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Shared ground heat exchange for the decarbonisation of heat

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Shared ground heat exchange can deliver low-carbon electrified heat where individual heat pumps or heat networks are not feasible, such as in terraced homes. However, there is a policy gap around these mid-scale heat solutions. We outline the benefits and challenges of shared ground heat exchange, and actions needed by policy, housing, and innovation stakeholders to support further deployment.

Overview

- **Heat decarbonisation policies recognise the role of individual heat pump systems and heat networks but overlook the mid-scale where shared ground heat exchange could be applicable.**
- **Shared ground heat exchange may be ideal for medium-density settings such as terraced houses, housing blocks, and small neighbourhoods.**
- **Shared ground heat exchange offers significant potential for growth, innovation, and improved customer experience.**
- **Formal recognition of shared ground heat exchange in national and local policy is required to enable full deployment potential to be achieved.**

Decarbonising heat

UK heat generation remains heavily reliant on fossil fuels. The energy used to heat buildings contributes about **23% of UK greenhouse gas emissions**, and only **5% of UK heat demand is met by low-carbon sources**. This must be addressed for the UK to meet its legally binding target of net-zero emissions by 2050.

Unlike decarbonising the electricity supply, where most changes take place far away from domestic dwellings, heat decarbonisation requires direct intervention in the 23m homes currently heated by a gas or oil boiler. The UK Government has set out its approach to addressing this challenge in the Heat & Buildings Strategy. This sets the ambition to increase deployment of heat pumps and heat networks and explore the potential of hydrogen for heating by 2026. However, there is a policy gap around mid-scale solutions like shared ground heat exchange, which could contribute to net zero.

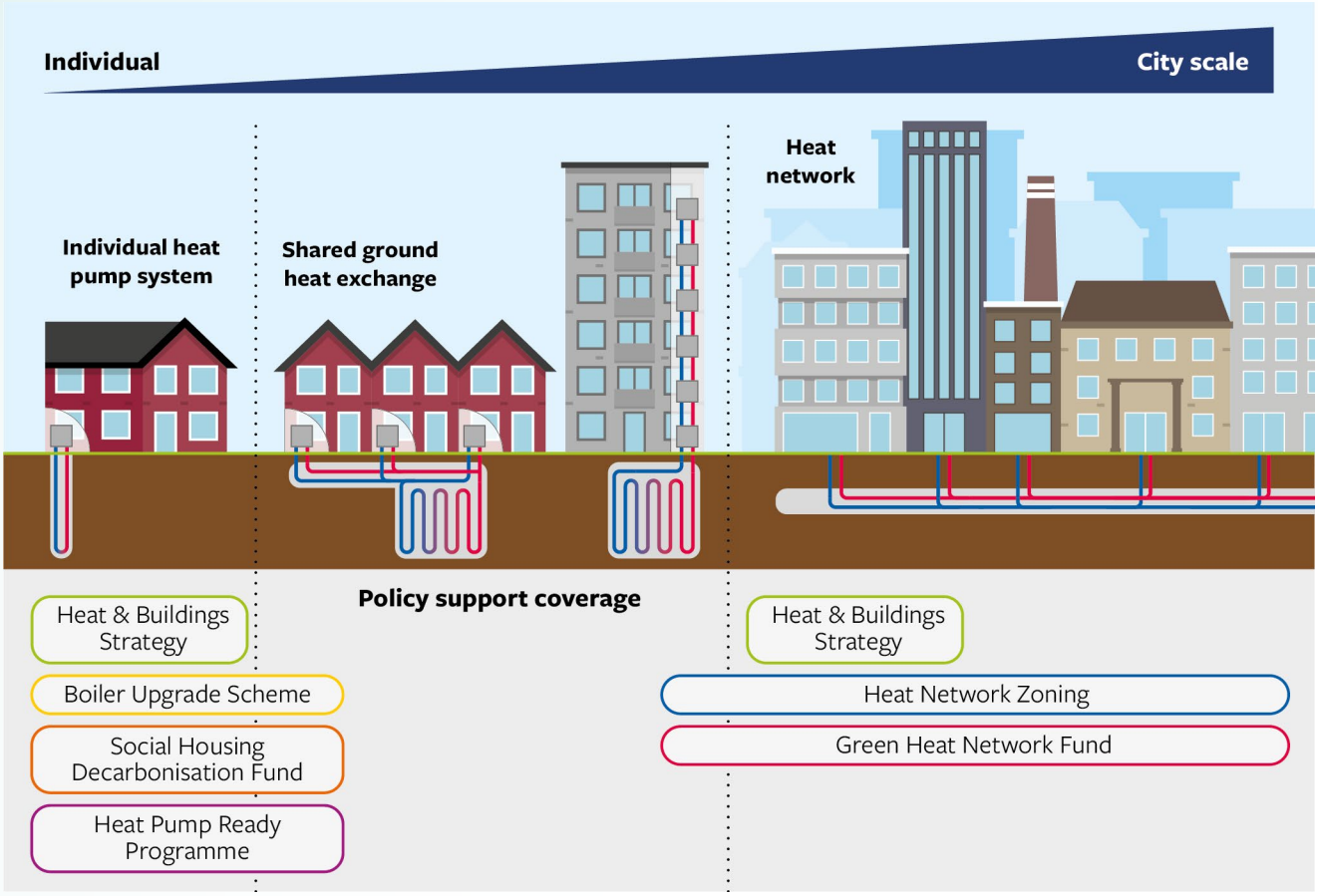


Figure 1. Policy and funding landscape for low carbon heat technologies over a range of scales

Definitions

- **Heat pump**: appliance which uses electricity and energy taken from the environment (air, ground or water) to provide heating and hot water.
- **Ground heat exchanger (GHE)**: pipes, typically in a borehole, which transfer heat to and from the ground.
- **Shared ground array**: multiple ground heat exchangers connected together for use by multiple dwellings.
- **Shared ground heat exchange**: distributed heat pumps in multiple dwellings connected to a shared ground array. They may be particularly suitable in medium-density areas.
- **Heat network**: central heat source connected to a range of users such as housing, commercial buildings, hospitals etc. Many configurations are possible.

Current policy landscape

We mapped current UK Government policies to explore the extent to which they recognised and supported shared ground heat exchange. Figure 1 shows the policy and funding gap around support for shared ground heat exchange. Here we examine these issues in more depth, looking at national and local approaches.

Heat and Buildings Strategy

The **Heat and Buildings Strategy** sets out the clear ambition for the UK to move away from fossil fuels for heating and cooling and to achieve net-zero by 2050, primarily through deployment of three key technologies:

- Heat pumps: with a focus on new-build homes and lower density areas, heat pump deployment is to increase from the current rate of 30,000/year to over 600,000/year by 2028.
- Heat networks: recognising that low carbon heat networks can unlock shared access to untapped heat sources and are especially suitable for high-density settings. There is a clear commitment to increasing heat network deployment.
- Hydrogen: the government anticipates making a decision by 2026 about the role of hydrogen in heat decarbonisation.

What this means for shared ground heat exchange: Because shared ground heat exchange systems combine distributed heat pumps with ambient heat distribution, they fall between the distinct policy areas of heat pumps and heat networks. They are potentially suitable for medium-density, semi-urban or rural areas, where individual heat pumps or heat networks may not be the best solution. However, because these are the areas of focus in the strategy, the potential benefits and particular challenges associated with greater deployment of shared ground heat exchange may not be recognised or addressed.

Heat Network Zoning

These are a key part of the Government's strategy to increase heat network deployment. Following an **initial consultation exercise**, proposals are being developed to bring in Heat Network Zones across England by 2025 (policies implemented in Scotland in 2021):

- Heat network zones across the country will be identified by central government where heat networks present the lowest-cost low-carbon solution for decarbonising heating.
- Within heat network zones, proposals suggest that all new buildings and large public-sector and non-domestic buildings, as well as larger domestic premises which are communally heated, would be required to connect to a heat network within a timeframe of 10 years.
- Local Zoning Coordinators will be appointed to designate and implement heat network zones. These are likely to be local or regional authorities, although there are **calls for other organisations to be eligible** to be Zoning Coordinator.

What this means for shared ground heat exchange: Shared ground heat exchange is recognised as eligible for inclusion in zones when it can be connected to larger heat networks in zones. In practice, zoning proposals mean heat networks are likely to grow outwards from city centres with their large non-domestic heat demands. Shared ground heat exchange systems have the potential to meet the demand in areas outside of urban centres, and offer a favourable economic solution where heat demands are lower and a route to decarbonise dwellings not currently included in proposals.

Local planning policies

Having committed to achieving net zero emissions by 2030, many local authorities are updating their climate-related planning policies. This presents an opportunity to ensure shared ground heat exchange is recognised as a heating technology which can support decarbonisation in the right settings.

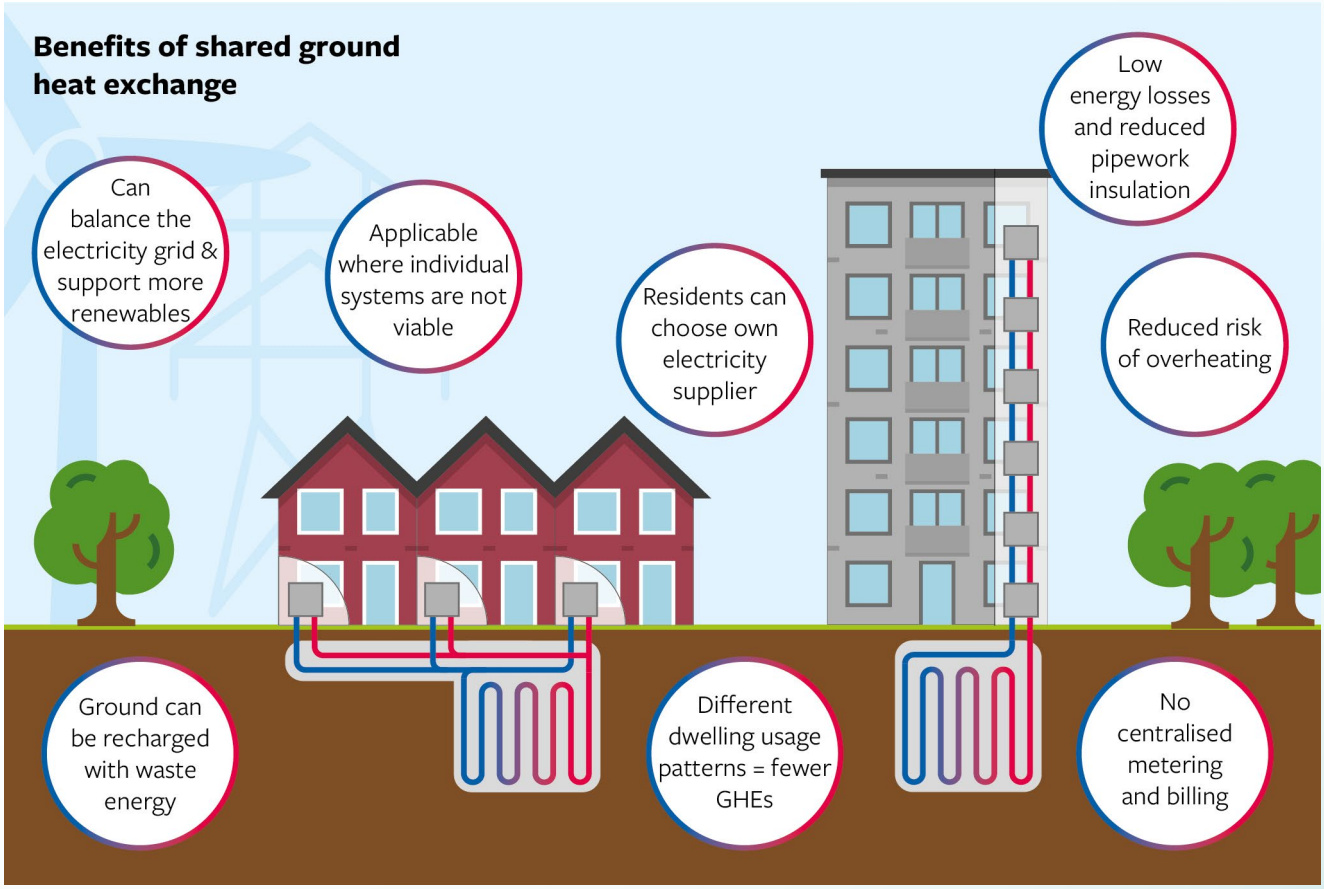
- Without local policy measures there is a risk of widespread shift to direct electric heating, instead of more efficient options like shared ground heat exchange.

What this means for shared ground heat exchange: as a net-zero compliant solution based on efficient electrified heat provision, shared ground heat exchange should be recognised as an eligible heating option in planning policies. Support for developers to consider shared ground heat exchange can be provided through local authority recommendations and sharing of case studies.

Current funding situation

There are several funding streams which could support social housing landlords, local authorities, and developers to invest in shared ground heat exchange (see Further Information). However, funding is primarily targeted at individual heat pump systems or large-scale heat networks, rather than the mid-scale shared ground heat exchange (Figure 1). Addressing the lack of support for shared ground heat exchange through funding streams which are aimed specifically at this market sector may help boost their deployment.

Figure 2. Potential benefits associated with shared ground heat exchange



Benefits of shared ground heat exchange

We identified several key benefits which shared ground heat exchange offers over individual ground source heat pump systems and heat networks (highlighted in Figure 2):

- **System efficiency**: Shared ground heat exchange systems can achieve the higher efficiency levels of ground-source heat pumps compared to air-source heat pumps, allowing for lower running costs for the residents. This increase in efficiency also comes at a lower capital cost per dwelling than installing individual ground source heat pump systems, due to shared infrastructure.
- **Dwelling space requirements**: Individual heat pump systems are limited in their application because they require some outside dwelling space for groundworks or equipment installation. Shared ground heat exchange connects each home to the shared borehole array through a network which does not require dwelling outside space.
- **Resident control**: Distributed heat pumps mean the residents can choose their own electricity supplier, and can switch tariffs to find the best deal.
- **Distributed infrastructure**: Unlike heat networks, distributed heat pumps only draw energy when it is needed and can avoid the need for large, centralised pumps and other expensive infrastructure.
- **Energy sharing**: There is potential to reduce the number of ground heat exchangers required due to the variance in peak loads, and peak load times, from the multiple occupancies, leading to smaller capital costs.
- **Metering and billing**: Heat network operators are usually required by law to meter and bill households for their heat consumption. In shared ground heat exchange systems, households pay for their heating through their normal electricity bill, meaning the system operator does not have to get involved in this complex and expensive process.
- **Ambient distribution**: Because systems circulate water at ambient temperatures, this avoids the heat losses commonly seen in traditional heat networks and reduces insulation requirements. This also alleviates the risk of overheating properties present with traditional high-temperature heat networks.
- **Maintenance requirements and lifespan**: Once the shared ground array and pipework infrastructure is installed, it requires little maintenance and should last as long as other buried infrastructure such as water supply networks. This should mean the system operates well beyond the payback period, essentially providing 'free' energy for decades.
- **Applicability to different settings:** Shared ground heat exchange could be used in suburban and rural locations where energy losses over increased distances would make high temperature systems infeasible.

Challenges to deployment

Shared ground heat exchange is a niche technology in the UK, with a few dozen schemes deployed to date. We identified several key challenges to wider deployment associated with the approach:

- **Market conditions**: With very few suppliers and installers of shared ground heat exchange, knowledge and expertise is held by a few specialist providers, and there are no widely agreed standards or best practice.
- **Awareness**: Related to the issue of market development is the challenge that many developers and their technical advisors are unaware of shared ground heat exchange when choosing what heat system may be best for their site.
- **Capital costs**: The small numbers of technology providers and lack of experience amongst installers contribute to high capital costs compared to conventional fossil-based heating systems.
- **In-home equipment**: Systems require equipment such as a hot water tank or heat battery to be installed in each home, along with the heat pump. There is currently no 'like-for-like' replacement for a gas combi boiler on the market and many households have given over space for a hot water tank to other uses. Properties with electric storage heating likely stand the most to gain from adopting heat pumps, although new radiators would need to be installed. A fabric-first approach should be considered, as with all heating system upgrades.
- **User perceptions**: Negative experiences with heat networks may cause unwarranted concerns about shared ground heat exchange, although SGHE does not suffer from the same inefficiency, overheating, or lack of supplier choice. Heat pumps also suffer negative perceptions because of consumer unfamiliarity and some examples of poor installation practice.
- **Utility status of heat providers**: So far heat has not been recognised as a statutory utility. This has led to poor consumer protection for some heat network customers and means scheme developers do not have the same rights to install street infrastructure as other utility providers, such as broadband.
- **Infrastructure ownership and maintenance:** There is no established business model which delivers scheme viability in privately owned systems. New mechanisms may need to be introduced if installers wish to recoup the initial capital costs, such as a one-off connection charge or an ongoing standing charge for each dwelling connecting to the shared ground array.
- **Electricity-to-gas price differential**: Electricity costs remain high compared to gas, and the majority of environmental costs are levied on electricity bills. Electrified systems such as shared ground heat exchange must therefore be highly efficient to achieve the same or lower operating costs as gas boilers. This situation could be addressed by the forthcoming review of rebalancing energy levies.

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Recommendations

Current policies tend to target individual heat pump systems or heat networks, with a gap identified around the mid-scale of shared ground heat exchange.

Based on the benefits, challenges and current policy landscape identified through the research, and through consultation with stakeholders, we propose some key recommendations:

National policy

- Recognition of shared ground heat exchange and its suitability for mid-scale, medium-density settings in national policy, including in the Heat Network Zoning proposals (*BEIS*).

Local implementation

- Recognise shared ground heat in local planning policies (*local authorities*).
- Identify where shared ground heat exchange may be the best solution for use in new developments (*local authorities, housing developers*).
- Ensure shared ground heat exchange is considered when developing heat network zoning plans (*Local Zoning Coordinators*).

Users

- Provide initial training and follow-on support to ensure users understand how to maintain comfort levels whilst operating the heating system efficiently and cost effectively (*landlords, system developers, installers*).

Business models

- More innovation and research into the creation of viable business models is required, including potential for utility business models and options for mixed-occupancy schemes (*system developers, new market entrants, researchers, innovation agencies, BEIS*).

Technical

- Development and provision of technical training for installers and suppliers (*training providers, system developers, local authorities*).
- Recognition and inclusion of shared ground heat exchange in standards for design, installation and operation. Compliance schemes to ensure standards are met (*standards bodies e.g. CIBSE, MCS; regulator, e.g. Ofgem; other relevant bodies e.g. Heat Trust*).
- Increased monitoring of installed system performance to better understand "diversity" benefit from connecting multiple households and reduce upfront costs (*system developers, landlords*).

About the authors

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Further information

The benefits, challenges and characteristics associated with shared ground heat exchange systems were identified through research by the University of Leeds and Leeds Beckett University. A Rapid Evidence Assessment and policy mapping exercise identified initial policy actions. These were developed through a collaborative workshop with stakeholders from across the industry, public sector, and policy spectrum in February 2022.

The shared ground heat exchange case studies, policy and funding mapping, Rapid Evidence Assessment data, and stakeholder workshop whiteboard can be accessed at: **https://doi.org/10.5518/1137**

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