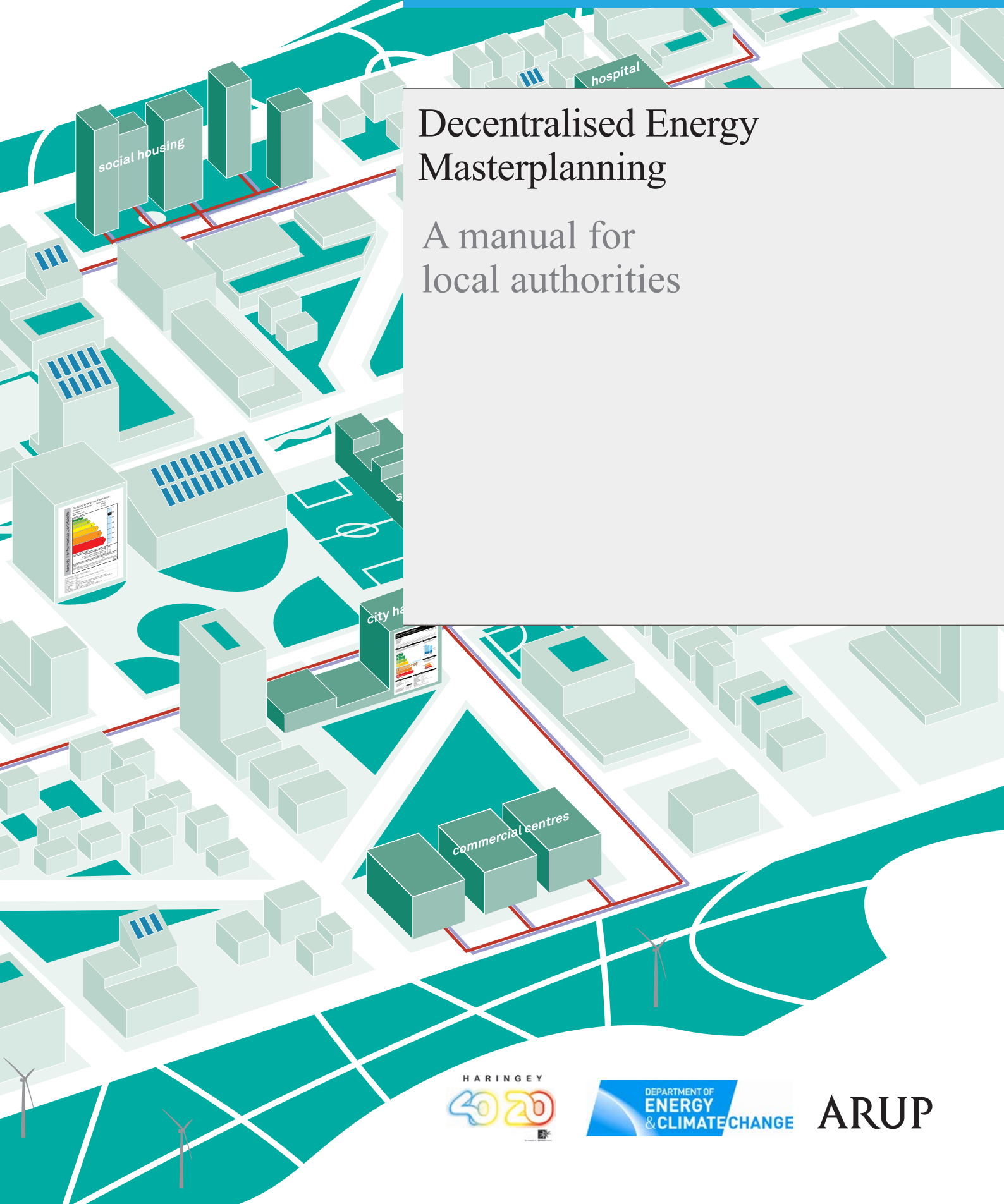
ARUP

Decentralised Energy Masterplanning

A manual for local authorities



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DEPARTMENT OF ENERGY & CLIMATE CHANGE

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Acknowledgements

This document was produced by Ove Arup and Partners as part of a commission from the London Borough of Haringey under the DECC funded Local Carbon Frameworks Programme. We are grateful for the support and extensive input from the steering group assembled by Haringey, which included representatives from the Greater London Authority, the London Development Agency and the London boroughs of Haringey, Islington and Waltham Forest.

Appendices

Appendix A

Sample District Heat Design Specification

Appendix B

Sample Feasibility Study Specification

1

Introduction

Cities and towns across the UK are grappling with the challenge of meeting stretching targets for reduction in CO_2 emissions across their areas.

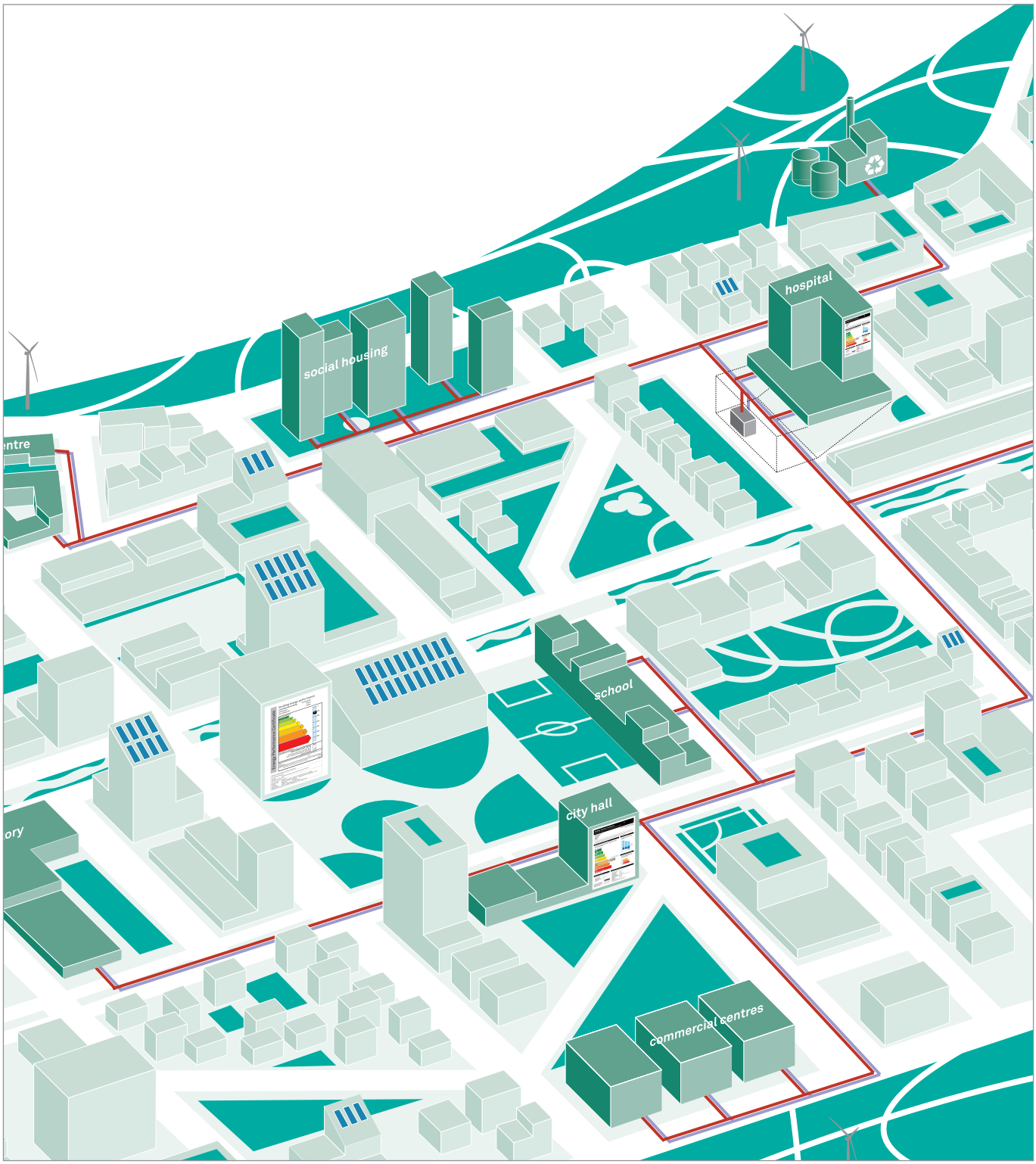
Among the technology options to generate low carbon energy combined heat and power systems connected to district heating networks stand out as one of the most effectively and most efficient solutions in high density areas.

District heating systems are therefore destined, to become a major element of urban low carbon energy strategies. This manual has been produced to help local authorities both to develop their energy strategies and to turn those strategies into delivered decentralised energy networks.

In recent years the London Development Agency (now incorporated into the Greater London Authority), in collaboration with Arup, has been a leader in the promotion and development of decentralised energy, with major investments in schemes across London and in its Decentralised Energy Master planning (DEMaP) programme of local authority support and capacity building. Other regions have seen similar programmes being developed and the Energy Savings Trust, working in collaboration with Arup, has provided support to local authorities across the country. These programmes are founded on the recognition that local authorities are uniquely placed to drive the deployment of decentralised energy but also that they need the tools and resources to be able to do so.

1

Introduction



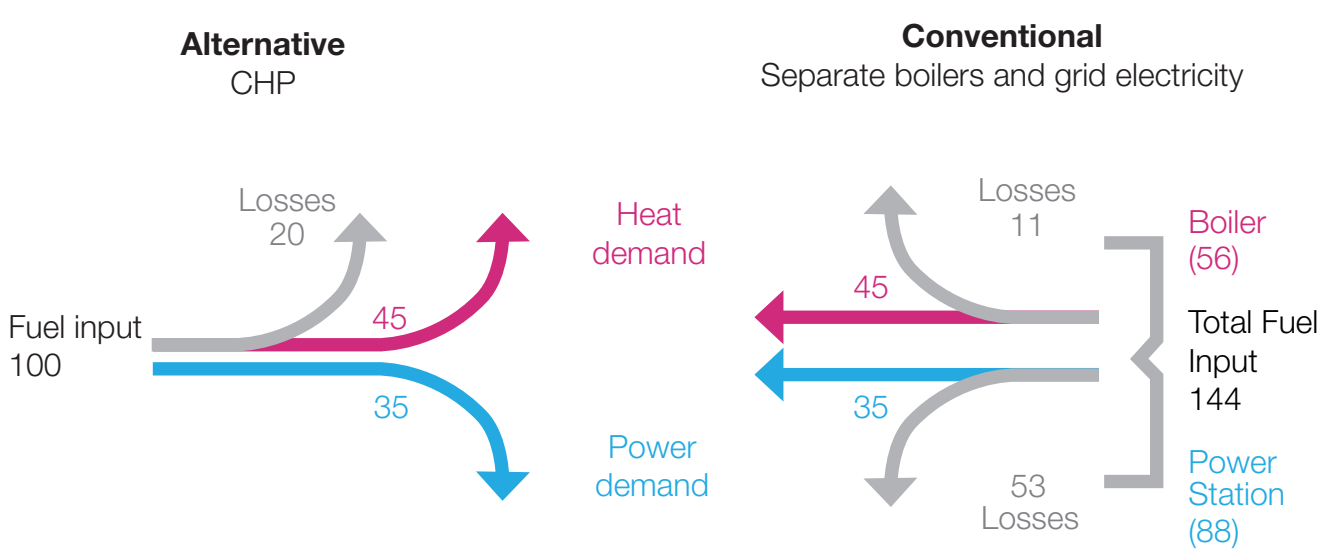
This Decentralised Energy Masterplanning Manual has been designed to provide one of the tools they need. Moreover, in a context of pressure on public sector resources, this method has been designed to be as resource efficient as possible, by enabling local authorities to take their DE opportunities much further down the delivery trajectory before they need to rely upon outside expertise.

1.1 What is Decentralised Energy?

Decentralised energy means the generation and distribution of energy closer to the locations where energy is consumed. Currently, electrical power in the UK is generally supplied from a relatively small number of very large power stations, most of which are in remote locations away from population centres. This approach creates a variety of inefficiencies in the overall energy system, of which the greatest is the inability to use the waste heat from power stations for beneficial purposes. By locating a generating station close to where the energy is used, decentralised energy offers the potential for the waste heat to be captured and distributed to buildings or industrial process which need it. Figure 1 shows the efficiency impact of a combined heat and power system compared with separate generation of heat and power.

Although decentralised energy can also refer to local generation of energy through renewable resources such as solar and wind energy, in this document the term is used solely to refer to combined heat and power systems connected to district heating networks.

Figure 1
Efficiency of Combined Heat and Power (CHP) generation



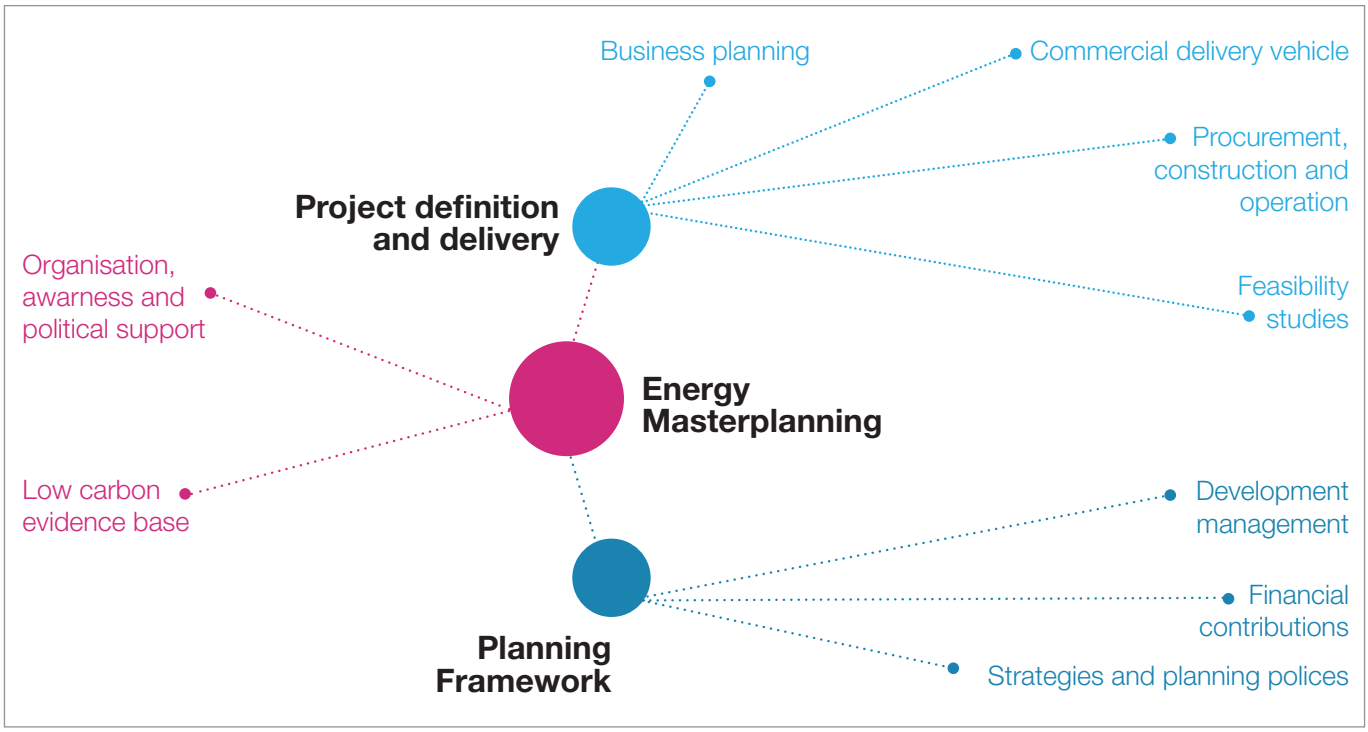
CHP reduces primary energy consumption in comparison to methods invloved in the seperate generation of space-heating, domestic hot water, and electricity

1.2 What is Decentralised Energy Masterplanning?

The decentralised energy masterplanning process draws upon London's experience of supporting local authorities and other DE developers from a starting point of first principles all the way through to project procurement and delivery. That process has been represented in the DE masterplanning trajectory, which sets out a step by step process of learning and development. The key stages in the trajectory are shown in Figure 2. The trajectory has been specifically designed for the local authority context and so it recognises the council's distinct roles of planning authority and developer/estate owner.

At the heart of the trajectory is the energy masterplanning process. This stage enables local authorities to assess the opportunities which emerge from their low carbon evidence base outputs (including heat mapping) and to produce a robust area-wide strategy which maximises the opportunity for large-scale schemes to capture and use waste heat from major energy sources. Without the energy masterplanning process in place, local authorities are at risk of adopting a piecemeal, reactive approach to individual combined heat and power opportunities which fail to realise the full carbon reduction potential of a single integrated system.

Figure 2
DE Masterplanning Trajectory



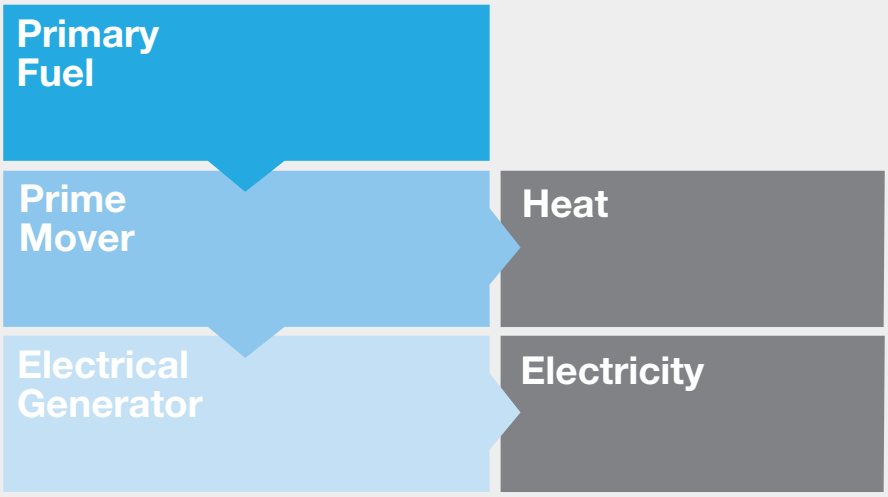
2

A brief introduction to decentralised energy

This section provides to the principles and challenges of decentralised energy systems, a brief introduction is provided to set the context for the more detailed guidance on the DE masterplanning process.

The concept of combined heat and power (CHP), which is illustrated in Figure 3, is that a Prime Mover (such as a gas engine) converts a primary fuel into electricity, whilst also recovering the heat by-product and feeding it into a local heat network. A range of generation technology options exist for use in district energy systems. In general terms all technologies recover waste heat as a by-product of electricity generation.

Figure 3



2

A brief introduction to decentralised energy

An example of the heat extraction method for a gas internal combustion engine is shown in Figure 4, for illustration purposes. In this example heat recovery takes place from the jacket heat exchanger and the exhaust system. It is noted that in many cases, heat can also be recovered from the intercooler and the lube oil circuit of such systems. In larger generators (such as power stations) heat can be recovered from the end of the process following electricity generation in a steam turbine.

The choice of technology for a particular application will be governed by the consideration of economic, technical, policy and planning related factors. These are discussed later in this Manual.

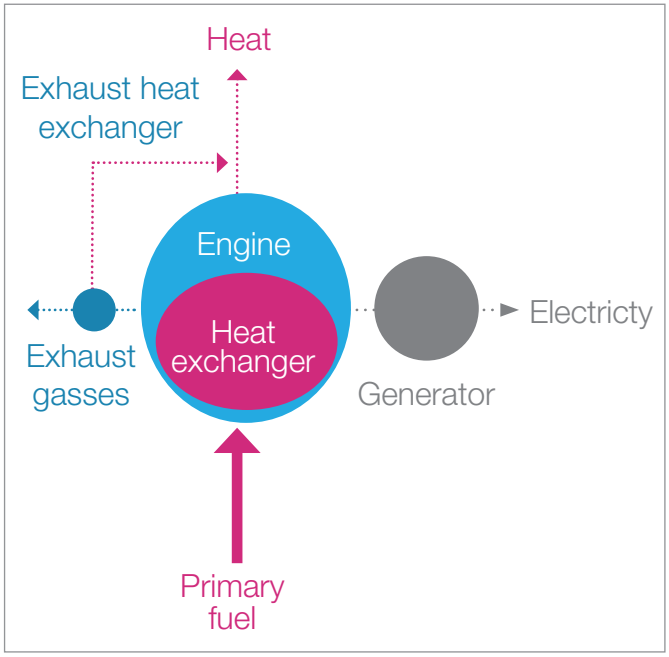
The medium (or energy carrier) normally used for modern district heating networks is water, but steam can also be used where there are higher temperature heat requirements (such as for industrial processes).

2.1 Key benefits of decentralised energy

In addition to the overall energy system efficiency and associated economic and carbon benefits, district heating networks offer a number of other advantages over the conventional stand-alone approach to building energy supply:

- They facilitate the deployment of embedded CHP and can thereby obviate the need for electrical network reinforcement and additional peaking plant.
- They can be supplied by a range of heat sources, either operating alone or as a combination of plant types.
- Heat networks with thermal storage can decouple the timing of generation and supply. In urban areas, the value of land impells heat users to be reluctant to have thermal storage onsite. Using a central thermal store at an energy centre can enable electrical heat generation to be switched off at times of low demand and to generate at times of peak demand. In Denmark, for example, heat networks have a key role in balancing wind generation intermittency.
- Heat networks facilitate fuel policy flexibility. By installing heat networks, new forms of heat generation or new fuels can be incorporated over time, because the pipework typically lasts three times as long as the prime mover (15 years vs. 45 years).
- Heat networks remove the requirement for individual gas connections, boilers and flues. In addition, the maintenance responsibility for the centralised plant is devolved from building level and can be assigned to a site management company or Energy Services Company (ESCo).

Figure 4
A typical CHP plant schematic



CHP boiler house

Pimlico District Heating Scheme Thermal Accumulator

2.2 Key drivers of scheme viability

District heating systems have been around for decades and in many European and North American cities they operate on a very large scale with the majority of the city's heating requirements being met in this way. The engineering challenges to creating new networks are therefore well understood and technical solutions are readily available in most situations. The real challenge with each opportunity is, how to design and deliver a network which is commercially attractive. This section highlights some of the key factors which will affect the viability of schemes:

- Scheme heat density
- Load diversity (e.g. mix of uses)
- Presence of anchor loads
- Scheme development costs
- Revenue potential from electricity and heat sales
- Avoided building energy system costs
- Scheme operating costs

Scheme heat density

The installation of district heating systems is very expensive, with the capital cost of just the network typically in the range of £1m to £3m per linear kilometre of pipework. Therefore it is costly to connect widely dispersed buildings. Conversely, where buildings are densely concentrated, for example with blocks of flats, district heating is an attractive option.

The spatial density of buildings and their thermal characteristics combine to define the 'heat density' of the buildings in an area. The indicative commercial viability of district heating systems can be expressed in terms of an area's heat, density (e.g. kWh/m^2/yr). Research undertaken for DECC has estimated that areas with a heat density of less than around 26 kWh/m^2/yr are unlikely to support a viable heat network[1]. However, heat density is but one factor which affects scheme viability and it should be taken as no more than a general guide, such as to inform a preliminary district heating opportunity screening assessment.

Load Diversity

Different types of building occupiers have varying demands for heat. For example, domestic householders' consumption of heat peaks in the early morning and during the evening, whilst during daytime it tends to be lower. In commercial offices, on the other hand, usage peaks in the morning but then tends to plateau through the rest of the day. Other uses, such as swimming pools, hospitals or prisons tend to have a flatter daily consumption profile.

Combining different types of buildings into a single district heating scheme can help to balance the load to create a more even daily and annual pattern of use. This will tend to increase plant utilisation rates (also expressed as percent on time) and to reduce the amount of peaking plant required. This will tend to improve both the technical feasibility and financial viability of schemes.

As an illustration of this principle, the diagrams in figures 5-7. show three typical daily patterns of use for, respectively, residential, office and hospital developments. The fourth diagram shows the impact of combining the three uses into a single district heating scheme. In the combined scheme there is still a morning peak and an overnight trough, but the residential and office uses in particular balance each other's load demands in the afternoon and evening, resulting in longer period of sustained demand and an overall flatter daily use profile.

1. Poyry and Faber Maunsell, 2009. The Potential and Costs of District Heating Networks: A report to the Department of Energy and Climate Change. The Poyry Faber Maunsell report expresses the viable heat density threshold as an average annual power density of 3,000kW/km2, and this figure is widely quoted in the literature on district heating.

2

A brief introduction to decentralised energy

Figure 5
Typical Daily Residential Heat Demand Profile

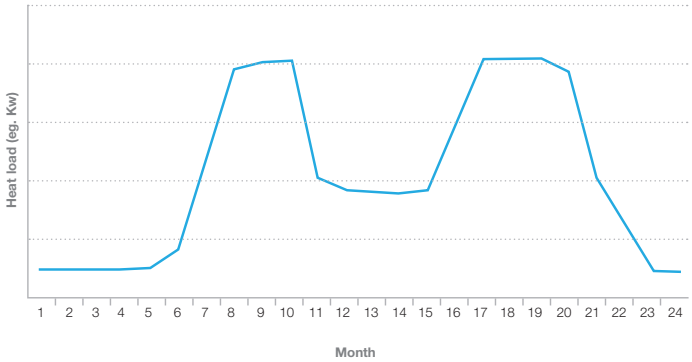


Figure 6
Typical Office Daily Heat Demand Profile

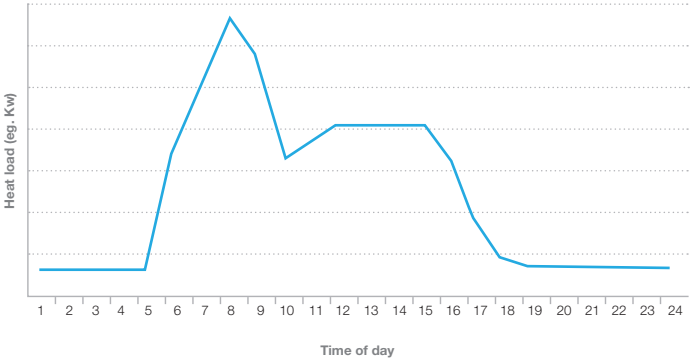


Figure 7
Typical Hospital Daily Heat Demand Profile

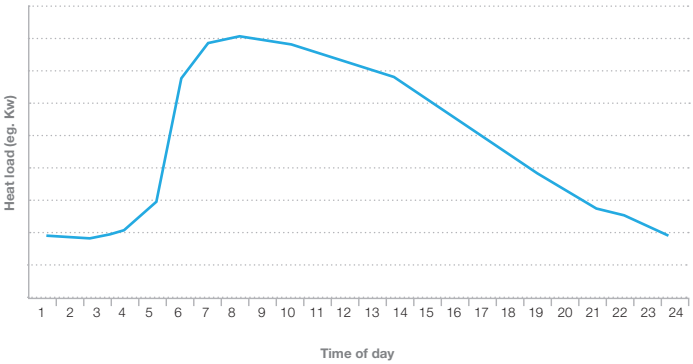
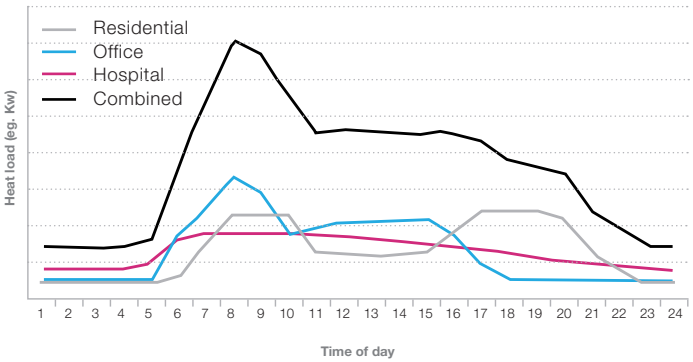
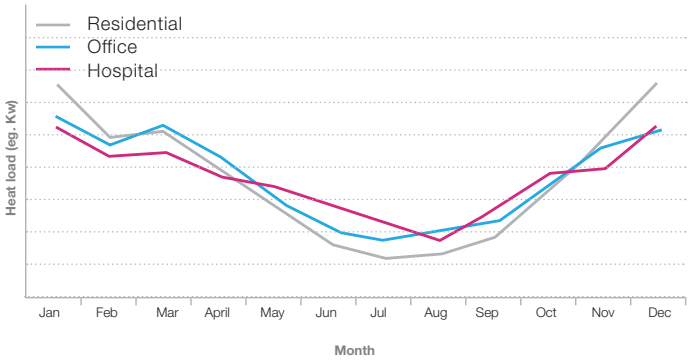


Figure 8
Typical Combined Daily Heat Demand Profile



The same principle can be applied to the management of annual demand, although for most uses, annual heat load patterns follow the seasons, with demand peaking in the winter and falling in the summer. The typical annual patterns of the three uses shown are shown below in figure 9.

Figure 9
Typical Combined Annual Heat Demand Profile



Presence of Anchor Heat Loads

Some building users have large demands for heat that are relatively steady over the course of a day and over a year. Often, these users are public sector organisations such as hospitals, universities, prisons and leisure centres with swimming pools. Manufacturing and industrial processes can also provide a steady anchor load to support a heat network, although some industrial uses have special requirements such as high grade (i.e. high temperature) heat which may not be compatible with general heating and hot water requirements.

Scheme Development Costs

Scheme development costs are made up of the following cost elements:

- design, planning and project management;
- commercialisation, procurement and other transaction costs;
- energy centre site development, plant and pipe costs;
- heat network installation, including any diversion or protection of existing utilities or assets affected by the network;
- fuel supply and power infrastructure upgrading (i.e. gas supply and grid connections);
- network connections to buildings;
- financing costs (i.e. the cost of borrowing or other financing mechanisms)
- land costs, including acquisition of rights or easements over land.

Of these costs, the heat network (i.e. the purchase installation of the pipes) often makes up the largest portion of the total cost of the scheme, which emphasises the importance of high heat density to provide sufficient heat consumption to underwrite the capital cost of network installation.

Heat networks are typically laid in the street, in common with other utility infrastructure. However, "hard dig" routes are considerably more costly than "soft dig" options such as along grass verges or canal towpaths. Where a street is already congested with existing utilities, the costs will be even greater.

The impact of financing costs is the same as for any capital investment: repayments on a loan begin as soon as it is made, but the revenue stream only commences once the network is installed and buildings are connected. Therefore schemes need to ensure a sufficient quantity of demand is connected early in the project life cycle and to consider carefully the opportunity for deferring or phasing the installation of the network and other capital expenditures.

Existing communal heating systems and site infrastructure which are suitable for reuse can offer significant opportunities to kick-start network opportunities. The ability to leverage the existing central plant assets and distribution infrastructure can clearly reduce investment costs and should be considered where possible; however it can also prove technically difficult to build, a thorough feasibility assessment would need to be undertaken.

Visits to existing energy centres can help build stakeholder understanding and confidence in the deliverability of DE schemes.

2

A brief introduction to decentralised energy

Revenue potential from electricity and heat sales

A CHP scheme connected to the electricity grid and to a district heating network will generate income streams from both the power and the heat.

A major barrier to the viability of CHP schemes is associated with the value of the electricity generated. The revenue potential from electricity sales depends on the value of electricity used on site and/or exported from the site.

In most cases, a CHP operator will not be an electricity licence holder under the Electricity Act 1989 and consequently will be able only to use generated electricity on site or to sell it on to the grid, i.e to the distribution network operator (DNO). The DNO purchases the exported power at the wholesale price, resulting in a very modest revenue stream for a CHP operator from the electricity which is surplus to the on-site requirements at the time it is generated. On the other hand, power from the CHP which is used on-site has the effect of displacing grid electricity which would have been purchased at the much higher retail price.

At present becoming an electricity supply licence holder is prohibitively expensive for relatively small scale CHP generators, but the regulatory framework is currently under review by DECC and OFGEM, and options to enhance CHP may become available in the future.

One option would be to allow an organisation which owns a number of buildings on different sites to pay on a net basis, where surplus power exported from a CHP would be credited against power imported to supply a different building owned by that organisation. This would have the effect of increasing the amount of the power output from the CHP which carried the higher retail value. Another option, introduced recently by OFGEM, is a ‘‘licence lite’’ arrangement to allow organisations owning generation plant (e.g. a local authority) to operate under the full licence owned by an electricity supply licence holder. At the time of writing this option is being considered by a number of London boroughs in partnership with the GLA but as yet no ‘‘licence lite’’ is known to have been sought or granted.

Installing district heating pipework in the street

Avoided building energy system costs

When a heat network connects to a building it effectively replaces the on-site heating plant, saving both money and space, especially in new buildings. This avoided cost can provide a resource to support the connection cost from the nearest network distribution pipe to the site being connected. In simple terms, if the cost of connection is less than the cost of installing an on-site heating system, then the connection will be viable for the building owner. If it is greater than the on-site option, the connection will not be made (unless mandated through regulation or planning policy). However whole life costs and costs and risk allocation assumptions should be considered to provide a ‘‘true’’ cost comparison.

For existing buildings, the same principle applies, except that in this case the potential for avoided costs occurs when the existing plant is nearing the end of its life, or when the building is undergoing major alterations. That means that all buildings, whether existing or new, have a “window of opportunity” for connection. If that window is missed, it may take a period of 10-15 years before the next opportunity arrives.

Scheme Operating Costs

The scheme operating costs include:-

- the cost of fuel or heat (the latter case would be where a DE scheme involved purchase of heat from a separate generating company – i.e. a GENCo);
- the cost of levies payable on fuel (any benefits to the scheme through fuel levy exemption should be taken into account as a saving);
- the cost of plant operation and maintenance (O&M);
- the cost of periodic plant replacement;
- the cost of management and administration of the scheme.

It will be seen that district heating scheme viability is highly sensitive to the price of fuel, since the price goes directly to the unit sale price of heat.

As a rule of thumb operation and maintenance will generally be more cost effective for large, centralised plant than for plant distributed in multiple locations.

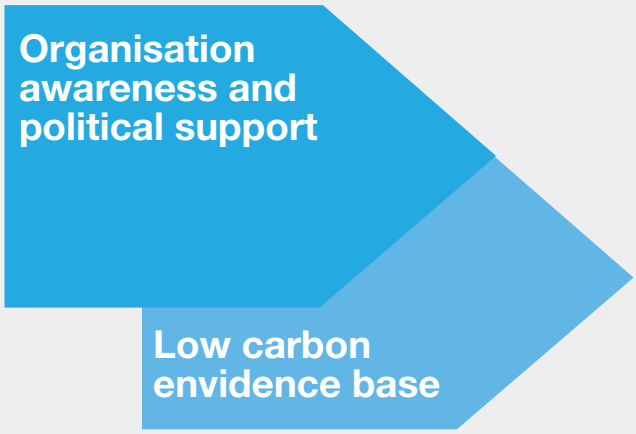
3

Capacity Building

This section covers the initial capacity building stages of organisation, awareness and political support. It has been developed to address the situation of a council with limited experience and resource capacity to deliver DE opportunities.

However, each council will be unique and caution should be exercised from expending too much effort on general capacity building exercises before progress is made on heat mapping. Discussions with officers and external stakeholders and partners can be much more effective when focused around specific opportunities known within the authority.

Capacity building



3

Capacity Building

An energy masterplanning workshop

3.1 Summary

The initial action is to establish the necessary structures and working groups within the local authority in order to pursue DE opportunities and to ensure that key officers have the necessary awareness and understanding of DE. There is also a need to ensure political support and stakeholder commitment, so that influential decision makers understand and are committed to progressing DE opportunities.

The elements that comprise capacity building can be categorised broadly, as:

- **Building the structures,** i.e. the internal networks and relationships. The delivery of DE schemes in any council organisation will require close working between different departments over a sustained period of time;
- **Required Resources,** ie, ensuring adequate budget and or staff time resources to promote or deliver DE opportunities
- **Improving technical understanding**, i.e. improving relevant officers' knowledge of DE and CHP technology, development opportunities for DE, how to lead a heat mapping exercise, how to assess energy statements, and related issues;
- **Raising awareness**, i.e. ensuring the benefits and opportunities for DE are understood by key officers through the authority. This also includes external stakeholder engagement, encouraging early discussions between the council officers and the owners/ managers of existing DE networks, potential heat customers or generators of waste heat that might be put into a DE scheme; and
- **Building political support,** i.e. developing support for DE amongst influential decision makers to gain their commitment to progressing DE opportunities.

These issues are detailed further in the sections below.

3.2 Building the structures

DE Champions

Councils should first identify key officers who will act as DE champions. There may be a need to consider organisational changes or new joint working structures to ensure a robust and sustainable capacity within the council to deliver the DE objectives. DE champions may be found in a variety of departments:

- Regeneration and Planning
- Environment and Sustainability
- Housing
- Infrastructure and Highways
- Estates teams

A contact list should be drawn up outlining the cross-departmental key DE officers and a map of the teams showing where responsibilities for DE lie.

Internal Working Group

Once the key DE individuals have been identified, a cross-departmental internal working group should be established to champion and progress DE. Below are some suggested terms of reference for the working group.

Purpose

The purpose of the DE steering group should be to promote DE potential in the authority and help integrate DE delivery objectives across all relevant council activities and strategies.

Objectives

The overall objectives of the group could be to:

- Ensure there is an integrated approach to delivering DE across the authority;
- Increase DE awareness and knowledge among staff;
- Increase political commitment to DE;
- Ensure opportunities to incorporate DE in development and master planning projects are identified at an early stage;
- Develop links with relevant external agencies and organisations in relation to DE;
- Ensure that the DE proposals advance to implementation stage;
- Ensure that the DE evidence base for the authority is regularly reviewed, updated and where relevant uploaded to a heat mapping website
- Ensure that DE opportunities are reflected in all authority policy and strategy documents;
- Identify opportunities for DE funding within the authority and secure necessary budget for delivery/ implementation of opportunities; and
- Review and comment on specific opportunities which arise through planning applications

Figure 10
Model DE Steering Group structure

Scope
The DE steering group could undertake the following tasks:

- Lead the delivery of DE workstreams, including feasibility studies and formation of commercial structures.
- Review LDF documents and other corporate plans and strategies to ensure they reflect an awareness and appropriate supporting language for DE.
- Provide training and awareness events for staff and, where appropriate, other stakeholders and partners (such as LSP or LEP members).
- Coordinate the identification and development of DE opportunities and form project teams as specific opportunities coalesce into specific proposals.
- Provide advice to officers on DE issues and questions, and where appropriate engage with external bodies (e.g. the CHP Association) to secure additional advice and support.

Membership and Structure
The cross-disciplinary structure of a steering group emerges out of a recognition that a range of disciplines and departments will be needed to support the delivery of DE projects. The DE steering group should consist of the following:

- The authority's Energy Champion(s), who should be responsible for leading the Group and chairing meetings;
- Officers from nominated teams who may be involved in the planning and delivery of DE or managing other aspects of energy systems, operation and use within the authority (e.g. housing, facilities management, regeneration and planning); and
- Further individuals may be invited to attend certain meetings as deemed necessary and agreed by the group, (e.g. local strategic partnership representative, housing providers or education, leisure and Section 106 officer).

Whilst a range of departments must be represented on the steering group, it is recommended that the group's membership is kept reasonably small in the early stages of developing DE networks.

Once specific opportunities have been identified through the evidence base, the Group should be expanded to include all those likely to be involved in implementation. The delivery of opportunities, such as the procurement of feasibility studies or even the development or commercial structures for the creation of council-owned DH networks, will be assigned to individual working groups formed for each project. The number of working groups is not prescribed as it will differentiate between authority circumstances.

It is important that the steering group is answerable to a suitable environmental or sustainability Board in order to monitor progress and sustain political support.

A model structure of a DE steering group is set out in Figure 10 above.

Roles and Responsibilities
Steering Group members should be expected to:

- provide expert advice based on their experience and knowledge and/or act as a conduit for the provision of external expertise; and
- represent their own council department's needs and concerns while working constructively with colleagues to achieve the overall objectives.

Steering Group members should be encouraged to:

- submit papers as required, highlighting issues and identifying potential solutions;
- share at the earliest time any potential opportunities for DE schemes;
- share experience with developing DE schemes including bringing forward specific details of these schemes, whilst respecting commercial or political sensitivities; and
- report back to other parties on the issues that have been discussed. This should include external parties such as the Local Strategic Partnership, Registered Social Landlords (RSLs) etc.

3.3 Required Resources

Committing to the production and delivery of an energy masterplan inevitably requires the commitment of resources, whether internal staff time or external consultancy support. The approaches to heat mapping and energy masterplanning have been developed to enable officers to undertake much of the early work in-house. In this section we have also highlighted the potential to adapt existing governance and interdepartmental communication networks to enable them to cover the needs of DE planning and delivery. These measures should help to minimise the additional resources needed.

Nevertheless, the experience in London suggests that the early planning and coordination work to define opportunities and to develop the masterplan could require around a half a full-time equivalent (FTE) staff resource, although the actual requirement will depend greatly on the size of the local area and nature and number of the DE opportunities. Once a particular opportunity has been identified, the resource requirement is likely to increase. Typically for a medium size district heating network, one full time equivalent staff resource could be required as well as significant external support to carry out technical feasibility studies, to secure business case approval, to design and manage procurement processes and to complete contracts.

The timescale for heat mapping and energy masterplanning is typically around four to six months, with the project development and delivery process taking in the range of 18-30 months for feasibility, business case, procurement and construction. Again, these figures are very approximate and should not be uncritically relied upon but could be used for initial resource and timetable planning.

3.4 Improving technical understanding

It is clearly important to improve the technical knowledge of nominated officers on decentralised energy (including CHP). It is likely that DE champions will come from a variety of professional and technical backgrounds and therefore it is useful for them to develop a common understanding of the principles of DE, covering the history, engineering background, case studies, implementation and delivery.

It is suggested that a series of workshops are convened with nominated officers whose remit is to progress DE in the authority (e.g. housing, education, leisure, facilities management, regeneration and planning teams), which could cover:

- Decentralised energy opportunities in the authority;
- Case studies, good practice examples and solutions to DE issues
- Development of protocols for considering DE as part of development and renewal programmes
- Technicalities of DE, which could include provision of a 'Technical Q and A' document.
- Workshop on how to lead a heat mapping exercise
- Workshop with planning officers to disseminate heat mapping results and how to use the evidence base to approach negotiations with developers
- Workshop covering suitable planning obligations and drafting suitable planning conditions to ensure DE opportunities are secured
- Workshop on potential funding sources
- Providing training for officers on Energy Statements that accompany major planning applications and checklist for assessing energy statements submitted with planning applications. The training session could include examples of current schemes and review of submitted energy statements

3.5 Raising awareness and building political support

Once the structures have been put in place within the Council with identified DE champions and a working group, and these individuals have developed a broad understanding of DE, it is then important to disseminate this information. Given the novelty of DE in many local authorities, securing political support will need to be a key early task for the DE champions, with the effort focusing on linking the DE agenda to key existing priorities such as cost savings, energy security or climate change mitigation.

Communication should be directed at:

- wider teams to ensure that the benefits of DE are understood by key officers across the authority;
- key decision-makers within the Council; and
- relevant stakeholders and partners that may become involved with DE.

It is suggested that a number of events are convened with the groups to raise awareness of the DE programme and opportunities, including:

- Events with officers from nominated teams whose remit is to progress DE in the authority (e.g. housing, education, leisure, facilities management, regeneration and planning teams) and to disseminate heat mapping results where appropriate.
- Events with key stakeholders to discuss DE opportunities in the authority and disseminate heat mapping results where appropriate. It is suggested that this might work well as a breakfast meeting, giving a presentation with key stakeholders, followed up with a forum-style discussion.
- Arrange group meeting with lead officers from neighbouring councils to discuss DE opportunities
- Information sharing session event open to all (e.g. businesses, stakeholders, councillors, general public) within the authority to provide an overview of decentralised energy

At this stage, it would also be useful for the council to make contact and engage with any stakeholders that are directly involved with the delivery of DE, for example the owners/managers of existing DE networks, potential heat customers or generators of waste heat that might be put into a DE scheme. Early discussions between council officers and these groups are essential to ensuring all DE opportunities are maximised.

3

Capacity Building

4

Heat Mapping

A heat map is a spatial plan of existing and planned building heat demand, and decentralised energy networks and generation equipment. The objective of a heat map is to enable the user to identify opportunities for developing or expanding DE networks.

A heat map can be a live database of information that can be regularly updated to show information on new developments or changes of use. It should be a comprehensive source of information that convenient alternative for example when considering off-site opportunities for new developments by removing the need for each site to collect information on neighbouring sites when investigating the potential for connection. A heat map would provide a large amount of the information required and would allow all parties including the local authority to be well informed.

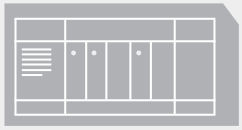
The heat map forms the basis of a DE masterplan for an area and it can act as an evidence base for DE policy.

Heat map development involves three key steps:

Data Gathering

Analysis

Implementation Plan



4

Heat Mapping

4.1 Data gathering

This step involves the gathering data from a variety of sources to populate the GIS-based heat map database. The following information will need to be gathered. Please see Heat Mapping Data Entry Form Appendix A for an example spreadsheet template for collecting this data. The DE Pre feasability toolkit ACT also includes a template for recording this data. The toolkit can be downloaded at www.arup.org/w.londonheatmap.org

Heat loads

Assemble heat load (heat or gas consumption) data for all existing and proposed buildings in the heat map area.

Whilst it is desirable to have a fully comprehensive database of all the buildings within the heat map area it is inevitable that efforts will need to be focussed on the sites that will be of most interest for a DE scheme.

Some buildings are more likely to be suitable for connection to a DE network than others. This is due to their heating load profile being complementary to the efficient operation of energy generation plant such as CHP (i.e. they show a fairly constant and large heat demand throughout the day and year). The data collection for these buildings should be prioritised as they are more likely to provide anchor heat loads for a district heating network. These building types are hospitals, hotels, leisure centres with swimming pools and prisons.

Buildings over which the local authority has control or greater influence, and which are therefore more likely to connect to a DE scheme should also be prioritised. This would include information gathering for local and central government estate as well as proposed new developments.

The spreadsheet template in Appendix A shows the level of information required to create a comprehensive database. This information can be broadly categorised as follows:

Building location - The X & Y coordinate values (i.e. northing and easting) used for a site should match the X & Y values found in the address point for that building (using the OS Address Point database). Where no address point is available the X & Y value should be within the boundary of the building. It is not advisable to use an X & Y value from a post code, as it represent several addresses.

Building address – The full building address is required as this enables crosschecking of coordinates and easy reference to specific buildings when corresponding with stakeholders.

Building ownership – Publicly owned buildings should be distinguishable from privately owned buildings.

Building typology – Buildings should be categorised by use (e.g. offices, hospitals, etc) to allow identification of the potential anchor heat loads. This is also useful for identifying whether a mix of building typologies are present and hence whether the heat demand profile is diversified to result in a more constant overall demand.

Building age – The year of construction of the building can act as an indication of the practicality of connection to the building or the likelihood of there being a desire for the building to connect.

New buildings (i.e. those built within the last ten years) are less likely to be opportunities for connection given that the current heat supply equipment will be early in its operational life and it may not be cost effective to replace relatively new equipment with a connection to a district heating scheme. New buildings also typically have a lower heat demand than older buildings.

Very old buildings may be listed or hard to treat in some other way which may limit the ability of the building to connect to a DE scheme.

Building status – Identify whether the building is existing or proposed. Future developments can also be identified such as those which are not in planning but are part of long term strategic plans for the development or redevelopment of an area.

Current heating supply – Fuel type, plant size (normally rated output in kW or MW, system type (e.g. gas boiler, oil boiler or biomass CHP), age of plant, replacement date.

Heat demand – The heat map should be consistent in the presentation of heat consumption as primary fuel (e.g. gas) or heat. This can be sourced from billing information (representing actual consumption) or estimated using published benchmarks for the building type (e.g. CIBSE Guide F). For new development it will be important to consider the influence of future changes to building regulations on energy consumption and as such forecasts for heat demand should take this into account. This information can be sourced from energy statements accompanying planning applications or using benchmarks.

The year of operation which the data collected represents should be recorded as this will allow the value to be normalised for long term average weather conditions (heating degree days) since weather varies on an annual basis. Heat consumption data is very much linked to how the building is used so more recent data will provide confidence that it is representative of the current occupancy of that building.

Confidentiality – Permission should be sought from the data provider before publishing any data. Confidential data can be identified as such and filtered out from any publications.

Development timescales – (for proposed development)Often new development is a catalyst for a DE scheme. In order to understand the phasing of a DE scheme it will be important to consider the start date for construction to ensure that any works required to accommodate DE scheme connection can be considered prior to construction. The completion date for each phase of the development will indicate when the buildings will connect and therefore require heat from a DE scheme.

Of all the above categories the essential information categories required for basic heat mapping are building location, building ownership, building typology, heat demand, confidentiality and development timescales for new development.

Heat supply equipment

Identify all major existing and proposed heat supply equipment in the heat map area.

Heat supply equipment includes combined heat and power plants (sometimes found in hospitals), waste incineration sites, boilers, anaerobic digestion plants and power stations. This data is collected so that those sites which offer the potential for expansion or have spare capacity may offer the opportunity to supply a DE network with heat.

This step focuses on major heat supply equipment. A suggested minimum thermal capacity of the equipment that would be of interest would be 2MWth. Boiler plant that supplies one building for example is unlikely to be of interest to a DE scheme as an opportunity for supply although it may well be kept as back-up should that building connect to the DE scheme as a heat load.

District heating networks

Identify all existing and proposed district heating networks in the heat map area.

There may be potential to extend existing or proposed district heating networks to serve new buildings or connect multiple schemes to form an area wide network. Information on the current supply system should be gathered and the network route should be plotted on the map.

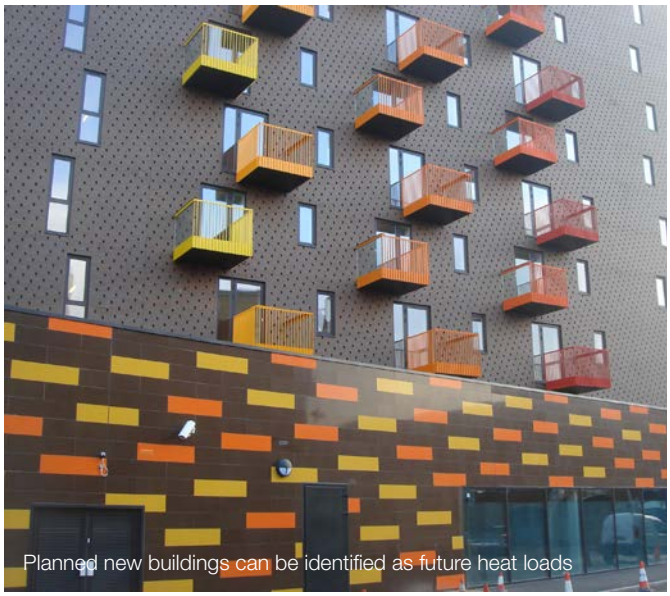
This section should also capture communally heated buildings, estates and campuses. These may be small networks compared to a district heating network but they offer the potential to connect multiple units or buildings to the network through one point of connection.

It is easier and cheaper to lay pipes along quiet park paths

than on busy major highways

4

Heat Mapping

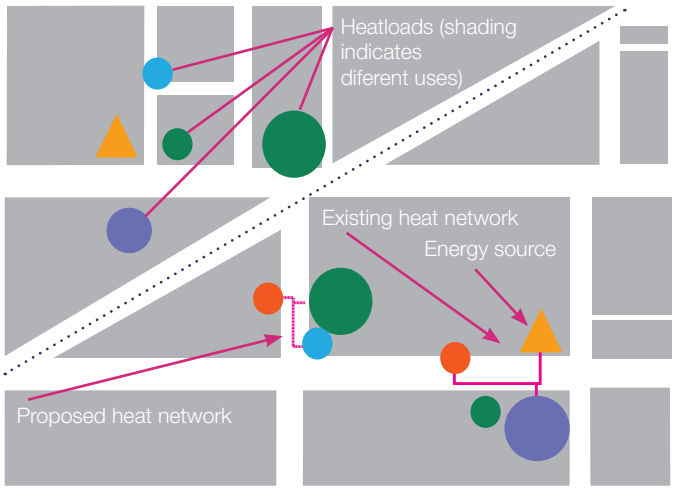

Planned new buildings can be identified as future heat loads

Output

Once all the data is collected it should then be uploaded into GIS format with an Ordnance Survey (OS) map as the base layer. Additional layers that may also be useful to overlay onto the map are policy areas and proposals, such as area action plan areas, designated development sites, OAPF areas, fuel poverty areas, social housing density and Economy 7 units.

An example of what the heat map might look like at this stage is shown below.

Figure 11
Example Heat Map Output



4.2 Analysis

The objective of this step is to identify 'focus areas' where there is high potential for district heating schemes. This stage involves opportunity and constraints mapping.

Identify areas of high heat demand density

The GIS map should be presented so that the size of heat demand of the buildings can be easily identified. This can be achieved by presenting the heat loads identified as circles or other icons which vary in size according to heat demand (i.e. larger circles represent larger heat demands). This can also be achieved by presenting contours of heat demand density; however this can be misleading if the database is not comprehensive. Buildings with no information will be shown as no heat demand when this may not be the case.

The typologies of the buildings should be represented on the map. For example each typology could be given a different colour so that the circles are now different sizes and different colours. This would enable 'clusters' of buildings of different typologies or priority typologies to be identified therefore providing some indication of the diversity of heat demand profiles whilst identifying the size of the heat loads.

Existing, planned and future heat loads should be identified. The phasing of the DE scheme is considered later.

Scope for extending existing networks

There may be potential to expand existing or proposed district heating networks to serve additional buildings. The buildings that are most likely to be able to justify further investigation into the feasibility and viability of connection are those with medium to high heat demands. A judgement will need to be made as to whether there is a significant opportunity. A collection of buildings in close proximity (within approximately 100 metres) with medium to large heat demands should represent a good opportunity whereas a single building with a medium heat load is unlikely to be a good opportunity.

Identify major heat supply plants

An existing or proposed major heat supply plant may offer potential to supply heat to the areas identified in the heat mapping. At this stage, information may not be available regarding spare capacity or space for additional plant to supply the network. The exercise is intended to identify the opportunity which can be qualified later.

Major heat supply plant should be represented so that they are distinguishable from heat loads for example a different shape (triangle) of varying size according to capacity.

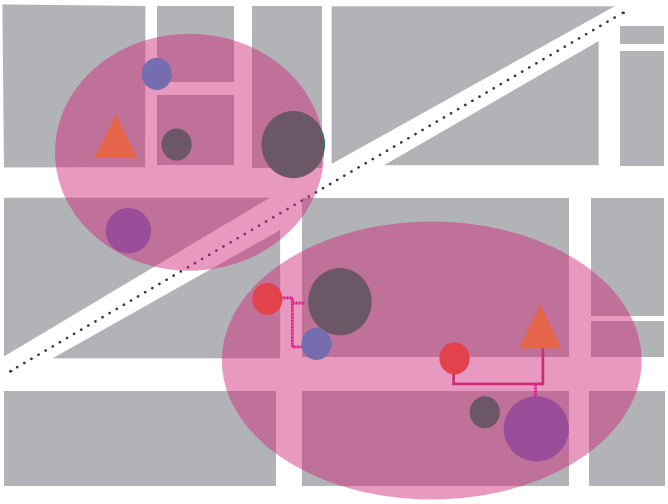
Identify physical constraints
Physical constraints include major highways, railways, waterways and cemeteries. Crossing these physical barriers may be costly or not permitted, and the focus areas may be limited by them. There may however be circumstances (e.g. where the heat loads are sufficiently large) in which the cost of crossing such barriers can be borne by the scheme ecconomics and hence the focus area would not be limited by this constraint.

Draw focus areas
The focus areas are rough indications of areas with highest potential for DE schemes exist. They do not need to be overly precise.

Major infrastructure and energy generation plant provide the potential for creating new networks

Draw a zone around each of the clusters of buildings and sites identified in the heat mapping. The presence of physical constraints will make these areas smaller and may limit connection to certain sites. Name the focus areas so that they can be referred to later. An example heat map showing the focus areas identified is shown below.

Figure 12
Example Focus Areas Output



Focus area prioritisation

The objective of this stage is to identify the focus areas which require short, medium and long term intervention to help realise the opportunities mapped. A number of factors will influence the prioritisation of intervention in the focus areas identified. Two key factors are:

Timescales – Existing buildings represent a current opportunity in that heat can be sold as soon as plant and pipework are complete. Proposed development represents short, medium and long term opportunities. The timescales for development should be easily distinguishable on the map. This may be achieved for example by re-colouring the heat load circles showing buildings to be constructed within a year as red (short term intervention), within 5 years as amber (short to medium term intervention) and within 15 years as green (long term intervention).

Ownership – Those opportunities which include new development or government estate are likely to be influenced more by the local authority than others. As such these may be prioritised over others. Ownership could be presented for example by hatching on circles which are not new development or government owned.

Other factors include political drivers, plant replacement programmes and others that are specific to the area. These can be considered at this stage also to generate a priority list of the focus areas identified.

At this stage it would be useful to hold a workshop or discussion with key internal stakeholders to agree which opportunities should be prioritised. Any new information brought to light regarding the circumstances of the opportunities can then be taken into consideration.

Focus area boundaries should not be taken as absolute indicators of which areas are or will be viable for a DH network; rather, their purpose is to concentrate limited time and resources on the locations where the opportunities are seen to be most promising.
As a minimum, these areas should be revisited every couple of years to ensure that awareness of new or changing opportunities remains up to date.

4.3 Implementation plan

The implementation plan is a 'next steps' plan to help the local authority to progress the opportunities identified. The prioritisation step in the analysis stage informs this stage of the process. Interventions required and the associated actions are dependent on whether short, medium or long term intervention is required. (Appendix B - Post Heat Map Implementation Plan Form) shows an example.

The implementation plan should be developed at the previously mentioned workshop or discussion session to obtain buy-in from internal stakeholders into the plan.

List the focus areas

Each focus area identified should be listed in order of priority with a description of the opportunity. This should in particular include a description of the planning status of any proposed development within the focus area. This will affect the level of influence that the local authority has on the development. If the development has not received planning consent there may be opportunity to require provisions for connecting to a DE scheme or future proofing for connection later. Developments with planning consent will be more difficult to influence but not impossible. Stakeholder engagement may be required as connection to a DE scheme may offer financial benefits.

List the barriers to DE development

By listing the barriers to development, the actions required to overcome these barriers may be identified. Barriers may be political, technical, planning timelines, ownership, etc. Examples of barriers are:

Commercial areas can provide a mix of heat load patterns, helping to smooth out overall heating demand curves and improving viability

- No provision for connection to an off-site DE scheme in energy statement of development planning application; and
- Limited public sector influence due to no new development or government owned buildings within focus area.

Identify the next steps and actions
The next steps should be primarily short term although medium and longer term actions may be noted here. The next steps should be specific to the local authority and that which is within their control. Examples of next steps are:

- Engage with private stakeholders to discuss potential scheme and assess appetite for connection;
- Engage with government estates department / housing department to discuss connection to potential scheme; and
- Introduce requirements within a planning application to connect to a DE scheme or future proof for connection.

Identify key dates
The key dates for the plan should relate to the opportunities for connection to a DE scheme and by which the identified action will need to be taken. Key dates could be planning application decision date, timescales for boiler replacement programmes, etc.

Identify actionees
The person identified as being responsible for this action should be engaged in this process and agreement sought from them that they accept responsibility for this action.

4.4 Outputs and Outcomes

The main output of the heat mapping process is a map showing the DE focus areas identified. As discussed earlier, this map is a live document and can be updated and amended later.

The implementation plan is a next steps plan for the local authority. It lists the actions required to progress the DE opportunities identified.

A report discussing the approach, analysis and results of the process is useful as not only does it record the process, but it can support the heat map as an evidence base for DE policy.

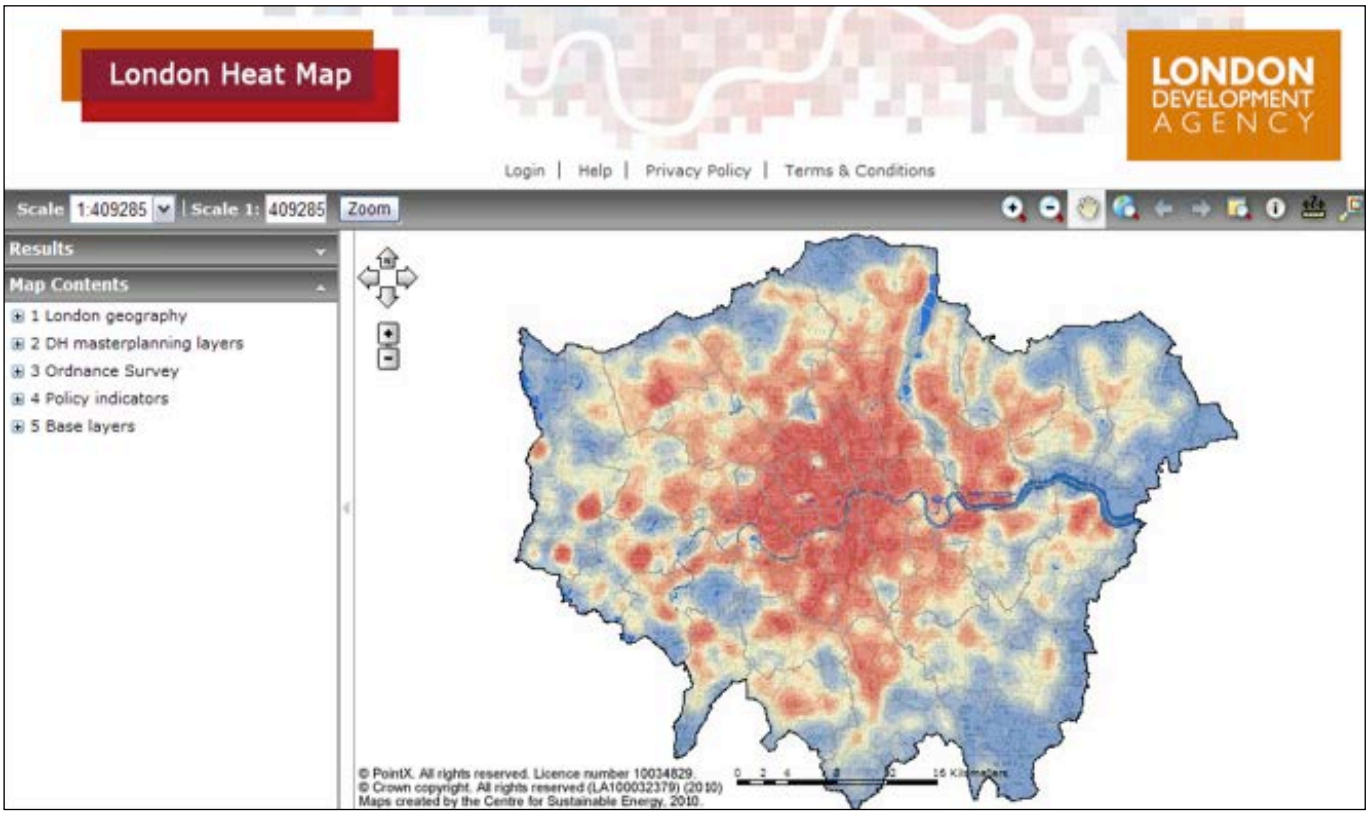


Figure 15
The London Heat Map website

Case Study

The London Heat Map Website

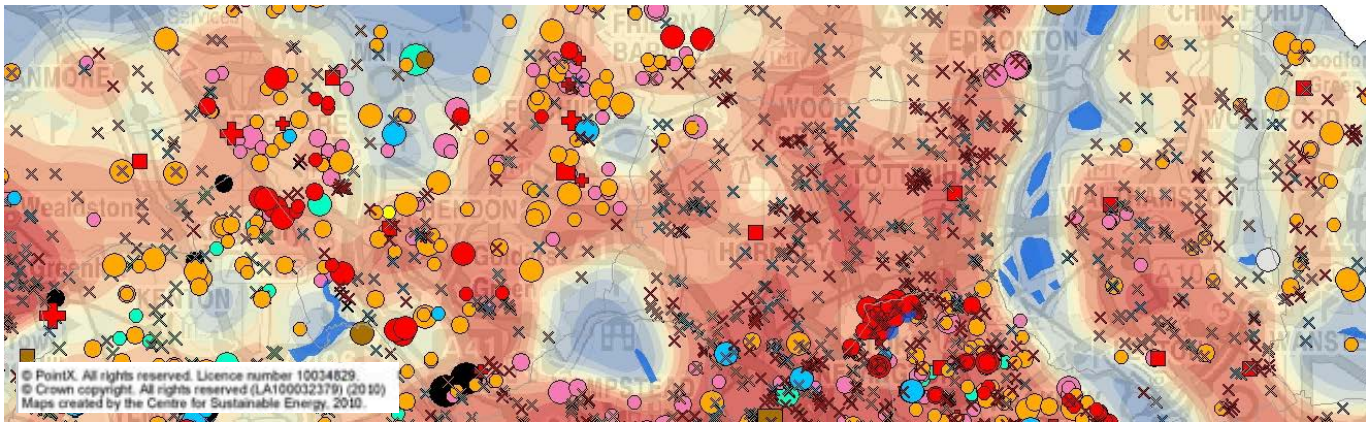
The London Heat Map (LHM) is a pan-London heat map. It is a GIS-based interactive tool that allows users to identify opportunities for DE projects in London.

The LHM provides spatial intelligence on factors relevant to the identification and development of DE opportunities: major energy consumers, fuel consumption and CO_2 emissions, energy supply plants, community heating networks, heat density etc. It is publicly accessible at **www.londonheatmap.org.uk**

Local authorities can use the map as the starting point to developing detailed energy master plans to inform DE policies in their Local Developent Frameworks and climate change strategies. Developers can use the map to help them meet London Plan DE policies (connection into an existing network or extending their own communal heating networks beyond their site boundaries).

The LHM is regularly updated and fully interactive by allowing users to upload and share energy data. A user manual for the London Heat Map can be found at **http://www.londonheatmap.org.uk/Content/HeatMap.aspx.**

More information on DEMaP and other useful information such as FAQs on DE and useful links can also be found on the website.



Case Study

London Borough Heat Maps

The DEMaP programme included a support package to boroughs to enable them to carry out heat mapping. The heat mapping support package consisted of a grant to boroughs to procure consultants to carry out a heat mapping study for their area and eight days of in-kind support from the DEMaP team of experts to help manage the process.

Nineteen borough heat mapping studies were carried out in the first two years.

The participating boroughs were:

Barnet	Hammersmith & Fulham	Lewisham
Bexley	Hillingdon	Redbridge
Brent	Kensington & Chelsea	Southwark
City of London	Kingston	Sutton
Ealing	Lambeth	Tower Hamlets
Enfield		Waltham Forest
Hackney		Westminster

The new heat maps contain real heat consumption data for priority buildings such as hospitals, leisure centres and local authority buildings. As part of this work, each of the boroughs developed implementation plans to help them take the DE opportunities identified to the next stages. The implementation plans include barriers and opportunities, actions to be taken by the council, key dates and personnel responsible.

The heat mapping reports along with the implementation plans for each of the boroughs that have taken part in the scheme so far are shown on the borough heat map page at **http://www.londonheatmap.org.uk/Content/borough_heat_map.aspx.**

All of the data collected through this process is also shown on the interactive heat map at **www.londonheatmap.org.uk.**

4

Heat Mapping

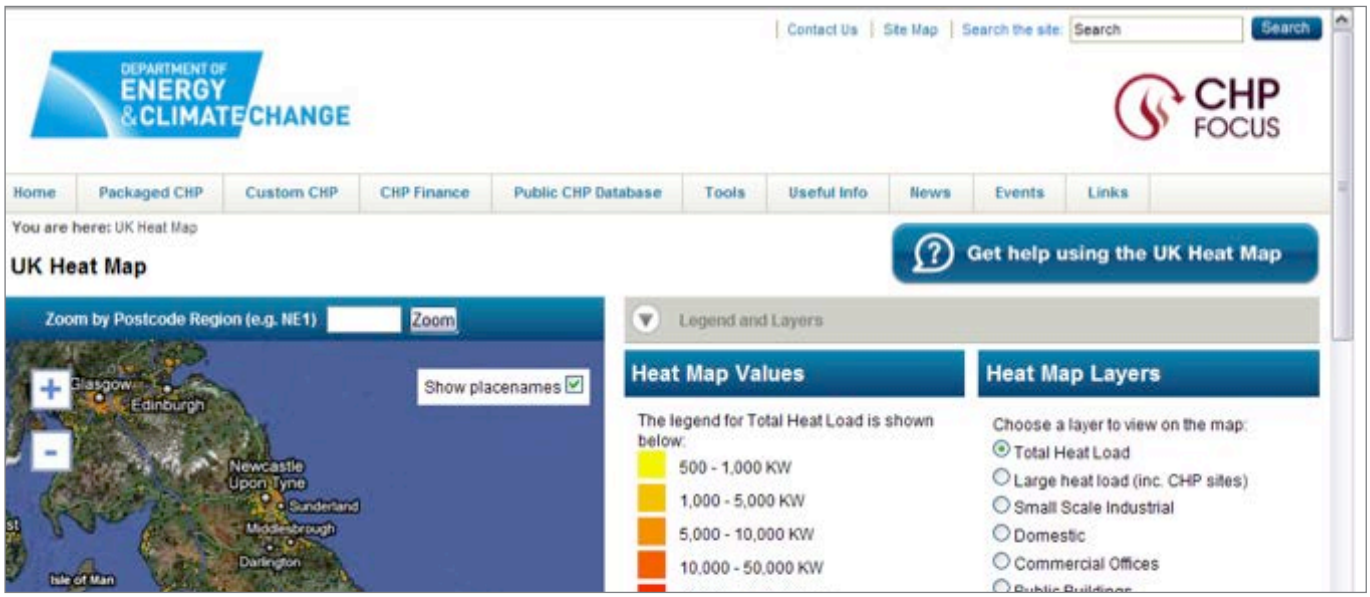


Figure 16
UK Heat Map Website

Case Study

UK Heat Map

A revised UK industrial heat map has been developed for the UK Government. The groundbreaking initiative is part of the Government's strategy to help promote decentralised energy for both new and existing buildings. The map has been developed as a successor to the original tool aimed at assisting power station developers to consider the opportunities for combined heat and power (CHP) as required under planning policy.

Due to the recently increased scope, the updated map can now be used by both small and large organisations to help identify the locations where CHP, renewable heat plants and district heating might have the greatest technical and economic potential, and therefore the largest positive environmental impact.

The interactive heat map presents the heat demand within the UK across various sectors. The search and zoom facilities allow users to search using grid references, highlight and isolate the heat use in specific post code districts. The search facility returns a high level of detail identifying the heat demand within the search area, which can be varied from 1 km^2 up to 100 km^2. The heat demand can also be separated by sector with large users highlighted on an individual basis. An updated national heat map is scheduled to be launched in November 2011.

CHP Focus is a new DECC initiative to support the development of combined heat and power in the UK. On the website you will find comprehensive information on all aspects of cogeneration, whether you are new to CHP or looking for specific information.

There is also free helpline support provided on **0845 365 5153**, where experts can provide guidance to those who require it.

Find more information about CHP Focus at **http://chp.decc.gov.uk/cms/** or for the UK Heat Map go to **http://chp.decc.gov.uk/heatmap/.**

DECC have also developed a CHP sizing tool which can be found at **http://chp.decc.gov.uk/cms/tools/.**

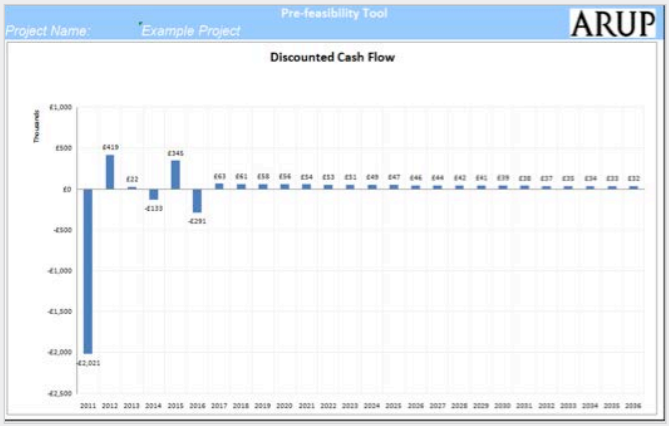
5

Energy Masterplanning

Delivering heat to buildings through a single large heat network relying upon a larger scale energy centre potentially offers significantly greater system efficiencies (and therefore carbon emissions reductions) than several smaller systems.

Furthermore, capturing surplus heat from existing large energy sources, such as power stations and waste incinerators, avoids the need for investment in new energy centres and consequently greatly improves the economic viability of the system.

Energy Masterplanning



A typical cash flow profile for a planned new network

5

Energy Masterplanning

This energy masterplanning process has been developed to help you identify, plan and deliver the strategic, large-scale CHP and district energy opportunities. The approach here is to begin at the end – to define the ultimate potential for heat networks in your area – and then to go back to the beginning to work out the pathway of individual phases which could realise that potential. Defining the end game will allow you to ensure that each small network will, if possible, act as a building block to a larger system rather than a permanently stand-alone system.

5.1 Before you begin

Before you begin this process you will need to have a number of information sources and tools in place. These are briefly described below.

Maps and heat data

At this stage you should have a heat map or other robust low carbon evidence base and these will give you a good idea of the parts of your locality which would be suitable for connection to a heat network. (If not, go back to Section 3.) You should print out a map showing:

- Existing anchor heat loads
- Existing major energy sources and existing or planned heat networks
- Planned development areas and energy sources
- Defined focus areas where these have been recommended from a heat mapping study.
- Opportunity Areas, Area Action Plan areas or other growth/ regeneration area boundaries.

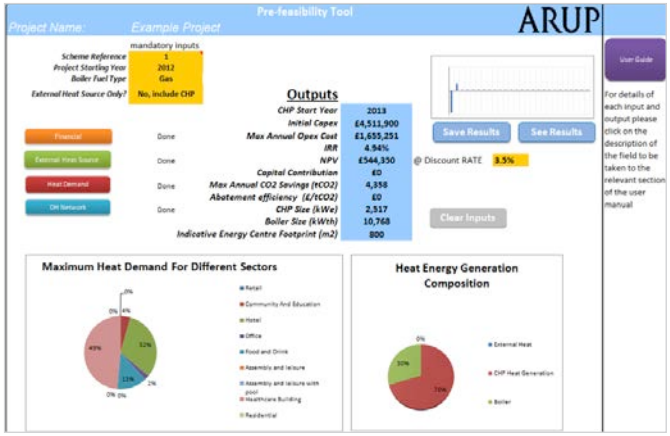
Alongside this map you should have a spreadsheet of all your existing and future planned anchor loads and major energy sources. This data will normally be exported from the heat map, but in any case the spreadsheet should contain data on the size and expected connection date of existing and planned anchor loads, energy sources, heat networks and major development areas. The connection date for new developments would normally be the completion date; for existing developments it would normally be the plant replacement date.

The type of development or type of owner will also give you an indication of the relative willingness of connection. For new development, planning conditions or planning obligations (discussed in the following sections) may oblige a developer to provide a connection to a new DH network. Public buildings, on the other hand, will be more likely to connect because they are within the control or influence of your local authority organisation. Existing private buildings will be more difficult to connect and should be regarded as a lower likelihood of connection unless contact has been made with the building owner.

Decentralised Energy Network Assesment Tool (DENeT)

As a companion to this Manual, Arup has developed an easy to use tool to support this masterplanning process. The tool (DENet) etestimates the energy and financial performance of potential schemes and provides outputs to give you an idea of the potential viability and carbon savings of different heat network combinations. The (DENeT) tool is designed as a method of prioritising the opportunities highlighted in the heat mapping. It is not a design tool, however, and a full feasibility study should be commissioned to identify technical and financial viability of specific schemes. It relies upon input data of heat loads and network pipe length, and can operate with or without an external heat source (based on input data).

Figure 14
Arup DENet Pre-Feasibility Toolkit Results Page



Risks, Issues and Opportunities Register

As you undertake the masterplanning process you will identify key risks, information gaps or opportunities which should be recorded for future reference and which will inform the implementation plan developed at the end of the masterplanning process. The risk register helps you to record risks and to identify mitigation actions and risk owners. A template risks and opportunities register is provided with the pre-feasability tool.

Opportunities and Constraints Mapping

During the heat mapping exercise you may already have begun to identify key constraints and network development opportunities. At this stage it is appropriate to extend this work to ensure that all areas of potential development are adequately mapped for the key features which will affect project feasibility and viability.

As always with data collection exercises, the trade-off between better information and the time to be invested in getting that information should always be assessed before proceeding. Perfect information is never possible; information gaps which remain at each stage should be flagged up and filled in where necessary at a later stage.

5.2 Starting information

To begin, you are likely to need the following resources:

- green infrastructure and conservation area mapping;
- major existing infrastructure routes maps. This is likely to be held within council records. Further information can be obtained from direct contact with major buried infrastructure operators, e.g. National Grid, DNOs, NG Gas, Water companies;
- constrained highways mapping. These will be available from council highways network manager and relate to roads with engineering difficulties or other restrictions on the availability of space for buried services.

  Highways with s.55 designations under the Highways Act (which prohibit road openings for a period after works are completed) should also be recorded. Other information on the potential to use roads as district heating routes can be obtained from the institutional knowledge held by highway authority network managers;

  A schedule or maps of potential "donor" sites which might be able to be developed as energy centres. These could include spare council land or land held by other large landowners. In London, for example BT exchanges and London Underground sites have been identified as potential donor sites. The site areas (m^2) and any key restrictions of each site should be recorded.

The information can be recorded on paper but it will be more effective in the long term to use the council's GIS resource if available, as this allows information to be consolidated and updated from time to time.

5.3 Highlight key constraints and opportunities

Once the necessary information has been collected, mark in red key constraints on tracing paper or on a computer using CAD or GIS software (although paper will work better for a group mapping exercise):

- major linear infrastructure (dual carriageways, railways, water courses, trunk water, gas and electricity mains). These features will be difficult (and therefore more costly to cross);
- watercourses. Similarly these are difficult to cross, although bridges can in some cases provide a route across (subject to accessibility, ownership and engineering impact);
- cemeteries. Digging through burial sites is almost certain to

Capacity building workshop

be prohibited; and
- conservation areas. Heritage restrictions may impose some limitations on network route installation, but they are also less likely to be suitable for retrofit connections and will therefore be a poorer opportunity for "en route" connections;

Similarly, mark in green key opportunities on a separate sheet or CAD/GIS layers:
- some linear routes, including waterways, off-street cycleways and footpaths, green corridors. Railways could be identified but these can be difficult to use in practice for a variety of safety and regulatory reasons;
- parks and other open spaces which might be able to be used as "soft dig" routes;
- key electrical installations (substations, feeder stations) which could enable export of power to the grid; and
- key fuel import installations. These could include gas mains and gasometers (for a gas CHP scheme) but also depots and wharves (for a solid fuel scheme).

Finally, mark in brown key potential "donor" sites on a separate sheet or CAD/GIS layer.

Together these three layers will provide a sound base for the creation of plausible heat networks.

5.4 Stage 1: Defining your 2050 heat network

With all relevant information now available, the first masterplanning step is to work out what your district heating network could look like in the long term, say by 2050. For most areas, thirty to forty years is enough time to connect all of your sites which have good potential for DE.

Step 1A: Finding Energy Sources

If you have an identified existing energy source which could supply a heat network, compare its annual energy (MWh) and rated power (MW) outputs with the heat demand for your area (if you have more than one source, add them together).

If there is much more energy supply than demand you can proceed with the analysis, but with the expectation that additional heat loads may need to be identified to secure a viable network from that source. If there is more demand than supply, you will need to identify the location for the additional energy requirement.

If you have not identified any potential heat sources then you will need to identify potential energy centre locations which would be developed as part of the heat network. The ideal location for the new energy centre will depend on a number of factors, including:
- meeting the site footprint requirements
- land costs and site availability (i.e. able to be acquired or used);
- proximity to major heat loads;
- fuel supply convenience; depending on the fuel type (i.e. gas or a solid fuel), this might be a location near a major gas transmission route, connected to rail sidings, attached to a wharf or near the trunk road network;
- proximity to electricity connection infrastructure, i.e. located near a major substation or feeder station;
- local environmental issues such as proximity to residential or other sensitive areas; and
- compatibility with relevant planning policies and site allocations (see the next section for more information on policies).

The first of these factors – the size of the site you would need – can be quickly estimated by using the pre-feasibility tool. Enter your heat load information into the model and it will provide a CHP size, expressed in kWe. From the *Rule of Thumb* tables at the back of this manual you can derive an approximate footprint area for your energy centre.

The other factors will generally be available from consultation with stakeholders and desk-based research. Where you have a number of potential sites these can be scored qualitatively against these criteria to help determine the preferred energy centre location.

Step 1B: Drawing network options

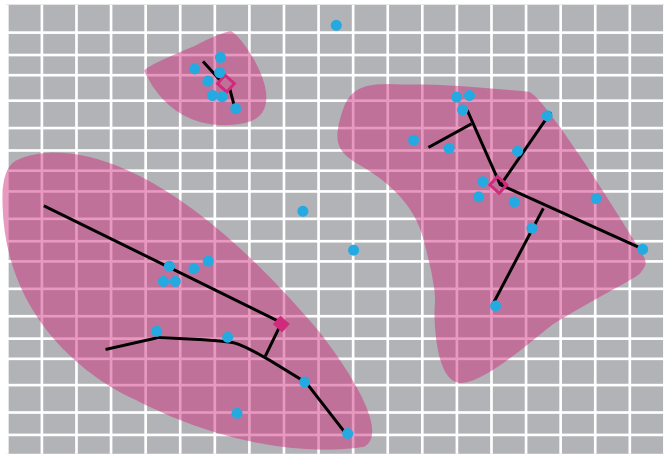
Once you have your actual or assumed energy centre site location you can begin to draw lines to connect the energy centre with the consumer sites or clusters of sites.

Using tracing paper, or working with CAD/GIS software, start by drawing wide corridors from your energy centre to your focus areas or other clusters. From there you can fill in more detailed connections from the main transmission corridor to individual sites or smaller clusters. Please note that the pre-feasibility tool will ask for transmission pipe lengths (main pipe corridors) and distribution pipework (connections to individual buildings) separately.

The lines should be informed by constraints and opportunities mapping but need not be very detailed at this stage. Keeping the route options simple will allow you to draw different options quickly.

River and rail crossings should be avoided

Figure 15
2050 Network concept



When drawing routes you should keep the following key principles in mind:

- cross soft ground where this choice is available. This can work out at a lower cost even where the soft dig route is somewhat longer than the hard dig route (up to a point);
- follow roads or other linear corridors such as cycle paths, waterways and green corridors; rail lines are also possible but more difficult to achieve in practice due to obtaining permissions from the railway undertaker;
- minimise number of bends and changes of direction in the network.
- avoid crossing major trunk roads and seek to place pipe routes along side roads where possible in preference to routes along trunk roads.
- avoid privately owned land unless it is known to be available (e.g. through a planning obligation or an established right of way);
- avoid railway, waterway and dual carriageway crossings, where possible
- avoid conservation areas where possible, and
- always avoid cemeteries.

Note that there may be more than one plausible option for your network. In such a case it may be appropriate to draw different options, but beware of over engineerin the route at this early stage.

Once you have drawn your network concept option(s), measure the length of the network, broken down by different ground types for both transmission and distribution pipework:

- hard urban: urban routes along main highways where pavements or roads will need to be dug up to lay the network (which are likely to be congested with other utilities);
- suburban: urban or suburban routes along minor roads where pavements or roads will need to be dug up to lay the network;
- brownfield: previously developed land, where buried obstructions (such as foundations of demolished buildings) or ground contamination may increase the cost of excavations; and
- greenfield: urban or suburban routes along green corridors where pavements or roads will not need to be dug up to lay the network.

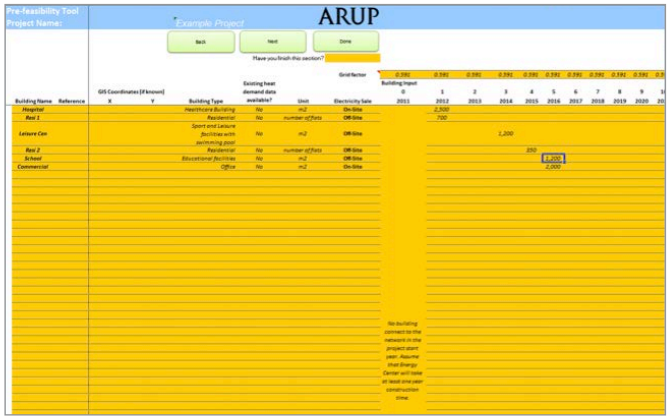
If you have not drawn the routes in detail, you may wish to apply a factor of up to 25% to account for the additional pipe lengths not shown on the plan and to reflect uncertainties in the measurement of the networks. This will aviod an overly optimistic model output.

Step 1C: Use the DENet tool

You should now have your three key inputs to use the DE Network Assesment tool:

- heat loads, broken down by development type and date of connection;
- network route length, broken down by ground and use type and date of installation. The dates should generally be the year before the buildings they are connecting, with the proviso that the transmission network will be installed prior to the distribution pipes; and
- external energy source, if relevant.

Figure 16
Data Input pages on DENet Tool



The pre-feasibility tool will also ask if you have more detailed inputs for energy costs but defaults information is pre-installed in the even that you do not have this.

Enter this information into the model and check the results for net pressent value (NPV), cost of carbon abatement, funding gap and internal rate of return (IRR). If they indicate that:

- the IRR is negative;
- the funding gap is excessive in relation to what can be reasonably borrowed or applied for as a grant; or
- the cost of carbon abatement is higher than £2000 per tonne of CO_2;

Go back to the plan and check whether you can change some of the parameters. If the modelled network appears viable, it may still be worth testing its sensitivity to changes, as the pre-feasibility assessment falls within a very wide confidence range.

Look at each of the three components of supply, demand and network:

- Supply: can the energy centre be moved somewhere closer to key heat loads?
- Demand: can you add more sites or alter the load diversity through a greater mix of development types? What if you remove more distant or isolated sites from the network?
- Network: Have you accounted for the build out timescale accurately? what if you separate a larger network into two separate networks with two separate energy centres? Can you find more of your route through greenfield (soft dig) or suburban land as opposed to hard urban?

You may need to check and adjust the 2050 network concept plan through a few iterations before you achieve an arrangement which seems to be viable. Do not overwork the concept options, however; it will be sufficient to establish an overall balance between heat supply and demand.

Ensure that you use the save function and that you have appropriately named the scheme '…..2050'.

5.5 Stage 2: Phasing Plans

Time is a key factor in the development of heat networks. The infrastructure itself takes time to install but more importantly the buildings to be connected will be available for connection at different times over many years. Existing buildings are typically not viable to be connected until a major plant replacement investment is already required, and new development can only connect when it is built. For both existing and future developments, if the window of opportunity for connection is missed, then it may be another 10-15 years before the next opportunity arises again (i.e. when the plant needs replacing again, or other major renewal or expansion occurs).

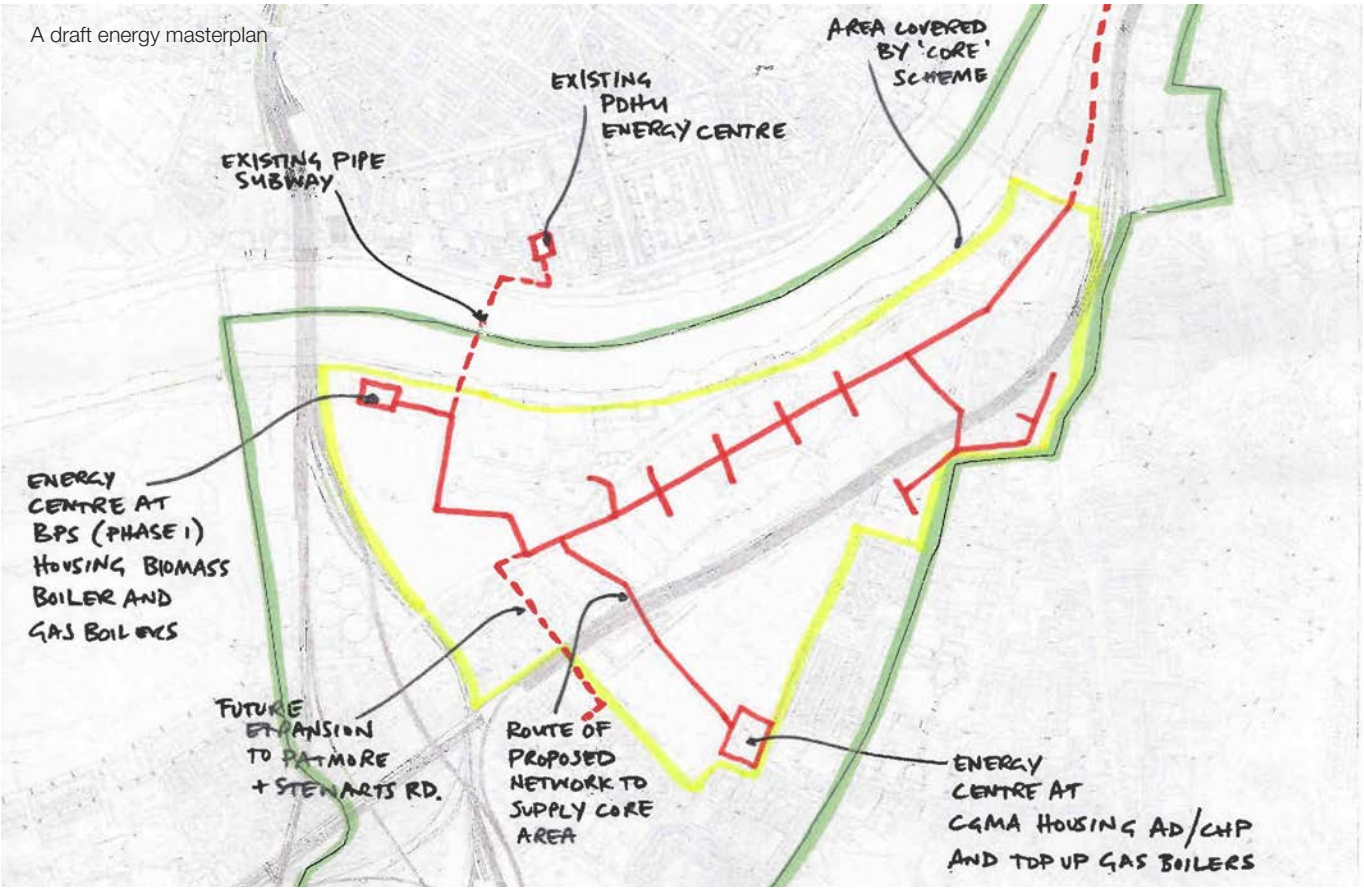
Furthermore, it rarely occurs that the planned spatial sequence of connections matches the temporal sequence of opportunities. In other words, you might find that the earliest connection opportunity is for a building or development site located some distance from your energy centre. Since construction of a long pipe route to connect that single distant site is unlikely to be viable, it may be necessary to provide an interim heat supply solution to that site, which is designed for future connection when the network does arrive.

These issues are addressed through the development of a phasing plan for the network concept.

Step 2A: Produce phasing plans

In order to understand these issues of timing, you will need to produce a series of heat maps showing only those sites which are available within defined time periods, such as:

- Phase 1: 0-4 years;
- Phase 2: 5-15 years (or to the end of the relevant development plan period); and
- Phase 3: 16+ years



If information on connection dates is of good quality, the second period could be broken down into two periods. The connection date for existing buildings should generally reflect expected year of major plant replacement, while for new buildings it is the planned year of completion.

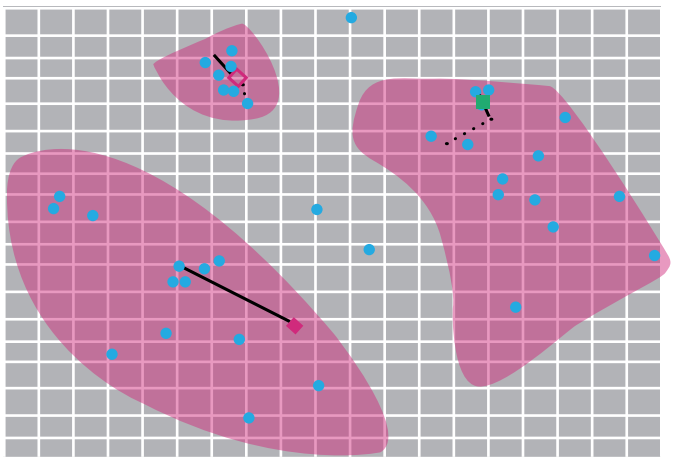
Where you don't know the connection date for a particular existing building, assume it will fall in the middle period, on the basis that most building heating plant will have a life cycle of around 12-18 years.

Your schedules of sites will need to be divided by phase to match the maps. As before, these would be exported from the heat map. Alternatively, the schedule can be sorted or filtered by date range using standard spreadsheet software (e.g. Microsoft Excel).

Step 2B: Draw the Phase 1 network

Taking the Phase 1 heat map, overlay your 2050 network concept and then draw on a separate tracing paper (or using CAD/GIS) a plausible network which follows the 2050 network as far as possible but which only connects the Phase 1 heat loads.

Figure 17
Phase 1 heat network



5

Energy Masterplanning

A combined heat and power plant

It may occur that Phase 1 can be delivered wholly from the planned energy centre site, or there may be a number of smaller clusters which emerge.

The Phase 1 network plan should be more detailed than for the 2050 concept plan. Take more care to keep to physically and practically possible routes, using the guidelines listed above. Also be sure to connect your network to each site which would be expected to have a consumer connection (this may be an individual building, development site, estate or a campus). As with the previous route mapping exercise, you may wish to apply up to a 25% increase to the pipe length estimates to account for the actual twists and turns of the route.

Step 2C: Use the pre-feasibility tool model

As before, enter your heat load, network and (if relevant) heat source data into the model. This will, again, generate a range of performance outputs to give an indication of the viability and energy requirement for this phase.

As with the overall network, the results should prompt you to consider changes to the network to improve its financial performance. In particular, you should consider breaking your planned networks into smaller clusters and seeing how that affects project viability. Make sure you save the results and appropriately name each cluster.

Where this results in a number of stand-alone networks which are not connected to the future main energy source, you will need to consider again whether there is a suitable site for the energy centre. Again, use the toolkit calculation of the CHP plant power output to make an estimate of footprint of your energy centre. For smaller networks these can potentially be placed in an existing building but if a site can be identified this will assist the planning and development process.

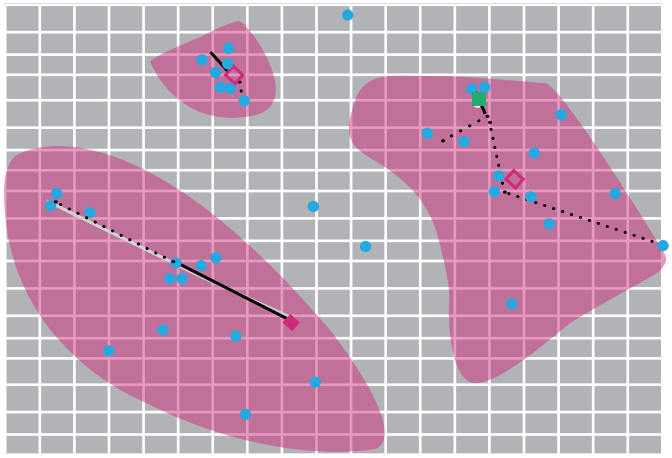
Once you have a Phase 1 network or a series of networks, you can move on to look at Phase 2.

Step 2D: Complete the later phases

The process for the later phases of the network follows a similar pattern, with each phase building upon the previous network inputs.

To begin, print a heat map (or use the GIS mapping) showing all the sites with Phase 2 connection dates. Lay the Phase 1 network over this map and then draw on a separate sheet of tracing paper the extensions of the network to connect to the new sites which will be available in this period.

Figure 18
Middle period heat network



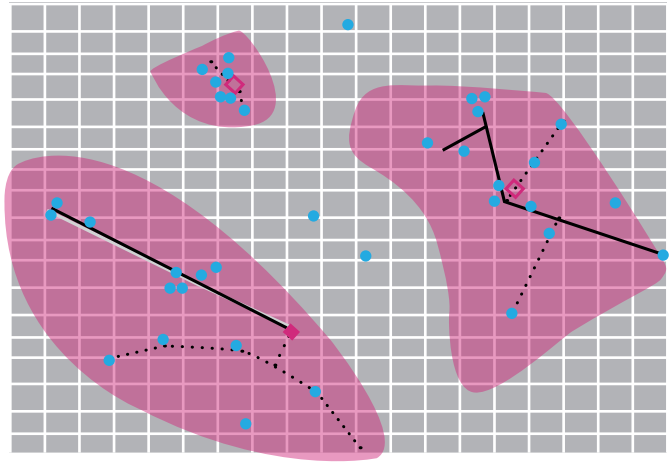
Once you have the first iteration of Phase 2 network drawn, you can put the new information into the toolkit. The toolkit allows you to enter both the pipes (transmission and distribution) and the buildings according to the year of installation or connection.

Without deleting the Phase 1 network inputs, enter the additional buildings to be connected in Phase 2. Then identify the additional pipework to be installed for the Phase 2 network and enter this information in the applicable year of installation. If you anticipate that the network will connect in Phase 2 to an external heat source, enter the available heat in this external heat source.

Now run the model. The toolkit will generate the energy centre requirements for the combined Phase 1 and Phase 2 network. As before, the model will provide an indication of the viability of this larger network, and you should follow a similar process of refinement as far as possible to achieve the combination of building connections which will deliver a viable investment.

Figure 19

Late period heat network



This process will continue for each of the phases until you have established your complete 2050 network concept. However, as you move forward in time, you should bear in mind the following points:

- The DE Network Assesment tool only allows building connections and pipe installations to occur within a 15 - year window. The toolkits cash flow model operates over 25 years, but the connections are constrained to the shorter time period. Therefore for later phases beyond Year 15 you may need either to assume that all buildings are connected in Year 15 or that the later Phase is a stand alone network.
- Related to the previous point, the cash flow model will have fewer years to pay back the investments which take place later than year one. This will tend to result in later phases appearing less viable than earlier phases, than if the later phase were modelled over the full 25-year period from the date of the later capital expenditure.

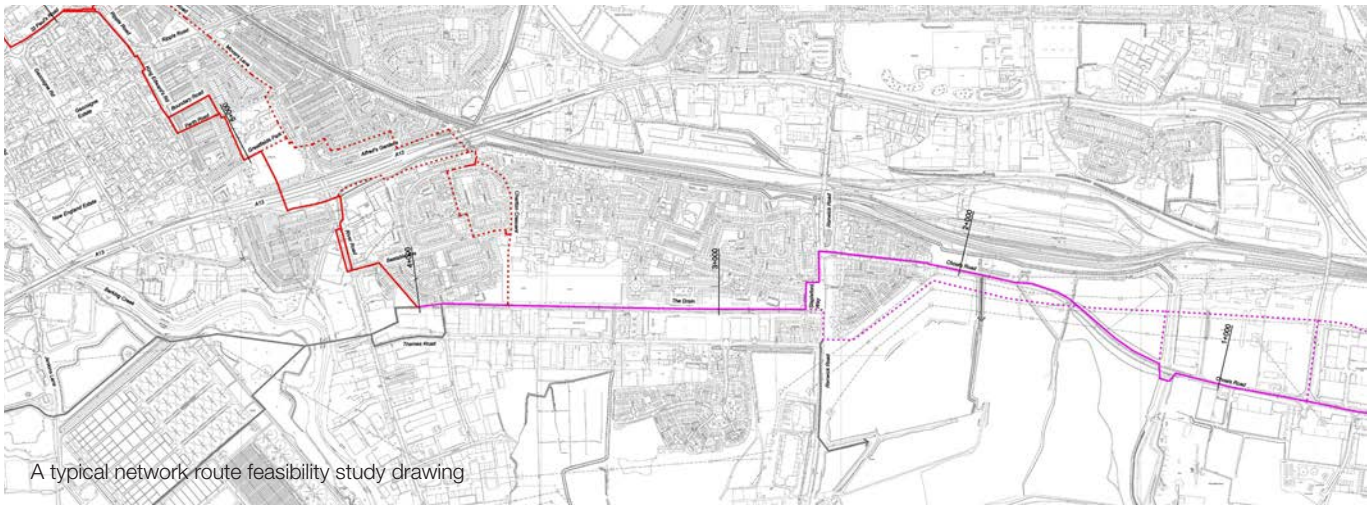
In any case, the viability assessment will be of decreasing relevance for the later phases, since the conditions which affect the viability of the later phases will be increasingly unknown. The main value of the masterplanning exercise for the later phases is more in determining the likely network structure than in assessing the cash flow impact.

Notwithstanding these practical limitations, the process should lead you to a robust energy masterplan with a clear vision of how your networks will grow over the next few decades. This will give you a sound evidence base to create policy and to ensure new development connects to or contributes to the networks and will give you a reliable basis for determining how to proceed with project development opportunities.

5.6 The Energy Masterplan

The 2050 network and the sequence of phasing plans together represent your Energy Masterplan. Although the pre-feasibility process is a very early stage assessment, these plans will provide an evidence base which can inform the development of planning policies, as explained in the next section.

Project development and delivery opportunities should also be prioritised on the basis of the energy masterplan, with the network section most likely to be viable, or which is most important to secure a long term network, being prioritised for feasibility study funding. The later steps towards project delivery are covered in Section 9.



A typical network route feasibility study drawing

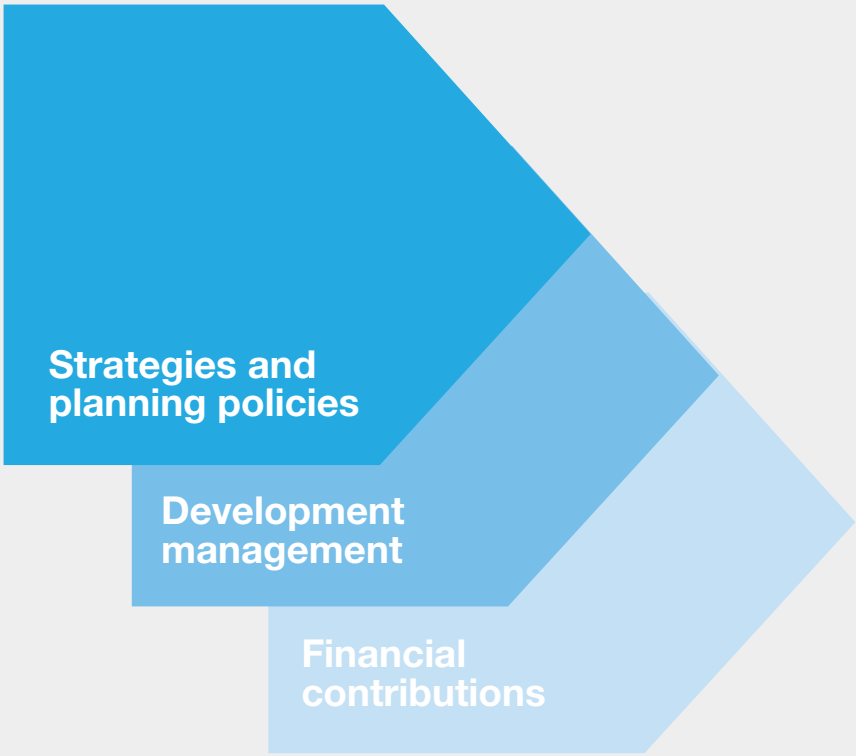
6

Planning Policy Framework

The role of local planning authorities in planning for and securing delivery of decentralised energy networks is crucial.

Chapters 6 to 8 provide guidance on this role and are based on the state of the planning system at the time of writing (July 2011). Ongoing reforms may affect some of the information and care should be taken to ensure that the recommendations are tested against any such reforms before being acted upon.

Planning framework elements for Decentralised Energy



6

Planning Policy Framework

6.1 Establishing the Framework

Establishing a supportive planning policy framework is an essential element for the successful delivery of the decentralised energy (DE) network. The Core Strategy should set out the high level framework for the subsequent more detailed Development Policy Documents (DPDs) or Supplementary Planning Documents (SPDs). PPS1 Supplement specifies that local requirements to implement decentralised energy should be outlined within development plan documents, rather than supplementary planning guidance, to ensure policy reaches Examination in Public as well as effective compliance from developers.

It is important that policies on DE are conveyed across all relevant Local Development Framework documents to ensure a coherent message and robust support for DE delivery. The table below provides an overview of DE policies that could feature in Core Strategies and Development Management DPD and the focus in which these should take. It should be noted that this guidance is not prescriptive and is intended to provide a broad and flexible indication of how DE policies can be incorporated within these documents.

The following sections set out the themes that should be typically covered within planning policy. The recommendations given below are based on experience of reviewing and drafting a range of adopted and emerging plans. They are not intended and should not be used as a replacement for any relevant national guidance or policy.

6.2 Energy Hierarchy

Policies should set out a clear energy hierarchy and require all developments to demonstrate that they will minimise carbon emissions, as follows:

- Using less energy, in particular by adopting sustainable design and construction measures
- Supplying energy efficiently, in particular by prioritising decentralised energy generation
- Using renewable energy

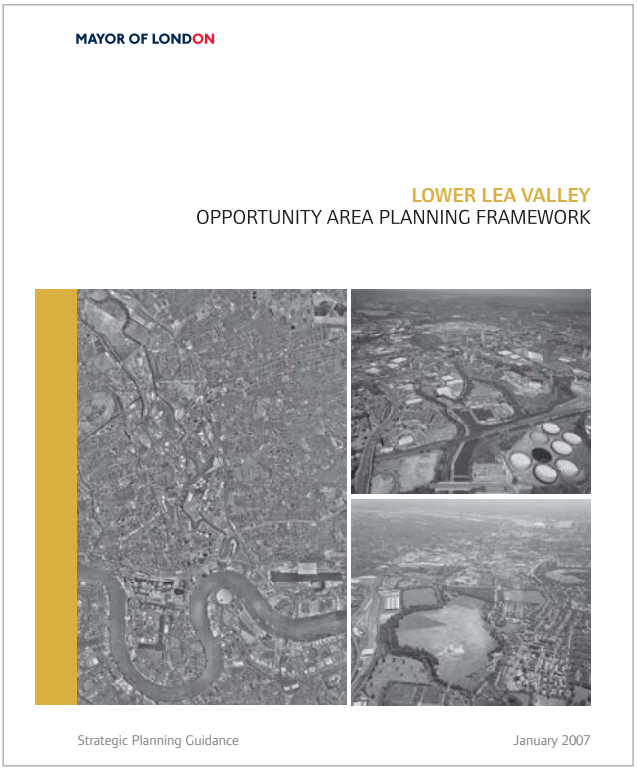
6.3 Energy Assessments

Policies should set out a requirement to demonstrate energy and carbon dioxide emission savings from energy efficiency (including CHP and community heating systems) and renewable energy measures. The policy could include an indication of the supporting information that developers would need to provide to the LPA with the planning application, or refer to a supporting document. It might however be expected to include some or all of the following:

- Evidence to show how the development would meet or exceed the relevant BREEAM / Code for Sustainable Homes standards.
- Evidence to show how the energy hierarchy has been applied in the design of the development.
- Evidence to explain how the development would accord with relevant policy requirements, or to justify any proposal that was not in accordance with these. In relation to the potential to connect to an existing or proposed network, reference should be made to the heat map or energy masterplan and the feasibility of connecting to a nearby network (say within 1,000m) should be assessed and documented.
- Evidence to show that, where there are potential customers for heat supplied by the proposed development, or existing heat

Table 1
DE Planning Policy matrix

Theme	Core Strategy DPD	Development Management DPD (if applicable)
Spatial	Local opportunity areas; broad locations for DE	Locational criteria for heat networks and energy development
Energy and Carbon in Design	Local targets or energy priorities	Requirements for energy in design of buildings
Connection to a DE Network	Local opportunity areas; broad locations for DE	Specifying when connection will be expected and possible exception criteria
Future Connection to a DE Network	Principle of design compatible with future connection – 'heat ready'	Set list of 'heat ready' measures and when they will be required.
Energy Generation and Networks	Setting targets for energy development quantum and mix. , with local targets, locations for energy development and safeguarding	Key design and mitigation criteria for major developments.
Financial Contributions (FC)	Confirm principles of FC, including tariff and/or carbon offset. Link to target	Targets or thresholds when the FC requirements will have effect.
Planning and Design Process	N/A	Requirements for Energy Statements



sources which could meet some or all of the demand created by the proposed development, the applicant had consulted with these parties before submitting their application.

The information sought should be proportional to the scale of the development proposal. Stand-alone energy statements should not be required where such information can be provided within a Design and Access Statement (DAS). The incorporation of an energy statement within a DAS is likely to be most appropriate for minor applications.

6.4 Existing and New Decentralised Energy Networks

DPDs should identify and safeguard existing heating and cooling networks and ensure that the potential for new heating and cooling provision by decentralised energy is maximised. Whilst the Core Strategy should set out the requirement to maximise DE by safeguarding existing networks and encouraging new networks, other DPDs should strengthen this further by stating how development proposals will be assessed in relation to DE.

Data on existing DE networks should be collated as part of a heat mapping study. Reference could be made to such studies to relevant locator national heat maps to help define where existing and proposed network routes are located.

6.5 Identifying DE Opportunity Areas

Identification of areas suitable for low-carbon energy should be as broad as possible so not to exclude potential opportunity areas for decentralised energy. The heat map and the energy masterplan will provide a sound evidence base for this. Where these are not in place, authorities should be generous in setting boundaries for heat network opportunity areas so that only the unambiguously unsuitable locations are excluded. Existing lower density neighbourhoods with very little redevelopment potential may be unsuitable for district heating but other currently marginal locations may have potential for becoming viable through growth in the network, redevelopment proposals, and public sector action to develop networks out of existing estates and public buildings.

6.6 Requirement to Connect

Policies can require developers to connect to an existing heat network unless it would not be feasible or viable to do so, and in such cases to make provision to connect in the future. The feasibility and viability test is explored in further detail below.

As before, such policies could be spatially defined to the areas of good DE potential. The heat map or energy masterplan would provide the main evidence base for the boundaries of this policy.

If there are existing networks or fully programmed future networks, a connection could be required, but in other less certain areas, the focus should be on safeguarding and future-proofing development to facilitate a future connection to a network.

6.7 Future Proofing Non-Connecting Developments

Policy should require a range of enabling or future-proofing measures where there is no district heating network at the time or where such a connection would not be feasible and viable. This will provide added flexibility and effectiveness to the DPD by steadily reinforcing, and not undermining, the potential for viable future district heating networks.

'Future proofing' of new development to enable connection when district heating circumstances are more advanced will strengthen the long term viability of developing such networks and meeting carbon reduction targets. Examples of future proofing include:

- Requiring the installation of pipes connections up to the property boundary to enable future district heating network connection;
- Requiring the incorporation of communal heating systems instead of in-unit boilers for developments where a future DH network connection would be viable. As a minimum policy should specify 'wet' heating systems and prohibit electrical

heating systems;

- Ensuring any system is DE-ready – i.e. it could be connected to supply a DE network with minimum retrofit. This would be achieved through measures such as built-in penetrations through building walls to the energy centre, allowing a pipe to be pushed through the wall without structural alterations; or significant works;
- Safeguarding an identified route within the development site for DE network connection apparatus (pipes, heat exchangers etc) or requiring the installation of pipe connections up to the property boundary;
- For energy-generating developments, securing a commitment to supply heat to future DE networks; and
- For energy-consuming developments, securing on-going obligations through S106 agreements to connect to a future DE network (subject to agreeing reasonable commercial terms).

6.8 CO_2 Emission Targets

The introduction of CO_2 emission targets enables policies to be monitored. In cases where the proposed target is above regional and national guidelines, an evidence base will be needed to substantiate the target.

Local authorities should consider capturing both small and large scale development within the target. Whilst smaller developments may contribute to small net additional CO_2 emissions, the incremental increase across the borough could result in a significant impact. This should however be balanced against the relative cost of the process at the smaller end for both applicants and local planning authorities.

One option is to assess CO_2 emissions in relation to Building Regulations. Setting targets against Building Regulations can enable all development proposals, regardless of their scale, to be captured to deliver proportionate CO_2 savings. When specifying type and size of developments, target polices will need to be realistic in what can actually be achieved, particularly in relation to small developments. This is considered more flexible than introducing different targets for different types of development, which will be more complicated to apply and could distort development potential by applicants scaling proposals to fall below the higher target threshold.

Local authorities should consider setting CO_2 targets based on the total site CO_2 emissions for all end uses, not just those regulated by Building Regulations.

6.9 DE Targets

As with CO_2 targets, the introduction of targets for the development of decentralised energy systems enables policies to be monitored. For individual applications, this would be translated as a target percentage of the energy demand to come from decentralised and renewable or low-carbon energy sources.

Targets should not be prescriptive on technologies and be flexible in how carbon savings from local energy supplies are to be secured. It is essential to note that, as with all planning policies, planning authorities must have an evidence-based understanding of the local feasibility and potential for renewable and low-carbon technologies. Only with a robust evidence base in place will authorities be able to set a target percentage for new development energy requirements to be sourced from decentralised and renewable or low-carbon sources.

6.10 DE network performance specification

A significant part of the purpose of the energy masterplan and related planning policies is to maximise the opportunity for a small number of large scale networks in favour of more smaller, and less efficient stand-alone CHP and district heating schemes. The use of a common specification of the key design parameters will help allow networks developed separately to be interconnected in the future without the use of heat exchange equipment (which reduce system efficiency) or major system retrofit.

There is no single national standard for urban district heating systems in the UK. However, some detailed specifications have been developed in recent years which can provide a template to be used by local authorities. One such standard was developed for the London borough of Barking and Dagenham for the Barking Energy Action Area. [1]A similar but less detailed guidance document was developed for the London Development Agency as part of its London Thames Gateway Heat Network. A copy of this guidance document is attached for reference at Appendix A.

These standards do not need to appear in DPDs but could be adopted as supplementary planning documents in order to ensure they obtain an appropriate status for planning applicants.

6.11 Financial Contributions

Financial contributions can play an important role in underpinning policy and creating the right incentives for developers. However, the regulations governing the use of financial contributions from new development have been significantly reformed as part of the introduction of the Community Infrastructure Levy (CIL). This has direct implications for the DE policy and this is covered in more detail in below.

Installing a new DH network

6.12 Viability/Feasibility Caveats

In order for a policy to be found effective and sound, policies must be flexible, fair and reasonable. Local authorities requiring the delivery of decentralised energy can add wording such as 'where viable and feasible' within policies. However, policies need to balance both being flexible to account for viability and feasibility considerations within specific developments but also be prescriptive enough to drive forward implementation. It is important that the issues of 'viability' and 'feasibility' are not used interchangeably, and that policies recognise the difference in these definitions.
It would be helpful if details on the viability (cost and financial implications) and feasibility (engineering and practical constraints) factors to be considered were included within a DPD or an SPD if appropriate. The list below provides a suggestion of some of the factors which could be identified in policy as affecting viability and feasibility. Further information on these factors is provided in Chapter 2 above.

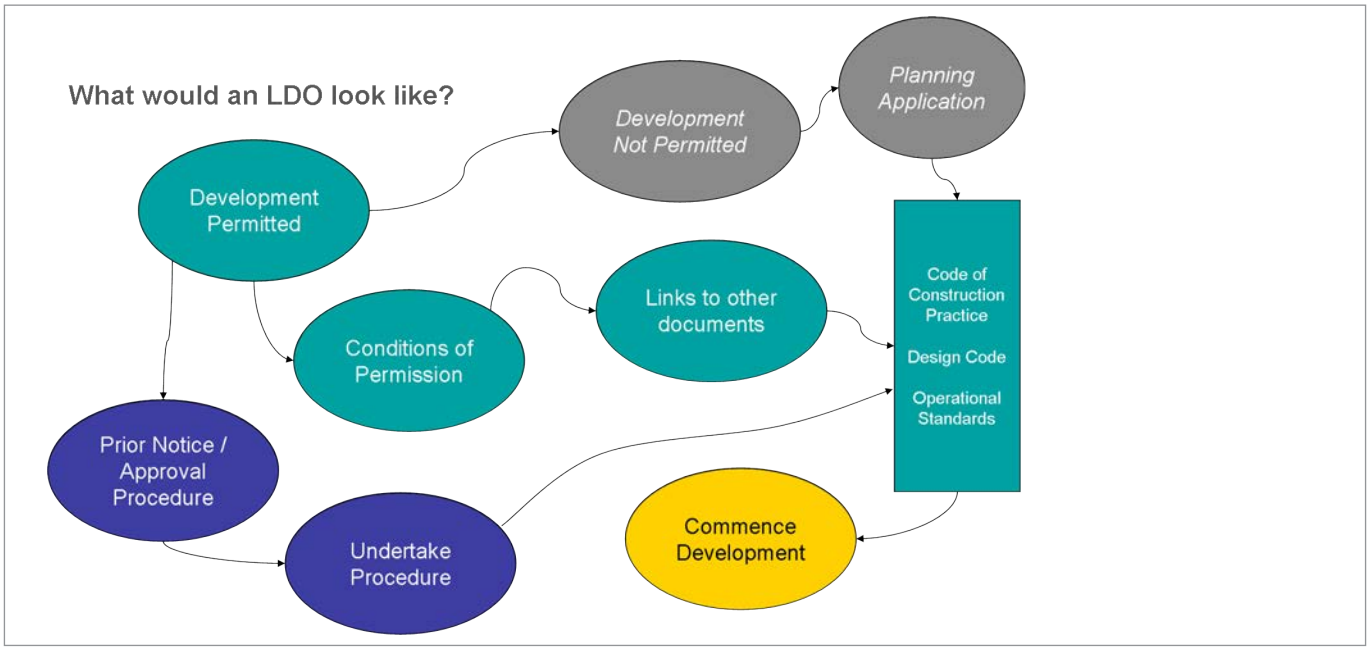
The size of the development

- The distance of the development to decentralised energy network pipes.
- The presence of physical barriers such as major roads or railway lines.
- The cost of connection and the impact this has on financial viability.
- What efforts the applicant has made to secure agreements to create a new network through connection of nearby buildings or estates. This will be an increasingly important part of driving the development industry to take ownership of the need to create new networks.
- Any planned district heating networks coming forward in the next two years.
- The proximity of any public sector estates and buildings with communal heating systems, especially use such as swimming pools, hospitals and large housing estates.
- Land use mix of proposed development.
- Land use mix and density of surrounding built environment.

[1]Community Heating Specifications for Barking Town Centre Energy Action Area. London Borough of Barking and Dagenham, September 2007. Web link: http://www.barking-dagenham.gov.uk/Environment/Documents/BTCEEADeveloperGuidanceSept07.pdf

6

Planning Policy Framework



Case Study

District Heating Local Development Order

Officers from the London boroughs of Havering, Barking & Dagenham and Newham worked together to draft a cross-borough Local Development Order (LDO) which is intended to create local permitted development rights for district heating and cooling network developments within the London Thames Gateway.

Arup led the development of the LDO as part of its support on the London Development Agency's decentralised energy delivery programme. Additional funding for the LDO project came from DCLG via the Planning Advisory Service as part of its LDO Pilots programme.

The need to secure planning permission is among a number of barriers to the rapid growth of District Heating (DH) networks and it is this concern which has led to the concept of a district heating and cooling Local Development Order. The idea of an order is that it would create a new class of local permitted development rights for specified aspects of DH networks. Such an order would be adopted at a local level under the provisions for LDOs created under the Planning and Compulsory Purchase Act 2004. The LDO would operate in a manner similar to the national permitted development regime.

The purpose of LDO is to streamline the development of district heating and cooling networks whilst ensuring adequate protection of the local streetscape and amenity. The LDO's benefits for DH network developers are to reduce the cost of network development (by avoiding individual planning applications for each route section) and to enhance the flexibility of network expansion and new connections to customers. The benefits for the local authorities are the delivery of a core policy objective of carbon reduction and ensuring that new DH networks are built to a common standard. Local communities should also be direct beneficiaries through having access to low carbon and more economic energy supplies for heating and hot water, thereby improving delivery of fuel poverty policy objectives.

The LDO has been drafted in full and is currently with the local authorities to initiate the formal adoption process.

7

Financial Contributions

New development creates new demand for infrastructure services. New development also causes impacts on the environment. Where such services cannot be fully provided on site, or where impacts cannot be fully mitigated, financial contributions are normally secured from the developer to fund appropriate off-site measures.

The mechanism for such payments has for many years been through legal agreements made under Section 106 of the Town and Country Planning Act 1990 (as amended). This system was reformed by the Planning Act 2008 and the Community Infrastructure Levy (CIL) Regulations 2010, with significant implications for securing financial contributions for decentralised energy related investment.

7

Financial Contributions

This section provides an overall summary, in relation to decentralised energy investment, on the scope and mechanisms for securing financial contributions and then spending the monies accrued. However, it should be noted that this is an evolving area of policy and practice and the recommendations in this manual are therefore based on the status of the relevant regimes at the time of writing. Information contained in this manual should be checked against any more recent regulatory or policy changes before being acted upon.

7.1 Tariffs versus Carbon Targets

There are, in principle, two alternative approaches available to a local authority wishing to secure financial contributions from new development which could be used to fund community energy infrastructure or other forms of low carbon energy investment. The first approach is to treat community energy infrastructure in the same way as any other infrastructure, and to charge new developments an amount proportional to their demand for that infrastructure. The levy to be charged for the infrastructure would be a flat rate applied evenly to all development (eg on a £/m^2 basis).

The accrued infrastructure fund would be used to deliver the infrastructure networks. This is the model traditionally used for funding schools, parks, medical facilities and other community infrastructure and which has now been reformed into the CIL.

The second approach, reflecting a "polluter pays" principle, is to set a target for carbon emissions from new development and then to apply a penalty charge for the level of emissions which exceeds this target. The penalty charge would be paid on, say a £/tCO_2 basis.

The accrued carbon fund would be used to invest in carbon reduction measures elsewhere, with the objective being to deliver an equivalent or greater reduction elsewhere than the excess emissions from the new developments which paid into the fund. This is the same approach in principle as is used globally through the Clean Development Mechanism. The government's draft proposal for the use of Allowable Solutions as part of achieving zero carbon in new development is another example of a carbon target approach (this is discussed in below).

Both approaches are valid and can be considered complementary. The use of tariffs in practice is now governed by the CIL Regulations, but the regulations also have an indirect effect on the use of carbon targets. At the time of writing the current government's approach to Allowable Solutions is unconfirmed, but when announced this is likely to affect the practice further.

7.2 Infrastructure Tariffs and CIL

The Community Infrastructure Levy (CIL) is a new government instrument to aid infrastructure investment in England and Wales. CIL largely replaces the use of Section 106 Agreements to secure financial contributions from new development and is intended to provide a mechanism which is simple, efficient, fair and transparent.

The Planning Act 2008 provides the broad framework for CIL and implementation details are contained within the CIL Regulations 2010.

The Planning Act is clear that CIL may only be spent on infrastructure. Although energy infrastructure is not included in the definition of infrastructure provided in the Act, DCLG has made it clear that the definition is intended to be inclusive and that decentralised energy systems are able to be funded by CIL receipts. This is set out in the CIL Companion Document which accompanied the Regulations.

Once a local planning authority adopts a CIL charging schedual the CIL is applied to virtually all new development at a flat rate expressed in £/m^2. The levy amount can be varied by development type (for example, non-residential development would not be expected to fund school places). A key implication for district heating network investment is that all developments within the charging area might be contributing cost of the new network even if some would not be connected to it.

Once collected, a local authority's CIL receipts will be pooled into a single fund with no statutory obligation to allocate investment in a way which reflected the assumed infrastructure requirements. Thus the required district heating infrastructure investment could be applied instead to a school building programme, or vice versa.

7.3 Setting a CIL Tariff

In order to implement CIL, local authorities will need to set their own charging schedule, which is to be evidence-based, appropriate to the area, consulted on, and scrutinised and approved through independent examination.

The energy masterplanning process can be used to calculate the energy component of the CIL tariff, by confirming the cost of planned new decentralised energy infrastructure to be delivered within the plan period.

7.4 Which levy approach to take, CIL or S.106

If a local authority chooses not to adopt a CIL, a district heating levy policy could be adopted and applied across the local are or selectively, e.g. within DE opportunity areas. Such a levy would be secured through Section 106 agreements.

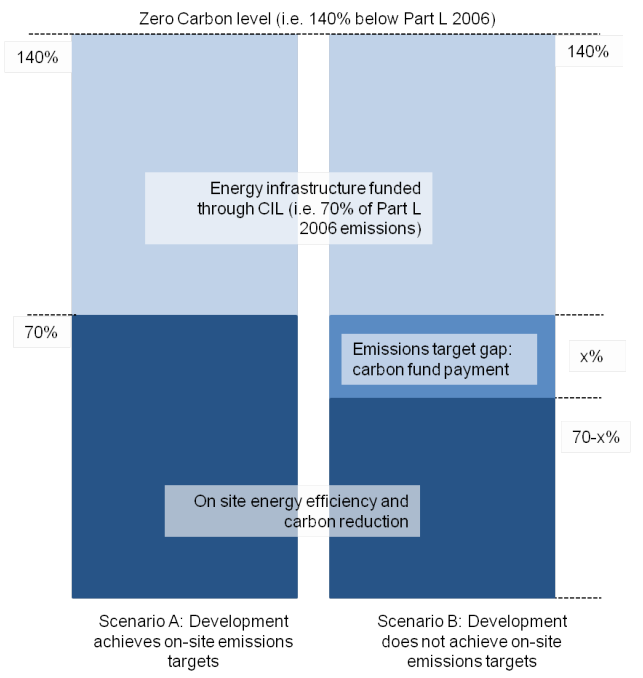


Diagram of a sample carbon target policy

However, once a CIL charging schedule is adopted, Section 106 agreements would not be permitted to be used to secure financial contributions for infrastructure. Furthermore, this restriction on the use of Section 106 agreements will apply universally from 2014, leaving CIL the only route in the future to securing infrastructure contributions.

7.5 Carbon Target Payments

Where a local authority sets a target for maximum carbon emissions (normally expressed as a percent reduction relative to the Building Regulations Part L), developments will need to consider a range of demand reduction and low carbon supply measures to meet that target.

Where the target cannot be met, a charge can be applied on the excess emissions. The payment would be secured through a Section 106 agreement. The justification for this charge would be that the money is needed to mitigate the environmental impact of excess carbon emissions by reducing emissions offsite by an equivalent or greater amount. In the language of the planning system, the payment is necessary to make acceptable a development which would otherwise be unacceptable.

7.6 Carbon Targets in the Context of CIL

In principle, there is no direct link between a levy such as CIL and the carbon target, since CIL is applied universally and uniformly whereas the carbon target payment depends on the actual performance of each development. However, there are linkages in three important aspects, as set out below.

First, the combined payments of CIL and the carbon fund payment could have an overall impact on development viability. This will need to be considered on a case by case basis and is no different from practice in the past, where abnormal development costs (such as brownfield site remediation) might be used to justify relaxing other planning targets (such as affordable housing) to maintain development viability.

Second, since the investment in district heating networks would be expected to reduce carbon emissions in the borough, it could be argued that part of the levy contribution was in effect a contribution to offsite carbon mitigation which would partially offset the excess emissions. Local authorities may consider providing a credit towards the carbon fund payment equivalent to the portion of the levy attributable to DE infrastructure.

Third, the prohibition on the use of monies collected through Section 106 agreements to fund infrastructure places constrains the range of carbon reduction measures which could draw upon these contributions. Clearly district heating infrastructure would be disqualified, but this may also be the case for any stand-alone energy installation, such as a large wind turbine. Similarly, electric vehicle charging infrastructure or smart grid rollout may also be ruled out. On the other hand, building-integrated renewables, building retrofit measures or behaviour-based interventions would appear to be eligible. There is no case law or precise guidance on these boundaries, but in any case the local authority will need to demonstrate that it is not using both CIL and carbon fund payments to deliver the same type of low-carbon measure.

7.7 Allowable Solutions

As mentioned above, the Government is currently considering mechanisms to enable the delivery zero carbon new homes by 2016 and all other buildings by 2019. At present, the Building Regulations act as the principal mechanism for delivering development-integrated sustainable energy, with the planning system acting to deliver district energy solutions and to address other environmental aspects of new development.

7

Financial Contributions

Zero carbon (see Figure 19) is expected to be achieved through a combination of:

1. Energy efficiency – covering space heating and space cooling energy demand;
2. Carbon compliance – whereby further CO2 reductions will be achieved using on-site energy remewable or low-carbon or direct connection to a heat network; and
3. Allowable solutions – options to cover the remaining emissions after energy efficiency and carbon compliance measures have been met.

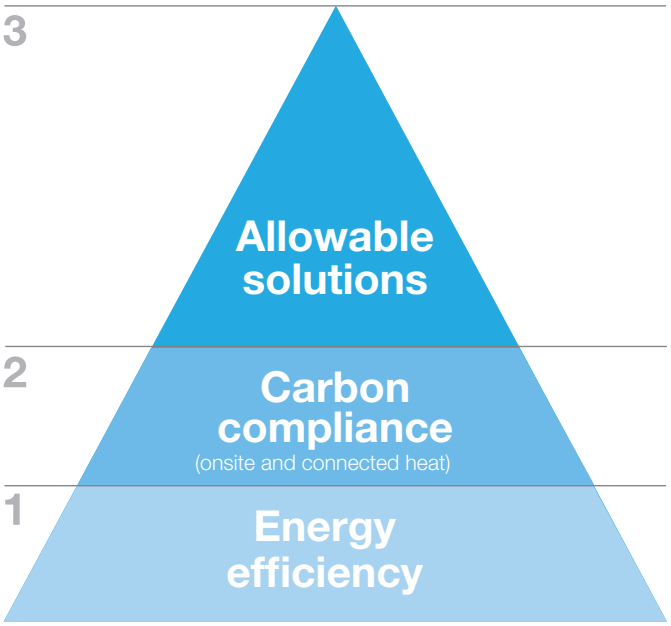
The need for Allowable Solutions arises because it is unlikely that a combination of energy efficiency and carbon compliance will by themselves be sufficient to achieve zero carbon development.

The Allowable Solutions model is equivalent to the Carbon target approach outlined above. However, the Government could use primary legislation to give a much wider scope to an Allowable Solutions regime than is currently available to local authorities constrained by the planning system and the Section 106 regime in particular.

In any case, the changes will almost certainly incorporate a lengthy notice period, allowing any local authority which adopts planning-based tariff and/or carbon target policies to make a smooth transition to the new regime. Thus there is no reason to use any uncertainties of future policy changes to justify a delay in implementing planning policies needed to drive low carbon development.

Figure 19

The Government's preferred zero carbon hierarchy



8

Development Management

The right planning decision is essential to ensure new development realises its full potential to support the delivery of decentralised energy opportunities.

The development management process relies upon the active engagement of planning officers. They can help developers consider the full range of low carbon energy solutions and ensure that planning decisions themselves – planning conditions and planning obligations – lock in the commitments set out within planning applications or secured through post-submission negotiations.

This section identifies some of the key issues which could arise in relation to new development and new energy infrastructure.

8

Development Management

8.1 Pre-Application Discussions

All district heating network developers should be encouraged to attend a pre- application meeting prior to submitting an application.

This meeting will provide an opportunity for the local authority to provide initial comments on the proposed scheme and inform the alignment of the route. This meeting should happen at a sufficiently early stage to allow the local authority real opportunity to influence the proposals.

It is suggested that the following issues are covered:

- Establishing the applications'precise scope, contents, information requirements, and submission programme;
- Establishing the extent of the red line boundary;
- Confirming the planning application fee;
- Confirming requirements in relation to environmental impact assessment;
- Identifying other consents which may be necessary;
- Identifying opportunities to coordinate with other proposed works;
- Identifying stakeholders to be consulted, including statutory bodies e.g. the Environment Agency and affected asset operators and landowners, including transport and utility undertakers.

8.2 Planning Conditions and Obligations

There are a number of avenues open to local authorities to secure the inclusion of DE-related provisions in new development. Authorities can use planning conditions, which are recorded on the planning permission decision notice, or use planning obligations to secure the infrastructure or commitments. These different methods are subject to different scopes and restrictions.

The use of planning conditions is governed by Circular 11/1995, which sets out the six tests with which conditions must comply. To be lawful, conditions must be:

- necessary;
- relevant to planning;
- relevant to the development to be permitted;
- enforceable;
- precise; and
- reasonable in all other respects

Where an authority has a choice between imposing conditions and entering into a planning obligation, the imposition of a condition is generally preferable. This is because the enforcement of conditions is more straightforward since it involves the use of the planning enforcement system, and because they can be imposed unilaterally. However, conditions are usually only enforced after a complaint as councils rarely have the resources to undertake pro-active conditions monitoring.

In comparison, the use of S106 planning obligations is governed by the Community Infrastructure Levy (CIL) Regulations 2010. Section 122 of the CIL Regulations sets out the limitation on the use of planning obligations. It states that:

> *A planning obligation may only constitute a reason for granting planning permission for the development if the obligation is—*
> ***(a)*** *necessary to make the development acceptable in planning terms;*
> ***(b)*** *directly related to the development; and*
> ***(c)*** *fairly and reasonably related in scale and kind to the development.*

Planning obligations are much more flexible than conditions and can cope with complex and contingent obligations. They can also be used to secure financial contributions, in-kind works and off-site provision. They are a land charge, and therefore the obligations run with the land and are visible on land charge registers. Planning obligations are therefore generally considered to hold greater weight than conditions. They are, however more complex to enforce than planning conditions.

8.3 Elements to be secured by conditions / planning obligations

In terms of securing the inclusion of DE-related provisions in new development, the use of planning conditions and planning obligations will vary depending on the exact nature of the benefit to be secured. In general, conditions are more suitable for site development features, such as future proofing schemes for connection to DE and simple enforcement and other low carbon measures.

Planning obligations are better for securing DE and connections within schemes. Planning obligations carry greater weight for developers, they allow them to enter into commitments to connect in future, they can include obligations to use heat as well as to connect to a network and can provide fall back positions (such as financial contributions) if the intended DE scheme is later found to be not viable or feasible.

A summary of the different types of benefits and the route to secure this provision is set out below.

An energy recovery facility can provide a source of low carbon heat

8.4 Creation of a new on-site heat network

For larger development schemes, authorities could seek the provision of on-site heat networks and this can be secured by either conditions or obligations.

The benefits of using obligations as opposed to conditions in this scenario is that obligations can incorporate phasing and fallback positions, they can secure financial contributions if agreed measures cannot be implemented or are shown not to be viable. Planning obligations may be able to secure a commitment to use heat as well as to install the connection (by requiring that this is built into tenancy agreements).

8.5 Connection to an existing third party DH network

Where there is an existing network, the Council can require the new development to connect to this system.

8.6 Future proofing new development to enable connection

The local authority can secure a number of measures to future proof the development to enable connection at a future date. The Council needs to consider whether the development is likely ever to connect, and if so, over what timescale (eg. one, five or ten years) and then how big a system will be required. Future proofing includes assessment of the building energy system and connection routes and space provision.

Planning conditions are normally suitable to secure future-proofing and are likely to agree drawings showing the layout of energy systems and to safeguard a route shown on the submitted plans. Future proofing conditions can be used in conjunction with Right to Connect planning obligations as set out below.

The use of conditions to secure future-proofing measures requires confidence that a network will be delivered in the near future. If this is not the case, authorities should consider using planning obligations to secure a contribution upon expiry of a defined deadline or trigger date (e.g. five years after commencement of development).

8.7 Securing commitment to connection to a future network

When a new network will not be in place before a development commences, the authority can seek a commitment to connect to that future network. Such an obligation will need to provide clauses which protect the developer from being obliged to pay for a connection when it is not viable to do so.

8.8 Securing financial contributions

Financial contributions are addressed in the previous chapter.

8.9 Securing heat supply from new energy development

In addition to securing DE within new developments, authorities should seek to secure commitments from new energy development (such as energy from waste, biomass and Anaerobic Digestion facilities). Such commitments could include:

- Securing funding or implementation for a DH network feasibility study;
- Securing commitment to agree to supply identified suitable heat loads, subject to reasonable endeavours protection;
- Agreeing a DH network viability threshold through S106 negotiations;
- Agreeing a fall-back position, e.g. on additional contribution to a low carbon fund if the DH network is not viable or if it is not delivered within an agreed timescale.
- Requiring the operation of a DH network in accordance with a consumer charter; and
- Requiring DH network to be designed and developed in accordance with a preferred design specification (where justified in policy terms).

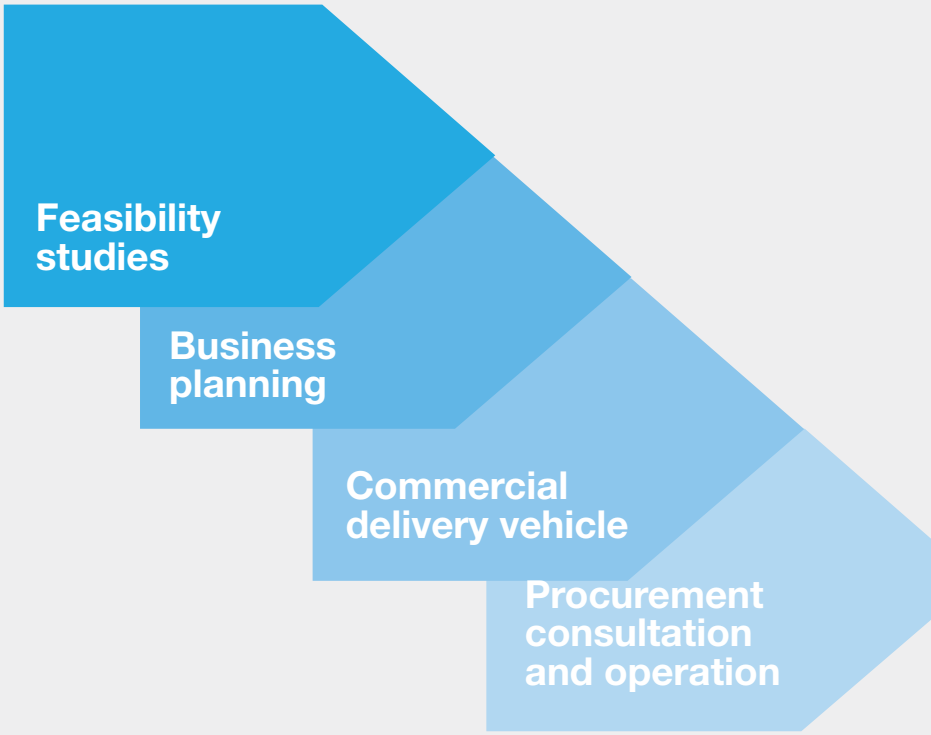
9

Project Definition and Delivery

This section covers the final stages of the DEMaP trajectory, which relate to the process of delivering a particular decentralised energy project.

While the planning stages of the trajectory would apply to all local authorities, this stage would be relevant only for those councils which had both a DE opportunity and the political will to take ownership of its delivery (or at least of its development).

Project Definition and Delivery Stages



9

Project Definition and Delivery

9.1 Feasibility Studies

Once a project opportunity is sufficiently well defined to justify more significant investment in its development, the next step is to commission a full feasibility study. The feasibility study will provide confirmation of the technical and commercial aspects of the scheme concept and provide a preliminary layout of the heat network to be delivered. The study will draw upon more detailed information than would be available at the pre-feasibility stage, such as site and building surveys and buried services details. The feasibility study will also be based upon CHP and heat network modelling software to determine the optimal network parameters and design. These inputs and analytical tools will enable the appointed consultants to provide advice on scheme costs and technical feasibility with much greater confidence.

However, it should be borne in mind that the feasibility study is still an early stage exercise; for example, in terms of the RIBA outline stages of project development, feasibility is likely to be part of Stages A-C, with construction occurring only in Stage J[1]. Thus there will remain a considerable degree of uncertainty about the details of the project, with the cost estimate often residing within a confidence range of as much as ±50%.

On the other hand, the feasibility study will provide a valuable documentation of the key risks and issues which the project faces. Furthermore, for a local authority which has undertaken much of the work prior to this stage on its own, the study provides an important opportunity for an experienced engineer to make a judgement on whether the scheme appears likely to succeed, and to advise on the key ingredients of success.

Key to the success of the study is a clear, well-defined scope. The scope should define what information is available at the start of the study and what outputs are required at the end of the study. The role of the client should also be made clear, i.e. how much practical support will be available to coordinate staff and stakeholders needed to inform or comment on the study. If the local authority does not have adequate resources to take a "hands on" role, this needs to be made clear in the invitation to tender.

For local authorities that have not undertaken such a study before, it is advisable to contact potential consultants informally to obtain a realistic idea of the likely budget and timescale for a particular project. This soft market testing process can ensure that there is a good match between the client's expectations and the consultant's ability to deliver.

Although each feasibility study will of course be unique in detail to the project in question, the principal outputs are likely to be common to most such studies. The key expected outputs are:

- An area map showing proposed pipe network routes including sizes and future potential connections, location of potential consumer buildings, existing and proposed energy plant location(s).
- A schematic diagram showing key plant and equipment, operating parameters and consumer interfaces
- Details of proposed energy generation plant – technology, output and location.
- Details of planned consumer buildings.
- A spreadsheet model demonstrating the financial viability of the scheme that can be shared with potential bidders to build, own and or operate the plant. This model should include the ability to vary the key parameters outlined in the scope of works.
- Key outputs from economic and operational modelling including summary energy consumption and demand, CHP energy outputs, summary profit and loss, capital costs, NPV and potential savings to consumers
- Details of CO_2 savings and relative value for money (i.e. £/tCO_2) for key options
- An assessment of procurement and implementation options.
- A summary risk matrix.
- An implementation programme

A suggested scope of a feasibility study has been prepared based on experience of previous commissions in London and is attached at Appendix B.

[1]Royal Institute of British Architects Outline Plan of Work 2007 (amended November 2008). See http://www.architecture.com/Files/RIBAProfessionalServices/Practice/OutlinePlanofWork(revised).pdf

Case Study

Broadwater Farm Estate Feasibility Study

The London Borough of Haringey had a number of opportunity sites for district heating and CHP highlighted as part of their heat mapping process. After an initial pre-feasibility study meeting with the DEMaP team it became clear that many of these opportunities were long-term.

Only two sites met the pre-feasibility criteria to quality for detailed feasibility which are:

– Borough influence
– Site heat loads
– Timescale
– Existing heat loads

The key project identified was actually not highlighted in the original heat mapping report. The Broadwater Farm estate contained approximately one thousand dwellings, two hundred of which are in two tower blocks served by communal boilers, and a number of large six-story 1960s apartment blocks, mostly council owned. The site also contained a doctors surgery with a home for the elderly attached and an oversized plantroom for the communal boilers that once housed boilers to heat the whole estate.

The detailed feasibility study considered the technical viability of connecting all the dwellings to a new district heating system and then considered the associated costs. The planned Decent Homes programme made it feasible to undertake the district heating network installation while the residents were decanted for short periods. A funding gap was identified by the consultants and soft market testing was undertaken to identify the marker of the interest and potential commercial structures and procurement routes.

The project is currently on hold but it is expected to be taken forward at some point in the future.

9.2 Business Planning

A feasibility study is normally a necessary prerequisite to the development of a business case for the council to take a more direct and invested role in the delivery of a DE opportunity. The feasibility study will provide the financial viability argument as well as a helpful analysis of the risk profile of a project.

From this stage, if the council wishes to continue to have ownership of the project, further funding will be necessary. This may be available from internal funds where there is good or particularly strong internal political support. Alternatively the council may need to apply for external funding support, available from EU funds or from current and emerging UK low carbon investment schemes. The range of sources which will be available at any one time will vary. However, at the time of writing, the below provides an initial indication of some of the sources of support which are, or which may in the near future, become available:

- **Financial contributions from new development:** The preceding section provides further details on the application of CIL and the use of section 106 agreements.
- **ELENA and JESSICA:** These European Investment Bank programmes provide, respectively, programme support for project development and capital funding for project delivery. In London the funds are expected to be made available through London-wide schemes administered via the GLA.
- **Prudential borrowing:**
- **Community Energy Saving Programme (CESP):** CESP is an energy company funded scheme which targets low income areas with funding to support low carbon energy investments.
- **Carbon Emissions Reduction Target (CERT):** Under CERT, energy companies are required to help their customers to make savings in the amount of CO_2 emitted by householders. This is achieved by promoting low carbon energy measures and investments.
- **Energy Company Obligation (ECO):** This new scheme is proposed in the government's Energy Bill. The ECO would replace CERT and CESP upon their expiry (in 2012). Energy companies would pay the ECO levy, and the resulting fund will be used to underpin the Government's Green Deal (see below), with financial support targeted at low income households and "hard to treat" properties.
- **Green Deal:** The government proposes the introduction of a new market-based scheme which would provide up front funding to pay for energy efficiency and carbon reduction investments. The money would be in effect a low interest long term loan (up to 25 years) to be repaid through the savings achieved from improved energy performance.
- **Renewables Obligation Certificates, Feed in Tariff, Renewable Heat Incentive:** These three government subsidy schemes provide an additional income stream for renewable energy installations, based on the type of technology and the amount of power generated. Each of these schemes is at a different stage of development and carries a different set of rules for applicability. The RO is up and running, the first review of FiT was announced February 2011 RHI has been announced but has not yet been implemented as a statutory instrument.

It should be borne in mind that, as stated previously, district heating schemes will have revenue streams once up and running. These revenues will make a contribution to the project viability and (subject to the risk profile) can be used to secure a loan or other project finance, which will be repaid from the revenues. It should also be borne in mind that district heating schemes are more like utility infrastructure investment than renewable energy investment in that district heating pipework is likely to last 40 years or more. District heating contracts typically reflect this so paybacks of less than 10 to 15 years, which one might expect from some renewables that have shorter lifespans, should not be expected. There may remain a funding gap which will need to be bridged in the form of a grant or other non-repayment funding, but for a good quality district heating scheme this will be considerably less than the total capital cost.

9.3 Commercial Delivery Vehicle

Assuming the feasibility study makes a positive recommendation to proceed, a key decision to be taken during the next stages of project development concerns the nature of the delivery vehicle, or commercial entity (or entities) which will procure, fund, construct and operate the new decentralised energy network. This is where the often used but often misunderstood term "ESCo" comes in.

ESCo is simply an abbreviation of "Energy Services Company". It does not automatically mean a company with a particular corporate structure or a specific scope of services, but instead is a general term embracing a wide range of delivery and ownership structures. A helpful introduction to the different types of ESCo is set out in Powering Ahead[1], a prospectus document produced jointly by the London Development Agency, London First, London Councils and the Mayor of London. The definitions and the graphic below are reproduced from that guide.

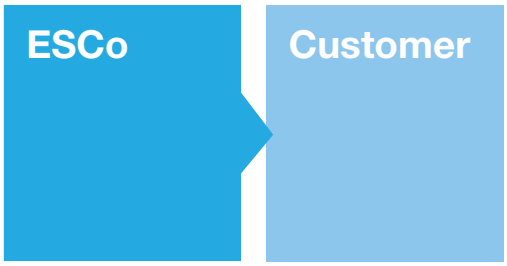
[1]Powering Ahead: Delivering Low Carbon Energy for London. London Development Agency, London First, London Councils and Mayor of London, October 2009.
Weblink: http://www.london.gov.uk/who-runs-london/mayor/publications/environment/powering-ahead-delivering-low-carbon-energy-london

Figure 20

Examples of DE project commercial structures
Source: Powering Ahead, 2009

Type 1 and 2 Projects

Southwalk MUSCo
Single entity responsibility for generation, infrastructure and selling to customers

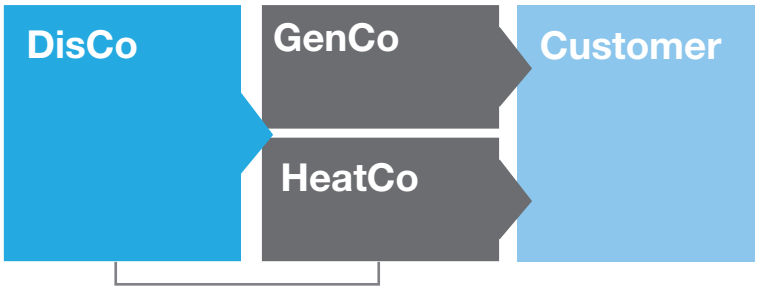


South East London combined heat and power

Single entity responsibility for generation, infrastructure and selling to HeatCo who in turns sells to customer

Kings Cross Central Development

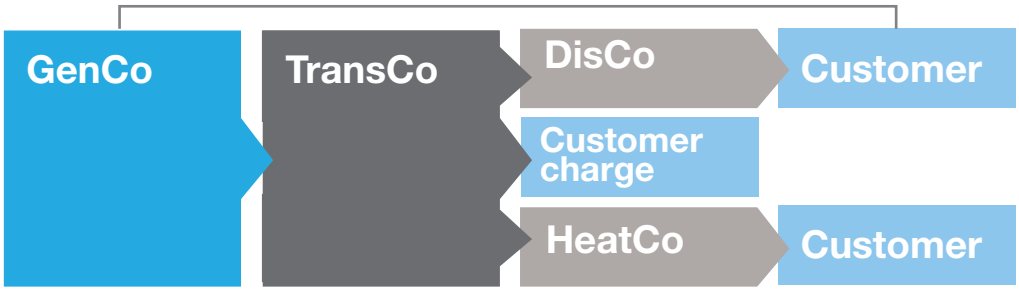
Two seperate vehicles; one responsible for generating and selling energy and the other responsible for the infrastructure



Type 3 Projects

London Thames Gateway, Heat Network

Separate vehicles for generation and transmission with various supply arrangements



Types of Energy Company

Energy services company (ESCo) - is a single entity responsible for generation, infrastructure and selling energy to the customer. It is also a general term which can encompass any of the more specific company types listed below.

Generation company (GenCo) - provides generation assets and sells electricity and heat; it is likely to be a commercial entity that remains at arm's length from the decentralised energy infrastructure.

Transmission company (TransCo) - owns transmission assets connecting local pipework.

Distribution company (DisCo) - owns and operates local pipework, with the ability to take energy from the GenCo and sell on to customers (in the absence of a HeatCo). A TransCo and DisCo may also be a single entity.

Heat company (HeatCo) - buys heat (and possibly other services) and sells to customers.

Note that any of these companies might in practice be public sector organisations acting as a front for customers or commercial billing organisations.

9.4 Selecting the Right Commercial Structure

Each project will have unique characteristics which will determine the appropriate commercial structure and professional advice will need to be sought at this stage. As a general guide, key factors affecting this decision will include the following:

Availability of funding and access to finance

Where a project is intended to be wholly private financed, the private sector will also take full control over the delivery vehicle. Where the local authority's own funds will be used, a more direct role in the company structure may be appropriate to ensure the local authority can secure an appropriate return on its investment. This may also help to reduce State Aid restrictions on the provision of public money to private companies or persons.

Ownership of anchor loads

If the council's own buildings, or other public sector buildings (such as NHS or education) will be key anchor loads, a more direct role for the local authority in the operation of the network may be more appropriate, although as the diagrams in Figure 20 show, heat customers are normally separated commercially from the heat generator, distributor and supplier. However, the council as an anchor customer may wish to hold at least partial ownership of the ESCo in order to retain control or influence over pricing strategies. This may also be relevant for council owned residential properties, where pricing control could incorporate an explicit policy to reduce the impact of fuel poverty on low income tenants.

Attitude to Risk

The local authority will need to take a view as to how much risk it will be willing or able to own. Each risk should be carefully evaluated and those risks which a local authority is not willing to own should be highlighted in the procurement documentation. Key risks that need to be assigned as part of any procurement process include:

- Capital risk – i.e. Capex costs being higher than budgeted;
- Operation and maintenance risk – i.e. bearing costs for O&M;
- Plant replacement costs – bearing risk associated with planned and unplanned deterioration of plant;
- Performance risk – maintaining an agreed level of supply;
- of heat in accordance with the service level agreement
- Customer credit risk - default and bad debts;
- Supply risk – shortfalls in commodity supplies;
- Technical know-how site management/ensuring appropriate maintenance;
- Health and safety risk;
- Financial reporting risk,
- Revenue risk surrounding insufficient demand – e.g. building delays/developers not signing up; and
- Development risk/demand guarantee - i.e. will the development be built out as expected resulting in the heat demands forecast for each year.

Developing the risk profile a local authority is willing to bear will take detailed negotiation with many departments. The overall process should not be underestimated. Consideration should be given to what risks an authority already owns, for example some own social housing through an arm's length management organisation (ALMO) and have communal boilers on a number of sites for which they collect revenues directly from tenants. Such a local authority already takes credit risk and this could be extended to new development.

9.5 Construction and Operation

The contracting strategy for the construction of a network will depend in part on the commercial structure but also on the scale and nature of the project. A combined design and build contract is the typical approach for an infrastructure project, while in some cases the contract will integrate financing and/or operation alongside the design and build scope.

For on-street networks, the pipe route is normally installed in a linear fashion, with completion section by section in order to minimise the impact on traffic movements. Once completed, the network typically requires little maintenance but the energy centre will have regular visits and monitoring to ensure optimal performance. Pipes are generally designed to last many decades but replacement or major renewal of central plant is typically required every 10 to 15 years.

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A

Appendix A
Sample District Heating Design Specification

CONSUMER CONNECTION TO A LARGE CHP DISTRICT HEATING SYSTEM

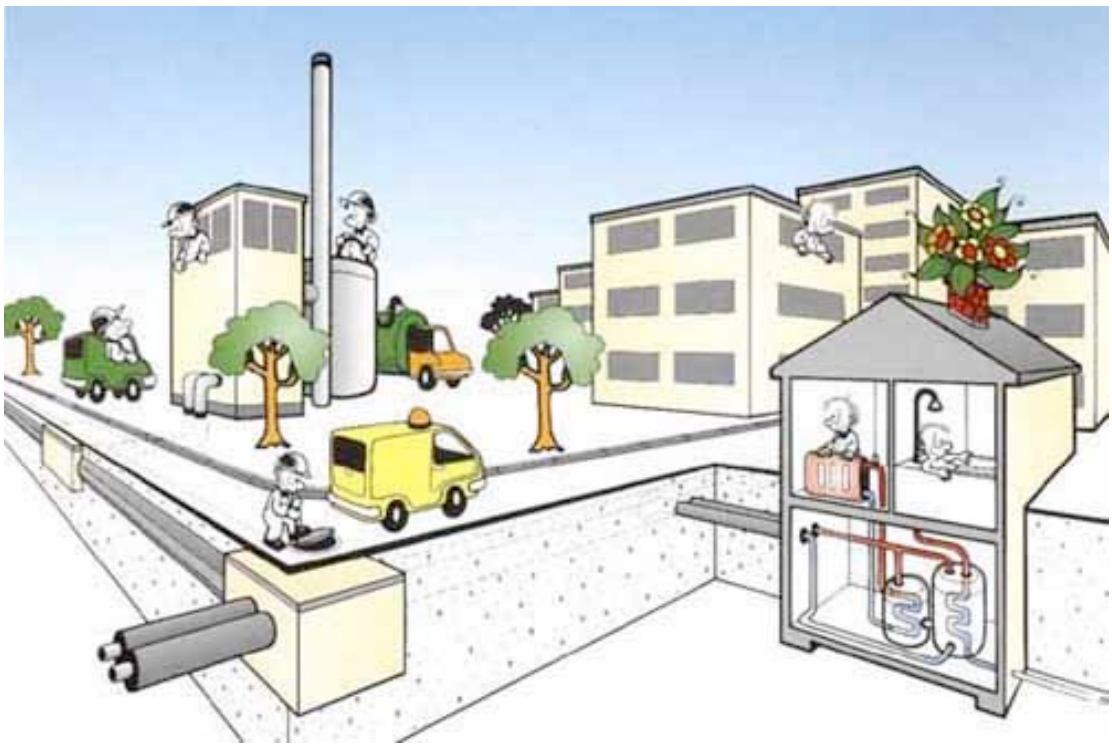
This document aims to provide technical information on equipment and operation of a typical consumer connection to a large District Heating system. Besides the consumer connection, the document also outlines the general structure and operation principles of the overall CHP/DH system.

1. A city wide CHP/DH system

District heat is produced in combined heat and power (CHP) plants or in large heating boiler plants. Customers receive heat through the hot water circulating in the district heating network.

District heating is a natural form of heating in densely-built areas. It keeps the environment clean and improves living comfort. District heating conserves energy and the environment to a significant extent. The greatest savings come from combined production of district heat and electricity. This saves one-third of fuel compared with separate production of electricity and heat. It also combats climate change.

Figure 1. A city wide CHP District Heating system



Finnish Energy Industries

Modern District Heating is reliable and flexible. For heat generation, there are several heat sources supplying the network from different locations. An optimum mix of fuels can be

used, including biomass, waste fuels and industrial waste heat, to achieve low carbon content and security of supply, both in terms of long term availability and price development. For heat distribution, reliability is built up from several factors: network configuration with redundancy loops, proven pipeline materials and installation methods, effective preventive and reactive maintenance procedures.

2. Consumer Connections

Substations

Each of the consumer buildings would be connected to the DH network with a consumer substation unit, in a hydraulically separated manner. A substation unit comprise all the necessary equipment for heating connection and for domestic hot water preparation. Consumer substations typically comprise two heat exchangers - one for heating and the other for centralised, instantaneous DHW production - complete with all necessary pumps, controls and valves.

The heat exchangers are usually brazed type plate heat exchangers, due to the lower investment and maintenance costs compared to sealed ones. The heat exchange surface is made of acid-proof steel, ensuring long life and avoiding the need for any maintenance. Due to easily accessible connections, the heat exchangers can be easily disconnected from the system if needed.

The substation units are typically fully prefabricated at the factory; completely assembled, pre-wired and assembled on a solid frame for floor mounting, except if there are transport size restrictions. In such cases the units are delivered in sections and assembled on site.

The DH consumer substations are significantly smaller than conventional boiler plants and consequently, a lot of space can be saved in new developments or taken to other use when existing boilers are removed. A heat exchanger substation can take as little as 10% of the space required by conventional boiler plant.

Figures 2 and 3 illustrate one example of consumer substations. It should be noted, however, that substation configuration can vary substantially depending on customer size, special requirements and preferences, for example regarding the DHW production.

A two-port control valve in the DH return pipe controls the amount of heat delivered. A temperature sensor in the secondary flow pipe, near to the heat exchanger outlet, provides the set point for the controller to position the valve and provide the correct amount of heat to match the consumer's momentary heat demand. A controller is normally provided as part of the package and includes time clock features, alarms and is capable of compensating to an outdoor sensor. It has night setback facilities and can control both the DHW and the heating circuit.

The use of direct, instantaneous DHW production is recommended over the DHW storage applications, for the following reasons:

- no risk of legionella
- lower heat losses at building
- savings in investment and space
- better cooling of the DH primary circulation water resulting in higher transmission capacity/lower pipe line investments, lower pumping costs and lower heat losses

Figure 2. DH substation

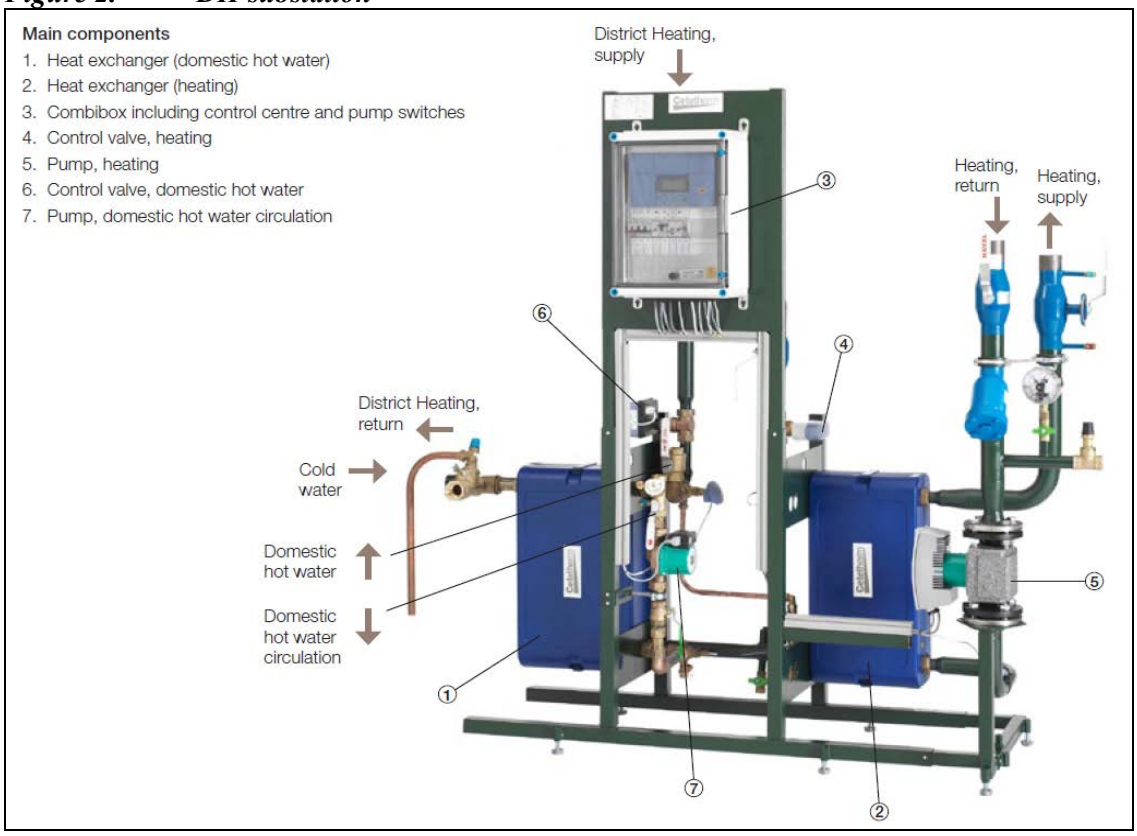
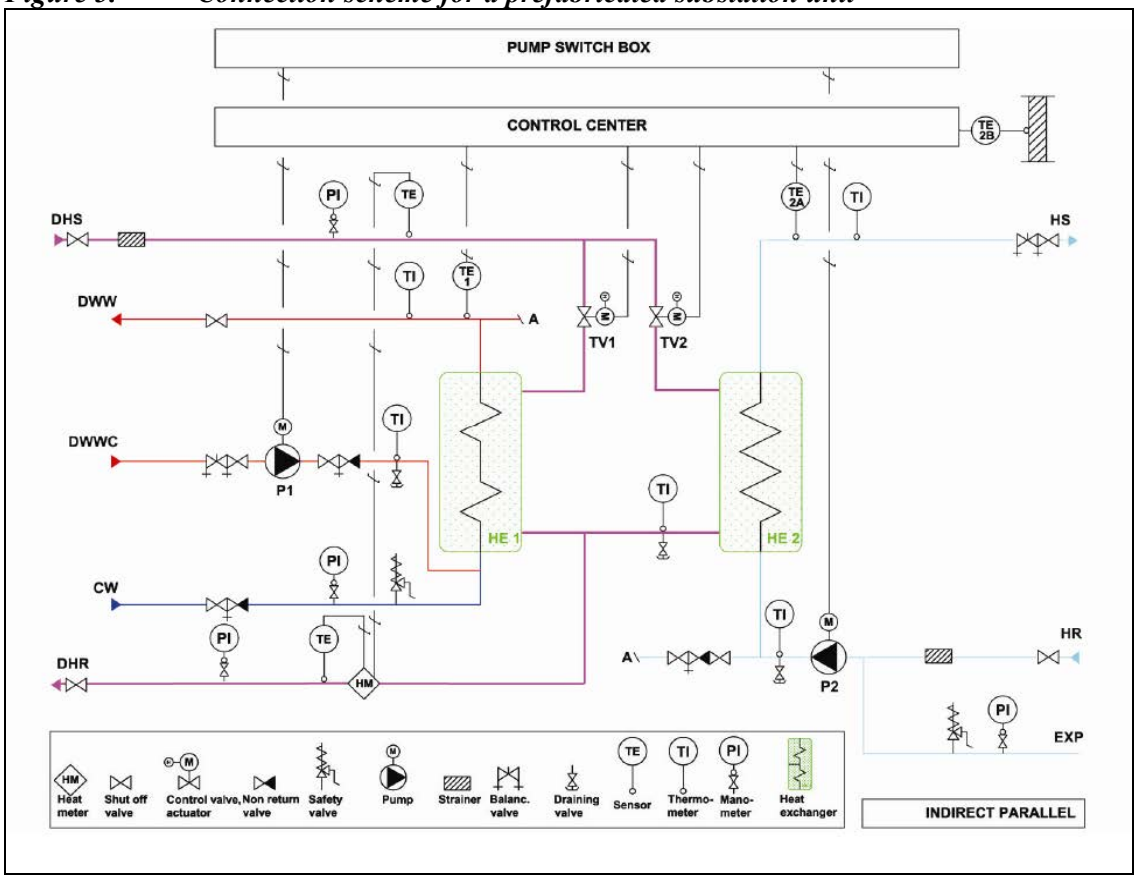


Figure 3. Connection scheme for a prefabricated substation unit



The following design recommendations should be followed to facilitate a technically and economically efficient operation.

Table 1. Recommended design temperatures, °C (Wet radiator systems and DHW)

Design Temperatures, °C	Primary side		Secondary side	
	Flow	Return	Flow	Return
Space heating • new • renovation	110	55	70-80 80	40-50 60
DHW	70	max. 25	55	10

The space heating secondary side temperatures depend on the internal heat distribution system. For example for air heating and floor heating the design temperatures are lower. Generally, the lower the secondary side temperatures are the better for the DH system.

The maximum pressure loss on primary side heat exchangers (space heating and DHW) is 20 kPa and on other substation piping and accessories 5 kPa (excluding control valves, normally designed for dp of 25-25 kPa).

Heat Metering

The heat metering at building level consists of a flow meter, temperature sensors and a calculation unit (integrator). There are different types of heat metering equipment, but ultrasonic flow meters have improved their competitiveness considerably within the last few years. Even though their investment cost is slightly higher than with the other flow meters, ultrasonic flow meters are recommended because of high operational reliability, maintenance free operation, high accuracy and the widest technical operational range considering the quality of DH water (impurities, conductivity, iron content, viscosity etc.).

Typically heat metering (at building level) belongs to DH supplier's scope of delivery, but the substation units to building owner's (developer's) responsibility.

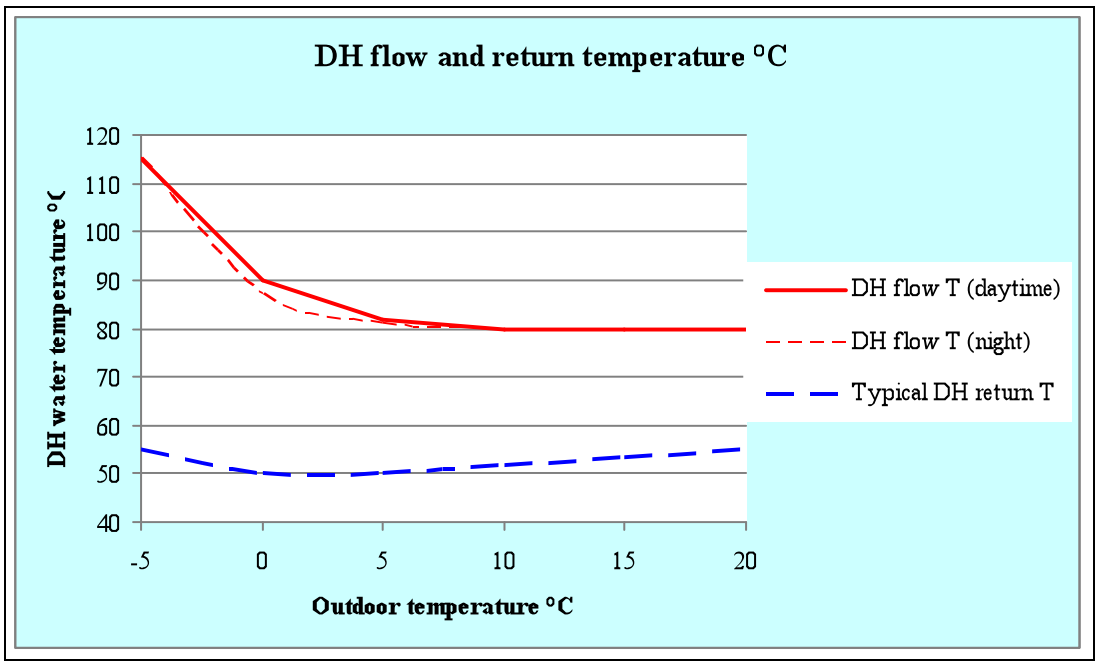
If individual heat metering is required for each flat, it needs to be considered separately.

3. LTGHN design parameters and operation principles

The London Thames Gateway Heating Network (LTGHN) District Heating system has been designed to accord with the widely used European practice for large scale CHP/DH systems with design conditions of 16 bar, 120 °C. Any sub-systems should preferably be designed to same parameters and operation principles. Applying standard design principles will facilitate the compatibility with any large scale CHP/DH scheme, and any separate distribution network could be connected directly (without interposing heat exchanger station or modifications) to a possible city wide system facilitating further improvement of energy sourcing, economy of scale benefits in operation, and better reliability of supply.

The primary network has been dimensioned with an operating temperature of 110 °C flow and 55 °C return at peak demand. The operation is based on variable flow and variable temperature design, where the actual momentary heat consumption level determines the actual water flow and flow temperature applied, the higher the consumption the higher the applied flow and temperature is.

Figure 4. Typical DH Flow Temperature as a function of outdoor temperature



The heat capacity to be distributed is regulated by changing the DH supply (flow) temperature and water flow (controlled by the consumer substations). The DH supply temperature is typically 80... 85°C until an outdoor temperature of 0...5°C. With colder weather, the temperature is gradually increased from 80°C to the maximum level. The maximum operating temperature of 110°C is applied at the local design outdoor temperature, which is -5°C in South England. The return temperature is fully dependent on correct/optimum design and operation of consumer substations and building heating systems, varying normally between 45…55°C.

The temperature regime applied varies somewhat between DH systems depending on local conditions, such as climate, type of heat production capacity (CHP), network length and consumer equipment (inc. possibly cooling).

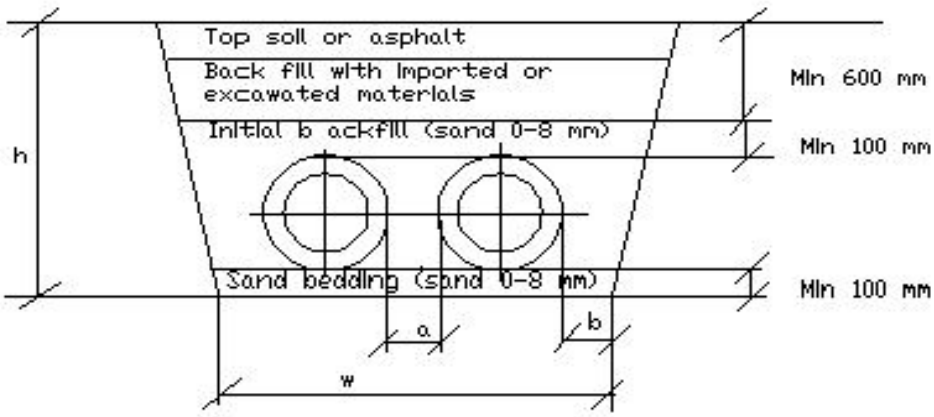
The DH circulation pumping is designed to provide all consumer substations at all times with a sufficient pressure difference, normally about 1 bar minimum. Speed regulated DH circulation pumps with frequency converter and pressure difference control are used to optimise the pump operation in different consumption and flow situations. The pumps are regulated by pressure difference, which is measured in the most distant points of the network (critical consumers). In case of long transmission lines and branch pipelines that need a higher pressure level, booster pump stations are used to ensure sufficient pressure difference to the most distant parts of the network.

4. Space requirement for DH pipeline installation

The district heating pipes will require a trench approximately 2-2.5 m wide with an overall working width of 5 m during pipe laying.

The following cross section of directly buried DH-pipe trench together with the table of main dimensions indicates the space requirements for different pipe dimensioning. For example, for transmission pipes with internal diameter 300 mm and external diameter of 450 mm, (including lagging), a total trench depth of 1.2 m would need to be dug to accommodate the pipes because the minimum distance from the top of the pipes to ground level is 600 mm.

Figure 5. Space requirement for DH pipeline installation



DN/casing	a (mm)	b (mm)	w (mm)	h (mm)
DN300/450				1200
DN400/560	200	200	1720	1360
DN500/630	200	250	1910	1430
DN600/800	250	300	2400	1600
DN700/900	250	300	2600	1700

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B

Appendix B
Sample Feasibility Study Specification

B

Sample Feasibility Study Specification

B1
Background

The London Heat Map (LHM) is part of the Decentralised Energy Master Planning (DEMaP) programme, developed by the LDA to meet the Mayor's target of meeting 25% of London's energy supply from decentralised energy by 2020. As part of the DEMaP programme, a suite of 'service packages' have been identified setting out the steps necessary to support boroughs to deliver a DE project, from concept, through to delivery. One of these service packages is Feasibility Studies which involves a detailed study of the feasibility of decentralised energy networks in specific locations that can act as a catalyst to wider networks across the boroughs.

Any borough that has reached the stage of specific Distributed Energy (DE) feasibility studies should have mapped the heat loads within the borough that provide sufficient density to make DE projects viable. The LDA has developed a London Heat Map (LHM) which can be found at www.londonheatmap.org.uk.

The LHM provides a web-based GIS resource containing high level data on decentralised energy (DE) across London. The LHM is hosted by the LDA and is regularly updated with information from boroughs and developers.
The LHM contains a combination of actual and estimated heat energy consumption data for all buildings in London.

As part of the DEMaP programme the [name of client] are currently seeking to appoint consultants to build on the heat mapping already undertaken for the borough in order to test the specific technical and financial practicality of DE systems within identified areas where development/refurbishment are to take place within a foreseeable timescale.

B2
Aim

The aims of this project are:
- To assess the technical feasibility of expanding the heat network at [location] including a study of the existing assets;
- To assess the financial viability of expanding the heat network at [location];
- To identify commercial delivery routes for expanding the heat network at [location];
- To provide an evidence base that will allow tender documentation to be written for the expansion of the heat network at [location] and its ongoing operation and maintenance.

B3
Scope of Work

- Collect information from key stakeholders relating to primary energy consumption, existing energy assets and systems and maintenance arrangements. This includes:
- [Buildings to be studied].
- Survey buildings and collect details relating to existing energy plant, metering points, system operating parameters, type and age of systems, controls, maintenance arrangements
- Review the existing capacity of the boiler house at [location] and consider engineering issues such as flueing, ventilation, access, future plant replacement and service connections.
- Liaise with the energy manager for Homes for [borough] and the current operators of the energy plant
- Analyse and normalise energy consumption data where possible and estimate peak demands at the consumer building through discussions with operating staff or from BMS where possible.
- Estimate the peak demand of the scheme at the energy centre(s) taking demand diversity into account
- Provide concept layout and sizing for district heating network including connections to potential consumer buildings
- Detail hydraulic interface arrangements and demarcation options, including schematic diagrams
- Develop a robust operational and economic model to enable the optimum low carbon plant capacity to be determined for different demand scenarios and the economic and CO_2 impact of different schemes to be analysed.
- The analysis will include a net present value (NPV) comparison of the planned DE scheme with the 'business as usual' case.
- The NPV calculation shall take account of all costs and revenues i.e. capital, operating, periodic replacement, fuel, energy sales, electricity etc over a 25 year period. Analysis shall be based on cost and price development in real terms (without inflation).
- The analysis shall be undertaken according to Treasury Green Book guidance and at higher discount factors to determine the extent to which private sector financing might be employed and the impact on the economics of this approach. Compare and evaluate all CHP/DE options against a 'business as usual' option.
- The model shall enable the economic value of CO_2 savings to be taken into account.
- The model will be capable of running sensitivities on all key inputs, including primary energy costs, energy selling prices, CO_2 value and discount factor
- Determine level of any capital funding gap (negative NPV at private sector discount factor)
- Determine the CO_2 savings compared with the 'business as usual' option

- Report on the cost of any CO_2 savings over the project, based on the capital funding gap
- Carry out a multi-factor (subjective) analysis of options, comparing factors such as deliverability & risk.
- Identify key project risks remaining and suggest ways of mitigating these
- Identify procurement options and recommend specific approach in consultation with key stakeholders
- Prepare programme for further development stages and delivery of the project
- Provide an evidence base for the preparation of tender information to take the project to market
- Present the project at a meeting of local residents and stakeholders in order to gauge opinions and explain benefits of community heating infrastructure.
- Any additional identified that could help to meet the aims of this work and strategic aims of the Council to support distributed energy networks in the borough.

B4
Project Outputs

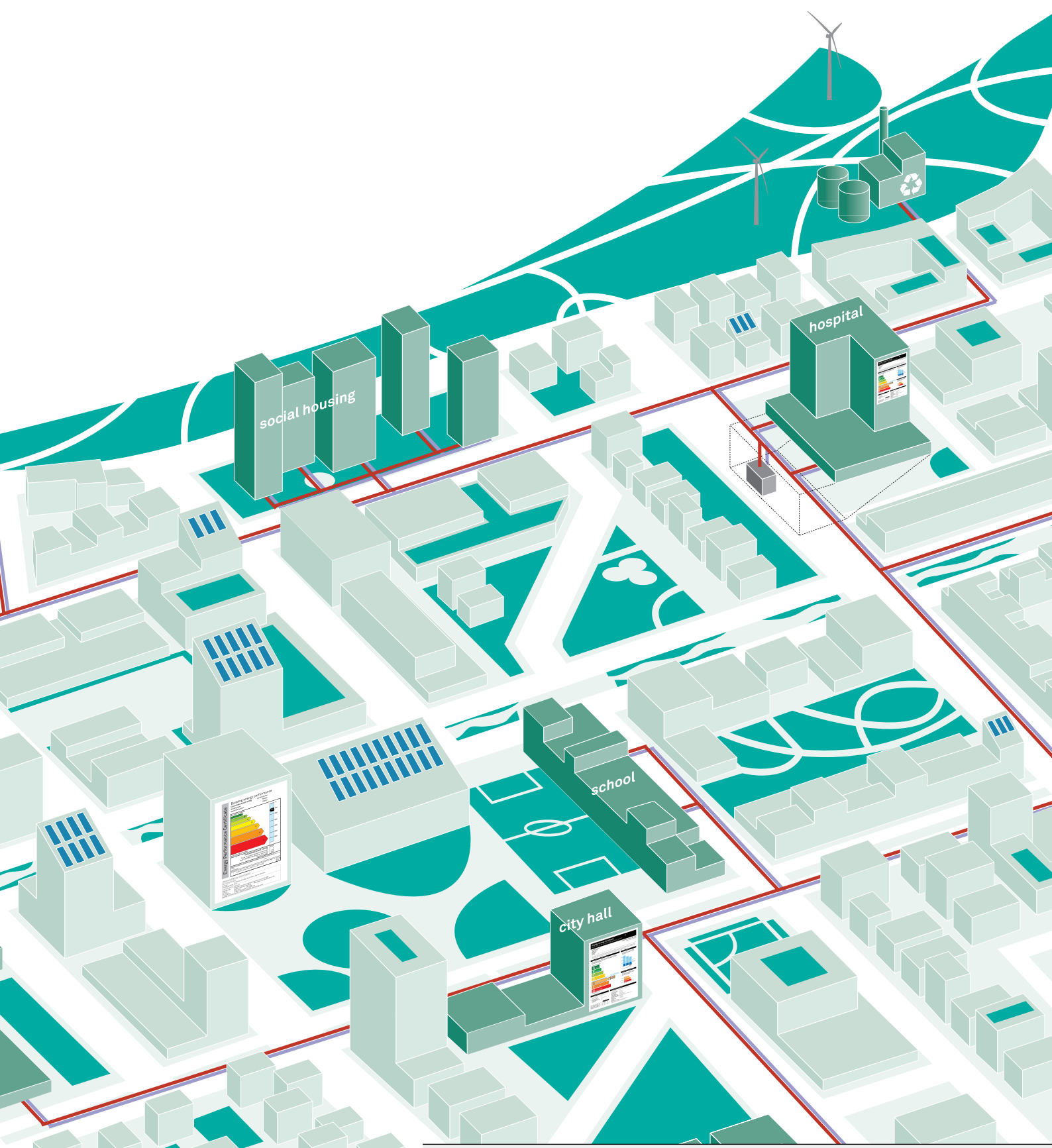
- The consultants will provide [name of client] with:
- Map showing proposed pipe network routes including sizes and future potential connections, location of potential consumer buildings, existing and proposed energy plant location(s).
- Schematic diagram showing key plant and equipment, operating parameters and consumer interfaces
- Details of planned consumer buildings
- Key outputs from economic and operational modelling including summary energy consumption and demand, CHP energy outputs, summary P&L, capital costs, NPV, CO_2 savings and £/tCO_2 for key options, potential savings to consumers
- Details of proposed energy generation plant – technology, output and location
- Details of CO_2 savings and value for money
- An excel model demonstrating the financial viability of the scheme that can be shared with potential bidders to build, own and or operate the plant. This model should include the ability to vary the key parameters outlined in the scope of works
- Summary risk matrix
- Potential procurement and implementation options
- Implementation programme
- Facilitate one, 2 hour workshop with local residents/stakeholders to provide information on the feasibility study being carried out and gauge their opinions on the opportunity for a communal heating system.

B5
Other studies

This study will build on earlier and current studies:

[Studies to be listed]

Information from these studies will be made available to the appointed consultants.



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September 2011

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