the Bristol Method:

how to use heat networks to lower the carbon footprint of a city

BRISTOL 2015 EUROPEAN GREEN CAPITAL

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Contents

Introduction

Heating currently accounts for 38% of UK greenhouse gas emissions so reducing the emissions from heating is essential to meet the UK's greenhouse gas reduction targets. In Bristol the council are committed to pursuing a range of low carbon heat and energy efficiency projects. Heat networks are expected to play an important role in transforming Bristol into a low carbon city.

The role of heat networks in the transition to a low carbon energy system is receiving increasing attention across much of Europe and this module explains Bristol City Council's approach to developing heat networks, the steps the city has taken, and how the schemes will develop in the future. It also discusses the importance of heat networks in integrating high levels of renewable electricity in the future.

What are heat networks?

Heat networks, often also referred to as district heating, supply heat, hot water and potentially cooling from a central source, through a network of insulated pipes, to homes and businesses. This means that individual homes and business do not need to generate their own heat (or cooling) on site.

Heat networks can be supplied with heat from a range of sources including heat recovered from power stations and industrial processes, waste-to-energy facilities, large-scale heat pumps, heat-only biomass boilers, electric boilers and solar thermal arrays. Heat and electricity can also be co-generated through biomass or gas-fired combined heat and power (CHP) plants.

Why is heat important?

In the UK, heat energy currently makes up 44% of final energy consumption, accounting for 38% of carbon emissions.

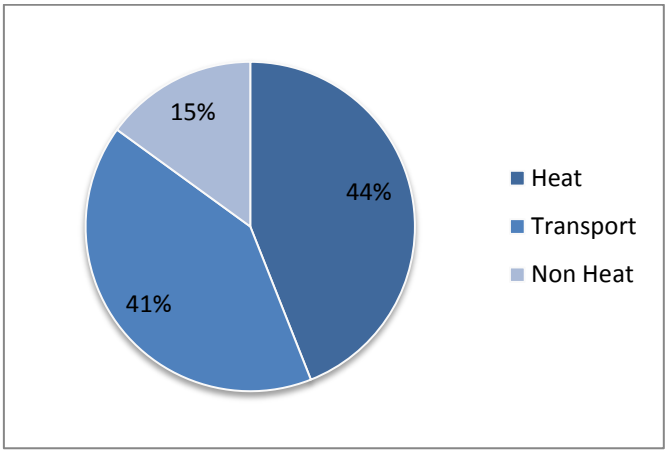
Meeting the UK's ambitious greenhouse gas (GHG) emissions targets will therefore require very significant cuts in emissions from heat. These can be achieved both by reducing heat use through energy efficiency, and by reducing the emissions intensity of heating through the adoption of low and zero carbon heat technologies. Heat networks are now widely recognised as likely to play an important role across Europe to achieve carbon reduction targets.

Heat networks in the UK

Heat networks are firmly established in many other European countries, accounting for 60% of the heat market in Denmark, 49% in Finland, 18% in Austria and 12% in Germany. In the UK they currently meet less than 2% of heat demand. Despite this the UK government has outlined ambitious plans for heat networks in the UK with results from DECC modelling indicated that up to 20% of UK domestic heat demand could be served by heat networks by 2030.

The government has also published a heat map for England which provides high resolution maps of heat demand across England. The map aims to assist local authorities in planning heat network projects and shows that nearly 50% of heat demand in England is concentrated enough to make heat networks worth investigating.

Local authorities are likely to play a number of important roles in developing heat networks, including as a sponsor, pivotal heat customer, heat source, planning authority and relationship broker. The Department of Energy & Climate Change (DECC) has been guiding local authorities to take the lead in the development of heat networks and almost all UK cities are investigating district energy. Core cities such as Sheffield have invested heavily in networks and are expanding them beyond the city centre. Leicester, Birmingham, Nottingham and Islington have also installed district energy networks.



Energy usage for heat, non-heat and transport, 2011
Source: The Future of Heating, DECC, 2013

The benefits of heat networks

Bristol, along with many other cities, is pursuing a range of low carbon generation and energy efficiency measures to reduce the carbon emissions from heat. However heat networks are likely to play an important role as the scale of heat networks enable renewable and low carbon energy technologies to be installed at a lower cost, in addition the energy centres at the core of networks tend to operate at higher efficiencies than localised boilers.

Additionally, extensive retrofitting of energy efficiency measures and/or the installation of individual building renewables may not be suitable for many urban buildings due to issues of space restrictions, heritage issues and costs. Heat networks can allow buildings in these areas to access low and zero sources of heating, hot water and cooling.

The carbon emissions associated with heat networks largely depend on the source(s) of heat generation. However once a heat network is established there is the opportunity to progressively decarbonise heat generation over time as the system is not locked in to one source of heat. Studies modelling the role of heat networks at the European-level have suggested that a strategy based on heat networks and energy efficiency could achieve EU 2050 greenhouse gas emission reduction targets at a lower cost to alternative electrification and efficiency focussed scenarios (see Connolly et al, 2014).

There is also increasing awareness of the potential benefits of heat networks in integrating renewables into the energy system, for example thermal stores integrated into heat networks can provide a cost effective opportunity to store excess renewable electricity from wind and solar power. Box 1 outlines the large-scale heat network in Copenhagen and how renewable electricity and low carbon heat can be integrated into the system.

In addition heat networks can contribute to other local aims such as those relating to fuel poverty, cost reduction, regeneration, local jobs and growth. In particular, heat networks can provide cheaper heat for residents at risk of fuel poverty.

District energy can therefore provide:

- Lower carbon emissions
- Lower energy costs
- Increased security of supply
- Better integration of the heat and power sectors

Once heat networks are installed, these benefits will be experienced by a wide range of people in Bristol, for example:

- Businesses and public sector bodies will have access to lower energy prices. This will enable public sector organisations such as the council to spend more on services for the people of Bristol.
- Social housing tenants will have access to cheaper heat.
- The city will benefit from reduced carbon emissions and better energy security.
- Local people will benefit in the long-term from better energy infrastructure in the city.

Case study: Heat networks in Denmark

Heat networks are very common in Denmark, accounting for 60% of heat. In Copenhagen, the heat network is one of the world's largest, supplying 98% of the city's heat needs through a 1,300km network of pipes. The city developed their heat network through a nodal approach, with many small networks initially established and eventually connected to form a large, flexible network.

Currently about 30% of the annual heat demand for the Copenhagen network is supplied from surplus heat from waste incineration plants, with the remaining heat sourced from geothermal energy and CHP plants. The CHP plants are currently fuelled with wood pellets, straw, straw pellets, natural gas, oil and coal but the city has a target to produce 100% of heat in the network from renewable energy and waste incineration by 2025. In this context, heat networks and CHP are seen as cornerstones of a low carbon energy policy that integrates renewable electricity and heat, providing a means to meet the challenge of balancing high penetrations of wind and solar in the power system.

As large amounts of wind (and other variable renewable energy sources) are introduced into the system, there will be times in which the production from wind turbines covers only a small part of the electricity demand. Similarly, there will be hours during which the production from wind turbines covers a very large part, or exceeds, electricity demand. In order to support very high penetrations of renewables in the system, heat networks are being developed which incorporate:

- Heat storage
- Electric boilers and heat pumps
- Turbines bypass options

Heat storage is already common in Denmark and allows CHP plants to decrease their output when there is sufficient (wind) electricity in the system whilst still being able to supply heat from the stores. Additionally the inclusion of electric boilers and heat pumps in heat networks can allow networks to use electricity for heat production when there is excess renewable electricity on the system. Finally, designing CHP systems with a 'turbine bypass' option allows CHP plants to switch to 'heat only' mode when there is excess electricity on the system.

Although the context in Denmark is very different, with heat networks backed by a series of Heat Laws and tax incentives since the 1970s, their approach to using heat networks to integrate low carbon heat and electricity is of great interest in Bristol and the city sees heat networks playing an important role in system flexibility and balancing as it moves to a low carbon energy system.

"I recently visited Copenhagen, which is a previous European Green Capital winner. In Bristol we want to develop a similar but more modest network to improve the city's energy infrastructure and reduce urban heat waste."

George Ferguson, Mayor of Bristol

Why is Bristol pursing heat networks?

Developing heat networks in the city is part of Bristol City Council's plans to transform Bristol into a low carbon city. A number of different heat networks are planned for key areas of the city, with the long-term ambition to join them up into one large network powering businesses and households.

In February 2010, Bristol City Council's Cabinet agreed the Climate Change and Energy Security Framework, which aims to improve Bristol's energy security and reduce the council and city's carbon dioxide emissions. In that context, an application was submitted to the European Investment Bank (EIB) under the ELENA Programme to secure £2.5m of grant funding to establish a large scale investment programme.

The ELENA programme has a number of strands, one of which is the implementation of a city-wide heat network. After the funding was awarded several studies were carried out looking at the feasibility of heat networks in the city, which concluded that a number of schemes were financially viable.

The development of heat networks would improve the city's energy infrastructure and also support the business plan for Bristol Energy – a municipal energy company that the council intends to launch later in 2015.

To establish which areas of the city would suit a heat network, the council's Sustainable City team commissioned the Centre for Sustainable Energy (CSE) to develop a heat map of Bristol. The funding from Europe also meant that further feasibility studies could be conducted, and in July 2014 Cabinet gave the go-ahead for work to start on a number of initial projects.

Existing heat networks in Bristol

Bristol already has a number of small heat networks owned and operated by the municipality's Housing Delivery Department. For example, the Temple scheme outlined in this document below includes the connection of two existing networks in the Redcliffe area of Bristol which have been operating since the 1960's. Both the Temple and Rowan schemes include either the expansion of these networks and/or the utilisation of biomass as a low carbon heat source. Similarly, the University of Bristol and the University Hospital Bristol Foundation Trust (UHBFT) were also once connected to a single heat network that was disconnected when the heat and power demands of these organisations diverged.

Bristol City Council also owns and operates numerous buildings (such as schools, leisure centres and offices) that have large, relatively steady, heat demands and so have the potential to act as anchor loads for heat networks. The Council is therefore seeking to use its building stock to help to drive the heat network programme forward.

What is Bristol doing?

The council is adopting a phased approach to the development of heat networks with ten initial sites identified where networks might be feasible. The ELENA funding enabled detailed feasibility studies of five of these sites to be carried out and for consultants to be appointed for the three most viable projects, to carry out additional work such as detailed design, to enable projects to be constructed.

The three projects currently being taken to detailed design/and or construction are:

- City Centre Part 1 – Cabot Ward
- Redcliffe & Temple – Lawrence Hill Ward
- Rowan – Whitchurch Park Ward

On the following pages, we provide an overview of each scheme.

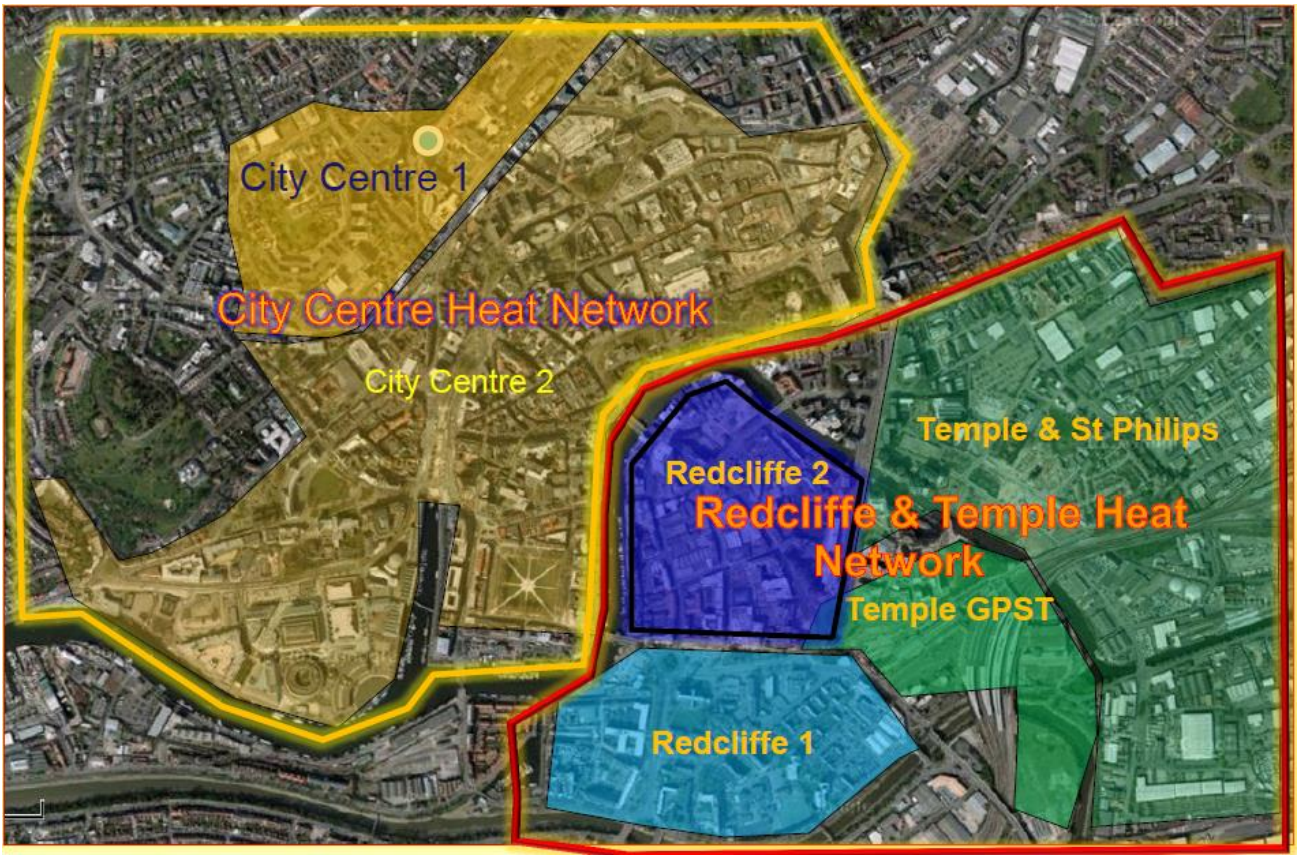


Figure 2: The image above shows the location of the City Centre and Redcliffe & Temple heat networks in Bristol City Centre.

City Centre Part 1 – Cabot Ward

Bristol City Council is working in partnership with the University Hospital Bristol Foundation Trust (UHBFT) and the University of Bristol to develop the first part of a City Centre heat network. It is proposed that the first part of the network will be centred on the Hospital and University buildings as they are two of the city's largest institutions, both are already familiar with the technology (and already utilise heat networks within their own estate) and all organisations involved are seeking to meet ambitious carbon reduction targets.

This is the largest of the proposed heat networks and involves Bristol City Council installing, owning and operating a gas-CHP generation plant in the UHBFT's existing energy centre. Depending on the final design, the system will have a generation capacity of between 2.6MWe and 6.8MWe, the latter based on the assumption that the Hospital's aging Steam network will be replaced with a more efficient low temperature heating network enabling much larger CHP plant to be installed. A heat network will be installed to connect the CHP plant to adjacent University buildings and council-owned social housing blocks. The CHP plant will supply heat and power to UHBFT at a rate that enables the council to repay its investment (capital and borrowing costs, operation and maintenance fees etc.) and provide UHBFT, adjacent University of Bristol buildings and the council's social housing blocks at Dove Street with low cost heat and hot water.

Connection to the heat network will be particularly beneficial for residents in Dove Street social housing as the blocks are currently electrically heated using night storage heaters. Due to the significant increase in the price of electricity compared to mains gas these systems are now expensive to run and many tenants are at risk of fuel poverty. To further reduce both costs to residents and carbon emissions the Dove St social housing blocks will be externally clad in 2016/17. The heating system conversion will happen after the cladding to ensure the new heating system is optimum for the new level of insulation.

Once Part 1 is complete, it is intended that a wider City Centre heat network will be installed (Part 2) which will connect additional University, commercial and City Council owned buildings, including social housing. This will result in greater reductions in carbon emissions and energy costs across Bristol.

"As a hospital trust, it's part of our role to help people be healthier. Developing a district energy network will have clear health benefits for those who are often hard-hit by fuel costs. This, along with the fact that the new energy centre will have a lower environmental impact than our current system, will help us fulfil our commitment to be a good neighbour to those living and working near our hospitals."

UHBHT Chairman John Savage

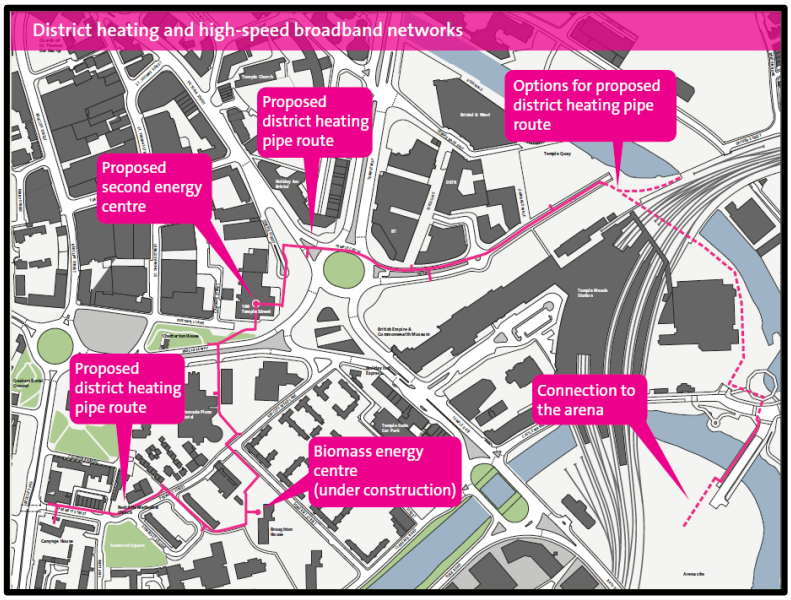
Redcliffe & Temple – Lawrence Hill Ward

This is a large network which encompasses the new Temple Quarter Enterprise Zone (TQEZ) and the Redcliffe area of Bristol, including Bristol City Council's offices at 100 Temple Street. The proposed network will initially distribute heat from a biomass (wood pellet) boiler, with gas boiler backup, and connect two social housing block networks already on a district heating scheme to Bristol City Council's 100 Temple St Office and potentially a nearby hotel. The district energy network will then extend into Bristol's Temple Quarter Enterprise Zone, utilising General Purpose Service Trench funding from the Department of Culture, Media & Sport that will incorporate superfast broadband ducts and private wire electricity. This will terminate at the new Bristol Arena, due to open in 2017, supplying existing and new TQEZ buildings along the route (see Figure 3 below).

Currently the social housing blocks in the Redcliffe and Temple area of Bristol are supplied by two existing gas boiler heat networks and 100 Temple Street is supplied by existing on-site gas boilers. The proposed scheme will connect the two existing heat networks to form a single network. The network will also be expanded to incorporate 100 Temple St office and Arena Island and a 1MW wood chip fuelled biomass boiler will be installed within the social housing plant room.

To facilitate the delivery of wood fuel for the biomass boiler an existing service area will be altered to enable access for wood fuel delivery vehicles and minimise disruption to tenants. In addition two of the social housing blocks, Broughton House & Yeomans House, will be externally insulated during the installation of the heat network.

The use of biomass will enable this project to benefit from Renewable Heat Incentive (RHI) payments. Payments will be made at a fixed tariff for 20 years offering the council reliable revenue and the opportunity to invest income in expansion of the network or other services. The anticipated completion date of the Redcliffe phase is January 2016 with other parts of the network connecting the TQEZ being delivered as part of other infrastructure projects to minimise disruption to the public. The full project is likely to be completed in 2017.



Rowan – Whitchurch Park Ward

A heat network is being installed within the Rowan House complex and will supply a total of five social housing blocks. Here a biomass (wood pellet) boiler will replace the existing fossil fuel (gas) boiler, meaning that residents will enjoy more energy efficient and lower carbon heating.

The existing old gas boilers in Rowan House plant room will be replaced with a single 360kW wood pellet fuelled biomass boiler with new gas boiler backup. A 36cu.m wood pellet silo will be constructed externally to the plant room. This project will also benefit from the RHI. The project is currently under construction and is due to be completed in September 2015.

Funding for both the Rowan and Redcliffe & Temple scheme comes partly from the council and partly from an Energy Company Obligation (ECO) contract with EDF. In addition, the TQEZ district heating pipework is being installed with funding from the UK government's Department of Culture, Media and Sport as part of the General Purpose Service Trench that will also include private wire and superfast broadband ducting.

Figure 4: heat network pipework ready to be installed in Bristol

How are we doing it?

Once the need for heat networks in Bristol was established, the project was included in a funding bid to the European Bank's ELENA programme.

Due to the complexity of the plans, Bristol City Council employed the services of a number of consultants to guide it through the development of schemes. Where key sites were identified, feasibility studies were then carried out and this process continues as more sites are added. Where a feasibility study has been completed and the site is financially viable, project plans were then developed in conjunction with specialist contractors. On the 1st of July 2014, Bristol City Council's Cabinet approved funding and delivery of the city centre network (Phase 1 to connect the hospital and university), Redcliffe & Temple network and Rowan network.

Overall, Bristol City Council aims to support the development of heat networks in the city through:

- the planning system;
- using its own buildings; and
- promoting heat networks to external building owners and occupiers.

Additionally a number of 'mini' networks are being developed, rather than one large network, with the aim to connect these networks as time progresses. To facilitate this method, a staged approach was utilised for each location, consisting of heat mapping, 'ground truthing', options appraisal and business model development. These stages are described in more detail below and largely follow the project stages identified in figure 5 and as outlined in the Homes and Communities Agency District Heating Good Practice Guide.

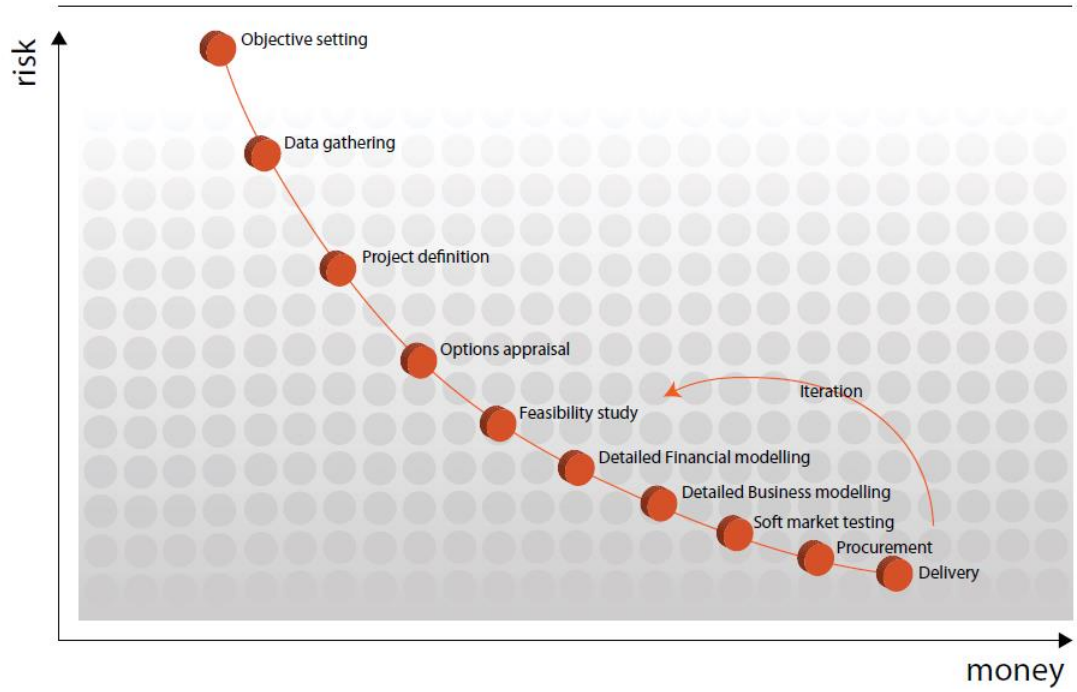


Figure 5: Stages of area wide heat network mapping by local authorities
Source: District Heating Good Practice Guide, Homes and Communities Agency, 2011

Utilising a staged approach:

1. **Heat Mapping**
   This stage involves the identification of heat loads across the authority where a heat network might work. Particular focus was put on heat islands of high demand, public sector 'anchor loads', and areas of proposed development where planning policy can support heat network delivery. Following the successful ELENA bid, the Energy Service Team worked with the Centre for Sustainable Energy to update heat maps of the city, originally produced by the council's Sustainable City team.

2. **'Ground truthing' of heat mappings results**
   This stage involves interrogating the findings of the heat mapping exercise utilising the 'on the ground' knowledge of key staff. Key considerations include details of the public sector anchor loads, the detailed heat demand and profiles of areas of mixed load (commercial and residential), and the presence of any showstoppers (such as expensive river crossings).

3. **Development and options appraisal of possible locations**
   This stage involves the detailed development of options in each feasible location. A range of consultants including CSE, Sustainable Energy Limited and Parsons Brinkerhoff have been appointed to carry out this work which has taken place in close co-ordination with other key public sector partners.

4. **Business model development**
   Heat networks can be delivered through a wide range of financial and ownership models, including full council ownership, community ownership, joint ventures, long-term concessions or design-and-build contracts, with each offering different risks and benefits. Different parties may also be involved in each stage of developing, delivering and operating the scheme.

   Business model development is a complex process and a number of consultants have been involved in modelling various options. However local authority involvement is likely to play an important role in ensuring business models and pricing structures are transparent and customers have trust in a monopoly supplier of heat.

Key success factors

A number of key enablers have been important in ensuring the progress of Bristol's heat networks plans. In particular, strong partnership working between public agencies, strategic energy planning, and the development of a diverse financial support base.

Partnership working

The projects have required close working between some of the largest institutions in Bristol, particularly as the timing of the proposals are key. For example, UHBFT currently owns and operates a 1MWe Gas CHP generation plant that produces low cost heat and power for the UHBFT campus buildings via its own steam network (heat) and private wire electricity network. This CHP plant is close to the end of its life, so the development of the heat network proposal has enabled UHBFT to consider options other than simply replacing existing plant.

Strong integration of planning between public sector bodies will also allow the planned 2.6MWe gas CHP unit to be extended to a 6.8MWe unit if, as technical investigations indicate, UHBFT are able to switch from their current high temperature steam system to a low pressure hot water system. This would provide significant energy, cost and carbon savings and allow a larger CHP system to be installed which would result in even greater commercial viability than currently identified.

Working in partnership with other large heat loads also allows for higher utilisation of heat networks, increasing viability. For example, mixing the high utilisation of a hospital with the seasonal / evening usage for domestic properties allows both parties to have a more cost effective system with a smoother aggregate load profile, longer hours of use and reduced standing charges (as plant maintenance and replacement costs are spread across a wide pool of customers).

To formalise the commitment of major partners the City Council, UHBFT and the University of Bristol signed a Memorandum of Understanding on 5th March 2015 which outlined how the organisations will work together and be committed to a target of initiating works in 2016.

Strategic planning

Closely linked to the need for strong partnership working is the role of strategic energy planning. Although Bristol is pursuing a number of small heat networks all of the schemes have been developed in the context of city-wide energy planning with the aim to connect the schemes into one large heat network in the future.

The city is also working with partners beyond Bristol to explore the long-term potential of industrial waste heat in the Avonmouth & Severnside areas of Bristol/South Gloucestershire. Together Bristol City Council, South Gloucestershire Council, SITA and a number of other partners are exploring the potential to develop an Avonmouth & Severnside Heat Network that would ultimately supply waste heat into the centre of Bristol and new development areas in South Gloucestershire.

Additionally the development of heat networks is being integrated with energy efficiency programmes and major road works to ensure that works are phased correctly and disruption is minimised. For example in the Redcliffe & Temple project heat network ground works will be integrated with major road alterations planned as part of the Bristol Arena development.

Diverse financial support

Heat network projects are long-term, high capital cost projects that require both substantial funding for project development and complex financial models for delivery. In order to support this accessing a range of financial support has been key.

The ELENA funding and support from DECC Heat Network Delivery Team (HNDU) has been important to enable the appointment of high quality consultants to prepare detailed appraisals of each project. This has included technical and feasibility studies and the development of a commercial model. The council has also worked with the Carbon Trust to review Bristol's planning policy and identify how it could support the development of district heating in Bristol.

Additionally, Government support initiatives are important to the viability of the schemes with support accessed through both the Renewable Heat Incentive and the Energy Company Obligation. Council officers are also in discussion with Salix Financing to explore the possibility of using Salix finance to part fund the installation. Salix Financing provides interest-free public sector finance on a revolving loan basis to undertake energy efficiency works to reduce carbon emissions and energy bills across the public estate, as long as the investments meet specific criteria and pay back within eight years.

What were the main barriers?

Despite there being a great deal of interest in heat networks in many UK cities there are still few systems in operation and there is a limited pool of knowledge and skills to support the development of projects.

Plans to develop heat networks in Bristol have necessitated that a wide range of teams (and multiple organisations) develop skills in heat network development. This, together with some reluctance to adopt new technologies, initially slowed progress but has been overcome by site visits to similar installations in other cities, and discussions about technologies to overcome concerns.

In order to get Cabinet approval, work had to be done internally to get buy-in from councillors and key stakeholders. This was achieved by presenting a robust case for heat networks and the benefits for the council and city. The appointment of a Commercial Energy Director at the Service Director level was also key to achieve senior management buy-in.

Initially finding funding for feasibility studies was another barrier and the European Investment Bank funding was crucial in providing the ability to employ consultants to carry out master planning, feasibility studies and heat network design but also to employ organisations like the Carbon Trust to provide support to Bristol in identifying what actions are required to develop, own and operate a successful heat network.

It is also worth noting that heat networks are a very active area of national policy interest. This has many benefits in terms of access to support from the DECC Heat Network Delivery Unit and the development of the recent Heat Trust accreditation scheme to provide customer protection. However it also does mean that staff involved in heat network development need to ensure they keep up to date with a developing policy field and factor the potential for policy change into business planning.

Stakeholders and governance

Funding from the European Investment bank was crucial in getting the heat network initiative off the ground. The plans have been, and continue to be, developed by Bristol City Council's Energy Service which is working with a number of consultants on the project.

The council's Housing Delivery team play an important role where projects involve council-owned social housing. A number of other council departments must also be consulted including Highways, Planning, City Design, Property Services and Procurement.

Project boards were created for each of the projects. These boards incorporated key stakeholders, and technical specialists are invited to present designs and developments as required. Within the council, three members of staff are currently dedicated to working full time on developing and establishing the district energy network. Bristol City Council's Cabinet have delegated responsibility to the Director of Energy Services, who signs off on the work streams.

The plans are still in the early stages, but support from local businesses and key stakeholders will be essential to the programme's success and there are a number of different stakeholder groups for each of the different proposed projects.

Measuring success and monitoring

Bristol has been diligent about instructing experienced consultants from the earliest stages of the project. This ensures that the designs are fit for purpose and designed to incorporate stakeholders' requirements. The systems are all designed to be "future proofed" and the success of the scheme will be evident in future years when the elements are linked together in a larger scheme.

The total capital value of these three schemes is £13.74 million. Based on the outputs of consultant assessments, the greenhouse gas reductions from the schemes are:

- City Centre scheme - GHG emissions reduced by at least 3,400 tonnes CO2e per year.
- Redcliffe Scheme - emissions reduced by 1,600 tonnes CO2e per year.
- Rowan House - emissions scheme reduced by 450 tonnes CO2e per year.

As projects progress success will be measured by the anticipated reduction in energy bills as well as carbon emissions reductions. Financial models have been created illustrating predicted energy price increases under current delivery methods. Models of the heat network schemes show predicted energy savings across energy users. This is particularly significant as predominantly fuel poor areas are being targeted by the proposed networks.

Success will also be gauged by the speed at which projects are delivered, and new projects are pushed through the pipeline.

Key lessons learned

Bristol City Council is developing plans and overcoming issues as they arise. Some advice for those entering the planning stage would be:

1. It's crucial to carry out energy master planning to identify appropriate network locations.
2. Identify some quick win district energy networks that could ultimately connect to a city wide network. If you focus only on grand projects they may not be cost effective and will take many years to develop.
3. Public sector anchor loads are crucial as they can provide the long-term contracts required to develop first phases of a heat network. Ensuring public sector partners and key heat load owners are involved in planning from an early stage helps to build relationships and ensure that opportunities aren't missed.
4. Consider planning requirements for new build that must meet a CO_2 reduction target or connect to a future district energy network e.g. Bristol's 20% CO2 reduction policy. This ensures new builds can connect to an existing network (see also London planning requirements).

Sources of further information

This module includes information from a variety of sources. To learn more about heat networks in cities, you may wish to consult the following documents:

- Connolly, D., Mathiesen, B. V., Østergaard, P. A., Möller, B., Nielsen, S., Lund, H., Persson, U., Werner, S., Grözinger, J., Boermans, T., Bosquet, M., Trier, D. (2013) Heat Roadmap Europe 2: Second Pre-Study for the EU27. Department of Development and Planning, Aalborg University.
- DECC (2013) The Future of Heating: Meeting the Challenge.
- District Heating Good Practice. Learning from the Low Carbon Infrastructure Fund (2011) Homes and Communities Agency.
- Heat and the City Project, District Heating Vanguards Network.
- Heat Network Delivery Unit, Department of Energy and Climate Change.
- London Heat Network Manual (2014) Greater London Authority.
- UNEP (2015) District Energy in Cities. Unlocking the Potential of Energy Efficiency and Renewable Energy.

ABOUT THE AUTHOR

Jess Britton is studying for a PhD in Energy Policy at the University of Exeter. Her thesis is examining the development of heat networks in the UK and Germany with a focus on the role of municipal utilities. She also regularly consults for local authorities and Ofgem on sustainable energy policy and is particularly interested in the role of new, often locally based, entrants in the energy market and their role in the energy transition. You can contact Jess via email at **j.britton@exeter.ac.uk**

BRISTOL 2015

European Green Capital is a prestigious annual award designed to promote and reward the efforts of cities to improve the environment. Bristol is the first ever UK city to win the award.

European Green Capital is run by The European Commission, recognising that Europe's urban societies face many environmental challenges – and that sustainable, low-carbon living is vital to the future of our cities and our people.

The award was first won by Stockholm in 2010. Since then, Hamburg, Vitoria-Gasteiz, Nantes and Copenhagen have carried the torch. Bristol will hand over to Ljubljana at the end of the year.

THE BRISTOL METHOD

The Bristol Method is a knowledge-transfer programme aimed at helping people in other cities understand and apply the lessons that Bristol has learned in becoming a more sustainable city, not just in 2015 but in the last decade.

Each module of the Bristol Method is presented as an easy-to-digest 'how to' guide on a particular topic, which use Bristol's experiences as a case study. The modules contain generic advice and recommendations that each reader can tailor to their own circumstances.

The Bristol Method modules are published on the Bristol 2015 website at **www.bristol2015.co.uk/method**

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