Programme Area: Smart Systems and Heat

Project: WP2 Manchester Local Area Energy Strategy

Title: Assessment of Domestic Low Carbon Transition Pathways in Bury

Abstract:

Arup was commissioned to undertake a high-level desktop screening of potential constraints not considered by the Energy Path Networks (EPN) tool to 15 specific low carbon, domestic pathways in different clusters in Bury. The factors assessed for constraints to the pathways were technical feasibility, flood risk, ground conditions, air quality, heritage and planning, and noise impact. The technologies considered were district heating, high temperature air source heat pumps (HT ASHP), hybrid heat pumps and low temperature air source heat pumps (LT ASHP). Each pathway was allocated a risk rating based on the constraints found to the implementation of these technologies at a domestic level.

Context:

The Spatial Energy Plan for Greater Manchester Combined Authority project was commissioned as part of the Energy Technologies Institute (ETI) Smart Systems and Heat Programme and undertaken through collaboration between the Greater Manchester Combined Authority and the Energy Systems Catapult. The study has consolidated the significant data and existing evidence relating to the local energy system to provide a platform for future energy planning in the region and the development of suitable policies within the emerging spatial planning framework for Greater Manchester.

Energy Systems Catapult

Energy Path Networks

Task 001 – Assessment of Domestic Low Carbon Transition Pathways in Bury

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Job number 242342-13

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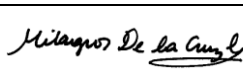
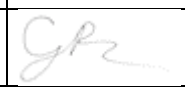
		Signature			
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Contents

1 Executive Summary

Arup was commissioned to undertake a high-level desktop screening of potential constraints not considered by the Energy Path Networks (EPN) tool to 15 specific low carbon, domestic pathways in different clusters in Bury.

The factors assessed for constraints to the pathways were technical feasibility, flood risk, ground conditions, air quality, heritage and planning, and noise impact. The technologies considered were district heating, high temperature air source heat pumps (HT ASHP), hybrid heat pumps and low temperature air source heat pumps (LT ASHP).

Each pathway was allocated a risk rating based on the constraints found to the implementation of these technologies at a domestic level, with the following results.

Table 1. Risk level rating for each domestic pathway

Pathway	Score
Semi-detached houses, 1914-1944, District Heat, cluster 2	L
Semi-detached houses, 1914-1944, District Heat, cluster 4	L
Flats, New Build, District Heat, cluster 2	L
Flats, New Build, District Heat, cluster 5	L
Terrace houses, New Build, District Heat, cluster 2	L
Terrace houses, New Build, District Heat, cluster 5	L
Terrace houses, pre-1914, HT ASHP, cluster 1	L
Terrace houses, pre-1914, HT ASHP, cluster 7	L
Semi-detached houses, 1945-1964, HT ASHP, cluster 1	L
Semi-detached houses, 1945-1964, HT ASHP, cluster 7	L
Semi-detached houses, 1945-1964, hybrid heat pump, cluster 1	L
Semi-detached houses, 1945-1964, hybrid heat pump, cluster 7	L
Flats, New Build, LT ASHP, cluster 3	L

Pathway	Score
Flats, New Build, LT ASHP, cluster 7	L
Terrace houses, New Build, LT ASHP, cluster 7	L

Arup's initial view is that all pathways proposed are technically feasible, with no major constraints that need to be further assessed before implementation. Mitigation measures are available to reduced constraints to low level risk, at a cost. The unit costs allocated for each technology may need to be revised for a number of pathways to make sure these measures are accounted for.

Early involvement with the developers of New Build properties is recommended to ease the future implementation of these technologies.

2 Introduction

Arup was commissioned by Energy Systems Catapult to undertake a high-level study to consider the feasibility and constraints of implementing specific low carbon transition pathways in different areas in Bury. Clusters 1, 2, 3, 4, 5, and 7 were the focus of this study.

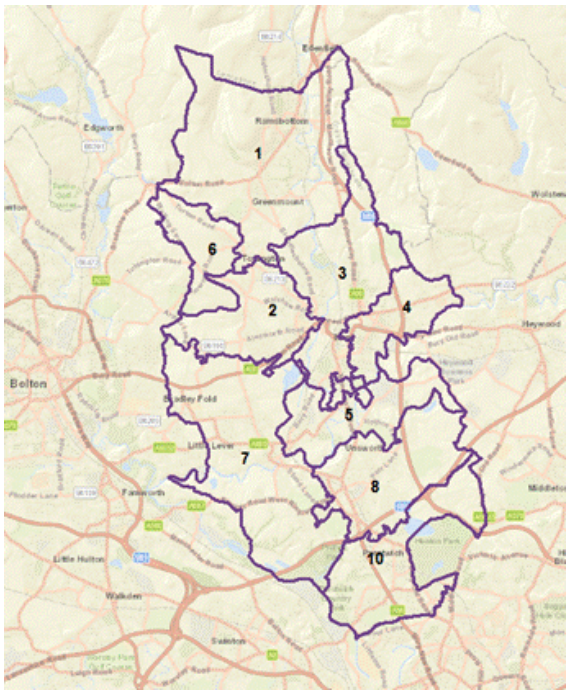


Figure 1. Bury cluster map

The following pathways and housing types are assessed in this report:

- Semi-detached houses, 1914-1944, District Heat, cluster 2.
- Semi-detached houses, 1914-1944, District Heat, cluster 4.
- Flats, New Build, District Heat, cluster 2.
- Flats, New Build, District Heat, cluster 5.
- Terrace houses, New Build, District Heat, cluster 2.
- Terrace houses, New Build, District Heat, cluster 5.
- Terrace houses, pre-1914, HT ASHP, cluster 1.
- Terrace houses, pre-1914, HT ASHP, cluster 7.
- Semi-detached houses, 1945-1964, HT ASHP, cluster 1.
- Semi-detached houses, 1945-1964, HT ASHP, cluster 7.
- Semi-detached houses, 1945-1964, hybrid heat pump, cluster 1.

- Semi-detached houses, 1945-1964, hybrid heat pump, cluster 7.
- Flats, New Build, LT ASHP, cluster 3.
- Flats, New Build, LT ASHP, cluster 7.
- Terrace houses, New Build, LT ASHP, cluster 7.

The analysis was based on tool output and data provided by ESC which included a UPRN register containing the transition pathways, building locations and heating system information. The proposed pathways were given to Arup to examine within the Bury cluster map, also provided.

This report has relied on information supplied by others, and Arup accept no liability for any errors or omissions in this information. Databases of information for the constraints have been sourced and energy consultants have taken perceived major constraints into analysis. Our initial views from this high-level study are reported in each section. The study carried out was high-level and further detailed assessments may be required.

The following factors were considered in this study:

Technical Feasibility

A high level assessment of access to properties and installation of technologies which considered the practical deployment, space required, structural work and pipework for the new heating systems. Assessment of the area and description of the house was based on investigation of Google map data where possible.

Flood Risk

Flood risk areas and flood zone information was obtained from the Environment Agency on data.gov.uk. Each technology and cluster was assessed separately to understand the flood risk for the pathways proposed. This is not a detailed flood risk assessment and further study may be required prior to any work commencement.

Ground Conditions

Coal Authority maps on www.gov.uk provided information on Development High Risk Areas and coal mine entries. These were identified per cluster where it might impact the technology proposed.

Air Quality

The Air Quality Management Areas (AQMA) were obtained from Defra's AQMA Interactive Map 2017 and identified around the Bury Council area to ensure there were no specific constraints or management plans in place which could affect the deployment of the proposed heating systems.

Heritage, Planning and Visual Impact

The National Heritage List for England at the Historic England website identified multiple listed buildings in the Bury Council area. There are 14 Conservation Areas in Bury, Conservation Area maps were obtained from the Bury Council website at http://www.bury.gov.uk/index.aspx?articleid=11498.

Noise Impact

Noise information was obtained from Defra's noise maps on data.gov.uk. This assessment included impact of construction and operation noise of the heating system to the surrounding locality.

3 Technical Feasibility

The assessment of technical feasibility of the pathways proposed has been divided per technology. Each part includes analysis of practical deployment, space required, and structural work and pipework required.

3.1 District Heating

The following six pathways use district heating as final heating system:

- Semi-detached houses, 1914-1944, District Heat, cluster 2.
- Semi-detached houses, 1914-1944, District Heat, cluster 4.
- Flats, New Build, District Heat, cluster 2.
- Flats, New Build, District Heat, cluster 5.
- Terrace houses, New Build, District Heat, cluster 2.
- Terrace houses, New Build, District Heat, cluster 5.

The installation of district heat within an existing or a planned development (new build) is markedly different. The exact location and layout of New Build properties could not be assessed with Google map data. Our assessment distinguishes between existing and New Build properties to differentiate between pathways.

3.1.1 Existing properties

Two pathways explore district heating in properties already built:

- Semi-detached houses, 1914-1944, District Heat, cluster 2.
- Semi-detached houses, 1914-1944, District Heat, cluster 4.

It was found that the assessment of these two pathways is very similar because the house type and period is the same for both clusters. The practical deployment of domestic connections for district heating is not affected by the cluster where properties are located.

3.1.1.1 Practical Deployment

The semi-detached houses in these two clusters are located mostly in residential streets away from Bury town centre. It is expected these areas will be congested with utilities at a domestic scale, typical of residential areas. The houses have spacious front and back gardens. Front gardens, normally used for parking, are easily accessible for a connection to a district heat network. The connection route could be similar to that of a domestic gas connection to the front of the house.

There is interest to develop a district heat network in Bury town centre to connect civic and commercial building, as well as in other areas of the Great Manchester Combined Authority in various stages of development. It may be possible that

there will be skilled staff in the area in the coming years, attracted by the number of district heating schemes.

The possibility exists for heat network pipes to flood, but it is unlikely. Leak detection and maintenance of the network equipment minimises this risk.

3.1.1.2 Space Required

All houses in these two pathways employ gas boilers as their primary heating system. The transition to district heating involves replacing this gas boiler with a Heat Interface Unit (HIU), which can be placed in the same location to avoid major alterations to the existing wet heating system. The ultimate location of the HIU is usually determined by the contractor responsible for retrofitting.

Existing radiators connected to the heating system would not need to be immediately replaced when transitioning to district heating. The temperature of the heat network is assumed to be hot water such that it can work with existing wet heating systems across a variety of consumers (domestic, commercial, etc). This will avoid unnecessary retrofitting at a large scale. No additional space is required.

3.1.1.3 Structural Work and Pipework

A domestic connection can be made at the front of the house for the two pathways, keeping in mind visual impact should be minimised. This reduces additional trenching (more expensive) or boxing in (visual impact) required if the connection was made to the side or back of the house.

The connection requires drilling into the wall regardless of which side it enters the house. 97% of the properties in these two pathways have filled cavity walls. This can be more difficult or time consuming than drilling into uninsulated cavity walls, which should be reflected in the capital costs of the retrofit.

Inside the house, the district heating network would terminate at the HIU. It is not possible to generalise where the HIU in all houses. It is expected that additional pipework will be required to reconnect the existing wet heating system to the HIU. This is not a concern for the implementation of district heating in these pathways.

3.1.2 New build properties

Four pathways explore district heating in properties yet to be built:

- Flats, New Build, District Heat, cluster 2.
- Flats, New Build, District Heat, cluster 5.
- Terrace houses, New Build, District Heat, cluster 2.
- Terrace houses, New Build, District Heat, cluster 5.

Since these properties have not been built yet, the technical feasibility of their domestic connection does not depend on the cluster where they are located. Flats are assumed to be single storey in 2-3 storey blocks (low rise buildings), and similar in both clusters. Terrace houses are assumed to be 2 storeys, and similar in both clusters.

3.1.2.1 Practical Deployment

Flats

New build flats in clusters 2 and 5 are designed to use electric resistive storage heating and a 300 L water cylinder as primary heating system, before transitioning to district heating in the future. This means they will initially use electric storage heaters, and will not have a wet heating system installed when first built.

Extensive retrofitting will be required to install district heating in these buildings. Pipework will need to be installed from the main heat network in the street to a heat exchanger in the building, and then to a HIU within each individual flat. Inside a flat, a wet heating system will need installing from the HIU to new radiators that replace the electric storage heaters. The HIU could also incorporate provision of domestic hot water, and this would need further connection to the existing system.

The retrofit work is possible and is not an obstacle to the implementation of this pathway. It is recommended to future-proof these new developments with a view to connect to a heat network, by allowing space in the design for pipework across the building and inside the flat.

Flooding of the building heat network can affect several properties at the same time. Adequate isolation of each property and quality materials should be employed to minimise this risk.

Terrace houses

New build terrace houses in clusters 2 and 5 are designed to use gas boilers as primary heating system. It is assumed that the front of the house will be accessible and suitable for a domestic connection to a heat network in the future.

New terrace houses within the same area are expected to be very similar. The works to transition to district heating (domestic connection, HIU installation, removal of old equipment) could be replicated easily which would facilitate the work. The extension of utility networks to these new developments could allow

for provision of space for domestic connection to a heat network, if planned at an early stage.

3.1.2.2 Space Required

Flats

A building heat exchanger provides hydraulic separation from the main heat network. This can be located in a plant room accessible for maintenance, with restricted access. New pipework along the building to each flat will also need to be accessible but not exposed to minimise damages.

Within the flat, the HIU could be placed within a utility cupboard, as it is expected to be of small size. The new radiators can be located where the electric storage heaters were originally installed, although their dimensions will depend on the temperature of the heat network. The pipework, if boxed in, can be run at high level or in the floor screed, where it will not affect the total living space.

The majority of these flats have an average floor area of 60m^2. It is recommended that the developer is made aware of the requirements explained above while the flats are not yet built, to provide space in the design that may be difficult to obtain later.

Terrace houses

The transition to district heating involves replacing the gas boiler with a HIU, which can be placed in the same location to avoid major alterations to the existing wet heating system. The ultimate location of the HIU is usually determined by the contractor responsible for retrofitting.

Wet heating systems installed in new build properties can be more efficient and may operate at lower temperatures due to the better performance of new properties. These radiators would not need to be immediately replaced when transitioning to a district heating network, which will have suitable flow and return temperatures to serve both existing and new properties. No additional space is required.

3.1.2.3 Structural Work and Pipework

Flats

New pipework is required for these pathways to be implemented, across the building and within each flat (new wet heating system).

The wet heating system pipework can be installed using space from the concrete floor screed (if available) to each room. This would require the flooring of the flat to be removed temporarily. Alternatively, the pipework can be external to the walls at high level and will need to be boxed in to avoid damage and minimise its visibility from the consumers. It is unknown if the additional work of removing electric storage heaters and installing a new wet heating system has been considered within the capital costs of the technology. It is recommended that the

developer is made aware of this in case any provisions can be made to allow for pipework to be installed after construction.

Terrace houses

The connection requires drilling into the front wall of these new houses. The wall type is stated as “new build wall”, which is assumed to be easy to drill.

Additional pipework is also expected to reconnect the existing wet heating system to the new HIU.

3.2 High Temperature Air Source Heat Pump

The high temperature air source heat pump (HT ASHP) heating system consists of the heat pump accompanied by a 500 L water cylinder. While there are several common characteristics between the HT, LT and hybrid ASHPs. The property types proposed for each pathway result in different analyses. The technologies will be assessed separately for each property type.

The following four pathways use HT ASHP as final heating system:

- Terrace houses, pre-1914, HT ASHP, cluster 1.
- Terrace houses, pre-1914, HT ASHP, cluster 7.
- Semi-detached houses, 1945-1964, HT ASHP, cluster 1.
- Semi-detached houses, 1945-1964, HT ASHP, cluster 7.

3.2.1 Practical Deployment

The terrace and semi-detached houses in cluster 1 are located in the same areas around Ramsbottom, Greenmount and Tottington, north of Bury. In cluster 7, the houses are located around Radcliffe. These are well connected towns that will facilitate the transport of equipment to individual houses.

Acoustic enclosures will be required to reduce noise and visual impact. The 500 L water cylinder will also require floor mounting in these properties. These additional requirements may not have been included in the capital costs of the EPN tool, and can have a minor impact on the costs.

The original heating system for these pathways is gas boilers. The transition to HT ASHP means that the existing wet heating system will only require few changes.

3.2.2 Space Required

HT ASHPs are to be installed outside to ensure free airflow and easy access for maintenance, preferably at the back of the house. The transition from gas boiler heating system to HT ASHP means that the existing radiators sized for high temperature water will be suitable for the new heating system. No additional space will be required inside the house, with the exception of the 500 L water cylinder.

Terrace houses

Terrace houses in clusters 1 and 7 have enough back garden space to install a HT ASHP. In many instances, the garden is largely occupied by outbuildings. To allow for sufficient space for installation and operation of the heat pump, the outbuildings may need to be removed or the HT ASHP installed at height. A flat surface is also required. Levelling may be needed where the garden is on a slope.

These houses have an average floor space of 80 m^2 – 100 m^2. This and the removal of the gas boiler allows for the addition of the 500 L water cylinder

indoors. Pre-war terrace houses may have narrower doors than modern houses, which may be a constraint to the options available for such a large water cylinder. It is possible to purchase 500 L cylinders of a diameter such that it can fit through narrow doors, with a height over 2 meters. It is uncertain the number of houses in these pathways where this solution will be required as door widths are not uniform across the pathways.

Semi-detached houses

Semi-detached houses in clusters 1 and 7 have large front and back garden areas. The back garden would be most suitable for installation of a HT ASHP. Levelling may be needed to provide a flat surface.

Houses in cluster 1 have an average area of 80 m^2, while those in cluster 7 had a larger average floor area of 100 m^2. These seems enough for the addition of the 500 L water cylinder indoors, supported by the fact that the existing gas boiler will be removed.

3.2.3 Structural Work and Pipework

No major civil or structural works are expected for the implementation of these pathways. Heat pumps will need to be located on a smooth, even surface which may need to be created. They can also be mounted at height with brackets where it can be accessed for maintenance without causing additional hazards.

Additional pipework will be required to connect the outdoor HT ASHP to the water cylinder indoors and the other internal systems.

Terrace houses

All terrace houses in these pathways have uninsulated solid walls. This is likely to be easy to drill to connect the HT ASHP to the inside of the house.

The location of the boiler in houses from this period is unknown and not uniform across houses in the same street, since the retrofit to central heating system may have occurred at any time. This may have a minor impact on capital costs.

Semi-detached

All semi-detached houses in clusters 1 and 7 have filled cavity walls. This can be more difficult or time consuming to drill and could have a minor impact on capital costs.

3.3 Hybrid Heat Pump

The hybrid heat pump consists of a low temperature air source heat pump (LT ASHP) providing space heating, and a gas boiler providing instantaneous domestic hot water and peak heating capacity for cold days. The following two pathways use hybrid heat pumps as final heating system:

- Semi-detached houses, 1945-1964, hybrid heat pump, cluster 1.
- Semi-detached houses, 1945-1964, hybrid heat pump, cluster 7.

The property type and age band for these pathways is identical as those assessed in the HT ASHP section, in the same clusters. Most houses in these pathways are in the same areas as those with HT ASHPs. The assessment will be very similar, with the difference that this pathway involves a low temperature system and a gas boiler, with no additional water cylinder.

3.3.1 Practical Deployment

There are no expected constraints in the implementation of hybrid heat pumps in clusters 1 and 7. The areas of study are well connected and can be reached for delivery of equipment. Slabs and acoustic enclosures can reduce noise and visual impact if this is a concern.

The transition from gas boilers (original heating system) to hybrid heat pumps needs only a few changes to the wet heating system.

3.3.2 Space Required

The houses in these pathways have large back gardens, suitable for the installation of a LT ASHP outdoors. This heat pump is of smaller capacity than that in the HT ASHP system, and may occupy a smaller space.

The gas boiler part of this system is likely to be installed in the same location as the existing boiler, without occupying extra space in the house. The hybrid heat pump can be implemented using existing radiators, incurring no unforeseen capital costs or additional space.

3.3.3 Structural Work and Pipework

No major civil or structural works are expected for the implementation of these pathways. LT ASHPs are to be installed on even surfaces.

Additional pipework is required to connect the LT ASHP to the boiler indoors and the original wet heating system. In cluster 1, 90% of the properties have filled cavity walls. In cluster 7, 5% of the properties have filled cavity walls. This can be more time consuming to drill and could have a minor impact on capital costs.

It is assumed that the previous gas boiler installation will have adequate flues and infrastructure. This will create ease for the new gas boiler installation as the previous connections can be used or retrofitted.

3.4 Low Temperature Heat Pump

The low temperature air source heat pump (LT ASHP) heating system consists of the heat pump accompanied by a 500 L water cylinder. The following three pathways use LT ASHP as final heating system:

- Flats, New Build, LT ASHP, cluster 3.
- Flats, New Build, LT ASHP, cluster 7.
- Terrace houses, New Build, LT ASHP, cluster 7.

Since these properties have not been built yet, the technical feasibility of their domestic connection does not depend on the cluster where they are located. Flats are assumed to be single storey in 2-3 storey blocks (low rise buildings), and similar in both clusters. Terrace houses are assumed to be 2 storeys.

3.4.1 Practical Deployment

Flats

New build flats in clusters 3 and 7 are designed to use electric resistive storage heating and a 300 L water cylinder as primary heating system. They will be fitted with electric storage heaters, and will not have a wet heating system when first built. A wet heating system will have to be installed, from the LT ASHP and 500 L water cylinder to new radiators that will replace the electric storage heaters.

It is assumed each flat will have its own LT ASHP, which will be located outdoors for free airflow, and where it can be accessed for maintenance. It can be located at the back of ground floor flats, and on the roof for top floor flats. For mid-floor flats, it can be mounted at height with brackets. Alternatively it can be on the ground and sharing space with the ground floor LT ASHP.

Terrace Houses

New build terrace houses in cluster 7 are designed to use gas boilers as primary heating system. The transition to final heating system requires replacement of the gas boiler with a 500 L water cylinder, and connection to the LT ASHP outdoors.

3.4.2 Space Required

Flats

It is assumed the 300 L water cylinder will be replaced by a larger one of 500 L capacity, as proposed by the EPN tool. The larger volume is reflected in increased height and diameter, which may not be possible to accommodate in the same location. The average floor area of these 1-2 bed flats is 60 m^2, which could be affected by the location of the 500 L water cylinder. It is recommended that the developer is made aware of this point to provide space in the design of the flat's utility area, or look into reducing the water cylinder capacity requirement.

The LT ASHP is to be located outdoors on a smooth, even surface when on the ground floor or roof. Provision can be made to ease the addition of this equipment around the building for all flats.

The new radiators can be placed where the electric storage heaters are, although their length could be larger than average due to the new low temperature system. The new pipework for the wet heating system can run at height and be boxed in.

Terrace houses

The average floor area of these 2-3 bed terrace houses is 60 m^2. The gas boiler in these new terrace houses is likely to be small. The 500 L water cylinder will need to be located elsewhere within the space available. This could be considered within the proposed layout of the house, or consider reducing the water cylinder capacity requirement.

The LT ASHP will be located outdoors, preferably at the back of these houses. A space could be designated for the unit to facilitate future installation.

A LT ASHP will provide low temperature water to the existing heating systems sized for high temperature water. The radiator surface at each room will need to be increased in order to keep the pre-heat period (time to achieve desired temperature indoors) the same as when first built. This translates into additional or larger radiators in various rooms of the house. Some of these rooms may be designed with little spare wall area.

It is recommended the developer is made aware of these future requirements on the layout of the house, to minimise constraints that can be avoided.

3.4.3 Structural Work and Pipework

Flats

New pipework is required for the new wet heating system at each flat. This can be installed using space from the concrete floor screed, or external to the wall at high level.

It is unknown if this additional work has been considered within the capital costs of the technology. It is recommended that the developer is made aware of this in case any provisions can be made to allow for pipework to be installed after construction. It is preferable to future-proof these new developments with a view to connect to a heat network.

Terrace houses

No major civil or structural works are expected for the implementation of these pathways. LT ASHPs are to be installed on even surfaces

Additional pipework will be required to connect the wet heating system to the new water cylinder and LT ASHP outdoors. The wall type is stated as “new build wall”, which is assumed to be easy to drill.

4 Flood Risk

This flood risk assessment has been done per technology and clusters involved, focusing on flood risk areas, and flood zones 2 (medium probability) and 3 (high probability). Flood risk areas cover only surface water flooding. Zone 2 refers to land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding. Zone 3 refers to land having a 1 in 100 or greater annual probability of river flooding.

4.1 District Heating

District heating is proposed in clusters 2, 4 and 5. Domestic connections and internal pipework are not affected by risk of flooding in the area. Flood risk has no impact on the connection to a local heat network.

4.2 Air Source Heat Pump

HT/LT ASHP and hybrid heat pumps are proposed in clusters 1, 3 and 7. ASHPs are to be installed outside of semi-detached and terrace houses, as well as flats (a fraction at ground level), which poses a risk if the property is in a flood risk area or flood zone.

A small number of houses with hybrid heat pumps or HT ASHPs to the south of **cluster 1** are in a flood risk area. An even smaller number of houses is within a flood zone 2, along the river Irwell north of Bury town centre. To avoid water reaching the ASHP in the worst cases, it could be installed on a concrete slab or at height to minimise the risk. If not, there could be permanent damage to the electrical and control components. The refrigerant could pose a further contamination risk, if leaked into the flood water.

The gas boilers in hybrid heat pumps can also be damaged by water ingress into the combustion chamber or the controls. Wall mounting of the boiler or a bund can minimise this risk.

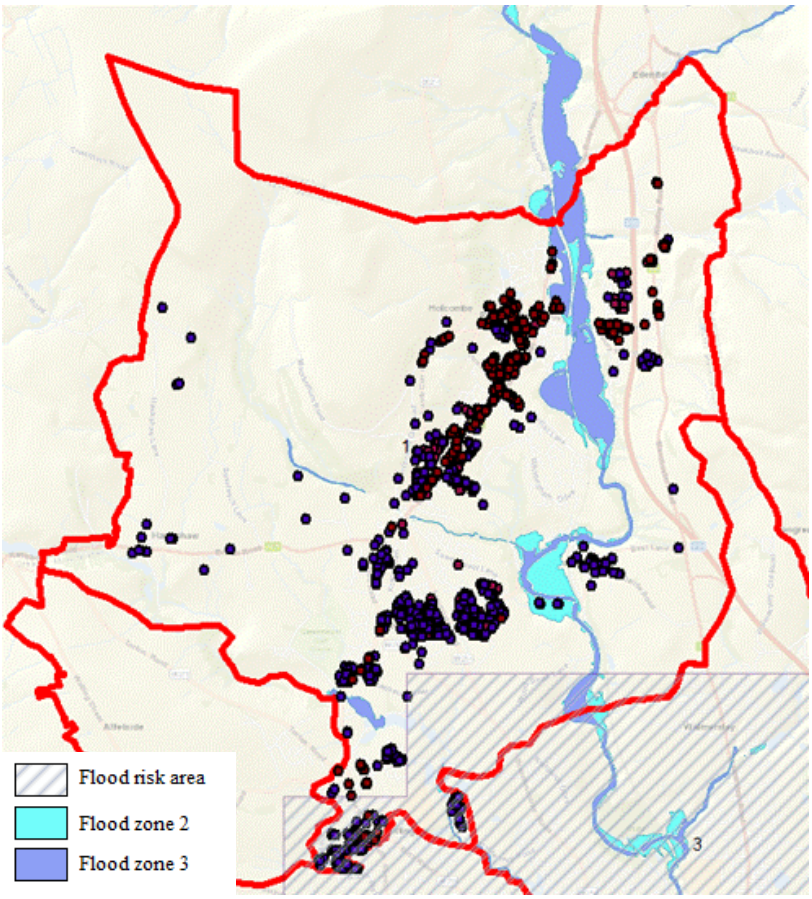


Figure 2. Cluster 1 – flood risk area and flood zones

The majority of the properties in **cluster 3** are at risk of surface water flooding. These consist of flats yet to be built that will be retrofitted with LT ASHP in the future. The points in the figure below show a single location for a development, and each can represent between 1 and 96 properties.

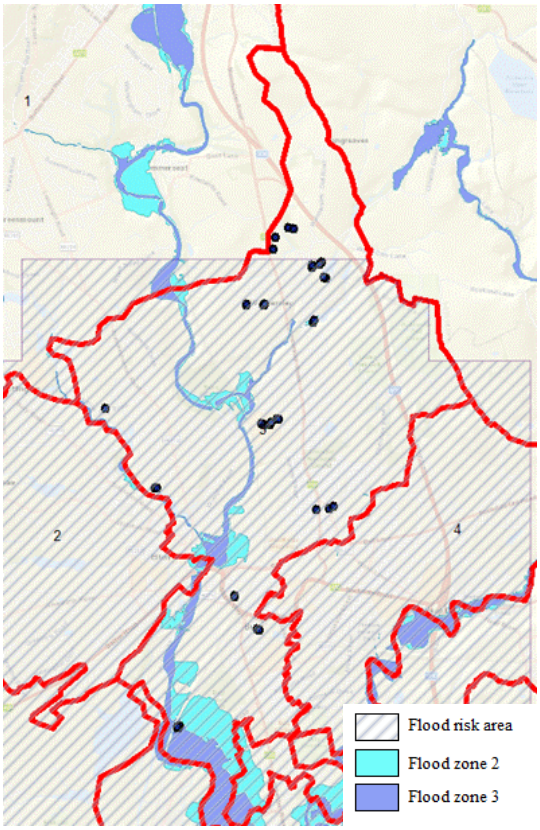


Figure 3. Cluster 3 – flood risk area and flood zones

Only a small number of properties are within a flood zone 2 or 3, near Pigs Lee Brook and Bury Sports Club. These amount to approximately 50 flats with their individual ASHPs. A fraction of these will be located at ground level.

LT ASHPs at risk of flooding within these areas will be those installed at ground level flats. This risk can be reduced by installing them at height or mounted on a slab, taking care to minimise visual impact.

The majority of the properties in **cluster 7** are in flood risk areas and at risk of surface water flooding. This includes existing houses proposed to be retrofitted with hybrid and HT ASHP, and flat/terrace houses yet to be built to transition to LT ASHP.

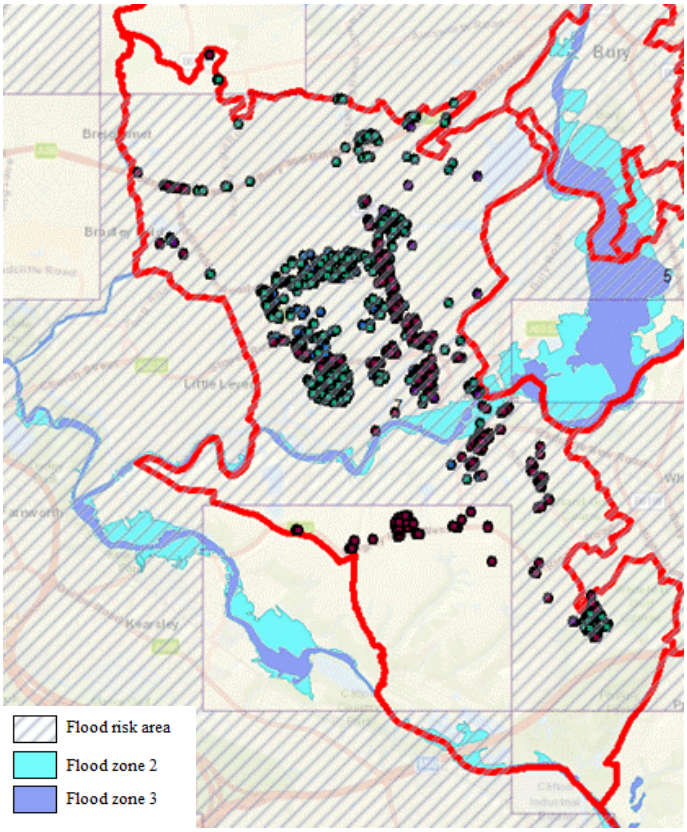


Figure 4. Cluster 7 – flood risk area and flood zones

A very small number of the properties proposed are found in a flood zone 2, close to the river Irwell by Radcliffe. These amount to 5 terrace houses and 13 flats, which could extend into a flood zone 3.

ASHPs at risk of flooding within these areas will be those installed at ground level, which is the majority for houses and a fraction of the flat developments. This risk can be reduced by installing them at height or mounted on a slab, taking care to minimise visual impact.

5 Ground Conditions

Ground conditions have been assessed per technology and clusters involved in the pathways, focusing on Development High Risk Areas (DHRA) and coal mine entries. All of Bury Council is in a coal mining reporting area.

Works taking place in an identified DHRA are required to provide a coal mining risk assessment to the Council, highlighting risks to neighbouring occupiers, public safety, highway users, as well as mitigation measures. Mine entries represent a risk to the heat network to be considered when defining the route to connect to specific dwellings.

5.1 District Heating

The domestic connection to a heat network involves some underground work, and will likely follow the route of gas connections. District heating is proposed in clusters 2, 4 and 5, and each will be analysed separately.

Properties in **cluster 2** consist of existing and new build houses and flats. There is a small number of mine entries near the existing semi-detached properties. A small proportion of all these houses are in DHRAs.

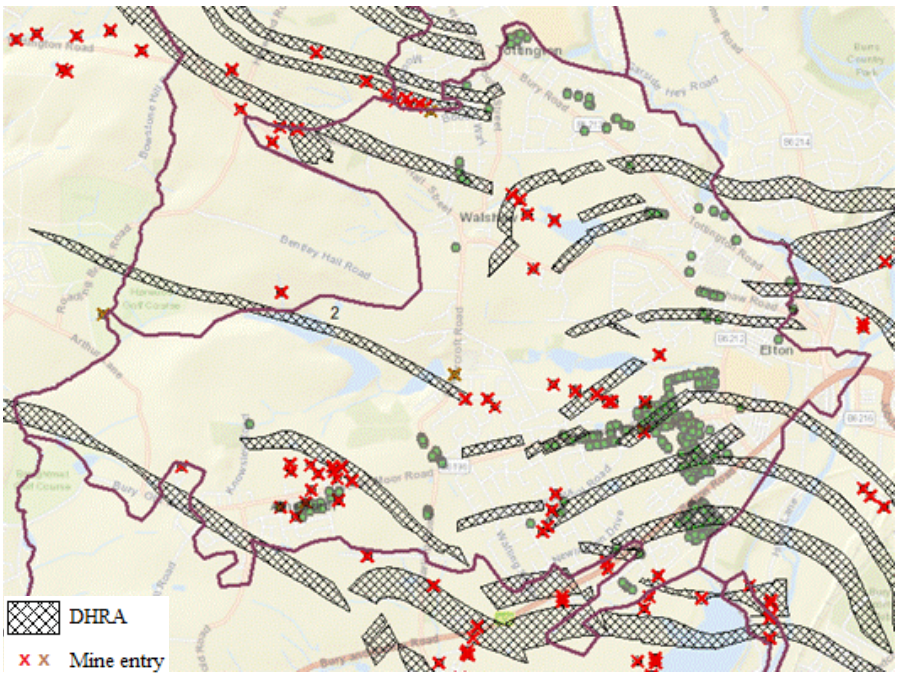


Figure 5. Cluster 2 – existing properties and DHRA/mine entries

A number of mine entries and DHRAs appear to affect the new build flats and terrace houses in cluster 2. It is important to remember that the points for new builds can represent a larger development instead of a single location. The area occupied by the total number of new builds could encompass more mine entries and DHRAs.

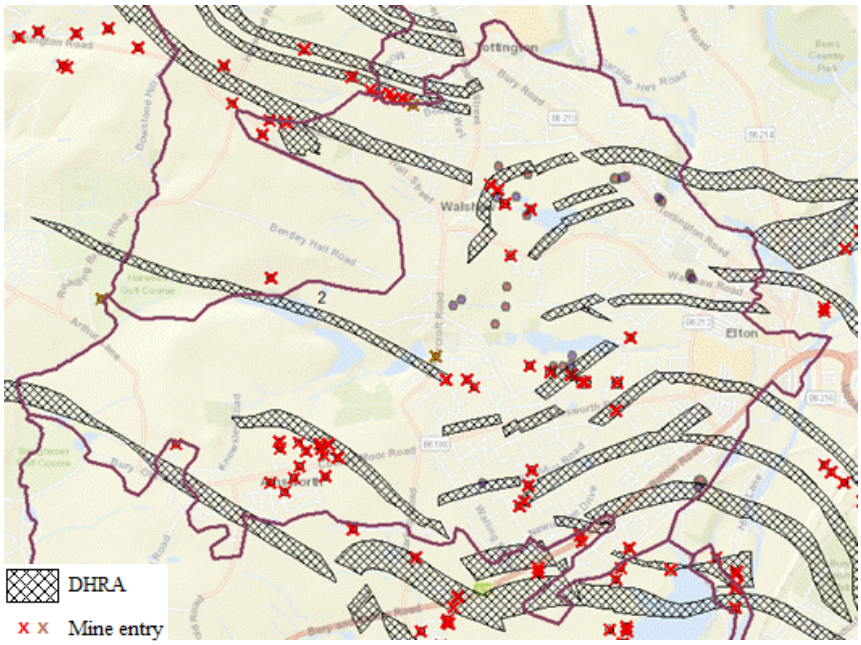


Figure 6. Cluster 2 – new build properties and DHRA/mine entries

Few existing properties in **cluster 4** are near mine entries. Some properties are also within a DHRA.

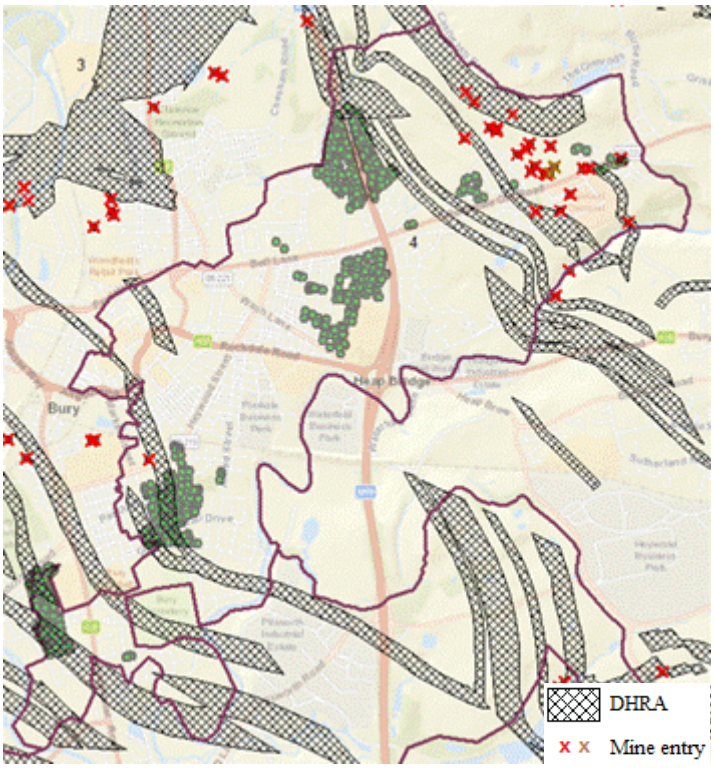


Figure 7. Cluster 4 – existing properties and DHRA/mine entries

Few new build properties in **cluster 5** are near mine entries or within DHRAs. The points in the figure below represent larger developments, which should be taken into consideration when addressing the ground risk for this cluster.

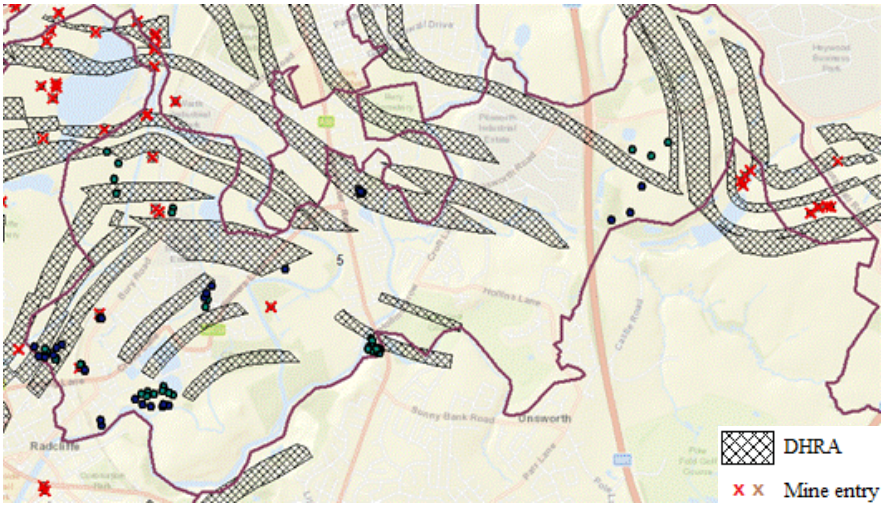


Figure 8. Cluster 5 – new build properties and DHRA/mine entries

5.2 Air Source Heat Pump

The installation of HT/LT ASHP or hybrid heat pumps involves superficial ground works. Ground conditions have no impact in the assessment of ASHP installation.

6 Air Quality

Certain areas of the Greater Manchester Combined Authority have been defined as an Air Quality Management Area (AQMA). This includes parts of the area of interest of this study, specifically some main roads shown in blue below. This figure is based on information reported by the respective local authorities for 2017.

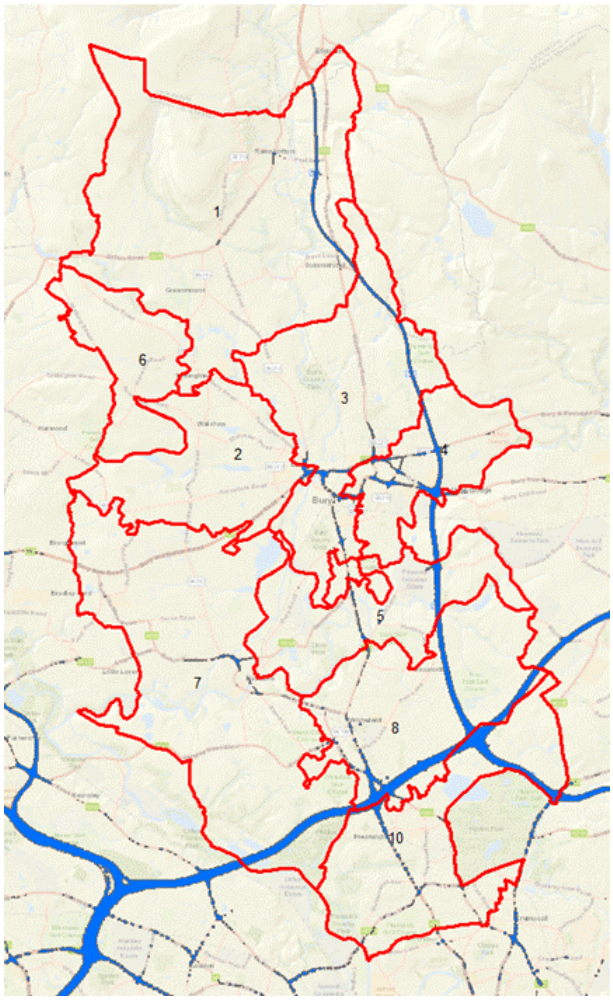


Figure 9. AQMA in the area of study

Additional traffic will be generated by the implementation of the technologies in this assessment during construction and retrofit. It is expected that the Government will continue to produce clean air strategies, such as the diesel and petrol car sale ban from 2040, to improve air quality in the roads.

Air quality has been analysed based on the impact of each technology.

6.1 District Heating

HIUs produce no direct air pollutant emissions. Air quality in clusters 2, 4 and 5 is not expected to be affected by the domestic connection element of this technology.

6.2 Air Source Heat Pump

HT and LT ASHPs produce no direct air pollutant emissions. These technologies have no impact on the local air quality of clusters 1, 3 and 7.

Gas boilers used in the hybrid heat pumps will contribute to pollution that may affect air quality of clusters 1 and 7. It is assumed that new gas boilers will have to comply with stricter regulations which will limit the pollutants output. Air quality of the area is not expected to worsen due to hybrid heat pumps.

7 Heritage, Planning and Visual Impact

The heritage, planning and visual impact assessment has been performed per technology and its relevant clusters. The heritage aspect is focused on Conservation Areas and listed buildings in the vicinity of the properties selected for the pathways studied. Planning considerations and visual impact of the technologies assessed were then explained.

Bury Council has Green Belts in their area, as shown below from GIS data obtained from data.gov.uk.

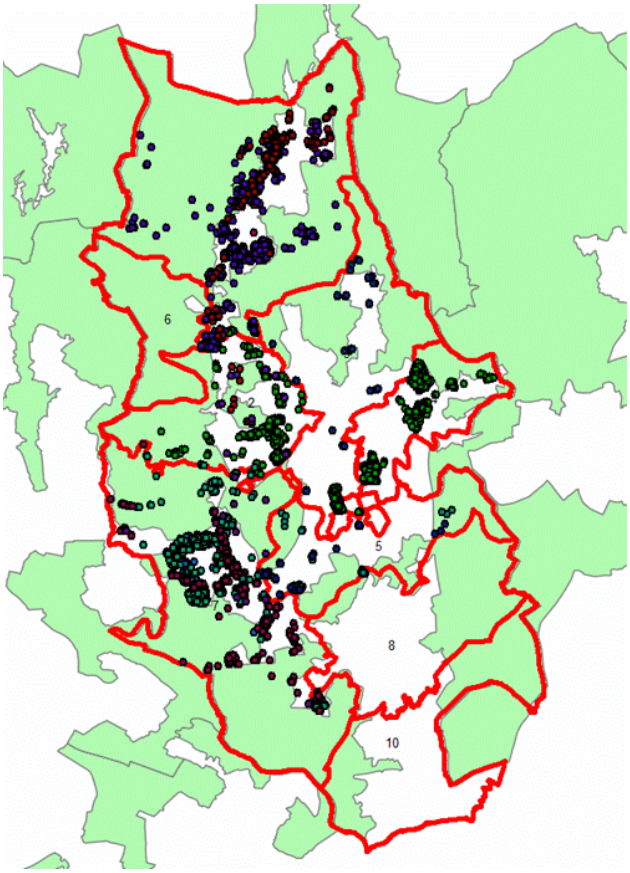


Figure 10. Green Belts in Bury Council and properties assessed

Some existing and new properties fall within green belt areas. Planning permission for the construction of these properties would have been approved prior to the transition to new low carbon technologies. It is likely that the introduction of new technologies with small visual impact such as heat pumps and district heating connections will not be met with major obstacles.

7.1 Heritage

There are 14 Conservation Areas designated in Bury. Seven of these affect the clusters studied. There are multiple listed buildings in the Bury area in the vicinity of the properties assessed. The implications of this for the implementation of the pathways is discussed in the following sections.

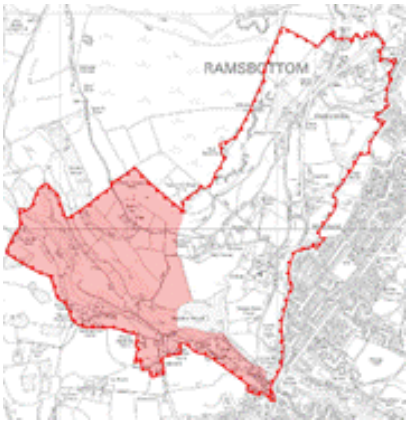
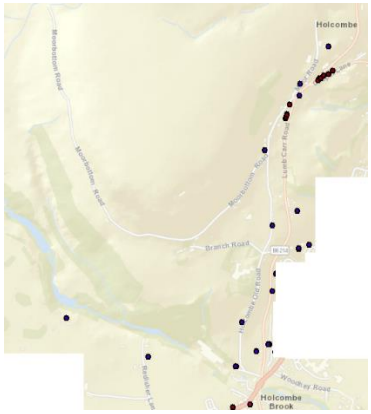
7.1.1 District Heating

Properties in clusters 2, 4 and 5 are to be connected to district heating. The areas of study were not within any of the Conservation Areas in Bury. No listed buildings were in the immediate vicinity of the properties in these clusters.

7.1.2 Air Source Heat Pump

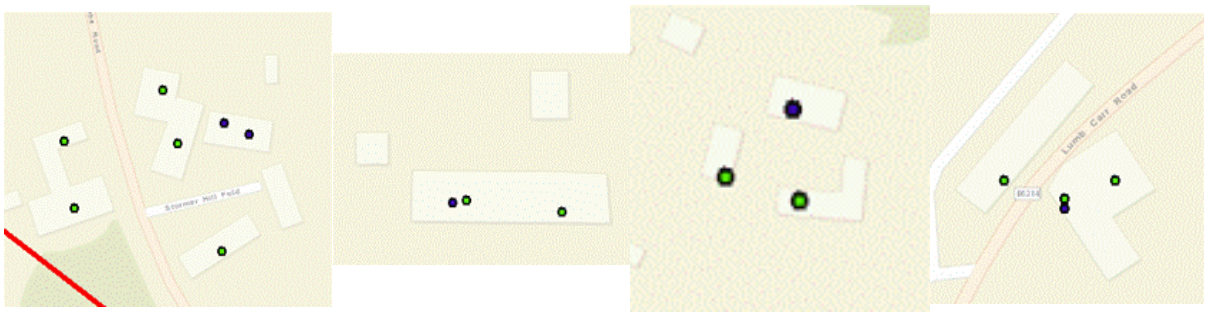
Properties in clusters 1, 3 and 7 are to have LT/HT ASHP or hybrid heat pumps installed. Conservation Areas and listed buildings are found in the proximity of the properties in these clusters.

Six Conservation Areas are found in **cluster 1**. A number of properties are found within a Conservation Area, as shown below. Note that not all properties shown in the right column are within the red line boundary of each Conservation Area.

Conservation Area	Properties in cluster 1
Bury New Road 	
Holcombe 	
Ramsbottom 	

Conservation Area	Properties in cluster 1
Brooksbottoms 	
Summerseat 	
Tanners, Ramsbottom 	

There are many listed buildings in **cluster 1**. The few instances where properties are in very close proximity to listed buildings are shown below.



Semi-detached houses (hybrid heat pump)

Terrace house (HT ASHP)

Figure 11. Cluster 1 – properties in close proximity of listed buildings

There is a single terrace house in **cluster 7** within the Conservation Area of Ainsworth, as shown below.

Figure 12. Cluster 7 – Ainsworth Conservation Area and property within it

There are no properties in cluster 3 that are within a Conservation Area. There are no listed buildings in close proximity to the properties in clusters 3 or 7.

7.2 Planning and Visual Impact

7.2.1 District Heating

District heating connections for houses in clusters 2, 4 and 5 have little visual impact, since it is expected the underground pipes will be trenched up to the house for connection. Connections to residential buildings in clusters 2 and 4 is expected to have one single point of entry and will be underground until reaching it. Connections may need to follow certain planning conditions, such as a maximum height or to be in an enclosure that blends with the rest of the house or building. Certain alterations to properties should fall under permitted development rights and not require planning permission.

The HIU has no additional visual impact if installed indoors.

Early engagement and discussions with the planning team will quickly inform about what is allowed by the Bury Council for this technology. This obstacle can be avoided by giving authorisation to specific amendments to a dwelling in order to connect to heat networks, in specific areas.

The Bury Council could greatly facilitate the implementation of this technology in the future by adopting a Local Development Order to grant planning permission for installation of pipes, cables, and engineering works related to district heating within defined areas of land.

7.2.2 Air Source Heat Pump

Installation of air source heat pumps on domestic premises (houses or flats) is considered permitted development in England and does not need a planning permission, if it meets certain conditions:

- Development is permitted only if the air source heat pump installation complies with the Microgeneration Certification Scheme Planning Standards (MCS 020) or equivalent standards.
- The volume of the air source heat pump's outdoor compressor unit (including housing) must not exceed 0.6 cubic metres.
- Only the first installation of an air source heat pump would be permitted development, and only if there is no existing wind turbine on a building or within the curtilage of that property. Additional wind turbines or air source heat pumps at the same property requires an application for planning permission.
- All parts of the air source heat pump must be at least one metre from the property boundary.
- Installations on pitched roofs are not permitted development. If installed on a flat roof all parts of the air source heat pump must be at least one metre from the external edge of that roof.

- Permitted development rights do not apply for installations within the curtilage of a Listed Building or within a site designated as a Scheduled Monument.
- On land within a Conservation Area or World Heritage Site the air source heat pump must not be installed on a wall or roof which fronts a highway or be nearer to any highway which bounds the property than any part of the building.
- On land that is not within a Conservation Area or World Heritage Site, the air source heat pump must not be installed on a wall if that wall fronts a highway and any part of that wall is above the level of the ground storey.

ASHPs should be located to minimise the effect on the external appearance of the building and area. HT/LT ASHP and hybrid heat pumps will have a similar visual impact in these pathways which can be reduced. They are to be installed in the back of houses and flats (or roof for top-floor flats for clusters 3 and 7).

For properties in a Conservation Area such as those found in cluster 1, it is important to maintain the character of the area as a whole. Appropriate materials and colour treatment can also be used if any housing for the unit is required. Planning permission may be required for external alterations in these areas. In particular in Holcombe Conservation Area, where permitted development rights have been removed.

There are very few properties in the pathways proposed that are adjacent to a listed building. This could be of significance, since a listed building's setting may include land close to the properties. Fixing of equipment to a listed building should not unnecessarily disturb or destroy its historic fabric. These instances will have to be looked at on a case-by-case basis to determine the extent of the listed building and whether permission is needed from the planning authority.

8 Noise Impact

This noise assessment has been divided per technology and clusters involved. The map below indicates the 24 hour annual average noise level of road sources.

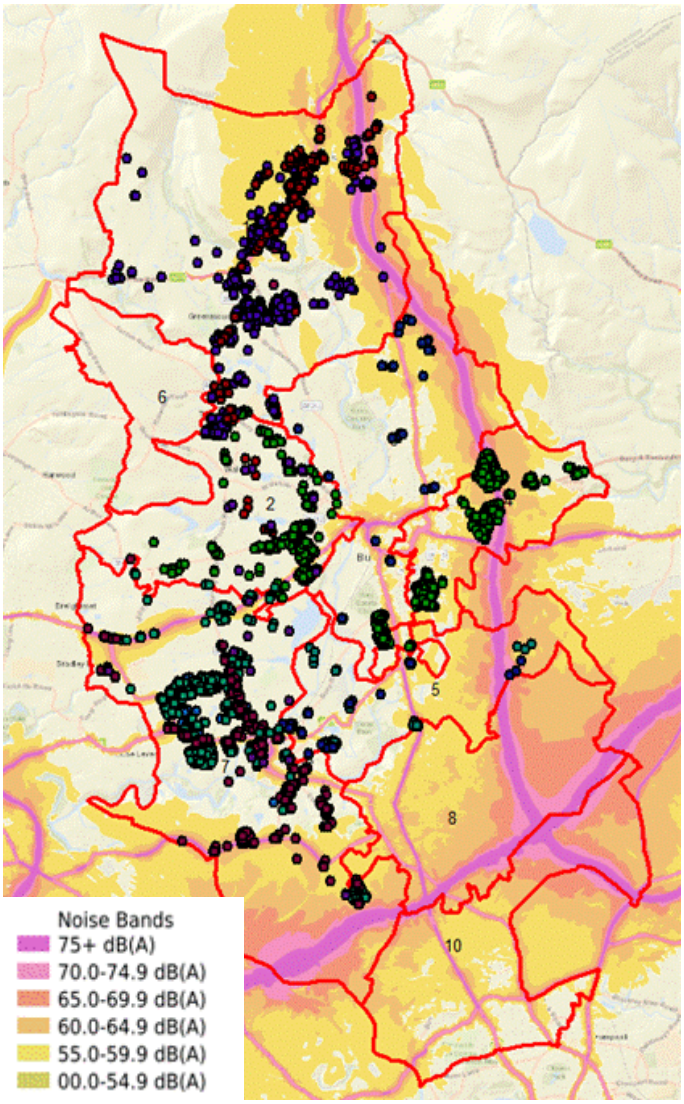


Figure 13. Road noise map

It was found rail noise did not affect Bury Council according to the noise map. The majority of the properties in these pathways are part of agglomerations, with the associated noise expected of urban areas.

8.1 District Heating

Construction noise is expected in the areas where heat network and domestic connections are to be installed. This may be more noticeable in cluster 2, and areas in clusters 4 and 5 with lower noise bands away from motorways and major roads. General construction hours and rules apply, and this will be temporary.

There is no additional noise expected from the operation of a district heat network. The Heat Interface Units are not expected to produce any more noise levels than current gas boiler installations. Noise is not a concern as part of the operation of this technology.

8.2 Air Source Heat Pump

The installation of HT/LT ASHP and hybrid heat pumps means noise is emitted from the fan and compressor which can be a nuisance. There may be limited impact on the overall noise levels when installed in semi-detached houses. A greater impact may be noticed in a cumulative installation. This is particularly true where heat pumps are proposed for rows of terrace houses and flats, with several units in a row close to each other.

ASHPs are proposed for terrace houses (new or existing) and flats in clusters 1, 3 and 7. In cluster 1, the majority of terrace houses are located along main roads. In cluster 3, the majority new build flats are planned in areas with existing noise levels from roads. In cluster 7, about half of the existing terrace houses are along main roads. The majority of new terrace houses and flats in cluster 7 are planned in areas away from main roads, with low noise levels.

Where existing noise levels are likely to be affected, mitigation measures such as acoustic enclosures can contain noise and regulate air flow. The cost of these enclosures is dependent on the make and model of the HT/LT ASHP and can be available in the range of £2,000 per enclosure. This can be deemed as significant as it is an additional 50% of the fixed capital cost proposed by the EPN tool. Anti-vibration mountings are also available which will further aid the reduction of noise emitted and disturbance to the adjacent houses. The implications of this may be that greater space is required for the installation of this technology. Locating the ASHPs at the rear of the properties would minimise disruption to pedestrians. This will minimise the risk of the Bury Council restricting the number of HT/LT ASHPs to install in certain areas.

9 Summary of findings for EPN pathways

The analysis carried out in the previous sections can be summarised in the following table which describes the constraints found per pathway proposed. A L-M-H score has been given to account for the risk to implementation of these technologies at a domestic level.

Pathway	Risks to implementation	Score
Semi-detached houses, 1914-1944, District Heat, cluster 2	No concerns regarding installation of plant and domestic connections to a district heating network.	L
	No concerns for this technology regarding flood risk.	
	Development high risk areas and mine openings affect a small number of properties in this pathway. Additional works to mitigate these risks may not be included in the capital costs proposed.	
	No concerns regarding heritage or planning.	
	No concerns regarding impact on air quality or noise levels with this technology.	
Semi-detached houses, 1914-1944, District Heat, cluster 4	No concerns regarding installation of plant in this pathway.	L
	No concerns for this technology regarding flood risk.	
	Development high risk areas and mine openings affect a small number of properties in this pathway. Additional works to mitigate these risks may not be included in the capital costs proposed.	
	No concerns regarding heritage or planning.	
	No concerns regarding impact on air quality or noise levels with this technology.	

Pathway	Risks to implementation	Score
Flats, New Build, District Heat, cluster 2	New build flats need retrofitting from electric storage heaters to a wet heating system with new pipework and radiators. Additional costs may not be included in the capital costs proposed.	L
	No concerns for this technology regarding flood risk.	
	Development high risk areas and mine openings appear to affect a number of properties, based on the single location given for the developments. It is possible that more mine entries and DHRAs will affect the total of properties. Additional works to mitigate these risks may not be included in the capital costs proposed.	
	No concerns regarding heritage or planning.	
	No concerns regarding impact on air quality or noise levels with this technology.	
Flats, New Build, District Heat, cluster 5	New build flats need retrofitting from electric storage heaters to a wet heating system with new pipework and radiators. Additional costs may not be included in the capital costs proposed.	L
	No concerns for this technology regarding flood risk.	
	Development high risk areas and mine openings appear to affect few properties in this pathway, based on the single location given for the developments. It is possible that more mine entries and DHRAs will affect the total of properties. Additional works to mitigate these risks may not be included in the capital costs proposed.	
	No concerns regarding heritage or planning.	
	No concerns regarding impact on air quality or noise levels with this technology.	

Pathway	Risks to implementation	Score
Terrace houses, New Build, District Heat, cluster 2	No concerns regarding installation of plant and domestic connections to a district heating network.	L
	No concerns for this technology regarding flood risk.	
	Development high risk areas and mine openings appear to affect a number of properties, based on the single location given for the developments. It is possible that more mine entries and DHRAs will affect the total of properties. Additional works to mitigate these risks may not be included in the capital costs proposed.	
	No concerns regarding heritage or planning.	
	No concerns regarding impact on air quality or noise levels with this technology.	
Terrace houses, New Build, District Heat, cluster 5	No concerns regarding installation of plant and domestic connections to a district heating network.	L
	No concerns for this technology regarding flood risk.	
	Development high risk areas and mine openings appear to affect few properties in this pathway, based on the single location given for the developments. It is possible that more mine entries and DHRAs will affect the total of properties. Additional works to mitigate these risks may not be included in the capital costs proposed.	
	No concerns regarding heritage or planning.	
	No concerns regarding impact on air quality or noise levels with this technology.	

Pathway	Risks to implementation	Score
Terrace houses, pre-1914, HT ASHP, cluster 1	Installation of plant is feasible with no major constraints. Dimensions of 500 L water cylinder should be kept appropriate for this type of house.	L
	A small number of houses are within a flood risk area or a flood zone 2. This risk can be eliminated with no major impact to costs.	
	Ground conditions have no impact on this technology.	
	No concerns regarding impact on air quality.	
	A number of properties in this pathway are within Conservation Areas and one in close proximity of a listed building. Planning permission may be required for external alterations in these areas, especially in Holcombe Conservation Area.	
	Acoustic enclosure and anti-vibration mounting can reduce the noise impact of a large number of ASHPs installed in rows of terrace houses. It is unknown if these measures have been incorporated in the capital costs.	
Terrace houses, pre-1914, HT ASHP, cluster 7	Installation of plant is feasible with no major constraints. Dimensions of 500 L water cylinder should be kept appropriate for this type of house.	L
	The majority of properties are in a flood risk area, and a very small number in a flood zone 2. This risk can be eliminated with no major impact to costs.	
	Ground conditions have no impact on this technology.	
	No concerns regarding impact on air quality.	
	One terrace house is found within the Ainsworth Conservation Area. For this instance, a planning permission may be required for external alterations.	
	Acoustic enclosure and anti-vibration mounting can reduce the noise impact of a large number of ASHPs installed in rows of terrace houses. It is unknown if these measures have been incorporated in the capital costs.	

Pathway	Risks to implementation	Score
Semi-detached houses, 1945-1964, HT ASHP, cluster 1	Installation of plant is feasible with no major constraints. Dimensions of 500 L water cylinder should be kept appropriate for spare floor area available in these houses.	L
	A small number of houses are within a flood risk area. This risk can be eliminated with no major impact to costs.	
	Ground conditions have no impact on this technology.	
	No concerns regarding impact on air quality.	
	A small number of properties are found within Conservation Areas. . Planning permission may be required for external alterations in these areas.	
	Acoustic enclosure and anti-vibration mounting can reduce the noise impact of a large number of ASHPs installed in quiet areas. It is unknown if these measures have been incorporated in the capital costs.	
Semi-detached houses, 1945-1964, HT ASHP, cluster 7	Installation of plant is feasible with no major constraints.	L
	The majority of properties are in a flood risk area. This risk can be eliminated with no major impact to costs.	
	Ground conditions have no impact on this technology.	
	No concerns regarding impact on air quality.	
	No concerns regarding heritage or planning.	
	Acoustic enclosure and anti-vibration mounting can reduce the noise impact of a large number of ASHPs installed in quiet areas. It is unknown if these measures have been incorporated in the capital costs.	

Pathway	Risks to implementation	Score
Semi-detached houses, 1945-1964, hybrid heat pump, cluster 1	No concerns regarding installation of plant.	L
	A number of houses are within a flood risk area and few in a flood zone 2. This risk can be eliminated with no major impact to costs.	
	Ground conditions have no impact on this technology.	
	No concerns regarding impact on air quality.	
	A number of properties in this pathway are within Conservation Areas and in close proximity of a listed building. Planning permission may be required for external alterations in these areas, especially in Holcombe Conservation Area.	
	Acoustic enclosure and anti-vibration mounting can reduce the noise impact of a large number of ASHPs installed in quiet areas. It is unknown if these measures have been incorporated in the capital costs.	
Semi-detached houses, 1945-1964, hybrid heat pump, cluster 7	No concerns regarding installation of plant.	L
	The majority of properties are in a flood risk area. This risk can be eliminated with no major impact to costs.	
	Ground conditions have no impact on this technology.	
	No concerns regarding impact on air quality.	
	No concerns regarding heritage or planning.	
	Acoustic enclosure and anti-vibration mounting can reduce the noise impact of a large number of ASHPs installed in quiet areas. It is unknown if these measures have been incorporated in the capital costs.	

Pathway	Risks to implementation	Score
Flats, New Build, LT ASHP, cluster 3	New build flats need retrofitting from electric storage heaters to a wet heating system with new pipework and radiators. Additional costs may not be included in the capital costs proposed.	L
	Space needs to be allowed for the installation of 500 L water cylinder and large radiators.	
	The majority of properties are in a flood risk area, with some in flood zones 2 and 3. This only affect ground level flats. The risk can be eliminated with no major impact to costs.	
	Ground conditions have no impact on this technology.	
	No concerns regarding impact on air quality.	
	No concerns regarding heritage or planning.	
	Acoustic enclosure and anti-vibration mounting can reduce the noise impact of a large number of ASHPs installed in blocks of flats. It is unknown if these measures have been incorporated in the capital costs.	
Flats, New Build, LT ASHP, cluster 7	New build flats need retrofitting from electric storage heaters to a wet heating system with new pipework and radiators. Additional costs may not be included in the capital costs proposed.	L
	Space needs to be allowed for the installation of 500 L water cylinder and large radiators.	
	All properties are in flood risk areas, and a few in a flood zone 2. This only affect ground level flats. The risk can be eliminated with no major impact to costs.	
	Ground conditions have no impact on this technology.	
	No concerns regarding impact on air quality.	
	No concerns regarding heritage or planning.	
	Acoustic enclosure and anti-vibration mounting can reduce the noise impact of a large number of ASHPs installed in blocks of flats. It is unknown if these measures have been incorporated in the capital costs.	

Pathway	Risks to implementation	Score
Terrace houses, New Build, LT ASHP, cluster 7	Installation of plant is feasible with no major constraints. Dimensions of 500 L water cylinder should be kept appropriate for spare floor area available in these houses.	L
	Additional/larger radiators needed to maintain original pre-heat period will require additional wall space inside the house.	
	All properties are in flood risk areas, and a few in a flood zone 2. This only affect ground level flats. The risk can be eliminated with no major impact to costs.	
	Ground conditions have no impact on this technology.	
	No concerns regarding impact on air quality.	
	No concerns regarding heritage or planning.	
	Acoustic enclosure and anti-vibration mounting can reduce the noise impact of a large number of ASHPs installed in rows of terrace houses. It is unknown if these measures have been incorporated in the capital costs.	

Arup's initial view is that all pathways proposed are technically feasible, with no major constraints that need to be further assessed before implementation. Mitigation measures are available to reduced constraints to low level risk, at a cost. The unit costs allocated for each technology may need to be revised for a number of pathways to make sure these measures are accounted for.

Early involvement with the developers of New Build properties is recommended to ease the future implementation of these technologies.