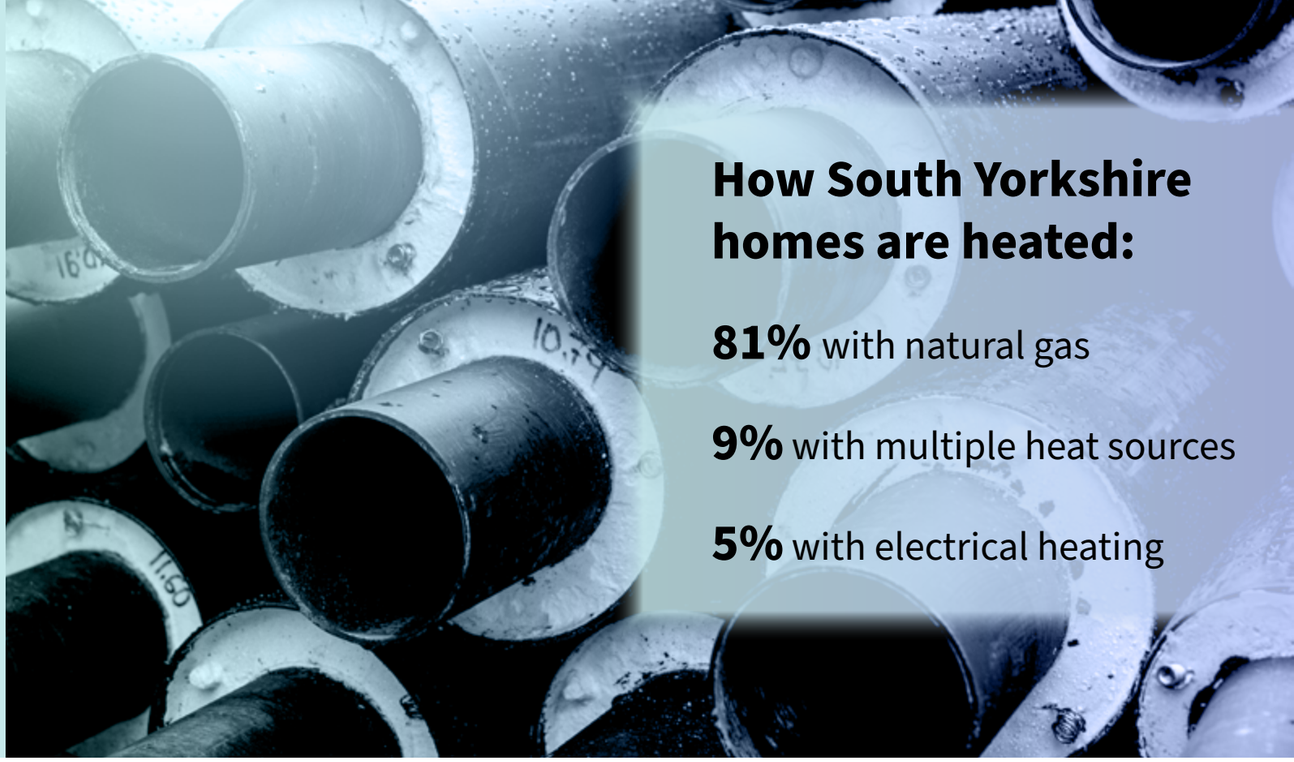
Decarbonisation of Residential Heat for the South Yorkshire Region

Project team:
University of Sheffield. Prof. Solomon Brown, Dr Timothy Hutty



Challenge Statement

According to the National Audit Office, in 2021, the UK's 28 million homes accounted for 18% of all UK greenhouse gas emissions[1]. In South Yorkshire, 81% of homes are heated with natural gas, followed by 9% with multiple heat sources and only 5% with electrical heating[2]. Thus, decarbonisation of home heating is both a challenge and a priority in order to reach net-zero by 2050. Electrification of heat, by replacing gas boilers with heat pumps, is the cornerstone of the government's heat decarbonisation strategy. Heat networks, which supply heat to multiple buildings from one or more centralised heat sources, will also play a part, and are anticipated to supply 7% of the UK's heat by 2035[3], and 20% by 2050[1].

South Yorkshire currently has two major heat networks, the Veolia District Energy Network and the E.ON Blackburn Meadows Heat Network. Plans have been submitted to expand the latter to more than double its current size[4, 5]. The region possesses notable unexploited heat sources, including waste heat from industry, and low grade geothermal heat from old coal workings[6]. Large commercial and public buildings will be the most important heating loads supplied by heat networks; but more clarity is needed on the extent to which residential heat could also be decarbonised by this means[7, 8].

Research Response

This research project aimed to address key outstanding questions around residential heat decarbonisation in the region. Firstly, which parts of the region should be prioritised for heat network development, and to what extent is the connection of residential properties a cost-effective decarbonisation strategy? Secondly, where residential properties could connect to heat networks, should fabric retrofit be prioritised over heat network connection? Thirdly, how does the level of ambition for cutting Green House Gas (GHG) emissions affect the cost-optimal heating strategy?

We broke the whole South Yorkshire region down into sub-areas of around 100 buildings, and used computational methods to lay out heat network routes. We then computed the overall cost of supplying heat to the region, through to 2050, as well as the associated emissions. We compared different combinations of heat sources and fabric retrofit levels.

Evidence and Outputs

The majority of South Yorkshire's residential building stock should decarbonise via electrification. District heat network (DHN) developments are highly capital intensive and the economics for deployment to areas with average housing density are poor. Our results suggest that the proportion of residential dwellings that can most economically decarbonise by joining a heat network is around 4%, representing 9% of residential heat demand. It becomes cost-efficient to connect residential dwellings when they are in close proximity to large anchor loads such as schools and hospitals.

However, whilst electrification will be the dominant form of heat decarbonisation in the South Yorkshire region, heat networks remain part of the optimal mix of solutions. Utilising waste heat from industry and energy-from-waste is projected to save around 3.5% on the annualised cost of heating for the region, versus the scenario with pure electrification. Utilising these heat sources could also reduce annual emissions by around 45,000 tCO_2, or 3% of the total with electrification. Development of minewater sources was not found to be cost-optimal in this study with energy prices around 1.5p/kWh more expensive than electrification resulting in a rise of circa £200 per annum for a typical house. Minewater sources could enable further cuts to emissions provided efficiency is high but this has not yet been demonstrated.

Where dwellings are connected to heat networks, certain fabric retrofit measures are recommended to implement beforehand. These recommended measures are loft insulation and cavity wall

1 National Audit Office (2024) Decarbonising Home Heating.
2 Office for National Statistics (2023) TS046 - Central heating.
3 DESNZ (2026) Warm Homes Plan.
4 E.ON (2024) Net Zero Sheffield Energy Generation and Storage Decarbonisation Routemap 2024-26.
5 SYMCA (2022) South Yorkshire Mayoral Combined Authority Energy Strategy.
6 E.ON (2025) Blackburn Meadows District Heat Network.
7 DESNZ (2025) Sheffield Heat Network Zoning - Zone Opportunity Report.
8 E.ON (2023) Blackburn Meadows District Heating Network Connection and city wide heat decarbonisation.

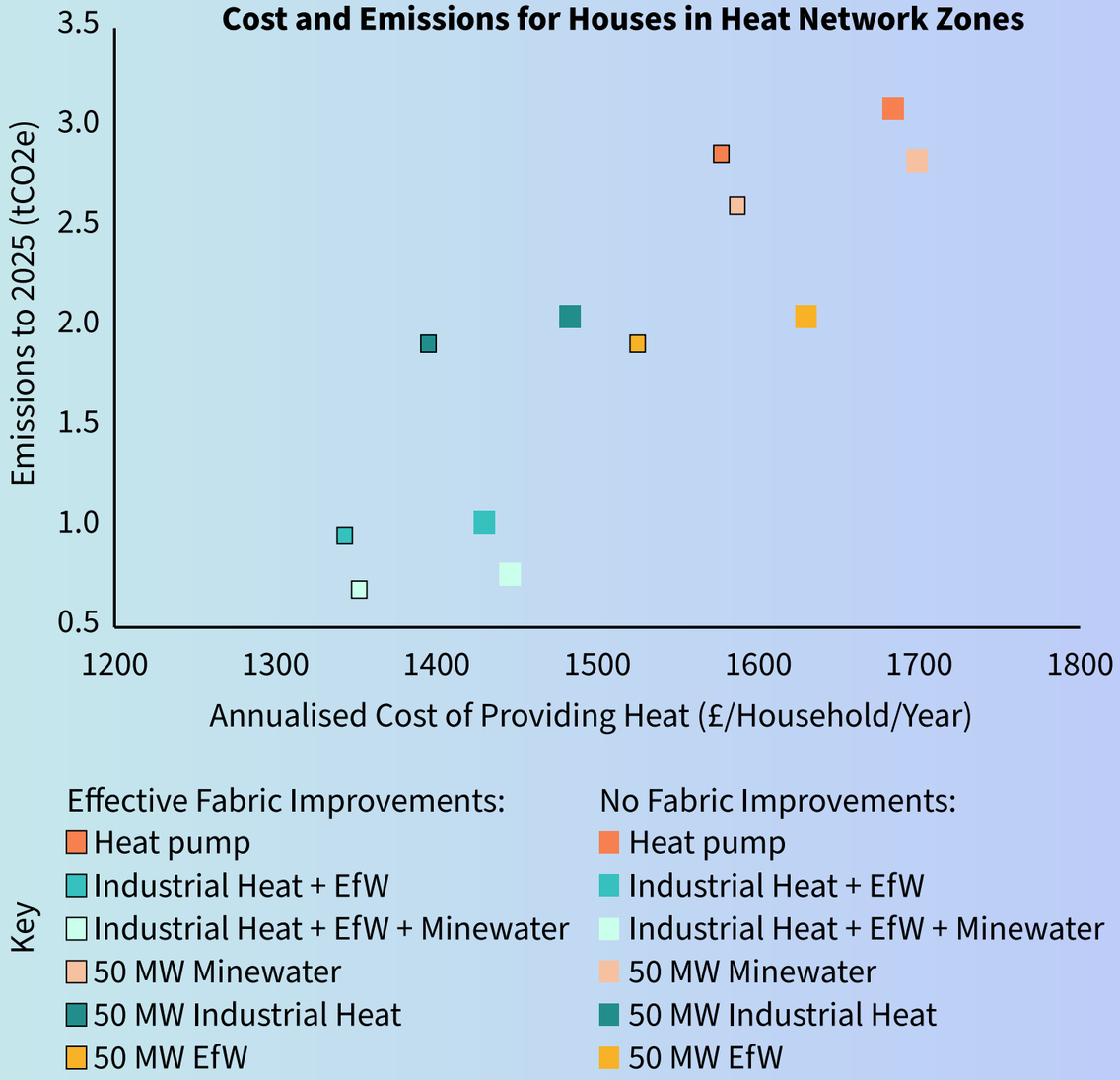


Figure 1: Cost and emissions for houses in heat network zones

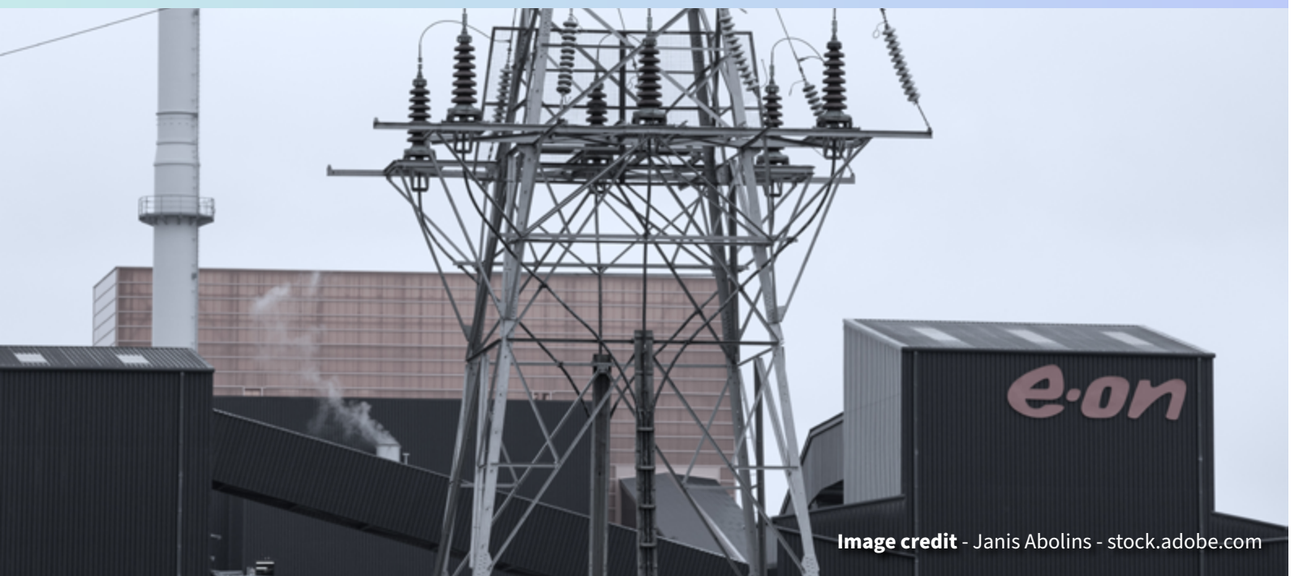


Image credit - Janis Abolins - stock.adobe.com

Utilising waste heat from industry and energy-from-waste is projected to **save around 3.5%** on the annualised cost of heating for the region

Utilising these heat sources could also **reduce annual emissions by around 45,000 tCO_2**

insulation. These measures reduce peak energy loads which leads to network savings of ~10%, as well as reduced energy costs. Floor insulation and solid wall insulation are found to be borderline cost-effective (cost of installation vs. operational savings and DHN infrastructure savings).

What does this mean for the region?

Usually, the local authority policy of pursuing fabric retrofit before heat network connection is sound. This finding applies to loft and cavity wall insulation. Economics for solid wall insulation or floor insulation are tight, and money may unlock quicker carbon savings if spent elsewhere.

The local authorities should continue to support the rollout of heat networks, with a particular priority to fully exploit existing energy-from-waste facilities and industrial heat resources. Exploitation of minewater is more costly but can achieve slightly deeper carbon savings.

Electrification will remain the dominant approach to heat decarbonisation for detached, semi-detached and terraced houses. Supporting electrification via investments in training and supply chains is critical.

Study Limitations

It is worth noting that this investigation did not look at the rebound effect where consumers respond to improved building performance by improving their thermal comfort, rather than saving energy. The rebound effect potentially weakens the case for fabric retrofit ahead of heat network connection.

The economics of residential heat network connections for new-build estates are known to be far better than for existing stock; this study focused only on existing stock.

Next Steps

The results of the study will be made available via the SYSC Residential Decarbonisation dashboard, enabling users to map results and compare different scenarios. The computed heat network layouts and their techno-economic metrics will be published as part of this.

The tools developed for this project are versatile and can be used to examine other decarbonisation strategies, such as small-scale local heat networks with communal heat pumps. There are also opportunities to look in more detail at emerging heat sources such as data centres, and to model decarbonised heat for new build estates. Models developed during this work are widely applicable and could be used for similar studies on any geographic area.

More studies are required on thermal comfort and the rebound effect from building fabric improvements; these would likely require real-world data collection.