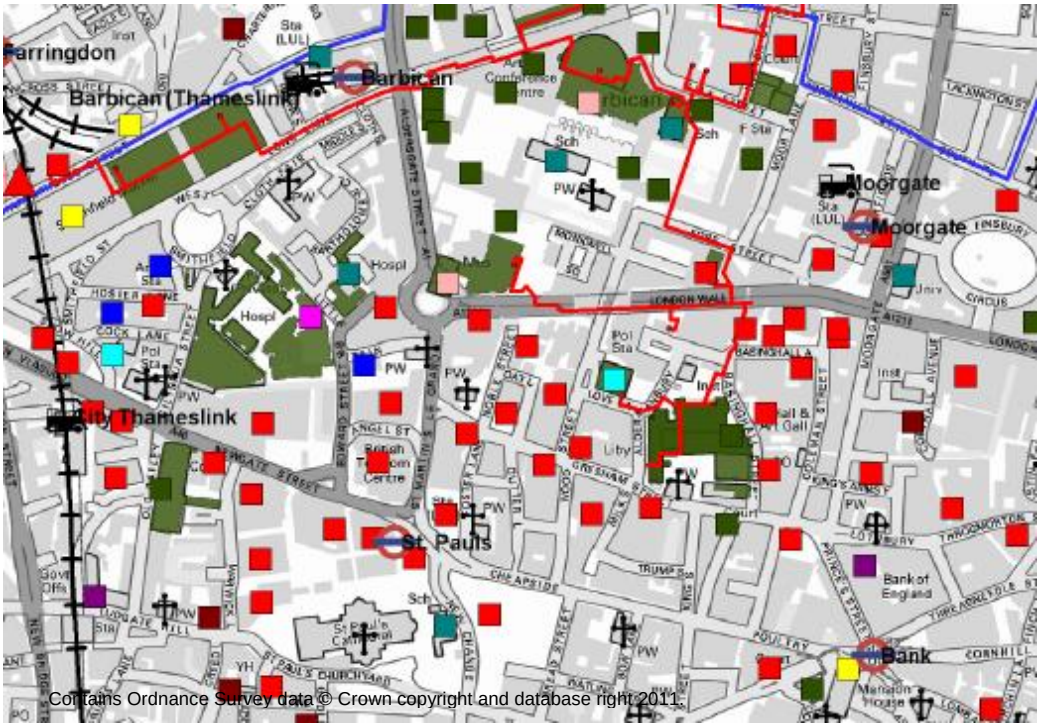
Intended for
City of London Corporation

Document type
Report

Date
March 2011

CITY OF LONDON CORPORATION LONDON HEAT MAP STUDY



RAMBOLL

CITY OF LONDON CORPORATION
LONDON HEAT MAP STUDY

Revision	**Final**
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Description	**Heat and cooling mapping for the City of London Corporation.**

Ref: 08126-100

(**Front cover image: Heat map of the City of London**)

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1. INTRODUCTION

1.1 Background

Ramboll Energy (RE) has been commissioned by the City of London Corporation (the Corporation) to carry out a heat mapping exercise of the Borough as part of the London Development Agency's (LDA) Decentralised Energy Master Planning (DEMaP) programme.

The LDA's Decentralised Energy and Energy Masterplanning Programme (DEMaP) has been developed to identify decentralised energy opportunities in London which will contribute to the Mayor's target of providing 25% of London's energy supply from decentralised energy sources by 2025.

In order to achieve this target, a partnership of local authorities, regional bodies and private sector stakeholders is required to plan for, develop and deliver DE projects. For example, the integration of local energy centres and heat distribution networks with sub-regional transmission networks requires co-ordination and concerted action.

The LDA, Greater London Authority (GLA) and London Councils are working together to offer a comprehensive support package to local authorities that promotes the delivery of Decentralised Energy (DE) in their boroughs and across London.

The development and implementation of DE opportunities in London is integral to local, regional and national climate change mitigation targets as defined by National Indicators 185 and 186, Carbon Reduction Commitment, Planning Policy Statement 1 supplement on Climate Change, the London Plan and the Government's Heat and Energy Saving Strategy.

Essential to the objectives of this brief is to enable the Corporation to implement economical low carbon District Heating (DH) and Cooling infrastructure and this requires planning policy to help implement.

In order to help achieve this, the LDA has made available some funding for Boroughs to gather actual energy data and identify areas with potential for DH networks within their boundaries. The Corporation was successful in securing this funding and appointed RE to carry out the work.

1.2 Scope

RE has undertaken this study on behalf of the LDA and the Corporation as part of Phase 1 (Capacity Building) support of the DEMaP Programme. The three key aims of this study are:

(a) Produce heating and cooling maps for the Corporation to identify areas of highest heating and cooling demand and the locations of existing CHP and cooling plant and energy networks.

(b) Identify potential areas for the development of further DH and cooling networks in the City of London (the City).

(c) Provide advice and support to the Corporation in interpreting and acting upon the results of the heat and chill mapping through a high level implementation plan.

The unique nature of the City is its relatively low level of resident population and its very high concentration of high specification, commercial buildings. As a result of this mix of buildings energy demands in the City are for cooling as well as heating therefore this study also required the recording of cooling data.

2. DATA GATHERING

2.1 Requirements

The brief required the data to be collected in an Excel spreadsheet template which was provided by the LDA (LDA template). The spreadsheet format has been designed to be easily updated, allowing for future revision. The spreadsheet format also allows it to be uploaded into a Graphical Information System (GIS) and used to update the London Heat Map. A summary of the template contents is shown in Table 1.

	Spreadsheet Tabs		
Information	Major Heat Loads	Major Heat Supply Plants	District Heating Networks
OXS	x	x	x
OYS	x	x	x
Object ID	x	x	x
Name	x	x	x
Address	x	x	Energy Centre Address
Postcode	x	x	Energy Centre Postcode
Ownership	x	x	x
New Development	x	x	
Typology	x	x	x
Heating supply	x		
Fuel source	x	x	x
Fuel consumption from all assets excluding CHP (MWh/year)	x	Fuel consumption from all assets including CHP (MWh/year)	Fuel consumption from all assets including CHP (MWh/year)
Fuel consumption from CHP (MWh/year)	x	Heat generation from all assets including CHP (MWh/year)	Heat generation from all assets including CHP (MWh/year)
Gross internal floor area (m2)	x		Length of trench (km)
Number of dwellings	x		Area Covered
Installed thermal capacity from all assets excluding CHP (MWth)	x	Installed thermal capacity from all assets including CHP (MWth)	Installed thermal capacity from all assets including CHP (MWth)
CHP Installed power (MWe)	x	x	x
CHP Installed thermal capacity (MWe)	x		
CO2 emissions (tCO2/year)	x	x	x
Year of Construction	x	Date of Construction	Date of Construction
Year of data collection	x	x	x
Start date	x	x	x
Completion date	x	x	x
Data Source	x	x	x
Confidentiality of data	x	x	x
Attach file	x	x	x
Borough	x	x	x
Real or estimated data?	x	x	x
Notes	x	x	x

Table 1 - Tabulated representation of the Heat Map Template

The search was focused primarily on the following building types;

- Hospitals
- Central government estate
- Local government estate (including social housing)
- Sport & leisure facilities
- Prisons
- Hotels
- Educational facilities
- Museums & art galleries
- Churches
- Private residential developments (>149 units or 9,999m^2 or heating load >200kW)
- Private commercial developments (>9,999m^2 or heating/cooling load>200kW)
- Other public buildings (e.g. theatres, fire stations, police stations)

2.2 Methodology

At the outset of the study it was decided to employ a web-based questionnaire to assist in the data collection exercise. The Corporation kindly provided an introductory letter, explaining the purpose of this work and introducing RE, to add authority to the process. The web-based questionnaire was created to make the data reporting easier by providing clear guidance on the requirements and to allow for missing data. This on-line database was designed to transfer the data seamlessly into the LDA template.

Initial contact was made by telephone, where we tried to establish the relevant person(s) who would be able to provide the data required. Where successful, contact details were obtained to which the covering letter and the hyperlink to the web-based questionnaire were sent via e-mail. The link to our web-based questionnaire was included to allow the respondent to easily input the data or pass it to a more appropriate individual within the organisation. In all instances we clearly offered the opportunity for any data released to be retained as confidential in accordance with the LDA requirements.

Where it was clear that no data would be forthcoming, it was decided that we would estimate energy use using benchmarking data. An attempt was made to determine the floor area of a number of buildings – concentrating on the largest by occupancy - through the use of GIS software - MapInfo. MapInfo provides the ability to measure the footprint of a building when the map is vector based. The footprint was multiplied by the number of floors of the building and when a building was found to have floors with differing areas, an average was estimated conservatively taking into account that we were seeking the Gross Internal Area (GIA). Of course this method is limited as basements and variable heights of buildings cannot be accurately taken into account, hence it should at best be considered a rough estimate.

National Indicator 185 (NI 185) has been developed by Government to measure the progress of local authorities' efforts to reduce CO_2 emissions from the relevant buildings and transport used to deliver its functions. Functions of an authority cover all their own operations and outsourced services. Each local authority reports on an annual basis. This database will help to identify all the buildings that could be included in a decentralised energy network within the authority. Additionally the energy consumption data should be considered very robust due to the requirements of reporting procedure. The NI 185 database was not available to this study but the Corporation made available the NI 194 – which deals with air quality reporting – database, from which we were able to interpret data.

The Local Land and Property Gazetteer (LLPG) is an address database held and maintained by each Local Authority. The database contains the list of addresses of all property in the authority area. The database is used to help identify buildings in the area that should be considered in the identification of priority buildings.

2.3 Identification of priority buildings

The methodology for collecting data for the heat map study was adjusted compared to other heat map studies carried out by RE because the City area is very different from other London Boroughs with few domestic properties and very large proportion of large commercial buildings. The methodology for data gathering was to target heat demand by building type as indicated in 2.1 - Requirements.

Main data collection issues are highlighted below for each type of building.

- Sport & leisure facilities

  - Heat consumption data was extracted from the NI 194 records combined with data for DH consumption.
  - Fitness centres were targeted but no data was received in the time available.

- Prisons
  - There are no prisons in the Borough.

- Hotels
  - Large hotels (> 149 bedrooms) were identified using an internet search together with data obtained from the Borough website. Gas consumption for heating and electricity consumption for cooling was approximated using CIBSE Guide F benchmarks.

- Education facilities
  - Gas consumption for schools and nurseries was extracted from the NI 194 database.
  - Additional entries were identified in the Local Land and Property Gazetteer (LLPG) database.
  - A number of schools gas consumption for heating was benchmarked using CIBSE Guide F.

- Police stations
  - 4 Police stations were identified and added to the template. One of these is currently connected to the Citigen DH scheme; the consumption of which is included within the Guildhall Complex data. Gas consumptions for the remainder of the police stations were obtained from the Corporation.

- Fire stations
  - One fire station was identified within the area and was mapped with data from the LDA.

- Hospitals
  - Gas consumption data was obtained for St. Bartholomew's Hospital through Barts and The London NHS Trust. Cooling was benchmarked with CIBSE Guide F with input from the trust on how much of the hospital is actively cooled.

- Museums & art galleries
  - Gas consumption data for the Museum of London was obtained and recorded.

- Central government estate
  - We contacted the Bank of England but at the time of writing this report we had not yet received the energy consumption data; this building, therefore, had to be benchmarked. Customs House gas consumption was obtained from LDA data and six more central government estate buildings have been benchmarked.

- Local government estate
  - Data was extracted from the NI194 database but was also obtained from gas bills and from records of consumption for the Citigen DH connections. Most buildings connected to the Citigen DH scheme also have other gas use, so the DH consumption was added in the CHP field in the spreadsheet in order to record both.
  - Existing residential estates have been benchmarked using data from the Ordnance Survey (OS) Address Point register and from the LDA database.

- Religious institutions

  - 47 Premises were identified through the LLPG database but due to the low heat demand, no attempt to gather actual consumption figures was made with the exception of St Paul Cathedral.

- Private residential units
  - Planning application data was obtained from online planning GIS applications at www.london.gov.uk and www.cityoflondon.gov.uk. Proposed developments were benchmarked based on future projections of heating and hot water demands. A number of buildings were identified through Ordnance Survey (OS) Address Point register.

- Private commercial units
  - Private commercial units were identified based on a variety of sources.
    - Websites for tall buildings and architecture.
    - Planning applications through GLA and the Corporation online GIS services.
    - Real Estate Agents selling and renting properties.
    - Google Streetview, Google Earth and Bing Bird's Eye View services.
    - Identified by the Corporation as close to existing DH infrastructure.
    - We were also given a list of the top 200 occupiers, however, not necessarily within the City of London.
  - The Corporation provided additional gas consumption data for 10 of their larger free-hold commercial buildings.

- Contact with Transport for London (TfL) was made to determine the potential for the provision of cooling to the Underground. RE understands that TfL are undertaking a programme of work – "Cooling the Tube" - to improve the conditions in the stations and on the trains, particularly during warmer months. Initial discussions with TfL indicate that they are considering all options but are initially concentrating on developing cooling using underground rivers, aquifers and the water that is continuously drained from the Underground, as well as the increased use of forced and natural ventilation.

2.4 Limitations of Data Collection

The time available to gather data when considering the requirements of the task created a significant challenge. The approach taken by RE to maximise the quality of the data collected will help to provide a platform from which a more detailed study can be performed in the future.

There are a number of limitations that have arisen;

- Estimated data is based upon a simple format using CIBSE Guide F which is based upon industry standard benchmark assumptions. This data will not be sufficiently sensitive to distinguish between similarly constructed buildings with very differing operation requirements.

- Actual data gathered, normally only represents – at best – the most recent 12 month cycle. Clearly this information is limited in that it represents the energy demand of a year which may not be considered a 'typical' due to the prevailing weather conditions throughout the metering period in question.

- Actual data provided by a building user/owner may not be accurate. The scope of this type of study will not be able to determine accuracy of the data.

- Metered gas consumption will often include the use of gas for demands other than heating and hot water, although it is recognised that the proportion is likely to be small.

- It is difficult to determine if electric heating forms part of the heating to a building without a detailed understanding of the services contained within the building.

- Where it has been established that electricity is used to heat buildings, it is often difficult to determine the proportion of consumption by heating and that by lighting and other appliances. In these cases benchmarking would have to be undertaken to approximate the demand by heat.

- In the case of private commercial property collecting data required the identification of the most appropriate person to contact. It was clear from a large number of institutions that they adopt a 'no name' policy which meant that we could not contact anyone within the organisation and so data had to be benchmarked.

2.5 Energy sources and district energy networks

A search was conducted to determine known energy sources and potential energy sources within the City.

2.5.1 Citigen

The City is home to London's major CHP scheme that incorporates both heating and cooling networks – Citigen - operated by E.On UK Ltd.

This CHP generation process produces up to 28MW of heat and approximately 25MW of electrical output to the national grid. Chilled water at 5°C is generated using 2 absorption chillers (one standby) rated at approximately 5.5MW each. In addition three vapour compression chillers rated at 1.1MW each can be used to supply chilled water at low levels of demand.

Figure 1 – Citigen Energy Centre (Photo courtesy of E.On UK Ltd)

The system serves a number of the Corporation's buildings including the historic Guildhall, the Barbican Arts Centre, the Guildhall School of Music and Drama, the Museum of London and London Central Markets (Smithfield).

Figure 2 – Citigen CHP Engines (Photo courtesy of E.On UK Ltd)

The CHP units are 2 Wärtsilä Vasa 18V46GD internal combustion engines capable to run on either natural gas or distillate fuel.

The heat energy is distributed at a normal operating temperature of around 105°C. A number of boiler plants provide back-up generation.

Citigen has some degree of capacity to expand both heating and cooling capacity as they have space within the energy centre; ultimately though, the existing pipe networks will limit the capacity without creating new networks. The available capacity of the heating and cooling networks was not established during the time available for this study.

2.5.2 London Thames Gateway Heat Network

The LDA is developing a sustainable district energy system. The London Thames Gateway Heat Network (LTGHN) is a hot water heat network that aims to connect diverse sources of affordable low/zero carbon heat to existing and new developments helping to create sustainable communities.

The LDA envisage sources of heat to come from existing industrial plant already in operation in the London Thames Gateway with future energy sources connecting later as they emerge and demand grows.

The whole heat network will be built in periodic stages; the timing yet to be determined but it will initially draw in the Sustainable Industries Park (SIP), Barking Town Centre. The heat network will be separately started in the Royal Docks area. Future phases will hope to see the joining of the Barking Town centre network with that in the Royals and further growth of the Network East and Westerly to Stratford.

Figure 3 - LTGHN Vision Plan (courtesy of LDA)

The planned LTGHN, however, does not intend to reach as far as the City as can be seen in Figure 4. Tower Hamlets has identified in their LDF Evidence Base a proposal for DH scheme that may, in the future, be able to bridge the gap from the LTGHN to the City but this would require considerable planning and it not yet been identified as a possibility.

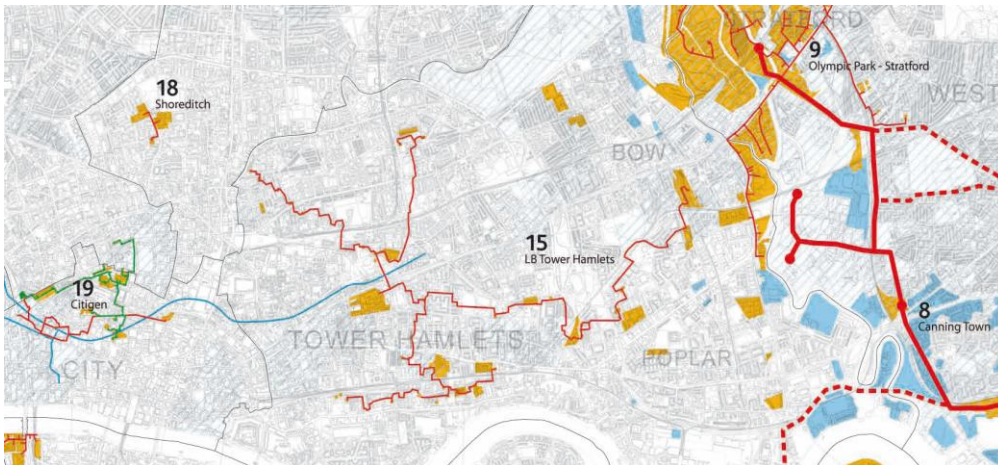


Figure 4: Proximity of the City to the LTGHN (courtesy of LDA)

2.6 Benchmarking

Benchmarking of buildings was based primarily on a number of references and are summarised in Table 2 below. We have used an average annual consumption for housing based on all properties measuring 61m^2. It is considered that this will be sufficiently representative of a mix of property sizes and sufficient for estimating the energy demand over the borough.

Building type	MWh per Annum		Reference
	per m2 GIA	per unit	
2 bed flat		8.165	Assuming 61 m2 per unit
Housing	0.134		2 bed flat gas consumption.
School - Primary (no pool)	0.113		GPG343
School - Secondary (no pool)	0.108		GPG343
Office	0.09095		Energy Consumption Guide 019
Office Cooling	0.018		CIBSE Guide F - Good Practice converted to GIA
New office modelling results part L modelling	0.068		Based on part L modelling
Future office - modelling part L 2010	0.0255		Based on Part L modelling
Hotel -Luxury		17.4	CIBSE Guide F - Good Practice
Hotel - Business/Holiday		15.08	CIBSE Guide F - Good Practice
Hotel Electricity used for cooling - Luxury		2.32	CIBSE Guide F - Good Practice
Hotel Electricity used for cooling - Business/Holiday		1.74	CIBSE Guide F - Good Practice
Hospital cooling taken as (HVAC) electricity demand for acute hospital	0.0195		CIBSE Guide F - midpoint between Typical and Good Practice values

Table 2 - Benchmarking Values

2.7 Future developments

A meeting involving key members in the Planning, Planning Policy and City Surveyor's departments was undertaken to understand whether any future planning developments would influence the potential for decentralised energy in the form of DH and cooling networks.

The Corporation, through its Draft Core Strategy 2010, has identified five Key City Places for development;

- Aldgate Area
- Cheapside and St Pauls
- Eastern Cluster
- Thames and the Riverside
- The North of the City

These areas are shown on Figure 5.

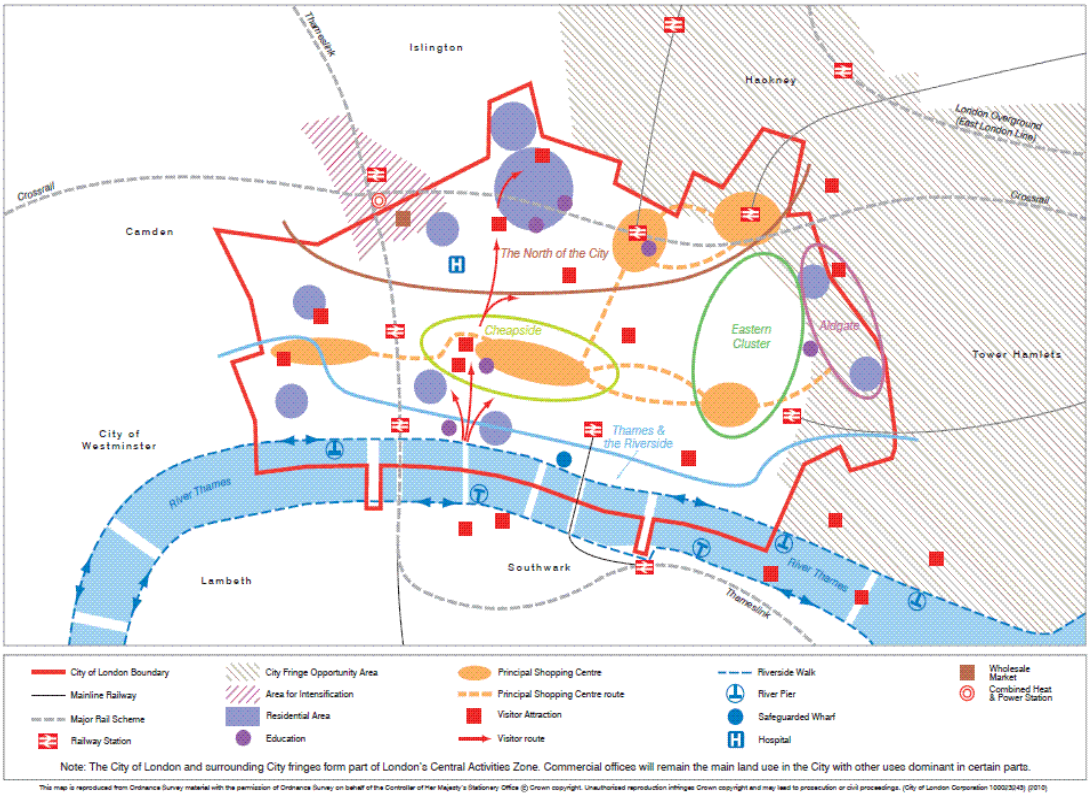


Figure 5 - City of London Strategic Areas

Aldgate Area

Core strategy CS8 identifies the need to increase high quality office floor space from existing floor space and to increase community and leisure floor space from existing. This will not add new and/or significant development but change the level of demand currently in place.

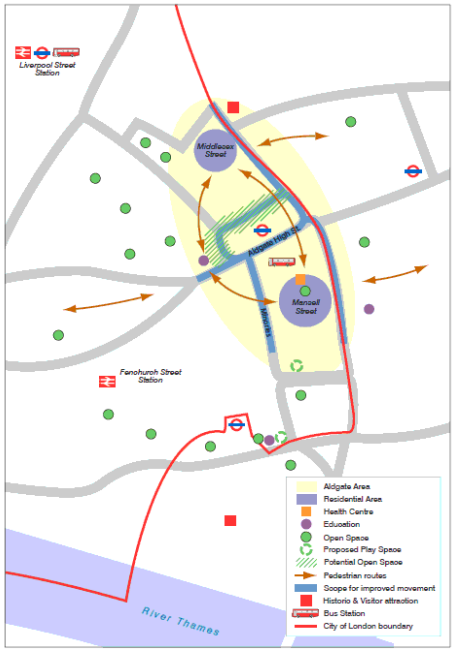


Figure 6 - Aldgate development area

Cheapside and St Pauls

Core Strategy CS6 aims to deliver an additional 41% of retail floor space in Cheapside between 2010 and 2017, which could provide a point of significant load for a DE network.

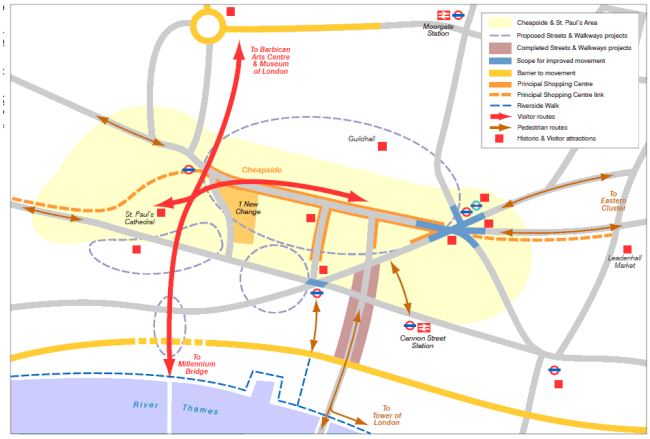


Figure 7 - Cheapside & St Pauls development area

Eastern Cluster

Core Strategy CS7 identifies the target to establish further tall and large buildings in this area and a reversal of trend for annual increases in energy use within the area. This clearly would provide significant opportunity to develop DE infrastructure.

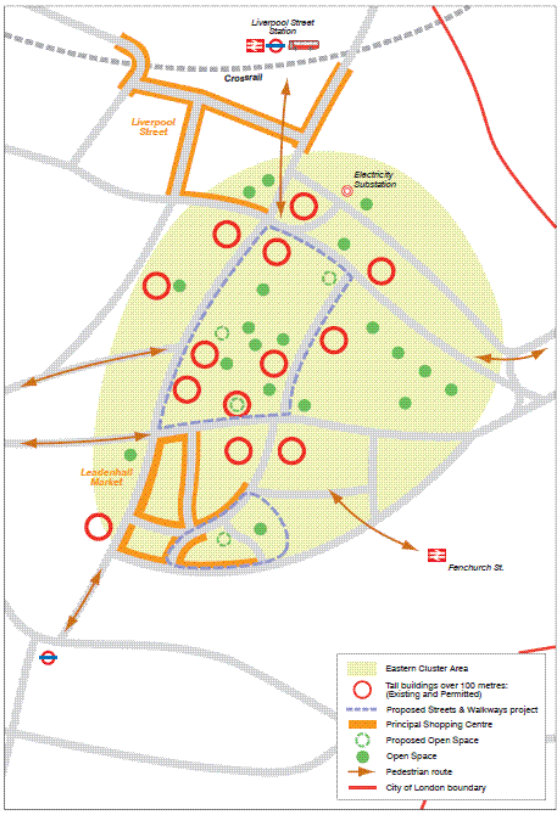
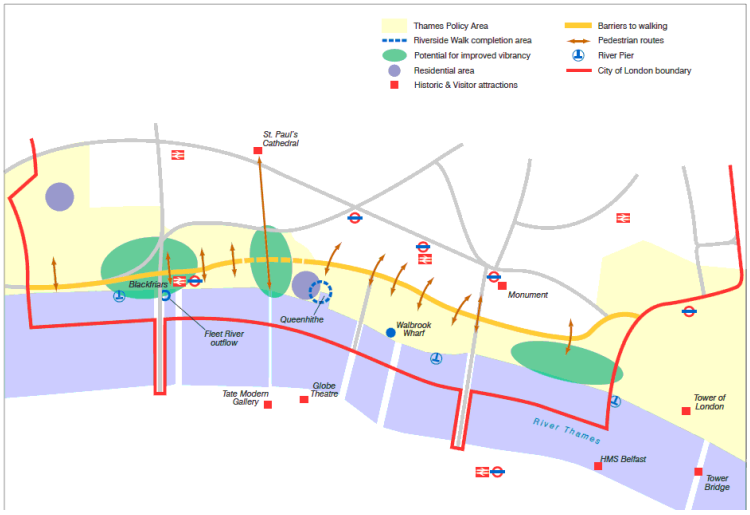


Figure 8 - Eastern Cluster development area



Thames and the Riverside

Core Strategy CS9 targets an increase in the number of hotels close to visitor attractions to help increase the number of visitors to the area.

Figure 9 - Thames and the Riverside development area

The North of the City

Core Strategy CS5 targets new development emerging in the mixed use area of Smithfield and the expansion of the Citigen scheme.

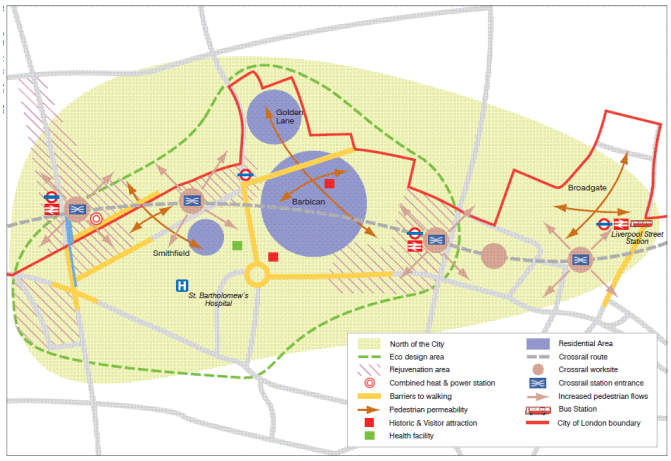


Figure 10 - North of the City development area

When considering the City as a whole, future developments in new housing are identified as growing at 90 units per year each year until 2025/26. This growth will be clustered close to existing residential areas in the City and would not represent a significant load to act as an anchor to any decentralised energy scheme but should be considered as a contributor.

RE determines that whilst areas have been identified for preferred development, the size of these developments would not necessarily be sufficiently large enough to influence the development of clusters.

3. HEAT MAP ANALYSIS

3.1 Criteria for Creating Clusters

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 the 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.
- Whereas highly insulated modern buildings often have relatively low heat demands, older buildings with higher heat loads and heating systems due for renewal can often present more valuable loads, and should be targeted. External DE heating and cooling supplies may also help avoid the need for visually intrusive services such as flues and roof top cooling plant.

3.2 Development Constraints

There are a number of constraints to the development of a DE network in the City.

3.2.1 Open Trench Excavation

The installation of DH and cooling pipes in conventional open trench excavations creates an array of problems in an area as highly developed as the City.

Although the size of any heat and cooling network has yet to be fully determined, the density of buildings and existing services, and the paucity of space for energy centres (see 3.2.5) would indicate that it could be extremely difficult or impossible to find routes for new large diameter DE and/or cooling pipes through the most heavily congested areas.

The Corporation has indicated areas of road network that are currently identified as being traffic sensitive making excavation particularly difficult and these are shown on Figure 11 and Appendix F. In addition to the traffic sensitivity of roads, it is likely that the volume of other utilities in the highways will be extensive, creating increased restrictions in the highway.

The Corporation's draft Core Strategy 2010 also identifies the objective to reduce disruption associated with utility infrastructure provision and maintenance through the provision and use of pipe subways. This could provide routes for DE networks.

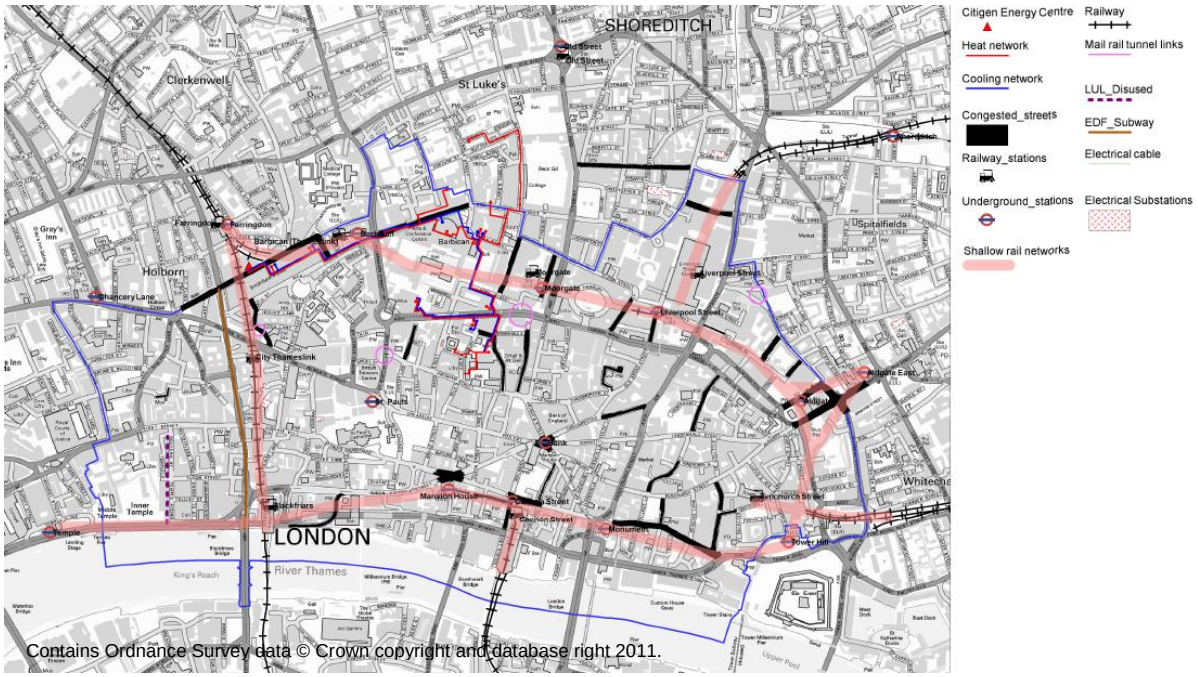


Figure 11 – Plan of Constraints

3.2.2 Underground Transport

Most of the London Underground tube lines, passing through the City, would be below typical open excavated trench depths (0.8m - 1.4m) but the areas in the immediate surrounds of the entrances are likely to be restricted due to the heads of the stairwells, etc.

It is understood that the District, Hammersmith,and City, Metropolitan and Thameslink lines, which pass through the City were constructed using a 'cut and cover' technique. We understand from the Corporation that the depth to the covers may be as shallow as 400mm from finished road level in certain areas.

The Crossrail rail network has been identified but is considered below the level that would cause any impediment. These networks are indicated on Figure 11.

3.2.3 Archaeological Remains

Although this study did not set out to determine the location and depth of archaeological sites, it must be recognised that London contains a significant number and of varying importance. The process of installing pipes may impact on such sites and subject to the results of the find would determine whether the proposed pipe route would have to be modified. This would clearly have significant impact on costs and even on the potential to connect to buildings.

A recent study undertaken for the Corporation[1] indicates that a significant area of the City has archaeological remains in depths of up to 6m.

1. City of London Decentralised Energy and Pipe Subways Study Vol. 1 – Baseline Study Jan2011

3.2.4 Air Quality Management Area

The City was declared an Air Quality Management Area in January 2001 for the pollutants nitrogen oxides (NO_x) and fine particles (PM_{10}). The City's Air Quality Action Plan identifies a number of Actions that predominantly seek to reduce the emissions from vehicular traffic but recognise the effect of emissions from heating plant.

Although the increased use of DE will help reduce the emissions from conventional heating plant and create a net reduction across the City, the location of new energy sources may contribute to locally increased emissions.

3.2.5 Energy Centre Locations

The City arguably hosts some of the most prestige commercial and retail space in the country. The lack of undeveloped land also heightens the value of that remaining. The potential locations for creating an energy centre are extremely hard to find.

Our Discussions with the Corporation did not yield any immediate opportunity sites within the City and it was felt better prospects may lie outside the City's boundary in neighbouring boroughs. There may be potential for energy centres to be created within the curtilage of a new development but it was recognised that the site of a new development may not provide the ideal location to deliver energy to other buildings.

3.3 Network Development Opportunities

Although a number of constraints have been identified there are opportunities that exist that would assist in the development of DE networks.

3.3.1 Tunnels

The presence of a network of services subways under the City may offer an opportunity to route pipes despite the existing subway network being low in number and coverage, Careful planning would have to be undertaken if additional tunnels are to be constructed to accommodate an enlarged network throughout the City.

3.3.2 Underground Energy Centres

RE has designed a number of subterranean energy centres, particularly in city environments. Our work for CTR, the operator of the central Copenhagen district heating scheme, has involved a number of energy centres which house boiler plant, pumps and ancillary equipment. Suitable discharge of combustion gases still needs to be achieved but the potential to alleviate the problem of finding sites for energy centres exists.

3.4 Cross Borough Opportunities

The City is bordered by seven of Boroughs;

3.4.1 Islington

Islington Borough Council (IBC) borders the North of the City and has recently been developing a DE scheme in the south of the borough in the Bunhill Row area.

A meeting took place between RE, the Corporation and IBC to understand the potential for cross-borough opportunities. A number of areas were identified where opportunities may exist;

Old Street Area

IBC are currently developing a DE network in the Old Street area. Centred on an energy centre located at Finsbury Leisure Centre, a network of heating pipes is designed to connect to the Stafford Cripps Estate, the Redbrick Estate and St Luke's Estate. The network may offer an opportunity to connect to the Golden Lane Estate in the north of the City.

Bunhill Row area

The area around Bunhill Row including the Cass Business School and the Old Artillery Buildings are considered potential development areas as the Citigen heat network runs through this area to feed the Peabody Estate.

Farringdon Road area

The area running parallel with Farringdon Road and adjacent to Farringdon Road Station is in the process of redevelopment and could present an opportunity to connect to the Citigen scheme.

3.4.2 Tower Hamlets

The area bordering Tower Hamlets has a number of developments and, in itself, could act as a cluster and provide an opportunity to the Corporation.

Of particular note are the areas around Bishopsgate/Old Spitalfields Market, Middlesex Street (Petticoat Lane) and Mansell Street.

3.4.3 Hackney

The border between the City and Hackney is quite small and the potential for DE is limited by the lack of buildings with significant heat demand. This border area is also sandwiched between Islington and Tower Hamlets which would influence any opportunity areas.

The City Road area has proposals for a number of large mixed used developments with a sizeable energy demand and for upgrading existing housing estates, but RE understands that any proposals for a DH system may rely on developments currently under construction in Islington. St. Leonard's Hospital and the Britannia Leisure Centre may also offer limited opportunity for the site of an energy centre but the surrounding area is not populated by very many buildings with high heat load. This would suggest that any development of a cluster may be constrained.

3.4.4 Westminster

Westminster is home to both the Pimlico District Heating Undertaking (PDHU) and the Whitehall scheme; both some distance from the eastern fringes of the City. A corridor straddling the Strand/Fleet Street may provide a link to the Whitehall DH scheme with many suitable loads (including the Royal Courts of Justice, Kings College, Somerset House, various large hotels and offices) en route.

The proximity of the Citigen system to the western fringes of the City may have potential to connect to the Strand/Fleet Street corridor.

3.4.5 Camden

The London Borough of Camden has a number of community or block heated housing estates and RE understands that there is some DE activity within the council. Unfortunately, we were unable to identify any opportunities in this area, within the time available for the study.

3.4.6 Southwark

The London Borough of Southwark neighbours the City but is separated by the River Thames. Southwark has identified a number of opportunities in the north of the Borough particularly in the area around the South Bank/Blackfriars.

LSBU/Elephant and Castle, the area around London Bridge and Tower Bridge, and the Tabard Gardens areas also Guy's Hospital has been identified as a potential anchor load for the London and Tower Bridge sub-areas. The Elephant & Castle MUSCo scheme is already proposed to the south of the LSBU/Elephant & Castle sub-area, lying between North Southwark area and Surrey Gardens Focus Area but is considered outside the range of inter-connection.

It is considered that a river crossing would require significant infrastructure investment and the viability given much consideration in the current investment environment.

3.4.7 Lambeth

The London Borough of Lambeth neighbours the City but is separated by the River Thames. The northern region of the Borough has shown the greatest potential for developing heat networks, although they appear to be adopting a policy of quite small; more local CHP schemes.

An exception is the South Bank Employer's Group (SBEG) who is actively seeking to establish a DE network to serve 14 of their members. A feasibility study has been commissioned by SBEG to assess the viability of this proposed scheme. Allied to this, there are housing and retail premises in close proximity together with the large St Thomas' hospital which already has a CHP energy centre.

The Vauxhall Nine Elms and Battersea DH system is considered too far away to be considered a viable possibility of inter-connection.

It is considered that a river crossing to connect with heat loads or a energy centre in Lambeth would require significant infrastructure investment and the viability given much consideration in the current investment environment.

3.5 Results

The results of the data collection exercise are contained in the LDA Template, attached as an appendix and summarised below.

In total RE were able to gather data 25 buildings through the NI 194 database from the Corporation. RE targeted over 260 buildings through various sources and the level of success of data gathering from these buildings is illustrated in Figure 12.

"No Success" indicates that neither a company nor a responsible person could be contacted. In these instances it was necessary to apply a benchmark to the building to obtain estimated heat data.
"Partial Success" indicates that we were successful in contacting a company and/or finding a responsible person, but did that no data was received.
"Success" indicates that we were successful in contacting a company and/or finding a responsible person and that data was received.

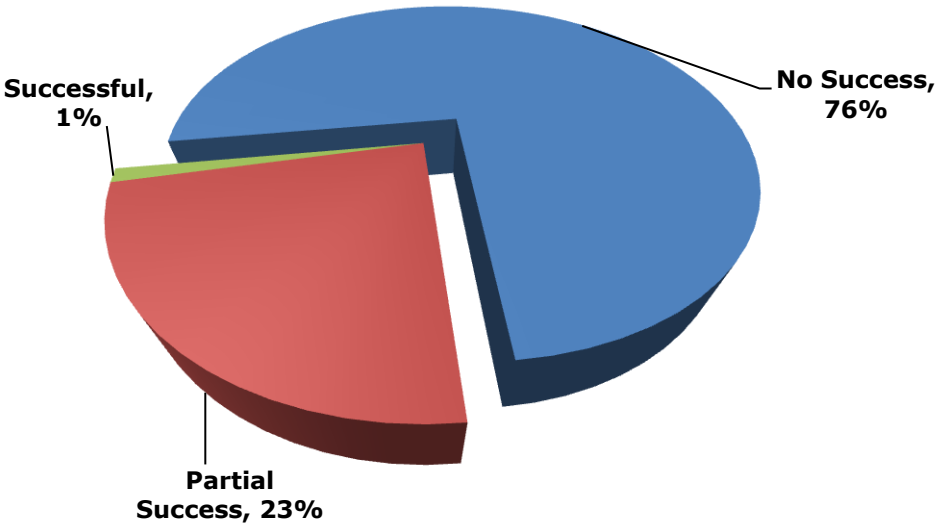


Figure 12- Breakdown of data gathering results

Table 3**Error! Reference source not found.** summarises the data collected for estimating the heating demand and Table 4**Error! Reference source not found.** summarises the data collection for all building types assuming potential for cooling.

A number of maps have been produced and are attached in Appendices as follows:

- Appendix A illustrates the raw data collected by building type over the borough.
- Appendix B illustrates the building data using graduated scaled points of reference to highlight the magnitude of energy demand for a given site and includes known planning developments.
- Appendix C illustrates the data collected by building type also highlighting the 'Citigen area'.
- Appendix D illustrates the data by building owner.
- Appendix E illustrates the cooling data collected by building.

The collected data has been sorted to show the numbers of buildings (x-axis) that consume a level of heat energy in MWh per annum (y-axis) in Figure 13. This diagram illustrates very well the propensity for buildings to have a high demand; at least 125 of the buildings identified consume over 1,000MWh heat per annum.

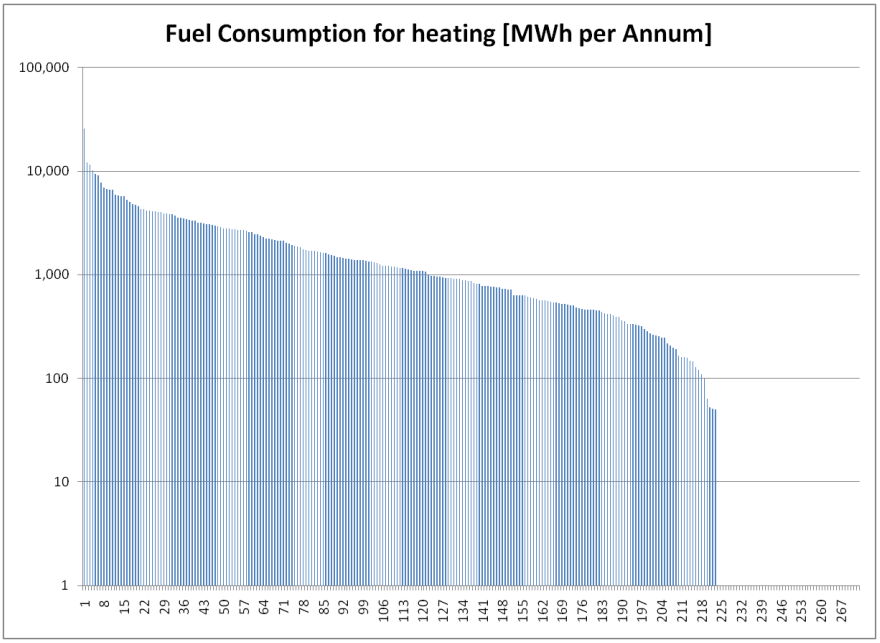


Figure 13 - Fuel Consumption Curve (numbers of buildings against MWh per annum)

Type of buildings	Nr of buildings	Total Fuel Consumption [MWh]	Floor Area [m2]	Residential Units
Multi-address buildings	1	3,195	12,887	284
Sport & Leisure facilities	3	8,365	147,413	-
Prisons	0	-	-	-
Hotels (> 99 units or 4,999 m2)	29	100,591	39,357	-
Education facilities	10	8,557	68,161	-
Police stations	3	3,045	-	-
Fire stations	1	128	840	-
NHS	1	25,549	106,629	-
Central government estate	9	14,758	130,600	-
Local government estate	49	57,913	181,671	2,460
Museums & Art Galleries	1	4,280	18,616	-
Churches	47	63	-	-
Private residential (> 149 units or 9,999 m2)	14	9,520	-	1,166
Private commercial (> 9,999 m2)	105	202,557	2,569,421	87
Other public buildings	0	-	-	-
	273	**438,521**	**3,275,595**	**3,997**

Ownership of buildings	Nr of buildings	Total Fuel Consumption [MWh]	Floor Area [m2]	Residential Units
Central government	14	43,480	238,069	-
Local government	66	78,214	446,622	2,460
Other public	0	-	-	-
Private	146	316,764	2,590,904	1,537
Other	47	63	-	-
	273	**438,521**	**3,275,595**	**3,997**

Data collection	Subtotal
Real	46
Estimate	177
No data	50
	273

Table 3 - All records for Heating

Type of buildings	Nr of buildings	Total Fuel Consumption [MWh]	Floor Area [m2]	Residential Units
Multi-address buildings	1	230	12,887	284
Sport & Leisure facilities	3	2,579	147,413	-
Prisons	0	-	-	-
Hotels (> 99 units or 4,999 m2)	29	15,540	39,357	-
Education facilities	10	125	68,161	-
Police stations	3	-	-	-
Fire stations	1	-	840	-
NHS	1	1,455	106,629	-
Central government estate	9	2,331	130,600	-
Local government estate	49	4,271	181,671	2,460
Museums & Art Galleries	1	-	18,616	-
Churches	47	-	-	-
Private residential (> 149 units or 9,999 m2)	14	-	-	1,166
Private commercial (> 9,999 m2)	105	45,784	2,569,421	87
Other public buildings	0	-	-	-
	273	**72,317**	**3,275,595**	**3,997**

Ownership of buildings	Nr of buildings	Total Fuel Consumption [MWh]	Floor Area [m2]	Residential Units
Central government	14	3,787	238,069	-
Local government	66	7,952	446,622	2,460
Other public	0	-	-	-
Private	146	60,579	2,590,904	1,537
Other	47	-	-	-
	273	**72,317**	**3,275,595**	**3,997**

Data collection	Subtotal
Real	6
Estimate	152
No data	115
	273

Table 4 - All records for Cooling

4. SAMPLE HEAT NETWORK

We have created a small heat network using nine buildings in the Bishopsgate area. The buildings selected have been chosen to form a small cluster and assume that an energy centre is located just outside the borough.

4.1 Pre-conditions

The outline of the DH network considered in this assessment has been based on the conditions described below.

The flow and return temperatures have been chosen as 90ºC and 50ºC. The distribution network is assumed as being pressure rated at 10 bar. A maximum pressure of 10 bar, a static pressure of 1.5 bar and an end-user pressure differential of 1 bar have been used for the hydraulic optimisation. The above conditions are currently considered the optimum for operating heat networks in the UK. It is good practice to operate heat networks at low flow and return temperatures to minimise heat losses and increase the longevity of the pipe asset. A high temperature difference between flow and return temperatures is very important to help minimise pipe sizes and thus the capital investment. Where existing networks operate on high temperatures and low temperature differences, steps should be taken to optimise the system as this will often increase the existing pipe capacity.

The necessary pipe dimensions are estimated by using the software package "SYSTEM RORNET", which is a simulation programme for hydraulic and thermal analysis of DH networks. SYSTEM RORNET (SR) calculates the optimum diameters of the pipes based on a known temperature difference between flow and return pipes, pressure levels, costs for piping and the maximum velocity in the pipes. SR has been designed by RE and specifically developed for DH and cooling network optimisation. SR is considered a leading industry software package.

4.2 Heat Loads and Diversity

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

In a DH network the branch supplying a single consumer is designed for the consumers peak load demand. A distribution pipe supplying several consumers is not designed to supply 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 a diversity in the time of demand. The peak load demand of each consumer, therefore, has to be multiplied by a diversity factor to find the heat load that the distribution pipe should be designed for.

The annual estimated heat consumptions in Table 2 are turned into maximum heat loads using a yearly yearly utilisation time and taking diversification in the system into account. The rounded heat demands demands and network heat loads for the scheme are shown in

Table 5.

Modelled Area	Estimated heat demand (MWh / Annum)	Max. estimated heat load (MW)
Bishopsgate area 9 consumers	39,300 MWh	16.4 MW

Table 5 - Rounded heat demands and loads estimated for the potential DH network.

4.3 Network Layout

A network layout has been developed for illustrative purposes and is shown as an output from RE's System Rornet software Figure 15 and overlaid on a map (in red dotted) Figure 14.

As we have not yet identified an energy centre, we have assumed that this is located outside the City.

The total length of the network is approximately 1.5 km. The largest pipe dimension is DN200.

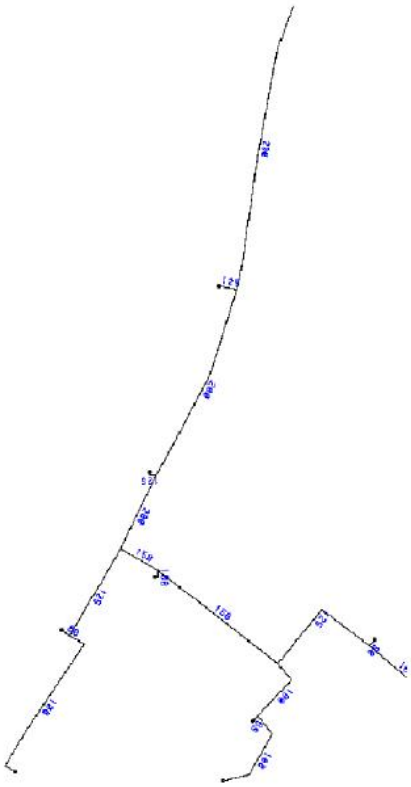


Figure 15 - System Rornet Output

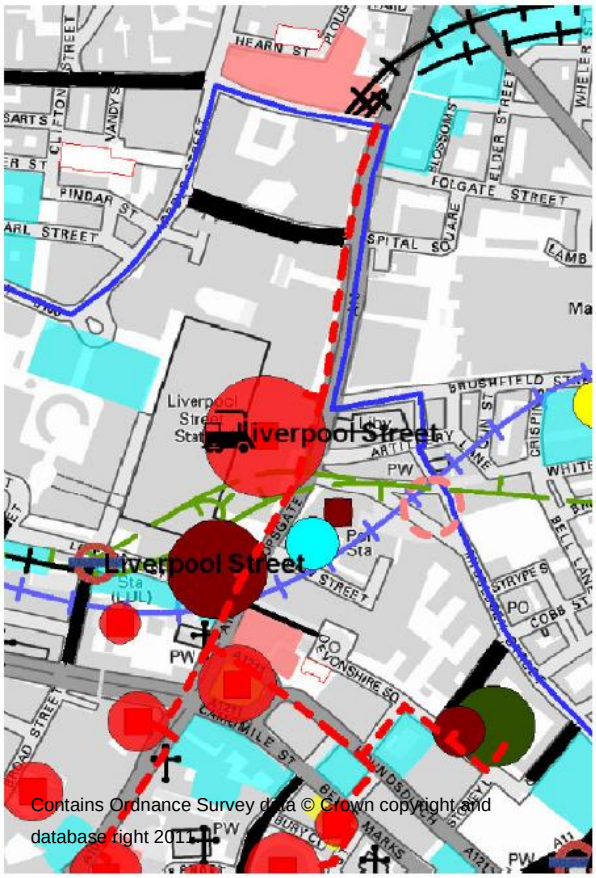


Figure 14 - Pipe layout on plan

4.4 Heat Loss from the Network

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 10 °C. The heat loss in a full load situation is found to be around 80kW which gives a heat loss of about 630 MWh per annum or 1.6% of the total energy generated. The measure of heat losses will vary throughout the year as demand rises and falls with the seasons.

4.5 DH Main Network Cost Estimate

The Bishopsgate network costs have been estimated at £1.6 million. This excludes the cost of the energy centre and any modifications required by buildings to connect to the heat network. The cost does reflect hard dig civil work but exclude intense traffic control that would be applicable to very dense urban areas.

5. IMPLEMENTATION PLAN

For the purposes of the Implementation Plan, the area potentially served by the expanded Citigen system has been considered, together with an area comprising the whole of the City of London. The density of heating and cooling loads is considered such that the entire City has the potential for DE coverage. In practice, factors such as locations for energy centres, ease of installing pipework, availability of anchor loads, and willingness of potential customers to connect will determine the local areas in which DE will start.

	DE Opportunity	Priority	Notes	Planning Status	Barriers	Next Steps	Key dates	Responsible person
	(Identified by location, name of development, scheme name or other)	(High, Medium or Low based on highest potential for delivery)	(Basis of assessment of delivery potential)	(Planning permission granted, outline application, detailed application, etc)	(Potential barriers for delivery of opportunity identified)	(Next steps for LA to facilitate delivery of opportunity identified)	(If action is not taken by this date the potential for delivery of the scheme may be reduced)	(Person responsible for taking action)
1	'Citigen Area'	High	Existing privately owned DH and cooling scheme and CHP energy centre. Heat network has capacity for growth; Possibility of expansion of H & C networks from energy centre. Significant additional developments able to connect.	In operation. Section 36 consent for 90MW (e) generation.	Citigen is a privately owned company and will develop on a strictly commercial basis.	Continue engagement with Citigen.	Ongoing	Andrew Crafter Principal Engineer
					Road network may prove to be a significant impediment to the installation of further pipework.	Undertake further heat mapping study to determine full extent of potential connectivity and determine impact on existing Citigen infrastructure.	Dec 2011	
					Cooling network already operating at full capacity.	Undertake further heat mapping study to determine full extent of potential connectivity and determine impact on existing Citigen infrastructure.	Dec 2011	

2	City of London	High	Density of existing building stock very high. Potential for connecting to city-wide decentralized energy scheme		No further energy centres identified in area.	Undertake further heat mapping study to determine full extent of potential connectivity to determine the likely requirements of energy provision in the City.	Dec 2011	Andrew Crafter Principal Engineer
						Following further heat mapping, identify how additional energy centres could be developed within the curtilage of a new development	Dec 2011	Janet Laban Planning Policy
					Potentially high level of existing services in highways may restrict space for heat and cooling networks.	Undertake a detailed survey of the City to determine impediments in highways to a depth of 2.5m	June 2012	Highways Department
						Undertake preliminary investigation into a city-wide services subway network for use by a decentralised energy system	June 2012	Andrew Crafter Principal Engineer, Steve Bage, Infrastructure Manager
					Clusters of buildings with potential to connect will be needed to make network extensions viable	Introduce planning policy that makes a requirement for future proofing building services design to be able to connect to DH and cooling schemes.		Janet Laban Planning Policy

6. SUMMARY AND CONCLUSIONS

The time available to undertake this study coupled with the relatively low data return meant that the resultant heat and cooling maps are not fully representative of the actual energy demand of the City. The exercise which has been carried out using benchmarking data shows that the City is densely populated throughout by major developments with only key landmark and some fringe areas less densely populated.

The small area the City - covering 3.14km^2 – makes it difficult to identify clusters of heat load as the distribution of heat demand throughout the City indicates that the whole of the city could be considered as a single cluster. This is also seen in the knowledge that the premise of a cluster is that an available heat source or a site suitable for a heat source can be identified, which has been identified to be practically impossible.

The cooling demand will tend to be centred around recent and new office developments, although other buildings may also provide useful cooling loads. It could be argued that new developments may be required to design building with less energy intensive systems, which may reduce the prevalence of cooling systems. Given that offices are widespread, the cooling demand cluster is considered to cover the majority of the City but excluding those areas which are predominantly residential.

The north-west of the City is currently served by the Citigen plant, however no further major heat sources have been identified nor does there seem to be any realistic opportunity of securing sites for major energy centres within the City. There are no obvious opportunities on the fringes of the City, in neighbouring boroughs, sufficient in size to cater for the heat demand of the City.

Citigen itself has potential for further development in terms of both increased generation of heat, cooling and power on site, and for an expanded energy network supplying heat and cooling to a wider area. This should be pursued as well as investigating the opportunity to optimise the operating temperatures of the heat network to help maximise its usefulness.

RE maintained frequent dialogue with the Corporation on the matter of energy sources. One discussion centred on the potential for energy centres to be created within the curtilage of a new development but it was recognised that the site of a new development may not provide the ideal location to deliver energy to other buildings and that it is unlikely that the space made available (subject to economic constraints) would be sufficiently large enough to capture enough buildings to justify the investment in a DE distribution network.

The Corporation’s view of developing heating and cooling networks was that it could prove very difficult to use the main highways as pipe routes given the disturbance to the City and the prevalence of other utility services. RE also identified a number of other constraints (3.2 – Development Constraints) that would also present challenges. However by using subways, basements, disused tunnels, and highways where feasible, DE networks may be feasible in many areas of the City.

The presence of a network of services subways under the City may offer an opportunity to route pipes but the existing subway network is insufficient in number and coverage, and may in some instances be too small or already occupied by other utilities to carry new large heating and cooling pipes. Careful planning will have to be undertaken if additional tunnels are to be constructed to accommodate an enlarged network throughout the City.