

**COMMUNITY HEAT DEVELOPMENT PROGRAMME**

**FEASIBILITY STUDY FOR FORRES DISTRICT HEATING PROJECT**



**26<sup>th</sup> June 2024**

**Version V3 for Community Issue**

**Project reference No: 1236.006**

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## Summary

The community of Forres in Moray has suggested the installation of a District Heat Network (DHN) to supply heat to the Council's properties in the town, and domestic and community properties on the route that the DHN would pass.

The community proposal was that the Council's properties would form the 'anchor' energy loads to justify laying the infrastructure, and that the other adjacent properties could be tied into the system as additional customers. The system could also be extended in future to take in other nearby domestic and commercial properties.

The suggestion is for a DHN running from the Forres Swimming Pool & Fitness Centre to the Forres House Community Centre. It would provide heat to those buildings; to Applegrove and Anderson's Primary schools; and to the new Forres Academy (if it is to be built on the Roysvale Park / Applegrove Primary footprint). An opportunity for connection would also be offered to around 44 domestic properties on the DHN route along Sanquhar Road and South Street, and to the Royal British Legion Club and St. Margaret's Church.

The Council's properties are estimated to represent between 66% and 76% of the total heat demand. This, and the low housing density on the route, mean that the scheme is thought unlikely to be financially viable without the Council's participation.

Government policy on transition to low carbon heating for existing buildings is still in development, but the Heat in Buildings Bill Consultation<sup>1</sup> proposed prohibiting 'polluting fuels' (e.g. gas and individual biomass boilers) by the end of 2038 for Council buildings, and in all buildings by 2045. The New Build Standard<sup>2</sup> means that the new Academy will have to have a 'clean' heating system installed. This would effectively mandate electrical heating (probably with heat pumps) or connection to a heat network. The combination of the impending Heat in Buildings Bill, the replacement of Forres Academy and the proximity of the Council's properties in Forres make a positive case for a District Heating Network to be deployed in the town.

This report considers various heat sources to power the proposed DHN:

- Ground Source Heat Pumps (GSHP) on a shared ambient array: This solution connects an array of vertical boreholes on an ambient heat network, with an individual heat pump in each building on the network. Heating systems in the

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<sup>1</sup> Scottish Government (2023) [Heat in Buildings Bill: Consultation](#)

<sup>2</sup> <https://www.gov.scot/collections/new-build-heat-standard/>

customer buildings would likely need significant modifications due to the relatively low temperature of the water supplied.

- Biomass (wood chip) fired energy centre: this would distribute hot water to the customer buildings via insulated underground pipes. Relatively minimal modifications would be required in the customer buildings.
- Heat extraction from the Mosset Burn and the wastewater treatment works were considered but found to be impractical.
- Individual Air source heat pumps (ASHP) have been considered as the counterfactual low carbon solution, should a district heat project not go ahead.
- Installation of any DHN would be disruptive in the short term while trenches are dug and piping installed, but this should be considered against the expected 50+ years operating life of such a system.

The cost of running heat pump and biomass systems cannot be forecast with confidence due to uncertainties of future energy pricing. However, historical and current prices for biomass and electricity suggest that a biomass fired system would be significantly less expensive to operate than heat pumps. Based on the assessment to date, a biomass fired system offers the greatest potential for lower energy prices.

Installation costs for the two systems are broadly similar for the heat network and shared infrastructure (biomass energy centre/borehole array), but the capital costs to individual buildings connecting are significantly higher for the GSHP network due to the need for a GSHP in each building as well as heating system and energy efficiency upgrades.

Greenhouse gas emissions from biomass and GSHP systems would also be broadly similar over their expected lifetime. Either option would offer emissions savings of about 80-90% compared to natural gas.

The main counterfactual considered against a DHN is the use of individual building air source heat pumps (ASHP). These are technically viable, and increasingly seen as the favoured option in Government policy. In the context of the proposed Forres DHN, the cost of running an ASHP is highly dependent on upgrades to the energy efficiency of individual buildings, future electricity prices, and on the ability to use time of use electricity tariffs. Retrofit of ASHP to existing buildings also involves a trade-off between making modifications to the heating system (installation cost) and accepting lower efficiency (higher running cost).

This report has not looked in any detail at the funding options or business model which could lie behind the installation and operation of the proposed DHN. Should the local community and Moray Council be supportive, a proposal could be prepared to apply to CHDP for Stage 3 funding to undertake this detailed economic feasibility study.

## **1 Introduction**

### **1.1 Background to this Feasibility Study**

The Scottish Government's '*Community and Renewable Energy Scheme*' (CARES) supports communities to engage with, participate in and benefit from the energy transition to net zero emissions. CARES is managed by Local Energy Scotland.

As part of that transition, the Government has funded Local Energy Scotland to deliver the '*Community Heat Development Programme*' (CHDP). The CHDP provides impartial technical advice to community groups seeking to decarbonise their heating.

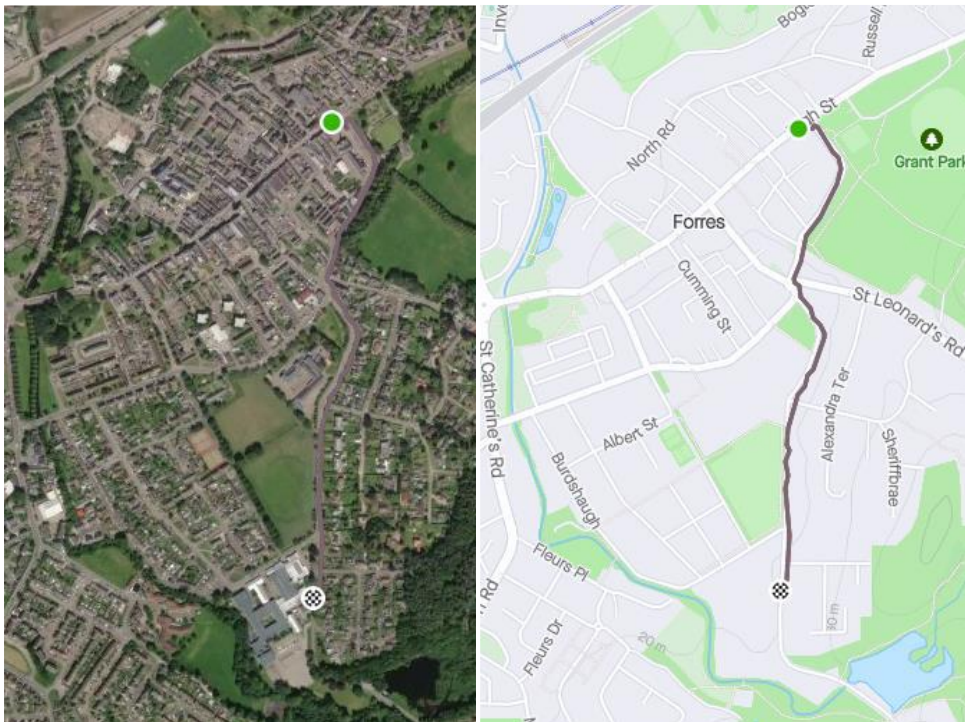
As appointed contractor to provide technical advice, Reheat Ltd ([www.reheat.uk.com](http://www.reheat.uk.com)) has prepared this feasibility study.

### **1.2 The Community and their Objectives**

The community group for the proposed district heating scheme is a newly established, informal group. It was started by Andrew McGhee, who has undertaken engagement with his neighbours to generate interest and achieve buy in, as well as establishing initial interest from Moray Council.

The project's ambition is to reduce CO<sub>2</sub> emissions from residential, community and council buildings in Forres in a way that is sustainable and financially competitive with fossil fuels.

The Community have proposed a biomass heat network that will focus on a spine connecting a number of council buildings which will form the anchor loads, with multiple community buildings and residential properties as additional customers.



*Figure 1: Map of Forres and the Proposed Heat Network Route*

Should this be viable, it is proposed that this is the first phase with further expansion in the future.

### **1.3 Scope of this Feasibility Study**

The feasibility study focuses on the biomass heat network proposed by the community. It includes:

1. High level assessment of the existing heat demand along the proposed route
2. A high-level feasibility of biomass district heating scheme options (with and without a new High School on the route):
  - a. Practical and technical considerations
  - b. Heat Network route and potential energy centre locations
  - c. Carbon impact
  - d. Estimated heating costs for Council Buildings
  - e. Introduction to heat sales/heating costs to domestic properties
  - f. Capital costs and potential financial support
3. Counterfactual: Individual low carbon options for domestic and council owned buildings.
  - a. Council Owned Buildings: Individual Biomass Boilers

- i. Practical and technical considerations
    - ii. Carbon impact
    - iii. Heating Costs
  - b. Domestic Properties: Individual ASHPs
    - i. Practical and technical considerations
    - ii. Carbon savings
    - iii. Heating costs
    - iv. Potential financial support for domestic properties
- 4. Options Appraisal
- 5. Introduction to Ownership Options
- 6. Conclusions and Next steps

The objective of the Community Heat Development Programme is to work with community groups to help develop their ideas for locally generated, low carbon heat project ideas. Therefore, the study does not include detailed counterfactuals for individual solutions for Council owned buildings or the new school.

## **1.4 Policy Context**

It is the Scottish Government's policy that by 2045 almost all buildings in Scotland must be using a zero-emissions heating system<sup>3</sup>.

### **1.4.1 Heat in Buildings Strategy and Heat in Buildings Bill Consultation**

In November 2023 the Scottish Government released the Heat in Buildings Bill Consultation<sup>4</sup> that will create the legislation required to implement the Heat in Buildings Strategy<sup>5</sup> from 2021. The Consultation closed in March 2024 and responses are now being analysed.

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<sup>3</sup> [Scottish Climate Change Act 2019](#)

<sup>4</sup> Scottish Government (2023) [Heat in Buildings Bill: Consultation](#)

<sup>5</sup> Scottish Government (2021) [Heat in Buildings Strategy](#)

### **Domestic Properties**

Of prime importance is that the Scottish Government have reconfirmed that “*the use of polluting heating systems<sup>6</sup> will be prohibited after 2045;*”. This will include all gas boilers. This is the final deadline, however, to facilitate the process of switching to clean heating over the years to 2045, they are proposing that when a property changes hands, those purchasing a home will have to end their use of polluting heating systems within a fixed period following completion of the sale. This is just a proposal at this stage and it is not known at this time if it will be implemented or by what date. However, if this is not the chosen mechanism it looks very likely that there will be some mechanism to achieve the switch to ‘clean heating’<sup>3</sup> in the relatively near future.

The Consultation also proposes introducing a new law that will require homeowners to make sure that their homes meet a reasonable minimum energy efficiency standard by 2033. Private landlords will need to meet the standard by 2028. The proposed energy standards include:

- 270 mm loft insulation;
- Cavity wall insulation (CWI);
- Draught-proofing;
- Heating controls;
- 80 mm hot water cylinder insulation;
- Suspended floor insulation

Owner occupied homes that have ended their use of polluting heating by 2033 will not be required to meet the minimum energy efficiency standard (this does not apply to private landlords, who will still need to meet the minimum energy efficiency standard by 2028, even if clean heating has been installed.)

### **Public Sector**

The Heat in Buildings Bill Consultation proposes that “all buildings owned by a Scottish public authority to be using clean heating systems by the end of 2038”<sup>7</sup>. It also proposes a range of potential duties on public authorities, including “Placing a new

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<sup>6</sup> Polluting heating systems are defined in the Consultation as “Heating systems which burn fossil fuels like gas boilers, oil boilers and liquid petroleum gas (LPG) boilers are ‘direct emissions heating systems’<sup>6</sup> because they do produce greenhouse gas emissions when we use them.”

<sup>7</sup> Scottish Government (2023) [Heat in Buildings Bill: Consultation, Section 6](#)

duty on public sector organisations which would prevent them from replacing a polluting heating system with another (unless impractical)”<sup>5</sup>.

Although these proposals are still at the consultation stage, it is clear that many property owners in Forres will need to start considering low carbon heat and the installation of energy efficiency measures in the coming years.

#### 1.4.2 New Build Standard

The New Build Standard<sup>8</sup> means that the new High School will have to have a ‘clean’ heating system installed. This would effectively mandate electrical heating (probably with heat pumps) or connection to heat for the new Academy.

#### 1.4.3 LHEES

All Local Authorities are required by Scottish Government to publish a Local Heat and Energy Efficiency Strategy (LHEES). The Moray Council LHEES Strategy will provide a new long-term plan to improve energy efficiency and decarbonise heat in Moray homes and buildings, including the identification of areas where heat networks will offer the most viable option for decarbonising heat. In the draft Moray Council LHEES, which is currently out for consultation, Forres has been identified as a Category 2 potential heat network area:

*“lack the scale of public sector anchor loads that would suggest the financial viability of a heat network. Additionally, ...present other limiting factors that require careful consideration.”*

*“While there are various public buildings in the area, those with the highest heat demand are the schools. There are developing plans for a new Forres Academy, yet the location remains undecided at present. There could be potential for heat networks surrounding a new Forres Academy, which should be explored as part of the design of the new school. Due to the relatively substantial heat demand from businesses and public buildings in the Forres town centre, there is interest from the community in a heat network there. The feasibility of this is currently being investigated by the community.”<sup>9</sup>*

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<sup>8</sup> <https://www.gov.scot/collections/new-build-heat-standard/>

<sup>9</sup> Moray Council Local Heat and Energy Efficiency Strategy 2023-2028: Draft for Public Consultation (2023) Pg 37 1 <http://www.moray.gov.uk/downloads/file154900.pdf>

In summary, while Forres is not a priority area for a heat network at this time, there is policy support for development of a network should it be possible to provide evidence a heat network would be financially viable and other limiting factors can be overcome. It is important to note that the final LHEES is not yet published and this could therefore be subject to change.

#### 1.4.4 Heat Network Regulation

At the present time, both the UK and Scottish Governments are in the process of implementing a range of policies and regulations relating to Heat Networks, to both facilitate their development, regulate the market and ensure consumer protection. Should the Forres heat network prove to be technically and financially feasible the latest heat network regulations and requirements such as the forthcoming Heat Network Technical Assurance Scheme<sup>10</sup> will need to be taken into account in the both the design and delivery of the network.

### 1.5 Counterfactual

In order to consider the feasibility of the proposed district heating network, we need to compare this option to a counterfactual – the other options for heat decarbonisation if this heat network does not go ahead:

#### ***Business As Usual Is Not An Option***

As set out in Section 1.4, Scottish Government policy direction is that ‘business as usual’ will not be a *long-term* option for those with gas heating, with mechanisms likely to come in to force to encourage a switch to ‘clean heating’ over the coming decade. We include the current running costs on gas in the options appraisal purely for context so that we can check whether the proposed heat network complies with policy requirements that low carbon heating delivers affordable clean energy supplies for households<sup>11</sup>.

#### ***Low Carbon Counterfactual***

If business as usual is not an option, then we propose the low carbon counterfactual to a district heat network in Forres would be individual low carbon installations.

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<sup>10</sup> <https://www.gov.uk/government/publications/heat-networks-regulation-technical-standards/heat-network-technical-assurance-scheme-hntas>

<sup>11</sup> Scottish Government (2023) [Draft Energy Strategy and Just Transition Plan](#), pg 12

- For domestic properties Scottish Government has identified heat pumps as ‘no and low regrets strategic technologies’<sup>12</sup> for most buildings. Given that individual biomass boilers on individual buildings have been defined as ‘polluting heating’ in the Heat in Buildings Bill consultation, depending on the outcome of the consultation, it is likely that heat pumps are the only option for the majority of domestic properties. Please see the attached FAQ documents for an explanation of this technology.
- For all other buildings, a detailed options appraisal of individual low carbon heating for each building is beyond the scope of this feasibility study. A single low carbon option of GSHPs has been assumed for the Moray Council buildings.
- The New Build Standard<sup>13</sup> means that the new High School will have to have a ‘clean’ heating system installed.

See Section 6 for full discussion of low carbon counterfactuals.

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<sup>12</sup> Scottish Government (2021) [Heat in Buildings Strategy, page 18](#)

<sup>13</sup> <https://www.gov.scot/collections/new-build-heat-standard/>

## 2 Forres Buildings and Layout

At this stage the proposed scheme will focus on a spine connecting a number of Moray Council buildings, along with 44 domestic properties and other community buildings.

The Council buildings, with their relatively high heat loads, would be the anchor loads for a district heating scheme in Forres and the cornerstone of the scheme's financial viability. A district heating scheme without them would be highly unlikely to be viable at present.

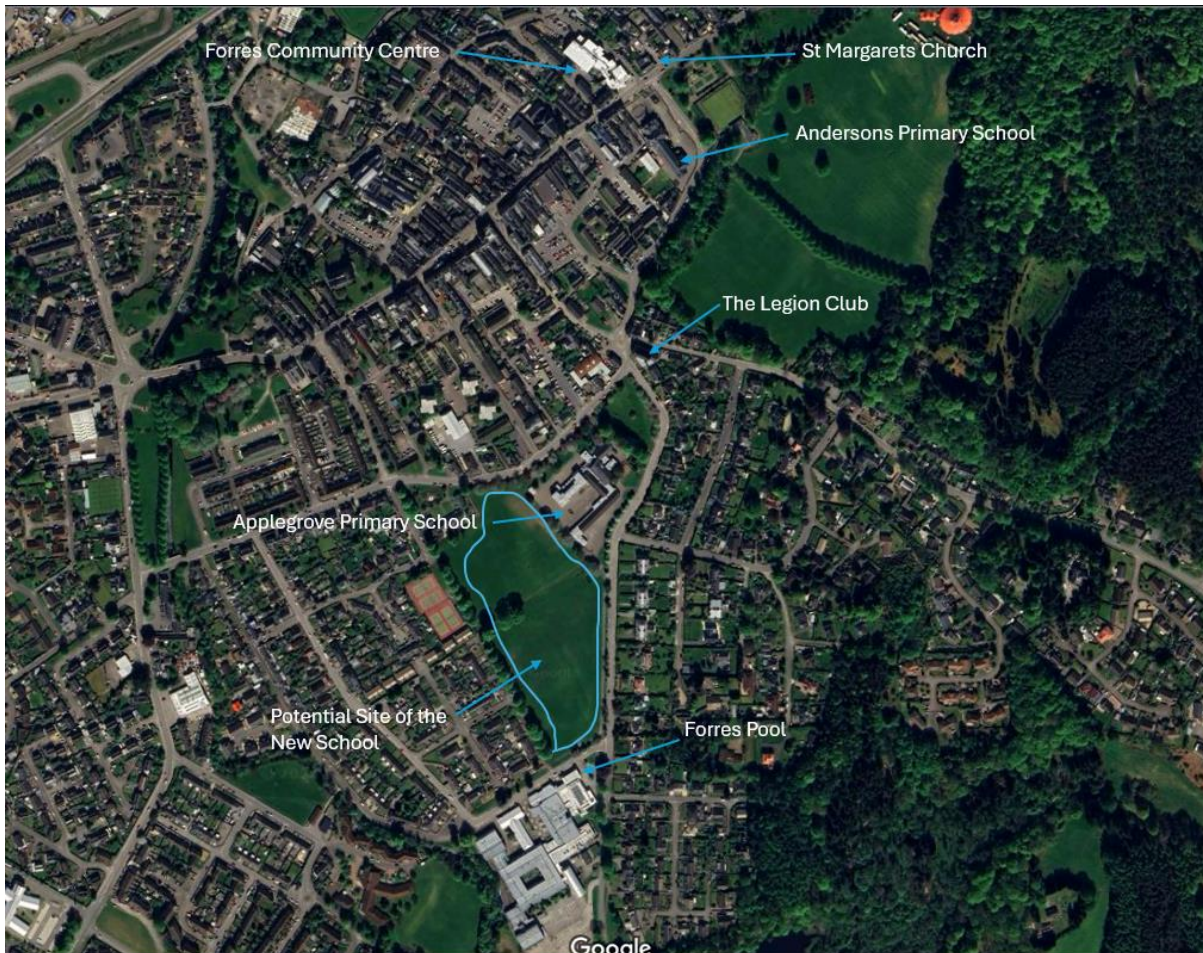


Figure 2: Map of Forres with potential heat loads

### 2.1 The Buildings

#### 2.1.1 Moray Council Buildings

It has been proposed that the following four Council buildings form the spine of the heat network and are the main anchor loads:

- Andersons Primary School: Stone built building, built in early 1800s,
- Forres House Community Centre and Library: Built in the 1970s
- Applegrove Primary School: Built in the 1950s, refurbishment including energy efficiency update in 2016.
- Forres Pool: Built in the 1970s, major refurbishment in 2016 including improved energy efficiency measures.



*Figure 3: Andersons Primary School*



*Figure 4: Forres House Community Centre & Library*



*Figure 5: Applegrove Primary School*



*Figure 6: Forres Pool*

The existing Forres Academy (on the route) will be closed in the near future due to issues with reinforced autoclaved aerated concrete (RAAC). The construction of a new school is a priority. Moray Council have announced<sup>14</sup> (22nd May 2024) that the preferred site for the new is Roysvale/Applegrove playing fields which would be on the route of the proposed heat network. The next step is a full consultation. If this site is confirmed, the new school could be included on the network and there is potential for the heat network project to be undertaken alongside this, using the school's footprint to host an energy centre.

This Feasibility Study will look at two heat network options:

- Heat Network Option 1: With the New School

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<sup>14</sup> [https://newsroom.moray.gov.uk/news/site-of-new-forres-academy-chosen#:~:text=Moray%20councillors%20have%20today%20\(Wednesday,of%20the%20new%20Forres%20Academy](https://newsroom.moray.gov.uk/news/site-of-new-forres-academy-chosen#:~:text=Moray%20councillors%20have%20today%20(Wednesday,of%20the%20new%20Forres%20Academy)

- Heat Network Option 2: Without the New School

### 2.1.2 Domestic Properties

The proposed spine network will also include approximately 44 domestic dwellings along the route. They are primarily owner-occupied houses, with a mixture of detached and semi-detached stone-built buildings, mainly from the 19<sup>th</sup> to 20<sup>th</sup> centuries. The remainder of the houses are of more recent construction, approximately 1960s.

*Table 1: Domestic Property Types and Numbers on the Proposed Route*

<b>Property Type</b>	<b>Number</b>
Detached bungalow	10
Detached house	17
End terrace house	3
Mid terrace house	1
Semi-detached bungalow	3
Semi-detached house	8
Top floor flat	2
<b>Total</b>	<b>44</b>



*Figure 7: Stone Built Houses on Sanquhar Road*

### 2.1.3 Other Buildings

There are also multiple small and medium business units, the British Legion Club and a Church along the proposed route. At this stage only the Legion Club and Church will be included. The economic and financial viability of including these smaller loads in any district heating scheme would be assessed at a detailed feasibility study stage.



*Figure 8: The Royal British Legion Club*



*Figure 9: St Margarets Church*

### **3 Existing Heating and Heat Demand**

#### **3.1 Current Heating**

All of the properties are on mains gas and it is therefore reasonable to assume that they will all have wet heating systems designed to operate at around 75°C.

In addition to gas heating, Forres Pool has heat recovery unit interfaced with solar panels which were installed in 2016.

#### **3.2 Heat Demand**

##### **3.2.1 Moray Council Buildings**

Moray Council provided gas bills for their four existing buildings on the proposed network. We have assumed that the gas boilers in these buildings are 85% efficient. This assumption would need to be checked at a detailed feasibility study stage.

In order to estimate the heat demand of the new school we were advised by Moray Council to use the footprint of the existing school and the Scottish Public Sector Benchmarking Tool<sup>15</sup> minimum estimate of the kWh/m<sup>2</sup>/yr. It should be noted that this figure is very approximate; It is likely that a school built now would have lower kWh/m<sup>2</sup>/yr than the current benchmarks and the planned footprint of the school is unknown at this time.

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<sup>15</sup> <https://www.zerowastescotland.org.uk/resources/scottish-public-sector-benchmarking-tool>

*Table 2: Moray Council Buildings Heat Demand*

<b>Site</b>	<b>Annual Gas Consumption (kWh)</b>	<b>Assumed boiler efficiency</b>	<b>Annual Heat Demand of Building (kWh)</b>	<b>Source</b>
Applegrove School	270,011	85%	229,509	Bills, 22/23
Andersons School	291,783	85%	248,016	Bills, 22/23
Forres Pool	846,585	85%	719,598	Bills, 18/19
Forres House	435,878	85%	370,496	Bills, 22/23
Forres (Proposed New High School)			1,004,872	Benchmarking <sup>16</sup>

It is important to note that these buildings would be the anchor loads for the network and their inclusion would be essential for its commercial viability.

### 3.2.2 Domestic Properties

A survey of domestic properties was conducted during the site visit which counted the number of types of houses on the proposed route. Energy Saving Trust average heat demand figures<sup>17</sup> have been used at this stage:

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<sup>16</sup> <https://www.zerowastescotland.org.uk/resources/scottish-public-sector-benchmarking-tool>

<sup>17</sup> Provided to Reheat by Local Energy Scotland.

*Table 3: Estimated Heat Demand of Domestic Properties*

	<b>Number</b>	<b>EST Estimated Heat Demand per Dwelling</b>	<b>Total Heat Demand (kWh)</b>
Detached bungalow	10	13,151	131,510
Detached house	17	22,449	381,633
End terrace house	3	13,948	41,844
Mid terrace house	1	12,015	12,015
Semi-detached bungalow	3	13,211	39,633
Semi-detached house	8	14,607	116,856
Top floor flat	2	6,876	13,752
<b>Domestic Total</b>	<b>44</b>		<b>737,243</b>

### 3.2.3 Other Buildings

The other larger heat users identified on the route are The Royal British Legion Club and St Margarets Church. They did not respond to our request for energy bill data, therefore estimates have been calculated using CIBSE Energy Benchmarking tool and an estimated floor area:

*Table 4: Other Buildings Estimated Heat Demand and Gas Use*

Building	m <sup>2</sup>	Benchmark	Annual Heat Demand (kWh)	Source	Assumed Gas Boiler Efficiency	Estimated Annual Gas Demand (kWh)
The Royal British Legion Club	255	139	35,445	<a href="#">CIBSE Energy Benchmarking Tool - Community Centre 'Typical Practice'</a>	85%	41,700
St Margarets Church	190	150	28,500	<a href="#">CIBSE Energy Benchmarking Tool - Church, 'Typical Practice'</a>	85%	33,529
		<b>Total</b>	<b>63,945</b>		<b>Total:</b>	<b>75,229</b>

There are a range of other small commercial premises on the route. Their heat demand and the economic viability of connecting them to a heat network would be assessed at a detailed feasibility stage.

### 3.2.4 Total Heat Demand

The total estimated heat demand:

- Heat Network Option 1 (including new School): 3,373,679 kWh/year
- Heat Network Option 2 (without new School): 2,368,807 kWh/year

Should the project progress to a detailed feasibility study, more accurate heat demand data would be required to increase robustness of the conclusions and inform design.

## 3.3 Energy Efficiency

### 3.3.1 Fabric First Approach

A fabric first approach refers to the concept that prior to considering low carbon heating solutions, the first thing that should be addressed is the energy efficiency of the properties. It involves upgrading building components/materials to ensure heat is maintained internally. To reach net-zero we not only need to reduce our reliance on fossil fuels, but also reduce our overall demand for energy.

*“fabric first approach is critical to the transition, reducing demand for energy, making homes warmer and easier to heat, and preparing them for zero emissions technologies.”<sup>18</sup>*

Improving the energy efficiency of buildings can reduce heat demand, therefore, can reduce running costs, improve the efficiency of low carbon heat solutions and potentially reduce the sizing, specification and capital cost.

### 3.3.2 Existing Energy Efficiency and Potential Improvements

#### **Moray Council Buildings**

Based on the high-level survey of the existing buildings (where this was possible) and what is known about these buildings at this time, it is likely that they will have relatively poor energy efficiency. Forres Pool is the exception as it is understood that the building underwent a major renovation in 2016 which included a new insulated roof, insulated walls and new high-performance doors and windows.

Recommending energy efficiency improvements for these buildings is beyond the scope of this feasibility study and may have already been undertaken by the Council. However, this should be assessed in detail ahead of the detailed design of a heat network and is highly likely to be a requirement if the proposals in the Heat in Buildings Bill Consultation are taken forward (see page 6).

#### **Domestic Properties**

The EPC ratings for the properties, where available, are summarised in Table 5:

*Table 5: Summary of Domestic EPC Ratings*

<b>EPC Rating</b>	<b>Number</b>	<b>% of EPCs</b>
C	1	4 %
D	16	62 %
E	9	35 %
<b>Total</b>	<b>26</b>	

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<sup>18</sup> [Scottish Government \(2021\) Heat in Buildings Strategy, page 6](#)

An EPC of C or above is defined in the Heat in Buildings Strategy as a good level of energy efficiency<sup>19</sup>, however the majority of buildings on the route are rated D or E.

Significant improvements in energy efficiency tend to be more expensive and disruptive for older, stone-built buildings. While some owners may choose to take forward a 'deep retrofit', it is likely that the majority will only undertake measures they are legally required to implement. The energy efficiency measures that are proposed in the Heating in Buildings Bill Consultation (see page 5), are unlikely to have a significant impact on the heat demand of these properties.

The properties built in the 1960s may have more scope for improving their energy efficiency.

Home Energy Scotland (HES) is a free and impartial Scottish Government funded advice service managed by the Energy Saving Trust. They are able to provide a range of property specific advice on appropriate energy efficiency measures and available grants and loans. We suggest that if the project moves forward, homeowners are encouraged by the community group to contact HES and understand their options.

Some examples of the savings that can be made for a typical domestic property are set out in Appendix 6.

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<sup>19</sup> [Scottish Government \(2021\) Heat in Buildings Strategy](#)

#### **4 Cooling Loads**

All buildings included in the current study are expected to have little to no cooling load with the exception of the proposed new high school building. As the design of this building has not yet commenced, the calculated energy demands are not yet known. For the purposes of the present study, the cooling load is assumed to be 50% of the heating load.

- Estimated heat demand: 1,004,872kWh/year
- Cooling load estimate:  $1,004,872\text{kWh} \times 0.5 = 502,436\text{kWh/year}$

## **5 Opportunities for Low Carbon District Heating**

This section of the report provides an appraisal of the low carbon district heating options that would achieve the community's objectives.

### **5.1.1 Suitability for a Heat Network**

District heating is the preferred low carbon option where it offers the best carbon savings, lowest running costs and, in addition, can also offer security of supply and also overcome barriers to individual action compared to individual low carbon solutions. However, they do bring a range of additional costs, disruption while installing the network and ongoing responsibility for metering and billing and complying with Heat Network Regulations<sup>20</sup>.

Based on the route of the proposed spine, the number of potential anchor load buildings and the findings of the site visit (undertaken by a Reheat Engineer) it was our opinion that a heat network in Forres had potential to meet these criteria and should be assessed in more detail.

### **5.1.2 Considerations and Potential Constraints**

#### ***Soil Depth for Trenching***

For a district heat network, trenches are dug and insulated pipes are placed underground at depths of 0.6 – 1m. UK Soil Observatory data was investigated and it was found that the soil in the area is categorised as 'Deep' which is defined as areas where "the soil and subsoil can be easily dug to a depth of more than 1 meter". Therefore, at this stage there is no reason to suggest that digging the trenching for a heat network would not be possible, however this would need to be confirmed through on-site testing if the project moves forward.

#### ***Disruption***

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<sup>20</sup> Policy and legislation on heat networks is currently an area that both the UK and Scottish Governments are developing:  
<https://www.gov.scot/publications/heat-in-buildings-progress-report-2023/pages/heat-networks-policy-and-delivery/>  
<https://www.gov.uk/government/publications/heat-networks-regulation-technical-standards/heat-network-technical-assurance-scheme-hntas>  
<https://www.gov.uk/government/publications/energy-security-bill-factsheets/energy-security-bill-factsheet-heat-networks-regulation-and-zoning>

The installation of a district heat network will inevitably cause some disruption while the trenches are dug and pipework is laid. However, the disruption should be put in the context of providing infrastructure that will deliver low carbon heat for 50+ years.

### ***Forres Conservation Area***

The Forres Conservation Area covers part of the proposed district heat route (see Appendix 1). This is unlikely to have an impact on the feasibility of a heat network as it is hidden underground once installed.

### ***Designated Landscapes***

Grant Park and Cluny Hill are listed on the Inventory of Gardens and Designated Landscapes. Therefore, they are unlikely to be available for locating energy infrastructure and this needs to be taken into consideration when defining the heat network pipe route.

### ***Heat Network Lifespan***

The heat network infrastructure should have a lifespan of over 50 years when designed and installed according to good practice. Should this project progress, by the time construction phase is reached it will be a legal requirement to meet technical standards in design and installation of the network which should ensure a long lifespan of the network.

#### **5.1.3 Heat Network Options**

This feasibility study will look at two potential heat network routes:

- Option 1: Including a new high school located on Roysvale Park
- Option 2: Without the new school

### ***Potential Energy Centre Locations***

Based on the site visit and consideration of the buildings, heat demand, geography and designations, the following potential locations have been identified for energy centres. These are preliminary proposals, subject to a number of factors, most importantly liaison with Moray Council to understand availability of these sites and future development plans.

#### **Heat Network Option 1 (with new high school): On the site of the new school**

This site has been selected for the following reasons:

- Proximity to the largest heat load on the network - the school (minimising distance and therefore cost of large diameter pipework and heat losses);
- Assumed availability of sufficient space (space requirements dependent on technology chosen and school site layout);

- Potential cost savings if it is constructed as part of the new school build.

Heat Network Option 2 (without the new school): Next to Forres Pool, on site of the former Forres Academy

This site has been selected for the following reasons:

- Proximity to the largest heat load on the network – the pool (minimising cost of large diameter pipework and heat losses),
- Assumed availability of sufficient space if old school is demolished (space requirements dependent on technology chosen)

***Initial District Heat Network Route***

Using the heat demand data of the anchor loads in Section 3.2, we have plotted the heat network route using Leanheat software, shown in Figure 10. Leanheat is specialist software that maps heat network routes.

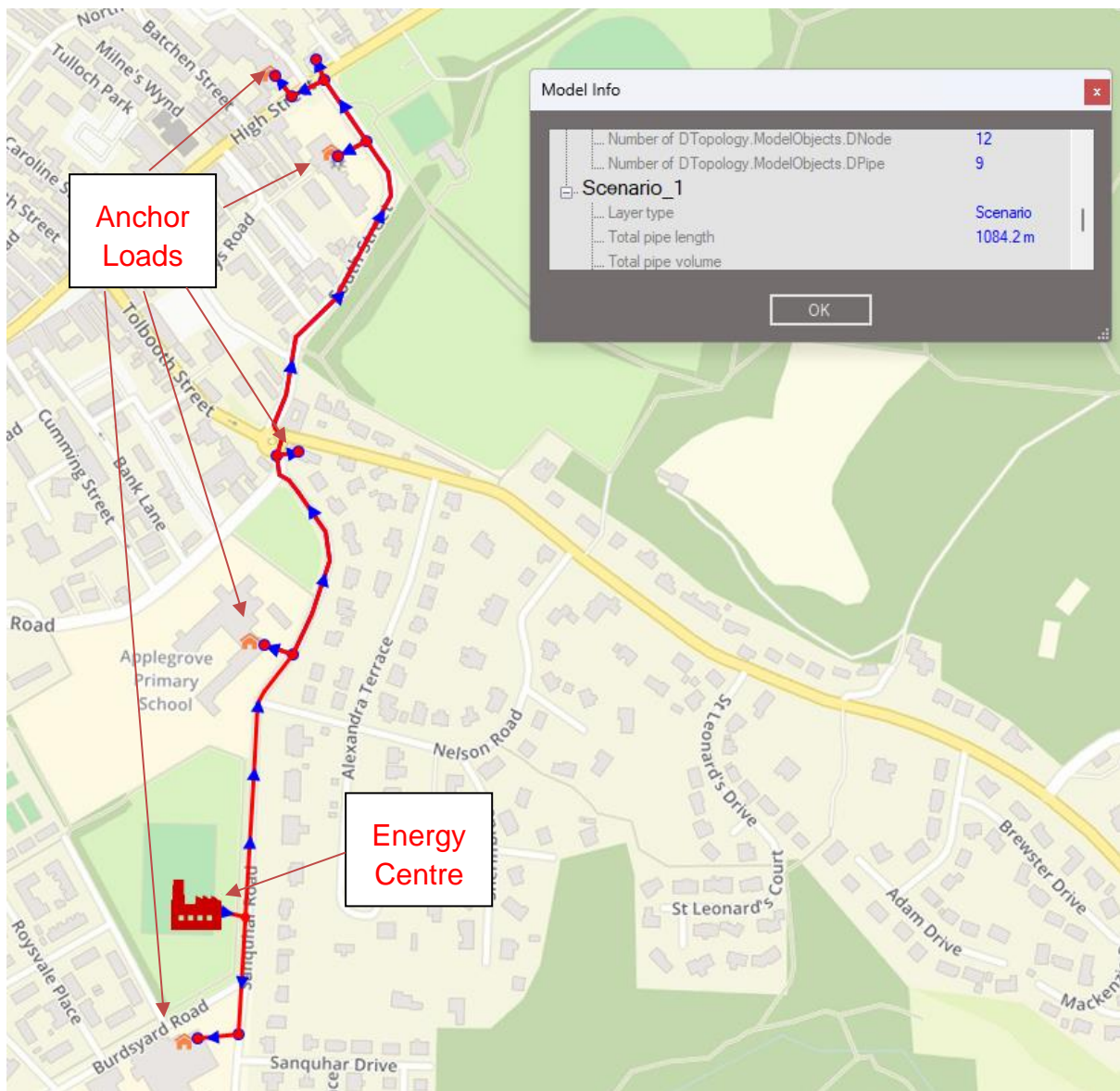


Figure 10: Leanheat Heat Network Route (Option 1 with new school on Roysvale Park)

This shows Option 1 with the energy centre located on the new school site. Option 2 would look the same, but with the energy centre located next to the pool.

At this stage we have not mapped connections to individual domestic properties or other buildings such as the Legion and St Margarets Church.

#### 5.1.4 Potential Heat Sources

##### **Burn of Mosset**

There is a small burn that runs through Forres. It passes within 150m of the Forres Pool.

However, the Burn is very shallow, with the normal depth of between 0.14m and 0.5m<sup>21</sup>. The Q95 for the Mosset Burn is 0.051 m<sup>3</sup>/s<sup>22</sup>. We conclude that the Burn would not have sufficient water depth and flow to provide any meaningful heat to the network through the inclusion of a water source heat pump.

### ***Waste Water Treatment Works***

The Forres Waste Water Treatment site serves an area larger than Forres itself. The above ground infrastructure is shown on the red box below, along with the proposed spine of the heat network. It is relatively close to the town, around 330m in a direct line from the nearest point of the heat network, but this could potentially be much further when allowing for technically viable trenching route. At a cost of £250 per metre for ground works and pipe, even at the minimum distance this would cost at least £82,000. It is also noted that there is an A road to cross which would add to the capital cost. A further consideration is that the waste water site is at the other end of the network to the largest heat demands which would increase the cost of the pipework in the main spine, as well as heat losses.

The waste water treatment works are therefore not considered a viable heat source at this stage, but could be considered should the network expand in the future.

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<sup>21</sup> <https://www2.sepa.org.uk/waterlevels/default.aspx?sd=t&lc=234331>

<sup>22</sup> <https://nrfa.ceh.ac.uk/data/station/meanflow/7009>



Figure 11: Location of the Waste Water Treatment and Proposed Heat Network

## **Biomass**

No major constraints were identified at this stage which would prevent biomass being a viable heat source for the network. This will be assessed in further detail in Section 5.2.

### **Closed Loop Boreholes**

A desk-based review of the key geological factors that could influence the viability of boreholes was undertaken:

- Superficial deposits approximately 15m depth.
- Bedrock geology Kingsteps Sandstone Formation.
- Thermal conductivity 1.9 – 2.7. Value carried forward for use in this report 2.3.
- Evidence of significant ground water. The area is prone to flooding, in part due to groundwater flow near the surface.
- The whole of the town sits upon a moderately productive aquifer.

Based on the findings, no major constraints were identified and closed loop boreholes will be assessed in further detail in Section 5.3.

#### **5.1.5 Low Carbon Technologies**

Based on the above considerations and constraints, we have identified the following technologies as being potentially feasible:

- Wood chip fired boiler/s
- Closed loop boreholes on an ambient network, with individual heat pumps

This options appraisal sets out a high-level assessment of these low carbon heat technology options, considering technical and practical feasibility, carbon savings, estimated running costs, estimated capital costs and potential sources of funding.

## **5.2 Biomass**

### **5.2.1 Biomass Energy Centre**

The major advantage of biomass is that biomass boilers efficiently and cost effectively provide heat at the same temperature as fossil fuel boilers. They would be an excellent

technical fit for the buildings on the network and mean there would be no requirement for major energy efficiency retrofit and existing wet heating systems can be utilised.

At this scale, wood chip fired boilers are recommended rather than wood pellets, as wood chip is significantly cheaper per tonne. Please see the “Wood Chip Boilers” FAQ issued alongside this report for further details of this technology.

This solution would require a centralised energy centre to house the wood chip boilers, buffer vessel (large thermal storage tank/s which improves overall efficiency of the system) and a fuel store to hold the wood chip. The energy centre for a network serving this part of Forres would be about the size of a typical Aldi store.

The design of the energy centre layout and fuel store is beyond the scope of this study and would require input from Moray Council on the availability of sites outlined on page 24. Of critical importance with a biomass energy centre is the design and ease of access of the fuel store. The energy centre would be designed to allow for future expansion of the network, for example sufficient space to install additional boiler capacity.

Using the estimated heat demand, we have calculated the required boiler sizes for the two options:

- Option 1: 1.5 MW total output.
- Option 2: 1 MW total output.

Both options would be specified as two boilers to provide an element of redundancy and improve efficiency.

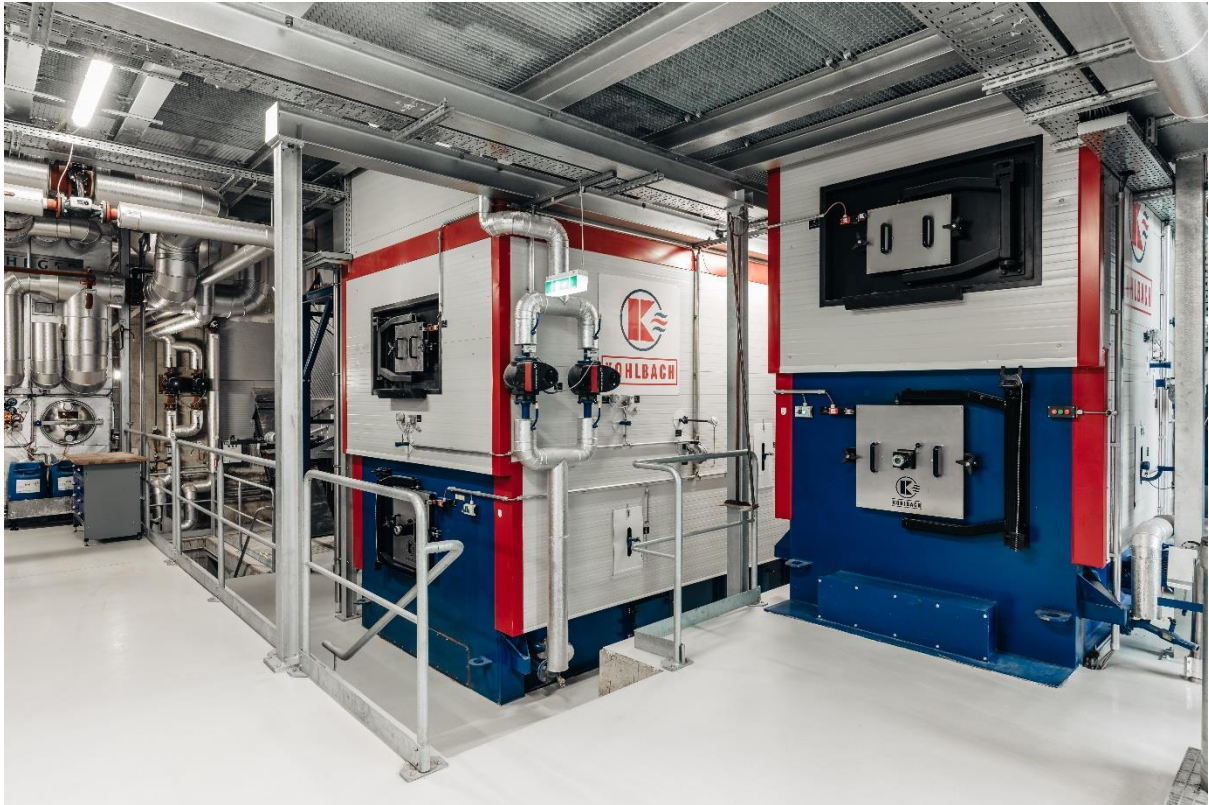


Figure 12: Example image showing of a 2MW and an 800kW biomass boilers



Figure 13: Example image of a 1.5MW and a 500kW biomass boilers

## 5.2.2 Heat Network Specification

The centralised energy centre housing the wood chip boilers would be connected to the properties via underground, insulated pipes. Each building has a heat interface unit (HIU) which transfers the heat to the buildings own central heating system for heating and hot water. Wood chip boilers would supply a heat network with temperatures of around 70-85 °C.

A high temperature network (third generation, see Appendix 2) is recommended for two reasons:

- The poor energy efficiency of the majority of the buildings mean that it can be challenging to achieve thermal comfort with lower temperature heating at a cost that is less than or equivalent to current heating bills.
- Lower temperature networks, or ambient networks (with individual heat pumps), would require the majority of buildings on this network to install larger heat emitters which would be required to deliver sufficient, lower temperature heat to achieve thermal comfort. Those buildings with microbore (very small diameter) pipework are likely to have to change all of their pipework. This involves cost and disruption. Engaging with property owners and encouraging sign-up to a heat network can be challenging, achieving this upgrade on all buildings before they can join the network is likely to create a considerable barrier to a successful heat network project.

## 5.2.3 Carbon Savings

A wood chip boiler on a district heating scheme would offer excellent carbon savings against gas:

*Table 6: Estimated carbon savings compared to current or assumed heating fuel*

	Current or Assumed Heating Fuel*	Biomass DH Option 1 (with new School)		Biomass DH Option 2: (without new School on Biomass DH)*	
	Annual Carbon Emissions per year (kgCO <sub>2</sub> e/yr)	Annual Carbon Emissions (kgCO <sub>2</sub> e/yr)	Annual Carbon Savings Against Gas (kgCO <sub>2</sub> e/yr)	Annual Carbon Emissions (kg/CO <sub>2</sub> e/yr)	Annual Carbon Savings Against Gas (kgCO <sub>2</sub> e/yr)
Total (all Buildings)	383,612	46,896	336,715	94,491	289,121

\*In order to provide a like for like comparison, these figures include the carbon emissions of the new school on GSHP.

Option 1 (including the school): 88% annual carbon emissions savings against gas.

Option 2 (without the school on the network, school on GSHP) would deliver slightly lower annual emissions savings of 75%. This is because at present the grid electricity

it is assumed the school GSHP would use has a higher carbon footprint per kWh than biomass.

The cumulative carbon emissions over 20 years, including projected grid decarbonisation for the new school on Option 2 are shown in Figure 14:

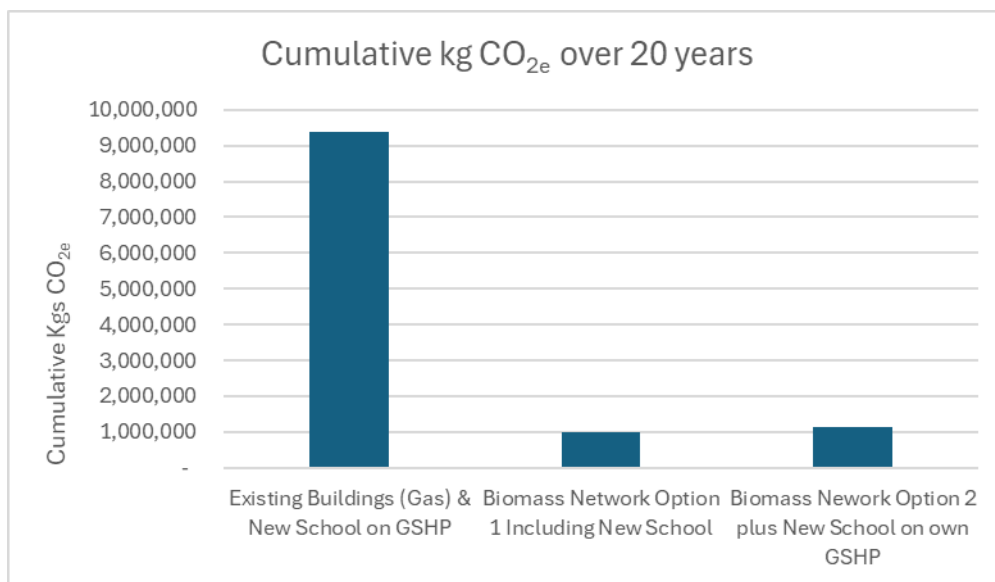


Figure 14: Cumulative CO<sub>2e</sub> emissions over 20 years

#### 5.2.4 Fuel Costs

Based on Reheat’s knowledge of the wood fuel market and other similar projects, a price of £130 per tonne of wood chip has been assumed.

Allowing for the heat demand of the buildings, the boiler efficiency (85%) and heat network losses (10%) the proposed networks would require:

Table 7: Annual fuel costs of wood chip

	Total kWh of Fuel (including boiler efficiency and heat network losses)	Tonnes of Chip	Price per tonne (£/tonne)	Annual cost of Wood Fuel
Option 1: DH with new school	4,365,937	1,156	£130	£150,231
Option 2: DH without new school	3,065,515	811	£130	£105,484

Wood chip at £130 per tonne is equivalent to around 4.5p per kWh of delivered heat, compared to gas at around 5.86p/kWh (including standing charge) for Moray Council and 6p/kWh<sup>23</sup> (plus standing charge) for domestic properties at present.

### 5.2.5 Operational Expenditure

The costs above represent the portion of the heating costs from the purchase of the fuel. However, for heating on a heat network there are a range of other ongoing costs which also need to be covered and included in the cost of heating to end users.

The other operational costs (OPEX) that may need to be accounted for include:

- Administration of fuel supply;
- Maintenance and servicing of boiler and other heat network infrastructure;
- Billing, metering and dealing with complaints;
- Charging model (p/kWh, standing charge), and whether different property types would be offered different rates (e.g. council buildings vs domestic properties, social tariffs etc);
- Risk of non-payment;
- Compliance with heat regulation requirements;
- Ownership model and objectives of running the network (for example a commercial organisation aiming for maximum profit compared to a cooperative aiming for reducing fuel poverty);
- Insurance;
- Costs of finance (depending on how the capital costs of the project are funded);
- Sinking fund for long-term plant replacement.

Costing and agreeing all of the above is beyond the scope of this feasibility study. However, it is noted that there is around 1.3 to 1.5 p/kWh gap between current heat cost per kWh and wood chip cost available to cover these costs and still be able to offer a saving against gas and comply with the Scottish Government's policy of delivering affordable heat.

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<sup>23</sup> Ofgem Price Cap April to June 2024

The gap between the gas cost and wood chip fuel cost is effectively the maximum OPEX for the project to be cost competitive with gas.

These costs can be covered by either a standing charge to access the network or by increasing the p/kWh price.

Should the project progress to a detailed feasibility study, a key component would be a full techno-economic appraisal.

### 5.2.6 Income

Heat networks typically generate income from the sale of heat to third parties on the network. How much income can be generated is related to the costs as described in the section above, the gas price and the chosen commercial and ownership models. It is not possible to assess potential income at this stage.

### 5.2.7 Capital Cost

#### **Capital Costs of the Heat Network and Biomass Energy Centres**

An initial estimate of the capital cost of the heat network spine and energy centre has been carried out. At this stage the costs are based on a number of significant assumptions relating to heat demand, heat network route and design of the energy centre and fuel store. Accurate capital costs can be assessed only after detailed design has been completed.

*Table 8: Capital Cost of District Heat Options*

	<b>Biomass DH Option 1: with School</b>	<b>Biomass DH Option 2: without School</b>
<b>Cost</b>	<b>£1,460,000</b>	<b>£1,200,000</b>

#### **Capital Costs for Connections to the Heat Network**

Each property connecting to the heat network will require a Heat Interface Unit and pipework from the main network.

Depending on the distance and the complexity of the connection, it is likely to cost between £3,000 and £8,000 per domestic property. The costs for other buildings will depend on the size of their heat demand and therefore the size and cost of the pipework and HIU. For the larger buildings this could be in the region of £10,000 to £50,000.

Who pays for the connection to the network would depend on the ownership and business model selected at a detailed feasibility and commercialisation stage.

## **Funding**

Funding for heat networks is discussed in Section 5.4. However, it is important to note the main source of heat network funding, the Scottish Heat Network Fund will only fund a biomass heat network where “other options (e.g. heat pumps or waste heat) have been found to be unviable”<sup>24</sup>.

### 5.2.8 Ownership Model

There are different models of who pays for and owns the infrastructure for a biomass heat network. At this stage it has been assumed that building owners will own the HIU and pay for the connection to the network, with the heat network infrastructure and energy centre being owned by a third party. These options are discussed in Section 8.1.

### 5.2.9 Other Considerations

#### **Planning permission**

Planning permission would be required for the Energy Centre.

#### **Fuel Sustainability**

To ensure sustainability and quality of the biomass fuel, it would be important to ensure that chip is sourced from a supplier on the Biomass Suppliers List that conforms to the current biomass sustainability criteria<sup>25</sup>.

#### **Air Quality**

The potential air quality impacts of a biomass boiler must be considered, and emissions would be approximately 20mg/GJ for particulate matter, 20mg/MJ for SO<sub>2</sub> and 60mg/MJ for NO<sub>x</sub><sup>27</sup>, compared to 5mg/MJ, 140mg/MJ and 33mg/MJ respectively from an oil boiler<sup>26</sup>. The addition of abatement technology, such as an electrostatic precipitator, to a boiler - which is now a standard offering from many leading manufacturers, can bring the particulate emissions down by as much as 85%.

Forest Research note that:

*“In more rural areas, where background levels from traffic, industry and high density housing are not a significant issue, a well designed flue should*

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<sup>24</sup> Advice received from SHNF 29<sup>th</sup> November 2023.

<sup>25</sup> [www.biomass-suppliers-list.service.gov.uk/about/sustainability-criteria/](http://www.biomass-suppliers-list.service.gov.uk/about/sustainability-criteria/)

<sup>26</sup> <https://www.testor.co.uk/blog/gas-hvac-plumbing/what-you-should-know-about-the-erp-and-nox-emission-control/>

*ensure that sufficient dispersion of combustion products takes place to ensure that the negative contribution to air quality at ground level is negligible... [and] that in rural areas open fires, garden bonfires and log stoves are common and the particulate emissions from these will be considerably higher than from a well maintained, correctly operated modern biomass boiler.”<sup>27</sup>*

### **Project lifespan**

A biomass boiler and ancillary items have a service life of 20 years<sup>28</sup>, with the heat network likely to be 50+ years.

#### **5.2.10 Biomass Conclusions**

- A wood chip energy centre on a high temperature heat network would be an excellent technical fit for Forres that would avoid the requirement for expensive and disruptive energy efficiency and internal radiator and pipework upgrades.
- It would deliver excellent carbon dioxide savings, these would be maximised if the new school is included on the network.
- The heating costs based on fuel would be lower than gas, leaving some headroom to cover operating costs and still deliver heat at a price the same or lower than gas.
- It is likely that the scheme economics will be better with the additional heat demand if the new school is on the network, and there could be some savings on the capital costs if the development is combined with the development of the new school.

## **5.3 Networked Heat Pumps and Shared Ground Array**

### **5.3.1 Description**

This solution connects an array of vertical closed loop boreholes on an ambient heat network, with an individual heat pump in each building on the network.

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<sup>27</sup> <https://www.forestresearch.gov.uk/tools-and-resources/fthr/biomass-energy-resources/reference-biomass/facts-figures/emission-levels/>

<sup>28</sup> CIBSE Guide M

### **Closed Loop Boreholes**

Closed loop vertical boreholes extract heat from the ground by circulating cold water through plastic pipes. As the cold water passes through the pipe, heat transfers into it from the ground, which is slightly warmer than the fluid in the pipes.

The thermal conductivity of the ground is taken as 2.3 and assuming full load hours of 2400 and average COP of 3.5:

*Table 9: Borehole Array Specification*

<b>Option</b>	<b>Total Drilling Depth</b>	<b>Number of Boreholes at 200m depth</b>
Option 1 (with the new high school):	31,183m	156 boreholes
Option 2 (without the new high school):	21,895m	109 boreholes

Boreholes are most effectively deployed in a single line, as grid formations result in increased thermal interference between boreholes, which reduces their effectiveness.

For Option 2 this can be achieved as the boreholes could be located along the route of the proposed heat network, and this would provide sufficient space for drilling. If boreholes were to be spaced approximately every 9m, the 109 boreholes required would fit along this route.

For Option 1 with the new high school, space would have to be found within the school grounds for the additional boreholes. As the layout and footprint of the school is not known at this stage, it has not been possible plot the position boreholes or assess whether or not there is sufficient space. It may be necessary to consider deeper boreholes. At this stage, for costing purposes, it will be assumed that all boreholes will be at 200m depth.

### **Ambient Heat Network**

Ambient heat networks are an emerging heat network architecture. The pipework connecting buildings runs at an ambient temperature in this model, hence the name. The pipework is still insulated however, to avoid thermal interference and to maximise flow temperature from the boreholes to the Heat Pump<sup>29</sup>. This means that the capital cost of installation is very similar to a higher temperature network.

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<sup>29</sup> <https://www.gogeothermal.co.uk/products/pipe/preinsulated-header-pipe>

## **Heat Pumps**

Each building would have its own heat pump, connected to the ambient loop. Each building/house would also need a hot water cylinder to provide domestic hot water.

### Commercial Heat Pumps

It is anticipated that at least some of the non-domestic buildings will require higher temperatures than heat pumps are normally able to deliver. The coefficient of performance (COP) of a heat pump depends on its output temperature. The lower the temperature, the more efficient the heat pump. For this reason, heating systems fed by heat pumps are generally designed to run at as low a temperature as possible, often in the region of 45°C for radiators or 35°C for underfloor heating. Although operating a heat pump at a higher temperature will reduce the efficiency in operation, for existing buildings this is sometimes the most cost-effective route to decarbonisation. This is because the cost of upgrading the fabric and/or heating system can be greater than the running cost saving associated with the improved efficiency.

Higher temperature heat pumps have been available for some time, and generally feature a two stage compressor cycle, where the output of the first feeds into the second. The requirement to have two compressors in series dramatically reduces the performance of the heat pump, but unlocks temperatures up to 80°C. However, there have been some recent advancements in heat pump design. An example is the ActionZero product range, which uses the superheat phase of the refrigeration cycle, along with an innovative 'stage-and-a-half' refrigeration cycle. These features result in significantly improved COPs at higher temperatures.



*Figure 15: Example of one brand of commercial heat pumps*

Hot water cylinders would need to be designed specifically to meet the domestic hot water needs of the larger buildings.

### Domestic Heat Pumps

There are range of domestic heat pumps available on the market, from small heat pumps suitable for flats (such as the Kensa Shoebox) to larger models suitable for medium to large properties.

Heat pumps are usually rated to a maximum of 65°C, however running them at this temperature would reduce the COP, and therefore increase their running costs.



*Figure 16: Kensa shoe box heat pump and small domestic hot water cylinder (e.g. for flats)*



Figure 17: Kensa Evo Heat Pump for medium to large domestic properties with hot water cylinder (e.g. for detached homes)

### 5.3.2 Carbon Savings

Closed loop boreholes on an ambient network would offer excellent carbon savings in comparison to gas, with an annual reduction of CO<sub>2e</sub> emissions of around 58% in 2024 (as it is assumed the standalone solution to the new school is also GSHPs, the total saving is the same for both options).

However, these figures only provide a snapshot of carbon emissions savings for a single year which does not accurately show the whole picture over the life span on the heat pumps (20 years); the UK Government has a target to decarbonise power by 2035, and in Scotland the Draft Energy Strategy and Just Transition Plan sets out ambitious plans:

*“The significant increase in installed capacity of renewable generation over the coming decade could mean Scotland's annual electricity generation is more than double Scotland's electricity demand by 2030, and more than treble by 2045”*

Therefore, the total carbon savings for the 20 year life cycle of the heat pumps has been calculated:

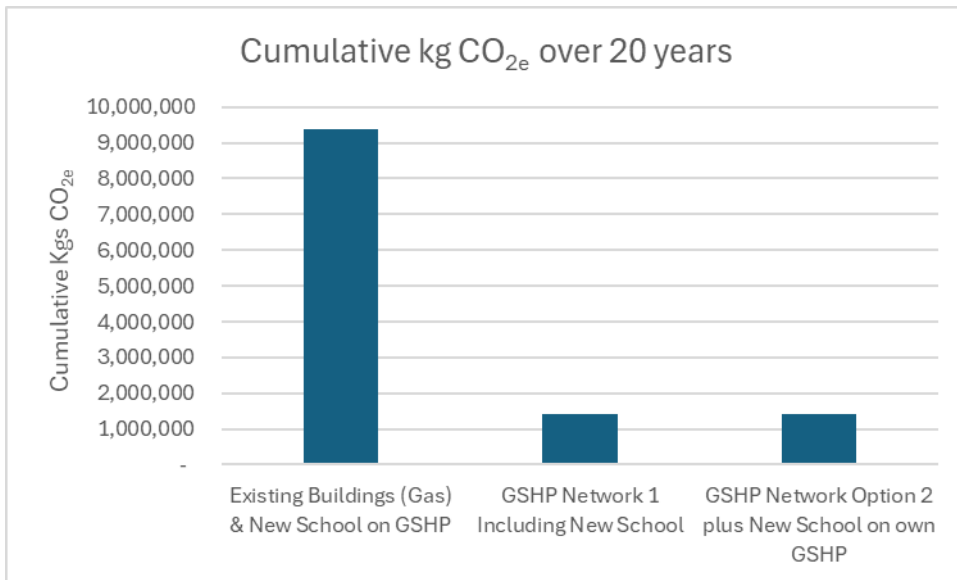


Figure 18: Cumulative kg of CO<sub>2e</sub> over 20 years

### 5.3.3 Heating Costs

Heating costs per kWh would be set by the price of electricity and the efficiency of the heat pump, known as the ‘seasonal coefficient of performance’ (SCOP). This is the average number of useful kWh of heat delivered for every kWh of electricity the heat pump uses over a year. Depending on factors such as the model of the heat pump, refrigerant, the set up and flow temperature, user behaviour and the weather, the SCOP will vary. A SCOP of 3.38 has been used, based on recent published data (see Appendix 4).

The emerging model for ambient heat networks, requires a connection fee be paid by the property owner to connect to the ambient loop. This is paid as a standing charge and is often compared to the model used for the gas network. At this stage, the standing charge for connection is not known as it would depend on factors such as ownership, funding/debt associated with the network and borehole array and commercial model.

Based on this, the cost per kWh of heat for Moray Council at their current electricity cost of 28.5p/kWh would be 8.4p/kWh of heat. This is around 2.4p/kWh higher than the current price they are paying for gas (including the gas standing charge), and that is before any charge for connecting to the ambient loop.

Table 10: Annual running costs on gas compared to GSHP for Moray Council existing buildings

	<b>Annual Heat Demand of Building (kWh)</b>	<b>Electricity Demand with SCOP of 3.38 (kWh)</b>	<b>Annual cost of electricity at Standard Tariff (28.5p/kWh)</b>	<b>Annual Gas Bill at 5.86p/kWh (inclusive of standing charge)</b>	<b>£ Savings against Gas BEFORE Cost of Connecting to Ambient Loop<sup>30</sup></b>
<b>Applegrove</b>	229,509	67,902	£19,352	£15,823	-£3,529
<b>Andersons</b>	248,016	73,377	£20,913	£17,098	-£3,814
<b>Forres pool</b>	719,598	212,899	£60,676	£49,610	-£11,066
<b>Forres House</b>	370,496	109,614	£31,240	£25,542	-£5,698

For domestic properties, the standard unit cost for electricity at the time of writing is around 24.5p/kWh<sup>31</sup>, which would result in a cost of 7.2p/kWh of heat with a SCOP of 3.8. This is about 20% higher than gas at the current price of 6.04p/kWh<sup>26</sup>. If it is assumed that buildings also switch their cooking to electric (thereby no longer having to pay the gas standing charge), there is a small saving of around £100 a year. In order to offer heat at a cost lower than or equal to gas, the standing charge to connect to the ambient loop would need to be around £100 per year or less.

However, based on the standing charges outlined by Kensa for commercially viable ambient loops, standing charges range from £150 a year for a flat up to £330 a year for a 7,700kWh year house (note that these are low heat consumption figures compared to the homes in Forres, see Section 3.2.2). Considerably more than the ~£100 available to be cost competitive with gas.

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<sup>30</sup> See Section 5.3.4

<sup>31</sup> See Appendix 5 for electricity and gas price methodology

Table 11: Estimated annual heating costs on gas and GSHP on an ambient loop

	<b>Annual Heat Demand of Building (kWh)</b>	<b>Electricity Demand with SCOP of 3.38 (kWh)</b>	<b>Annual cost of electricity at Standard Tariff (24.5p/kWh)</b>	<b>Annual Gas Bill at 6.04 p/kWh and standing charge of 31.43p/day</b>	<b>Savings against Gas BEFORE Cost of Connecting to Ambient Network</b>
Detached bungalow	13,151	3,891	£953	£1,049	£96
Detached house	22,449	6,642	£1,627	£1,710	£83
End terrace house	13,948	4,127	£1,011	£1,106	£95
Mid terrace house	12,015	3,555	£871	£968	£98
Semi-detached bungalow	13,211	3,909	£958	£1,053	£96
Semi-detached house	14,607	4,322	£1,059	£1,153	£94
Top floor flat	6,876	2,034	£498	£603	£105

However, a further consideration is the potential impact of time of use tariffs. Electricity companies offer domestic time-of-use tariffs, some specifically for heat pump users, that can improve the running costs of a heat pump. The savings are dependent on the specifics of the tariff and percentage of the heat demand that can be shifted into the lower cost periods. It is assumed that similar tariffs are, or will become, available for Councils and other types of buildings.

Depending on each building's ability to shift use into the low-cost time periods, it is possible that enough of a saving could be made to cover a standing charge, but it is very difficult to say this with confidence at this time.

Table 12: Estimated impact of shifting energy use to 'Cosy Rate'<sup>32</sup>

	Annual Cost of electricity with Varying Percentage of kWh at 'Cosy Rate'			
	10%	25%	50%	75%
Detached bungalow	£922	£847	£723	£599
Detached house	£1,573	£1,446	£1,235	£1,023
End terrace house	£977	£899	£767	£636
Mid terrace house	£842	£774	£661	£548
Semi-detached bungalow	£926	£851	£727	£602
Semi-detached house	£1,024	£941	£803	£666
Top floor flat	£482	£443	£378	£313

### The Future of Electricity Prices

As has been illustrated over the last couple of years, unit energy costs will not remain fixed and price shocks from global events can have a significant impact. However, gas and electricity move in relation to each other as the cost of electricity tracks the cost of gas because gas generation sets the marginal wholesale price.

It is recognised in the Scottish Government's Heat in Buildings Strategy that the present cost of electricity *"is incompatible with our net zero objectives and acts to disincentivise take up of zero emissions heating technologies"*<sup>33</sup>, however, the powers to reform the energy market remain with the UK Government. At the UK level, the Powering up Britain Energy Security Plan (2023)<sup>34</sup> states that:

*"We accept the Independent Review of Net Zero recommendation that Government should commit to outlining a clear approach to gas vs. electricity 'rebalancing' by the end of 2023/4 and should make significant progress affecting relative prices by the end of 2024. Rebalancing will generate the clear short-term price signal necessary to shift both households and businesses to lower carbon, more energy efficient technologies like heat pumps."*

Therefore, it is possible that government policy will at some point in the near future begin to influence the price of electricity to make heat pumps more financially viable.

<sup>32</sup> Example time of use tariff: Cosy Octopus, rates June 2024

<sup>33</sup> Scottish Government (2021) [Heat in Buildings Strategy](#). page 87

<sup>34</sup>

[https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/1148252/powering-up-britain-energy-security-plan.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1148252/powering-up-britain-energy-security-plan.pdf)

### 5.3.4 Operational Expenditure

#### ***Borehole Array and Ambient Network Operational Expenditure***

As with biomass systems, there are various ongoing operational costs. For this option the major cost is the repayment of the finance:

- Costs of finance (depending on how the capital costs of the project are funded);
- Maintenance of the boreholes (relatively minor);
- Administration of the standing charge
- Risk of non-payment;
- Costs of administration of the ownership vehicle and compliance with heat regulation requirements (if ambient loops are covered);
- Insurance;
- Sinking fund for long-term plant replacement (minor in comparison to biomass - boreholes and network have 50 plus year lifespan).

The emerging model for ambient heat networks is that these costs are covered by a standing charge to connect to the network. At this stage it is not possible to assess these costs or the resulting standing charge. This cost is a critical factor in whether or not the overall annual heating costs for properties is equal to or lower than gas.

#### ***Heat Pump OpEx***

The annual maintenance costs of the individual heat pumps are likely to be similar to gas boilers.

### 5.3.5 Capital Cost and Funding

#### ***Borehole Array and Heat Network***

Drilling costs have been estimated to be around £43 per metre.

Although the specification of the pipework is different, the cost per m is very similar to the biomass network at around £250/m. The total estimated network cost for the spine only would be in the region of £250,000. This does not include the cost of the pipe work from the spine into each property (as with the biomass costs at this stage).

*Table 13: Capital Cost of Borehole Array and Ambient Loop Spine*

	<b>Estimated Total Drilled Depth</b>	<b>Estimated Cost of Borehole Array</b>	<b>Cost Ambient Loop Spine</b>	<b>Total</b>
Option1: with new School	31,183m	£1,340,873	£250,000	£1,590,873
Option 2: without new School	21,895m	£941,486	£250,000	£1,191,486

### **Heat Pumps**

At this stage, it is beyond the scope to size and cost all of the heat pumps that would be required on the network. However, Table 14 shows some indicative heat pump costs for a range of sizes from one heat pump manufacturer:

*Table 14: Illustrative Heat Pump Costs*

<b>Property Type</b>		<b>Model</b>	<b>Cost of Heat Pump Only</b>
Domestic	Smaller property	Kensa Shoebox NX 3kW	From £4,500
	Medium to large	Kensa Evo	Range from £7,400 for 7kW to over £10,000 for 17kW.
Council & Other Buildings		Kensa Q	80kw from £28,500 (can be installed in cascade)

This table presents only the cost of the heat pump and does not include the costs of installation, hot water cylinders or any upgrades to radiators or pipework. In the case of the Council and other non-domestic buildings, new plant rooms may be required or there may be costs for existing plant room alterations.

It is assumed at this stage that the heat pumps are owned and purchased by the property owner but other options would be considered when ownership and commercialisation models are developed.

It is beyond the scope of this report to identify potential funding for Moray Council's heat pumps. Domestic properties are eligible for a grant of £7,500 towards a heat pump and a further loan of up to £7,500.

### 5.3.6 Ownership Model

As referred to in Section 5.3.3, the emerging model for this type of network is that a connection fee is paid by the property owner to connect to the ambient loop and the property owner owns their own heat pump.

For example, one such company operating in the community heat field is Kensa. Their standing charge is adjusted annually with inflation. The agreement is for 40 years and would transfer to each new property owner should the house be sold. After the 40 years, the agreement can roll over so that there is continuity of supply, but properties have the option to serve 3 months' notice to cancel the contract at this point.

It is not known at this stage whether the network at Forres would be an attractive investment for this type of company.

### 5.3.7 Other Considerations – low temperature heating

As discussed above, heat pumps are more efficient at lower flow temperatures (around 35-45°C. At lower flow temperatures heat emitters transmit heat to rooms at a lower rate – this means larger heat emitters are required to achieve thermal comfort in the majority of properties<sup>35</sup>. This will need to be addressed by replacing single panel radiators with double or triple panel radiators, installing larger radiators and/or additional radiators. This will add to the installation cost and involve some degree of disruption and redecoration. The installation costs presented below allow for this work.

If the central heating system has microbore pipework, it is very likely that new pipework need to be installed.

If this disruption is not acceptable, high temperature heat pumps could be considered, however they are more expensive to purchase and are not as efficient, with a COP of around 2, and would therefore incur higher running costs. It is understood that new refrigerants are improving the COP, but as yet we are not aware of any published data on their in-situ performance.

Improving energy efficiency: It is always best practice to take a fabric first approach. The building fabric and insulation levels and airtightness impact directly on sizing of the heat pump – a building with poor energy efficiency will have a higher heat demand and therefore require a higher capacity heat pump. This will result in higher capital costs and higher electrical energy requirements. Evidence does *not* suggest that poor energy efficiency impacts on the efficiency (the COP) of the heat pump<sup>36</sup>, as long as

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<sup>35</sup> [Climate Exchange \(2021\) Heat pump use in Scotland: an evidence review, p22](#)

<sup>36</sup> [Climate Exchange \(2021\) Heat pump use in Scotland: an evidence review.](#)

heat emitters are correctly sized. Any planned energy efficiency work should be carried out or at least specified ahead of the specification of the heat pump.

We strongly recommend that accurate heat loss calculations are carried out prior to specification to ensure the heat pump and equipment are appropriately sized for that individual property. This will lead to better heat pump efficiency and lower running costs, reduces the risk of under sizing, and ensures sufficient heat and hot water to the property all year round.

### ***Domestic Hot Water***

GSHPs cannot provide instantaneous hot water. To overcome this technical limitation, each property would need to have a hot water cylinder installed. For a domestic property this will require around 2m x 1m x 1m of space (the size of a modern fridge freezer). The cylinder can also be installed in a garage, outdoors in a purpose-built store, or in the loft, but this may decrease efficiency (it takes more energy to heat the water when the cylinder is exposed to the cold). The size of hot water tank for larger buildings is beyond the scope of this study.

Where there is insufficient space for a hot water cylinder, a heat battery can be considered. They are around a quarter of the size of a hot water cylinder but do cost more.

### ***Cooling for the New School***

Because the pipework making up the network is very cold, the network can be used for cooling without the need for a compressor cycle in most cases. This could be an advantage for the new high school which is likely to have a cooling load, however this could be achieved with the school alone, without the heat network.

#### **5.3.8 Ground Source Heat Network Conclusion**

- In order to provide thermal comfort on low temperature heating, the majority of buildings will require improvement to the energy efficiency, new radiators and potentially new pipework as well as finding space for a hot water cylinder.
- GSHPs would offer significant carbon savings in comparison to gas, which will improve year on year as the grid decarbonises.
- At the current price of electricity and gas, and while the electricity price is still linked to the gas price, there is no clear answer on whether or not it would be cheaper or equivalent to gas. However, it looks unlikely unless buildings are able to shift a high proportion of their heat use to 'cheap' periods on time of use tariffs.

## 5.4 Funding

### 5.4.1 Heat Network

Financing a heat network is not straight forward and the options available depend to a large extent on who owns the heat network. Ownership considerations and options are discussed in Section 8.1.

The main funding source at present is the [Scottish Heat Network Fund](#) (SHNF). If Moray Council choose to have some role in ownership they are likely to have access to a range of other grants and loans, such as [Scotland's Public Sector Heat Decarbonisation Fund](#). There are also novel funding mechanisms open to Local Authorities such as platforms such as [Abundance Investment](#) as an example.

### 5.4.2 Connecting to a Heat Network

For domestic properties there are no grants available at this time, but Home Energy Scotland do currently offer a loan of up to £7,500 for connections to renewably powered heat networks, which should cover the cost for most domestic properties<sup>37</sup>. However, it should be noted that this would limit connections to the heat network to the 'self-funding' audience, and those that do not have the resources to cover the loan repayment will be excluded at this time. Depending on the overall objectives of heat network and ownership model, it may be decided that upfront cost to connect to the network is borne by the network operator.

The Heat Networks Delivery Plan mentions that support will be available to individual property owners wanting to connect to a heat network through loan from the Energy Efficiency Business Support Service but further research on this scheme and eligibility, or alternative options, would be required if the project moves forward. It is beyond the scope of this report to identify sources of funding for the Council owned buildings.

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<sup>37</sup> <https://www.homeenergyscotland.org/home-energy-scotland-grant-loan>

## **6 Low Carbon Counterfactual**

This section considers the low carbon heating options available to the individual buildings on the proposed heat network route, should a heat network project not go forward.

### **6.1.1 Moray Council Properties (Existing)**

It is beyond the scope of this feasibility study to undertake feasibility studies for individual low carbon heating systems for the four or five Council owned buildings on the proposed heat network. However, the following factors will need to be considered:

#### ***Biomass***

In the Heat in Buildings Bill Consultation biomass heating is not defined as 'clean heating' for an individual buildings and therefore is not an option as low carbon heat source for these buildings if there is no heat network. This was the Scottish Government's proposal in the consultation but has not yet been confirmed in legislation.

#### ***Heat Pumps***

The remaining low carbon heat technologies for these buildings are ASHPs or GSHPs. Both of these technologies are most efficient when they provide lower temperature heating (as described in Section 5.3.7), where they can achieve Seasonal Coefficients of Performance (SCOP) of around 3 and 3.5 respectively (improvements in specification and technology could deliver improved COPs but these values are based on published operational figures). A switch to a lower temperature heating would require the upgrade of all radiators and potentially pipework if small diameter microbore has been used.

Higher temperature heat pumps (achieving temperatures of 60-80°C) are available. At present there is a lack of reliable, published evidence on the SCOPs that these can achieve and it is also a period of innovation and development in this technology.

However, assuming system that was able to deliver a SCOP of 3.38, at current electricity prices of 28.5p/kWh (provided by Moray Council), this would result in an annual heating costs around 5% higher than current gas bills.

### 6.1.2 Moray Council – New School

The New Build Standard<sup>38</sup> means that the new High School will have to have a ‘clean’ heating system installed. For a new building that should be designed with a high standard of energy efficiency and low temperature wet heating system, it can be assumed that heat pumps would be the most appropriate technology. The new school is also likely to have a cooling requirement. Based on this, for the purposes of a counterfactual GSHPs have been identified as a likely technology option, but it is beyond the scope of this report to provide any further details on costs or running costs.

### 6.1.3 Domestic Properties and Other Buildings

As outlined in Section 1.5, the low carbon counterfactual for domestic properties is individual ASHPs.

#### ***Description***

ASHPs work by extracting heat from outside air and transferring it into the building; they use around 1kWh of electricity to deliver around 3kWh of heat. This ratio is known as the Coefficient of Performance (COP). A full description of ASHPs can be found in the “ASHP FAQs” document.

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<sup>38</sup> <https://www.gov.scot/collections/new-build-heat-standard/>



*Figure 19: Air Source Heat Pump*

### ***Practical Considerations***

External wall space:

ASHPs need to be located externally and are usually placed freestanding beside the property or mounted on the wall.

Identifying suitable external space can be more challenging for flats and terraced houses.

Low temperature heating:

As with GSHPs, ASHPs operate most efficiently at lower temperatures than traditional fossil fuel heating systems and cannot provide instantaneous hot water. This has a range of implications including larger radiators, improved energy efficiency and the need for a domestic hot water cylinder (see Section 5.3.7 for full details).

### ***Carbon Savings***

As previously discussed (see 5.3.2), as the grid will gradually decarbonise over the coming decades, the carbon savings of an ASHP are best illustrated by their

cumulative emissions over 20 years (lifespan of an ASHP). They provide excellent carbon savings against gas:

*Table 15: Cumulative kg CO<sub>2e</sub> for a domestic ASHP and carbon savings against gas*

	<b>Average Estimated carbon emissions per Property on ASHPs kg CO<sub>2e</sub> (Cumulative over 20 years)</b>	<b>Carbon Savings against Gas (Cumulative over 20 years) kg CO<sub>2e</sub></b>
Detached bungalow	6,242	467,194
Detached house	10,655	1,363,224
End terrace house	6,620	144,018
Mid terrace house	5,703	37,551
Semi-detached bungalow	6,270	136,408
Semi-detached house	6,933	413,749
Top floor flat	3,264	46,244

### **Heating Costs**

As described in Appendix 4, we assume that for every kWh of electricity an ASHP uses it will deliver 3.02kWh of usable heat. At current gas and electricity prices<sup>39</sup> an ASHP would be marginally more expensive to run than gas heating for most homes. Note that this table assumes properties no longer have to pay a gas standing charge – this would not be the case if gas connection was retained for cooking.

Smaller homes, where the gas standing charge forms a greater proportion of the bill, may save money against gas:

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<sup>39</sup> [Ofgem Energy Price Cap April to June 2024](#)

Table 16: Annual cost of heating with an ASHP and savings against gas

	<b>Annual Cost of ASHP per Property (SCOP 3.02)</b>	<b>Savings Against Gas</b>
Detached bungalow	£1,067	-£18
Detached house	£1,821	-£111
End terrace house	£1,132	-£26
Mid terrace house	£975	-£6
Semi-detached bungalow	£1,072	-£18
Semi-detached house	£1,185	-£32
Top floor flat	£558	£45

As with a GSHP, time of use tariffs could make a dramatic difference if it is possible to shift a proportion of kWh into the low cost periods.

### **Sources of Financial Support**

It is beyond the scope of this report to provide individualised specification and costing for ASHPs. However, the average cost of an ASHP, including installation of hot water cylinders and upgraded radiators, is between £7000 and £13,000<sup>40</sup>. Given the relatively low energy efficiency of the properties, and the likelihood of them requiring new radiators and pipework, a price towards the higher end of this range is a reasonable assumption to make. If pipework also needs changing this would be an additional cost which will depend on the size and structure of the property.

A grant of up to £7,500 can be sought per property from Home energy Scotland towards the heat pump. A further interest free loan of up to £7,500 is also available, payable over 10 years<sup>41</sup>.

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<sup>40</sup> <https://www.homeenergyscotland.org/heat-pumps/an-introduction-to-heat-pumps/>

<sup>41</sup> <https://www.homeenergyscotland.org/home-energy-scotland-grant-loan>

### **Other Considerations**

Air source heat pumps are low maintenance and have a lifetime of up to 20<sup>42</sup> years.

The annual service cost is currently around £150.

In most cases ASHPs will be classed as a 'permitted development' and therefore planning permission would not be required, unless buildings are listed. For any properties with the Forres Conservation Area they would need to be located on the rear elevation. Multiple ASHPs on a single buildings (i.e. flats) are not permitted development and would require planning permission (however, it has been recognised that this is restrictive and amendments are being considered<sup>43</sup>).

A building warrant will often be required<sup>44</sup> to install a heat pump and this should also be checked with your local authority.

Visual impact: the units would be visible on the outside of the blocks and individual buildings.

Installation of an ASHP would be relatively straight forward and quick in comparison to a heat network. However, consideration needs to be given to the level of disturbance and redecoration of fitting new radiators and potentially also pipework where microbore pipework is present.

Permission is required from the 'Distribution Network Operator' (DNO) to connect a heat pump to the electricity grid. The installer will usually take care of this.

## **6.2 Low Carbon Counterfactual Summary**

Based on the analysis above, should a low carbon heat network not progress, the following are the main considerations when comparing individual low carbon heat options against gas:

- According to current policy proposals, biomass will not be an option for individual buildings if they are taken forward into legislation.
- Heat pumps are most efficient, therefore cost effective, at low flow temperatures: to work efficiently this will mean upgrades are required to building

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<sup>42</sup> CIBSE (2020) Guide M - Maintenance engineering and management

<sup>43</sup> [https://www.legislation.gov.uk/ssi/2024/102/pdfs/ssipn\\_20240102\\_en\\_001.pdf](https://www.legislation.gov.uk/ssi/2024/102/pdfs/ssipn_20240102_en_001.pdf) See sections 2.2 and 2.3.

<sup>44</sup> [The Scottish Government \(2010\) Low carbon equipment and building regulations – A guide to safe and sustainable construction Air Source Heat Pumps.](#)

fabric of the vast majority of buildings, as well as radiator upgrades, space for domestic hot water cylinders and potentially new pipework.

- For the majority of buildings on the network, there is no technical barrier to the installation of individual heat pumps.
- Even at low flow temperatures, with SCOPs based on published in-situ performance data, heat pumps are likely to result in higher running costs, at current electricity prices, unless considerable utilisation is made of time of use tariffs. It is unknown how feasible this will be, we cannot predict what proportion can be realistically shifted into the low cost time periods.

## 7 Options Appraisal

### 7.1 Carbon Emissions Comparison

At present wood chip has lower CO<sub>2</sub> emissions per kWh than heat pumps running on grid electricity.

The carbon emissions for any technologies reliant on grid electricity can be expected to fall year on year until full grid decarbonisation is achieved. To illustrate this, the cumulative CO<sub>2</sub> emissions over a 20 year period are shown in Figure 20:

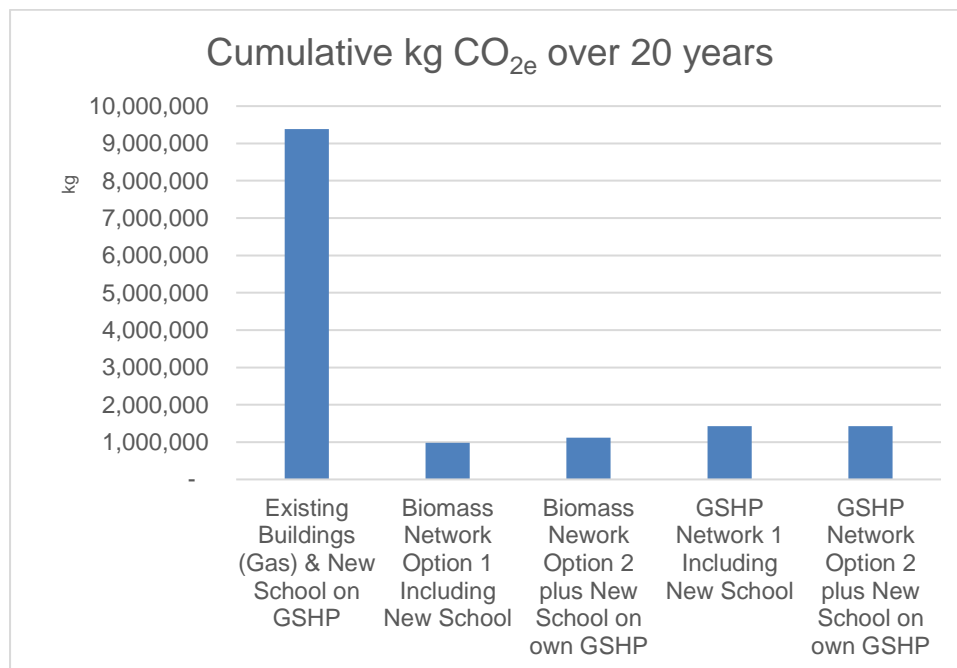


Figure 20: Estimated cumulative tonnes of CO<sub>2e</sub> over 20 years

Government projections of grid decarbonisation suggest that carbon emissions per kWh of heat from an ASHP or GSHP would reach the levels of wood chip around 2034.

Individual solutions based on ASHPs would result in marginally higher carbon emissions than GSHPs due to the slightly lower SCOP.

A very simplistic analysis shown in Figure 21, suggests that it could take up to a further 20 years for the cumulative, year on year emissions to be lower than a wood chip system.

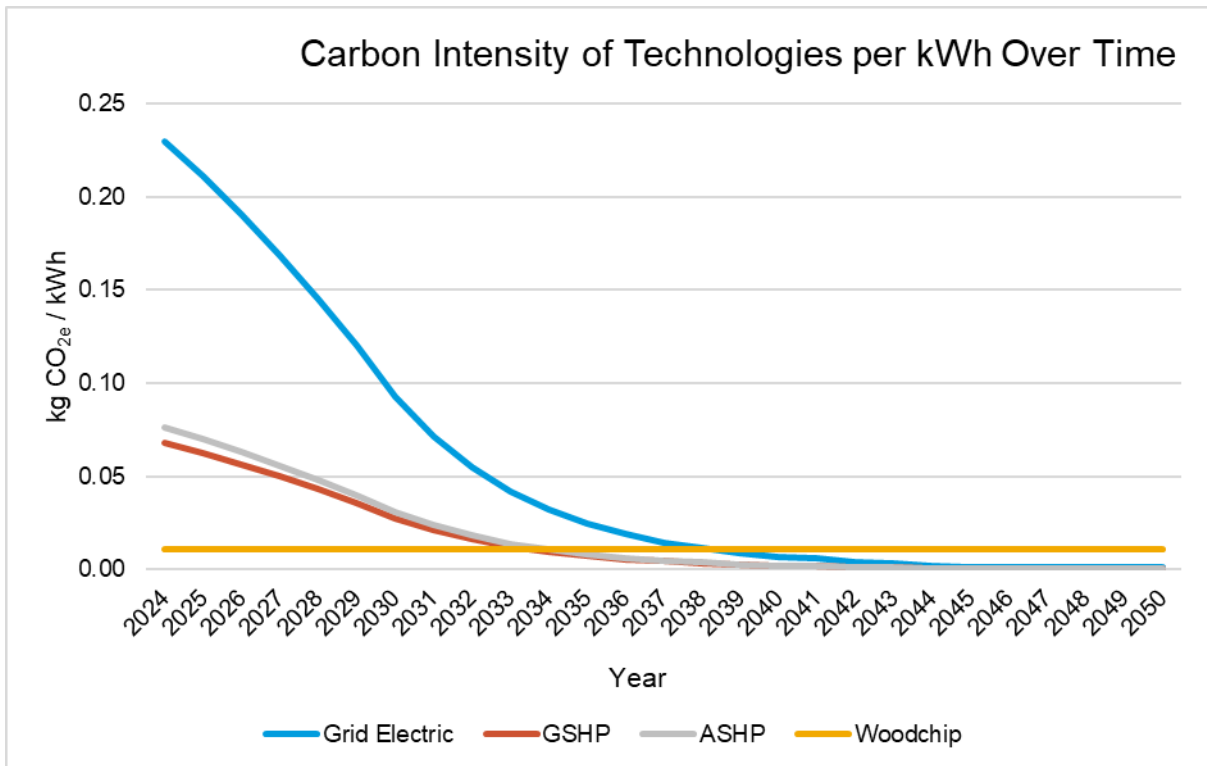


Figure 21: Carbon intensity of heat technologies per kWh forecasted

The lifespan of the heat network infrastructure for a biomass or ambient network is at least 50 years or more. Over this timescale the total carbon emissions of the GSHP or biomass network, or individual ASHPs would be very similar.

In summary, all of the above options would deliver significant carbon emissions savings in comparison to business as usual for those on fossil fuels, with biomass offering the greatest savings over the next 20 years.

## 7.2 Annual Heating Costs Comparison

One of the aims of the Scottish Government Net-zero policy is that it will deliver *affordable* clean energy supplies for households<sup>45</sup> and the principles underlying the Community Heat Development Programme include reducing long-term operating costs or have costs equal or marginally higher than current costs but has a positive carbon impact. Therefore, we have undertaken a calculation that shows the ‘like for like’ total annual fuel cost for the low carbon heating options being considered.

<sup>45</sup> <https://www.gov.scot/publications/draft-energy-strategy-transition-plan/pages/3>

At this stage we cannot accurately estimate what the cost will be for every user within the Forres project area, but taking an average usage of around 16,700kWh per annum for domestic users, we can give a high-level estimate of what the indicative costs would be for different technologies<sup>46</sup>, without the network costs for GSHP Network or Biomass Network at this stage:

*Table 17: Comparison of heating costs for a typical domestic property on different technologies*

	Current p/kWh Purchased Fuel	Current p/kWh Delivered Heat	Cost of Heating Fuel	Additional Annual Costs - standing charges/network costs etc	Total
Gas	6.04	7.11	£1,187	£115	£1,301
Biomass Network	3.44	4.50	£751	?	?
GSHP Network (Standard tariff)	24.5	7.25	£1,211	?	?
ASHP (standard tariff)	24.5	8.11	£1,355	0	£ 1,355

*Table 18: Moray Council total cost of heating for the existing council buildings on different heat technologies*

	Current p/kWh Purchased Fuel	Current p/kWh Delivered Heat	Cost of Heating Fuel	Additional Annual Costs - standing charges/network costs etc	Total
Gas	5.86	6.89	£108,073	Included in p/kWh	£108,073
Biomass Network	3.44	4.50	£70,512	?	?
GSHP Network (standard tariff)	28.5	8.43	£132,181	?	?
ASHP (standard tariff)	28.5	9.44	£147,938	0	£147,938

At this stage, the figures suggest that once a standing charge to access the network was been included, a GSHP on an ambient network would likely result in higher heating costs. This could be mitigated by use of time of use tariffs but this could be hard to communicate to potential customers.

Based on running costs, it would be hard to justify the GSHP on an ambient loop over an individual ASHPs as the SCOP is only marginally better according to published in-situ data but the standing charge would more than wipe out this benefit.

Biomass fuel costs are significantly lower than gas. We can conclude that the biomass network has the greatest potential to offer low carbon heat at a price that is equal to or lower than gas but further detailed feasibility work is required to understand the ongoing operating costs and final price that could be charged to consumers.

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<sup>46</sup> See Appendix 5 for Energy Prices methodology

Defining the costs of running the networks would be a key part of a more detailed feasibility study.

### 7.3 Simple Capital Costs Comparison

The capital costs of options have been split into costs of the core network (energy centre or borehole array and the heat network spine), and the costs for each property joining the network. Who is responsible for the costs of connecting each building is dependent on the ownership and business model selected at later feasibility stages.

Total estimated capital cost for the energy centre/borehole array and heat network spine:

*Table 19: Estimated capital costs of the energy centre/borehole array and spine of the heat network*

		£
<b>Biomass Energy Centre and Heat Network</b>	<b>Biomass Network Option 1 including New School</b>	£1,461,378
	<b>Biomass Network Option 2 without New School</b>	£1,195,420
<b>Borehole Array and Ambient Loop</b>	<b>GSHP Network Option 1 including New School</b>	£1,590,873
	<b>GSHP Network Option 2 without New School</b>	£1,191,486

Estimated costs per building:

*Table 20: Estimated capital costs to council and non-domestic buildings*

	Council and other non-domestic buildings		
	Property Specific Heat Infrastructure		Energy Efficiency, Water Cylinders and Pipework Upgrades
<b>Biomass Network Options</b>	HIU per property, plus connection to spine	£10,000 to £50,000 for larger buildings	£0
<b>GSHP Network Options</b>	Heat pump per property, plus connection to spine	Example price 80kw from £28,500 (Council buildings like to require between 150 and 350 kW of heat pump capacity each) plus £250/m for connection to spine.	Unknown at this stage

Table 21: Estimated capital costs for domestic buildings

	Domestic		
	Property Specific Heat Infrastructure		Energy Efficiency, Water Cylinders and Pipework Upgrades
<b>Biomass Network Options</b>	HIU per property, plus connection to the spine	Smaller properties: £3000	£0
		Larger properties: £8000	£0
<b>GSHP Network Options</b>	Heat pump per property, plus connection to the spine	Smaller properties: £4500 plus £250/m pipework	Unknown at this stage
		Larger properties: up to £10,000, plus £250/m pipework	Unknown at this stage

Based on the simple capital costs to date, overall the capital costs of the GSHP ambient network are considerably higher than the biomass network once the heat pump, energy efficiency and radiator and pipework upgrades are taken into account.

The capital cost to each property joining a biomass network would be considerably lower than individual heat pumps and associated work.

Based on capital costs, a biomass network appears to be the most favourable option at this time.

## 7.4 Other Considerations

### Third Generation (high temperature network) vs Shared Ambient Loop or low temperature individual heat pump

A biomass heat network can provide heat at the same temperature as the existing fossil fuel boilers, therefore removing any requirement to upgrade internal pipework, radiators and energy efficiency. This is a significant benefit against a shared ambient loop as they share the similar costs and disruption of installing the heat network.

However, the benefits of this are not straight forward to assess at this stage in comparison to individual heat pumps, as the costs and disruption of internal upgrades may be outweighed by the cost and disruption of the heat network infrastructure.

Assessing these costs, particularly for the Council buildings would be a key component of a detailed feasibility study.

### Coordination of Installation of Energy Efficiency Measures and Individual Heat Pumps on a heat network

The existing ambient heat networks that we are aware of to date are primarily focused on social housing, where there is a single property owner who can plan and deliver the required heat pump and cylinder, energy efficiency and pipework. Achieving this work with a large number of individual property owners could prove challenging.

### Space Requirements

The HIU required for a biomass heat network is similar size to gas boiler, whereas for heat pumps space must be found for the heat pump and a hot water cylinder.

## **7.5 Options Appraisal Summary**

When comparing the the options of individual ASHPs, a biomass heat network and networked heat pumps on a shared ground loop, the following conclusions can be drawn:

- A biomass heat network would be a technically viable low carbon solution, providing high temperature hot water (70-85°C), which negates the costs and disruption of major energy efficiency or wet heating system upgrades that would be required for any heat pump solutions (individual or on heat network).
- Over the 20 year lifespan of the biomass boiler/s it would offer excellent carbon emissions savings, marginally better than a GSHP ambient network or individual heat pump solutions, with similar carbon emissions over a 40-year period.
- The biomass fuel costs would be lower than gas, meaning there is a margin to cover ongoing operational costs. Whether this is sufficient to be economically viable would need to be assessed with a detailed techno-economic appraisal.
- Without a considerable use of time of use tariffs, it does not look like a GSHP network could provide heat at a price equal to or less than gas at this time, once a standing charge for connection is included. Individual ASHPs have more scope to achieve this if time of use tariffs are taken advantage of, but this is not certain.
- Based on the costings undertaken to date, the capital costs of the biomass network would be lower than the GSHP ambient loop network. The costs to individual properties, assuming they take on the cost of the HIU and pipework to the spine, are likely to be lower than the costs of an ASHP and associated

energy efficiency and other upgrades, even allowing for HES grants towards the heat pump and energy efficiency measures. Depending on the commercial model, these costs to households and the resulting barrier to joining, could be removed and covered in other ways such as slightly higher p/kWh of heat etc.

- The biomass heat network project would only be viable if the Council Buildings are included on the network.
- The development and installation of a heat network is a long term project and there would inevitably be some localised disruption while the heat network is installed. This disruption should be put into context of delivering infrastructure that will deliver low carbon heat for the next 50+ years. It should also be compared against the internal disruption of energy efficiency upgrades, new radiators, hot water cylinders and potentially pipework that would be required for any of the low carbon alternatives which are all based on low temperature heating from heat pumps. Business as usual is not an option.

## **8 Conclusions and Next Steps**

Based on the energy efficiency and heat demand of the buildings along the proposed route, a higher temperature biomass heat network is likely to be the most effective option for delivering thermal comfort at a price that is equal to or less than gas. The heat demand of the Council buildings will be critical to the viability of the project. The project's financial viability will be improved if the new school is included on the network.

Based on the options appraisal and summary set out in 7.5, we recommend moving to a detailed feasibility study for a biomass heat network in Forres.

### **8.1 Ownership Options**

It is understood that there is no appetite for community ownership of the heat network project should it proceed. Therefore, it is likely that ownership by Moray Council or a private sector third party would be the likely options, should the project be commercially viable. Scottish Government have recently published guidance on models for heat network development<sup>47</sup>.

While there is currently no legally constituted community group leading this project, the community may want to consider whether there are any other mechanisms for retaining some level of community benefit and control in the project.

### **8.2 Next Steps**

#### Development meeting:

Reheat will provide an online session to the Forres community group and other key stakeholders on the report findings, answer any questions and look at next steps for the project.

#### CHDP Stage 3 Enhanced support.

CHDP has a newly introduced 'Stage 3 Enhanced Support' stage. The overall Stage 3 objective is to take projects further along their development journey towards being 'implementation ready', subject to fulfilling a range of assessment criteria.

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<sup>47</sup> Scottish Government (2024) Heat Networks Deliver Models  
<https://www.gov.scot/publications/heat-networks-delivery-models/pages/8/#page-top>

Stage 3 work will address the specific challenges within each project, with a package of support tailored to suit the project and help progress it as far as possible against priority milestones.

Potential Stage 3 activities for Forres will be included in the Development Meeting presentation, and this will be the opportunity for the Forres stakeholders to comment, discuss and decide if a Stage 3 proposal should be prepared. If it is agreed, then Reheat will prepare the proposal and submit to Local Energy Scotland who will appraise it against key criteria and decide if Stage 3 support will be provided. One key criteria is evidence of support from the community to continue to stage 3.

The critical issues to assess in greater detail include:

- Liaison with Moray Council:
  - Understanding the Council's interest in driving forward a heat network in Forres.
  - To understand their interest and investigate opportunities to combine build of an energy centre with the new school development.
  - Defining low carbon counterfactual for the Council buildings in greater detail, including technical options, capital costs and running costs (if within scope of CHDP).
- Collect actual heat demand data for those buildings where estimates or benchmarks have been used.
- More detailed design of the energy centre and network route and improved costings.
- Detailed techno-economic feasibility for the proposed biomass network, particularly understanding whether it can deliver heat equal to or less than gas.

#### Decision not to progress a heat network?

If Forres community group/Moray Council decide not to progress a heat network project, a project promoting individual household decarbonisation could be considered.

This could range from a light touch promotion of the current grants available from HES through to a community collective ASHP purchase project. Collective action can overcome many of the barriers to pursuing a low carbon heating solution, as no one homeowner has to be the 'first mover', and working together can overcome some of the uncertainties associated with moving to an unfamiliar technology, as well as helping identify suitable installers etc. If this is of interest, please contact LES to discuss further and define whether support may be available through a CHDP Stage

3 project or whether learnings can be shared in future when a proposed pilot project has concluded with another community.

#### Fabric first:

We recommend that a fabric first approach is taken, and potential energy efficiency improvements are researched and implemented by all buildings irrespective of whether Forres decide to take forward a low carbon heat network project at this time. There is currently funding available for domestic energy efficiency measures and, as well as being good practice, it is likely to become mandatory at some point in the future to reach an EPC of C in private properties (see 3.3.1). The Forres group could approach Home Energy Scotland and discuss opportunities for promoting their services and grants within Forres, offering personalised advice on energy efficiency grants available to interested households.

#### Stay in Touch:

Stay in contact with Local Energy Scotland on how your community heat project is progressing. LES will assist where possible to support your community's efforts.

#### Feedback to Scottish Government:

One of the objectives of the Community Heat Development Programme is “to learn how communities and groups of householders can work together to make buildings in their communities more environmentally friendly to heat.” This includes learning about the barriers currently facing community heat. All feasibility studies are shared with Scottish Government, and Reheat have quarterly meetings to feedback key findings and themes on the feasibility of community heat projects. Findings will also be shared in guidance to support other communities learnings.

Statement from the Scottish Government, October 2023:

*“The Scottish Government is committed to delivering decarbonised heat and has an ambitious programme of at least £1.8 billion investment over the course of this Parliament to make our buildings easier and greener to heat. Scottish Government funding is already available through grants and loans to individual householders, communities and businesses, and for developers of district heating schemes.*

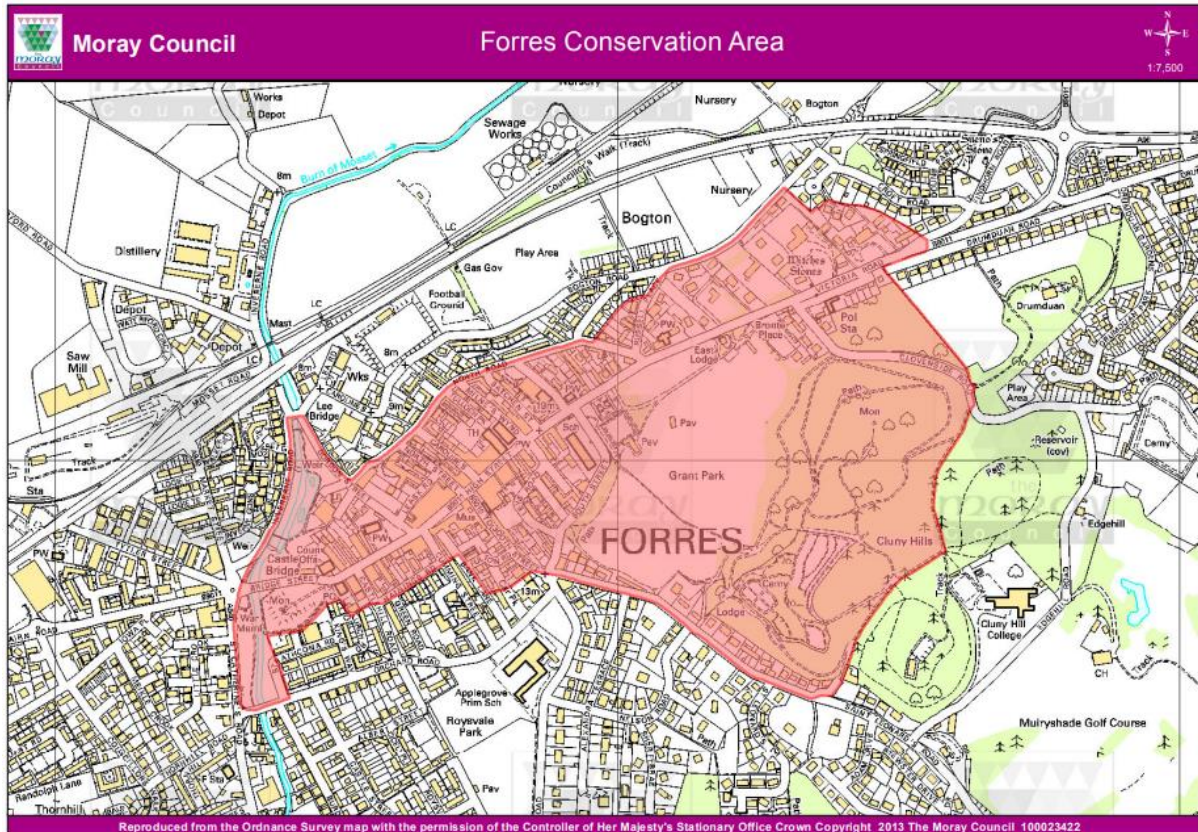
*The Community Heat Development Programme (CHDP) is looking to pilot communal ways to decarbonise heat. The Scottish Government is aware that some projects that move through feasibility via the CHDP might face a gap in support for later stages. The Scottish Government remains committed to making sure that opportunities for community energy are realised by targeting support accordingly, and will consider options for fair and appropriate ways to fill funding gaps identified through the CHDP.”*



## Appendix 1: Designated Landscapes and Buildings

### Forres Conservation Area

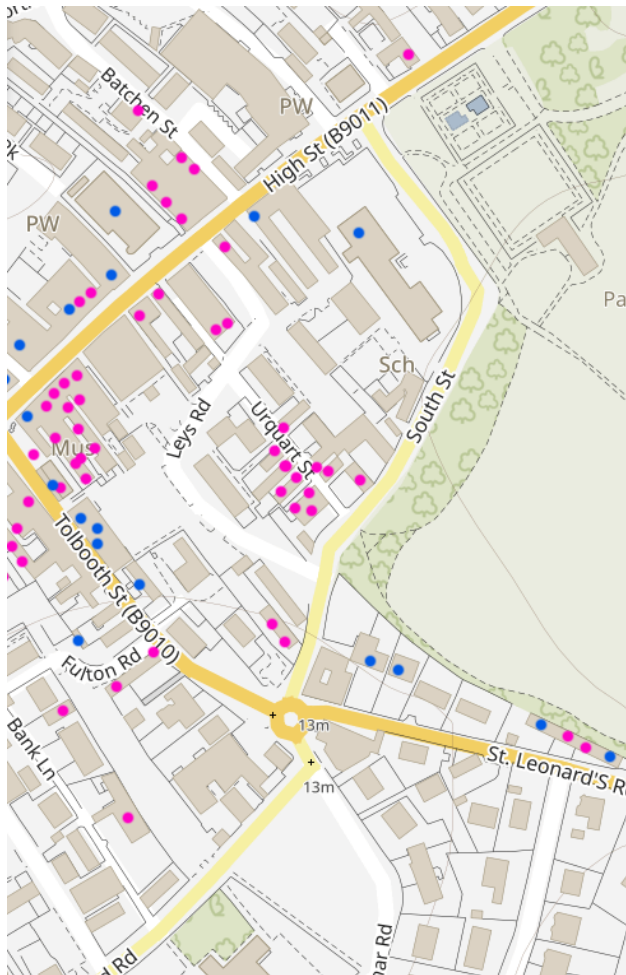
Map of Forres Conservation Area<sup>48</sup>:



<sup>48</sup> <http://www.moray.gov.uk/downloads/file86283.pdf>

## Listed Buildings

Map of listed buildings in Forres<sup>49</sup>:



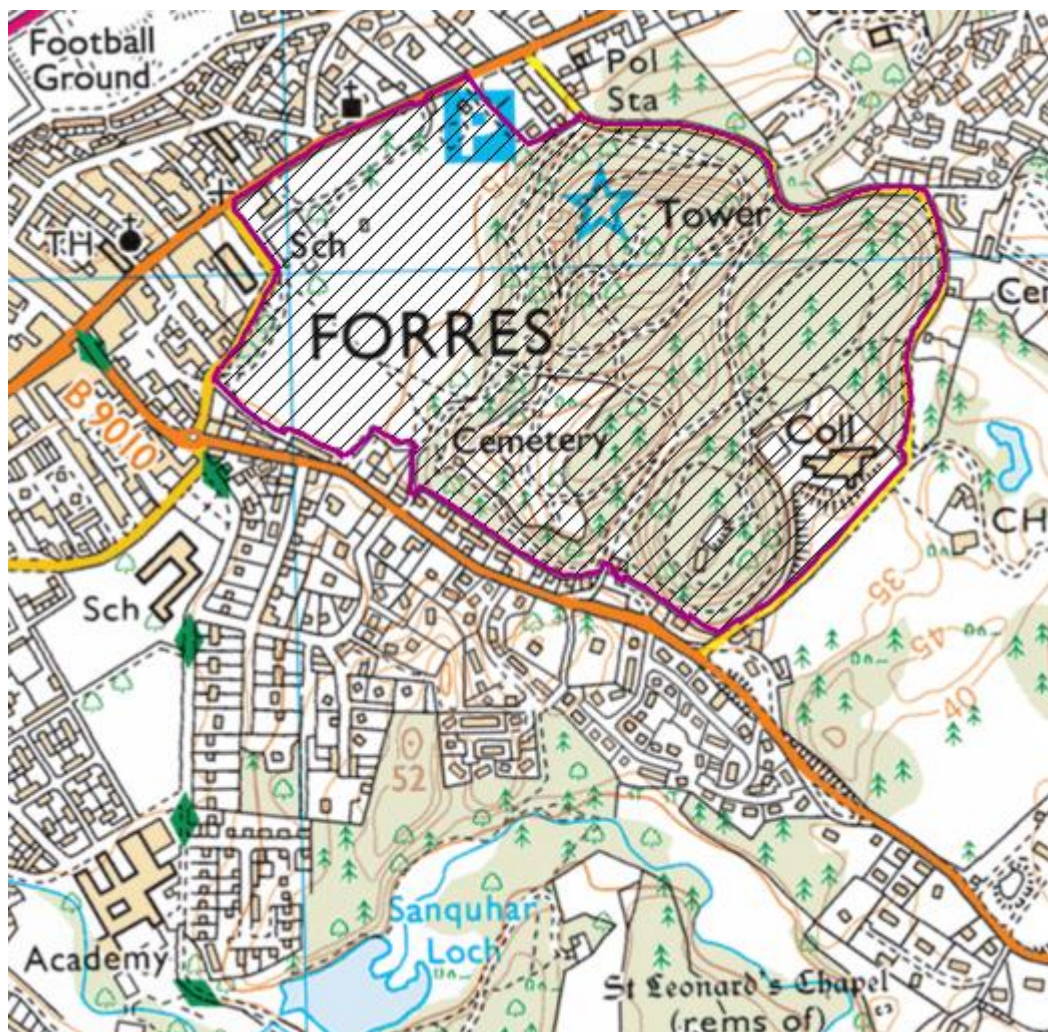
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49

<https://hesportal.maps.arcgis.com/apps/Viewer/index.html?appid=18d2608ac1284066ba3927312710d16d>

### **Designated Landscapes**

Grant Park and Cluny Hill are on the Inventory of Gardens and Designed Landscapes<sup>50</sup>:



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<sup>50</sup> <https://portal.historicenvironment.scot/designation/GDL00201>

## Appendix 2: Definition of Heat Network Types

From CIBSE CP1 (2020) Heat Networks: Code of Practice for the UK (CP1), page 11:

**Third generation (3DHC):** Traditional centralised topology with energy centre(s) supplying heat outwards to buildings. Supplying at around 90–60 °C and with return temperatures at around 50–40 °C, 3DHC would generally consist of well-insulated, pre-insulated pipework with significant centralised thermal storage. 3DHC can supply domestic hot water (DHW) directly, but cooling would be a separate system. No interchange/transfer of heat between buildings is possible.

**Fourth generation (4DHC):** Traditional centralised topology with energy centre(s) supplying heat outwards to buildings. Supplying at around 60–45 °C with a wider  $\Delta T$  and return temperatures at around 30–15 °C, 4DHC would generally consist of highly insulated, pre-insulated pipework that is more likely to be plastic, with very large centralised thermal storage. 4DHC will usually need supplementary boosting to supply DHW, and cooling would be a separate system. No interchange/transfer of heat between buildings is possible.

**Fifth generation (5DHC):** Is a non-traditional topology with decentralised plant (usually heat pumps) supplying heat along ultra-low-temperature headers in a spine/backbone (ambient loops may be possible in smaller systems). Supplying at <45 °C, the  $\Delta T$  is less relevant with return temperatures around 25–15 °C. 5DHC often consists of uninsulated plastic pipework with very low heat losses. 5DHC usually includes seasonal thermal storage and perhaps some short-term localised thermal storage. 5DHC will always need supplementary boosting to supply DHW temperatures. 5DHC has a built-in cooling supply and can interchange heating/cooling between buildings across the network.

### Appendix 3: Calorific Value of Fuels

Fuel	Gross CV	Gross CV
	kWh/kg	kWh/litre
Natural Gas	14.01	0.01
Wood Chip	4.09	N/A

Reference: DESNZ (2023) UK Government GHG Conversion Factors 2023

[www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2023](https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2023)

## Appendix 4: Heat Pump SCOP Assumptions

As explored in 3.2 of Meek (2021), the Seasonal Coefficient of Performance (SCOP) metric used by installers to forecast efficiency is not an accurate figure to predict the efficiency of the whole heating system in reality and will most likely exaggerate performance. However, the average in-situ figure includes poorly designed installed systems. Therefore, in the calculations in this report we have used an average of the installer figure and average in-situ performance on the basis that we are assuming the system is well specified and installed.

As HPs are less efficient when generating water hot enough for domestic hot water, this lowers the average SCOP.

### ASHPs

	SCOP	References
Average in-situ	2.72	<u>Meek, C (2021) Heat pumps: lessons from an Ofgem dataset for ASHPs</u>
Average	3.02	This is the figure used in the ASHP calculations in this report (average figure used across industry/average of the two figures from Meek (2021)).
Installer forecast	3.32	<u>Meek, C (2021) Heat pumps: lessons from an Ofgem dataset for ASHPs</u>

### GSHPs

	SCOP	References
Average in-situ	3.19	<u>Meek, C (2021) Heat pumps: lessons from an Ofgem dataset for GSHPs</u>
Average	3.38	This is the figure used in the GSHP calculations in this report (average figure used across industry/average of the two figures from Meek (2021)).
Installer forecast	3.57	<u>Meek, C (2021) Heat pumps: lessons from an Ofgem dataset for GSHPs</u>

## Appendix 5: Energy Prices

As has been illustrated over the last two years, unit energy costs can fluctuate significantly. Not only that, they do not move relative to each other as the market drivers acting on each fuel are different. This means the absolute and relative costs of energy will change over time.

The electricity price tracks the price of gas, because gas generation sets the marginal wholesale price. Therefore, although the prices of both may go up and down, they will fluctuate with each other. This means that when comparing heat pumps to gas, while the exact £ difference will vary the relative position (i.e. whether gas is more or less expensive than electricity) will remain the same.

Wood chip does not move relative to gas and electricity and is considerably less influenced by global economics and shocks due to its relatively local supply chains.

As it is not possible to meaningfully predict future prices, in order to illustrate the variability we have selected three price points: the current spot price at the time of writing and the highest and lowest prices seen over the last five years. The prices and references are set out in the following sections for each fuel along with a table summarising all fuels and price scenarios:

### Electricity Prices

The current price of electricity as of the date of writing, is capped by the Ofgem Default Price Cap. The cap for the period 1<sup>st</sup> April 2024 to 30<sup>th</sup> June 2024 is 24.5p/kWh (including VAT at 5%)<sup>51</sup>.

As a comparison, the lowest price over the last five years was 15p/kWh in 2018<sup>52</sup>, including VAT at 5%. As an illustration of higher possible tariffs, we have used the highest price per kWh permitted under the Energy Price Guarantee which was up to and slightly over 37p/kWh for those paying by standard credit in some regions in the January to March 2023<sup>53</sup>.

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<sup>51</sup> <https://www.ofgem.gov.uk/information-consumers/energy-advice-households/check-if-energy-price-cap-affects-you>

<sup>52</sup> DESNZ Energy Prices Domestic Prices (20/03/2023) [www.gov.uk/government/statistical-data-sets/annual-domestic-energy-price-statistics](http://www.gov.uk/government/statistical-data-sets/annual-domestic-energy-price-statistics)

<sup>53</sup> <https://www.gov.uk/government/publications/energy-price-guarantee-regional-rates/energy-price-guarantee-regional-rates-january-to-march-2023>

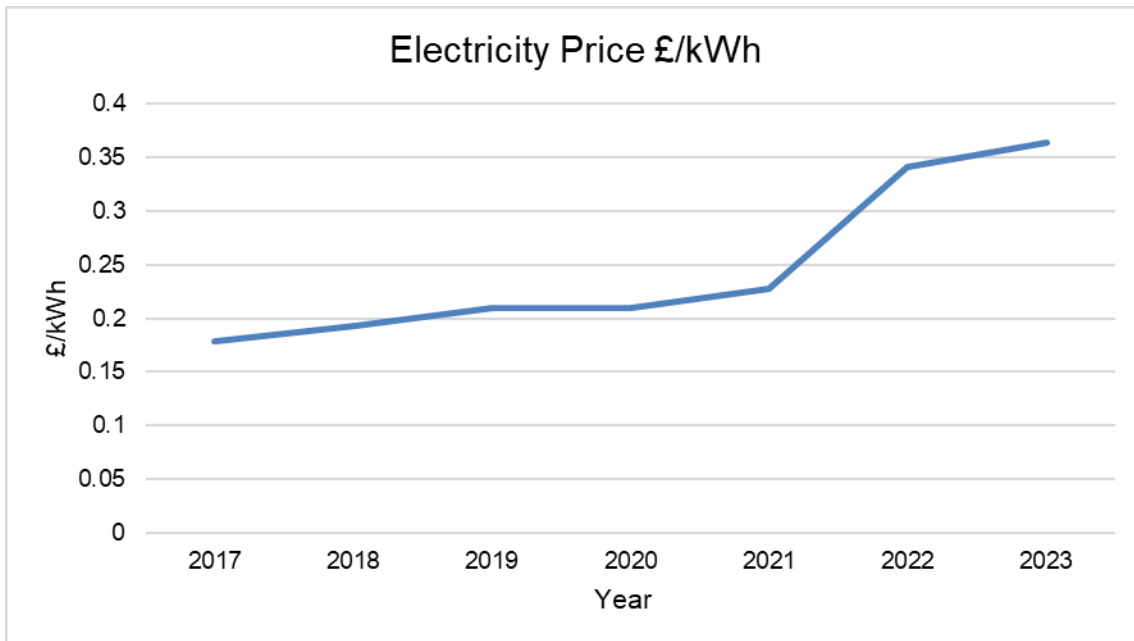


Figure 22: Electricity prices 2018 to 2023<sup>54</sup>

As households already pay their standing charge irrespective of a switch to heating with electricity this cost is excluded from the calculations.

### Gas

The current price of gas as of the date of writing, is capped by the Ofgem Default Price Cap. The cap for the period 1<sup>st</sup> April 2024 to 30<sup>th</sup> June 2024 is 6.04p/kWh (including VAT at 5%)<sup>55</sup>.

As with electricity, using the same data sources, we have identified examples of the lowest and highest tariffs seen over the last five years:

- Lowest: 3.72p/kWh<sup>56</sup>

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<sup>54</sup> DESNZ Energy Prices Domestic Prices (29/01/2024) [www.gov.uk/government/statistical-data-sets/annual-domestic-energy-price-statistics](https://www.gov.uk/government/statistical-data-sets/annual-domestic-energy-price-statistics)

<sup>55</sup> <https://www.ofgem.gov.uk/information-consumers/energy-advice-households/check-if-energy-price-cap-affects-you>

<sup>56</sup> Energy Prices Domestic Prices: Average variable unit costs for gas in Great Britain (DESNZ) (2023)

- Highest: 11.235p/kWh<sup>57</sup>

It is assumed that households will also switch to electric cooking and there will therefore be a saving of the gas standing charge.

### Wood chip

There are no published data sets on the prices of wood chip. Reheat have direct knowledge of the costs of wood chip as we purchase chip for a number of our clients. Based on that expertise, £130/tonne including VAT represents what we expect the price of wood chip to be on average at present. Chip has not moved significantly in price over recent years.

### Summary Table

	Current Price			Lowest Price in Last 5 Years			Highest Price in Last 5 Years		
	Purchase Price		Delivered Heat	Purchase Price		Delivered Heat	Purchase price		Delivered Heat
<b>Gas (85% efficient)</b>	6	p/kWh	7.11	3.72	p/kWh	4.65	11.24	p/kWh	14.04
			p/kWh			p/kWh			
<b>Electricity (ASHP SCOP 3.02)</b>	24.5	p/kWh	8.11	15	p/kWh	5.0	37	p/kWh	12.3
			p/kWh			p/kWh			
<b>Electricity (GSHP SCOP 3.38 )</b>	24.5	p/kWh	7.25	15	p/kWh	4.4	37	p/kWh	10.9
			p/kWh			p/kWh			
<b>Wood chip (boiler and heat network)</b>	130	3.44	4.5						
	£/tonne	p/kWh	p/kWh						

<sup>57</sup> <https://www.gov.uk/government/publications/energy-price-guarantee-regional-rates/energy-price-guarantee-regional-rates-january-to-march-2023>

<b>efficiency 77%)</b>									
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## Appendix 6: Energy Efficiency Measures – Potential Savings

The table below shows the potential savings from a generic range of energy efficiency measure for a range of properties according to the Energy Saving Trust. The £ savings are based on the average estimated annual heat demand of properties calculated by EST. Not all of these measures will be suitable for the properties and individual, tailored recommendations and savings can be provided by Home Energy Scotland ([www.homeenergyscotland.org/contact-advice-support-funding](http://www.homeenergyscotland.org/contact-advice-support-funding)):

	<b>% Saving (EST average Semi- detached figures)</b>	<b>Potential Annual Savings at 10 p/kWh (delivered heat price)</b>	<b>% Saving (EST average Bungalow figures)</b>	<b>Potential Annual Savings at 10 p/kWh (delivered heat price)</b>	<b>% Saving (EST average Detached figures)</b>	<b>Potential Annual Savings at 10 p/kWh (delivered heat price)</b>
Solid Wall Insulation	34.9%	£478	30.5%	£412	38.4%	£538
Cavity Wall Insulation	25.6%	£350	22.5%	£304	28.5%	£399
Floor Insulation	7.1%	£97	14.2%	£191	7.4%	£104
Roof and Loft Insulation (0-270mm)	23.0%	£315	42.9%	£579	24.3%	£341
Roof and Loft Insulation (120-270mm)	28.5%	£390	41.4%	£560	23.5%	£330

Scenario 1 Total	65.0%	£890	87.6%	£1,183	70.1%	£983
Solid Wall Insulation	34.9%	£478	30.5%	£412	38.4%	£538
Cavity Wall Insulation	25.6%	£350	22.5%	£304	28.5%	£399
Floor Insulation	7.1%	£97	14.2%	£191	7.4%	£104

#### References:

- [Advice on insulating your solid walls - Energy Saving Trust](#)
- [How to install cavity wall insulation - Energy Saving Trust](#)
- [Floor insulation information and advice - Energy Saving Trust](#)
- [Roof and loft insulation guide - Energy Saving Trust](#)
- [Roof and loft insulation guide - Energy Saving Trust](#)

## Appendix 7: Carbon Emissions Methodology

Although it is often reported that renewable energy is ‘zero carbon’ or ‘net zero’; that is not in fact the case. All types of heating systems (renewable or not) emit some carbon and other greenhouse gases as part of the production of fuel they use, or use of electricity in its operation, or in manufacturing of the equipment itself - which is known as ‘embedded carbon’. Official Government measurement of carbon emissions accounts for these factors via ‘conversion factors’.

We have used the ‘UK Government GHG Conversion Factors 2023<sup>58</sup>’ for wood chip, gas and electricity use. These conversion factors include carbon dioxide emissions (CO<sub>2</sub>) - the most dominant greenhouse gas that comes from burning fossil fuels, as well as other gases that significantly contribute to global warming, all of which together are quantified in one single officially agreed metric called CO<sub>2</sub>e<sup>59</sup>.

The emissions figures we have produced are based upon the heat demand figures set out in Section 3.2 and assume that is the same for each of the options. This does not measure the total carbon footprint of the property as that would need to account for other impacts such as electrical use (not for heating) and individual contributions associated with things like travel and food consumption. It also does not take account of the embedded carbon of the technologies and is not a full lifecycle analysis.

	Unit	kg CO <sub>2</sub> e
Gas	kWh	0.18
Wood chip	Tonnes / kWh	43.89 / 0.0107
Electricity	kWh	0.207

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<sup>58</sup> DESNZ (2023) UK Government GHG Conversion Factors 2023 ([www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2023](http://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2023))