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Mapping of district heating feasibility studies in Scotland

Colin Sinclair, Gozde Unkaya and Tom Jennings
Building Research Establishment (BRE)
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1 Executive summary

1.1 Aims and findings

This study presents research conducted by the Building Research Establishment (BRE) to collect, analyse and map data relating to previous district heating (DH) feasibility studies in Scotland. DH feasibility study data, obtained primarily from industry stakeholders, was collated, sorted and analysed in order to identify common barriers restricting DH development, and to map study locations. This research aims to support emerging national DH policy and to enhance the Scottish Heat Map.

We analysed 44 studies which comprised a total of 76 proposed DH schemes. We also undertook an additional high-level review, and mapping, of a further 33 'in development' schemes that were included in the Scottish Government's 'Low Carbon Heat Database'. Therefore, a total of 109 proposed DH schemes were reviewed and mapped. It is worth noting that data collection from stakeholders was severely hampered by the Covid-19 pandemic.

1.2 Key scheme characteristics

- **Scheme viability**: When considering the 76 proposed schemes that were reviewed in detail: 46 proposed DH schemes were reported by the authors as being viable and 22 schemes were reported as being unviable (with circa 37% being reported to be financially unfeasible). No assessment of viability was reported for the remaining 8 schemes. It should be noted that the viable/unviable assessments noted above relate to the conclusions as drawn by the authors of the respective feasibility reports. It was outwith the scope of this study to assess and/or validate the conclusions of the feasibility reports. As a result, the definition of viability is likely to vary between the reports.
- **Property mix**: When considering the 109 schemes: 68 schemes (62%) explored the feasibility of serving a mix type of buildings (domestic, commercial and/or industrial);

29 schemes (27%) explored the feasibility of serving domestic buildings. Ten studies (9%) explored the feasibility of serving commercial buildings. Two studies (2%) explored the feasibility of serving industrial facilities.

- **Main heating technologies**: 33 schemes were based on a gas-fired combined heat and power (CHP) system; 22 schemes were based on biomass boilers; and 13 schemes did not specify a proposed primary heating technology.
- **Heat demand**: The estimated network heat demand of 38 schemes was between 2,000 and 10,000 MWh. 28 schemes did not report any heat demand figures.
- **Costs**: Cost parameters (such as CAPEX, OPEX, annual savings, etc.) were found to be reported in many ways and costs were not fully transparent in many studies. As a result, we were unable to analyse costs in significant detail within the constraints of the project timeline and budget.

The data collected on DH schemes was also used to underpin a new layer in the Scottish Heat Map.

1.3 Key barriers

Semi-structured interviews with eight key stakeholders identified the key barriers that the stakeholders believed to be restricting the development of DH schemes in Scotland, including:

- high capital costs and long payback periods of DH projects;
- high demand risk (payback period being dependent on consumer demand);
- lack of DH technical knowledge and skills in the industry;
- lack of investment interest and lack of investor involvement in the process;
- lack of realistic business cases and delivery/procurement models; and
- lack of stakeholder and consumer awareness and lack of stakeholder buy-in.

The feedback from the interviewees suggested that developing technical skills in the industry would be essential in order to improve the quality and reliability of feasibility and design studies, and ensure successful delivery and operation of DH schemes. Feedback suggested that this would involve training DH consultants, design teams, contractors and system operators. Developing sound business and procurement models in a timely and efficient manner and implementing a cross-sectional approach were also suggested as being essential for the successful delivery of DH projects.

Interviewees were also asked about current and anticipated impact of the Covid-19 pandemic. However, at the time of the interviews, the impact of the virus was not clear and mitigation measures were in the early stages of development.

1.4 Recommendations

The Scottish Government may wish to consider carrying out further research on the financial and technical shortcomings identified in individual DH network projects. This in turn could provide the opportunity to validate the key findings of this report.

The Scottish Government may also wish to consider investigating ways in which DH feasibility studies (e.g. particularly those studies that receive government support) can be analysed and reported in a consistent manner to enable a greater level of cross-comparison between schemes. Some potential areas for improvement could include aspects such as producing guidance on standardised feasibility report formats; methodologies for calculating and presenting information on key energy, heat, carbon savings and/or financial metrics; and building upon existing research and policy (i.e. Local Heat and Energy Efficiency Strategies).

Contents

2 Background

2.1 Objectives

By 2030, Scotland aims to reduce its emissions by 75% compared to 1990, while growing the economy, increasing the wellbeing of the people of Scotland, and protecting and enhancing the natural environment. Decarbonisation of heat systems will play an essential role in achieving these targets and responding to the global climate emergency. In order to support further deployment of heat networks in Scotland, the Scottish Government introduced a Heat Networks (Scotland) Bill[1] to the Scottish Parliament in March 2020. The Bill will lead to the introduction of regulation to the heat network sector in Scotland. The Scottish Government has also proposed introducing a statutory duty on local authorities to produce Local Heat and Energy Efficiency Strategies (LHEES), which will set out long term, local strategies for the decarbonisation of heat in buildings, including the deployment of heat networks.

Alongside the Scottish Government, a wide range of actors (including Local Authorities (LAs), Further and Higher Education (FHE) establishments, Health Boards, Registered Social Landlords (RSLs) and others) have explored the potential for developing district heating (DH) schemes. Whilst many feasibility studies have been undertaken to assess the technical and commercial viability of schemes, studies have not always led to investment and/or development of DH infrastructure. Research is therefore required to collect and analyse information from previous studies to support emerging national DH policy and to enhance the Scottish heat map.

The main aim of this research is to:

- Help address gaps in information and analyse and map existing feasibility studies for DH in Scotland,
- Deliver a filterable dataset that can be used by policymakers, planners, district heating developers, significant energy consumers, etc. to identify opportunities to develop low carbon solutions.
- Analyse previous DH study reports (where available) to gain insight on the proposed schemes including potential barriers to their development.

[1] https://www.parliament.scot/parliamentarybusiness/Bills/114590.aspx

3 Methodology

3.1 Overview

The following methodology was applied to deliver the research objectives:

Data collection phase:

- Conduct background research to identify and collect DH data including undertaking web-based research and engagement with stakeholders, experts, key networks and actor groups, etc.
- Develop and maintain a spreadsheet to collate and analyse key information on the DH feasibility studies.

Analysis phase:

- Analysis of the data to understand the nature of the proposed projects, barriers to development, policy-considerations, etc.
- Development of an output spreadsheet (and subsequent GIS shapefile) containing key data on the identified projects.

Interview stage:

- Conduct semi-structured interviews with key stakeholders to gather views on common barriers restricting DH development.

Reporting

- Reporting on key findings.

These stages are presented in more detail below.

3.2 Data collection phase

In this phase we contacted a wide range of stakeholders to request data regarding previous DH feasibility studies. The project attempted to engage with stakeholders who were likely to have considerable interest in DH project development (e.g. Local Authorities, further and higher education sector, health sector, registered social landlord membership associations, etc.) as well as with organisations who support, or have previously supported, Scottish or UK Government DH-related support schemes (e.g. Zero Waste Scotland, Energy Saving Trust, Scottish Enterprise, Scottish Futures Trust, etc.). A full list of stakeholders that were contacted, and the number of DH feasibility reports provided, is shown in Table 1 in Section 4.1.1. Additional desk-based research was also undertaken to identify publicly available DH feasibility reports.

3.3 Analysis phase

In this phase, key project information was extracted from the available DH feasibility studies and analysed to identify trends and insights. The parameters for this analysis were divided into two categories: project background information and technical information. The project background information included the study date, author, location and serving category. Technical information covered the aspects related to heating technologies, network demand and proposed project scope as stated in each study.

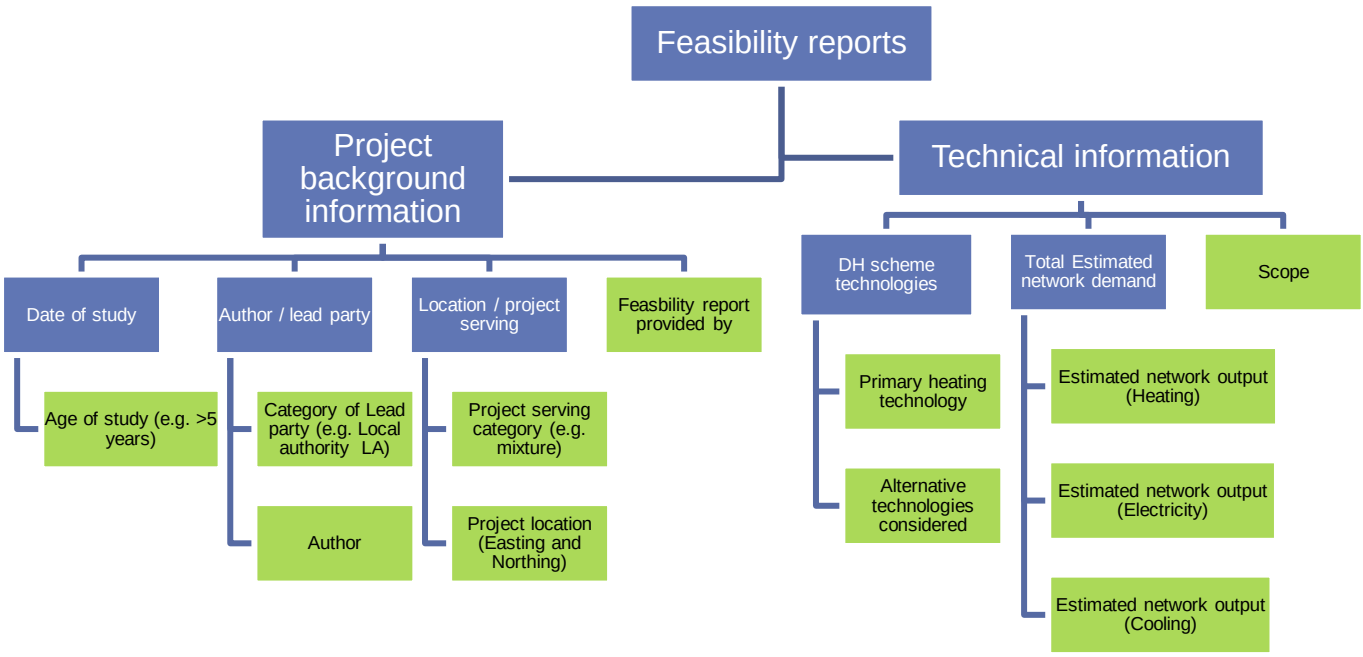

Figure 1 Structure of key information gathered from feasibility reports by filtering data

Applying the methodology shown in Figure 1 enabled a structured analysis to identify trends in the data. The results are presented in Section 4.

3.4 Interview stage

Semi-structured interviews with key stakeholders (eight in total) were undertaken in order to gain additional insight as to the reasons why some DH feasibility studies have not secured investment or progressed. An interview 'topic-guide' (as per Appendix A) was developed to provide structure to the interview and the topic-guide was shared with the interviewees in advance to allow them time to consider their responses. The interviews focussed on the following questions:

- What type and number of DH feasibility studies did interviewees have experience of, and direct involvement with, within last 3-5 years?;
- What did interviewees believe were the main reasons that schemes have / have not progressed to investment stage?;
- What are the main barriers restricting development of DH schemes in Scotland?;
- What can be done to help overcome these barriers?; and,
- What effects could Covid-19 have on the pipeline of DH projects in Scotland?

Interviewees were asked to provide answers on their own experience, based on projects that they had had direct involvement in. The interview findings are presented in Section 4.

4 Results

4.1 Overview

BRE identified and contacted over 20 different stakeholders to request DH feasibility reports or similar data. We attempted to engage several key organisations including those who have funded DH feasibility studies, or provided similar support, as well as key over-arching bodies /

groups representing multiple stakeholders. It is important to highlight that several stakeholders struggled to provide data, or meaningfully support the research, due to significant pressures related to the growing Covid-19 situation at the time. Of the 20+ organisations contacted, eight provided DH feasibility reports which resulted in 39 feasibility reports being received. To mitigate against the lack of stakeholder engagement, BRE undertook additional desk-based research to source publicly available feasibility studies and this highlighted an additional five feasibility studies. The 44 reports presented a total of 76 individual DH schemes. Table 1 below summarises the data obtained.

In addition to the above, the Scottish Government supplied their 'Low Carbon Heat Database' (version dated 25 March 2020) in support of the project. This database included 175 individual entries, containing information about a variety of district heating projects including operational schemes. Some 33 schemes that were stated as either 'in development' or 'under construction' were added to the master data sheet[2]. The date of study, location, DH scheme technologies and estimated network demand were also extracted from this database and added into our master data sheet for further analysis and mapping purposes.

Table 1 Stakeholder organisations and DH feasibility reports summary

Stakeholder	**DH feasibility study reports provided**	**Other sources of information**
Scottish Enterprise		16 case studies – 16 DH schemes
1x University	1 feasibility report – 1 DH scheme	
4x Local Authorities	11 feasibility reports – 18 DH schemes	
Energy Saving Trust	10 feasibility reports – 19 DH schemes	
Zero Waste Scotland report		1 report - 13 DH schemes
Scottish Government – Low Carbon Heat Database		Database including 33 DH schemes
Other - web search		5 reports – 9 DH schemes
Sub-total	22 reports – 38 DH schemes	22 reports – 71 DH schemes
Total	44 reports – 109 DH schemes	

It should be noted that it is unclear if the number of studies assessed within the project accounts for a low or high percentage of all DH studies in Scotland. That said, given that a significant source of data for the project was studies that had obtained support from various public-sector support schemes then it is likely that a reasonably high percentage of public-sector led projects have been identified. At the same time, it is likely that schemes championed by private / commercial organisations may be under-represented although, given the strategic

[2] We have not carried out any additional checks to verify the status or development stage of these entries. The information included in the Low Carbon Heat database may not be updated regularly.

and high-profile nature of district heating schemes it is unlikely that a significant number of private schemes would have been assessed without engagement or knowledge of local public sector actors.

4.2 Analysis

4.2.1 Analysis and mapping of scheme feasibility studies

We analysed a total number of 44 reports (including a total number of 76 DH schemes) based on their scope, outcomes, heating technologies, serving types and heat demand. A map of the locations of proposed DH system nodes across Scotland has been generated using Northing and Easting coordinates determined from reviewed feasibility studies. In addition to this, we reviewed and analysed the information provided in the Scottish Government's Low Carbon Heat (LCH) Database, which included 33 viable project entries with a status of 'in development' and/or 'under construction'. Therefore, a total number of 109 DH schemes were mapped (as shown in Figure 2).

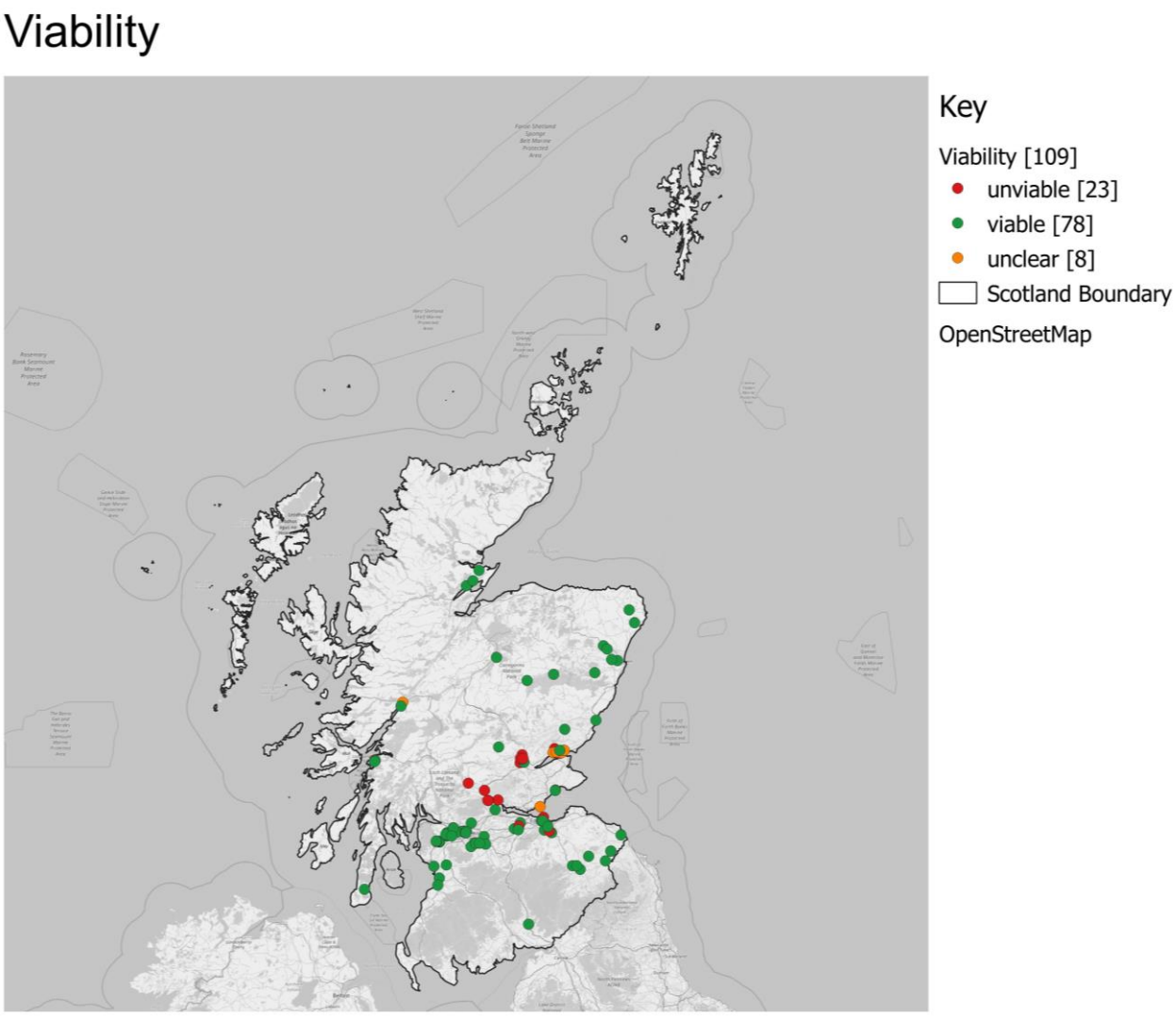

Figure 2 GIS map - viable and unviable DH schemes assessed in this study

Out of 76 DH schemes covered in the 44 reports, a total number of 23 schemes were found to be unviable, whereas a total number of 45 DH schemes were found to be viable. Outcomes of a total number of eight DH studies were not stated in the analysed reports (these studies are

shown as ‘unclear’ in the GIS map). The reasons for DH schemes being deemed unviable in the feasibility reports are shown in Figure 3.

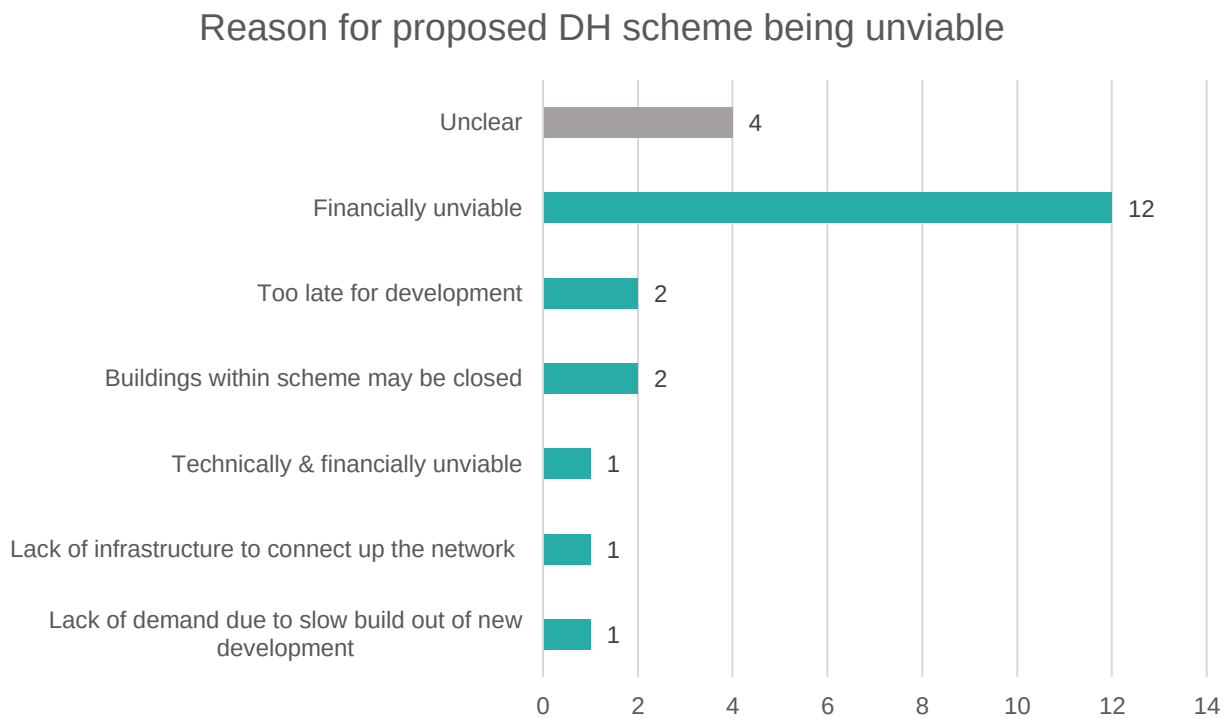

Figure 3 Reasons for proposed DH scheme being unviable from the 46 schemes analysed

A total number of 68 studies (62% of the schemes – viable and unviable) explored the feasibility of serving a mix type of buildings (domestic, commercial and/or industrial). 29 studies (27% of the studies) investigated the feasibility of serving domestic buildings. 10 studies (9%) investigated the feasibility of serving commercial buildings, and 2 studies (2%) investigated the feasibility of serving industrial facilities. See Figures 4 and 5.

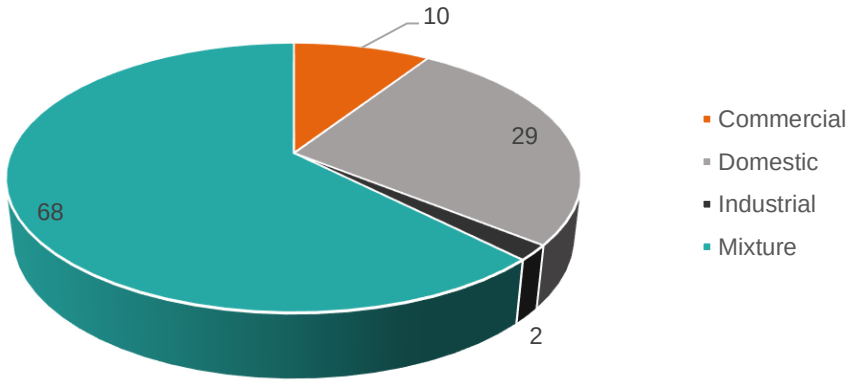

Figure 4 Number of proposed DH schemes broken down by the proposed sector they would supply

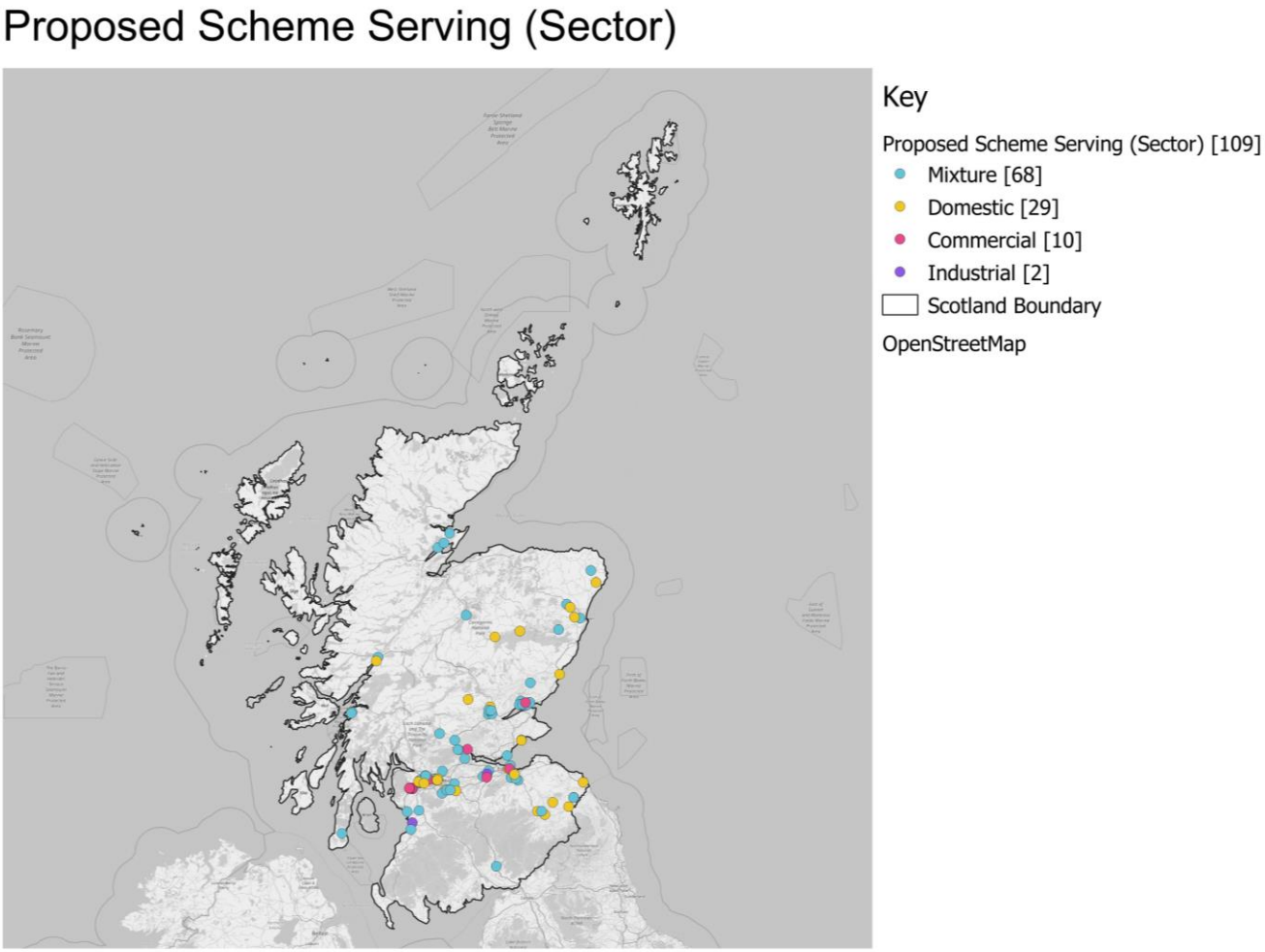

Figure 5 GIS map - proposed DH scheme by sector

As shown in Figure 6, the majority (i.e. 33 schemes) of schemes were based on a gas-fired combined heat and power (CHP) system. This was followed by biomass boilers (22 studies). A total number of 13 studies did not identify the primary heating technology considered within the feasibility study.

Most studies also investigated the feasibility of including a mix of renewable energy options such as solar PV panels, solar thermal collectors and heat pumps. Waste heat recovery from sewage and seawater were assessed in a small number of studies. One study assessed the feasibility of industrial waste heat recovery from a local distillery.

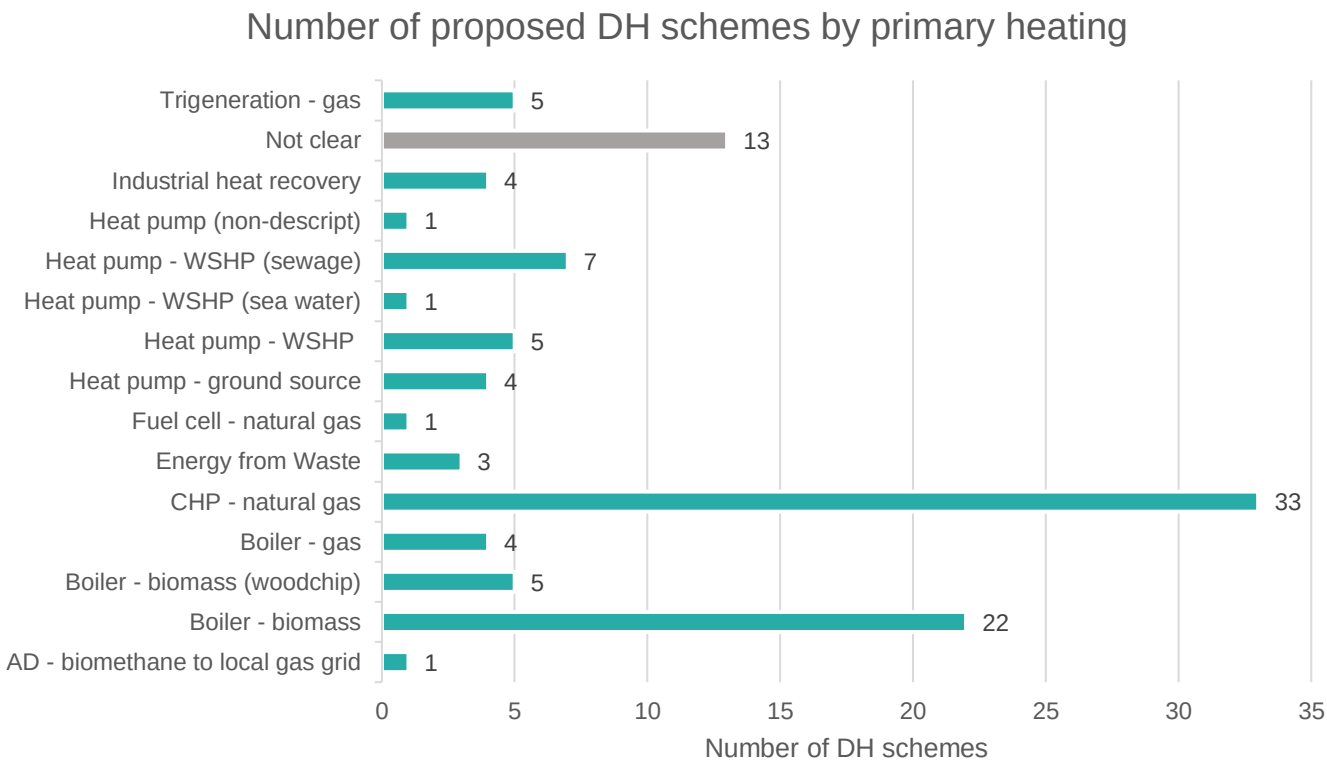

Figure 6 DH schemes by primary heating technology

Figure 7 shows that gas-fired CHP was commonly assessed for sites in urban areas (such as Glasgow and Edinburgh), whereas biomass fired boiler was considered for sites located in more rural areas. Sea-water heat pumps were mainly considered for sites in and around Dundee.

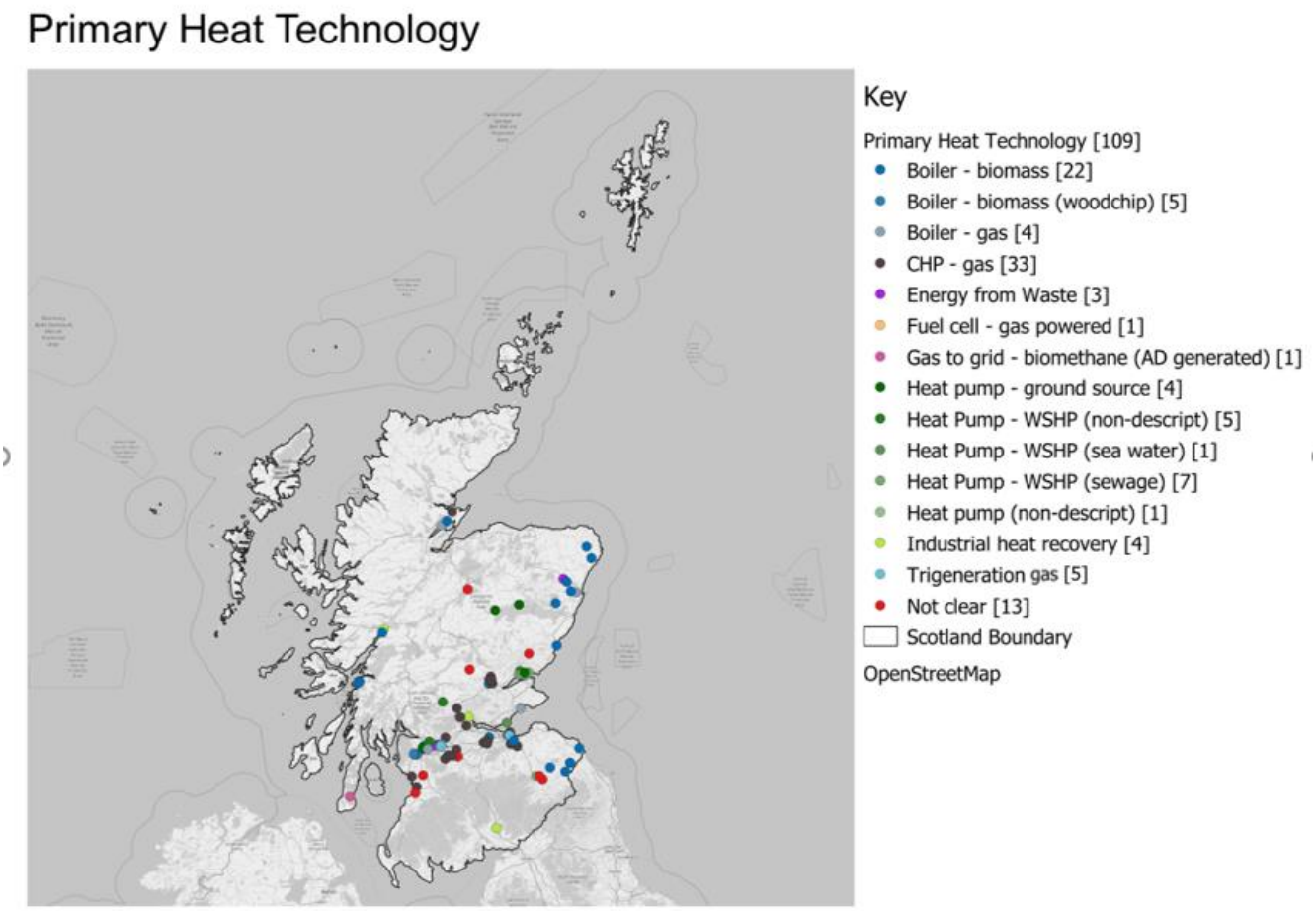

Figure 7 GIS map - DH schemes arranged by technologies assessed in feasibility studies

Thirty-two DH studies did not include any estimate of network heat demand. The estimated network heat demand of 38 DH schemes were between 2,000 and 10,000 MWh per annum. There were three studies with a total estimated heat demand of greater than 100,000 MWh. See Figures 8 and 9.

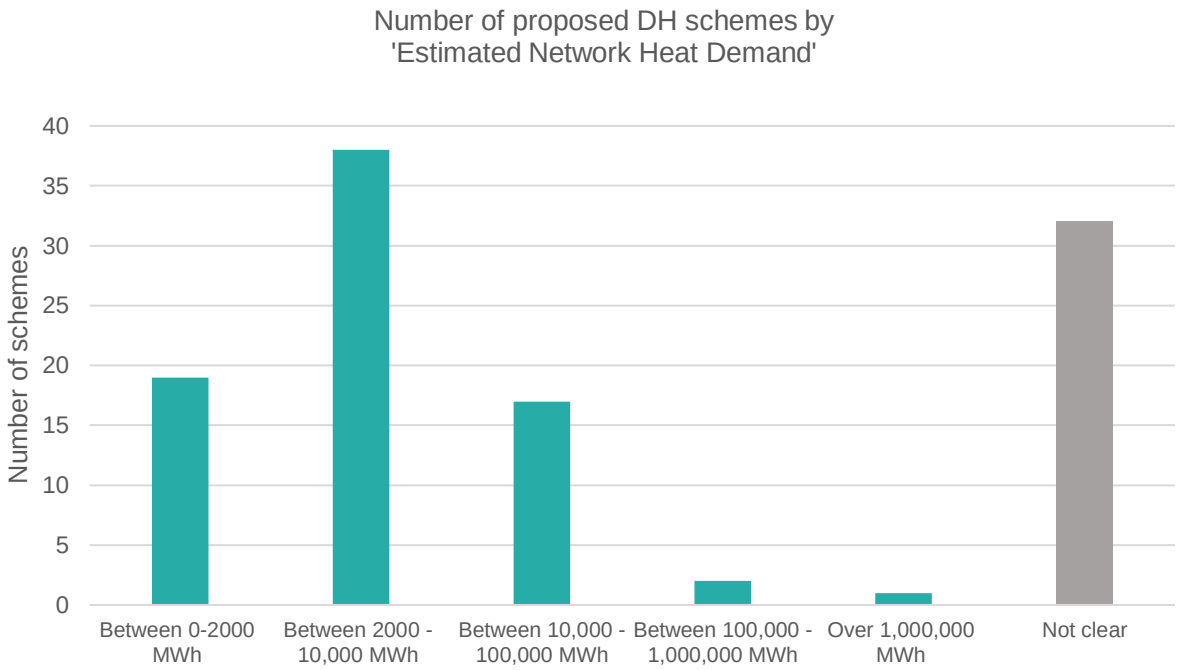

Figure 8 Estimated network heat demand

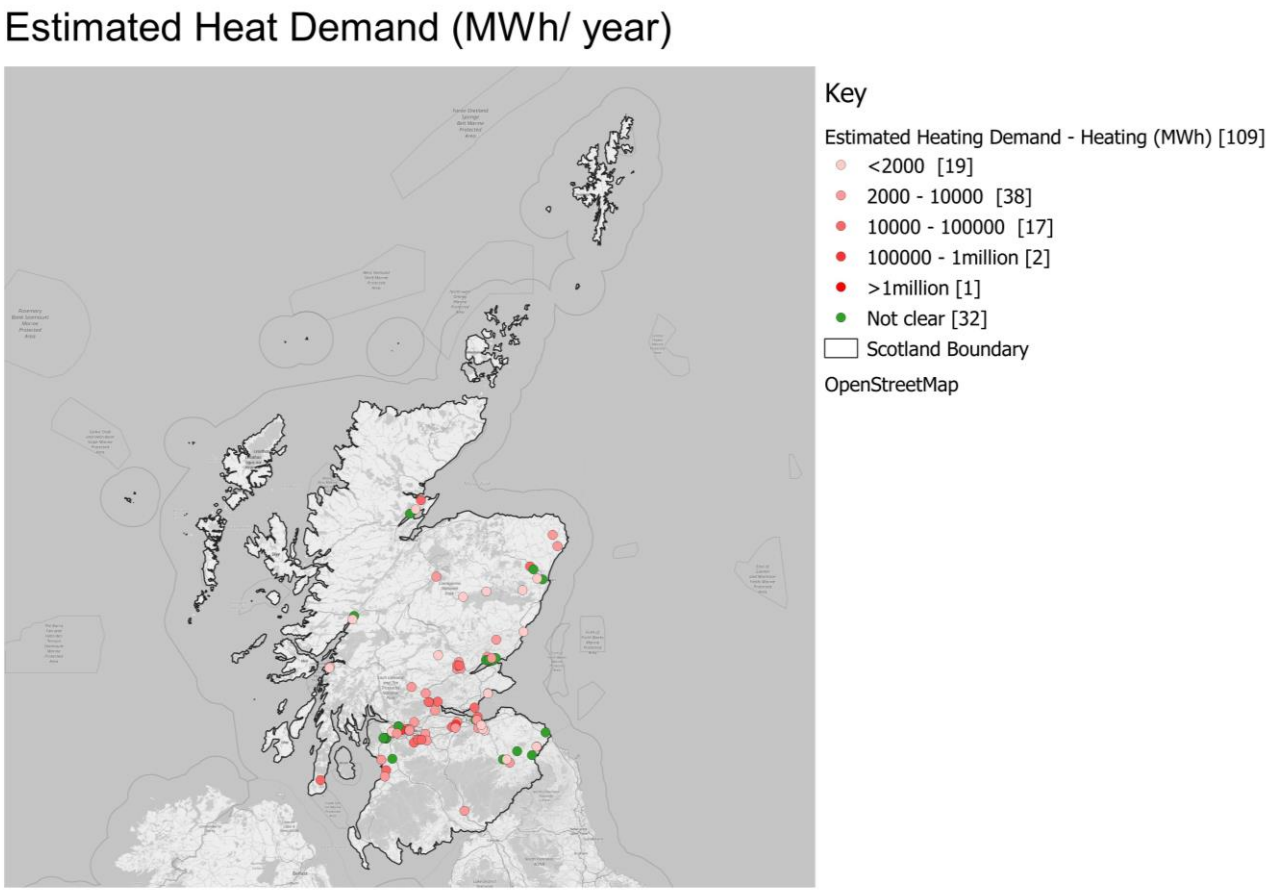

Figure 9 GIS map – estimated network heat demand indicated in each feasibility study

Other key considerations include:

Potential emissions savings:

The potential carbon dioxide (CO_2) emissions reductions identified in feasibility reports were reported in a wide range of timescales and units. Examples include:

- Tonnes of CO_2 reduction over 20 years, and average annual CO_2 reduction;
- Tonnes of CO_2 reduction per £1million capex spend;
- Displaced electricity carbon emission savings per annum (Total CO_2 Kg/annum);
- Annual carbon savings as a percentage reduction compared to 'business-as-usual';
- 40 Year CO_2 equivalent savings in kilo-Tonnes.

As a result of the above variability, we were unable to calculate or analyse emissions savings in significant detail within the constraints of the project timeline and budget.

Costs:

Cost related parameters such as (CAPEX, OPEX and cost savings) were also found to be reported in different formats and many reports did not make costs fully transparent. As a result, we were unable to analyse project costs in significant detail within the constraints of the project timeline and budget.

Approximately 40% of the studies that were examined were produced within the last 3 years and 30% of the studies were published more than 5 years ago. Whilst CAPEX costs may provide a rough indication of the scale of the proposed scheme it should be noted that costs (and/or other costs metrics) presented may be significantly out of date.

4.2.2 Proximity analysis

Analysis was undertaken to assess the proximity of the 109 DH schemes identified in this study to existing district heating schemes operating in Scotland. This analysis enabled us to determine how many of the studied schemes are in close proximity to existing district heating schemes. It should be noted that the existing DH schemes considered in this study came from the Scottish Government's 'Heat Networks Data 2020' database, which includes systems that fall within the Heat Network (Metering and Billing) Regulations 2014 and the Heat Network (Metering and Billing) (Amendment) Regulations 2015 (i.e. they range from relatively small-scale communal heating scheme to larger scale community heating schemes).

Table 2 presents the number of sites that have DH schemes within 250m, 500m and 1km distance.

Table 2 Proximity analysis - total number of studied DH schemes that are in close proximity to existing DH schemes

Total number of studied DH schemes within a 250m distance to existing DH networks	**Total number of studied DH schemes within a 500m distance to existing DH networks**	**Total number of studied DH schemes within a 1km distance to existing DH networks**
46 out of 109 (42%)	62 out of 109 (57%)	87 out of 109 (80%)

The analysis suggests that 87 (out of 109) studied DH schemes have an existing DH network within 1km distance. As shown in Figure 10 (which presents the existing DH networks data (in red) and the studied schemes (in blue)), a large number of DH networks are located in urban areas. The feasibility studies reviewed in this study are also clustered around the urban areas.

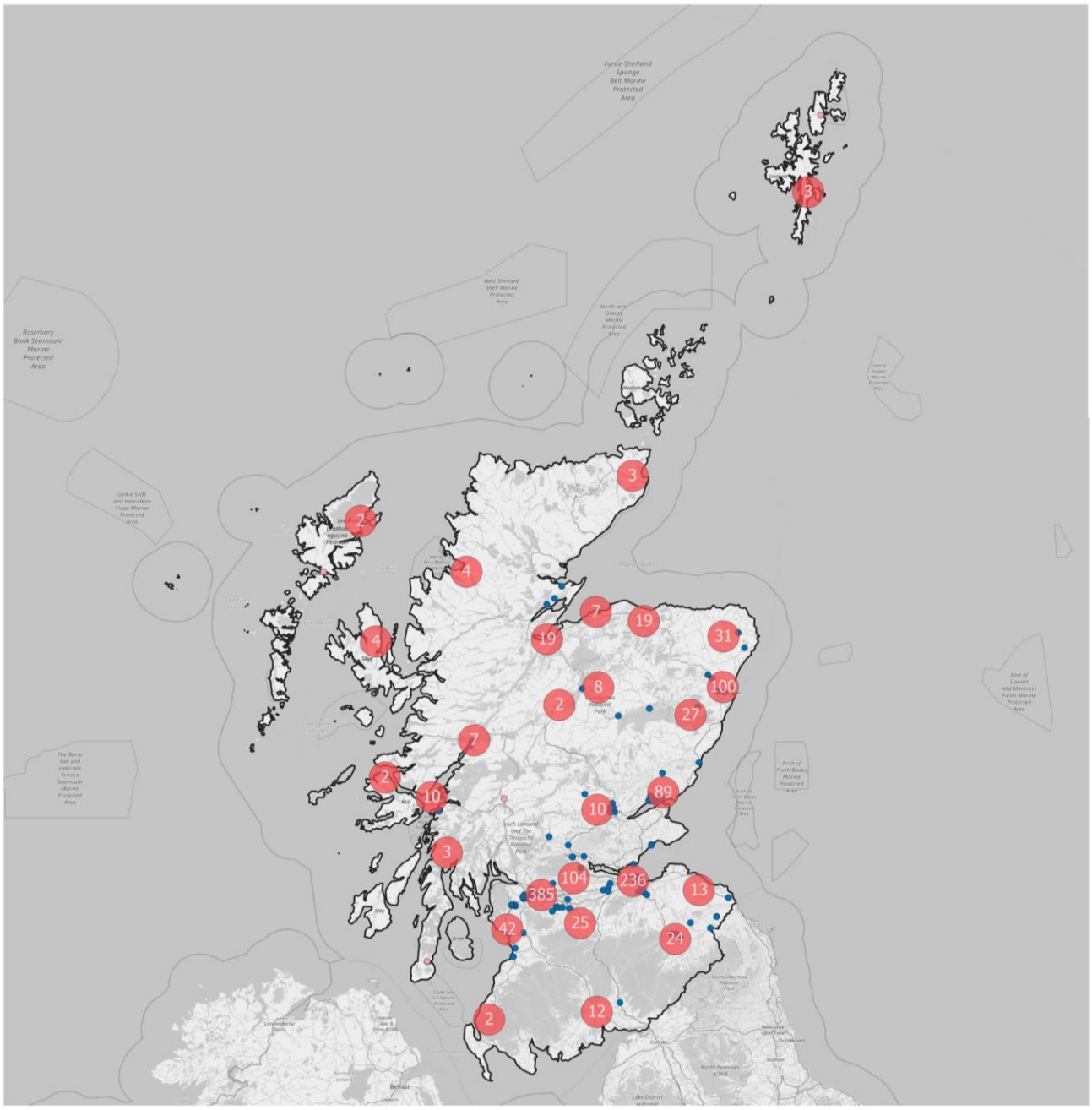

Figure 10 Distribution of existing heat networks (red clusters: total number of existing DH networks, blue dots: locations of the studied DH schemes)

4.3 Interviews with stakeholders

In total eight, 30-minute interviews were conducted with interviewees from Zero Waste Scotland, a UK low carbon promotion organisation, Scottish Future Trust, Scottish Enterprise, Health Facilities Scotland, University of Strathclyde, Stirling Council and Dundee City Council.

4.3.1 Key findings

The barriers that prevented the further development of DH feasibility studies were discussed with the interviewees. The feedback received during the interviews were largely aligned with key issues being highlighted as stakeholder engagement, cost, business case and procurement.

Table 3 presents all the barriers identified by the stakeholders.

Table 3 The key barriers identified via stakeholder interviews

Key Barriers	Key Theme	Interviewee A	Interviewee B	Interviewee C	Interviewee D	Interviewee E	Interviewee F	Interviewee G	Interviewee H
High capital costs and long payback periods.	Cost		x	x	x		x	x	x
High demand risk (as financial viability of DH schemes depends on stability of heat demand).	Cost		x	x	x		x	x	x
Lack of DH technical knowledge and skills in the industry.	Stakeholder engagement		x		x	x	x	x	
Lack of realistic business cases and delivery/procurement models.	Business case/Procurement	x				x	x	x	x
Lack of investment interest and lack of investor involvement in the process.	Business case/Procurement		x	x			x	x	
Lack of stakeholder and consumer awareness, lack of stakeholder buy-in.	Stakeholder engagement	x			x		x	x	
Lack of good quality feasibility studies - The quality of feasibility studies varies significantly. Most studies require further detailed information before deciding.	Quality			x		x	x		
Lack of certainty of funding initiatives and March 2021 deadline for RHI scheme.	Business case/Procurement		x				x	x	
Lack of project risk assessment and stakeholder reluctance to take on risk.	Business case/Procurement					x	x	x	
Geographical and site-specific constraints limit the number of DH opportunities (such as contamination, railways, etc).	Technical	x					x		x
Competition against gas-based heating is difficult. Gas prices are lower than DH.	Cost		x		x				x
The DH project development process is lengthy - requires a long time, and therefore, transaction costs are high.	Cost			x	x				
Difficulty of working with a range of stakeholders due to multidisciplinary nature of DH projects.	Stakeholder engagement			x			x		
Lack of strategic and integrated approach. Most projects tend to implement an organisation-based approach where they follow their own individual goals and targets, resulting in poor collaboration and strategy.	Policy/Regulations			x			x		
Lack of regulations associated with DH causing insufficient clarity for the future of DH.	Policy/Regulations			x					
Lack of ability for LAs to initiate large scale DH projects due to high capital cost.	Cost	x						x	
Building stock is not ready for DH adaptation (in terms of implementing the required energy efficiency measures). This requires high capital cost.	Technical		x						
Complications due to land ownership - undertaking rights.	Business case/Procurement				x				

Misleading information provided in feasibility studies due to conflict of interest of contractors, reducing the reliability of feasibility studies.	Business case/Procurement						x		
Lack of certainty that public buildings will be able to be connected in future with sell-off of LA estate.	Business case/Procurement				x				
Lack of awareness of existing specialist DH advisory / support schemes.	Business case/Procurement				x				

4.3.2 Suggestions to overcoming barriers

The interviewees provided their suggestions and opinions on how to best overcome the barriers preventing the deployment of DH schemes in Scotland. The key suggestions can be summarised as:

- Developing technical skills in the industry is essential in order to not only improve the quality and reliability of feasibility and design studies, but to also ensure successful delivery and operation of DH schemes. Feedback suggested that this would involve training DH consultants, design teams, contractors and system operators.
- Financial support for feasibility and procurement could enable the delivery of more DH schemes. The lack of capital investment and long payback periods are the key barriers reducing the uptake of DH developments. Feedback suggested that there is a need for additional and innovative funding mechanisms that could enable the DH sector to compete against low-cost heating technologies and attract more investors. Tax reliefs or similar initiatives were noted as ways of potentially providing benefits to DH developers and local authorities.
- Developing sound business and procurement models in a timely and efficient manner and implementing a cross-sectional approach were suggested as being essential for the successful delivery of DH projects. Feedback suggested that feasibility studies that lack clear business models fail to provide value for stakeholders.
- Feedback suggested that there is a need to increase stakeholder and consumer awareness. Respondents highlighted that educating consumers and stakeholders on DH technologies and systems, and its potential environmental, societal and financial benefits could attract more stakeholders.
- Respondents suggested that implementing a more integrated and strategic approach could increase stakeholder interest and create more business opportunities for the DH sector. It was highlighted that it is highly important to acknowledge the multi-disciplinary nature of DH projects and provide more strategic and overarching guidance to the industry, addressing all the key aspects: energy efficiency, land use/ownership, transport, planning and so on.

4.3.3 Potential impact of Covid-19 on DH sector

Upon the request of Scottish Government, we gathered additional feedback from the interviewees on the (at the time) emerging Covid-19 risks and their current and potential impact on the DH industry. Opinions and suggestions regarding Covid-19 varied significantly. Key feedback was as follows:

- A large percentage of stakeholders mentioned that the Covid-19 situation was likely to reduce the DH investment opportunities as other essential service sectors (such as healthcare, food, retail, etc) would likely get prioritised over the DH sector. Due to the Covid-19 business restrictions (such as social distancing on sites) and related financial risks, some DH projects and related work have been put on hold.

- A small percentage of stakeholders indicated that the impact of Covid-19 in the industry has not been very significant so far and that their on-going projects have not been impacted by the Covid-19 situation.
- A small percentage of stakeholders indicated that it was not possible to fully assess the potential impacts of the Covid-19 as it was too early to observe changes in the DH sector.

4.4 Limitations and uncertainties during the work

Not all organisations contacted were able to respond to requests for data. For example, in many instances the ongoing Covid-19 situation meant that many Scottish Local Authorities contacts had been reassigned to deal with the ongoing situation and did not have the time available to meaningfully input to the project. Similarly, the Registered Social Landlord sector was also heavily impacted by the pandemic and thus there was only limited engagement over the course of the project.

Given that many DH feasibility studies were deemed to be commercially sensitive it meant that many reports could not be obtained for analysis.

The variable quality, format and content of the DH feasibility reports meant that it was not always possible to extract comparable data/information from every report. Furthermore, where information was unclear, these data points have been recorded as ‘unclear’ within the Excel spreadsheet.

5 Conclusions and recommendations

5.1 Conclusions

The following conclusions are drawn:

- The study collated a total of 44 feasibility reports consisting of 76 DH schemes. In addition to this, 33 DH schemes (coming from the LCH database) were included in our study.
- The structure, level of detail calculation methodologies used, and the content of the feasibility reports significantly varied.
- Feedback, obtained from stakeholders during semi-structured interviews, highlighted the following key barriers as restricting the development of DH schemes in Scotland:
    - High capital costs and long payback periods of DH projects
    - High demand risk (payback period being dependent on consumer demand)
    - Lack of DH technical knowledge and skills in the industry
    - Lack of investment interest and lack of investor involvement in the process
    - Lack of realistic business cases and delivery/procurement models
    - Lack of stakeholder and consumer awareness and lack of stakeholder buy-in
- Stakeholder opinions about the potential impact of Covid-19 on the DH sector, and their suggestions as to how these impacts could potentially be overcome varied significantly. The current, and anticipated future, impact of Covid-19 in the DH sector was therefore unclear as organisational mitigation and coping strategies are likely to vary in the short term.

5.2 Recommendations

The Scottish Government may wish to consider carrying out further research on financial and technical shortcomings of existing DH networks feasibility projects. This in turn could provide the opportunity to validate the key findings of this report.

Stakeholders may wish to consider investigating ways in which DH feasibility studies (e.g. particularly those studies that receive Government support) can be analysed and reported in a consistent manner to enable a greater level of cross-comparison between schemes. Some potential areas for improvement could include aspects such as producing guidance on standardised feasibility report formats, methodologies for calculating and presenting information on key energy, heat, carbon savings and/or financial metrics and building upon existing research and policy (i.e. Local Heat and Energy Efficiency Strategies).

climateXchange

Scotland's centre of expertise connecting climate change research and policy

info@climatexchange.org.uk
+44(0)131 651 4783
@climatexchange_
www.climatexchange.org.uk

ClimateXChange, Edinburgh Centre for Carbon Innovation, High School Yards, Edinburgh EH1 1LZ

6 Appendix A – Interview guide

Introduction

- Opening pre-amble to introduce the research and to provide information on the interview process and treatment of data etc.
- Note: The primary focus of the interviews is to get the interviewees thoughts on the key factors influencing whether, or not, projects proceed once initial feasibility work has been carried out.
- Answers should be based on the interviewees own experience, based on projects that they have had direct involvement in.

Question Guide

1. By way of introduction / for background context, please briefly tell us about the type of DH feasibility studies that you have experience in, e.g.
    - What type of DH projects?
    - What has been your role in the studies / projects?
    - Are the feasibility studies that you have experience with been public or privately funded? Are they typically solely public, solely private, or mixed-use schemes, etc.?
    - Other background to help understand the nature of the interviewee's DH feasibility study to investment stage exposure.
2. Considering DH feasibility studies that you have had direct involvement with (in say the last 0 to 3-5 years);
    - What number of feasibility studies have you had experience in / knowledge of? (approximately)
    - What percentage of these studies have progressed (or are highly likely to proceed) to investment stage (approximately)?
3. Considering the same project and timeline, can you please explain what you think are the main reasons that schemes have / have not progressed to investment?
    - Do the reasons differ significantly, scheme to scheme?
    - In your experience, which of these factors 'always' apply, 'sometimes' apply?
    - If the reasons differ significantly, what scheme-specific variables drive the difference? i.e. in your opinion are there common barriers affecting specific scheme types (e.g. multi-residential, mixed used commercial), designs (main fuel or technology types, etc.) locations (urban, rural, standalone scheme vs. connection to existing DH network, etc.), etc. and, if so, what are they?
4. What do you think are the top 2 or 3 barriers restricting development of DH schemes in Scotland as of today / the near future?
5. What do you think could be done to help overcome each of these top 2 or 3 barriers?
6. How do you see Covid-19 affecting the pipeline of DH projects in Scotland e.g. will it significantly impact / hinder development?
    - If so, what could be done to limit the impact?
7. Any final thoughts / opinions?