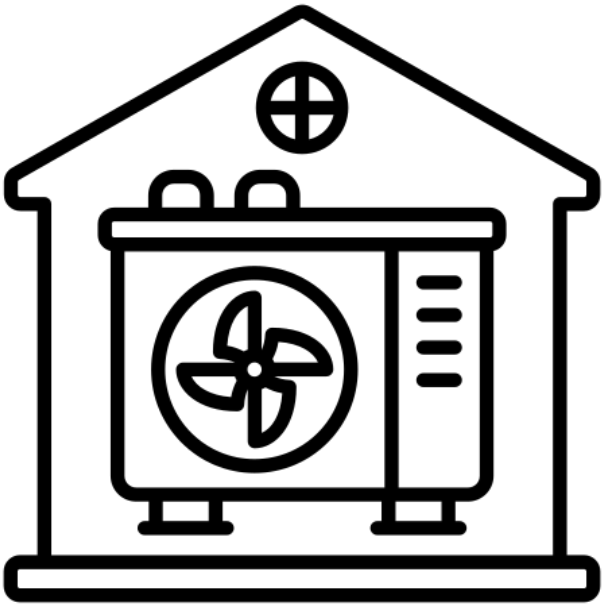
The City of Edinburgh Council

Edinburgh Local Heat and Energy Efficiency Strategy
December 2023



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THE CITY OF EDINBURGH COUNCIL

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1. Foreword

1.1.1. “On behalf of the City of Edinburgh Council, I am pleased to introduce the first iteration of the Edinburgh Local Heat and Energy Efficiency Strategy (LHEES).

1.1.2. “The Edinburgh LHEES is ‘a long-term strategic framework for the improvement of the energy efficiency of buildings in the local authority’s area, and the reduction of greenhouse gas emissions resulting from the heating of such buildings.’ The Edinburgh LHEES will help steer interventions over the coming years aimed at making buildings in Edinburgh more energy efficiency and migrating the heating of buildings away from fossil fuel-based solutions such as gas boilers to zero direct emissions solutions such as heat pumps and heat networks. The Edinburgh LHEES therefore links to the Scottish Government’s target of decarbonising the heating of all buildings in Scotland by 2045 and, in turn, the wider target of making Scotland net zero carbon by 2045, as well as the Council’s own target of making Edinburgh a net zero carbon city as set out in its 2030 Climate Strategy.

1.1.3. “It is important to recognise that achieving these targets will be extremely challenging, and will necessitate large-scale activity by both the public sector and the private sector and the commitment of significant resources. A wide variety of stakeholders will require to be mobilised towards these goals.

1.1.4. “The Edinburgh LHEES is being published at a time of great flux, with areas such as the regulatory regime for heat networks; regulations around gas boilers; funding mechanisms for retrofit; the role of hydrogen; and the electricity pricing system all currently under review. The decisions taken with respect to these areas will inform what is and is not achievable over the coming years.

1.1.5. “In light of these challenges, the Delivery Plan for 2024 to 2028 that has been prepared alongside the inaugural Edinburgh LHEES focuses on the areas where it is considered there is greatest potential for intervention in the short to medium-term in light of the limited existing powers and resources the Council has access to. The focus of the Delivery Plan is therefore upon areas where the Council has the greatest influence, for example the retrofit of its own estate and the roll-out of heat networks in areas where the Council has significant influence, as well as on the areas of Edinburgh that represent the most significant opportunities in Edinburgh. It is envisaged that future iterations of the Delivery Plan will have a wider focus.

1.1.6. “I hope you find the Edinburgh LHEES to be a useful document in setting out how Edinburgh’s buildings can move to net zero.”

– Councillor Cammy Day, Leader of the City of Edinburgh Council

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3.1. Introduction

3.1.1. This document is the Local Heat and Energy Strategy (LHEES) for the City of Edinburgh. An LHEES is a long-term plan for decarbonising heat in buildings and improving energy efficiency across a local authority. The Local Heat and Energy Efficiency Strategies (Scotland) Order 2022 requires all Scottish local authorities to publish an LHEES, along with a Delivery Plan, by the end of 2023. The central drivers of the Edinburgh LHEES are the statutory national targets of achieving net zero emissions by 2045 (with a 75% reduction by 2030) and, so far as reasonably possible, eradicating fuel poverty by 2040. The Edinburgh LHEES is a place-based and locally-led strategy for Edinburgh covering the following aims:

- Improving the energy efficiency and decarbonising the heat supply of buildings.
- Eliminating poor energy efficiency as a driver for fuel poverty.

3.1.2. The Edinburgh LHEES follows an area-wide approach, meaning it addresses all buildings in the City of Edinburgh area, not just the Council's own building stock. It covers all homes (whether owned by owner-occupiers, social landlords, or private landlords) and all non-domestic buildings (whether owned by the Council, other public bodies, businesses, or the third sector). The Edinburgh LHEES is not just a plan for the Council but one relevant to all owners and occupiers of Edinburgh's buildings, and thus can only be delivered by the concerted effort of all of these people.

3.1.3. The Edinburgh LHEES utilises a standardised methodology to:

- Set out how each segment of Edinburgh's building stock needs to change.
- Identify strategic heat decarbonisation zones within Edinburgh and set out the principal measures for reducing buildings emissions within each zone.
- Prioritise areas for delivery.

3.1.4. Information on key concepts such as heat networks, heat pumps, and energy efficiency is set out in the Edinburgh LHEES.

3.2. Methodology

3.2.1. The methodology for preparing the Edinburgh LHEES has largely followed the guidance issued by the Scottish Government and Zero Waste Scotland where possible. Details of the approach taken to carrying out the analysis underpinning the designation of the Strategic Zones and Delivery Areas is set out in this document. Production of the Edinburgh LHEES has been supported by the consultancies Turner & Townsend; Ramboll; Changeworks; (all stages) and Atkins (stages one and two). Challenges arising during the process have included shortages of data and errors in both datasets and tools. The Edinburgh LHEES has been shaped by both internal and external consultation.

3.2.2. Following the submission of a Screening Report, the Council was advised that a Strategic Environmental Assessment was not required for the Edinburgh LHEES.

3.3. Policy and strategy context

3.3.1. The Edinburgh LHEES sits within a complex and rapidly evolving landscape of policies, strategies, and regulations. The primary policies among these which were central to the development of the Edinburgh LHEES are summarised in Table 01:

Table 01: Key national policies underpinning the Edinburgh LHEES

Policy area	Policy	Description
Heat decarbonisation; energy efficiency	The Climate Change (Emissions Reduction Targets) (Scotland) Act 2019	Statutory targets for reducing all of Scotland's greenhouse gas emissions to net zero. These includes a headline target of net zero by 2045 and intermediate reductions targets, such as a 75% reduction by 2030.
Heat decarbonisation; energy efficiency	Climate Change Plan (2018, 2020)	Targets and a comprehensive set of policies for emissions reductions by 2032 covering all emission categories, including relevant categories of electricity generation, buildings, and industry.
Fuel poverty	Fuel Poverty (Targets, Definition and Strategy) (Scotland) Act 2019	Statutory targets to be achieved by 2040: no more than 5% of households in Scotland in fuel poverty and no more than 1% of households in Scotland in extreme fuel poverty
Heat networks	Heat Networks (Scotland) Act 2021	A framework for developing heat networks throughout Scotland and statutory target of heat networks supplying 2.6 terawatt hours of thermal energy by 2027 (equivalent to circa 120,000 additional homes) and 6 terawatt hours by 2030 (equivalent to circa 400,000 additional homes).
Heat decarbonisation; energy efficiency; fuel poverty	Heat in Buildings Strategy (2021)	Programmes, standards and regulations for heat, energy efficiency and fuel poverty to ensure that all buildings are energy efficient by 2035 and use zero direct emissions heating and cooling systems by 2045, as well as minimising fuel poverty in line with statutory targets.

3.3.2. National policies give rise to a series of ambitious goals around energy efficiency improvements and reductions in fuel poverty. The key policy targets and regulations relating to the Edinburgh LHEES are summarised below:

- By 2045, buildings in Scotland will no longer contribute to climate change.
- By 2040, no more than 5% households in Scotland will be in fuel poverty and no more than 1% will be in extreme fuel poverty (Fuel Poverty (Target, Definition and Strategy) (Scotland) Act 2019).
- By 2030, over one million homes and 50,000 non-domestic buildings in Scotland will have converted to zero or low emissions heating systems (Heat in Buildings Strategy).
- By 2030, 6.0 terawatt hours of heat energy will be supplied by heat networks in Scotland by 2030 (Heat Networks (Scotland) Act 2021).
- All homes in Scotland will achieve an Energy Performance Certificate of at least 'C' by 2040 (Energy Efficient Scotland).

- The use of direct emissions heating systems in new buildings in Scotland is proposed to be prohibited from 1 April 2024 (New Build Heat Standard).

3.3.3. A key challenge in respect of the Edinburgh LHEES is that many of the national policies, strategies, and regulations that will determine the climate for the delivery of Edinburgh LHEES are still in formulation. These include the Heat in Buildings Bill, the permitting and consenting regime for heat networks in Scotland, and the finalised Energy Efficiency Standard for Social Housing post 2020 (EESSH2).

3.3.4. The 2030 Climate Strategy is the overall strategy for Edinburgh to become a net zero city by 2030. The Edinburgh LHEES sits below the Climate Strategy, being the strategy for transitioning the heating of buildings in Edinburgh to net zero. The Climate Strategy identifies seven priorities for action, of which two relate directly to the Edinburgh LHEES: "accelerate energy efficiency in homes and buildings" and "enable the development of a citywide programme of heat and energy generation and distribution". It sets the following targets of relevance to the Edinburgh LHEES:

- All new Council-led housing developments to be net zero.
- Develop regional renewable energy solutions.
- Identify Heat Network Zones across the city.
- Develop a plan for retrofitting social housing across the city to the highest energy standards, to reduce energy demand and tackle fuel poverty.
- Establish an Energy Efficient Public Buildings Partnership.

3.4. Ongoing activity in Edinburgh

3.4.1. There is significant activity ongoing in Edinburgh around energy efficiency and heat decarbonisation. Key areas of activity include:

- Energy efficiency improvements to the Council's existing social housing stock under the "whole house retrofit" approach.
- Energy efficiency improvements to mixed-tenure buildings (buildings where ownership is shared between the Council and private owners) via the Mixed Tenure Improvement Service (MTIS).
- Energy efficiency improvements to private homes at risk of fuel poverty via Area-Based Schemes.
- The development of new social housing with zero direct emissions heating sources and to Passivhaus energy efficiency standards.
- Energy efficiency improvements to the Council's operational estate, spearheaded by a pathfinder pilot project.
- Development of heat network projects in Edinburgh, most significantly ongoing work to appoint a concessionaire to deliver and operate a heat network in Granton Waterfront.

3.4.2. There are a range of existing initiatives that can support private building owners with improving energy efficiency and decarbonising heat. Home Energy Scotland, Business Energy Scotland, and Local Energy Scotland are services funded by the Scottish Government and managed by the Energy Saving Trust. They provide households, businesses, and community

groups with advice and support on saving energy, decarbonising properties, and generating renewable energy. They also administer various grant and loan schemes to help owners with retrofit costs. The Scottish Government manages multiple schemes, targeted largely at public bodies (though with exceptions). These include funds and support to retrofit non-domestic public buildings, social housing, and privately-rented and owner-occupied housing in fuel poverty. The Scottish Government leads the Heat Network Support Unit which provides support and administers grant funding to facilitate heat network developments.

3.5. Baselining

3.5.1. To set the context for the Edinburgh LHEES, a comprehensive assessment of the current performance of the city's building stock has been undertaken, providing a thematic overview of Edinburgh's building stock in the context of heat decarbonisation and energy efficiency. It profiles characteristics such as energy performance; fuel type; tenure; type; and age. This information helps inform key decisions about the Edinburgh LHEES and its direction. The data used to prepare this assessment was primarily drawn from the Home Analytics and Non-Domestic Analytics datasets. Headline findings from the assessment include the following:

- 69% of homes in Edinburgh are flats – a far greater proportion than Scotland overall.
- Private landlords account for 21% of homes in Edinburgh – again far greater than Scotland overall.
- Around half of all homes in Edinburgh are located in mixed-tenure buildings.
- Homes in Edinburgh are significantly older than the Scottish average, with a tenth being listed and a quarter lying within conservation areas.
- Most homes in Edinburgh (91%) are connected to the gas grid.
- Due to the lack of data for the non-domestic stock there are many unknowns around the baseline building stock performance.

3.5.2. Key implications from the assessment are that:

- 120,938 homes in Edinburgh have an Energy Performance Certificate rating worse than 'C' and will therefore require upgrading to meet national targets.
- To achieve recommended levels of energy efficiency, 129,706 homes in Edinburgh will require wall insulation (including 80,708 homes with hard-to-treat solid walls); 66,903 homes in Edinburgh will require (improved) loft insulation; and 52,279 homes will require improved glazing: a total of 248,888 interventions.
- To achieve decarbonisation of heat, at least 229,798 homes in Edinburgh will need their existing fossil fuel-based heating systems replaced, the vast majority of them (227,550) being homes currently heated using gas boilers.
- At least 6,551 non-domestic buildings in Edinburgh will need their existing fossil fuel-based heating systems replaced.

3.5.3. This baseline assessment has identified the following key challenges with regards to Edinburgh's building stock:

- Edinburgh's very high proportion of flats (including its traditional tenements) and mixed-tenure buildings will greatly increase the challenge of implementing solutions. Unlike standalone homes with a single owner, where decisions can be straightforwardly taken, taking forward interventions to blocks of flats and other

mixed-tenure buildings will require securing agreement from a range of stakeholders, including difficult to engage with parties such as absentee landlords. Given that coordinating even relatively uncontroversial matters such as essential repairs has historically proven challenging in some cases, it is envisaged that securing agreement from all necessary stakeholders for potentially complex and costly interventions will be particularly challenging. The high prevalence of flats also gives rise to practical challenges, for example a lack of space in which to install heat pumps and limited potential to install solar panels to offset electricity costs. However, with the appropriate financing options and a clear regulatory landscape there is a major opportunity for rolling out large-scale archetype-based retrofit projects.

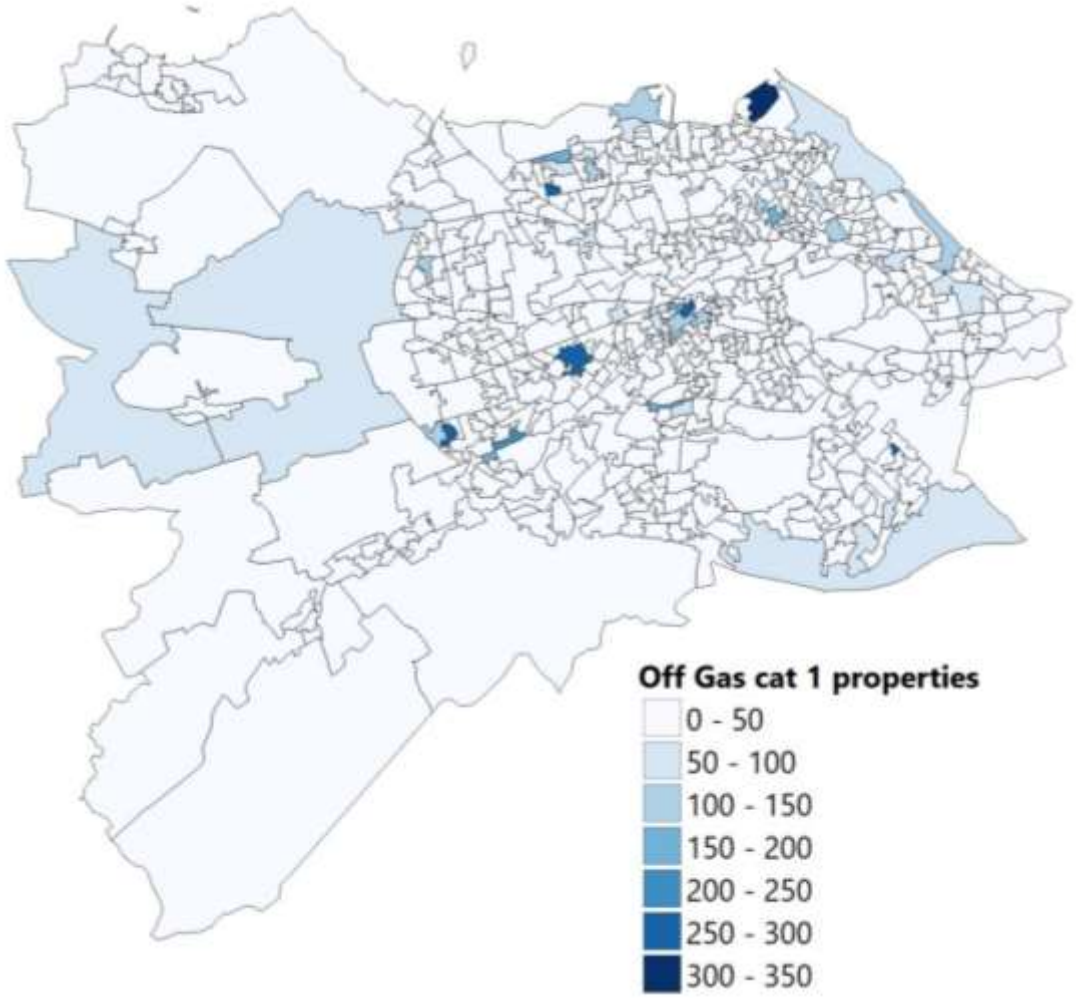
- As a predominantly urban local authority, the vast majority of homes in Edinburgh are connected to the gas grid, as compared to other local authorities where a greater proportion of residents are reliant on alternative heating solutions such as oil. When secondary fuels are included, over 99% of homes in Edinburgh use gas. This is likely to increase the challenge of migrating homes to zero direct emissions heating sources, as gas heating offers many benefits: it is relatively cheap; offers a high flow temperature; is well understood in the marketplace; and it has a well-developed supply chain. As set out in section 10.3, the move to zero direct emissions heating will need to make financial sense for building users. Heat networks can potentially play a major role in retaining many of the benefits of gas, with the added benefits of maintenance cost savings and screening customers against energy price volatility.
- Relative to Scotland overall, Edinburgh has a very high proportion of rental homes owned by private landlords: more than one in every five homes. Conversely, Edinburgh has a considerably smaller social housing sector. This means that the City of Edinburgh Council (and other social housing providers) have far less direct influence over housing stock than other Scottish local authorities. Additionally, this means that achieving net zero will require securing buy-in from a large cohort of private landlords, who are likely to be primarily profit-driven and who do not have a direct incentive to improve energy efficiency of their properties (e.g. compared to owner-occupiers who can benefit from lower bills and increased comfort).
- Relative to Scotland overall, Edinburgh has a considerably older housing stock, with close to a third of homes being over a century old. One in 10 homes are listed. As set out elsewhere in the Edinburgh LHEES, this historicity gives rise to both practical and policy challenges to carrying out interventions.
- Edinburgh has a higher proportion of homes with uninsulated walls than Scotland (over two-fifths), and in particular has a high proportion of hard-to-treat solid stone walls. One in five homes in Edinburgh do not have double/triple glazing.

3.6. Generation of Strategic Zones and pathways

3.6.1. Analysis has been carried out to identify “Strategic Zones” in Edinburgh for each LHEES Consideration. These are areas that highlight pathways for intervention, e.g. what the optimal solution is in an area to decarbonise heat. This analysis sets a starting point for the generation of, and prioritisation, of more granular Delivery Areas, as well as for further engagement and actions in the Delivery Plan. Through stakeholder engagement and data

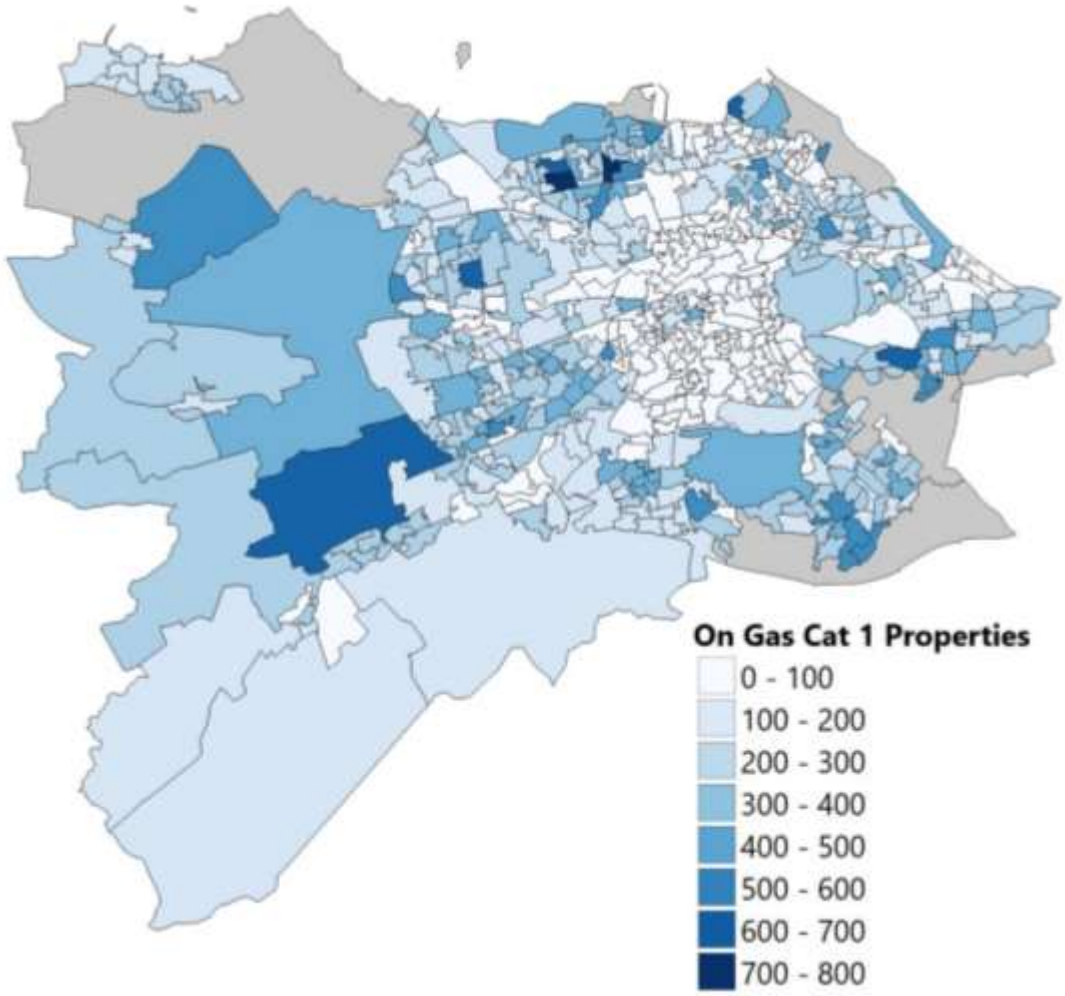
analysis, the Council has identified three priority areas of focus: fuel poverty; heat networks; and heat pump-ready properties.

3.6.2. The first LHEES Consideration concerns the strategy for decarbonising buildings that are not currently connected to the gas grid. Strategic Zones have been produced showing the areas of Edinburgh containing the greatest number of homes not connected to the gas grid assessed as having good potential to be migrated to heat pumps. These areas are distributed across Edinburgh with no easily interpretable geographical pattern. 39.2% of homes in Edinburgh not currently connected to the gas grid are assessed as falling into category 1, i.e. have the greatest potential to be converted to heat pumps. The below plan shows datazones in Edinburgh with the highest number of on-gas grid category 1 ('heat pump ready') properties (darker zones represent a higher number of properties).



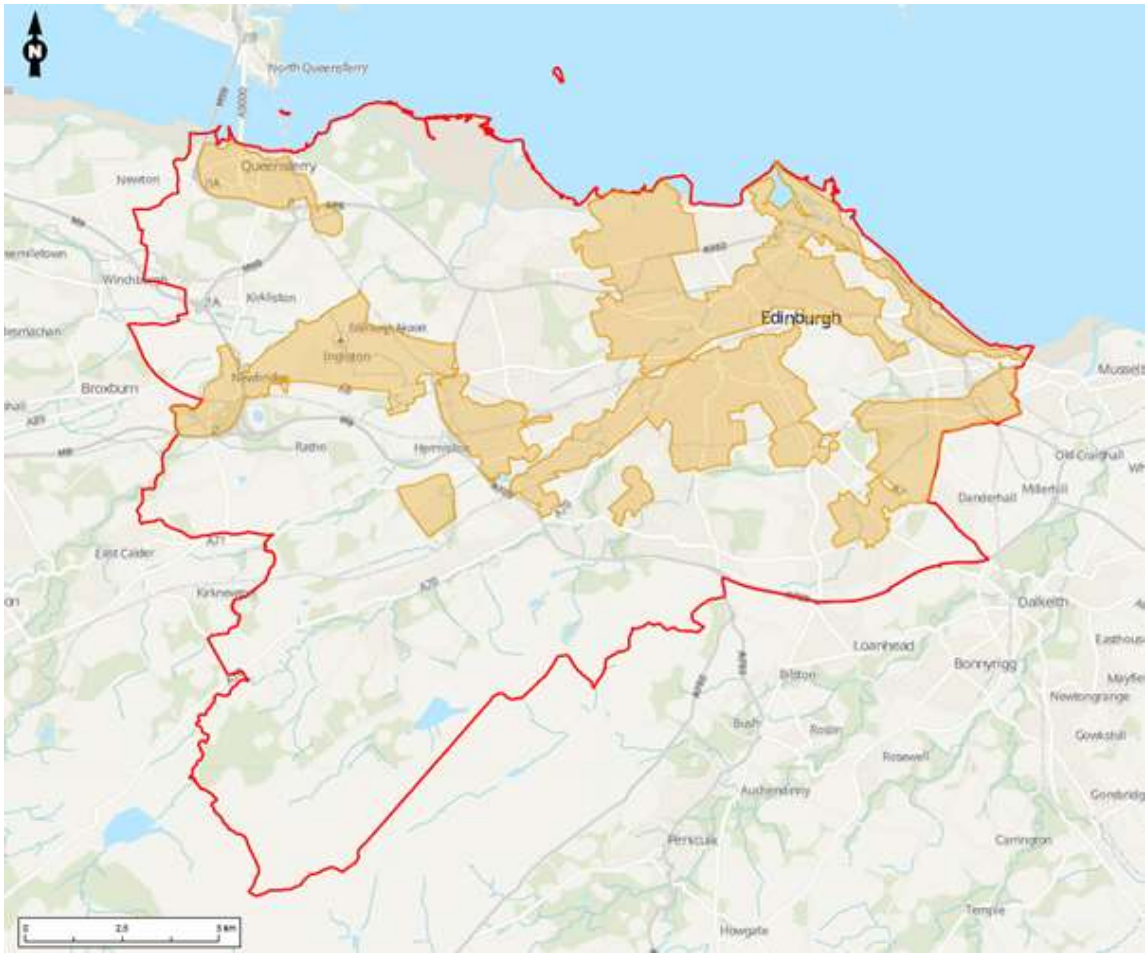
3.6.3. The second LHEES Consideration concerns the strategy for decarbonising buildings that are currently connected to the gas grid. Strategic Zones have been produced showing the areas of Edinburgh containing the greatest number of homes connected to the gas grid assessed as having good potential to be migrated to heat pumps. These areas are distributed across Edinburgh with no easily interpretable geographical pattern. 44.7% of homes in Edinburgh not currently connected to the gas grid are assessed as falling into category 1, i.e. have the greatest potential to be converted to heat pumps. The below plan shows the datazones in

Edinburgh with the highest number of off-gas grid category 1 ('heat pump ready') properties (darker zones represent a higher number of properties).



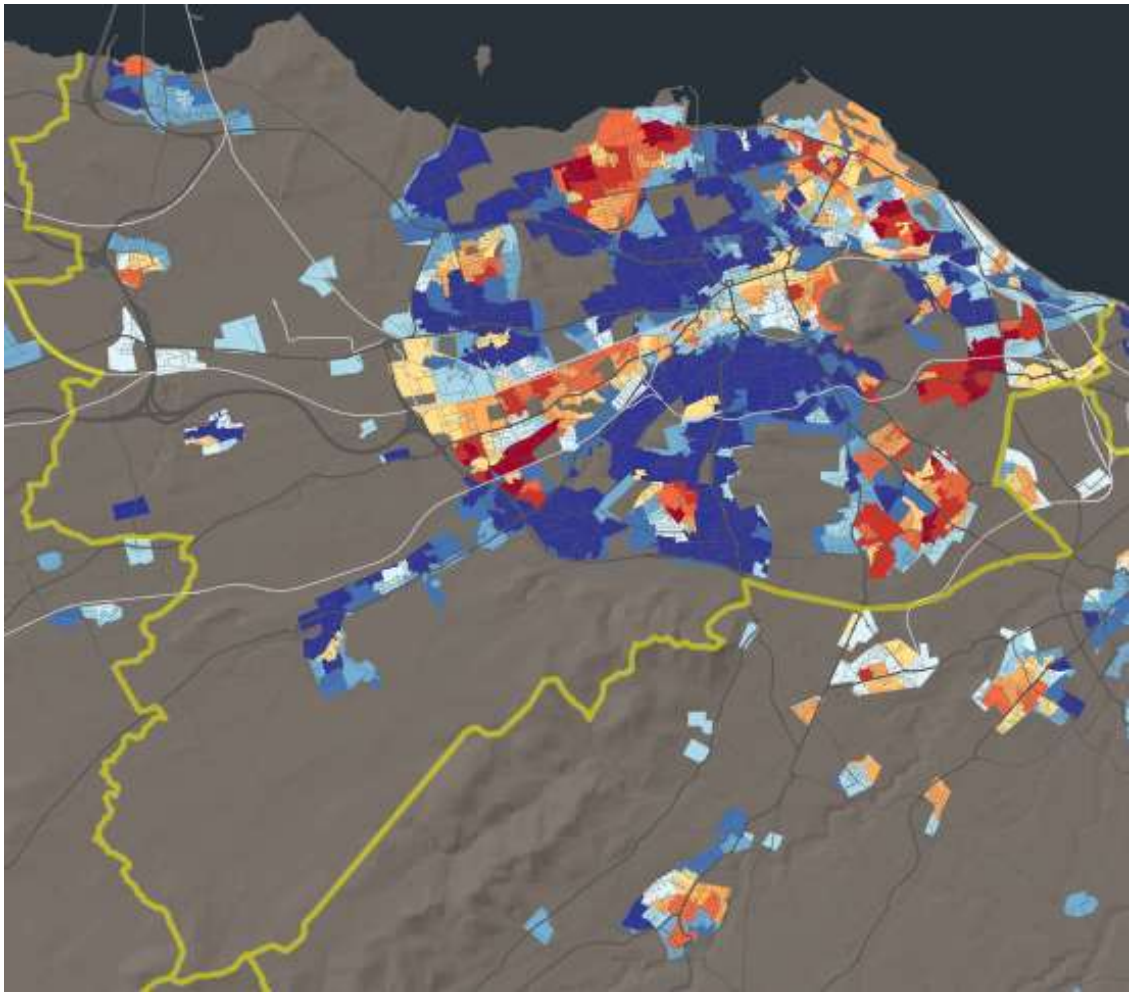
3.6.4. For both off gas and on gas properties, the most realistic and pragmatic approach for Edinburgh is to begin with less complicated and simpler decarbonisation projects, moving into more complex retrofits as the Council, supply chain, stakeholders and property owners expand their learning. As such, the Council proposes a focus on category 1 properties. The Delivery Plan therefore highlights Delivery Areas with a focus on category 1 properties.

3.6.5. The third LHEES Consideration concerns the scope to develop heat networks providing decarbonised heat. Edinburgh has a relatively high heat density, good availability of heat sources, and many buildings with high energy use intensity which can serve as “anchor loads” increasing the viability of a heat network. These advantages may give rise to scope for large and continually expanding city heat network (or “network of networks”) covering much of Edinburgh’s population. 17 prospective Heat Network Zones across Edinburgh have been identified based on data analysis and stakeholder engagement, spanning a significant proportion of Edinburgh and representing a diverse mix of areas where there is economic and practical viability for a heat network (there is heat demand and potential to supply heat), as well as taking into account practical considerations. The 17 prospective Heat Network Zones are shown in the below plan; the Delivery Plan presents more detailed maps and prospective Heat Network Zones to take forward.



3.6.6. The fourth LHEES Consideration concerns poor energy efficiency in Edinburgh. Strategic Zones have been produced showing the areas of Edinburgh with the poorest energy efficiency. These are closely aligned to areas with high concentrations of historic buildings, reflecting the challenges associated with (for example) insulating solid stone walls.

3.6.7. The fifth LHEES Consideration concerns poor energy efficiency as a driver of fuel poverty in Edinburgh. Due to concerns about the robustness of the outputs generated by the LHEES Methodology for this Consideration, the Council intends to instead utilise the 2020 Scottish Index of Multiple Deprivation (SIMD) rankings as a proxy for fuel poverty. The below plan shows the SIMD rankings of each datazone of Edinburgh (warmer zones represent more deprivation, i.e. a higher likelihood of fuel poverty). The Delivery Plan identifies the specific Delivery Areas identified for this strategic priority.



3.6.8. The sixth LHEES Consideration concerns mixed-tenure, mixed-use, and historic buildings – buildings that for practical reasons are likely to prove more challenging to retrofit. Strategic Zones have been prepared for each of these themes.

3.7. Edinburgh LHEES findings and next steps

3.7.1. The baseline analysis undertaken as part of the Edinburgh LHEES has identified multiple key challenges to decarbonising heat in buildings and improving energy efficiency across a local authority stemming from the particular characteristics of Edinburgh's building stock.

3.7.2. The analysis undertaken against the six LHEES Considerations has given rise to "Strategic Zones". These Zones are at the heart of the Edinburgh LHEES, setting out at a strategic level potential pathways for decarbonisation of Edinburgh's building stock and identifying areas of pressure in terms of energy efficiency.

3.7.3. Three areas of activity have been identified that are assessed as representing the most appropriate focus for the inaugural Edinburgh LHEES:

- Targeting areas with the highest occurrences of fuel poverty and the 20% most deprived areas of Edinburgh as per the Scottish Index of Multiple Deprivation.
- Decarbonising Council-owned housing and non-domestic stock in line with national timescales.

- Supporting wider decarbonisation of Edinburgh within the funding and resources that are made available to the Council, beginning with a focus on facilitating a city-wide heat network (or "network of networks"), and upon area with the largest numbers of heat pump-ready homes as a prospective "quick win" in terms of heat decarbonisation.

3.7.4. The following high-level principles are proposed to underpin how the Edinburgh LHEES is delivered and, in turn, how buildings in Edinburgh are made more energy efficient and their heating decarbonised:

- [A] Interventions should be on a "fabric first" basis;
- [B] Interventions should be solution agnostic;
- [C] Interventions must make financial sense for building users;
- [D] New build properties offer the greatest potential;
- [E] Significant additional external funding will be required;
- [F] More comprehensive and robust data is needed;
- [G] Additional levers will be required to catalyse change.

4. Introduction to the Edinburgh LHEES

4.1. Overview of the Edinburgh LHEES

4.1.1. This document is the Local Heat and Energy Strategy (LHEES) for the City of Edinburgh. It has been prepared in response to the Local Heat and Energy Efficiency Strategies (Scotland) Order 2022, which requires all Scottish local authorities to publish an LHEES – defined as "a long-term strategic framework for the improvement of the energy efficiency of buildings in the local authority's area, and the reduction of greenhouse gas emissions resulting from the heating of such buildings" – by 31st December 2023, and thereafter at intervals of no more than five years.

4.1.2. The scale of the challenge this represents should not be underestimated. Achieving this goal will require greatly increasing the pace of deployment of zero direct emissions heating systems. The decarbonisation of buildings has been compared to the advent of central heating in the 1960s.[1] At a UK level, the Committee on Climate Change has estimated that approximately £250 billion will need to be invested in upgrading UK homes by 2050 to achieve targets around carbon reductions.[2] As of mid-2021, Edinburgh was home to 0.79% of the UK population.[3] On a pro rata basis, this would indicate that £1.964 billion of investment was needed in homes in Edinburgh. This does not include investment required in non-domestic properties. In December 2022, the Scottish Government estimated that it would cost over £33 billion to "upgrad[e] the energy efficiency of domestic and non-domestic properties and replac[e] their heating systems with zero emissions alternatives"; on a pro rata basis, this would represent a cost of £3.170 billion in Edinburgh.[4] Investment of this scale will inevitably necessitate a role for private capital, as it is highly unlikely to be fundable by the public sector alone. As the Council's own limited resources will be focused on its own sizeable and complex estate, alternative funding sources and solutions will be needed for other organisations' properties in the city.

4.1.3. The Scottish Government has estimated that the typical cost of decarbonising a home will be £10,000 to £12,000: a typical cost of £10,000 for a heat pump, along with costs of up to £2,000 for energy efficiency measures.[5] However, it is noted that these costs will vary greatly depending upon the characteristics of the home, and in some cases will be far higher. The costs of decarbonising non-domestic properties will also vary significantly.

4.1.4. The function of the Edinburgh LHEES is to set out the overall strategy for achieving heat decarbonisation and energy efficiency improvements in the building stock of Edinburgh. It assesses the scale of the challenge in terms of the degree and cost of the work required to Edinburgh's building stock and identifies a route map of potential "pathways" for delivery.

4.1.5. The Edinburgh LHEES sets out how Edinburgh will help realise national ambitions around the heating of buildings in Scotland and what this means for the climate and for building users. At a national level, the Heat in Buildings Strategy sets out a vision that by 2045, buildings in Scotland will no longer contribute to climate change.[i] The Fuel Poverty (Targets, Definition and Strategy) (Scotland) Act 2019 sets a target of no household in Scotland being in fuel

[i] This target in turn relates to the statutory target of achieving net zero carbon emissions in Scotland by 2045 (with interim targets of a 75% reduction by 2030 and a 90% reduction by 2040) set by the Climate Change (Emissions Reduction Targets) (Scotland) Act 2019.

poverty by 2040. Achieving these targets will require both investing in the fabric of buildings to improve their energy efficiency and investing in zero direct emissions heating solutions.

4.1.6. At an Edinburgh level, the Edinburgh LHEES sits beneath the 2030 Climate Strategy, which sets a target of Edinburgh being a net zero city by 2030. Of the seven priorities set out in the Strategy, the first is to accelerate energy efficiency in homes and buildings.[ii] The second is to enable the development of a citywide programme of heat and energy generation and distribution. The Edinburgh LHEES will help translate the targets and priorities of the 2030 Climate Strategy into actions. However, it is important to note that Edinburgh is not currently on trajectory to decarbonise all buildings in the city by 2030, and so from that perspective the 2030 net zero city target will not be attainable unless the pace of activity – and, by extension, the resources available – significantly increases (which would be extremely challenging given resource pressures and the disruption to building occupiers this would entail).

4.1.7. The Edinburgh LHEES is the principal mechanism for the locally led, place-based decarbonisation of heat in buildings, having cognisance to the specific context and priorities of Edinburgh. It will support local planning, coordination, and delivery of the heat transition throughout Edinburgh. It will set out how each segment of Edinburgh's building stock needs to change; identify strategic zones for heat decarbonisation and the principal measures needed in each zone; and prioritise area for delivery. It will help direct capital investments.

4.1.8. It is important to note that achieving the headline targets set out in the Edinburgh LHEES will not be possible without significant action by other organisations. In particular major legislative, regulatory, and budgetary decisions by the Scottish Government and UK Government will be required for the Edinburgh LHEES to be successfully delivered. At present, there is no financial strategy for the investment required to decarbonise Edinburgh or Scotland. The Edinburgh LHEES therefore largely sets out what may be possible with the commensurate resources and powers being made available.

4.1.9. The audience for the Edinburgh LHEES includes residents of Edinburgh; businesses and third sector organisations with a presence in the city; the Scottish Government; other public sector bodies; utility network operators; and developers.

4.1.10. The Edinburgh LHEES should be read in conjunction with the Delivery Plan, which sets out how the Edinburgh LHEES is to be implemented, with a focus on early, low-regrets actions over the first five years of the Edinburgh LHEES (2024 to 2028).

- The Edinburgh LHEES sets out Strategic Zones that provide pathways for the decarbonisation of heat and the improvement of energy efficiency in different areas of Edinburgh. The Edinburgh LHEES also sets out areas of focus, the Council's approach, and high-level principles to guide activity over the period.
- The Delivery Plan identifies the actions the Council itself will take to deliver the Edinburgh LHEES, and the Delivery Areas in which these actions will be concentrated. It is important to note that there is no dedicated budget for the delivery of the Edinburgh LHEES. Actions set out in the Delivery Plan are therefore focused on currently funded area of activity and additional areas of activity that can be met from existing resources, albeit this can be revisited should additional funding be

[ii] The 2030 Climate Strategy notes that energy utilised to heat and power Edinburgh's buildings accounts for 68% of the city's total emissions.

made available for the delivery of the Edinburgh LHEES. Accordingly, the more substantial actions set out in the Delivery Plan are heavily skewed towards the Council's own estate.

4.1.11. The Edinburgh LHEES has been prepared in a limited timescale and in the context of challenges such as data limitations, methodological issues, and a rapidly evolving regulatory context. These factors have inevitably had a bearing upon the end results. It is envisaged that the second iteration of the Edinburgh LHEES will benefit from a more stable regulatory context, better quality data, and additional time and resources for preparation.

4.1.12. Achieving the ambitions of the Edinburgh LHEES will require partnership working across the public, private and third sectors. As such, the Edinburgh LHEES has been developed with input from key stakeholders and is subject to an open public consultation. Through these engagements, the Council has sought to establish a foundation for area-wide joint action. The Edinburgh LHEES presents an opportunity for a holistic approach at the intersection of multiple policy areas. Edinburgh can capitalise on benefits wider than just net zero and fuel poverty, including economic growth, green employment and skills, just transition, and the development of a clean heat and retrofit supply chain benefitting owners across all tenures.

4.2. Edinburgh LHEES governance

4.2.1. The Edinburgh LHEES is a formal strategy of the City of Edinburgh Council in line with the Local Heat and Energy Efficiency Strategies (Scotland) Order 2022.

4.2.2. The Edinburgh LHEES falls within the remit of the Council's Policy and Sustainability Committee.

4.2.3. The Council has appointed a dedicated Energy Officer who will be responsible for the finalisation of the Edinburgh LHEES and Delivery Plan following consultation and subsequently lead work looking at what can be delivered.

4.3. Edinburgh LHEES structure and layout

4.3.1. The structure and layout of the Edinburgh LHEES is briefly summarised below. The document is aligned to the LHEES Guidance issued by the Scottish Government, but with some adjustments aimed at improving the flow of information from an Edinburgh perspective.

- Chapter 1 is the foreword to the Edinburgh LHEES from the Leader of the City of Edinburgh Council, Councillor Cammy Day.
- Chapter 2 sets out the contents of the Edinburgh LHEES.
- Chapter 3 is the executive summary of the Edinburgh LHEES.
- Chapter 4 is the introduction to the Edinburgh LHEES. This includes a general overview of the Edinburgh LHEES, a summary of the structure and layout of the Edinburgh LHEES, and a summary of what is and is not in the scope of the Edinburgh LHEES, along with a review of key concepts underpinning the Edinburgh LHEES.
- Chapter 5 sets out the methodological approach to the Edinburgh LHEES. This includes a description of the approach of the Council to preparing the Edinburgh LHEES, a summary of the LHEES Considerations, a summary of consultation and engagement undertaken as part of the preparation of the Edinburgh LHEES, and a review of formalities associated with the Edinburgh LHEES.

- Chapter 6 sets out the policy and strategy context for the Edinburgh LHEES, looking at the relevant policy and strategies at a local, Scottish, and UK level.
- Chapter 7 summarises ongoing workstreams of relevance to the Edinburgh LHEES.
- Chapter 8 sets a baseline assessment of Edinburgh's property stock and its performance in terms of the LHEES Considerations.
- Chapter 9 identifies "Strategic Zones": geographical subdivisions of Edinburgh that allow for the visualisation of spatial trends aligned with the LHEES Considerations, helping identify pathways (strategic approaches) for the decarbonisation of the building stock in each Strategic Zone. This chapter also identifies potential Heat Network Zones within Edinburgh.
- Chapter 10 summarises the findings of the Edinburgh LHEES and sets out the next steps.
- Chapter 11 contains the appendices to the Edinburgh LHEES.

4.3.2. This iteration of the Edinburgh LHEES has been prepared as a traditional text-based document. However, the scope for (and benefits of) displaying the Edinburgh LHEES outputs in a more interactive fashion, for example utilising GIS or StoryMaps, is recognised and the Council intends to explore this for updates to, and future iterations of, the Edinburgh LHEES.

4.4. Edinburgh LHEES scope and limitations

Scope

4.4.1. The scope of the Edinburgh LHEES is the decarbonisation of building stock in Edinburgh via a combination of energy efficiency improvements and zero direct emissions carbon solutions, helping deliver the vision that by 2045, buildings in Scotland will no longer contribute to climate change. The Edinburgh LHEES therefore relates to the overall vision of making Scotland net zero carbon by 2045. It is noted however that the Edinburgh LHEES is only one strand of a wider programme of activity required to achieve net zero carbon, and does not encompass other areas such as transport and agriculture. Further, the focus of the Edinburgh LHEES is upon decarbonisation and its scope therefore does not include matters such as climate resilience and ecology.

4.4.2. The Edinburgh LHEES covers the entirety of the City of Edinburgh local authority area, including the city proper, the settlements of South Queensferry, Kirkliston, Newbridge, Ratho Station, and Ratho, and various smaller settlements in rural west Edinburgh.

4.4.3. The focus of the Edinburgh LHEES is primarily on the physical changes required to decarbonise Edinburgh's building stock, e.g. capital investment in energy efficiency measures and energy infrastructure. It does not focus upon activities aimed at reducing energy consumption and ameliorating fuel poverty, for example advice on conserving household energy and financial support with energy bills for low-income households. However, some consideration is given to the wraparound activities required to support physical improvements to the building stock.

4.4.4. For the purposes of the Edinburgh LHEES, "energy efficiency" refers purely to the energy required to heat a property. It does not include energy utilised for other purposes, for example the energy used to power household appliances or the energy used for industrial processes in commercial buildings such as factories.

4.4.5. It is recognised that the move to net zero carbon is heavily driven by technological advancements, e.g. the development and enhancement of solutions for the generation, transmission, and storage of energy from low/zero emissions sources. The Edinburgh LHEES is not a strategy for supporting innovation or technical innovation. However, cognisance has been given to the scope for emerging solutions, for example green hydrogen, to play a role in achieving net zero.

4.4.6. The Edinburgh LHEES includes analysis on rooftop solar PV potential for domestic properties (Figure 25) but does not include plans for wider renewable generation opportunities such as solar farms, renewable potential for non-domestic properties, the deployment of other renewable, or electricity and heat storage options throughout the city.

Limitations

4.4.7. Transforming Edinburgh's building stock is a large, complex, multigenerational challenge which will require extended time and resources. The Council has been delivering projects in this area for over a decade and the publication of the Edinburgh LHEES is a milestone which will set the agenda for the coming two decades to the net zero deadline. The Edinburgh LHEES makes its contribution but with recognised limitations.

4.4.8. The datasets underpinning the Edinburgh LHEES represents complex and rapidly shifting real circumstances. This can mean that sometimes the data available has gone out of date or is incomplete. The following have been the main limitations:

- Fuel poverty and extreme fuel poverty have arisen to become acute and evolving issues at a national scale following the cost-of-living crisis, but the data is not entirely up-to-date with some of these major shifts.
- Only 16% of Scotland's non-domestic buildings have an Energy Performance Certificate (EPC) and there is not a large amount that can be done with this partial dataset. Due to a lack of information, it has been difficult to plan decarbonisation pathways for non-domestic buildings in the way the Council would have preferred.

4.4.9. The Council receives a grant of £75,000 per annum from the Scottish Government from 2022/23 to 2027/28 to deliver the Edinburgh LHEES. Compared to the scale of investment the Edinburgh LHEES is intended to direct over the coming two decades, this amount is insufficient. With severe stress on its budget and limited funding from the government the Council has been limited against the ambition it would like to deliver on. A realistic and practical level of funding will be required if the Council is to match the scale of delivery required to reach net zero.

4.4.10. The landscape around funding and regulation is rapidly evolving, with certain vital pieces of information unavailable at the time of writing. These include:

- The content of the Heat in Buildings Bill.
- The findings of the Green Heat Finance Taskforce
- Detail on the permitting and consenting regime for heat networks in Scotland.
- Information on mandatory heat network connections.
- A timescale for banning the installation of gas boilers in existing properties.
- Finalised Energy Efficiency Standard for Social Housing post 2020 (EESSH2) guidance.
- Confirmation on grant funding post-2026.

- Details on the reform of Energy Performance Certificates.
- Confirmation on funding for local authorities for new duties associated with LHEES and heat networks.

4.5. Review of key concepts

4.5.1. This section of the Edinburgh LHEES briefly reviews select relevant key concepts.

Heat decarbonisation

4.5.2. Heat decarbonisation refers to reducing or completely removing the carbon produced as a negative by-product of heating buildings. Heating buildings is essential for people's health and wellbeing, but is also one of the major contributing factors to carbon emissions. At a Scottish level, as of 2019, 81% of households used mains gas as their primary heating fuel, while 8% used other emissions generating fuels such as oil, liquefied petroleum gas, solid mineral fuels, and biomass. 1% used communal heating systems, while 11% used electrical heating.[6] Figures for Edinburgh are set out in Chapter 8.

4.5.3. In practice, heat decarbonisation is largely about replacing existing carbon intensive heating solutions (such as gas boilers) with lower carbon alternatives. The main options for zero direct emissions heating include direct electric heating; heat networks; heat pumps; and hydrogen.

4.5.4. The Climate Change Committee has prepared scenarios for the decarbonisation of heat in buildings across the UK overall.[7] The share of demand met by each net zero heating system as of 2050 in its "Balanced Net Zero Pathway" is set out in Table 02. This scenario envisages heat networks and heat pumps as fulfilling the vast majority (94%) of heat demand, with direct electric heating and hydrogen boilers accounting for the remainder.

Table 02: UK building heat demand by source (2050 scenario)

Heat source	% heat demand
Direct electric heating	1%
Heat networks	42%
Heat pumps	52%
Hydrogen boilers	5%

Source: Climate Change Committee

4.5.5. Key challenges to heat decarbonisation include the installation and operating costs of the alternative heating solutions (which are often higher than the existing solutions); the limited availability of people with the technical skills required to install and maintain these alternative heating solutions; local and national constraints on the electricity grid; the need for extensive retrofit works to make existing properties suitable for low carbon heating solutions, and knowledge and perceptions of low carbon technology amongst the public.

4.5.6. Wet heating systems operate on the basis of supply/flow and return temperatures. The supply/flow temperature is the temperature of the water sent to the radiator, while the return temperature is the temperature of the water returning to the heating system. Conventional radiators in the UK are designed to operate with supply/flow temperatures of 82°C and return temperatures of 71°C. Zero direct emissions heating systems generally utilise lower temperatures. For example, an air source heat pump utilises an optimal supply/flow

temperature of 45°C and a return temperature of 40°C,[iii] while fourth generation heat networks generally utilise a supply/flow temperature of 55°C and a return temperature of 25°C. The practical implication of this is that replacing a gas boiler with a zero direct emissions heating system will require the property in question to be suitably adapted to enable the heating system to operate effectively. In particular, the property will require to be well-insulated and suitable radiators will be required. Radiators for low temperature heating system typically require to be around 2.5 times larger than a conventional radiator and are generally made out of materials with high thermal conductivity, for example Zintec steel.[iv] This can give rise to challenges when retrofitting properties.

4.5.7. In 2023, research was published on the energy performance of Scottish public buildings and the impact thereof on their ability to use low-temperature heat in the buildings.[8] The research looked at the scope to utilise low temperature heating systems in 121 buildings owned by the City of Edinburgh Council. The research concluded the following:

- Pre-1980 buildings do not require renovation of the building envelope to use low temperature heating, albeit this is preferable. These buildings could operate with supply/flow temperatures of below 70°C for 96% to 99% of the year, and below 55°C for 67% to 71% of the year.
- Post-1980s building (which predominantly utilise mechanical ventilation systems) could have limitations in terms of their ability to utilise low temperature heating, especially in windy conditions.
- New and renovated buildings are recommended to be designed to operate with a cap on supply/flow temperature of 55°C.

Energy efficiency

4.5.8. Energy efficiency considers the amount of energy required to heat a building and the building's ability to retain that heat. This can be affected by many factors including the design of the property and the materials used to build it. Physical measures to increase energy efficiency can include adding wall, roof, and floor insulation; low energy lighting; improved heating controls; and double or triple glazed windows. Energy efficiency is also dictated by the actions of users, for example avoiding heat waste by keeping doors and windows closed. In simple terms, the more energy efficient the building, the lower the quantity (and cost) of energy will be needed to heat it.

4.5.9. The most common way to measure energy efficiency is through an Energy Performance Certificate (EPC), which provides a simple rating of energy efficiency of the building. This rating is derived from two main factors: the amount of energy required per square metre, and the level of carbon dioxide emissions produced by the building (quoted in tonnes per year). Ratings can range from "A" (very efficient) to "G" (very inefficient). EPCs will typically include recommendations to improve the energy efficiency of the building and a potential rating. Ratings are valid for 10 years and, in Scotland, must be completed by organisations on the national EPC Register. The Scottish Government is reviewing EPCs with a view to

[iii] As specified by BS EN 14511.
[iv] Another option is to utilise a fan-assisted radiator which can achieve three times as much heat output as a conventional radiator.

introducing new metrics that better measure energy efficiency.[v] In February 2023, the Climate Change Committee stated that EPCs are "used to define standards and targets for reducing emissions from homes – but are poorly suited to this role" and "do not accurately incentivise the energy efficiency and heating solutions required to deliver net zero homes"; the Committee recommended that domestic EPCs should be reformed to focus on four primary metrics: "Energy" (total energy use intensity, measured in kilowatt hours per square metre per annum); "Fabric" (space heating demand intensity, measured in kilowatt hours per square metre per annum); "Heating" (heating system type, ranked from 1 to 6); and "Cost" (energy cost intensity, measured in pounds per square metre per annum).[9] It is understood that revised Energy Performance of Buildings (Scotland) Regulations are programmed to be put before the Scottish Parliament in 2024.

4.5.10. Achieving good energy efficiency in historic buildings is recognised as being inherently more challenging than with modern properties due to typical design features of historic buildings such as solid stone walls and wooden sash-and-cash windows. Various initiatives have been undertaken to attempt to develop standardised packages of interventions for specific building archetypes. The Niddrie Road project in Glasgow – a retrofit of eight one-bedroom tenement flats in Glasgow by the Southside Housing Association – has been hailed as an exemplar. The project saw interventions delivered including triple glazing; air sealing via insulation of walls, floors, and lofts; and the installation of mechanical ventilation systems, along with the installation of air source heat pumps serving four of the flats. The project has significantly improved energy efficiency and reduced occupants' heating bills. However, the costs of the project average £35,000 to £40,000 per flat (with costs for larger properties likely to be higher), meaning its scope to be rolled out more widely may be limited.[10]

Insulation

4.5.11. Insulation here refers to the use of materials to slow the rate at which heat is lost from a building to the outside. This is one of the most affordable and effective ways of reducing heat demand by improving heat retention. The main elements of a typical building that can be insulated to increase heat retention are the roof/loft; the floor; the walls; and the windows. The most common kind of insulation option is blanket insulation which is easier to install and cost-effective. A variety of materials may be used dependent on availability and the size of the space, including wool fibre, polyethylene, and foam.

4.5.12. Roof insulation is key to containing heat as heat naturally rises out of the building; up to 25% of heat can be lost through a building's roof.

4.5.13. Floor insulation is generally focused on insulating the ground floor of a building; this can be carried out in older buildings that have suspended timber floors, or on top of concrete floors. The Leeds Sustainability Institute has calculated that carpets can reduce air leakage in some homes by up to one-third.[vi] [11]

[v] Energy Performance Certificates were developed to measure the cost efficiency of running a building in terms of its energy performance. As a result, the higher installation and running costs of a heat pump relative to a gas boiler would mean that an EPC would not recommend the replacement of a gas boiler with a heat pump, even though this would reduce the carbon emissions of the building.

[vi] It is estimated that 1.2 million people in the UK have no carpet or other flooring in their bedrooms and living rooms, 760,000 of them in social housing.

4.5.14. Cavity walls can be insulated through injecting insulation into the cavity. This method is primarily applicable for homes newer than 1920s. For older homes that have solid walls, insulation can still be installed to increase energy efficiency. This can be applied to the inside or outside of the wall, however, outside insulation may require more time, costs, and planning. Solid wall insulation is more expensive but does make a considerable increase in the amount of heat retained.

4.5.15. Windows can be made more energy efficiency by the use of double or triple glazing. Where the replacement of windows is not possible – for example in period properties – an alternative solution is to install a secondary internal window.

Fuel poverty

4.5.16. Fuel poverty is defined in Scotland as a household spending more than 10% of its income on fuel costs where the remaining household income is insufficient to maintain an adequate standard of living. Statutory targets for the reduction of fuel poverty are set by the 2019 Fuel Poverty (Targets, Definition and Strategy) (Scotland) Act.

4.5.17. Whilst income poverty and fuel poverty are often correlated, the latter focuses on households in any income band that are spending a disproportionally high amount of money on fuel bills. Often fuel poverty impacts those in energy inefficient rented homes where it is not possible for the tenant to implemented energy efficiency improvements.

4.5.18. The number of Scottish households in fuel poverty is currently projected to rise due to increases in energy prices. The UK Government has implemented temporary measures to combat the effects of the increase in energy pricing including the Energy Bills Support Scheme and the Warm Home Discount scheme for households on pension credit or low incomes.

Direct electric heating

4.5.19. Direct electric heating is the use of electricity to heat spaces and water directly (rather than interpolating other systems such as heat pumps). Direct electric heating solutions are typically relatively low cost and require very little maintenance. There are multiple different heating systems that directly utilise electricity, including:

- Electric central heating – a “wet” system similar to that associated with a gas boiler, but with the hot water being supplied from an electric boiler, which uses an immersion heater or element to heat the water. Electric combi boilers can supply both heat and hot water.
- Electric radiators – convection and radiation-based heaters that use an element to heat a thermodynamic fluid (typically glycol) which conducts the heat to the surface of the radiator.
- Panel heaters – simple convection-based heaters that draw in cold air, run it over a exposed wire element, and emit warm air.
- Infrared heaters – heaters that emit radiant heat, instantly warming people and objects rather than the air, meaning good insulation is not essential.
- Storage heaters – heaters that use an element to heat a ceramic or clay brick which is then gradually released. The heaters warm the bricks during the night (capitalising on the lower cost “Economy 7” electricity tariff) with heat then being slowly released as hot air during the day. Modern storage heaters have controls and thermostats.

4.5.20. Direct electric heating has a coefficient of performance of 1 – i.e. every kilowatt of electricity utilised generates one kilowatt of heat – compared to around 0.9 for a gas boiler. However, as electricity unit prices in the UK have traditionally been around three times higher than gas unit prices, direct electric heating is not generally cost effective.[vii] As a result, alternative solutions may be more economical, for example heat pumps (which typically have a coefficient of performance of 3 to 4, helping offset the higher input cost).[viii] Significant additional adoption of direct electric heating is therefore unlikely unless the cost of electricity in the UK falls. The running costs of direct electric heating can be cross-subsidised using solar panels or other micro-generation technologies, which provide "free" electricity. However, solar panels are most efficacious during the daytime in sunnier months and are generally at their least effective when demand for heat is typically highest, meaning storage of electricity (or heat) is necessary to balance the load. Other micro-generation technologies such as wind turbines or hydro power generally have limited potential in an urban setting.[ix]

4.5.21. Direct electric heating does not generate direct emissions. The UK Government has committed to fully decarbonising the UK's electricity grid by 2035.[12] As a result, from 2035 onwards direct electric heating should not make any indirect contribution to carbon emissions. At a UK level, the required peak capacity of the National Grid is expected to double from 60 gigawatts to 20 gigawatts in 2050, with a quadrupling of green electricity.[13]

Heat networks / communal heating systems

4.5.22. A heat network is a heating system that works on the principle of distributing heat generated at one or more central sources to users rather than generating heat using systems in individual properties. The centrally generated heat is distributed through pipes to customers such as homes, commercial buildings, and public sector buildings (known as "off-takers") who control the heat they receive via an interface unit. The most important customers in terms of scale and consistency of heat demand are known as "anchor loads".

4.5.23. Heat networks are classified by "generation", with the generation referring to a major change in the underlying technology.

- First generation heat networks date from the 1880s, supplying heat using steam at temperatures of up to 200°C produced centrally by burning coal and waste and transmitted using concrete ducts. First generation heat networks were largely superseded in the 1930s, although some remain in use worldwide.
- Second generation heat networks date from the 1930s, supplying heat using pressurised hot water via pipes at temperatures of over 100°C produced centrally by burning coal, waste, and oil.
- Third generation heat networks emerged in the 1970s in response to that decade's energy shocks. They distribute centrally generated heat from sources including gas,

[vii] As of June 2023, the OFGEM price caps were 33.2 pence per kilowatt hour for electricity and 10.3 pence per kilowatt hour for gas (a price ratio of 3.22:1).

[viii] The coefficient of performance is a measure of the efficiency of a heating system, expressed as a ratio of the power output to the power input. For example, an electric heater may convert 1 kilowatt of electricity into 1 kilowatt of heat (a coefficient of performance of 1). A coefficient of performance greater than one means that the system is outputting more energy than is being input.

[ix] While solar panels are less challenging to implement in an urban setting, one obstacle is that, as solar panels can be used to export electricity to the national grid, they put pressure on grid capacity which may mean the potential to deploy solar panels at scale in some areas of Edinburgh is limited.

combined heat and power, biomass, and waste at temperatures of 70°C to 100°C using pre-insulated metal pipes. Most existing heat networks in the UK are third generation.

- Fourth generation heat networks are emerging in response to concerns around climate change. They incorporate higher levels of renewable heat sources, e.g. heat pumps and waste, and supply heat and hot water at lower temperatures (below 70°C), using plastic pipes reducing transmissions losses. Due to the lower temperatures, boosting is required for domestic how water.
- Fifth generation heat networks distribute heat at ambient temperatures (between 10°C and 30°C), thus minimising transmission losses. Rather than a centralised heat source, heat is generated at multiple points across the network. Buildings can both consume and provide heat, turning them into "prosumers". Other design characteristics include the use of networks for both heating and cooling (with bi-direction thermal energy flows); integrated thermal storage to balance demand; and optimised energy flows based on algorithms utilising real-time data. Due to the lower temperatures, boosting is required for domestic how water. Fifth generation heat networks are complex and costly and therefore may be best suited to projects where there is a need to balance heating and cooling demands.

4.5.24. Heat networks are most efficient in dense built-up urban areas due to cost efficiencies, but have also been proposed as a solution for more rural communities without gas connections. Across Scotland, as of 2022 there were an estimated 1,080 heat networks supplying approximately 1.18 terawatt-hours of heat to around 30,000 homes and 3,000 non-domestic properties. There are dozens of existing heat networks in Edinburgh, but these are generally relatively small-scale, focused on a single off-taker (for example the University of Edinburgh), and supplied from carbon emitting heat sources.

4.5.25. Heat networks can contribute to heat decarbonisation by supplying heat from a centralised low/zero direct emissions source, for example the air, geothermal heat, or waste heat (such as heat generated from the incineration of refuse, which would otherwise be vented into the atmosphere and "wasted"). Even when heat networks supply heat from a more carbon intensive source, they can enable the larger system to be decarbonised in the future without having to make changes to each individual property supplied by the network.

4.5.26. An advantage of heat networks in the context of heat decarbonisation is that they do not place the same demand pressures on the electricity grid as heat pumps or direct electric heating. A heat decarbonisation solution for Edinburgh that incorporates a mix of heat networks and electricity-based solutions will therefore give rise to fewer electricity infrastructure requirements than one focused on electricity-based solutions.

4.5.27. The main challenge to deploying heat networks is the upfront capital costs required in terms of constructing the energy centre and associated infrastructure as well as making the connections to individual properties. Most schemes deployed in Scotland so far have been delivered by local authorities to serve their estates or by property developers to serve new building developments. Engineering solutions have been developed to help reduce upfront costs, including pipework being laid above ground and trenchless options.

4.5.28. Heat networks have hitherto been largely unregulated in Scotland and the UK. The Heat Networks (Scotland) Act 2021 introduces a regulatory regime for Scotland. As heat networks

are classed as commercial rather than domestic supplies, they are not covered by the OFGEM energy price cap (or the UK Government's Energy Price Guarantee).[14]

4.5.29. A communal heating system is a smaller-scale heat network wherein heat generated at a central source is distributed to two or more units within a single building. Communal heating systems are most commonly associated with blocks of flats. As of 2023, there were approximately 14,000 blocks of flats in the UK served by communal heating.[15]

Heat pumps

4.5.30. Heat pumps are devices that heat buildings through capturing existing heat in the environment. The pump captures heat from the environment and uses a heat exchange to increase it to supply heat to a building. The pump itself produces no carbon dioxide emissions, albeit electricity is required to power the system. Unlike most heating technologies, heat pumps can also be used for cooling (by reversing the flow of refrigerant). A typical heat pump serving a home will range from 6 kilowatts to 15 kilowatts; the cooler the minimum outdoor temperature, the larger the heat pump that will be required. A typical cost for a heat pump serving a home would be approximately £10,000.[16]

4.5.31. There are two main types of heat pumps: air source heat pumps and ground source heat pumps, which capture heat from the air and from the ground respectively. Air source heat pumps are the most common option currently in use in Scotland. Other types include water source heat pumps and sewer source heat pumps.

4.5.32. As heat pumps capture "free" heat from the environment (e.g. from the air), they can achieve comparatively high coefficients of performance (typically 3 to 4). However, this must be balanced against the relatively high unit cost of electricity in the UK (typically around three times greater than the unit cost of gas), which generally makes the economic case for migrating from gas to heat pumps marginal at best. Heat pumps are therefore a financially attractive alternative to direct electric heating, but are less so with regards to gas. The running costs of heat pumps can be cross-subsidised using solar panels (albeit as noted solar panels are least effective when heat demand is highest, e.g. after sunset and in the winter) or other micro-generation technologies. To help minimise the running costs of heat pumps, the UK Government has proposed to require all heat pumps installed in the UK to be capable of modulating electricity consumption in response to time-of-use tariffs, enabling customers to align usage with costs. The UK Government has also undertaken to "rebalance" electricity and gas costs. Other proposals have included removing "green levies" used to subsidise renewable energy schemes from household electricity bills.[x] [17]

4.5.33. Heat pumps work best in well insulated buildings and where pipes and radiators are appropriately sized; as wet heating systems based on heat pumps have lower flow temperatures than those based on gas boilers, larger radiators are needed to achieve the same results. As a result, the like-for-like replacement of a gas boiler with a heat pump may not deliver optimal results without complementary upgrades to the energy efficiency of the property being carried out. The efficiency of heat pumps generally varies depending upon the time of year, being lower when temperatures are lower (when heat demand is generally higher), meaning user comfort can be poor during cold periods (below 7°C).

[x] As of 2021, "environmental and social levies" used to fund various initiatives around clean energy and fuel poverty accounted for approximately 12% of electricity bills (£119 per year per home), compared to 3.4% of gas bills (£33 per year per home).

4.5.34. Heat pumps cannot provide hot water on demand in the same way as a combi-boiler. Therefore, for a heat pump to supply hot water to a property, a hot water cylinder will be required to store the hot water (potentially supplemented by an immersion heater). This can give rise to complications such as a risk of legionella bacteria. Alternately, hot water demand can be met using another solution such as an instantaneous water heater.

4.5.35. Other challenges associated with heat pumps can include the operating noise (which can reach 60 decibels) and the need for a suitable space in which to install the heat pump.

4.5.36. Currently, approximately 3,000 to 4,000 domestic heat pumps are installed in Scotland annually, with the vast majority being air source heat pumps.[18] The Scottish Government has set a target of increasing annual heat pump installations to 170,000 by 2030.[19] At a UK level, approximately 50,000 to 60,000 heat pumps are installed annually; the UK Government wishes to increase this to 600,000 by 2028. Public knowledge and awareness of heat pumps is poor, with a poll in 2022 suggesting 80% of UK residents do not know what a heat pump is.[20] The UK is one of the slowest adopters of heat pumps in Europe; at current rates of installation, it would take 400 years for all homes in the UK to be fitted with a heat pump.[21]

4.5.37. There are currently an estimated 3,000 to 4,000 heat pump engineers in the UK; the charity Nesta has estimated that 27,000 heat pump engineers will be required to carry out the proposed 600,000 installations annually from 2028 (approximately 22 installations per engineer per annum). While qualified gas engineers can be retrained to work on heat pumps in a matter of weeks, new heat pump engineers will likely require to complete a three-four year college course or apprenticeship. Nesta has proposed offering existing gas engineers a financial inducement to retrain.[22] [23]

4.5.38. The UK Government has created various schemes to support the heat pump industry, including the Heat Pump Investment Accelerator Competition (which is providing capital grants towards heat pump manufacturing); the Heat Pump Ready Programme (which is supporting the development of new heat pump technologies); grants for training to install heat pumps; and a new Low Carbon Heating Technician apprenticeship.

4.5.39. In March 2023, the UK Government consulted on a proposed Clean Heat Market Mechanism (CHMM) to support the development of the heat pump market. The aim of the CHMM is to provide the heating appliance industry with sufficient confidence to make investments in scaling up, in turn expanding heat pump manufacturing in the UK; reducing the installation and operating costs of heat pumps; and growing the number of skilled heat pump installers. The proposed CHMM would require manufacturers of heating appliances to sell a minimum number of low-carbon heat pumps in the UK market each year relative to gas, oil, or LPG-fired boilers, with the ratio beginning at 4% in 2024/25 and rising steadily thereafter. This would operate via a system of tradeable credits, giving manufacturers flexibility as to how to meet their obligations. Manufacturers would be fined £5,000 for every fossil fuel-fired boiler sold over their quota. The UK Government has suggested that the CHMM could support the installation of 60,000 heat pumps in 2024/25, rising to 90,000 in 2025/26; 150,000 in 2026/27, 250,000 in 2027/28; and 400,000 in 2028/29.[24]

4.5.40. While hitherto much of the focus on heat pumps has been around building-level heating solutions, there is also growing interest in large-scale heat pumps that can serve heat networks. The German manufacturer MAN ES has produced a 48-megawatt heat pump, thousands of times more powerful than a model that would be used to heat a home. Most existing heat pump-based heat networks utilise several pumps, for example Stockholm's heat

network has a capacity of 215-megawatt based upon two 40-megawatt heat pumps and five 27-megawatt heat pumps.[25]

4.5.41. While heat pumps are a zero direct emissions heating solution, they can emit hydrofluorocarbons, which have a global warming potential over 1,000 greater than CO_2. Research by Eunomia Research & Consulting and the Centre for Air Conditioning and Refrigeration Research of London Southbank University suggests that the annual leakage rate for domestic heat pumps averages 3.5%, recommending seeking to reduce leakage in the short-term while incentivising increase usage of low global warming potential refrigerants in the longer-term.[26]

Hydrogen

4.5.42. Hydrogen is the most common element in existence, and can potentially be used to generate electricity, fuel cars, and heat buildings. It is a potential alternative to natural gas, currently the primary heat source for Scotland, that does not release CO_2 when burned. It has the potential to be produced domestically, helping insulate consumers from price fluctuations associated with imported fossil fuels such as natural gas. However, increasing hydrogen usage would require significant investment in production and distribution infrastructure; upgrading boilers and other gas-fired appliances; and testing of how infrastructure and appliances perform using hydrogen.[xi] Hydrogen is a highly volatile and flammable element and extensive safety measures as well as specially-adapted infrastructure (e.g. pipes and boilers) are therefore required to prevent leakage and explosions. The cost of producing hydrogen (particularly green hydrogen) is also currently relatively high, albeit expected to fall with time and scale.

4.5.43. Hydrogen can be produced via several different methods which impact the carbon emissions of the resource. There are other types of hydrogen production methods, but there are three types that are the most common in Scotland:

- "Grey hydrogen" (or "black hydrogen") is produced through using steam to decompose methane into hydrogen and carbon dioxide (or by burning coal to isolate hydrogen) and therefore produces carbon dioxide emissions (circa 10 kilograms of CO_2 for every 1 kilogram of grey hydrogen), meaning while it is a zero direct emissions heat source (i.e. combusting the hydrogen does not produce carbon emissions), producing it creates carbon emissions. Grey hydrogen does not use carbon capture to retain the carbon produced during the process and hence is the most polluting process. However, it is currently the most available and cost-effective production method and hence is the most common, representing over 99% of global production.
- "Blue hydrogen" is produced via the same means as grey hydrogen, but the CO_2 byproduct is partially sequestered through carbon capture and storage (CCS) technology, thus reducing the carbon emissions released into the atmosphere by 90% to 95%. However, there is uncertainty about the scope for large-scale CCS. Blue hydrogen also currently accounts for less than 1% of global hydrogen production.
- "Green hydrogen", or renewable hydrogen, separates water into hydrogen and oxygen using electrolysis powered by renewable energy. It therefore produces no

[xi] For example, there are concerns around combustion knock associated with hydrogen.

carbon emissions. This option is the lowest carbon approach, but production is expensive. Green hydrogen currently accounts for less than 0.05% of global hydrogen production.

4.5.44. While hydrogen itself is a zero-carbon energy source, the combustion of hydrogen can emit nitrogen oxide, a greenhouse gas. Should hydrogen leak into the atmosphere, it can interact with greenhouse gases and exacerbate their global warming potential. 9 kilogrammes of water are required to produce 1 kilogram of green hydrogen, with implications for water conservation.[27]

4.5.45. At present, the Gas Safety (Management) Regulations 1996 limit the concentration of hydrogen that can be transmitted via existing public gas networks in the UK to 0.1%. The UK Government has mooted raising this limit, with a landmark decision on the future role of hydrogen in space heating in the UK expected to be taken in 2026.

4.5.46. Testing has been carried out on a private network at Keele University supplying a mix of up to 20% hydrogen to live buildings, while concept "hydrogen homes" with 100% hydrogen-fuelled appliances have been developed at Northern Gas Networks' innovation site in Gateshead. A pilot project supplying 100% green hydrogen to homes, "H100", is currently under development in Levenmouth, Fife with the network scheduled to begin operation in 2024. It has been suggested that a 20% mix could be added to the UK's gas grid from 2028, with a shift to 100% hydrogen by the mid-2040s.[28]

4.5.47. The UK's gas grid companies have carried out investments to make the grid ready for transmission of 20% hydrogen blends. SGN has indicated that, subject to positive regulatory decisions, large-scale migration of buildings to hydrogen could begin in 2030, with a transition period of around 20 years.[29] The Energy Networks Association has stated that moving to a 20% hydrogen blend across the gas grid would save approximately six million tonnes of CO_2 per annum.[30] From the perspective of gas grid operators, hydrogen represents an opportunity to continue to drive value from existing gas transmission infrastructure, which could become obsolescent in a scenario where heat demand was met via other means such as electric heating and heat networks.

4.5.48. Since 1996, all gas appliances installed in the UK have been required to be designed to operate with a hydrogen mix of up to 23%. Using higher levels of hydrogen would require installing upgraded appliances. In December 2022, the Department for Business, Energy and Industrial Strategy (BEIS) began consulting on potentially requiring all boilers to be installed in the UK from 2026 to be "hydrogen-ready".

4.5.49. In May 2023, the UK Government stated that its Energy Bill (formerly known as the Energy Security Bill) would include provisions for a hydrogen levy to fund a mechanism to subsidise hydrogen transport and storage – thus bridging the production cost gap between natural gas and green hydrogen – with the levy to be in place by 2025.[31] The cost of the hydrogen levy was forecast by the thinktank "Onward" to be £118 per year for an average dual fuel household. [32]

4.5.50. In June 2023, Secretary of State for the Department for Energy Security and Net Zero Grant Shapps MP suggested that hydrogen is unlikely to be used to heat homes and that it is better suited to energy storage, heavy industry, and transport, noting reservations around the quantity of pipework requiring to be replaced and the challenge of producing the requisite volume of green hydrogen. Mr Shapps also stated that the Government no longer intended

to introduce a hydrogen levy on household energy bills, suggesting that the costs of subsidising hydrogen would need to be met "further up the chain".[33]

4.5.51. In June 2023, the Carbon Trust published a briefing setting out its view on the role of hydrogen in the UK's energy system. While seeing a significant role for hydrogen in decarbonisation more broadly, the Carbon Trust opined: "The overwhelming majority of evidence indicates that hydrogen boilers would be less efficient and more expensive to run than electrified heat, such as heat pumps. Retrofitting hydrogen heating infrastructure is highly complex and cost-intensive, even in the UK where there is an existing gas network for residential heating. While there may be a limited number of applications for hydrogen-based heating as part of a regional cluster approach (e.g. where the primary hydrogen use is for industry), hydrogen should not be pursued as the primary route to decarbonisation of home heating."[34]

4.5.52. In 2023, the International Energy Agency suggested that hydrogen would have a "negligible" role in heating. A House of Lords stated that hydrogen is "not a serious option for home heating in the short to medium-term and its use is expected to be limited in the long-term". A 2023 study by ETH Zürich suggested that a green hydrogen heating system in the European Union would be approximately "two to three times more expensive" than one relying on heat pumps, as well as having a greater adverse environmental impact.[35]

4.5.53. The Scottish Government's Hydrogen Action Plan suggests that hydrogen "can be used to decarbonise many parts of our economy, including industry, transport, power and heat […] transported through the gas grid it could help decarbonise commercial premises and make a contribution to decarbonising home energy use". However, it also states "we do not consider that hydrogen will play a central role in the overall decarbonisation of domestic heat and therefore cannot afford to delay action to decarbonise homes this decade through other available technologies."[36]

4.5.54. The scope for hydrogen to place a significant role in the decarbonisation of Edinburgh's buildings is therefore unclear at this time, with significant unknowns around cost, regulation, and other matters. The prevailing view appears to be that, while hydrogen may have some applications, it is unlikely to be a "silver bullet" that supersedes other solutions.

Solar water heating

4.5.55. Solar water heating is the use of solar power to raise the temperature of water, which is then stored in a hot water cylinder. Solar collectors filled with a mix of water and glycol (typically installed on the building's roof) convert light into heat and then transfer this heat to the water in the cylinder. Solar water heating typically meets only a modest share (circa 10%) of a home's overall heat demand; the proportion of hot water demand met by solar water heating ranges from 25% to 90% depending on the time of year. It therefore generally requires to be supplemented by other heating systems. Solar water heating requires space to install the solar collectors and the hot water cylinder.

Biomass

4.5.56. Biomass here refers to the combustion of wooden pellets, chips, or logs (or some other plant matter) to generate heat. This is one of the longest-established renewable energy sources, with the approach being sustainable where the vegetation used as a fuel source is replanted at a sufficient rate to ensure a continuous supply and ensure carbon storage in trees is not reduced. Biomass systems work in a broadly similar fashion to conventional gas boilers.

4.5.57. Biomass can be a viable option for some residential and commercial properties, particularly those that are not connected to the gas or electrical grid,[xii] or for older buildings which cannot utilise other energy efficiency improvements. A key consideration when installing a biomass system is securing and storing the fuel source.

4.5.58. While biomass is deemed a low carbon heating solution, it does result in some direct emissions, albeit these can be mitigated via design, operation, and maintenance choices. It is therefore not a zero direct emissions heating solution.

4.5.59. The Scottish Government has stated that biomass (or other forms of bioenergy such as bio-heating oil or bio-propane) may have a role in heating buildings in off-gas grid areas where this displaces fossils fuels (such as liquefied petroleum gas) and where zero direct emissions alternatives are unsuitable. The Scottish Government has established a Bioenergy Working Group which will publish a Bioenergy Action Plan setting out the most appropriate and sustainable approach to the use of bioenergy in Scotland.

Micro combined heat and power

4.5.60. Micro combined heat and power (micro-CHP) is the simultaneous generation ("cogeneration") of heat and electricity on a micro-scale (less than 50 kilowatts). A domestic micro-CHP system is typically of a similar size to a domestic boiler. Traditionally micro-CHP systems have been fuelled by natural gas or liquefied petroleum gas, but some systems run off biogas or biodiesel. A step beyond micro-CHP is micro combined cooling, heat, and power (CCHP), or "trigeneration". This entails the simultaneous generation of heat and electricity with some of the heat produced used to produce coolth using an absorption chiller.

4.5.61. Micro-CHP is considered a low carbon alternative to gas boilers as it is more efficient, as heat produced as a by-product of the generation of electricity is captured. Additionally, generating electricity for use on site avoids transmission losses. The low carbon nature of micro-CHP can be maximised by the use of biofuels rather than fossil fuels. Micro-CHP is, however, not a zero direct emissions heating solution, and the relative environmental benefits of generating electricity on-site will diminish as the UK's electricity grid is increasingly decarbonised.

4.5.62. Micro-CHP may represent a good solution for properties where zero direct emissions solutions are not feasible. However, as they still generate direct emissions, they will not be suitable for widespread use if buildings are to be fully decarbonised. Future advances may deliver zero direct emissions micro-CHP systems, for example running off green hydrogen.

Electricity pricing

4.5.63. As noted above, the high cost of electricity in the UK is a barrier to the electrification of heat via solutions such as direct electric heating and heat pumps. This is a product of the UK's pricing regime which ties the cost of electricity to that of gas. Analysis by the Energy & Climate Intelligence Unit suggests that gas prices accounted for 95% of the increase in UK electricity prices seen in 2022.[37]

4.5.64. Based on analysis of 33 European countries as of July 2023 by the Household Energy Price Index, the UK had the second highest electricity unit prices, behind only Ireland. Of the 29 countries for which both electricity and gas prices were available, the UK had the fourth highest ratio of electricity prices to gas prices, behind only Belgium, Latvia, and Estonia.[38]

[xii] According to the 2019 Scottish House Condition Survey, 17% of dwellings in Scotland are estimated to be outwith the coverage of the gas grid.

Table 03: Electricity and gas end-user unit prices in European countries, c€/kWh (July 2023)

Country	Electricity unit price	Gas unit price	Ratio
Austria	32.3	13.7	2.4
Belgium	33.2	7.5	4.4
Bulgaria	13.2	7.4	1.8
Croatia	14.4	4.6	3.1
Cyprus	35.2	N/A	N/A
Czechia	40.0	12.4	3.2
Denmark	35.6	13.5	2.6
Estonia	25.8	6.4	4.1
Finland	20.3	N/A	N/A
France	27.0	10.0	2.7
Germany	38.6	11.3	3.4
Greece	25.5	7.1	3.6
Hungary	9.9	2.7	3.6
Ireland	47.1	16.2	2.9
Italy	37.7	14.7	2.6
Latvia	38.7	9.3	4.2
Lithuania	25.2	10.8	2.3
Luxembourg	21.4	9.7	2.2
Malta	12.3	N/A	N/A
Montenegro	10.5	N/A	N/A
Netherlands	31.9	16.8	1.9
Norway	12.9	N/A	N/A
Poland	23.3	7.3	3.2
Portugal	22.5	14.7	1.5
Romania	16.2	6.2	2.6
Serbia	9.8	4.2	2.3
Slovakia	19.7	6.1	3.2
Slovenia	19.4	12.1	1.6
Spain	21.2	10.2	2.1
Sweden	23.6	28.9	0.8
Switzerland	28.0	18.8	1.5
Ukraine	4.2	2.0	2.1
United Kingdom	44.0	11.3	3.9
Average	24.9	10.6	2.4

Source: Household Energy Price Index

4.5.65. As noted in section 6.2, the UK Government has set out proposals for a "rebalancing" of gas and electricity prices. This has the potential to incentivise greater adoption of electricity-based heating solutions, and equally to disincentivise the use of gas.

Resources for private building owners

4.5.66. There are a range of existing initiatives that can support private building owners with improving energy efficiency and decarbonising heat. The key initiatives are summarised below.

4.5.67. **Area-Based Schemes** are an initiative delivered by local authorities which delivers energy efficiency improvements (primarily improved insulation) to private homes in areas of high fuel poverty.

4.5.68. The "Home Energy Scotland" service managed by the Energy Saving Trust provides households with advice and support on saving energy. Home Energy Scotland administers the **Home Energy Scotland Grant and Loan** scheme, which offers homeowners grants and interest-free loans for energy efficiency upgrades and renewable technology installations, including grants of up to £7,500 towards heat pumps. Home Energy Scotland also administers the **Private Rented Sector Landlord Loan**, which offers loans to registered private landlords for energy efficiency measures and renewable energy installations; loans to landlords with portfolios of five of fewer properties are not charged interest, while loans to landlords with six of more properties are charged interest at a rate of 3.5%.

4.5.69. The **Warmer Homes Scotland** scheme administered by Warmworks provides grants to homeowners and private tenants to improve the energy efficiency of homes via measures such as the installation of insulation and central heating systems. The typical value of interventions is around £5,000. Support is restricted to people living in a home with poor energy efficiency who are either aged 75 or older with no working heating system or aged 16 or older and in receipt of certain benefits.

4.5.70. The **ECO4 scheme** and **Great British Insulation Scheme**[xiii] are administered by large UK energy suppliers. The schemes provider homeowners and tenants with "fabric first" upgrades, with a focus on lower cost interventions such as improved insulation. ECO4 is targeted at homeowners and tenants in receipt of certain benefits living in homes with an Energy Performance Certificate rating of 'D' or lower. The Great British Insulation Scheme is targeted at a wider base with 80% of funding ring-fenced for households in homes in Council Tax bands A to E with an Energy Performance Certificate rating of 'D' or lower, while 20% of funding is ring-fenced for households on means-tested benefits or in fuel poverty.

4.5.71. The **Energy Redress Scheme** administered by the Energy Saving Trust provides charities, community interest companies, co-operative societies, and community benefit societies with grants to assist households at risk from cold homes and high energy bills. This includes the Carbon Emissions Reduction Fund, which can be utilised for projects that will reduce carbon emissions from energy use.

4.5.72. The "Business Energy Scotland" service managed by the Energy Saving Trust provides small and medium-sized enterprises with advice and support on saving energy. Business Energy Scotland operates the **SME Loan and Cashback Scheme** which offers loans of up to £100,000 (and cashback grants of up to £30,000) to finance investments in energy efficiency

[xiii] Formerly known as the ECO+ scheme.

improvements such as insulation, LED lighting, double/secondary glazing, and the installation of renewable technologies such as solar panels and wind turbines.

4.5.73. The "Local Energy Scotland" consortium provides support and advice for community energy projects. It currently operates the **Let's Do Net Zero Community Buildings Fund** (which provides grants worth up to 80% of eligible costs – capped at £80,000 – for community organisations to invest in renewable technologies and energy efficiency measures), the **Let's Do Net Zero Off Electricity Grid Communities Fund** (which provides development and capital funding for off-grid communities to develop resilient, net zero-ready local independent electricity grids), and the **Community Heat Development Programme** (which provides support to groups of householders and community organisations to help them develop proposals for local low and zero carbon heat projects).

4.5.74. The Scottish Government's **Heat Network Fund** provides grants for large-scale heat network and communal heating system projects in Scotland that deliver emissions reductions and demonstrate a positive social and economic benefit. The Fund will provide enabling support of up to 10% of CAPEX (capped at £100,000), commercialisation support of up to 10% of CAPEX (capped at £1 million), and capital grants of up to 50% of CAPEX. Grants must be drawn down by March 2026.

4.5.75. The **Smart Export Guarantee** is a UK Government scheme that requires larger UK electricity suppliers to pay small-scale generators of low/zero carbon electricity for excess electricity exported to the National Grid. Tariffs must be above zero, with different suppliers offering different tariffs. The scheme applies to solar photovoltaic, wind, hydro, and anaerobic digestion installations of up to 5 megawatts and micro-combined heat and power installations of up to 50 kilowatts. The Smart Export Guarantee can help defray the costs of installing renewable energy technologies. However, the typical tariffs from exporting electricity under the Smart Export Guarantee are relatively modest, with the best rate offered by energy suppliers in January 2023 being 15 pence per kilowatt hour (compared to a UK price cap of 33.2 pence per kilowatt hour).

4.5.76. Various UK mortgage lenders have introduced schemes wherein customers can access financial inducements to install a heat pump, for example interest-free loans and cashback.

4.5.77. In addition to the above, there are a wide variety of public and third sector resources offering advice on matters such as energy conservation and reducing energy bills. These include the Council's Advice Shop, Citizens Advice, and Changeworks, which is contracted by the Council to provide advice to households.

4.5.78. The majority of funding schemes relating to energy efficiency and renewable energy installations will, as it currently stands, expire in 2025 or 2026 upon the expiration of the current terms of the UK Parliament and Scottish Parliament. As a result, there is little certainty as to the longer-term prospects for funding of projects of this nature.

Resources for public sector building owners

4.5.79. There are a range of existing initiatives that can support public sector building owners with improving energy efficiency and decarbonising heat. The key initiatives are summarised below.

4.5.80. The Scottish Government's **Social Housing Net Zero Heat Fund** offers local authorities (along with registered social landlords and energy services companies) grant funding equivalent to 45%-50% of eligible costs for social housing retrofit projects delivering zero direct emissions

heating systems (such as heat pumps and heat networks) and energy efficiency improvements.

4.5.81. The Scottish Government's **Scotland's Public Sector Heat Decarbonisation Fund** provides grants to Scottish local authorities, universities, and arm's-length external organisations to decarbonise their estates. The Fund will meet up to 80% of eligible costs.

4.5.82. The Scottish Government's **Scottish Central Government Energy Efficiency Grant Fund** offers Scottish central government organisations with no access to borrowing powers (including health boards and further education colleges) capital grants of up to £2 million per annum towards heat decarbonisation and energy efficiency retrofit projects.

4.5.83. The **Scottish Public Sector Energy Efficiency Loan Scheme** administered by Salix Finance offers local authorities and certain other Scottish public bodies interest free loans for "spend to save" energy efficiency retrofit projects to help achieve net zero carbon.

4.5.84. As noted, the Scottish Government's **Heat Network Fund** provides grants for large-scale heat network and communal heating system projects in Scotland. Additionally, the **District Heating Loan Fund** administered by the Energy Saving Trust offers local authorities (along with registered social landlords, small and medium sized enterprises, and energy services companies) unsecured loans of £1 million plus for heat network projects, with a typical interest rate of 3.5% for low-risk projects.

4.5.85. The Scottish Government's **Non-Domestic Energy Efficiency Framework** has been established to help Scottish public bodies carry out energy efficiency retrofit projects with a value of £1 million plus to non-domestic buildings, with payment for works linked to the realisation of outcomes such as energy bill savings or carbon emission savings. Organisations utilising the Framework can access up to £50,000 of grant-funded project management, technical advisory, and procurement advisory services.

5. Methodology

5.1. Edinburgh LHEES approach

5.1.1. The Council has prepared the Edinburgh LHEES and the Delivery Plan in line with the guidance issued by the Scottish Government and the methodology issued by Zero Waste Scotland, with departures as required due to data availability or other considerations as set out below.

5.1.2. In line with the guidance and methodology, the preparation of the Edinburgh LHEES and Delivery Plan has followed eight stages. The activity carried out in each stage is summarised below:

- Stage 1: Policy and strategy review – this stage entails identifying the national and local policies, targets, and strategies relating to the Edinburgh LHEES, as well as identifying resources and stakeholders germane to the delivery of the Edinburgh LHEES.
- Stage 2: Data and tools library – this stage entails identifying and maintaining a record of the data and tools required for the analysis underpinning the Edinburgh LHEES.
- Stage 3: Strategic zoning and pathways – this stage entails assessing the present performance of Edinburgh's building stock in terms of energy efficiency and heat decarbonisation and setting out "Strategic Zones"[xiv] and "pathways"[xv] for each of the six LHEES Considerations.
- Stage 4: Generation of initial Delivery Areas – this stage entails setting out proposed "Delivery Areas" for each of the LHEES Considerations.[xvi]
- Stage 5: Building-level pathway assessment – this stage entails identifying detailed interventions to decarbonise buildings within Delivery Areas and quantifying the costs and benefits of these interventions.
- Stage 6: Finalisation of delivery areas – this stage entails finalising the Delivery Areas identified at stage 4 based upon considerations such as existing programmes of work and priority areas for intervention.
- Stage 7: LHEES – this stage entails assembling the outputs from the earlier stages into the Edinburgh LHEES itself – i.e. this document, its appendices, and supporting materials.
- Stage 8: Delivery Plan – this stage entails preparing a Delivery Plan setting out how the Edinburgh LHEES is to be implemented, with a focus on early, low-regrets actions over the first five years of the Edinburgh LHEES (2024 to 2028).

[xiv] A "Strategic Zone" is a geographical area that "present[s] a visualisation of the potential pathways to decarbonise the building stock at a local authority level" created "to understand the baseline performance, the scale of potential and initial areas of focus".

[xv] A "pathway" here refers to the approach taken to decarbonise a property, i.e. the potential energy efficiency retrofit technologies and low carbon heating system.

[xvi] A "Delivery Area" is a geographical area that is more granular than a Strategic Zone that "set[s] out clusters of buildings within a Strategic Zone or across the whole local authority that identify potential solution(s) at a delivery level".

5.1.3. In 2021, the Council appointed the consultancy Atkins to support with stages one and two (policy and strategy review and data and tools library) of the Edinburgh LHEES. The analysis carried out by Atkins underpins the Edinburgh LHEES, in particular Chapter 6. The following recommendations were made by Atkins:

- "Where various policies/funding mechanisms overlap with the different LHEES objectives, coordination of resources will be required to effectively align with and achieve these objectives."
- "Update action plans for Renewable Energy and Heat Networks to set out specific investment targets, and timelines."
- "Develop a dedicated hydrogen strategy with timelines that align with industry (e.g. SGN's plans for use of hydrogen and what impact this may have of carbon emissions). This can play more of an active role in [the Council's] net zero objectives post-2030 and at least provide estimates for how the gas grid may be decarbonised between now and 2030."

5.1.4. In 2023, the Council appointed Turner and Townsend, Ramboll, and Changeworks to support with stages three to eight of the Edinburgh LHEES. The analysis carried out by these suppliers underpins Chapter 8 and Chapter 9 of the Edinburgh LHEES.

5.1.5. The Council has appointed an Energy Officer to coordinate the publishing, implementation, and delivery of the Edinburgh LHEES and Delivery Plan. In particular it is anticipated that the Energy Officer will place a central role in the roll-out of heat networks across Edinburgh.

5.1.6. The Council's approach to producing the Edinburgh LHEES has been shaped by the short timescale in which the strategy was required to be produced to comply with the Local Heat and Energy Efficiency Strategies (Scotland) Order 2022. In particular the statutory timescale has meant that consultation on the Edinburgh LHEES has required to be abbreviated.

5.1.7. In line with the LHEES Methodology, the Council has utilised the Home Analytics dataset maintained by the Energy Saving Trust as the principal source for data on Edinburgh's housing stock. Consideration was given as to whether this dataset could be supplemented using data held by the Council on its own housing stock. Following discussions with relevant Council officers, it was determined that the datasets held by the Council are not suitable for analysis of this nature. However, data held by Changeworks as part of its role in delivering Area-Based Schemes in Edinburgh has been utilised to augment the Home Analytics dataset.

5.1.8. Manual review of the outputs of the Domestic Baseline Tool and Non-Domestic Baseline Tool has identified high levels of inaccuracy in some fields. For example, the quality of data on property age from the Non-Domestic Baseline Tool is very poor. Where there are significant concerns around data quality this information has been omitted from the Edinburgh LHEES.

5.1.9. The Council has made use of the following data portals:

- The SP Energy Networks LHEES Portal, which enable the impact of installing low carbon technologies on the electricity network to be simulated, identifying network constraints and required reinforcement works (and consequent costs). This has been used to inform the selection of Delivery Areas for heat pumps.
- The Scottish Water Waste Water Heat Extraction Opportunities, which sets out flow data for sewage pipes of over 300 millimetres in diameter and with potential sewage flow rates of 40 litres per second or more (estimated using hydraulic flow modelling)

to enable analysis of where wastewater infrastructure may be suitable as a source of low carbon heat. This tool has been utilised as part of analysis around potential heat sources for heat networks. Figure 05 sets out a high-level overview of wastewater heat extraction heat opportunities in Edinburgh.

5.1.10. The Council has collaborated with the following existing research projects to augment the Edinburgh LHEES:

- The Edinburgh Climate Change Institute has carried out research on behalf of the Infrastructure Investment Programme Board that aims to create a consolidated GIS-based plan of all infrastructure in Edinburgh germane to achieving net zero, drawing together data from a vast range of sources. This plan has been overlaid with other relevant datasets, including linear heat density clusters.
- Energy Systems Catapult has produced a "Local Energy Asset Representation" (LEAR) for southeast Scotland (defined as Edinburgh, Fife, and the Lothians). The LEAR is a visual representation of local energy assets (e.g. energy generation and storage assets) along with other data sets such as fuel poverty.

Heat network Consideration – methodology

5.1.11. Analysis to inform the identification of prospective Heat Network Zones was carried out by Ramboll. The analysis was based on metrics such as linear heat density, anchor load threshold criteria, and gridded heat density, supplemented by local knowledge.

5.1.12. The first step of the analysis was to identify and collect all the datasets required for the analysis (following the LHEES Methodology – Stage 4 – Heat Networks Approach V04). The main dataset that was used for the analysis was the 2020 Scotland Heat Map dataset. This dataset was cleaned and prepared for input into GIS. Additional datasets were also used to identify opportunities and constraints; these datasets are set out in Table 50.

5.1.13. The second step of the analysis was to identify potential zones based on linear heat density (LHD). LHD is used as an indicator of the likeliness of financial viability of a heat network. However, it is not the only criterion. LHD is calculated by dividing the total annual heat demand by the total length of the network. Where there is no heat network in place, LHD benchmarks are used to identify a buffer zone around areas of heat demand. In Edinburgh, LHDs of 4,000 kilowatt hours per metre per year and 8,000 kilowatt hours per metre per year were used to create two sets of buffer zones. The size of buffer zones were later limited to 250 metres to screen buildings with particularly high heat demand. Figure 07 summarises the methodology that was followed to identify the potential zones in the City of Edinburgh, while Figure 08 and Figure 09 depict the area covered by the buffer zones for the two scenarios.

5.1.14. The third step of the analysis was to prioritise the potential zones identified in the second step by applying criteria focused on anchor loads to indicate likely viability for heat networks. An anchor load is a building with a high heat demand that, if connected to a heat network, can enable its financial viability. Due to the high number of buildings with high heat demands in Edinburgh, the default value of 500 megawatt hours per annum (suggested by the methodology) was used to map anchor loads. Following the mapping of all the anchor loads, all the potential zones with fewer than two anchor loads were removed based on the Council's long-term vision for the development of large-scale heat networks in the city, with the identification of strategic Heat Network Zones that were not driven purely by the

presence of anchor loads. Figure 10 summarises the methodology used to create two sets of prioritised potential zones: one representing long-term potential and the other representing the opportunities likely to be more commercially attractive in the short-/medium-term.

5.1.15. The fourth step of the analysis was to review the sets identified in the third step at a stakeholder engagement workshop. Based upon feedback from the workshop, Ramboll selected one set of prioritised potential zones comprising urban and suburban areas (criteria of LHD of 4,000 kilowatt hours per metre per year, anchor loads of 500 megawatt hours per year, and two or more anchor loads) (Figure 11) and dense urban areas (criteria of 8,000 kilowatt hours per metre per year, anchor loads of 500 megawatt hours per year, and two or more anchor loads) (Figure 12). The categorisation of an area as dense urban, urban, or suburban was based on the area's heat density and number of anchor loads. Figure 13 depicts the single set that was taken forward for further analysis.

5.1.16. The fifth step of the analysis was to overlay the selected prioritised zones with development sites identified in City Plan 2030 and existing plans for heat networks (as depicted in Figure 14). New developments are considered high potential areas for the development of heat networks, and accordingly they were included in the initial Heat Network Zones if there was a prioritised zone in near proximity. Similarly, areas with planned heat networks can also serve as starting networks for the development of larger district networks and therefore they were included in the initial Heat Network Zones if there was a prioritised zone in near proximity.

5.1.17. The sixth step was to use additional data to refine the initial Heat Network Zone boundaries. These datasets (presented in Table 50) include heat density (used to refine zone boundaries in order to include areas with high heat density in near proximity with a selected prioritised zone missed by the methodology); available heat sources (used to refine the zone boundaries to include available heat sources in near proximity to a selected prioritised zone) and practical constraints such as rivers, major roads, and rail lines (used to split large zones when a significant constraint(s) was present). Overall, this information was used either to combine zones, expand the boundaries of a zone to account for opportunities in near proximity, or split zones where the development of a single heat network was deemed technically difficult, e.g. where pipes would need to cross a railway line. Figure 15 presents the outcome of this analysis.

5.1.18. The seventh and final step was to divide initial Heat Network Zones with the aim of creating zones with common characteristics to facilitate the discussion around the development of heat networks in these areas. These form the prospective Heat Network Zones. The division was based on knowledge of the local area and building typologies. An overview map of the prospective Heat Network Zones is presented in Figure 24, while further information on the prospective Heat Network Zones is set out in section 9.4.

Other LHEES Considerations – stage 3 methodology

5.1.19. The Council's stage 3 followed the standardised methodology provided by Zero Waste Scotland on behalf of the Scottish Government. From the eight-stage process set out in the LHEES Methodology, the first six stages encompass data analysis and evidence gathering in order to complete the latter stages of producing a Strategy document and a Delivery Plan for the implementation of the Edinburgh LHEES. The purpose of Stage 3 of the LHEES Methodology is to support local authorities to understand the current energy efficiency and

heat decarbonisation performance of the building stock at a local authority wide level. It also supports further analysis to set out Strategic Zones and pathways for each LHEES Consideration, as far as reasonably possible. The Strategic Zones identify potential solutions for inclusion in the LHEES (Stage 7) when accompanied by the outputs of the Heat Network Zone analysis (from Stage 4).

5.1.20. The main outputs from Stage 3 were the "Domestic Baseline Tool" and "Non-Domestic Baseline Tool", which use Home Analytics as the core source data to enable analysis of each sector. These tools set out the baseline performance of Edinburgh's buildings using archetypes, ages of buildings, tenures, heating system types, floor area. The data can be aggregated and analysed to set out Strategic Zones. These tools were the main outputs which were then used to input data to generate various heat maps. The outcomes of the baseline analysis are set out in Chapter 8.

5.1.21. The heat maps visualise opportunities focusing on the LHEES Considerations including heat pump readiness and energy efficiency. The maps therefore inform the Strategic Zones for Edinburgh and, thus, pathways to decarbonisation.

Other LHEES Considerations – stage 4 methodology

5.1.22. The objective of stage 4 is to generate initial Delivery Areas at a higher granularity than stage 3 across Edinburgh. This analysis serves as the starting point for more detailed engagement, building level assessment of interventions and cross-checking against the Policy and Strategy Review to enable finalisation of the Delivery Areas.

5.1.23. The standard procedure suggested by the LHEES Methodology was used to develop delivery areas. This consists of GIS techniques to generate potential areas.

5.1.24. The databases used to generate the maps are Home Analytics, Non-Domestic Analytics, and the Address Gazetteer data, depending on the type of property (domestic, non-domestic, mixed use). This consisted of using the postcode-level domestic database (Home Analytics) property counts to generate heat maps. The maps are generated by using the property counts to create a continuous 100 metre by 100 metre grid defining areas of high density of different properties.

5.1.25. Zones of high concentration were defined by using a 2x standard deviation method. This means than when a value falls outside 2x the standard deviation of a cluster, the boundary is defined at the limit of that grid cell. These delivery areas also show property level point data categorized by the above criteria. For category 1-3 properties it also provides sub-categories based on heat pump, biomass, direct electric heating, and mixed biomass-direct electric heating.

5.1.26. The outcome of this assessment is a list of delivery areas mapped and with a summary table listing the properties within. These delivery areas are classified based on the following criteria:

- Off-gas grid (shows the initial delivery areas with the highest number of properties in off-gas category 0 / off-gas category 1 / off-gas category 2 / off-Gas category 3).
- On-gas grid (Shows the initial delivery areas with the highest number of properties in on-gas category 0 / on-gas category 1 / on-gas category 2 / on-gas category 3).
- Mixed tenure, mixed-use and historic buildings (shows the areas with the highest concentration of domestic mixed-use / domestic mixed tenure / non-domestic mixed

use / mixed use (domestic and non-domestic) / listed properties (domestic and non-domestic. These delivery areas also show the concentration of properties within a conservation area).

- Poor energy efficiency and energy efficiency as a driver for fuel poverty (the generated Delivery Areas with the highest concentration of properties scored highest to be suitable for interventions including heat pumps, double glazing, loft insulation, and wall insulation).

5.1.27. This data is used as a basis for stage 5 and to inform the Delivery Plan.

Other LHEES Considerations – stage 5 methodology

5.1.28. The goal of stage 5 is to establish in more detail the type of interventions required to decarbonise the buildings identified in stage 4 from a heating and energy efficiency perspective. Stage 5 helps to gain an improved understanding of the costs and the energy and carbon savings associated with interventions.

5.1.29. The Council followed the standard procedure suggested by the LHEES Methodology. This involved the use of the Portfolio Energy Analysis Tool (PEAT) alongside processed Home Analytics information; together, they provide a wide range of information around energy efficiency and heat decarbonisation measures applicable at the individual building (address) level, which can be aggregated into information at an area-wide or delivery area level (for example, total financial cost, total CO_2 reduction resulting from measures, running cost savings, etc). Outputs for Stage 5 are created by matching addresses identified from Delivery Areas, integrating these with the PEAT, and then summarising the results with a delivery code. This allows for re-prioritisation of delivery areas depending on specific priorities, e.g. most properties within a Delivery Area, Delivery Areas with the highest total CO_2 reduction, etc.

5.1.30. Outputs from the above are presented through a Power BI dashboard, integrating Stage 4 GIS map results with Stage 5 inputs. The dashboard is interactive, allowing the user to select and view different priorities.

5.1.31. The outputs from Stage 5 represent an examination of core data indicators across the Strategic Zones structured around building characteristics, such as energy efficiency or heating type. They have been used to prepare the Delivery Area maps set out in the Delivery Plan.

5.2. LHEES Considerations

5.2.1. The guidance issued by the Scottish Government stipulates that the Edinburgh LHEES should be framed around the "LHEES Considerations".[xvii] These form the basis for understanding, interpreting, and developing the pathways to decarbonisation. They cover the overarching priorities at the national level which should apply to each local authority, though in different ways and to different degrees. One of the main ways to view the Edinburgh LHEES is as a tool to fulfil each of these Considerations. The LHEES Considerations are set out in Table 04.

[xvii] Referred to as "LHEES Priorities" in earlier versions of the LHEES Methodology.

Table 04: LHEES Considerations

Theme	Consideration	Description
Heat decarbonisation	Off-gas grid buildings	Transitioning from heating oil and LPG in off-gas areas
Heat decarbonisation	On-gas grid buildings	On-gas grid heat decarbonisation
Heat decarbonisation	Heat networks	Decarbonisation with heat networks
Energy efficiency and other outcomes	Poor building energy efficiency	Poor building energy efficiency
Energy efficiency and other outcomes	Poor building energy efficiency as a driver for fuel poverty	Poor building energy efficiency as a driver for fuel poverty
Energy efficiency and other outcomes	Mixed-tenure, mixed-use and historic buildings	Mixed-tenure, mixed-use buildings, listed buildings, and buildings in conservation areas

5.2.2. The scope of the Edinburgh LHEES with regards to each consideration is as follows:

- Off-gas grid buildings: identifying "low regrets" pathways and opportunities for converting properties not connected to the gas grid that currently use high emissions alternatives to gas (for example, oil, liquefied petroleum gas, and solid fuels) for heating to zero direct emissions alternatives.[xviii] This entails categorising properties based upon their suitability for heat pump retrofit, ranging from properties that already have a low or zero direct emissions heating system to properties that have tertiary potential due to needing significant fabric upgrade to be heat pump ready or otherwise being less suited to heat pump technology.
- On-gas grid heat decarbonisation: identifying pathways and opportunities for converting properties currently heated using natural has to zero direct emissions alternatives. Similarly to the prior Consideration, this entails categorising properties based upon their suitability for heat pump retrofit.
- Heat networks: identifying zones within Edinburgh where heat networks are judged to present a potential option for decarbonisation based on factors such as heat demand density, the presence of anchor loads, and specific opportunities or constraints. This analysis will form the basis of the formal designation of Heat Network Zones in Edinburgh in line with the Heat Networks (Scotland) Act 2021.
- Poor building energy efficiency: identifying areas of Edinburgh with poor building energy efficiency and identifying pathways and opportunities for addressing this.
- Poor building energy efficiency as a driver of fuel poverty: identifying areas of Edinburgh where poor building energy efficiency is a driver of fuel poverty to ensure that area-based energy efficiency and heat decarbonisation projects are effective in reducing fuel poverty, and to identify areas of extreme fuel poverty where further support may be required.

[xviii] For the avoidance of doubt, homes currently heated via electrical means with no direct emissions are not in the scope of this Consideration.

- Mixed-tenure, mixed-use and historic buildings: identifying areas of Edinburgh where there are buildings of mixed-tenure, buildings of mixed-use, historic buildings, and conservation areas to identify the appropriate interventions in each case.

5.2.3. To focus limited resources, the Council has opted to prioritise on aspects of these Considerations for the Edinburgh LHEES, as set out in Table 05:

Table 05: Prioritisation of LHEES Considerations

Consideration	Prioritisation
Off-gas grid buildings / on-gas grid buildings	Category 1 properties (properties suitable for a zero-emission heating system, e.g. a heat pump). This will help build momentum with less complicated retrofits.
Heat networks	Heat networks present a major opportunity for Edinburgh to decarbonise at scale and provide homes and businesses with access to affordable energy. Edinburgh is well placed to reap the benefits of a city-wide heat network (or "network of networks").
Poor energy efficiency / poor energy efficiency as a driver of fuel poverty	Edinburgh has a significant number of buildings with poor energy efficiency. However, these have to be targeted to arrive at a more manageable volume for the short-mid-term. These should be homes where poor energy efficiency is a driver for fuel poverty since these homes are in most urgent need of support.
Mixed-tenure, mixed-use and historic buildings	There is a large volume of these building types in Edinburgh. The Council has an existing programme of supporting retrofit of mixed-tenure and mixed-use buildings focused on areas with high fuel poverty. This is currently limited in scale due to the complexities of dealing with these properties. This work will be used as the basis for future expansion as resources permit.

5.3. Areas of strategic importance

5.3.1. The Council has identified multiple regions of strategic importance, all of which have been incorporated into various aspects of the Edinburgh LHEES:

- City Plan 2030 development areas
- Areas with ongoing or planned infrastructure development
- Areas of economic importance
- Business and industrial areas
- Areas of future planned retrofit scheme delivery
- Areas with planned retrofits by the Council on its own stock

5.3.2. Each of these areas are relevant in their own way to one or multiple aspects of the Edinburgh LHEES, including delivery area selection and development, and prospective Heat Network Zones. They have fed into the analysis and are key influencers in the development of delivery areas. Moving forward, these areas and the Edinburgh LHEES will continue to feed into each other to maximise synergies between Council policies and projects as well as encourage efficient use of public resources.

5.4. Consultation and engagement

5.4.1. As an area-wide plan which concerns everyone in Edinburgh, it is imperative that the Edinburgh LHEES has cross-stakeholder buy-in. While the Edinburgh LHEES is a data-driven and evidence-based strategy, it is also subject to interpretation and prioritisation which feed into the decisions taken. The Council has taken steps, including a public consultation, to ensure people can provide their input and feedback on proposals. This section describes the stakeholder consultation and engagement work undertaken to date.

5.4.2. The approach to engagement and consultation has been developed based on the LHEES Guidance, which emphasises continuous stakeholder engagement, albeit while reflecting the significant practical constraints of the statutory timescale for preparation of the Edinburgh LHEES which have obliged the duration and extent of consultation to be curtailed.

5.4.3. In November 2022, the Council formed an internal working group for the Edinburgh LHEES and for heat networks. The working group brings together staff from the Council's Edinburgh Waterfront; Housing and Regeneration; Neighbourhood Environmental; Planning; Policy and Insight; Shared Repairs; Strategic Asset Planning; and Sustainable Construction Delivery service areas. The working group has been used to raise awareness of the Edinburgh LHEES within the Council, share information on projects between key staff, and as a sounding board for emerging proposals.

5.4.4. From January 2023 to November 2023, the Council attended a series of "Clean Heat Forum" events organised by Transition Edinburgh, a community-led network that "connects and supports community groups, and initiates practical projects that strive for a greener, fairer, healthier and more resilient Edinburgh". The event was used to raise awareness of the Edinburgh LHEES and share information on the emerging proposals around heat networks.

5.4.5. In April 2023, the Council delivery team met with Scottish Government officers to discuss the emerging Edinburgh LHEES. During the meeting, the Council identified certain challenges associated with the development and delivery of the Edinburgh LHEES, including timescales; the lack of certainty as to the availability of funding following 2026/27; the rapidly evolving policy and regulatory context; the potential requirement for a Strategic Environmental Assessment; and uncertainty around the regulatory provisions for heat networks.

5.4.6. In May 2023, the Council hosted an event to provide tenement owners with information on maintenance, management, shared repairs, retrofit, and energy efficiency within tenements in Edinburgh. Speakers at the event included Home Energy Scotland and the charity Under One Roof (which provides advice on tenement maintenance and management). The event was utilised to raise awareness of the Edinburgh LHEES and share information on the support available to tenement owners.

5.4.7. In June 2023, the Council presented on the Edinburgh LHEES to the Edinburgh Association of Community Councils.

5.4.8. As part of stage 1 (policy and strategy review), key stakeholders germane for the Edinburgh LHEES were mapped. The ultimate outputs of this exercise are set out in section 11.4. These stakeholders were targeted as part of the wider public consultation exercise.

5.4.9. For stage 2 (data and tools library), the Council identified and engaged with stakeholders responsible for datasets required support the preparation of the Edinburgh LHEES. This primarily included Scottish Government (Scotland Heat Map); Energy Saving Trust (Home

Analytics, Non-Domestic Analytics and PEAT data); Scottish Power Energy Networks (Grid capacity data), the Edinburgh Climate Change Institute and Net Zero Edinburgh (consolidated GIS data of Edinburgh's infrastructure and environment required to achieving net zero), and others. This stage also entailed executing information sharing agreements with the Council's consultant team and updating licence agreements with the Energy Saving Trust accordingly.

5.4.10. For stage 3 and 4 the Council invited numerous stakeholders to review the maps and other outputs as part of a series of virtual sounding boards, workshops, one-on-one meetings, and public events. Stakeholders helped to sense check emerging outputs and highlight any data that had been omitted, and to identify any indicators or areas that are considered to be strategically important for Edinburgh. This included workshops on emergent Heat Network Zones where stakeholders advised on the scale of the ambition and fed back on boundaries of these zones.

5.5. Strategic Environmental Assessment

5.5.1. The Environmental Assessment (Scotland) Act 2005 sets a statutory requirement for Scottish public bodies to carry out a Strategic Environmental Assessment (SEA) of the expected environmental impacts of strategies expected to have a significant environmental impact.

5.5.2. The Council prepared a Screening Report for the Edinburgh LHEES and Edinburgh LHEEDP, which was submitted to the SEA Gateway on 10th May 2023. The Council's view was that an SEA was not required in this case as the Edinburgh LHEES and Edinburgh LHEEDP were not expected to have a significant environmental impact. This view was based on the following:

- The Edinburgh LHEES will not introduce any new powers, initiate any legislation, or allocate any significant resources. It is primarily an information document that identifies opportunities.
- The Edinburgh LHEES does not itself set headline targets, as these are set nationally. The Edinburgh LHEES will rather identify the optimal pathways for achieving said national targets – for example, it will identify which buildings in Edinburgh are better suited to connecting to heat networks and which are better suited to being served by heat pumps, based on technical data.
- The Council's 2030 Climate Strategy has been subject to a full SEA.[39] The Climate Strategy sets out strands of work required to make Edinburgh a net zero city, one of which is "net zero energy generation and energy efficient buildings". This strand of work includes "improving the energy efficiency of Edinburgh's existing homes", "developing heat networks", and "develop[ing] a mechanism for unlocking and enabling domestic and small business energy retrofit at pace and scale". These items cover the key areas of focus of the Edinburgh LHEES. This strand is therefore considered to cover the same ground as the Edinburgh LHEES, meaning an SEA of the Edinburgh LHEES would largely duplicate the recent SEA for the 2030 Climate Strategy.
- The national Heat in Buildings Strategy – which sets out the goal of achieving net zero emissions in Scotland's buildings which the Edinburgh LHEES is to deliver – has also been subject to a full SEA.[40]

5.5.3. In June 2023, the Council received screening responses from the Consultation Authorities (Historic Environment Scotland, NatureScot, and the Scottish Environment Protection

Agency). Each of the authorities concluded that the Edinburgh LHEES is unlikely to have significant environmental effects. Accordingly, on 21st June 2023, the Council wrote to the SEA Gateway to advise that, as the Responsible Authority under the Environmental Assessment (Scotland) Act 2005, the Council had determined that SEA was not required.

5.5.4. It is anticipated that an SEA may be required for the statutory Heat Network Zone designation process, expected to take place in the first half of 2024.

6. Policy and strategy context

6.1. Summary of key targets and regulations

Targets

6.1.1. Key headline targets relative to the Edinburgh LHEES are summarised below:

- Decarbonise the heating of all buildings in Scotland by 2045.
  - Decarbonise the heating of one million homes across Scotland by 2030.
  - Decarbonise the heating of 50,000 non-domestic buildings across Scotland by 2030.
  - All publicly owned buildings to meet zero direct emissions heating requirements by 2038.
  - All new homes developed by local authorities or Registered Social Landlords to be zero emissions by 2026.
  - The vast majority of Scottish off-gas homes switching to zero direct emissions heat.
  - One million Scottish on-gas homes switching to zero direct emissions heat.
- Supply 6.0 terawatt hours of heat energy from heat networks in Scotland by 2030.[xix]
  - Supply 2.6 terawatt hours of heat energy from heat networks in Scotland by 2027.
- No more than 5% of households in Scotland in fuel poverty by 2040 (and no more than 1% in extreme fuel poverty).
  - No more than 15% of households in Scotland in fuel poverty by 2030 (and no more than 5% in extreme fuel poverty).
  - No more than 10% of households in Scotland in fuel poverty by 2035 (and no more than 3% in extreme fuel poverty).
- Net zero greenhouse gas emissions by 2045.
  - A 75% reduction in Scottish greenhouse gas emissions by 2030.
  - A 90% reduction in Scottish greenhouse gas emissions by 2040.

Regulations

6.1.2. Key existing and proposed regulations relative to the Edinburgh LHEES are set out below. It is noted that this is a high-level summary and, in most cases, certain exemptions or relaxations are in place.

- All homes in Scotland to achieve a minimum Energy Performance Certificate rating of 'C' by 2033.[xx]
  - All private rented homes marketed to new tenants to have a minimum Energy Performance Certificate rating of 'C' as of 2025.

[xix] For context, the current figure is 1.18-terawatt hours.
[xx] "Where technically and legally feasible and cost-effective."

    - All private rented homes actively rented to have a minimum Energy Performance Certificate rating of 'C' as of 2028.
    - All social housing in Scotland to achieve a minimum Energy Performance Certificate rating of 'B' by 2032.
    - No social housing in Scotland with an Energy Performance Certificate rating below 'D' to be re-let from December 2025.
    - All homes in Scotland with households in fuel poverty to achieve a minimum Energy Performance Certificate rating of 'B' by 2040.
    - All homes in Scotland with households in fuel poverty to achieve a minimum Energy Performance Certificate rating of 'C' by 2030.
- All homes in Scotland to use zero direct emissions heating systems by 2045.
    - Prohibiting the use of direct emissions heating systems in new buildings in Scotland from 1 April 2024.
    - Proposals to require the installation of zero (or very near zero) direct emissions heating systems in existing buildings from 2025, with a backstop of 2045.
- All non-domestic buildings in Scotland to be net zero by 2045.
    - All publicly owned buildings to use zero direct emissions heating systems by 2038.

6.2. National policy landscape

6.2.1. The policy landscape for carbon reduction and energy efficiency in Scotland is complex with multiple relevant policies and rapidly evolving targets. National policies give rise to a series of ambitious goals around energy efficiency improvements and reductions in fuel poverty.

Climate change

6.2.2. The Scottish Government has set headline targets for the reduction of greenhouse gas emissions. The **Climate Change (Emissions Reduction Targets) (Scotland) Act 2019** sets statutory targets around reducing Scotland's emissions of all greenhouse gases to net zero. These includes a headline target of net zero by 2045, with intermediate target reductions of 56% by 2020, 75% by 2030, and 90% by 2040.

6.2.3. The **Climate Change Plan** (2018, 2020) sets out targets for emissions reductions by 2032 in view of energy requirements for electricity generation, buildings, and industry. The Plan sets an overall target of reducing emissions by 28% by 2032. For buildings, a target of a 33% reduction in emissions between 2018 and 2032 is set. By 2032, emissions from domestic buildings are targeted to decrease by 23%, and emissions from non-domestic buildings are targeted to reduce by 53%.

6.2.4. Within the "electricity" section of the Climate Change Plan, targets are set linked to renewable energy production and decarbonisation. From 2020 onwards, Scotland's electricity grid intensity is targeted to be below 50 grammes of CO_2 per kilowatt hour, with at least 1 gigawatt of renewable energy in community or local ownership. Going forward, a target is set of Scotland's electricity demand being "largely" generated from renewable sources (including onshore wind, offshore wind, hydro, solar, marine and bioenergy) by 2032. This is linked to the rising demand in electricity for home usage, as homes switch from gas to

electricity. As set out by SP Energy Networks, there are two primary factors driving increased electricity consumption: people switching to electric to heat their homes, and people generally using more electricity, for example for electric vehicle charging. SP Energy Networks has identified a requirement to increase peak demand capacity fourfold by 2050.

6.2.5. Within the buildings section of the Climate Change Plan, Scotland's statutory fuel poverty targets require that by 2040 no more than 5% of households are in fuel poverty; that no more than 1% of households are in extreme fuel poverty; and the fuel poverty gap is reduced to £250 (adjusted for 2015 prices). This is in line with the **Fuel Poverty (Targets, Definition and Strategy) (Scotland) Act 2019**. The Plan notes that the current rate of conversions to low and zero direct emissions systems – for example, heat pumps, heat networks, and (potentially) hydrogen – need to be substantially increased to meet targets.

6.2.6. The latest iteration of the **Climate Change Plan**, as revised in 2020, integrates the targets set in the **Climate Change Act 2008** as amended in 2019. The revised Plan notes the continued need to invest in renewable generation, heat networks, and related infrastructure to ensure greenhouse gas emissions. The Plan also notes increased homeworking and how this changes the profile of heating and electricity demand (including increased risk of fuel poverty and energy debt due to increased domestic energy use at home) and the potential to support jobs in low/zero heat and energy efficiency-related sectors.

6.2.7. The most recent **Programme for Government** (2022) sets out several actions linked to supporting heat and energy policy. Several targets are linked to reducing the effects of fuel poverty through financial support towards heating costs. This includes the £214 Child Winter Heating Assistance (which supports families of severely disabled children and young people with their energy costs); the Winter Heating Payment (which guarantees a £50 annual payment to around 400,000 low-income households); doubling the Fuel Insecurity Fund to £20 million to help households at risk of self-disconnection or self-rationing of energy use in response to OFGEM energy price cap rises; and expanding Home Energy Scotland advice centres. These actions do not directly relate to the Edinburgh LHEES but will support a reduction in the immediate impact of fuel poverty. More directly linked to the Edinburgh LHEES, the Programme expands the criteria for the Warmer Homes Scotland fuel poverty programme (through lowering the youngest required age to 60 years old) and introduces a Scotland-wide public information campaign to highlight help and support available to households as well as energy efficiency measures for households to minimise heating costs.

Energy efficiency and zero direct emissions heating

6.2.8. The **Heat in Buildings Strategy** (2021) sets out how buildings in Scotland will be heated to meet greenhouse gas reduction targets whilst addressing fuel poverty. The Strategy updates the Energy Efficient Scotland route map and commits to putting in place standards and regulation for heat and energy efficiency to ensure that all buildings are energy efficient by 2035 and use zero direct emissions heating and cooling systems by 2045. The Strategy sets out 107 actions and proposals that the Scottish Government will take to work towards target and aspirations. By 2030, over one million homes and over 50,000 non-domestic buildings are targeted to have converted to using zero or low emissions heating systems. The Strategy further sets a target of all public sector buildings in Scotland using zero direct emissions heating by 2038.

6.2.9. The **Heat in Buildings Bill** is a bill announced by the Scottish Government that will "set out our initial proposals for the role that regulations can play in driving better energy efficiency standards and zero direct emissions heating in Scotland's existing buildings from 2025".[41] The Bill is expected to introduce more stringent energy efficiency standards. Consultation on the Bill is expected to begin by the end of 2023.

6.2.10. The Scottish Government had originally proposed that all private rented homes in Scotland would be required to achieve a minimum EPC rating of 'D' by 2025. This has been revisited in light of recognition of the disruption caused by the COVID-19 pandemic, it is now proposed that, as of 2025, any home marketed for private rent must have a minimum EPC rating of 'C', while all actively privately rented homes must have a minimum EPC rating of 'C' by 2028 (albeit with exemptions where a 'C' rating is not cost effective or technically feasible).

6.2.11. The **Energy Efficiency Standard for Social Housing post 2020** (EESSH2) sets out a raised standard for the energy efficiency of social housing in Scotland in order to reduce carbon emissions and eradicate poor energy efficiency as a driver for fuel poverty. EESSH2 sets out a milestone of all social rented homes in Scotland achieving at least EPC 'B', or otherwise being as energy efficient as practically possible, by the end of December 2032 ("within the limits of cost, technology and necessary consent"). ESSHS2 further sets out that no social housing below EPC 'D' should be re-let from December 2025 (subject to temporary specified exemptions).[42] A new milestone to replace the 2032 target is currently being developed.

6.2.12. There are not currently minimum EPC standards for non-domestic properties in Scotland.[xxi] However, the Scottish Government has started that it will introduce regulations in 2025 requiring all non-domestic buildings to meet zero direct emissions heating requirements by 2045 (and all publicly owned buildings to meet zero direct emissions heating requirements by 2038).[43] In August 2023, the commercial property consultancy Knight Frank carried out analysis on Scotland's office stock in which it concluded that properties with an EPC rating of 'F' and 'G' accounted for 13% of total floor area, which would in principle be unlettable if the same standards were in place in Scotland as in England and Wales. Properties with an EPC rating below 'C' accounted for 55% of floor area, while properties with an EPC rating below 'B' accounted for 79% of the floor area; this implies that, were the same standards in place in Scotland as in England and Wales, 55% of office floor space in Scotland would be unlettable as of 2027 and 79% as of 2030, underscoring the quantity of work likely to be required.[44]

6.2.13. **Energy Efficient Scotland** (2018) is a 20-year route map aimed at making Scotland's buildings net zero carbon by 2050, in a way that is socially and economically feasible. Two main objectives are set out in the route map: remove poor energy efficiency as a driver for fuel poverty, and reduce greenhouse gas emissions through more energy efficient buildings and the decarbonisation of heat supply. The road map aims to have all Scottish homes achieve at least an EPC 'C' rating by 2040 (where technically and financially feasible), with a target set for fuel poor households of all homes in this category reaching at least an EPC 'C' rating by 2030. For homes, the aim is to achieve a 15% heat demand reduction and 35% heat from low carbon sources by 2032. For non-domestic properties, the aim is to achieve 20% heat demand reduction and meet 70% of heat demand from low carbon sources by 2032.

[xxi] The "Minimum Energy Efficiency Standards" in place in England and Wales make it an offence for a landlord to lease out a non-domestic property with an EPC rating of 'F' or 'G' unless an exemption is in place. It is expected that the minimum EPC rating will be raised to 'C' in 2027 and 'B' in 2030.

6.2.14. The UK Government's **Clean Growth Strategy** (2017) sets a goal of getting as many homes as possible to at least an EPC rating of 'C' by 2035 (2030 for rental homes and fuel poor homes). These are the same target ratings, as set out in the Energy Efficient Scotland roadmap, but with different timescales. The Clean Growth Strategy also sets out a pathway for expanding heat networks, setting out a scenario of heat networks supplying up to 17% of heat demand in residential properties and 24% of heat demand in (non-industrial) non-residential properties by 2050 (compared to approximately 1% of all buildings in the UK presently).

6.2.15. The UK Government has stated that it intends to ban the sale of gas boilers from 2035, albeit with an exemption for "households who will most struggle to make the switch to heat pumps or other low-carbon alternatives" – expected to cover around 20% of homes in the UK. The UK Government has further stated that it intends to ban the installation of oil and LPG boilers and coal heating in off-gas grid homes from 2035.[45]

6.2.16. The Scottish Government's **Hydrogen Action Plan** (2022) suggests that hydrogen "can be used to decarbonise many parts of our economy, including industry, transport, power and heat […] Transported through the gas grid it could help decarbonise commercial premises and make a contribution to decarbonising home energy use." Actions set out in the Plan include "maintain dialogue with SGN and National Grid to understand the role hydrogen can play in meeting our heat decarbonisation targets."[46]

6.2.17. The Scottish Government has announced the establishment of a **National Public Energy Agency**, **Heat and Energy Efficiency Scotland**, to "provide the leadership and coordination needed to accelerate delivering the decarbonisation of heat across Scotland". The Agency is planned to be operational on a standalone basis by September 2025. The Agency will accelerate transformational change in the heating of buildings; aid public understanding and awareness; and coordinate delivery of investment. A pledge to establish a new public energy company has been put on hold.[47]

6.2.18. The Scottish Government has convened a **Green Heat Finance Taskforce** with the remit of developing "a portfolio of innovative financial solutions for building owners in Scotland to ensure that by 2045, our homes and buildings no longer contribute to climate change, as part of the wider just transition to net zero".[48] It is understood that the Taskforce will publish its finding in two sequential reports: the first "setting out the heating finance landscape in Scotland and barriers to the growth of private financing" and making "recommendations to support scaling of individual products like green mortgages", and the second focusing on "communal, or area based mechanisms, including heat as a service models" and "options for social housing".

Fuel poverty

6.2.19. The **Fuel Poverty (Targets, Definition and Strategy) (Scotland) Act 2019** establishes a revised definition of fuel poverty as well as setting statutory targets to be achieved by 2040: no more than 5% of households in Scotland in fuel poverty and no more than 1% of households in Scotland in extreme fuel poverty. Intermediary targets are also set for 2030 and 2035. The new definition of fuel poverty in Scotland is as follows: a household is in fuel poverty if the household's fuel costs (necessary to meet the requisite temperature and amount of hours as well as other reasonable fuel needs) are more than 10% of the household's adjusted net income and after deducting these fuel costs, benefits received for a care need or disability, childcare costs, the household's remaining income is not enough to maintain an acceptable

standard of living. This also include a definition of acceptable levels of heating, and the number of hours which this covers for an average household.

Heat networks

6.2.20. Heat networks in the UK have historically been largely unregulated. The **Heat Network (Metering and Billing) Regulations 2014** place obligations on heat suppliers to notify the Office for Product Safety and Standards about any new heat networks on or before the day the heat network becomes operational, to install metering devices (where cost effective), and bill off-takers based on actual consumption. The UK Government is currently preparing UK-wide **Heat Networks Technical Assurance Standards**.

6.2.21. Heat networks have been identified as a key technology for meeting emission reduction targets as set in out in the Climate Change (Emissions Reduction Targets) (Scotland) Act 2019. The **Heat Networks (Scotland) Act 2021** aims to encourage greater use of heat networks in Scotland through the introduction of a regulatory system. The Act, and the subsequent **Heat Networks (Heat Network Zones and Building Assessment Reports) (Scotland) Regulations 2023**, put in place regulations on heat networks, including introducing a consent and license regime; making provision for Heat Network Zones and a permit system giving operators exclusivity; and giving licence holders powers such as wayleaves. The Act aims to encourage consumer confidence through an improved regulatory system and ensure greater certainty for investors. The practical steps for implementing the regulatory regime and supporting the development of heat networks are outlined in the Scottish Government's **Heat Networks Delivery Plan** (2022).

6.2.22. The key elements of the regulatory regime introduced by the Heat Networks (Scotland) Act are as follows:

- Operators of heat networks must secure a license to ensure they are "solvent, fit and proper" and that heat networks are developed and maintained to high standards. Licence holders will be granted new rights such as wayleaves, compulsory purchase powers, and road work and surveying rights. OFGEM is proposed to serve as the licensing authority for Scotland, with consumer protection powers around matters such as fair pricing; quality and reliability of service; transparency of information; and additional protections for vulnerable customers. Licences will be awarded to companies rather than on a site-by-site basis.
- Developers/operators of heat networks must secure consent before building or operating a heat network. A consent is a site-specific permission to develop and operate a heat network. The Scottish Government's Energy Consents Unit will be the consent authority by default; local authorities may request to be the consent authority (or may be designated as such by the Scottish Government).
- Developers/operators of a heat network must hold a permit to build or operate a heat network in a given Heat Network Zones. Permits bestow exclusive rights upon developers/operators. The Scottish Government will be the permit authority, and will award permits on a competitive basis. Consideration is required as how permits will interface with existing heat networks and with existing concession agreements.
- Asset schedules and transfer schemes will be put in place to provide for the transfer of operational rights for heat networks to a different operator to avoid supply interruptions if an operator ceases to operate a heat network.

- Certain areas will be designated as Heat Network Zones: areas particularly suitable for heat networks. These zones will form the basis of the heat network permits regime.

6.2.23. The Act sets a statutory target of heat networks supplying 2.6 terawatt hours of thermal energy by 2027 and 6.0 terawatt hours by 2030 (compared to approximately 1.18 terawatt hours per annum currently). This is equivalent to 3% and 8% of current total demand. This is equivalent to approximately 120,000 additional homes by 2027 and 400,000 additional homes by 2030; on a pro rata basis, this would translate to around 11,500 additional homes in Edinburgh by 2027 and 38,400 additional homes in Edinburgh by 2030 (albeit the Act does not specify the source of the demand so in practice some of this demand will relate to non-domestic properties).

6.2.24. The Act requires the owners of public sector non-domestic buildings with an annual heat demand of at least 73 megawatt-hours per year to produce "building assessment reports" (BARs) – summary reports on the heating systems and demand of buildings. It is anticipated that the duty to complete BARs will eventually be extended to private sector building owners. BARs must be completed on a five-yearly basis. Completed BARs are to be submitted to local authorities and to the Scottish Government to inform the development of heat networks and the designation of Heat Network Zones by enabling potential anchor loads to be identified.[xxii]

6.2.25. The Scottish Government has established the **Heat Network Support Unit** (HNSU) with the remit of helping overcome challenges associated with the deployment of heat networks in Scotland, including providing support/expertise and grant funding.

6.2.26. As noted in section 6.4, City Plan 2030 introduces a requirement for all new developments to connect to a heat network where possible. At present, there is no requirement in law for existing properties to connect to a heat network.

6.2.27. The UK Government's **Energy Bill** (formerly known as the **Energy Security Bill**), introduced to Parliament in June 2022, introduces a UK-wide regulatory regime for heat networks. With respect to Scotland, the Bill enables the UK Government to designate the Gas and Electricity Markets Authority (GEMA) as the licensing authority for heat networks in Scotland as set out in the Heat Networks (Scotland) Act 2021. The Bill further empowers the UK Government to amend the Heat Networks (Scotland) Act 2021 to make provision for monitoring compliance with, and enforcing conditions of, heat network licences in Scotland.

New builds

6.2.28. The Scottish Government has stated that "with very few exceptions" new homes built in accordance with the **Building (Scotland) Amendment Regulations 2015** will achieve an EPC rating of at least 'C', with around 95% of homes expected to achieve 'B' or better.[49]

6.2.29. The **Building (Scotland) Amendment Regulations 2022** were put in place in December 2022 to drive further improvements to building performance. These regulations require developers to reduce energy emissions for new buildings. The amended regulations are aligned to the proposal to prohibit direct emissions heating systems from April 2024.

[xxii] Local authorities are therefore required both to prepare BARs for their own estate and also to collate the data from all BARs produced within their area.

6.2.30. Following these increased regulations on energy efficiency in new homes, the **New Build Heat Standard** (scheduled to be in effect by April 2024) will prohibit the use of direct emissions systems for the heating (or cooling) of any new buildings for which a building warrant is required, both domestic and non-domestic. Past this date, only zero direct emissions systems (for example, heat pumps, heat networks, and direct electrical heating) will be allowed in new buildings. This represents a significant pivot away from the longstanding use of gas boilers as the heat system of choice in Scotland.

6.2.31. The **Domestic Building Environmental Standards (Scotland) Bill** introduces new minimum environmental design standards for all new-build housing to meet the Passivhaus standard (or a Scottish equivalent) in order to improve energy efficiency and thermal performance. The bill was lodged in 2022, with plans to make subordinate legislation within two years to give effect to the proposal. Passivhaus standards consider a whole building approach focusing on energy efficiency and ensuring buildings maintain an almost constant temperature through solutions such as triple glazing and additional insulation. In December 2022, the Scottish Government stated that it intended to make secondary legislation within two years to enact minimum design standards for all newly built housing requiring it to achieve the equivalent of Passivhaus standard.

6.2.32. The **Net Zero Public Sector Buildings Standard** (2021) is a voluntary building standard which supports public bodies to meet net zero standard for their new build and refurbishment infrastructure projects. This standard has guidance for six stages of the project lifecycle to support quality assurance.

6.2.33. The **Performance of Non-domestic Buildings (Scotland) Regulations 2016** requires that non-domestic buildings with a floor area of more than 1,000 square metres produce an Energy Action Plan at the point of sale or rental. The Energy Action Plan must set out how building owners will improve energy efficiency and reduce the building's greenhouse gas emissions.

Energy planning

6.2.34. A fundamental challenge to the decarbonisation of heating is the cost of electricity relative to gas. In the UK, unit prices for electricity have traditionally stood at around three times those of gas. As noted in section 4.5, this has made the economics of switching from gas boilers to electricity-based heat solutions (including heat pumps and direct electric heating) highly challenging. The **Independent Review of Net Zero** (2022) called for a "rebalancing" of gas and electricity prices. The Independent Review states, "the past approach of levying policy costs and taxes onto electricity bills keeps the price of electricity artificially high and can stifle the signal for the use of low-carbon technologies, from electrifying industrial fuel use to vehicles and heat pumps" and "keeping the relative price of electricity vs. gas consistently competitive on a long-term basis will be the single biggest determinant of ensuring that the transition brings a significant amount of savings to the average household".[50] This recommendation was accepted by the UK Government, which in its 2023 policy paper **Powering Up Britain: Energy Security Plan** committed to setting out proposals in 2023/24 for the rebalancing of electricity and gas costs to reduce electricity costs and "generate the clear short-term price signal necessary to shift both households and businesses to lower-carbon, more energy efficient technologies like heat pumps".[51]

6.2.35. The **Scottish Energy Strategy** (2017) sets a 2050 vision for energy in Scotland: to provide a "flourishing, competitive local and national energy sector, delivering secure, affordable, clean

energy for Scotland's households, communities and businesses". The Strategy sets out three central principles: take a whole-system view, have an inclusive energy transition, and a smarter local energy model. Two main targets are set by this Strategy: for the equivalent of 50% of the energy for Scotland's heat, transport, and electricity consumption to be supplied from renewable sources by 2030, and for the productivity of energy use across the Scottish economy to be increased by 30% in by 2030.

6.2.36. In January 2023, the Scottish Government published the first draft of the national **Energy Strategy and Just Transition Plan**. The Energy Strategy sets out plans for transitioning Scotland to a climate friendly energy system. It sets targets including increasing renewable electricity generation capacity by 20 gigawatts by 2030 and for hydrogen to meet 15% of Scotland's energy needs by 2030. Key actions (some existing and others new) identified in the Energy Strategy with strong relevance to the Edinburgh LHEES include:

- Boosting the Home Energy Scotland advice service and widening the eligibility criteria of the Warmer Homes Scotland fuel poverty programme.
- Providing a tailored package of support to remote and rural off grid communities through the Community and Renewable Energy Scheme, helping them to upgrade their energy systems.
- Through Climate Action Hubs and Climate Action Towns, providing a vehicle for communities to work to identify local solutions and build a pipeline of investible projects and opportunities at a regional level.
- Investing over £1.8 billion in decarbonising homes and buildings through Heat and Energy Efficiency Scotland over the course of the 2021-2026 Parliament.
- Establishing a new regulatory regime for heat networks in Scotland and appropriate financial mechanisms.

6.2.37. The **Hydrogen Policy Statement** (2020) sets out a vision for Scotland to become a leading producer of reliable, competitive, and sustainable hydrogen. The Statement includes support for the development of a low-cost hydrogen capability to meet an initial ambition of producing five gigawatts of renewable and low-carbon hydrogen by 2030. The Statement identifies a potential role for hydrogen in decarbonising heat.

6.2.38. The **British Energy Security Strategy** (2022) sets out a package of measures intended to deliver "secure, clean and affordable British energy for the long term". The Strategy sets out a 10-point plan; points of relevance to the Edinburgh LHEES are driving the growth of low carbon hydrogen; greener buildings; and green finance and innovation. Measures set out in the Strategy include zero-rating VAT on the installation of energy saving materials for five years; promoting the manufacture of heat pumps in the UK; promoting "green mortgages";[xxiii] and seeking to generate 10 gigawatts of low carbon hydrogen by 2030.

6.2.39. The UK Government's **Energy Bill** (formerly known as the **Energy Security Bill**) was introduced to Parliament in June 2022. The Bill sets out multiple measures relating to the generation of energy (with a reduced reliance on imported fossil fuels) and the regulation of the energy market. Key measures introduced in the Bill include:

[xxiii] Preferential mortgage terms offered on properties with greater energy efficiency.

- Enabling a large-scale hydrogen heating trial to inform strategic decisions on the role of hydrogen scheduled to be taken in 2026.
- Scaling-up heat pump manufacturing and installation.
- Introducing a regulatory regime for fusion energy.

Housing

6.2.40. The **Housing to 2040** strategy (2021) sets out a vision "where new homes are designed to be energy-efficient and use zero emissions heating systems and where existing homes are retrofitted to improve their energy efficiency and decarbonise their heating systems, whilst making fuel poverty a thing of the past", along with a route map for how to achieve this vision. The strategy sets a target of delivering 100,000 new affordable homes by 2031/32 (70% of these social rent) and retrofitting existing homes so their occupants can benefit from improved energy efficiency and decarbonised heating. This is linked to the aims of the Heat in Buildings strategy. The strategy reiterates the target of emissions from heating buildings in Scotland reaching zero by 2045. The strategy notes that this will necessitate changing the heating systems in over two million homes and over 100,000 non-domestic buildings, and that this will requirement investment from the public sector, homeowners, private and social landlords, and others.

6.2.41. **Scotland's Sustainable Housing Strategy** (2013) notes Scotland's requirement for warm, high-quality, affordable, and low carbon homes. It details the delivery of the Home Energy Efficiency Programmes for Scotland (HEEPS); appropriate use of standards and regulation; and market transformation. The Strategy sets out a route map to 2027 with targets to achieve a reduction in fuel poverty, and a reduction in housing emissions.

6.2.42. The **Tenements (Scotland) Act 2004** regulates tenement flats in Scotland. This covers ownership, duties, and demolition. The Tenement Management Scheme, as outlined in schedule 1 of the Act, lists the "scheme property" (explaining what parts for the tenement every flat owner should maintain) and explains how owners are to come to arrangements about maintenance ("scheme decisions") and how costs are to be shared. The Climate Change (Scotland) Act 2009 amends the Tenement Management Scheme to reclassify the installation of insulation as a maintenance measure rather than an improvement, allowing works to be approved via a majority rather than unanimously as previously.

Supply chain

6.2.43. The Scottish Government's **Heat in Buildings Supply Chains Delivery Plan (2022)** sets out actions for developing the supply chain required for a transition to a "green heat" basis. Actions include allocating funding for research and development; using public procurement to maximise supply chain impacts; and developing a supplier-led incentives scheme to provide a route to market for new business models and consumer propositions. The Plan states that "the Green Heat supply chain is largely balanced at existing levels of demand" but notes a need for "skilled workers to support future deployment rates of heat pumps, heat networks, thermal insulation and direct electric heating systems".

6.2.44. The **Climate Emergency Skills Action Plan 2020-2025** published by the Scottish Government and Skills Development Scotland sets out actions to meet skills demand associated with the transition to net zero, including those in energy transition and construction. In terms of construction, the Plan notes "an anticipated increased demand for professional level skills for jobs in planning, design, surveying and management" and "a requirement for the

development of specialist knowledge and skills round retrofit, zero emissions heating systems and heat networks for professional, technical and craft roles, as well as data and smart systems skills for delivering energy management in buildings services".

6.3. Local policy landscape

6.3.1. Local policies support the realisation of national goals through solutions which are adapted for Edinburgh's local circumstances, including developing new sustainable homes and upgrading existing homes to become more energy efficient.

6.3.2. The 2030 Climate Strategy (2021) is the overall strategy for Edinburgh to become a net zero city by 2030. The Climate Strategy identifies seven priorities for action, of which two relate directly to the Edinburgh LHEES: "accelerate energy efficiency in homes and buildings" and "enable the development of a citywide programme of heat and energy generation and distribution".

6.3.3. The Climate Strategy sets the following key targets of relevance to the Edinburgh LHEES:

- All new Council-led housing developments 2020-2030 to be net zero.
- Develop regional renewable energy solutions, 2024-2027.
- Identify Heat Network Zones across the city.
- Develop a plan for retrofitting social housing across the city to the highest energy standards, to reduce energy demand and tackle fuel poverty.
- Establish an Energy Efficient Public Buildings Partnership.

6.3.4. The City of Edinburgh Council's **Council Emissions Reduction Plan** (2021) sets out proposals for reducing all the Council's emission sources, including building energy usage.

6.4. Planning policy context

6.4.1. Section 3F of the **Town and Country Planning (Scotland) Act 1997** requires all Scottish planning authorities to include policies in their local development plans requiring all developments to be designed to "avoid a specified and rising proportion of the projected greenhouse gas emissions from their use, calculated on the basis of the approved design and plans for the specific development, through the installation and operation of low and zero-carbon generating technologies".

6.4.2. The **Edinburgh Local Development Plan** (ELDP) (2016) is the Council's currently adopted LDP, however its successor, the emerging **City Plan 2030**, is the settled view of the Council having been consulted upon, approved by the Council, and submitted for examination; as such, it should be afforded material weight.

6.4.3. The **National Planning Framework 4** (NPF4) was adopted by Scottish Ministers in February 2023. It sets the context for development planning in Scotland and provides a framework for the spatial development of Scotland as a whole.

Edinburgh Local Development Plan

6.4.4. Policy Des 6 – "Sustainable Buildings" of the ELDP states that planning permission will only be granted for new developments where it has been demonstrated that the carbon dioxide emissions reduction target has been met (with at least half of this reduction to be achieved through the use of low/zero carbon generating technologies such as solar panels, heat pumps, and heat network infrastructure) and that other features are incorporated that will

reduce or minimise environmental resource usage and impact (for example, green roofs and measures to promote water conservation). The Council sets out specific current requirements in an "S1 Sustainability Form" which applicants for planning permission must complete to demonstrate they have complied with the policy.

6.4.5. Policy RS 1 – "Sustainable Energy" of the ELDP states that planning permission will be granted for development of low and zero carbon energy schemes (for example solar panels, district hearing, energy-from-waste plants, and small-scale wind turbine generators) will be granted where these do not cause significant harm to the local environment (in terms of natural heritage and area character) or to amenity). The policy further states that proposals to fit micro-generation equipment onto existing buildings will be assessed using policy RS 1 along with non-statutory planning guidance for householders, and that where the development of energy-from-waste plants or biomass is proposed, the opportunity for local reuse of heat energy is expected to be explored.

City Plan 2030

6.4.6. Policy Env 7 – "Sustainable Developments" of City Plan 2030 mandates that all detailed proposals involving the construction or change of use of one or more buildings must incorporate "all reasonably practicable measures to address the climate emergency". For change of use proposals, the applicant must set out how the proposal incorporates "measures to increase resilience to future climate change and minimise greenhouse gas emissions such as built fabric efficiency improvement and low and zero carbon generating technology".

6.4.7. Policy Env 8 – "New Sustainable Buildings" of City Plan 2030 mandates that new building developments for which a building warrant is required must "[achieve], predominantly through ultra-high fabric energy efficiency, a 'net zero' level of operational greenhouse gas emissions", with this requirement to be controlled via planning conditions. The policy further states that "all new development requires to embed ultra-high fabric energy efficiency into its design and construction, with the optimal approach being for it to be built to Passivhaus standards" and that "the incorporation of low and zero carbon generating technologies into the new development is also supported."

6.4.8. Policy Inf 16 – "Sustainable Energy and Heat Networks" of City Plan 2030 states that the development of "low and zero carbon energy schemes including small-scale wind turbine generators, solar panels, ground and air source heat pumps, water source heat and power, heat and/or power networks where energy comes from a renewable/low carbon source, and energy storage schemes that help support low and zero carbon energy schemes" will be supported where these do not harm natural heritage, area character, or amenity. The policy further states that proposals to fit micro-generation equipment onto existing buildings will be assessed using the above policy and non-statutory guidance for householders.

6.4.9. Policy Inf 16 further states that "all new developments should connect to an existing or planned heat network or other significant heat source wherever possible to do so", that "where this is not possible then all substantial development must, subject to a viability and feasibility study, instead include a source of renewable/low carbon heat generation […] and associated heat network", and that any developments not heated through heat networks must be future proofed to allow a future connection to be made.

National Planning Framework 4

6.4.10. Policy 1 – "Tackling the climate and nature crises" of NPF4 encourages development that addresses climate and nature crises. It states, "when considering all development proposals significant weight will be given to the global climate and nature crises." The policy requires local authorities' Local Development Plans to ensure spatial strategies will reduce emissions.

6.4.11. Policy 2 – "Climate mitigation and adaptation" of NPF4 promotes development that minimises emissions. It includes the provisions that "development proposals will be sited and designed to minimise lifecycle greenhouse gas emissions as far as possible" and that "development proposals to retrofit measures to existing developments that reduce emissions or support adaptation to climate change will be supported". The policy requires Local Development Plans to set spatial strategies to reduce, minimise, or avoid greenhouse gas emissions.

6.4.12. Policy 11 – "Energy" of NPF4 encourages renewable energy development onshore and offshore. The policy sets out a range of provisions, including that "development proposals for all forms of renewable, low-carbon and zero emissions technologies will be supported". The policy further sets out that "grid capacity should not constrain renewable energy development. It is for developers to agree connections to the grid with the relevant network operator". Local Development Plans are required to identify a range of opportunities for energy development.

6.4.13. Policy 12 – "Zero waste" of NPF4 encourages development consistent with the waste hierarchy. It sets out a range of provisions, including that development proposals for new or extended landfill sites will only be supported where waste heat and/or electricity generation is included, and that development proposals for energy-from-waste facilities will not be supported except under limited circumstances, including that a functional heat network can be delivered.

6.4.14. Policy 19 – "Heating and Cooling" of NPF4 promotes development that supports decarbonised solutions to heat and cooling demand. It sets out a range of provisions, including that "development proposals within or adjacent to a Heat Network Zone identified in a LDP will only be supported where they are designed and constructed to connect to the existing heat network"; that "where a heat network is planned but not yet in place, development proposals will only be supported where they are designed and constructed to allow for cost-effective connection at a later date"; and that "national and major developments that will generate waste or surplus heat and which are located in areas of heat demand, will be supported providing wider considerations, including residential amenity, are not adversely impacted". Local Development Plans are required to take account of the relevant LHEES.

6.4.15. NPF4 promotes using empty buildings and developing on brownfield sites – particularly in the Central Belt of Scotland. Areas where land has not been used for decades, or where the land is accessible by sustainable modes, should be prioritised. There are several areas in Edinburgh which fit these requirements, such as Granton Waterfront. Within the heating and cooling policy section, the Edinburgh LHEES is referenced as the point of reference as well as Heat Network Zones. Within the quality homes section, net zero homes are noted as supporting a green economy and tackling fuel and child poverty. There are no energy-focused actions linked specifically to Edinburgh.

Permitted Development Rights

6.4.16. Under the Town and Country Planning (General Permitted Development) (Scotland) Order 1992 (as amended) householders in Scotland possess Permitted Development Rights that enable them to carry out certain developments without requiring planning permission. These rights include the installation of solar panels; air, ground, and water source heat pumps; free-standing wind turbines; and biomass heating systems.[52] Certain non-domestic properties benefit from the same Permitted Development Rights.

6.4.17. As set out in the Heat in Buildings Strategy, the Scottish Government is considering introducing Permitted Development Rights for heat networks and extending existing Permitted Development Rights for micro-renewable technologies.

7. Ongoing activity in Edinburgh

7.1. Edinburgh context

7.1.1. Edinburgh is one of four local authorities in Scotland with a predominantly urban character. The city proper is relatively compact and densely populated, with tenement buildings and blocks of flats being the most common housing type.

7.1.2. Edinburgh has a significant degree of built heritage, with two UNESCO World Heritage Sites (one of which covers much of the city centre), 50 Conservation Areas, and around 5,000 listed buildings and structures, ranging from Georgian and Victorian tenements to medieval castles. This heritage presents challenges for decarbonisation, both in terms of practicalities (for example, the inability to deploy cavity wall insulation to solid wall buildings) and policy (for example, the inability to replace sash-and-case windows with more thermally efficient uPVC windows). The retrofitting of historic buildings is a challenge in and of itself.

7.1.3. Edinburgh is home to a range of large and complex buildings, including an international airport; football and rugby stadia; major hospitals; military installations; a prison; and multiple rail stations. These buildings will each present their own challenges in terms of achieving net zero.

7.1.4. The City of Edinburgh Council is the largest property owner in Edinburgh. Its estate includes over 20,000 social homes; 124 schools; and multiple other operational buildings including nurseries, libraries, museums, galleries, offices, depots, storage facilities, community centres, sporting facilities, a crematorium, a mortuary, greenhouses, and public toilets. The Council is also the owner of a sizeable investment estate including industrial units, shops, and offices. The Council's ownership of these properties naturally gives it far greater ability to take forward works to decarbonise these properties. However, it equally means that the costs of these works will in the first instance fall to the Council, representing a significant financial burden at a time of ongoing budgetary pressures.

7.1.5. Edinburgh has seen significant development in recent years. From 2013 to 2022, 21,767 new homes were completed in Edinburgh.[53] With each passing year, the property stock of Edinburgh is becoming gradually more modern as newly built properties make up an increasing proportion of all properties. This represents an opportunity to improve the overall performance of the city's building stock in terms of energy efficiency and heat decarbonisation by designing for these issues from the outset, which is inevitably more straightforward than making changes retroactively.

7.2. 2030 Climate Strategy

7.2.1. The 2030 Climate Strategy (2021) is the overall strategy for transitioning Edinburgh to a net zero carbon city. The Edinburgh LHEES sits below the Climate Strategy, being the strategy for transitioning the heating of buildings in Edinburgh to net zero.

7.2.2. The Climate Strategy sets out 27 actions to be progressed under the theme of "net zero energy generation and energy efficient buildings". These actions, and the current progress against each, are set out below.

- "Set progressive planning policies to increase energy standards in new buildings" – as set out in section 6.4, City Plan 2030 sets rigorous standards for new development in Edinburgh. In particular the policy requires new developments in Edinburgh to

achieve “a ‘net zero’ level of operational greenhouse gas emissions”. This means that all new developments in Edinburgh following the adoption of City Plan 2030 will require to be developed to net zero carbon standard. Further, City Plan 2030 requires all new developments in Edinburgh to connect to a heat network “wherever possible”. This policy will help drive the expansion of heat networks in Edinburgh by providing investors/operators with some assurance as to future connections.

- “Require the use of low and zero emissions technologies to heat and power the city’s buildings” – this action from the Climate Strategy is closely linked to one of the central purposes of the Edinburgh LHEES. A focus of the Edinburgh LHEES is on the decarbonisation of buildings in Edinburgh, which would necessitate the use of zero direct emissions heating systems. Low emissions heating systems still contribute to carbon emissions and therefore will not be an acceptable means of delivering the Edinburgh LHEES. City Plan 2030 mandates that all new buildings in Edinburgh achieve “a ‘net zero’ level of operational greenhouse gas emissions”, and requires them to connect to a heat network "if practical". This will be complemented by the proposed ban on gas boilers in new buildings in Scotland and other national regulations. The process for transitioning existing buildings to low and zero direct emissions heating technologies will be more complex and will require a "carrot and stick" mix of obligations (e.g. regulatory requirements) and incentives.
- “Convene a City Heat and Energy Partnership” – a City Heat & Energy Efficiency Board was established in 2022 with the remit of developing joint investment and heat masterplans for Edinburgh. The Board is co-led by the University of Edinburgh and SP Energy Networks in collaboration with the Council; businesses; community groups; the third sector, the education and culture sector; utilities; and other stakeholders.
- “Develop a city-wide heat and energy masterplan” – the Edinburgh LHEES will in effect form the first iteration of a city-wide heat and energy masterplan, with the City Heat & Energy Efficiency Board to carry out further work subsequently.
- “Develop a long-term city partner shared investment strategy to deliver the citywide heat and energy masterplan” – the shared investment strategy will follow on from the Edinburgh Heat and Energy Masterplan. It is envisaged that it will build upon investment proposals emerging from the Edinburgh LHEES. The Edinburgh Climate Change Institute is mapping the investment plans of all members of the City Heat & Energy Efficiency Board.
- “Agree appropriate delivery mechanisms for the energy investment strategy” – the shared investment strategy will follow on from the Edinburgh Heat and Energy Masterplan.
- “Establish a strategic partnership with SP Energy Networks” – the Council has established a senior working relationship with SP Energy Networks that enables both parties to raise matters for consideration. SP Energy Networks also co-chairs the City Heat & Energy Efficiency Board.
- “Align current and future grid development to the city’s projected energy needs” – the aforementioned partnership with SP Energy Networks gives the Council the

ability to seek to influence grid investments to align them with development activity in Edinburgh.

- "Develop regional renewable energy solutions which draw on the area's wind, geothermal, hydro and solar assets" – by dint of its urban character, comparatively small area, and geology, Edinburgh has fewer intrinsic opportunities for renewable energy generation that elsewhere in Scotland. However, the city has seen deployment of small-scale schemes such as hydropower at Harlow Reservoir and Saughton Park. Edinburgh Airport and Edinburgh Zoo are among the landowners in Edinburgh with plans for solar meadows. Other potential opportunities include the extraction of heat from the Firth of Forth and from disused mine workings.
- "Learn from the H100 hydrogen pilot" – the Council is maintaining a watching brief on the H100 hydrogen pilot and on the wider developments in the hydrogen sphere. It is recognised that there are considerable differences of opinion as to the scope for hydrogen to play a meaningful role in space heating.
- "Collaborate with regional partners to decarbonise the region's energy infrastructure" – some small-scale collaboration has been carried out to date, for example dialogue between the Council and Midlothian Council / East Lothian Council around a potential cross-boundary Heat Network Zone in southeast Edinburgh. It is envisaged that further dialogue will take place around the scope to utilise heat from disused mine workings.
- "Identify Heat Network Zones across the city" – this action is closely linked to the central purpose of the Edinburgh LHEES. Some initial analysis has been undertaken to identify areas within Edinburgh with strong potential for the development of a heat network, and several potential strategic heat networks are in various stages of development. Building upon the work to date, the Edinburgh LHEES provides robust analysis on the areas of Edinburgh with the greatest potential for Heat Network Zones. This analysis, along with additional data from building assessment reports, will form the basis of recommendations around the formal designation of Heat Network Zones in Edinburgh in line with the emerging regulatory regime stemming from the Heat Networks (Scotland) Act 2021.
- "Ensure all Council-led infrastructure investment plans seek opportunities to connect to heat networks, beginning with our learning estate programme" – City Plan 2030 requires all new buildings in Edinburgh to connect to a heat network "if practical". In terms of existing buildings, where heat networks are present or are planned to be delivered, the scope to connect to these will be explored. This will begin with Granton Waterfront where existing Council operational properties are proposed to connect to the heat network once operational.
- "Work with communities and developers to deliver heat networks which meet the needs of key public sector buildings and major new developments across the city, beginning with Granton Waterfront and the BioQuarter" – as set out in section 7.3, the Council and its partners are developing a suite of heat network projects, with Granton Waterfront and Edinburgh BioQuarter the two furthest advanced projects.
- "Collaborate on place-based joint energy infrastructure projects which maximise opportunities to deliver low-cost, clean, renewable energy to neighbourhoods and

communities, with a focus on areas experiencing inequalities" – no projects of this nature have been delivered to date. Consideration would need to be given to energy sources, funding models, and other practicalities.

- "Align strategic investment in the electricity grid with development plans, to support increased local energy generation" – as noted above, the Council has established a strategic relationship with SP Energy Networks.
- "Explore the potential for creating local energy generation communities as part of proposed net zero communities' pilots" – phase two of the Net Zero Communities pilot will include an evaluation of community energy generation potential using "Green Heat in Green Spaces" data.
- "Develop a city-wide programme of community energy generation investment opportunities" – this programme has not yet been developed. Phase two of the Net Zero Communities pilot will inform development of this.
- "Develop a Whole House Retrofit delivery programme for retrofitting social housing across the city to the highest energy standards, to reduce energy demand and tackle fuel poverty" – as set out in section 7.3, an investment programme is underway to retrofit the Council's housing stock in line with the Energy Efficiency Standard for Social Housing 2.
- "Establish an Energy Efficient Public Buildings Partnership to collaborate on retrofit, align investment plans and encourage confidence in, and planning for, the business and skills supply chain needed to deliver" – this partnership has been established as part of the City Heat & Energy Efficiency Board.
- "Ensure retrofit programmes create green jobs and fair work opportunities for citizens, targeting those at greatest risk of poverty" – Council-led retrofit programmes will deliver community benefits as part of the procurement process.
- "Call on the Scottish Government to work with city partners to identify and deploy sufficient resources to deliver net zero public buildings" – the Scottish Government has deployed the Scottish Central Government Energy Efficiency Grant Fund, Scottish Public Sector Energy Efficiency Loan Scheme, and Scotland's Public Sector Heat Decarbonisation Fund to support the costs of retrofitting national public sector bodies' buildings. However, the costs of fully retrofitting all public sector buildings in Edinburgh is unlikely to be capable of being funded by the public sector directly, and so it is anticipated that mechanism will require to be developed to leverage institutional funds into retrofit in Edinburgh. Further, as set out in the Delivery Plan, greater certainty over long-term funding is necessary.
- "Develop a new mechanism and business plan to support small businesses, owner occupiers and private landlords to affordably retrofit their properties" – while grant funding from bodies such as Home Energy Scotland and Business Energy Scotland is available, it is recognised that these bodies will not be able to meet all the costs of retrofitting properties in Edinburgh. The scale of investment required is likely to require institutional funding. As above, a mechanism will require to be developed to support this investment.
- "Develop electricity grid infrastructure and capacity to respond to increased demand from electric-powered heat" – as noted above the Council has established a strategic

relationship with SP Energy Networks. The Edinburgh LHEES identifies the Strategic Zones where heat pumps are most likely to present a good solution.

- "Work with SP Energy Networks and the Scottish Government to identify measures to reduce the cost of electricity and support citizens to transition away from gas" – a reduction in electricity prices is likely to be pivotal to the decarbonisation of heat in Edinburgh, as presently the high cost of electricity relative to gas can make the viability of solutions such as heat pumps and direct electric heating a challenge. Reducing electricity prices is largely outwith the competencies of the Council. However, there is scope to reduce dependency on high grid prices via increased generation within Edinburgh (ranging from micro-renewable installations on buildings to larger projects such as solar meadows and hydropower) coupled with storage.
- "Call on the Scottish Government to bring forward at speed improved schemes to support citizens to fund energy efficiency upgrades and decarbonise of heat in their homes" – support for households to improve energy efficiency and decarbonise heating is provided by Home Energy Scotland and via Area-Based Schemes, as well as via others schemes such as Warmer Houses Scotland and ECO4 / the Great British Insulation Scheme. The lack of long-term certainty around these schemes has been identified by the Council as a challenge in terms of developing a long-term strategy for decarbonising homes. As noted above, institutional funds are likely to be required to achieve retrofit and decarbonisation of all homes.
- "Scope and test innovative approaches to retrofit in challenging mixed-tenure settings, to develop models and accelerate progress" – as part of the retrofit of its social housing stock and operational estate, the Council has developed models for the retrofit of various building archetypes.

7.3. Council estate and Council-led area interventions

Refurbishment of existing social housing

7.3.1. The Council is the largest registered social landlord in Edinburgh and one of the largest in Scotland with a growing portfolio of approximately 19,000 social homes.

7.3.2. The Energy Efficiency Standard for Social Housing 2 (EESSH2) sets a milestone of all social housing in Scotland achieving an Energy Performance Certificate rating of 'B' or better, or being "as energy efficient as practically possible", by the end of 2032 ("within the limits of cost, technology and necessary consent"). The EESSH2 further states "no social housing below EPC Band D should be re-let from December 2025, subject to temporary specified exemptions." The EESSH2 is currently being reviewed by the Scottish Government. As of March 2023, 12% of the Council's social homes met EESSH2.

7.3.3. The Council's investment in housing is underpinned by the Housing Revenue Account Business Plan for the 30-year period 2023/24 to 2052/53. The Business Plan projects that, based on annual rent increases of 2.5%, 81% of the Council's portfolio of social housing could be brought up to EESSH2 standard over the lifetime of the Business Plan, i.e. by 2053. Accelerating this transformation would require increased rent or grant income.[54] Conversely, should rent income increase by less than this, the ability of the Council to achieve this target would be impeded.

Whole House Retrofit

7.3.4. The Council fully adopted a "Whole House Retrofit" (WHR) approach to the retrofit of high-rise housing blocks in 2023. This entails a "fabric first" approach to improving energy efficiency, designing-out poor performance (e.g. reducing heat loss, removing thermal bridges/cold spots, and reducing the build-up of moisture via an appropriate ventilation strategy) whilst ensuring all elements complement one another rather than work against one another. The Council has predicted that a WHR approach can reduce energy demand for the average home by 50% to 75%.

7.3.5. To support the delivery of the WHR programme, the Council is recruiting additional staff, upskilling existing staff, and delivering apprenticeships.

7.3.6. The cost of delivering the WHR programme is estimated to average approximately £56,000 per home. However, some properties are likely to prove significant more expensive to address; the refurbishment of the residential blocks Inchmikery Court and Oxcars Court (representing a total of 151 homes) via the installation of a new external building envelope sitting 1.5 metres outwith the existing frame to improve the energy efficiency of the buildings (with a targeted improved Energy Performance Certificate rating of 'B') is projected to cost £25 million to £30 million: approximately £166,000 to £199,000 per home.

7.3.7. As noted, the WHR programme takes a fabric first approach. The Council does not currently plan to replace existing heating systems until they are nearing the end of their working lives., but the interventions carried out under the WHR programme will support the move to zero direct emissions heating systems at a future date. As noted below, all new build Council housing developments use zero direct emissions heating systems.

Mixed Tenure Improvement Service

7.3.8. The Council's Mixed Tenure Improvement Service (MTIS) delivers improvements to energy efficiency (as well as common repairs and maintenance) in mixed tenure buildings where there are a mix of properties owned by private owners and the Council. The costs of common works are shared amongst the respective owners in line with the title deeds of the buildings in question and the Tenements (Scotland) Act 2004. MTIS organises, plans, and oversees works with input from tenants and private owners.

7.3.9. In 2021, the MTIS began a £30 million programme of upgrades to the Wester Hailes neighbourhood of Edinburgh, with the Council investing £20 million and private owners and Area-Based Scheme funding making up the remainder of contributions. The first two years of the works saw energy efficiency upgrades carried out to over 900 homes, including over 670 Council-owned homes and 230 privately-owned homes.

7.3.10. Following on from the Wester Hailes pilot, the MTIS service is planned to be expanded to cover other areas of Edinburgh, initially Lochend and Restalrig.

Area-Based Schemes

7.3.11. Area-Based Schemes (ABS) provide grant-in-aid for private households at risk of fuel poverty, prioritising harder to treat homes that require solid wall insulation or complex cavity wall insulation. The aim of the scheme is to bring all homes up to EPC 'C' standard by 2030.

7.3.12. ABS are funded by the Scottish Government and designed and procured by local authorities. The City of Edinburgh Council was offered £5.16 million of funding for 2022/23.

7.3.13. ABS are focused on homes in economic disadvantaged areas (Council Tax bands A to C and low-ranking SIMD areas) with an EPC rating below 'C'. Eligibility for the ECO3 scheme can be used as a proxy for eligibility.

7.3.14. ABS have been found to be a good solution for mixed tenure and multi-occupancy properties.

7.3.15. Between 2013/14 and 2023/14, a total of 11,072 interventions were carried out across Edinburgh under ABS, including 5,226 instances of cavity wall insulation; 4,005 instances of solid wall insulation; and 519 instances of loft insulation.

Development of new social housing

7.3.16. The Council resumed the development of new social housing in 2008 via its 21st Century Homes programme. In 2017, the Council set a target of delivering 10,000 new social homes by 2027.

7.3.17. In 2020, the Council adopted a housing sustainability approach. As part of this, no new Council homes are fitted with gas boilers, and homes are built to Passivhaus standard.

7.3.18. As of January 2023, the Council had 613 social homes under construction, with a further 1,044 in design or pre-construction. The housebuilding capital budget for 2023/24 was approximately £100 million. Current major ongoing and planned developments are:

- D1 – 75 homes (including 48 social homes) heated via an air source heat pump-based communal heating system.
- Fountainbridge – 464 homes (including 186 social homes) heated via individual air source heat pumps.
- Granton Waterfront, phases 1 to 4 – 2,864 homes (including circa 700 social homes) heated via a 4-megawatt sewer-source heat pump (with a ground-mounted solar photovoltaic array helping meet the heat pump's electricity requirements).
- Greendykes K and L – 140 homes (including 74 social homes) heated via a mix of individual air source heat pumps and individual exhaust air source heat pump.
- Meadowbank – 680 homes (including 240 social homes) heated via individual air source heat pumps, supplemented via mechanical ventilation with heat recovery.
- Murrayburn Gate – 73 homes (including 41 social homes) heated via individual air source heat pumps.
- Powderhall – 259 homes (including 107 social homes) heated via individual air source heat pumps, supplemented by electric radiators, with rooftop mounted solar photovoltaics.
- Silverlea – 142 homes (including 91 social homes) heated via individual air source heat pumps.
- Western Villages – 444 homes (including 195 social homes) heated via an air source heat pump-based communal heating system.

7.3.19. The development of new social housing by the Council is steadily increasing the stock of energy efficient homes in Edinburgh.

Operational estate

7.3.20. The Council has a large and complex operational estate of over 400 buildings, many of them of advanced age. The Scottish Government's Heat in Buildings Strategy sets a target of all publicly owned buildings in Scotland meeting zero direct emissions heating requirements by 2038. The Council has set a target of all operational properties achieving net zero status by 2030.

7.3.21. In 2019, the Council adopted an Energy Management Policy that set out three aims with regards to the estate: to minimise energy consumption; to achieve ongoing improvements through recording, benchmarking, monitoring, and reporting on energy usage; and to promote the conservation of energy.[55] The Council's Corporate Property Strategy align lifecycle investment in the Council's operational estate with works to decarbonise properties.

7.3.22. Key identified challenges associated with decarbonisation of the operational estate include:

- The greater unit cost of electricity relative to gas, meaning a transition from natural gas to electricity will, all other things being equal, increasing running costs of buildings.
- Electricity grid constraints associated with a move from natural gas-based to electricity-based heating solutions.
- Practical challenges associated with retrofitting certain buildings.
- Financial challenges where retrofit does not present a conventional payback.

7.3.23. New Council operational buildings are built to Passivhaus standard by default to minimise energy consumption. For existing buildings, the Council has adopted an EnerPHit-informed standard as the most appropriate standard for deep energy retrofits.

7.3.24. In 2022, the Council approved the EnerPHit Tranche 1 Programme: a £61.83 million programme to retrofit 12 Council operational buildings to an EnerPHit-informed standard over the period 2022/23 to 2027/28.[56] This programme is intended to serve as a pathfinder for the retrofit of further Council properties.

7.3.25. In June 2023, the Council submitted a planning application for Brunstane Primary School, the first operational building to be piloted via the EnerPHit Tranche 1 Programme. Surveys of the school identified multiple challenges including a lack of insulation, poor U-values, poor airtightness, and significant thermal bridges. The measures that will be undertaken in response to these challenges are replacing doors and windows, adding new external wall insulation, adding roof insulation, replacing curtain walling with rainscreen cladding, and installing air source heat pumps providing space heating. The retrofit is planned to achieve a 73% reduction in energy usage, while increasing user comfort via providing more consistent temperatures and improved fresh air circulation.

Investment portfolio

7.3.26. The Council also has a large investment portfolio of over 1,000 buildings which are leased out to provide an income stream to the Council. By dint of this the Council is one of the largest commercial property landlords in Edinburgh.

7.3.27. The portfolio is highly diverse, with the main categories of property being (in descending order of quantity) industrial units, retail units, offices, and leisure properties (hotels, bars, and restaurants). It varies considerably in terms of age, condition, and other factors. The

portfolio experiences growth via a combination of acquisitions, new developments, and repurposing of existing Council assets as investment properties.

7.3.28. The Council's Portfolio Strategy sets a goal of managing the portfolio in accordance with the Council's climate and sustainability commitments.[57] The Strategy identifies that some elements of the investment portfolio require improvements in energy performance. The Strategy sets an action of preparing improvement plans to identify the necessary measures to improve the sustainability to the portfolio, with the relevant works to be undertaken when relevant funding has been identified.

7.3.29. New developments instructed by the Council as additions to the investment estate will be developed to achieve extremely high levels of energy efficiency. For example, the Hyatt Centric Edinburgh Haymarket hotel currently being developed for the Council (as head tenant) will be heated entirely using electricity, and is expected to achieve the best energy performance of any hotel of this scale in Scotland.

Parks and greenspaces

7.3.30. The Council has participated with Greenspace Scotland in the ParkPower project, which aims to leverage urban green and blue spaces to decarbonise energy in Scotland.

7.3.31. Saughton Park in Edinburgh has been transformed into Scotland's first "green-powered park". The park now incorporates a micro-hydro scheme to generate electricity and ground-source heat pumps to generate heat.

7.3.32. In June 2020, the consultancy Ramboll prepared a report for the Council on the energy potential of greenspaces in Edinburgh.[58] A total of 165 greenspaces were reviewed, of which two sites were identified as having the greatest potential:

- Inverleith Park – identified as a potential heat export site, with opportunities for both water-source heat pumps and ground-source heat pumps.
- Jack Kane Centre and Park – identified as a potential heat island site, where the energy demand of buildings on site could be met on site.

7.3.33. In August 2020, Ramboll prepared a follow-up report for the Council.[59] The follow-up report set out a technoeconomic appraisal of the potential for low carbon heat projects at Inverleith Park and the Jack Kane Centre and Park. The report identified the following:

- Inverleith Park – potential for 6.37-megawatt capacity heat pumps.
- Jack Kane Centre and Park – potential for 0.16-megawatt capacity heat pumps.

7.3.34. Further development of this progress is pending management resource and funding.

7.4. Heat networks

Overview

7.4.1. The City of Edinburgh Council is currently supporting the development of multiple heat networks projects in Edinburgh. Of the 17 heat network projects being supported by the Scottish Government as of March 2023, four were in Edinburgh.[60]

7.4.2. In addition to its role as a developer and customer of heat networks, the Heat Networks (Scotland) Act 2021 and The Heat Networks (Heat Network Zones and Building Assessment

Reports) (Scotland) Regulations 2023 introduce a number of duties for the Council with regards to heat networks. These are as follows:[xxiv]

- Conducting a review to consider whether one or more areas within Edinburgh is likely to be particularly suitable for the construction and operation of a heat network (and publishing the results of the review).
- Designating areas deemed particularly suitable for the construction and operation of a heat network as "Heat Network Zones".
- Acting as "consent authority" for Edinburgh, i.e. awarding (and revoking) consents for the development of heat networks in Edinburgh.[xxv]
- Producing "building assessment reports" (BARs) for non-domestic buildings owned by the Council with an annual heat demand of at least 73 megawatt-hours per year, providing data on heat sources and demand, to inform whether areas are suitable for the development of heat networks.

Existing heat networks

7.4.3. Data from the Scotland Heat Map indicates that there were 153 heat networks and communal heating systems in Edinburgh as of 2023 – around 14% of the Scottish total. These are listed in Table 48 and illustrated in Figure 01.

7.4.4. Based on the Scotland Heat Map data, the following statements can be made about the 153 heat networks and communal heating systems:

- 127 (83%) of the heat networks / communal heating systems ran off a (gas) boiler; 11 (7%) ran off a combined heat and power plant; and one (1%) ran off trigeneration, with 18% (12%) running off an unknown technology.
- Three (3%) of the heat networks / communal heating systems were micro (less than 45 kilowatts); 113 (74%) were small to medium-sized (≥45 kilowatts to <1 megawatt); and 20 (13%) were large (≥1 megawatt) with 17 (11%) being of unknown size.
- The neighbourhoods of Edinburgh (defined using intermediate areas) with the greatest number of heat networks / communal heating systems were "Old Town, Princes Street and Leith Street" (18 / 12%); "South Gyle" (10 / 7%); "Tollcross" (12 / 8%); "Deans Village" (12 / 8%); and "Meadows and Southside" (10 / 7%).

7.4.5. It is understood that many of the existing heat networks / communal heating systems are serving multiple units within a single building, or form part of a university campus or other cluster of buildings under a single ownership. It is further understood that most of the existing heat networks / communal heating systems run off mains gas and therefore would not currently contribute to the fulfilment of the targets set out in the Edinburgh LHEES. It is therefore envisaged that work will be required to decarbonise most of the existing heat networks.

7.4.6. It is noted that many of the existing heat networks fall within prospective Heat Network Zones. Dialogue with the Scottish Government has indicated that the emerging permit

[xxiv] The Act also empowers the Scottish Government to designate bodies as the "permit authority" or "licensing authority". It is possible that the Council could be designated the permit authority and/or the licencing authority for Edinburgh.

[xxv] Subject to the Council writing to the Scottish Government to request it be designated as the consent authority, or the Scottish Government designating the Council as the consent authority.

regime will not apply to existing heat networks, i.e. existing heat networks that fall within a Heat Network Zone will not require to secure a permit in order to continue operating, nor will permit holders have the ability to "take over" existing heat networks within the Heat Network Zone in question. However, the introduction of the permitting system may nonetheless give rise to some challenges where there are existing heat networks, for example:

- If an existing heat network operator within a Heat Network Zone does not hold the permit for that zone, this may impede them from being able to expand their network.
- Where a heat network developer has secured a permit for a Heat Network Zone, the presence of existing heat networks within the zone may mean that the available demand is less than envisaged, for example where one or more anchor loads are already connected to an existing heat network.

First National Assessment

7.4.7. The First National Assessment of Potential Heat Network Zones was published by the Scottish Government in 2022.[61] The assessment utilises data on heat demand to identify potential Heat Network Zones in Scotland; it does not account for considerations such as future developments, existing heat networks, sources of heat, and practical barriers. The analysis set out in the Edinburgh LHEES therefore builds upon the First National Assessment by incorporating a wider raft of considerations.

7.4.8. The prospective Heat Network Zones identified in the First National Assessment are primarily based upon linear heat densities of 4,000 kilowatt hours per metre (of pipe) per year as a baseline, or 8,000 kilowatt hours per metre (of pipe) per year as a more stringent approach.

7.4.9. The First National Assessment (baseline analysis) identified a total of 647 potential Heat Network Zones across Scotland with a notional combined heat demand of 25,672,514 megawatt hours per annum.[xxvi] Anchor loads account for 14.1 terawatt hours per year – 54.9% of total demand.

7.4.10. Within Edinburgh, the First National Assessment identified a total of 41 potential Heat Network Zones. A map of the zones is shown at Figure 02. The 41 zones represented a total of 51,206 properties (38,649 residential and 10,942 non-domestic), with a total combined heat demand of 3,404,609 megawatt hours per annum.[xxvii] 569 anchor loads accounted for 43% of heat demand. Significantly, 24,531 (48%) of the properties were identified as "heritage" properties.

7.4.11. The single largest zone in Edinburgh identified in the First National Assessment is zone "CE-309-St1", which is centred on the city centre, with spurs stretching southwest to Marchmont and Morningside, southeast to Newington, northwest to Orchard Brae, and northeast to Shrubhill. A map of this zone is shown at Figure 03. The zone includes 14,024 properties with a combined annual demand of 1,011,845 megawatt hours per annum.[xxviii] 79% of the properties are "heritage" properties.

[xxvi] I.e., 25,673 gigawatt hours or 25.7 terawatt hours
[xxvii] I.e., 3,405 gigawatt hours or 3.4 terawatt hours
[xxviii] I.e., 1,012 gigawatt hours or 1.0 terawatt hours

7.4.12. The First National Assessment provides a useful illustration of where Heat Network Zones are most likely to be viable, and the potential scale of heat networks that could be realised in Edinburgh. Some of the Heat Network Zones identified in the First National Assessment may be unviable due to the practical considerations set out above, but conversely other zones may emerge due to pipeline property developments not captured by the First National Assessment.

Granton Waterfront

7.4.13. The Granton Waterfront is a 140-hectare brownfield ex-industrial neighbourhood. Over the next 10-15 years, the Council will take forward a major mixed-use regeneration of the area delivering thousands of homes, a primary school, a medical centre, and significant new commercial space. In line with the target of Edinburgh achieving net zero carbon by 2030, the Council is seeking to deliver a low carbon heat network that will supply cost-competitive heat from low carbon sources to Granton Waterfront and the surrounding area.

7.4.14. The Council has assessed various options for delivering a low carbon heat network at Granton Waterfront. In March 2022, the Council finalised an options appraisal and detailed technical feasibility study that identified a preferred solution for the heat source: a 4-megawatt heat pump utilising heat from the sewer running beneath Granton Waterfront, supplemented by two 10 megawatt electric boilers for resilience, with a 1-megawatt ground-mounted solar photovoltaic array helping meet the network's electricity requirements.

7.4.15. The anchor loads for the heat network would be 12 existing and new public sector buildings totalling over 86,900m^2, along with 3,383 domestic properties and a further 9,000m^2 of commercial space. There is scope to add additional connections.

7.4.16. Building on this preferred technical solution, the Council finalised an outline business case in March 2023. As part of this, a full options appraisal was carried out with a commercial advisor. Based on the size, scale and complexity of the network, and the risks around managing the timescales to meet the first connections along with securing enough heat demand to ensure its viability, it was determined that the preferred route to delivering the heat network is a concession model. This would see the Council enter into a 40-year design, build, operate, finance, and maintain concession agreement with a private sector concessionaire, ensuring a partner with a proven track record in managing networks takes this forward whilst achieving a high degree of risk transfer to the private sector while retaining Council control over key aspects including price controls and capped returns.

7.4.17. The projected capital expenditure required to deliver the heat network is £81.048 million. Grant funding of £19.892 million from the Heat Network Fund would achieve an internal rate of return of 10%, making the project commercially attractive.

7.4.18. The techno-economic model developed for the project indicates that, for a typical household with an assumed annual demand of 3,670 kilowatt hours, the heat network would achieve a fixed tariff of £621 and a variable tariff of £287, representing an indicative total annual cost of £909. This compares to a projected annual cost of £821 for gas boilers with 85% efficiency and low maintenance needs and £971 for gas boilers with 85% efficiency and high maintenance needs.

7.4.19. The next step for the Granton Waterfront heat network is to procure a concessionaire. It is planed that the heat network will be operational in late-2025 to coincide with the occupation of the first new homes delivered by the Granton Waterfront regeneration.

Edinburgh BioQuarter

7.4.20. Edinburgh BioQuarter is a major life sciences development in the Little France neighbourhood of Edinburgh centred on the Royal Infirmary of Edinburgh and the Royal Hospital for Children & Young People. The Edinburgh BioQuarter partnership – comprising the Council, NHS Lothian, Scottish Enterprise, and the University of Edinburgh – has developed proposals for a mixed-use expansion of Edinburgh BioQuarter delivering two million square feet of commercial innovation space and 2,000 homes. Work is currently ongoing to appoint a private development partner to take forward the future development of Edinburgh BioQuarter.

7.4.21. A sustainability strategy developed for Edinburgh BioQuarter requires all new buildings to be direct zero carbon by 2030 (and all existing buildings by 2040).

7.4.22. In March 2023, the consultancy Ramboll published a feasibility study on the scope to develop a heat network serving Edinburgh BioQuarter.[62] The study concluded the preferred solution was a fourth-generation heat network and district cooling network utilising waste heat from the Millerhill Recycling and Energy Recovery Centre supplemented by peaking electric boilers.

7.4.23. The study found that the proposed heat network would achieve a variable heat charge tariff of circa 7.5 pence per kilowatt hour. It would achieve carbon savings relative to the business-as-usual scenario (which assumes a mix of gas boiler and building-level air source heat pumps) of 5,700 to 14,300 tonnes of carbon dioxide equivalent over the 40-year project period – 9.8% to 24.6%.

7.4.24. The next step for the project is for the various off-takers (including the Council) to develop business cases for connecting their properties to the proposed heat network.

Gracemount

7.4.25. In 2022, the Council appointed Buro Happold to prepare a feasibility study on the scope for a new heat network in the Gracemount neighbourhood of Edinburgh.[63] The proposed network would serve a cluster of Council-owned buildings – Gracemount High School; Gracemount Leisure Centre, Gracemount Nursery; Gracemount Primary School; Kaimes School; Libertus Services; St Catherine's RC Primary School; and the South Neighbourhood Office and Library – and the NHS Medical Practice.

7.4.26. The feasibility study assessed various options based on air source heat pumps and ground source heat pumps which were compared with a counterfactual option of building-level air source heat pumps. The preferred option was identified as being a closed loop 750-kilowatt ground source heat pump with a 2,300-kilowatt electric boiler top-up and a 25,000m^3 thermal store.

7.4.27. The heat network would achieve a heat sales tariff of 13.3 pence per kilowatt hour, which is comparable to that achieved by building-level air-source heat pumps but higher than the current cost of gas (circa 7.5 pence per kilowatt hour). However, it is noted that future increases in gas prices would narrow this gap, while there is scope to achieve lower electricity prices via (for example) private purchasing agreements.

7.4.28. The heat network would achieve carbon savings of 35,426 tonnes of carbon dioxide equivalent over a 40-year period relative to gas – savings of 96.5%. Further reductions could be achieved by sourcing green electricity.

7.4.29. The projected cost of delivering the heat network is £4.2 million, which represents a negative net present value. Grant funding of £1.62 million would achieve a positive internal rate of return of 4%.

7.4.30. The next step for the Gracemount heat network will be to prepare an outline business case.

Seafield

7.4.31. In 2023, the Council appointed a design team led by 7N Architects to prepare a masterplan for the regeneration of the Seafield Regeneration Area (SRA) in Edinburgh. As part of the commission, the design team was charged with producing "a low/zero carbon energy strategy for the SRA, to include an initial technical assessment of the scope to utilise heat from the Seafield Waste Water Treatment Works and the Firth of Forth for a district heating scheme".

7.4.32. The design team has produced initial proposals for a heat network serving the SRA that would utilise wastewater discharged from the Treatment Works at a temperature of 15°C. The heat network could potentially be scaled further to serve other properties in the vicinity.

7.4.33. This proposal is at an early stage but offers scope to incorporate a low carbon heat network solution into a comprehensive regeneration project from the outset, potentially delivering significant efficiencies and informing other new developments.

Cross-boundary Heat Network Zones

7.4.34. In 2022, Zero Waste Scotland and Buro Happold – in conjunction with the City of Edinburgh Council, East Lothian Council, and Midlothian Council – carried out analysis on potential cross-boundary heat network opportunities in the three aforementioned local authority areas.[64] The analysis identified three potential cross-boundary zones King's Buildings; Millerhill and Shawfair; and the Royal Infirmary of Edinburgh and Edinburgh BioQuarter.

7.4.35. The designation of cross-boundary Heat Network Zones is likely to add complexity in terms of the emerging licencing and permitting regime, albeit section 52 of the Heat Networks (Scotland) Act 2021 makes provision for Heat Network Zones spanning two or more local authority areas.

Communal heating systems

7.4.36. Multiple existing Council buildings have communal heating systems. The current communal heat source is primarily natural gas fired boilers, with some buildings being augmented by gas-fired combined heat and power machines or solar thermal storage vessels.

7.4.37. In 2023, the Council inaugurated a new framework for the operation, management, and maintenance of communal heating systems for Council homes. The framework covers design development guidance and support in addition to operational, maintenance, metering, and billing services for existing and new build housing developments that are served by communal heating or local heat networks.

7.4.38. The framework has been utilised for the Council's D1 development in Granton Waterfront, which comprises 75 flats heated via a communal heating system fed by two air source heat pumps and two water-to-water heat pumps, achieving a flow temperature of 65°C and a return temperature of 57°C. Each flat will be fitted with smart meters. Under the terms of the framework, Vitali Energy will operate and maintain the communal heating system on behalf of the Council.

7.5. Solar installations

7.5.1. The City of Edinburgh Council (in partnership with the Edinburgh Community Solar Co-operative) has carried out multiple solar installations, primarily on the roofs of Council-owned buildings. These have typically been relatively small-scale and are dependent on the orientation of the building's roofs. Additionally, installing solar panels on building roofs has in some cases caused issues when the roofs in question required maintenance, with cost and disruption associated with relocating the panels. This has led the Council to explore the potential of larger-scale ground-mounted solar installations.

7.5.2. Initial investigation has been undertaken on several Council-owned sites to assess their readiness for solar installations, in particular the readiness of grid connections.

7.5.3. The replacement of Feed-in Tariffs with the Smart Export Guarantee means that developing solar installations for the purposes of exporting electricity is now unlikely to be financially viable. Given this, solar installations are likely to be most viable where the electricity generated can be used to supply buildings in the vicinity.

7.5.4. There is considered to be good potential for solar installations in Edinburgh, but further investigation into technical and commercial viability is required. A map of homes in Edinburgh identified as having good solar suitability is shown at Figure 25.

7.6. Energy for Edinburgh

7.6.1. In 2016, the Council incorporated Energy for Edinburgh Limited ("EFE"), an arm's length energy services company. A business plan prepared at this time identified three immediate areas of focus for EFE: solar photovoltaics, heat networks, and non-domestic energy efficiency. The company has not traded since being incorporated. The company currently has approximately £190,000 of funding available for energy project activities.

7.6.2. In April 2023, the Council prepared an options appraisal on the future of EFE. The appraisal concluded that there is currently no clear role for EFE but that it could potentially be used to progress heat network projects subject to further, more detailed, assessment. In August 2023, the Council's Policy and Sustainability Committee agreed that, following the publication of the Edinburgh LHEES, the Council should develop a business case looking at the scope for EFE to deliver heat network projects on a joint venture approach, to include exploration of embedding cooperative principles and community wealth building into EFE.

7.7. Conservation areas adaptation

7.7.1. On 2 November 2022, the City of Edinburgh Council's Planning Committee agreed to establish a short-term working group to assess the additional challenges association with the adaptation of homes in conservation areas to improve their energy efficiency, reflecting the need to balance making these improvements with protecting Edinburgh's built heritage.

7.7.2. In response to the decision, in spring 2023 the Council carried out consultation with residents living in listed buildings and/or conservation areas in Edinburgh on the challenges associated with adapting their homes to make them more efficient. The Council subsequently established a working group comprising planning officers; elected members; bodies with an interest in the historic environment, energy saving, and/or fuel poverty; and residents to review the feedback from the consultation and develop potential solutions. The

outcome of the working group was to improve communication of guidance and policies around retrofit works to historic buildings in Edinburgh.

7.8. Net zero communities

7.8.1. The 2030 Climate Strategy introduced a commitment to pilot a "net zero communities" approach: identifying a scalable approach to the retrofit of private housing across a community. The aim of the pilot is to improve understanding of building typologies; assess the level of opportunity for net zero projects within the community; enable community collaboration and decision making; identify existing funding packages; explore more strategic approaches to funding; and explore supply chains.

7.8.2. The Net Zero Communities pilot has been carried out on behalf of the Council by Changeworks. The second phase of the pilot will deliver the following:

- A technical feasibility assessment with detailed archetype modelling of measures and costs of net zero interventions for bungalows and one other typology, including evaluation of community energy generation potential.
- An engagement plan setting out community barriers and needs to support further community buy-in for community-led retrofit.
- High level toolkits and data for wider community use and deep modelling of "comfort as a service" potential to inform a scalable business case.

7.8.3. The Council is also involved in the Net Zero Neighbourhoods initiative led by the Cities Commission for Climate Investment (3Ci), which is exploring neighbourhood-level decarbonisation programmes. 3Ci has convened a Net Zero Investment Taskforce that is investigating the opportunities, challenges, and solutions around bringing additional private investment into neighbourhood-level decarbonisation projects.

7.9. Supply chain development and procurement

7.9.1. As set out in section 4.5, there are significant pressures on the availability of skills associated with heat decarbonisation, in particular a lack of heat pump installers in the market.

7.9.2. The Council has held discussions with Scottish Enterprise (Scotland's national enterprise agency) around the strengthening of the supply chain for net zero heating solutions. Scottish Enterprise's primarily focus is on manufacturers, technologists, and solution providers, but the agency will also support installers/contractors who have with innovative approaches that can reduce costs and disruption. Consideration has been given to staging "meet the buyer" events to stimulate the supply chain. Scottish Enterprise wishes to understand how the delivery of Local Heat and Energy Efficiency Strategies across the 32 Scottish local authorities will impact on the market.

7.9.3. Scotland Excel has developed a framework for procurement associated with Local Heat and Energy Efficiency Strategies. The framework is planned to be active from 2024 and is divided into three lots as follows:

- Lot 1 – Local Heat and Energy Efficiency Strategies (provision of services for Scottish local authorities related to Local Heat and Energy Efficiency Strategies).
- Lot 2 – Heat Network Zoning (provision of services for Scottish local authorities related to heat network zoning, supporting local authorities to review and evaluate the potential for heat networks at a strategic, area-wide level and to further the

development of Heat Network Zones from this strategic level towards project identification and feasibility assessment).

- Lot 3 – Local Area Energy Planning (the provision of services for Scottish local authorities related to Local Area Energy Plans, supporting local authorities to complete the technical analysis required for Local Area Energy Plans to enable net zero planning).

7.9.4. As set out in section 4.5, various government schemes are in place to help develop the supply chain, particularly with regards to heat pumps. While technological innovation is outwith the scope of the Edinburgh LHEES, it is recognised that this support has the potential to improve deliverability of heat decarbonisation.

7.10. City Heat & Energy Efficiency Board

7.10.1. A City Heat & Energy Efficiency Board for Edinburgh was established in 2023. This sits below the wider Edinburgh Infrastructure and Investment Programme Board (IIPB), now rebranded as the Net Zero Edinburgh Leadership Board, which was established to "support collaborative development of strategic city infrastructure in line with Edinburgh's net zero target by 2030".

7.10.2. The City Heat & Energy Efficiency Board is one of four thematic boards feeding in to the IIPB. Its aim is to "develop a whole city strategic approach for new build and retro fit of domestic and public buildings to meet [Edinburgh's] future energy needs" and to "ultimately deliver a Heat and Energy Masterplan that supports inclusive growth, workforce opportunities".

7.10.3. The goals of the Board are to:

- Develop a whole city strategic approach for new build and retrofit of domestic and public buildings while building new financial models for estates transformation.
- Complete an analysis of large building retrofit needs across the city.
- Deliver a Heat and Energy Masterplan.
- Develop an energy project pipeline.
- Share learning from feasibility studies and pilot retrofit projects.

8. Baseline analysis

8.1. Overview of building stock

8.1.1. This chapter of the Edinburgh LHEES provides a thematic overview of Edinburgh's building stock in the context of heat decarbonisation and energy efficiency. It profiles the stock in terms of characteristics such as energy performance; fuel type; tenure; type; and age. The data used to populate this chapter is primarily drawn from the Domestic Baseline Tool and Non-Domestic Baseline Tool, which themselves are based upon Home Analytics and Non-Domestic Analytics databases.

Emissions

8.1.2. Table 06 sets out the emissions of Edinburgh as of 2020. In total, Edinburgh produced 2,046 kilo-tonnes (i.e. 2.046 million metric tonnes) of emissions expressed as carbon dioxide equivalents (CO_2e). The domestic sector (households) accounted for the plurality of emissions in Edinburgh. The next largest sector was transport, which is outwith the scope of the Edinburgh LHEES. The third largest sector by emissions was the commercial sector (the use of electricity and gas by businesses, other than where this falls into other sectors).

8.1.3. Edinburgh accounted for 5.4% of overall Scottish emissions. For context, Edinburgh accounted for 0.3% of Scotland's land area and 9.6% of its population as of mid-2021.[xxix] The breakdown of emissions for Edinburgh is considerably different to that of Scotland, reflecting Edinburgh's character as a largely urbanised local authority area with a service sector focused economy. The domestic, commercial, and public sectors accounted for a disproportionately large share of emissions in Edinburgh relative to Scotland, while the agriculture, industry, and land use sector accounted for a disproportionately small share.

Table 06: Breakdown of emissions in Edinburgh and Scotland by end user sector (kt CO_2e) (2020)

Sector	Edinburgh emissions	Edinburgh percentage	Scotland emissions	Scotland percentage
Domestic	698	34.1%	8,236	21.7%
Transport	597	29.2%	8,496	22.4%
Commercial	247	12.1%	2,024	5.3%
Industry	176	8.6%	6,644	17.5%
Public	164	8.0%	1,208	3.2%
Waste management	124	6.0%	1,477	3.9%
Agriculture	29	1.4%	7,635	20.1%
Land use, land use change, and forestry	11	0.5%	2,223	5.9%
Total	**2,046**	**100%**	**37,945**	**100%**

Source: Department for Business, Energy and Industrial Strategy, UK Local Authority and Regional Greenhouse Gas Emissions

[xxix] National Records of Scotland: Land area and population density by administrative area, Scotland, mid-2021

8.1.4. Table 07 sets out the change in emissions in Edinburgh between 2010 and 2020 by sector. Overall, emissions fell by 44.6%. The commercial sector saw the largest fall in emissions, while the transport and domestic sectors saw the lowest reduction.

Table 07: Emissions in Edinburgh by end use sector (kt CO_2e) (2010 to 2020)

Sector	2010	2020	Change	% change
Domestic	1,135	698	–437	–38.5%
Transport	901	597	–304	–33.8%
Commercial	725	247	–477	–65.9%
Industry	352	176	–175	–49.8%
Public	289	164	–125	–43.3%
Waste management	N/A	124	N/A	N/A
Agriculture	N/A	29	N/A	N/A
Land use, land use change and forestry	18	11	–7	–40.2%
Total	**3,419**	**2,046**	**–1,526**	**-44.6%**

Source: Department for Business, Energy and Industrial Strategy, UK Local Authority and Regional Greenhouse Gas Emissions

Housing stock

8.1.5. There is no single definitive count of the number of buildings in Edinburgh. In part this is due to the number of buildings continually fluctuating as buildings are constructed and demolished. In part it is due to whether certain structures (for example, outbuildings) are treated as separate buildings or whether they are treated as an ancillary element of another building; the approach to this differs by dataset. As of March 2023, the Lothian Valuation Joint Board recorded 262,616 domestic properties (homes) and 23,180 non-domestic properties in Edinburgh: a total of 285,796 buildings.

8.1.6. The analysis carried out found that there was an overall total of 266,144 homes in Edinburgh. Of these, 69% are flats and 30% are houses.

Table 08: Breakdown of homes in Edinburgh by type

Type	Number	Percentage
Flat	184,382	69.3%
…of which block of flats	74,754	28.1%
…of which flat in mixed-use building	36,654	13.8%
…of which large block of flats	36,630	13.8%
…of which small block of flats	36,344	13.7%
House	81,160	30.5%
…of which detached house	23,109	8.7%
…of which mid-terrace house	22,392	8.4%
…of which semi-detached house	21,648	8.1%
…of which end-terraced house	14,011	5.3%

Type	Number	Percentage
Other/unknown	602	0.2%
Total	**266,144**	**100%**

Source: Domestic Baseline Tool

8.1.7. Data from 2017 shows that, compared to Scotland overall, Edinburgh has a far greater proportion of flats, and a far lower proportion of terrace, semi-detached, and detached homes.

Table 09: Breakdown of homes in Edinburgh and Scotland by type (2017)

Type	Edinburgh number	Edinburgh percentage	Scotland number	Scotland percentage
Flats	168,500	67.8%	980,290	37.7%
Terraced	30,671	12.3%	532,963	20.5%
Semi-detached	24,751	10.0%	511,583	19.7%
Detached	24,215	9.7%	558,911	21.5%
Unknown	222	0.1%	19,427	0.7%
Total	**248,359**	**100%**	**2,603,174**	**100%**

Source: National Records of Scotland, Dwellings by Type

8.1.8. The 266,144 homes identified as part of the analysis had an average annual heat demand of 11,537 kilowatt hours, representing a total combined demand of 3.071 billion kilowatt hours per annum (3,071 million megawatt hours per annum).

8.1.9. 60% of homes in Edinburgh are owner-occupied. 21% are rented from private landlords, 11% are rented from the Council, and 8% are rented from housing associations.

Table 10: Breakdown of homes in Edinburgh by tenure

Type	Number	Percentage
Owner-occupied	158,172	59.4%
Rented	107,370	40.3%
…of which rented from private landlords	55,958	21.0%
…of which rented from the Council	21,065	7.9%
…of which rented from housing associations	30,347	11.4%
Unknown	602	0.2%
Total	**26,144**	**100%**

Source: Domestic Baseline Tool

8.1.10. Data from 2017 to 2019 shows that, relative to Scotland overall, Edinburgh had a broadly identical mix of owner occupied to rented properties. However, 61% of rental homes in Edinburgh were owned by private landlords and 39% were owned by social landlords, whereas at a Scottish level two-thirds of rental homes were owned by private landlords. The private rented sector therefore plays a far more significant role in Edinburgh than nationally. 95% of private rented homes (and 82% of social rented homes) in Edinburgh are flats.

Table 11: Breakdown of homes in Edinburgh and Scotland by tenure (2017–2019)

Type	Edinburgh number (000s)	Edinburgh percentage	Scotland number (000s)	Scotland percentage
Owner occupied	148	63%	1,530	62%
Rented	88	37%	949	38%
…of which private rented	54	23%	311	13%
…of which social rented	34	14%	638	26%
Total	236	100%	2,479	100%

Source: Scottish Government, Scottish House Condition Survey: 2017-2019 Local Authority Tables

8.1.11. 48.9% of homes in Edinburgh are located in mixed-tenure buildings. This introduces challenges around the decision-making when multiple owners must align their choices and timings to enable a retrofit.

Table 12: Breakdown of homes in Edinburgh by mixed-tenure status

Mixed-tenure status	Number	Percentage
Not mixed-tenure	135,331	50.8%
Mixed-tenure	130,211	48.9%
Unknown	602	0.2%
Total	**266,144**	**100%**

Source: Domestic Baseline Tool

8.1.12. Only 16% of homes in Edinburgh date from post-2002, i.e. 84% of the city's housing stock is over 20 years old. The largest age band of homes is older pre-1919 buildings (29%) which are hard to treat and require an affordable solution for their owners to decarbonise. Many of these buildings will be among the 10.2% of Edinburgh's domestic buildings which are listed, making it generally unviable to clad them with external wall insulation. It is understood that insulating these buildings (i.e. internal wall insulation which might be the only viable option) can be cost prohibitive, disruptive, and sometimes impractical.

Table 13: Breakdown of homes in Edinburgh by age

Type	Number	Percentage
Pre-1919	78,225	29.4%
1919-1949	35,643	13.4%
1950-1983	71,912	27.0%
1984-1991	14,589	5.5%
1992-2002	23,294	8.8%
Post-2002	41,879	15.7%
Unknown	602	0.2%
Total	**266,144**	**100%**

Source: Domestic Baseline Tool

8.1.13. Data from 2017 to 2019 shows that, relative to Scotland overall, Edinburgh had a significantly older housing stock, with around half of all homes pre-dating 1945.

Table 14: Breakdown of homes in Edinburgh and Scotland by age (2017–2019)

Age	Edinburgh	Scotland
Pre-1945	48%	30%
1945 onwards	52%	70%
Total	**100%**	**100%**

Source: Scottish Government, Scottish House Condition Survey: 2017-2019 Local Authority Tables

8.1.14. The analysis found that there were 27,282 listed homes in Edinburgh – approximately 10% of the overall stock. 69,095 homes sat within conservation areas – 26% of the total stock.

Table 15: Breakdown of homes in Edinburgh by listed status

Type	Number	Percentage
Listed	27,429	10.2%
…of which A listed	6,253	2.3%
… of which B listed	15,288	5.7%
… of which C listed	5,888	2.2%
Not listed	238,715	89.7%
Total	**266,144**	**100%**

Source: Domestic Baseline Tool

Performance of housing stock

8.1.15. This section of the Edinburgh LHEES sets out baseline data on the city's housing stock.

8.1.16. Table 16 breaks down the housing stock on Edinburgh by energy performance certificate (EPC) rating. As set out in section 6.1, the Scottish Government has set a target of all homes in Scotland achieving a minimum EPC rating of 'C' by 2033 where "technically and legally feasible and cost-effective", with regulations to be introduced to this effect. 144,604 homes in Edinburgh (54.3%) achieve an EPC rating of 'C' or above, while 120,938 (45.4%) do not.

Table 16: Breakdown of homes in Edinburgh by energy performance certificate rating

Type	Number	Percentage
A/B	33,263	12.5%
C	111,341	41.8%
D	87,144	32.7%
E	26,336	9.9%
F/G	7,458	2.8%
Unknown	602	0.2%
Total	**266,144**	**100%**

Source: Domestic Baseline Tool

8.1.17. Data from the Scottish House Condition Survey indicates that 53% of homes in Scotland achieved an EPC rating of 'C' or above as of 2021. While not directly comparable, this suggests Edinburgh has a similar performance as Scotland overall in terms of EPC ratings.

Table 17: Breakdown of homes in Scotland by EPC rating (2021)

Type	Number (000s)	Percentage
A/B	123	5%
C	1,185	48%
D	896	36%
E	248	10%
F/G	11	0%
Total	**2,463**	**100%**

Source: Scottish House Condition Survey

8.1.18. 51.0% of homes in Edinburgh have insulated walls, while 48.7% have uninsulated walls. There are approximately 129,706 homes in Edinburgh with uninsulated walls. Of these, 80,708 (62%) are solid brick or stone; 41,592 (32%) are cavity construction; 3,776 (3%) are timber frame; and 3,630 (3%) are system built.

Table 18: Breakdown of homes in Edinburgh by wall construction and insulation

Construction type	Number	Percentage
Insulated	135,836	51.0%
…of which cavity, insulated	89,450	33.6%
…of which solid brick/stone, insulated	7,895	3.0%
…of which system built, insulated	15,611	5.9%
…of which timber frame, insulated	22,880	8.6%
Uninsulated	129,706	48.7%
…of which cavity, uninsulated	41,592	15.6%
…of which solid brick/stone, uninsulated	80,708	30.3%
…of which system built, uninsulated	3,630	1.4%
…of which timber frame, uninsulated	3,776	1.4%
Unknown	602	0.2%
Total	**266,144**	**100%**

Source: Domestic Baseline Tool

8.1.19. Of the 41,592 homes with uninsulated cavity walls, 24,273 were classified as having hard-to-treat cavity walls, as set out in Table 19.

Table 19: Breakdown of hard-to-treat cavity walls in Edinburgh by reason

Construction type	Number	Percentage
Narrow uninsulated cavity risk	13,550	5.1%
Empty cavity: building likely greater than three storeys	10,697	4.0%

Construction type	Number	Percentage
Empty cavity: very severe or severe exposure zone	26	0.0%
Total	**24,273**	**9.1%**

Source: Domestic Baseline Tool

8.1.20. Data from the Scottish House Condition Survey indicates that 58% of homes in Scotland have insulated walls, while 42% have uninsulated walls. While not directly comparable, this suggests that Edinburgh performs somewhat worse than Scotland overall in terms of wall insulation.

Table 20: Breakdown of homes in Scotland by wall construction / insulation (2021)

Construction type	Number (000s)	Percentage
Insulated	1,478	58%
…of which cavity, insulated	1,371	54%
…of which solid/other, insulated	107	4%
Uninsulated	1,051	42%
…of which cavity, uninsulated	522	21%
…of which solid/other, uninsulated	529	21%
Total	**2,529**	**100%**

Source: Scottish House Condition Survey

8.1.21. 130,842 homes (49% of the total) in Edinburgh have lofts. Of these, 63,939 (48.9% of all homes with lofts) achieve the recommended level of loft insulation of 250 millimetres or more, while 66,903 (51.1% of all homes with lofts) have below the recommended level.

Table 21: Breakdown of homes in Edinburgh by loft insulation

Type	Number	Percentage
Loft	130,842	49.2%
…of which 99 mm ≤	25,823	9.7%
… of which 100 mm to 249 mm	41,080	15.4%
… of which ≥ 250 mm	63,939	24.0%
No loft	134,700	50.6%
Unknown	602	0.2%
Total	**266,144**	**100%**

Source: Domestic Baseline Tool

8.1.22. Data from the Scottish House Condition Survey indicates that, of the 76% of homes in Scotland that have lofts, 64% achieved at least 200 millimetres of insultation.

Table 22: Breakdown of homes in Scotland by loft insulation (2021)

Insulation	Number (000s)	Percentage
Loft	1,915	76%
…of which 99 mm ≤	130	5%

Insulation	Number (000s)	Percentage
… of which 100 mm to 199 mm	564	22%
… of which ≥ 200 mm	1,221	48%
No loft	614	24%
Total	**2,529**	**100%**

Source: Scottish House Condition Survey

8.1.23. 81% of homes in Edinburgh have double or triple glazing, while 19% have single (or partial) glazing.

Table 23: Breakdown of homes in Edinburgh by window glazing

Glazing	Number	Percentage
Double/triple	214,263	80.5%
Single/partial	51,279	19.3%
Unknown	602	0.2%
Total	**266,144**	**100%**

Source: Domestic Baseline Tool

8.1.24. 91% of homes in Edinburgh are connected to the gas grid, while 9% are not. Data from the Scottish House Condition Survey for 2017-2019 indicates that around three times as many properties were not connected to the gas grid at a Scottish level as in Edinburgh.

Table 24: Breakdown of homes in Edinburgh by gas grid connection

Gas grid connection status	Number	Percentage
Connected	241,396	90.7%
Not connected	23,735	8.9%
Unknown	1,013	0.4%
Total	**266,144**	**100%**

Source: Domestic Baseline Tool

8.1.25. 85.5% of homes in Edinburgh are heated using mains gas, while 12.4% are heated using electricity. Fewer than 1% of homes use other fuels such as liquified petroleum gas, oil, and biomass/solid fuels. 1.2% of homes have no fuel. A further 13.6% of homes use mains gas a secondary fuel, indicating that in total 99.1% of homes in Edinburgh have some degree of reliance upon mains gas as a fuel type.

Table 25: Breakdown of homes in Edinburgh by primary and secondary fuel type

Type	Primary number	Primary percentage	Secondary number	Secondary percentage
Mains gas	227,550	85.5%	36,317	13.6%
Electricity	33,110	12.4%	33,659	12.6%
Oil	622	0.2%	15	0.0%
Biomass/solid fuels	602	0.2%	6,884	2.6%

Type	Primary number	Primary percentage	Secondary number	Secondary percentage
Liquefied petroleum gas	512	0.2%	64	0.0%
No fuel	3,146	1.2%	N/A	N/A
No secondary system	N/A	N/A	188,603	70.9%
Unknown	602	0.2%	602	0.2%
Total	**266,144**	**100%**	**266,144**	**100%**

Source: Domestic Baseline Tool

8.1.26. Data from the Scottish House Condition Survey indicates that 11% of homes in Scotland are heated via electricity, while 80% use mains gas.

Table 26: Breakdown of homes in Scotland by main fuel type (2021)

Type	Number	Percentage
Mains gas	2,027	80%
Electricity	270	11%
Oil	146	6%
Liquefied petroleum gas	26	1%
Biomass/solid fuels	26	1%
Communal heating system	32	1%
Total	**2,527**	**100%**

Source: Scottish House Condition Survey

8.1.27. Table 27 sets out the main heating system of homes in Edinburgh. The vast majority of homes utilise a boiler. A very small proportion of homes are currently heating via heat networks / communal heating systems or heat pumps.

Table 27: Breakdown of homes in Edinburgh by main heating system

Type	Number	Percentage
Boiler	223,294	83.9%
Storage heaters	20,883	7.8%
Room heaters	8,584	3.2%
Communal	6,768	2.5%
No heating or hot water system	2,883	1.1%
Other	1,878	0.7%
Heat pump	1,252	0.5%
Unknown	602	0.2%
Total	**266,144**	**100%**

Source: Domestic Baseline Tool

8.1.28. Data from 2017 to 2019 shows that, relative to Scotland overall, Edinburgh had a broadly similar proportion of homes with full central heating. Private rented homes were significantly more likely to lack full central heating.

Table 28: Homes in Edinburgh and Scotland with central heating by tenure (2017–2019)

Tenure	Edinburgh central heating	Edinburgh no central heating	Scotland central heating	Scotland no central heating
Owner occupied	96%	4%	96%	4%
Private rented	90%	10%	91%	9%
Social rented	98%	2%	98%	2%
Total	**95%**	**5%**	**96%**	**4%**

Source: Scottish Government, Scottish House Condition Survey: 2017-2019 Local Authority Tables

8.1.29. Of the 266,144 homes in Edinburgh, it is calculated that 54,932 households (20.6%) are in fuel poverty, while 18,364 (6.9%) are in extreme fuel poverty.[xxx] The Scottish House Condition Survey suggests that, as of 2021, 19.6% of households in Scotland were in fuel poverty, while 9.5% were in extreme fuel poverty. These figures are likely to have been exacerbated due to the ongoing cost of living crisis.

Non-domestic stock

8.1.30. Table 29 sets out a breakdown of non-domestic properties in Edinburgh by classification as of March 2023. It can be seen that the four largest categories – offices; shops; industrial subjects; and hotels – together account for 76.4% of all non-domestic properties in Edinburgh. Relative to Scotland overall, Edinburgh has a significantly higher proportion of offices and hotels, and a significantly lower proportion of industrial and leisure properties.

Table 29: Breakdown of non-domestic properties in Edinburgh and Scotland by type (March 2023)

Type	Edinburgh number	Edinburgh percentage	Scotland number	Scotland percentage
Offices	7,009	30.2%	44,536	17.2%
Shops	5,785	25.0%	54,597	21.0%
Industrial subjects	3,147	13.6%	57,445	22.1%
Hotels etc	1,780	7.7%	5,657	2.2%
Public houses	503	2.2%	3,535	1.4%
Leisure, etc	419	1.8%	27,384	10.5%
Religious	400	1.7%	5,908	2.3%
Public service subjects	352	1.5%	9,219	3.6%
Other	3,785	16.3%	51,303	19.8%
Total	**23,180**	**100%**	**259,584**	**100%**

Source: Lothian Valuation Joint Board, General Statistics

[xxx] Fuel poverty is here defined as fuel bills accounting for over 10% of household income, while extreme fuel poverty is defined as fuel bills accounting for over 20% of household income.

8.1.31. Table 30 sets out non-domestic properties in Edinburgh as enumerated by the Non-Domestic Baseline Tool. This returns a considerably lower figure for the number of properties in Edinburgh, which is a result of differing methodologies for identifying properties. The proportion of each property is also considerably different. The data from the Non-Domestic Baseline Tool gives a total of 19,094 properties in Edinburgh, with over half of these being retail properties.

Table 30: Breakdown of non-domestic properties in Edinburgh by type

Classification	Number	Percentage
Retail	10,401	54.5%
Offices	3,072	16.1%
Cafés, pubs, restaurants, and takeaways	1,689	8.8%
Residential	1,606	8.4%
Storage / distribution	444	2.3%
Hotels	363	1.9%
Education	307	1.6%
Clubs and community centres	296	1.6%
Health	220	1.2%
Light manufacturing / industry / workshop	137	0.7%
General sports and leisure	82	0.4%
Museums, art galleries, libraries, law courts	50	0.3%
Heavy manufacturing / industry	36	0.2%
Large entertainment sites (e.g. theatres, cinemas, conference centres)	22	0.1%
Emergency services	11	0.1%
Other / screened out	358	1.9%
Total	**19,094**	**100%**

Source: Non-Domestic Baseline Tool

8.1.32. Table 31 breaks down the non-domestic stock by floor area. Properties of up to 500 square metres (5,382 square feet) represent over 80% of the stock.

Table 31: Breakdown of non-domestic properties in Edinburgh by floor area

Floor area[xxxi]	Number	Percentage
0-100 m^2	7,478	39.2%
101-500 m^2	8,125	42.6%
501-1,000 m^2	1,332	7.0%
>1,001 m^2	2,159	11.3%
Total	**19,094**	**100%**

Source: Non-Domestic Baseline Tool

[xxxi] The categories in the Non-Domestic Baseline Tool overlap, e.g. "0-100 m^2, 100-500 m^2". Dialogue with Changeworks has indicated that the categories are rolling.

8.1.33. Table 32 breaks down the non-domestic stock by the Scottish Government's Urban Rural Classification (8-fold). Reflecting the primarily urban nature of Edinburgh, over 95% of properties are classified as being located in large urban areas. The remainder are located in accessible small towns (primarily properties in South Queensferry) and accessible rural areas (primarily the outskirts of Edinburgh proper and outlying villages such as Balerno, Dalmeny, Kirkliston, Newbridge, and Ratho).

Table 32: Breakdown of non-domestic properties in Edinburgh by urban-rural classification

Classification	Number	Percentage
1: Large urban areas	18,171	95.2%
2: Other urban areas	0	0%
3: Accessible small towns	265	1.4%
4: Remote small towns	0	0%
5: Very remote small towns	0	0%
6: Accessible rural areas	658	3.4%
7: Remote rural areas	0	0%
8: Very remote rural areas	0	0%
Total	**19,094**	**100%**

Source: Non-Domestic Baseline Tool

Performance of non-domestic stock

8.1.34. Table 33 breaks down the non-domestic stock of Edinburgh by heating system. Relative to domestic properties, a significantly greater proportion of properties are heated by electricity, which is the main fuel type for over half the non-domestic properties in Edinburgh.

Table 33: Breakdown of non-domestic properties in Edinburgh by main fuel type

Type	Number	Percentage
Mains gas	6,417	33.6%
Electricity	10,836	56.6%
Oil	134	0.7%
Other	1,707	8.9%
Total	**19,094**	**100%**

Source: Non-Domestic Baseline Tool

8.1.35. The 19,094 properties had a total combined annual heat demand of 828,229 kilowatt hours per annum.

8.1.36. Due to the lack of data for the non-domestic stock there are many unknowns around the building stock performance.

Headline findings

8.1.37. The headline findings from the baseline analysis are set out below:

- **69%** of homes in Edinburgh are flats – a far greater proportion than Scotland overall.
- Private landlords account for **21%** of homes in Edinburgh – again far greater than Scotland overall.

- Around half of all homes in Edinburgh are located in mixed-tenure buildings.
- Homes in Edinburgh are significantly older than the Scottish average, with a tenth being listed and a quarter lying within conservation areas.
- **120,938** homes in Edinburgh have an EPC rating worse than 'C' and will require upgrading to achieve the target of all homes attaining this by 2033.
- To achieve recommended levels of energy efficiency, **129,706** homes in Edinburgh will require wall insulation (including 80,708 homes with hard-to-treat solid walls); **66,903** homes in Edinburgh will require (improved) loft insulation; and **52,279** homes will require improved glazing: a total of **248,888** interventions.
- To achieve decarbonisation of heat, at least **229,798** homes in Edinburgh will need their existing fossil fuel-based heating systems replaced, the vast majority of them (227,550) homes currently heated using gas boilers.
- At least **6,551** non-domestic buildings in Edinburgh will need their existing fossil fuel-based heating systems replaced.

Challenges and opportunities

8.1.38. The assessment of the baseline stock identifies both challenges and opportunities in terms of heat decarbonisation. The key challenges identified are:

- Edinburgh's very high proportion of flats (including its traditional tenements) and mixed-tenure buildings will greatly increase the challenge of implementing solutions. Unlike standalone homes with a single owner, where decisions can be straightforwardly taken, taking forward interventions to blocks of flats and other mixed-tenure buildings will require securing agreement from a range of stakeholders, including difficult to engage with parties such as absentee landlords. Given that coordinating even relatively uncontroversial matters such as essential repairs has historically proven challenging in some cases, it is envisaged that securing agreement from all necessary stakeholders for potentially complex and costly interventions will be particularly challenging, and in many cases unrealistic without further guidance and regulation from the Scottish Government. The high prevalence of flats also gives rise to practical challenges, for example a lack of space in which to install heat pumps and limited potential to install solar panels to offset electricity costs.[xxxii] However, with the appropriate financing options and a clear regulatory landscape there is a major opportunity for rolling out large-scale archetype-based retrofit projects.
- As a predominantly urban local authority, the vast majority of homes in Edinburgh are connected to the gas grid, as compared to other local authorities where a greater proportion of residents are reliant on alternative heating solutions such as oil. When secondary fuels are included, over 99% of homes in Edinburgh use gas. This is likely to increase the challenge of migrating homes to zero direct emissions heating sources, as gas heating offers many benefits: it is relatively cheap; offers a high flow temperature; is well understood in the marketplace; and it has a well-developed supply chain. As set out in section 10.3, the move to zero direct emissions heating

[xxxii] By their nature, flats have a low ratio of roof space to internal floor space, while the roofs of modern blocks of flats are often used for plant.

will need to make financial sense for building users. Heat networks can potentially play a major role in retaining many of the benefits associated with gas, with the added benefits of delivering maintenance cost savings and screening customers against energy price volatility whilst providing net zero heat.

- Relative to Scotland overall, Edinburgh has a very high proportion of rental homes owned by private landlords: more than one in every five homes. Conversely, Edinburgh has a considerably smaller social housing sector. This means that the City of Edinburgh Council (and other social housing providers) have far less direct influence over housing stock than other Scottish local authorities. Additionally, this means that achieving net zero will require securing buy-in from a large cohort of private landlords, who are likely to be primarily profit-driven and who do not have a direct incentive to improve energy efficiency of their properties (e.g. compared to owner-occupiers who can benefit from lower bills and increased comfort).
- Relative to Scotland overall, Edinburgh has a considerably older housing stock, with close to a third of homes being over a century old. One in 10 homes are listed. As set out elsewhere in this document, this historicity gives rise to both practical and policy challenges to carrying out interventions.
- Edinburgh has a higher proportion of homes with uninsulated walls than Scotland (over two-fifths), and in particular has a high proportion of hard-to-treat solid stone walls. One in five homes in Edinburgh do not have double/triple glazing.

8.1.39. No specific opportunities have been identified from the baseline analysis. As a more general point, it is noted that Edinburgh is a generally affluent city with a buoyant housing and commercial property market, meaning investment in upgrading properties may be more forthcoming than in areas with less buoyant markets. Edinburgh is also a compact, densely-populated city which may give rise to economies of scale and efficiencies around the roll-out of some solutions, for example heat networks. Edinburgh also benefits from the presence of many public sector bodies, universities, and other organisations who are expected to be key partners in delivering the Edinburgh LHEES.

9. Generation of Strategic Zones and pathways

9.1. Overview

9.1.1. This chapter of the Edinburgh LHEES sets out Strategic Zones for each of the six LHEES Considerations, identifying what needs to be done at a strategic level to adapt buildings (and the relevant infrastructure) in Edinburgh over the next 15-20 years to achieve the central aims of the Edinburgh LHEES – the "pathways" for decarbonising each element of the building stock.

9.1.2. This analysis sets a starting point for the generation of, and prioritisation, of Delivery Areas, as well as for further engagement and actions in the Delivery Plan.

9.1.3. Through stakeholder engagement and data analysis, the Council has identified the following priority areas of focus:

- Fuel poverty
- Heat networks
- Heat pump ready properties

9.2. Off-gas grid buildings

Introduction

9.2.1. This Consideration concerns the strategy for decarbonising buildings that are not currently connected to the gas grid. As set out in Chapter 8, approximately 9% of homes in Edinburgh are not currently connected to the gas grid. Buildings that are not currently connected to the gas grid represent a natural focus for heat pumps.

9.2.2. The focus of this Consideration is upon categorising the areas of Edinburgh not currently served by the gas grid based upon their readiness for heat pump retrofit. Properties falling into category 1 are deemed to have the greatest potential, followed by those in Category 2. Therefore, the category 1 Strategic Zones are the logic areas of focus for the deployment of heat pumps.

9.2.3. The Delivery Plan identifies Delivery Areas within the category 1 Strategic Zones that are proposed to be short-term areas of focus for heat pump retrofit.

9.2.4. Properties falling in Category 3 are assessed as having the lowest potential for heat pump retrofit. Some of these properties fall into prospective Heat Network Zones, and therefore connection to a heat network may be a viable alternative in these cases. Category 3 properties that do not fall into prospective Heat Network Zones represent the greatest challenge in terms of heat decarbonisation. Depending on the existing heating solution for these buildings, options may include direct electric heating or bioenergy.

Process

9.2.5. Within this Consideration, indicators have been identified for each of the four categories into which properties are to be grouped in terms of readiness for heat pump retrofit.

- Off gas grid – properties to be assessed under this Consideration are initially identified by using the Home Analytics dataset to identify properties not connected to the gas grid.[xxxiii]

9.2.6. Category 0 properties are those currently have a low or zero direct emissions heating system, or are connected to a heat work.

- Properties falling under category 0 are identified by using the Home Analytics dataset to identify properties currently heated using a heat pump or via a heat network.[xxxiv]

9.2.7. Category 1 properties are those considered as being highly suited for heat pump retrofit, being well insulated properties with wet heating systems.

- Category 0 property – properties that fall into category 0 are excluded. Data for this indicator is derived from the Home Analytics dataset.
- Listed property – properties that are listed are excluded from category 1, as listed buildings entail additional considerations for retrofit (such as listed building consent). Data for this indicator is derived from the Home Analytics dataset.
- Conservation Area – properties that are within a Conservation Area are excluded from category 1, as Conservation Areas entail additional considerations for retrofit. Data for this indicator is derived from the Home Analytics dataset.
- Insulated walls – properties must have insulated walls to be included in category 1, as this is required to achieve the energy efficiency required for heat pumps. Data for this indicator is derived from the Home Analytics dataset.
- Double/triple glazed windows – properties must have double or triple glazed windows to be included in category 1, as this is required to achieve the energy efficiency required for heat pumps. Data for this indicator is derived from the Home Analytics dataset.
- Loft insulation 99mm+ – properties must have at least 99mm of loft insulation to be included in category 1, as this is required to achieve the energy efficiency required for heat pumps. Data for this indicator is derived from the Home Analytics dataset.
- Main heating LPG, oil or biomass/solid – properties must be heated using liquefied petroleum gas, oil, or biomass/solid fuel, i.e. a "wet" system, to be included in category 1. This is as wet systems are considerably easier to transition to heat pumps than electric heating systems (or properties with no existing heating system). Data for this indicator is derived from the Home Analytics dataset.

9.2.8. Category 2 properties are those considered as having secondary potential for heat pump retrofit, needing moderate fabric upgrades and/or the addition of wet distribution systems.

- Category 0 or 1 property – properties that fall into category 0 or 1 are excluded from category 2. Data for this indicator is derived from the Home Analytics dataset.
- Insulated walls – properties that have uninsulated solid walls, or are system built, or have timber frames are excluded from category 2, as insulating these wall types to

[xxxiii] This is done by selecting properties where the value for "off gas grid" is "yes", or where the value for "off gas grid" is "unknown" and the value for "main fuel type" is not "mains gas".
[xxxiv] This is done by selecting properties where the value for "main heating system" is "communal" or "heat pump".

an appropriate standard is considered beyond a moderate upgrade. Data for this indicator is derived from the Home Analytics dataset.

- Risk of narrow uninsulated cavity – properties that have narrow uninsulated cavities are excluded from category 2, as these walls will be challenging to bring up to the energy efficiency required for heat pumps. Data for this indicator is derived from the Home Analytics dataset.

9.2.9. Category 3 properties are those identified as having the least current potential for heat pump retrofit, i.e. significant fabric upgrades would be required to make them heat pump ready.

- Category 3 properties are identified as off-gas properties that do not fall into category 0, 1, or 2 as part of the above assessment.
- Main heating fuel is oil or LPG – properties must be heated using liquefied petroleum gas or oil to be included in category 3. This is as solid fuel-based systems are considered to be more suited to switching to biomass in these circumstances. Data for this indicator is derived from the Home Analytics dataset.

Outputs

9.2.10. Of the 24,146 homes in Edinburgh not currently connected to the gas grid, 2,218 (9.2%) fall into category 0, i.e. they already have a low or zero direct emissions heating system, or are connected to a heat network. 9,470 properties (39.2%) fall into category 1, i.e. are identified as having the greatest potential for heat pump retrofit, while a further 7,223 properties (29.9%) fall into category 2, i.e. have secondary potential for heat pump retrofit. The remaining 5,235 (21.7%) properties fall into category 3, having the lowest potential for heat pump retrofit. Overall, therefore, approximately 78% of homes in Edinburgh not currently connected to the gas grid already have decarbonised heating or have good/reasonable potential to migrate to heat pumps, while 22% would require significant works to effectively migrate to heat pumps.

Table 34: Breakdown of off-gas domestic properties in Edinburgh by category and tenure

Category	Local authority	Housing association	Owner occupied	Private rented	Total
0	210	653	654	701	2,218
1	1,711	1,249	4,308	2,202	9,470
2	143	365	4,574	2,141	7,223
3	1,157	188	1,870	2,020	5,235
Total	**3,221**	**2,455**	**11,406**	**7,064**	**24,146**

Source: Domestic Baseline Tool

9.2.11. The number of off-gas homes falling into each category for each datazone of Edinburgh is visualised in Figure 16, Figure 17, Figure 18, and Figure 19. It can be seen that there is limited geographical patterning to the distribution of category 1 off-gas homes in Edinburgh, with pockets of category 1 properties throughout the city. Interventions in relation to this consideration are therefore likely to be focused on specific neighbourhoods rather than wider areas of the city. Homes in category 3, i.e. those homes that are least suited to be adapted to heat pumps, are somewhat concentrated in the city centre.

9.2.12. The 10 datazones with the highest counts of category 1 off-gas homes are set out in Table 35. These areas may be strong candidates for early-stage interventions to retrofit homes for the installation of heat pumps.

Table 35: Edinburgh datazones with highest counts of category 1 off-gas homes

Datazone	Name	Cat 1 off-gas homes	Total off-gas homes	% off-gas homes Cat 1
S01008770	Western Harbour and Leith Docks – 03	316	596	53.0%
S01008658	Dalry and Fountainbridge – 08	277	1,197	23.1%
S01008478	Stenhouse and Saughton Mains – 06	266	712	37.4%
S01008569	Moredun and Craigour – 01	264	420	62.9%
S01008456	The Calders – 03	263	537	49.0%
S01008932	Muirhouse – 04	254	423	60.1%
S01008462	Murrayburn and Wester Hailes North – 04	249	357	69.8%
S01008843	Broughton South – 04	200	1,069	18.7%
S01008929	Muirhouse – 01	195	635	30.7%
S01008516	Morningside and Craighouse – 03	175	673	26.0%

Source: Domestic Baseline Tool

9.2.13. The 10 datazones with the highest proportions of category 1 off-gas homes owned by the City of Edinburgh Council are set out in Table 36. This indicates the geographical areas where the Council has the greatest influence in terms of being able to roll-out heat pumps.

Table 36: Edinburgh datazones with highest % of local authority-owned category 1 off-gas homes

Datazone	Name	Council-owned Cat 1 off-gas homes	Total off-gas homes	% off-gas homes Council owned Cat 1
S01008462	Murrayburn and Wester Hailes North – 04	235	259	65.8%
S01008569	Moredun and Craigour – 01	260	273	61.9%
S01008456	The Calders – 03	259	273	48.2%
S01008929	Muirhouse – 01	194	380	30.6%
S01008906	West Pilton – 03	115	135	29.1%
S01008455	The Calders – 02	129	136	23.9%
S01008562	Hyvots and Gilmerton – 04	50	58	10.3%
S01008903	Drylaw – 05	24	27	5.0%
S01008702	Craigmillar – 02	16	22	5.0%
S01008679	Old Town, Princes Street and Leith Street – 06	39	256	5.0%

Source: Domestic Baseline Tool

9.2.14. Overall, the analysis carried out against this Consideration indicates that a significant proportion of homes in Edinburgh not currently connected to the gas grid offer strong

potential for conversion to heat pumps. However, the properties with the greatest potential are largely scattered across the city, with limited obvious focal points.

9.2.15. The most realistic and pragmatic approach for Edinburgh is to begin with less complicated and simpler decarbonisation projects, moving into more complex retrofits as the Council, supply chain, stakeholders and property owners expand their learning. As such, the Council proposes that early interventions should focus on category 1 properties which are most "heat pump ready". The Delivery Plan highlights Delivery Areas with a focus on category 1 properties.

9.3. On-gas grid buildings

Introduction

9.3.1. This Consideration concerns the strategy for decarbonising buildings that are currently connected to the gas grid. As set out in Chapter 8, the vast majority of domestic properties and the majority of non-domestic properties in Edinburgh are currently heated via mains gas. The decarbonisation of the heating of buildings in Edinburgh will necessitate every property served by gas being retrofit with an alternative heating solution.

9.3.2. The focus of this Consideration is upon categorising the areas of Edinburgh currently served by the gas grid based upon their readiness for heat pump retrofit. Properties falling into category 1 are deemed to have the greatest potential, followed by those in category 2. Therefore, the category 1 Strategic Zones are the logic areas of focus for the deployment of heat pumps.

9.3.3. The Delivery Plan identifies Delivery Areas within the category 1 Strategic Zones that are proposed to be short-term areas of focus for heat pump retrofit.

9.3.4. Properties falling in Category 3 are assessed as having the lowest potential for heat pump retrofit. Some of these properties fall into prospective Heat Network Zones, and therefore connection to a heat network may be a viable alternative in these cases. Category 3 properties that do not fall into prospective Heat Network Zones represent the greatest challenge in terms of heat decarbonisation. Green/blue hydrogen may be a potential solution for these properties, albeit as set out in section 4.5 the prospects for hydrogen are still unclear.

Process

9.3.5. Within this Consideration, indicators have been identified for each of the four categories into which properties are to be grouped in terms of readiness for heat pump retrofit.

- On gas grid – properties to be assessed under this Consideration are initially identified by using the Home Analytics dataset to identify properties connected to the gas grid.[xxxv]

9.3.6. Category 0 properties are those already connected to a heat network (or communal heating system), which are deemed to be highly suited to a heat pump solution.

- Properties falling under category 0 are identified by using the Home Analytics dataset to identify properties currently connected to a heat network.[xxxvi]

[xxxv] This is done by selecting properties where the value for "main heating system" is "communal".
[xxxvi] This is done by selecting properties where the value for "off gas grid" is "no", or where the value for "off gas grid" is "unknown" and the value for "main fuel type" is "mains gas".

9.3.7. Category 1 properties are those considered as being highly suited for heat pump retrofit, being well insulated properties with wet heating systems.

- Category 0 property – properties that fall into category 0 are excluded. Data for this indicator is derived from the Home Analytics dataset.
- Listed property – properties that are listed are excluded from category 1, as listed buildings entail additional considerations for retrofit (such as listed building consent). Data for this indicator is derived from the Home Analytics dataset.
- Conservation Area – properties that are within a Conservation Area are excluded from category 1, as Conservation Areas entail additional considerations for retrofit. Data for this indicator is derived from the Home Analytics dataset.
- Insulated walls – properties must have insulated walls to be included in category 1, as this is required to achieve the energy efficiency required for heat pumps. Data for this indicator is derived from the Home Analytics dataset.
- Double/triple glazed windows – properties must have double or triple glazed windows to be included in category 1, as this is required to achieve the energy efficiency required for heat pumps. Data for this indicator is derived from the Home Analytics dataset.
- Loft insulation 99mm+ – properties must have at least 99mm of loft insulation to be included in category 1, as this is required to achieve the energy efficiency required for heat pumps. Data for this indicator is derived from the Home Analytics dataset.

9.3.8. Category 2 properties are those considered as having secondary potential for heat pump retrofit, needing moderate fabric upgrades and/or the addition of wet distribution systems.

- Category 0 or 1 property – properties that fall into category 0 or 1 are excluded from category 2. Data for this indicator is derived from the Home Analytics dataset.
- Insulated walls – properties that have uninsulated solid walls, or are system built, or have timber frames are excluded from category 2, as insulating these wall types to an appropriate standard is considered beyond a moderate upgrade. Data for this indicator is derived from the Home Analytics dataset.
- Risk of narrow uninsulated cavity – properties that have narrow uninsulated cavities are excluded from category 2, as these walls will be challenging to bring up to the energy efficiency required for heat pumps. Data for this indicator is derived from the Home Analytics dataset.

9.3.9. Category 3 properties are those identified as having the least current potential for heat pump retrofit, i.e. significant fabric upgrades would be required to make them heat pump ready.

- Category 3 properties are identified as on-gas properties that do not fall into category 0, 1, or 2 as part of the above assessment.

Outputs

9.3.10. Of the 241,396 homes in Edinburgh currently connected to the gas grid, 4,778 (2.0%) fall into category 0, i.e. they already have a low or zero direct emissions heating system, or are connected to a heat network. 107,847 properties (44.7%) fall into category 1, i.e. are identified as having the greatest potential for heat pump retrofit, while a further 33,603 properties (13.9%) fall into category 2, i.e. have secondary potential for heat pump retrofit. The remaining 95,168 (39.4%) properties fall into category 3, having the lowest potential for heat pump retrofit. Overall, therefore, approximately 61% of homes in Edinburgh currently connected to the gas grid already have decarbonised heating or have good/reasonable

potential to migrate to heat pumps, while 39% would require significant works to effectively migrate to heat pumps. This indicates that the migration of on-gas homes to heat pumps is likely to prove considerably more challenging than the migration of off-gas homes.

Table 37: Breakdown of on-gas domestic properties in Edinburgh by category and tenure

Category	Local authority	Housing association	Owner occupied	Private rented	Total
0	957	2,403	726	692	4,778
1	20,291	10,174	63,905	13,477	107,847
2	2,278	2,522	22,561	6,242	33,603
3	3,600	3,511	59,574	28,483	95,168
Total	**27,126**	**18,610**	**146,766**	**48,894**	**241,396**

Source: Domestic Baseline Tool

9.3.11. The number of on-gas homes falling into each category for each datazone of Edinburgh is visualised in Figure 20, Figure 21, Figure 22, and Figure 23. It can be seen that there is limited geographical patterning to the distribution of category 1 on-gas homes in Edinburgh, with pockets of category 1 properties throughout the city. Interventions in relation to this consideration are therefore likely to be focused on specific neighbourhoods rather than wider areas of the city. Homes in category 3, i.e. those homes that are least suited to be adapted to heat pumps, are somewhat concentrated in the city centre.

9.3.12. The 10 datazones with the highest counts of category 1 on-gas homes are set out in Table 38. These areas may be strong candidates for short-term interventions to retrofit homes for the installation of heat pumps.

Table 38: Edinburgh datazones with highest counts of category 1 on-gas homes

Datazone	Name	Cat 1 on-gas homes	Total on-gas homes	% on-gas homes Cat 1
S01008549	Gilmerton South and the Murrays – 03	2,263	2,577	87.8%
S01009002	Dalmeny, Kirkliston and Newbridge – 06	1,328	1,597	83.2%
S01008704	Craigmillar – 04	1,240	1,661	74.7%
S01008768	Western Harbour and Leith Docks – 01	1,077	1,515	71.1%
S01008720	Jewel, Brunstane and Newcraighall – 04	766	885	86.6%
S01008931	Muirhouse – 03	709	808	87.8%
S01008920	Granton and Royston Mains – 01	685	1,111	61.7%
S01008908	West Pilton – 05	681	823	82.8%
S01008701	Craigmillar – 01	643	744	86.4%
S01008771	Western Harbour and Leith Docks – 04	627	642	97.7%

Source: Domestic Baseline Tool

9.3.13. The 10 datazones with the highest proportions of category 1 on-gas homes owned by the City of Edinburgh Council are set out in Table 39. This indicates the geographical areas where the Council has the greatest influence in terms of being able to roll-out heat pumps. It can be seen

that the Granton South and Wardieburn and the Murrayburn and Wester Hailes North areas of Edinburgh may offer good potential for Council-led retrofit projects.

Table 39: Edinburgh datazones with highest % of Council-owned category 1 on-gas homes

Datazone	Name	Council-owned Cat 1 on-gas homes	Total off-gas homes	% on-gas homes Council owned Cat 1
S01008918	Granton South and Wardieburn – 03	257	298	86.2%
S01008919	Granton South and Wardieburn – 04	226	267	84.6%
S01008461	Murrayburn and Wester Hailes North – 03	412	557	73.7%
S01008460	Murrayburn and Wester Hailes North – 02	277	380	72.9%
S01008463	Murrayburn and Wester Hailes North – 05	251	364	69.0%
S01008471	Broomhouse and Bankhead – 04	238	360	66.1%
S01008459	Murrayburn and Wester Hailes North – 01	275	426	63.7%
S01008712	Bingham, Magdalene and The Christians – 01	363	580	61.0%
S01008917	Granton South and Wardieburn – 02	237	395	59.0%
S01008930	Muirhouse – 02	414	653	57.2%

Source: Domestic Baseline Tool

9.3.14. Overall, the analysis carried out against this Consideration indicates that a significant proportion of homes in Edinburgh currently connected to the gas grid offer strong potential for conversion to heat pumps, albeit with a substantial majority of homes falling in category 3. However, the properties with the greatest potential are largely scattered across the city, with limited obvious focal points. Several areas of the city where the Council has extensive ownership of category 1 on-gas homes may be logical locations for early intervention.

9.3.15. The most realistic and pragmatic approach for Edinburgh is to begin with less complicated and simpler decarbonisation projects, moving into more complex retrofits as the Council, supply chain, stakeholders and property owners expand their learning. As such, the Council proposes that early interventions should focus on category 1 properties which are most "heat pump ready". The Delivery Plan highlights Delivery Areas with a focus on category 1 properties.

9.4. Heat networks

Introduction

9.4.1. This Consideration concerns the decarbonisation of space heating using heat networks. The Strategic Zones relating to this Consideration are the areas of Edinburgh that are deemed to be particularly suitable locations for the development of a heat network.

9.4.2. Edinburgh has a relatively high heat density, good availability of heat sources, and many buildings with high energy use intensity which can serve as "anchor loads" increasing the viability of a heat network. All of these have resulted in Edinburgh being ranked as the third-highest Scottish local authority area for potential of heat delivered by a heat network. There

may be scope to deliver a city-wide heat network (or "network of networks") covering much of Edinburgh's population.

9.4.3. This Consideration is of particular significance in that the Strategic Zones identified for it will form the basis of a statutory exercise that will be undertaken in line with the Heat Networks (Scotland) Act 2021 and Heat Networks (Heat Network Zones and Building Assessment Reports) (Scotland) Regulations 2023 to legally designate Heat Network Zones in Edinburgh. Therefore, unlike the other Considerations, the Strategic Zones associated with this Consideration will eventually have legal status, albeit the definitions of the Strategic Zones may evolve between the publication of the Edinburgh LHEES and the completion of the statutory exercise that will subsequently be undertaken. As noted in section 6.2, the Heat Network Zones will form the basis of a permitting regime that is intended to catalyse investment in heat networks by providing heat network operations with exclusive access to the consumer base within a Heat Network Zone.

9.4.4. To distinguish between the Strategic Zones relating to the heat networks consideration that are identified as part of the Edinburgh LHEEs and the Heat Network Zones that will be designated as part of the subsequent statutory exercise, the former are hereafter referred to as "prospective Heat Network Zones" and the latter as "statutory Heat Network Zones".

9.4.5. It is important to note that a location not falling within a designated Heat Network Zone does not preclude the development of a heat network in that area; conversely, a location falling within a Heat Network Zone does not guarantee that a heat network will be developed there. Heat network zones purely identify areas that are assessed as having the greatest potential for heat networks, i.e. where heat networks are expected to be most viable. The Heat Network Zones set out in the Edinburgh LHEES are not an exhaustive schedule of the locations in Edinburgh where a heat network may prove viable, but rather the areas where heat networks are judged to have the greatest viability and/or to be of the greatest strategic importance.

9.4.6. Consideration has been given to potential heat sources for heat networks in Edinburgh. It is recognised that the best solution for a given heat network will depend upon site-specific technical and commercial factors, and therefore the Edinburgh LHEES is not prescriptive about heat sources. However, potential sources have been identified and highlighted to inform subsequent work to deliver heat networks. Key potential sources of heat in Edinburgh include:

- Air source heat pumps – producing heat centrally using air source heat pumps.
- Sewer source heat pumps – capturing heat from the sewers running beneath Edinburgh. Scottish Water has advised that only sewers above 300mm in diameter and with potential sewage flow rates of 40 litres per second or faster are likely to be suitable. A plan showing these sewers in Edinburgh has been provided. A map of potential wastewater extraction opportunities is shown at Figure 05.
- Water source heat pumps – capturing heat from watercourses such as the Firth of Forth or the Almond River. Smaller watercourses such as the Water of Leith or Union Canal are unlikely to offer significant potential due to the environmental impact of extracting heat being proportionately greater.
- Seafield Waste Water Treatment Works – capturing heat from the treatment works, which currently discharges water into the Furth of Forth at a temperature of 15°C.

- Mine water heat – capturing heat from disused mine workings under Edinburgh. A map of known workings is shown at Figure 04. The Coal Authority has been appointed to prepare a more detailed initial opportunity map for Edinburgh.
- Waste heat – capturing heat generated as a byproduct of activities in Edinburgh.[65] Analysis of Scotland Heat Map data shows 63 potential waste heat sources in Edinburgh – comprising seven bakeries; two breweries; three data centres; one distillery; 48 supermarkets; and two wastewater treatment plants – with a total combined waste heat potential of 127,372 megawatt hours. A map of potential waste heat sources is shown at Figure 06.
- Millerhill Recycling and Energy Recovery Centre – utilising heat generated from the incineration of waste at the MRERC in Millerhill, Midlothian, which has the potential to offer a maximum heat export of 20 megawatt thermal to a heat network.

Process

9.4.7. Analysis has been undertaken to identify the locations in Edinburgh where it is judged that heat networks may represent a viable heat option. It is noted that the Edinburgh LHEES does not itself formally designate Heat Network Zones; rather, it sets out an evidence base that will support the formal designation of zones via a statutory process at a later date.

9.4.8. Analysis to identify the potential Heat Network Zones was undertaken on behalf of the Council by Ramboll. In line with the LHEES Methodology, Ramboll imported heat demand data from the Scotland Heat Map and created buffer zones around specific linear heat density levels. Detailed information on the methodology is set out in section 5.1.

9.4.9. In July 2023, a workshop facilitated by Ramboll and Turner & Townsend was held with key Council officers along with representatives of the Scottish Government's Heat Networks Regulation Team; SP Energy Networks; the University of Edinburgh; and Edinburgh World Heritage Trust.[xxxvii] The purpose of the workshop was as follows:

- To review the shortlisted options and determine which was the most appropriate on which to establish a baseline map.
- To review the baseline map and suggest any modifications and refinements based upon the knowledge and experience of the workshop attendees.

9.4.10. Key points raised in the workshop included:

- The emerging Heat Network Zones serve many of the most densely populated areas of Edinburgh.
- Heat networks may prove challenging to deliver in areas of archaeological significance, for example the Old Town. Conversely, however, heat networks may be a better solution than heat pumps for many tenemental properties due to avoiding the need for as extensive retrofitting and the need to find a location to install the heat pumps.
- Overly large Heat Network Zones raise the risk that property owners do not invest in zero direct emissions heating systems due to anticipating that they will be served by a heat network (which may take some time to manifest) whereas overly small heat

[xxxvii] It was determined that it would not be appropriate to invite heat network developers/operators to the workshop as the Council was in the process of tendering for a concessionaire to deliver a heat network serving Granton Waterfront and therefore a conflict of interest could potentially arise.

networks raise the risk of stranded assets if zero direct emissions heating systems are installed serving properties that are later connected to a heat network.

- Having a single Heat Network Zone or a small number of zones poses the risk that heat networks will take a very long time to be delivered due to the right to develop the heat network resting with a single developer.
- To operate effectively, heat networks are likely to require a means of storing heat.

9.4.11. Further consultation with key stakeholders identified the following points:

- There is a risk that heat network delivery models will drive unwanted behaviour, e.g. if contracts require off-takers to pay for a minimum quantity of heat, thus compromising efforts to minimise energy usage.
- Fifth generation (ambient) heat networks have the potential to minimise waste by balancing heating and cooling loads. This may work most effectively in areas where there are residential properties and commercial properties in close proximity. Commercial properties such as offices, data centres, and supermarkets may have significantly coolth requirements which can be offset against the heat requirements of residential properties.
- The development of a heat network in the Old Town of Edinburgh may prove challenging due to the solid rock making the deployment of pipework costly.

9.4.12. Following the workshop, the map was further refined to reflect considerations such as alignment with physical barriers (e.g. railway lines).

9.4.13. It is noted that the prospective Heat Network Zones have been informed primarily by technical considerations. Additional work would be required to refine the zones to reflect commercial considerations, for example the minimum size/demand required for a zone to be viable.

Outputs

9.4.14. Based upon the analysis and consultation set out above, 17 prospective Heat Network Zones in Edinburgh have been identified. Table 40 presents summary information on the 17 prospective Heat Network Zones (extracted from the Heat Network Zone Summary tool). A map of the zones is shown at Figure 22.

Table 40: Summary of prospective Heat Network Zones in Edinburgh

ID	Name[xxxviii]	Screening criteria	Annual heat demand (MWh / year)	Anchor loads
01	New Town	▪ LHD level: 8,000 kWh / metre / year ▪ LHD anchor load prioritisation count: ≥ 2 ▪ Anchor load definition: 500 MWh / year	112,025	37
02	Leith Walk	▪ LHD level: 8,000 kWh / meter / year ▪ LHD anchor load prioritisation count: ≥ 2 ▪ Anchor load definition: 500 MWh / year	439,127	43

[xxxviii] Names are purely illustrative.

ID	Name[xxxviii]	Screening criteria	Annual heat demand (MWh / year)	Anchor loads
03	Old Town & Southside	▪ LHD level: 8,000 kWh / metre / year ▪ LHD anchor load prioritisation count: ≥ 2 ▪ Anchor load definition: 500 MWh / year	706,174	149
04	Gorgie & Dalry	▪ LHD level: 8,000 kWh / metre /year ▪ LHD anchor load prioritisation count: ≥ 2 ▪ Anchor load definition: 500 MWh / year	630,021	14
05	Craigleith	▪ LHD level: 8,000 kWh / metre / year ▪ LHD anchor load prioritisation count: ≥ 2 ▪ Anchor load definition: 500 MWh / year	287,103	33
06	Granton	▪ LHD level: 4,000 kWh / metre / year ▪ LHD anchor load prioritisation count: ≥ 2 ▪ Anchor load definition: 500 MWh / year	190,383	26
07	Leith	▪ LHD level: 8,000 kWh / metre / year ▪ LHD anchor load prioritisation count: ≥ 2 ▪ Anchor load definition: 500 MWh / year	119,369	32
08	Portobello & Seafield	▪ LHD level: 4,000 kWh / metre / year ▪ LHD anchor load prioritisation count: ≥ 2 ▪ Anchor load definition: 500 MWh / year	88,143	10
09	Morningside	▪ LHD level: 8,000 kWh / metre / year ▪ LHD anchor load prioritisation count: ≥ 2 ▪ Anchor load definition: 500 MWh / year	283,938	17
10	South East Edinburgh	▪ LHD level: 4,000 kWh / metre / year ▪ LHD anchor load prioritisation count: ≥ 2 ▪ Anchor load definition: 500 MWh / year	187,528	38
11	Colinton Mains	▪ LHD level: 4,000 kWh / metre / year ▪ LHD anchor load prioritisation count: ≥ 2 ▪ Anchor load definition: 500 MWh / year	11,675	5
12	South West Edinburgh	▪ LHD level: 8,000 kWh / metre /year ▪ LHD anchor load prioritisation count: ≥ 2 ▪ Anchor load definition: 500 MWh / year	119,474	27
13	Heriot-Watt	▪ LHD level: 4,000 kWh / metre / year ▪ LHD anchor load prioritisation count: ≥ 2 ▪ Anchor load definition: 500 MWh / year	68,751	17
14	Sighthill & Gyle	▪ LHD level: 4,000 kWh / metre /year ▪ LHD anchor load prioritisation count: ≥ 2 ▪ Anchor load definition: 500 MWh / year	138,136	45
15	Ingliston	▪ LHD level: 4,000 kWh / metre /year ▪ LHD anchor load prioritisation count: ≥ 2 ▪ Anchor load definition: 500 MWh / year	90,287	34
16	South Queensferry	▪ LHD level: 4,000 kWh / metre /year ▪ LHD anchor load prioritisation count: ≥ 2 ▪ Anchor load definition: 500 MWh / year	75,742	8

ID	Name[xxxviii]	Screening criteria	Annual heat demand (MWh / year)	Anchor loads
17	Second New Town	▪ LHD level: 8,000 kWh / metre /year ▪ LHD anchor load prioritisation count: ≥ 2 ▪ Anchor load definition: 500 MWh / year	185,446	10

Source: Heat Network Zone Summary

9.4.15. The 17 zones cover a significant proportion of Edinburgh. Collectively, they represent 3,733,322 megawatt hours of heat demand.[xxxix] This is a similar quantum to the First National Assessment, which, as set out in section 7.4, identified 41 zones with a total combined heat demand of 3,404,609 megawatt hours per annum.

9.4.16. The zones cover a range of areas, including densely populated inner-city neighbourhoods; suburban residential areas; industrial areas; Edinburgh Airport; and Heriot-Watt University's campus. They encompass a significant proportion of the city's population and the vast majority of its key employment areas.

9.4.17. Further analysis and consultation will be required to fully assess the opportunities presented by each zones. However, the following observations are made:

- The Council is currently in the process of tendering for a concessionaire to build and operate a heat network within the Granton zone.
- Other projects are at various stages of development within the Ingliston; South East Edinburgh; and Portobello & Seafield zones.
- The Old Town & Southside zone has by far the largest heat demand, followed by the Gorgie & Dalry zone and the Leith Walk zone.

9.4.18. Strategic challenges to the roll-out of heat networks in these zones are expected to include:

- Potential difficulties in developing cost competitive proposition for off-takers, particularly for as long as mains gas remains an alternative option.
- Potential difficulties securing connections, particularly while there is no legal requirement for any existing buildings to connect to heat networks.
- Challenges associated with sub-ground conditions, for example the presence of archaeological remains or bedrock.
- Challenges securing appropriate sites for energy centres and substations, particularly in the more central zones which are densely developed and are generally sensitive places to develop in terms of aesthetics.

9.4.19. It is noted that the Council will require to go through a further statutory process to formally designate Heat Network Zones. Given this, the prospective Heat Network Zones set out in the Edinburgh LHEES are likely to evolve somewhat.

9.4.20. Further information on the delivery of heat networks in Edinburgh is set out in the Delivery Plan.

[xxxix] I.e., 1,419 gigawatt hours or 1.4 terawatt hours

9.5. Poor building energy efficiency

Introduction

9.5.1. This Consideration identifies strategic areas of focus in Edinburgh in terms of poor energy efficiency, identifying where interventions are required to drive reductions in heat demand.

9.5.2. Poor energy efficiency has been assessed based on three indicators: single glazed windows, no/minimal loft insulation, and uninsulated walls.

Process

9.5.3. Three indicators have been identified for this LHEES Consideration:

- Single glazed windows – this indicator has a 33.333% weighting. It is a binary indicator used to identify properties with single glazed windows, which contributes to low energy efficiency. Data for this indicator is derived from the Home Analytics dataset.
- Loft insulation – this indicator has a 33.333% weighting. It is a binary indicator used to identify properties with no/minimal loft insulation, which contributes to low energy efficiency. Data for this indicator is derived from the Home Analytics dataset.
- Wall insulation – this indicator has a 33.333% weighting. It is a binary indicator used to identify properties with uninsulated walls, which contributes to low energy efficiency. Data for this indicator is derived from the Home Analytics dataset.

Outputs

9.5.4. Analysis was conducted on the 265,542 homes in Edinburgh with a confirmed heat demand above zero to identify which suffered from poor energy efficiency, utilising the metrics set out above. The data indicates that uninsulated walls is by far the biggest driver of poor energy efficiency, with close to half of all homes in Edinburgh affected by this issue. Slightly under one-fifth of homes have single glazed windows. A significant number of homes (44,403 – 16.7% of the total stock) have both uninsulated walls and single glazed windows. 6,156 homes – 2.3% of the total stock – were afflicted with all three characteristics; these homes could be expected to represent the absolute poorest stock in terms of energy efficiency.

Table 41: Breakdown of poor energy efficiency homes in Edinburgh by characteristic(s)

Characteristic(s)	Number	Percentage
Loft insulation <100 mm	25,823	9.7%
Single glazed windows	51,279	19.3%
Uninsulated walls	129,706	48.8%
Single glazed windows / loft insulation <100 mm	6,686	2.5%
Single glazed windows / uninsulated walls	44,403	16.7%
Uninsulated walls / loft insulation <100 mm	15,598	5.9%
Uninsulated walls / loft insulation <100 mm / single glazed windows	6,156	2.3%

Source: Domestic Baseline Tool

9.5.5. The number of homes with uninsulated walls in each datazone of Edinburgh is visualised in Figure 26. It can be seen that these homes are concentrated in the city centre and in the neighbourhoods to the south, with additional pockets in the north and east of Edinburgh.

Figure 27 shows the distribution of homes with solid stone/brick walls, which are likely to prove particularly challenging to insulate; again these are clustered around the city centre.

9.5.6. The 10 datazones with the highest number of homes with uninsulated walls owned by the City of Edinburgh Council are set in Table 42. This indicates the geographical areas where the Council has the greatest influence in terms of being able to roll-out wall insulation.

Table 42: Edinburgh datazones with highest count of Council-owned homes with uninsulated walls

Datazone	Name	Council-owned homes with uninsulated walls	Total homes	% homes Council-owned with uninsulated walls
S01008929	Muirhouse – 01	227	635	35.7%
S01008746	Northfield and Piershill – 04	198	604	32.8%
S01008787	Great Junction Street – 03	190	212	89.6%
S01008675	Old Town, Princes Street and Leith Street – 02	186	785	23.7%
S01008760	Restalrig and Lochend – 05	158	513	30.8%
S01008757	Restalrig and Lochend – 02	143	417	34.3%
S01008809	Hillside and Calton Hill – 04	141	543	26.0%
S01008785	Great Junction Street – 01	139	533	26.1%
S01008801	Easter Road and Hawkhill Avenue – 04	121	730	16.6%
S01008703	Craigmillar – 03	118	482	24.5%

Source: Domestic Baseline Tool

9.5.7. The 10 datazones with the highest proportions of homes with all three characteristics of poor energy efficiency are set out in Table 43. This indicates the geographical areas with the greatest issues in terms of energy efficiency. It can be seen that the areas in question are largely more affluent areas of the city with significant elements of build heritage. This suggests that poor energy efficiency in Edinburgh is largely a product of the city's aged housing stock.

Table 43: Edinburgh datazones with highest count of homes with all three characteristics of poor energy efficiency

Datazone	Name	Homes with three characteristics	Total homes	% homes with three characteristics
S01008676	Old Town, Princes Street and Leith Street – 03	221	661	33.4%
S01008868	Deans Village – 01	105	673	15.6%
S01008882	Murrayfield and Ravelston – 02	105	446	23.5%
S01008861	Stockbridge – 05	98	414	23.7%
S01008593	Blackford, West Mains and Mayfield Road – 07	84	327	25.7%
S01008627	Morningside – 04	83	262	31.7%

Datazone	Name	Homes with three characteristics	Total homes	% homes with three characteristics
S01008685	Canongate, Southside and Dumbiedykes – 06	82	1235	6.6%
S01008852	New Town West – 04	73	642	11.4%
S01008600	Newington and Dalkeith Road – 02	71	337	21.1%
S01008850	New Town West – 02	70	465	15.1%

Source: Domestic Baseline Tool

9.5.8. The analysis against this Consideration has identified the quantity of interventions that will be required to achieve good energy efficiency across Edinburgh's residential stock. It has also identified the geographical areas where the greatest number of interventions are expected to be required. The analysis shows that the required interventions are concentrated in areas of Edinburgh with significant levels of historic buildings, suggesting that taking forward these interventions will in many cases require a more specialised approach.

9.5.9. The datazones with the greatest proportion of Council-owned homes with poor wall insulation may represent logical candidates for early intervention.

9.6. Poor building energy efficiency as a driver for fuel poverty

Introduction

9.6.1. This Consideration identifies strategic areas of focus in Edinburgh in terms of poor energy efficiency where this is a drive of fuel poverty, identifying where interventions are required to drive reductions in fuel poverty via reducing heat demand.

9.6.2. Poor energy efficiency as a driver of fuel poverty was assessed based on four indicators: the assessed probability of the households of the home in question being in fuel poverty, coupled with three indicators pertaining to poor energy efficiency (single glazed windows, no/minimal loft insulation, and uninsulated walls).

9.6.3. The nature of interventions relating to this Consideration will be influenced by the tenure of the building.

Process

9.6.4. Four indicators have been identified for this LHEES Consideration – one pertaining to fuel poverty and three pertaining to energy efficiency:

- Probability of fuel poverty – this indicator has a 50% weighting. It refers to the assessed probability of the household of the home in question being in fuel poverty. Data for this indicator is derived from the Home Analytics dataset.
- Single glazed windows – this indicator has a 16.666% weighting. It is a binary indicator used to identify properties with single glazed windows, which contributes to low energy efficiency. Data for this indicator is derived from the Home Analytics dataset.
- Loft insulation – this indicator has a 16.666% weighting. It is a binary indicator used to identify properties with no/minimal loft insulation, which contributes to low energy efficiency. Data for this indicator is derived from the Home Analytics dataset.

- Wall insulation – this indicator has a 16.666% weighting. It is a binary indicator used to identify properties with uninsulated walls, which contributes to low energy efficiency. Data for this indicator is derived from the Home Analytics dataset.

Outputs

9.6.5. Analysis was conducted on the 265,542 homes in Edinburgh with a confirmed heat demand above zero to assess properties in fuel poverty and where poor energy efficiency was a likely contributor to that. It is estimated that 54,944 homes (20.7% of the total) in Edinburgh are in fuel poverty, while 18,367 (6.9%) are in extreme fuel poverty.

9.6.6. Incidences of high fuel poverty and poor energy efficiency (measured based on the proportion of uninsulated walls) in each datazone of Edinburgh are visualised in Figure 28. It can be seen that the greatest concentration is shown to be in the historic city centre and the surrounding areas, as opposed to the areas of Edinburgh traditionally associated with deprivation. Given this, the Council has reservations about the robustness of these conclusions. Accordingly, the Council has opted not to focus on these conclusions for the purposes of interventions aimed at mitigating fuel poverty, but rather will continue to concentrate on areas of Edinburgh with high levels of deprivation as identified using the 2020 Scottish Index of Multiple Deprivation (SIMD), as this is judged to be a more robust approach. SIMD data is visualised in Figure 29.

9.6.7. Addressing fuel poverty is a longstanding priority for the Council, and properties at risk of fuel poverty have been the focus of Area-Based Scheme and other initiatives. As and when resources and powers are made available for the delivery of the Edinburgh LHEES, the Council will potentially look to grow activities in these areas further by reaching various tenure types (and potentially also non-domestic buildings) to catalyse area-wide transformation of the building stock. The Delivery Plan identifies Delivery Areas identified for this Consideration.

9.7. Mixed-tenure, mixed-use, and historic buildings

Introduction

9.7.1. This Consideration concerns the strategy for decarbonising buildings that are complex due to being mixed-tenure (i.e. with properties of different tenures within the same building, e.g. a block of flats with privately-owned and Council-owned flats), mixed-use (i.e. occupied by both domestic and non-domestic properties), and/or historic (i.e. listed and/or within a conservation area). These buildings are likely to prove challenging to decarbonise due to the range of stakeholders involved, their design, and planning policies that restrict interventions.

9.7.2. Mixed-tenure buildings present complexities due to the added challenge of securing buy-in from the different parties within the building. A primary example would be multi-storey buildings in which the Council still owns some properties, but others have passed to private owners under the Right to Buy policy (and may in turn have become private rented properties). In buildings such as this, the Council is unable to act unilaterally, but would require to secure buy-in for any interventions from all parties.

9.7.3. Mixed-use buildings, for example a block of flats with commercial units on the ground floor, present complexities due to the different owners/tenancies and design considerations associated with the different use classes.

9.7.4. Historic buildings present complexities due to their design generally not being conducive to the typical interventions that would be carried out to boost a building's energy efficiency, for example solid stone walls that cannot be treated with cavity insulation. This is compounded by planning policies which restrict the interventions that are permissible, for example prohibiting the replacement of traditional sash and cash windows with more energy efficient, but non-historically accurate, uPVC windows. Achieving a high standard of energy efficiency in a historic building can in some cases require complex bespoke interventions.

Process

9.7.5. Within this Consideration, indicators have been identified for each of the sub-Considerations.

9.7.6. Three indicators have been identified for the mixed-tenure sub-Consideration:

- Dwellings in building – this indicator is used to identify if there is more than one dwelling within a building. This indicator has a 25% weighting. Data for this indicator is derived from the Home Analytics dataset.
- Mixed tenure – this indicator is used to identify if there are properties identified as being mixed tenure within a building. This indicator has a 25% weighting. Data for this indicator is derived from the Home Analytics dataset.
- Parent and child UPRNs – this indicator is used to identify buildings with a mix of domestic and non-domestic properties. This indicator has a 50% weighting. Data for this indicator is derived from the One Scotland Gazetteer.

9.7.7. One indicator has been identified for the listed buildings sub-Consideration:

- Identification of listed buildings: listed building grade – this indicator is used to identify if the domestic property in question is registered as a listed building (no data was available to identify listed non-domestic properties). Data for this indicator is derived from the Home Analytics dataset.

9.7.8. Two indicators have been identified for the Conservation Areas sub-Consideration:

- Identification of properties in Conservation Areas: Conservation Area – this indicator is used to identify if the domestic property in question falls within a Conservation Area. Data for this indicator is derived from the Home Analytics dataset.

Identification of properties in Conservation Areas: Conservation Area – this indicator is used to identify if the property in question falls within a Conservation Area. Data for this indicator is derived from the Scotland Heat Map.

Outputs – mixed-tenure and mixed-use

9.7.9. Of the 266,144 homes in Edinburgh, 265,542 have a confirmed annual heat demand above zero. Of these 265,542 homes, 183,583 (69.1%) are located within buildings containing more than one dwelling and 130,211 (49.9%) are located within buildings with more than one tenure represented (i.e. buildings containing some combination of owner-occupied, privately rented, and/or socially rented homes). The former figure reflects the large proportion of flats in Edinburgh, which is characterised by its tenements. The latter figure represents the mix of ownerships across Edinburgh, with tenements often comprising a mix of owner-occupied homes and privately-rented homes, and blocks of flats developed by the public sector often comprising a mix of social housing and owned occupied/privately rented homes acquired as part of the Right to Buy Scheme. Buildings containing multiple homes and where multiple

tenures are represented are likely to prove considerably more challenging to retrofit than mono-ownership/mono-tenure buildings due to the added difficulties of securing agreements, allocating costs, and coordination.

9.7.10. Analysis of Unique Property Reference Numbers (UPRNs) in Edinburgh indicates that there are a total of 20,267 "parent shell" UPRNs (i.e. buildings), of which 18,642 (92.0%) are domestic, 1,162 (5.7%) are non-domestic, and 463 (2.3%) are "mixed". Mixed tenure buildings therefore account for a relatively low proportion of the total building stock in Edinburgh. Mixed tenure buildings in Edinburgh will typically be tenements (or more modern blocks of flats) with commercial units on the ground floor. As with mixed-ownership and mixed-tenure buildings, mixed-use buildings are likely to prove more challenging to retrofit.

9.7.11. The number of homes within buildings within more than one dwelling and within mixed-tenure buildings for each datazone of Edinburgh is visualised in Figure 30 and Figure 31.

9.7.12. The 10 datazones with the highest number of homes within buildings with more than one dwelling are set out in Table 44.

Table 44: Edinburgh datazones with highest number of homes in buildings with >1 dwelling

Datazone	Name	Homes in buildings with >1 dwelling	Total homes	% homes in buildings with >1 dwelling
S01008549	Gilmerton South and the Murrays – 03	1,689	2,577	65.5%
S01008768	Western Harbour and Leith Docks – 01	1,395	1,515	92.1%
S01008651	Dalry and Fountainbridge – 01	1,311	1,311	100%
S01008673	Meadows and Southside – 08	1,302	1,328	98.0%
S01008685	Canongate, Southside and Dumbiedykes – 06	1,197	1,235	96.9%
S01008658	Dalry and Fountainbridge – 08	1,196	1,197	99.9%
S01008843	Broughton South – 04	1,052	1,069	98.4%
S01008665	Tollcross – 07	1,033	1,055	97.9%
S01008920	Granton and Royston Mains – 01	1,009	1,111	90.8%
S01008691	Meadowbank and Abbeyhill North – 03	908	912	99.6%

Source: Domestic Baseline Tool

9.7.13. The 10 datazones with the highest number of homes within mixed-tenure buildings are set out in Table 45.

Table 45: Edinburgh datazones with highest number of homes in mixed-tenure buildings

Datazone	Name	Homes in mixed-tenure buildings	Total homes	% homes in mixed-tenure buildings
S01008549	Gilmerton South and the Murrays – 03	1,277	2,577	49.6%
S01008673	Meadows and Southside – 08	993	1,328	74.8%
S01008658	Dalry and Fountainbridge – 08	815	1,197	68.1%

Datazone	Name	Homes in mixed-tenure buildings	Total homes	% homes in mixed-tenure buildings
S01008843	Broughton South – 04	778	1,069	72.8%
S01008806	Hillside and Calton Hill – 01	735	762	96.5%
S01008800	Easter Road and Hawkhill Avenue – 03	733	735	99.7%
S01008778	The Shore and Constitution Street – 01	704	797	88.3%
S01008691	Meadowbank and Abbeyhill North – 03	687	912	75.3%
S01008496	Gorgie West – 05	677	677	100%
S01008855	Canonmills and New Town North – 03	671	705	95.2%

Source: Domestic Baseline Tool

9.7.14. Overall, the analysis carried out against this Consideration sets out the high proportion of multi-occupancy and mixed-tenure buildings in Edinburgh, reflecting the prevalence of flats in the city and the diverse ownership thereof. With 69.1% of homes in Edinburgh being in multi-occupancy buildings and 49.9% being with mixed-tenure buildings, planning and execution the works necessary to achieve improved energy efficiency and heat decarbonisation is likely to be complex, costly, and challenging.

Outputs – historic buildings

9.7.15. Of the 266,144 homes in Edinburgh, 265,542 have a confirmed annual heat demand above zero. Of these 265,542 homes, 27,282 (10.3%) are located within listed buildings and 68,834 (25.9%) are located within conservation areas.

9.7.16. The number of homes within listed buildings and within conservation areas for each datazone of Edinburgh is visualised in Figure 32 and Figure 33. It can be seen that homes in listed buildings are heavily concentrated in central Edinburgh, reflecting the historicity of the Old Town and New Town of Edinburgh. Homes within conservation areas follow a broadly similar pattern, but with a wider spread that reflects the distribution of Edinburgh's 50 conservation areas.

9.7.17. The 10 datazones with the highest number of homes in listed buildings are set out in Table 46. This indicates the geographical areas where retrofit activities are likely to be more challenging given the nature of the buildings in question and the relevant planning policies. It can be seen that Dean Village and the Old Town and New Town of Edinburgh are the areas with the highest counts of homes in listed buildings, with in some cases virtually all of the homes within the datazones being within listed buildings.

Table 46: Edinburgh datazones with highest number of homes in listed buildings

Datazone	Name	Homes in listed buildings	Total homes	% homes in listed buildings
S01008868	Deans Village – 01	651	673	96.7%
S01008852	New Town West – 04	621	642	96.7%
S01008869	Deans Village – 02	604	778	77.6%

Datazone	Name	Homes in listed buildings	Total homes	% homes in listed buildings
S01008677	Old Town, Princes Street and Leith Street – 04	586	679	86.3%
S01008871	Deans Village – 04	576	593	97.1%
S01008849	New Town West – 01	542	552	98.2%
S01008854	Canonmills and New Town North – 02	501	522	96.0%
S01008850	New Town West – 02	461	465	99.1%
S01008679	Old Town, Princes Street and Leith Street – 06	456	785	58.1%
S01008851	New Town West – 03	451	727	62.0%

Source: Domestic Baseline Tool

9.7.18. The 10 datazones with the highest number of homes in conservation areas are set out in Table 47. Again, this indicates the geographical areas where retrofit activities are likely to be more challenging given the relevant planning policies.

Table 47: Edinburgh datazones with highest number of homes in conservation areas

Datazone	Name	Homes in conservation areas	Total homes	% homes in conservation areas
S01008673	Meadows and Southside – 08	1,328	1,328	100%
S01008685	Canongate, Southside and Dumbiedykes – 06	1,089	1,235	88.2%
S01008859	Stockbridge – 03	788	788	100%
S01008675	Old Town, Princes Street and Leith Street – 02	785	785	100%
S01008869	Deans Village – 02	777	778	99.9%
S01008778	The Shore and Constitution Street – 01	773	797	97.0%
S01008679	Old Town, Princes Street and Leith Street – 06	746	785	95.0%
S01008851	New Town West – 03	727	727	100%
S01008855	Canonmills and New Town North – 03	704	705	99.9%
S01008777	North Leith and Newhaven – 06	681	707	96.3%

Source: Domestic Baseline Tool

9.7.19. Overall, the analysis carried out against this Consideration reflects the historic nature of Edinburgh's built environment, with a high number and proportion of homes within historic buildings and neighbourhoods, particularly in central Edinburgh. The analysis identifies central Edinburgh as the area that is likely to prove most challenging to retrofit in terms of both the practical challenges of adapting the buildings in question and the planning policies governing what changes to the buildings are permissible.

9.7.20. Decarbonising heat in historic buildings is likely to prove challenging regardless of the solution chosen. Heat networks have the advantage of requiring less extensive works to the buildings, but deploying the necessary pipework in areas with (for example) cobbled streets and extensive archaeological remains is likely to be onerous. Heat pumps, however, are likely to prove challenging given the extensive works needed to the building to enable heat pumps to work effectively (for example, making the property highly energy efficient and oversizing the radiators) and the need to identify a suitable location to site the heat pumps themselves (which is likely to be particularly challenging in traditional tenement properties which generally have only a modest curtilage).

9.7.21. It is important to note that not all listed buildings are alike and some will inevitably prove more straightforward or more complex to adapt than others.

10. Edinburgh LHEES findings and next steps

10.1. Summary of Edinburgh LHEES findings

10.1.1. The baseline analysis undertaken as part of the Edinburgh LHEES (Chapter 8) has identified multiple key challenges to decarbonising heat in buildings and improving energy efficiency across a local authority stemming from the particular characteristics of Edinburgh's building stock. In summary, these are:

- A very high proportion of flats and mixed-tenure buildings.
- Very high levels of existing gas grid connections.
- A high proportion of privately-rented homes and relatively small social housing sector.
- An aged housing stock with a significant proportion of listed buildings.
- A high proportion of homes with uninsulated walls, and in turn a high proportion of homes with hard-to-treat solid stone walls.

10.1.2. The analysis undertaken against the six LHEES Considerations has given rise to "Strategic Zones". These Zones are at the heart of the Edinburgh LHEES, setting out at a strategic level potential pathways for decarbonisation of Edinburgh's building stock and identifying areas of pressure in terms of energy efficiency.

10.1.3. The Strategic Zones for the three Considerations relating to heat decarbonisation are summarised below. In effect, the Strategic Zones for these Considerations show where heat pumps are judged to be a good solution, where heat networks are judged to be a good solution, where both are a viable solution, and where neither is judged to be a viable solution. This will help inform activity taken forward to decarbonise buildings.

- The Strategic Zones for off-gas grid buildings set out where there is greatest potential to migrate homes in Edinburgh not currently connected to the gas grid to heat pumps. The distribution of category 1 (highest potential) properties does not follow an easily interpretable geographic pattern.
- The Strategic Zones for on-gas grid buildings set out where there is greatest potential to migrate homes in Edinburgh currently connected to the gas grid to heat pumps. The distribution of category 1 (highest potential) properties does not follow an easily interpretable geographic pattern.
- The Strategic Zones for heat networks set out where there is judged to be greatest potential for the deployment of heat networks in Edinburgh. 17 zones have been identified across Edinburgh, reflecting a broad mix of different areas.

10.1.4. The Strategic Zones for the three Considerations relating to energy efficiency and other outcomes are summarised below. Rather than focusing on solutions, these Strategic Zones highlight areas of Edinburgh where there are the most acute pressures, and where there are characteristics of the building stock that is expected to add complexity to interventions.

- The Strategic Zones for poor building energy efficiency highlight the areas of Edinburgh where there are the highest incidences of poor energy efficiency due to inadequate insulation of walls, windows and/or lofts. These incidences of poor energy efficiency are concentrated in the more historic area of Edinburgh.

- The Strategic Zones for poor building energy efficiency as a driver for fuel poverty highlight areas of Edinburgh with both fuel poverty and high incidences of poor energy efficiency. Due to concerns about the robustness of the data emerging from the analysis relating to this Consideration, the Council has opted to instead use SIMD rankings as a proxy for fuel poverty.
- The Strategic Zones for mixed-tenure, mixed-use, and historic buildings highlight where there are high incidences of buildings that are expected to prove more challenging to retrofit due to their design and ownership. The Strategic Zones around historic buildings are as expected. The Strategic Zones for mixed-tenure and mixed-use buildings do not follow an easily interpretable geographic pattern.

10.2. Edinburgh LHEES areas of focus and approach

10.2.1. Since the Edinburgh LHEES covers a 20-year journey to decarbonisation, it is imperative to be selective about the highest priorities which the Council should bring forward. Three areas of activity have been identified that are assessed as representing the most appropriate focus for the inaugural Edinburgh LHEES:

- Targeting areas with the highest occurrences of fuel poverty and the 20% most deprived areas of Edinburgh as per the Scottish Index of Multiple Deprivation.
- Decarbonising Council-owned housing and non-domestic stock in line with national timescales.
- Supporting wider decarbonisation of Edinburgh within the funding and resources that are made available to the Council, beginning with a focus on facilitating a city-wide heat network (or "network of networks"), and upon area with the largest numbers of heat pump-ready homes as a prospective "quick win" in terms of heat decarbonisation.

10.2.2. Edinburgh's approach to delivering these priorities will need to consider both the role of the Council as well as that of all other parties in delivering the Edinburgh LHEES. It is imperative that the Edinburgh LHEES is not considered as a route to only decarbonise the Council's own (or only public sector owned) buildings, but rather a plan for everyone in Edinburgh to collectively decarbonise the city's stock. This includes a key role for the Council to help organise this activity as well as an indispensable role for the Scottish Government in making the resources and powers available to enable this. However, it also includes an equally important role for every property owner, investors, public bodies, relevant service providers and operators, the supply chain, heat network operators, and many others who will collectively deliver the ambition of the Edinburgh LHEES. Engaging these stakeholders will require appropriate incentives ("carrots and sticks").

10.2.3. The Council will seek to build the Edinburgh LHEES into its effective network of existing partnerships and relationships, and also seek new partnerships where they are productive. This is in recognition of the fact that on its own, the Council is unable to retrofit properties which it does not own or provide funding for those who ineligible for government schemes. Strong partnerships and coordinated activity will therefore be the basis for encouraging and directing wider action toward priorities.

10.2.4. The Edinburgh LHEES covers delivery of energy efficiency and decarbonisation measures across multiple tenures, types, and ages of building as well as heat networks across the city.

It does so with a deadline of 2040 for eliminating fuel poverty and 2045 for achieving net zero, making it one the most complex and urgent challenges facing the city. It is therefore critical to adopt a programmatic approach for delivering the Edinburgh LHEES, accounting for the host of factors that need to be aligned for success, such as: a robust supply chain and efficient avenues to procure work; funding and financing to support property owners; and clear communication on best practice and the help available. The Delivery Plan provides the basis for this approach, which the Council would seek to build upon as and when the Scottish Government makes further resources available for the delivery of the Edinburgh LHEES.

10.3. Edinburgh LHEES principles

10.3.1. The Edinburgh LHEES does not set out actions or allocate resources: these are the preserve of the Delivery Plan, which is the document that translates the evidence base, analysis, and strategic prioritisation set out in the Edinburgh LHEES into activity. The role of the Edinburgh LHEES is to present the scale of the challenges and the most effective pathways for addressing them. However, this section of the Edinburgh LHEES sets out certain high-level principles that are proposed to underpin how the Edinburgh LHEES is delivered and, in turn, how buildings in Edinburgh are made more energy efficient and their heating decarbonised.

[A] Interventions should be on a "fabric first" basis

10.3.2. Mindful of the adage that "the cheapest unit of energy is the one you do not consume", the minimisation of heat demand via improved energy efficiency is crucial to reducing fuel poverty.

10.3.3. While there are challenges around improving energy efficiency, the issues in question are largely practical/technical; energy efficiency improvements are therefore generally considerably less complex than heat decarbonisation interventions, and are considerably more likely to be no regret/low regret.

10.3.4. It is noted that physical interventions are typically not themselves enough to achieve sustained major reductions in heat demand; behavioural change is also vital.

10.3.5. Related to the above, it is important to ensure that solutions do not result in perverse incentives. For example, business cases developed to support the development of heat networks should not be contingent on heat demand rising or plateauing, and contractual arrangements put in place to deliver heat networks should not commit off-takers to consuming a minimum quantum of heat. Generating heat sustainably is a solution to a problem, not an end in itself.

[B] Interventions should be solution agnostic

10.3.6. The specific heating solution that is most appropriate for each building in Edinburgh will depend on a variety of factors, including financial considerations. Given this, it is proposed that the Council should take a solution agnostic approach to the decarbonisation of buildings in Edinburgh rather than favouring or prioritising a particular technological solution. Decisions on solutions should generally be taken on a technical basis. The role of the Edinburgh LHEES is to make the space and provide the direction and opportunities for people to decarbonise their properties in the best way they see fit. Where the Council needs to take direct decisions about energy efficiency and heat decarbonisation technologies (such as for retrofit of its own stock or to aid households in fuel poverty) these will be taken based on

capital and operating costs, practicality, infrastructure constraints and other considerations deemed appropriate by Council officers.

10.3.7. It is, however, recognised that the UK Government and Scottish Government have each undertaken significant measures to support the roll-out of heat pumps and heat networks. These include capital grants, regulatory regimes, supplier development programmes, and skills development programmes. Given this, it is considered that pragmatically, heat pumps and heat networks are likely to represent a more immediate opportunity than other solutions, for example direct electric heating. Further, it is recognised that heat networks are in some cases unlikely to be able to proceed without support from the public sector in the form of connecting anchor loads to the network, meaning in certain areas, e.g. the prospective Heat Network Zones, there may be a strategic case for selecting heat networks over heat pumps as a solution for buildings over which the public sector has influence.

10.3.8. Similarly, the Edinburgh LHEES does not rule out the scope for (green/blue) hydrogen to play a significant role in the heating of buildings in Edinburgh. However, it is recognised that the available evidence suggests there may be significant practical barriers to the widespread roll-out of hydrogen as a space heating solution. Given this, it is considered that the Council should retain an open mind to the use of hydrogen, but avoid relying upon it.

10.3.9. An exception to this principle is that City Plan 2030 mandates connections to existing heat networks.

[C] Interventions must make financial sense for building users

10.3.10. As set out in section 4.5, heat decarbonisation is not straightforward, with all solutions having their own challenges. Due to a combination of technical and economic factors, there is no solution that is universally competitive with gas in terms of cost and performance.

10.3.11. While the importance of migrating away from gas is recognised, this must be balanced against the needs of building users. The Council will generally not be able to support interventions where these result in additional heating costs and/or reduced amenity to building users. In particular the Council will generally not be able to support interventions to social homes that present a risk of increasing fuel poverty or reducing tenants' wellbeing. Additionally, it will generally be challenging to justify the replacement of plant that is not nearing the end of its working life, both from a financial and an embodied carbon perspective.

10.3.12. In the hypothetical event that all buildings in Edinburgh currently heated by gas boilers were somehow immediately migrated to zero direct emissions heating solutions, this would introduce significant cost pressures for many households and other building users.

10.3.13. It is recognised that various models have been developed that entail front-funding of interventions to buildings that reduce running costs and improve user comfort, with building users using some or all of the savings achieved to repay the upfront investment. An optimal arrangement will be financially beneficial for both the building user and the funder of the interventions while improving user comfort and reducing carbon emissions.

10.3.14. Related to the above, it is considered that decarbonisation of heat on a strategic scale is likely to be extremely challenging possible without a major structural change in electricity pricing. The current price differential between gas and electricity, which as set out in section 4.5 is one of the greatest in Europe, makes widespread electrification of heat unviable in many cases.

[D] New build properties offer the greatest potential

10.3.15. Many of the challenges associated with improving energy efficiency and decarbonising heat stem from the practical difficulties associated with retroactively implementing measures in buildings that were never designed for them. This results in design challenges along with ancillary issues such as disruption for building users. Given this, new build properties represent a natural opportunity to address these issues from the outset.

10.3.16. As set out in section 6.4, City Plan 2030 requires all new build properties in Edinburgh to "[achieve], predominantly through ultra-high fabric energy efficiency, a 'net zero' level of operational greenhouse gas emissions". In practice this amounts to a ban on gas boilers in new buildings in Edinburgh. The Scottish Government has also announced a proposed ban on the installation of gas boilers in new buildings in Scotland from 1 April 2024.

10.3.17. As set out in section 7.3, the Council itself ceased installing gas boilers in new Council-built social homes in 2020.

10.3.18. To facilitate the transition to net zero, it is important that planning policies and building regulations ensure that new building properties are designed and built to achieve the various targets set out by the Scottish Government.

10.3.19. Where the redevelopment of properties is concerned, while new build properties will inevitably be more energy efficient than the vast majority of older properties, this must be balanced against the embodied carbon of existing buildings. The choice of whether to redevelop or refurbish buildings will require careful consideration of multiple factors.

[E] Significant additional external funding will be required

10.3.20. As set out in this document, the capital costs of implementing the Edinburgh LHEES are vast.

10.3.21. While the City of Edinburgh Council has prepared the Edinburgh LHEES, it is important to note that the Council does not have sole responsibility for achieving the Edinburgh LHEES. In particular it is noted that responsibility for improving energy efficiency and decarbonising heat for properties that the Council does not own does not sit with the Council. The Council has limited powers and resources to compel other property owners to invest in their properties.

10.3.22. The Council's own financial resources will be focused on works to Council-owned properties, which themselves will be very costly to retrofit. It is extremely unlikely that the Council will be able to put significant resources into works to non-Council owned properties, except where these works are externally funded as in the Area-Based Schemes. Funding for works to non-Council owned properties will need to come from a range of sources, including the building owners themselves, institutional lenders, and grant funds.

10.3.23. As noted, the Scottish Government has established a Green Heat Finance Taskforce with the remit of developing "innovative financial solutions" for the retrofit of buildings in Scotland. Various other initiatives are ongoing around potential mechanisms for financing works to buildings. It is hoped that this work will deliver solutions that can be used to roll-out retrofit works on a widespread basis, albeit it is recognised that previous attempts such as the "Green Deal" have proven highly challenging with limited take-up.

10.3.24. The national funding landscape for retrofit works is complex with a vast array of grant and loan funds. It is suggested that there may be merit in rationalising this.

10.3.25. It is noted that all Scottish local authorities have been awarded a flat budget of £75,000 over the six-year period from 2022/23 to 2027/28 to "develop their strategies and delivery plans". The Council has utilised some of this resource to prepare the inaugural Edinburgh LHEES, and will utilise funding in later years to develop the second iteration. Remaining funding will be used for administration costs and to support the progression of small-scale early-action projects. While this funding is greatly welcomed, it is suggested that additional funding, confirmed over a longer-term period, will be required to fully administer the delivering of the Edinburgh LHEES, in particular the roll-out of heat networks. Further consideration of administrative resources is set out in the Delivery Plan.

10.3.26. Beyond the £75,000 budget, the Council does not currently have a budget in place for the delivery of the Edinburgh LHEES. While there may be some potential to optimise how existing funding streams, such as the Area-Based Schemes, are utilised, it is considered that this potential is fairly limited. Successful delivery of the Edinburgh LHEES will require additional ring-fenced resources.

10.3.27. Where the Edinburgh LHEES and associated workstreams – for example heat networks – give rise to additional duties for the Council for which fees are levied, it is considered that these must be set on a full cost recovery basis to avoid putting pressure on existing Council budgets.

[F] More comprehensive and robust data is needed

10.3.28. The analysis conducted as part of the preparation of the Edinburgh LHEES (and by other local authorities) has highlighted significant gaps and deficiencies in the data available on Scotland's building stock. For example, information on the energy efficiency and heating solutions of non-domestic buildings in Scotland is limited and inconsistent. These data gaps have been compounded by issues with the LHEES Methodology that have emerged over time.

10.3.29. Various areas of relevance to the Edinburgh LHEES are severely lacking in data. For example, data on existing heat networks in Scotland is very limited.

10.3.30. Bridging these data gaps will require both work by local authorities to improve understanding of the local picture and work by national bodies to strengthen data collection and compiling.

[G] Additional levers will be required to catalyse change

10.3.31. While, in line with principle 'C', interventions should ultimately be of the benefit of building users, it is suggested that additional powers to compel change will be required to deliver heat carbonisation in a timeous manner.

10.3.32. Without the appropriate standards, the Council is only able to encourage and inform homeowners and businesses to retrofit their properties after which it is their choice. Another example is that without widely available and easily accessible access to economically attractive finance, homes and businesses are unlikely to retrofit or be able to retrofit; the work of the Green Heat Finance Taskforce is required to unlock these avenues.

10.3.33. As noted, City Plan 2030 will mandate that new buildings connect to existing heat networks where this is possible. However, this policy has not yet been tested. Further, City Plan 2030 cannot compel existing properties to connect to heat networks. It is suggested that, for the roll-out of heat networks to be effective, new primary legislation compelling certain customers to connect to heat networks is likely to be required.

10.3.34. Also as noted, the proliferation of flats and mixed-tenure buildings in Edinburgh will greatly increase the complexity of implementing heat decarbonisation due to the difficulty of securing buy-in from all necessary stakeholders. It is suggested this may require legislative change that make it more straightforward for works to be agreed to be instructed to buildings of this nature, for example reform of the Tenements (Scotland) Act 2004 to widen the scope of the Tenement Management Scheme to cover energy efficiency upgrades and changes to heating systems.

10.3.35. In principle, every gas boiler in Edinburgh will require to be replaced to achieve net zero. Every additional gas boiler that is installed in an existing or new building therefore adds to the scale and cost of work that will be required to achieve net zero. Without action by government to prohibit this, the challenge of achieving net zero will continue to rise as technologies which, from a carbon perspective, are obsolescent continue to be installed. Further, the time and money invested in the installation of gas boilers (and other non-net zero carbon heating solutions) represent resources that could instead have been invested in net zero carbon heating solutions, while so long as gas boilers remain an option migration to other solutions by users and suppliers will be slower. A ban on the instalment of replacement gas boilers in existing buildings is therefore urgently needed.

11. Appendices

11.1. Heat network background information

Schedule of existing heat networks and communal heat networks in Edinburgh

Table 48: Schedule of existing heat networks and communal heat networks in Edinburgh

Name[xl]	Size	Technology	Intermediate area
"(013) / St Margaret's Court"	Unknown	Boiler	Baberton and Juniper Green
"(023) / Veitch's Square"	Unknown	Boiler	Stockbridge
"1 Dorset Place"	Small to medium (≥45kW to <1MW)	Boiler	Bruntsfield
"1 Exchange Crescent"	Large (≥1MW)	Boiler	Tollcross
"11-15 Thistle Street"	Small to medium (≥45kW to <1MW)	Boiler	New Town West
"113-115 George Street, Edinburgh"	Small to medium (≥45kW to <1MW)	Gas boiler	Deans Village
"116 Dundas St"	Small to medium (≥45kW to <1MW)	Boiler	Canonmills and New Town North
"1-17 Slateford Green"	Small to medium (≥45kW to <1MW)	Boiler	Gorgie West
"12 Royston Mains Crescent"	Small to medium (≥45kW to <1MW)	Other/unknown	Granton and Royston Mains
"12 Simpson Loan"	Small to medium (≥45kW to <1MW)	Boiler	Meadows and Southside
"120 Lasswade Road"	Small to medium (≥45kW to <1MW)	Boiler	Gracemount, Southhouse and Burdiehouse
"124-125 Princes Street"	Small to medium (≥45kW to <1MW)	Boiler	Deans Village
"13 Manor Place"	Small to medium (≥45kW to <1MW)	Gas boiler	Deans Village
"13 Simpson Loan"	Small to medium (≥45kW to <1MW)	Boiler	Meadows and Southside
"14 Morrison Crescent	Small to medium (≥45kW to <1MW)	Boiler	Dalry and Fountainbridge
"154 Dalry Road"	Small to medium (≥45kW to <1MW)	Boiler	Dalry and Fountainbridge
"1-6 Atholl Crescent"	Small to medium (≥45kW to <1MW)	Boiler	Tollcross
"160 Dundee Street"	Unknown	Other/unknown	Dalry and Fountainbridge
"17 Lauriston Park"	Small to medium (≥45kW to <1MW)	Boiler	Tollcross
"1984 - Argyle House"	Large (≥1MW)	Boiler	Tollcross
"2 Brandfield Street"	Small to medium (≥45kW to <1MW)	Boiler	Dalry and Fountainbridge
"20/22 Saughton Mains Terrace"	Small to medium (≥45kW to <1MW)	Other/unknown	Stenhouse and Saughton Mains
"21 Queen's Bay Crescent, Joppa, Edi"	Small to medium (≥45kW to <1MW)	Boiler	Joppa

[xl] All sic.

Name[xl]	Size	Technology	Intermediate area
"23-1 South Fort Street, Edinburgh"	Small to medium (≥45kW to <1MW)	Boiler	Bonnington
"24-28 Frederick Street, Edinburgh"	Small to medium (≥45kW to <1MW)	Gas boiler	Old Town, Princes Street and Leith Street
"26 Norton Park"	Small to medium (≥45kW to <1MW)	Boiler	Hillside and Calton Hill
"27 Hyvot Mill Road"	Small to medium (≥45kW to <1MW)	Boiler	Hyvots and Gilmerton
"3 Semple Street Exchange Place 3"	Small to medium (≥45kW to <1MW)	Boiler	Tollcross
"34 South Gyle Crescent"	Small to medium (≥45kW to <1MW)	Boiler	South Gyle
"343 Gorgie Road"	Small to medium (≥45kW to <1MW)	Boiler	Gorgie West
"38 Thistle Street"	Small to medium (≥45kW to <1MW)	Boiler	New Town West
"39-41 George St"	Small to medium (≥45kW to <1MW)	Boiler	Old Town, Princes Street and Leith Street
"4/5 Lochside View"	Small to medium (≥45kW to <1MW)	Boiler	South Gyle
"4/8 South Charlotte St"	Small to medium (≥45kW to <1MW)	Boiler	Deans Village
"43 Melville Street"	Small to medium (≥45kW to <1MW)	Boiler	Deans Village
"44/46 Hanover Street"	Small to medium (≥45kW to <1MW)	Boiler	Old Town, Princes Street and Leith Street
"45 George Street"	Small to medium (≥45kW to <1MW)	Boiler	Old Town, Princes Street and Leith Street
"5 Semple Street Exchnage Place 2"	Large (≥1MW)	Boiler	Tollcross
"6 Royston Mains Close"	Small to medium (≥45kW to <1MW)	Boiler	Granton and Royston Mains
"60 Bingham Drive, Edinburgh"	Small to medium (≥45kW to <1MW)	Boiler	Bingham, Magdalene and The Christians
"6-10 Bellsbrae, Edinburgh"	Unknown	Boiler	Deans Village
"63-65 George Street The Auction Hou"	Small to medium (≥45kW to <1MW)	Gas boiler	Old Town, Princes Street and Leith Street
"6-8 George Street Edinburgh"	Small to medium (≥45kW to <1MW)	Boiler	Old Town, Princes Street and Leith Street
"68-70A George Street, Edinburgh"	Small to medium (≥45kW to <1MW)	Boiler	Old Town, Princes Street and Leith Street
"7 and 9 Lanark Road"	Small to medium (≥45kW to <1MW)	CHP	Currie East
"7 Exchange Crescent"	Large (≥1MW)	Boiler	Tollcross
"7 Lochside View, Edinburgh"	Small to medium (≥45kW to <1MW)	Boiler	South Gyle
"7 Melville Cresent"	Small to medium (≥45kW to <1MW)	Gas boiler	Deans Village
"7 St Nicholas Place"	Small to medium (≥45kW to <1MW)	Boiler	Gorgie West
"8 Simpson Loan"	Small to medium (≥45kW to <1MW)	Boiler	Meadows and Southside
"80 George St"	Unknown	Other/unknown	Deans Village
"9 Gilmour's Close, Edinburgh"	Small to medium (≥45kW to <1MW)	Boiler	Old Town, Princes Street and Leith Street

Name[xl]	Size	Technology	Intermediate area
"90 - 92 George Street"	Small to medium (≥45kW to <1MW)	Boiler	Deans Village
"Abbeyhill, 82 Montrose Terrace"	Small to medium (≥45kW to <1MW)	Boiler	Abbeyhill
"Anna Macleod Hall"	Large (≥1MW)	CHP	Currie West
"Ardmore House, 40 George Street, Ed"	Micro (Less than 45 kW)	Other/unknown	Old Town, Princes Street and Leith Street
"Atholl Exchange, 6 Canning St"	Small to medium (≥45kW to <1MW)	Boiler	Tollcross
"Bainfield Student Accomodation"	Large (≥1MW)	Other/unknown	Dalry and Fountainbridge
"Boiler 1, 50 Frederick Street, Edin"	Small to medium (≥45kW to <1MW)	Boiler	New Town West
"Boiler 1, 6 Redheughs Rigg, Edinbur"	Small to medium (≥45kW to <1MW)	Boiler	South Gyle
"Boiler 1, Edinburgh Quay 2, Edinbur"	Small to medium (≥45kW to <1MW)	Boiler	Dalry and Fountainbridge
"Boiler 1, Osborne House, 1-5 Osborn"	Small to medium (≥45kW to <1MW)	Boiler	Deans Village
"Boiler 1, Quartermile One, 15 Lauri"	Small to medium (≥45kW to <1MW)	Boiler	Meadows and Southside
"Boiler 2, 50 Frederick Street, Edin"	Small to medium (≥45kW to <1MW)	Boiler	New Town West
"Boiler 2, 6 Redheughs Rigg, Edinbur"	Small to medium (≥45kW to <1MW)	Boiler	South Gyle
"Boiler 2, Edinburgh Quay 2, Edinbu"	Small to medium (≥45kW to <1MW)	Boiler	Dalry and Fountainbridge
"Boiler 2, Osborne House, 1-5 Osborn"	Small to medium (≥45kW to <1MW)	Boiler	Deans Village
"Boiler 2, Quartermile One, 15 Lauri"	Small to medium (≥45kW to <1MW)	Boiler	Meadows and Southside
"Boiler 3, 6 Redheughs Rigg, Edinbur"	Small to medium (≥45kW to <1MW)	Boiler	South Gyle
"Boiler 3, Edinburgh Quay 2, Edinbur"	Small to medium (≥45kW to <1MW)	Boiler	Dalry and Fountainbridge
"Boiler 3, Quartermile One, 15 Lauri"	Small to medium (≥45kW to <1MW)	Boiler	Meadows and Southside
"Cables Wynd Edinburgh"	Unknown	Boiler	Great Junction Street
"Cables Wynd House"	Large (≥1MW)	Boiler	Great Junction Street
"Capital Building"	Small to medium (≥45kW to <1MW)	Boiler	Old Town, Princes Street and Leith Street
"Castlebrae Glebe"	Unknown	Boiler	Craigmillar
"Causewayside House"	Small to medium (≥45kW to <1MW)	Boiler	The Grange
"Centrum house"	Small to medium (≥45kW to <1MW)	Boiler	Canonmills and New Town North
"Chalmers Street"	Small to medium (≥45kW to <1MW)	Boiler	Meadows and Southside
"Christina Miller Energy Centre"	Small to medium (≥45kW to <1MW)	Other/unknown	Currie West
"Christina Miller Energy Centre"	Small to medium (≥45kW to <1MW)	CHP	Currie West
"Commercial Quay"	Unknown	Other/unknown	The Shore and Constitution Street

Name[xl]	Size	Technology	Intermediate area
"Conference House, 152 Morrison Stre"	Small to medium (≥45kW to <1MW)	Boiler	Tollcross
"Cornerstone Building"	Small to medium (≥45kW to <1MW)	Boiler	South Gyle
"Deanhaugh St, Stockbridge, Edinburg"	Small to medium (≥45kW to <1MW)	Boiler	Stockbridge
"Drum Edinburgh"	Unknown	Boiler	Gilmerton South and the Murrays
"Elder House, 24 Elder Street"	Small to medium (≥45kW to <1MW)	Boiler	Old Town, Princes Street and Leith Street
"Elliot House"	Small to medium (≥45kW to <1MW)	Boiler	Hillside and Calton Hill
"Ferniehill Avenue/Drum Avenue"	Small to medium (≥45kW to <1MW)	Boiler	Fernieside and Moredun South
"Fortune Place (St Barnabas)"	Micro (Less than 45 kW)	CHP	Old Town, Princes Street and Leith Street
"Fountain Court"	Small to medium (≥45kW to <1MW)	Boiler	Moredun and Craigour
"George Square 1"	Unknown	CHP	Meadows and Southside
"Greendykes and Wauchope House"	Large (≥1MW)	Other/unknown	Niddrie
"Greendykes C"	Small to medium (≥45kW to <1MW)	Other/unknown	Craigmillar
"Greendykes Edinburgh"	Unknown	Boiler	Niddrie
"Harvester Way, Wester Hailes, Edinb"	Small to medium (≥45kW to <1MW)	Boiler	Clovenstone and Wester Hailes
"Haston House"	Small to medium (≥45kW to <1MW)	Boiler	South Gyle
"Hays Community Business Centre"	Small to medium (≥45kW to <1MW)	Boiler	Niddrie
"Holyrood Park House"	Small to medium (≥45kW to <1MW)	Boiler	Old Town, Princes Street and Leith Street
"Kings Buildings 1"	Unknown	CHP	Blackford, West Mains and Mayfield Road
"Lady Nicolson Court"	Small to medium (≥45kW to <1MW)	Boiler	Canongate, Southside and Dumbiedykes
"Lanark Road West"	Small to medium (≥45kW to <1MW)	CHP	Currie East
"Lighthouse Court"	Small to medium (≥45kW to <1MW)	Boiler	Granton and Royston Mains
"Lochrin Square"	Small to medium (≥45kW to <1MW)	Other/unknown	Tollcross
"Lomond & Leven House, Edinburgh"	Small to medium (≥45kW to <1MW)	Boiler	South Gyle
"London Road, Edinburgh"	Small to medium (≥45kW to <1MW)	Boiler	Meadowbank and Abbeyhill North
"Maidencraig Court"	Small to medium (≥45kW to <1MW)	Boiler	Blackhall
"Market Court"	Small to medium (≥45kW to <1MW)	Boiler	Granton and Royston Mains
"Milton Road Heating System"	Small to medium (≥45kW to <1MW)	Boiler	Joppa
"Murryburgh House"	Small to medium (≥45kW to <1MW)	Gas boiler	Murrayfield and Ravelston
"Nine Edinburgh BioQuarter, 9 Little"	Unknown	Boiler	Craigmillar

Name[xl]	Size	Technology	Intermediate area
"Omni Centre, 28 Greenside Place"	Small to medium (≥45kW to <1MW)	Boiler	Old Town, Princes Street and Leith Street
"Orchard Brae House, 30 Queensferry"	Large (≥1MW)	Boiler	Comely Bank
"Oriam South Bldg"	Small to medium (≥45kW to <1MW)	Boiler	Currie West
"Pollock Halls 1"	Unknown	CHP	Newington and Dalkeith Road
"Princes Edinburgh"	Unknown	Trigeneration	Old Town, Princes Street and Leith Street
"Quartermile One, 15 Lauriston Place"	Large (≥1MW)	Other/unknown	Meadows and Southside
"Riverside House, 502 Gorgie Road"	Small to medium (≥45kW to <1MW)	Boiler	Stenhouse and Saughton Mains
"Roland House, Newbridge"	Micro (Less than 45 kW)	Boiler	Dalmeny, Kirkliston and Newbridge
"Rosewell House, 2A Harvest Drive"	Small to medium (≥45kW to <1MW)	Other/unknown	Dalmeny, Kirkliston and Newbridge
"S0891 Clarendon House"	Small to medium (≥45kW to <1MW)	Boiler	Deans Village
"Sailmaker, Edinburgh"	Large (≥1MW)	CHP	Western Harbour and Leith Docks
"Saltire Court, 20 Castle Terrace, E"	Large (≥1MW)	Other/unknown	Tollcross
"Saltire Street (Upper Strand)"	Large (≥1MW)	Boiler	Granton and Royston Mains
"Saunders Court"	Small to medium (≥45kW to <1MW)	Boiler	Corstorphine
"Shore Road"	Small to medium (≥45kW to <1MW)	Boiler	Queensferry West
"Sirius Building, Clocktower Estates"	Small to medium (≥45kW to <1MW)	Other/unknown	South Gyle
"Slateford Green"	Small to medium (≥45kW to <1MW)	Boiler	Gorgie West
"Slateford Student Accomodation"	Small to medium (≥45kW to <1MW)	Other/unknown	Shandon
"SPACE, 11 Harewood Road"	Small to medium (≥45kW to <1MW)	Boiler	Craigmillar
"Spectrum House, 2 Powderhall Road"	Small to medium (≥45kW to <1MW)	Boiler	Broughton North and Powderhall
"Sports Academy Bldg"	Small to medium (≥45kW to <1MW)	Boiler	Currie West
"St James Shopping Centre"	Large (≥1MW)	Boiler	Old Town, Princes Street and Leith Street
"Station Car Park"	Unknown	Boiler	Old Town, Princes Street and Leith Street
"Stenhouse Mill Wynd"	Small to medium (≥45kW to <1MW)	Boiler	Slateford and Chesser
"Stewart House"	Small to medium (≥45kW to <1MW)	Boiler	New Town West
"Tanfield House"	Large (≥1MW)	Gas boiler	Broughton North and Powderhall
"The Green, Longstone Road, Edinburg"	Large (≥1MW)	Boiler	Longstone and Saughton
"The Student Housing Company (Edinbu"	Small to medium (≥45kW to <1MW)	CHP	Abbeyhill
"The Student Housing Company (Edinbu"	Small to medium (≥45kW to <1MW)	CHP	Tollcross

Name[xl]	Size	Technology	Intermediate area
"The Student Housing Company (Edinbu"	Small to medium (≥45kW to <1MW)	Boiler	Dalry and Fountainbridge
"The Tun"	Small to medium (≥45kW to <1MW)	Boiler	Longstone and Saughton
"The Waterfront"	Small to medium (≥45kW to <1MW)	Boiler	Granton and Royston Mains
"Thomsons Court, 58 Grassmarket, Edi"	Small to medium (≥45kW to <1MW)	Boiler	Old Town, Princes Street and Leith Street
"Thorntree Court"	Unknown	Boiler	South Leith
"Vantage Point, 23 St Johns Rd"	Small to medium (≥45kW to <1MW)	Boiler	Corstorphine
"Waterfront Avenue, Edinburgh"	Large (≥1MW)	Boiler	Granton and Royston Mains
"Wemyss House, 6-8 Wemyss Place"	Small to medium (≥45kW to <1MW)	Boiler	New Town West
"West Pilton Crescent"	Small to medium (≥45kW to <1MW)	Other/unknown	West Pilton
"Westcott House"	Small to medium (≥45kW to <1MW)	Boiler	Queensferry East
"Westfield Avenue"	Small to medium (≥45kW to <1MW)	Other/unknown	Gorgie West
"Westfield Court"	Large (≥1MW)	Boiler	Gorgie West
"Wharton Square, Edinburgh"	Large (≥1MW)	Boiler	Meadows and Southside
"William Arrol Building"	Large (≥1MW)	Boiler	Currie West

Figure 01: Plan of existing heat networks and communal heat networks in Edinburgh

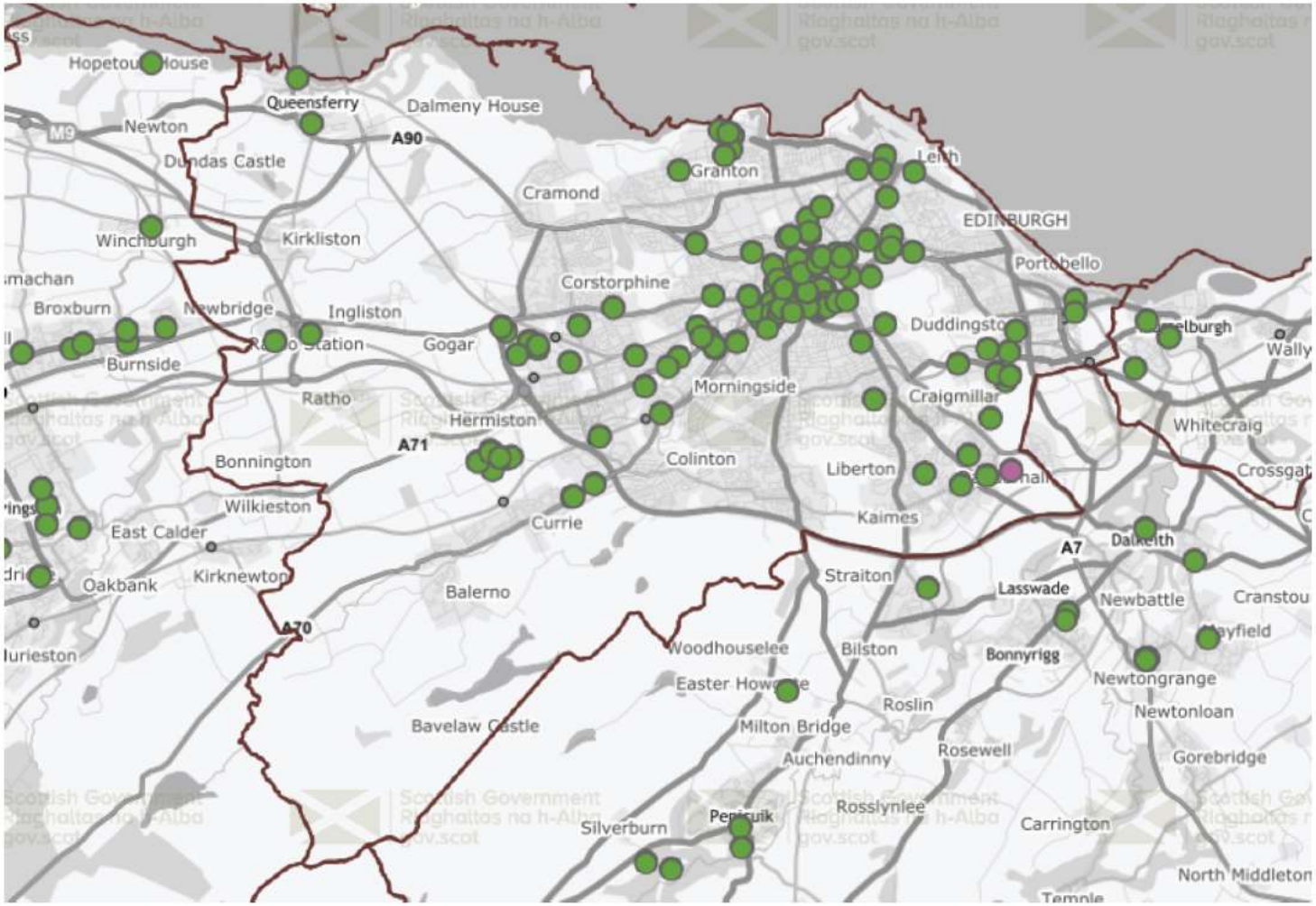


Figure 02: First National Assessment – potential Heat Network Zones identified in Edinburgh (baseline and stringent criteria)

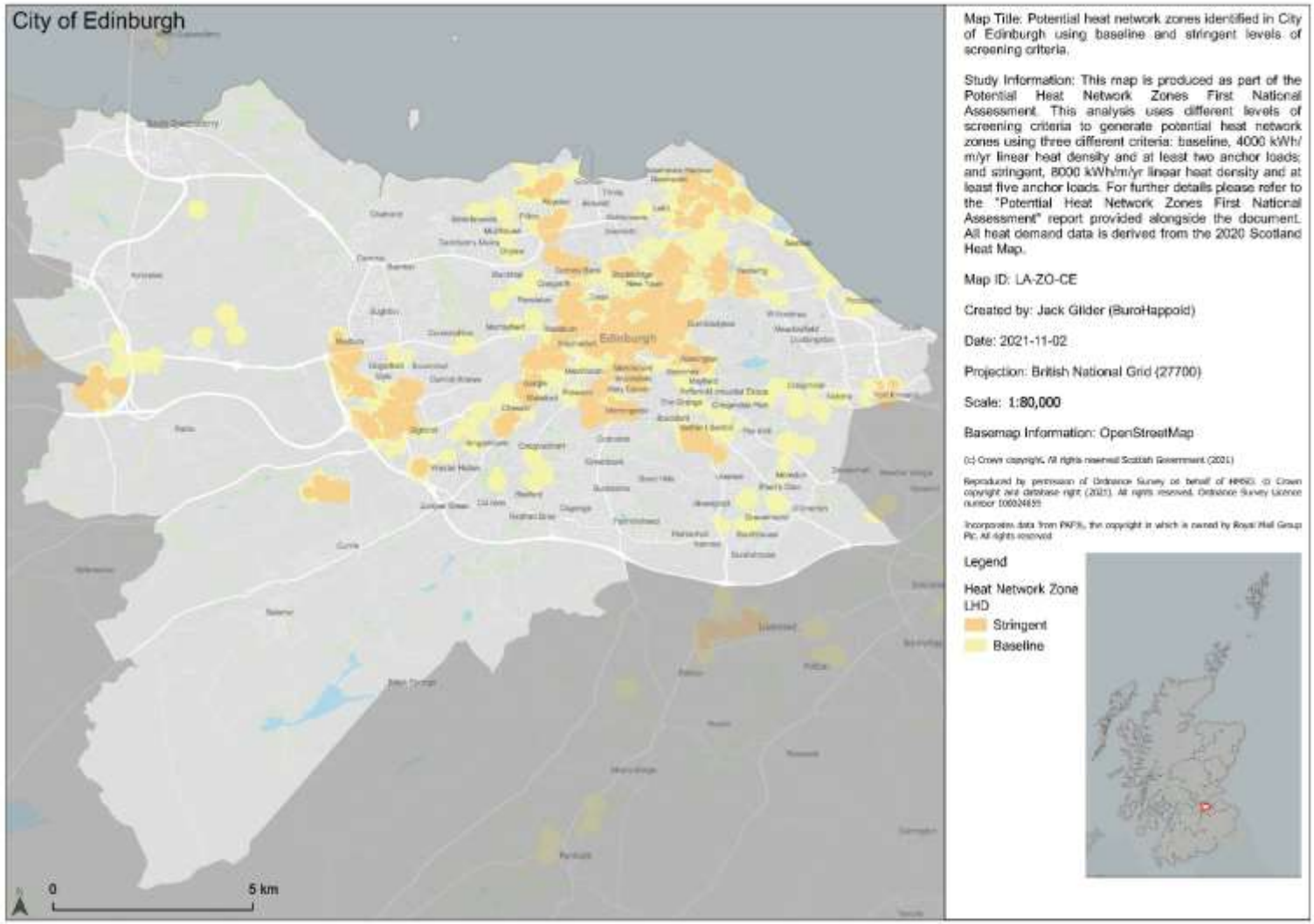


Figure 03: First National Assessment – largest potential Heat Network Zone identified in Edinburgh (stringent criteria)

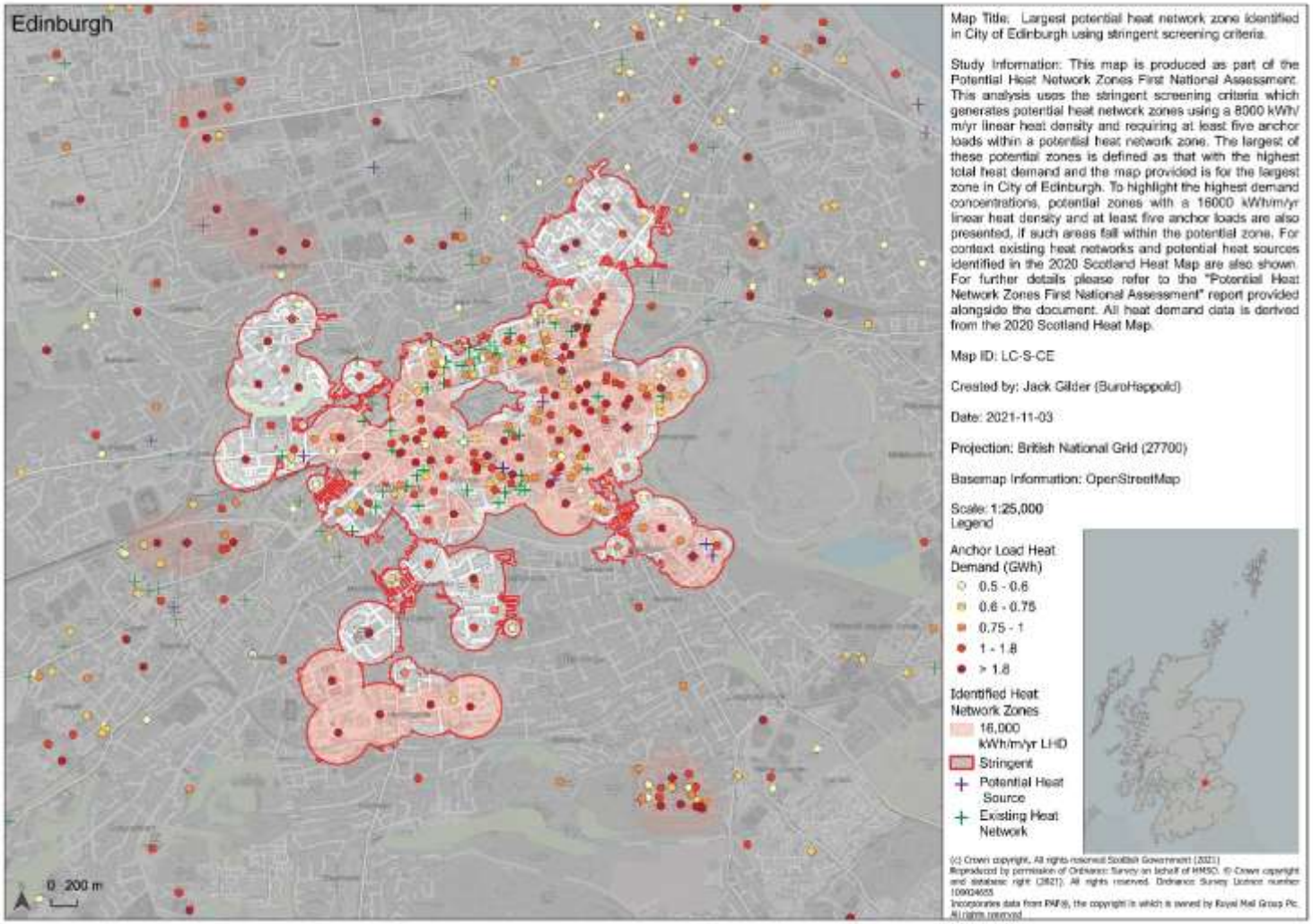
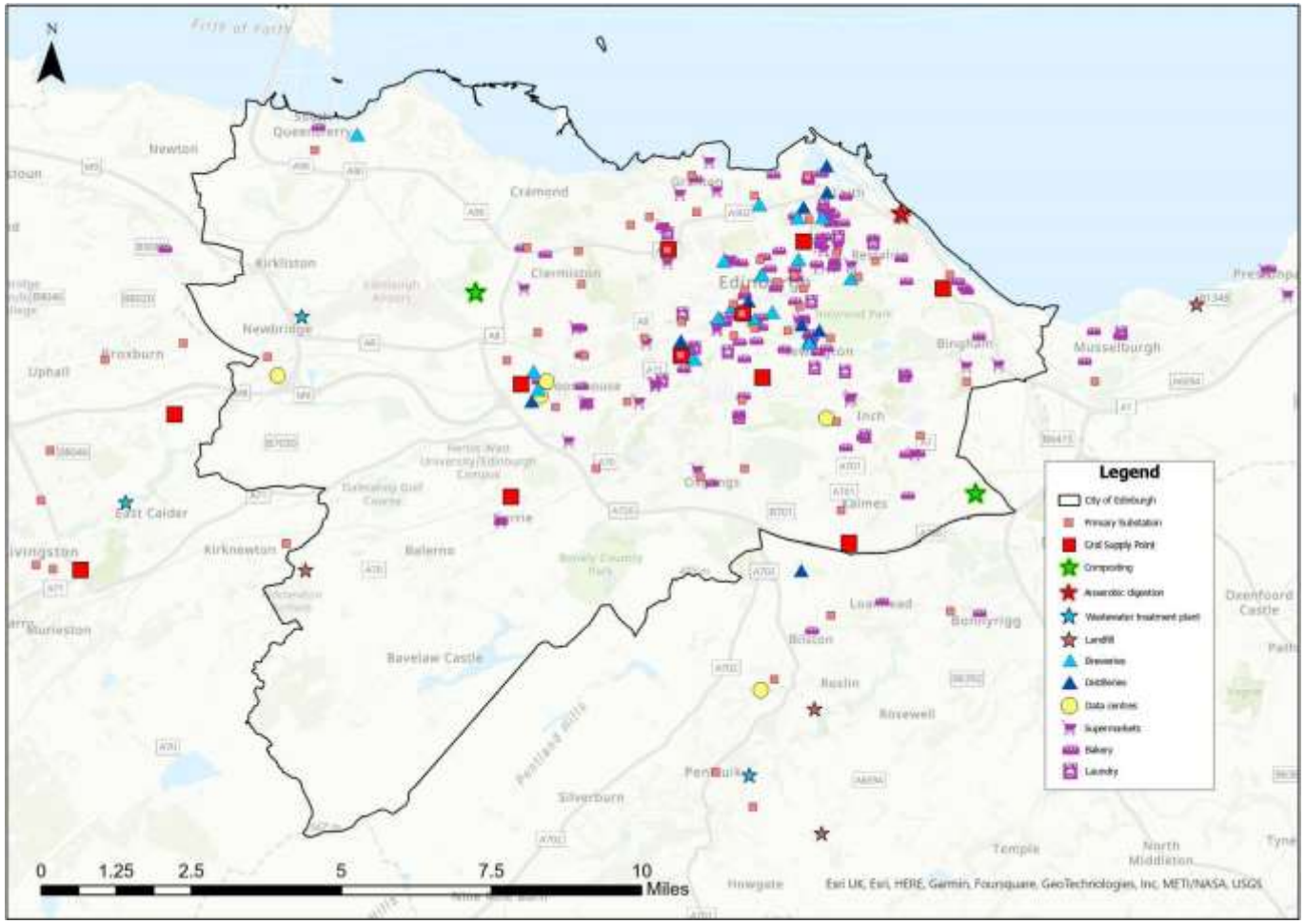


Figure 04: The Coal Authority map of underground workings in Edinburgh [xli] 66

[xli] Workings are shown in lime green.

Figure 05: Scottish Water map of potential wastewater heat extraction opportunities in Edinburgh [67]

Figure 06: Map of potential waste heat sources in Edinburgh [xlii] 68



[xlii] The potential waste heat sources identified in the figure mirror the sectors identified in the ClimateXChange 2020 report Potential Sources of Waste Heat for Heat Networks in Scotland. The report identifies and quantifies the likely waste heat potential 10 sources (distilleries, breweries, bakeries, paper and pulp, laundry, supermarkets,

Datasets used to identify waste heat sources in Edinburgh

Table 49: Datasets used to identify waste heat sources in Edinburgh

Waste heat source	Evidence source
Data centres	▪ Data Center Map - Edinburgh Data Centers ▪ EPCC – Advanced Computing Facility ▪ University of Edinburgh – ACF Migration Frequently Asked Questions
Breweries	▪ The Brewery Bible – Scotland Breweries
Distilleries	▪ Truly Edinburgh – Edinburgh Whisky Distilleries ▪ Truly Edinburgh – The Best Gin Distilleries in Edinburgh ▪ VisitScotland – Whisky Distilleries in Scotland ▪ Scotch Whisky Association – Distillery Map ▪ Wandering Spirits Global – Scotland Whisky Distillery Map ▪ Whisky Invest Direct – Malt Whisky Distilleries in Scotland
Supermarkets	▪ ArcGIS – OpenStreetMap Shops for Europe
Bakeries	▪ ArcGIS – OpenStreetMap Shops for Europe
Laundries	▪ ArcGIS – OpenStreetMap Shops for Europe
Landfill sites	▪ SEPA – Scotland's Waste Sites and Capacity Data Tool ▪ SEPA – Scottish Pollutant Release Inventory
Primary substations	▪ SP Energy Networks - Distributed Generation SP Distribution Heat Maps – SPD Primary Substations
Grid supply points	▪ SP Energy Networks - Distributed Generation SP Distribution Heat Maps – SPD Grid Substations

data centres, electricity substations, wastewater treatment plants (WWTP), and landfill). While data sharing restrictions currently preclude the sharing of the underlying data, the following map identifies the location of the same sources updated to 2023 with the exclusion of paper and pulp as no facilities were present in Edinburgh. Further steps could be taken to quantify the heat from these sources following the ClimateXChange methodology.

11.2. Heat network methodological information

Datasets used to inform the Heat Network Zone analysis

Table 50: Datasets used to inform the Heat Network Zone analysis

Dataset	Source
Heat demand	Scotland Heat Map
Heat density raster	Scotland Heat Map
Existing heat networks	Scotland Heat Map
Planned heat networks	The City of Edinburgh Council
Local Development Plan sites	The City of Edinburgh Council
NAEI large point emitters	National Atmospheric Emissions Inventory
SEPA waste sites	Scottish Environmental Protection Agency
Energy supply points	Scotland Heat Map
Wastewater treatment plants	CXC Waste Heat Dataset
Process loads - supermarkets, bakeries, breweries, distilleries, laundries, paper and pulp sites	CXC Waste Heat Dataset
Data centres	CXC Waste Heat Dataset
Primary substations	Scottish Power Energy Networks
Grid supply points	Scottish Power Energy Networks
OS greenspace	Ordnance Survey
Rivers and waterbodies	Ordnance Survey (OS OpenMap Local)
BGS Hydrogeology 625k	British Geological Survey
GeoTH Hot Sed Aquifer prospects	Scotland Heat Map
Coal mining reporting areas	British Geological Survey / The Coal Authority
The Coal Authority discharge Points	British Geological Survey / The Coal Authority
Roads, railway tracks, road/railway tunnels	Ordnance Survey (OS OpenMap Local)
Home Analytics	Energy Saving Trust

Figure 07: Linear heat density buffer zone methodology

Figure 08: Buffer zones based on linear heat density of 4,000 kWh per metre per year

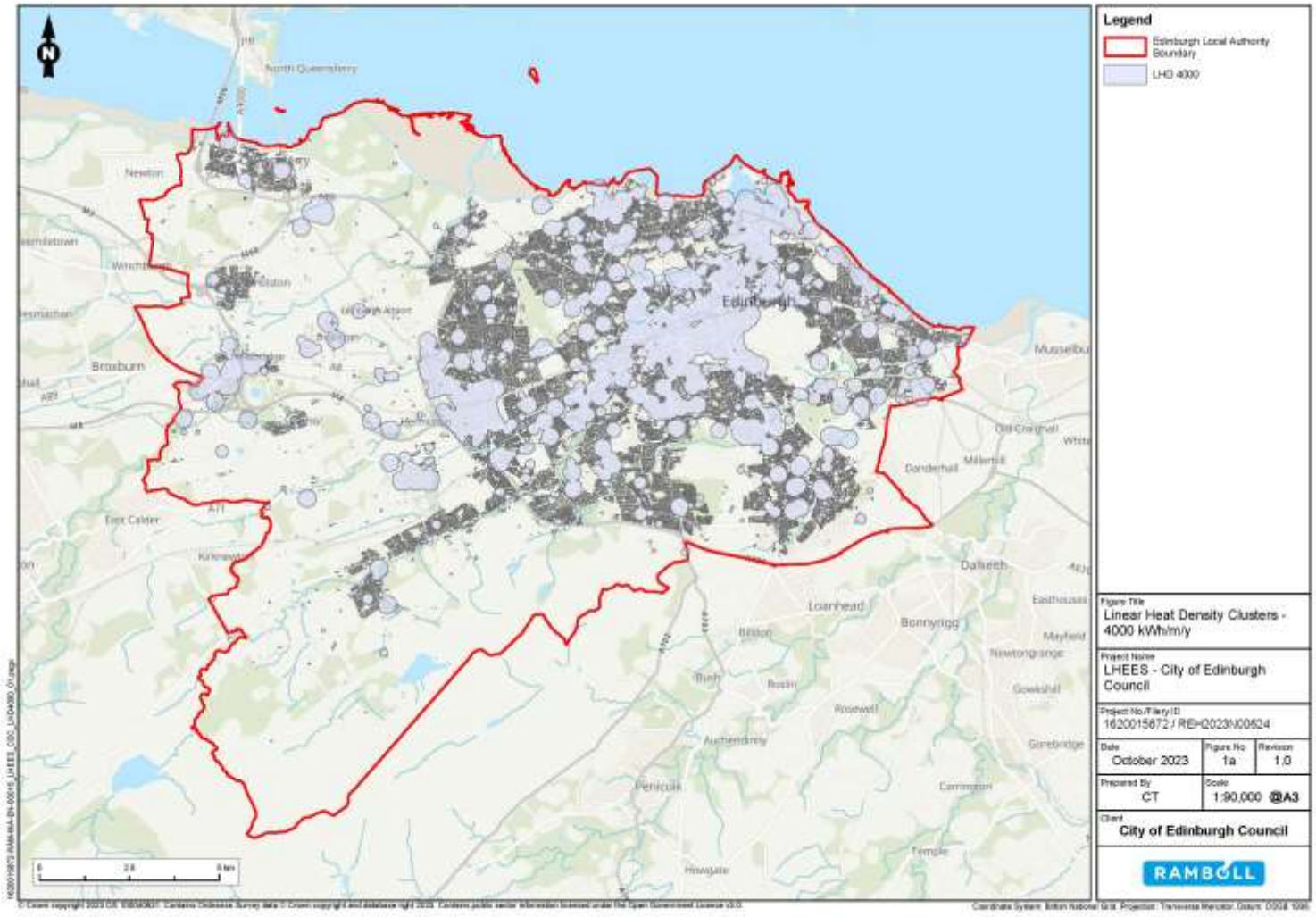


Figure 09: Buffer zones based on linear heat density of 8,000 kWh per metre per year

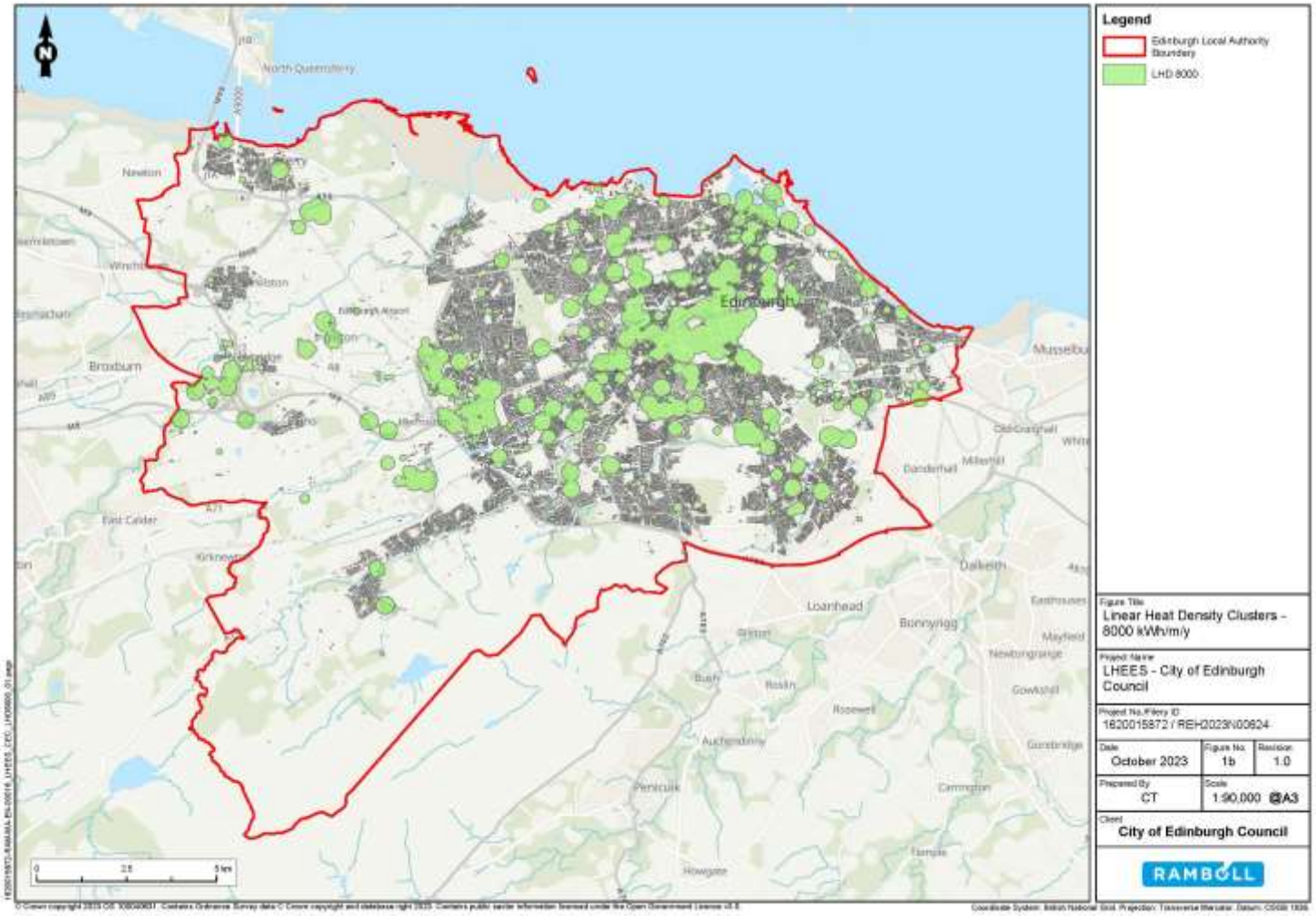


Figure 10: Process for the prioritisation of potential zones

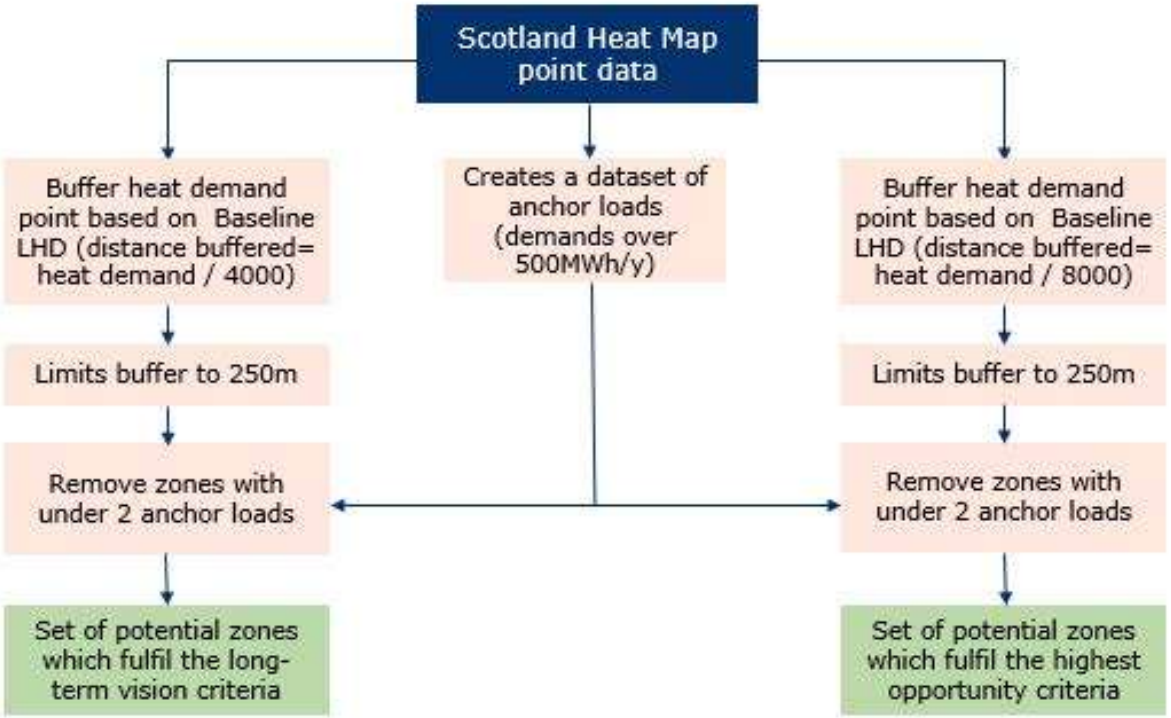


Figure 11: Prioritised potential Heat Network Zones in Edinburgh based on linear heat density of 4,000 kWh per metre per year

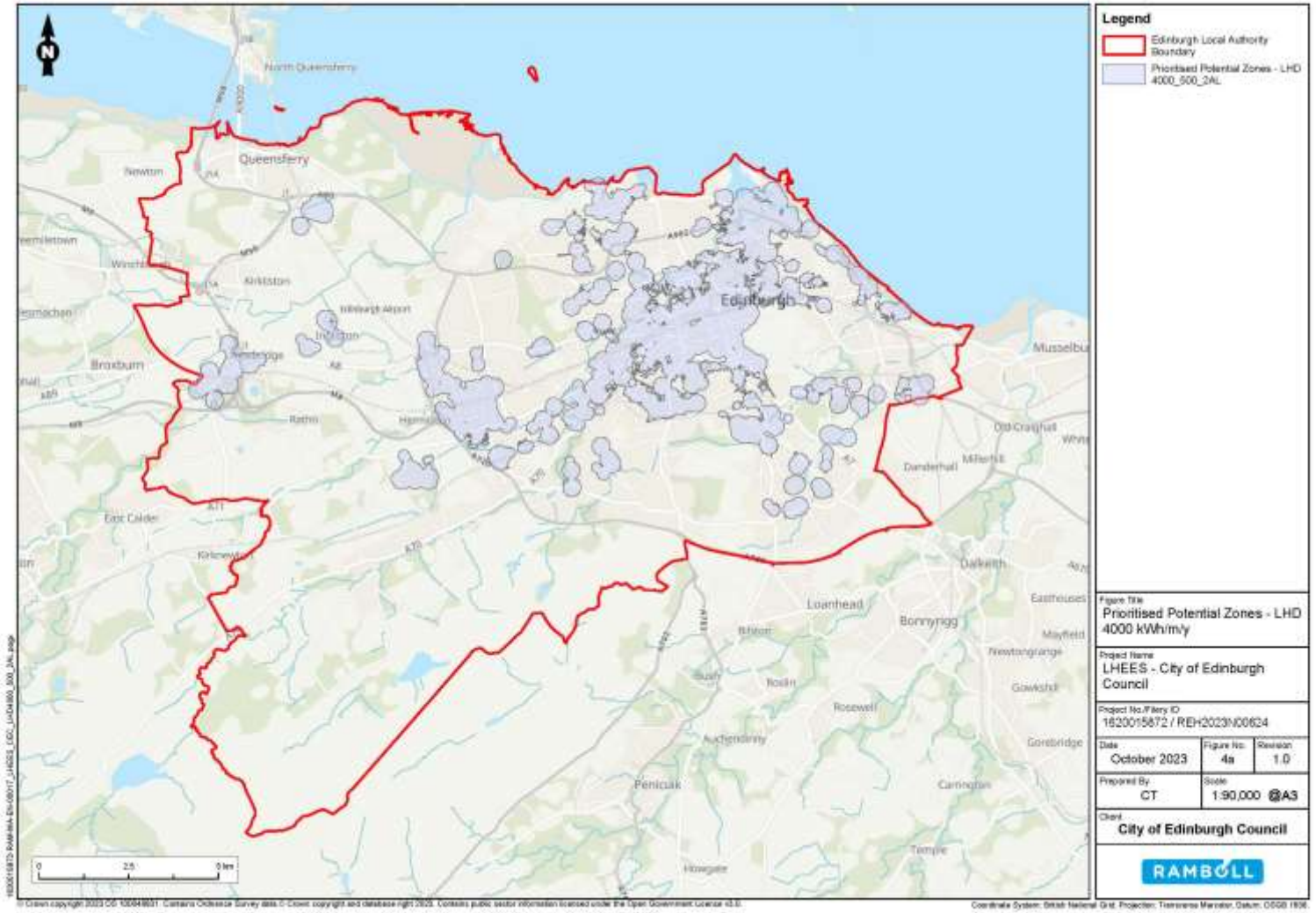


Figure 12: Prioritised potential Heat Network Zones in Edinburgh based on linear heat density of 8,000 kWh per metre per year

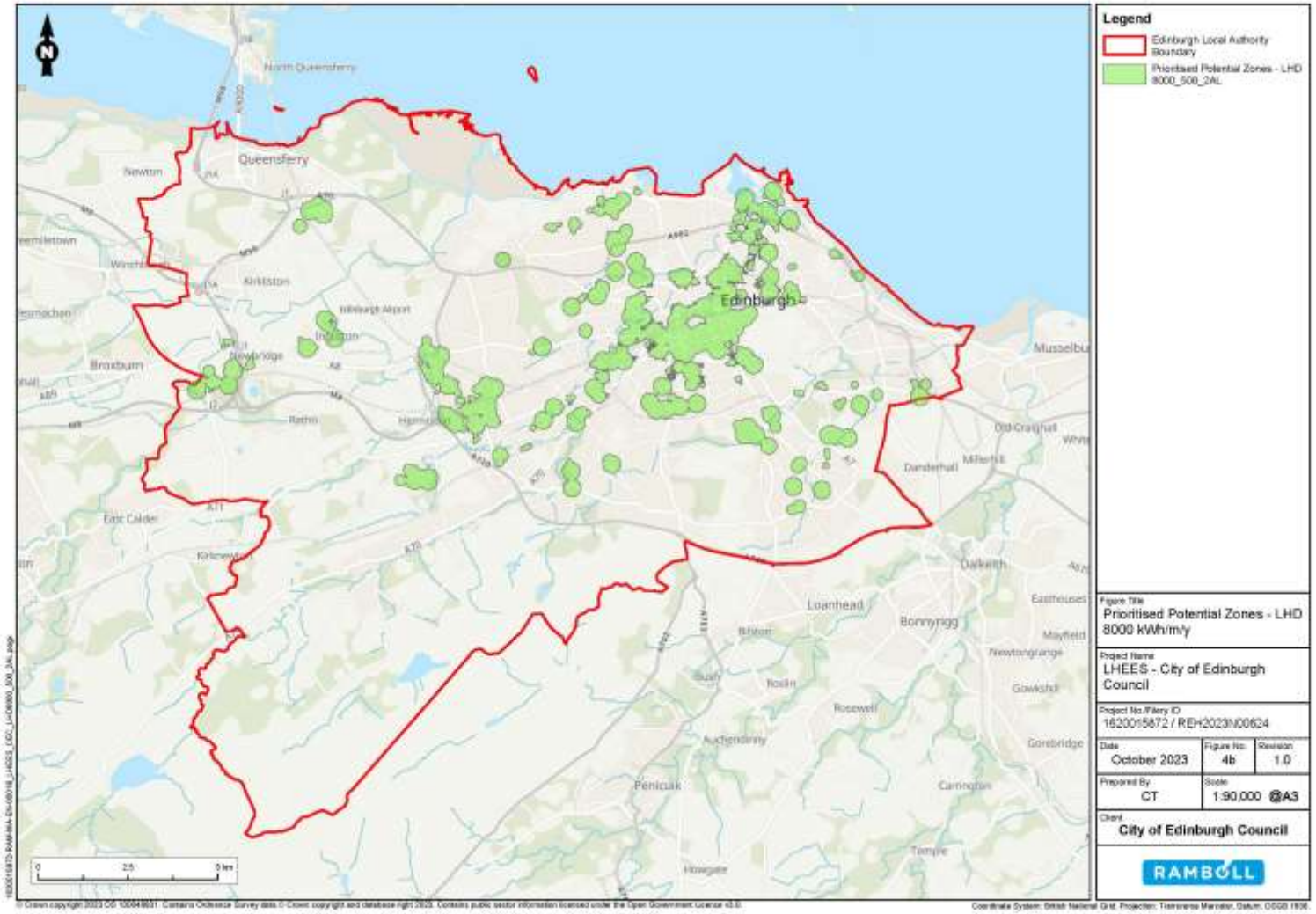


Figure 13: Selected prioritised potential Heat Network Zones in Edinburgh

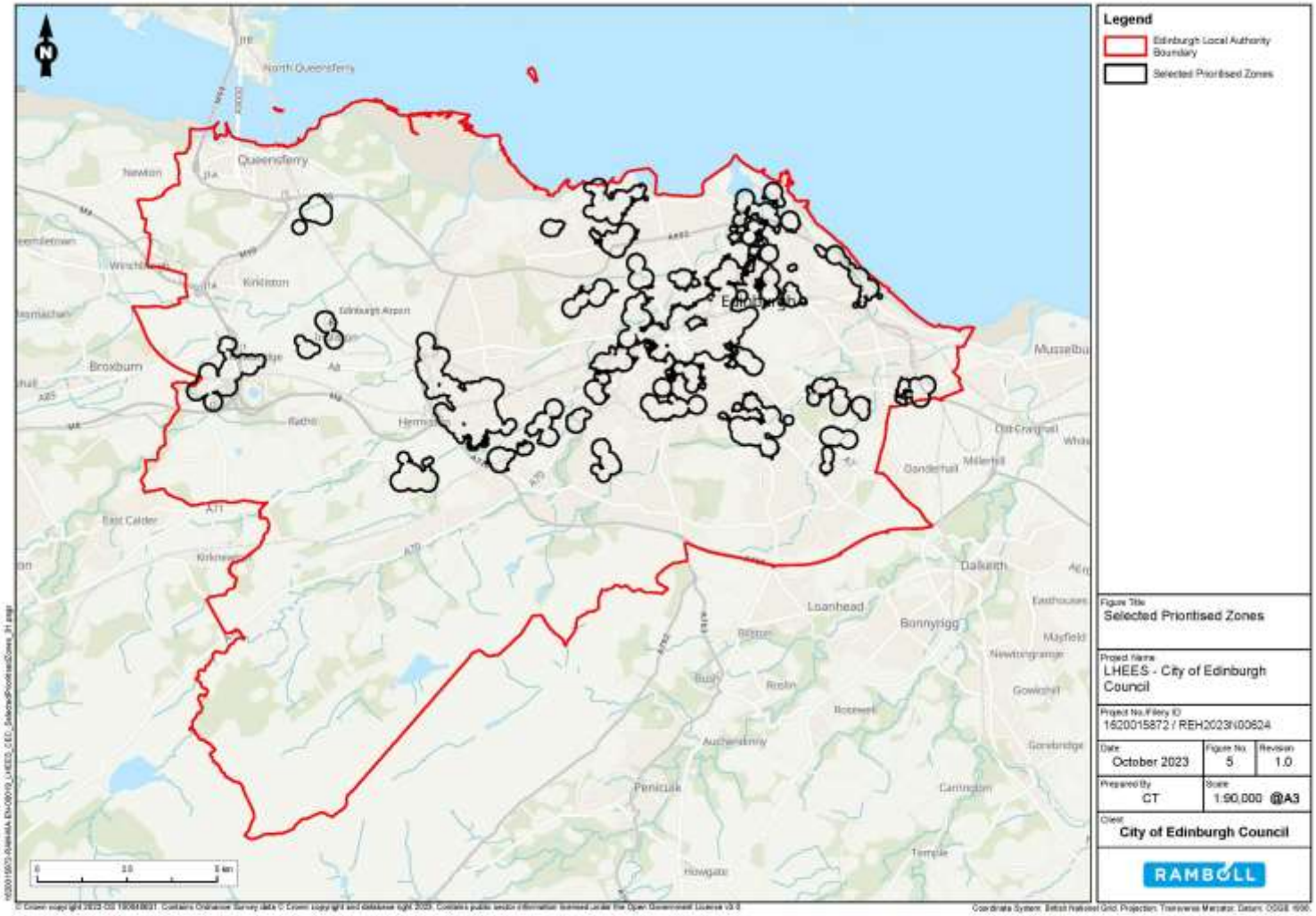


Figure 14: Initial Heat Network Zones in Edinburgh, overlaid with areas of new development and planned heat networks

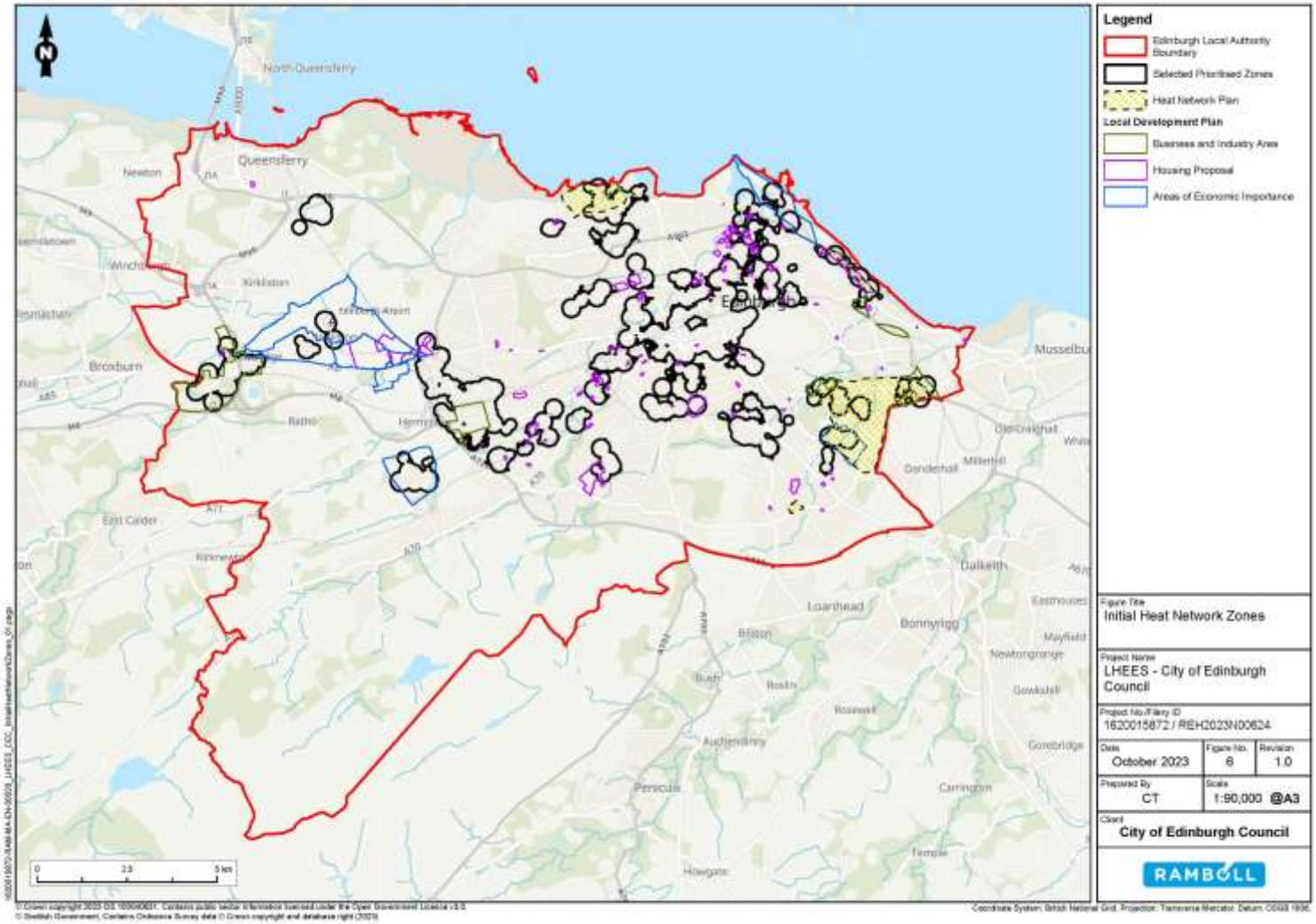
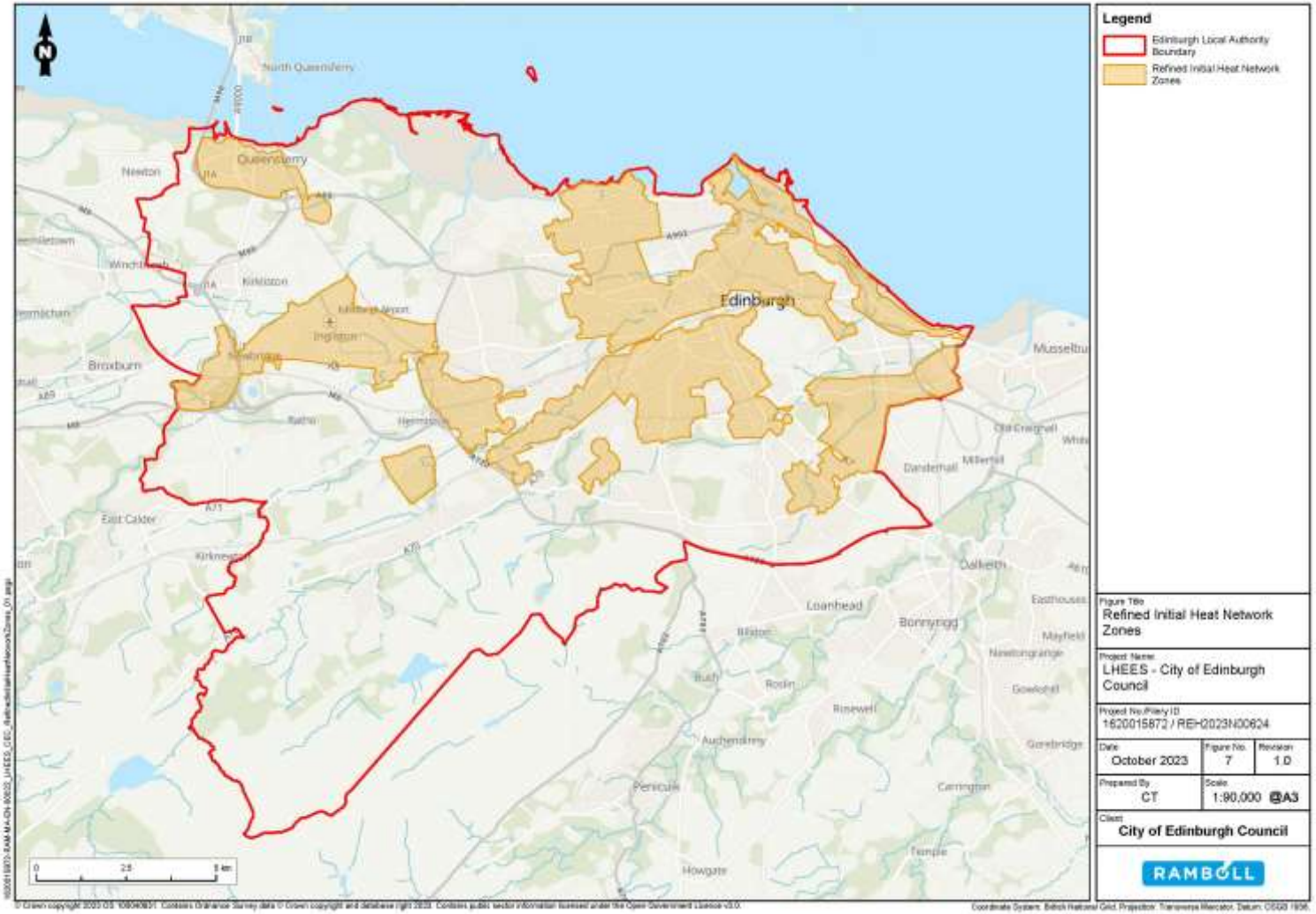


Figure 15: Refined initial Heat Network Zones in Edinburgh



11.3. Strategic Zones

Figure 16: Off-gas homes in category 0

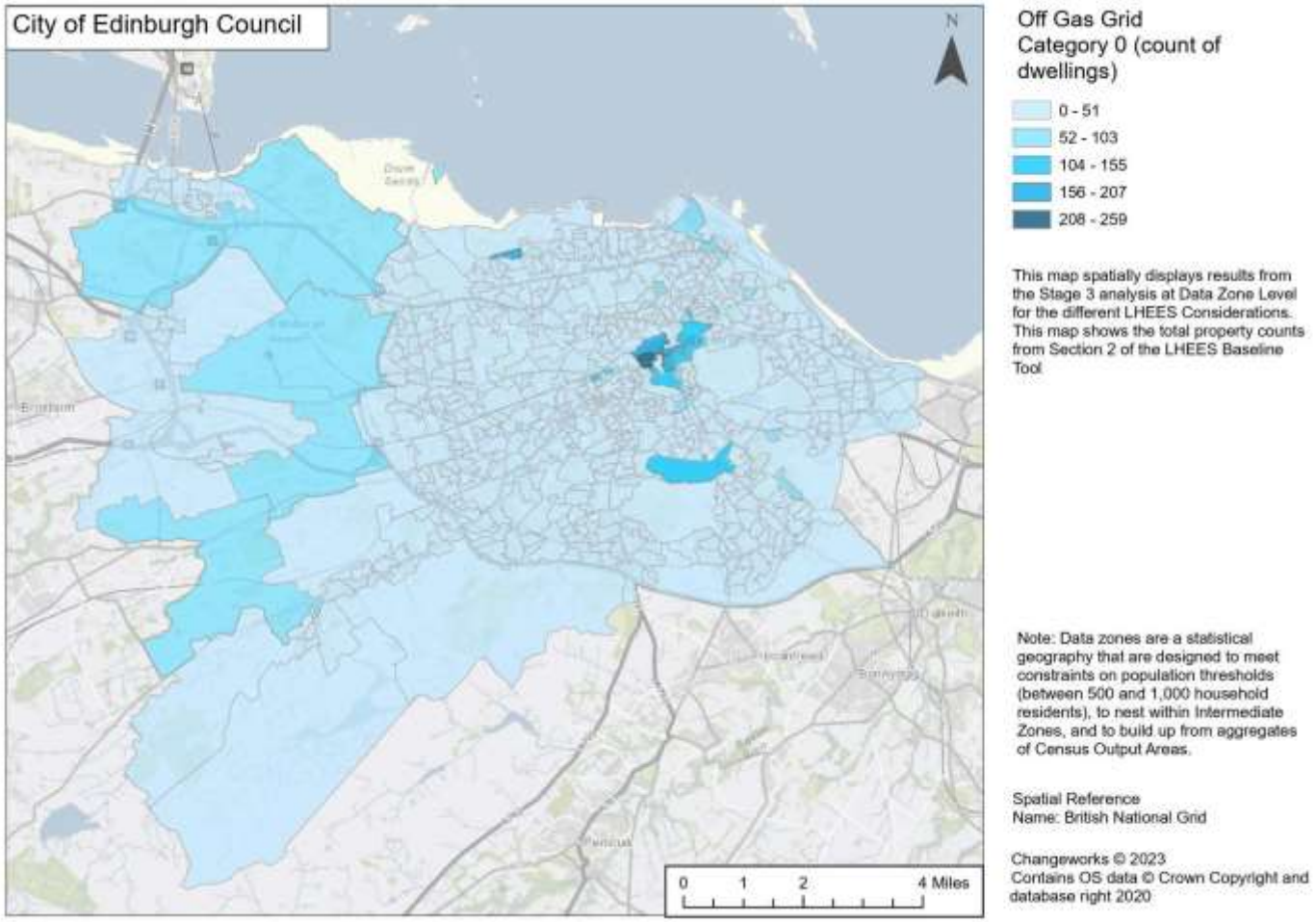


Figure 17: Off-gas homes in category 1

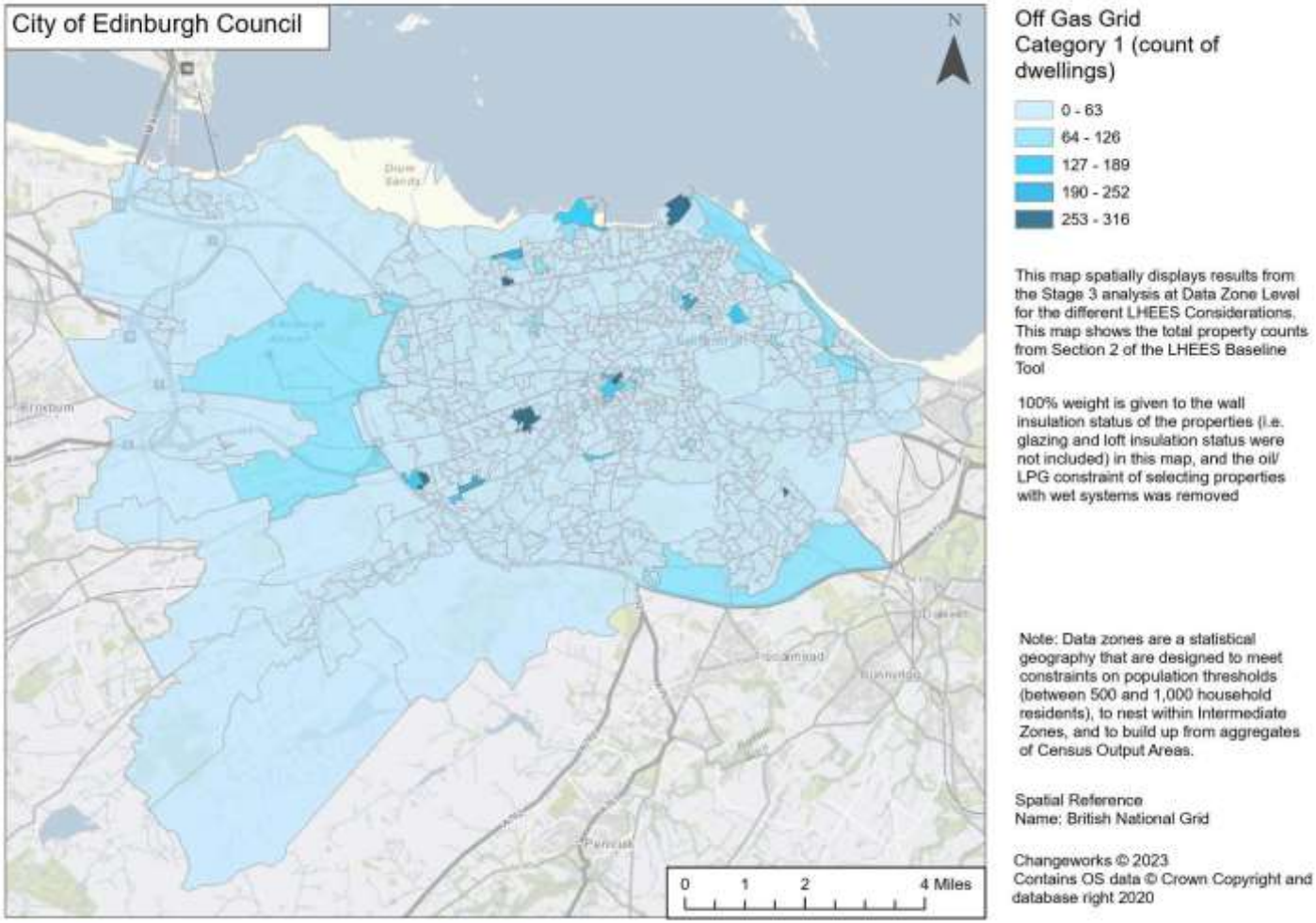


Figure 18: Off-gas homes in category 2

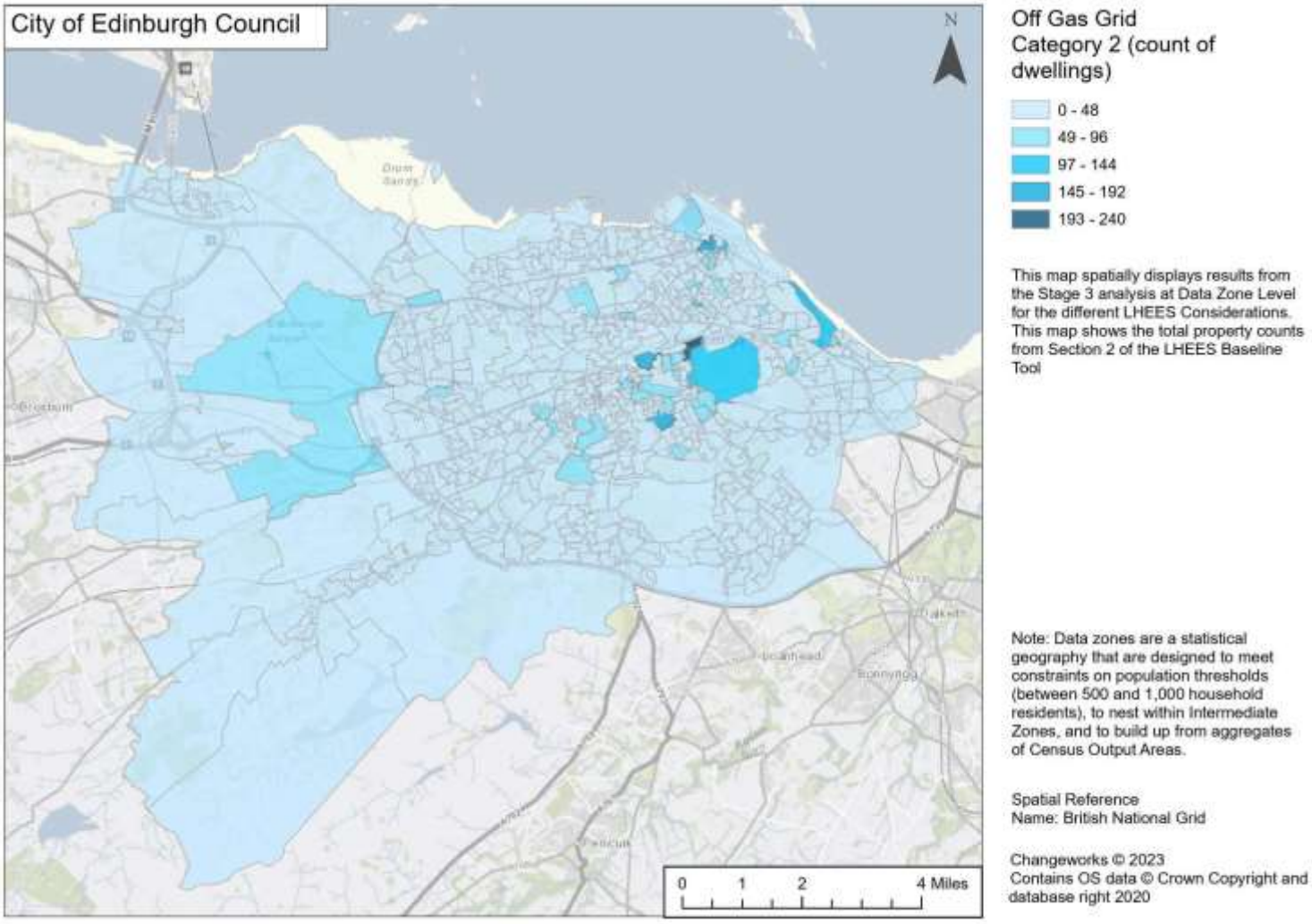


Figure 19: Off-gas homes in category 3

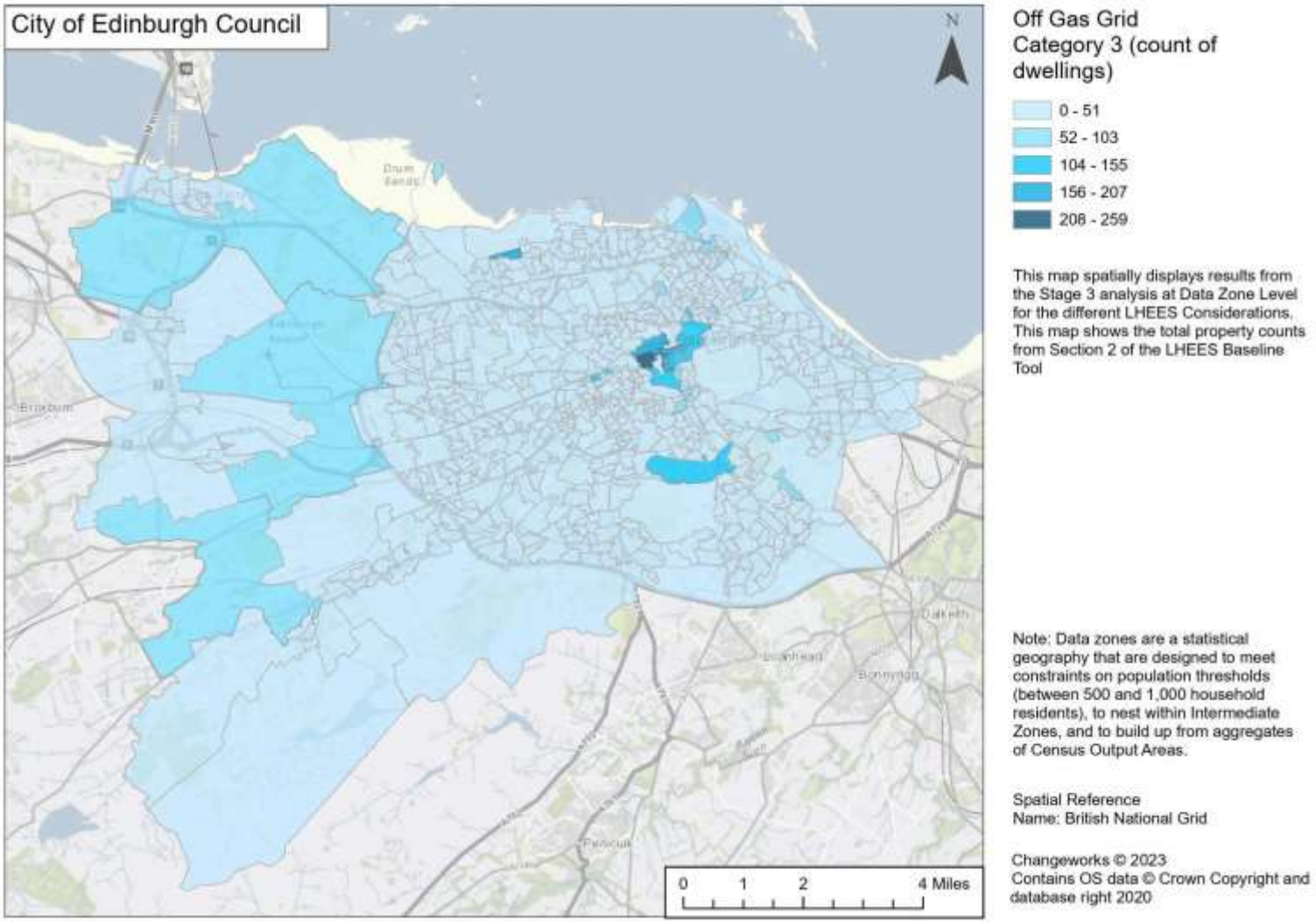


Figure 20: On-gas homes in category 0

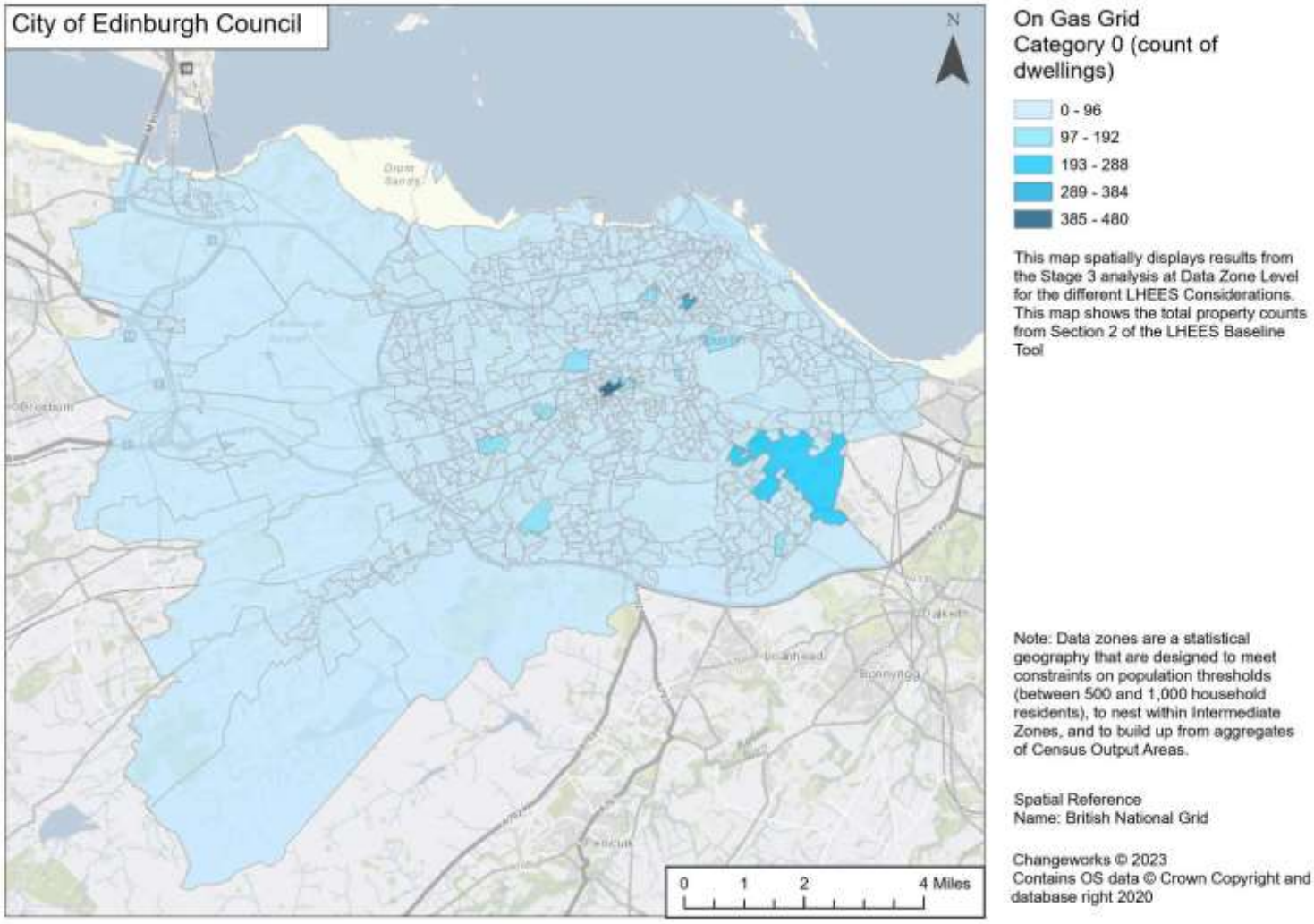


Figure 21: On-gas homes in category 1

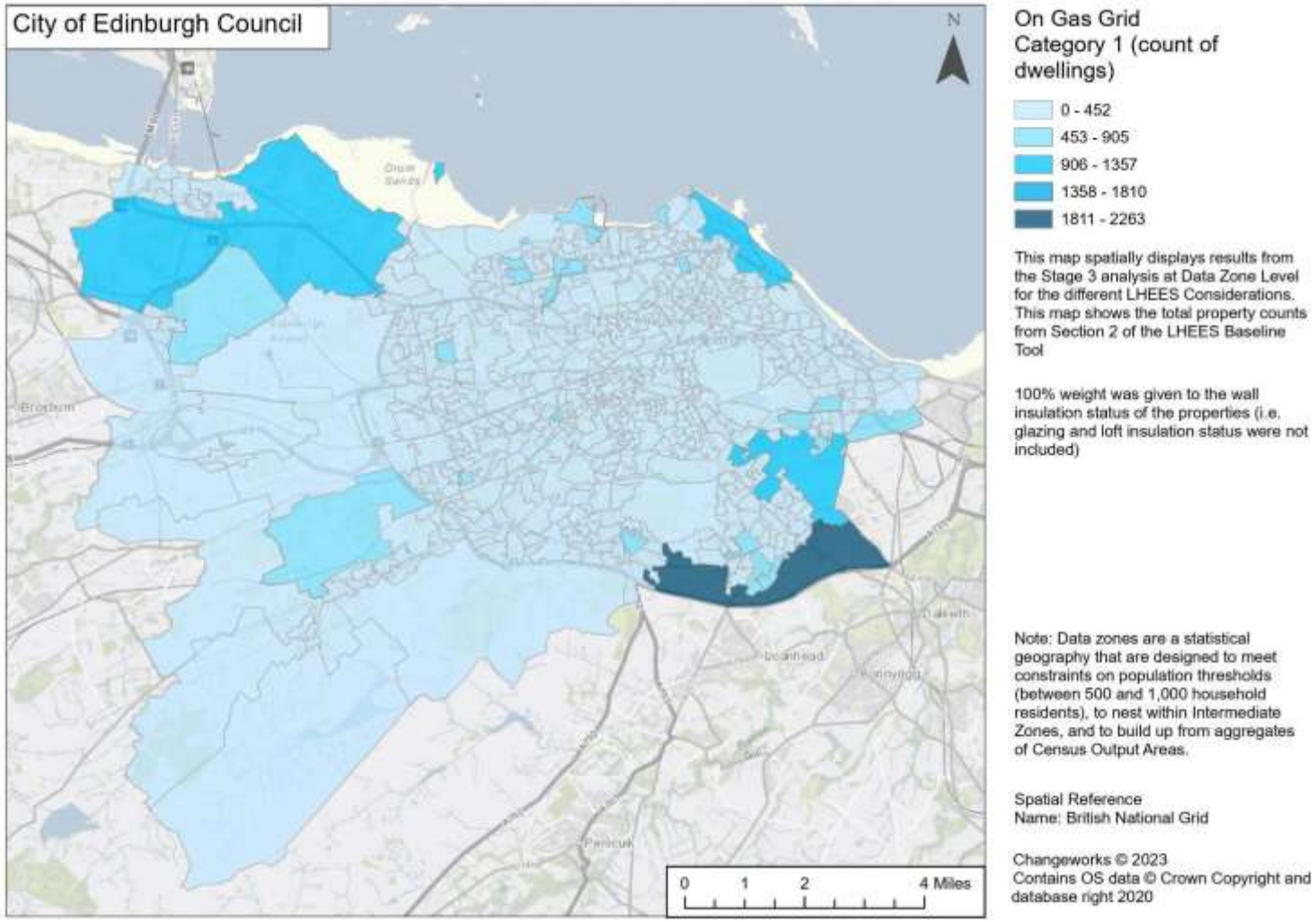


Figure 22: On-gas homes in category 2

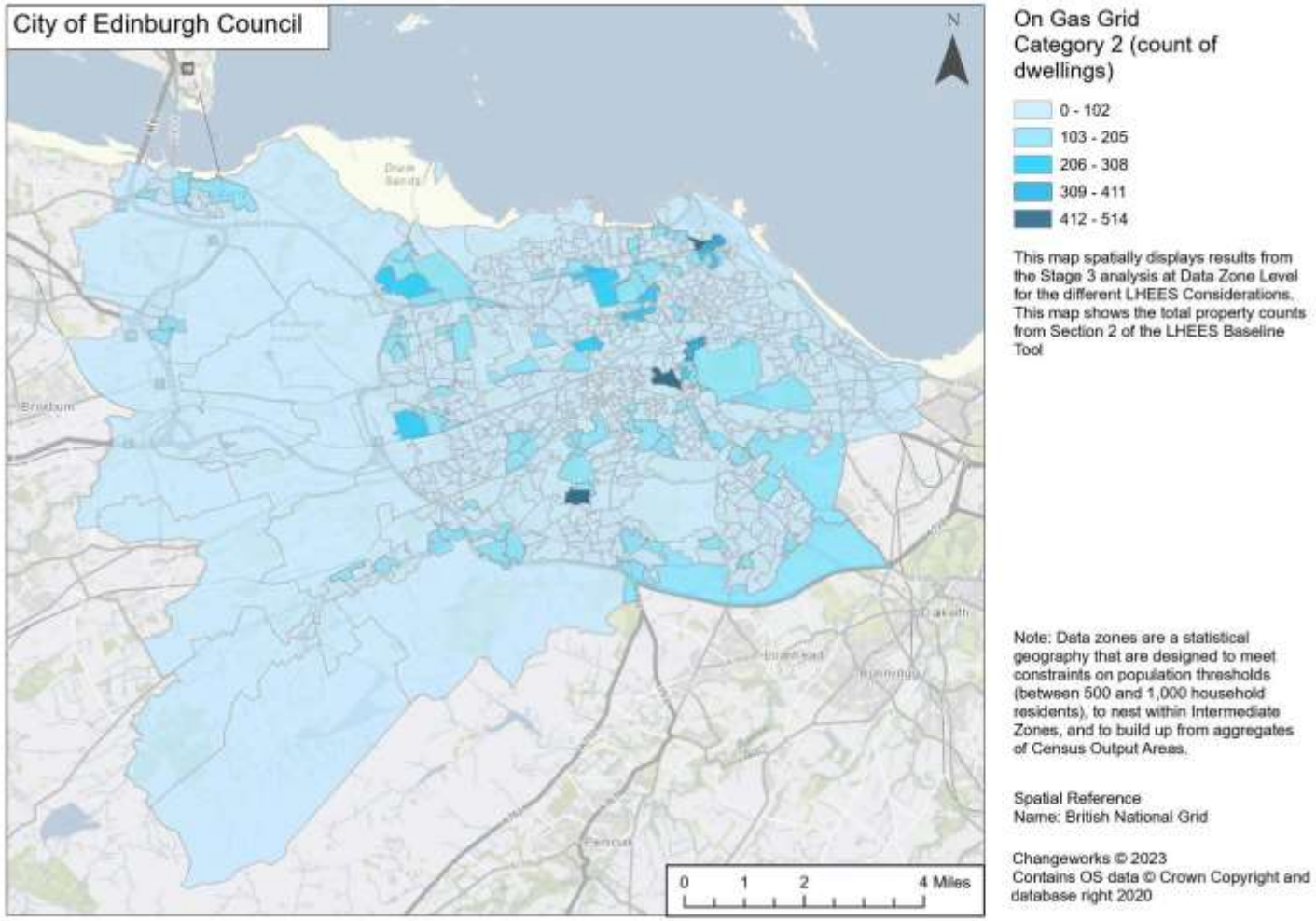


Figure 23: On-gas homes in category 3

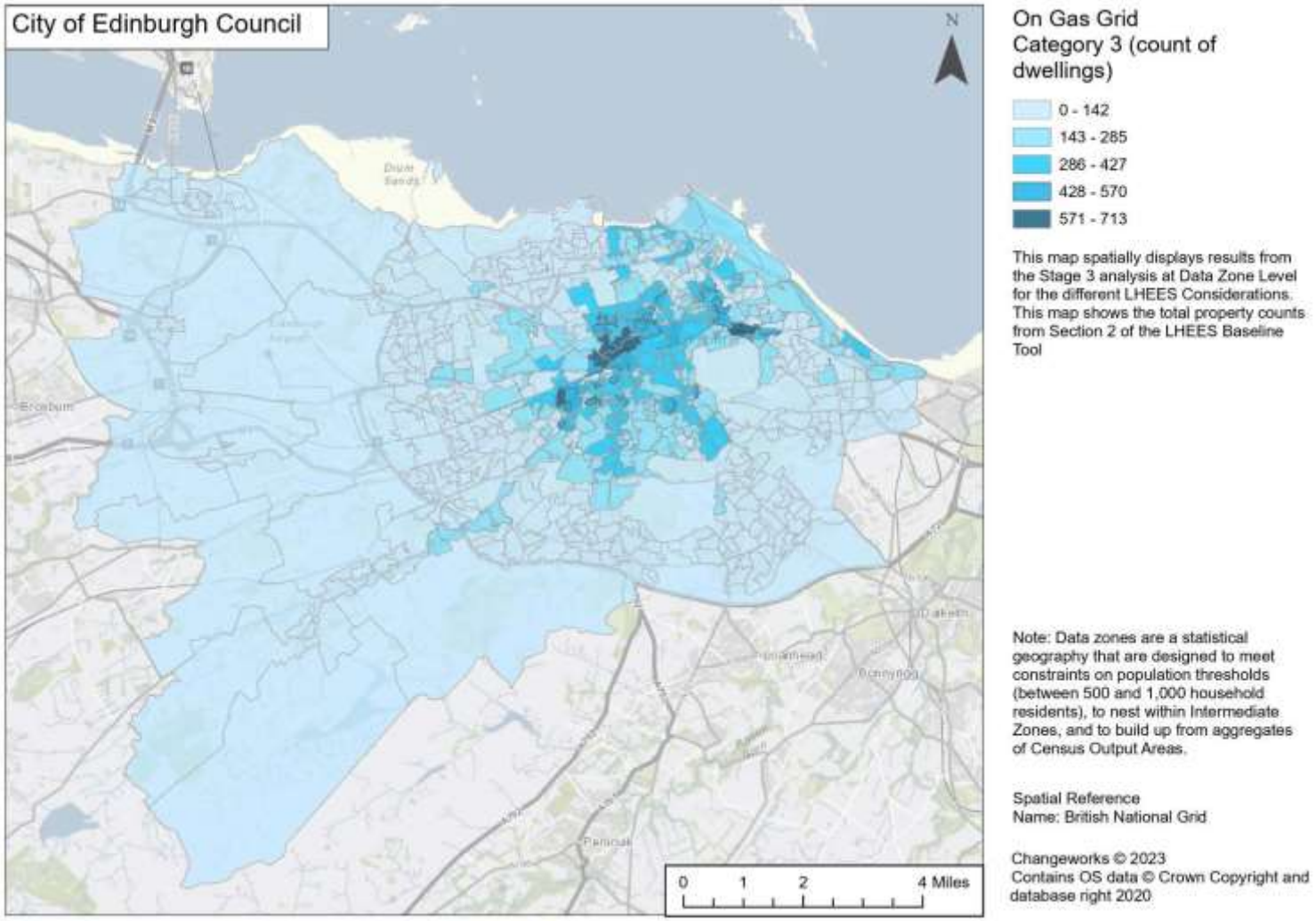


Figure 24: Prospective Heat Network Zones in Edinburgh

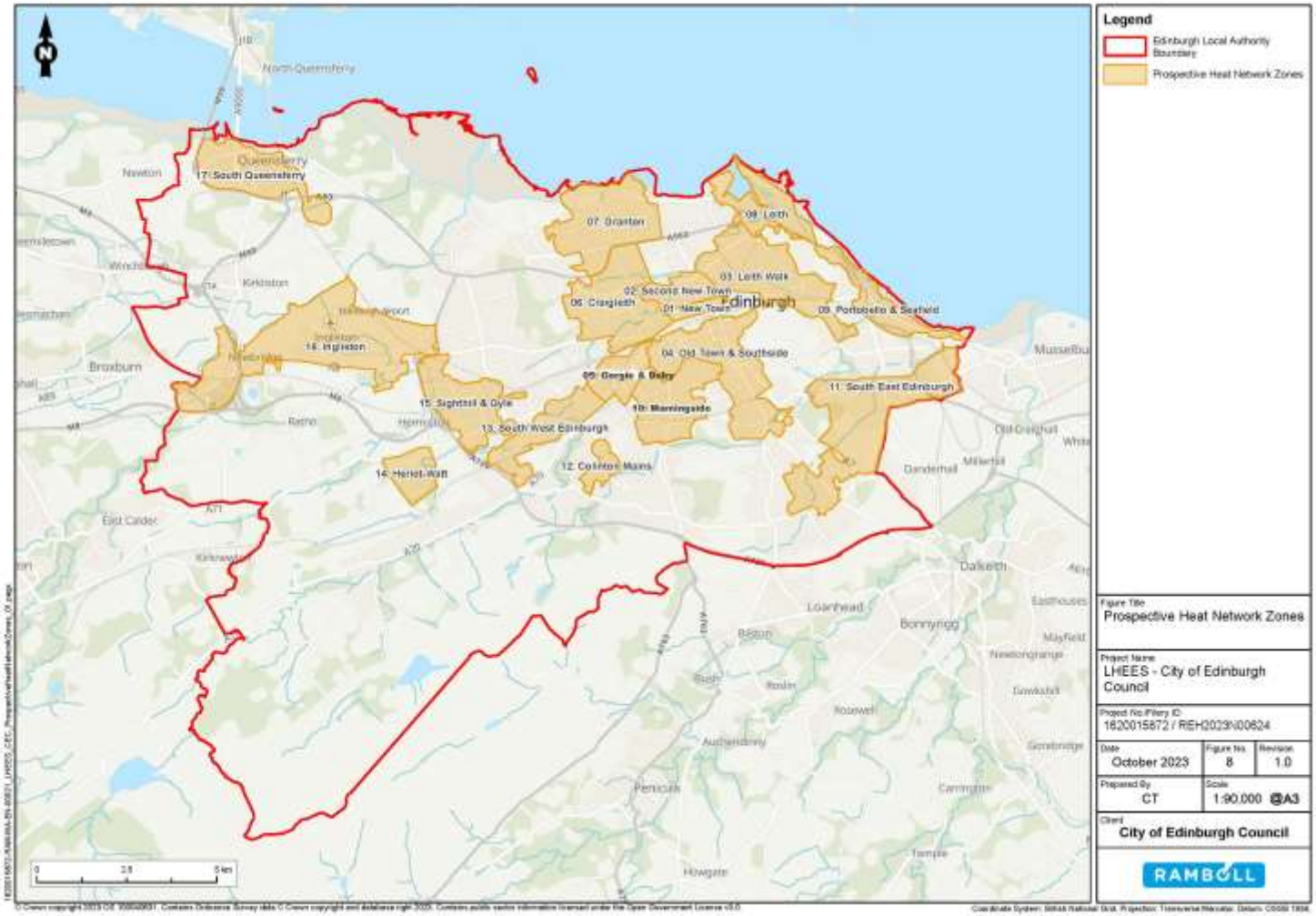


Figure 25: Homes in Edinburgh with solar suitability

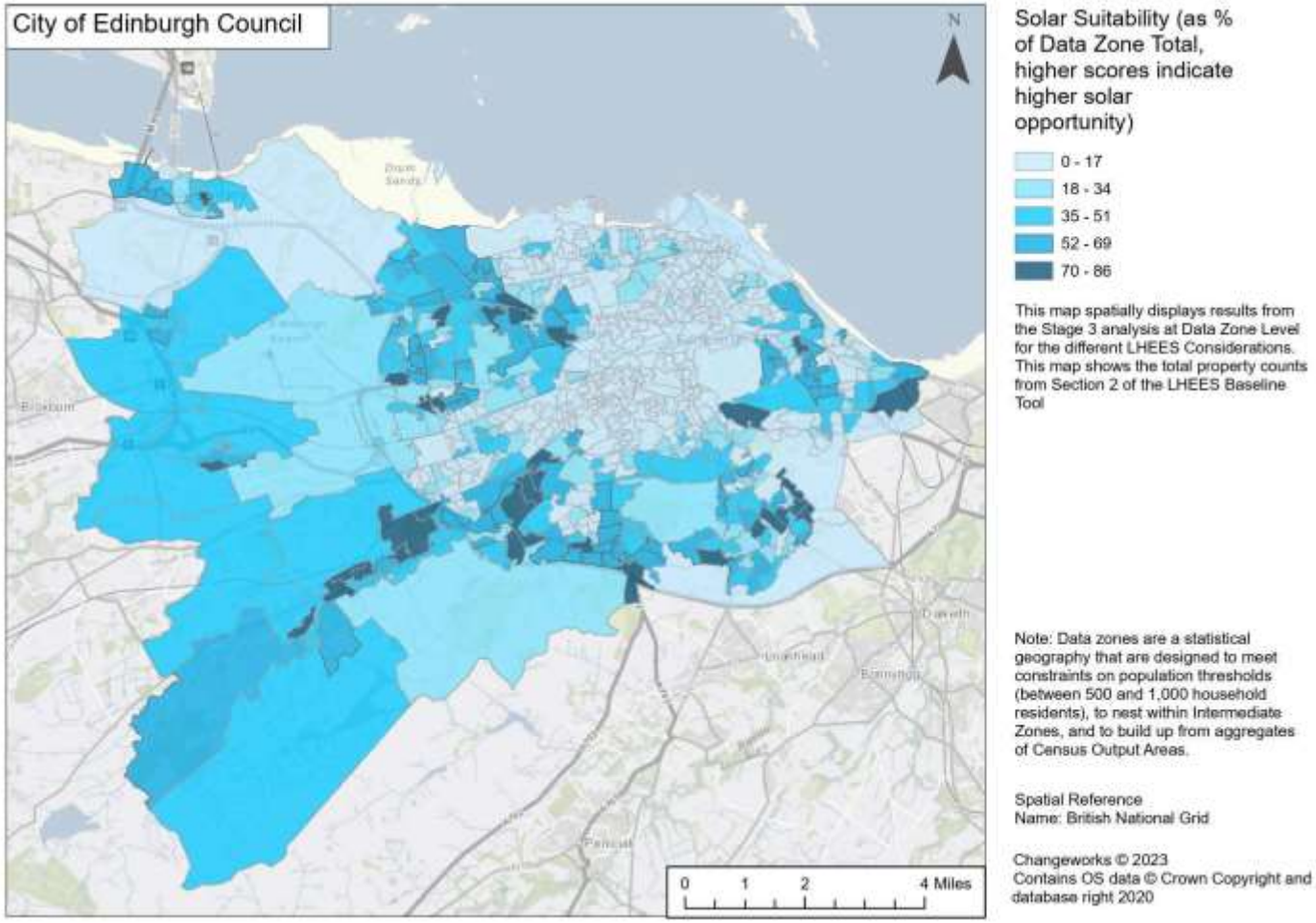


Figure 26: Homes with uninsulated walls in Edinburgh

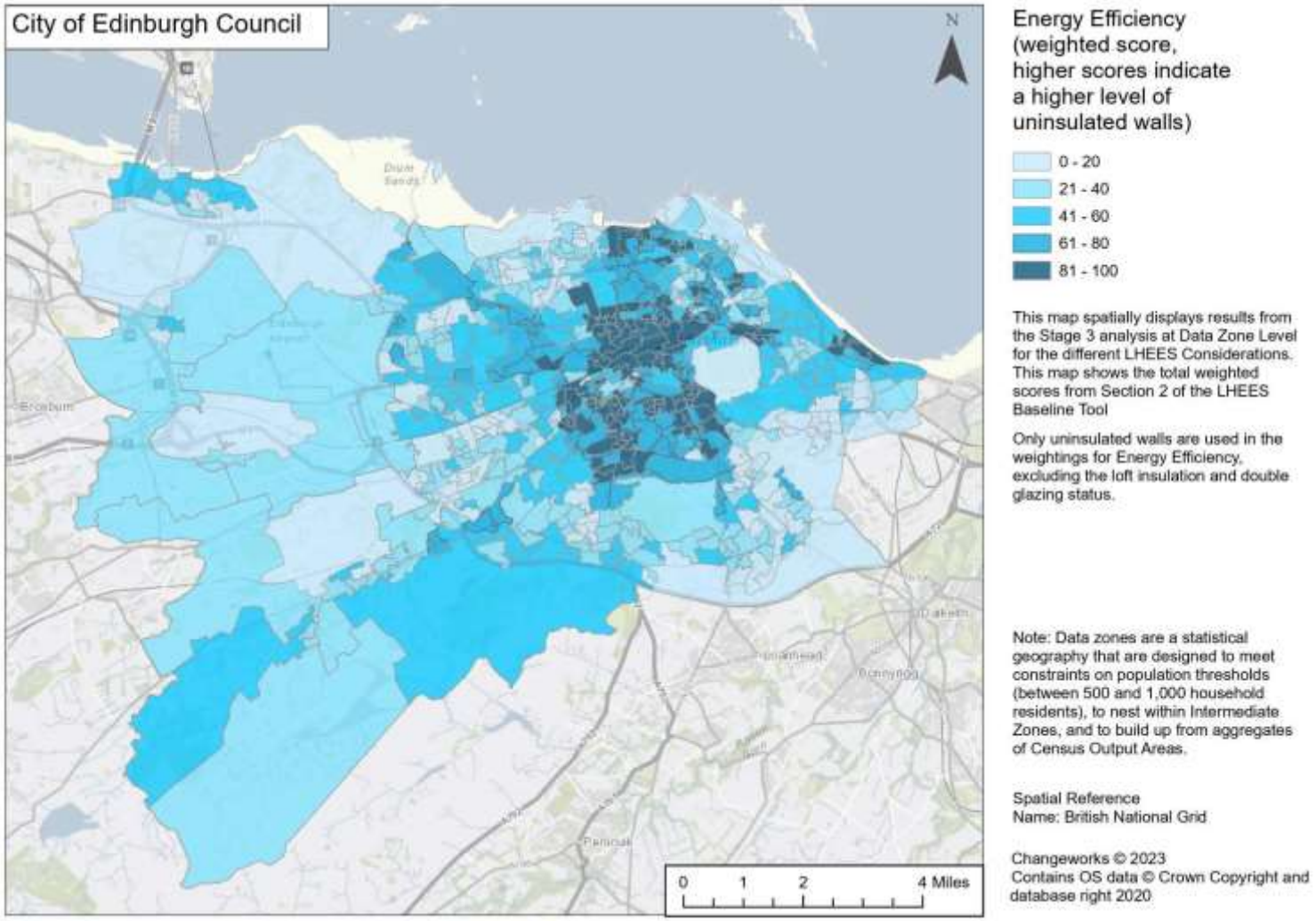


Figure 27: Homes with solid brick/stone uninsulated walls in Edinburgh

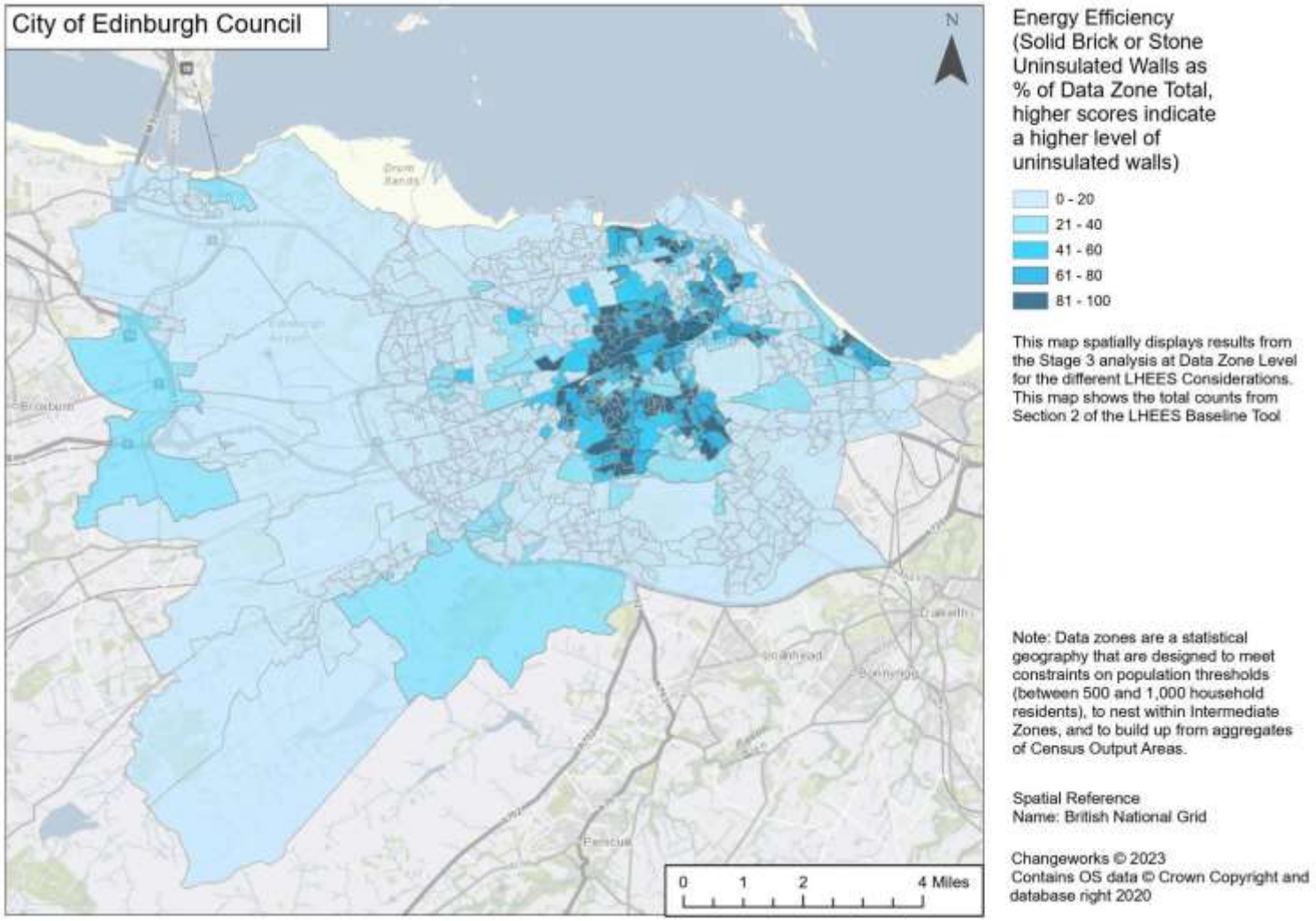


Figure 28: Areas of high fuel poverty and poor energy efficiency

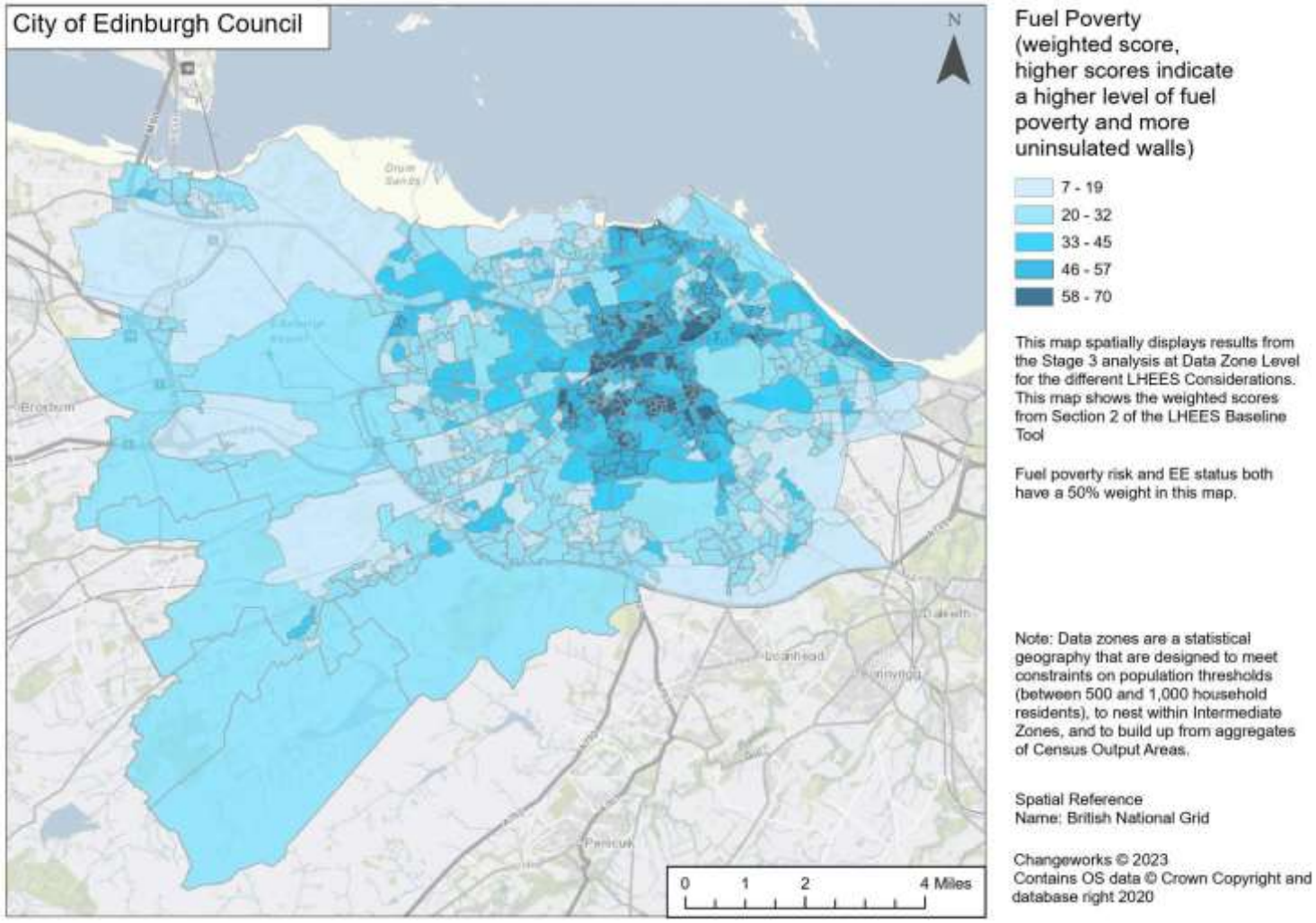
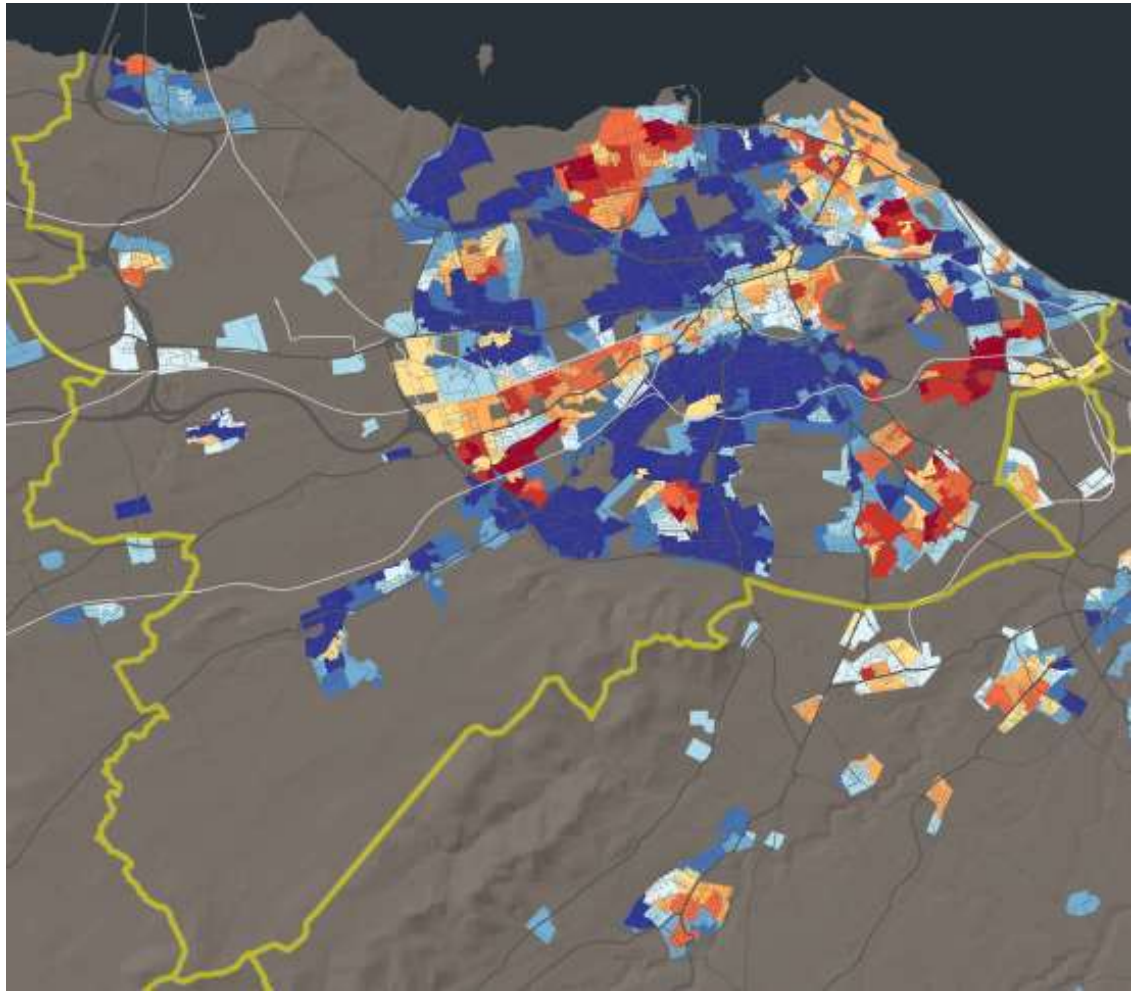


Figure 29: Scottish Index of Multiple Deprivation 2020 heat map of Edinburgh [xliii]



[xliii] "Warmer" areas have a lower ranking on the SIMD, i.e. they are more deprived.

Figure 30: Mixed-tenure homes in Edinburgh

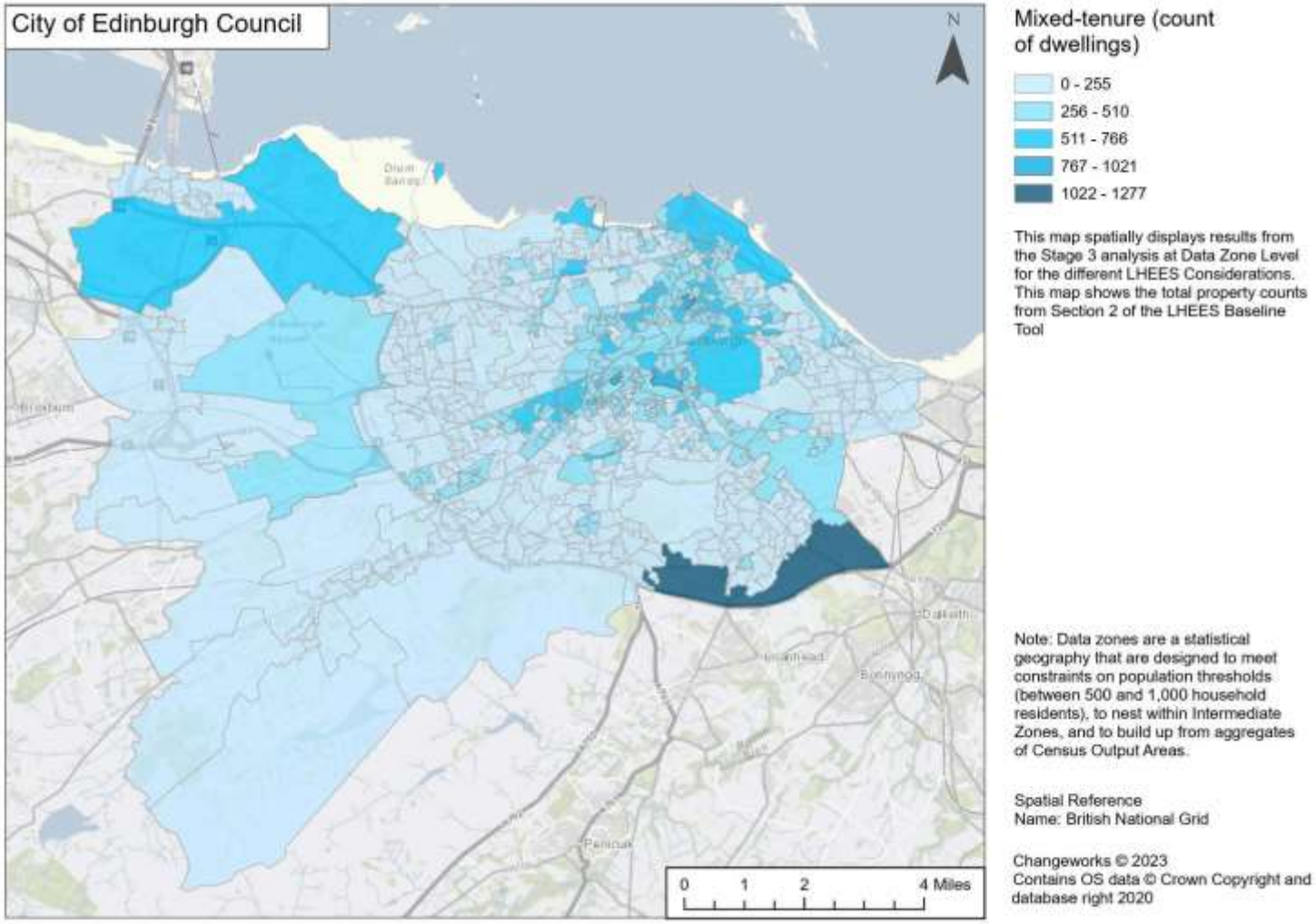


Figure 31: Homes in Edinburgh in buildings with >1 dwellings

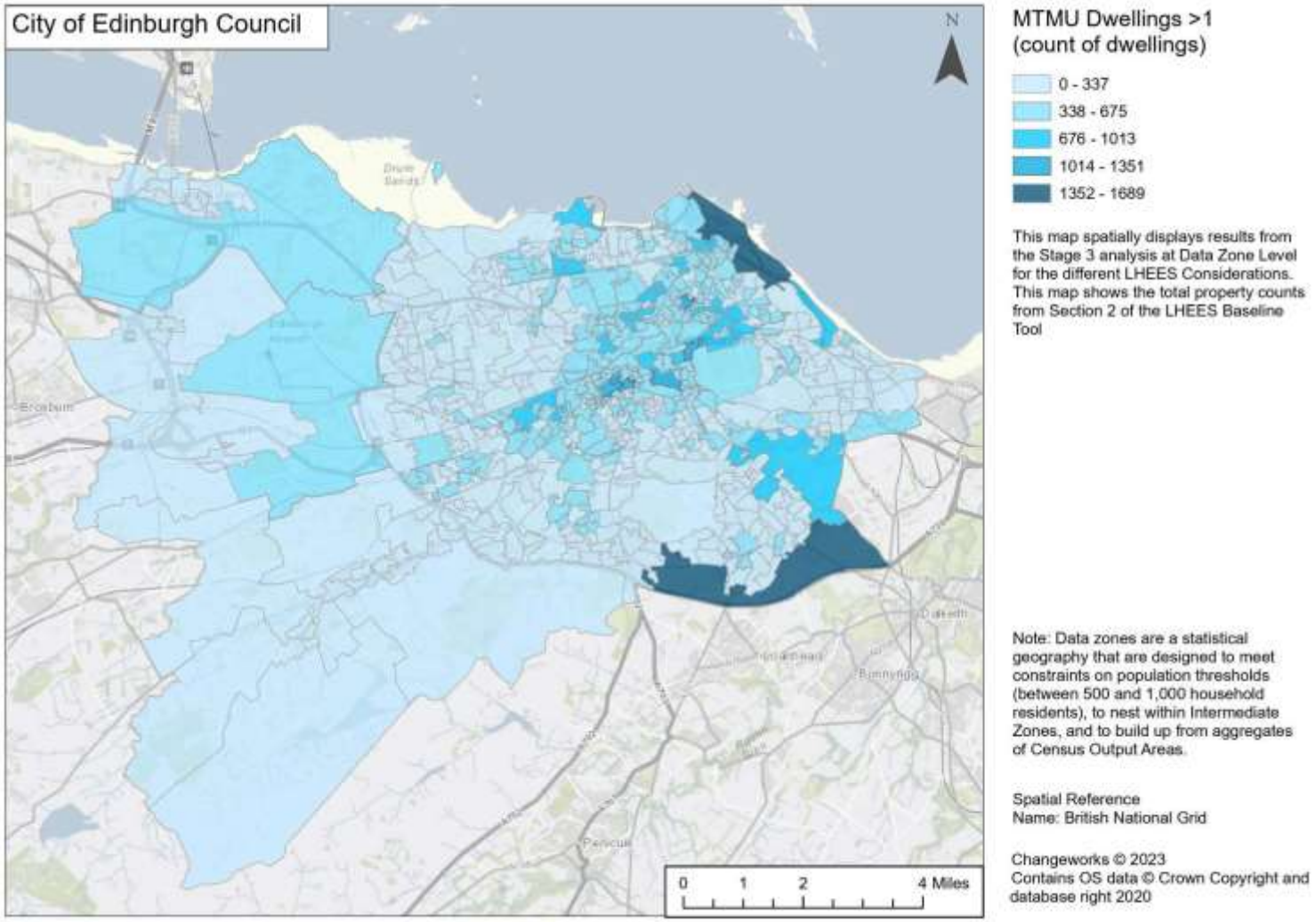


Figure 32: Homes in listed buildings in Edinburgh

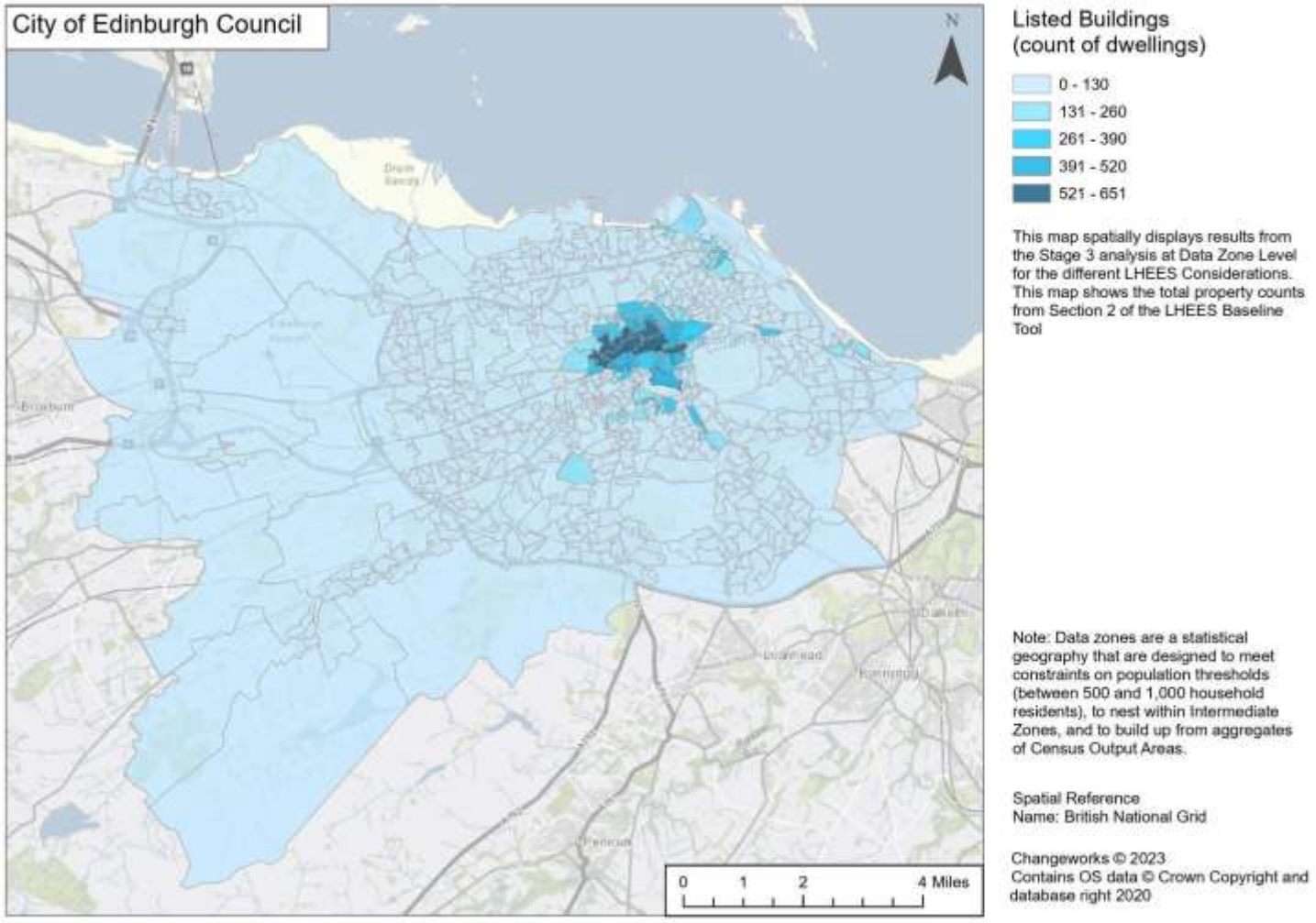
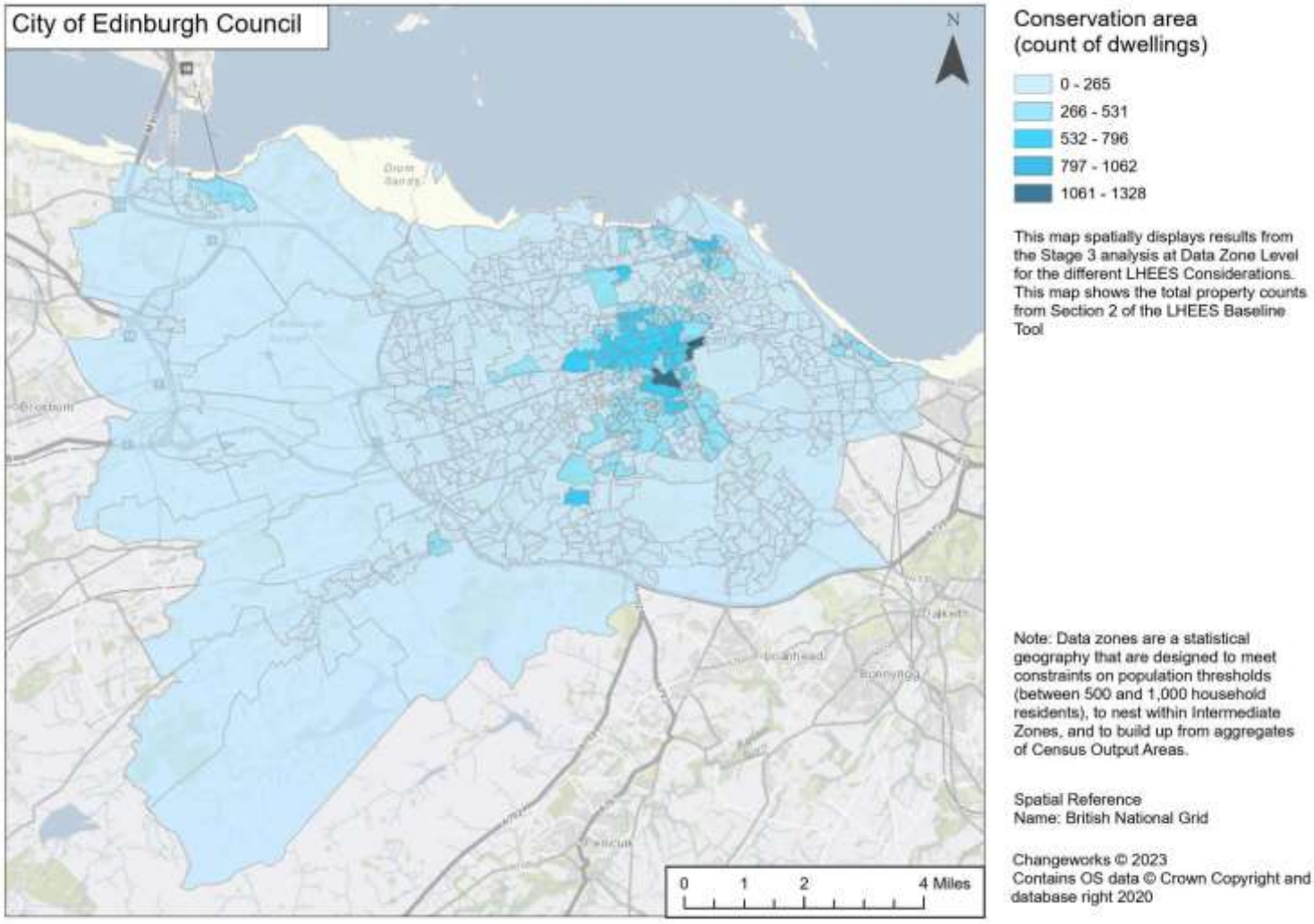


Figure 33: Homes in conservation areas in Edinburgh



11.4. Core stakeholders

Public sector

- Business Energy Scotland
- The Coal Authority
- Energy Saving Trust
- Green Heat Finance Taskforce
- Heat and Energy Efficiency Scotland
- Heat Network Support Unit
- Heat Networks & Non-Domestic Regulations Unit
- Historic Environment Scotland
- Home Energy Scotland
- Local Energy Scotland
- NHS Lothian
- Office of Gas and Electricity Markets (OFGEM)
- Scottish Enterprise
- Scottish Futures Trust
- Scottish Government
- Scottish Water / Scottish Water Horizons
- UK Government

Academic

- Edinburgh Climate Change Institute
- Edinburgh Napier University
- Heriot-Watt University
- University of Edinburgh

Residents and communities

- Association of Community Councils
- Clean Heat Forum
- Edinburgh Tenants Federation
- Our Future Edinburgh

Business

- Edinburgh Chamber of Commerce
- Energy for Edinburgh
- Essential Edinburgh
- Federation of Small Businesses
- Midlothian Energy
- Novoville
- Salix Finance
- Scotia Gas Networks (SGN)
- Scottish Power Energy Networks (SPEN)
- Utilita Energy

Housing providers

- Ark
- Blackwood Homes
- Cairn Housing Association
- Hanover (Scotland) Housing Association
- Harbour Homes
- Hillcrest Homes
- Home Group
- Homes for Scotland
- Lar Housing Trust
- Link Housing Association
- Lister Housing Co-operative
- Manor Estates Housing Association
- Muirhouse Housing Association
- Places for People Scotland
- Prospect Community Housing
- Trust Housing Association
- Viewpoint
- West Granton Housing Co-Operative
- Wheatley Homes East

Third sector

- Changeworks
- Energy Action Scotland
- Edinburgh Community Solar Co-operative
- Edinburgh Voluntary Organisations' Council (EVOC)
- Edinburgh World Heritage
- Greenspace Scotland
- Scotland Excel
- Social Investment Scotland
- Under One Roof
- Zero Waste Scotland

Commissions and partnerships

- Cities Commission for Climate Investment (3Ci)
- City Heat and Energy Partnership
- Edinburgh Building Retrofit and Improvement Collective
- Edinburgh Climate Commission
- Energy Efficiency Public Buildings Partnership
- Net Zero Edinburgh
- Warmworks

11.5. Glossary

Abbreviations

Table 51: Edinburgh LHEES abbreviations

Abbreviation	Definition
3Ci	Cities Commission for Climate Investment
ABS	Area-Based Scheme
ASHP	Air source heat pump
C	Celsius
CAPEX	Capital expenditure
CCS	Carbon capture and storage
CHMM	Clean Heat Market Mechanism
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
COP	Coefficient of performance
EFE	Energy for Edinburgh
EESSH	Energy Efficiency Standard for Social Housing
EESSH2	Energy Efficiency Standard for Social Housing post-2020
ELDP	Edinburgh Local Development Plan
EPC	Energy Performance Certificate
ESCo	Energy services company
EST	Energy Saving Trust
FIT	Feed-in Tariff
FNA	First National Assessment
GIS	Geographic information system
GSHP	Ground source heat pump
GW	Gigawatt
GWh	Gigawatt hour
HEEPS	Home Energy Efficiency Programmes for Scotland
KT	Kiloton
KW	Kilowatt
KWh	Kilowatt hour
LA	Local authority
LED	Light-emitting diode
LHD	Linear heat density
LEAR	Local Energy Asset Representation
LHEES	Local Heat and Energy Efficiency Strategy

Abbreviation	Definition
LPG	Liquefied petroleum gas
MTIS	Mixed Tenure Improvement Service
MW	Megawatt
MWh	Megawatt hour
MWth	Megawatt thermal
NPF4	National Planning Framework 4
OFGEM	Office of Gas and Electricity Markets
PEAT	Portfolio Energy Analysis Tool
SAP	Standard Assessment Procedure
SEA	Strategic environmental assessment
SEG	Smart Export Guarantee
SGN	Scotia Gas Networks
SIMD	Scottish Index of Multiple Deprivation
TW	Terawatt
TWh	Terawatt hour
UK	United Kingdom
UNESCO	United Nations Educational, Scientific and Cultural Organization
UPRN	Unique Property Reference Numbe
WHR	Whole house retrofit

Terms

Table 52: Edinburgh LHEES terms

Term	Definition
Anchor load	A building with a large, dependable, long-term, demand for heat which can offer surety of demand to a heat network operator, helping make the heat network commercially viable.
Baselining	Baselining is the purpose of understanding at local authority or strategic level, the current status of the buildings against the LHEES Considerations, targets, and indicators.
Biomass	Combustion of wooden pellets, chips, logs, or some other plant matter to generate heat.
Coefficient of performance	The power output by a system relative to the power input. A higher coefficient of performance represents a more efficient system.
Communal heating system	A smaller-scale heat network wherein heat generated at a central source is distributed to two or more units within a single building
Coolth	Cold as a commodity (Cf. heat / warmth).
Data Zone	Data zones are groups of output areas which have populations of around 500 to 1,000 residents.

Term	Definition
Delivery Area	Delivery areas are at a higher granularity than Strategic Zones. These spatial zones should set out clusters of buildings within a Strategic Zone or across the whole local authority that identify potential solution(s) at a delivery level. They will be an important starting point for identifying a range of projects, regulation and actions that are within the competence of the Scottish Government, local authorities and wider partners (included as actions to be developed in the Delivery Plan).
Delivery Plan	A Delivery Plan is a document setting out how a local authority proposes to support implementation of its Local Heat and Energy Efficiency Strategy.
Direct electric heating	Use of electricity to heat spaces and water directly (rather than interpolating other systems such as heat pumps).
Electric boiler	A boiler that works on the principle of heating water by passing it through an element, with carbon emissions based on the electricity grid emissions factor.
Energy centre	A building in which heat is generated.
Energy efficiency	The amount of energy required to heat a building (given its size) and the building's ability to retain that heat. The most common way to measure energy efficiency is through an Energy Performance Certificate (EPC), which provides a simple rating of energy efficiency of the building, albeit EPCs were originally designed to assess the cost of heating a building rather than the emissions associated with doing so.
Energy services company	A company providing energy services.
EnerPHit	A Passivhaus standard for the retrofit of existing buildings.
Fossil fuel	A non-renewable energy source, e.g. gas, oil, or coal.
Fuel poverty	As defined by the Fuel Poverty (Targets, Definition and Strategy) (Scotland) Act 2019, circumstances in which a household spends over 10% of their net income after housing costs is spend on fuel needs and their residual income is less than 90% of the UK Minimum Income Standard, i.e. is insufficient to maintain an adequate standard of living.
Geographic information system	Software for analysing and displaying geographically-referenced information.
Gigawatt	A unit of power equal to one billion (1,000,000,000) watts.
Greenhouse gas	Gases in the earth's atmosphere that trap heat, in the main carbon dioxide; chlorofluorocarbons; methane; nitrous oxide; ozone; and water vapor.
Heat decarbonisation	Reducing or eliminating the carbon produced as a negative by-product of heating buildings.
Heat network	As defined in the Heat Networks (Scotland) Act 2021, a (district) heat network is "a network by which thermal energy is distributed from one or more sources of production to more than one building".
Heat pump	A heating solution that works on the principle of capturing thermal energy (heat) from a source such as the air, the ground, or a body of water (such as a river, sea, or sewer) and using the refrigeration cycle can convert it to supply

Term	Definition
	heat to the end user. The carbon emissions of a heat pump are based on the grid emissions factor.
Indicator	For a given Consideration, the purpose of an Indicator is: (1) to act as a key information field to help characterise and baseline the local authority; (2) to act as a key information field to support strategic zoning and generation of initial delivery areas; (3) if suitable, to act as a key information field to measure progress against Targets over the duration of the Edinburgh LHEES - set out in the Delivery Plan. For some Considerations, one Indicator may be sufficient, but for others a range may be appropriate.
Insulation	Use of materials to slow the rate at which heat is lost from a building to the outside. This is one of the most affordable and effective ways of reducing heat demand by improving heat retention.
Intermediate Zone	Intermediate zones are a statistical geography that are designed to meet constraints on population thresholds (2,500-6,000 household residents), to nest within local authorities, and to be built up from aggregates of data zones.
Kilowatt	A unit of power equal to one thousand (1,000) watts.
LHEES Considerations	The LHEES Considerations are a list of technologies, building typologies and policy priorities used to identify and target interventions. They comprise: Heat networks; Off-gas grid buildings; On-gas grid buildings; Poor building energy efficiency; Poor building energy efficiency as a driver for fuel poverty; and Mixed-tenure, mixed-use and historic buildings.
Linear heat density	In the context of a heat network, the annual demand for heat per meter of pipework.
Local Heat and Energy Efficiency Strategy	A long-term strategic framework for the improvement of the energy efficiency of buildings in the local authority's area, and the reduction of greenhouse gas emissions resulting from the heating of such buildings.
Megawatt	A unit of power equal to one million (1,000,000) watts.
Mixed-tenure, mixed-use and historic buildings	Mixed-tenure and mixed-use buildings could include a mixture of owner occupied, private rented and social housing, and also non-domestic uses, or simply multiple ownership within the same tenure. Historic buildings include the buildings that are within conservation areas or those that are listed buildings. These categories may require established alternative approaches and regulation for the installation of low carbon heat and energy efficiency solutions and where specific advice and support might be available relating to the installation of these solutions.
Net zero carbon	A scenario in which any carbon emissions are balanced by the removal of the same quantum of carbon from the atmosphere, meaning there has been no net change in carbon.
Passivhaus	A building standard wherein buildings achieve high levels of energy efficiency and user comfort.
Prospective Heat Network Zones	The analysis carried out for strategic zoning and pathways for the heat networks Consideration is to identify prospective zones rather than the otherwise used naming convention of Delivery Areas. The prospective zones identified are to be included in the Edinburgh LHEES and should inform actions

Term	Definition
	around further investigation / progression within the Delivery Plan. The heat networks Consideration analysis and activity carried out within the Edinburgh LHEES is also anticipated to support activity related to formal zone designation as required by the Heat Networks (Scotland) Act 2021.
Raster	A matrix of squares, or grid, used as a method of data analysis in a geographic information system.
Solar photovoltaic	Technology that converts sunlight into electricity energy.
Solar water heating	Use of solar power to raise the temperature of water, which is then stored in a hot water cylinder.
Solid fuel	Solid material that is burned to produce heat, for example coal or wood.
Strategic Zone	Strategic Zones present a visualisation of the potential pathways to decarbonise the building stock at a local authority level. These could, for example, be split out by intermediate zone or data zone. They are useful to understand the baseline performance, the scale of potential and initial areas of focus, which could be used to inform Delivery Areas and follow on engagement.
Tariff	The price charged for energy.
Targets	Targets are the measurable aspect of the Consideration and are likely to be taken directly from national and/or local policy documentation, for example net zero by 2045, or EPC 'C' by 2040. Targets are likely to comprise of end-point targets and milestone targets and would sit along a timeline within (and beyond) the Edinburgh LHEES. This timeline would help to prioritise the types of projects undertaken within the Edinburgh LHEES over its duration.
Terawatt	A unit of power equal to one trillion (1,000,000,000,000) watts
uPVC	Unplasticized polyvinyl chloride
U-value	A measure of thermal transmittance, i.e. the extent to which an object (for example, a pane of glass) allows heat to pass through. U-values generally range from 0.1 (minimal heat loss) to 1.0 (high heat loss).
Watt	The basic unit of power.
Weighting	For some Considerations, one Target and Indicator may be sufficient, but for others a range of Indicators may be appropriate to contextualise and characterise performance against a Target and/or progress towards a Consideration. If multiple Indicators are used in strategic zoning or the identification of delivery areas, a Weighting can be applied based on the importance of each.
Zero direct emissions heating system	A heating system that does not itself emit carbon (albeit the production of the fuel uses to drive it may have emitted carbon).

11.6. Endnotes

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