The Socio-Economic Impact of Realising Zero Carbon Heat in the LHEES Zones of Edinburgh, Midlothian and East Lothian

Executive Summary

Climate actions affect much more than emissions, particularly so in the case of heating in buildings. Expanding heat networks and improving building fabric across the areas described in the Local Heat and Energy Efficiency Strategies (LHEES) for Edinburgh, Midlothian and East Lothian would have an impact on cold and damp in homes, regional air quality and fossil fuel emissions. The total discounted value of these impacts (across the period 2025 – 2050) is £2.1 billion, or over £13,000 per household. Excluding carbon mitigation benefits, the total social impact is £353 million (£2,035 per household). These results demonstrate that heat network expansion and domestic retrofits can simultaneously advance climate goals while delivering substantial health and wellbeing improvements, particularly for vulnerable populations. These findings support an integrated approach to heat decarbonisation and energy efficiency that brings together environmental and social considerations.

Suggested reference:

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Foreword

Scotland's ambition of a Just Transition that delivers a decarbonised society by 2045 is in direct alignment with Vattenfall's mission to enable fossil-freedom. Among the major challenges on this journey, heat stands out as both a critical and complex area to tackle. To accelerate progress, we urgently need clarity on which low-carbon heat solutions will be deployed where—giving communities, businesses, and investors the certainty to plan and act. In many areas, particularly in dense urban environments, heat networks are not only the most effective option—they are the only viable one. Delivering these networks will bring not just carbon reductions, but direct economic benefits, new jobs, improved health outcomes and long-term social value for local communities.

An unjust energy system impacts the individuals and communities of Scotland every day. The Just Transition must provide a clean low carbon energy system that is affordable and accessible by all as well as providing a platform for generating skilled jobs. Across our region, and in the context of this report, the Just Transition is the framework to determine how we can fashion a new energy system that offers access to affordable heat. Our region can exchange damp homes, excess cold and shortened lives for a healthier and higher quality of living.

These are known as 'co-benefits'; they cannot be simply monetised; they offer a package of positive impacts that improves lives. And so, with a such a prize, those of us concerned with the delivery of district heating must reflect and ask ourselves, what is our role in this Just Transition?

Heat networks are made for a regional impact. These regional investments will overhaul the way hundreds of thousands of homes and buildings are heated and require the support and financial commitment from the principal stakeholders in the region, be they the public, the private sector or the wider community. By necessity, stakeholders will need to cooperate, collaborate and coordinate. As such, we need to find compelling reasons, which enable cooperation. Reasons like good health; longer lives; skilled jobs in the local economy; as well as mitigating the impacts of climate change.

So, we ask the question, are heat networks a lightning rod around which not only carbon solutions are delivered but through which socially positive outcomes are secured? What is the social cost, the health cost, of poorly heated homes? Where the mission is the Just Transition – what are the social dividends? Will this help deliver a healthier nation, that lives longer? We seek to provide greater clarity on how to express and understand these dividends by explaining the additional benefits that are currently not accounted for in financial models or given a value in the development of business cases.

As such Vattenfall Heat UK and the Edinburgh Climate Change Institute (ECCI), have partnered to carry out research that explores the health impacts affecting the people of Edinburgh and the Lothians. The work assumes that all homes within the published heat network zones of Edinburgh, East Lothian and Midlothian can and will connect to a heat network. The research shows what happens when our homes are dry; when families keep the heating on when they are cold and when all of us can breathe cleaner air.

Vattenfall asked ECCI whether we can apply a pounds and pence figure to the additional benefits. The research shows that in addition to the benefits derived from climate change mitigation the residents, particularly vulnerable residents, experienced healthier and longer lives and, just in this part of Scotland, this equates to around £2 billion over 25 years. We acknowledge that this paper does not look into the cost of making these changes, nor who would pay for them and whether they are affordable, or indeed how to make them so. This is another part of the puzzle that must be explored.

The analysis looks at the social impact of the heat network connections and fabric improvements, and also the valuation of carbon mitigation which looks at the environmental effect. The premise of this work is that each household is heating their home to a sufficient internal temperature. The conclusion is that by doing so we all benefit, not least by reducing the burden on the national health service but also by improving everyone's chance of living healthier life. We are excited by the chance to continue this work and bring the explicit value created into our decision making when delivering the Just Transition.

We are very thankful to Andrew Sudmant, Ruaidhri Higgins-Lavery and Jamie Brogan and the wider team of the ECCI for this research and we invite the people of Edinburgh and the Lothians (and beyond) to reach out as we continue to coordinate our efforts and collaborate together to understand how district heating can play its role in delivering the just transition.

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Introduction

Climate change and the social imperative of realising healthy, warm homes for all, represent two of society's most pressing concerns. The implementation of Local Heat and Energy Efficiency Strategies (LHEES) across Edinburgh, Midlothian and East Lothian presents a unique opportunity to address both challenges simultaneously. By connecting domestic buildings to heat networks and implementing comprehensive retrofit programs, these strategies can reduce carbon emissions, improve public health, and contribute to alleviating fuel poverty.

While the climate change impacts of such heat networks are well-documented, their broader societal impacts remain less understood. This report quantifies these wider benefits when paired with energy efficiency measures, across improvements in air quality, reductions in excess cold and dampness, and the monetary value of carbon emission savings (based on the UK government's carbon value figures). Using the UK Green Book methodologies and the ECCI's place-based co-benefits model, we analyse these social, economic and environmental impacts across each of the 30 heat zones in this region, taking into consideration local factors including characteristics of buildings, existing air quality, and population density, among other factors.

Our assessment of these 30 heat zones covers 56% of the population in Edinburgh, Midlothian and East Lothian[1] (figure 1). These heat zones have been identified in LHEES as having high potential for coordinated strategies for energy efficiency and decarbonised heat deployment, however each presents a unique set of challenges and opportunities. While our analysis highlights the benefits of energy efficiency and heat interventions in these LHEES zones, further analysis is needed to consider the costs of fabric improvements and zero carbon heating. In addition, more work is needed to understand the fabric measures that are needed on a building-by-building basis. Finally, it should be noted that many social, economic and environmental impacts are not considered in this analysis and need to be taken up by future analysis. For example, this analysis has not investigated the impacts on mental health, employment or energy security.

This assessment comes at a crucial juncture in Scotland's energy transition[2]. As LHEES frameworks are established, maintaining momentum is vital. Our analysis provides evidence-based insights to support this ongoing transformation of our heating infrastructure.

[1] https://www.scotlandscensus.gov.uk/documents/scotland-s-census-2022-rounded-population-estimates-data/
[2] https://www.gov.scot/publications/green-heat-finance-taskforce-report-part-2/

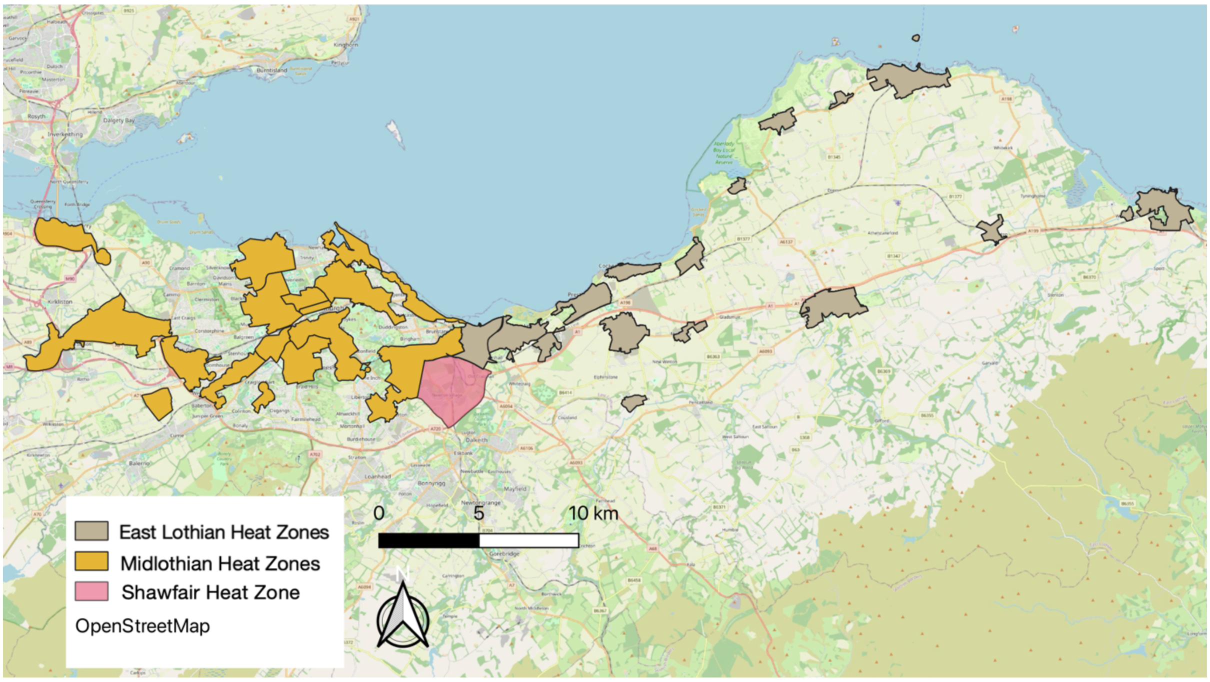

Figure 1- Prospective Local Heat and Energy Efficiency Zones across Edinburgh, East Lothian and Midlothian (Shawfair)[3]

Key Findings

This analysis estimates the benefits of combining domestic retrofits with connections to district heat networks. Using SAP methodology, we have modelled the necessary fabric improvements for each household type to reach EPC C. These interventions include floor/roof/internal/external and cavity wall insulation, double/triple glazed windows and draught-proofing, among others). It is important to note that this report does not include an analysis of the costs of deploying these interventions, solely demonstrating the potential societal gains. The important considerations of ensuring sufficient energy efficiency upgrades in buildings before connecting to district heating have been included in our methodology.

Below we present results from our analysis. First, we present the total scale of the social and environmental benefits on a per household basis in each of the LHEES zones across the City of Edinburgh, East Lothian and Midlothian (*Fig. 1*). Second, we consider what different social and environmental benefits comprise the overall projected benefits, before breaking down these impacts into modelled pathways. These benefits are disaggregated by household and beneficiary type, before discussing strategic findings and wider implications of the analysis.

[3] https://experience.arcgis.com/experience/c2714dd1647449bca511d7f445b73f29/?draft=true

1) Impacts by local area

Zero carbon heating across the LHEES zones of Edinburgh, Midlothian and East Lothian would realise £2.1 billion in (discounted) benefits across the period 2025 – 2050. Per household the average value is £13,047, or approximately £522 per year. Benefit per household range from £9,499 to £16,784 (*Fig. 2*). The highest per household benefits are found in Longniddry where benefits 177% higher than in Leith Docks. Building age, type, and size are the key factors leading to the highest values being found in Longniddry as larger and more inefficient homes can result in greater potential for GHG emissions mitigation, greater potential for cold and damp issues in home, and higher energy use which leads to greater potential for local air quality improvements.

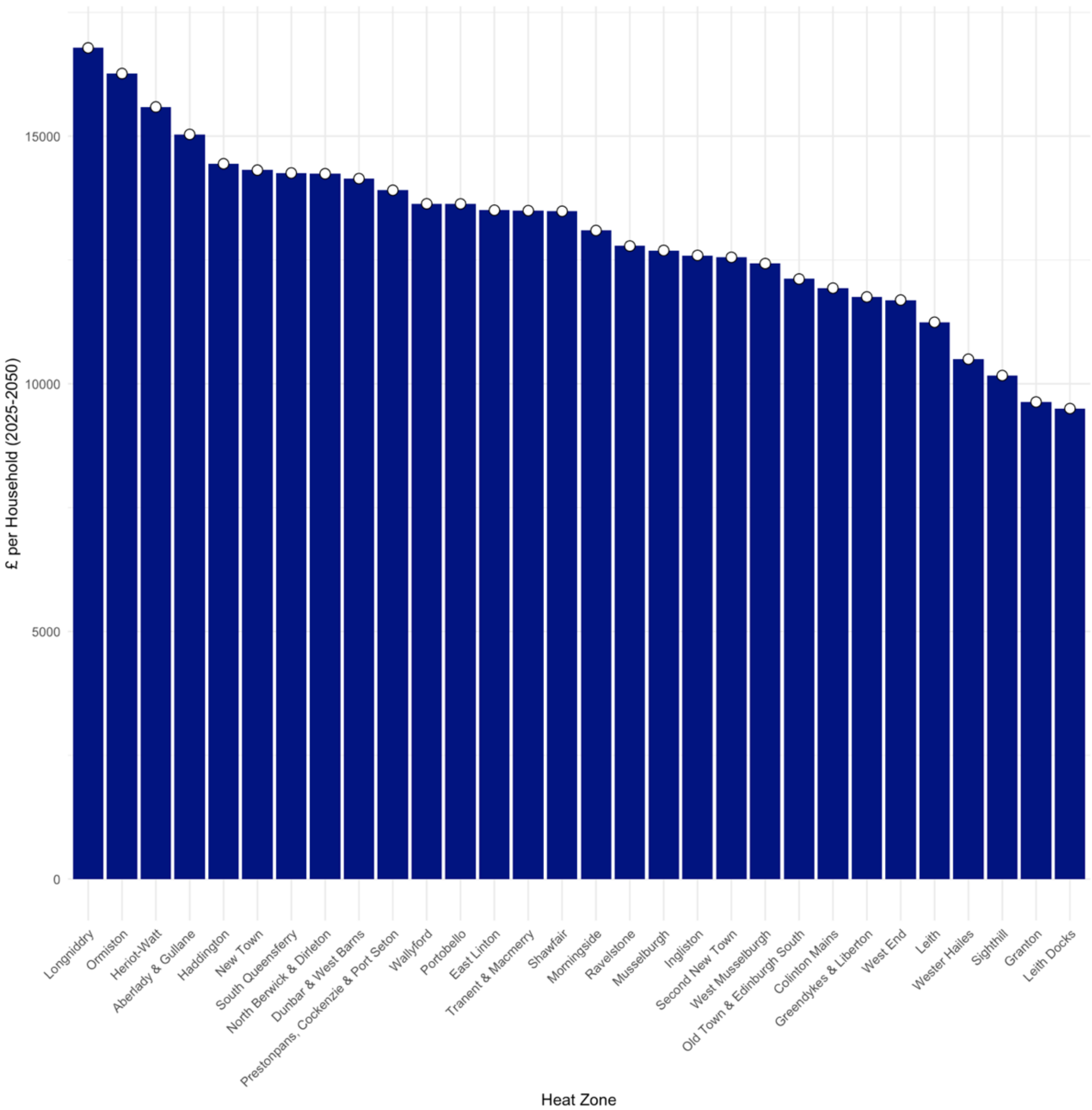

Figure 2 - Projected co-benefits by heat zone (mean £ per household, 2025 - 2050)

Analysis here assumes the heat source supporting heat network expansion is both zero carbon and also produces no air pollutants, however the Millerhill Recycling and Energy Recovery Centre (RERC), an energy from waste facility, is anticipated to be a key source of heat for the first stages of heat network development. According to the UK's local emissions accounting framework neither the air pollutant emissions nor the GHG emissions from the waste incineration are assigned to local inventory[4]. Emissions from the waste recovery facility already exist independent of whether the facility is used to support a heat network. To test the degree to which registering heat from the RERC as zero carbon and zero air pollutant affects our results we removed this assumption and found that the total benefit of the heat network changed from £17.8 million to £16.7 million. To test whether these emissions might have a localised effect we assigned these emissions to the immediate local area (a strong assumption) and found that the total social benefit to the Shawfair LSOA would fall from £13,484 per household to £12,648 across all benefit types.

2) Comparing the socio-economic impacts of zero carbon heat

Four impacts of climate action are assessed in this analysis

- Air quality: Reductions in pollutants from fossil fuel combustion results in improved health outcomes and quality of life improvements for residents.
- Excess cold and dampness: Increased internal temperatures from energy efficiency improvements and more effective heating systems reduces risk of dangerously cold homes, improving health outcomes, reducing pressure on the NHS and improving quality of life. Cold and damp, though often found in the same homes, are two separate socio-economic impacts.
- Reduced greenhouse gas (GHG) emissions: The 'carbon value' of GHG emissions is the financial value of future GHG mitigation measures not being needed as a consequence of GHG mitigation measures being applied today. The value per tonne of GHG mitigation is estimated by the UK Government[5].

Impacts on air quality, excess cold, and damp are understood by this analysis to be social impacts while the value of reduced GHG emissions is understood to be an economic impact.

Across the four categories, GHG mitigation benefits represent 83% of the projected benefits (*Fig. 3)*. Without GHG mitigation benefits, a total of £353 million of benefits is estimated, or approximately £2035 per household. Within the three social benefit types (*Fig. 4*), excess cold is the most significant, contributing 59% of the total social benefits of action, air quality represents 34% and dampness reductions are 7%.

[4] https://www.theccc.org.uk/wp-content/uploads/2020/12/Sector-summary-Waste.pdf
[5] https://www.gov.uk/government/publications/valuing-greenhouse-gas-emissions-in-policy-appraisal/valuation-of-greenhouse-gas-emissions-for-policy-appraisal-and-evaluation

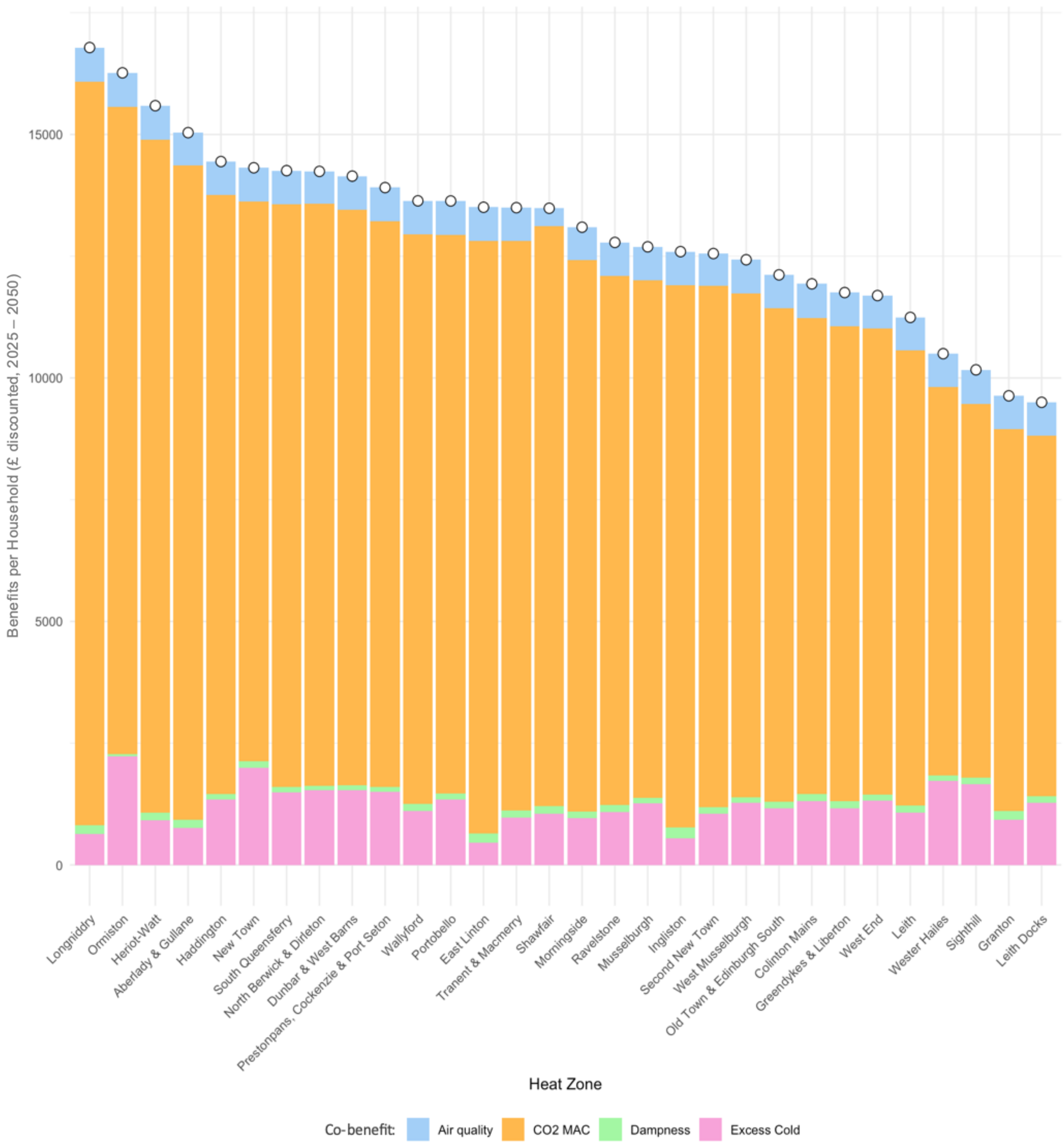

Figure 3 – Mean co-benefit outputs by type per household by heat zone (£ discounted, 2025 – 2050)

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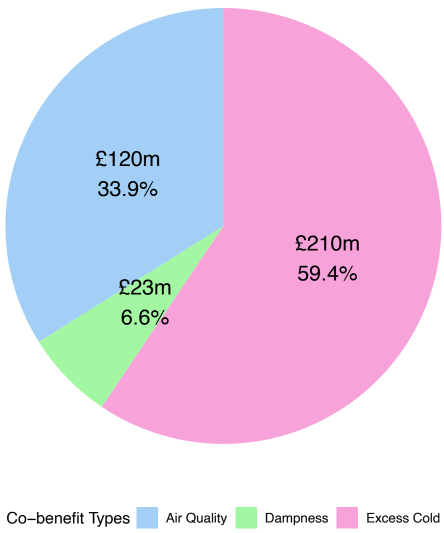

Figure 4 - Pie chart of social benefit breakdowns by co-benefit type (excluding GHG mitigation).

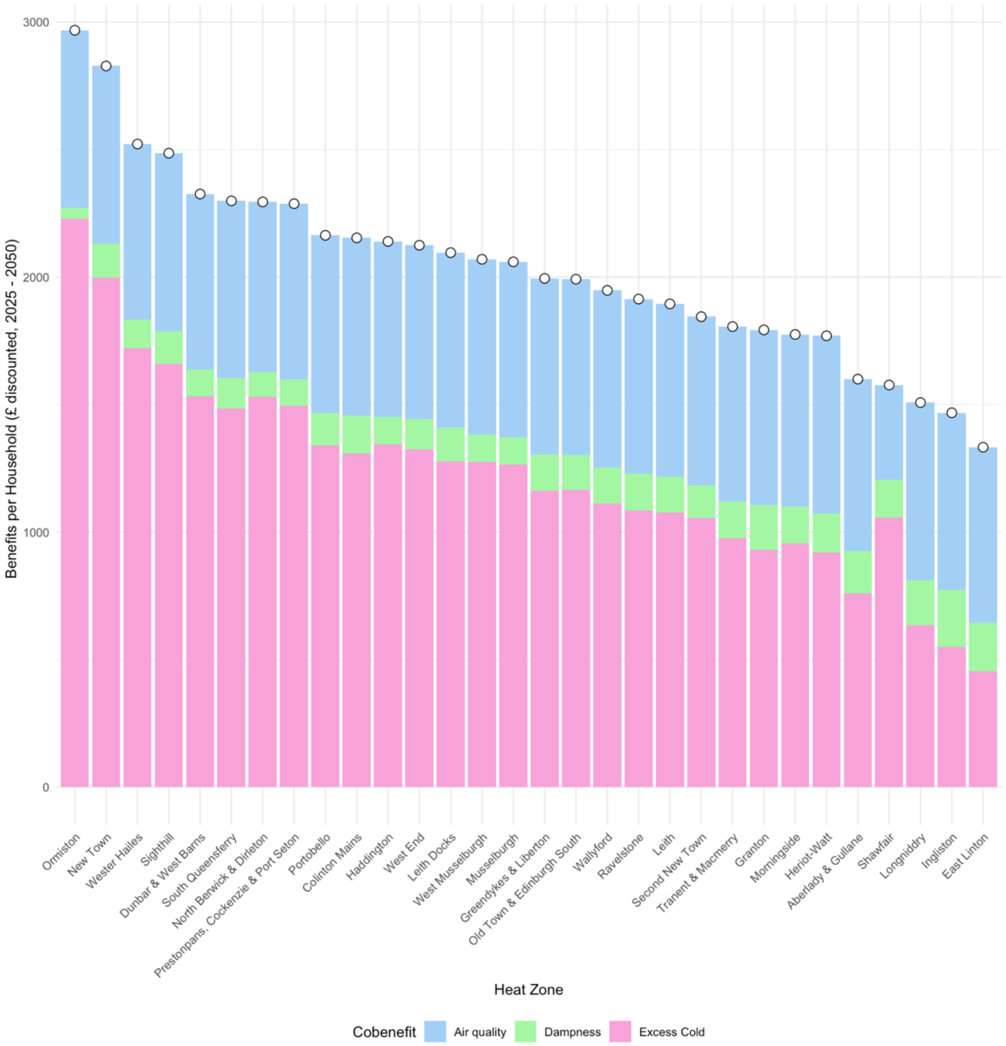

Figure 5 - Social benefit breakdowns by co-benefit type and Heat Zone (excluding GHG mitigation).

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Figure 5 shows the social benefit breakdowns excluding the value of carbon mitigation by heat zone. Co-benefits per household range from £1333 to £2968 across all cobenefit types. The value of these social impacts arises mostly from improvements in the internal temperature of buildings (figure 4), resulting in better health outcomes and improved quality of life for residents. Reductions in air pollution, for example from reduced fossil fuel combustion from gas boilers result in savings valued at £120 million over the period 2025 – 2050. As previously discussed, air quality implications from Shawfair's RERC haven't been included in figure 5, explaining the relatively lower level of air pollution savings. The variation in results across heat zones is related to numerous factors, like the age and income levels of residents within each datazone/heat zone, as well as building type and other local characteristics.

3) How different households will be affected

Local context shapes the kind of co-benefits of climate action that emerge and the scale of those benefits (and costs). Larger homes require more heating which leads to a greater opportunity for GHG emissions mitigation. Densely-populated areas often have worse air quality, creating an opportunity for health benefits from actions that reduce harmful pollutants. Some of the characteristics that affect the co-benefits of climate action are geographic while others are socio-economic. The relationship between these factors, however, is often complex. For example, wealthier households are better able to pay for heating but often live in larger homes that can be more vulnerable to damp and mould.

Figure 6 shows the relationship between 15 representative household archetypes (listed from lowest to highest income) and the average level of co-benefits by type from a connection to a heat network and building retrofits to reach EPC C. Results show no clear association between incomes levels and the level or composition of co-benefits, suggesting that achieving zero carbon heating will benefit all households. While the level of benefit is relatively smaller for the archetypes with the lowest incomes (A1 and A2), these relative benefit for these households may be bigger than the benefit received by households at higher levels of income.

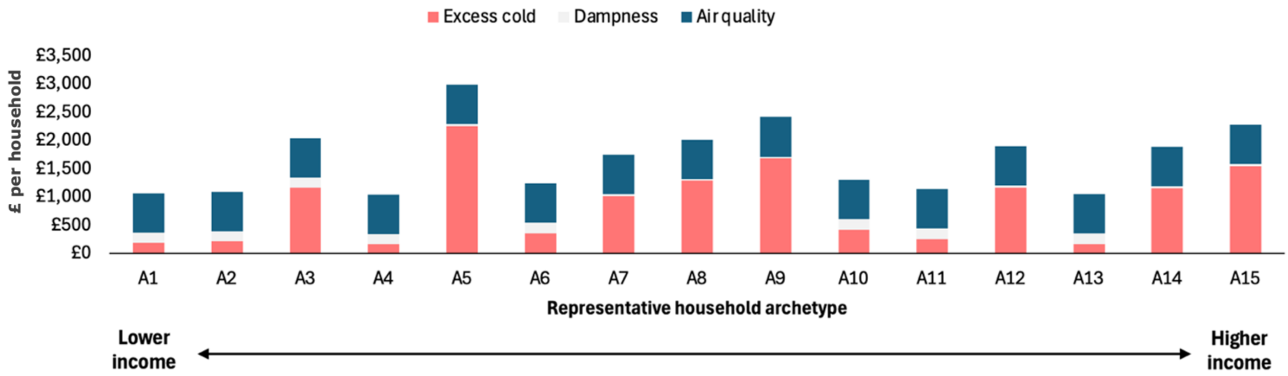

Figure 6 – Co-benefit variation by household archetype (£ discounted, 2025 - 2050)

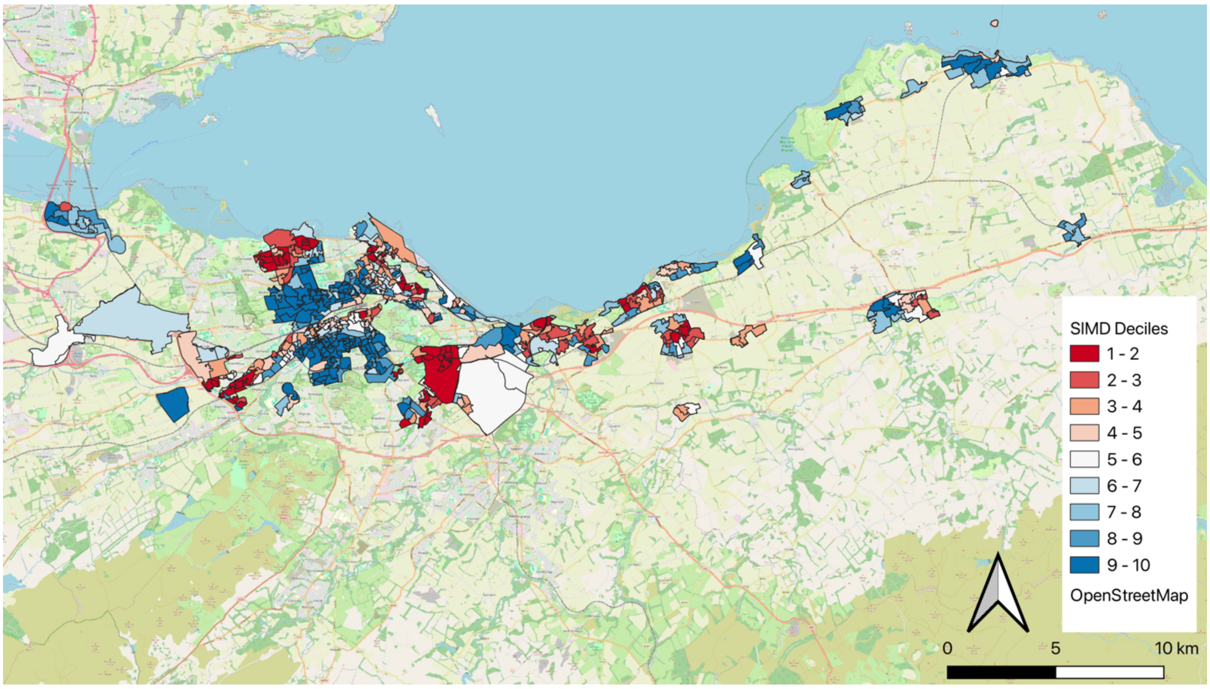

Figure 7 - Scottish Index of Multiple Deprivation (SIMD) deciles by data zone and heat zone (lower values are more deprived).[6]

Figure 7 shows the Scottish Index of Multiple Deprivation (SIMD), a measure of the level of socioeconomic challenges facing households that is measured for every data zone (neighbourhood) across Scotland. *Figure 8* shows the scale of co-benefits by data zone across Scotland. Comparing these figures, we can see that the largest benefits in some cases overlap where deprivation is highest, highlighting the role zero carbon heating could play in alleviating socioeconomic deprivation. Generally speaking, however, the scale of benefits from zero carbon heating does not have a positive or negative relationship with the SIMD,

[6] https://www.gov.scot/collections/scottish-index-of-multiple-deprivation-2020/

suggesting a need for careful development of zero carbon heat to align with efforts to alleviate deprivation.

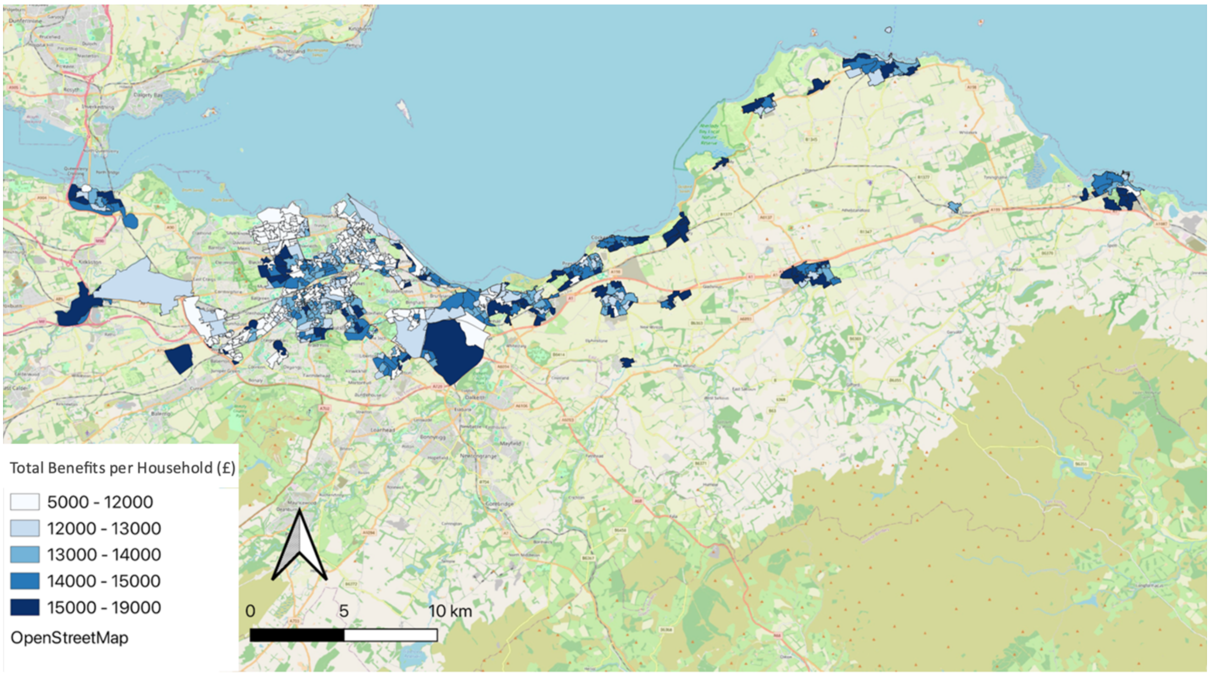

Figure 8 - Total social value per household by datazone and heat zone (£ discounted, 2025 - 2050)

Unlocking the Potential of Heat Decarbonisation

The expansion of heat networks and energy efficiency measures across Edinburgh, Midlothian, and East Lothian presents a transformative opportunity to simultaneously address decarbonisation, public health, social equity, and economic resilience. Our analysis estimates that the implementation of heat networks, together with comprehensive retrofits across 30 designated LHEES zones, could deliver a total discounted benefit of approximately £2.1 billion between 2025 and 2050. Notably, £353 million of these benefits are attributable to social co-benefits—improvements in air quality and exposure to damp and cold. These findings suggest that transitioning to zero-carbon heating is not merely an environmental imperative but also a multifaceted social policy intervention.

This evidence aligns closely with existing policy frameworks. Scotland's Heat in Buildings Strategy (2021)[7] and the statutory requirements under the Local Heat and Energy Efficiency Strategies (Scotland) Order (2022)[8] establish a clear governmental mandate for local authorities to advance low-carbon heating solutions. Moreover, the Fuel Poverty (Scotland) Act (2019)[9] reinforces the necessity of ensuring that the transition to net zero does not

[7] Scottish Government (2021). *Heat in Buildings Strategy: Achieving Net Zero Emissions in Scotland's Buildings.*
[8] Scottish Government (2022). *Local Heat and Energy Efficiency Strategies (Scotland) Order 2022.*
[9] Scottish Government (2019). *Fuel Poverty (Targets, Definition and Strategy) (Scotland) Act.*

exacerbate existing inequalities. By targeting both decarbonisation and building performance, heat networks can serve as an integrated mechanism to achieve a range of policy outcomes—from reducing greenhouse gas emissions to mitigating cold-related illnesses and alleviating the economic burden on vulnerable households.

Despite these promising prospects, several implementation challenges and policy gaps must be addressed. First, the financial viability of heat networks is constrained by high upfront capital costs, which are often borne by private investors or individual homeowners, while many of the resulting benefits, including reduced public health expenditures and GHG emissions mitigation, accrue to society as a whole. Second, while the LHEES framework provides a valuable planning tool, it lacks robust enforcement mechanisms to ensure comprehensive connectivity. Coordination among local authorities, private developers, and energy companies remains fragmented, and the existing supply of skilled installers and engineers is insufficient to meet anticipated demand. Additionally, public awareness remains low, and consumer apprehensions regarding cost and system reliability could impede the adoption process.

Importantly, our analysis does not capture all potential benefits of heat network expansion. In particular, the synchronised connection of all homes that would be achieved via the development of a heat network could unlock additional advantages that our current model underestimates. When all households, especially those with the highest emissions and those experiencing severe fuel poverty, are connected concurrently, the benefits can be significantly amplified. Such an approach enables novel financing mechanisms and policy innovations. For example, during periods of low heat demand, the network could provide subsidized or free heat to households in need, effectively leveraging surplus capacity to enhance social equity. Moreover, simultaneous rollout may yield economies of scale, reduce overall installation costs, and foster community-based models such as heat-as-a-service. These opportunities point to substantial unquantified benefits that warrant further research.

To fully realize the potential of heat networks, targeted policy interventions are required. Innovative financing mechanisms such as green bonds, municipal climate funds, and property-linked financing should be expanded to distribute the high initial costs over time. In parallel, local authorities need enhanced powers and clearer governance structures, such as regional heat network delivery agencies, to ensure consistent implementation and robust coordination among stakeholders. Investment in workforce development is critical to address current skills shortages in retrofitting and heat network installation. Finally, comprehensive public engagement and consumer protection measures are essential to secure widespread buy-in and ensure that the benefits of the transition are equitably distributed. The Scottish Climate Intelligence Service, a program financed by the Scottish Government and local authorities, is uniquely positioned to play a key role across all of these challenges and to ensure a coordinated approach across local and national government.

In conclusion, our study provides compelling evidence that expanding heat networks and retrofitting buildings can yield annual benefits exceeding £522 per household. Finding ways to embed these benefits may be critical to advancing zero carbon heating. More generally, and arguably more importantly, evidence from this analysis support recent academic literature (Sudmant et al., 2024[10]) in highlighting the need for establishing a firmer connection between social, economic and climate policy both in Scotland and across the UK.

[10] Sudmant, A., Boyle, D., Higgins-Lavery, R., Gouldson, A., Boyle, A., Fulker, J., & Brogan, J. (2024). Climate policy as social policy? A comprehensive assessment of the economic impact of climate action in the UK. Journal of Environmental Studies and Sciences, 1-15.