Department of Energy & Climate Change

Low Carbon Pioneer Cities Heat Networks Project: a process evaluation

January 2015

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URN 15D/441

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Glossary of acronyms

DECC	Department of Energy and Climate Change
GIB	Green Investment Bank
HNDU	Heat Networks Delivery Unit
LA	Local Authority

Executive summary

Introduction

The Low Carbon Pioneer Cities Heat Networks project began in March 2013 with the intention of supporting five of England's core cities (two city regions and three unitary authorities) to move towards the deployment of low carbon heat networks. The following authorities took part in the initiative: Leeds City Region, Greater Manchester (city region), Newcastle, Nottingham and Sheffield. The project comprised grant funding to cover the costs of feasibility work to investigate the potential for heat networks in each area. The project also entailed giving cities some access to light touch support from experts and policy officials within the Department of Energy and Climate Change (DECC). Each local authority had different objectives and milestones according to their context, which were agreed with DECC.

The project sought to directly address barriers around skills and funding; however, observed (and responded to where possible) other issues emerging once Local Authorities (LAs) had the resources and skills to progress projects. Learning about these points fed into the development of the Heat Networks Delivery Unit (HNDU) scheme, and considered an important part of the pioneer cities scheme.

About the evaluation

In October 2013, Sheffield Hallam University was commissioned to conduct a process evaluation of the Low Carbon Pioneer Cities Project. The evaluation was underpinned by four aims, as follows:

1. Investigate the extent to which the project helped LAs to overcome barriers to developing low carbon heat networks.
    a) How far have the five cities progressed?
    b) Which elements of the project itself worked well and which worked less well?
2. At the city level, which practices have worked well or less well?
3. Understand the local context that has driven (and affects) the development of heat networks.
4. Identify and clarify specific decision making processes at a local level.

The qualitative research involved 86 semi-structured in-depth interviews with relevant local authority officers and other key stakeholders from each of the five cities over three rounds of fieldwork. This enabled the evaluation team to track projects as they were implemented, and better understand issues over the project lifetime.

Findings

Findings from the evaluation are structured around a series of themes derived from the evaluation aims and research questions, including:

- motivations for taking part in the pioneer cities project
- the extent to which the project has succeeded in overcoming the two key barriers to early stage heat network development it was intended to target

- other barriers emerging, and key learning about local practice
- dynamics around using low carbon sources to fuel heat networks
- future plans

What motivated the cities to take part in the project?

All of the cities involved in the Low Carbon Pioneer Cities Project had made commitments in their climate change strategy action plans for the delivery of low carbon, affordable heat solutions which included exploring the development of heat networks. They were attracted to the Low Carbon Pioneer Cities Project as an opportunity to fund and initiate new heat network projects.

The development of heat networks was also viewed as a way of addressing issues around security of energy supply, reduction of fuel poverty, economic development and the creation of a potential revenue stream.

All of the cities reported struggling to identify sources of funding to initiate new heat networks projects. The receipt of grant funding through the project was therefore welcomed.

To what extent has the project succeeded in overcoming the barriers to early stage heat networks development that it was intended to address?

The available evidence suggests that, overall, the project has been successful in helping the cities to overcome the two key barriers it set out to address: lack of funding to conduct feasibility studies and lack of capability. The absence of funding to enable the cities to conduct feasibility studies was addressed through the provision of grant funding and three of the cities felt that they would not have been able to source this funding from elsewhere. Others felt they may have been able to source funding from elsewhere but that it would have taken longer to acquire and that the amount secured may have been insufficient.

In terms of addressing barriers around skills, whilst there is evidence of notable 'up skilling' across the cities as a result of the project, the knowledge and skills gained are neither comprehensive nor necessarily permanent in the face of predicted staff reductions.

Other barriers emerging and key learning about local practices

Having provided support to allow LAs to overcome skills and funding barriers, other challenges and learning emerged in local areas (considered to be an important aspect of the pilot project).

As such, the research also explored several areas of cities' practice in relation to heat networks development and identified additional barriers to progression, and learning for other cities in key areas. These barriers and areas of learning overlap, and are therefore grouped together in themes, below.

- **Gaining leadership and senior officer and political support:** Galvanising senior officer and elected member support and approval was considered crucial to the progression of plans for heat networks development. The project was felt to help overcome this potential barrier through the provision of a robust evidence base (in the form of the feasibility studies).This provided senior managers and elected members with a clear and independent account of the feasibility of heat networks proposals, enabling informed decision making. In two cases, the funding made available through the project helped fund project managers to champion the project and engender the support of senior decision makers.
- **The importance of governance structures:** Participation in the project has also prompted the cities to consider what governance structures should be in place to enable heat networks development - this was highlighted as a learning point by participants.

- **Obtaining data from potential customers and suppliers on heat use and supply:** All five cities have experienced difficulties obtaining data from potential customers and suppliers on heat use and supply. This is for a variety of reasons that are beyond the control of the project and of DECC, resulting in the scaling back of proposals in two cases. All cities felt that this challenge would continue to cause difficulties as the projects progressed towards detailed business plans.
- **Identifying funding for capital costs:** None of the cities had yet reached the capital development stage. The evidence suggests that although the project has stimulated thinking about potential sources of funding for capital works, the firm identification of funding sources remained an issue for the future.
- **Identifying suitable consultancies:** Although all five cities managed to appoint suitable consultants to conduct feasibility studies on their behalf, three of the five cities were frustrated at the lack of choice of suitable consultants and had not received the number of strong submissions they had anticipated.

  A small number of large multinational companies appear to dominate the consultancy market with two such organisations becoming the lead consultants in four of five cities. Officers across the five cities also agreed that the release of multiple contracts to the market in close succession can create capacity issues even amongst large consultancies. Discussions with consultants revealed that under these conditions, consultants may become selective about the contracts they take on.
- **Engaging stakeholders:** All LA officers interviewed felt that effective internal and external stakeholder engagement was critical to the successful delivery of the project. Views differed amongst LAs as to who was best placed to lead on the engagement of external stakeholders, depending on trust and time availability. Largely due to time constraints amongst LA officers, consultants led on external stakeholder engagement in three of the five cities with mixed results. However, both parties generally advocated a more collaborative approach between consultants and LAs.
- **Officer time:** Officers across the cities confirmed that their time was increasingly constrained in light of budget cuts and associated staff reductions. The project made two key contributions to the alleviation of these time pressures. First, through the provision of funding to commission consultants to conduct feasibility studies and second, by funding dedicated project managers in two authorities, both of whom had all or a proportion of their time set aside for overseeing the project. However, time to support and manage consultants was constrained where project managers were not in place.

Factors affecting financial viability

Through this project, LA officers and consultants identified a range of factors impacting on the financial viability of heat networks, some of which are already well known, including:

- the need to have a high concentration of heat loads in close proximity to the heat source
- cost of the fuel source in both the short and long term
- the price charged to the customer (how competitive it is compared to other sources?)
- subsidies available (e.g. Renewable Heat Incentive)
- scope to generate and sell electricity as well as heat (private wire or to the grid)
- construction costs (including laying pipework)
- the rate of return

Progress towards low carbon sources; and dynamics that may affect this

This section explores the drivers of the adoption of **low carbon sources** to fuel heat networks, how far the cities have progressed towards the utilisation of these sources and associated challenges. Key findings include:

- All five cities were committed to the principle of using low carbon sources and some were already using heat from waste to fuel existing networks. This was driven by strategic commitments to carbon reduction and to some extent, pressure from existing or prospective large institutional customers.
- However, due to uncertainties surrounding more innovative fuel sources, those cities that had not already identified heat from waste as their main fuel source were likely to opt to use gas or gas CHP at least until other low sources become more viable.
- LAs had to balance their carbon reduction ambitions against the need to ensure that heat prices are as attractive as possible to prospective customers.

The utilisation of low carbon sources was more easily achievable for those with access to an existing heat from waste facility. Three of the five cities were using existing heat from waste facilities as their main or one of a number of heat sources.

Next steps and future challenges

A number of key challenges lay ahead as the cities progress further towards deployment. The most immediate being to establish whether the proposed schemes to emerge from the project were viable enough to take forward to capital development. If further feasibility work establishes viability then a full business case needs to be developed and funding secured. Whilst this process is playing out, all of the LAs expected to continue to grapple with reduced budgets and staff losses, which could destabilise plans.

When reflecting on the role the LAs intended to play once networks were constructed, it was widely felt by local authority officers that LAs are well placed to facilitate and/or deliver the installation of heat networks, and most were eager to own or part own the physical infrastructure. However, whilst two cities aspired to maintain involvement in every aspect of the network (infrastructure, management and supply) there was no appetite amongst the other three for playing this role, mainly due to budgetary and resource constraints, lack of expertise, fear of reputational risks if problems occurred and concerns that they would undermine competition by becoming heat suppliers.

In terms of future support needs of the cities beyond the project, LAs identified the following areas: support from DECC in encouraging the expansion of the UK heat networks consultancy sector; promoting stability in the market; fostering confidence in heat networks as an investment opportunity; and improving awareness of the benefits of heat networks amongst businesses and the public. The cities also widely felt they would need continued access to expert advice beyond the lifetime of the pioneer cities project.

1. Introduction

Sheffield Hallam University was commissioned by the Department of Energy and Climate Change (DECC) to conduct a process evaluation of the Low Carbon Pioneer Cities Heat Networks project - an initiative intended to support five of England's core cities (two city regions and three unitary authorities) to move towards the deployment of low carbon heat networks. The following authorities took part in the initiative: Leeds City Region, Greater Manchester (city region), Newcastle, Nottingham and Sheffield.

The project involved the allocation of grant funding to the five cities to support the early stage planning and development of low carbon heat networks. This funding could be used flexibly by the cities but was generally used to fund independent consultants to produce feasibility studies. Some cities utilised a proportion of this funding to cover the costs of project management posts to oversee the delivery of the project. In addition to the grant funding, officers within DECC also provided 'in kind' support in the form of expert advice and guidance to the cities.

The project sought to directly address barriers around skills and funding; however, observed (and responded to where possible) other issues emerging once local authorities (LAs) had the resources and skills to progress projects. Learning about these points was fed into the development of the Heat Networks Delivery Unit (HNDU) scheme, and considered an important part of the Pioneer Cities scheme.

1.1 Background: Heat networks in the UK

Heat networks have been identified by the UK government as an important part of the UK's future low carbon energy supply.

Governmental commitment to heat networks stems from a recognition of their many benefits. They are well suited to densely populated areas and can reduce carbon emissions when deployed in these environments (DUKES, 2012). A further benefit of heat networks is that they can be powered using a variety of fuels, including lower carbon sources such as biomass and energy from waste. Heat networks are also attractive due to their cost-effectiveness and viability compared to individual renewable technologies and their potential to reduce energy costs for consumers (DECC, 2012a, 2012b; Poyry, 2009; Lund *et al*., 2010).

In spite of these benefits, heat networks remain rare within the UK, providing just 2 per cent of UK heat demand (DECC, 2012c), when The National Carbon Delivery Plan (DECC, 2011) states that up to 14 per cent of our heat demand could be met in this way. There are various historical, technical, financial and organisational reasons for this low provision. It is within this context that the Pioneer Cities project was launched, with the aim of starting to address key barriers that occur during the early stages of heat network development.

1.2 Barriers to heat network development

A number of studies have established a range of systemic and practical challenges that LAs face in developing heat networks in the UK (see for example: Ambrose, 2014; DECC, 2013; Heat and the City, 2012; Kelly and Pollitt, 2010). Extracting from these, four key themes emerge, all of which have been affirmed by the evaluation:

1. **Substantial project development costs**. Costs, in addition to capital costs, may include: preparing feasibility studies, attracting finance, master planning and legal advice. At this stage there is high uncertainty over project viability, meaning it is hard to secure investment.
2. **Internal skills and expertise necessary to deliver projects**, especially in the absence of 'off-the-shelf' approaches or established procedures, or a sufficiently established group of authorities within the UK from which to generate learning. Many authorities have little or no experience of heat network development.
3. **Financing or facilitating finance for capital costs** for the implementation of heat networks is a central challenge, particularly in the context of reduced LA budgets.
4. **Little direct ownership over existing energy infrastructure.** In some cases, the ownership and on-going responsibility for existing heat networks has been transferred from LAs to private sector bodies resulting in a loss of control.

The project sought to help barriers 1 and 2 above (issues related to initiating the development of heat networks).

1.3 Research design

The process evaluation began in October 2013 and concluded fieldwork in October 2014. The evaluation was underpinned by four aims, as follows:

1. Investigate the extent to which the project helped LAs to overcome barriers to developing low-carbon heat networks.
    a. How far have the five cities progressed?
    b. Which elements of the project itself worked well and which worked less well?
2. At the city level, which practices have worked well or less well?
3. Understand the local context which has driven and affects the development of heat networks.
4. Identify and clarify specific decision making processes at a local level.

1.4 Structure of the report

This report is structured around a series of themes derived from a combination of the research aims above and the more detailed research questions (see Appendix 1) that have guided the evaluation. As such, the structure presented in this report is as follows:

- cities' motivations for taking part in the pioneer cities project;
- how far the project has succeeded in overcoming two key barriers to early stage heat network development;
- the use of low carbon sources to fuel heat networks;
- other barriers emerging, and key learning about local practice;
- next steps and challenges.

A qualitative approach was taken to the evaluation - a total of 86 in depth interviews (majority face to face) were conducted with the project leads[1] and other key stakeholders from each of the five cities. Interviews generally lasted between 45 and 90 minutes. Interviews were undertaken over a series of rounds (5-6 interviews conducted in each city per phase) between November 2013 to October 2014, to track projects as they were implemented, and better understand issues over the project lifetime. Each member of the research team was allocated as a 'case study lead' to one of the five cities. This enabled them to build a rapport with key stakeholders within the city and a detailed understanding of the project and the local context in which it was delivered.

Respondents for the first round of interviews were selected in order to achieve a diversity of perspectives on the project and to better understand the broader context within each city, including progress with project delivery and any challenges encountered to date. As a result of the diverse natures of the five projects, a different set of stakeholders were interviewed in each city. The project leads and project sponsors[2] (usually a senior LA officer) were interviewed in each city at each stage due to their roles as coordinators of the projects.

Other interviewees were identified (usually in conjunction with the lead officer) at the outset of each round in order to enable the best insights into particular issues and barriers pertinent to the project at that point in time. For example, during round 1, the agreement or otherwise of potential (commercial and public sector) customers to provide data on heat use to consultants and later to agree to connect to existing or potential future networks was identified as being critical to project success. Interviewees in round two therefore included potential customers of the network. Similarly, as projects came to an end, political approval from the relevant LA cabinet was identified by those leading the projects within the LA as being key to the onward progression of plans and proposals to emerge from the project; hence cabinet members were interviewed where possible during round three. Usually, the project lead was able to put the research team in touch with the relevant individuals. A list of the respondents interviewed cannot be provided for reasons of confidentiality.

Interviews were based around semi-structured topic guides developed to directly address the research questions and were reviewed, revised and approved by DECC ahead of each of the three rounds of interviews. Separate topic guides were prepared to guide interviews with particular groups of stakeholders, such as consultants, potential customers and elected members.

In addition to the 86 interviews with stakeholders across the five cities, interviews were also conducted with 'project level stakeholders' (civil servants) who played a key role in the design, delivery and management of the Low Carbon Pioneer Cities Project. The main aim of these interviews was to help the research team to gain a more detailed understanding of the origins of the project, its high level aims, perceptions of its strengths and weaknesses and the support available to LAs beyond the lifetime of the project.

All interviews were professionally transcribed verbatim and the data coded using NVivo software[3] to ensure rigour and enable both geographical and thematic analysis of data. The former involved looking in detail at the experiences of individual cities across the full range of themes determined by the research questions (see Appendix 1). The latter involved comparing and contrasting data relating to the same key themes across the five cities and enabled the research team to explain differences in outcomes between them.

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[1] Officers nominated to lead the project within each city or city region.
[2] Senior LA officers with overall responsibility for project delivery.
[3] A platform for the analysis of unstructured data.

1.5 Limitations

The findings from this report are based on a small number of LAs and may not reflect the diversity of authorities (and their experiences) in England and Wales. As 'pioneer cities', the five cities included in this study are not typical of other towns and cities around the country in terms of their ability to develop heat networks projects i.e. they already have heat networks in place or have made strategic commitments to their development. Whilst interviewees comprised a range of stakeholders at the LA level (to provide further depth and insight into the experience of low carbon heat networks), we are aware that their views may not be representative of all those involved in that particular heat network's development process.

Findings

2. Motivations for participating in the project

All of the cities involved in the Low Carbon Pioneer Cities Project had made commitments in their climate change strategy action plans to the delivery of low carbon, affordable heat solutions, which included exploring the development of heat networks. They were attracted to the Low Carbon Pioneer Cities Project as an opportunity to fund and initiate new heat network projects.

The development of heat networks was also viewed as a way of addressing issues around security of energy supply, reduction of fuel poverty, economic development and the creation of a potential revenue stream.

Struggling to identify sources of funding to initiate new heat networks projects was reported by all of the cities. The receipt of grant funding through the project was therefore welcomed.

2.1 Aims of participation

The Low Carbon Pioneer Cities Project was designed to support LAs through the early stages of heat network development. As Table 1 illustrates, all of the cities, with the exception of Sheffield, strived to achieve similar objectives from the project, aiming, as a minimum, to conduct feasibility work for the development and/or expansion of heat networks.

Table 1: Main aims of participation

City	Main aim of participation
Leeds City Region	Develop a robust evidence base which allows for identification of opportunities for heat network development on which to conduct detailed feasibility.
	Develop technically and financially feasible schemes in Leeds city centre and Huddersfield town centre and develop business cases.
Greater Manchester	Develop a plan to enable delivery of Greater Manchester Climate Change Strategy through implementation of low carbon and district heating projects.
Newcastle	Develop a technically and financially feasible scheme that is ready to go to procurement.
Nottingham	Develop business cases for expansion of existing network and development of new networks.
Sheffield	Identify solutions to issues of governance and ownership to enable consolidation of existing and planned networks.

The table in Appendix 2 lists the strategies and policies in place within each city which promote the deployment of heat networks. Common themes across these strategies is an

acknowledgement of the wide ranging expected benefits of heat networks, including carbon reduction, security of energy supply (particularly where electricity is also generated through combined heat and power), reducing fuel poverty, economic development and competitiveness and a potential revenue stream for LAs. The breadth of expected benefits associated with heat networks and their ability to help address multiple agendas of importance to LAs was cited in all of the five cities as the primary reason for strategic commitments to the promotion of heat networks.

"We recognise links between waste management, security of [energy] supply, the move towards a low carbon energy infrastructure and economic development. So strategically the fit was perfect." (LA Officer)

“Heat networks can address a range of issues, it's not just about making a return on investment, it's also about job creation, alleviation of fuel poverty, attracting inward investment and so on.” (LA Officer)

“We have concerns around increasing fuel poverty and the ability of the city to be able to reduce the escalation of energy bills for economic purposes, so part of what we're trying to do is ensure businesses as well as households are incentivised to invest in the city because the energy supply is secure and less expensive than elsewhere." (LA Officer)

2.2 Why did cities take part in the Low Carbon Heat Networks Project?

A range of factors were driving the pursuit of low carbon heat sources amongst the cities, including:

- existing heat networks were already in place and there was an aspiration to expand them (this was the case in two cities)
- cities have an existing source of low carbon heat that is not being utilised (i.e. a waste incineration plant not currently supplying a heat network)
- existing strategic commitments to carbon reduction, and
- pressure from some existing and potential customers (notably large institutions such as universities, colleges and hospitals) to ensure their heat is generated from low carbon sources in order for them to meet their own carbon reduction targets.

Having existing sources of low carbon heat within a city was an obvious advantage in terms of utilising low carbon sources from the outset. Four of the five cities have the potential to use heat from waste to fuel their proposed networks. Two of the five cities already supplied existing networks with heat from heat from waste plants and in both cases, the plants had sufficient capacity left to fuel new networks or network extensions. In another city the development of a heat network had been driven by the existence of an underutilised source of heat from waste.

As outlined previously, existing strategic commitments to carbon reduction and associated targets within the cities were also key drivers of low carbon heat networks, encouraging cities to strive harder to identify possible sources or at least to make their networks low carbon source 'ready'.

"Driving progress, we've got strategies, we've got a carbon target and we have the ability and the will to decarbonise our heat generation" (LA Officer).

There was also evidence across three of the cities of pressure from large public institutions (colleges, universities or hospitals) to ensure that heat networks were fuelled by low carbon sources in order to meet their own carbon reduction targets.

“The council's listening to the customers, so what we were hearing was they want lower carbon heat because the higher education sector's now got carbon targets which they are seeking to hit, so the drivers in that sector were greater than perhaps the drivers in other commercial and residential sectors and that's been quite important.” (LA Officer)

Although low carbon sources were important to both LAs and other institutions with commitments to carbon reduction, it was equally clear that heat costs remained the key factor determining whether a potential customer was likely to connect to the network or not. LAs therefore needed to balance their aspirations to use low carbon sources against the need to keep prices low.

"These projects […] offer lower cost energy and energy security to businesses and homes in the region. They’re probably the key drivers over the low carbon drivers, although they are important as well." (Project Sponsor)

3. Effectiveness of the project in overcoming barriers to the development of low carbon heat networks

This section considers the extent to which participation in the project has helped the cities overcome barriers directly targeted by the project. However, as outlined later in this report, it is recognised that as the LAs proceeded with developing heat networks, other barriers emerged, which the project interacted with in varying ways. These other barriers and learning around these issues are also discussed in this section of the report.

The available evidence suggests that, overall; the project has been successful in helping the cities to overcome the two key barriers it set out to address – funding feasibility work and skills development – in the short term. However, the extent to which these barriers have been overcome in the longer term is uncertain. A range of additional barriers were identified, including obtaining data on heat usage, heat supply and technical information on buildings; inappropriate governance structures; leadership; absence of strategic commitments to low carbon heat networks; identifying funding to cover capital costs; the financial viability of heat networks; and accessing suitable consultancy services.

3.1 Barriers to progress towards low carbon heat networks

As the following table illustrates, the project was designed to directly address two of the main barriers faced by LAs through the provision of funding and expert advice. However, as outlined later in this report, it is recognised that as the LAs proceeded with developing heat networks, other barriers emerged, which the project interacted with in varying ways.

3.2 To what extent has participation helped the cities overcome the barriers directly targeted by the project?

3.2.1 Funding early stage development work

Local authority officers and elected members within three of the five cities reported that they had been struggling to locate funding for the development of new heat networks - without this funding, some of their initial work around heat networks would not have been possible.

“This project has totally, 100% helped us move on with our aspirations to develop new networks. Undoubtedly we would not be as advanced as we are without the initial funding for the feasibility studies for instance.” (Elected member)

“It's been absolutely critical, without it we wouldn’t be anywhere near this stage. We wouldn't have a pipeline of potential projects; we wouldn’t have feasibility studies and business cases." (Project Lead).

The other two cities felt that although they may have been able to fund this work without the grant funding (either through internal funding or by borrowing), the funding package would have taken much longer to assemble and the amount raised would probably have been less.

"We were going to do this piece of work anyway but took advantage of the funding because I would probably have had to fight for it." (LA Officer)

“I think we'd have probably got to the stage that we're at now but it would have taken a considerably longer period of time, certainly the [amount] that we got would have been very difficult to come by given the cuts.” (LA Officer)

However, in both of these cases, LA officers explained how having a larger amount of money available than they would have been able to raise through other channels had enabled them to be more ambitious in their aspirations, such as investigating possibilities for more extensive networks or a larger number of small heat networks. For example, greater funding at their disposal led one city to widen their search across the city region, identifying 54 potential schemes for further investigation.

"I think [the LA] was getting itself into a position where it was going to be able to find some funding potentially for feasibility but what the DECC funding has enabled us to do is build a much bigger programme. Without the funding this might not have been possible." (LA Officer)

3.2.2 Developing capability

In addition to the provision of grant funding, the cities also benefitted from access to experts from DECC and the Green Investment Bank (GIB), as part of the pioneer cities project. This 'in-kind' support was made available to the project in recognition of the fact that the development of heat networks was a complex area and that previous research had identified lack of technical and commercial expertise as a problem in commissioning, interpreting and using feasibility studies.

Several LAs admitted that a lack of knowledge and expertise in the development of heat networks was a particular barrier for them: "If somebody has the range of skill sets and ability to deliver this sort of technical feasibility work and then translate it into a procurement programme and project manage that procurement they're not likely to be working in a LA." (Project Sponsor)

“I'd say there was a barrier in terms of having the right level of technical and commercial expertise to really know what the feasibility studies and business cases were about." (Project Lead)

This access to experts was felt by several of the cities to enable them to become more informed clients, and be able to engage more knowledgeably with consultants. One LA officer commented that DECC had helped with developing the brief issued to consultants, ensuring that they got what they needed from the commission.

The involvement we've had with DECC has helped us shape the brief that we put out to consultants, so that what would come back would be useful to us in helping our decision making commercially.” (LA Officer)

Particular individuals from HNDU and, to a lesser extent, GIB were repeatedly praised by project leads for helping to address gaps in LA expertise.

Key to success here appeared to be the way in which experts from within DECC, HNDU and GIB had gone about advising the cities. This was reportedly done through two key channels: first, through routine monthly teleconferences where relevant experts would be present and through more ad-hoc advice in response to specific issues and queries that arose during the course of the project

Lead officers in three of the five cities commented that they had found the routine contact with DECC (monthly teleconferences) to be encouraging, helpful and supportive (in terms of transforming aspirational thinking into realistic aims), accessible, with open lines of communication, and being able to 'bounce ideas around'. The other two cities did not comment as extensively on the value of this contact and had treated this engagement as more of a

progress monitoring exercise. Across the cities that found this contact particularly useful, several officers commented that they felt reassured by having regular, easy access to expert advice tailored to their particular circumstances, and appreciated the 'open door' policy, whereby the cities could seek support from them as and when it was required.

"DECC have been a revelation in terms of wanting to get involved and having a genuine interest, and employing people like [Officer from DECC] and other leading experts and communicating with the Combined Heat and Power Association and all of the low carbon pioneer cities in helping us shape some of that strategic aspiration and thinking into deliverable outcomes." (LA Officer)

Other, more indirect activities which resulted in increased knowledge amongst LA officers included picking up information from in-depth discussions with technical and commercial consultants and asking consultants to run sessions clarifying various technical aspects of the heat networks development process.

In two of the cities, a proportion of the grant funding was used to fund (or part fund) full time project managers to oversee the delivery of the project. In both cases this represented a way of importing into the authority some of the expertise that was lacking as well as ensuring that project delivery was not merely another task added to the duties of an existing officer. This was felt by those LAs concerned to have been hugely beneficial in terms of giving them access to commercial and technical expertise 'in house', improving the quality of briefs to consultants as well as helping officers and elected members to interpret the findings from the feasibility work.

Overall, there was consensus across the cities that, through these various activities, they had acquired important new knowledge. Despite these benefits, it is not, however, possible to claim that this barrier has been permanently resolved and that problems regarding a lack of expert knowledge of heat networks will not arise again within these authorities. This is primarily because the support and advice provided through DECC, consultants and project managers was project-specific and available for a finite period (unless project manager posts were extended). For example, although the expertise supplied by DECC, HNDU and GIB was appreciated, it tended to respond, on a 'trouble shooting' basis, to project-specific issues and was not intended to equip LAs with a comprehensive skill set. Similarly, project managers were recruited on a temporary basis to support delivery of a specific project and in both cases there was uncertainty as to whether it would be possible to fund these posts in the longer term. If these posts are lost, now the project has ended, much of the knowledge they brought will also be lost leaving those authorities with piecemeal knowledge.

However, in the longer term, three lead officers highlighted the potential roles of the Core Cities group, (heat network sub group) and the CHP and UK District Energy Associations as sources of ongoing support and knowledge exchange.

3.3 Wider learning about the development of heat networks in the five cities

Evidence from the evaluation reveals that – once project development was in progress - LAs experienced a broader range of issues other than early development funding and skills and knowledge in heat networks. In the set of issues discussed in the following section, the interaction of the project with the local area context could either form a barrier to project progression, or create favourable circumstances which facilitated progression. This section reports on the nature of these issues, the degree to which the project appears to have interacted with them, and whether they appear to remain barriers at the end of the project for some LAs.

- **Leadership and senior officer and political support:** Resources made available through the project helped engender senior officer and elected member support by

providing a robust evidence base (feasibility studies) to enable informed decision-making and in two cases, helping to fund project managers to champion the project. However, existing strategic commitments to heat network development were also key in engendering and maintaining this support.

- **Governance structures:** Cities felt they had learnt about the importance of considering, at an early stage, what governance arrangements should be in place once heat networks are constructed. Participation in the project has also highlighted the potential of city regions to lead early stage development of projects in order to embed them in broader strategies and programmes and inject commercial reality.
- **Obtaining data from potential customers and suppliers on heat use and supply:** All five cities have experienced difficulties obtaining data needed from customers or suppliers, for a variety of reasons. In two cases this has resulted in the scaling back of proposals. All cities felt that this challenge would continue to cause difficulties as the projects progressed.
- **Identifying funding for capital costs:** None of the cities had yet reached the capital development stage and they anticipated potential challenges in identifying further funding.
- **Accessing suitable consultancy services:** Three of the five cities felt there was not enough choice of suitable consultants in the UK. There was also a perception that having five cities seeking the same expertise at a similar point in time exacerbated this issue.
- **Issues relating to the financial viability of heat networks:** Almost all of the local authority officials interviewed considered the financial viability of networks as marginal due to the price of competing energy sources and long pay back periods. In spite of this, LAs remained keen to pursue heat networks due to the potential civic benefits.

3.3.1 Leadership and senior officer and political support

The nature of local leadership and senior-level buy in to the project was widely reported by project leads to be a critical factor in maintaining progress with their project and vital in terms of securing the permissions required to advance plans heat networks.

This section explores some of the lessons to emerge from the evaluation regarding:

- the importance of having support for the project amongst the most senior officers and elected members; and
- the importance of having a dedicated project manager operating within a clear strategic and organisational structure to drive projects forward

During the second round of interviews in March/April 2014, project leads in several of the cities commented that a key challenge ahead was securing the support of LA officers' at the most senior level and elected members to take forward proposals to emerge from the project, whether through further feasibility work or applications for capital funding (both requiring funding). In the event, securing these approvals was reportedly relatively straightforward for most LAs, felt to be mainly due to provision of the robust, independent feasibility studies that the project funded. There were also reports across the cities that there was senior level support for

the projects as they enabled the local authority to deliver on their broader policy commitments to carbon reduction and to low carbon heat networks specifically.

These findings underline how the project was valued by LA decision makers as a first step towards realising existing strategic commitments to low carbon heat networks and also how the provision of independent assessments of feasibility had enabled them to make informed decisions. There were, however, some challenges in terms of engendering and maintaining high level support. Reductions in the number of staff, as a result of budget cuts sometimes meant the loss of key senior officers and/or elected members who had previously championed the project:

"The original project sponsor left in May and then we went into a big black hole between May and August when all that [reorganisation and change in political administration] was playing out and it's took me all this time to get some enthusiasm back for it." (Project Lead)

Using some of the available funding to appoint a project manager to oversee project delivery emerged as a key asset in maintaining support for the project at a senior level during time of organisational change. The two authorities that had appointed dedicated project managers felt that the creation of this role had been vitally important in helping to build and sustain the support of senior managers and elected members and maintain impetus during times of flux. The main reason for this appeared to be the fact that a dedicated project manager had the time (and mandate) to invest in building support for the project.

"I suspect if my previous boss hadn't set up this role this [project] would probably have died a death." (Project Lead)

In summary, the evidence suggests that the resources made available through the project were helpful in engendering the support of senior officers and elected members, providing an evidence base (in the form of feasibility studies) to enable informed decision making and in two cases, helping to fund project managers to champion the project and keep it on the agenda of key decision makers during times of upheaval. However, it is equally clear that existing strategic commitments to heat networks development were also key in engendering and maintaining senior level support for the projects.

3.3.2 Governance structures

It was not an explicit objective of the project to address governance arrangements for the exploration, delivery and management of heat networks. However, it was apparent that LAs have learnt a number of lessons through participation in the project as to how governance arrangements can impact on progress in developing heat networks in different ways.

Significantly, participating in the project had prompted the cities to think ahead and consider the governance structures that might be required to govern the heat networks once built. The level of proposed involvement in heat networks governance varied across cities but, in each case, the ambition was for LAs to retain a stake in any heat networks developed. In particular, LAs were keen to retain ownership of the physical infrastructure in order to retain potential financial benefits of owning physical assets as well as maintain control over the future direction of heat network development.

Some of the main lessons to emerge from the study in relation to governance emerged from the experiences of the two cities where the projects were led by city-regions rather than individual authorities. The following benefits and opportunities associated with embedding a project of this nature within a city regional structure (as opposed to within individual authorities) were identified by those with experience of this:

- **Greater private sector involvement:** Two of the cities had a greater level of formal private sector involvement in project governance as a result of the project being led by

city regions rather than individual LAs. It was argued by these authorities that private sector involvement had injected more 'commercial reality' into emerging proposals.

- **Links into broader programmes:** Projects led by city-regions were linked into related projects and investment programmes such as those relating to carbon reduction and energy and infrastructure programmes ensuring good strategic alignment. A key benefit here was that the project could potentially be linked into central government and European capital funding programmes, such as the European Regional Development Fund, City Deals and the Local Growth Fund, opening up options for capital funding.

"Looking forward I see long term delivery around carbon reduction will be through the [city] region, it's going to be the principal driver, probably the principal mechanism for getting the funding." (Elected member, City-Region Energy Board chair)

- **Addressing inequality:** City-regions also felt they had greater scope to address issues of inequality across the LAs making up the city-region, for instance, by identifying opportunities for and progressing heat networks in smaller LAs in the city-region where there was little internal capacity to do so. In one city-region, a number of opportunities in smaller, less well-resourced LAs were identified through heat mapping activities, leading those authorities to consider heat networks development in more detail.

3.3.3 Obtaining data from potential customers and suppliers on heat use and supply

Obtaining detailed demand and supply side data (including current and project heat use data from potential customers and output data from existing and proposed heat sources and heat networks) is critical to the production of accurate and robust feasibility studies, and for reaching informed conclusions on viability. However, problems obtaining data from potential customers and heat suppliers were reported across the five cities but were particularly acute in three cities. Interviews with LA officers, consultants and potential customers revealed a range of reasons why data proved difficult to obtain and collate, including customers struggling to obtain heat usage data from suppliers or only being able to provide partial data and data being in unusable formats when supplied. Consultants reported that many smaller businesses found it a burden to supply the data and in larger organisations it could be difficult to identify and make contact with those within organisations with the jurisdiction to supply the required data - this was a particular challenge in relation to organisations that formed part of chains or larger companies, who required permission from a central source (i.e. a head office) to disclose this data. Moreover, some organisations that may potentially benefit from the proposed heat networks were reluctant to supply data as they remained unconvinced of the merits of getting involved in a heat networks project.

The following quotes illustrate some of these issues.

“The whole project has been one of the most frustrating projects I've ever worked on, just getting data has been a nightmare. In the smaller businesses people didn't have the time to consider it, they're busy and it's just a burden to them to get involved with anything like this.” (Consultant)

“It's down to a combination of factors...perception, effort, often it was related to national organisations having outlets in a city and that outlet saying 'we can't provide you with the data locally, you'll have to go out to our head office' and the corporate centre would not be interested in a local level scheme generally." (Project Sponsor)

In an attempt to overcome these issues, one city undertook an additional round of data collection in an attempt to address the gaps in data that resulted from the various difficulties, and another city reported that it had was more fruitful to focus data collection efforts on a

smaller number of more cooperative potential customers, even though this may limit the size of the proposed network.

“We have had to alter the timescales for an additional round of data collection, because it has been a lot more difficult than anticipated. We've tried to be more targeted by identifying the top 100 heat loads in the area [and targeting them]." (Project Lead)

Overall, it is evident that difficulties obtaining data have presented a challenge for all five cities and in two cases has resulted in the scaling back of proposals. All cities felt that this particular challenge would continue to cause difficulties as the projects progressed.

3.3.4 Identifying funding for capital costs

For most of the cities, identifying options for funding the capital costs associated with the delivery of heat networks was not felt to pose a particular problem. However, it should be borne in mind that none of the projects had, at the time of writing, reached the stage where they were ready to move on to capital works.

In terms of the options identified by the cities at this early stage, Prudential borrowing[4] was repeatedly cited as a preferred source of funding due to what were perceived to be favourable interest rates. The Public Works Loan Board was also cited as an option by a number of cities and joint borrowing through public-private partnerships to increase borrowing potential and reduce the risk borne by LAs was also being considered in three of five cities.

“Financing has never been a big issue[….] councils have access to funding through Public Works Loan Board so it means they've got the cheapest way of funding it, they'll be more likely to fund the project than the private sector is, yet we're still struggling with the same question of does it pay back?” (Project Lead)

However, as the above quote suggests, despite many LAs being explicit that they were not expecting significant returns on any investment in heat network development (certainly not in line with the levels of return that private investors would need to justify investment), they would need to have confidence that, at the very least, the heat networks will generate sufficient revenue to repay loans for capital works, including interest.

Although financing capital costs was an area in which DECC could offer advice, most authorities did not feel that they had thus far needed much support in this area. Nevertheless, lead officers in two cities reported having useful engagement with DECC and the GIB which had prompted them to consider a broader range of approaches to securing finance, such as joint ventures.

3.3.5 Accessing suitable consultancy services

Although all five cities managed to appoint consultants to conduct feasibility studies on their behalf, three of the five expressed felt there was not enough choice of suitable consultants, with officer widely believing that much of the relevant technical knowledge resided in Scandinavia, which was considered to be considerably ahead in terms of developing heat networks.

"There's an abundance of knowledge in Scandinavia and countries more advanced in their thinking about district heating. We weren't overly blessed with choice". (LA Officer)

There was also a perception amongst the authorities that having five LAs seeking the same expertise at a similar point in time exacerbated the existing lack of choice. Two large multinational companies working across two of the cities acknowledged that they had limited

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[4] The new Prudential system encourages local authorities to invest in the capital assets that they need to improve their services. It allows them to raise finance for capital expenditure without government consent as long as they can afford to service the debt out of their revenue resources (DCLG, 2014) See: https://www.gov.uk/government/policies/giving-local-authorities-more-control-over-how-they-spend-public-money-in-their-area--2/supporting-pages/investment-in-local-government-capital-assets

capacity as a result. LA officers feared that this situation would worsen once the HNDU began issuing funding.

"It's a small world, the world of heat networks in the UK…we found that £1 million worth of consultancy coming onto the market at once placed real pressure on some of the consultancies." (LA Officer)

Also worthy of note is the fact that two large multinational consultancies became the lead consultants in four of the five cities. Linked to this, it was reported that within one city a large consultancy had been selective about which work packages they tendered for, ostensibly 'cherry picking' projects. Comments passed by a consultant suggest that in light of a plentiful supply of work they were opting to work on what they believed to be the most viable projects:

"We had a long debate internally about what we should bid for and we decided we'd bid for one package only which was to do with a part of the city with enormous heat demand. We thought if we are going to take on this contract, let's try and find something viable." (Consultant)

3.3.6. Engaging stakeholders

All of the LA officers interviewed felt that effective internal and external stakeholder engagement was critical to the successful delivery of the project. Underpinning this belief was an acknowledgement that that the feasibility work could not be completed without the cooperation of prospective customers and suppliers due to the need to access their heat use data and to gauge their interest in joining the proposed networks, informing technical and economic feasibility work. It was widely felt that the network would not come to fruition without the support of senior officers and elected members and commitment from suppliers and customers.

Views differed across the cities as to who was best placed to lead on the engagement of external stakeholders. Trust and access to data were central themes in these discussions. In some LAs, officials felt that they themselves should be leading in the engagement of stakeholders (as they had more knowledge of the local authority's needs) and in others local authority officials felt that a neutral and independent consultant was better placed to press stakeholders for data and information. In three of the cities, consultants led on the process of external stakeholder engagement, charged with the task of obtaining data on heat usage, generation and current heat costs from prospective customers and suppliers.

There was general acknowledgement across all the cities, however, that in an ideal world where time was not a constraint there would be important roles for both consultants and LA officials in different parts of the process. This was particularly the case in one city with the LA preparing the groundwork with local organisations and customers for consultants going in to have robust discussions about data and heat pricing:

"There's only so much of this activity that you can sub-contract to consultants, so they're really good at doing the technical engineering led work and financial modelling but there's no substitute for a trusted LA to go and sit down with the manager of a Hotel or whoever, the LA carries quite a lot of weight and gives people confidence, so all LAs need to have the capacity to do that engagement and consultation which isn't always possible."(LA Officer)

The benefits of a collaborative relationship, and that the LA was viewed as a 'trusted messenger' was a view also shared by some of the consultants. One consultant explained that stakeholder engagement could be a viewed as a 'chicken and egg' situation which is why LAs were required to persuade people to get involved.

"It's chicken and egg because we're not going to get a network until somebody signs up to a heat network, they're not going to sign up to a heat network until there's a heat network, and that is common across any heat network you choose to develop. But you have to have a basis on which to go and engage with those people and the next step is for the council to go and

more robustly engage and say 'we'd like to engage, we think we've got a thesis, are you going to commit?'." (Consultant)

3.3.7 Factors impacting on the financial viability of heat networks

Almost all of the LA officials interviewed considered the financial viability of networks as marginal due to the price of competing energy sources and long pay back periods. This was even considered to be the case in those cities where an existing network infrastructure was already in place. In spite of this, LAs remained keen to pursue heat networks, recognising that although the forecast rates of return might be considered too low to interest private sector investors, the potential civic benefits to flow from heat networks made the investment worthwhile.

LA officials and consultants identified a range of factors impacting on the financial viability of heat networks, including:

- the need to have a high concentration of heat loads in close proximity to the heat source;
- cost of the fuel source in both the short and long term;
- the price charged to the customer (how competitive it is compared to other sources?);
- subsidies available (e.g. Renewable Heat Incentive);
- scope to generate and sell electricity as well as heat (private wire or to the grid);
- construction costs (including laying pipework);
- the rate of return.

4. Progress towards low carbon sources

This section explores the drivers of the adoption of **low carbon sources** to fuel heat networks, how far the cities have progressed towards the utilisation of these sources and associated challenges. Key findings include:

- All five cities were committed to the principle of using low carbon sources and some were already using heat from waste to fuel existing networks. This was driven by strategic commitments to carbon reduction and to some extent, pressure from existing or prospective large institutional customers.
- However, due to uncertainties surrounding some lower carbon fuel sources, those cities that had not identified heat from waste as their main fuel source were likely to opt to use gas or gas CHP at least until lower carbon sources became more viable.
- LAs had to balance their carbon reduction ambitions against the need to ensure that heat prices are as attractive as possible to prospective customers.
- The utilisation of low carbon sources was more easily achievable for those with access to an existing heat from waste facility. Three of the five cities were using existing heat from waste facilities as their main or one of a number of heat sources.

This section is structured under the following three sub-sections:

- drivers of the adoption of low carbon sources;
- choosing low carbon sources; and
- challenges associated with the use of low carbon sources.

4.1 Drivers of low carbon heat

A range of factors were driving the pursuit of **low carbon heat sources** amongst the cities, including:

- low carbon sources already in use to fuel existing networks (heat from waste used in two cities);
- cities have an existing source of low carbon heat that is not being utilised (i.e. a waste incineration plant not currently supplying a heat network);
- existing strategic commitments to carbon reduction; and
- pressure from some existing and potential customers (notably large institutions such as universities, colleges and hospitals) to ensure their heat is generated from low carbon sources in order for them to meet their own carbon reduction targets.

These drivers are now explored in more detail.

Having existing sources of low carbon heat within a city was an obvious advantage in terms of utilising low carbon sources from the outset. The most likely existing source of low carbon heat in the five cities was energy from waste. Two of the five cities already supplied existing networks with heat from such plants and in both cases the plants had sufficient capacity left to fuel new networks or network extensions. There was also an example within one city of where the development of a heat network had been driven by the existence of an underutilised source of heat from waste. In this city, two incinerators existed (one under construction) with the potential to supply heat networks - in this case, exploring the heat networks that this may enable was a key focus of the project.

As outlined previously, existing strategic commitments to carbon reduction and associated targets within the cities were also key drivers of low carbon heat, encouraging cities to strive harder to identify possible sources or at least to make their networks low carbon source 'ready'.

"Driving progress, we've got strategies, we've got a carbon target and we have the ability and the will to decarbonise our heat generation" (LA Officer)

There was also evidence across three of the cities of pressure from potential or existing large institutional customers to ensure that heat networks were fuelled by low carbon sources. Universities, colleges and hospitals were the sorts of organisations most likely to be applying this pressure in order to help meet their own carbon reduction targets. This was believed by LA officers to be less of a concern amongst private sector or residential customers where price was believed to be more of a priority.

“The council's listening to the customers, so what we were hearing was they want lower carbon heat because the higher education sector's now got carbon targets which they are seeking to hit, so the drivers in that sector were greater than perhaps the drivers in other commercial and residential sectors and that's been quite important.” (LA Officer)

However, although low carbon sources were important to both LAs and other institutions with commitments to carbon reduction, it was clear across the authorities that heat costs remained the key factor determining whether a potential customer was likely to connect to the network or not. LAs therefore needed to balance their aspirations to use low carbon sources against the need to keep prices low.

"These projects […] offer lower cost energy and energy security to businesses and homes in the region. They’re probably the key drivers over the low carbon drivers, although they are important as well." (Project Sponsor)

4.2 Choosing low carbon sources

Despite commitments to the principle of low carbon sources in all of the cities, three of the cities proposed (at least in the short to medium term) to fuel their networks using gas or gas CHP, either alone or as part of a combination of fuels. In these cases, the cities were relying on the increased efficiency of energy supply through the economies of scale derived from a heat network to deliver carbon savings as opposed to the use of low carbon sources.

The heat sources currently being used or planned for potential networks in each city include:

- Energy from waste (four cities)
- Biomass (two cities)
- Geothermal (explored in two cities)
- Gas Combined Heat and Power (CHP) (three cities)

- Anaerobic digestion (two cities)
- Waste heat from industrial process (explored in two cities)

Of the available options for low carbon sources, energy from waste was the most popular and was either being used in existing networks, or being considered for new networks in four of five LAs. Energy from waste plants were reported by their operators to be strategically and financially viable without the inclusion of heat generation: they provided a means of waste disposal for LAs and additional income through electricity generation for the plant operator. Heat networks were a secondary – but important – consideration and the key issue was ensuring that the plant operator did not suffer financial loss as a result of the costs of connecting the plant to a heat network. Recently developed energy from waste plants tended to be constructed with the capability to be connected to a heat network but older plants were not. Therefore, it could not always be assumed that the operator of an energy from waste plant would necessarily agree to supply a heat network given the potential costs involved and negotiations were ongoing in two cities.

Where less proven technologies, such as geothermal and anaerobic digestion, were being considered, they were generally viewed as potential sources for the future that may replace gas at a later date if the technologies were proven to be viable.

In those cities not looking (at least initially) to utilise low carbon sources, it was anticipated that carbon savings would be achieved through the consolidation of individual or smaller communal ageing boilers into one single gas heat source. However, all of those cities planning to use gas saw this as a short to medium term solution or 'bridging fuel' until lower carbon sources became more viable.

"Gas is probably our best option in terms of a bridging fuel, not a forever fuel, but [something to use] over the next 20 years in order to get us from a high to low carbon economy. So I think if you were investing in decentralised energy networks and you're doing that by having a gas CHP in the first instance, as long as you're building them in a way that can be retro-fitted that's a perfectly viable investment." (Project Sponsor)

In some instances, where existing networks were being consolidated or expanded, additional carbon savings would flow from the replacement of oil-fired systems with gas CHP. Further carbon savings could also be made through the modernisation of existing networks to improve efficiency, as was planned in one city.

In summary, where heat from waste was not a possibility, or where an additional 'back up' fuel was needed, most cities favoured gas and expected to secure carbon savings through economies of scale rather than the fuel source. However, all cities proposing to use gas saw it as a 'bridging fuel' and planned to make the transition to low carbon sources once they became more financially and technologically viable.

4.3 Challenges associated with the use of low carbon sources

Some of the possible barriers to adopting low carbon sources, as cited by LA officers and consultants, included:

- the risks of deploying new and unproven technologies (i.e. geothermal, anaerobic digestion);
- possible political/ resident opposition to sources involving incineration;
- possible interruptions to the supply of some fuels (i.e. biomass);
- fluctuations in price (i.e. biomass);

- availability of land to develop new heat generation plants;
- lack of sources of waste heat.

These challenges are now explored in more detail.

The imperative to provide a dependable service to customers naturally meant that those cities exploring more innovative sources such as anaerobic digestion, for example, were unwilling to utilise them until the technologies had been proven, become more widely available and affordable.

However, challenges still existed in relation to the use of more established sources such as heat from waste or biomass. These sources had, in the past, encountered objections from the public and local politicians in two cities on the basis that the incineration of waste or biomass might compromise air quality. Historic concerns regarding the disposal of ash resulting from the incineration of waste were also an issue in one city.

"Politically we can't touch energy from waste because there was contamination of ash from the incinerator which was spread on allotments and footpaths in the 1990s. Biomass, we've got an air quality management zone in the city centre so that was ruled out." (LA Officer)

For those considering biomass, additional challenges existed including a perception amongst LA officers and some consultants that biomass supply chains are not sufficiently reliable and concerns about the practicalities of storing biomass fuels and maintaining the quality of the fuel when in storage.

Those cities that aspired to establish new incineration facilities or new heat generation plants of any description also recognised that they faced many potential challenges including political and public opposition, lack of finance for capital costs and lack of suitably located land.

In spite of these challenges and the fact that most of the cities planned to use more traditional fuels initially, all five cities remained committed to the use of low carbon sources and at least two of the cities had requested that consultants help them identify the most viable future sources.

"We've asked consultants to look at the whole range of options, so gas CHP, biomass CHP, biomass boilers, even geothermal. I think it's fair to say that in the early stages of delivering heat networks we're probably going to look at gas CHP cos it's the most tried and tested, least risky from a technical and commercial point of view, but in all the feasibility work we've said give us a view on what the low or zero carbon solution could be in the future." (Project Lead)

In summary, although all five cities were committed to fuelling new and existing networks using low carbon sources, uncertainties regarding more innovative technologies limited the options available to several of the cities, particularly those without access to the most immediately available low carbon source: heat from waste.

5. Future plans

A number of key challenges lay ahead as the cities progress further towards deployment, the most immediate being to establish whether the proposed schemes to emerge from the project were viable enough to take forward to capital development. If further feasibility work establishes viability then a full business case needs to be developed and funding secured. Whilst this process is playing out, all of the LAs expected to continue to grapple with reduced budgets and staff losses which could destabilise plans. In terms of future support needs beyond the project, LAs identified the following areas of support from DECC: encouraging the expansion of the UK heat networks consultancy sector; promoting stability in the market; fostering confidence in heat networks as an investment opportunity; and improving awareness of the benefits of heat networks amongst businesses and the public. The cities also widely felt they would need continued access to expert advice beyond the lifetime of the pioneer cities project.

5.1 Next steps and future challenges

Although, as outlined earlier in this report, participation in the project has helped the cities to overcome a range of barriers to the early stage development of low carbon heat networks, a number of key challenges lay ahead as they progress further towards deployment. The most immediate challenge is to firmly establish whether the proposed schemes to emerge from the project are viable enough to take forward to the capital development stage. In three of the cities, HNDU funding was already, at the time of writing, being used to conduct more detailed feasibility work and another city intended to seek this funding in the near future.

If further feasibility work establishes that a proposed scheme is viable then a full business case will need to be developed. If it is established that a proposed scheme will generate a sufficient rate of return to attract private investment or that it would not but the civic benefits would be compelling enough that the LA wishes to proceed in any case then the next challenge would be for LAs to secure an investor and/or raise their own capital funding. Views of the local authority officials suggest that this stage may be challenging due to difficulties around reduced budgets, staff turnover and complex legal and governance arrangements arising out of leasing out existing networks.

Despite these challenges, lead officers within three of the five cities were hoping to be in a position to begin construction of their new networks within two years.

When reflecting on the role that the LAs could play once networks were constructed, LA officials felt that they were well placed to facilitate and/or deliver the installation of heat networks due to:

- their strategic and statutory functions (i.e. as planning authorities);
- their status as trusted civic organisations;
- their potential role as sponsors and underwriters of heat network schemes;
- their experience in bringing different groups of people and organisations together to enable the delivery of large projects;
- their ability to offer relative financial and market security for investors;

- their ownership of large numbers of high-demand buildings as well as concentrations of domestic dwellings (e.g. high density social housing) in or near urban centres; and
- their ability to explore not-for-profit possibilities through the development of arms-length management organisations (ALMOs), reducing the potential for monopoly pricing of heat.

Despite these shared beliefs, there was significant variation between the cities in terms of the role they envisaged playing in project implementation going forward. As previously outlined, all cities were very eager to either own or part own the physical infrastructure of the network and to therefore maintain control in this sense, particularly over where it went

"I think [with] the civic quarter, the city council will probably either wholly or partly own the pipes in the ground, that's the bit we've got the biggest interest in. I don't think we're as interested in the supply of energy 'cos that can come from a range of sources". (Project lead)

However, whilst two cities aspired to maintain involvement in every aspect of the network, (infrastructure, management and supply) planning to buy and sell heat through ESCOs, there was no appetite amongst the other three for being involved in the management of the network and the supply of heat. This lack of interest was due to various factors, including budgetary and resource constraints, lack of expertise, fear of reputational risks if problems occurred and concerns that they would undermine healthy competition by becoming heat suppliers.

"If you have the pipes freed from one operator it gives more competition and opens up that market to more people. It's trying to follow the electricity or even rail network model, network rail own the lines and different companies use them." (LA Officer)

One of the cities that had considered management arrangements in more detail than the others intended to own the network (through a Special Purpose Vehicle) whilst contracting out the management function.

5.2 Future support needs

Lead local authority officials were asked to reflect on what support they may need from DECC in the longer term to succeed in the deployment of heat networks. The following issues were raised:

- **Small supply of consultants:** The project leads felt that there was a small supply of consultants in the area of developing heat networks. Within this project two of the LAs had to apply to the same organisation for consultants. Officials, therefore suggested that there could be a role for DECC in encouraging the expansion of the heat networks consultancy sector in the UK if this does not occur naturally.
- **Continued access to expertise:** In two of the cities, local authority officials expressed concerns about the loss of access to expertise that would occur following the end of the project, as project managers' contracts came to an end and in-kind support from DECC was scaled back.
- **Certainty regarding heat networks policy:** Officials in two cities expressed concerns about changes in recent policy (e.g. Feed in Tariffs and the Renewable Heat Incentive) which they felt might undermine investor confidence. As such, they called upon DECC to promote stability in the market and foster confidence in heat networks as an investment opportunity.

- **Promoting and encouraging heat networks development:** Officers in one city felt there was a role for DECC in raising awareness/educating consumers and investors of the benefits of heat networks and tackling outdated perceptions of them as unreliable and ineffective.

6. Conclusions

The evaluation suggests that the following aspects of the project aided progress towards the development of heat networks in the five participating cities:

- **The 'strategic fit' between the project and broader LA policy and strategy**. The project provided the opportunity for LAs to move closer to their strategic aims around decarbonisation, economic competitiveness and alleviating fuel poverty, as well as galvanising support for the creation of new or expanded heat networks.
- **The ability to appoint dedicated project managers (through funding provided by the project), focused on heat networks,** was hugely beneficial in terms of maintaining focus, progress and galvanising senior level support, particularly during times of organisational upheaval.
- **Improved knowledge with respect to developing heat networks:** LA officers reported acquiring significant commercial and technical knowledge through regular contact with DECC and the Green Investment Bank.
- **The appointment of consultants to conduct feasibility work:** The use of consultants meant that heat networks experts could be utilised to engage relevant stakeholders, reduce the burden on over-stretched local authority officials and provide robust feasibility studies that were viewed more positively by key decision makers.
- **Local authorities as partners in the delivery of heat networks:** The evaluation suggests that LAs are well positioned to lead the early stage development of heat networks projects, with the five participating authorities being well placed to understand local needs, engage local organisations and customers and deliver on their broader aims around decarbonisation, energy efficiency and alleviating fuel poverty.

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Appendix 1: Research questions

Overall aims of the research

The following four aims were agreed at the project inception meeting held on 8.10.13:

1. Investigate the extent to which the project helped LAs to overcome barriers to developing low-carbon heat networks.
    a. How far have the five pioneer cities progressed?
    b. Which elements of the project itself worked well and which worked less well?
2. At the city level, identify which practices have worked well or less well.
3. Understand the local context which has driven and affects the development of heat networks.
4. Identify and clarify specific decision making processes at a local level in order to inform DECC's heat networks model.

Research questions

The following research questions, now organised by theme, will be addressed fully through the research and will form the basis of topic guides.

Motivations

- What was the primary reason for developing the heat network in each area?
- Were there secondary aims as well?
- How are primary and secondary aims integrated and/or prioritised against each other?

Funding and support from DECC

- How was the advisory support received from DECC perceived by the five cities?
- What support did each of the five cities receive from DECC?
- What did the support received from DECC achieve? What specific outputs and outcomes flowed from the support provided by DECC?
- Was there a need for an alternative type of support? Was this accessed?
- What do the cities think would have happened without the funding?
- What activities would have been undertaken anyway?
- What activities couldn't have been undertaken without the funding and support?
- Was all of the funding spent on the intended activities?
- Was it easy to find suitable suppliers to meet project needs?
- What activities were funded and proportion of the funding was allocated to each area of activity?
- What could the DECC policy team have done more of to support the cities particularly in terms of advice, funding, award process etc.?

- How easy did cities find the grant awards process? (Bearing in mind that this is done via a standard template).
- How useful was it to have the funding available from day one of the project?

Engagement and consultation

- Have the cities taken steps to raise awareness of stakeholders and the public regarding heat networks both generally and specifically in relation their plans?
- If so, who/which groups have they engaged with?
- What has been their approach to consultation and engagement?
- Is the heat networks development project linked into local partnerships and boards?
- If so, how well is this working?

Governance

- What are the governance arrangements in place to oversee the project/make decisions associated with it? What is the composition of any steering groups or committees established or used for this purpose?
- What arrangements, if any, are in place to ensure that the project is linked in to wider strategic plans for the city?
- Did any of the cities adapt or change plans for the heat networks project in response to wider strategic plans or initiatives within the cities?
- Did cities find it helpful or otherwise to align the project with the broader strategic context?

Progress within the cities

- Did each of the cities achieve the objectives they set out in their original work programme? Why/why not?
- If plans changed, how did they change and why? How easy was it to change plans?
- How were decisions regarding changes to the scope of the project taken? How widely were they consulted on? Were they escalated to DECC?
- What practices worked well or less well for LAs in initiating and driving forward the development of heat networks (and specifically, low carbon heat networks)? May include:
  - political decision making
  - partnerships
  - LA structure
  - learning from other cities
  - membership of forums and other bodies
  - buying models or practices
  - quality assurance of contracted work
  - internal expertise.

Partnership working

- What external partnerships have been important in developing heat networks? What has aided or hindered successful engagement with these partners?
- What groups of non-domestic users have the cities engaged with?

- What has been the experience of the cities in terms of engaging with non-domestic users?
- What role have consultants played in the project?
- To what extent have consultants influenced the project? How and in what ways?
- Has the role/influence of consultants in the project been as envisaged or different?
- Has there been any engagement with SMEs as part of the project?
- What has been the balance between the use of internal and external knowledge and expertise? Was this balance as envisaged?

Progress towards low carbon sources

- To what extent are plans for heat networks low carbon, either now, or with potential to be so in the future?
- What factors will affect whether low carbon sources are used when heat networks are eventually constructed?
- Are cities considering a later transition to low carbon? If so, when is this likely to happen and what will facilitate/determine this?
- What barriers have been encountered specifically with reference to attempts to identify and exploit low carbon sources of heat?

Lessons learnt

- Has any learning been gained about the viability or otherwise of different approaches to the development of heat networks?
- What factors have affected the viability of these approaches?
- Has any learning been gained more generally?

Next steps

- What next steps followed after the funding had ceased and were these part of a sustainable long term plan to deliver heat networks?
- Can LAs demonstrate how funded activity fits into plans for the long term strategic development of heat networks in the area?
- How confident are cities that their plans will progress successfully?
- Have LAs secured other commercial or public funding to progress plans?
- What further risks or barriers do LAs anticipate within the next few years (as they lead up to construction and beyond)?
- What are the timescales for construction/deployment of planned heat networks in each of the cities?
- How successful have the cities been in raising the profile of heat networks at the strategic level? In what ways? (e.g. cited in strategic policy documents, buy-in at senior officer level, political support etc.)

Questions to specifically inform DECC's heat networks model

- What key decisions or considerations play a part in designing the heat network? Consider decisions around scale, heat load, fuel source and other key characteristics such as thermal storage, motivations for developing the network e.g. fuel poverty.
- What (broadly speaking) will be the pricing model for each city? What is the concept behind this model? What cost and benefit criteria are being used?

Appendix 2: Strategies and policies referencing heat networks

Table A.1: Strategic commitments to heat network development across the five cities

City	Strategies referencing heat networks	Link to strategy
Leeds City Region	The Leeds draft Local Development Framework includes a policy on Heat Networks (Policy EN4, p121). York City Council LDF (2011) includes planning condition that new developments integrate CHP or district heating where feasible (Policy CS21) The Leeds Climate Change strategy (2012) includes a 'priority for action' to "Develop an arms-length energy company for Leeds to lead the strategic development of renewables and district heating networks" by 2015 (p21).	http://www.leeds.gov.uk/docs/CD01%20Core%20Strategy%20Consolidated%20Version.pdf. http://www.york.gov.uk/downloads/file/1774/cd1_-_core_strategy_submission_publication http://www.leeds.gov.uk/docs/Climate%20Change%20Strategy%202012%20AW.pdf
Greater Manchester	Manchester City Council's Climate Change Delivery Plan (2010) pledges to undertake a lead role in delivering a distributive heating and cooling network in the city centre and to promote low-carbon heating and cooling systems. The Greater Manchester Climate Change Strategy includes specific proposals for heat networks and energy generation from renewables which would result in locally owned low carbon generation of 3TWh of heat.	http://www.manchester.gov.uk/downloads/download/5648/climate_change_delivery_plan http://www.agma.gov.uk/low_carbon_hub/our_priorities/energy/index.html
Newcastle	Local Development Framework for Newcastle and Gateshead (Draft Policy CS16- under consultation) The Newcastle City Council Climate Change Strategy and Action Plan (2010) The Climate Change Strategy and Action Plan (2012)	http://www.newcastle.gov.uk/sites/drupalncc.newcastle.gov.uk/files/wwwfileroot/environment/energy/ncc_energy_masterplan_may_2012.pdf http://www.newcastle.gov.uk/environment-and-waste/climate-change-and-energy-saving/our-climate-change-commitment
Nottingham	The Sustainable Energy Strategy (2010)	http://www.nottenergy.com/projects/public_sector/the_nottingham_2020_sustainable_energy_strategy/

Sheffield	Sheffield Local Plan (2009): Policy CS65 Renewable Energy and Carbon Reduction Sheffield Decentralised Energy City Strategy (2011) makes extensive reference to the importance of heat networks.	https://www.sheffield.gov.uk/planning-and-city-development/planning-documents/local-plan/core-strategy.html Provided on request. No longer on council website.

Appendix 3: Informing the development of the DECC heat networks model

This section summarises the process that the cities worked through during the project in order to identify viable schemes, the decisions that this required and the factors identified through this process as determining the viability of the heat networks scheme.

The early stage heat network development process

In terms of the model of heat networks development they followed, the cities worked through a clear series of activities during their projects, moving from high-level heat mapping across relatively wide geographic areas, through to feasibility studies of specific geographic clusters eventually moving on to the development of full business cases for viable schemes (although some cities were yet to reach this stage). During this process the cities had to make decisions about:

1. The physical design of the heat network
2. The financial or business model underpinning the network
3. The procurement and financing of the network
4. The management and operation of the network

The decisions in each of these areas are summarised in Figure A.1 in Appendix 3.

It is important to appreciate the complex interdependencies between these decisions: for instance, changes to the physical design of the network or operational arrangements may affect the network's financial model, which in turn may influence the way that the network is procured. These interdependencies can give rise to a situation in which it is difficult to make one decision because of uncertainty about another; for example, the supplier of heat may find it difficult to design and cost the network without a commitment from customers, but customers may be reluctant to commit to joining the network until prices and contract lengths are fixed. As a result of these kinds of issues (in addition to previously reported data issues) encountered during the lifetime of the project, three of the five cities had decided to focus on developing plans for smaller, core networks for which customers existed as opposed to building large speculative networks.

"Building these schemes slowly and progressively and bringing additional loads online rather than starting out trying to be too ambitious and building networks with the intention of connecting buildings in future because that isn't going to be financeable." (Consultant)

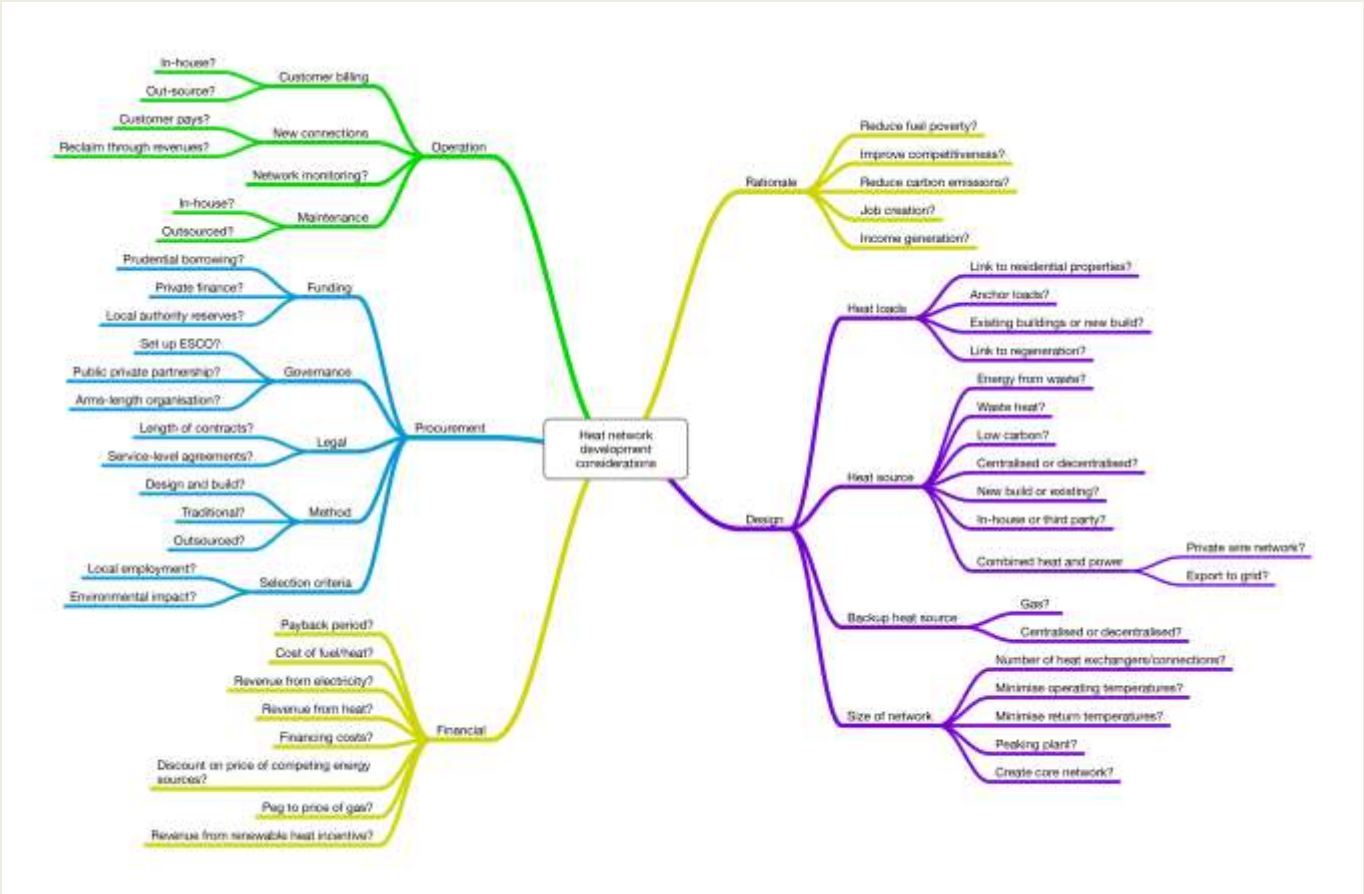
Factors impacting on the financial viability of heat networks

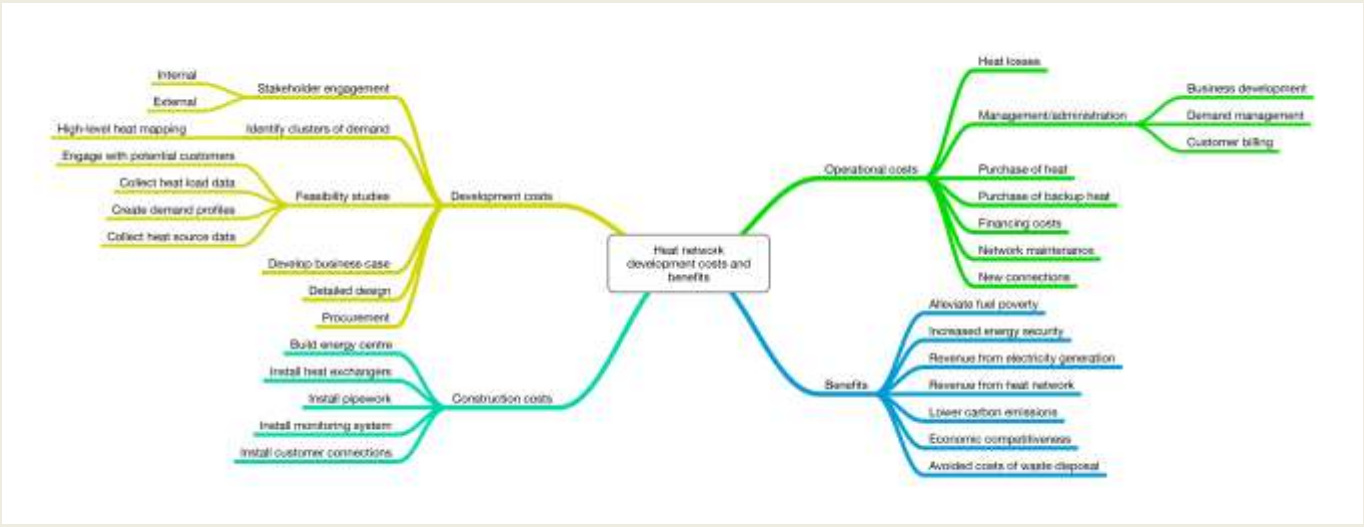
There was a general feeling across the cities that, at present, the financial viability of networks is marginal at best due to the price of competing energy sources and long pay back periods. This was even seen to be the case in those cities where network infrastructure is already in place. In spite of this, LAs remained keen to pursue heat networks, recognising that although the forecast rates of return would generally be too low to interest private sector investors, the potential civic benefits to flow from heat networks made the investment worthwhile.

LA officers and consultants identified a range of factors impacting on the financial viability of heat networks, some of which are already well known, including:

- the need to have a high concentration of heat loads in close proximity to the heat source;
- cost of the fuel source in both the short and long term;
- the price charged to the customer (how competitive it is compared to other sources?);
- subsidies available (e.g. Renewable Heat Incentive);
- scope to generate and sell electricity as well as heat (private wire or to the grid);
- construction costs (including laying pipework); and
- the rate of return.

The diagrams below were developed based on the themes and issues (codes) identified in the interview data from the five case study cities. The diagrams then went through a series of iterations, whereby each member of the evaluation team 'sense-checked' the diagrams and edited them accordingly, ensuring that they reflected the findings in their own particular case study. The diagrams therefore provide a 'generic' and 'at a glance' representation of the issues that need to be considered during the development of a heat network, based on the collective insights gathered from the five cities.




Heat network development costs and benefits
Development costs
Stakeholder engagement
Internal
External
Identify clusters of demand
High-level heat mapping
Feasibility studies
Engage with potential customers
Collect heat load data
Create demand profiles
Collect heat source data
Develop business case
Detailed design
Procurement
Construction costs
Build energy centre
Install heat exchangers
Install pipework
Install monitoring system
Install customer connections
Operational costs
Heat losses
Management/administration
Business development
Demand management
Customer billing
Purchase of heat
Purchase of backup heat
Financing costs
Network maintenance
New connections
Benefits
Alleviate fuel poverty
Increased energy security
Revenue from electricity generation
Revenue from heat network
Lower carbon emissions
Economic competitiveness
Avoided costs of waste disposal

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