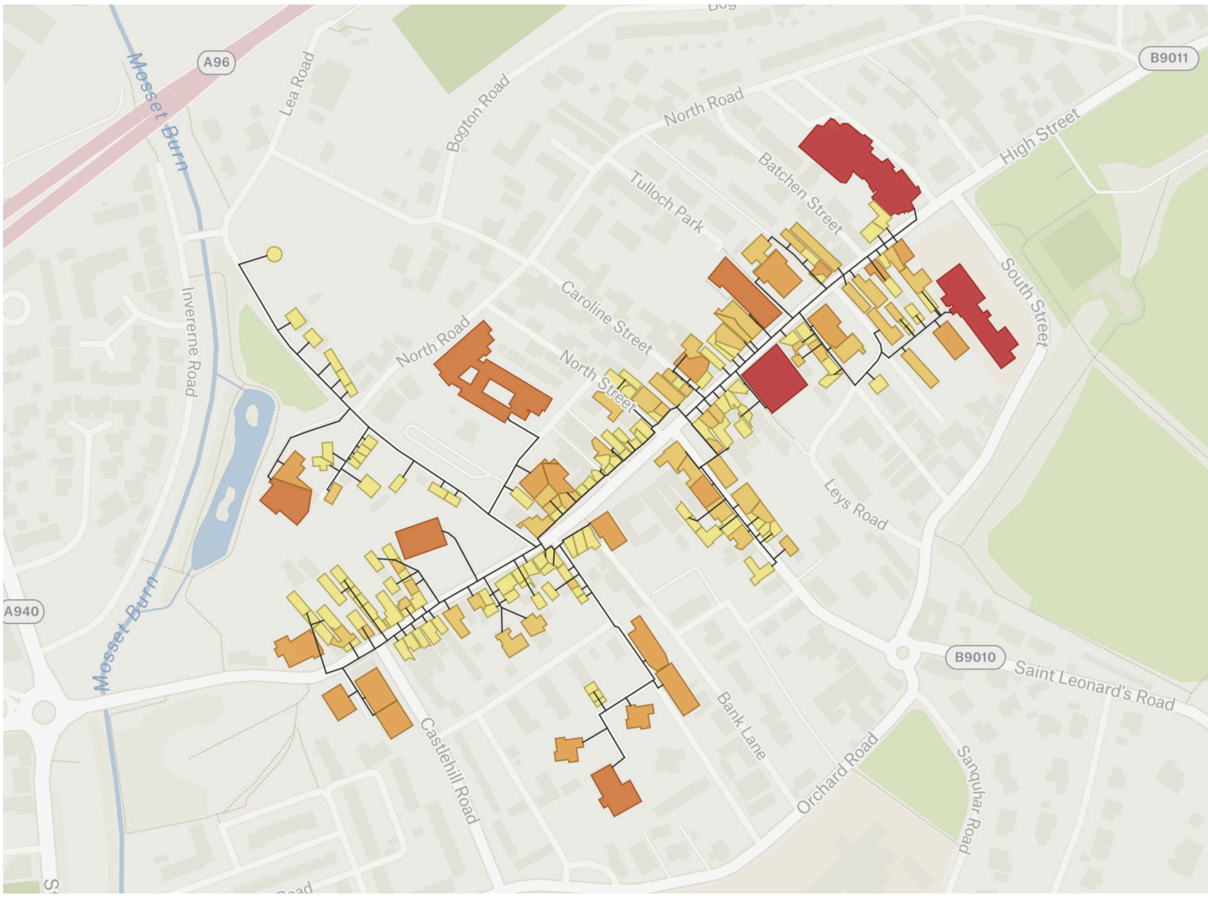
Community Heat Development Unit

Forres Heat Network Case Study



Funded by the Energy Redress Scheme

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Contents

Power and Energy Units

Term	**Description**
kW	Unit of power.
kWh	Unit of energy. For example a 3kW kettle running continuously for 1 hour consumes 3kWh of electrical energy.
MWh	1,000 kWh
GWh	1,000,000 kWh

1. Executive Summary

1.1. Introduction

The Community Heat Development Unit (CHDU) is an ambitious research and innovation project led by Sharenergy and funded by the Energy Redress Scheme that aims to jumpstart a wave of community owned low carbon heat networks in the UK. The focus of the CHDU[1] project is on centralised district heat networks inspired by the Bishop's Castle Heat and Wind project led by Lightfoot Enterprises[2] and Shropshire and Telford Community Energy[3].

Following a process of techno-economic modelling and a nationwide site search to identify locations which are best suited to district heating, Forres, in Scotland, was identified as a location to investigate further with a particular focus on the high street, an area already identified by Moray Council as having heat network potential in their Local Heat and Energy Efficiency Strategy[4]. This area is of particular interest since much of the building stock are Victorian terraced houses with minimal outdoor space, interspersed by dense blocks of flats and a number of public buildings owned by Moray Council. The hard to insulate nature of much of the housing in the area and lack of space to install individual air source heat pumps (ASHPs) means that connecting to a centralised heat network may be a more viable option for heating decarbonisation compared to installing individual heat pumps.

This case study reports on the potential for a community owned heat network in Forres, focusing on a model where most of the heat is supplied by large ASHPs with much of their electric demand met by a nearby community owned wind turbine. A CHDU project summary report and case studies at Bishop's Castle, Morecambe and Letchworth are published on the CHDU project website: https://communityheat.org.uk.

1.2. Proposed Low Carbon Heat Network

The proposed low carbon heat network aims to provide around ~90% of the annual heat demand of connected buildings using a large 1.69MWh_{th} ASHP with

[1] https://communityheat.org.uk
[2] https://lightfootenterprises.org/heat-network/
[3] https://stcenergy.org.uk
[4] Moray Council, (2024). Local Heat and Energy Efficiency Strategy

~10% of the heat being supplied by centralised gas back-up boilers. The heat sources would be installed alongside a 400m^3 hot water tank to store heat when it can be produced cheaply for use later.

It is necessary to reduce the cost of electricity consumed by the ASHP as much as possible to ensure financial viability of the network. Wind generation correlates well with heat demand, as it tends to be windier during the colder months when heat demand is higher. The proposed scheme includes the development of a ~3MW onshore wind turbine to supply around 90% of the electricity consumed by the ASHP. This wind turbine could potentially be located towards the north west of Forres and would supply electricity to the ASHP via a direct wire, exporting any excess generation to the electricity network. The wind turbine would be owned and operated as part of the heat network scheme. Allowances have been made for the costs associated with connecting the wind turbine to the grid however a grid connection application would need to be submitted to Scottish and Southern Electricity Networks to fully understand the costs and timescales involved.

Customers joining the scheme during the initial phase of construction would be offered a connection with no upfront costs. The scheme would charge customers for their heat usage in a similar manner to how gas and electricity is supplied. Customers would be charged an annual standing charge, roughly equivalent to the annualised costs of maintaining and replacing an individual gas boiler, and a unit price for heat consumed which would be metered on a per property basis. The overall price of heat would be comparable to the cost of heating a home using a boiler running on mains gas.

The main benefits to customers joining the scheme are insulation against the spikes in the global gas markets experienced in recent years and an investment free opportunity to decarbonise their heating. Centralised district heat networks also offer a low-hassle means of decarbonising domestic heating since they require little interference to the heating system within a home: all that is required is for the existing gas boiler to be switched for a heat interface unit and connected to the pipework main in the street. The scheme takes care of the maintenance of the network and heat interface units. There is an additional benefit that, by removing their gas heating system, customers can disconnect from the gas network and hence save on paying the daily gas standing charge, provided they have no other appliances which require gas.

1.3. Financial Performance

The scheme revenues are generated from heat sales and standing charges paid by heat network customers, and from the export of excess wind generation, not consumed by the heat network heat pumps, to the electricity network. Assuming ca. 200 domestic customers and ca. 120 non-domestic customers, mostly located along Forres High Street, joined the scheme the initial payback period is estimated to be 24 years, with a 25 year project IRR of 6.7% on a capital investment of £15.8m. The projected 25 year project balance is ca. £1.6m and the 50 year project balance is estimated as being ca. £22m following replacement of the wind turbine and heat generating after the first 25 years of operation. The overall project lifetime is modelled as 50 years, which aligns with the expected lifetime of the heat network pipework. These figures assume that a capital grant of ca. 50%[5] of the heat network capital costs can be awarded by Scotland's Heat Network Fund.

The Scheme's main financial challenge is matching or reducing the annual energy cost of customers compared to mains gas heating systems. Currently gas prices are low (7.4p/kWh[6]) compared to electricity, at these prices the Scheme is only just financially viable assuming heat is sold by the network at an equivalent price.

The viability of the scheme is dependent on achieving an average cost for connecting each property to the network of around £8,500, excluding the cost of installing pipework from the network main to the property. Estimates by Buro Happold[7] suggest that the cost of connecting a domestic house could be ~£9,000 in 2025 prices. Scheme finances could be improved by charging the public sector and larger non-domestic anchor loads a higher connection fee but set at a price which is less than the cost of these buildings decarbonising their heating on an individual basis. It has been suggested that the Home Energy Scotland Grant[8] may be extended to fund heat network connections which will greatly benefit the finances of the proposed heat network in Forres.

[5] This grant amount is equivalent to ~30% of the total costs of the heat network Scheme when the costs of installing the wind turbine and grid connection are included.
[6] Assuming an oil boiler efficiency of 84%.
[7] https://www.usdn.org/uploads/cms/documents/161214_-_connecting_existing_buildings_to_dhns_-_technical_report_00.pdf
[8] https://www.homeenergyscotland.org/home-energy-scotland-grant-loan

Approximately 40% of the Scheme's income is from the sale of grid electricity. There is a risk that the export of excess wind generation will be limited due to constraints on the upstream transmission network; however a G99 grid connection application will need to be submitted to SSEN before the extent of this is understood.

1.4. Governance

If the scheme progresses a new Community Benefit Society (CBS) would need to be set up to own the wind turbine and manage the Scheme. A CBS would enable a share offer to be launched ensuring community ownership of the Scheme, including the wind turbine. It is anticipated that this CBS would contract out much of the development, operation and maintenance activities to skilled contractors, while ensuring local ownership and governance.

If a local CBS were to develop a heat network in Forres, they will need a high degree of support. We envisage a federated system where multiple individual societies are supported by a specialised centralised development, advice and administration service with the addition of well supported peer to peer learning between the societies. Unfortunately, we do not think the time is right for setting up this centralised service at this point as options for viable heat networks are so limited. However, the ideas for such a service developed as part of this project should be further developed for the future.

1.5. Supply of Local Electricity

The CBS could also act as a license exempt Class A Small Supplier[9] to benefit from the recent BSC P442 Modification[10] which can enable some cost savings (expected to be up to ~5p/kWh) when wind generation exported to the grid is matched to consumption on a half hourly basis. Benefit is limited to Class A Small Suppliers who supply up to a maximum of 5MW of electricity (or 2.5MW if supplied to domestic customers).

[9] UK Government, (2001). The Electricity (Class Exemptions from the Requirement for a Licence) Order 2001
[10] Ofgem, (2024). https://www.ofgem.gov.uk/decision/approval-bsc-modification-p442

Additionally, if the P441[11] modification to the local energy trading rules is approved, the CBS, acting as a Small Supplier, could also potentially supply a significant proportion of Forres with low-cost electricity alongside the heat network. This is because most of Forres is supplied by the same primary substation and is expected to be considered "local" to the proposed wind turbine following implementation of P441. This would strengthen the scheme's revenue stream and, by reducing the cost of purchasing locally generated electricity, potentially enable customers who are not located on the heat network route to decarbonise their heating using individual heat pumps.

1.6. Conclusions and Next Steps

A centralised heat network is proposed which aims to deliver an affordable solution to decarbonising the heating of both domestic and non-domestic properties. The scheme would supply heat through a centralised energy centre connected to a local distribution network, and export surplus electricity to the national grid. This provides a dual revenue scheme: stable income from long-term heat supply agreements and additional income from sales of wind generated electricity which is not consumed by the network heat pumps. The proposed Forres heat network is projected to reduce carbon emissions from heating for those joining the scheme by 90%.

The scheme offers customers a low-carbon alternative to fossil-fuel heating without requiring them to fund the upfront cost of installing individual heat pumps as customers will be able to join the initial phase of the scheme at no upfront cost. Ongoing heat tariffs are structured to match the cost of heating properties with gas central heating and provide customers with cost certainty and protection against future volatility in global energy markets. Long-term operation and maintenance of the network, including lifecycle replacement of plant, are factored into the scheme's business model, ensuring reliable heat delivery across its 50-year life.

The success of the scheme depends on achieving sufficient customer density within the network area at the point of construction. Heat network economics typically favour early connection of as many properties as possible, as retrofitting connections at a later stage is more costly. This creates a strong

[11] Ofgem, (2024).
https://www.ofgem.gov.uk/decision/dcp441-proposal-increase-number-allowed-change-report-alternative-variations-two-three-authority-decision

incentive for local stakeholders to coordinate demand aggregation in the early phases of deployment. The scheme also relies on a suitable regulatory environment and access to power purchase agreements to maximise the value of exported wind generated electricity.

The two main priorities should be establishing local support and progressing the development of the community owned wind turbine. It is essential that local community support is demonstrated for a community owned heat network scheme to progress. A local event in Forres organised by Sharenergy and Community Energy Moray had 10 attendees, including representatives from local organisations and Graham Leadbitter, the Scottish National MP for Moray West, Nairn and Strathspey, and Shadow SNP Spokesperson for Energy Security and Net Zero. A follow-up webinar is planned for later in the autumn. It is anticipated that attendance of scheme advocates at local events will be essential in establishing local support. Local advocates for such a scheme should get in touch via chdu@sharenergy.coop to register their interest and continue discussions about how the scheme could be progressed.

Figure 1: Charlotte Goodwind of CEM, Graham Leadbitter MP and Ben Cannell at the public event in Forres

Should local support be demonstrated, a more detailed feasibility study is recommended to develop the heat network proposal to the stage where an application to the Scottish Heat Network Fund can be submitted alongside a planning application for the community owned wind turbine.

2. Community Heat Development Unit Project

2.1. Overview

The Community Heat Development Unit (CHDU) is an ambitious research and innovation project led by Sharenergy and funded by the Energy Redress Scheme that aims to jumpstart a wave of community owned heat networks in the UK.

The experience of community heat network projects in the UK is that many are suggested, but few are successful. We want to bring a data-led approach to identifying where the best chances for successful community heat networks are – drawing on work that has already been done but adding the crucial element of community ownership that is Sharenergy's specialism.

This 2 year project focussed on identifying possible locations where a domestic focussed low-carbon heat network could operate and developing a business model that can operate in these 'sweet spots', as well as a Community Heat Delivery Unit to support the development of locally-owned networks.
More information about the CHDU project is available online at https://communityheat.org.uk.

2.2. Site Identification

A site search across mainland GB has been conducted to identify the most feasible locations where a centralised heat network incorporating large air source heat pumps and on-site renewable electricity generation could be developed. Specifically, these are areas the CHDU techno economic model has identified as being able to generate enough income through sales of heat and electricity to pay off the loans required to finance the projects.

The sites identified during this process were correlated with locations of existing community energy organisations who were interested in collaborating on a heat network project. Working with Local Energy Scotland's[12] Community

[12] Local Energy Scotland, https://localenergy.scot

Heat Development Programme, Forres was identified as a suitable location to conduct a low carbon heat network case study.

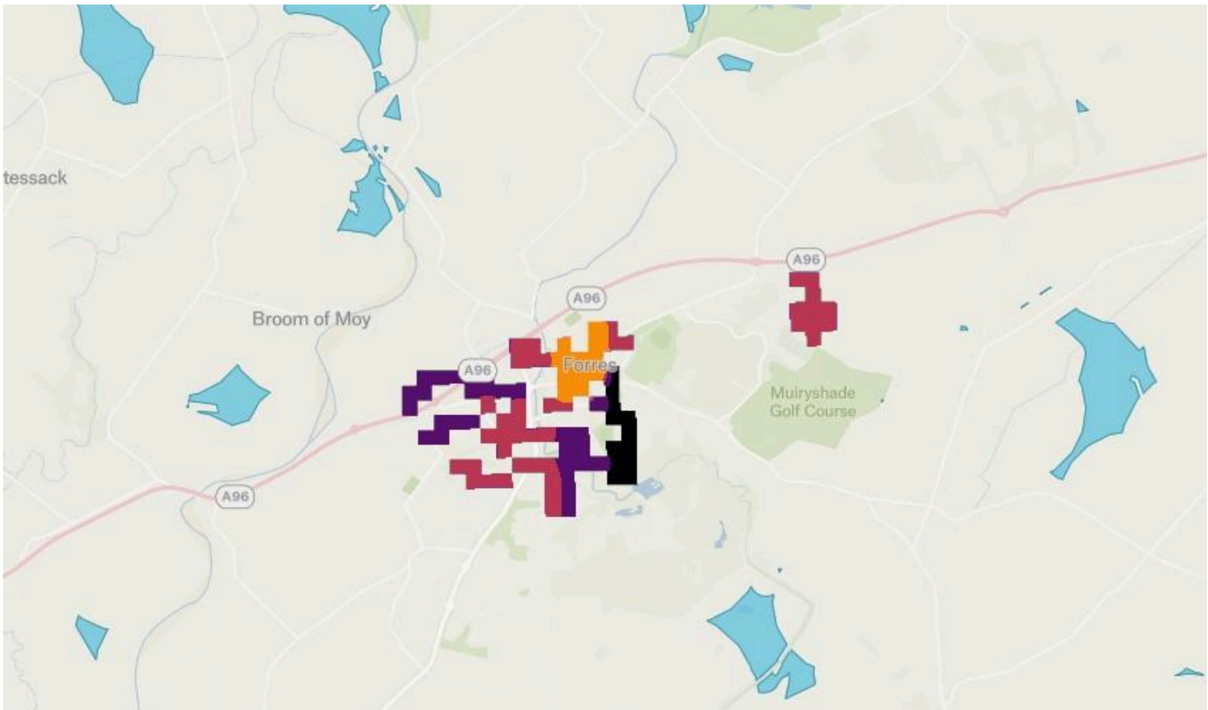

Figure 2: Potential network locations (yellow-black) and wind sites (blue)

A site centered around Forres High Street was selected due to the possibility of linking non-domestic anchor loads with high density, solid wall terraces. These properties face challenges in moving to individual heat pumps and the heat network allows for the potential for adding wind generation. While other potential sites in the area could offer better payback periods, these sites tended to include non-domestic buildings only, which goes against the principals of the CHDU project which is aiming to support communities to decarbonise their homes.

3. Network Focus Area

This case study investigates the heat network potential of an area in the north-east of Forres. The area under investigation is fairly well defined by the seven Output Areas highlighted in the figure below, defined in this report as the *focus area*.

Figure 3: The highlighted Output Areas are well aligned with the heat network focus area

3.1. Residents of Forres

Forres is a historic town situated in Moray, northeast Scotland. Located near the Moray Firth and surrounded by agricultural land, the town is a key service centre for the wider rural area, offering a range of amenities, schools and small businesses. The town has a population of approximately 10,000 residents with the average age being higher than that of the Scottish national average. While parts of Forres are among the least deprived in Scotland, one area (in red, below) which is covered by the heat network focus area, is among the 20% most deprived in Scotland[13].

[13] Scottish Index of Multiple Deprivation, (2020). https://simd.scot/

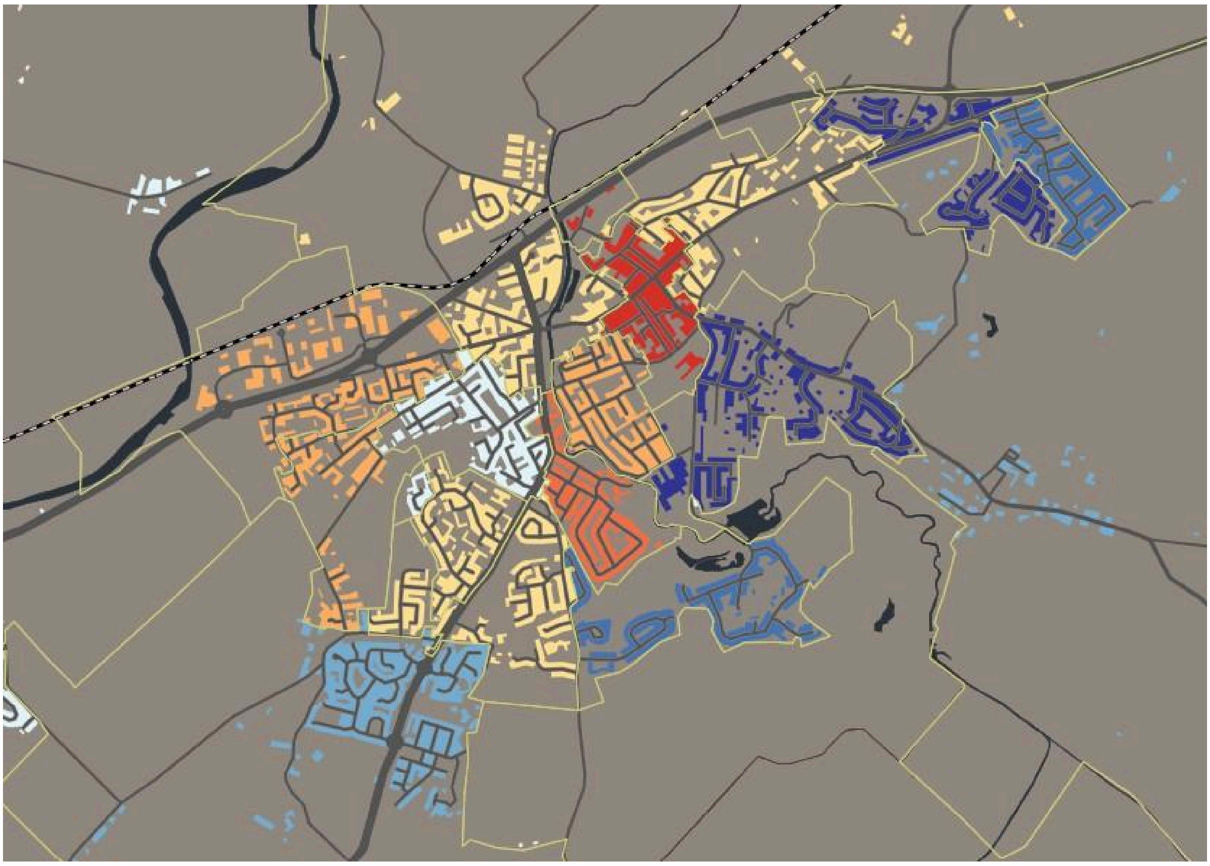

Figure 4: Deprivation in Forres (Blue to red: Least deprived to most deprived)

Forres has a mix of housing stock, including traditional stone-built homes, post-war developments and newer energy-efficient builds.

Compared to the rest of Scotland, Forres has a lower proportion of ethnic minority groups, and a slightly lower average of people classified as disabled. It has a higher proportion of social renters, low-income households, and homes lacking modern heating systems. Engaging with this community will be essential to ensure that any energy transition is inclusive and responsive to local needs.

3.2. Housing Profile & Suitability

The housing density per hectare within Forres is illustrated in Figure 5. The High Street has the highest building density in the town suggesting this area is most suitable for heat network development.

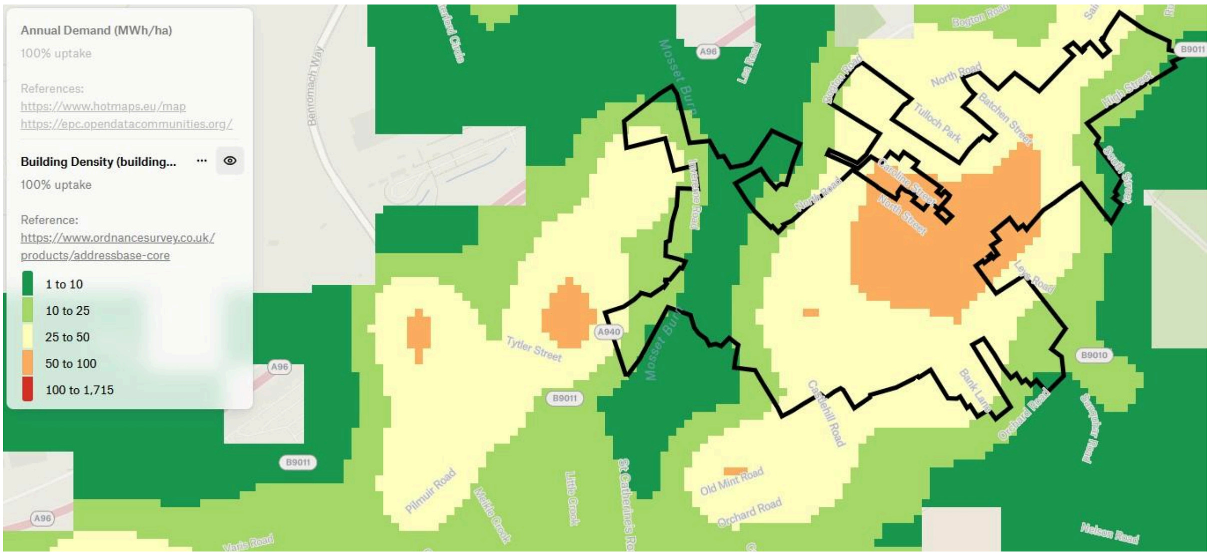

Figure 5: Building density within Forres focus area

An understanding of local housing types is essential in assessing the suitability and design of a heat network. The table below compares the distribution of housing types in the focus area and the national average for Scotland.

Housing Type	Focus area	Scotland[14]
Detached house	18.9%	23.9%
Semi-detached house	14.8%	23.3%
Terraced house	15.4%	18.2%
Purpose-built block of flats or tenement	39.1%	32.4%
Flats in converted or commercial buildings	9.7%	2.0%
A caravan or temporary structure	0.3%	0.2%

Table 1: Housing Types in the focus area vs. Scotland

3.2.1. Key observations

Lower proportion of detached housing

Detached homes account for 18.9% of the housing stock in the focus area, slightly below the national average of 23.9%. This suggests fewer high-footprint properties and more limited scope for technologies that require external space, such as individual ground or air-source heat pumps.

[14] Scotland's Census, (2022). https://www.scotlandscensus.gov.uk/

Low prevalence of semi-detached homes

Semi-detached properties represent 14.8% of all homes in the focus area, considerably lower than the national average (23.3%). While these homes are often suitable for energy retrofit measures and individual ASHP installation, their lower density can pose challenges for the cost-effectiveness of connecting them to a centralised heat network due to the additional pipework required.

Lower share of terraced housing

Terraced houses make up 15.4% of the housing stock, significantly below the national figure of 18.2%. While originally built as single-family dwellings, many of these buildings have since been subdivided into flats. Typically 2-3 storeys high, they are constructed with solid brick or stone walls under slate roofs, often featuring sloping ceilings and room-in-roof (RiR) layouts. These factors limit the scope for fabric-first improvements, particularly where cavity or external wall insulation is not viable.

The area's high urban density, characterised by narrow back lanes and very small rear yards, makes the installation of individual ASHPs particularly challenging. However, this density is an advantage for the viability of a heat network, as less pipework is needed per property, improving both installation efficiency and long-term operating costs.

Figure 6: Three storey buildings in the focus area

Figure 7: Example of rear of buildings in the focus area

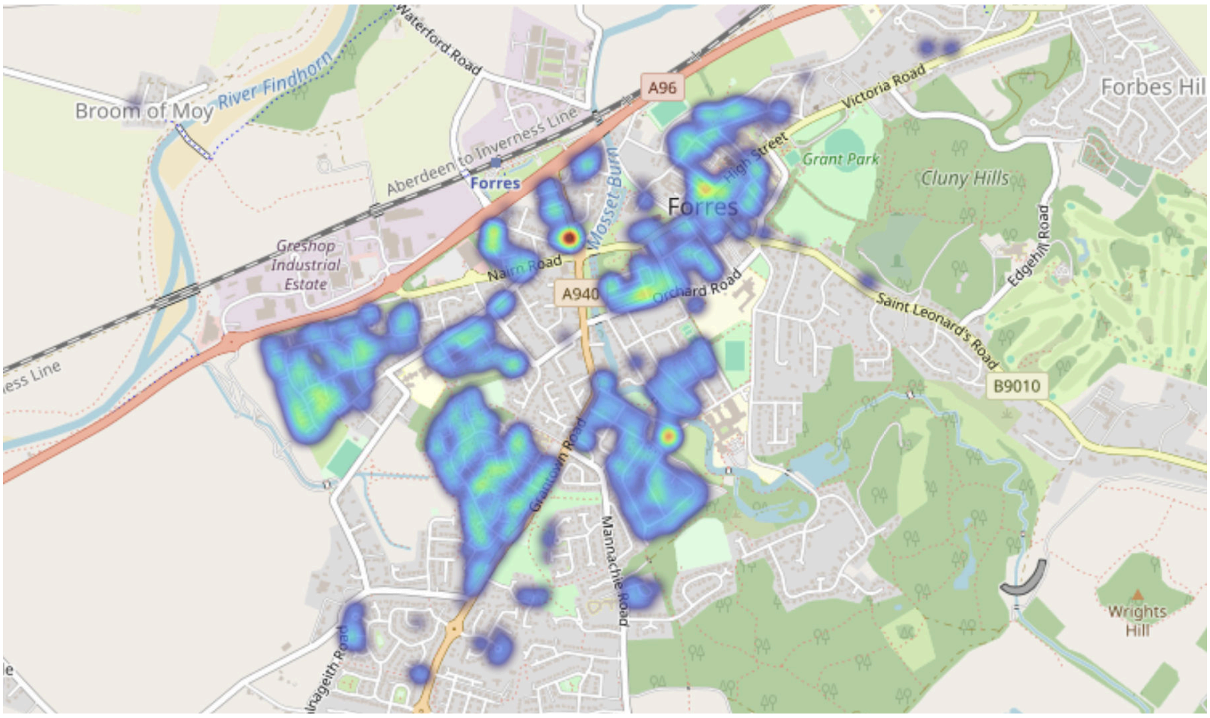

Figure 8: Density of terraced housing in Forres based on EPCs (red=more dense)

High concentration of flats

The focus area includes a particularly high proportion of flats. Notably, 9.7% of homes are flats located in converted or commercial buildings, substantially higher than the national average of 2%. These properties often sit above shops or businesses and are typically harder to retrofit due to poor energy performance, fragmented ownership, and complex tenancy arrangements. Upgrading them individually can be difficult, making building-wide or communal heating systems a more viable approach.

In addition, purpose-built flats account for a further 39.1% of local housing stock, compared with 32.4% nationally. Altogether, flats of all types make up 48.8% of homes in the area, well above the Scottish average of 34.4%. This high prevalence of multi-residential dwellings strongly supports the case for shared or communal heating solutions, which are often more cost-effective and technically feasible than building-by-building interventions.

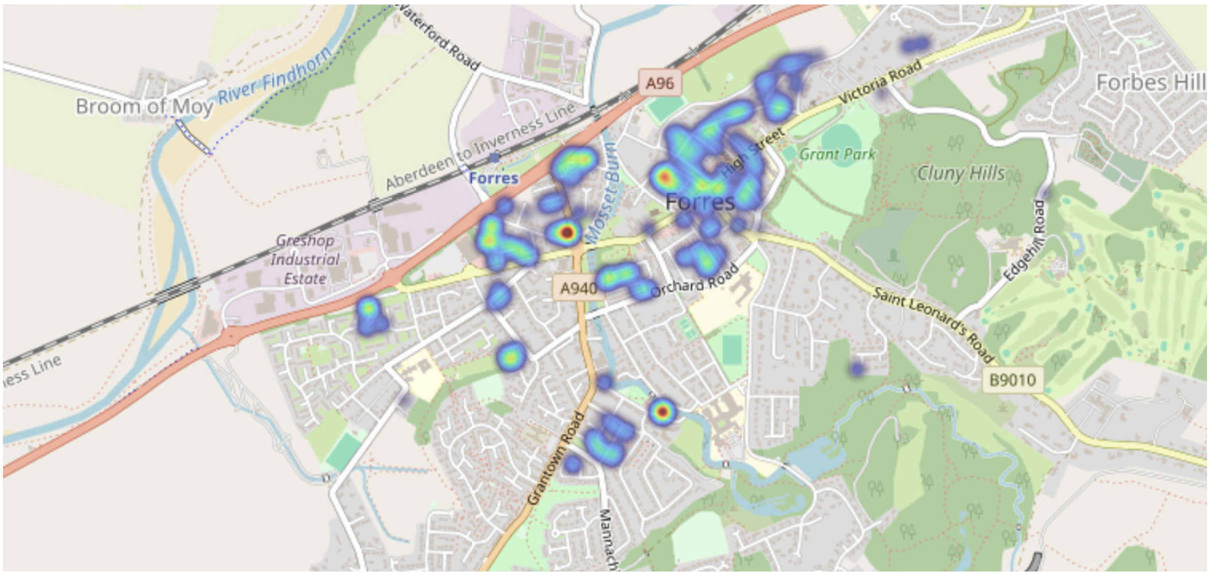

Figure 9: Density of flats in Forres based on EPCs (red=more dense)

3.3. House Tenure and Vulnerability

Table 2 presents the proportion of tenure types of buildings across the Forres focus area.

Tenure Type	Forres focus area	Scotland[15]
Owned	52.0%	62.3%
Shared ownership	0.0%	0.9%
Social rented	22.4%	22.5%
Private rented	22.9%	12.9%
Rent free	2.2%	1.4%

Table 2: Comparison of tenure type in the Forres focus area and Scotland (2022 Census)

[15] Scotland's Census (2022). https://www.scotlandscensus.gov.uk/

High Proportion of Rented Homes

According to the 2022 ScottishCensus, 45.3% of households in the Forres focus area rent their homes, compared with 35.4% nationally. This includes:

- 22.9% in the private rented sector (compared to 12.9% nationally)
- 22.4% in social rented housing (compared to 22.5% nationally)

The large private rental sector, compared to the national share, combined with the high number of converted flats, typically points to older housing stock. These dwellings often have outdated layouts, variable energy efficiency, and fragmented ownership structures, which can create challenges for implementing whole-building retrofit or heating solutions. In these cases, private landlords may have limited incentive to invest, particularly if tenants are responsible for energy bills.

The proportion of social housing in the focus area (22.4%) is similar to that nationally (22.5%). Social landlords are often key early adopters and there may be leverage from housing associations or councils as anchor clients for a heat network.

Low Proportion of Owned Homes

A lower proportion of homes in the focus area are owned (52.0%) in comparison with Scotland (62.3%), suggesting that there are fewer financially secure households with the power to opt in to a heat network or fund their own heat pump installations.

3.4. Estimate of Heat Demand

An estimate of the density of annual heat demand across the heat network focus area is presented in Figure 10. The demand density is derived using datasets from the Hotmaps[16] project and Display Energy Certificates[17] using a process described in detail on the CHDU project website[18].

[16] https://www.hotmaps-project.eu
[17] https://epc.opendatacommunities.org
[18] https://communityheat.org.uk/interactive-map/thermal-demand-mapping/

Figure 10: Heat demand density in the Forres focus area

The heat demand density suggests the heat network should be centred about the High Street area with Andersons Primary School acting as one of the anchor loads, as circled in red to the east side of the map. The red area to the bottom of the image is Forres Swimming Pool and Fitness Centre and Forres Academy, which are not included in the proposed network for reasons discussed in Section 8 of this report.

4. Community Engagement

During the course of the CHDU project Sharenergy have discussed the proposed heat network with the following local stakeholders:

- Moray Council
- SSEN
- Community Energy Moray
- AES Solar
- Moray Climate Action Network
- Local Energy Scotland

A public event in Forres was organised where the CHDU project and proposed heat network was discussed in addition to Community Energy Moray (CEM) presenting their community energy projects. The event was attended by 10 people from the local area including representatives from CEM, Moray Climate Action Network, AES Solar, tsiMoray and local residents and community advocates. Graham Leadbitter, the Scottish National MP for Moray West, Nairn and Strathspey, and Shadow SNP Spokesperson for Energy Security and Net Zero was also in attendance. The attendees were generally supportive of the proposed scheme however it is not yet clear which local organisations would be willing and able to act as local advocates for the heat network project.

5. Community Benefits

The proposed community heat network in Forres offers a wide range of social, economic, and environmental benefits. These are particularly significant for areas experiencing higher rates of fuel poverty, limited heating infrastructure, and economic challenges.

5.1. Affordable, Stable Heating Costs

The network aims to deliver heat at a price comparable to traditional gas heating, which will be significantly cheaper for households currently reliant on electric heating:

- Local census data reveals a higher-than-average density of electric storage heaters in the area. These homes stand to benefit the most from the shift.
- Locally generated renewable electricity used within the network will help shield residents from spikes in national energy prices, offering long-term price stability.

Addressing Local Heating Needs

The table below shows the percentage of households with different heating systems in the proposed location:

Type of central heating in household	Focus area	Scotland
No central heating	3.8%	2.1%
Mains gas only	66.3%	73.4%

Type of central heating in household	Focus area	Scotland
Tank or bottled gas only	0.5%	1.3%
Electric only	15.4%	9.0%
Oil only	0.0%	5.1%
Wood only	0.3%	0.5%
Solid fuel only	0.0%	0.3%
Renewable energy only	4.0%	1.1%
District or communal heat networks only	3.2%	0.5%
Other central heating only	0.8%	0.5%
Two or more types of central heating	7.8%	6.1%

Table 3: 2022 Census statistics on existing heating systems in the proposed heat network location

While mains gas is the dominant heating source in the focus area, its usage is notably lower than the national average (66.3% vs 73.4%). This is consistent with Forres' housing stock, which has fewer detached and semi-detached homes, and more flats, especially in converted buildings, where gas retrofitting may be less viable.

The area also shows a higher reliance on electric systems (over 15% in the focus vs 9% nationally). This makes the area a prime candidate for alternative, more efficient heating systems, although the cost of connecting buildings without existing wet heating systems to a heat network is higher.

The 3.2% of properties which are already connected to a district or communal heat system are flats within the Varis Court, Hanover Housing development. It is understood that these flats are currently heated by a gas communal heating system. This development is well suited to connecting to a district heating system, since it is only the centralised gas boiler which would need to be replaced by a heat exchanger, requiring no interference with the heating systems of individual flats.

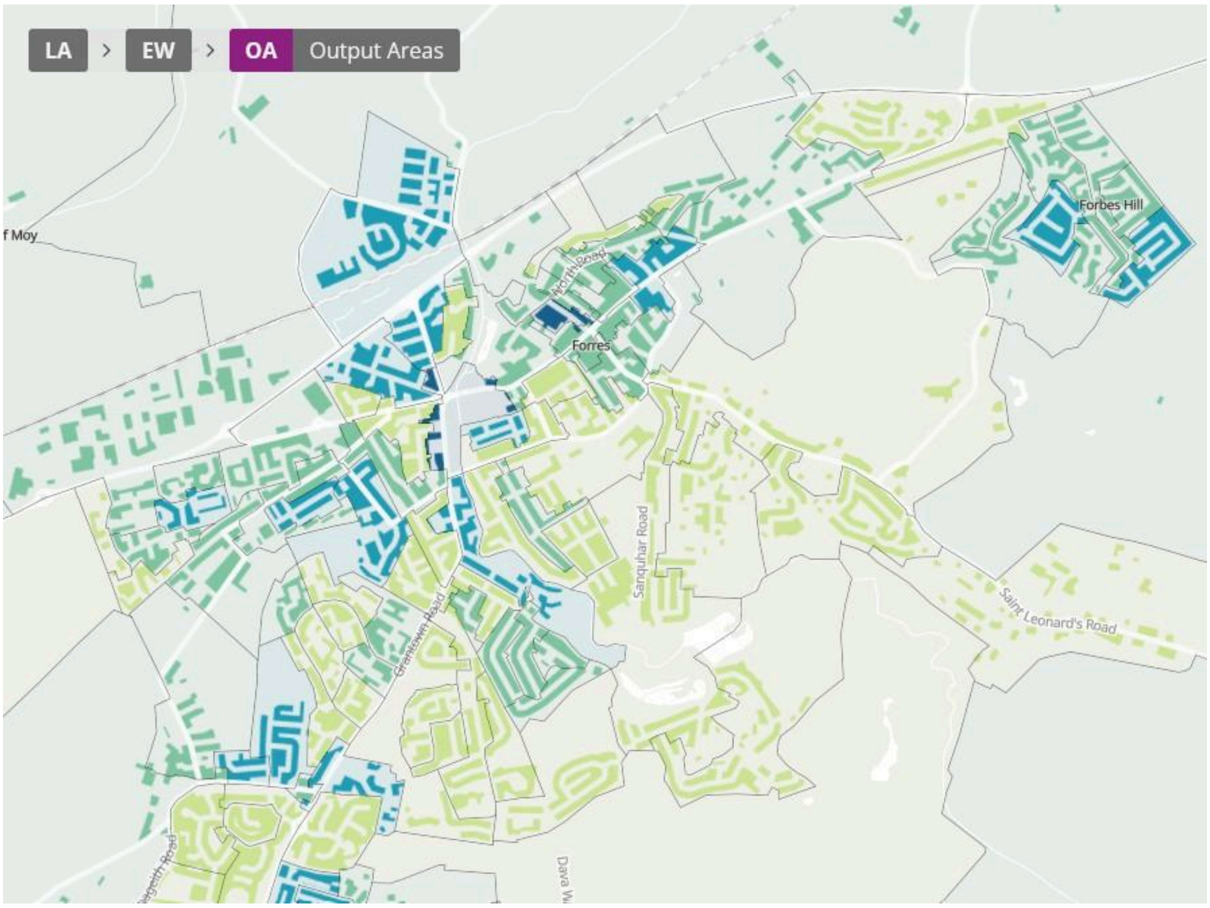

Figure 11: Density of buildings on electric storage or room heaters

There is a strong correlation between houses on electric storage or room heaters and houses which are privately rented. Joining the proposed heat network benefits landlords of electrically heated properties two fold since it will improve the EPC ratings of the buildings whilst providing some of the funding to install the heat interface unit and network connection up front.

5.2. Tackling Fuel Poverty

While data is not available for the focus area specifically, fuel poverty is a significant local issue, with rates in in the wider Moray area at 32%[19], significantly higher than the national average of 24%[20]. Properties with gas or electric heating are exposed to fluctuations and price spikes in the global energy markets, such as those experienced in 2022 when Russia invaded Ukraine. A community led centralised heat network which uses local wind generation to supply much of the electricity to the heat pumps, insulates customers from price shocks and offers them improved cost certainty.

[19] 2023 data, http://www.domesticenergymap.uk/
[20] The Scottish Fuel Poverty Advisory Panel, 2025 Fuel poverty in rural and remote Scotland

Well designed wet heating systems should improve the comfort of residents compared to electric storage heaters and reduce their daily heating costs. The heat network connection offer of supplying each customer with a heat interface unit and connecting their property to the heat main avoids the upfront cost of a landlord or owner-occupier looking to upgrade their heating system.

5.3. Reliable, Low Carbon Heat

Community heat networks can offer greater reliability than aging individual heating systems. The use of renewables and low-carbon infrastructure contributes to lower greenhouse gas emissions and supports the broader goal of balancing carbon production and reduction. Air quality in Forres is generally considered good, but a reduction in gas boiler usage may offer additional local benefits.

5.4. Social and Economic Impact

Local job creation may be supported through construction, operations, and maintenance. Community infrastructure projects can provide training and employment pathways. Community ownership and participation in the project fosters local pride, collaboration, and cohesion, helping to strengthen neighbourhood resilience.

While the project contributes to national climate goals, its primary aim is local: to provide affordable, clean, and dependable heating for the residents of Forres.

6. The Heat Demands and Opportunity

6.1. Why Install a Heat Network?

'Heat Network' is the term now used for 'district heating' (DH) or 'community heating'. Heat networks are the interconnection of heat loads such that they can be served from centralised heat sources.

Heat networks currently provide 2% of UK heat demand and the Committee on Climate Change estimated in 2015 that with Government support, they could provide 18% of heat demand by 2050 in a least-cost pathway to meeting carbon targets.

Heat network advantages include:

- The load diversification across a heat network and the use of thermal storage means the capacity of the central Energy Centre is smaller than the sum of the capacities of plant installed for heating each building. There is also better utilisation and possible higher operating efficiencies from expensive low-carbon heating plant such as heat pumps.
- Flexibility to change the heat source, and scope to locate plant at an optimum location e.g. a heat pump that takes heat from a river can be located near to that river; a heat network initially heated by biomass can be switched to heat pumps at a later date.
- Enables removal of individual boilers in each building.
- Heat network connection equipment in each building requires very little maintenance and no legally required gas safety check, as is required for gas boilers.
- Allows for simpler inclusion of thermal storage. Thermal storage is a tried and tested, low risk technology, and can be up to 100 times cheaper per unit of energy stored than batteries.

Larger/centralised plants offer a number of advantages:

- Can be cheaper to build and operate than boilers/heat pumps in each building.
- The higher operating efficiencies of centralised plant mean low-temperature 4th generation heat networks (~65℃ flow temperature) can be more efficient than individual systems and should be able to make use of existing heating systems within buildings without the need for expensive and disruptive retrofit.
- Maintenance costs usually lower per unit of heat generated.
- Easier to achieve direct supply of cheaper electricity from local renewable generation to heat pump.

Heat networks are an established technology, although more common in other countries. For example, over 60% of homes in Denmark are heated from a heat network, and many of these are community owned. In the UK heat networks are less common and tend to be in cities, e.g. in London Battersea Power station used to heat thousands of homes in Westminster before it closed, and all the sports and other buildings on the Olympic Park in east London are on a heat network. On a smaller scale the best example is the low carbon heat network installed in the village of Swaffham Prior[21], east of Cambridge.

6.2. Energy Performance Certificates

6.2.1. What is an EPC?

An Energy Performance Certificate (EPC) rates the energy efficiency of a building on a scale from A (most efficient) to G (least efficient). EPCs are legally required when a property is built, sold, or rented. The rating is based on the building's construction and energy systems, such as insulation, heating, and lighting, not on how energy is actually used by its current occupants.

While EPCs are now widely available, it's important to note that not all properties have one, particularly older homes that haven't changed hands or been rented in recent years. Owner-occupied homes, especially those owned long-term by older residents, may be underrepresented in EPC datasets. Homes with EPCs may not represent all homes in an area, but because EPCs are required for sale or rental, they are likely to form a broadly representative sample of the local housing stock.

EPC data can still provide valuable insights into overall housing efficiency and help identify areas that may benefit most from energy improvements, like those targeted by a community heat network.

6.2.2. EPCs in the Proposed Heat Network Location

Comprehensive EPC data for the focus area is not available and what data there is, is from 2018, however the table below shows the percentage of households by EPC rating:

EPC energy rating	Forres (2018)[22]	Scotland (2023)[23]
A-B (Most Efficient)	4.9%	7%
C	42.1%	49%
D	39.5%	34%

[21] Swaffham Prior Heat Network
[22] 2018 data, GreenSCIEES
[23] 2023 data, https://www.gov.scot/collections/scottish-house-condition-survey/

E	11.1%	7%
F	1.9%	2%
G (Least Efficient)	0.4%	1%

Table 11: Domestic EPC ratings in Forres and Scotland

Majority of Homes Rated C or D

A combined 81.6% of homes are rated C or D, in line with the national average (83%). C rated homes are the most common, with 42.1% of homes in this band. While C-D ratings are considered "average" efficiency, C is now the target minimum rating for future energy efficiency policy for landlords, from 2030. Figure 12 presents the spread of C- and D-rated domestic properties in Forres, including in the focus area.

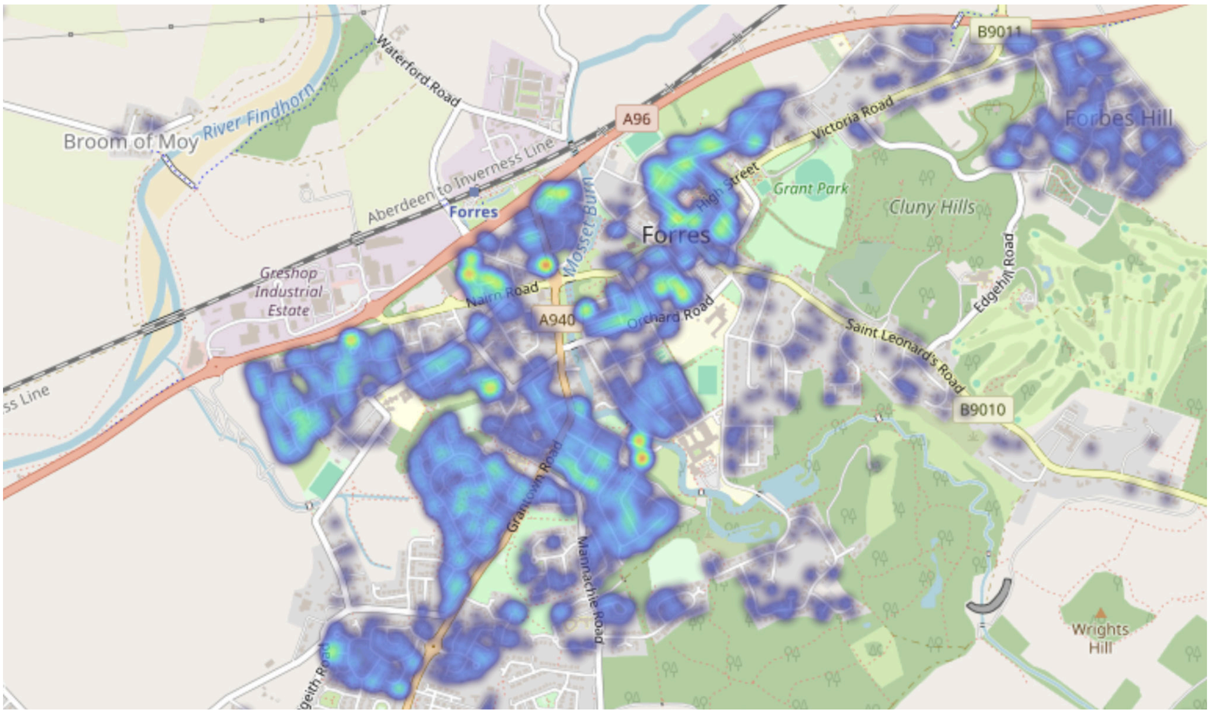

Figure 12: Location of domestic properties in Forres with EPC rating of C or D

Low Proportion of Low-Efficiency Homes

An E rating is currently the minimum required EPC rating for private rental properties, with F and G rated homes considered to be very inefficient. 13.4% of homes in Forres are rated E, F or G compared with 10% nationally, Figure 13 shows a high concentration of these lower rated properties are located in the focus area.

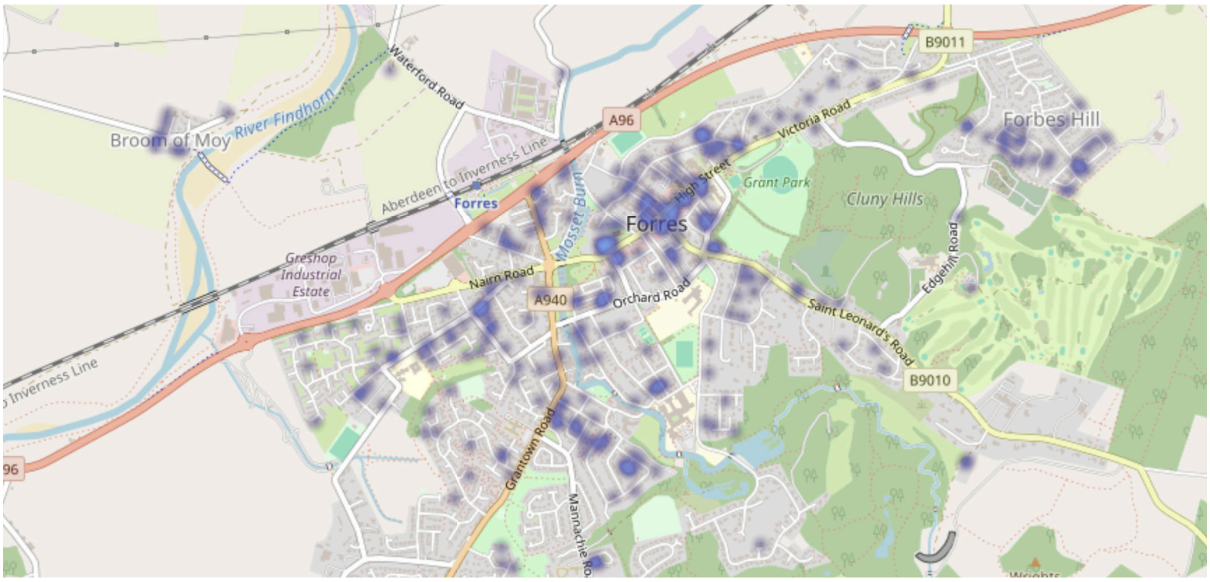

Figure 13: Location of domestic properties in Forres with EPC rating of E-G

It appears that housing stock in the focus area may be significantly less energy efficient than the rest of Forres, with almost no high efficiency homes (A-B), and a higher-than-average number of low-rated properties (E-G), reflecting a legacy of older housing, limited investment in retrofit, and potentially a high proportion of rented or subdivided homes. Figure 14 shows the location of domestic properties with an EPC that were built before 1919, and the majority are located in or near the focus area.

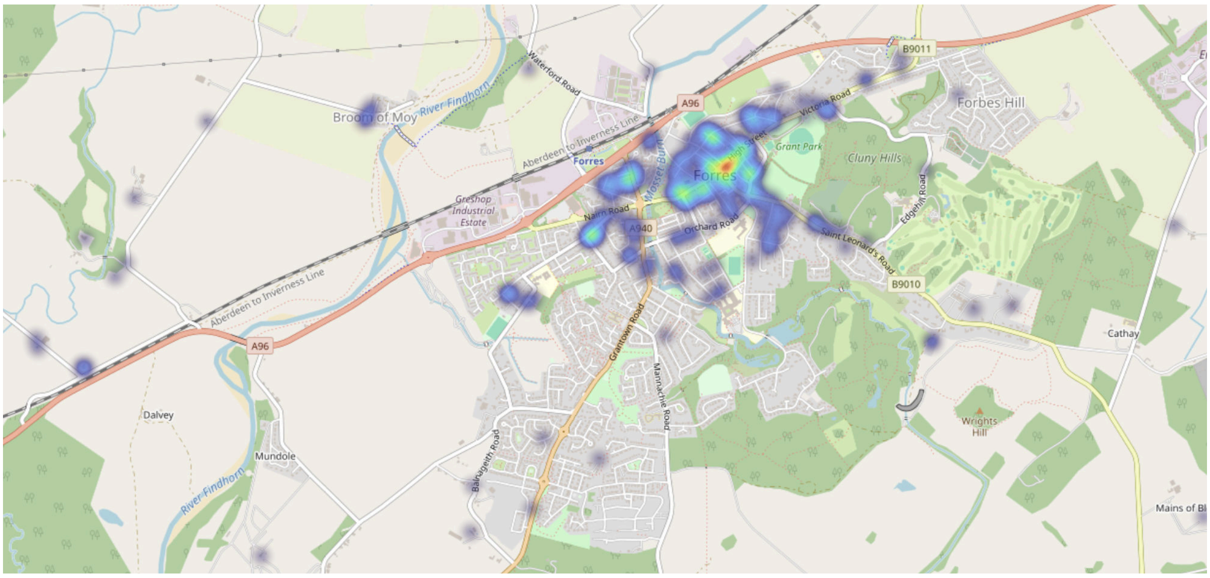

Figure 14: Location of pre-1919 domestic properties in Forres with an EPC

The figure below shows the location of terraced housing in the focus area

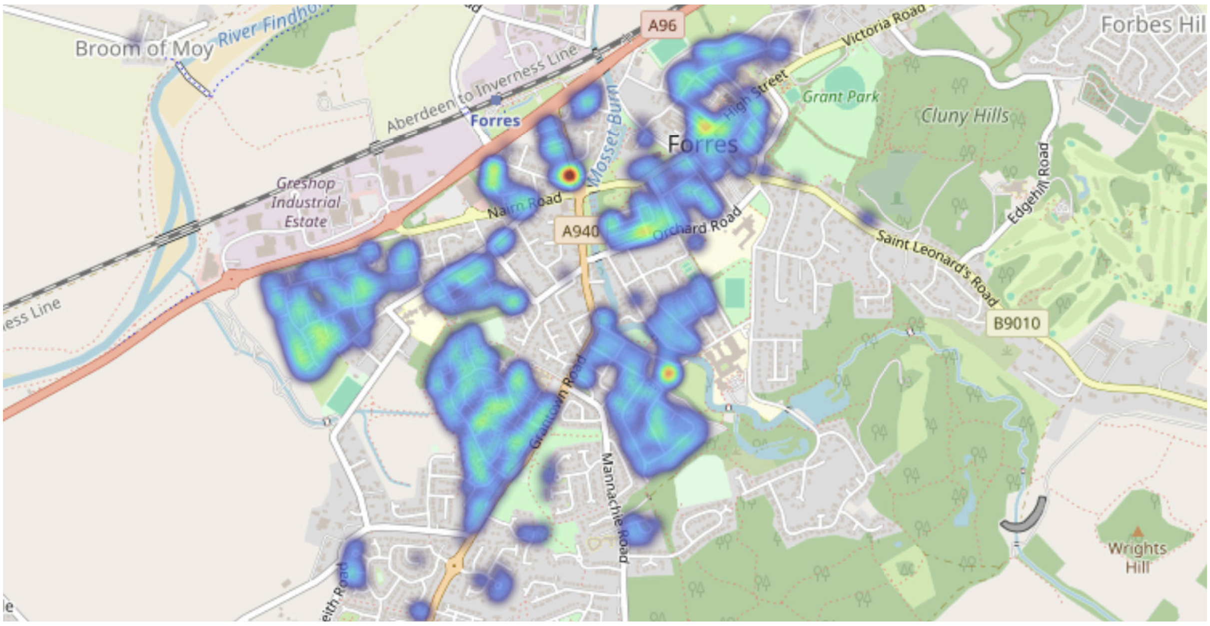

Figure 15: Location of terraced housing in Forres with an EPC

6.3. Existing Heating Systems

There are pros and cons to connecting any existing heating system to a new heat network. As reported in Table 5 the majority of houses in the case study area have gas central heating (66.3%) or electric heating (15.4%).

6.3.1. Gas central heating

A gas central heating system typically consists of a gas boiler and radiators. Gas central heating already has a wet system (radiators and pipes) in place, and, since the proposed heat network will operate at a similar flow temperature to a gas boiler, they can often be reused. These systems are common in the UK, so retrofit experience is well developed and the systems will be familiar to installers, meaning that it will generally be relatively straightforward to swap the existing gas boiler with a heat interface unit (HIU).

The challenges of connecting an existing gas central heating system to a centralised heat network are that gas disconnection and boiler removal will be required.

6.3.2. Direct Electric Heating

Direct electric heating systems include storage heaters, panel heaters or fan heaters. They are often installed in flats or hard-to-retrofit homes where the installer wants to avoid fitting pipes and are more common in fuel-poor or hard-to-heat homes. As they do not have existing pipework or radiators, full installation of a wet system will be required, which may be costly and disruptive due to the potential need to open up walls and floors.

6.4. Heat Anchor Loads

Anchor loads are buildings with a large, consistent heat demand, giving a predictable baseline heat consumption. Heat networks are most efficient when operating steadily, and a consistent anchor load helps to ensure that heat pumps run at optimal levels. Anchor loads can also provide financial stability, making the business case stronger and providing revenue to cover fixed costs or cheaper tariffs for smaller customers. Anchor customers are often public-sector organisations (e.g. schools, NHS) with long-term energy contracts, reducing the risk of demand loss. Heat networks can be built around the anchor load and then expanded over time to connect more homes or businesses, which may be lower risk and more manageable than connecting everything at once.

While the best public buildings in Forres are not located within the network focus area (e.g. the swimming pool and secondary school), there are a number of larger public buildings which the network could connect to including Forres Town Hall, Forres House Community Centre and Library and Andersons Primary School. There are also a large number of non-domestic properties along the high street which have complementary heating profiles to the nearby residential properties.

7. Technology

7.1. Air Source Heat Pumps

7.1.1. What are Air Source Heat Pumps?

The CHDU heat network model uses large multi-stage air source heat pumps (ASHPs) to provide most of the heat to the network. These heat pumps use electrically powered pumps to move heat from the air into the heat network.

The efficiency of heat pumps at a single point in time is referred to as their coefficient of performance (COP) which is the ratio of the heat energy emitted to the electrical energy consumed. The instantaneous COP of an ASHP varies due to operating conditions such as the temperature of the air entering the unit, typically the outdoor ambient air temperature, and the temperatures of the incoming and outgoing coolant. The seasonal COP (SCOP) of the heat pump is calculated by dividing total heat energy generated within a calendar year by the total electrical energy consumed.

Figure 16: Vestervig Fjernvarme[24] 1.2MW ASHP (highlighted) and biomass energy centre

Typically domestic ASHPs installed in the UK achieve a seasonal coefficient of performance (SCOP) of over 3, meaning they produce over 3 times as much heat as electricity consumed. ASHPs connected to a medium temperature centralised district heat network in Forres which produce heat at an average annual temperature of approximately 65℃ are expected to operate at a SCOP of around 2.85. Providing heat to a network at this temperature means that individual buildings shouldn't need to upgrade the pipework and radiators used connected to their gas central heating systems.

7.1.2. Why Choose Air Source Heat Pumps?

ASHPs have been selected for these case studies instead of other heat sources since they are more affordable than other heat pumps such as ground or water source systems and less reliant on specific local conditions, meaning they can be installed with fewer restrictions and disruptions. Other technologies could be explored when specific areas are given further consideration.

[24] https://segenergy.dk/en/vestervig-fjernvarme

7.2. Thermal Storage

Within a district heat network, thermal energy storage takes the form of a hot water tank used to store generated heat for use when it is needed. An example of a thermal storage tank used in a district heat network is visible in Figure 17.

Figure 17: Example of a thermal store

7.2.1. Why use thermal energy storage?

Heat pumps don't always produce heat at exactly the moment people need it. Thermal stores allow the system to generate heat when it's most efficient to do so (e.g. during off-peak electricity hours or when the wind turbine is generating), and use it later when demand peaks. If the heat pump can't temporarily meet demand (e.g. in very cold weather), the system can draw on stored heat. This reduces how often the network needs to use a backup boiler, which is more expensive and higher in carbon emissions. Thermal storage also means that any heat generated that is not used immediately can be captured and used later, avoiding waste and improving overall system efficiency.

7.3. Back Up Plant

7.3.1. Why are backup boilers needed?

ASHPs rely on electricity and external ambient temperature to generate heat efficiently, however they are vulnerable to performance degradation in very low temperatures, grid outages and technical faults. As a heat network needs to be able to supply heat reliably, it is important to have a contingency system in place that can maintain internal temperatures and avoid disruption in heating services if the ASHP becomes inoperable.

The backup boilers can also top up the heat generated by the ASHPs to meet peak demand during the colder months. Using backup boilers in this way is financially beneficial to the network since the much more expensive ASHP could be reduced in size, compared to if it was required to meet 100% of the peak heat demand. For example, sizing the ASHP to meet 90% of the total annual heat demand means that it can have approximately 50% of the capacity compared to if it were sized to meet the peak heat demand. This is illustrated in Figure 18.

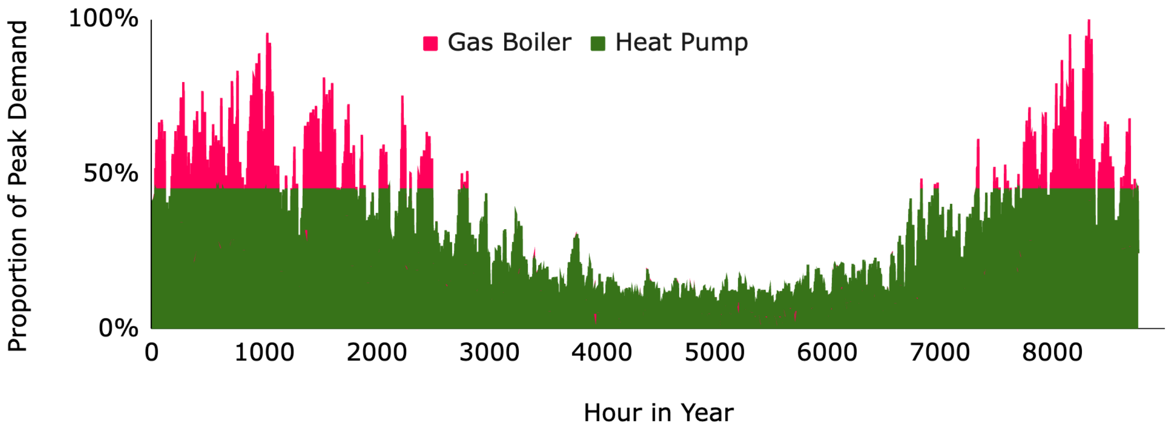

Figure 18: Split of heat supply throughout a year, 10% of heat from gas

7.3.2. Technology

Forres is connected to the national gas network so a gas boiler would be most suitable to provide backup heat. Gas boilers connected to the mains gas network typically have several advantages over an oil boiler, providing quicker start-up times, lower maintenance requirements and no storage requirements. Gas boilers also have lower CO_2 emissions and fewer particulates, making them a cleaner choice for low-carbon strategies.

In the future, these gas boilers could be replaced by electric boilers to further decarbonise the heat network, but this would require a reduction in the price differential between gas and electricity (the “spark gap”) to maintain the financial viability of the network.

7.4. Renewable Electricity Source

7.4.1. Key Benefits of ‘Onsite’ Renewable Generation

The financial viability of a heat network which uses ASHPs to supply much of the heat is directly related to the price of electricity used to power the heat pump and other core infrastructure including water pumps and circulation systems, and control and monitoring systems.

Generating electricity from renewable sources is typically cheaper than importing electricity from the grid, particularly as energy prices rise, and ensures a more stable cost of heat generation since it is decoupled from global fossil fuel prices. This also opens up the potential for secondary income streams since surplus electricity could be sold to a local offtaker through a private wire agreement, offering a more favourable price than their existing supplier, or exported to the national grid though typically at a much lower price.

Using onsite renewable generation to power the network energy centre reduces carbon emissions compared to importing electricity from the grid, and the export of electricity potentially pushes gas generation off the grid, reducing the carbon intensity of grid electricity.

7.4.2. Available Options

Wind power

Wind has the advantage that its generation profile is better aligned with heat demand compared to solar: wind speeds (and therefore output) are typically higher in autumn and winter, which corresponds to peak heating needs:

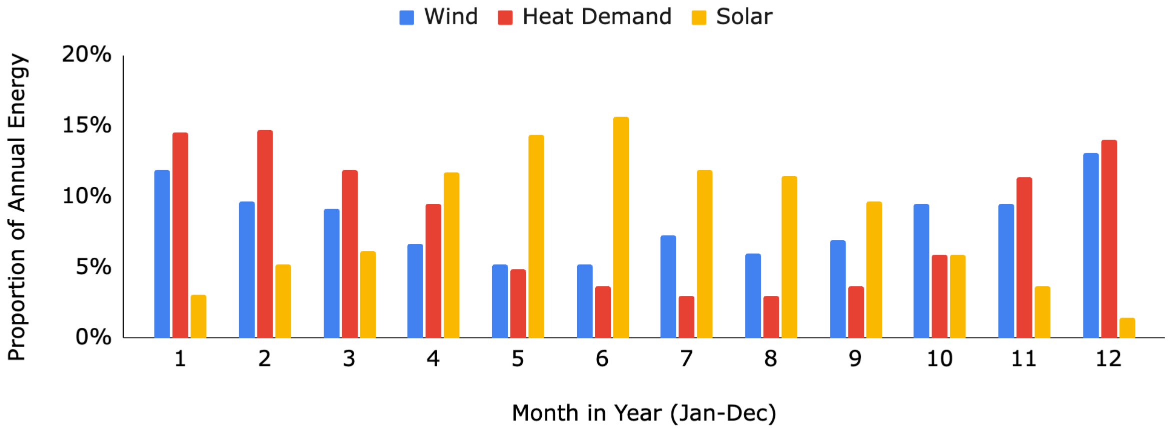

Figure 19: Monthly Wind and Solar Generation vs Heat Demand

A 3 MW wind turbine can produce approximately 3x more electricity than an equivalent capacity in solar PV over the course of a year; higher generation means more energy to use onsite or sell to others, improving the economic case. However planning permission for onshore wind remains difficult to obtain in many areas, and careful consideration needs to be given to landscape and noise considerations - site-specific wind resource assessment is essential for viability.

Solar PV

Solar PV generally has lower capital costs than wind, and has historically been easier to gain planning permission, however solar generation is highest in summer and during daylight hours, when heating demand is lowest, creating a mismatch with energy use. Site selection work indicates that, where feasible, wind power is strongly preferable due to better seasonal alignment with the heat network's electricity needs.

7.5. Network Pipework and Building Connections

Pipework forms the physical backbone of a heat network. It is used to transport heated water from the energy centre to individual buildings and for returning cooler water back to the energy centre.

Pipes are typically pre-insulated steel or plastic, designed to minimise heat loss through effective insulation, withstand high temperatures and pressures, and resist corrosion and external damage. Steel pipes are often used for high-temperature, high-pressure main distribution pipes, while plastic options may be suitable for lower-temperature branches. Typical diameters vary from small branch pipes (~25–50 mm) to large distribution mains (up to 400 mm or more), depending on the heat load and the number of buildings being served.

7.5.1. Installation Considerations

The installation cost of pipework is normally the largest capital expense in a heat network project. The most significant factor is not the pipe itself but the cost of digging and laying the trench. Often referred to as the "civil works" portion of the project, trenching costs include excavation, pipe laying, backfilling, and reinstatement.

The term ‘soft dig’ refers to trenching through open ground such as fields, parks, or gardens, and ‘hard dig’ to refer to trenching under roads, pavements, and other built-up areas. Hard dig is significantly more expensive than soft dig, highly disruptive to traffic and local access, and may require road closures, traffic management and longer working times. Proper planning and route optimisation can help reduce costs by favouring soft dig areas where feasible.

7.5.2. Connection to Existing Buildings

To connect each property to the heat network, new pipework will need to be installed between the main network pipe running along the road and the property’s internal heating system. Where properties have a front garden, these pipes will need to be buried underground as they pass through it. A suitable entry point to the house will then be identified. For properties with a basement, installation is typically more straightforward: the pipes can enter at the most convenient location and run through the basement to the area nearest the current boiler.

The actual connection between the heat network and the property is via a Heat Interface Unit (HIU), also known as a Hydraulic Interface Unit. This unit would typically be installed where the property's existing boiler is located (replacing the boiler), as this area usually has the necessary space and provides the simplest access to the existing heating and hot water systems.

However, if the current boiler is situated outside or in an unheated space (such as a shed), the HIU would be relocated inside the property to avoid any risk of freezing. Unlike a traditional boiler, an HIU does not require ventilation or a flue, produces no noise or odour, and is generally more suitable for indoor installation. This flexibility allows for a wider range of potential locations within the home. Ideally, the HIU would be installed in a basement, as this provides easy access to the heat network pipes running beneath the road or pavement.

The HIU itself is wall-mounted and roughly the same size as a gas combination boiler. It requires a mains electricity supply to power the circulation pump and internal controls. HIUs are typically encased in a white metal or durable grey polystyrene cover.

Figure 20: HIU located in a property

Each HIU includes a heat meter that measures the amount of heat drawn from the network. This meter is read automatically, with the data also used to help identify any faults within the HIU or the wider system.

Heating system compatibility and installation

The heat network is designed to work with a standard "wet" heating system, where hot water is circulated through radiators or underfloor heating to provide space heating. In properties that already have a wet system in place, it may be possible to retain and connect it to the new HIU, provided it is in good condition and compatible with the heat network's flow temperatures. The HIU contains a plate heat exchanger, which ensures the radiators can continue to operate at their existing pressure. A report by Marches Energy Agency[25] has shown that for a heat network flow temperature of 65-70℃, no building upgrades should be necessary.

[25] https://mea.org.uk/

For properties that currently rely on a "dry" heating system, such as electric panel heaters or storage heaters, a new wet system would need to be installed. This involves fitting radiators or underfloor heating, as well as the associated pipework. Although this represents a more significant installation effort, it enables the property to benefit from more efficient and controllable heating through the heat network, often with lower ongoing energy costs compared to electric heating.

8. Proposed Heat Network

8.1. Network Layout

A district heat network is designed to efficiently distribute low-carbon heat from the centralised heat source (in this case an ASHP and backup boiler) to connected buildings across the site. The proposed layout reflects both engineering best practices and site-specific constraints to optimise performance and minimise costs.

Figure 21: Annual Heat Demand of Buildings in Network

The heat network is projected to connect to **333** residential and/or commercial properties split across 174 buildings. Initial uptake is expected to include 124 non-domestic properties and 209 residential properties. There is the potential for the network to be expanded to include additional properties, with Applegrove Primary School of particular interest in this regard. This extension could be simultaneous with the main project or added later. Any later extension would need to attract additional grant funding or and/or require new properties to fund their connection to the network. A relative reduction in the price of electricity purchased from the grid would help make any extension more viable as there would almost certainly be a significant increase in the amount of electricity the system would need to import from the grid. The network length is estimated to be 2.93km.

8.2. Heat Demands

The total annual heat demand of buildings connected to the network is 7.028GWh excluding network losses. Table 7 lists the heat demands associated with the buildings in the proposed network.

Domestic Properties	
Domestic Properties	2,880 MWh
Non-Domestic Properties	
Andersons Primary School	328 MWh
Forres House Community Centre	365 MWh
Co-operative Supermarket	227 MWh
Forres Town Hall	197 MWh
St. Laurence Church	137 MWh
Other non-domestic buildings	2,894 MWh
Sub-total	*4,148 MWh*
Heat network losses	517 MWh
Total	**7,545 MWh**

Table 7: Annual Heat Demand of Buildings in Network

The average annual heat demand of domestic properties connected to the network is 13,780 kWh.

The annual heat demand of non-domestic properties have been estimated from a combination of gas usage data reported by ReHeat[26] and the THERMOS software. The annual heat demand of domestic properties has been derived using EPC data, using estimates from THERMOS where EPC data is unavailable.

Note that the swimming pool and soon to be re-located Forres Academy are excluded from the network. It is understood that the proposed location for the redeveloped Academy is close enough to the High Street that connection to the network may be possible in the future once the network is established. The swimming pool is considered to be located too far from the High Street for it to be financially viable to connect based on the current understanding of heat network development costs.

8.3. Energy Centre

8.3.1. Proposed Site

A suitable location for the energy centre containing the ASHP may be the site of a former Tesco which is close to the main trunk of the proposed network. The site has been vacant for ~20 years but was recently purchased by AES Solar, a local solar specialist, and is yet to be redeveloped. AES Solar have indicated that they are open to considering the prospect of a heat network energy centre being located on part of this site.

[26] Dr Oisín de Priall & Benji Wilson, Reheat, March 2025, Community Heat Development Programme, Forres District Heating Project - Stage 3.

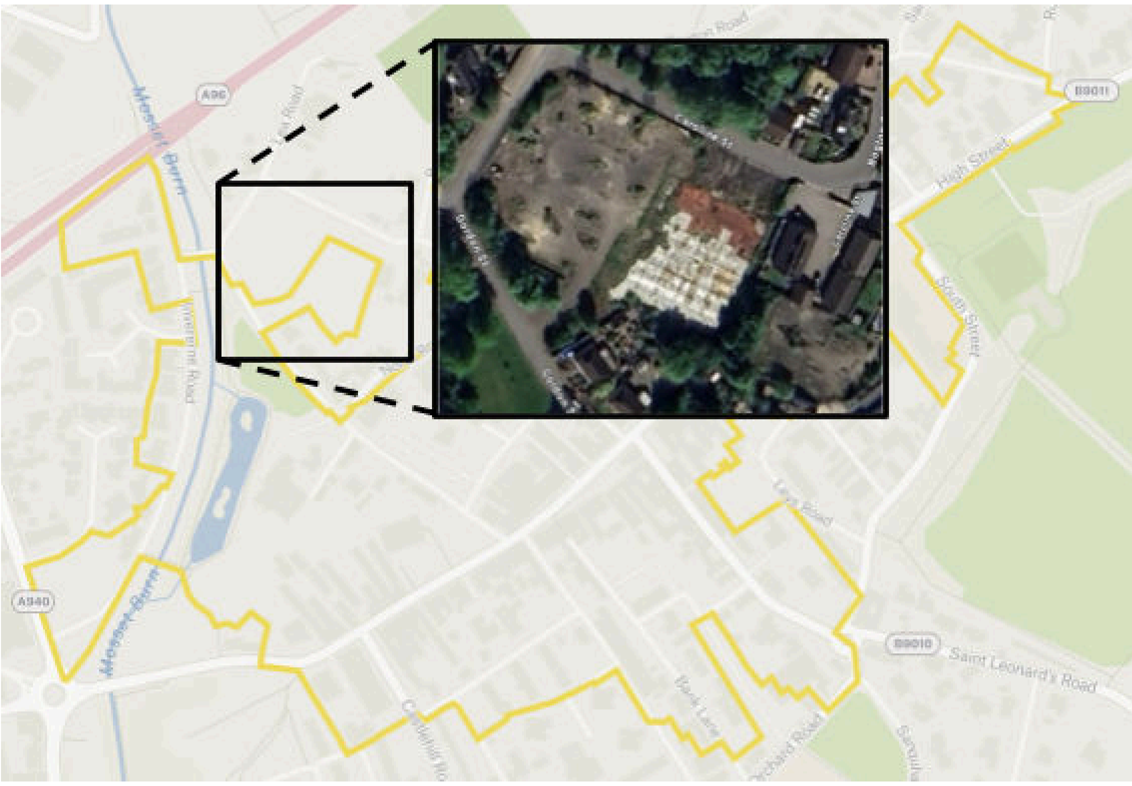

Figure 22: Proposed location of ASHP at former Tesco site

It is anticipated that the energy centre, thermal storage and heat pumps, which would supply the proposed heat network with heat, would occupy up to 25% of the available space at the site. If the former Tesco site were to be developed to include other electricity users there is the possibility of developing a micro electricity grid which could enable other users to benefit from excess low carbon electricity generated by the proposed wind turbine.

Figure 23: View of former Tesco site

While this site is located in close proximity to Forres High Street, there are a number of domestic properties close to its boundary. There are examples of large ASHPs being located close to residential properties in the UK however a detailed noise assessment would need to be completed to understand the impact of noise produced by the ASHP fan beds on local residents and understand any requirements for remedial measures.

8.3.2. ASHP, Thermal Storage and Gas Back-up Boilers

A sensitivity analysis has been conducted by Carbon Alternatives using EnergyPro[27] to assess the most optimal combination of ASHP size and thermal storage volume while achieving significant carbon savings.

Analysis by Carbon Alternatives has suggested that installation of a 1,690kWth ASHP coupled with a 400m^3 thermal store would provide a good balance of maximising carbon savings while also ensuring the network is economical. This ASHP is sized to provide ~90% of the total annual heat demand of the heat network customers, with the remaining ~10% of heat demand provided by backup gas boilers.

The gas backup boilers are sized to meet 100% of the peak heat demand of ~3MW, ensuring security of supply during periods of high demand or ASHP downtime. These boilers would need to be placed in close proximity to the ASHP hydraulic interface for efficient system integration, and would require flue installation and connection to the mains gas network. The gas boilers could be replaced with electric boilers in the future to further decarbonise the network.

8.4. Renewable Generation

A wind turbine with a peak power output of 3MW is under consideration. Ideally this would be sited close to the heat network energy centre to minimise the length of the power cable to the heat pumps and grid connection. Nearby potential sites which could accommodate a wind turbine with a tip height of up to ~130m are presented in Figure 24.

[27] https://www.emd-international.com/software/energypro

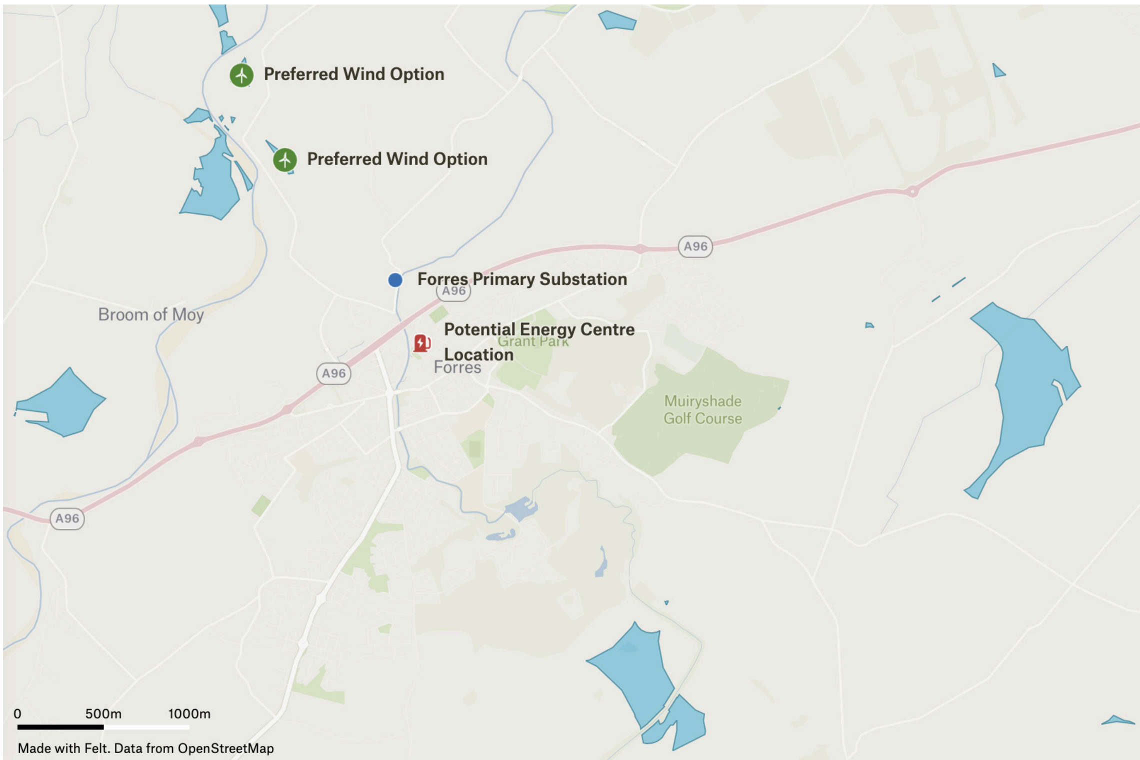

Figure 24: potential wind turbine locations (highlighted blue)

The two sites to the North West of Forres are identified as preferred options due to their proximity to the proposed Energy Centre location, where the ASHP would be installed, and the local primary substation. Land owners at these potential sites have not yet been consulted about leasing their land for a wind installation but this is an important next step if the proposed heat and wind project were to proceed.

An annual wind degradation of 1.2% is modelled to represent a reduction in the annual energy yield of the wind turbine due to the degradation of components.

8.5. Grid Connection

The potential to connect a multi-megawatt wind turbine and ASHP to the Forres primary substation was discussed at a Connection Surgery with Scottish and Southern Electricity Networks (SSEN).

It is anticipated that the wind turbine would connect to a new transformer which served the Energy Centre and potentially future electricity users at the former Tesco's site. An additional cable would connect this new transformer back to the 11kV/33kV Forres primary substation to the north of the town, see Figure 25, to enable export of excess generation and import of additional electricity from the grid. These two cables could share a trench and would need to cross the railway line, A96 and Mosset Burn to connect the proposed wind turbine to the energy centre and primary substation.

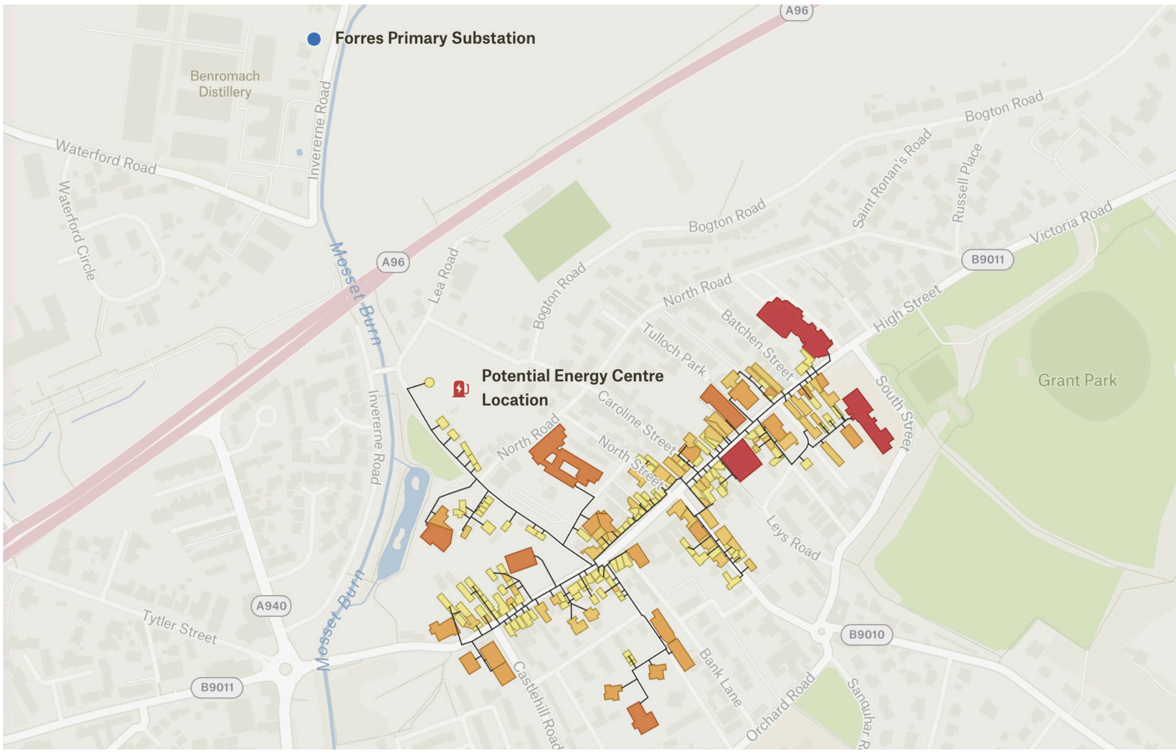

Figure 25: location of primary substation

SSEN have indicated that while current constraints in the upstream transmission network will limit the possible export of excess wind electricity to the grid, they are unsure what the situation will be in 3-5 years. This uncertainty is partly related to ongoing work to redefine the order of the queue of projects planned to connect to the network.

While the analysis reported here has included a significant cost allowance for upgrading the grid connection at the energy centre site and trenching cabling to connect the proposed wind turbine to the energy centre, SSEN have encouraged the submission of a grid connection application so a more detailed cost estimate can be provided. A grid connection application is also required for SSEN to estimate when the proposed wind turbine and ASHPs could be connected to the electricity network and detail any expected level of generation curtailment.

8.6. Electricity Offtaker

No electricity offtaker has been identified who could be sold excess electricity generated by the wind turbine. There is the possibility that any future developments on the old Tesco's site could share the grid connection of the proposed heat network Energy Centre and consume some of the excess wind generated electricity. This would be of dual benefit: the offtaker would receive electricity at a discounted rate compared to purchasing from an electricity supplier, and the heat network Scheme would receive additional income compared to exporting electricity via the electricity grid.

8.7. Summary of Energy Usage

Annual Energy Usage Summary (MWh)	
Wind Turbine Generation	7,884
Generation Consumed by Network	2,430
% Generation Consumed by Network	31%
% of Network Heat from Generation	85%
Generation Exported to Grid	5,441
Electricity Imported	160
Gas Consumed	650

Table 8: Annual energy usage

9. Financial Performance of Heat Network

9.1. Assumptions Made

9.1.1. Tariffs

The electricity tariffs detailed in Table 9 have been used in the financial modelling of the proposed Forres heat network.

Tariffs	
Heat Sales Unit Price	7.43p/kWh[28]
Heat Sales Standing Charge	£375/annum[29]
Gas Purchase	6.24p/kWh
Unit Price of Exported Wind Generation	9.5p/kWh[30]
Grid Import for use in ASHP	23p/kWh[31]

Table 9: Energy Tariffs used in Techno-Economic Modelling

9.1.2. Scotland's Heat Network Fund

Scotland's Heat Network Fund (SHNF) is a capital grant programme, launched in 2022, that is open to organisations and businesses in the public, private and third sector, and that provides support for the development of heat network projects including:

- New low or zero emissions district heat networks or communal heating systems,
- The expansion of existing networks, and
- Decarbonisation of existing systems by replacing an existing polluting heat source.

To be eligible, projects must be based in Scotland, contribute to Scotland's zero emissions heat targets, demonstrate social and economic benefits, and meet the legal definition of a heat network. Grants are awarded on a co-funded basis, can be awarded for both commercialisation and construction support, and are capped at 50% of eligible capital costs (with a £1 million maximum grant capped at 10% of total CAPEX for commercialisation costs). The current grant scheme requires funds to be drawn down in full by March 2030.

[28] To match domestic customers' current gas heating cost. Based on a gas price of 6.24p/kWh and gas boiler efficiency of 84%.
[29] Equivalent to annualised cost of replacing (£2,750) and maintaining (£100/annum) a gas boiler over 10 years.
[30] Income from exported electricity sales consists of an export PPA price, embedded generator benefits and benefits related to license exempt supply (BSC Modification P442).
[31] Average of dual day/night tariff.

9.1.3. Equity and Debt

Development Loan

During the construction and early development stage, the project may require short-term working capital through a development load, with an assumed interest rate of **8.0**%. This loan covers pre-revenue expenditure and would typically be repaid or refinanced upon completion.

Long-Term Loan

Following commissioning, a large portion of the capital costs will be refinanced through a long-term loan. Loan rates aligned with the National Wealth Fund[32] have been assumed, which at the time of writing are set at gilt pricing +40bps. This assumes that the Local Authority will be at least partially involved in developing and owning the scheme. The loan for purchasing and installing the pipework is modelled as having a term of **50 years** and an interest rate of **5.35%**. The loan for purchasing and installing the network energy centre, household connections and renewable generation is modelled as having a term of **25 years** and an interest rate of **5.95%**. Both loans are modelled as annuities. This debt is structured to be repaid from operational income (heat and electricity sales) and sized to ensure sufficient headroom for contingencies and maintenance reserves.

Community Shares

A further share of capital may be raised through community shares, allowing local residents and supporters to invest directly in the project. While shares have not been included in our techno-economic model, it's likely that a proportion of the capital would be financed through community share raising, with an interest rate of 4% to 5% in line with typical expectations for community energy investments. Community shares are non-transferable and interest is not guaranteed, but still represent a key engagement and financing tool.

9.1.4. Inflation

General inflation has been modelled at **2.5**% annually for the escalation of operational costs and heat pricing.

9.1.5. Project Lifespan

The financial model assumes a total project lifetime of **50 years**, which aligns with the expected minimum operational lifespan of the heat network pipework.

[32] https://www.nationalwealthfund.org.uk/local-authority-services/our-lending-offer

For simplicity, major plant replacements (e.g. ASHPs and the wind turbine) are modelled as occurring after 25 years.

9.2. Capital Costs

Capital costs include the costs of the materials and components needed in the development of the heat network, and the costs of installing them. Reasonable estimates of capital costs are reported here using publicly available sources and previous project experience, however more detailed feasibility work would need to be completed in order to gain quotes from potential suppliers. Further details of how the capital costs have been derived are available on the CHDU project website[33]. The capital costs for the proposed heat network in the Forres focus area are presented below.

Energy Centre (£k)	
Heat pumps	£1,542
Network pumps	£250
Backup boilers	£312
Thermal storage	£187
Energy Centre Building	£450
Network Pipework (£k)	
Pipework	£540
Trenching and Installation	£2,155
Customer Connections and HIUs (£k)	
Internal works and HIUs (£8.5k per property)	£2,533
Renewables (£k)	
Wind turbine purchase and installation	£4,043
Cabling between generator and grid connection	£150

[33] https://communityheat.org.uk/techno-economic-model/network-capex-costs/

Grid connection	£500
Planning, design & regulatory costs (£k)	
Commissioning costs	£633
Design & Project Management	£1,266

Table 10: Details of CAPEX costs (£k)

The total CAPEX costs are reported in Table 11 alongside the total amount of SHNF that may be available.

Summary of CAPEX Costs (£k)	
Energy Centre	£2,742
Network Pipework and Trenching	£2,695
Customer Connections	£2,533
Renewables	£4,693
Planning, design & regulatory costs	£1,900
Contingency	10%
Total	**£15,830**
Eligible for Scottish HNF grant	£8,847
Scottish HNF grant amount	£4,822
Total excluding SHNF grant	**£11,007**

Table 11: Summary of CAPEX costs post grant (£k)

9.3. Replacement Costs

The following components are assumed to require replacement after 25 years of operation. The costs of replacement are partially funded by surplus accrued by the scheme during its first 25 years of operation, and a 25 year loan.

Energy Centre (£k)	
Heat pumps	£1,542
Coolant pumps	£250
Backup boilers	£312
Thermal storage	£187
Customer Connections and HIUs (£k)	
Internal works and HIUs	£805
Renewables (£k)	
Wind turbine purchase and installation	£4,043
Total	**£7,140**

Table 12: Summary of REPEX costs (£k), today's prices

9.4. Ongoing Costs

9.4.1. Administration

The cost of running a Community Benefit Society (CBS) will vary depending on whether the day to day administration is carried out by the organisation's Directors or externally by an administrative service. It is recommended that a scheme of this size and complexity should use external administrators. The annual cost of running a CBS set-up to own the proposed Forres heat network is estimated to be around £10,000.

9.4.2. Metering and Billing

The staff costs for metering the system and billing customers are assumed to be approximately £95.00 per connection per year. In Forres the annual costs for metering and billing is expected to be around £28,310.

9.4.3. Insurance

Insurance costs for renewable energy assets vary depending on the technology. For wind installations, insurance is typically around £2,993/MW[34]. In addition, insurance for the heat network is estimated at £5,000 per year.

9.4.4. Rent and Rates

For energy centre

An allowance of £1,000pcm has been included to cover land rent. It is understood that buildings whose main use is for a 'heat network' are exempt from business rates.

Land required for renewable generation

The land required for any connected renewable generation will also be subject to rent. For solar PV, we would assume a land rental rate of approximately £546 per hectare, and for wind, a rate of £10,000 per MW of capacity of the wind turbine. Annual land rent for a 3MW wind turbine in Forres is estimated to cost around £30,000. Business rates for the 3MW wind turbine are assumed to be £7,500 per year.

9.4.5. Maintenance

Regular maintenance of the components of a heat network are essential to keep it operating efficiently and reliably over its lifetime. Annual maintenance costs for the proposed network in Forres include:

Energy Centre	
Component	**Total annual cost (£)**
1% of CAPEX on thermal storage	£1,870
1% of CAPEX backup boilers and network pumps	£5,620
Heat pump	£2,000
Land rent	£12,000
Total	£21,500

Table 13: Annual maintenance costs for components in the Energy Centre (£k)

[34] Inflated to 2025 prices from [Solar and Wind Insurance Costs: Onshore wind and solar PV costs review, BEIS/WSP, 2020]

Network		
	£/MWh	**Total annual cost (£)**
Network (pipes etc)	£0.60/MWh	£4,530[35]
HIUs	£80/connection	£23,840
Total		£28,370

Table 14: Annual maintenance costs for components in the network (£k)

Wind Annual O&M Cost (£k)	
Wind	£83,300

Table 15: Annual maintenance costs for renewables (£)

9.4.6. Cost of finance

Loans have been modelled at the following rates and terms:

Loan type/purpose	**Rate**	**Term**
Development loan	8%	2 years
Equipment loan	5.95%	25 years
Pipework loan	5.35%	50 years

Table 16: Assumed loan rates and terms

9.5. Overall Financial Performance of Heat Network

9.5.1. Year 1 Cashflow

The expected year 1 cashflow is detailed in Table 17.

[35] Includes total demand + pipework losses

Income (£k)	
Electricity sales to grid	£514
Heat unit sales	£522
Heat network standing charge sales	£112
Sub-total	£1,148
Outgoings (£k)	
Operations, Maintenance and Administration	£223
Electricity purchase from grid	£36
Gas purchase for back-up boilers	£41
Loan repayments (capital and interest)	£823
Sub-total	£1,125
Year 1 Cashflow	£23

Table 17: Year 1 Cashflow (£k)

These figures assume a steady rent level rising with inflation. Some savings could be made in early years by sculpting the rents so higher figures are paid later in the project when cashflows are eased due to reduction in debts.

9.5.2. Payback Period and IRR

The Internal Rate of Return (IRR) is a financial tool used to assess the economic viability of a project. It represents the overall rate of return the project is expected to generate over its lifetime. If IRR exceeds the required rate of return, such as the cost of capital, it suggests the project is likely to:

- Cover its costs
- Remain financially stable over time
- Offer modest returns to shareholders, helping justify community investment
- Strengthen the case funding or grant applications.

Conversely, if the IRR falls below the required rate of return, the project may struggle to meet its financial obligations and may be considered financially unviable.

The project 25 year IRR for the proposed heat network in Forres is **6.7%**, assuming £4.8m of capital grant funding, increasing to 7.7% over the 50 year project lifetime. This indicates that the project is expected to generate a return just above the cost of capital suggesting the project is financially viable, with the potential to cover its costs, maintain financial stability, and deliver modest returns to community shareholders.

The relatively small annual positive cashflow of £23k results in the initial payback period being 24 years, which is just within the 25 year period of the initial equipment loans. The low cashflow and long payback period mean there is limited flexibility in the project finances to mitigate cost overruns or fix equipment failures. The cashflow and payback periods should be reviewed when detailed quotes for equipment purchase and network development have been received. The 25 year project balance is predicted to be £1.6m which is expected to partially fund replacement of the heat and electricity generating equipment.

The scheme is only just viable with a capital grant which covers 31% of the total project CAPEX, which is equivalent to 48% of the heat network CAPEX if the cost of the wind turbine and associated grid connection is excluded. Reducing the grant amount by ~5% (from 48% to 43%) results in the scheme becoming unviable due to the income being unable to match the increased loan repayments.

10. Carbon Projections

10.1. Establishing the Counterfactual

To assess the carbon savings from a heat network, the first step is to define the baseline, i.e. what emissions would have been generated if the heat network were not built, based on the existing heating mix in the focus area. This is compared to the following scenarios:

- The proposed low-carbon heat network scheme.
- Individual ASHPs.

Assumptions used:

- Number of properties connecting to the network: 333 (209 domestic, 124 non-domestic)
- Total annual heat demand: 7,028 MWh
- Average demand per domestic building: 13,780 kWh
- Average demand per non-domestic building: 33,452 kWh
- Emissions calculated using 2025 UK Government GHG conversion factors (kg CO_2/kWh)

10.2. Emissions from Existing Heating Systems

The mix of heating systems in the proposed Forres heat network focus area is discussed in section 5, using data from the 2021 Census. The emissions factors for the different heating systems in the network focus area, adjusted for fuel efficiencies, are presented in Table 18.

Heating type	**Proportion of Properties**	**Fuel CO2 emissions (kg CO2e)**	**% Assumed efficiency**	**Emissions per kWh heat (kg CO2e)**
Mains gas only	66.3%	0.18296	90%	0.203
Electric only	15.4%	0.2072	100%	0.207
Tank/bottled gas only (LPG)	0.5%	0.2145	85%	0.252
Oil only	0.0%	0.26813	85%	0.315
Wood only	0.3%	0.0115	75%	0.015
Solid fuel only	0.0%	0.34721	85%	0.408
No central heating	3.8%	Left out as baseline undefined		
Mixed/Other	8.6%	0.22	100%	0.220

Table 18: Emissions factors and efficiencies for heating types in Forres

Baseline carbon intensity: 0.174 kg CO_2/kWh heat
Annual emissions: 1,222,454 kg CO_2
Per building: 3,671 kg CO_2

10.3. Comparison of Heat Scenarios

Table 19 presents the annual CO_2 emissions of buildings included in the proposed Forres heat network. The carbon intensity of electricity consumed from the grid has been averaged across the 50 year project lifetime using projections of grid carbon intensity published in the UK Government Treasury's Green Book[36].

Scenario	Total annual emissions (tonne CO_2e)	Per building on network (kg CO_2e)	g/CO_2e per kWh of heat
Existing heating mix	1,222	3,671	174
Heat Network Current Grid[37]	152	456	22
Heat Network Future Grid	123	370	18
Individual ASHPs Current Grid[38]	449	1,350	64
Individual ASHPs Future Grid	55	166	8

Table 19: Annual emissions of the buildings including in the proposed heat network, averaged over 50 year project lifetime

The analysis shows that developing a low carbon heat network in the centre of Forres is expected to reduce annual CO_2 emissions by 90%, from 1,222 tCO2e to 123 tCO2e. Each year, the heat network is expected to save 1,099 tonnes of CO_2 emissions which equates to 54,950 tonnes across the 50 year lifetime of the network.

The heat network offers carbon savings over individual ASHPs of 66% assuming the carbon intensity of the grid remains at 2025 levels. However, it is anticipated that over the 50 year project lifetime individual ASHPs would reduce CO_2 emissions more than the heat network based on the projected trend of grid decarbonisation. This is due to the network's use of back-up / top-up gas boilers to provide 10% of the network's annual heat demand, however these could be replaced by electric boilers in the future as the relative cost of electricity vs gas reduces. It is worth noting that most of the buildings on the proposed Forres heat network route would struggle to install individual ASHPs which achieve a SCOP of 3.24 due to the limited availability of outdoor space making it hard to install an ASHP and meet building regulations, and the

36 https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

37 Assuming an ASHP SCOP of 2.85.

38 Assuming a SCOP of 3.24.

difficulty in successfully insulating properties which were constructed pre-1900s.

11. Planning and Permitting

11.1. Current Planning and Permitting Regulations

Community-scale heat networks are subject to a combination of national planning policy, local planning regulations and environmental permitting requirements.. While there is currently no single unified permitting process for heat networks, key regulatory considerations include:

- Underground works: consent may be required for trenching and pipe-laying under highways or public land.
- Above-ground infrastructure: the energy centre may require full or prior approval from the local planning authority
- Environmental and noise assessments: particularly as the energy centre includes a large heat pump.
- Building interfaces: if retrofitting public or private buildings, additional listed building consents or landlord approvals may be required.

11.2. Heat Networks in Scotland: Policy Drivers and Local Context

The Heat Networks (Scotland) Act 2021[39] requires each local authority in Scotland to carry out a review to consider the suitability of areas within its geographic area for construction and operation of heat networks. While no 'strategic zones' have been identified due to the diversity and scattered location of building archetypes in Moray, Moray Council have identified a number of locations that are potentially suitable for heat networks, including in Elgin (for which a feasibility study is being undertaken) and Forres, and the council's Local Heat and Energy Efficiency Strategy[40] (LHEES) 2023-2028 notes community interest in a heat network in Forres town centre due to relatively high heat demand.

[39] Heat Networks (Scotland) Act 2021
[40] Moray Council, (2024). Local Heat and Energy Efficiency Strategy

12. Operation and Governance

If the scheme progresses, there are five options:

1. Set up a new, local, Community Benefit Society (CBS). A CBS would enable a share offer to be launched giving community ownership for the scheme. This CBS could also own the new wind turbine. This would however be a big commitment for a group of volunteers, on a project with a 50 years lifespan, even if admin support was provided as has been allowed in the costings. It would also be a relatively risky investment for the investors as there is very little leeway in the finances for extra costs or reduced revenues.
2. Partner with an existing local CBS, such as Community Energy Moray (CEM), although CEM have not suggested they would take on such a scheme. The advantage of using an existing CBS rather than a new CBS is that they have access to wider resources and expertise and could then consider delivering similar schemes elsewhere.
3. Partner with a specific Heat Network CBS. If a local CBS were to develop a heat network in Forres, they will need a high degree of support. We envisage a federated system where multiple individual societies are supported by a specialised centralised development, advice and administration service with the addition of well supported peer to peer learning between the societies.
4. Partner with a Local Authority who can take the lead and raise the capital required. This is how the Swaffham Prior scheme is being delivered. At the moment only Local Authorities have the power to dig up roads for installing Heat Network pipes so some sort of council partnership may be required anyway. This arrangement would relieve the pressure on the local volunteers and remove the risk from the shareholders, but the scheme could then be bound up in the workings of local government.
5. Partner with a private sector company to deliver and run the scheme on a commercial basis. This would reduce the workload and responsibility for community volunteers but would also give less local control. The rates of return are also not likely to be attractive enough to a private enterprise.

13. Alternative Local Energy Scheme

While the Community Heat Development Unit project focuses on centralised district heat networks, an alternative approach has been identified in the

Bishop's Castle case study[41]. This model adapts the Energy Local[42] concept, with a locally installed wind turbine supplying much of the electricity consumed by participating households. Revenue from electricity sales would then be used to service loans taken out to cover the part of the cost of individual ASHPs installations in domestic properties. Forres is theoretically well suited to the proposed distributed heat and wind scheme since the electricity supply in the town of Forres is distributed via a single primary substation (located next to the Benromach Distillery), meaning that electricity generated by the proposed wind turbine could be distributed locally. This style of scheme is dependent on the P441[43] modification to the local energy trading rules being finalised and approved, without which it could not be implemented.

Further details of such a scheme are discussed in the CHDU Bishop's Castle case study report. It is anticipated that an equivalent scheme in Forres could be more financially viable, and support more homes, due to the proposal of installing a larger, multi-megawatt wind turbine.

14. Next Steps

As reported in section 9.5, even with a substantial grant the scheme is only marginally viable. The scheme requires grant support amounting to ~30% of the total project capital costs, which is equivalent to around 50% of the heat network infrastructure and commercialisation costs eligible for Scottish Heat Network Funding (which is capped at 50%). The remaining funding would need to be raised through loans, community mechanisms such as share offers or community bonds and investment from non-domestic customers such as private landlords, housing associations and the local authority to fund their connection to the proposed network. It is understood that the Home Energy Scotland Grant (which partially funds domestic heat pump installations) may be expanded to fund connection of households to a heat network, which would significantly improve the financial viability of the proposed heat network scheme.

The two main priorities should be establishing local support and progressing the development of the community owned wind turbine. It is essential that local

[41] https://stcenergy.org.uk/bishops-castle-heat-and-wind-project/
[42] https://energylocal.org.uk
[43] https://www.ofgem.gov.uk/decision/dcp441-proposal-increase-number-allowed-change-report-alternative-variations-two-three-authority-decision

community support is demonstrated for a community owned heat network scheme to progress. It is anticipated that attendance of scheme advocates at local events will be essential in establishing local support. Local advocates for such a scheme should get in touch via chdu@sharenergy.coop to register their interest.

Developing a community owned, multi-megawatt wind turbine is essential to the heat network scheme finances and potentially a viable standalone community energy project. The preferential wind sites to the north west of the town are approximately 4km from Kinloss Barracks, a Ministry of Defence facility. It is understood that the barracks make occasional use of their runway and would need to be consulted on which wind locations are compatible with their operations.

Should support local for a heat network be established, a detailed feasibility report should be commissioned. This would aim to enable a submission of the proposed heat network to the Scottish Heat Network fund and would need to include and expand upon:

- Detailed quotes for heat network pipework purchased and installation.
- Submission of a G99 grid connection application to SSEN for the wind turbine and heat network energy centre.
- Statements of interest from domestic and non-domestic users who are interested in connecting to the proposed network, and recording of accurate heat demand data based on individual gas and/or electricity consumption data.
- Detailed wind assessment and environment impact report.
- Submission of a planning application for development of the community-owned wind turbine.
- Detailed noise assessment of the network energy centre and ASHP.
- Explore support available from other organisations to develop and run a community heat network, including CHDU (& CARES).
- Consideration of a distributed electricity model as an alternative to a full scale heat network.

The funding for this body of work from the Energy Redress Fund has come to an end. Sharenergy are currently considering what role they can play in further work on community heat networks and further funding options to enable them to do so.