Decarbonising Heat

Background

This presentation is part of the LHEES Community Retrofit Pilot Project for Swinton, prepared by Southern Uplands Partnership for Scottish Borders Council in 2024. Whilst this was a standalone project, it links to the Energy Efficiency Supply Chain project by the same team which has been running since 2020. The project brief called for:

"Identification of potential pockets where property archetype, existing heating types, energy ratings and higher energy use may suit a small focussed retrofit project, and where the demographics may indicate that owner occupiers could be open to such a scheme."

This presentation looks specifically at Decarbonising Heat including options for heat networks. The role of Retrofit Archetypes for energy efficiency is covered by a separate presentation.

Decarbonising Heat

As part of the net zero transition, every house needs to change to a decarbonised heat supply. In the absence of a coordinated strategy, each household will end up making their own choice about how to decarbonise heat, as and when they see fit.

These decisions will be driven by a wide range of motivations which cannot be readily aligned, such as:

- Ability and willingness to invest
- Understanding of technologies
- Failure of existing system
- Response to media and marketing
- Capacity to access to incentive programmes
- Experiences of neighbours and family

Decarbonising Heat

The time available to develop a coordinated strategy is limited. Heat Pumps are currently the default option to replace gas and oil boilers in most houses, and there are various government and industry programmes to support that. It is expected that the number of houses with Heat Pumps will increase significantly by 2030, and it will then become difficult for alternative systems to gain market share.

However it is widely recognised that Heat Pumps will not be the best answer for many households, for reasons such as:

- Cost of installation
- Level of disruption
- Poor level of insulation to the building fabric
- Electricity grid constraints

The purpose of this research is to consider alternative systems and whether they would be feasible in the short term.

Demand: Households + Communities

We will end up with lots of people doing different things with different suppliers, losing the opportunity for shared procurement, shared learning, shared maintenance where there would be benefits in terms of programme and cost.

- Existing reliance on gas/oil boilers has shared learning embedded in the established supply chain and robust installer networks. It will take many years to replicate this ecosystem for decarbonised technologies.
- There are few if any models for how households and communities can collaborate to organise and structure ways to access professional advice and funding or engage with supply chains.

Supply: Trades + Industry

At the same time, the supply chain is also trying to understand how to approach this transition.

- Most activities rely on established working methods and best practice – they know what they are doing.
- They need to maintain current activities and income streams whilst familiarising themselves with the new technologies – reskilling + accreditation.
- Until there is clearly defined demand they will be hesitant to commit to that transition.
- Nevertheless they will be called on to advise households and communities for advice, which most will not be confident to provide, and some not competent.

Joining the dots…

Both the supply and demand sides are seeking to find trustworthy and objective sources of information on the technologies and how to deploy them, which also needs to be honest and open about risks and constraints.

There is demonstrated interest from communities to pursue this, and there are professionals with the knowledge and willingness to advise, but there is a lack of:

- Trusted information
- Access to funding
- Procurement support

Joining the dots in the Scottish Borders

Rural areas like the Scottish Borders have distinct drivers.

Constraints:

- Lack of capacity for professional advice
- Predominance of micro-enterprise
- Geographic dispersal and low density

Opportunities:

- Well developed community structures
- Well established but informal coordination between traders which does not rely on third parties
- Fewer legal constraints from multi-tenure buildings
- Ready availability of land and renewable fuel sources

Current status in Swinton

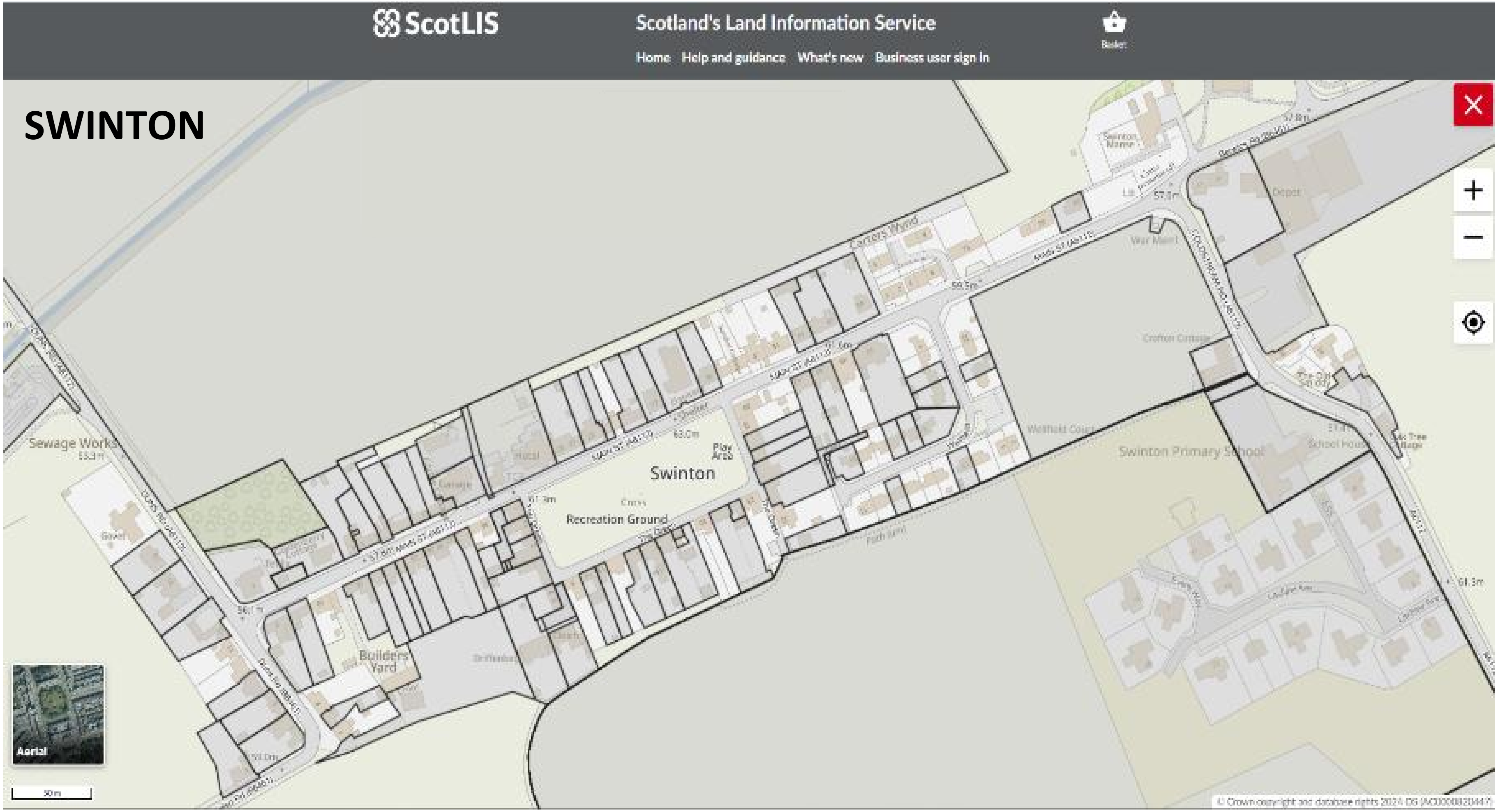
The Scottish Government Home Analytics Database indicates the houses in Swinton are currently heated with the following mix.*

- Oil boilers: 42
- LPG gas boilers: 8
- Solid fuel: 19
- Biomass boilers: 3
- Air Source Heat Pumps: 29**
- Electric storage heaters: 28
- Room heaters: 10

Heat demand for the whole village is estimated at 2.3m kWh/year currently, an average of 19,000 kWh/year for each house.

* These numbers have not been confirmed on site.
** 21 of these ASHP are in the new-build houses on Laidlaw Avenue and Everly Way

Current status in Swinton



Community attitudes

Attitudes to developing a community heat strategy can be broadly considered under these five possible approaches.

- **Zero demand:** high cost, high risk, disruptive, passionately supported by those heavily engaged but low number, concern about lack of funding support.
- **Your own system:** lack of understanding of technology, anecdotal perception of poor performance and cost.
- **Exclusive group:** openness to consider a group scheme, not necessarily appropriate for the archetypes we have.
- **Whole village:** openness to consider, and interest in having delivery managed by outside organisation, perceived as reducing retrofit requirement, includes public and commercial buildings.
- **Varied systems:** acceptance this is the default outcome.

Community survey

As part of the project we ran a survey to help understand community attitudes towards the possibility of a heat network. Surveys were distributed to 136 households with 29 (21%) returned.

- Tenure: all but 1 of the respondents were owner occupiers (96%). (Data for the village as a whole indicates the actual figure is 56%).
- Fuel source: 45% of respondents used electricity and 41% relied on oil for heating. (This is reasonably consistent with data for the village as a whole: elec. 48%, oil 30%.)
- Drivers: respondents agreed that a heat network would need to: lower the cost of heating (90%); be low maintenance (83%); and have consumer protection for reliability of supply (76%).
- Investment: the majority of respondents said they would either invest in a community owned heat network (24%) or consider investing (59%).

Community survey

We asked if being part of a heat network meant only minimal retrofit was needed (e.g. wall insulation) to meet the LHEES targets, would that make it a more attractive proposition?

- 58% found a heat network more attractive **if only minimal retrofit** (e.g. wall insulation) **was needed**
- 10% were **not swayed** by this consideration
- 31% were **unsure**

We asked how people would prefer the heat network to be operated and managed - locally or by an external energy company?

- 48% **preferred a co-ownership model** between the community and business.
- 31% **favoured local community initiatives**.
- 13% **chose other options**, seeking the most experienced and effective management.
- 3% **wanted private businesses** alone to manage the network.

Community survey

Overall Insights

a. **Uncertainty and the Need for Information**: A significant proportion of respondents remain unsure about joining a heat network, indicating a need for clear communication about benefits, costs, and reliability.
b. **Financial Considerations**: Lowering costs, both upfront and ongoing, is the most critical factor for respondents when considering a heat network.
c. **Preference for Local and Shared Management**: There is a strong inclination toward community involvement in managing heat networks, suggesting that local engagement could be key to successful adoption.
d. **Backup Concerns**: Individual backup systems are preferred, likely due to concerns over the reliability of the heat network during extreme conditions.

Community Regeneration

Developing a coordinated strategy for heat decarbonisation can also support Community Regeneration and 'Placemaking'. No one can force private home owners to adopt a specific heating system, it can only happen with community support. This applies to any strategy, but is especially the case where a Whole Village Network is considered as it relies upon a large proportion of households voluntarily agreeing to connect to the system. It may also include some level of community investment and ownership.

Community Energy Systems

Heat is just one part of the renewable energy transition. We will also be generating our own electricity with solar panels, storing it in batteries, and using it to charge our electric vehicles. All of those systems can work at the level of an individual house or a community as a whole. This is called **Distributed Energy Resources** (DER).

A coordinated energy strategy could include these sorts of energy generation and storage alongside heat, such as:

- Batteries to consolidate unused rooftop solar generation
- Community owned solar arrays or wind turbines
- Biomass storage and processing centres

Possible approaches

Here are five possible approaches to a community heat strategy.

Z. **Zero demand:** minimal space heating demand
> retrofit to very high level essential (Passivhaus-equivalent)

Y. **Your own system:** individual system for each house
> retrofit to high level preferred

X. **Exclusive group:** shared system for cluster of properties
> retrofit to medium level preferred

W. **Whole village:** heat network supplying the whole village
> retrofit desirable but not required

V. **Varied systems:** no overall strategy, mix of systems
> retrofit is individual choice

Following is a simple SWOT analysis for each approach.

Z. Zero demand

Zero demand: minimal space heating demand
> retrofit to high level essential (Passivhaus)
> emphasis on Fabric First
> negates the need for any permanent heating system

S. Reduces overall energy demand, takes pressure off grid
W. Cost, resource + labour intensive, very disruptive
O. Creates extensive + multiple work packages, guarantee of lots of ongoing employment
T. Only viable for higher income households or with high level of public funding

Y. Your own system

Your own system: individual system for each house
> retrofit to high level preferred
> emphasise on Decarbonising Heat
> heat pumps, pellet biomass, electric storage, heat battery

S. Consistent with existing system where individual owners decide how to manage
W. Owners may lack sufficient understanding of options, adds to pressure on grid constraints
O. Creates extensive + multiple work packages for electrical and plumbing trades
T. More likely to be viable for higher income households, poor understanding in operation.

X. Exclusive group network

Exclusive group: shared system for cluster of properties
> retrofit to some level preferred
> emphasis on Decarbonising Heat
> shared ground source heat pumps, biomass

S. Good for clusters of the same archetype of concurrently built development, including flats

W. Requires consensus of all property owners

O. Increased efficiency of operation SCOP and reduced cost + disruption

T. Might preclude larger area systems with decarbonised enclaves amidst heat ghettos

W. Whole village network

Whole village: heat network supplying the whole village
> retrofit desirable but not required
> emphasis on Decarbonising Heat by whole community
> heat pumps or biomass (all fuel sources)

S. Takes onus off individual owners, in most cases needs minimal changes to building fabric.

W. Requires consensus of majority of property owners, design procurement + funding protracted due to scale

O. Economy of scale, centralised admin and maintenance, potential for community ownership

T. Reliant on longer term supply contracts, households still subject to price fluctuations

V. Varied systems

Varied systems: no overall strategy, mix of systems
> retrofit is individual choice
> this is an outcome, not a choice
> Negates need for any coordinated strategy

S. Allows individuals to make choices and at a pace to suit their circumstance, no intervention required.
W. Owners may make decisions with insufficient understanding of whole transition
O. Innovative and untested solutions might arise
T. Fragmentation means community benefits are not pursued and no influence about meeting targets.

Possible approaches

In the absence of a coordinated strategy, each household will make their own choice about how to decarbonise heating and we will be left with varied approaches. To consider what a coordinated strategy could look like, we will consider these options in more detail.

- **Your own system**
- **Exclusive group network**
- **Whole village network**

Note: as part of this project we consulted with various businesses that design, install or operate decarbonised heat systems:

- Kensa: shared borehole systems
- SAV Systems: heat pump based district heating + HIUs
- HeatNet: biomass based district heating

Your own system

There are lots of heating systems that can be installed in individual houses with zero direct carbon emissions:

- Heat Pumps (Air or Ground source)
- Biomass boilers (pellet)
- Electric storage heaters
- Heat battery (linked to solar PV)
- Heat Recovery Ventilation

Your own system: Heat Pumps

Air Source Heat Pumps are becoming the default option to replace gas or oil boilers. Heat Pumps are a well proven technology (they are essentially just a fridge working in reverse) and do work efficiently in cold climates, but may not be suitable for every house or household.

Pros + Cons:

- They run at lower temperature than gas or oil boilers so may need larger radiators + pipes. Higher temperature systems are available to overcome that but are less efficient to run.
- Unlike combi boilers, a hot water cylinder is needed and space may not always be easily found for that.
- Electricity supply may need to be upgraded.
- Whilst they will work in any house, they will be more efficient if the house has a reasonable level of insulation and airtightness.
- Best left running 24/7 which people can find hard to adjust to.

Your own system: Storage Heaters

Storage Heaters use a lot more electricity than Heat Pumps for the same heat output, but as the electricity grid transitions to clean energy this becomes decarbonised heat. Where overall space heating demand is very low, such as in small houses or flats especially if well insulated, or due to occupancy patterns and behaviour, it can be argued that the simplicity of installing and operating storage heaters is preferable to the high cost and disruption of installing a Heat Pump.

Pros + Cons:

- Simple and low cost to install.
- Instantaneous water heaters can be feasible for small homes, avoiding the need for a hot water cylinder.
- Electricity supply may need to be upgraded.
- Energy companies offer off-peak rates to reduce energy costs.

Your own system: Heat Recovery Ventilation

Heat Recovery Ventilation is becoming a common feature in new build houses and can also be used for Retrofits. This is a whole house ventilation system that captures heat from stale air extracted from kitchens and bathrooms, transferring it to fresh incoming air supplied to living and bedrooms. This can significantly reduce the amount of space heating required, and ensures heat is distributed equally around all rooms.

Pros + Cons:

- Houses need a relatively high level of airtightness for Heat Recovery Ventilation to be effective.
- It can be difficult to find routes for ducting in existing houses.

Exclusive group network

Heating system shared by a cluster of houses, probably of the same Archetype and often built as part of the same development. Typically used where there is common ownership (e.g. social housing) but can also be done collaboratively between private homeowners. Houses with existing shared grounds, access or maintenance requirements are a useful starting point. Exclusive networks can be:

- restricted version of whole village network (see below) or
- individual heat pumps running off shared boreholes.

Exclusive group network: Shared Boreholes

Shared Borehole schemes are emerging as a common type of group network. This is where every house has its own Heat Pump unit but they are connected to shared boreholes. Heat Pumps run much more efficiently from a Ground Source (GSHP) compared to an Air Source (ASHP) but drilling a borehole is expensive, so it makes sense for that cost to be shared amongst a group of houses.

Pros + Cons:

- Same as for individual Heat Pumps i.e. need space for the unit and hot water cylinder, radiators may need to be larger etc.
- Having a shared system takes some of the onus off individual households, but there will still be maintenance requirements.
- Can only supply a ring-fenced group which may not be readily expanded, and works best if all households in the group sign up.

Whole village network

This is a Heat Network supplying a whole community, with pipes from a central heat source connected to each house via a Heat Interface Unit (HIU). Open to all households and needs reasonable level of uptake to be feasible but can be expanded or connected to later.

- eliminates onus on individuals
- not affected by insulation levels
- not affected by grid constraints
- owned by community/business
- costs upfront or within bills
- subject to long term fuel costs

Multitude of heat sources:

- Biomass (agricultural waste)
- Heat pump (Air/Ground/Water)
- Waste heat (industry, sewer)

Whole village network: Heat Interface Units

The only functional part of a heat network for any house is the Heat Interface Unit. The HIU transfers heat from the hot water in the pipes coming from the network, to the central heating and hot water systems in the house. An HIU is about the size of a combi boiler and can be fitted on a wall or in a cupboard.

Pros + Cons:

- Operates at high temperature so does not need any changes to radiators + pipes.
- Provides instantaneous hot water so does not need hot water cylinder.

Whole village network: Biomass

If suitable biomass materials, such as timber or agricultural residues, can be locally sourced they are an obvious fuel source for heat networks in rural areas.

Pros + Cons:

- Generates local employment and supports local businesses
- Can be subject to commodity price fluctuation
- Requires sustainable fuel source to be genuinely "renewable"
- Modern automated systems

Whole village network: Heat Pumps

Using Heat Pumps to supply a centralised heat network rather than houses having their own units may seem counterintuitive but there are many potential benefits.

Pros + Cons:

- Large commercial units are more efficient to run
- Professionally managed installation, operation and maintenance
- Part of Community Energy System
- Electricity grid upgrade to single point of connection
- Can use Ground or Water Source which are more efficient than Air Source.

Case studies

Following are a range of case studies. There are currently few heat networks in the UK so some of these examples are from Europe where they have been popular for many years.

1. Swaffham Prior, England > heat pumps
2. Fountainbridge, Scotland > shared boreholes
3. Stetteldorf, Austria > straw bale
4. Lichtenegg, Austria > biomass
5. Hornsyld, Denmark > waste heat
6. Middelfart, Denmark > Heat-as-a-Service

Case study 1. Swaffham Prior, England

Swaffham Prior in Cambridgeshire has a population of about 800. It is the first village in the UK to retrofit a renewable heating network into an existing community. About 70% of the residents currently rely on oil to provide heating. Almost half of the properties have committed to the heat network and homes that have signed up will be connected in a phased approach, with the aim to have 90% of the village connected in the next 5 years. The system is operated with ground and air source heat pumps.

Case study 2. Fountainbridge, Scotland

Lar Housing Trust converted this derelict church into townhouses and built a new apartment block alongside it. A borehole was drilled right beside the church, providing the heat source for the whole development. The system was installed by Kensa, with each unit having one of their ‘shoebox’ heat pumps connected to the shared borehole. Kensa continues to own and maintain the shared ground array, leaving customers responsible for only their individual heat pumps and internal space heating/hot water systems.

Case study 3. Stetteldorf, Austria

Stetteldorf am Wagram is a town of about 1,000 residents in the rural and heavily forested Korneuburg district of north east Austria. It has a heat network connected to 320 houses supplied by a biomass boiler burning wheat straw bales. The straw burns at a rate of about 284 kg/hour which would be over 1,100 tonnes per year. There is also a backup boiler burning wood chip. The network has been operating since 1994, expanded in 2009.

Case study 4. Lichtenegg, Austria

Lichtenegg is another rural town of about 1,000 residents in north east Austria. A heat network was installed in 1987 with a biomass boiler burning wood chips from local forestry residues. As the village has expanded houses continue to be connected to the network.

Case study 5. Hornsyld, Denmark

Hornsyld is a rural town of about 1,600 residents in the Jutland region of Denmark. In 2021 a district heating system was proposed to use waste heat from a local business (a grain dryer and animal feed producer) supplemented by a biomass boiler and backup gas boiler run by another business. The scheme is based on 60% of houses connecting, but has enough capacity to supply the whole village. The aim is for the waste heat to supply 90% of the demand, supported by a large thermal store.

Case study 6. Middelfart, Denmark

In 2021, work began converting the towns of Strib, Røgle and Vejlby in the Middlefart region of Denmark from gas to district heating. The cost of the system, delivered, installed and commissioned, is covered through a monthly subscription for Heat-as-a-Service (HaaS) instead of residents having to pay upfront. The system is based on waste heat, sustainable woodchip and waste incineration, and had 800 households originally connected but has expanded significantly.

Conclusion

Swinton, like many small rural villages, has some unique challenges and opportunities to decarbonise home heating.

- Heating is predominantly from oil or LPG boilers, solid fuel, electric storage or room heaters, with few heat pumps installed as yet, so the opportunity exists to develop a coordinated strategy for decarbonising heat in the village as a whole.
- Housing is predominantly of the traditional Archetypes with solid stone walls and room-in-roof which are hard to retrofit to a high level of energy efficiency, so it is likely that they will continue to have relatively high levels of heat demand.
- The village has a compact layout and is surrounded by open farmland, posing few physical constraints for various heat network options or other types of Community Energy System.
- In the absence of a coordinated strategy being developed over the next few years, individual heat pumps will most likely become the default choice, but uptake will depend on individual circumstances.

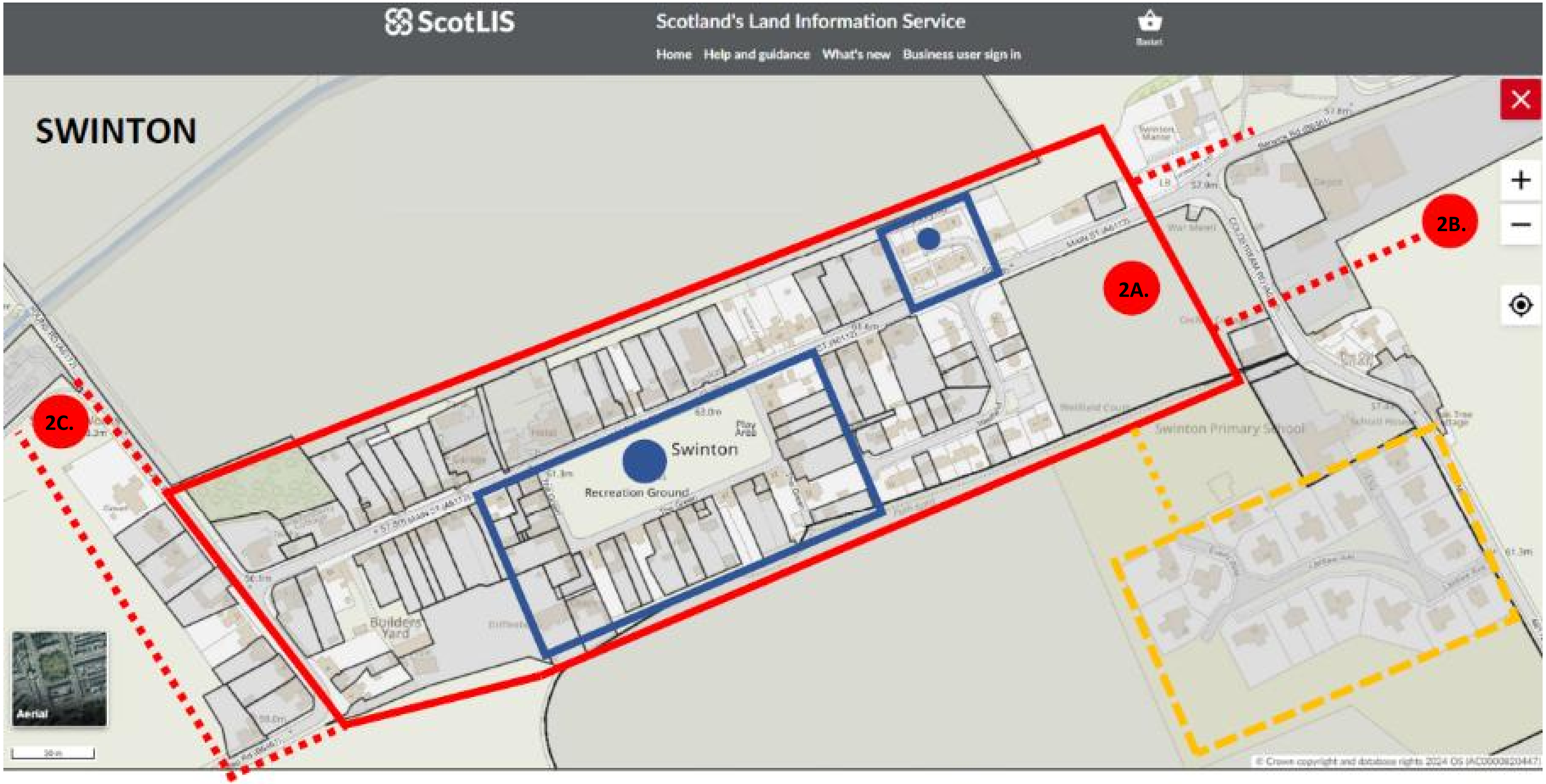
Options for Swinton

Developing a coordinated strategy to decarbonise heat in Swinton could take numerous forms depending on the preferred approach.

- **Z. Zero demand:** support all property owners (owner occupiers or social/private rental) to retrofit to a high standard through a collaborative procurement programme.
- **Y. Your own system:** support property owners to install Heat Pumps (where appropriate) through a group purchase scheme.
- **X. Exclusive group:** identify appropriate clusters of houses where a shared borehole system for Heat Pumps might be feasible.
- **W. Whole village:** seek proposals from consultants and suppliers for designing a local heat network, possibly as part of a broader Community Energy System.

The following map provides some suggestions for how a shared borehole cluster (1.) or whole village scheme (2.) could be laid out.

Options for Swinton



- **1. Shared GSHP Communal Heat Clusters**
  - 1A. The Green c.26-30 houses
  - 1B. Carters Wynd c.9 houses
- **2. Village District Heat Network**
  c.120 houses + hotel/school/church
  - 2A. GSHP (village centre)
  - 2B. Biomass (industrial site)
  - 2C. WWHR (sewerage works)
- **Possible extension to new-builds**

Next Steps…

Scottish Borders Council will continue to explore opportunities that will help to decarbonise buildings through the use of manufacturing and emerging technologies and are happy to provide key contacts to allow communities and businesses to identify solutions.

Council encourage communities to develop their own decarbonisation ideas and explore options for individual properties, businesses and community solutions. Once a range of options have been identified, communities have access to range of resources to assist them in taking these forward.

See contacts and useful links at the end of this document.

Glossary

LHEES	Local Heat and Energy Efficiency Strategy, the Scottish Government policy that requires all Local Authorities to develop a strategy for decarbonising buildings in their area.
Net Zero	Cutting carbon emissions to a small amount of residual emissions that can be absorbed by nature, or Carbon Capture and Storage (CCS), leaving zero change in atmospheric levels.
Retrofit	Where new features and technologies are added to existing buildings. To achieve Net Zero that means anything that will make buildings more energy efficient or climate resilient through measures such as better insulation and installing renewable energy equipment.
ASHP	Air Source Heat Pump, which uses an external Fan Coil Unit to extract heat from the air.
GSHP	Ground Source Heat Pump, which uses a borehole or array of buried pipes to extract heat from the ground.
WSHP	Water Source Heat Pump, which extracts heat from water sources such as lakes and rivers.
COP	Coefficient of Performance, rating method for Heat Pumps of how many units of heat energy can be produced per unit of electrical energy used (ASHP typically 2-3, GSHP/WSHP 5-6). Sometimes referred to as SCOP which allows for Seasonal variability or performance.
HIU	Heat Interface Unit, the equipment that connects the pipes from a heat network to the space heating and hot water systems in a house instead of having their own gas or oil boiler.
DER	Distributed Energy Resources, involves generating power closer to where it's consumed utilising local resources like solar and wind, and energy storage like batteries, compared to traditional centralised energy generation.
Passivhaus	Certification scheme for buildings that provide very high levels of energy efficiency through things like insulation and airtightness. This can reduce the need for space heating to the extent that a conventional heating system is not needed.

Useful links

- For information about the Scottish Borders Local Heat and Energy Efficiency Strategy and Delivery Plan please visit: scotborders.gov.uk/lhees
- To view information and guidance on community engagement provided by Scottish Borders Council please go to: scotborders.gov.uk/say/community-engagement or email the team at communityengagement@scotborders.gov.uk
- South of Scotland Enterprise (SOSE) provide a range of services for enterprising communities, see: southofscotlandenterprise.com/community
- Scotland's Heat Network Fund overview and guidance for communities, see: gov.scot/publications/heat-network-fund-application-guidance/
- Heat in Buildings Strategy, see: gov.scot/publications/heat-buildings-strategy-achieving-net-zero-emissions-scotlands-buildings/pages/2/
- Home Energy Scotland (HES) energy and funding advice for homeowners: homeenergyscotland.org
- Business Energy Scotland (BES) offers business support: businessenergyscotland.org
- Local Energy Scotland (CARES) provides support for community schemes: localenergy.scot

Thanks to our partners

During the course of this project, we have consulted with various organisations, government agencies and private businesses that could help to progress a decarbonised heat strategy for Swinton. We would like to take this opportunity to thank them all for their invaluable advice and assistance.

We would also like to thank the community of Swinton for allowing us the opportunity to explore community-based decarbonisation solutions for this pilot project.

This document was produced as part of the LHEES Community Retrofit Pilot Project undertaken by Southern Uplands Partnership for Scottish Borders Council in 2024.

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