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# LONDON HEAT MAP STUDY FOR LONDON BOROUGH OF EALING

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# CONTENTS

# 1. INTRODUCTION

In February 2010, Ramboll were appointed by the London Borough of Ealing to carry a heat mapping study as part of the LDA's Decentralised Energy Masterplanning Programme (DEMaP). Our work was structured to meet the aims of the study as defined in the brief, which were as follows:

1. Produce a heat map of the Borough.
2. Provide advice and support to the Borough in interpreting and acting upon results of the heat mapping.
3. Identify potential areas for the development of further district heating networks in the Borough.

The course of the study was broken down into 3 stages:

1. Assemble heat load data for priority buildings in the Borough, using as much actual energy consumption data as possible. Mapping of all priority buildings using Ordnance Survey coordinates. All data was recorded on an excel spreadsheet template, with fixed fields for completion and issued to the LDA for conversion to a GIS heat map.
2. Upon receipt of the heat map from the LDA, the map was analysed and clusters of buildings and development areas were identified as having the best potential for delivering future district heating networks.
3. A high level implementation plan was then produced for the Borough, on a tabular format template, highlighting each individual DH network opportunity associated barriers, next steps, key dates and key personnel within the Council for moving it forward.

The broader objective of this exercise was to enable the results to be fed directly into the emerging Local Development Framework documents. In particular, based on the findings of the current study, the Strategy and Sites Development Plan Documents can identify areas/sites with specific District Energy Network (DEN) opportunities in the Borough.

This will also be supplemented by the Infrastructure Delivery Plan, which will establish the delivery mechanisms (including ongoing funding/maintenance) for DEN proposals within the Borough over the London Development Framework (LDF) plan period (i.e. up to 2026). Moreover the Development Management DPD will establish policies for the assessment of DEN proposals, and set criteria to ensure that new development links into established networks. It is expected that clear guidance from the Council will provide the certainty needed to attract investment in DEN proposals within the Borough.

# 2. DATA COLLECTION

The main objective of the project was to collect actual heat demand data for a list of priority buildings for later illustration on the London heat map website.

## 2.1 Methodology

The methodology for collecting data for the heat map study was set out by Ealing Borough in collaboration with the LDA.

The data gathering methodology adopted was guided by the list of 'priority buildings' identified in the project scope and entered into the excel spreadsheet template.

Most of the data was collected by Ramboll and this can be found, in spreadsheet format, in Appendix A.

During the data collection exercise, the LDA provided additional information on buildings in the Borough. This information was gathered in previous studies and did not necessarily include buildings classified in this study as being "priority buildings". Where appropriate the LDA consolidated the data provided to them by Ramboll, with that they already had. A spreadsheet of the LDA data is shown in Appendix B.

In reality the data gathering is an ongoing process which needs to be continued by the Borough, as some contacts have not been able to return data within the timeframe.

The methodology for data gathering was to target heat loads by the priority building type as listed here.

- Multi-address buildings – predominantly public residential
    - Gas consumption data for council-owned estates was provided to us by Ealing Council. Premises were mapped using the Local Land and Property Gazetteer (LLPG) database and using streetmap.co.uk website.

- Sport & leisure facilities
    - Data for council-owned premises has been recorded from the NI185 database.

- Prisons: There are no prisons in the Borough.

- Hotels
    - Large hotels (> 149 bedrooms) were identified using an internet search. CIBSE Guide F benchmarks were used to estimate the energy consumption.

- Education facilities
    - Gas consumption for schools and nurseries was recorded from the NI185 database.
    - Thames Valley University data sent to us by Ealing council was recorded.

- Police stations
    - Police stations were identified via an internet search. LDA to pursue consumption data.

- Fire stations
    - Fire stations data was made available to us by Ealing Council.

- Hospitals
    - Gas consumption data for the hospitals was obtained from the NHS website.
    - Data for the Ealing PCT sites was made available to us by Ealing Council.

- Museums & art galleries
    - This typology was identified through the NI185 database.

- Central government estate
    - We have contacted JobCentre Plus but were told that JobCentre Plus do not own or manage the premises they occupy and that no data was available.

- Local government estate
    - Gas consumption data was recorded from the NI185 database. Energy for electrically-heated buildings and premises with no data was approximated with CIBSE Guide F benchmarks.

- Religious institutions
    - Due to the low impact on the heat map, no consumption data for religious premises were pursued.

- Private residential units (>149 units or 9,999m$^2$)
    - Private residential units were identified based on the planning application data and area development plans sent to us by the Council and identified on the Council's website. Proposed developments were benchmarked based on a 20% or 50% reduction of Part L value depending on the predicted construction date.

- Private commercial units (>9,999m$^2$)
  - Private commercial units were identified based on the planning application data and area development plans sent to us by the Council and identified on the Council's website. Where possible, data for mixed use developments was split into multiple entries according to the typology. Proposed developments were benchmarked based on a 20% or 50% reduction of Part L value depending on the predicted construction date.

- **Supermarkets** were identified via an internet search. Contact was made with the following company headquarters to determine a level of interest in connecting to a heat network; Sainsbury, TESCO, ASDA, Waitrose, Morrisons, Marks & Spencer and Iceland. Only Morrisons responded with data but unfortunately this arrived too late to be able to be included in the analysis, however the loads that were indicated would appear to offer potential to a network. Lidl and Aldi were not able to be contacted.

- During the study we also contacted **Park Royal Partnership**. Park Royal Partnership is an organisation that represents the interests of the occupants of the Park Royal Industrial Estate. We engaged in several conversations with the Partnership but we understand that they do not hold individual energy data for their members. We understand that the Partnership has approximately 1500 members and that they may buy their energy as a group. This policy would be advantageous in any future discussions regarding a potential heat network in this area.

- Other public buildings
  - A couple of unique buildings were identified in the NI185 database and planning applications.

**Heat Demand**

A building's heat demand depends on the heat loss of the building fabric, the ventilation rate, and domestic hot water usage.

Typical existing houses and buildings in the UK are fairly inefficient in terms of heat usage when compared to similar European examples. New policies have affected and considerably improved the new building stock in terms of energy demand; an average existing home requires four times more energy to heat as the average new home.

It can be seen, therefore, that it is existing homes and buildings that benefit most from being connected to an efficient district heating network.

In this project, we have collected and estimated the annual heat demand (measured in MWh) for potential district heating networks in the London Borough of Ealing. The heat demand represents the sum of all the estimated heat consumptions of consumers. The heat demand is used to determine the heat load to the proposed network(s) (measured in MW), which is then used to establish the capacity required of the system as a whole.

Where actual consumption data could not be obtained within the timescales available, estimated consumption data was calculated for existing buildings by using floor areas and benchmark figures taken from CIBSE Guide F (2004). Proposed developments were benchmarked based on a 20%, 50% or 80% reduction of Part L value depending on the predicted construction date. Benchmarks used are as follows:

- Assuming 210 kWh/m$^2$/annum (CIBSE F table 20.1 Offices, Air conditioned, prestige)

- Assuming 67 kWh/m$^2$/annum (80% of 2006 Part L Benchmark for Office)

- Assuming 80 m$^2$/unit (80% of 2006 Part L Benchmark for Residential)

- Assuming 47 kWh/m$^2$/annum (80% of 2006 Part L Benchmark for Residential)

- Assuming 58 m$^2$/unit and 47 kWh/m$^2$/annum (80% of 2006 Part L Benchmark for Hotel)

Where floor area data was not available within the timescales available to produce estimated heat consumption figures for existing buildings that were expected to have a high heat load, the buildings were included in the heat map with a zero heat load but with a view to adding in a heat load should the data become available in the future.

**Major Heat plants and district heating networks**
The study brief asked to identify major existing and proposed heat supply plants. The brief also called for identifying existing decentralised energy systems, communal heating systems or heat networks.

A major heat supply plant is considered to be a larger plant such as Energy from Waste (EfW) plant, a power station of several MW that doesn't currently export heat either partly or fully, or large industrial sites where there are processes that produce heat that is not utilised.

Energy or heat networks are existing or proposed networks that will have an accompanying energy centre (that may be CHP enabled). The energy centre would not be repeated in the major heat supply plant section, as it is not likely to have excess capacity to feed any new network. Having said that this network and its energy centre has a potential for being a good starting point for further development and expansion of networks.

To identify sources of useful heat, the following resources were consulted:
- Industrial Heat Map website
- Planning Applications
- LEP database
- Eionet LCP (Large Combustion Plant) Database
- DECC CHP Database
- OFGEM CHP database

The LEP database was consulted and no existing district heating networks were identified for inclusion.

## 2.2 Methodology considerations

With the relatively limited time scale of data gathering, it was important to prioritise the buildings and effort in line with the potential heat load and connection opportunity. Accordingly, a heavier focus was placed on gathering the data for hospitals, council-owned premises, proposed developments and hotels.

Remaining building types were also pursued by identifying the relevant premises in the LLPG database and sending standard letters to the concerned parties. Least focus was placed on the building types which were going to be investigated by the LDA, i.e. fire stations, police stations, TfL premises, commercial floor space listed in the VOA database.

The Borough's LLPG database was extensively used to identify potential buildings and consumers to be pursued. The LLPG database was then interrogated to obtain OS coordinate points for a specific address.

Where data was not found in the database, internet searches and mapping websites (Google, Streetmap, NHS, Expedia) were used to find and map additional premises.

Special consideration was given to proposed developments, which were identified through planning applications and data sent to us by the Borough. Proposed developments were recorded by clustering all the buildings to a point in the centre of the development. Floor areas were split between residential and commercial typology and benchmarks based on Part L energy reduction were used accordingly. Updated planning policies now provide greater incentive for new developments to become good candidates to start a district energy network.

Additional issues should be considered when analysing the data.

- 'Double counting' – future developments with estimated heat demand may overlap existing sites where heat demand is already counted. Data collected from various sources may overlap data which was already on the London heat map.

- Estimated data, as noted in the spreadsheet, may differ from actual consumption depending on, e.g. building fabric, occupancy patterns and actual building performance.

- Existing networks and major heat supply plants – existing networks that will have an existing energy centre that may be CHP, should not automatically be considered as a major heat supply plant, as they are not likely to have excess capacity to feed a new network. A major heat supply plant should be considered to be a power station that doesn't currently export heat, or a large industrial site where there are processes that produce waste heat. No heat supply plants were identified within the Borough by Ramboll, however the data already on the LHM website lists a number of smaller CHP units within the Borough as 'Major Heat Supply Plants'.

- Information was sought from the VOA by the LDA but at the time of completing the report this data had not been made available.

- The LDA provided data was from a previous study, so some of the buildings, by definition, would not be considered as "priority buildings".

- A proportion of the information gathered was partially incomplete, as information could not be returned within the timescale of the study.

# 3. HEAT MAP ANALYSIS

The heat demand of over 600 buildings (including those buildings identified by the LDA) was included in the assessment

The original maps received from the LDA mapped types of buildings but no heat data was illustrated. These maps can be seen in Appendices 1 and 2. Whilst these maps highlight clusters of buildings they do not necessarily help exploit opportunities with respect to clusters of heat. Ramboll therefore produced the heat demand map which can be seen in Appendix 3.

Due to the relatively large number of priority buildings and building categories it was found necessary to group the data differently to enable the illustration of the heat demand data.

Appendix 3 shows five building categories each illustrated by a different coloured dot or square. To further clarify the size of the dot or square indicates the magnitude of energy consumption, i.e. the larger the dot or square the larger the heat demand. The dot representing existing buildings while the square represents proposed.

The building categories are listed below with an indication of the building type:

- Private: Private residential, private commercial, hotels, education, museums, multi-address buildings (businesses)

- Local Government: Local Government Estate, education, sports & leisure, museums

- Central Government: Central Government Estates

- Other public: NHS, Fire, Police, other public, multi address (public with central boilers)

- Unidentified: This data consists primarily of data received from the LDA.

On the heat demand maps (Appendices 3, 4 and 5) the major supply plants will be indentified by a triangle (△) and a potential new network or development with CHP will be, proposed and be identified by a square (□).

The heat map appendices produced for this report is for support and overall illustration only. For any detailed assessment of building data and their location the London Heat Map website has to be explored.

## 3.1 Larger district heating regions

The borough can be grouped into smaller more manageable geographical regions that can later be used as a method of phasing the introduction of the district heating network and this can be seen in Appendix 4.

As much as possible the grouping has been based on dividing the Borough by major road, rail and water course. This decision is based upon practical reasons. Crossing major road infrastructure can be quite difficult especially when the road is a major artery for an area. Restrictions such as maintaining bus and ambulance movements can reduce the available working space and time. Rail and water offer similar restrictions which tend to be overcome by either bridges or tunnels but these come at a significant additional cost.

The quantitative heat demand assessment results are presented in Table 1.

| **Larger Regions** | **Estimated heat consumption (MWh/yr)** |
|---|---|
| 1. South Central Ealing | 87,000 |
| 2. Acton | 40,000 |
| 3. Park Royal | 9,000 |
| 4. Southall | 39,000 |
| 5. Central Ealing | 24,000 |
| 6. North Central Ealing | 3,000 |
| 7. Northolt | 10,000 |
| 8. Greenford | 15,000 |
| | |
| **TOTAL HEAT DEMAND** | **227,000** |

**Table 1: Regional heat demands for potential district heating network(s)**

The above figures are an underestimation of the amount of heat available within the Borough. The number of buildings, that it within the time scale of the project has been possible to identify the heat demand for, is only a fraction of the actual number of buildings in the Borough.

Also is has not been possible to obtain data for all the buildings identified. Appendix C has the more detailed list of the buildings within each region and their heat demand. From this the priority buildings with no heat data identified and which could be targeted for obtaining heat demand data can be seen.

## 3.2 Criteria for creating clusters (Focus Areas)

Clusters need to be developed around the existence of one or more of the following factors;

Large heat user(s)

- Large heat users are the most crucial element of any cluster development. Ideally a number of large energy users or a number of energy users concentrated into a small area creates an ideal environment. Often (one or more) anchor loads are sought as these can provide either a secure and sizeable income stream or be seen as a landmark building that influences the thinking of others in the vicinity.

Large heat producer

- The provision of a primary energy source is also a requirement. Any successful network should seek out a local source of energy, preferably a source of waste heat. Waste heat would normally be assumed to come from a source which would normally have to 'dump' heat as part of its process. Waste heat can often be secured at a price less than conventional energy sources from fossil fuel, for example. Where no such waste heat can be found, conventional sources of fossil or biomass should be sought.

Existing networks and/or new development(s)

- In some instances small heat networks may already have been developed and could form part of a new wider network; they may also contain a heat source that can be used either directly as a primary energy source or as future back-up. In most instances, however, they will have been sized to accommodate the intended load and have little capacity for expansion.
- Larger networks may also have been developed and the extent to which new networks and buildings can interlink would be subject to discussion with the operator of such a network.
- New developments can provide an ideal platform for creating a new heat network that is able to connect to a wider area. The new development can act as the anchor load and as the site of any primary energy source. This often makes the development of a wider network more viable as the initial asset provisions can be accommodated by the new development.

Public buildings(s)

- Connecting public buildings not only provides a series of potential anchor loads but also sends a very positive message to other building owners in the area. This action often provides assurance from prospective connectors, who may harbour concerns over that suitability and connectivity to a heat network.

Building Diversity

- In an ideal scenario a heat network should strive to secure a variety of buildings with differing demand profiles and heat loads. This variation helps to optimise the sizing and selection of heat network equipment. It should be noted that whilst this is desirable, it is by no means essential that this should always apply.

## 3.3 Focus areas

Whilst a number of buildings have been identified throughout the Borough and grouped into regional areas, it was decided to identify a number of smaller areas that could be focused upon to provide potential for heat network development.

With the criterion listed above in mind the process by which a focus area is determined is by trying to group as many large heat users together as possible and at the same time corral as many of the smaller heat users as possible. The focus areas are also determined by areas where an energy strategy is already in process or where planning permission is being sought or given to a larger residential and/or mixed use development.

This process may result in a focus area crossing across the regional areas identified and it may cross larger roads, railways and rivers just as it could be excluding some buildings that appear to be within reach, but it would be expected that a detailed feasibility study would determine the scope for a heat network within the areas.

1. A network can be initiated by the **South Acton Estate** (16 phases), which is a substantial development with a possible total of 3,200 residential dwellings. Other developments in the vicinity which can act as catalysts are the Oaks Shopping Centre, Bollo Lane and Acton Town Hall Complex.

   Within this Focus Area 55 buildings/connections have been identified.

2. **Ealing Metropolitan Centre**. A network in this area could be initiated by two new developments: Arcadia and Dickens Yard. Those are large mixed-use development with a proposed community heating schemes. Arcadia is to have a 90 kWe CHP system. In the future, this network can encompass the Ealing Council building and other premises in the vicinity as identified on the heat map.

   **Green Man Lane Development** – a community heating scheme is proposed for this development. As far as is known, the developer has appointed an ESCO operator. This network could be linked to the Ealing Metropolitan Centre network described above and then extend west to connect Cambridge Yard and further to Ealing Hospital.

   Within this combined Focus Area 53 buildings/connections have been identified.

3. **Copley Estate**. These residential buildings currently operate on community heating schemes. These schemes can be linked to form an initial network that could be expanded out.

   Within this Focus Area 53 buildings/connections have been identified.

4. (4c) **Southall Gas Works**. This is an opportunity for an initial district energy system in Southall. Even more important is the fact that this network could be supplied with waste heat from the proposed Blue-NG power station, immediately in the vicinity of the development. Southall Gas Works network could extend south and east to Suterwalla site which is earmarked as a large mixed-use development area (including Dominion House and Phoenix House), the White Hart and a number of smaller development areas.

   Within this Focus Area 6 buildings/connections have been identified for 4c (33 having been connected for the whole of Area 4).

5. **Ealing Hospital** Area. There major hospital site is adjacent to an extensive development of residential properties, with a light industrial estate further to the west. The hospital would form an ideal anchor load for any development in this area.

   Within this Focus Area 8 buildings/connections have been identified.

6. Linking of communal boiler systems. A number of council-owned estates are densely located in this area. A closer investigation of potential consumer heat loads and profiles is

worthwhile in this area. The housing units in the **Ferrier Road/Union Road** area are believed to benefit from communal boiler systems. This presents an ideal opportunity to link these together. Properties nearby including the local school could also be drawn into a small network.

Within this Focus Area 7 buildings/connections have been identified.

7. **Greenford Road**. There are a number of buildings in this area but they are not large heat users and are not in close proximity with each other in sufficient number to gain the critical mass needed for a network.

   Within this Focus Area 25 buildings have been identified.

8. **North Acton** - Southern Park Way – Park Royal – EfW. This area may be of interest because of a proposed EfW facility declared cooperation between Ealing and Brent Councils, and a high level of interest from the Park Royal Partnership. However, the heat demand in this area is anticipated to be low potentially affecting the commercial viability of a network

   Within this Focus Area 8 buildings have been identified.

In total over 220 buildings/connections have been identified as being within the 8 Focus Areas.

Table 2 summarises the estimated heat loads for each of the Focus Areas.

| **Focus Area** | **Estimated heat consumption (MWh/yr)** |
|---|---|
| 1. South Acton Estate | 29,233 |
| 2. Ealing Metropolitan Centre / Green Man Lane | 28,992 |
| 3. Copley Estate | 21,705 |
| 4. (4c) Southall Gas Works. | 23,907 |
| 5. Ealing Hospital | 35,477 |
| 6. Ferrier Road / Union Road | 1,071 |
| 7. Greenford Road | 7,221 |
| 8. North Acton | 8,169 |
| **TOTAL HEAT DEMAND** | **155,775** |

**Table 2: Focus Area heat demands for potential district heating network(s)**

These Focus Areas are indicated in Appendix 5. The buildings for each focus area are listed in Appendix D.

# 4. IMPLEMENTATION PLAN

## 4.1 Focus areas

Having identified Focus Areas where a heat network may be able to be created, we have tried to ring fence heat loads within. We have then extracted the building data within each Focus Area and tabulated the summary data. The data tables, for each Focus Area, can be found in Appendix D.

The data in the Focus Area tables are set out in order of greatest magnitude of annual energy consumption. It should be noted that we consider some of the information regarding the energy consumption not consistent with the type and use of the building, so it is possible that the original data provision may include errors. Some buildings have no heat data but have been included for information as they may have the potential of contributing to the development of a heat network.

The ranking of the Focus Areas has been generally set out on a High/Medium/Low basis. This ranking is to allow the Borough to concentrate their efforts in areas of greatest potential. A Low ranking does not mean to convey the impression that the area has no potential for a heat network; merely that it is comparably less likely than another.

Ranking also takes into consideration local impacts such as major road, rail and water course that may impede the development and/or expansion of a heat network and these are set out in the 'Barriers' column of the Implementation Plan in Appendix E.

At this stage we have not determined the viability of each building connection as this is an activity that would occur during a more detailed feasibility study. Appendix E contains the tabulated Implementation Plan with respect to each Focus Area and the Focus Areas are illustrated in Appendix 5.

The implementation plan needs to be read and utilised in conjunction with the information conveyed in Section 6, 7 and 8 below.

## 4.2 Further data gathering

In order for the Borough to maximise the opportunity of each Focus Area, consideration should be given to gathering data on the buildings that this study was unable to retrieve due to time constraints. This work could be considered as part of the detailed study of individual Focus Areas or as a separate study.

## 4.3 Cross Borough opportunities

Ealing is bordered by a number of neighbouring Boroughs. In the process of analysing the data we have identified that there are two areas where cross-border cooperation should be considered.

In the area near North Acton close to the Park Royal site there is a cluster of 3 or 4 heat loads that may be worthy of being connected to a heat network. The remainder of the area close by within Ealing Borough, does not appear to provide sufficient heat load. It is possible that should Brent Borough Council be developing a network close to this area that this small cluster may benefit better by connecting to this network.

In the South Acton area close to Chiswick High Road, a small cluster of buildings exist but it is considered that these lie within the Borough of Hounslow. Should the South Acton cluster extend sufficiently south enough, via Bollo Lane for example, to make such a connection viable this should be considered as a suitable site to connect to.

# 5. COMPLETE DISTRICT HEATING SYSTEM

District heating (DH) is a method of delivering heat from a variation of heat producing sources to a variation of heat customers. Heat produced from sources such as natural gas, oil or renewables burned directly in boilers or through combined heat and power (CHP), or a combination of both, can be delivered to residential dwellings, commercial & public offices, schools, warehouse and factory, hospitals plus industrial process heating.

Conventionally the heat demand in a DH system is met by waste heat from power stations and EfW plants utilising a heat generation which would otherwise be wasted and subsequently it comes at a very low cost. In smaller schemes it is common to look at installing the heat production, which often unfortunately adds cost to the scheme.

The advantage of a district heating system is the flexibility and the ability to utilise a variety of heat sources, including what can be called low-grade heat.

While CHP and district heating enable the delivery of low-carbon energy on a large scale, it is the renewable fuel used in the process that makes all the difference. For this reason, the use of biomass, biogas, or biofuel is becoming more widespread though the sourcing of such fuels must be analysed with care.

When considering implementing DH, Ramboll's experience shows that two of the key principles are to avoid advanced technologies during the early stages and to avoid overspending on the district heating network. A phasing of the build-out would be part of the suggested approach.

A number of options are likely to emerge when the objectives of a district heating project are considered. We will briefly outline a couple of the principles that we would suggest to be followed in a project.

First we think it important to avoid advanced technologies at the early stage of a project. Simple or proven technologies are cheaper to install, they carry less risk in terms of operation and maintenance and once the project is running and creating revenue, there will be a more solid base for further investments.

The second principle is to avoid overspending on the network and therefore a phasing of the build-out would be part of the suggested approach. District heating networks require considerable investments and it is necessary to optimise dimensions both in the initial situation and with a view to future proofing. The crucial part of the establishing of a district heating system is to ensure that enough customers connect at an early stage.

The complete district heating system includes everything between the heat exchanger at the heat production facility to the consumer's heat exchanger.

A complete district heating system includes as main components:

Heat Production

Pumps

Pressurisation system

Controls

Pipes

Heat exchangers and End-user installations

In addition a thermal store could be part of a system as well.

The network links up the heat production and the end users.

Often a feasibility study is carried out in broad terms to assess the viability of a district heating scheme. A feasibility study can be carried out to different levels of detail and can look more closely at technical and/or financial issues. Planning and implementation is also often focused early on. Not until a preliminary or detailed design would we generally look in detail at identifying all the equipment necessary for a specific district heating system.

The heat production facility is generally considered to include heat only boilers (HOB) and/or the production of both electricity and heat i.e. CHP.

CHP is, as a rule of thumb, only operated as a base load as, depending on the technology, it may be difficult and/or inefficient to operate according to daily variations in demand. In a well designed district heating network heat from CHP will provide between 60% and 80% of the annual heat requirement with heat-only boiler plants providing the peak load and back-up.

Larger solar thermal arrays are also sometimes included in a district heating system. There are a number of examples in Europe where large-scale solar thermal arrays have been integrated with district heating networks. District heating schemes offer maximum energy utilisation from solar energy as a heat sink for the low temperature water.

There are technical and hydraulic components of a district heating scheme that are important to the design and operation of a system and there are considerations to be made in respect to temperatures, pressure, base and peak heat load and reserve or back-up requirements.

In general a district heating network can be divided into three main parts:

- The transmission network
- The distribution network
- The internal heating system at the consumer.

The transmission network operates at high temperatures and pressures and carries large amounts of heat from larger heat producing units such as central power plants, waste incineration plants, to strategically placed heat exchanger stations where the heat is transferred to the distribution network.

The distribution network, operating at lower temperatures and pressures than the transmission network, supplies heat to each individual consumer. Normally, the transmission and distribution network interact only through heat exchangers meaning that they are hydraulically separated. In many cases this also applies for the interface between the distribution network and the internal heating system at the consumers.

The cost of installing the heating network depends in summary on four factors:

- The design operating temperature and pressure
- The complexity of existing services
- The length of the network
- The peak heat demand

Although not considered for this study it might be an option to use the heat distribution network for district cooling purposes in the summer. For example, the network can be used to transmit hot water to decentralised absorption chillers producing chilled water for a group of consumers. In this way it is possible to utilise any the surplus heat from the heat production plant e.g. the CHP plant in the summer.

From a design and operation point of view higher temperatures are desirable when considering the use of absorption chillers. A high temperature heat source will reduce the overall size of the chilled system. Therefore, from a district cooling point of view, the higher the operation flow temperature in the distribution network the better.

## 5.1 District heating network outline

As part of the heat map study work Ramboll has outlined two examples of a heat network. An area around the Ealing Metropolitan and Green Man Lane was selected and can be seen in Appendices 6 and 6.1. A further area in South Action was selected and can be seen in Appendices 7 and 7.1. Further details can be seen in the sections below.

### 5.1.1 Pre-conditions

The outline of the district heating network considered in this assessment is based on the conditions described below.

The flow temperature has been chosen as 90ºC and the cooling of the district heating water, which could also be expressed as the delta (Δ) T through all consumer installations, chosen as 40ºC (meaning that the consumers return the district heating water at or below 50º C). A ΔT of 40 ºC at a flow temperature of 90ºC is normally a very cost effective option to minimise construction costs of district heating networks while still meeting the standard heating design temperatures within the properties for connection.

The distribution network is recommended as being pressure rated at 16 bar. A maximum pressure of 16 bar and a static pressure of 1.5 bar, therefore, has been used for the hydraulic optimisation. A pressure difference of 1 bar at the end-user installations has also been assumed.

It is assumed that there are no significant changes in ground level throughout the study area but no information is available in this respect.

The necessary pipe dimensions are estimated by using the software package "SYSTEM RORNET", which is a simulation programme for hydraulic and thermal analysis of district heating networks. SYSTEM RORNET (SR) calculates the optimum diameters of the pipes based on knowledge about temperature difference between flow and return, pressure levels, costs for piping and the maximum velocity in the pipes. SR is a Ramboll in-house software package specifically developed for district heating and cooling network optimisation.

### 5.1.2 Heat loads and Diversity

Heat loads are used for network dimensioning and are calculated based on the annual heat demand.

In a district heating network the branch supplying a single consumer is designed for the consumers peak load demand. A distribution pipe supplying several consumers is not designed for supplying all the consumers with their peak load demand at the same time; the individual peak load demands will not occur at the same time due to diversity. Therefore, the peak load demand of each consumer has to be multiplied by a diversity factor to find the heat load that the distribution pipe should be designed for.

The annual heat demands in Tables 3 & 4 are turned into heat loads using a yearly utilisation time of 2,250 hrs per annum taking diversification in the system into account.

The rounded heat demands and network heat loads for the schemes are shown in Tables 3 & 4.

| **Area** | **Estimated heat consumption (MWh/yr)** | **Max. Heat Load (MW)** |
|---|---|---|

| | | |
|---|---|---|
| Part of Focus Area 2. | 25,000 | 11.1 |
| Part of Focus Area 5. | 35,000 | 15.6 |
| others | 2,400 | 1.1 |
| | | |
| **TOTAL HEAT DEMAND OF NETWORK:** | **62,400** | **27.8** |

**Table 3: Rounded heat demands and loads estimated for the potential district heating network.**

| **Area** | **Estimated heat consumption (MWh/yr)** | **Max. Heat Load (MW)** |
|---|---|---|
| Part of Focus Area 1. | 27,000 | 12.0 |
| | | |
| **TOTAL HEAT DEMAND OF NETWORK:** | **27,000** | **12.0** |

**Table 4: Rounded heat demands and loads estimated for the potential district heating network.**

### 5.1.3 Network layout

#### 5.1.3.1 Ealing Metropolitan/Green Man Lane

A network layout showing the proposed nominal diameters is seen below:

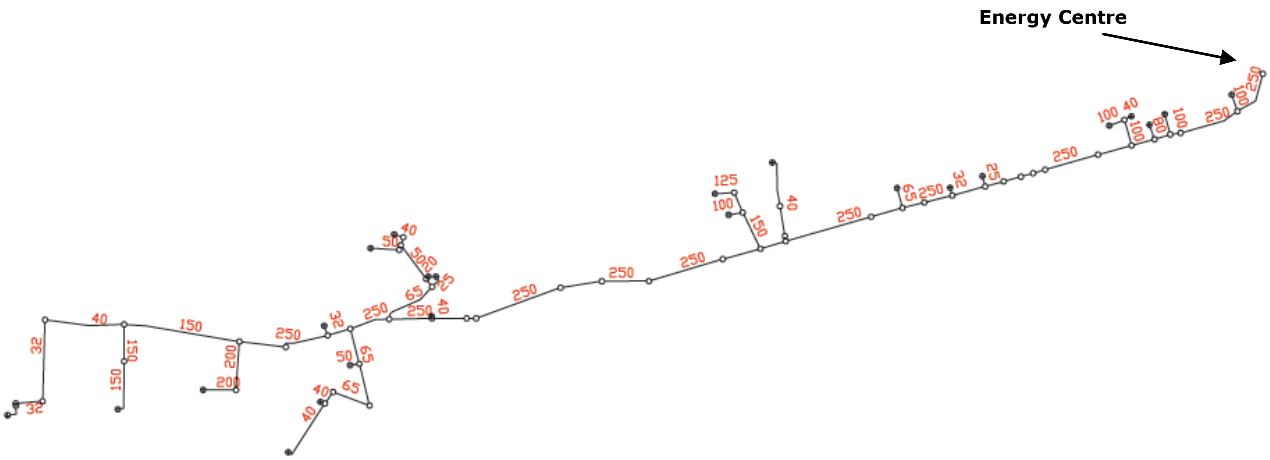


**Figure 1: Example heat network layout – Ealing Metropolitan/Green Man Lane.**

The total length of the network is approximately 6.5 km. The largest pipe dimension is DN250.

The network outline above can also be seen Appendix 6.1.

#### 5.1.3.2 South Acton

A network layout showing the proposed nominal diameters is seen below:

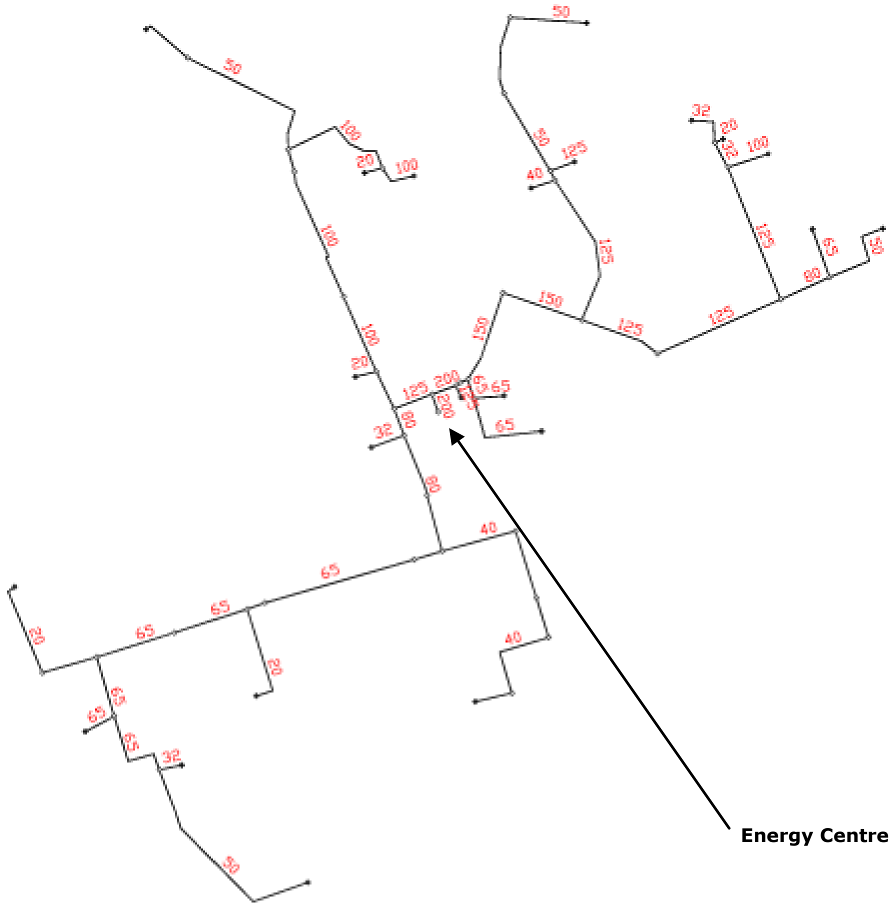


**Figure 2: Example heat network layout – South Acton.**

The total length of the network is approximately 4 km. The largest pipe dimension is DN200.

The network outline above can also be seen Appendix 7.1.

### 5.1.4 Heat Loss from the Network

#### 5.1.4.1 Ealing Metropolitan/Green Man Lane

The network heat loss has been estimated based on the proposed pipe dimensions, the flow and return temperatures and the assumption that the surrounding soil is at 8 °C. The heat loss in a full load situation is found to be around 280 kW which gives a heat loss of around 2,000 MWh per annum.

#### 5.1.4.2 South Acton

The network heat loss has been estimated based on the proposed pipe dimensions, the flow and return temperatures and the assumption that the surrounding soil is at 8 °C. The heat loss in a full load situation is found to be around 135 kW which gives a heat loss of around 1,000 MWh per annum.

### 5.1.5 District heating main network cost estimate

#### 5.1.5.1 Ealing Metropolitan/Green Man Lane

The network costs have been estimated to be around £9,740,000. This excludes the cost of the energy centre and any modifications required by buildings to connect to the heat network.

#### 5.1.5.2 South Acton

The network costs have been estimated to be around £3,900,000. This excludes the cost of the energy centre and any modifications required by buildings to connect to the heat network.

### 5.1.6 Comments on network

The networks indicated are an example of connecting a number of buildings across focus areas. The focus areas are to some extent indicative and a network does not have to consist of the precise number of buildings.

The outlined networks are, in UK terms, relatively large both in respects to the length and demand that is being met.

The exact approach and connection of buildings should be investigated in more detail.

# 6. DISTRICT HEATING VIABILITY

District heating represents a significant capital investment. Often it requires long term investment to pay for the establishment of a district heating network.

This very high level assessment study does not include a detailed cost analysis which would be required to fully evaluate the viability of a complete district heating scheme. This study does not provide enough information to fully evaluate the viability of a complete district heating scheme with all its capital costs and operation and maintenance over a whole life cycle.

This assessment only looks at the outlined heat network as an example from when it leaves the energy centre and to a node or point of entry into a building or area of buildings. It does not include any heat production facility or energy centre, any heat exchangers and/or consumer interface units.

The network costs are generally by far the most significant investment which can account for as much as 70% of the total capital investment.

This is of course very rough estimate based on a basic network outline which needs to be validated with a feasibility study.

When looking to establish the feasibility and/or options available in respect to implementing a district heating infrastructure there are a number of potential variations and/or level of detail that can be required. It is unlikely that there will be one model that fits all potential schemes and it will be important to look at the particular scheme to establish the best way forward.

In terms of viability there will be other measures than capital costs and short paybacks should be contributed a value. Ramboll's experience from Denmark is that district heating offers many environmental, social and in a longer perspective also economic benefits to a community or country as a whole.

The history of both large and medium scale district heating systems bears evidence that the scale of the investment and the length of the payback period make both the funding and the organisations implementing and operating the system very important when considering a scheme.

The delivery vehicle is frequently referred to as an Energy Services Company (ESCO) in the UK but a traditional ESCO is not necessarily always the answer. The scale of the technical installations, the complexity involved in the phasing of the scheme and the commercial arrangements could call for a different approach. Again the details of the specific scheme proposed will and should have an influence in the model chosen.

The requirements of those who finance schemes will have a strong influence over the chosen delivery vehicle, and the nature of energy supply agreements. They will lead to fundamental requirements that will include:

- Return on capital
- Servicing of debts
- Loan period
- Supply agreements

Looking at the history of district heating in the UK each of the models used in the past has been driven by Local Authority leadership, influenced by specific local priorities, and constrained by policies governing the apportionment of risk and public sector borrowing.

There is a variation on the ESCO model which has been termed a MUSCO (Multi Utility Services Company). This approach has not yet been implemented on any significant scale in the UK. The UK's largest MUSCO is currently being planned in London[1].

Setting up the delivery model for a potential district heating scheme is often a study in itself.

The demand for flexibility could be the most serious obstacle to a framework contract with a private enterprise, but also the financing, which is essential to the future heat price. This is very important because it will influence the heat price and thereby the competitiveness of the scheme compared with the alternatives.

An obvious conclusion, therefore, could be that the delivery vehicle will have to be based on a public framework agreement, possibly including private stakeholders but with strong influence from local government. The planning requirements and the fuel poverty issue also point in the direction of a public enterprise.

The investment in the pipe network is substantial and long-term and developers often find it difficult to identify any special conditions that would make the scheme more attractive to them.

If we look at the most successful schemes in the UK, like Sheffield and Nottingham, they were originally set up by the city councils as public enterprises driven by social and environmental goals.

We are not aware of any modern district heating scheme in any part of the world that has been established without public investment or other public support mechanisms and it seems unlikely

[1] The London Borough of Southwark has determined that the regeneration of the Elephant & Castle district should be a model of sustainable development with particular focus on reducing the energy-related carbon footprint of the new developments. The regeneration is privately funded but facilitated by the public sector (LB Southwark), necessitating a private sector solution to the provision of low carbon energy services to the site.

that significant scaled scheme can go ahead without local authority initiative and financial support from either local or central government.

In section 7 we look a little further at non technical issues to consider when venturing into a district heating project.

# 7. OTHER DISTRICT HEATING NETWORK ISSUES

There are a number of technical issues that have to be overcome to be able to establish a heat network but the development, installation and operation of a system has some very important aspects from the (relatively) short term engagement to the very long term operation and maintenance.

The following outlines some of the non-technical issues that need careful consideration and inclusion prior to the development of a heat network.

## 7.1 Local Authority and stakeholder engagement

Engaging the Local Authority (LA) and other stakeholders early in the development process can result in a simplified marketing requirement.

A continued engagement will allow aspects of the future system to be explained and accepted. Many of the benefits that can be deployed through a district heating (DH) system can be relayed through local meetings and positive press coverage. It is important that, at this stage, robust technical and commercial support and guidance is offered to ensure that the correct technical and economical message is conveyed.

## 7.2 Marketing

Marketing, particularly to third party potential business, is key in informing and reassuring. New developments that will have obligations under National Planning Policies may feel that their options are limited by the presence of a local heat network and will require gentle and informative guidance as to the benefits of a DH system. Typically discussions would concentrate on capital cost savings over a traditional solution, operational cost savings, reliability of operation, efficiency and controllability of the DH system and space saving. In many instances many aspects of building design can be simplified and enhanced by not having to design in space for boiler flues, for example.

A different approach can be taken with existing buildings whose heating plant has reached, or is about to reach, the end of its working life. In many cases a need is automatically created and can be met with a DH connection. Discussions at this stage can typically involve speed of solution and cost rather than the other benefits.

Maintaining a close awareness of existing buildings without an immediate need for a connection will be an ongoing activity until such time that their heating system comes to the end of its working life. Other factors like fuel price or modernisation may accelerate a change.

Clearly these activities will require resources – particularly at the outset –maintained throughout the business via the use of a computerised customer database.

## 7.3 Local Authority involvement

The LA involvement is essential in creating the correct environment for the success of a DH system. Much of the assistance that the LA can contribute is the coordinated view of new and existing development when considered from a LDF perspective. This critical element will provide an, as yet, developing DH system useful foresight of potential future business.

Close cooperation with the Planning Department will help develop a coordinated approach to helping the LA adhere to National Planning Policies particularly with respect to Energy and Sustainability.

A continued dialogue and understanding with the 'Highways' department will ensure that the installation of the DH apparatus in LA possessed land can be identified to ease the financial and technical risks involved in the ongoing development.

Ideally a LA would want to have cross-party consensus on the development of a DH system but it is important that such a development should have, at least, a champion at Councillor level; if not at Officer level. Maintaining the political will for such a scheme in the early days of development can provide a powerful boost to the uptake of a DH system.

## 7.4 Operating company

### 7.4.1 Structure

Very early in the conceptual stage of business development, a decision has to be made regarding the future structure of the Operating Company. Typically, reference is made to an Energy Services Company (ESCo); this being a common offered solution. In reality the formation of an operating company can be borne out of the inclusion of a number of sources and be quite fluid in its structure.

If the LA is driving the initial agenda, it is they who can provide the initial staff to operate the Company. LAs have a broad skills base from which they can second specific requirements until such time as the company can recruit. Typically resources from housing, engineering, highways and finance departments would have the skills base to provide assistance and may be able to be seconded on an extended or permanent basis.

More specialist skills that are unique to DH systems, e.g. pre-insulated pipe laying will have to be contracted in. It is unlikely that the Company would become sufficiently large enough to directly employ such specialism but it could share this with neighbouring developments as the demand increases.

The size of the initial business may preclude a formal structure but the diagram below indicates a typical organisation.

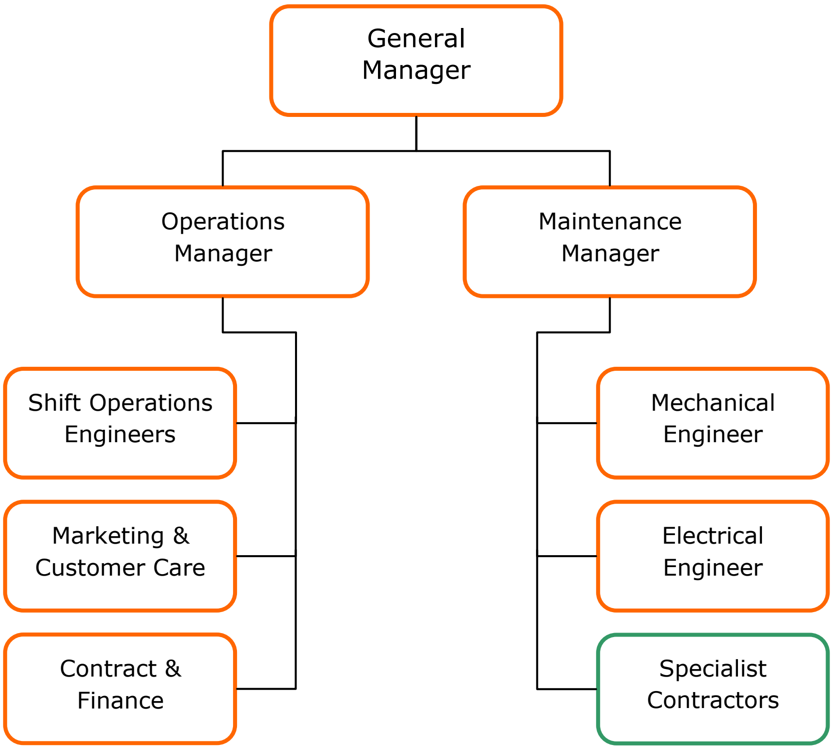


**Figure 3: Typical organisational structure.**

A General Manager will be required to provide the company figurehead, take responsibility for business development and interaction with shareholders and key stakeholders. The General Manager will be instrumental in driving expansion and growth.

The identification of a separate Operation and Maintenance work streams is to ensure that sufficient importance is allocated to each. The asset base will grow to a multi-million pound responsibility and the Company should ensure that sufficient resources are allocated to its long term care.

The Maintenance team may need to grow over the early years, depending upon the intended size of the DH system. It is prudent to identify this team early on to allow familiarisation by the team of the technology. This is critical in engendering confidence in the new customers of the system, particularly in the very early months of operation.

Specialist services should be handled by contractors and this can often lead to a long term partnership through which benefits and security can be developed.

The Operational work stream is no less important but has a different kind of imperative. It can also be seen to compose of a technical and a non-technical requirement.

The technical operation of the system ideally requires constant monitoring and control to take place. A control facility will have to be established for both the energy production and the DH network. This can act independently of labour but it is not possible to make all decisions and manual intervention is ultimately required. Decision making for the operational strategy – which can change periodically – has to be carried out. Finally the whole DH system has to be monitored for correct operation and for information feedback to the Maintenance work stream.

The non-technical element of the work requires marketing, contract and financing skills and again these can be seconded in. Marketing skills should be seen as an early requirement to assist in the development and acceptance of the concept of the DH system. Finance and contract issues will require sufficient resources to ensure revenues are secured. This will require suitable operational assistance from accurate metering and data collection.

It is possible, of course, to outsource some or all of these work streams but whatever the set-up of the operating company might be, it is necessary to have a core staff dedicated to the operation of the system. It is important to ensure a high degree of stability in staff so that the lessons learned during the operation of the system can be more effectively adopted in the operation strategy. It is for this reason, though, that it should be carefully considered whether the operation should be outsourced.

### 7.4.2 Delivery Vehicle

The size and structure of an operating company, be it a traditional ESCo or any other arrangement, will depend on the duties undertaken by that specific company and whether these duties include maintenance.

There are a number of models that can be identified which can be used to establish an 'ESCo'. Each of these models can be been driven by Local Authority leadership, influenced by specific local priorities, and constrained by policies governing the apportionment of risk and public sector borrowing and can be broadly characterised into five models:

- Private enterprise driven by public sector framework agreement
- Private enterprise driven by public sector stakeholding
- Social enterprise driven by public sector stakeholding
- Social enterprise driven by consumer and public sector stakeholding
- Public enterprise driven by social and environmental goals

The variations between these models are largely the result of the following factors:

- Public sector borrowing: The need to minimise borrowing that would appear on a Local Authorities balance sheet, as required by Central Government.
- Exposure to risk: The need to minimise the potential exposure of a Local Authority to financial risk if an ESCo was to default on finance repayments.
- Expansion and replication: The ability of the ESCo and its partners to expand and replicate energy networks across towns and cities.
- Social and environmental goals: The ability of an ESCo to strategically deliver on social and environmental goals in the short, medium and long term.

### 7.4.3 Financing

Clearly the ongoing access to finance to further develop the DH system is an essential element of the success of the system.

Whether through public borrowing, privately provided debt or equity finance or European infrastructure investment funds, the cash flow for repayment will need to generate sufficient surplus to cover the lenders required rate of return.

The lender will need to be provided with sufficient security in the event that the ESCo is unable to service its debts. This could take the form of equity geared finance but can also be in the form of energy supply contracts particularly if sufficient number of contracted anchor loads can be secured – often this can come from the LA controlled buildings.

The period of the loan repayment could vary from 5-20 years for Bank debt finance or private equity, to 10-15 years or more for public sector borrowing or European investment funds or a combination of a number of sources. Clearly care has to be taken to ensure the financing matches the long term business plan.

Debt risk has to be sufficiently factored into any financing arrangements with individual housing typically carrying the highest debt risk. This can be mitigated through contracting with the housing provider who will have already factored this into their business models.

#### 7.4.4 Contract arrangements

The type and duration of the energy supply contracts will be intrinsically linked to the financing options open to the ESCo.

Energy supply contracts can be made up of a number of items ranging from a balance of capital and revenue, including operational incentives and penalties.

It may be possible to require consumers to pay the full cost of heating connections, thereby reducing the risk associated with recovery of capital costs through an availability charge. This, though, can often make connections to smaller buildings unviable. Larger ESCos may have the financial strength to offset some of the capital cost through an availability charge, making connection more attractive financially to building developers and managers. The balance of the capital cost recovered from the long term revenue of the energy charge.

District heating, by its very nature, represents a monopoly supply but this is necessary to securitize the high capital costs. This, however, can raise concerns for customers – particularly commercial building managers who may have the ability to negotiate wholesale energy tariffs. It is therefore important that supply agreements are transparent and linked to retail and/or fuel price indices to ensure they remain competitive throughout the life of the contract.

Variable and optional contract elements can include time weighted tariffs to reward the avoidance of demanding heat at peak times. Operational 'cooling' tariffs ensure that the building connected to the DH system consumes energy correctly (kWh/$m^3$ DH water delivered).

### 7.5 Building surveying/Optimisation

Identifying existing buildings capable of being connected to a DH system will initially involve ascertaining whether they have a 'wet' heating system, typically those using radiators.

Clearly buildings that have electric based heating systems will not be suitable without significant modification. This work is still possible and has been typified, for example, in the refurbishment of tower blocks originally built with electric underfloor heating.

Buildings that are notionally able to connect to a DH system may still need to be determined for suitability. Many heating system are designed using old design techniques applicable to coal fired heat generation and are not suitable for DH without some modification.

Whilst the process of surveying a single building is not time consuming, the process of surveying all buildings initially highlighted for connection will require a carefully structured programme of work. The interpretation and determination of any solution required will then have to be disseminated to the building owner to start the process of optimisation.

Optimisation of building heating systems requires careful adaptation and negotiation with the building owner. This activity can be time consuming and must be considered at the earliest opportunity as the process may take several months and require investment to undertake. It is possible that evidence of the operating parameters has to be gained prior to an assessment being complete and this could require a winter period being monitored further adding time to the process. It is possible that this process can create an unpopular environment between building owner and DH operator so it is critical that the impact and potential disruption are communicated as soon as possible. It is often the maintenance staff of the building that can provide the most insight into a building heating system and building a close working relationship with these people can simplify the optimisation process.

## 7.6 Planning

An important and inherent part of the implementation plan is the need to assess the potential of connecting heat loads beyond the original scope. This may include areas beyond which any control can be employed.

It is quite possible that in situations where heat loads surround a boundary between LAs, for example, it should be considered that these heat loads can form part of the scope of the system. Careful coordination with neighbouring LAs should take place to ensure the optimum solution for cross-border heat supply is arranged.

The identification of buildings currently in the planning process should be considered carefully as to whether they can form part of a future system. The development of a DH system may take several years by which time any building having previously identified through the planning process, is likely to have been completed with a conventional energy source. Whilst the building may still be able to be connected, the building owner is likely to be left with a stranded asset.

## 7.7 Licensing and Legislation

Any new Energy Centres will require planning consent under the standard procedure required of by the Town and Country Planning Act 1990.

Emissions from installations with a gross energy input of more than 50MW will be legislated under the auspices of the IPPC Directive. The Directive has a number of requirements that the ESCo will have to adhere to. The ESCo shall need to demonstrate that BAT techniques have been employed, that a suitable Environmental Management System is in place with robust control systems and procedures and that a full understanding of the releases to atmosphere can be shown.

Emissions from installations with a gross energy input below 20MW will require approval to be granted by the Local Planning Authority.

The installation of pipework into the ground will require to be carried out under the provisions of the Roads and Street Works Act 1991 and the Traffic Management Act 2004. This provision is applicable in the case of land under the control of the Local Highway Authority, TfL or other statutory body (Authority). The Authority can grant licenses to install and maintain apparatus but also can constrain when and for how long the highway can be opened for. Considerations such as traffic sensitivity, bus and ambulance routes will determine the working window for pipe installations and maintenance. Knowledge of these potential restrictions must be part of the detailed planning to ensure that the capital (and subsequent maintenance) costs are not adversely affected.

When pipework and equipment is installed in land not controlled by the Authority, the ESCo will have to enter into negotiation with the land owner(s) for this right. This can be a lengthy and costly process as legal agreements will have to be drawn up in advance of any work being carried out. The cost of this work plus the ongoing (annual) charges, likely to be levied by the land owner, should be weighed up against the additional capital cost of a less direct pipe route.

Generally District Heating undertakings are classified as a Specialist Rating Unit (SRU) class and the responsibility of the rating lies with one of the regional SRUs. Valuation of the equipment has been a matter of discussion for some years but the VOA adopts a policy that such undertakings should be valued under the Contractor's Basis. There generally is a potential for reasoned discussion with the regional SRU regarding the final valuation.

# 8. RECOMMENDATIONS & WAY FORWARD

Ramboll's experience is that district heating offers many environmental, social and in a longer perspective, economic benefits to a community or country as a whole. For example, around 60% of all households in Denmark are connected to a heat network with three-quarters of that heat supplied as waste heat from CHP plants, some of which are biomass fueled. A further 12% comes from waste incineration, 6% is biomass burned in boilers and 3% is industrial waste heat. Only the remaining 4% is natural gas or oil used in back up boilers during peak demand or to provide spare capacity in case of emergency or maintenance.

Eight Focus Areas were identified in this study and ranked in the flowing order;

South Acton – High
Ealing Metropolitan Centre / Green Man Lane – High

Copley Estate – Medium/High
Farrier Rd/Union Rd – Medium/High

Ealing Hospital/Hanwell - Medium

Southall – Low
Greenford Rd - Low
North Acton - Low

The heat network proposals for the Borough of Ealing and others like it are fundamental to the UK and its environmental targets. Hitherto, there has been insufficient importance placed on the role heat networks can play in the future energy demands of the country.

Recently though the UK has finally seen heat moving up the political agenda. Heat and its production and utilisation are being discussed through various consultations. This heat map study and future potential implementation of schemes is timely and can show the way forward.

The investment in a heat network and can be considerable and it is important that the work is planned to reduce risks.

When implementing district heating there are a number of good practices and recommendations in relation to the design and installation that have been developed over the years.

This study is a very early high level assessment of the potential network locations. The next phase should be to complete a more detailed feasibility study of the preferred schemes as a whole.

- A detailed and more in-depth study would examine the heat demands and their connection to a district heating system in more detail.

- Due to the varying sizes of the district heating networks considered in this study and to fully consider the potential for a Borough-wide approach, a more detailed study needs to consider the transmission/distribution network approach as to what will be the best technical solution in combination with the viability of the scheme.

- The investment is significant and a more detailed study should look at phasing the implementation of the heat networks and look at reducing the investment risk.

- A detailed cost analysis and viability calculation based on whole life cost should be carried out on each network.

It is likely that even following a detailed feasibility study that a number of questions and uncertainties will remain. These should be thoroughly investigated and/or determined directly.

The detailed specification for the installation and maintenance of the district heating network is something worth considering as early as possible in the project process. This helps to gain greater certainty for both the capital and operating costs.

Ramboll would recommend that;

- A feasibility study or number of feasibility studies be undertaken for each of the recommended Focus Areas potential heat networks.

- A study should be undertaken to determine what other buildings, not identified within the scope of this study, could form part of the core heat networks.

- For each heat network an additional investigation should be undertaken to consider the network and the heat production facility in more detail.

- A study should be undertaken to determine the heat data for buildings that this study was unable to retrieve

- A study should be undertaken to determine how the heat energy demands for the Borough – as a whole - can be met, particularly from low carbon sources. This work should be considered in light of the developing heat networks.

- Consideration should be given to determining an overarching energy plan with all neighbouring Boroughs.

Once the decision has been taken to establish a district heating scheme it is Ramboll's experience that the next stage should be a preliminary design.

The project process can be listed as below, what is included within the different stages will depend on time and budget available but it is important to the success of the scheme that it is planned and investigated thoroughly.

- Feasibility study – can be carried out at different levels
- Preliminary design
- Detailed design
- Tendering / procurement
- Construction management
- Supervision
- Commissioning