replacement communal heating/hot water system installed which is 100% fossil fuel based and expected to have a life of 35 years. Although there is the potential at some future point to use waste water from commercial use to power the system, this is neither assured nor likely to happen for several years, if at all. This is an extraordinarily short-sighted imposition of a carbon-producing system that most residents object to strongly and is completely counter to the CoL's stated objectives to reduce carbon emissions.
Middlesex Street Estate	Petticoat Tower	2-bed	Flat		Top floor	Communal heating	Communal system							Open windows when it's too warm in the winter	No control	Other	Radiators have controls but they are not very effective - more like "off" or "on" rather than any gradual change. Centrally, the system is controlled by computers or manual overrides and regularly fails to provide efficient or reliable heating.	7	7	Yes - a little	Yes - both		Yes	Maybe	d	I am a non-resident leaseholder. I am not able to attend a workshop in person, but I would appreciate the opportunity for a Zoom or online option to attend. The communal heating and hot water system is generally unpopular with residents as an option for our homes. We are not happy with the proposed replacement being 100% fossil fuel powered and believe this (among other CoL policies) stands in stark contrast to the stated aim to reduce the CoL's carbon footprint. Air quality in our area is already among the poorest in the country, yet recent projects by the CoL have included the venting of vehicle exhaust fumes from a basement car park directly onto our communal "garden" area that is an amenity for residents. There is a lack of accountability and clear strategies to reduce the carbon footprint of estates like ours, and only vague promises and ambitions for the future. Any "green" strategy needs to engage with residents and be more than just a box-ticking consultation or survey exercise.
Middlesex Street Estate	Petticoat Tower	1-bed	Flat		Middle floor	Communal heating	Communal system								No control			5	6	No	Yes - both		Yes	Yes	n	I would like to see the city installing Cavity wall insulation to help with reducing our carbon footprint
Southwark Estate	Collinson Court	3-bed	Flat		Middle floor	Own gas boiler		Combi gas boiler			Thermostat							5	7	No	Yes - bathroom only	We don't have a kitchen ventilation fan	Yes	Maybe	m	Your poster at our estate doesn't explain what Etude is.
Southwark Estate	Collinson Court	1-bed	Flat		Middle floor	Own gas boiler		Combi gas boiler		Point-of-use heater	Thermostat							4	6	No	Yes - bathroom only	there is no fan in the kitchen currently - open window if necessary	Yes	Yes	w	The flat need very little heating. South facing windows warm it up on sunny winter days. North facing bathroom and kitchen windows allow cross vent in summer
Southwark Estate	Horace Jones House	1-bed	Flat		Middle floor	Other			Immersion		Thermostat			Open windows when it's too warm in the winter				5	10	No	Yes - bathroom only	I don't have any ventilation fans as far as I'm aware (there wasn't this option on the drop down list). I have a Vent Axia Sentinel Kinetic heat recovery unit. I really don't know how effective this as I've had periods where I've turned it off for a long while and honestly can't tell what difference it makes. It would be good to understand a bit more about it and if I'm using it effectively or maybe my flat is too small for any difference to be noticeable.	Yes	Yes	r	I would like to understand the scope of the survey/consultation. I feel it really needs to look at the residences and the environment in which they are situated.
Southwark Estate	Sumner Buildings	3-bed	Flat		Top floor	Own gas boiler		Combi gas boiler				Additional plug-in electric heaters				Other	Timed boiler	6	8	Yes - a little	No - we turn it off	There is no ventilation. We can only open the windows that are too old and difficult to open	Yes	No		The windows are too old and not isolated properly. There is no thermostat.
Southwark Estate	Sumner Buildings	2-bed	Flat		Top floor	Own gas boiler		Combi gas boiler			Thermostat							1	7	No	Yes - both		Yes	Yes	m	Even with putting secondary glazing on all windows and insulated plasterboard on all external walls, being on the top floor of a building with no insulation at all (the outside walls have no air gap), means the flat is very expensive to keep remotely warm. I would be interested in what options are available given the restrictions on cladding a restricted building such as Sumner Buildings. Is a green roof an option?
Sydenham Hill Estate	Lammas Green	3-bed	House	Mid terrace		Own gas boiler		Combi gas boiler			Thermostat							5	5	No	Yes - both		Yes	No		The city is cutting down trees on my estate and the new trees will struggle to survive. This is not very environmentally friendly.

Please select the estate in which you live.	Please select the block in which you live.	How many bedrooms does your home have?	Which of the below best describes your home?	Which best describes your house	Which floor are you on?	What's the main heating source in your home?	Communal system	Combi gas boiler	Immersion heater	Point-of-use heater (e.g. electric shower, hot tap etc)	Thermostat	Additional plug-in electric heaters	Additional gas heaters	Open windows when it's too warm in the winter	No control	Other	You selected "other". Please briefly describe other ways in which you control the temperature of your home.	How comfortable is your home in the winter?	How comfortable is your home in the summer?	Does your home suffer from damp?	Do you use your kitchen and bathroom ventilation?	Could you tell us why you don't use all or some of your ventilation fans?	Do you have broadband and wifi?	Would you be willing to share your energy bill data with us (anonymously)	If you would like us to say.	Use this space to add anything else you would like to say.
Sydenham Hill Estate	Lammas Green	2-bed	Flat		Middle floor	Own gas boiler		Combi gas boiler			Thermostat							3	6	No	No - we turn it off	I don't have them	Yes	Yes	li	I think the biggest issue for communal energy use at Lammas Green is the huge amount that the outdoor lighting around the green is often on, even in the middle of bright days. Such a tremendous waste! Hours and hours of the lights switched on, for absolutely no need. Really wasteful.
Sydenham Hill Estate	Lammas Green	3-bed	House	End terrace		Own gas boiler		Combi gas boiler		Point-of-use heater	Thermostat							5	5	Yes - a little	Yes - kitchen only	Bathroom extractor needs connecting correctly, if the kitchen needs vrnylating we open a door.	Yes	No		As far as is known all the houses in Lammas Green have cavity wall filling.
William Blake Estate	Donnelly House	1-bed	Flat		Middle floor	Electric underfloor heating			Immersion			Additional plug-in electric heaters						2	6	Yes - a lot	Yes - both		Yes	Yes	in	
William Blake Estate	St James Mansions	1-bed	Flat		Middle floor	Own gas boiler		Combi gas boiler			Thermostat	Additional plug-in electric heaters						3	8	No	Yes - bathroom only	I have a window in my kitchen which I open but no window in my bathroom hence the ventilation fan comes on automatically when I switch on the light there.	Yes	Yes	s	Much of the temperature problems in my flat are due to badly fitting windows - gaps where heat escapes, and draft comes in; single glass which does not provide much insulation either against cold air/wind or heat/direct sun.
William Blake Estate	St James Mansions	1-bed	Flat		Middle floor	Own gas boiler		Combi gas boiler			Thermostat	Additional plug-in electric heaters						4	8	No	Yes - bathroom only	There is only a ventilation system in the bathroom as it's a windowless room. Ventilation only comes on when light is switched on - it'll go off soon after light is turned off.	Yes	Yes	s	The biggest problem about wasted energy use in my flat is due to the number of ill fitting single-glazed windows - I lose a lot of heating due to draft problems even when windows are closed
Windsor House	Windsor House	2-bed	Flat		Middle floor	Communal heating		Combi gas boiler			Thermostat							1	9	Yes - a lot	Yes - both		Yes	Yes		The windows are archaic. The walls are also badly insulated, so they often become very cold in the winter, and as soon as humidity touches the cold walls, mould grows.
Windsor House	Windsor House	1-bed	Flat		Ground/Lowest floor	Own gas boiler		Combi gas boiler			Thermostat			Open windows when it's too warm in the winter				0	2	Yes - a lot	Yes - both		Yes	Yes	g	Windsor house ground floor has a huge problem with damp. I have to run a dehumidifier all winter and most of summer to keep it under control which is hugely damaging to the environment.
Windsor House	Windsor House	2-bed	Flat		Middle floor	Own gas boiler		Combi gas boiler			Thermostat			Open windows when it's too warm in the winter				3	10	Yes - a lot						
York Way Estate	Kinefold House	2-bed	Flat		Ground/Lowest floor	Electric storage heater				Point-of-use heater	Thermostat							5	5	No	Yes - bathroom only	Does not work correctly	Yes	Maybe	d	Since we were moved from Gas to electric systems, our costs for energy have gone through the roof. This as resulted in us not using heating during winter months, which is not really acceptable in this day of age.
York Way Estate	Kinefold House	3-bed	Flat		Middle floor	Communal heating	Communal system								No control			3	8	No	Yes - bathroom only		Yes	No		
York Way Estate	Lambfold House	2-bed	Flat		Top floor	Communal heating	Communal system									Other	Inefficient thermostats on radiators. Either off, or full bore.	8	10	No	No - we turn it off	The noise is like a jet engine and can't be controlled.	Yes	No		The flats become unbearably hot in sunny weather in summer. I need to run fans most of the time. This is due to large windows, which are nearing the end of their useful life - several leak. If they could be replaced, or have a reflective thermal film applied, the flat would be cooler and energy used in running the fans can be saved.
York Way Estate	Lambfold House	2-bed	Flat		Middle floor	Communal heating	Communal system				Thermostat							6	8	No	Yes - both		No internet	Maybe	a	I dont take part in online forums
York Way Estate	Penfields House	3-bed	Flat		Middle floor	Communal heating		Combi gas boiler							No control			7	5	No	Yes - both		Yes	Maybe	d	