West Midlands Local Authority
Low Carbon Economy Programme

Implementation steps to large scale district heating

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sustainability west midlands

Improvement and Efficiency West Midlands

Report information

Title: Implementation steps to large scale district heating
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Client: Improvement and Efficiency West Midlands (IEWM)

Project Manager: Anna Bright (SWM)
Project Contributors: Anna Bright (SWM), Richard Rees (Birmingham City Council), Michael Checkley and Andrew Walster (Coventry City Council), Nick Morris (Leicester City Council), Rob Purdon (EnviroEnergy Ltd) and Nottingham City Council.

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SWM would like to thank the following local authorities for their time in providing information and insight for the case studies included in this guide.

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1. Introduction

The production of heat uses more energy than the generation of electricity or transport in the UK.

Most heat is produced by burning fossil fuels with the majority generated from gas, meaning that heat production is responsible for around a third of the UK's greenhouse gas emissions.

The Climate Change Act 2008 set a legally binding target to cut UK carbon dioxide (CO_2) emissions by 80% by 2050 from 1990 levels, with at least a 34% reduction to be achieved by 2020. The 2009 Renewable Energy Directive also includes a target for the UK to produce 15% of its energy from renewable sources by 2020.

District heating networks as part of a decentralised energy system have the potential to supply low or zero carbon energy in dense urban areas whilst providing long-term flexibility to accommodate new and emerging heat production technology and energy sources.

A district heating scheme comprises an energy centre producing thermal heat in the form of steam or hot water, and a network of insulated pipes to deliver heat from the energy centre to end users.

Heat networks can be supplied with heat from a diverse range of energy sources including:

- power stations
- energy from waste (EfW) plants
- industrial processes
- biomass and biogas fuelled boilers and combined heat and power (CHP) units
- gas-fired CHP units
- fuel cells
- heat pumps
- geothermal sources
- electric boilers and even solar thermal arrays

The ability to integrate diverse energy sources means customers are not dependent upon a single source of supply. This helps guarantee reliability, continuity of service and can introduce an element of competition into the supply chain.

District heating networks can currently extend up to around 30km from the generating plant and distribution networks can be hundreds of kilometres long. This is sufficient to carry heat across cities, smaller communities and industrial areas. The distance a network can reach is also easily extended by simply adding more providers of heat, or 'heat sources', along the way.

Networks also have the ability to balance the supply and generation of heat, across location and over time. Over the course of the day, heat demand shifts between residential

consumers to commercial, industrial and public buildings and back again. A heat network can match and manage these flows, whilst maximising the utilisation of the plant providing the heat. Demand can also be managed across seasons, with networks supporting the operation of distributed absorption cooling plants in the summer providing cooling on a significant scale.

2. Benefits of district heating

The benefits of district heating networks are shown in Table 1.

Table 1: Benefits of district heating

Consumer	✓ Small space requirement and safe operation ✓ Easy to control and operate ✓ Affordable cost and long term price stability ✓ Can help address fuel poverty and give peace of mind to vulnerable populations by: ○ ensuring the efficient management of heat provision ○ providing more stable prices ○ offering lower prices - district energy schemes can offer lower costs than microrenewables in achieving low or zero carbon energy supply. ✓ Resilient design to provide secure heat ✓ Modern networks are metered so consumers only pay for what they use
Developer	✓ Lower cost solutions: a heat network may provide a lower cost method of achieving carbon targets than the equivalent use of microrenewables ✓ District Energy networks can be set up as an attractive Energy Services Company (ESCo) offering, adding development value or removing the developers need for long term engagement in the project ✓ Can give greater design flexibility
Local area and wider environment	✓ Flexibility for fuel changes, possibility to optimise fuel mix ✓ Lower CO_2 emissions ✓ Potential for low carbon economy via use of locally sourced fuels (e.g. biomass) ✓ District Energy with CHP is the most energy efficient way of providing heat to buildings ✓ Decision making often at a local level therefore reflecting the needs of the local area

Current reliance on inefficient fossil fuel use for energy production creates a vulnerability to the volatility of energy prices. Through more efficient energy consumption and large scale district heating networks, energy needs can be met while reducing fuel demands therefore achieving some protection against fuel capacity issues and energy price fluctuation.

3. When to consider district heating

There are trigger points when energy supply should be considered in the life of any area, development, or building such as:

- When the heating or cooling system in an existing building is approaching the end of its life and needs replacing
- When an existing building is being refurbished, or brownfield redevelopment is being undertaken, and there is an opportunity to upgrade the building fabric and energy systems
- When a new building or greenfield development is being planned
- If a community or building manager has concerns about energy security, price volatility, long-term cost, or wants to reduce carbon emissions
- If congestion of electricity distribution networks and supply security are issues
- If a business opportunity to profit from the sale of energy arises

4. Developing district heating networks

Some local authorities may lack knowledge of the technical and feasibility development process necessary for the delivery of a district heating project. However, most projects follow a similar process which can be broken down into a number of specific stages[1] as shown in Figure 1.

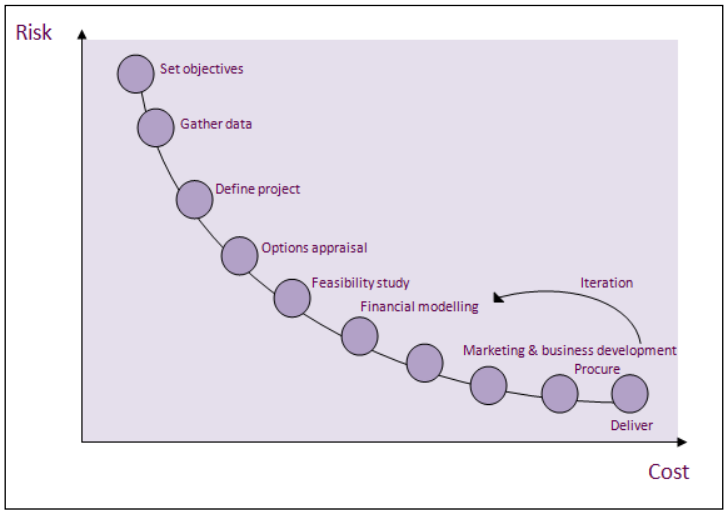

Figure 1: Project development process

As can be seen in Figure 1, each stage of the process must be financed and as such there is a progressive increase in costs. However, as the project progresses the risk of project failure decreases.

[1] As set out in; *Community Energy: Planning, Development and Delivery*, King and Shaw, 2010

The development of district heating networks relies on the identification of an area with the right mix of heat demands and connecting buildings.

Activities that should be undertaken as part of the data gathering stage are:

- Mapping energy consumption in the area considering ownership and control
- Mapping energy supplies in the area, including local heat and fuel sources
- Mapping existing and planned district heating schemes
- Mapping new development in the area
- Identifying suitable locations for an energy centre
- Identifying routes for potential district heating pipe work

A feasibility study should be undertaken to assess the potential for district heating in more detail. The study may consider specific requirements of individual buildings, the phased development of the network, and the route of the network. It will result in a robust conclusion on the viability of the proposed district heating network including the economics, and will give all the technical information necessary to move onto the procurement process.

5. The district heating scheme

5.1 Heat production

Large scale district heating networks offer an affordable way of achieving low carbon energy supply in densely populated areas meeting domestic, commercial and some industrial space heating and domestic hot water requirements, as well as cooling in some situations.

The use of Combined Heat and Power (CHP) with district heating results in greater fuel efficiency. CHP produces usable heat and electricity in one single, highly efficient process. This contrasts with conventional ways of generating electricity where vast amounts of heat are wasted. The overall efficiency of CHP plants can be in excess of 80% at the point of use. In comparison, a UK combined cycle gas turbine plant (CCGT) can range in efficiency between 49% and 52% with coal-fired plants having an efficiency of just 38%. Due to the efficiency of CHP, emissions to the environment are approximately 30% less than separate generation of electricity and heat.

As the energy is produced locally, CHP avoids efficiency losses incurred through transmission and distribution of electricity through the National Grid and local distribution networks.

The technology selected for energy production is dependent upon a range of criteria but will largely be influenced by the economics of the project. A number of technologies may be used within a single energy centre to ensure efficient and reliable operation across the range of heat demands. Energy production technologies can include:

- Gas turbine CHP
- EfW or biomass boiler and steam turbine
- Gas reciprocating CHP

- CCGT CHP

Resilience should be considered when addressing heat production to ensure that if a heat source fails, there is sufficient alternative heat supply available to meet consumer demands. This usually means gas boilers are used for back-up and peak heat supply, but any source can be considered provided minimum service levels can be maintained.

5.2 Heat distribution

The key objective of any district heating network is to provide heat to customers under all conditions.

Heat is distributed to consumers in the form of hot water from the heat source via district heating pipe work. District heating networks should be designed so that they can be interconnected allowing access to lower cost heat sources. Smaller energy centres may also be decommissioned allowing the network to be supplied from larger energy centres with an associated reduction in maintenance costs.

Boilers and generating engines operate most efficiently when there is a steady, smooth load. Therefore, by having a mix of end user with different heat demand profiles can help get the most out of the energy centre.

Certain buildings such as hospitals, hotels, large housing complexes, prisons, swimming pools, ice rinks and universities have a large and steady demand for energy over a 24 hour period. As a result they make ideal cornerstones for the development of district heating schemes and are known as anchor loads. Convention centres, arenas, and stadiums also have large demands although these are irregular and related to the number and frequency of events. They can also act as anchor loads.

Heat networks with thermal storage can allow efficient operation of CHP irrespective of heat demand. Heat from the store can then balance the daily variations on heat demand, minimising the need for heat only boilers.

The consumers that are connected to a network will determine the required water temperature and pressure, temperature differences and load profiles for the whole system. An energy centre will normally control these variables.

District heating networks need significant planning and design, and have considerable associated costs. In dense urban environments hard surfaces will need excavating to install the pipe work at high cost. If the pipe work is installed to the desired standards it is reasonable to expect life-times in excess of 50 years. Quality control through strict supervision at the installation stage is crucial to ensuring long network lifetime.

The heat network must be designed so that heat can be delivered to consumers at all times:

- It must be capable of supplying hot water to consumers with sufficient temperature and temperature difference to meet demand

- It must be designed to minimise heat losses
- The pressure across the network must not allow hot water to boil at any time
- Pressure differences between flow and return pipes must always be sufficient to meet the required heat at all consumers
- The route should be designed to ensure long pipe lifetime, through minimising pipe stresses
- The route should be practical and distances should be minimised
- The pipes should have sufficient capacity for all heat loads that may reasonably be expected to connect in the future

5.3 Heat metering

Heat must be accurately metered at any point where it is bought and sold. Metering is usually placed at the consumer connection. The heat supply to a consumer may be billed at individual meters for each dwelling. Alternatively, heat costs can be shared by multiple occupancy housing, based on a communal heat meter. This reduces the capital costs associated with multiple heat meters, but its viability depends on the type of housing and it does not encourage energy saving amongst individual consumers.

Heat meters are normally owned, installed and maintained by the heat supplier.

Automatic meter reading (AMR) systems collect data from remote meters and transfer the data to a central database for billing and analysis of information on consumption patterns. AMR can reduce operational costs by removing the need for manual meter readings. Ideally all new district heating networks should include AMR.

6. Heat Networks Funding Stream

The aim of the fund is to encourage and support the development and growth of heat networks in England and Wales through the provision of grant funding and specialist support to local authorities. The £7m fund is designed to support local authorities to identify, evaluate and develop new heating and cooling networks and the expansion of existing heating and cooling networks in England and Wales. The fund will be managed by the Heat Networks Delivery Unit (HNDU) at the Department of Energy and Climate Change (DECC).

Local authorities and their partners are invited to bring forward proposals to develop and deliver low carbon heat networks. Government is particularly keen to support plans for networks that draw their heat energy (immediately or in the future) from renewable, sustainable or recoverable sources as an alternative or alongside gas CHP. Bids which seek to develop low temperature delivery networks are also encouraged.

The fund will meet 67% of the estimated eligible external costs of heat mapping, associated master planning, developing technical proposals, financial evaluations, appropriate governance procedures and processes, project management and any other agreed appropriate works to allow the preparation of investment documents, business plans, financial models etc. which facilitate the installation of new heat networks and the

improvement and/or expansion of existing heat networks. Local authorities will be required to provide the other 33% of funding.

The main purpose of the grant funding is to allow projects and developments to progress to the development of a business plan that is sufficiently robust to allow them to produce an investable proposition to attract a range of finance options including commercial investment.

The bidding process started in September 2013 and will continue until March 2015 through up to six bidding rounds.

7. Procurement of district heating networks

The contract structure that is most appropriate for a district heating project depends in part on the main contractual elements:

1. **Works elements**
    a. Design
    b. Construction and connection of consumers
    c. Financing

2. **Services elements**
    a. Energy purchase
    b. Generation of heat and electricity
    c. Operation and maintenance
    d. Metering and billing
    e. Connection of new customers
    f. Supply of heat or heat and electricity to connected customers
    g. Customer services

3. **Property agreements**
    a. Sale or lease of operational land and buildings
    b. Easements, rights of way and access arrangements on private land and buildings
    c. Street works licence

District energy systems can be procured, constructed and operated in a many ways. This varies from individual contracts for each contractual element to bundles of services and works procured under a comprehensive agreement. The most common contract structures are described here.

7.1 Energy Services Company (ESCo)

In this type of contract the energy services company (ESCo) agrees to supply heat to the customers, and therefore to build and operate the district heating network. This contract could work upon a defined set of consumer buildings to be connected, or to provide heat to developments within a defined area.

Agreements with an ESCo are long term so that the ESCo can remunerate the investment made. If the ESCo is financing the construction of the district heating network, provision of a demand guarantee or other means of moderating demand risk is essential if the cost of capital is to be contained.

If future demand is unpredictable, or it is not possible to give a comprehensive demand guarantee, the agreement may take the form of a Concession which could provide for exclusivity within a defined area and/or period of time. The contracts required under an ESCo are:

- Master agreement
- Connection contract
- Heat supply contract
- Service level agreement (SLA)
- Property leases

Template heat supply contracts for residential and commercial customers are drawn up as part of the ESCo agreement. These contracts specify the prices that could be charged and the quality of service, so that the customers need deal only with the ESCo.

The SLA defines the commercial incentives between the project sponsor, ESCo, developers and customers. The sponsor and ESCo agree how the network will be built and operated, including carbon performance, flow and return temperatures, reliability and downtime. Developers and the ESCo agree how connection will be achieved, including lead times and compensation in the event of delay. Customers and the ESCo contract for levels of service quality, with compensation in the event of non-performance. Levels of compensation differ significantly for commercial and residential customers.

7.2 Design, build and operate (DBO)

The design, build and operate (DBO) contractor usually supplies heat wholesale to the sponsor who then sells the heat to customers. As such, the DBO contractor takes on all risks associated with the provision of heat, except demand and credit risk. A DBO contract is more appropriate where the sponsor wishes to retain a direct relationship with customers.

The price at which heat will be supplied, taking account of the required level of availability and standards of performance, is the key commercial consideration on which procurement should be focused.

The contracts usually included in this type of agreement include:

- DBO Contract
- Wholesale heat supply contract with SLA
- Connection contract
- Property leases

The DBO contract would normally be for at least fifteen years, to provide long term incentive and allow the contractor to be remunerated for funding the cost of constructing the district heating scheme. There may need to be a separate financial agreement although for all but the largest schemes it should be possible to require bidders to make their own financial arrangements. At the end of the contract, the assets are normally handed over to the sponsor.

Once the contractor is selected there is a risk that they may try to increase design and build (D&B) costs through variations, and operation and maintenance (O&M) costs through early replacement of assets and other techniques. A robust SLA agreed at the time of contract award is a way of ensuring good value through a DBO contract. As a result, the time taken for procurement and getting to contract is likely to be lengthy and resource intensive.

The wholesale heat supply agreement defines the way that the price is determined to supply heat to the sponsor.

The DBO is normally responsible for connecting customers to the district heating network, although the connection contract may be between the sponsor and the occupier or developer of the premises to be connected.

7.3 Network delivery and operation contract

Network delivery and operations contracts are appropriate where demand is dominated by a limited number of customers such as council-owned buildings, social housing, or a shopping centre.

The project sponsor (typically the landlord) would be responsible for pricing of heat and for the customer interface, and would normally pay for and own the assets. They take the majority of risk in operating the service (i.e. as a result of non-availability of heat supply) and might also retain responsibility for new connections and the expansion of the network.

Risk associated with appropriate design and operation of the system is carried by the supplier.

In principle, the D&B contract and the O&M contract should be considered separately but may be awarded together, as performance risk will be mitigated by assigning responsibility for the design, build and operations to one contractor.

The D&B and O&M specifications for this contract type usually require a greater level of detail than those with an ESCo or DBO contract as most of the risks are borne by the sponsor.

7.4 Operation and maintenance contract

A network operation and maintenance (O&M) contract may be appropriate where an existing district heating scheme is being upgraded, or where a new district heating scheme is to be installed by the main building contractor.

The O&M contract is likely to leave most risks with the asset owner, and will be short in duration to retain the incentive to run the scheme efficiently.

An O&M contractor will not normally be willing to accept contracts with penalty clauses. This is in contrast to an ESCo or DBO contractor who can be penalised for poor performance. The contract value is usually too small for the risk of being penalised to be covered by prospective revenues under the contract, and the assignment of responsibility for service failure is likely to be disputed.

8. Good practice, overcoming barriers, and lessons learned

The Homes and Communities Agency (HCA) is the national housing and regeneration delivery agency for England. Its role is to create thriving communities and affordable homes. The HCA's Low Carbon Infrastructure Fund (LCIF) was launched in 2009. Its purpose was to support the development of district heating as part of the delivery of new homes and the refurbishment of existing housing stock.

The funding was focused on housing growth areas in England and bids were sought from local authorities. £21 million was allocated to an initial tranche of 13 projects.

A report was produced in August 2011 to provide the lessons learnt from the LCIF programme. The main lessons learnt were as follows:

1. Defining objectives

Objectives should be defined before commencement of project and could be carbon emission reductions, affordable energy or security of supply. Each local community will have different priorities and it is important to engage with the community through local groups and organisations to identify their preferences. Once objectives are agreed the project can be designed to achieve them.

2. Familiarity with the market

Once a project moves to the delivery stage it can be constrained by what is available and deliverable in the current commercial energy services market. As such it can be beneficial to undertake early engagement with the commercial energy and utility market, including mainstream energy companies and ESCo's to understand what they can provide. Smaller companies may offer flexibility and have the appropriate expertise but may lack the financial strength to take on larger projects. In contrast, larger companies may have the scope to take on bigger projects, but may need to sub-contract particular aspects of delivery to smaller, specialist companies. Where the project is part of a new-build development, it is critical to have a knowledge of commercial models used by house builders and the interface with the financial models used in the energy market.

Market engagement can present risks to public sector organisations in complying with public sector procurement procedures. Care must be taken in early engagement or soft market testing to avoid impacting on public sector obligations under such procedures, and running the risk of challenge.

3. *Experience of project partners*

Often local authorities and their commercial partners have varying levels of knowledge and understanding of district heating technology. Local authorities may also have limited experience of the commercial energy sector and the necessary steps towards delivery of a district heating scheme. In contrast, energy companies may not understand planning policy and local authority decision making processes. This lack of experience can lead to protracted contractual negotiations. If one partner does not have the necessary level of experience then this should be addressed and where necessary a third party brought in to offer expertise.

4. *Establishing roles and relationships*

The level of work associated with the successful implementation of a district heating project is significant and it is therefore essential to define roles and responsibilities from the outset. The delivery of a project will benefit from the appointment of an experienced project manager which could be jointly appointed. Local authorities should establish a delivery team to implement the project, ideally involving a cross section of internal staff. Key stakeholders in the project should be involved from the outset. Communication is essential and delivery teams should be kept well informed about progress. Project risks should be allocated to the partner having the greatest level of control over them with clearly defined roles and responsibilities.

5. *Engaging in delivery*

The delivery of a district heating scheme will inevitably run into challenges and it is important that the project manager and delivery teams are able to address these changes and use innovation in finding solutions. Local authorities and their partners should identify organisations that have already been through a similar process and learn from their experiences.

6. *Legal complexities*

The legal aspects of developing a district heating network, such as reaching contractual agreements, can be time consuming and complicated. Again, there is benefit in local authorities embarking on a project to liaise with other authorities that have gone through the same process to see if there is a way that common contract terms can be replicated. The costs associated with legal services can also be significant. However, engaging with legal experts early in the process can be useful in overcoming issues.

7. *Cost of external support*

An element of funding should be made available to cover the cost of any external support. This is especially true for larger schemes where technical feasibility studies and legal and financial advice are required. On average, development costs account for approximately 10% of capital expenditure. Currently this could be part funded via the Heat Networks Funding Stream.

8. Allow enough time

Local authorities that have been though the process of implementing a district heating scheme suggest that to allow for contract negotiation, at least eight months should be allowed to secure planning consent and comply with procurement processes.

9. Local authority case studies

9.1 Birmingham City Council

Drivers for the district heating network

In 2003 Birmingham City Council recognised that the installation of a district heating network could address issues of fuel poverty and was best undertaken during the period of economic regeneration. City centre regeneration plans coincided with scheduled replacement of gas boilers for a national convention centre and this provided an opportunity to establish a district heating scheme.

The Deputy Leader and several officers attended a presentation by Utilicom (now Cofely District Energy (CDE)) on the Southampton Geothermal Heating Company. This type of scheme was attractive to the Council as it minimised capital investment and risk, and transferred this to the private sector.

More recently in 2013, Birmingham's Green Commission set a vision of building a leading green city and reducing the city's total carbon emissions by 60% by 2027 against a 1990 baseline through its Carbon Roadmap. This aims to extend the early good work in the city and also acts as a driver to expand the city centre district heating network as well as develop new networks across the city.

Data collection and feasibility

CDE were commissioned to undertake feasibility studies of two potential schemes; the Broad Street Scheme located in the city and the Eastside Scheme in Aston to the east of the city centre. Half the cost of the feasibility studies was funded by the Community Energy Programme. The feasibility studies focused on large organisations that could act as heat loads within the areas. The feasibility studies indicated that both schemes were technically and financially viable as a result of the density of heat loads. As a result of the feasibility studies the Council decided to progress with both schemes.

Workshops were then held with key organisations to demonstrate the benefits of signing up to the district heating scheme.

Project team

Councillor Paul Tilsley, the Deputy Leader of Birmingham City Council at the time, was Member Champion and officer champions were included from various council departments including engineering services, highways, finance and legal.

Initially, the Council's financial and legal teams were skeptical of the benefits of the proposed district heating schemes as a result of risk-averse accounting and legal criteria, a

short-term cost focus for procurement, and cautious local interpretations of EU procurement and state aid rules. However, the Council's engineering services team were committed to the project and managed to overcome these concerns.

Procurement

The tender specification for a contractor to design, build, finance and operate both district heating schemes took 12 months to prepare. During this time contractual agreements were finalised between the Council, Aston University and Birmingham Children's Hospital. These three partners jointly procured the project using a competitive dialogue process. As a result of the procurement process CDE were selected as the preferred partner to deliver both schemes under 25 year 'concession' contracts.

The contract for the Broad Street Scheme was between the Council (on behalf of individual users) and CDE. The Eastside Scheme contracts followed the same template and were between CDE and the Council (on behalf of Birmingham Children's Hospital) and CDE and Aston University. The terms of the contract provide a profit share between these core partners.

Development of the heat network

Birmingham District Energy Company (BDEC) was established as a wholly owned subsidiary of CDE, working in partnership with the Council. BDEC have been operating the district heating schemes since 2007.

The total cost to install the Broad Street Scheme was £2.1 million. A grant of £322,000 from the

Community Energy Programme was secured to help deliver the Broad Street Scheme.

Figure 2: Installation of district heating pipework in Birmingham

When implementing the Broad Street Scheme CDE were able to use an existing heat distribution network installed in the 1980's connecting the International Convention Centre (ICC), National Indoor Arena (NIA) and Hyatt Hotel, which saved on the capital cost of new pipes. An existing energy centre at the ICC also resulted in considerable cost savings.

The total capital costs for the Eastside Scheme were £4.1 million, which were partly met by a £1 million grant from the NHS Energy Saving Capital Grant Scheme.

The current schemes do not include thermal storage but back-up gas boilers are available to provide resilience for heat supply. The Council are considering the development of thermal stores in future networks with help from the University of Birmingham due to their expertise in energy storage through the Centre for Cryogenic Energy Storage.

Since the completion of the initial district heating schemes several additional connections have already been made including the Magistrates Court, Masshouse 7, Bagot Street halls of residence, additional buildings at Aston University, additional Council owned buildings and the new Library of Birmingham.

Several tower blocks in the city centre have been connected to the network but this was funded by the Council together with a Low Carbon Infrastructure Fund grant from the HCA with the aim of addressing fuel poverty.

Expansion

The initial scheme was redesigned to allow for future expansion by the inclusion of connection valves. New connections are usually identified as a result of redevelopment and therefore it is important that developers are aware of the district heating network and encouraged to make contact with BDEC.

An Executive Board meets regularly with the aim of identifying potential new connections. The Executive Board is chaired by BCC and includes representatives from the core members of the scheme. The Council's planning department is invited to these meetings so that new developments and changes in building ownership are highlighted and can be considered.

Figure 3: Tower block connect to district heating network

New pipework is currently being installed to connect the two ends of the scheme together via the New Street gateway redevelopment. This will allow for expansion to the south and east of the city centre. This is shown in Figure 4.

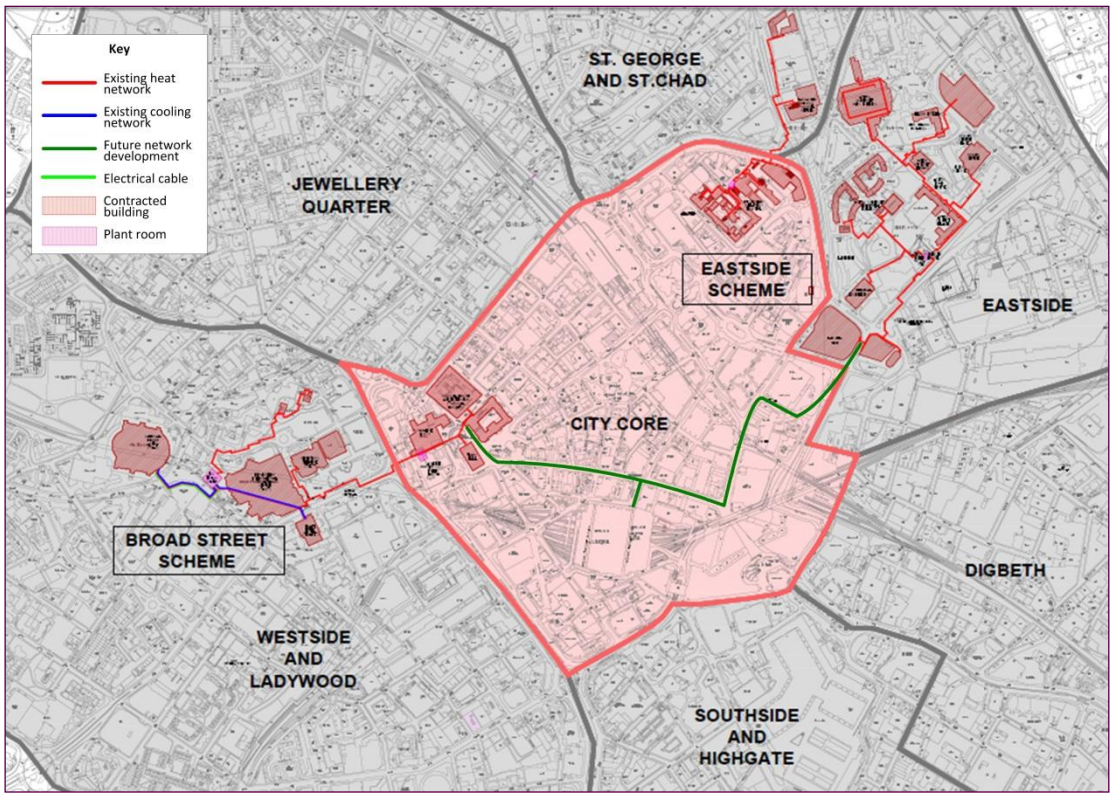

Figure 4: Connection of two district heating networks in Birmingham City Centre

When new district heating pipe work is installed it has been critical to schedule this with other key events in the city centre such as the German Christmas Market so as to minimise disruption. It has also been critical to ensure the works are aligned with the transport and utilities installations taking place at the same time or in the near future, as well as respecting the businesses and residents in the area.

BDEC and the Council are keen to introduce renewable energy sources to the network to deliver further CO_2 savings and resilience. This might include biomass CHP engines, biomass boilers, waste heat from gasification and anaerobic digestion.

BCC has been successful in securing grant funding from DECC's HNDU to help complete research and documentation which will enable the delivery of heat networks at strategic locations in the city. This will be completed outside of the BDEC arrangement. Initially, city energy mapping will be completed, followed by energy masterplanning at five of the most promising sites. The energy masterplanning will take the five most promising sites, identify the potential pipe runs and analyse the specific risks, issues, barriers, opportunities and economic potential. Further feasibility work has also been approved for the Tyseley Environmental Enterprise District where BCC are keen to understand the potential to

capture waste heat from the EfW facility, Icknield Port Loop and the Selly Oak, Edgbaston and Bournville corridor, which will take place in the near future.
Many potential district heating networks could cross local authority boundaries. For this reason Birmingham City Council are speaking with other local authorities covered by the Greater Birmingham and Solihull Local Enterprise Partnership about the potential for joint projects.

The Council anticipate that smart grids (i.e. computer based remote control and automation) will have a place in driving efficiency in the operation of district heating networks.

Learning points

- A strategic approach backed by political support and officer champions will help large scale district heating schemes to be implemented
- For district heating schemes to be implemented it is important to have support from the Council and the private sector
- Having planning guidance that includes requirements for renewable energy in large scale developments can encourage developers to include connections to district heating developments in their proposals
- Sharing knowledge between local authorities with successful district heating networks is a good way for local authorities to share their experiences and knowledge, and raise concerns
- Capital funding can help kick-start district heating schemes and it is important to have an awareness of potential funding opportunities
- It is important to understand authorities and projects/redevelopments that might cross local authority boundaries and so the Council are speaking to the Greater Birmingham and Solihull LEP and the local authorities covered by this area
- Local authorities can be held back by limited in-house technical expertise and knowledge of procurement routes
- Current funding available from HNDU can be useful in carrying out initial studies to inform the development of district heating networks. The application process is not too onerous however it is important to understand how the local authority can raise match funding

Contact: Richard Rees
Strategic Energy Delivery Officer, Birmingham City Council
richard.rees@birmingham.gov.uk
0121 675 0285

9.2 Coventry City Council

Drivers for the district heating network

There were three main drivers for the Coventry Heatline project:

1. Economic:
    - The Council wanted to use the waste heat from the Energy from Waste (EfW) plant which had been supplied to the nearby Peugeot factory until 2008.

- Coventry and Solihull Waste Disposal Company own the EfW plant and are keen to raise its efficiency as far as is practicable. By doing this through the inclusion of combined heat and power and connection to the district heating network it is more likely that the EfW facility will be classed as an R1 'recovery' operation (under the Waste Framework Directive) in the future. This would move the operation up the waste hierarchy and could avoid the imposition of future additional environmental taxes.

Figure 5: Coventry EfW facility

2. Social:
    - Provision of district heating could have the potential to tackle fuel poverty particularly within the areas of social housing in and around the city centre

3. Environmental:
    - District heating using heat from waste incineration avoids the need to burn gas and emit carbon as a result
    - It will help the Council meet legally binding low carbon commitments, such as the carbon reduction commitment
    - It could save up to 25,000 tonnes of carbon when maximised

Project team

To drive the project forwards the Council established a project team which included representatives from the following departments:

- Streetscene and Greenspace
- Sustainability and Low Carbon
- Special projects finance
- Inward investment
- Project management

The Council used their in-house lawyer but used external technical consultants.

Data collection and feasibility

The Council engaged AECOM as technical consultants and commissioned them to produce a heat map of the city showing potential energy users along with heat sources. This indicated that there was sufficient demand for the district heating network within the city centre but it was important that all stakeholders also had the desire to move the project forward.

Buildings owned by the Council were identified as having the potential to provide the anchor load for the district heating network, along with other buildings including those owned by Coventry University.

The Council then worked with environmental consultants SKM Enviros to confirm the business case for the city centre scheme and develop tender documents. Other consultants were appointed to advise on more specific aspects of the project, such as conducting ground surveys along the preferred pipe route and assessing pinch points.

The business case and associated reports were then presented to the management board and elected members. It was agreed that the Council would go ahead with the procurement of the district heating network on the basis that it would not have to commit any capital to the project.

Procurement

To fund the development of the district heating network the Council managed to secure £2.1 million funding from the HCA (Homes and Communities Agency).

The Council decided to tender for the provision of the district heating network via a design, build, finance, operate (DBFO) contract through an accelerated closed tender process. The contract would be in effect for 25 years and would involve the successful bidder taking the heat from the EfW facility, delivering it to the city centre buildings and managing supply to the buildings on a concessionary basis.

In response to the tender the Council received four expressions of interest and three bids. The winning bidder was Cofely District Energy and they were selected on the basis of their method of financing the project and on the end costs that would be incurred by the Council. Cofely have invested over £3.2 million in the project.

The procurement process took approximately 12 months.

Development of the heat network

The contract is being delivered by Coventry District Energy Company (CDEC), a company owned by Cofely District Energy working in partnership with Coventry City Council.

Phase I of the project to connect the seven city centre administrative buildings and Coventry Cathedral to the EfW facility commenced in early 2013. The administrative buildings that are connected include:

- Council House
- Civic Centres 1-4
- Coventry Sports and Leisure Centre
- Herbert Art Gallery and Museum

Figure 6: Installation of district heating network in Coventry

This involved laying 3.6 km of underground pipes. To simplify the process all pipe work was laid in highways owned by the Council and the local Highways Authority were included in discussions throughout project development. The cost to lay pipework was in the region of £1,500 per metre. Pipes were pre-stressed (heat and pressure was applied to test welds and expose any

leaks) to avoid the potential for leaks once the pipes were laid and first used to transport water. Expansion joints are also used to account for expansion of welds although this is not possible in areas where straight routes must be used.

Securing the connection to Coventry Cathedral is seen by the Council as a particular achievement due to its internationally recognised iconic status and its classification as a Grade 1 listed building.

Resilience is built into the district heating network by inclusion of back up boilers at the EfW facility and in the city centre, plus the ability to bring in a mobile containerised boiler if necessary.

The city centre scheme has been operational since September 2013 and generates 10GWh heat energy per year. There has been no interruption to supply in first six months of operation. The CO_2 savings achieved as a result of the district heating network are 2,000 tonnes per year initially.

Cofely are currently in the process of installing a 20 metre high, 650 m^3 thermal store to act as a buffer tank for heating water when it is not being used. This will be the only visible part of the district heating network and will have a carbon counter at the top which will be visible from the Coventry ring road.

Expansion

Phase II of the project will involve expanding the heat network to city centre businesses, industry and homes. This includes the Friargate development and the area to the north of the city centre - possible buildings that might be connected include Coventry University, the Magistrates Courts, the central Police Station, Britannia Hotel, and the Transport Museum.

The Council are in discussions with the three major registered social landlords with a view to connecting tower blocks to the district heating networks. Older tower blocks are often poorly insulated and some use electrical heating which is costly and can lead to residents being at risk of falling into fuel poverty. However, clarification of Energy Company Obligation (ECO) support for this type of work is required and there are questions over the mechanisms by which residents would be billed for heat.

Learning points

- Grants or capital funding can be extremely helpful in justifying the business case for a district heating network and kick-starting projects that are ‘shovel ready’.
- The Council feel that a competitive dialogue tender process could have been a better way of procuring the district heating network due to the potential for greater negotiation and clarification with bidders.
- For successful delivery of a district heating network the local authority must be behind the project. They often own buildings which can be the anchor load for the heating network, and also own land and highways through which the pipe work will be laid.

- The cost of heat to be provided via the district heating network must be less than gas in order to fund the infrastructure required.
- Feedback from the staff at the Council House is that control over ambient temperature is better since the building has been connected to the district heating network.
- It may be necessary to consider how to overcome potential concerns that district heating networks can be monopolistic in nature and might restrict options for switching due to long-term contracts of 25 years.

Contact: Michael Checkley
Sustainability & Low Carbon Manager, Coventry City Council
Michael.Checkley@coventry.gov.uk
02476 832155

9.3 Leicester City Council

Drivers for the district heating network
Leicester has long been forward thinking with regard to environmental management and in 1990 it was designated Britain's first Environment City by the Royal Society for Nature Conservation, in recognition of its progress and commitment.

District heating has been operational in Leicester since the 1950's on Council estates with a combined heat and power engine at one site. The Council had an ambition to extend the existing district heating network to connect more city centre buildings including those owned by the local authority. The reasons for this were a desire to provide cheap, reliable and low carbon heat.

The Council applied for and secured a grant to implement an extended scheme in 2004-2005. However, at this time it was envisaged that the Council would need to contribute significant capital costs to the project which was not possible at that time. As a result the funding unfortunately could not be used.

Following a change in political leadership the district heating project was reenergised in 2007 and a detailed study was undertaken which confirmed the potential of utilising existing district heating schemes.

Data collection and feasibility
The Council had commissioned Arup to undertake a feasibility study during the 1990's and this was revisited in 2007 and brought up to date. The study involved heat-mapping, identification of buildings that could be connected to a city centre heat network and the best location for energy centres.

The study allowed the Council to engage with potential public sector partners and understand technical and organisational barriers that may impact upon the scheme. A broader Leicester Stakeholder Group was established to take this forward and included the Council, the University of Leicester and HMP Leicester.

A business case and commercial plan for the district heating network were produced. They identified considerable potential revenues and a good payback period and as a result the Leicester scheme moved to procurement.

Financial officers recommended that a third party should provide capital for the district heating project and take on the associated financial risks. This reduced the potential for revenue for the Council and transferred control to the chosen partner. However, it was agreed that allowing the market to determine the best solution through competitive dialogue was preferable to the Council taking on risk.

Project team
The Council formed a team to progress with procurement which included a project director (the Director of Housing) and a project manager. A working group was created including legal, financial, technical and environmental expertise. Other departments including highways and planning were also consulted. The project was championed by the Leader of the Council at the time.

The Council also utilised technical expertise from the Combined Heat and Power Association as required.

Procurement
The Council carried out Soft Market Testing which finished in 2008. Seven responses to the Soft Market Testing were received.

The Council then progressed to the competitive dialogue tender process in 2009. The Council issued the OJEU notice on behalf of the Leicester Partnership. The key assessment criteria that were defined for the district heating network were that it should deliver:

- Affordable and reliable warmth
- Secure and sustainable energy supply
- Significant reduction in CO_2 emissions
- Expansion potential
- No direct capital investment by the Council members of the Leicester Partnership
- A pilot study to assess the cost/benefit of individual residential heat meters
- Confidence in a long-term partner to deliver the agreed solution – both in terms of experience and financial standing

These criteria allowed for private sector innovation and the Council had three responses to the OJEU notice. The competitive dialogue process took approximately 12 months and at the end of the process the Council awarded a year contract to Cofely District Energy.

Development of the heat network
The heat network was installed across the city centre by the Leicester District Energy Company (a subsidiary company of Cofely District Energy) and involved the laying of over 16km of new pipe work. The associated capital costs were £15 million, £14 million of which was invested by Cofely District Energy with the remaining £1 million being funding from the Community Energy Saving Programme (CESP). During phases 1-3 of the project 15

administrative buildings, 3,000 domestic properties and the University of Leicester were all connected to the network. Each phase of work was carried out separately, and then these networks were linked together. Pipe installation work had to cease over the Christmas period to avoid disruption to shoppers and businesses in the city centre. The network has been fully operational since early 2013.

As well as operating the city centre scheme Cofely also operate two standalone schemes, the Beatty Avenue biomass scheme and Aikeman Avenue network, which includes connections to schools and other buildings.

Operation of the district heating network currently delivers a reduction in carbon emissions of 12,000 tonnes per annum.

Expansion
Extension of the current district heating network is addressed by a Strategic Board. Expansion plans include connection to the prison, hospital and other public and private sector buildings.

The Local Plan introduced in 2006 includes a policy on Renewable Energy requiring major developments to be designed to meet a percentage of their energy needs from renewable energy generated on site. This is a helpful driver when discussing connection of major developments to the district heating network with developers.

The district heating network does not currently have a thermal store but the Council are looking at the contractual implications of adding a thermal store and the best means of funding this.

The Council are keen to further de-carbonise the district heating network by moving away from gas fired CHP to renewable energy sources. They also recognise that there may be potential to develop smart grid technology for the heat network.

The Council are also considering various sources of funding including the HNDU and ECO (Energy Company Obligation).

Learning points

- The input of significant time and resources by the Council is required to deliver a successful district heating scheme
- A successful district heating project will need to have a political sponsor and champion
- It is important to have a dedicated and experienced project manager who is capable of working across council departments
- It is important for a local authority to have a good understanding of the contract with the private contractor and to be commercially aware

Contact: Nick Morris
Head of Energy Services, Leicester City Council
Nick.Morris@leicester.gov.uk

0116 454 2229

9.4 Nottingham City Council

Drivers for the district heating network

The London Road Heat Station was built in 1953, by the Boots company for use as an industrial power station. It was originally powered by three coal fired boilers. The plant was in use until the early 1970's when the site was purchased by Nottingham Corporation and was leased to British Coal.

In 1968 the Nottingham Corporation chose incineration as their future method of refuse disposal following a feasibility study by Associated Heat Services. The report showed that waste heat from refuse could be used to heat proposed new residential and commercial redevelopments in Nottingham. The National Coal Board (NCB) were also seeking markets for coal-fired district heating at the time.

Development of the heat network

The corporation set up the incineration and district-heating scheme as a joint venture with NCB. The scheme then had two sources of heat: the new Eastcroft energy from waste (EfW) facility and the London Road Station. The new scheme of linking EfW with district heating was the biggest of its kind in the UK costing £5 million.

In 1995, with the demise of British Coal, the scheme transferred wholly to Nottingham City Council, and began trading as EnviroEnergy (Nottingham) Limited. Today EnviroEnergy is wholly owned by Nottingham City Council. EnviroEnergy has 32 employees based at London Road, Nottingham. This is largely engineers but also includes office staff, a network manager, a plant manager and a business development manager. The company Board includes local councilors.

EnviroEnergy operates a 14.5 megawatt condensing turbine and 85km of piping. District heating is supplied to almost 5,000 homes and 100 businesses across Nottingham including the Victoria and Broadmarsh shopping centres, the National Ice Centre/Nottingham Arena, Nottingham Trent University, BioCity, HMRC, the Royal Centre and various other large local developments.

The hot water is supplied to customers through an extensive pipe network that covers a large area of the city centre. The EfW facility and district heating network together supplies Nottingham 3.5% of its annual heat and 2.1% of its annual power consumption. Commercial buildings use more than twice the amount of heat than the domestic connections.

Commercial customers that wish to connect to the network are required to contribute to the capital costs associated with the supply and installation of pipe work and a heat exchanger located on the premises. In exchange customers are provided with a ten year guarantee for the heat exchanged, a 40 year life expectancy for the equipment, lower

servicing and maintenance costs and exemption from the Climate Change Levy due to the classification of energy as renewable.

Where possible EnviroEnergy aim to do the majority of connection work in-house. However, there are occasions when they need to bring in specialist expertise. The laying of district heating pipe work is covered under the Nottingham and Derby City Councils' Joint Highway Framework which runs from 2013 – 2017. This makes procurement of such services much easier and the Framework can be used by any other local authorities that are part of the Midlands Highways Alliance.

It is important for EnviroEnergy to index heat tariffs to a relevant energy specific index so that prices increase in line with gas price rises.

Planning guidance issued by the Council states a 10% renewable requirement for major developments and this is a useful driver when talking to developers about the benefits of connection to the district heating network.

The Council also provide metering and billing services for social housing within Nottingham and on behalf of other local authorities and housing associations, including several in the West Midlands region. These services include the provision of advanced pre-payment and in-home display units that have been designed and manufactured in house specifically for district heating. Properties are largely high rise estates with biomass boilers.

Expansion

Most new sites are commercial sites due to their high heat loads. The high costs associated with the connection of domestic properties to the district heating network means that this is generally less commercially viable, other than in the case of high rise tower blocks where they may be able to address issues of fuel poverty and utilise funding such as the Energy Company Obligation (ECO).

A new district heating main has been laid to the south and south east of city centre. This was done as the area was identified as one where large developments were taking place. This installation was financed using £3 million from the Low Carbon Infrastructure Fund. However, since the pipe work was installed development has slowed considerably as a result of the recession and as such the new heating main is not currently delivering any heat.

EnviroEnergy are keen to put extra heat into the system to improve resilience and are hoping to add renewables such as biomass and gas fired CHP. This would also allow partial shut downs of the heating network to take place for pipe replacement.

There is currently no thermal store on the network and when the demand for heat is lower in the summer, steam is diverted to the turbine resulting in more electricity being produced. However, EnviroEnergy are hoping to increase the summer heat requirements by the provision of more absorption chilling. They are also looking at connection to an overnight electric vehicle bus charging facility for 21 vehicles.

The Council have secured funding from the HNDU to address efficiency by reducing heat loss from the network.

Learning points

- The network is operated by the Council and therefore any surplus generated can be returned to the local authority
- The network has had a positive impact on the City's carbon emissions with an annual reduction of 27,000 tonnes
- A reduced rate of development over the last four years has limited expansion of the scheme
- It is important for EnviroEnergy to retain staff as they have a huge amount of expertise gained over the last 40 years since the scheme has been operational

Contact: Rob Purdon
Business Development Manager, EnviroEnergy Ltd.
robpurdon@enviroenergy.co.uk
07903 419708

10. Relevant organisations

Organisation	Website
Chartered Institution of Building Services Engineers (CIBSE)	http://www.cibse.org/index.cfm?go=page.view&item=2526
Combined Heat and Power Association (CHPA)	http://www.chpa.co.uk/
DECC CHP Focus	http://chp.decc.gov.uk/cms/
DECC CHP Quality Assurance Programme (CHPQA)	http://chpqa.decc.gov.uk/
DECC Heat Networks Funding Stream	https://www.gov.uk/government/publications/heat-networks-funding-stream-application-and-guidance-pack
Decentralised Energy Knowledge Base (DEKB)	http://www.dekb.co.uk/
Heat and the City	http://www.heatandthecity.org.uk/
International District Energy Association	http://www.districtenergy.org/
International Energy Agency (IEA)	http://www.iea.org/chp/policybestpracticesforchpdhc/
UK District Energy Association (UKDEA)	http://www.ukdea.org.uk/

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