South of Scotland
Heat Networks Prospectus

Executive Summary

This Prospectus aims to raise the profile of heat network opportunities in the South of Scotland, by presenting around twenty potential projects across a range of scales and readiness levels, technology types and geographic contexts.

Introducing heat networks

Heat networks distribute thermal energy from a central source to multiple customers, and tend to fall into two main categories:

- **District Heat Networks**, which operate at elevated temperatures and generally supply heat to customers at the temperatures needed by their buildings and/or processes without further boosting.
- **Shared Heat Collector Networks** distribute lower-temperature heat to customer buildings, where distributed heat pumps upgrade it to the temperatures required by the building or process. This can be across multiple buildings or in a single communal space.

Both types of heat network offer benefits in terms of ease of access to low carbon heat sources, efficiency of operation and long-lasting infrastructure. These factors can lead to heat networks being able to provide heat that is lower in cost and has lower climate and air quality impacts.

District Heat Networks tend to be viable in town centres, “campus” environments or industrial areas. By contrast, Shared Heat Collector Networks can be viable at a wide range of scales, starting with a row of cottages or a small block of flats all the way up to whole neighbourhoods. This Prospectus identifies seven Shared Heat Collector Network “archetypes” by which these networks can be classified. They are differentiated by their scale, the type of buildings they would serve, whether they require retrofit to existing buildings or serve new builds and the degree to which they lend themselves to community involvement.

The national landscape for heat networks development is characterised by supportive policy and funding opportunities, with further progress anticipated in the coming years on consumer protection, authorisation and regulatory oversight, technical standards and stimulating demand. Scottish Local Authorities’ recent Local Heat and Energy Efficiency Strategies (LHEES) are key drivers of heat network development in the regions where they have been identified as strategically important, including in the South of Scotland.

Several large District Heat Networks are currently in development in Scottish cities, including Aberdeen, Edinburgh and Glasgow. Meanwhile, Shared Heat Collector schemes are being constructed across the UK, whether taking advantage of Scottish Government or Westminster funding, or using developers’ or landowners’ own funding sources. These include schemes to replace polluting heating systems in existing buildings and those which serve new-build, sometimes at a substantial scale. These schemes variously use heat from large arrays of boreholes, heat exchange with underground water reservoirs, waste heat from data centres and industry and large air source heat pumps.

South of Scotland’s context

As a small but diverse region, the South of Scotland is agile and dynamic. The region’s largest population centres of Dumfries, Hawick, Stranraer and Galashiels are joined by several smaller towns of circa 3,000 to 5,000 population, as well as many smaller settlements and populated rural area. Natural assets of relevance to heat networks include rivers (with most major settlements adjoining or spanning large rivers like the Nith, Annan, Tweed and Teviot); bedrock and aquifers that are favourable for ground heat extraction; and a large timber industry that gives rise to considerable amounts of sustainable biomass as residues. The scale of onshore wind generation in the region could present important future opportunities for District Heat Networks, which are able to use cheap, green electricity to charge up thermal stores, or can be co-located with green hydrogen production to capitalise on the waste heat from electrolysers. Coupled with this, community benefit funds present an opportunity for communities to collectively invest in infrastructure to make heat networks more commercially viable.

Scottish Borders’ and Dumfries and Galloway’ Local Heat and Energy Efficiency Strategies (LHEES) approach heat decarbonisation in a locally-led place-based way, acknowledging the specific challenges that exist in each area. These challenges include: predominantly older and inefficient building stock, a high proportion of the population living in small settlements or rural settings, and high proportions of buildings (~35%) that are not served by the gas grid. On the other hand, the localised positive impacts of heat networks in the South of Scotland might include job creation, skills enhancement and wealth retention; fuel poverty alleviation; and boosting the region’s contribution to Scotland’s decarbonisation targets.

Heat Network opportunities in the South of Scotland

This Prospectus introduces seven District Heat Network opportunities and an initial twelve Shared Heat Collector Network opportunities across the South of Scotland. The projects highlighted are either at a pre-feasibility or feasibility stage, with additional development work required to refine concepts, validate supply and demand assumptions, establish stakeholder interest (especially among potential customers and heat suppliers) and develop designs: in short, to establish the business case for investment. The locations are: Peebles, Stranraer, Hawick, Dumfries, Galashiels, Tweedbank and Darnick, Crossmichael, Smailholm, Swinton, Langholm, Gretna, Tweedbank, Selkirk, Kelloholm, Annan and Lockerbie. Dumfries, Galashiels and Tweedbank feature more than one opportunity. Depending on the network “archetype”, they could be applicable in towns, villages, streets and industrial estates beyond those mentioned here.

What next?

The Prospectus outputs and ongoing heat network activity at individual sites are to be taken forward to understand the delivery model(s) required to support the establishment of a programme of smaller heat network development opportunities across the region. The Prospectus also aims to stimulate those conversations between interested parties that could inspire practical action and investment in pilot projects and nascent larger projects, building momentum for the sector in the region. If you are interested in being part of the conversation, you can reach out to the organisations which have jointly published this Prospectus, contact details can be found in the “What next?” section on page 15.

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Purpose of the Prospectus

This Prospectus aims to raise the profile of heat network opportunities in the South of Scotland. The projects highlighted are either at a pre-feasibility or feasibility stage, with additional development work required to refine concepts, validate supply and demand assumptions, establish stakeholder interest (especially among potential customers and heat suppliers) and develop designs: in short, to establish the business case for investment.

The purpose of presenting this range of opportunities is to demonstrate what could be possible in terms of heat network development in the region, drawing attention to those opportunities that have the potential to deliver highest impact either through their scale or the fact that they are widely replicable. This Prospectus makes a contribution to the closing of the gap between investors' desire to fund heat network projects and the supply of investible opportunities in the region.

The content of this Prospectus is based on current information and insight at the time of writing, and the concepts for each heat network opportunity will be subject to change when new information comes to light, including from parties not consulted in the process of the publication's development. The opportunities are modelled potential options, and any actual project that is taken forward could be a variant of, a development of or a completely different undertaking to what is presented.

The Prospectus aims to stimulate those conversations between interested parties that could inspire practical action and investment in pilot projects and nascent larger projects, building momentum for the sector in the region. If you are interested in being part of the conversation, you can reach out to the organisations which have jointly published this Prospectus: Scottish Borders Council, Dumfries and Galloway Council and South of Scotland Enterprise. Contact details can be found in the "What next?" section on page 15.

Renewable energy specialists Natural Power carried out the research, analysis and interpretation that underpins this Prospectus, supporting decision-making by the project partners with respect to the opportunities that have been included. Natural Power authored written and graphical content for this publication and produced geospatial outputs that South of Scotland Enterprise and the Local Authority partners will be able to use for future heat networks development work.

Introducing Heat Networks

Definition and benefits

The Heat Networks (Scotland) Act 2021 defines heat networks as systems that distribute thermal energy from a central source to multiple consumers. Most heat networks in Scotland distribute heat rather than cooling. The heat supplied through these networks is variously used to provide space heating, water heating or heat to processes. Heat networks can be advantageous over individualised heat generation and supply for the following reasons:

- They can more easily access low carbon heat sources located at a distance from a building that may not be economically or technically feasible to access otherwise.
- They can generate and supply heat with a greater efficiency than is achievable with individual building-scale systems.
- They can be extremely long-lasting infrastructure, with lifetimes measured in generations rather than years.
- They can be easier to integrate than other low-carbon heating alternatives, for example by requiring less indoor space, having minimal visual impact and not requiring a garden or significant outside space.
- They can support fuel poverty alleviation.

These factors can lead to heat networks being able to provide heat that is lower in cost and has lower climate impacts than the alternatives. Additional co-benefits can include improved air quality and building safety (particularly if a heat network is replacing gas or oil boilers or solid fuel use); a better and lower-hassle consumer experience; and supporting community and placemaking initiatives. However, none of these benefits are a given: a heat network needs to be built in the right place, designed in the right way, and managed and operated correctly to achieve such impacts.

Two types of heat network

Heat networks can convey thermal energy from source (or sources) to users at any temperature. However, they tend to fall into two main categories:

1. Networks that distribute hot water at a temperature that can be directly used by most connected buildings' heating systems or processes, without further temperature boosting. The case studies and opportunities that feature in this Prospectus and are referred to as **District Heating** meet this definition. Network operating temperatures are normally between 50 and 90 degrees centigrade.

2. Networks that distribute cooler water, normally at or close to the temperature of the environmental or waste heat sources that feed into them. The connected buildings use heat pumps to extract thermal energy from the circulating water and efficiently boost its temperature to the required level. Because customers share the infrastructure that harvests heat, but not the plant that upgrades it, this type of network is referred to as a **Shared Heat Collector Network**. The term Shared Ground Loop network is also common, although diverse heat sources can be accessed, not just the ground.

District Heating schemes tend to be viable in more densely populated areas, or those where there are multiple buildings or facilities that demand large amounts of heat at elevated temperatures. The case studies and opportunities in the South of Scotland that are highlighted in this Prospectus are mostly located in town centres, although campus-style locations and a cluster centred on a large hospital also feature.

By contrast, Shared Heat Collector Networks can be viable in places where the heat demand is less concentrated. The smallest and simplest form of a Shared Heat Collector Network is a pair of buildings sharing a ground or water heat collector, for example two neighbouring homes sharing a single borehole which feeds their own heat pumps.

It has been estimated[1] that, from a technical perspective, <u>around 80 %</u> of the UK housing stock is suitable for connection to a Shared Heat Collector Network. The proportion of buildings that could feasibly be connected to District Heat Networks is considerably lower because of the greater importance of heat demand density as a driver of technical and economic viability.
The advantages of Shared Heat Collector Systems can include:

- No or low losses from network pipework, because its operating temperature is close to ambient;
- Cheaper pipework and cheaper trenching, because pipework often does not need to be insulated;
- Minimal requirement for maintenance of network components (customers still need to maintain their heat pumps, although there can be opportunities to arrange this collectively);
- No requirement for land or a building to house an energy centre (although space requirements for heat pumps in or next to customer buildings can be higher than is required for District Heat Network connection equipment);
- Consumers retain choice for their electricity supplier (with their heat pump consuming electricity in order to 'pump' heat from the network to the internal heating system).

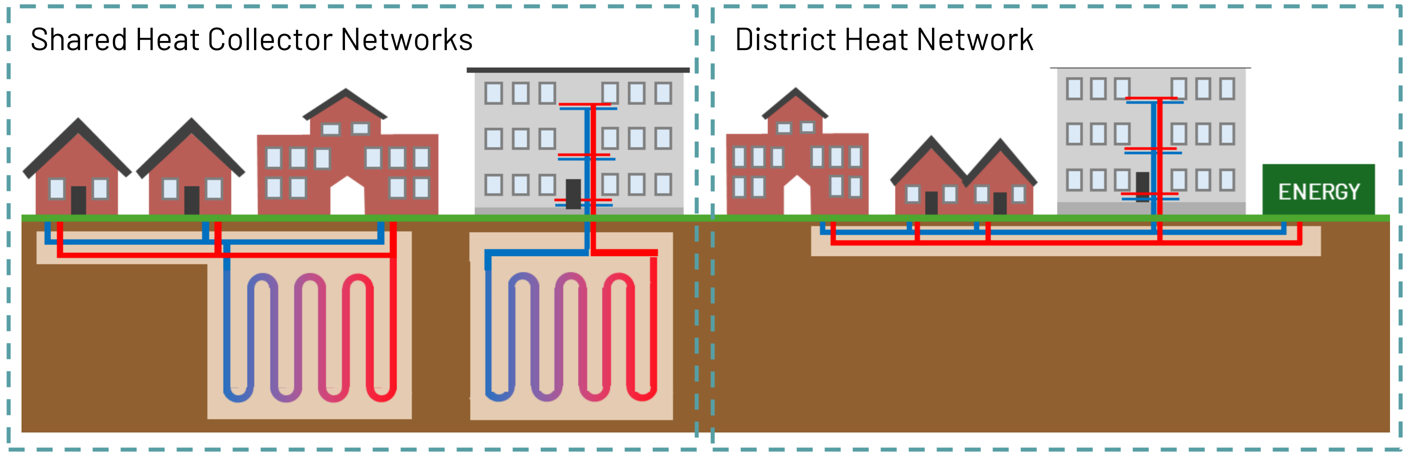


Figure 1: An illustration of Shared Heat Collector Networks and a District Heat Network

There are many instances in which a particular site could be beneficially served by either a District Heat Network or a Shared Heat Collector Network. Assessing which type is the better choice requires an options assessment and comparison of the business case for each, considering capital costs, operating costs, non-monetary benefits, ownership models and risks.

Shared Heat Collector Network Archetypes

We have identified seven types of Shared Heat Collector Network opportunity, which are differentiated by their scale, the type of buildings they would serve, whether they require retrofit to existing buildings and the degree to which they lend themselves to community involvement.

Settlement-wide
The most ambitious scope for a Shared Heat Collector Network. Would involve very large heat collectors – e.g. arrays of hundreds of closed-loop boreholes, large diameter open loop wells or river/lake/sea water abstraction. Large capital investments required.

Urban neighbourhood
A size down from a settlement-wide network, a Shared Heat Collector Network serving a neighbourhood of a few streets (which could be residential or commercial/industrial) can be a manageable scale to develop and fund. **This type of network can contribute to Placemaking initiatives.**

New developments
New developments could be housing estates, industrial/commercial areas or mixed use. A Shared Heat Collector Network can be installed at the same time as other utilities, minimising capital cost. Likely to represent strong financial viability and low demand risk.

Anchor load-led
Anchor loads can provide better certainty of heat demand and more cost-effective connections for Shared Heat Collector Networks (thanks to economies of scale). Some anchor load-led projects might be quite simple, whereas others could involve one or several large loads 'anchoring' many domestic or small commercial connections.

Blocks of flats
Flats can have more limited options for clean heating systems than other buildings. Shared Heat Collector Networks can offer all flats access to a valuable heat source, regardless of which floor they are on. Projects can be relatively simple and cost-effective. **This type of network is very highly replicable across the region.**

Street
The development of this scale of Shared Heat Collector Network could be initiated by residents themselves, accessing funding that is specifically targeted at small communities and neighbourhoods. **This is likely to be the archetype with the most widespread viability across the region.**

Heat source-led
Sometimes a suitable greenspace or body of water is the feature that stimulates investigation of a Shared Heat Collector Network opportunity and underpins its viability, especially if circumstances exist to construct heat collectors at cost-effective or convenient moments (e.g. when other groundworks are planned). This can also be true for sources of waste heat.

The features of some of these archetypes might equally apply to District Heat Networks, or the type of heat network that serves multiple properties in a single building (Communal Heat Networks).

National state of play

The last few years have seen significant developments in the heat networks sector, both at a Scottish level and UK-wide. This pace of change is not going to let up; 2025 and 2026 are expected to see more activity with far-reaching consequences in the policy, regulatory, masterplanning and project development spheres, as well as in markets for the products and services required to construct and operate heat networks.

Relevant Scottish Government policy elements active in 2025

- Heat in Buildings Bill
- Energy Efficiency Standard for Social Housing
- Heat Networks Delivery Plan 2022
- New Build Heat Standard
- Heat Network Support Unit and Heat Network Fund
- 2024-25 Programme for Government
- The Heat in Buildings Strategy 2021
- The Local Heat and Energy Efficiency Strategies (Scotland) Order 2022
- Update to the Climate Change Plan 2018-2032
- The Heat Networks (Scotland) Act 2021
- The Fuel Poverty (Targets, Definition and Strategy) (Scotland) Act 2019
- The Climate Change (Emissions Reduction Targets) (Scotland) Act 2019

There are numerous Scottish Government policies and regulatory instruments deriving from fuel poverty and climate change reduction imperatives that are relevant to the heat networks sector. On top of these, UK-wide development is taking place in the realms of:

- consumer protection (the subject of a DESNZ/Ofgem consultation in early 2025);
- authorisation and regulatory oversight (relevant to Scotland because Ofgem will be the regulator for heat networks across Great Britain, implementing applicable regulation in each devolved area);
- technical standards for heat networks (being jointly developed by Ofgem, the Scottish Government and DESNZ); and
- stimulating demand for lower-cost heat pump installations through a Clean Heat Market Mechanism.

Energy planning in Scotland took a great leap forward in 2023 and 2024 with the development of Local Heat and Energy Efficiency Strategies (or LHEES) by all local authorities. LHEES support Scotland's net zero and fuel poverty goals by setting out local priorities and future actions for decarbonising heating and improving energy efficiency. Scottish Borders Council and Dumfries and Galloway Council's LHEES have been published online and are freely accessible. In the preparation of these documents, Councils and their advisors undertook analysis of the entire building stock across their area and explored which solutions could allow different groupings of buildings to end their contribution to climate change through their use of heating. LHEES identified zones where heat networks showed the most promise as a decarbonisation solution.

Projects pipeline

Several large District Heat Networks are currently in development in Scottish cities[2]: major projects are being constructed at Torry, Aberdeen; Shawfair, Midlothian and Granton, Edinburgh, while projects are in the latter stages of pre-construction work at South Clyde, Glasgow and Glasgow Harbour. Industry is looking towards even larger schemes in the future[3], as well as ambitious 'heat highways' connecting large waste heat sources to these expanded District Heat Networks. However, this trend towards larger and longer in no way diminishes the potential for smaller District Heat Networks outside of Scotland's larger cities.

Shared Heat Collector schemes (all using ground source heat) are being constructed or commissioned in Glasgow, Motherwell and Aberdeen with partial funding from the Scottish Government. Meanwhile, the business case is being developed for an extension to the AMIDS Shared Heat Collector scheme in Paisley. Outside of Scottish Government funding schemes, organisations have been quietly developing their own projects to replace polluting heating systems in existing buildings or to serve new-build. Elsewhere in the UK, Shared Heat Collector schemes are being constructed at scale to serve new housing estates comprising hundreds of homes, using heat from large arrays of boreholes, heat exchange with underground water reservoirs and waste heat from data centres and industry.

Funding and finance

The ways in which projects are financed and the models through which they are delivered are diverse. However, most projects are delivered with a blend of return-seeking capital (loans and equity), capital grants and commercialisation grants. Sometimes customers are charged an upfront connection fee which contributes to the cost of construction. Returns on investment are achieved through the sale of heat over long timescales, secured by heat supply agreements between the heat network operator and the customer. It is common for local authorities (in the case of District Heat Networks) and landlords (in the case of smaller Shared Heat Collector schemes) to hold a financial stake in the project.

Forthcoming supporting research

Forthcoming research and other initiatives that will increase the sector's attractiveness include:

- The development of a ground source heat screening tool by Energy Systems Catapult, British Geological Survey and NHS England.
- The generation of a heat pump suitability dataset for neighbourhoods in England and Wales, with extension to Scotland planned, by the social innovation agency Nesta[4]. This will supplement similar assessments conducted as part of the development of LHEES.
- Research into the social benefits that could be realised by the development of District Heat Networks in designated zones in Midlothian and Edinburgh.

South of Scotland: local context

As a small but diverse region, the South of Scotland is agile and dynamic. There are many examples of cross-regional collaboration between the two local authorities (Dumfries and Galloway Council and Scottish Borders Council), and wider collaboration across the Borderlands which also encompass the northernmost English counties.

Settlements, geology and hydrology

About half of the region's population of over 260,000 lives in towns of at least 3,000 people. The largest centres of economic activity and population are Dumfries (33,470), Hawick (10,630), Stranraer (10,110) and Galashiels (10,060). Other sizeable towns not covered in this prospectus include Kelso (6,870); Selkirk (4,540); Dalbeattie (4,160); Newton Stewart (4,030); Castle Douglas (4,000) and Jedburgh (3,860). Most of the region's major settlements adjoin or span large rivers like the Nith, Annan, Tweed and Teviot. Provided that suitable conditions are present, the rivers represent important potential heat sources for neighbouring urban areas.

The bedrock that underlies the region is, for the most part, of a favourable type and composition for ground source heat schemes – be they large ground source heat pumps powering District Heat Networks, or groups of boreholes supplying distributed heat pumps through a Shared Heat Collector Network. Sandstones and mudstones, which often have good thermal conductivity and underground water flows and are relatively easy to drill, tend to dominate. There are localised areas where conditions may be especially favourable; for example, there are thought to be hot sedimentary aquifers underneath Dumfries and Newcastleton, and the geology of the area around Dalbeattie features granite that may have an elevated temperature due to localised underground heat generation in addition to the background conduction from above and below that is present everywhere.

Although coal mining was never as prevalent in the South of Scotland as it was further north and south, there are abandoned mines in the vicinity of West Linton and Kelloholm, which could be valuable heat sources.

Relevant economic activities

The sectors that contribute the majority of turnover and gross value add (GVA) in the region are food and drink manufacture, energy, financial and business services, tourism and agriculture. There are several large industrial sites that produce products like polymers, dairy products, paper products, chemicals and whisky or generate electricity. With large areas of land used for forestry, the South of Scotland's timber industry produces large quantities of sustainable biomass in the form of offcuts and other processing residues.

Renewable electricity generation, in particular onshore wind, is an important sector in the region. The imbalance between peak electricity generation and regional demand, combined with the constraints that currently affect the export of electricity to the power-hungry south, has an important impact that is relevant to heat networks: frequent periods of low electricity market prices (when renewables are often curtailed, wasting their generation potential). Although the mechanisms for capitalising on the opportunity of cheap, green electricity are immature and not yet widely used, this feature of the regional energy landscape could be highly relevant for District Heat Networks in the future. Heat networks that feature significant thermal storage capacity can charge up stores when energy is cheap and green, thus avoiding needing to import when energy is more expensive and more carbon intensive. Furthermore, production sites which generate waste heat can be co-located with demand for heat through District Heat Networks.

People and Place

According to the Development Trusts Association Scotland[5], placemaking is a process through which places that people want to live, work, or explore are created. Placemaking approaches are being applied at all scales within the region as a means of planning for and delivering improvements to the urban and rural built environment as well as the social and cultural fabric of an area. This can involve the creation of new places and/or the improvement of existing ones through regeneration.

The Local Heat and Energy Efficiency Strategies for both Scottish Borders and Dumfries and Galloway are explicitly "place-based" and locally-led. They seek to integrate heat decarbonisation initiatives into Place Plans, and ensure that local priorities and realities are taken into account in regional energy planning. They acknowledge the specific challenges that exist in each area, such as predominantly older and inefficient building stock, a high proportion of the population living in small settlements or rural settings, and high proportions of buildings that are not served by the gas grid. The Strategies introduce solutions that address those locally-relevant challenges, including detailing some of the heat networks opportunities in the region.

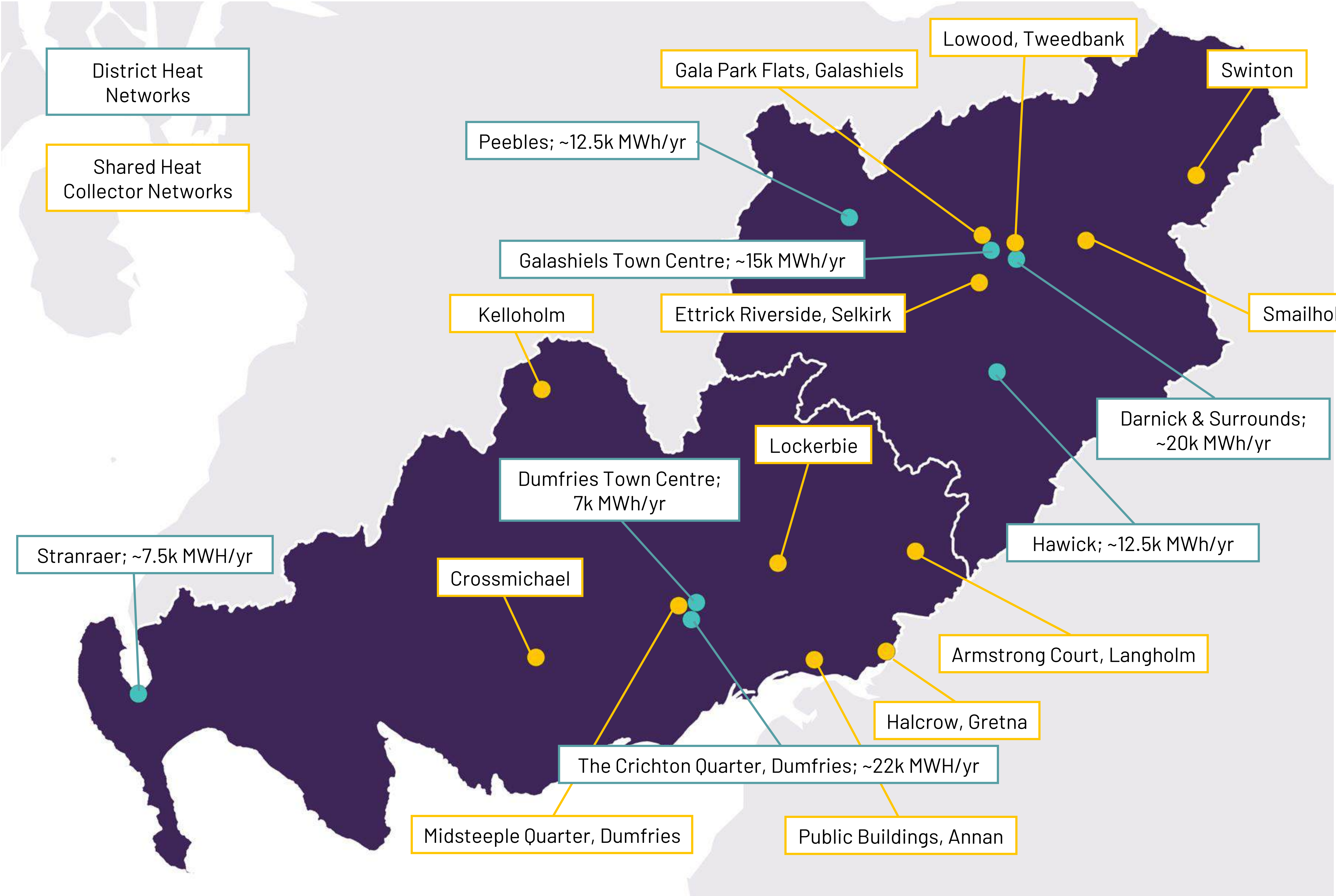
Heat networks can contribute to placemaking through their potential to deliver decarbonisation *en masse*, to reduce fuel poverty and air pollution, to increase retention of energy expenditure in the local economy and through their potential co-delivery with other placemaking activities. Through these mechanisms, heat networks can contribute positively to progress in the following areas which have been identified as specific challenges for the South of Scotland[6]:

- a low wage economy with limited opportunities for people (through local job creation, skills enhancement and wealth retention);
- poverty, deprivation and inequality (through reducing energy bills, especially where offers of connection are targeted at social housing and areas where residents are known to be at high risk of fuel poverty); and
- the region's contribution to Scotland's decarbonisation targets.

At the same time, challenges exist that the developers of heat networks need to assess and address. Economic change can lead to new demands for heat, which can be connected to heat networks – but closures, relocations and process changes can also occur which remove demand (and revenue) from a heat network. Opportunities to create skilled, sustainable jobs are highly desirable, but current skills gaps and limited capacity within the industry can pose severe constraints on the rate of growth of the sector if people and skills are not invested in ahead of time. Both District Heat Networks and Shared Heat Collector Networks require large upfront investments relative to the cost of alternatives, although they promise to deliver steady benefits and investment returns over time.

The region's local authorities themselves are key players in the nascent local heat networks sector, and are likely to play an active role in the future development of District Heat Networks and larger Shared Heat Collector Networks – either as leads or enablers. The proactivity of Scottish Borders Council and Dumfries and Galloway Council in supporting the development of specific heat networks, as well as the development of the sector as a whole, is an asset which promises to propel the region's contribution to Scotland's heat networks and climate change targets.

South of Scotland Heat Networks Prospectus Opportunity Locations



What next?

This Prospectus aims to raise the profile of heat network opportunities in the South of Scotland. To find out more about the following topics, the weblinks below are a good place to start:

Projects that are being developed and constructed with Scottish Government support, or have been supported in the past	https://www.gov.scot/collections/heat-network-project-reports/
Dumfries and Galloway's Local Heat and Energy Efficiency Strategy	https://www.dumfriesandgalloway.gov.uk/environment-community-safety/climate-emergency/what-we-doing
Scottish Borders' Local Heat and Energy Efficiency Strategy	https://www.scotborders.gov.uk/housing-homeless/energy-saving-advice/
Publications, information and case studies from South of Scotland Enterprise	https://www.southofscotlandenterprise.com/driving-change/net-zero
The Scottish Government's Heat Network Support Unit, which provides grant funding and expert advice	https://www.heatnetworksupport.scot/
Guidance from the Scottish Government about Local Heat and Energy Efficiency Strategies and Delivery Plans	https://www.gov.scot/publications/local-heat-energy-efficiency-strategies-delivery-plans-guidance/

The Prospectus outputs and ongoing heat network activity at individual sites are to be taken forward to understand the delivery model(s) required to support the establishment of a programme of smaller heat network development opportunities across the region.

This Prospectus aims to stimulate discussion between interested parties. If you would like to join the conversation, you can reach out to the organisations which have jointly published this Prospectus:

South of Scotland Enterprise	NetZero@sose.scot
Dumfries and Galloway Council	sarah.farrell@dumgal.gov.uk
Scottish Borders Council	housingenquiries@scotborders.gov.uk

DISTRICT HEAT NETWORKS

The following pages introduce seven District Heat Network opportunities across some of the larger urban areas in the South of Scotland, initially identified in each Council's Local Heat and Energy Efficiency Strategy (Shared Heat Collector Network opportunities are presented from page 35 onwards). The opportunities are presented in approximate order of their level of development maturity, with the most developed opportunities (those for which feasibility work has been completed) first:

Dumfries and Galloway	Scottish Borders
The Crichton Quarter, Dumfries Dumfries Town Centre Stranraer	Darnick and Surrounds Galashiels Peebles Hawick

With two District Heat Network opportunities in Dumfries, joined by a Shared Heat Collector Network opportunity at the Midsteeple Quarter, there could be scope in the medium to long term to join these networks to form a larger interconnected system. This is briefly presented in a section dedicated to a Dumfries Heat Network Corridor on page 33.

Each opportunity page features a description of the location's geographic, economic and social context; justification of why a heat network is being suggested or developed in this location; and details of the heat network concept including a map of possible connected buildings and main pipe routes. A capital cost estimate is included, along with a statement on expansion potential.

Note on interpretation
Symbols are used to highlight the key features that differentiate each opportunity:

	Level of project development: 1 pre-feasibility assessment only 2 feasibility study completed 3 further developed post-feasibility 4 commercialisation, construction and beyond
	Location, e.g. Town centre, outskirts, campus, centred on anchor loads
	Heat source, e.g. water source, ground source, air source, data centre, industrial waste heat

Heat sources identified refer to those which would generate the majority of the energy distributed by the network over the course of a year. In all instances, backup plant of a different type would also be installed in order to provide resilience and potentially to supplement the named sources during times of exceptionally high heat demand.

To the best of the authors' knowledge at the time of writing, the buildings that are named as possibly being able to connect to a District Heat Network, including "potential anchor loads", are expected to continue to be used in a manner similar to their present use. However, future changes of use and status could occur, which might increase or decrease the amount of heat needed by those buildings.

If they had been developed in 2025, the schemes could have been eligible for grant funding from the Scottish Government's Heat Network Fund, which supports the deployment of low and zero-carbon heat networks. Although the scheme is currently only open to projects that can be commissioned before March 2026, the Scottish Government is likely to continue their financial and technical support to heat networks in some form in the future.

A similar situation exists with funding for the decarbonisation of social housing, which has to date included support for heat networks serving socially rented homes but is not confirmed beyond 2026. Some funds that target households at risk of fuel poverty, such as Warmer Homes Scotland might be applicable in certain circumstances.

Depending on project specifics, additional financial support may be available through the Green Heat Innovation Support Programme, the Social Housing Net-zero Heat fund or the Public Sector Heat Decarbonisation Fund (the former temporarily closed at the time of writing).

Maps
Information on the maps and plans that follow in this section is directly reproduced from digital and other material from different sources. Minor discrepancies may therefore occur.

For the avoidance of doubt:

1. The maps and plans should be used for identification purposes only.
2. The Natural Power Consultants Limited accepts no responsibility for the accuracy of data supplied by third parties.
3. The Natural Power Consultants Limited accepts no liability for any use which is made of this plan by a party other than its client. No third party who gains access to this plan shall have any claim against The Natural Power Consultants Limited in respect of its contents.

The Crichton Quarter Energy Network

Dumfries and Galloway

Project development | Campus (multiple uses) | Multiple heat sources

The Crichton Trust is the lead partner in a public/social partnership that is progressing feasibility work for a new energy network. This network could potentially supply heat to buildings on the Crichton Estate as well as neighbouring properties. Promising hydrogeological investigations suggest that open loop ground heat collectors could meet a major portion of the demand.

Photo credit: The Crichton

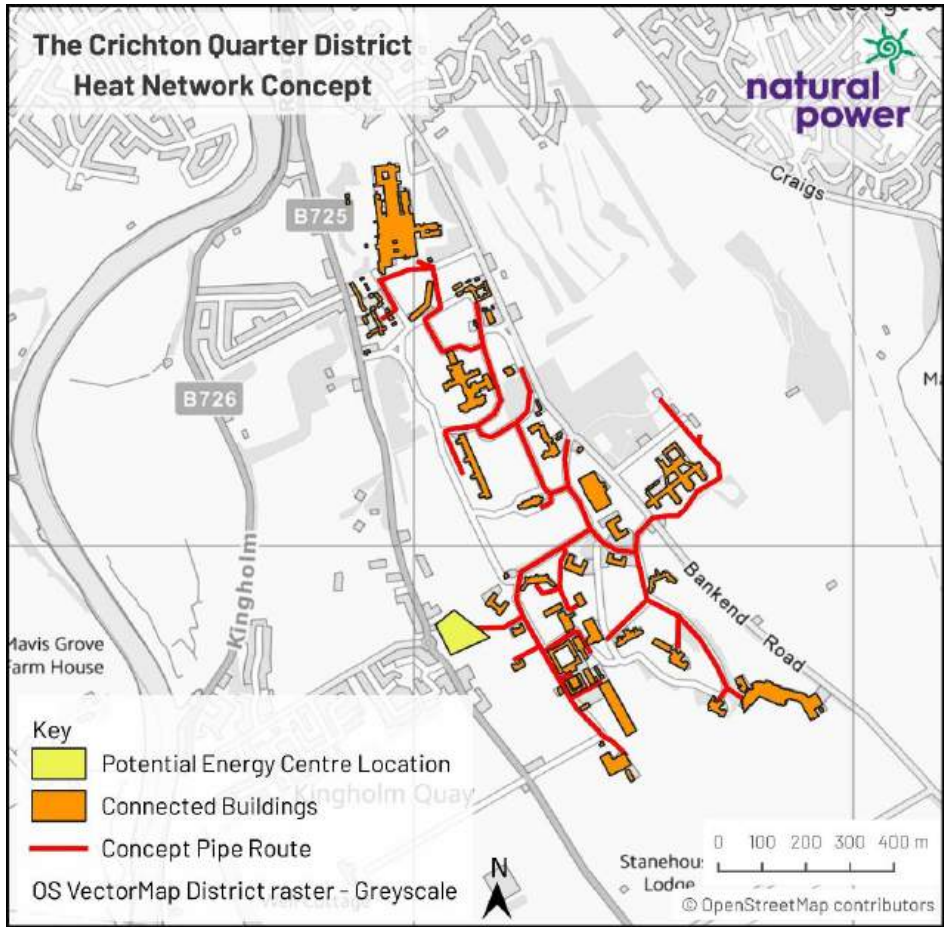
The Crichton Estate is a 34-hectare parkland estate located on the southern edge of Dumfries. There are 27 diverse buildings on the estate which are home to over 160 SME businesses and two universities. Buildings include a church, a 3-star hotel, a restaurant and bar as well as offices and other workplaces.

The Crichton Trust, who owns, manages and develops the estate, has been progressing a heat network opportunity in the wider area of the Crichton Quarter (approximately 80 hectares) which also encompasses nearby NHS buildings (four large healthcare centres and hospitals), a planned 5-star hotel, Dumfries and Galloway College and adjacent residential communities.

Feasibility work in support of the heat network project has been undertaken, investigating several options in terms of which buildings and low carbon heat sources could be connected, phasing of development over time, and how other energy system components could be symbiotically developed. The remainder of this page presents the most likely first phase of development.

Trial boreholes were constructed in 2022/23 to investigate the productivity of the Dumfries Basin Aquifer that lies beneath The Crichton. The hydrogeological assessment established the open loop boreholes' expected minimum productivity. The temperature of the water, extracted from 145 metres below ground level, was about 10.5°C. The implied capacity of the borehole pair was between 210 and 350 kW. Geological experts suggest that warmer temperatures may exist at deeper depths.

Open loop ground source heat extraction is likely to be combined with other waste heat sources for the first phase of heat network development at the Crichton Quarter. Air source heat pumps, heat recovery from data centres and other innovative heat generation solutions are being considered, while electric and hydrogen boiler plant could provide additional backup for resilience. A proportion of the site's electricity demand could be met from a new, dedicated solar farm contributing to The Crichton's long-term vision for energy sustainability. The Crichton has been engaging with the Distribution Network Operator to explore the implications of a significant increase in power demand at the campus.



Number of potential connections
36 (100% non-domestic)

Largest potential anchor loads
Easterbrook Hall, Pool and Spa
Multiple NHS buildings
D&G College

Annual heat supplied
16,000 MWh (initially 22,000 MWh, reducing as energy efficiency improves)

Heat supply capacity
10 MW (initially)

Potential heat sources
Ground + air source heat pumps, waste heat recovery

Costs, revenues and financial performance: The estimated capital cost for the District Heat Network is £20-£24M (with the total cost for the energy network, including microgrid, solar PV and energy storage, being estimated to be £30-34M). The network financial model has been designed to offer heat tariffs that are cost-competitive with heating from a gas boiler, taking into account all operational and equipment replacement costs that would be incurred by the heat network, and assuming that capital grants are able to support some of the design and build cost.

Expansion potential: High. Feasibility studies have considered supplying new housing developments in future phases, and it could also be possible to offer connections to existing housing – potentially almost doubling the amount of heat supplied via the network. In the longer term, there may be opportunities to interconnect with other planned heat networks in Dumfries, as described in the section *Dumfries Heat Network Corridor* on page 33.

Dumfries Town Centre District Heat Network

Dumfries and Galloway

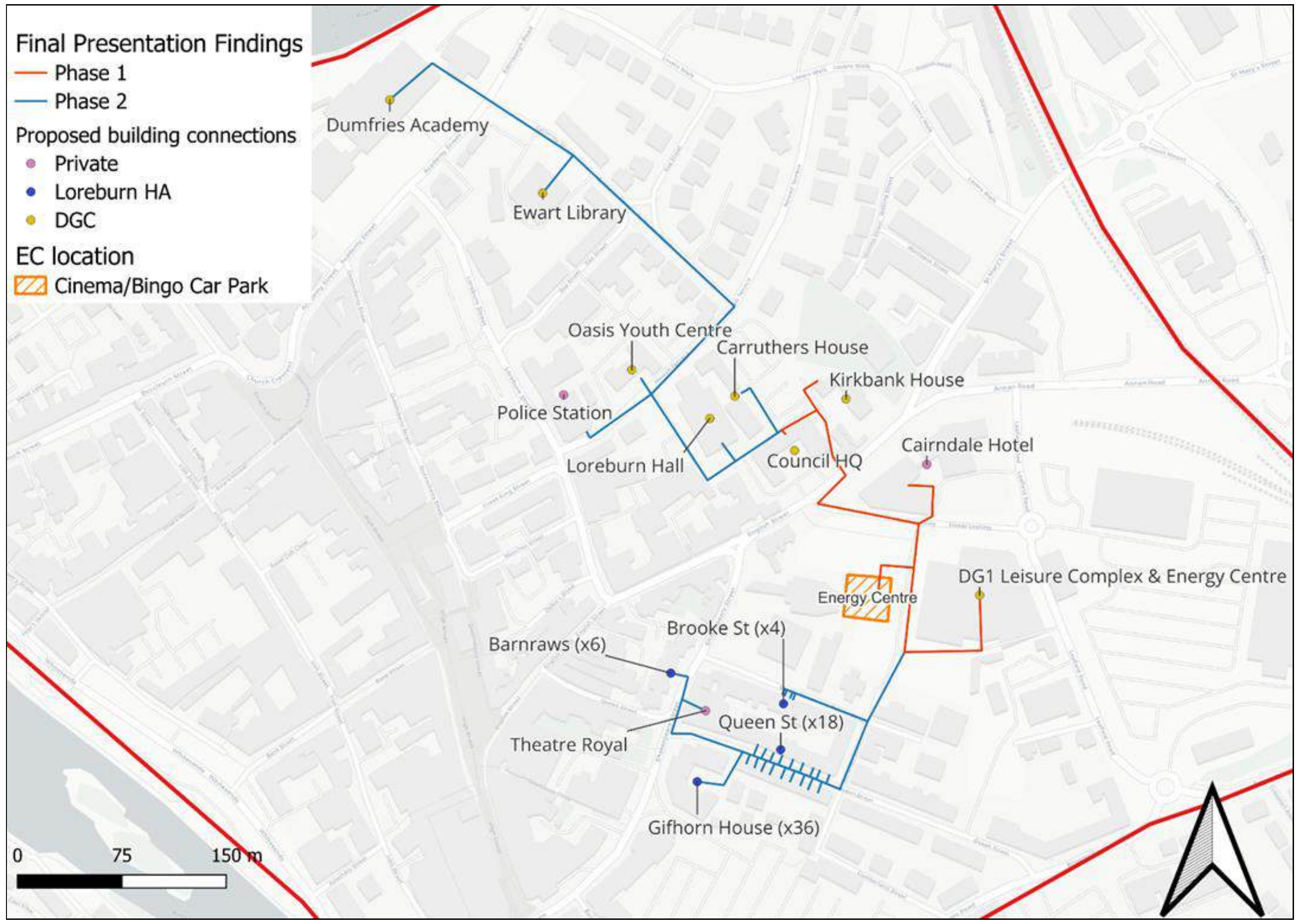
Project development | Town centre | Multiple heat sources

A Feasibility Study has recently concluded that a District Heat Network in Dumfries Town Centre could be economically viable, especially if a potential data centre development goes ahead and is able to supply low-carbon waste heat to the network.

Dumfries is the largest town in the South of Scotland, with an urban centre that is home to key local authority-owned buildings such as the DG1 Leisure Centre, Dumfries Academy and the Dumfries and Galloway Council Headquarters. Several other large public and private sector buildings exist along the path of a line drawn between the northernmost Council building (the Academy) and the leisure complex. There are also a large number of socially rented homes in the vicinity of the leisure centre, managed by a single owner (Loreburn Housing Association). Close to these is the Theatre Royal, the oldest working theatre in Scotland.

A data centre is being considered for development on a potentially vacant open space close to the leisure centre. This facility could be a source of significant quantities of waste heat which could be used and distributed to heat customers through a District Heat Network. The modern types of data centre being deployed most widely in dense urban areas are 'immersion cooled' facilities, which can reject their surplus heat at a valuable 45 to 60 degrees centigrade. By comparison to the 30 to 45 degrees available from older data centres, this waste heat can be much more efficiently "upgraded" to the operating temperature of a District Heat Network. It may also be possible for the network to operate at the same temperature as the waste heat. However, in Dumfries Town Centre some buildings that could connect to a District Heat Network currently need upwards of 80 degrees centigrade, which means that a heat pump will be required to boost the temperature for them until their internal systems can be adapted for lower temperature operation.

A Feasibility Study has recently been completed on behalf of Dumfries and Galloway Council, establishing the group of buildings that could be served by an initial phase of a District Heat Network, and those that could be connected in a later phase. The Study has involved engaging with some of the owners of key non-Council buildings such as the Cairndale Hotel and the Police Scotland building. Various heat supply options were modelled. The Study found that whether or not data centre waste heat forms the foundation of supply for a District Heat Network in Dumfries, one or more other types of heat generation plant will be required to provide full resilience and back up. Possible technologies include large air source heat pumps.



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Number of potential connections	64 Domestic 11 Non-Domestic
Largest potential anchor loads	DG1 Leisure Complex Cairndale Hotel Dumfries Academy
Annual heat demand	7,000 MWh
Heat supply capacity	5.2 MW
Potential heat sources	Data centre heat recovery + air source heat pumps
Estimated capital cost	£12.6M

Expansion potential: High. The blue network elements shown on the map represent a second phase of build out of the District Heat Network, and there are many other surrounding buildings that could be considered for further expansion. In the longer term, there may be opportunities to interconnect with other planned heat networks in the town, as described in the section *Dumfries Heat Network Corridor* on page 33.

Stranraer District Heat Network

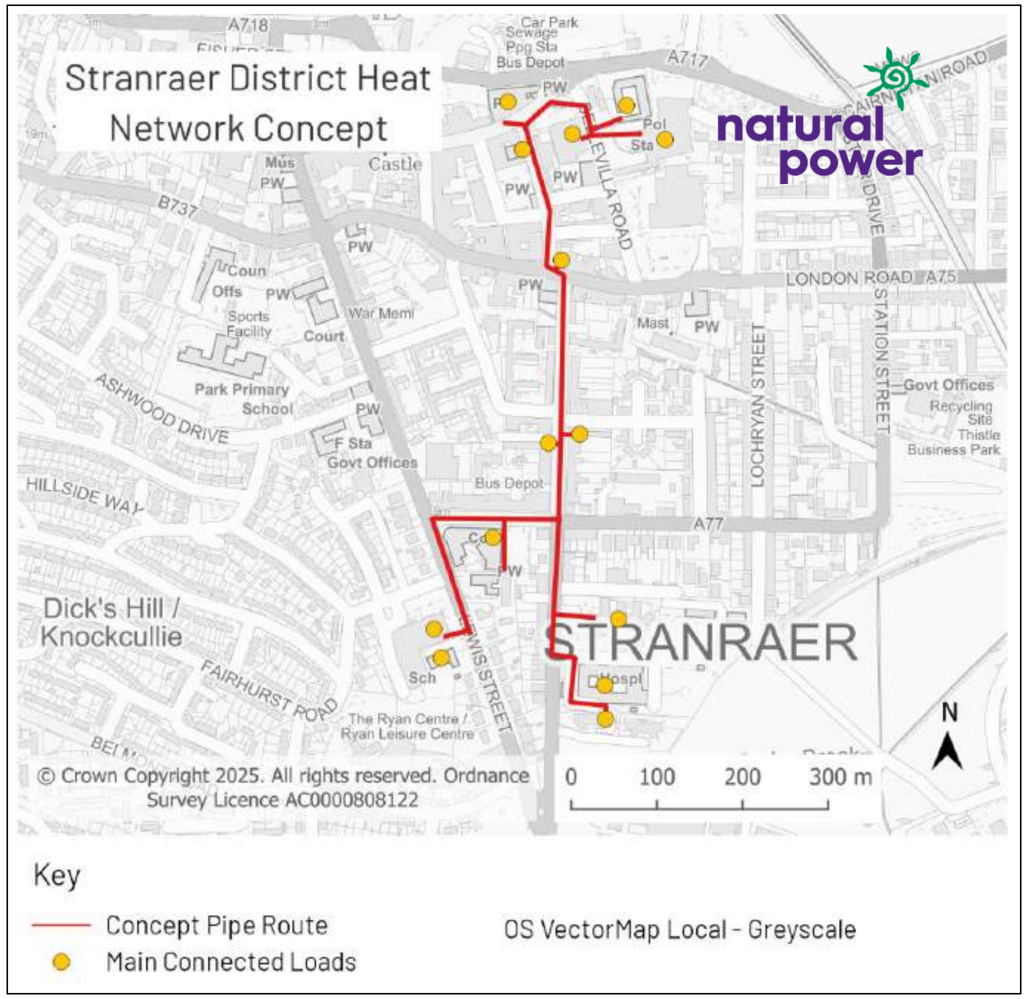
Project development | Town centre & outskirts | Multiple heat sources

In Stranraer, large heat users at either end of a north-south spine could share a low-carbon heat supply, with smaller consumers on and around Dalrymple Street also offered a connection. Waste heat from a cheesemaking factory or marine source heat could complement ground or air source heat pumps to power the network.

Located on Loch Ryan, Stranraer is close to the ferry port that connects Scotland with Northern Ireland. Industries associated with the ferry port as well as tourism are major contributors to the local economy. The town is also home to a large-scale creamery (the Caledonian Cheese Company Limited) and a cheese packing facility (McLelland Cheese Packing Limited), both operated by the Lactalis Group. The Waterfront has been, and continues to be, a focal point for regeneration.

Key services located in Stranraer serve both the town and a wider rural area; this includes the Galloway Community Hospital and a branch of the Dumfries and Galloway College. The town's population is a little over 10,000.

Several processes that generate waste heat are carried out on the Lactalis site. The company has undertaken various studies of heat use and waste heat production, with further work ongoing to understand where and how much heat could be available for repurposing. The temperature of the waste heat will depend on the process from which it arises, but could be as high as 80 - 100°C from some sources – while waste heat that is currently dissipated to the atmosphere in cooling towers might only be at 45°C. Higher-temperature waste heat could be directly supplied to a heat network via a heat exchanger, while lower-grade thermal energy would require a 'booster' heat pump to elevate the temperature to match the operating temperature of the network.



Number of potential connections
40 - 150 domestic 50 non-domestic

Largest potential anchor loads
North West Castle Hotel Galloway Community Hospital Ryan Leisure Centre

Annual heat supplied
7,000 MWh

Heat supply capacity
2 MW

Potential heat sources
Industrial waste heat + ground or air source heat pumps

The largest heat consumers in the town are located at either end of a north-south line that starts at the southern end of Dalrymple Street with the Galloway Community Hospital, Waverley Medical Centre and nearby Ryan Leisure Centre, and runs north towards the waterfront and the North West Castle Hotel. Although the distance between the southern and northern anchor loads is several hundred metres, the magnitude of the heat demands could justify their interconnection.

If waste heat from the Lactalis site is made available to the network, the energy centre could be located at the southern end of the network where there is also open space that could host ground heat collection infrastructure or large air source heat pumps. Marine source heat could also be an option at the northern end of the network, although the tidal nature and silty water of Loch Ryan may complicate design and operation.

Estimated capital cost: £9M, including heat generation plant, energy centre building, trenched distribution network, customer connections and the design, planning and commercialisation costs necessary to realise the project.

Expansion potential: High. Regeneration around the Waterfront would provide good opportunities for new and refurbished buildings to connect to the heat network, potentially matched by new heat generation from a marine source heat pump. The industrial area to the south of the Hospital could also be considered for a later phase of expansion.

Darnick & Surrounds District Heat Network

Scottish Borders

Project development | Anchor load-led | Multiple heat sources

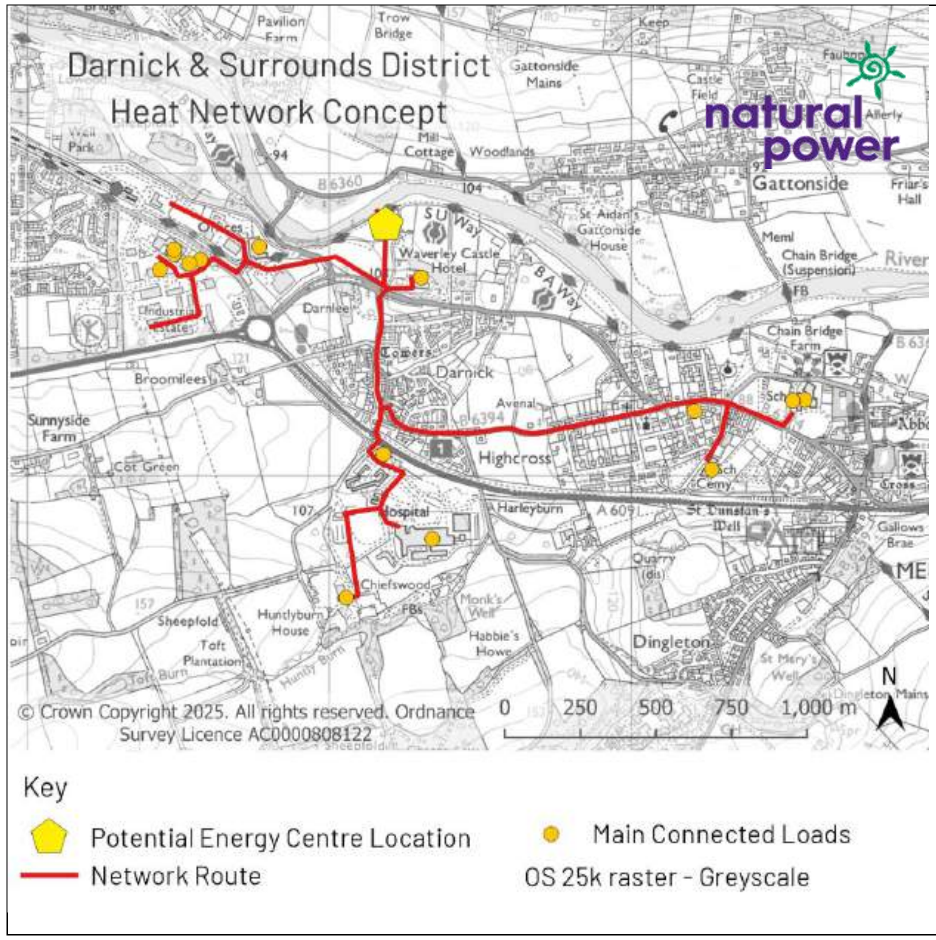
The Borders General Hospital is a heat-intensive facility that could 'anchor' a District Heat Network spanning three neighbouring settlements and, potentially, a major new mixed-use development.

Three settlements line the southern bank of the River Tweed to the east of Galashiels. Furthest upstream is Tweedbank, with its late-20th century housing, public services, sporting facilities and industrial estate (the largest in the region). To the east is the much older village of Darnick, which contains many 19th century and older buildings as well as more recent developments. Further downstream again is the larger town of Melrose, the western half of which (the nearest to Darnick) consists of housing of various ages, two primary schools and a rugby club. Areas of undulating farmland and parkland divide these three settlements.

To the south of Darnick is the Borders General Hospital, which opened in 1988 and caters to the healthcare needs of a large proportion of the Scottish Borders. The hospital boasts a range of medical services, including emergency care, general surgery, and palliative care. As a facility with a very large heat demand, the hospital could be a key anchor load for a District Heat Network. Meanwhile, north of Darnick is a substantial tract of land where mixed-use development is being progressed by Scottish Borders Council. This site, known as Tweedbank Expansion, will feature several hundred new dwellings as well as a residential care home and business units. More detail on the Tweedbank Expansion is available on page 49 in the Shared Heat Collector Networks section of this Prospectus.

In addition to the Borders General Hospital, the presence of a dozen or so other significant heat demands in the 'T' shape formed by eastern Tweedbank, Darnick and western Melrose creates an opportunity for a District Heat Network spanning the three settlements. There is potential to also supply properties on the new Tweedbank Expansion development.

Photo credit: © **M J Richardson** (cc-by-sa/2.0) / Cropped from original



Number of potential connections
66 (100% non-domestic)

Largest potential anchor loads
Borders General Hospital Waverley Castle Hotel Melrose Rugby Football Club

Annual heat supplied
20,000 MWh

Heat supply capacity
6 MW

Potential heat sources
River source + ground source heat pumps

If the network developed at Tweedbank Expansion is a Shared Heat Collector Network (as presented elsewhere in this Prospectus), the different operating temperatures of the two systems might limit how heat could be shared between them – although there could still be benefits to doing so. However, if the network at Tweedbank Expansion is designed as a District Heat Network, direct hydraulic connection (with the Tweedbank Expansion network delivered as part of the wider scheme) could be possible.

A river source heat pump could provide the majority of the network's heat demand. An initial review of the flow rate of The River Tweed suggests that the river will have sufficient capacity in both summer and wintertime. There are also promising options for a secondary low-carbon heat source – such as a ground source heat collector utilising the green space around the hospital – that could increase the security of the heat supply, and potentially reduce the amount of energy that would be transported along the north-south 'spine' of the network.

Estimated capital cost: £16M-£18M to develop river water heat collector system, heat generation plant, energy centre, distribution system and establish building connections.

Expansion potential: High. There are opportunities to connect to further non-domestic loads in Melrose. As a longer-term ambition, this potential District Heat Network could eventually interconnect with the existing heat network serving the Borders College campus to the west (and itself possibly extended to new education facilities and other buildings). Domestic loads could also connect to the District Heat Network where they are close to pipe routes.

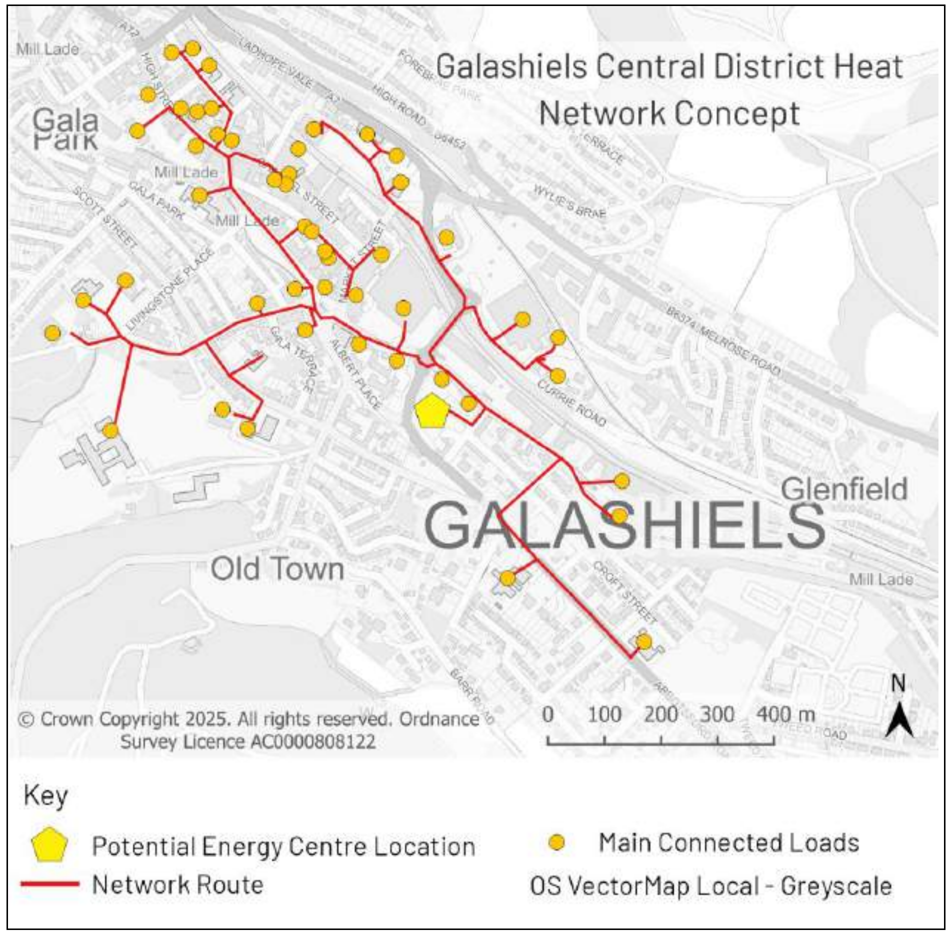
Galashiels Central District Heat Network

Scottish Borders

Project development Town centre Multiple heat sources

In the centre of Galashiels, a District Heat Network combining several heat sources (river, wastewater and/or air source heat pumps) could supply a mix of public and private non-domestic buildings.

The 'town centre' of Galashiels includes the High Street and other main shopping streets. Surrounding this historic commercial district are several public buildings that use significant amounts of heat: several schools, a care home, a library, a health centre and emergency services headquarters. There are also 10-15 large retail park-style premises, including supermarkets. The Gala Water flows along the northern edge of the town centre, with the Borders Railway beyond roughly following the line of the river through the steep-sided valley.



Number of potential connections	49 (100% non-domestic)
Largest potential anchor loads	Galashiels Academy Swimming Pool Residential Home
Annual heat supplied	15,000 MWh
Heat supply capacity	5 MW
Potential heat sources	River source heat pump + wastewater source heat pump + air source heat pump

The proposed District Heat Network scheme in central Galashiels aims to provide low carbon heating to a diverse mix of 49 non-domestic buildings under a mix of public and private ownership. These buildings include emergency services, schools, leisure facilities, commercial spaces and industrial loads, with a total annual heat demand of approximately 15,000 MWh.

Key anchor loads for the scheme would be Galashiels Academy (following its rebuild, which will incorporate a new swimming facility to replace the existing Galashiels Swimming Pool) and Waverley Residential Home. Other significant loads include large supermarkets and retailers and Abbotsford Mill (although accurate energy consumption figures for the latter have yet to be confirmed at this stage). Emerging or potential developments such as the new accommodation and retail space that are planned for the town could be connected to the District Heat Network once they are built.

The network would require around 5.6 km of trenching to install the distribution pipework, with the preferred route taking advantage of the limited soft-dig areas such as Scott Park wherever available in order to reduce costs.

A river source heat pump could provide 'baseload' heat generation, supplying a fairly steady amount year-round. An initial review of the flow rate of the Gala Water suggests that the river may not have sufficient capacity to supply the higher demand that will occur in wintertime. A second low-carbon heat source could supply the shortfall, potentially supplemented by peak-shaving thermal storage and/or electric boiler plant. Promising secondary low-carbon heat sources include a wastewater heat pump using the major sewer pipeline that runs close to the river and parallel to Croft Street, and large air source heat pumps located in open space or on the roof of a large building.

A primary challenge would be securing a strategically located energy centre within the relatively dense urban environment, where land availability is limited. Similarly, installing pipework along major roads, particularly the High Street, poses logistical and economic challenges, requiring a balance between minimising disruption while ensuring efficient routing.

Estimated capital cost: £11-13M to develop river water and wastewater heat collectors, heat generation plant, energy centre, distribution system and establish building connections.

Peebles District Heat Network

Scottish Borders

Project development | Town centre | Water source (river)

A Peebles District Heat Network could connect key anchor loads such as the Peebles Hydro Hotel and Hay Lodge Hospital in a system that would supply over 100 domestic and non-domestic demands. Heat could be generated from the River Tweed and supplemented by ground or air source heat pumps.

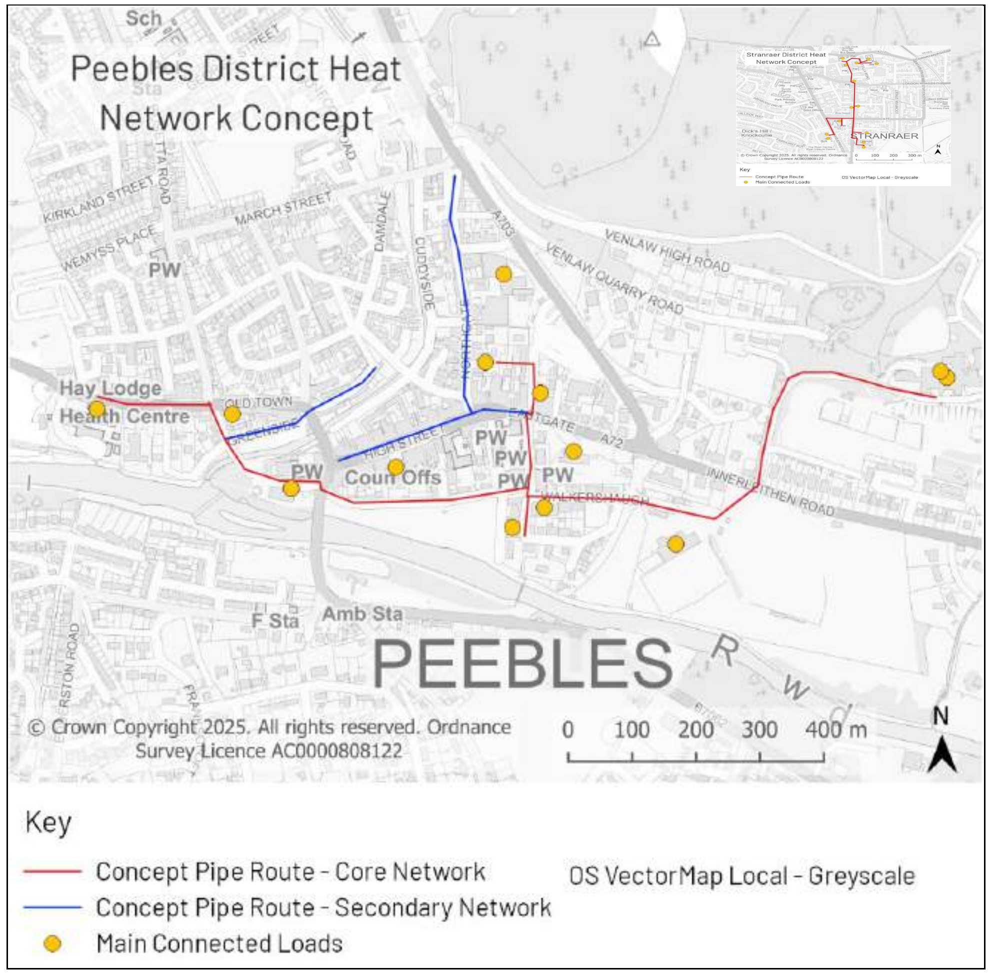
Peebles boasts a rich heritage, featuring a historic core area designated as a Conservation Area and roots tracing back to a past rooted in textile manufacturing. The market town serves as a services hub for individuals residing in the surrounding rural areas of Tweeddale as well as its approximately 9,100 residents. In recent years, the town has embarked on regeneration efforts, such as the redevelopment of the former March Street Mill into residential and commercial spaces. A new Town Action Plan[7] was completed in 2024, outlining projects across various themes, including sustainable growth, business and creative industries and wellbeing.

The River Tweed could be an important source of renewable heat, with a desk review suggesting that the depth and flow rate are favourable for supporting a large river source heat pump. River source heat pumps of this type require a certain quantity of water to be diverted from the river, passed through a filtration system and heat exchanger, and returned to the river a few degrees colder than at the intake.

A District Heat Network in Peebles could take the bulk of its heat from the river, being supplemented if required by ground or air source heat pumps. Electric boiler plant would provide backup.

The District Heat Network could supply several anchor loads including the Peebles Hydro Hotel and Hay Lodge Hospital, as well as serving some intermediate smaller commercial properties and selected domestic properties (most likely social housing close to the network pipe routes). The good density of heat demand around the town centre suggests that a District Heat Network could be financially viable while offering low-carbon heat at an affordable price, although this would be strongly influenced by the eventual build and operating costs of the scheme.

There are also several streets with relatively dense heat demand and a high proportion of buildings that are Listed and/or are heritage buildings within a Conservation Area. The heat network may be able to supply these additional connections through the inclusion of some 'secondary' branches whose revenue generation and carbon-saving potential justifies the additional pipework and trenching costs.



Number of potential connections
32 Domestic 89 Non-Domestic

Largest potential anchor loads
Peebles Hydro Hotel Hay Lodge Hospital Retail and commercial

Annual heat supplied
12,000 MWh

Heat supply capacity
4.5 MW

Potential heat sources
River source + ground source heat pumps

Estimated capital cost: £12-14M, including heat collectors and heat generation plant, energy centre building, trenched distribution network, customer connections and the design, planning and commercialisation costs necessary to realise the project.

Expansion potential: High. The red network route shown in the map connects the main anchor loads in the Peebles area. The additional 'secondary' blue network spurs could further extend the District Heat Network to provide additional benefit to the local area.

Hawick District Heat Network

Scottish Borders

Project development | Town centre | Multiple heat sources

Hawick town centre could sustain a low carbon District Heat Network with key loads such as the Borders College, Hawick High School and Hawick Community Hospital forming the main spine of a network. Ground source heat pumps, supplemented with air source heat pumps could power the network.

The market town of Hawick has a population of some 14,000 people and hosts essential services for several thousand more people who live across a large and otherwise rural area. Hawick is home to a high school and several primary schools; a community hospital and GP practice; and care facilities, churches and social services. The town's heritage includes a historic core (a Conservation Area), and reminders of an industrial past based around textile manufacture. Regeneration achievements to date include the development of business facilities and industrial units and the expansion of the Borders College's Hawick campus. A new Place Plan[8] was completed in 2024, incorporating projects across themes that include tourism, town centre living and leisure.

A District Heat Network in Hawick could connect some of the largest heat consumers in the town, including the High School. There could also be scope to extend supply to some of the heritage buildings (both homes and businesses) that may have fewer choices for decarbonising their heating compared to unlisted buildings and those outside Conservation Areas.

The Borders Distillery could be a different type of customer: although distilleries typically need higher temperatures for their processes than District Heat Networks can usually supply, some distilleries are considering investing in specialised high temperature heat pumps that are able to upgrade heat from 90°C to 120°C. This may allow them to obtain at least a proportion of the heat they need from District Heat Networks.

A ground source heat pump system could provide the majority of the required heat generation. Green space around the High School could be a suitable location for ground heat collectors. An air source heat pump could provide a secondary heat source for peak demand times during the winter, potentially supplemented by thermal storage and/or electric boiler plant.

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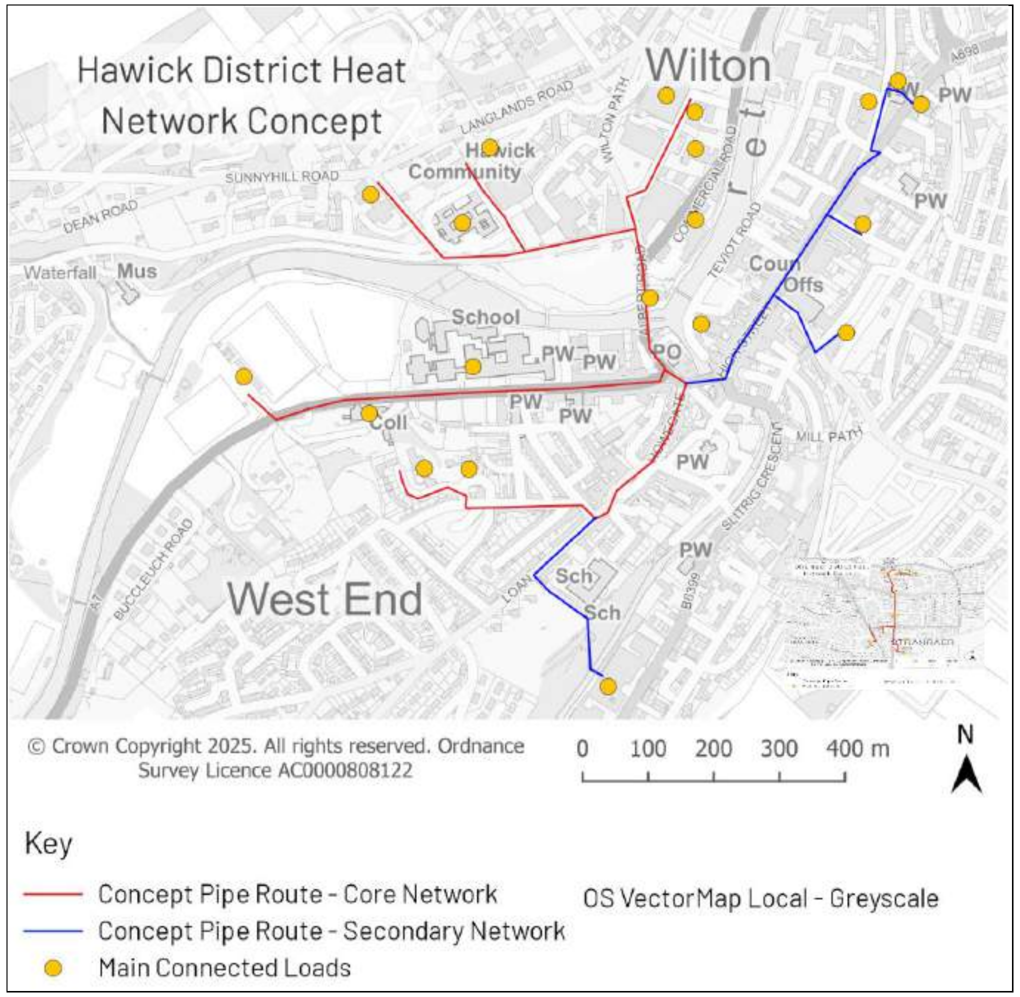
A desktop review of the flow rate of the River Teviot suggests that it is unlikely to have sufficient capacity to supply more than a minor fraction of the heat demand of the network presented here. Although river source heat remains an option, further investigation is required to establish feasibility.

A further low-carbon heat source opportunity at Hawick wastewater treatment plant has been assessed, but was deemed too small to make a significant contribution to the heat network's overall requirements and unlikely to be economic compared to ground and air source heat generation.



Number of potential connections
108 Domestic 128-400+ non-Domestic

Largest potential anchor loads
Hawick High School Borders Distillery (partial) Retail and commercial

Annual heat supplied
13,000 MWh

Heat supply capacity
4 MW

Potential heat sources
Ground + air source heat pumps

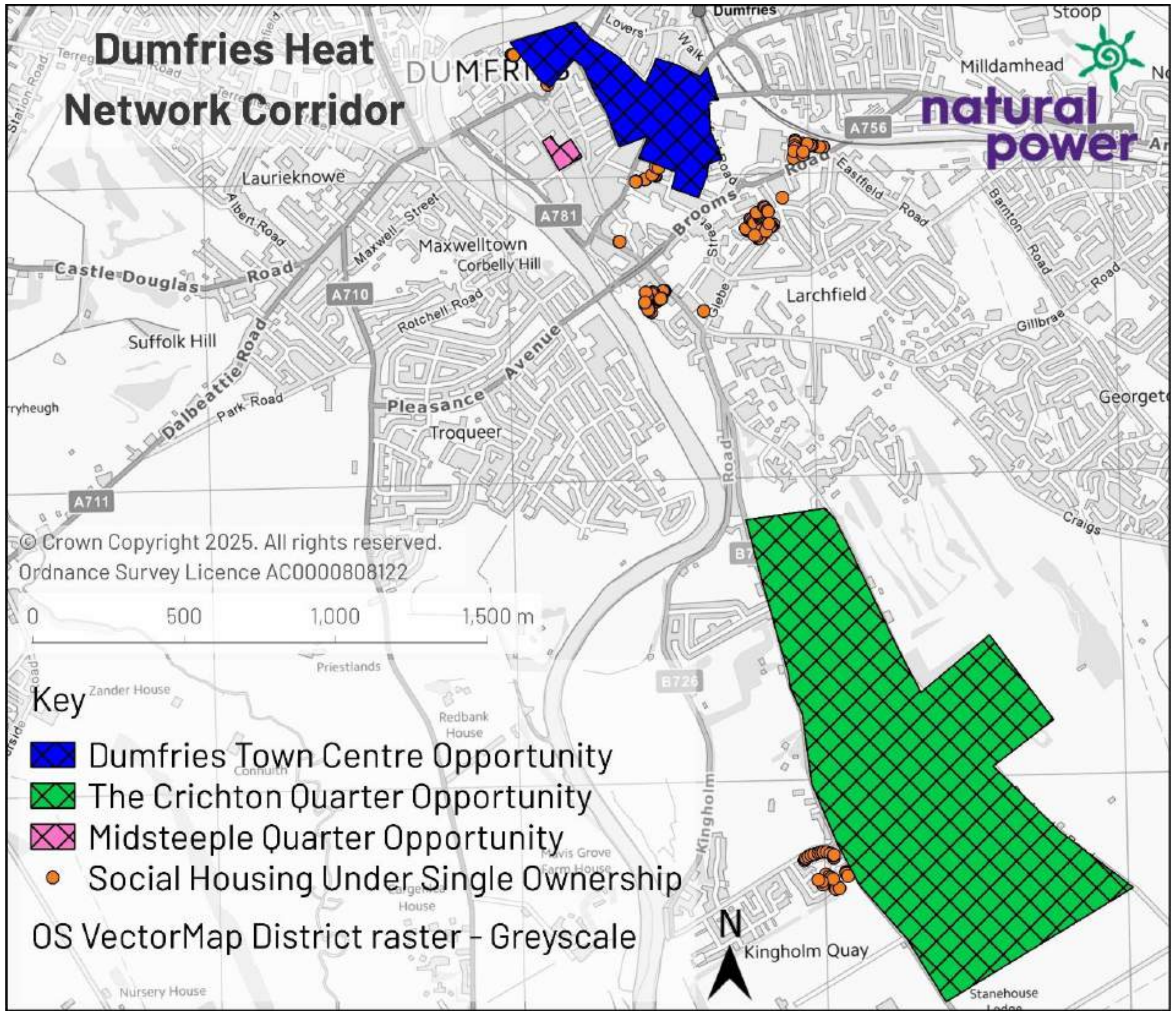
Estimated capital cost: £16-18M, including ground heat collectors and heat generation plant, energy centre building, trenched distribution network, customer connections and the design, planning and commercialisation costs necessary to realise the project. The Core Network outlined in red in the diagram could be developed as a first phase.

Futureproofing: The High School represents around a fifth of the heat demand on the network, so its future consumption is key to the long-term viability of the scheme. Although the High School is likely to be rebuilt in the medium term (to modern building performance standards), the increased floor area and planned incorporation of other community services means that the heat load is expected to increase rather than decrease. This, coupled with the likely phased nature of a school rebuild, means that demand risk associated with the High School is not especially high.

Dumfries Heat Network Corridor

Two District Heat Networks in Dumfries are at an advanced stage of feasibility assessment, while smaller opportunities have been identified in the area in between them. In the medium to long term, interconnection and energy sharing between networks could create a 'Heat Network Corridor'.

Feasibility studies have been completed for two separate potential District Heat Networks in Dumfries: Dumfries Town Centre (featured on page 21) and The Crichton Quarter (page 23). The organisations which are leading on the development of these opportunities have identified that future expansions could facilitate some kind of energy-sharing relationship. There are significant numbers of social housing properties that are owned by the same organisation between the large District Heat Networks, raising the possibility that these homes could also be connected.



SHARED HEAT COLLECTOR OPPORTUNITIES

The following pages introduce twelve Shared Heat Collector Network opportunities in villages and towns across the South of Scotland. These opportunities test and present the types of network that could be possible, selected to demonstrate the diversity of opportunities available as well as the quality of individual opportunities. In many cases, the locations stated serve simply as examples, and similar schemes would be possible to develop across other sites in the region.

Scottish Borders	Dumfries and Galloway
Heat in a rural local energy system, **Smailholm**	Rural community heat scheme, **Crossmichael**
Village heat and retrofit scheme, **Swinton**	Socially rented flats, **Langholm**
Retrofit Shared Ground Loop for flats, **Galashiels**	Planned housing development at **Halcrow**
Planned housing development at **Tweedbank**	Community minewater heat scheme, **Kelloholm**
Business Centre heat scheme, **Selkirk**	Low carbon town centre regeneration, **Midsteeple Quarter, Dumfries**
	Public buildings cluster, **Annan**
	Waste heat distribution network, **Lockerbie**

Note on interpretation
Each opportunity page features a description of the location's geographic, economic and social context; justification of why a heat network is being suggested or developed in this location; and details of the heat network concept. A capital cost estimate is included, along with a statement on expansion potential.

Symbols are used to highlight the key features that differentiate each opportunity:

	Shared Heat Collector Network archetype, e.g. urban neighbourhood, street, block of flats, new development, anchor load-led, heat source-led
	Defining social characteristic, e.g. community-led, partnership delivery, customer social benefit, public sector-led
	Heat network customers are retrofitted properties or new build
	Heat source, e.g. ground source, water source, industrial waste heat

If they had been developed in 2025, the schemes could have been eligible for grant funding from the Scottish Government's Heat Network Fund, which supports the deployment of low and zero-carbon heat networks. Although the scheme is currently only open to projects that can be commissioned before March 2026, the Scottish Government is likely to continue their financial and technical support to heat networks in some form in the future.

A similar situation exists with funding for the decarbonisation of social housing, which has to date included support for heat networks serving socially rented homes but is not confirmed beyond 2026. Some funds that target households at risk of fuel poverty, such as Warmer Homes Scotland might be applicable in certain circumstances.

Maps
Information on the maps and plans that follow in this section is directly reproduced from digital and other material from different sources. Minor discrepancies may therefore occur.

For the avoidance of doubt:
1. The maps and plans should be used for identification purposes only.
2. The Natural Power Consultants Limited accepts no responsibility for the accuracy of data supplied by third parties.
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Rural Community Heat Scheme, Crossmichael

Dumfries and Galloway

Street | Community-led | Retrofit | Water source (Shared Ground Loop))

In Crossmichael, there is an opportunity to decarbonise existing domestic properties with clean heating systems that make use of locally available renewable heat resources, including the River Ken. A water source Shared Heat Collector Network is one potential option.

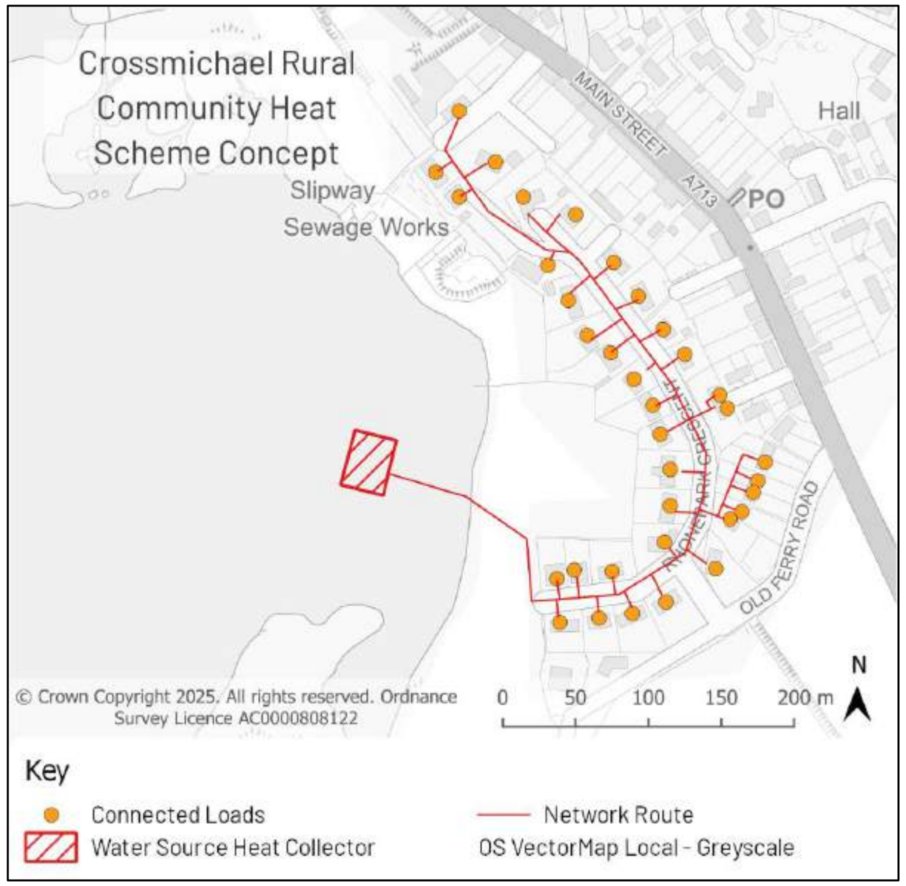
Crossmichael is a picturesque village located in the Glenkens region of Dumfries and Galloway. It is situated on the eastern shore of the River Ken and is steeped in history, with its origins tracing back to early medieval times. The homes and other buildings in Crossmichael exhibit a blend of traditional and modern construction according to their age.

Crossmichael Community Council is keen to support decarbonisation projects in the local area. A separate community organisation, Glenkens Community Arts Trust, is championing the delivery of the Glenkens & District Community Action Plan, which includes a local decarbonisation element. Crossmichael is prone to flooding and therefore the Community Council is keen to see any projects support flooding mitigation measures. In developing a potential future project, both organisations agree that it is essential that people within the community are appropriately consulted and given an opportunity to shape proposals. Developers, whether from within the community or outside, need to invest in engagement and communication, building interest locally and dealing with concerns.

The scheme presented here, as an example, focuses on supplying the homes on Rhonepark Crescent. The 35 existing domestic properties currently use a variety of heating systems. Crossmichael is not connected to the gas grid and therefore most homes have an oil boiler or an electric heating system. A water source Shared Heat Collector Network would offer a zero-emission solution for as many homes as chose to connect. A water source scheme would cost significantly less than a ground source equivalent.

Closed-loop "pond mats" would be likely to be selected as the technical solution for water heat extraction at this scale. These consist of a long length of plastic pipe that is coiled into flattened loops and fixed to a supporting structure. The pipe contains a mixture of water and a biodegradable and wildlife-safe antifreeze, and leak detection systems can be fitted so that if leaks do occur it is possible to isolate and repair them quickly before significant pollution occurs.

Photo credit: © **Billy McCrorie** (cc-by-sa/2.0) / Cropped from original



Number of potential connections
35 (100% domestic)

Annual heat supplied
600 MWh

Heat supply capacity
400 kW

Heat source
Closed loop pond mats + distributed heat pumps

Pond mats requiring around 1,000m^2 of space in the river, which is several hundred metres wide at this point, would be required to meet the demand from all 35 homes. The pipes would be fixed to a frame that holds them at least 1.2 metres below the surface of the water but keeps them above the riverbed. Although the equipment would only be minimally visible once installed, it would be necessary to locate it in an area where it is acceptable to discourage access by swimmers, boats and watersports, to prevent damage to equipment or risks to people's safety.

Estimated capital cost and funding: £700,000 - £900,000 for the scheme illustrated, including heat pumps and internal works (approx. £23,000 per home). This is over and above costs of any energy efficiency measures required in each property, which would probably be undertaken anyway in the coming years. In addition to government grants that may be available, partial or full funding for the shared infrastructure may be available from heat network developer-installers, who can finance upfront CAPEX if a long-term agreement is in place.

Replicability: Medium. This type of housing is common in the South of Scotland. However, suitable locations for closed loop pond mats close to housing are much more limited. Shared Heat Collector Networks using ground source heat are much more widely replicable.

Expansion potential: High. The adjacent existing housing also mostly features non-renewable heating systems, which will need to be replaced with clean heating systems in the coming decades. The heat supply capacity of the River Ken is vast, although with increasing distance from the water other heat sources such as closed loop boreholes may become more favourable.

Heat in a Rural Local Energy System, Smailholm

Scottish Borders

Street | Community-led | Retrofit | Ground source (Shared Ground Loop)

In Smailholm, a committed group of village residents is developing an ambitious Local Development Plan, including plans for a local energy system that could reduce energy costs and cut carbon. Alongside renewable electricity generation and use, the Smailholm Futures initiative is investigating solutions to decarbonise heating for buildings in the village. Shared Heat Collector Networks could contribute to the community's aspirations, sharing resources for mutual benefit. This model could be widely replicable in other villages across the region.

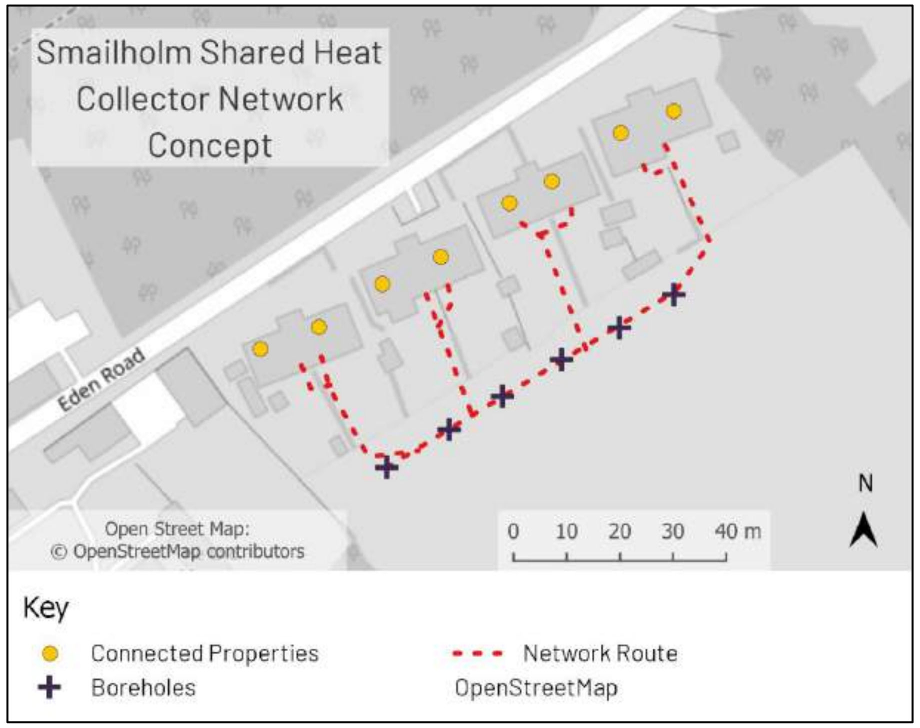
Smailholm is a Borders village with a population of around 120 people. Farmland surrounds a village core, while several clusters of farms and farm cottages near to the village are considered to also be part of the Smailholm community. The village hall is a well-used centre of social and community activity.

Since 2023, volunteers from the community have been progressing a placemaking process with support from the Community Council and Scottish Borders Council. This process has been named "Smailholm Futures". Visioning activities have drawn out several themes which the community feel should be priorities. Energy is one of three priority themes, with progress anticipated across energy efficiency, clean heating (most buildings currently use oil) and local renewable electricity generation and use. While technology options are important considerations, the team is investigating the advantages of community versus individual energy assets, how these might be managed and how blending financing from different types of investors could work.


Photo credit: Ian Malcolm

A heat network could form part of the local energy system being conceptualised through Smailholm Futures. A community-wide scheme could ultimately serve several groupings of buildings, with each cluster served by its own shared ground heat collector, all managed by a single entity as a single system. Small District Heat Networks could also be applicable for properties clustered around farms.

The diagram and key figures below illustrate how a Shared Heat Collector Network could be developed for one potential cluster, a row of eight semi-detached cottages. With landowner agreement, boreholes could be constructed in the pasture behind the cottages. Post-construction, the boreholes would be below the surface and the land could continue to be used for livestock grazing.



Number of potential connections
Up to 8 (100% domestic)

Annual heat supplied
90 MWh

Heat supply capacity
50 kW

Heat source
Closed loop boreholes + ground source heat pumps

Estimated capital cost: £200,000 - £300,000 for the cluster illustrated (around £32,000 per home), including boreholes, groundworks, heat pumps and internal heating system components – although cost savings may be possible where homes have existing wet heating systems that are suitable for re-use. Additional clusters are likely to have higher per-property costs because heat demands are generally higher for buildings elsewhere in the village.

Funding opportunities: Options for financing and benefits sharing arrangements could include bringing together contributions from scheme installer-operators, community shareholders and external investors. These arrangements could cover renewable electricity generation and distribution assets as well as the renewable heat scheme(s).

Replicability: High. Shared Heat Collector Networks could heat many of the other buildings in Smailholm, and are also widely feasible in rural villages and private estates across the region. The funding, ownership and operating models being explored in Smailholm could be replicated in other communities where there is strong buy-in to a Place Plan that features heat decarbonisation.

Village Heat and Retrofit Scheme, Swinton

Scottish Borders

Neighbourhood | Partnership delivery | Retrofit | Ground source (Shared Ground Loop)

In Swinton, heat networks at different scales are being considered alongside energy efficiency retrofit for the village's predominantly pre-1919 building stock. An open space, The Green, could host a borehole heat collector system shared by a fleet of heat pumps in each of the surrounding buildings. This is an arrangement that could be widely replicable in other villages in the region.

In 2024, Scottish Borders Council and Southern Uplands Partnership undertook a Community Retrofit Pilot Project in the village of Swinton. This project contributes to the Council's Local Heat and Energy Efficiency Strategy implementation. Swinton was selected as a location with characteristics that suggest that a small, focused retrofit project could contribute to placemaking and resilience.

The Pilot Project considered solutions for the whole of the community, which comprises more than 120 buildings. Mains gas is not available in Swinton. Although many recently built dwellings have air source heat pumps, the majority of older buildings (many dating from the 18th century) are heated with oil or electric storage heaters. A high proportion of homes are Listed or are in a Conservation Area. For the village's older homes, a high-level assessment suggests that the optimum decarbonisation pathway is likely to involve energy efficiency retrofit works before installation of a heat pump.

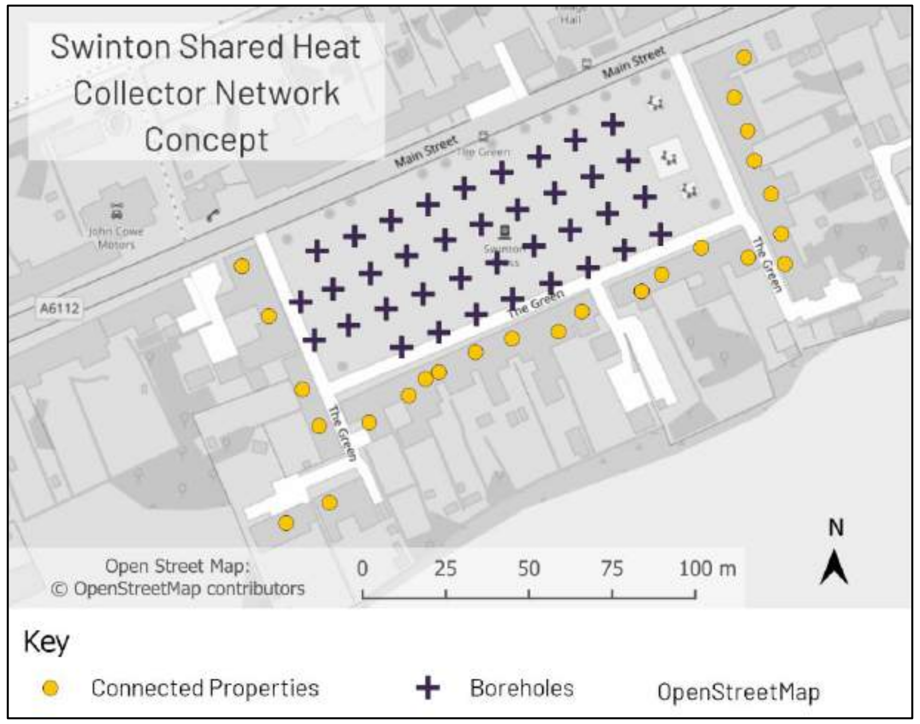
The Pilot Project concluded that either a village-wide District Heat Network, or several clusters of shared-collector heat networks, could be a viable foundation for a coordinated (rather than piecemeal) decarbonisation strategy for the village. A survey of residents found that almost everyone thought that a heat network would need to cost less than they currently spend on heating; be low maintenance; and incorporate good consumer protection.

Photo credit: © **Danieljksn** (cc-by-sa/4.0) / Cropped from original

The village-wide District Heat Network could use centralised ground source heat pumps, heat recovery from the wastewater treatment works, a biomass boiler or a combination of these. This option could be designed to meet the heating requirements of all participating buildings without requiring them to undergo extensive retrofit (although energy efficiency improvements would still help to reduce costs and carbon). A majority of survey respondents found a heat network to be a more attractive prospect if only minimal retrofit was needed.

The second heat network option, a Shared Heat Collector Network serving one or more clusters of buildings, would initially only serve a proportion of the village. However, such a scheme could be easier to deliver, and could be designed to meet more specific needs that apply to the group by virtue of the buildings' age, type of occupant and hyper-local heat resources.

The diagram and key figures below illustrate a Shared Heat Collector Network for the 26 mainly pre-1919 buildings that surround The Green in the village centre. This greenspace is home to the Swinton Cross (a Listed Building), hosts village events and is used for sport and recreation. However, once built, grassed-over boreholes constructed under The Green would not interfere with any of these uses.



Number of potential connections
26 (~90% domestic)

Annual heat supplied
380 MWh

Heat supply capacity
250 kW

Heat source
Closed loop boreholes + distributed ground source heat pumps

Some energy efficiency work is likely to be required in most of the buildings that could connect to this network. The Pilot Project proposed specific energy efficiency measures that could be installed in the traditional row cottages and terraced houses located around The Green, with a cost per property usually ranging between £10,000 and £25,000.

Estimated capital cost: £900,000 - £1.1M for the Shared Heat Collector Network, heat pumps and internal heating systems (around £40,000 per building); £250,000+ for the energy efficiency works that are likely to be recommended before homes can connect to the network.

Replicability: High. The Community Retrofit Pilot Project identified a further 9 villages in the Borders of similar population that are also not on the gas grid[1], with similar villages also existing across Dumfries and Galloway.

Expansion potential: Medium. The Pilot Project identified one additional location for a Shared Heat Collector Network, although the layout of the village suggests that such a scheme could be feasible for other clusters too. A village-wide District Heat Network is also considered to be a viable option.

[1] Morebattle, Borgham, Oxton, Foulden, Eddleston, Bowden, Bonchester Bridge, Lilliesleaf and Paxton.

Socially Rented Flats, Langholm

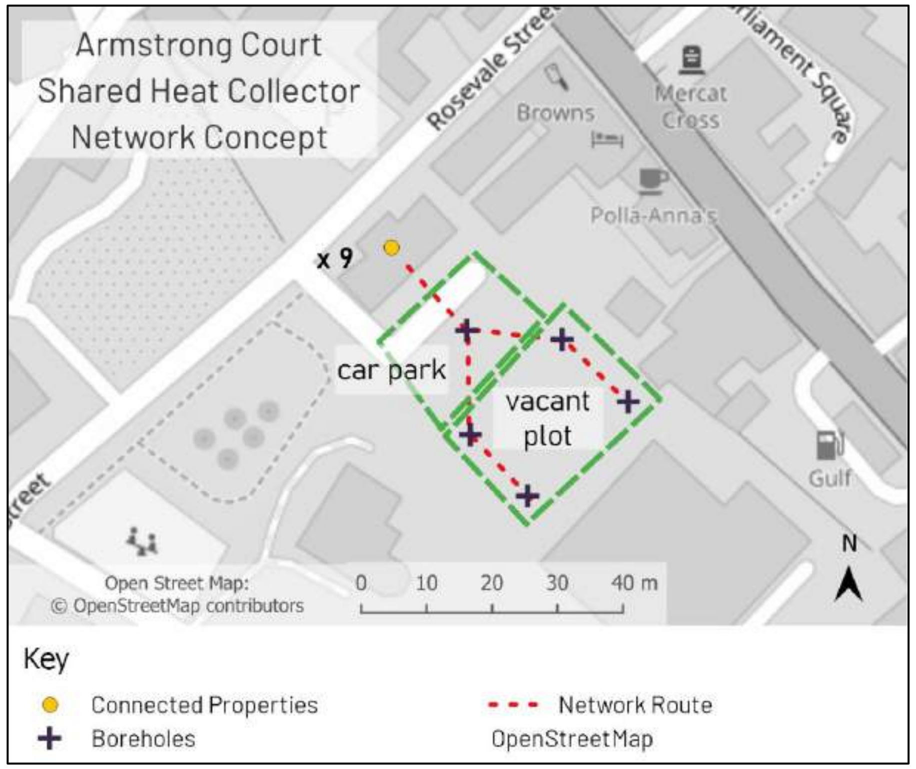
Block of flats | Social impact | Retrofit | Ground source (Shared Ground Loop)

A large Housing Association is undertaking a broad-reaching programme of energy retrofit, targeting homes with a high risk of fuel poverty. An example in Langholm illustrates the potential for Shared Heat Collector Networks to form part of this programme, and the high degree of replicability across the region.

Loreburn Housing Association is delivering a rolling programme of retrofit works across the 2,000+ homes that the organisation lets as social rent across Dumfries and Galloway. These works include improved insulation, solar PV and clean heating systems (either heat pumps or high-retention electric storage heaters). The retrofit programme is targeting the most vulnerable tenants and the least energy-efficient housing first.

Armstrong Court is a block of nine one-bedroom flats built across three storeys. The building is close to the centre of Langholm, and behind the residents' car park is a plot of vacant land also owned by the Housing Association. The flats were built in 1991, and have current EPC energy efficiency ratings of D (top and ground floor flats) and C (middle floor flats). They are heated with electric storage heaters. As part of its programme of retrofitting, the Housing Association is considering installing solar PV, additional loft insulation and either upgrading the storage heaters or installing heat pumps, which could be air source or ground source.

The existence of vacant land behind the flats could make the installation of 4-8 boreholes for a Shared Heat Collector Network relatively straightforward.



Number of potential connections	9 (~100% domestic)
Annual heat supplied	50 MWh
Heat supply capacity	35 kW
Heat source	Closed loop boreholes + distributed ground source heat pumps

Dumfries and Galloway

A Shared Heat Collector Network could reduce tenants' electricity consumption for heating by a factor of between 3 and 5 while delivering the same or better level of comfort than electric storage heaters. The potential energy saving would depend on the equipment selected and the design of the heat emitters (radiators, underfloor heating or alternatives). Heat pumps with wet heating systems are better able to provide the right amount of heating for the comfort of the occupants and the health of the building, especially when weather conditions are changeable.

Flats benefitting from solar PV will at times be able to run heat pumps on free, solar energy. Tenants would pay for the rest of the electricity consumed by the heat pump in their flat as part of their normal electricity billing. In the long term, it is possible that rents may be adjusted in recognition of the considerable cost saving enabled by the connection to the ground source heat network.

Estimated capital cost: £200,000 - £250,000 (around £25,000 per dwelling), including the cost of heat pumps and new wet heating systems for every flat. Electrical upgrades are unlikely to be required, because flats will use less electricity than before both in terms of peak and annual total demand.

Funding opportunities: Partial or full funding for the ground loop infrastructure may be available from heat network developer-installers, who can finance a proportion of the upfront CAPEX if a long-term agreement is in place which includes a standing charge paid by the landlord or tenant. Government grants for heat networks and/or social housing retrofit may also be applicable.

Replicability: High. Loreburn Housing Association owns more than 2,000 homes, many of which will require energy efficiency retrofit and new affordable, clean heating systems over the coming decade. Donald Court in Castle Douglas is one example among many of a location which presents a similar investment opportunity in terms of technical scope, social benefits and likely costs. Other Registered Social Landlords (RSLs) also have a large number of suitable sites, similar investment drivers and access to the same funding streams.

Retrofit Shared Ground Loop for Flats, Galashiels

Scottish Borders

Block of flats | Social impact | Retrofit | Ground source (Shared Ground Loop)

Blocks of flats can have fewer options for clean heating systems due to a lack of outdoor space. Two large blocks in Galashiels have recently benefitted from insulation improvements, and the social landlord owner is considering various options for further addressing fuel poverty. By accessing heat deep below the buildings, a Shared Heat Collector Network could be space-efficient, invisible and quiet.

Scottish Borders Housing Association (SBHA) is the largest social housing provider in the Scottish Borders. The organisation manages and rents out over 5,000 properties across the region, and is committed to providing safe, quality and energy efficient affordable homes. SBHA is investing in energy efficiency improvements through its programme of planned maintenance and upgrades.

In Galashiels, Gala Park and Gala Court are two blocks of flats, between 3 and 5 storeys high, which face each other across their respective courtyards. They are separated by a cul-de-sac road end and car parking spaces. The blocks were constructed in the 1950s, with various improvements having been made in the years since. Most recently, internal wall insulation has been installed in properties across both blocks in order to improve energy efficiency. There are more than 80 flats, the majority of which are socially rented by SBHA. The flats are heated with electric storage heaters.

Number of potential connections
85-90 (100% domestic)

Annual heat supplied
600 MWh

Heat supply capacity
360 kW

Heat source
Closed loop boreholes + distributed ground source heat pumps

SBHA is considering options for replacement heating systems that could reduce residents' expenditure on energy at the same time as improving comfort. A feasibility study has recently been completed by a company specialising in Shared Heat Collector Network installations and ground source heat pumps designed with flats in mind. This found that a Shared Heat Collector Network serving most, or all the flats is technically feasible. The study also concluded that the works may be possible to part-fund through an investment by the installer and/or a third party, who could own the below-ground infrastructure and recoup their investment over a long timescale through a standing charge being levied on the landlord or tenants (or shared between them).

A Shared Heat Collector Network would offer a zero-emission solution, needing 3 to 5 times less electricity to run than electric storage heaters delivering the same level of comfort. Tenants would pay for the electricity consumed by the heat pump in their flat as part of their normal electricity billing.

The 30-40 connected boreholes could be installed underneath the grass and drying areas in the courtyards, under parking spaces and under the road. The density of the flats relative to the modest amount of open space around them poses technical challenges, but solutions exist to overcome them.

For example, in order to generate enough heat to supply all the dwellings, the boreholes would need to be installed to a greater depth than the 200-metre limit that is standard industry practice. The main impacts of this design feature would be a narrowing of the range of firms able to construct the boreholes (deeper drilling is a more specialist task), and the requirement for a different level of permission from the environmental regulator SEPA. However, the scale of this scheme justifies the modest additional cost impact of these factors.

Photo credit: © **Mary and Angus Hogg** (cc-by-sa/2.0) / Cropped from original

Estimated capital cost: £2.0M - £2.5M, including the cost of heat pumps and new wet heating systems for every flat. Electrical upgrades are unlikely to be required, because flats will use less electricity than before both in terms of peak demand and daily or annual total demand.

Replicability: Medium. Blocks of flats of this size are reasonably common in the South of Scotland, and are often majority owned by Registered Social Landlords (RSLs). Suitable ground conditions for closed loop boreholes are near-ubiquitous.

Expansion potential: Modest. More flats exist adjacent to the main Gala Park block, but are accessed from a different cul-de-sac, which could provide space for the boreholes that would be required to serve those flats if a similarly-designed system were to be installed there.

Planned Housing Development at Halcrow, Gretna *Dumfries and Galloway*

New development | Social impact | New build housing | Ground source (Shared Ground Loop)

Shared Heat Collector Networks can be an attractive option for new housing developments. At Halcrow, Gretna, a housing association plans to build 93 new homes which will need to have clean heating systems. A heat network is one potential option among others that will be considered. This model could be replicated wherever new development is taking place in the South of Scotland.

Cunninghame Housing Association (CHA) is an active housebuilder in the South of Scotland, having completed 147 new build homes in 2023/24. The organisation is planning to expand upon their stock of more than 400 homes currently rented out across Dumfries and Galloway (in addition to their operations in North and East Ayrshire) by developing further new build.

Between 2019 and 2022, CHA constructed 90 new build homes on the site of a former greyhound stadium on the outskirts of Gretna. The housing association has since purchased additional plots of land adjacent to the now-thriving residential estate. Designs have been prepared for the construction of an additional 93 houses, comprising mostly 2- and 3-bedroom family homes as well as bungalows adapted for various accessibility needs. Timescales for the finalisation of designs and submission of a planning application are uncertain. As with all social housing in Scotland, developments are dependent on government funding in order that homes can be let at affordable rents while meeting the comparatively higher standards required of social housing compared to private.

Credit: Cunninghame Housing Association

A decision has not yet been made on the type of heating systems that would be installed in the planned new homes. A Shared Heat Collector Network would offer a zero-emission solution, complying with the New Build Heat Standard and offering low energy bills to the future occupants. Approximately 2 homes could be supplied from each of the closed-loop boreholes that would be likely to be selected as the technical solution for ground heat extraction. This would allow the boreholes, which would be spaced between 8 and 12 metres apart, to be installed along the line of the roads, or it would equally be possible to locate them in gardens, green spaces or under the acoustic bunds which line the northern edge of the site. All infrastructure could be constructed in advance of housebuilding work.

Number of potential connections
97 (100% domestic)

Annual heat supplied
700 MWh

Heat supply capacity
400 kW

Heat source
Closed loop boreholes + distributed ground source heat pumps

Estimated capital cost: £1.8M – 2.0M over and above costs of constructing homes and connecting essential utilities. This must be considered against the cost of installing alternative heating systems for the new dwellings.

Funding opportunities: If it were being developed in 2025, this scheme might have been eligible for grant funding from the Scottish Government targeted at heat network deployment. Partial or full funding for the ground loop infrastructure may be available from heat network developer-installers, who can finance upfront CAPEX if a long-term agreement is in place which includes a standing charge paid by the landlord or tenant.

Replicability: High. This type of new housing development is common in the South of Scotland, whether through Registered Social Landlord (RSL) developers or those building for the private market. Suitable ground conditions for closed loop boreholes are near-ubiquitous.

Expansion potential: High. The adjacent existing housing features gas boilers, which will need to be replaced with clean heating systems in the coming decades.

Tweedbank Expansion, Lowood

Scottish Borders

New development | Social impact | New build housing | Ground source (Shared Ground Loop)

A new mixed-use development on the Tweedbank Expansion will feature up to 400 homes. A Shared Heat Collector Network is one option for heating those new homes, with below-ground infrastructure constructed at the same time as installing other essential utilities.

Scottish Borders Council has earmarked the 14-hectare Lowood Estate in Tweedbank for a mixed-use development through its Local Development Plan, and the Council is actively involved in developing the site. The new development will eventually feature 350-400 domestic properties, a community centre, a 60-bed care village, and space for business and innovation. Access roads to some areas of the site have already been completed.

A decision has not yet been made on the type of heating systems that would be installed in the new buildings that are planned. Feasibility work for a District Heat Network has been carried on behalf of Scottish Borders Council, complemented by further strategic development work which considered a Shared Heat Collector Network as an alternative.

A Shared Heat Collector Network would offer a low running cost solution that complies with the New Build Heat Standard. The number of closed-loop boreholes that would be required to supply the new buildings depends directly on the amount of heat that they require, both in terms of the peak demand in cold weather and as a year-round total. The heat loads assumed by the District Heat Network feasibility study imply that around 300 boreholes would be needed to supply the housing alone; however, if the new homes were constructed to an enhanced energy efficiency standard (such as the LETI new build benchmark or the 'Silver' level of sustainability in the Scottish Building Standards), the number of boreholes could be approximately halved.

Number of potential connections
350 (100% domestic)

Annual heat supplied
2,000 – 7,000 MWh

Heat supply capacity
1 - 3 MW

Heat source
Closed loop boreholes + distributed ground source heat pumps

Estimated capital cost: If homes are built with higher heat loads, the scheme would cost £8M – 10M over and above costs of constructing the homes and connecting essential utilities. If they are built to enhanced energy efficiency standards, the capital costs could approximately halve. In either case, the cost of a Shared Heat Collector Network must be considered against the cost of installing alternative heating systems for the new dwellings.

Funding opportunities: In addition to government grants, partial or full funding for the ground loop infrastructure may be available from heat network developer-installers, who can finance upfront CAPEX in return for a standing charge paid by the landlord or tenant through a long-term agreement.

Replicability: High. This type of new development is common in the South of Scotland. Suitable ground conditions for closed loop boreholes are near-ubiquitous.

Expansion potential: High. The planned business developments and care village that accompany the housing at Tweedbank Expansion could also be connected to a Shared Heat Collector Network. This infrastructure could also potentially interface with a District Heat Network that could be developed between east Tweedbank, Darnick, the Borders General Hospital and west Melrose (outlined on page 25 in the District Heat Network Opportunities section) – or the District Heat Network could extend to supply new buildings at the Tweedbank Expansion directly.

Community Minewater Heat Scheme, Kelloholm

Dumfries and Galloway

Neighbourhood | Partnership delivery | Retrofit | Ground source (several options)

Kelloholm has an opportunity to transform its heating infrastructure by using geothermal energy from abandoned coal mines. A shared heat collector system could provide a sustainable alternative to fossil fuel heating. Kelloholm could set a precedent for other former mining communities looking to repurpose underground resources for a greener future.

Kelloholm is a village in Dumfries and Galloway, originally established as a model mining community in 1921. Over the years it has grown, and the built-up area has merged with neighbouring Kirkconnel. The two villages share certain essential amenities such as schools and shops. Like many communities in the region, Kelloholm faces environmental challenges which are exacerbated by climate change. Flood risks are among these challenges, which both impact new development in the area and provide an imperative for reducing greenhouse gas emissions.

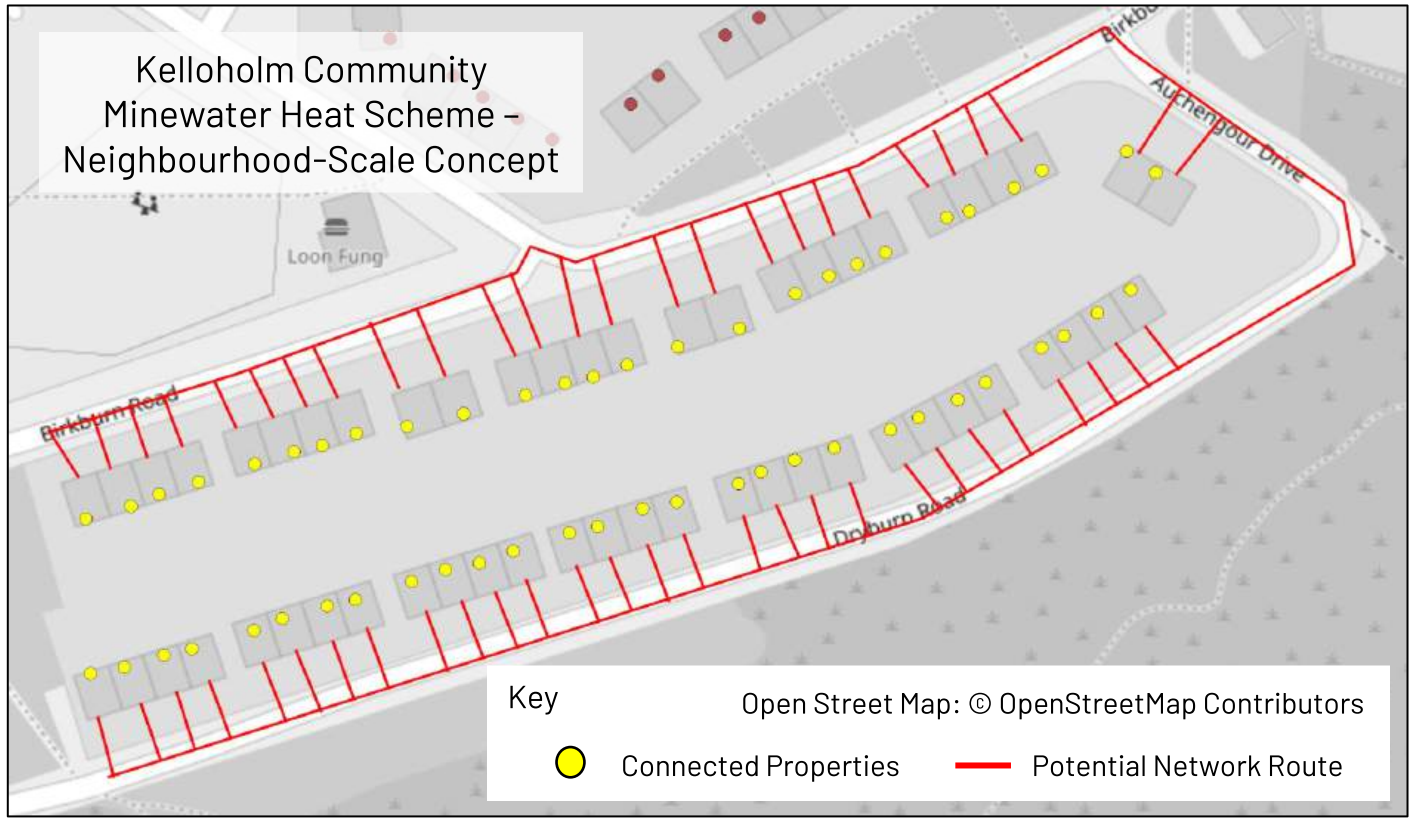
Dumfries and Galloway Council is prioritising decarbonisation, having declared a climate emergency in 2019 and set ambitious targets to achieve regional net-zero status by 2040. Its Route Map for Carbon Neutrality (2021-2026) highlights the importance of collaboration with local communities to drive sustainability initiatives. Residents and organisations are encouraged to participate in shaping decarbonisation projects, ensuring local engagement and resilience against climate challenges.

Due to the presence of mine water under the town, there is a promising opportunity to harness sustainable energy in Kelloholm through shared infrastructure that utilises the geothermal potential that lies beneath. Abandoned coal mines often become flooded with water that warms due to geothermal gradients, reaching temperatures between 10 to 20°C, and potentially higher at greater depths. This mine water can serve as a reliable heat source for ground source heat pumps with the potential for high efficiency operation. There are several technical options for accessing the heat in the minewater, including:

- pumping water from flooded mine workings to the surface, either from pre-existing shafts or specially drilled boreholes, and passing this through a heat exchanger before returning it via a second shaft or borehole;
- constructing 'closed loop' heat collectors by immersing pipework or engineered heat exchangers in a flooded mine shaft;
- circulating water warmed by the mine water through a Shared Heat Collector Network, with individual ground source heat pumps in each connected building;
- using water warmed by the mine water as the heat source for large ground source heat pumps which serve a heat network.

Any development will need to comply with the requirements of the Strategic Flood Risk Assessment, incorporating flood risk mitigation measures wherever possible.

The scale of scheme that could be viable will depend on the ease or difficulty of accessing the minewater heat source, and on its capacity. Viable schemes could range from a neighbourhood of a few streets (if minewater access proves to be relatively easy and cheap), up to a village-wide network (which may be the only viable scale if minewater access is harder). The scheme depicted below is one of several options for neighbourhood-scale schemes in Kelloholm. In the longer term, there could be potential for connecting several initially separate networks together and/or extending networks to new connections nearby.



	Village-wide scheme	Neighbourhood scheme (as per map shown)
Number of potential connections	Up to ~700 domestic connections and 30 non-domestic	Up to 54 domestic connections
Annual heat demand	3,000 MWh+	340 MWh
Heat supply capacity	2 MW+	190 kW
Potential heat sources	Mine water + distributed ground source heat pumps	

Estimated capital cost: £1M -£1.5M for the network and heat pump elements of the neighbourhood-scale scheme shown. A cost estimate for the minewater heat collector is not possible to provide at pre-feasibility stage, due to the large potential for variation due to scale, local conditions and mine depths. However, the minewater-side costs are likely to be the same order of magnitude as the network and heat pump costs.

By capitalising on the geothermal energy stored in its abandoned mines, Kelloholm could significantly reduce its carbon footprint, while residents of one or more neighbourhoods are provided with a cost-effective clean heating system.

Business Centre Heating Scheme, Selkirk

Scottish Borders

Industrial Estate | Retrofit | Multiple heat sources

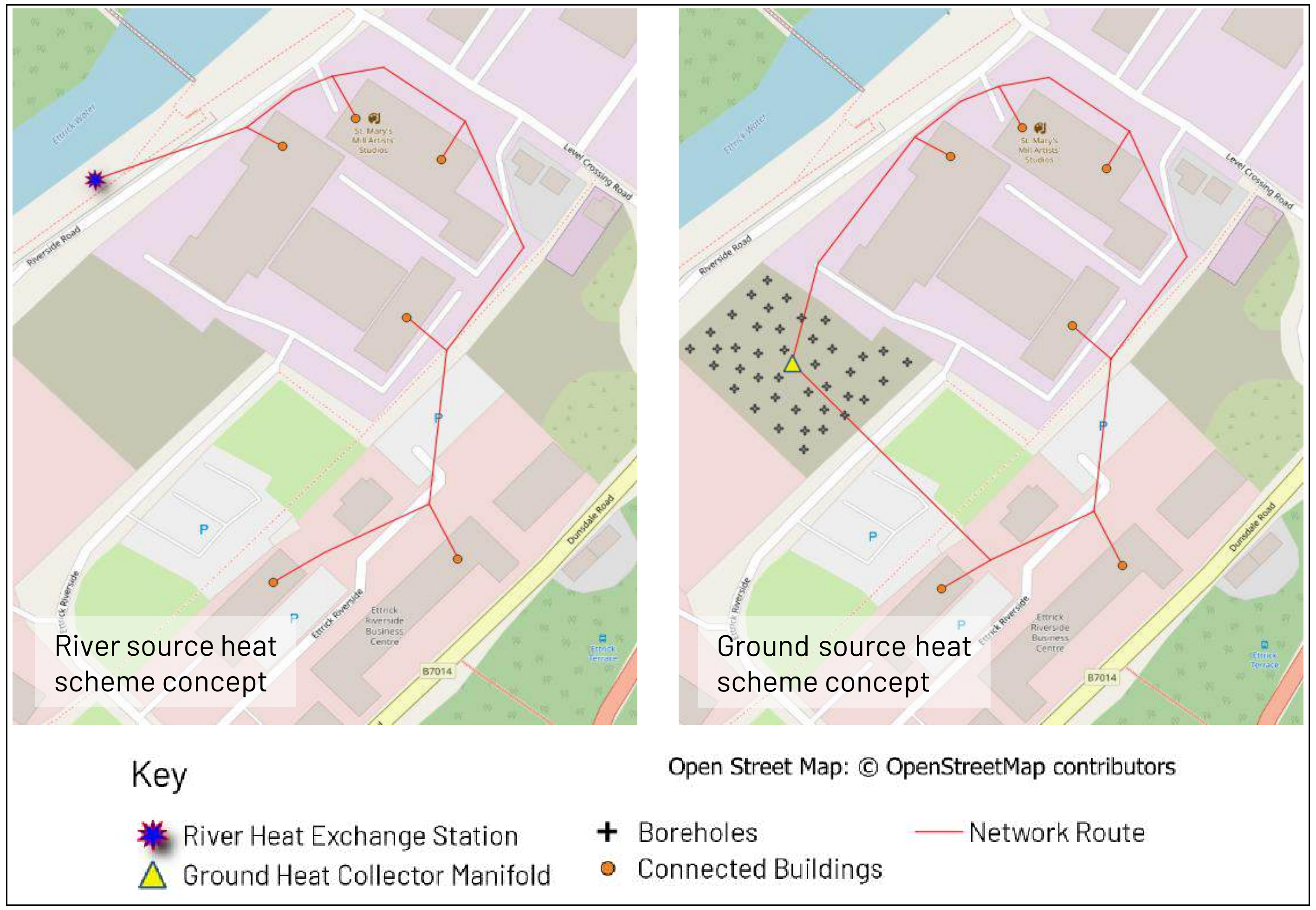
In Selkirk, there is an opportunity to decarbonise existing non-domestic properties within the Ettrick Riverside area by implementing clean heating systems that utilise locally available renewable heat sources.

Selkirk is a historic town in the Scottish Borders. Nestled in the Ettrick Valley, the town has long been a hub for industry and trade. The Ettrick Riverside area, situated along the banks of the Ettrick Water, is a key business and employment centre, housing a mix of modern and repurposed industrial buildings. Once a focal point for textile production, the area is now home to a variety of enterprises, contributing to Selkirk's evolving economy. With its scenic riverside setting and close ties to Selkirk's wider commercial and cultural life, Ettrick Riverside plays an important role in the town's development. South of Scotland Enterprise has its headquarters at Ettrick Riverside.

While Selkirk is connected to the gas grid, many properties within the industrial estate still rely on oil or electric heating systems. Decarbonising these buildings presents an opportunity to implement zero-emission heating solutions using locally available renewable heat sources.

A water source heat scheme could harness thermal energy from the Ettrick Water, which a desk review suggests has suitably high flow rates. This scheme would involve abstraction of a quantity of flowing river water, transferring heat from the river water to the Shared Heat Collector Network via a heat exchanger, and return of the water to the river.

Alternatively, a Shared Heat Collector Network distributing heat from an array of boreholes could provide a similarly low-carbon heating option. If the boreholes were of the closed loop type, around 100 would be needed. With careful spacing, these could fit into the open space between Riverside Road and the Industrial Estate internal road – or boreholes could also be constructed under car parks. Hydrogeological investigation would be required to establish whether an open loop ground heat collector is feasible in this location; if possible, such a scheme would be cheaper and require construction across a much smaller area of land.



Number of potential connections	6 (100% non-domestic)
Annual heat demand	1,500 MWh
Heat supply capacity	1 MW
Potential heat sources	River heat collector + distributed heat pumps OR Closed loop boreholes + distributed heat pumps

Estimated capital cost and funding: £1.9 - £2.1M for the water source scheme, including the distributed heat pumps and internal works. For the ground source scheme, the estimated cost is £2.2 – 2.4M. These figures are over and above the costs of any energy efficiency measures required in each building, which may be undertaken separately.

Replicability: Medium. Business districts and industrial estates similar to Ettrick Riverside are found in towns across the South of Scotland, making the concept of a Shared Heat Collector Network applicable in other locations. In particular, the **Charlesfield Industrial Estate near St Boswells** is in the process of developing a grain distillery, has an on-site aerobic digester and is undergoing wider regeneration – this site has high replicability. However, the feasibility of a water source heat scheme depends on proximity to a suitable river or body of water. In contrast, ground source schemes using boreholes are more widely replicable, as they can be deployed in various settings where space for borehole drilling is feasible. **Expansion potential:** High. Centrally located within an industrial estate, the scheme has expansion opportunities along the river, including Selkirk Leisure Centre.

Low Carbon Town Centre Regeneration, Dumfries Dumfries and Galloway

Neighbourhood Community-led Retrofit and new build Ground source (several options)

The area around the High Street in Dumfries is undergoing a transformation. Phased restoration and redevelopment of buildings in the Midsteeple Quarter area, led by and for the benefit of the community, will bring new residents and economic and cultural activities. New demand for heat could be met from an open loop ground source heat system accessing the underlying aquifer.

Midsteeple Quarter is both the name of the part of Dumfries Town Centre that surrounds the historic Midsteeple building, and the name of the community benefit society that aims to regenerate that part of the town centre. The organisation is engaged in restoring, developing and leasing buildings for the benefit of the community.

Midsteeple Quarter owns six buildings with frontages on the west side of the High Street. Bringing these buildings back into beneficial use forms the first part of a longer-term 'Blueprint' masterplan. In early 2025, the portfolio included seven new build apartments, 'pop-up' spaces available for short-term lease, several shops leased on a longer-term basis, and workshop, hot-desking and community spaces. It is likely that in the future there will be further redevelopment of derelict and uninhabitable areas of buildings, whether already owned or as potential future acquisitions.

The Standard Building on the High Street has been retrofitted to improve energy efficiency and futureproofed for connection to a Shared Heat Collector Network. The age, construction, heritage status and cultural importance of many of the other buildings will constrain the type of energy efficiency retrofit that can be delivered. However, with many of the properties within the buildings currently relying on electric panel or convective heaters, there is considerable scope for reducing the high heating costs that the community organisation and its tenants currently bear.

Credit: Midsteeple Quarter

A hydrogeological desk study has been carried out to assess the feasibility of constructing an open loop ground source heat collector at Midsteeple Quarter. Such a system would extract groundwater from an aquifer, harvest thermal energy from the water, and then return it via a second well.

A particularly productive aquifer is believed to exist under the site thanks to the way that two different rock types are layered over one another underneath Dumfries. The underlying geology permits a significant amount of horizontal flow along fractures in the rock, but much more constrained vertical flow. The feasibility study concluded that 10 litres/second is an achievable rate for sustained groundwater pumping and reinjection, and that the mineral content of the water is relatively low (reducing the risk of fouling of heat exchangers or recharge wells). This flow rate is sufficient to supply a total heat load 3 to 4 times the estimated heat demand of Midsteeple Quarter's currently habitable portfolio assuming 100% occupancy.

Indicative heat demands for different stages of Midsteeple Quarter redevelopment

	Existing portfolio and development with Outline Planning Permission, plus 124 Irish Street	Medium to long term expansion (50% uninhabitable floor area restored to use)	Realisation of full Blueprint vision plus supply to neighbouring buildings
Number of potential connections	Up to 17 (up to 40% domestic)	30 – 40 (~60% domestic)	100+
Annual heat supplied	Up to 240 MWh	Up to 370 MWh	Circa 800 MWh
Heat supply capacity	Up to 160 kW	Up to 200 kW	Circa 330 kW
Heat source	Open loop borehole with heat exchanger		

Drill rig access to the locations where boreholes could be constructed is a particular challenge for the Midsteeple Quarter. However, the community organisation's vision of opening up closes (narrow streets or passageways) between buildings could facilitate access for the mobile machinery and equipment that would be required. In order to locate the abstraction and reinjection wells as far apart as possible (thus reducing thermal interference between them), it would be beneficial to locate one borehole in the Council-owned car park on Irish Street. The Council's Social Work offices adjacent to this car park could also be connected to the heat network.

Further options assessment work would be required to determine whether a Shared Heat Collector Network with distributed heat pumps or a small District Heat Network offers the most attractive benefits. Potential interconnection with a wider Dumfries heat network (see section *Dumfries Heat Network Corridor* on page 33) could influence the trade-off between these two low carbon options. Whether supplying a fleet of separate smaller heat pumps, or a centralised energy centre equipped with large heat pumps, the temperature of the aquifer at a depth of 100-200 metres is expected to enable heat pumps to operate with slightly better efficiency than would be the case with closed-loop boreholes (although some gains would be offset by the electricity required to pump ground water from this depth). It is suspected – but not yet evidenced – that warmer temperatures may be found at greater depths, potentially enabling additional efficiency gains.

Estimated capital cost: £1.1M – 1.3M for a scheme meeting the heat demands of Midsteeple Quarter's existing portfolio plus around 20 additional homes and 200m^2 of extra commercial floor area, including the cost of heat pumps. The estimate also includes the cost of new wet heating systems for properties currently using electric heaters.

Annan Public Buildings Cluster

Anchor load-led | Public sector-led | Retrofit | Ground source (Shared Ground Loop)

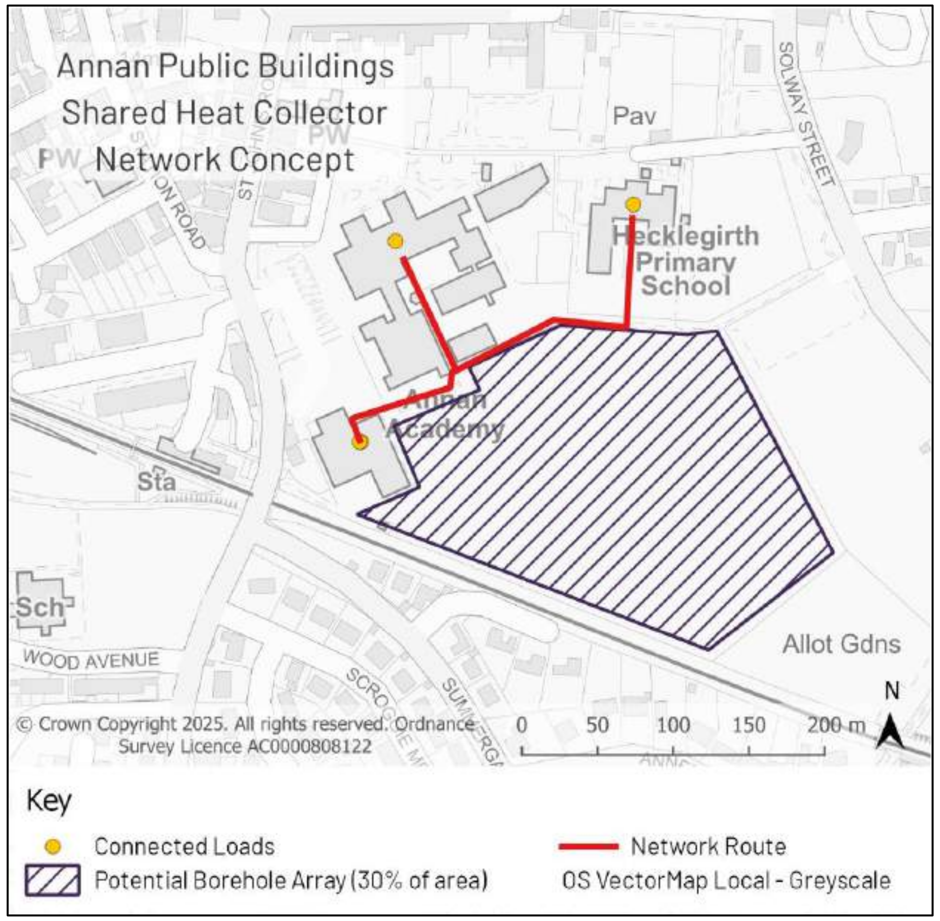
A cluster of educational and community buildings in Annan provides an exceptional opportunity for the development of a Shared Heat Collector Network. The strength of the opportunity derives from the buildings' consistent and reliable heat demand, their close proximity to each other and the existence of a large open space in the vicinity.

There could be as few as four connected loads in this Shared Heat Collector Network, which takes the opportunity provided by their layout and proximity to green space to decarbonise all at once. The connected buildings would be Annan Community Centre, Annan Swimming Pool, Hecklegirth Primary School and - the largest of the four - Annan Academy. The Academy would be the most critical stakeholder, not only due to its heat demand which dominates the network, but also because the Academy's playing fields would be the preferred location for boreholes to be installed.

Annan Academy serves approximately 850 students as a six-year comprehensive secondary school. Its history traces back to the 17th century and some of its buildings date from the late 18th century. The campus includes a four-lane public swimming pool and games hall, accessible to the community after school hours and during holidays. Adjacent to Annan Academy is Hecklegirth Primary School, built in 1963 and recently refurbished, currently accommodating around 200 pupils. The town also benefits from the Annan Community Centre, which offers various facilities and services to local residents. Collectively, these establishments contribute to the educational and recreational fabric of Annan.

The existence of the Annan Academy playing fields to the south of the school could make the installation of around 100 boreholes for a Shared Heat Collector Network relatively straightforward. Once installed, the below-ground infrastructure (needing around 30% of the space) would be near-invisible and would not prevent the playing fields from being used for sport as they always have been.

Dumfries and Galloway



Number of potential connections	4
Annual heat supplied	1,200 MWh
Heat supply capacity	680 kW
Heat source	Closed loop boreholes + distributed ground source heat pumps

A Shared Heat Collector Network could reduce the dependant buildings electricity consumption for heating by a factor of between 3 and 5 while delivering the same level of comfort than their current heating systems. The potential energy saving would depend on the equipment selected and the design of the heat emitters (radiators, underfloor heating or alternatives). Given the age of at least part of both Annan Academy and Hecklegirth Primary School, energy efficiency retrofit works could be required to ensure that the heat pump system installed can work effectively and efficiently with the building fabric.

Estimated capital cost: £2.0M, including the cost of heat pumps and distribution to each customer building. Electrical upgrades would potentially be required, but have not been investigated at this stage.

Funding opportunities: Partial or full funding for the ground loop infrastructure may be available from heat network developer-installers, who can finance a proportion of the upfront CAPEX if a long-term agreement is in place which includes a standing charge paid by the landlord or tenant. Government grants for heat networks may also be applicable.

Replicability: Medium. This network draws its strength from the dense cluster of public sector buildings combined with the large greenspace adjacent. Such simple arrangements are relatively rare in the region, but Shared Heat Collector Networks serving clusters of less closely-packed public buildings would be possible to find more widely.

Waste Heat Distribution Network, Lockerbie

Dumfries and Galloway

Heat source-led | Partnership delivery | Retrofit | Industrial waste heat

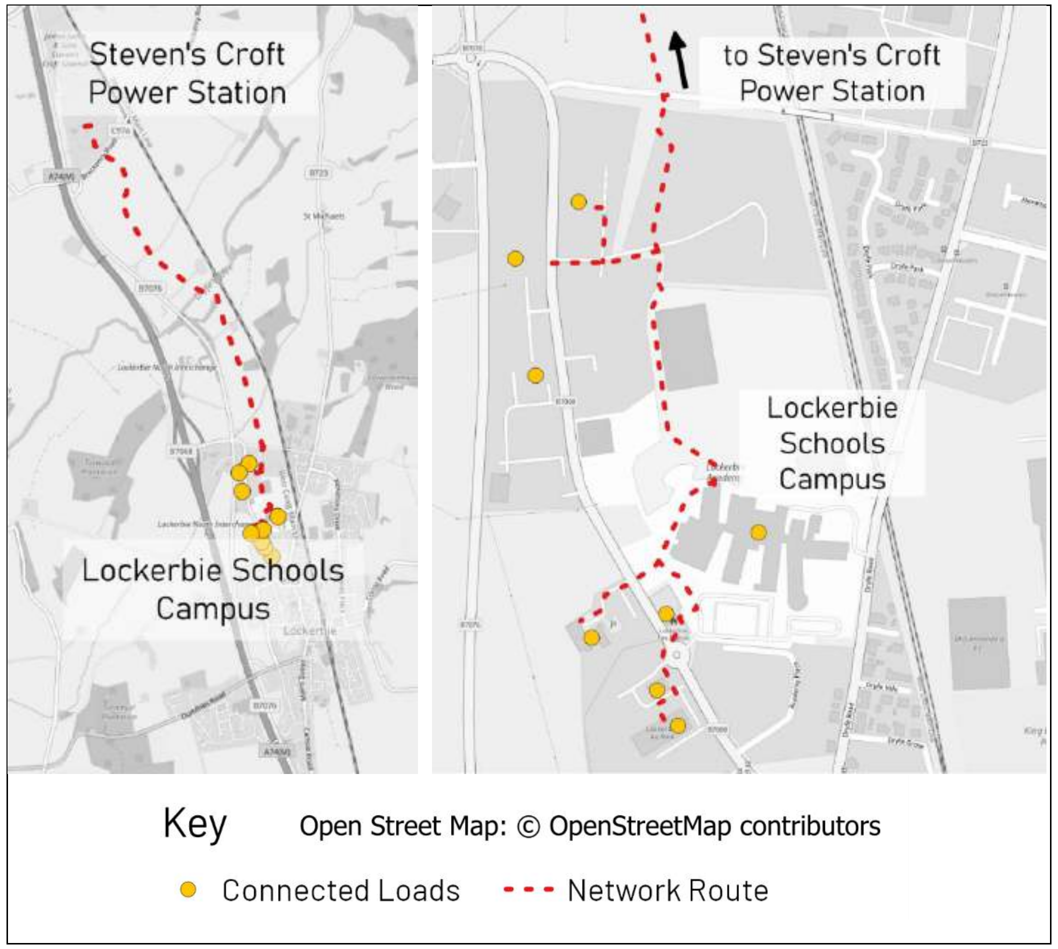
Waste heat from a renewable power station near Lockerbie could supply a heat network operating at near-ambient temperatures, with distributed heat pumps upgrading the heat on-site to meet individual buildings' needs. The value of the waste heat could justify its transport over an extended distance.

Three kilometres north of the town of Lockerbie, Steven's Croft Power Station is a 44 MW biomass electricity generator fuelled by timber production waste, coppiced wood and recycled fibre. In addition to electrical power, the plant generates both high temperature heat (which is sold to nearby sawmills' timber drying facilities) and low temperature waste heat (which is rejected to the atmosphere via the site's air-cooled condenser module).

Photo credit: © **Chris Newman** (cc-by-sa/2.0) / Cropped from original

The availability of significant quantities (tens of megawatts) of waste heat at a temperature of between 35 and 40 degrees centigrade presents an opportunity for the town. The land between is mostly farmland and there are few physical obstacles to the installation of a pipeline. The amount of pipe involved in this heat transmission route (6 - 7km) is around ten times less than the amount needed to collect an equivalent amount of heat from closed-loop boreholes. However, the transmission pipe would have a larger diameter, and would need to be insulated to limit heat loss to the ground.

If a proportion of its low-grade waste heat was provided to heat customers, the power station operator could reduce their operating costs, and potentially generate revenues from selling the heat. Additional work is required to confirm the technical feasibility of taking waste heat from the power station, and to establish the level of interest from the power station operator in entering a long-term heat supply agreement. If this opportunity proved not to be possible to progress, alternative heat sources could be accessed – albeit probably at a higher capital cost and higher operating cost.



Number of potential connections	~8 (public sector and commercial)
Largest potential anchor loads	Schools Campus Kilco Chemicals
Annual heat supplied	2,500 MWh
Heat supply capacity	1.5 MW
Heat source	Waste heat from biomass power station

Scheme Description: A pair of large pipes could convey tepid water to the edge of Lockerbie, where the network would split into branches to serve the customer buildings. Each building would be served by its own heat pump system, which could operate with very high efficiency thanks to the relatively warm temperature of the waste heat distribution network (a Coefficient of Performance - or COP - of 5 is easily possible for space or hot water heating applications). This would mean that heat pump electricity costs would be very low, although if there was a charge for consumption from the waste heat network this would be offset against the energy bill savings.

Careful consideration would need to be given to the provision of backup plant to supply heat into the network during periods when the power station is not operating, such as during planned maintenance.

Capital Costs: The capital cost of the scheme is likely to be slightly greater than the cost of an equivalent capacity scheme using a local borehole array to supply the same group of customer buildings. However, the potential for lower heat costs could justify the additional investment.

Precedent: The AMIDS "5th generation" heat network in Glasgow transports ambient-temperature heat from a wastewater treatment plant to buildings over 2km away. Phase 1 of this network is complete and supplying heat consumers with a similar total heat demand to the Lockerbie scheme outlined above (although the energy centre and network are sized for an expanded future heat customer base).

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[3] Scottish Renewables (2024) *National Heat Networks: A Vision For Scotland*. Available at: https://www.scottishrenewables.com/assets/000/004/310/National_Heat_Networks_A_Vision_for_Scotland_original.pdf (Accessed: 20/03/2025).

[4] Nesta (2025) *Mapping heat pump suitability across Great Britain.* Available at: https://www.nesta.org.uk/project/mapping-heat-pump-suitability-across-great-britain/ (Accessed 26/03/2025).

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[7] Peebles Placemaking Team (2025) *A plan for Peebles: Local Place Plan & Town Action Plan.* Available at: https://place.ccrbpeebles.co.uk/ (Accessed: 26/03/2025).

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Appendix: Opportunity Development Approach

Overall approach

The analysis of heat network opportunities and development of the presentations contained in this Prospectus was carried out by The Natural Power Consultants Ltd. The approach was designed to advance prospects for heat networks to be constructed in the South of Scotland, by further developing existing concepts and identifying new opportunities.

The new opportunities can be considered to be at a "pre-feasibility" level of development, with additional work required to confirm technical and economic viability and to establish and build stakeholder interest. As such, the approach sought to achieve a level of accuracy and robustness that is appropriate for pre-feasibility projects. In practice, that meant focusing on those elements that had the strongest impacts on results:

- applying greatest scrutiny to the larger heat demands being considered for connection to a potential heat network and those low carbon heat sources that promise to be able to supply a majority of a network's heat demand;
- engaging with stakeholders with the greatest level of interest in and influence over a potential heat network project;
- focusing on those elements which have the greatest influence on the capital cost, and applying benchmark cost estimates[2] to elements which represent a smaller proportion of the total cost or that vary less from project to project.

Data sources

The Scotland Heat Map and the Energy Savings Trust's Home Analytics and Non-Domestic Analytics datasets were used in the assessment of opportunities and preparation of this Prospectus. Outputs from Dumfries and Galloway Council and Scottish Borders Council's Local Heat and Energy Efficiency Strategy (LHEES) development process were also used, as were the Councils' Local Development Plans. Building Assessment Reports (BARs) for public sector buildings were used where available. Reports were reviewed in detail for those opportunities that had been the subject of previous feasibility or investigatory work, or assessments by potential developers.

Data validation

The national datasets which contain estimated heat demand for every building in the region draw together information from diverse sources and use a variety of methodologies for the estimation depending on what underlying information exists. Although some heat demands are estimated with a high degree of confidence (from actual consumption data or building specific energy performance modelling), others are much more crudely estimated from a recorded building footprint, an assumed number of storeys, an assumed or recorded building type and benchmark heat demand figures. This latter group inevitably contains some significant over- or under-estimates for the heat demand. There are also occasionally missing or misplaced buildings, and duplicates are frequent.

A critical step in the assessment of the heat network opportunities was the validation of the larger heat demands in areas that showed promising heat demand densities. This involved manual screening for data points that could be partial duplicates; validation of footprint and floor area estimates through geospatial data and street-level imagery; searches for Building Assessment Reports and Energy Performance Certificates that post-date the generation of the datasets used; consultation with project partners holding local knowledge and direct engagement with building owners.

Shortlisting of opportunities

To best achieve the aims of the Prospectus, the opportunities featured needed to show strong standalone investable potential. However, it was also important to cover the full range of those types of opportunities which are believed to be highly replicable across the region (such as Shared Heat Collector schemes for blocks of flats). Within the group of locations and concepts presented, it was desirable to incorporate diversity in order to better illustrate the diversity of the region-wide opportunity. A classification system for Shared Heat Collector Network opportunities was developed to aid the understanding of the degree of coverage that was being delivered.

The density of heat demand in an area was a key zone selection criterion. The type of buildings contributing significantly to the total network heat demand was also a parameter for selecting certain opportunities over others. The low carbon heat resources that appear to be available in a particular location also informed selection decisions, with the assessment of those resources requiring analysis of likely river flow rates and depths; underlying geology and hydrogeology; and processes carried out at industrial sites where waste heat could be available.

Network refinement and concept development

Heat network opportunities on the working shortlist were further refined using many of the same criteria that were used to shortlist them. Initial concepts for network pipe routes and groupings of buildings that could potentially connect to that network were drawn in a Geospatial Information System (GIS) program, and key quantities calculated such as pipe lengths and land areas for heat collectors. Plant capacities and key component numbers were developed to match the demand.

Capital costs were estimated by applying benchmark costs from publicly available reports and price book publications and knowledge gained through engagement with suppliers as part of Natural Power's delivery of heat network feasibility studies and business plans in other locations. Wherever possible, capital cost estimates were compared with estimates from designers and installers of similar heat network projects elsewhere. Capital cost estimates included planning, design, commissioning, legal and commercial costs in addition to equipment, materials and installation costs.

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[2] Benchmark cost information was obtained from sources including the following:

- Ramboll for Scottish Enterprise (2024) *Cost analysis of a typical 4th and 5th generation heat network.* Available at: https://www.scottish-enterprise.com/learning-zone/research-evaluation-and-insight/2024/cost-analysis-of-a-typical-4th-and-5th-generation-heat-network (Accessed 27/03/2025).
- AECOM (various editions) *Spon's Mechanical and Electrical Services Price Books*.
- Element Energy and UCL for the Climate Change Committee (2020) *Assumptions log: Development of trajectories for residential heat decarbonisation to inform the sixth carbon budget*. Available at: https://www.theccc.org.uk/wp-content/uploads/2020/12/Element-Energy-Trajectories-for-Residential-Heat-Decarbonisation-Executive-Summary-Assumptions-Log.xlsx (Accessed 27/03/2025).