LIVERPOOL CITY REGION PLANNER CAPACITY BUILDING HEAT NETWORKS

FINAL REPORT

FEBRUARY 2012

north west improvement and efficiency partnership

CLASP. Climate Change Local Area Support Programme

ARUP

Contents

Section 1 Introduction

1.1 Background

The Liverpool City Region (LCR) - comprising of Halton, St. Helens, Liverpool, Wirral, Sefton and Knowsley - identified the need to ensure opportunities and related issues for combined heat and power (CHP) and district heating are not missed when planning for new development through the delivery of Local Development Frameworks (LDF).

This LCR project builds on previous work commissioned by Merseyside Environmental Advisory Service (MEAS) that has examined LCR's renewable energy options and for emerging planning policy. This includes the Liverpool City Region Renewable Energy Capacity Study Stage 1 & 2 Reports and Mechanisms for Delivering Sustainable Energy Infrastructure. These studies collectively provide the evidence base for Local Development Frameworks across LCR.

1.2 Purpose of this Project

This project started on 4 July 2011, with a presentation event to LCR planning officers. The content of the presentation was informed by a range of issues identified in the previous studies and the project brief developed by MEAS.

Following the presentation local authorities were asked to identify key issues where further information and guidance was required. This resulted in a number of surgery sessions being held to discuss priority issues in greater detail. The final output of the project was the preparation of this report.

The purpose of this report is to provide general information and guidance on a range of issues relating district heating. The report has been prepared to help inform plans, policies and supporting guidance to assist planners, developers and communities to better understanding heat networks. Guidance, data requirements and tools for assessing the potential of heat networks are provided in Appendix A

Section 2 Key Issues

2.1 Introduction

This section provides a brief overview of the key issues covered by the presentation event and identified and discussed at each surgery session. The section sets out how sections 3, 4 and 5 and Appendices A to D of the report cover a number of district heat network specific issues raised.

2.2 The Presentation

The presentation was produced in response to the issues identified in the project brief and from issues identified in previous studies. A summary of the presentation is provide below. The full presentation is provided in Appendix B.

Part 1: Context

- What is Good District Heating?
- The Energy Efficiency Directive (EED)
- Liverpool City Region: The Journey So Far
- Liverpool City Region : Projecting Future Demand
- Liverpool City Region : Strategic Opportunities

Part 2: Technical Issues

- Stage 1: Understanding the areas, sites and buildings
- Stage 2: Calculating energy consumption and profiling
- Stage 3: Calculating Carbon
- Stage 4: Technology options
- Stage 5: Deliverability & Viability – Understanding Business Case

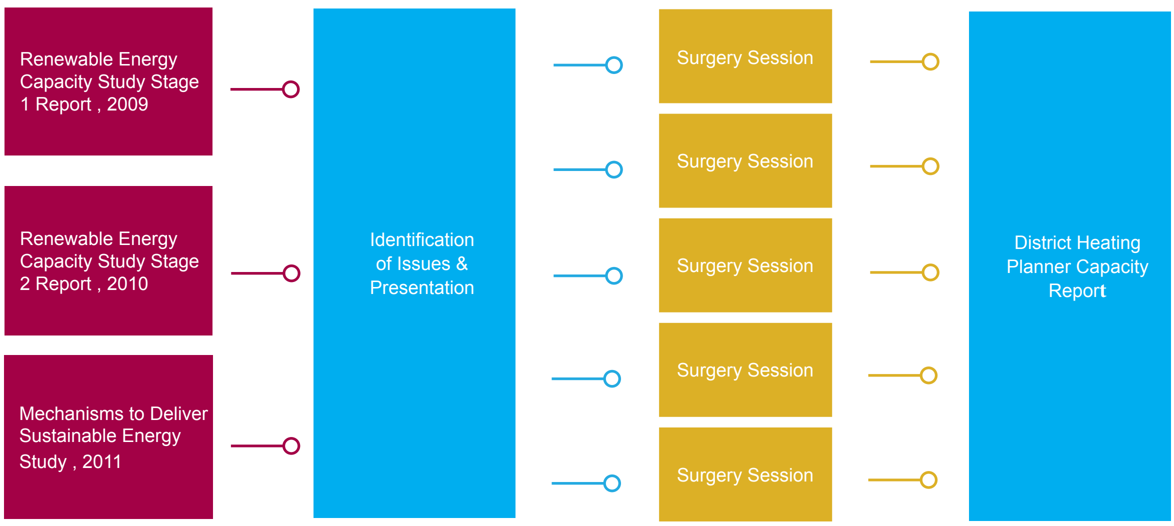


Figure 1: Process of Delivering Planner Capacity Building Report

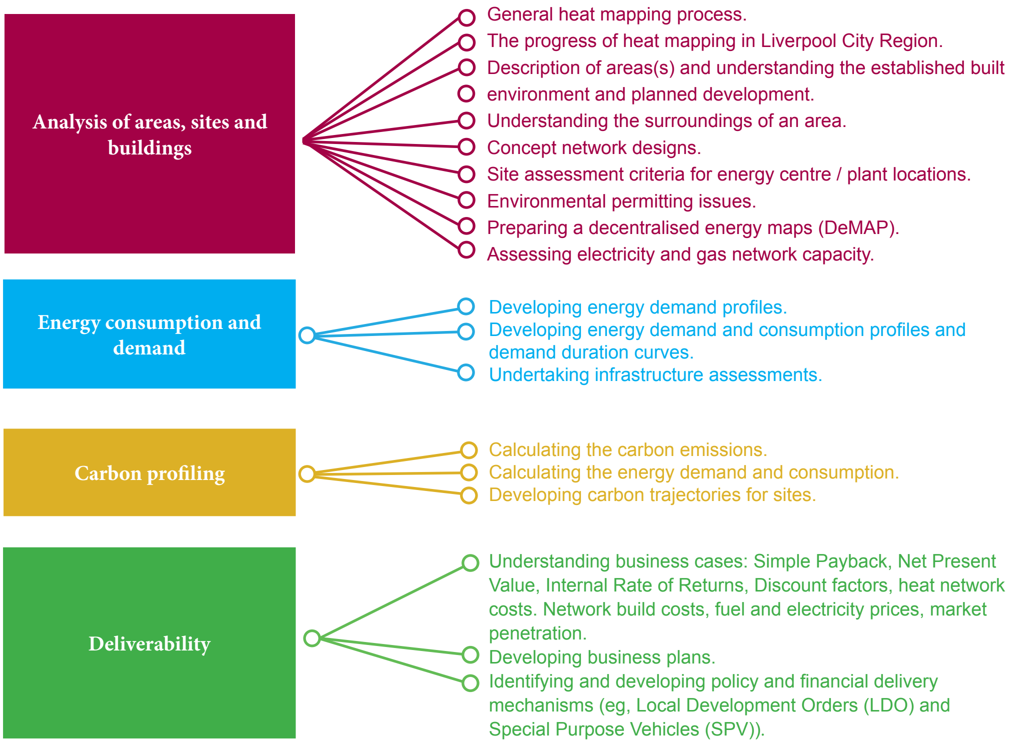


Figure 2: Summary of Key Issues that informed the Presentation Slides

2.3 Surgery Sessions

A total of five surgery sessions were held for Liverpool, St. Helens, Halton, Sefton and Knowsley. Each session was based on the key issues raised by planning officers in response to the presentation and discussions held at the presentation event.

Each surgery session involved a range of officers from planning, regeneration and asset management Council services. Surgery sessions were guided by an agreed agenda, but were informal in nature and officers were encouraged to raise further issues on energy related matters in order to increase wider understanding of energy issues. Notes were made at each session and then used to inform the content of this report that captured the key issues raised and provide guidance where relevant.

It is important to note that this project focuses primarily on CHP and district heat networks. It does not cover other technology options such as solar and wind. The surgery sessions often covered a broad range of topics and issues that often transcended district heating and included wider issues relating to energy and climate change. However, these issues are beyond the main scope of this project and therefore not covered in any detail in this report, though other sources of information and guidance are signposted where possible.

A summary of the key issues per surgery session is set out in Figure 4 with a reference provided to where an issue has been addressed in the report.

2.4 Report Structure

- **Section 3:** Provides general information on district heating as a technology option, how it works, benefits and barriers, key principles in developing a network, energy options for Combined Heat & Power (CHP)and district heating, key steps for developing heat network schemes and key viability indicators.
- **Section 4:** Covers a range of energy mapping matters including the overarching process for delivering energy infrastructure and where energy mapping fits into this process, an overview of the approach undertaken in LCR to date, the benefits and issues when considering more detailed energy mapping, the use of GIS for heat mapping and wider energy mapping functions and data gathering and analysis.
- **Section 5:** Provides guidance for plan and policy plan preparation issues, including the potential to future proof areas for district heating, developing ‘living documents’, utilising mechanism such as Local Development Orders (LDO), developing energy statements and strategies and calculating carbon.
- **Section 6:** Conclusions.
- **Appendix A:** Useful Guidance, Data and Tools.
- **Appendix B:** Presentation Slides
- **Appendix C:** Heat Mapping Methodologies.
- **Appendix D:** Carbon Conversion Factors.

Surgery Session	Description of Surgery Session	Report Reference
Surgery Session 1 Liverpool	The Council were seeking to identify and prioritise 'Areas of Major Change' and in doing so understand their capacity to undertake work that moves the baseline work already completed for the Stage 1 and 2 studies forward. Expertise and data sources required to: • Undertake future heat mapping. • Understanding the relationship between calculating energy demand / consumption and calculating CO_2 emissions. • Assessing future developments and linking with district heating areas..	Section 4 Appendices A, B & D
Surgery Session 2 St. Helens	The Council sought advice on data sources required to: • Estimate likely uptake and participation in district heating. • Undertake electricity and heat demand profiles. • Calculating CO_2 emissions and cost / benefit estimates of implementing DH schemes.	Sections 4 and 5 Appendices B & C
Surgery Session 3 Halton	The Council asked for advice and guidance to understand: • Energy demand and how this affects the technical and economic viability of a proposed district heating scheme. • The links between the recent work undertaken for LCR and how this fits with the emerging LDF. • Implementation, maximising private sector involvement through a flexible planning approach, identifying other opportunities • Understanding financial viability factors and how this can be linked to the LDF.	Section 3, 5 Appendix D
Surgery Session 4 Sefton	The Council sought advice on: • General district heating matters relating to the technology, how it work and general principles when considering district heating. • Development Management issues relating to Energy Statements.	Section 3 & 5
Surgery Session 5 Knowsley	The Council sought specific advice on its emerging Core Strategy and the implications for district heating. The polices options discussed included: • CS 2: Development Principles. • CS 11: Principal Regeneration Area - Knowsley Industrial and Business Parks. • CS 22 & 23: Sustainable Development, Renewable and Low Carbon Infrastructure. • CS 24: Managing Flood Risk. • A Draft Sustainability in Design and Construction SPD.	Section 3 & 4

Figure 3: Summary of Surgery Session Issues and Report Structure

Section 3 District Heating

3.1 Introduction

One of the common issues identified through discussion with officers in all the Councils was the general need to better understand district heating and its benefits. This section provides an overview of district heating as an energy option.

3.2 Overview

All modern buildings have energy requirements in order to provide heating, electricity and often cooling for occupant comfort and functionality. These energy demands are traditionally met by a mix of electricity supplied by the national grid with gas boilers and potentially chillers serving individual buildings. An alternative approach is to use district heating which is an infrastructure for delivering heat to multiple buildings from a central heat source. Heat is generated in an energy centre and pumped through a network of pre-insulated pipes to the end heat consumer. At this point heat is either fed directly into the consumer's central heating system or transferred by a heat exchanger contained within a hydraulic interface unit (HIU), which also contains a heat meter for monitoring heat consumption for billing purposes.

3.3 How District Heating Works

One of the long-term benefits of district heating is its scalability. Once the initial pipework is established, new developments and buildings can be plugged into the main distribution network, with local distribution networks delivering heating or cooling to customers at a competitive cost. Any building can be connected onto the network, including dwellings, retail, commercial buildings and industrial facilities.

Both the space heating system and the domestic hot water systems within each building are the same as for buildings with individual gas boilers, with the added benefit of hot water available immediately on demand. Providing sufficient temperatures can be achieved, district heating is fuel flexible and a number of technologies could be utilised including CHP, biomass, and Energy from Waste. District heating has the potential to deliver a number of benefits both to the building owner/heat consumer and the wider community.

3.4 Potential Barriers

There are also some recognised barriers to decentralised energy in the UK, including :

- Expensive to install due to the high costs of the network infrastructure.
- Long payback period for infrastructure.
- Lack of experience of district heating in the UK.
- Potential constraints associated with planning and management of development.
- The lack of a regulated market for heat.
- Difficulty and expense of setting up contracts to supply.

3.5 Potential Benefits - Building Owner

Cheap heat: The type and scale of technology typically used to feed heat into DH schemes means that heat can be delivered to the end consumer at a competitive price, usually cheaper than the base case alternative of using heat from localised gas fired boilers.

Maximises building standards: By connecting to existing plant and networks help developers meet and exceed Code for Sustainable Homes and BREEAM standards.

Reduced maintenance: The maintenance requirements of heat exchangers are far fewer than that of a boiler. Boiler maintenance will be the responsibility of the DH owner/operator and the maintenance cost of the Hydraulic Interface Unit (HIU) will usually be included in the heat tariff.

Reduced spatial requirements: The HIU for a domestic property is smaller than that of a boiler of the same capacity. Space savings for commercial and industrial buildings will be even greater.

No flue: Centralised plant means that no flues will be required in individual buildings. This can have positive architectural and spatial benefits.

Safety: Centralising heat generation removes the necessity to have gas in all buildings. This removes any potential risk of carbon monoxide poisoning or gas explosion.

3.6 Potential Benefits - Community

Reduced CO_2 emissions: District heating facilitates the implementation of a number of low carbon technologies including gas CHP, biomass boilers and several energy from waste (EfW) technologies.

Fuel flexibility: District heating is completely technology and fuel independent providing sufficient flow temperatures can be achieved. District heating enables whole areas to be switched to new and emerging technologies with ease. For example gas fired CHP could be replaced with a hydrogen fuel cell as and when they become economically viable with no disruption to consumers.

Fuel security: District heating allows fuels and/or technologies to be utilised which would be uneconomic at a smaller scale. For example whereas biomass CHP is unproven at a building scale it is a well established technology at a larger scale.

3.7 District Heating Principles

It is theoretically possible to develop a district heat network in any area where there are multiple heat consumers. However, typically the economic viability of district heating is usually optimised when networks are implemented within high density urban or industrialised areas. Installing a district heating network is a major capital investment. The cost depends on the number of buildings, their proximity and how much heat they require. For example the network cost per dwelling for a block of flats would be substantially less than that for lower density housing development requiring individual network connections to each dwelling.

Heat demand density is a key parameter when considering district heating feasibility. Network cost should be minimised whilst maximising the flow of energy - and hence revenue - through the pipes. Ideal loads for district heating would offer one point of connection, require a continuous supply of heat, be located close to the heat source and carry little risk ie, it is likely to be present for the entire life of the district heating scheme. Loads would also ideally require Low Temperature Hot Water, thus ensuring minimum distribution heat losses. In addition to individual large loads, areas of high building density should be targeted.

- District Heating areas are typically city or town centre locations where several large buildings such as hotels, shopping centres and office blocks exist in close proximity to each other.
- Areas of high building - and therefore heat – density will typically require less district heating infrastructure than an area of low building density. Consequently these areas will typically have a lower capital cost than low density areas and hence prove to be required, with residential heat loads being seasonally dependant.
- Additional complexities arise through heat metering and billing issues. Building ownership/occupation is also considered important. Buildings owned by Councils, social landlords and Governmental organisations are often more likely to connect to a scheme and have a longer term presence than commercial customers.
- In order to minimise risk and develop a financially viable scheme, a general strategy for developing a district heating scheme would be needed. This would need to secure the connection of a single or small number of large anchor loads within close proximity to the heat plant. Ideally a small, manageable number of anchor loads would be identified rather than managing several smaller loads which would incur more time, resources and cost. Once an anchor load has been established other large singular point loads should be targeted together with areas of higher building density.
- Although district heating schemes can have primary distribution mains often totalling many kilometres, the distance between loads is rarely more than a few hundred meters. It is therefore important to identify pipe routes which run close to potential heat loads.
- Areas of change can offer opportunities to integrate district heating between new development and the established built environment. Heat mapping should therefore seek to factor new development and interventions such as programmes for the retrofitting of existing buildings wherever possible to understand current and future demand.
- New build and retrofitting programmes involve dispersed and fragmented sites / buildings coming forward over time are likely to have a negative impact on the commercial viability of networks.

3.8 Energy Options for District Heating

A feasibility and viability assessment of CHP /district heating schemes, should consider a number of energy options. For CHP/ district heating the options likely to be considered will include:

- Biomass and gas fired CHP supplying district heating (including Private Wire options for electricity).
- Biogas (from waste) powered CHP supplying district heating (including Private Wire options for electricity).
- Biomass heat-only boilers supplying district heating and individual buildings.

3.9 Energy Plant

District heating works by generating heat in a centralised location known as the energy centre, usually from a boiler or a CHP plant. After generation, the heat is distributed to the customer via a network of insulated pipes, referred to below as the associated infrastructure.

The size of the energy demand of a existing and future consumer(s) will dictate the size of the energy plant needed and the potential for expansion of plant as new development and / or consumer join a heat network over time should be a key consideration when planning district heat networks.

The scale and associated impacts, particularly air quality, traffic, and visual impact make energy centres potentially incompatible with many existing land uses. However, to optimise the effectiveness of energy output, proximity to energy customers, in particular for heat, is a key feature of decentralised heating technologies.

3.10 Associated Infrastructure

The heat network route is essentially influenced by the location of the energy centre and energy customer. The associated infrastructure for underground heat distribution typically consists of a pair of buried, pre-insulated pipes for the flow and return of hot water. These might range from 200mm up to 900mm diameters including insulation. In an urban area, these are normally buried at a depth of at least half a metre with the need to avoid congested services a key issue in determining location.

Heating pipes will ideally be positioned to maintain a degree of separation from any adjacent buried services where possible, both for reasons of accessibility and, particularly in the case of high voltage cabling, to ensure any heat losses will not affect existing services. Isolation valves are installed at each branch of the network with manhole access.

3.11 Key Steps for Heat Networks

In order to assess the feasibility of a community energy scenario, the following process must be undertaken.

Stage 1: Briefing Data: Once a potential heat share opportunity has been identified, further data should be gathered on:

- Phasing information, floor areas, and design energy and emission targets of the development, community / plot being assessed.
- Heat sources such as spare heat availability and flue gas heat recovery potential, and connotations of potential heat sources including costs of heat sharing modifications, impact on core business, sale value of property, contractual / tenancy agreements, liabilities and insurances.

Stage 2: Energy Assessment

Demand and Consumption: This is the essential data needed to assess heating demand for each building is the annual heat consumption (kWh /m² / year), peak heat loads (kW), and heating demand profiles. Once this information has been calculated, an accumulated site heat demand profile can be established.

Utilisation of Waste Heat: Flue Gas Heat Recovery or Spare Heat Generation Capacity are considered to be heat sources can be analysed in terms of kW rating and typical hourly operational statistics to find an available heat source profile. The heat source availability profile can then be compared to the heat demand profile to gauge how well they match. Thermal storage can also be integrated when appropriate to increase the compatibility between the two profiles.

Stage 3: Technology Selection: Subsequent to the above findings, plant can be selected to supplement any viable heat share capacity. Typically this technology may include CHP, Biomass Boiler, Gas Fired Boiler and Thermal Storage.

Stage 4: Distribution Infrastructure: Analysis of Infrastructure is required to include an estimation of footprint size and location of an 'energy centre' to house plant and calculations for sizing, connections, cost and route of district heating pipework.

Stage 5: Emissions Assessment: A calculation of the scheme's total CO_2 emissions relating to emission rates associated with specified generation plant configuration and savings in CO_2 emission; Community Heating in comparison to Base Cases.

Stage 6: Economic Assessment: This assessment must be carried out to find a simple payback period, cumulative cashflow and financial sensitivity testing. The most economically viable community heating schemes are those with a high demand density and a stable heating requirement throughout the day.

3.12 Heat Network Viability

This section provides information and guidance for plan and policy preparation matters when considering district heating schemes in LCR. All the LPAs in LCR are developing new plans and policies as part of their Local Development Frameworks (LDF). Discussions with local authorities identified a number of issues that needed to be addressed when considering plan and policy preparation.

Technical Options

- General data gathering on land ownership, buildings occupancy and tenure, energy consumption.
- Consideration of plant options including energy profiles, fuels, energy tariffs, waste streams for EfW technology preferences.
- Opportunities for dual renewable capability (fuel processing and use).
- Emissions factors related to heat and power for consumer Carbon Reduction Commitment (CRC) and Emissions Trading Schemes (ETS) and Climate Change Agreement (CAA) accounting.
- Potential for heat network capacity expansion plan options.

Costs / Funding / Finance

- Capital and operation.
- Public and Private funding suitability.
- Appropriate / inappropriate financial models.
- Main opportunities for influencing and gaining revenue income.
- Freeholder benefits.
- Financial sector contribution (banks, investors, pension funds etc).

Risks

- To local authorities leading/facilitating a major project.
- Consumer and commercial sensitivities.
- Dealing with political and other key risks such as wider economic and finance conditions.

Utilities

- Identification of role of utilities companies.
- Advantage / disadvantage of introducing new companies.

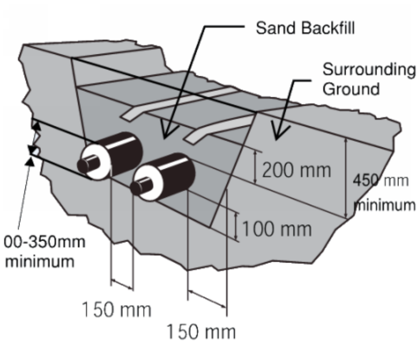


Figure 4: A Typical Cross Section of a District Heating Pipe Network

Financial Viability Indicators

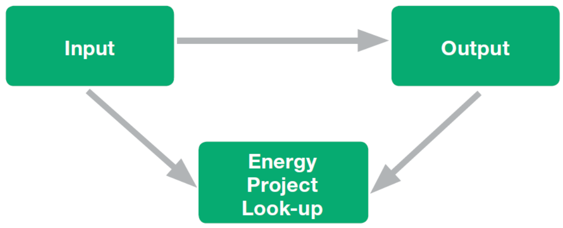
There are a wide range of factors taken into consideration when testing the commercial viability of options. A summary of the typical factors considered when considering the viability of a district heating option is provided below.

- Capital Expenditure (Capex) is the capital used by a company to upgrade a company's physical assets. This upgrade will allow companies to maintain or increase their scope of operations. The investment in capital expenditure can be in property, equipment, buildings or maintenance of existing assets.
- Internal Rate of Return (IRR): is the discount rate used in capital budgeting, which makes the net present value of all cash flows from a particular project equal to zero. It can be used to measure, compare and rank the profitability of investments, and in general, the higher the projects IRR, the more desirable it is to undertake the project.
- Operational Expenditure (Opex): is the financial ongoing cost of running a project, business or process. Opex is expenditure a business incurs due to normal business running operations. The Opex is the costs incurred following the initial capital expenditure (capex) or capital cost.
- Simple Payback: Simple payback is a useful way for comparing the range of types of schemes sizes. The measure has limitations and is indicative only and does not represent the actual payback period. In order to identify the actual payback detailed analysis will be required is required. Simple Payback represents the capital cost divided by first year operating margins.
- Net Present Value: In finance the net present value (NPV) of a time series of cash flows, both incoming and outgoing, is defined as the sum of the present values (PVs) of the individual cash flows. NPV provides an indicator of what the 'worth' of scheme is and the value that can be attached to that scheme. An NPV that is negative indicates that further subsidy would be needed to make the scheme operational.

A number of viability tools have been developed to assist local authorities undertake pre-feasibility analysis of district heat networks. Details of these tools are set out in Appendix D.

Viability Tools

There are a increasing number of tools available to provide an pre-feasibility level of understanding of whether a CHP / heat network is feasible and viable. A number of these tools are presented in Appendix A.



As part of the LCR Renewable Energy Capacity Study Stage 2 Report, a viability assessment tool has been developed to assist each LCR local planning authority consider potential for low and zero carbon energy generation associated with new development proposals.

The tool consists of three key components:

1. Planning Application 'Input';
2. Priority Zone Reference Energy Project Look-up; and
3. 'Output' Summary.

The tool provides an enhanced filtering process for developments that planning officers can use.

The tool uses a combination of bespoke input development figures and relevant characteristics, alongside previously derived financial characteristics (e.g. plant-specific CAPEX (capital expenditure) and operation and maintenance (O&M) cost levels).

The Stage 2 Report recommends that LCR develops the viability tool further as an online tool.

Section 4 Heat & Energy Mapping

4.1 Introduction

The planning system provides the framework whereby development is managed and delivered. The emerging planning policy frameworks across LCR will need to set out a clear direction for achieving low carbon development and the creation of the necessary supporting energy infrastructure.

This section discusses a range of issues when planning for district heating at a strategic level. Further Detail on heat mapping methodologies used for other areas in the UK is provided in Appendix C.

Figure 5 provides an overview of the key steps for planning and delivering energy infrastructure. The content of this section covers topics that would typically be addressed at the Energy masterplanning, strategy and policy and development management stages of the diagram.

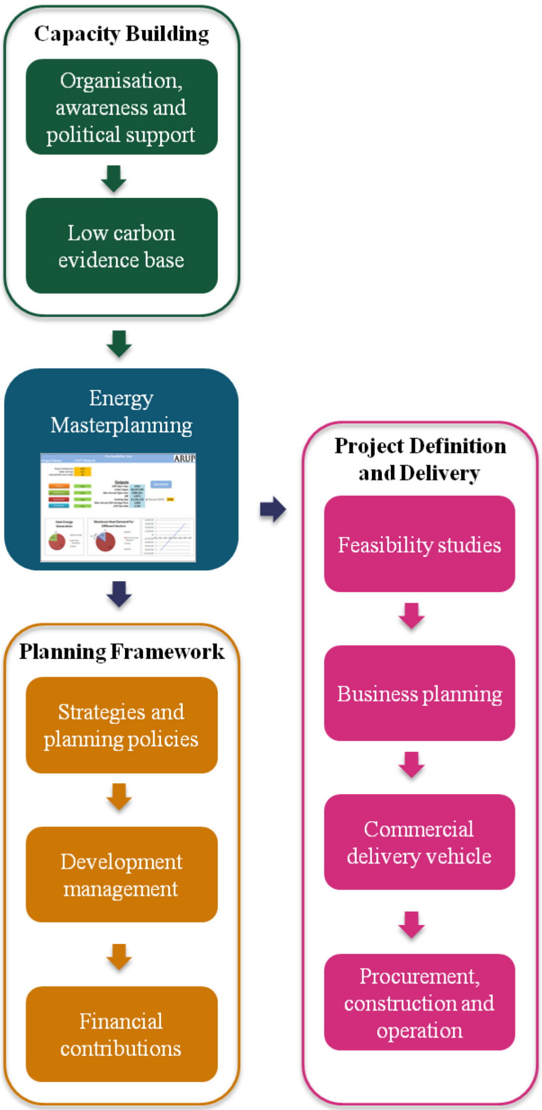


Figure 5: Summary of Energy Project Key Stages

4.2 Identifying Opportunities and Locations

A DPD / SPD should provide a tool for developers and planners that informs the planning process and provides a starting point for negotiating developer contributions that would support the delivery of district heating schemes.

A DPD could present the areas where infrastructure can be installed. With respect to district heating there are opportunities to integrate the established / existing with new development and therefore where proposed development sites are identified in a DPD.

Consideration should be made as to whether district heating could provide energy to that site but also connect areas of new development and the established built environment. It should also indicate where technology options will require a planning permission and where permitted development rights remove the need for planning consents.

4.3 The Approach in LCR

A baseline heat energy assessment has already been developed for the Liverpool City Region through the delivery of the LCR Renewable Energy Renewable Energy Study Stage 1 and 2 Reports. This baseline provides the starting point for developing more detailed and targeted analysis over the plan period of a DPD.

For the Liverpool City Region Stage 1 and 2 studies heat mapping has been done on a grid square scale using information from the UK's National Atmospheric Emissions Inventory (NAEI). Use of NAEI is a more precise method than using utility energy consumption information at a post code scale. The mapping undertaken presents 1km² grid squares presented in a range of shades.

The darkest squares were investigated to see where the demand came from, and how big the demand load was. This work provided strategic direction identifying the most likely areas for potential district heating schemes. This potential was investigated further in the Stage 2 study.

The study identified 10 priority zones could deliver district heating (primarily CHP but other low and zero carbon energy technologies) also have the potential to contribute to energy delivery in these and other areas. Further site specific investigation was then recommended into the feasibility and viability of these zones and identification for further opportunities for district heating.

More detailed analysis was carried out as part of the Mechanisms to Deliver Resilient Energy Infrastructure study. This study identified a total of 12 projects across the LCR amounting to over £200 million of capital investment. The projects were identified to have the capacity to generate 79,000 MWh of electricity and 280,000 MWh of heat and 119,000 tonnes of CO_2 savings annually. The study also identified a business case for the LCR capital programme with an attractive internal rate of return of 10%.

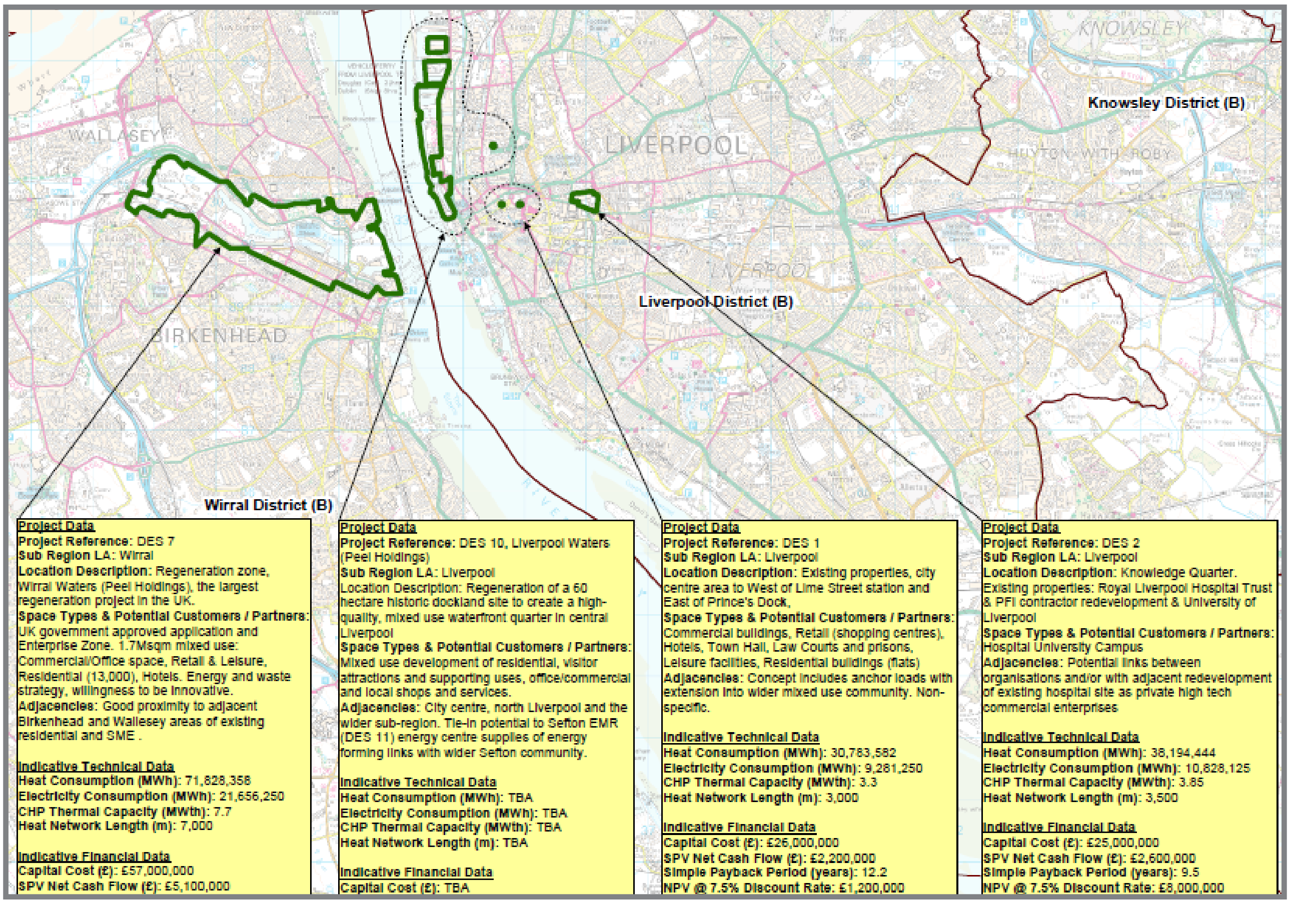


Figure 6: Extract of Analysis for District Heating Areas in LCR. Source: Mechanisms to Deliver Energy Infrastructure Report

4.4 Considering Detailed Heat Mapping

There are several options that can build on the heat mapping undertaken in LCR to date. Each option is based on modelling space and water heating demand of individual buildings - rather than analysis of grid squares - that are connected to heat distribution networks. The advantages of an individual building assessment approach are:

- The creation of significantly more geographically detailed local heat maps (grid based approaches have limitations as the break down as the map resolution approaches the scale of the grid squares).
- A finer individual building and sectoral breakdown of heat demand than that used for the Stage 1 & 2 studies heat map.
- Incorporation of locally collected energy demand data within a single address-level data structure
- Analysis of dataset(s) that lists building addresses in defined areas.
- Sorted in order of heat demand, and used as a shortlist for identifying actual and potential high users of heat.

This approach provides the opportunity to focus on much more defined / local areas, and use development plans and information on individual projects to prioritise and direct more detailed analysis. The main issue for each local authority will be the need to target its skills and resources at the appropriate level.

4.5 Using GIS for Heat Mapping

A Heat Map is a Geographic Information System (GIS) tool which layers and links information on a wide number of issues to inform planning decisions. The information needed to be covered for a heat map includes:

- Energy Demand – such as domestic, commercial and industrial heating
- Energy Supply – such as “waste” industrial heat, biomass fuel sources, technology providers, existing infrastructure
- Opportunities/ Constraints – such as locations of major energy loads, development opportunities, existing infrastructure flood zones etc.

Spatial information can be complemented through the development of GIS tools that query / interrogate the datasets used in the GIS. This allows the Heat Map to be used to inform the planning policy, site allocation and planning decisions during the development control / management stages.

GIS can be used to understand the impacts of different development scenarios in terms of energy consumption / demand for different scales, locations and mixes of uses and identifying suitable locations for renewable heat opportunities and the deployment of energy plant and heat distribution infrastructure.

More detailed information on using GIS for heat mapping is provided in Appendix C.

4.6 Developing Energy Maps

A key tool that should be developed by local authorities and / or the City Region is a Decentralised Energy Map (DeMAP).

The primary purpose of a DeMAP would be to map and present all existing and planned district heating networks across the City Region. The mapping should include:

- Categorisation of built environment typologies.
- Mapping of strategic development areas in accordance with the Core Strategy Key Diagrams, Allocations DPD, SPDs and master plans.
- Indication of where future windfall sites and areas suitable for retrofitting could occur.
- Mapping of buildings / estates in terms of need for future retrofit and upgrading / replacement of energy infrastructure such as boilers.
- Land value information and indications and categorisation of areas in terms of discount rates for financing energy projects.
- The development of a DeMap would ensure LDFs are informed and can adapt to other proposed district heating network development emerging in surrounding areas, which may trigger a district heating network being considered in the future.
- A DeMAP should be accessible to stakeholders and allow them to identify the proximity of district heating networks to a proposed development site / area. Each mapped network would include supporting information such as:
  - The age and operational status of the network.
  - Whether a technical feasibility and economic viability assessment has been undertaken.
  - Where a feasibility study has been undertaken present the key findings in terms of technical feasibility and economic viability.

4.7 Data Gathering and Analysis

The Heat Map GIS model should be based on the following key types of information: •

- Address locations and site / property boundaries.
- Property and occupancy details including building use, gross floorspace, heating system type, operating hours, length and type of tenure.
- Energy consumption details for public and private buildings (gas and electricity) - preferably metered readings, ideally being half hourly metering, utility tariffs.

Potential sources for this information include:

- Proposed development from sources such as Strategic Housing Land Availability Assessments (SHLAA), Employment Land Reviews, masterplans, development briefs, planning applications.
- (Local) National Land and Property Gazetteer VOA commercial floorspace database.
- Town Centre Intelligence.
- ONS Annual Business Inquiry and Business Rates data.
- Residata Classification of residential address types.
- House Stock Condition Surveys.

Other sources and types of data for analysis and benchmarking include:

- Expenditure, Food Survey, Fuel Poverty data.
- CIBSE Guide F Floorspace heat demand benchmarks.
- Average energy consumption for employer uses and employees derived from DECC statistics.
- Employment Land Density such as the HCA's Employment Densities Guide (2nd Edition, 2010).

For further information on data requirement see Appendix C, which provides guidance on typical data sources and Appendix D which provides links to further guidance, tools and data sources.

Section 5 Planning Documents

5.1 Future Proofing for Heat Networks

DPD / SPDs should consider planning policy and / or guidance on how to 'future proof' development proposals. Future proofing would ensure that future district heating development and connections are possible, should the option become viable in the future. It is anticipated that this would consider:

- Protecting existing and new highways where a network connection could be achieved in the future.
- Ensuring that all buildings (residential and commercial) are designed with additional capacity to ensure connection to energy infrastructure in the future. For example additional 'expansion' room is designed for pipes, valve heads, additional boilers and heat exchanges can be retrofitted in the future. This would be based on the scenarios whereby the capital cost of infrastructure reduces significantly and / or the price of the existing energy sources become unviable.
- Preparing Local Development Orders to ensure more effective delivery of networks.
- Identifying where other infrastructure (eg, utilities, transport and Green Infrastructure) could be a constraint to making a connection.
- Planning wayleaves for servicing infrastructure.

For the planning and identification of sites for energy plant, it is essential that proper appraisal and management of impacts is undertaken. For plan and policy making, this means creating a supportive framework that ensures planning does not become a barrier to the delivery of generation plant. This could include the identification and allocation of sites specifically for the development of energy centres / plant in DPDs (eg, through the consideration of sites identified in the National Land Use Database (NLUD), areas with existing or future employment land allocations in development plans as part of the Employment Land Review process).

Each LPA would need to provide specific guidance on how it would deal with applications for energy plant ie, the type and scale of plant and the potential for adaptation and extension of plant over time.

This could include identification of suitable sites in a DPD that can be linked to heat networks and guidance on how to secure planning consent for what can be challenging development proposals.

Such advice may be provided by the LPA through specific technical guidance for use by planning officers and applicants alike such as an SPD or a more informal guidance note. Key planning issues for energy plant development are presented in Figure 7.

5.2 Developing 'Living Documents'

A DPD / SPD will require a monitoring framework. This should measure the deployment of energy infrastructure at all stages of the planning process including post planning permission.

A DPD/ SPD should be supported by monitoring framework which would consider a number of indicators including:

- Energy consumption /demand.
- Capital cost and funding options for energy infrastructure.
- Changes to land values and development costs.
- Masterplans, outline and detailed planning applications and revisions to planning conditions.
- Changes to specifications of refurbishment / retrofit programmes for existing sites and buildings.
- Energy infrastructure capacity of utility networks.

5.3 Considering Local Development Orders

Permitted development rights under the General Development Procedure Order (GDPO) 1995 are set at the national level. Local Development Orders (LDO) is an extension of permitted development and can be applied to all or part of the land that makes up a Local Planning Authority (LPA). The geographic / land coverage and level of detail of an LDO is at the discretion of the LPA, The scale and nature of an LDO is decided upon locally in response to local circumstances.

Circular 01/2006 provides the guidance on changes to the development control system implemented by the commencement of provisions in the Planning and Compulsory Purchase Act 2004 and changes to the General Development Procedure Order (GDPO) 1995. The Circular states that an LDO can only be made to implement policy contained in a development plan document or in a local development plan. However, Section 188 of the Planning Act 2008 removes the need for LDOs to be linked to development plan policy.

Certainty plays a major role in what LDO is prepared. An LPA can develop an LDO at different levels of detail and geographic coverage providing an LPA with a tool to control the type and number of planning applications submitted in an area. This approach provides flexibility for LPAs to attract and engage developers without being overly prescriptive ie, whereby a developer decides that a detailed LDO is not considered suitable for the scale and type of development they proposed and therefore opts not to use the LDO and instead prepares and submits a planning application meeting their preferred requirements.

From a planning consents perspective, hot water pipes for heating will require planning permission. They do not have permitted development rights under the Town and Country Planning Act General Permitted Development Order 2005 (GPDO). Whilst the GPDO does provide rights to other types of utility infrastructure, such as for gas and water, the Order does not specify any particular rights for hot water used for the purposes of heating. Class E of Part 17 of the GPDO

Planning Consideration	Key Issue
Overall land area: Any potential building(s) or site(s) would need to be large enough to house the required plant to service the energy scheme. Land area requirements depend on the load served and heating technology selected. External space would be needed for thermal storage, access for fuel delivery, maintenance and miscellaneous equipment delivery must be included. The site area required for fuel handling/storage can vary depending on the type of fuel required.	Finding large enough sites in the correct location will be a key planning consideration of any sequential suitability test for a site. Need to review potential sites in the context of other strategic site searches, for example for new housing or retailing sustainable locations.
Proximity of the site to demand locations: Ideally any potential energy centres would be located amongst or as close to the heat consumers as possible. Whilst larger schemes may be able to bear the cost of pipe length to transfer heat from a remote production facility to the load centre, any significant distance weakens the economics of the scheme. Proximity of a significant electricity consumer that could be directly supplied in case of CHP plant can also improve scheme economics.	Proximity will be the key consideration for project viability.
Vehicular access to the site: The requirement for access depends on the technology/fuel type. As a minimum 24 hour access to the site will be required, with heavy plant access during construction, and periodically throughout the life of the plant. Miscellaneous deliveries of goods will also be required. Additional access requirements arise for biomass based fuels. These requirements could amounts of vehicle movements a day / week. If additional or alternative access could be via rail or shipping eg, sites in port locations then this could significantly reduce movements.	Where heavy vehicular activity takes place, it can be assumed that proposals will be unsuitable in populated areas that would be affected by 24 hour movements. However this will be investigated to determine whether it can be conducted in programmed manner. Transport access will be a considered in detail for the shortlisted sites.
Availability of utilities on/in proximity to the site: Ideally the site or building shall already have utility connections in place. Gas, water, sewerage and electricity connections would preferably be in place or the site should be close to existing main utility distribution networks to allow easy and low cost connection.	Utilities provision will be a consideration for the shortlisted sites.
Ability to erect buildings to house plant, with necessary permits and consents: The energy centre site will be a continuously operating industrial facility. Suitable sites would have to accommodate this. The facility is likely to include: vehicular access (see above) including parking and delivery space and potentially weighbridge facilities; buildings that house plant, a small amount of office space, and welfare amenities; and external thermal stores. The site will also require a flue.	Key impact appraisal considerations will include: • NO2 and PM10 emissions – higher NO2 emissions in particular can trigger local Air Quality Management thresholds requiring mitigation measures such as higher chimney stack and fluoride controls, and additional approval under the Clean Air Act (1993). • Particulate emissions – pollution control equipment and stack height may need to be specified to meet the Council's requirements. • Amenity impacts on neighbours – factors include design of building; noise; vehicle movements. • Environmental – biodiversity local, national and international designations; and statutory heritage assets. • Ground conditions including contamination and presence of water. • Utilities provision will be a consideration for shortlisted sites.

Figure 7: Summary of Key Issues for Energy Plant Development

does make allowances in relation to water, however it relates specifically to the supply of water thereby ruling out circulation of hot water for the supply of heat.

Unlike energy centres, which can be particularly complex and have varied and significant impacts, the associated hot water pipe networks can be considered to be relatively straight forward in planning terms. Following construction, underground networks will have no or limited visual or land use capacity impact. The opportunity therefore to take advantage of local authority powers to extend permitted development rights to create Local Development Orders (LDO) should therefore be considered. In particular as such powers can help to overcome barriers to efficient delivery of successful decentralised energy projects including:

- Limiting of investor certainty given the risk associated with the planning consents process;
- Localised objections to disturbance created by excavations and construction work and also linked to wider objections to energy centres that could generate extensive delays;
- Duplication of impacts management during the construction phase;
- Costly and repetitive applications for associated infrastructure generating limited (potentially insufficient) application fee income for the local planning authority.

5.4 Developing Energy Statements

Energy statements are often developed together with the building regulation regimes of Code for Sustainable Homes and BREEAM, and where LPAs have energy and carbon policies and targets. An Energy Statement could include:

- Policy Review: Provide a brief review of the key policy issues for the proposed development in the LPA setting out relevant energy and CO_2 specific targets.
- Development Profile: Provide a profile of the proposed development and its phasing.
- Analysis of Energy Demand and Consumption: Provide analysis of the estimated total energy (heat and electricity) consumption for the proposed development and set out the energy requirement of any policy target set. When estimating energy consumption a statement should:
    - Provide energy consumption figures (electricity and heat) in kWh/m² per annum for different building types.
    - Clearly set out the assumptions used to calculate the amount of energy consumed for heating and electricity by different space types.
    - Where possible ensure that energy calculations use performance indicators from a variety of sources. Benchmarking should use data from sources such as DECC, Chartered Institute of Building Service Engineers (CIBSE) and Building Services Research and Information Association (BSRIA) guidelines.
    - Present separate consumption figures in terms of total electricity and heat requirements per annum and a combined total.
- Present Energy Options: The statement should set out the energy options ie, building integrated and distributed energy options for the proposed development. Each option should provide details on the amount of infrastructure needed to meet the relevant energy / CO_2 target (eg, for district heating this would mean details such as the size of the energy centre and concept designs for the pipeline networks). It should also provide an assessment of the suitability of the energy option(s) in terms of financial viability and also physical compatibility for the development.
- Next Steps: The statement should provide guidance on how (if any) energy infrastructure will be delivered as part of the development, for example:
    - In an outline planning application the statement could present the steps needed to be considered at the detailed planning application stage such as more detailed energy assessment of building types at the detailed design stage.
    - If it is a detailed planning application evidence to inform planning conditions and S106 agreements.

5.5 Energy Strategies

For longer term, major applications an energy strategy should be developed at the beginning of the master planning process. This should include an examination of the targets that should be achieved in terms of energy performance and the contribution of low or zero carbon technologies. The strategy should also include a screening of likely technologies and management options to deliver the strategy. This can then be considered in more detail once a proposals reaches more detailed outline / detailed planning stage. At this point the main task would be to complete a feasibility study to identify a short list of options that may be further examined during the detailed design stages of the development project.

5.6 Energy and Carbon Profiling

A Development Plan Document (DPD) / Supplementary Plan Document (SPD) should be prepared with an understanding of the energy demand and consumption implications of new development and its capacity and suitability to integrate energy infrastructure to meet that energy need.

It will therefore be increasingly important that LDFs are informed baseline information on energy matters. This includes information on building types, infrastructure capacity, energy consumption and CO_2 emissions that should be combined to develop a development profile for an area. An example of types of information a development profile should cover includes:

- Descriptions of the established built environment.
- Identify 'areas of change' in terms of areas to be retained / demolished and new build.
- A schedule that sets out:
  - The development mix and phasing of new development and retrofitting of existing buildings.
  - Floor space and roof space for each use.
  - Proposed phasing and anticipated timescale for the completed development including a risk assessment of phases.
- An energy profile setting out the total energy demand of the completed development(s).
- A CO_2 profile that is informed by an energy profile. This should present the equivalent annual CO_1 emissions from the completed development in terms of a whole development and individual plots, where the development is on a large scale / phased. Where appropriate, CO_2 profiles should also include the CO_2 emissions of established / retained development.

5.7 Calculating Carbon

Calculating CO_2 is also likely to be a future requirement for planning applications and could be included as a requirements of an energy statement. CO_2 emissions factors are used to calculate CO_2

In the UK there are two carbon emissions factors commonly used. These include:

- Carbon Emission Factors used for the National Calculation Methodology which is the Standard Assessment Procedure (SAP). These factors are used to support planning applications.
- DEFRA Carbon Conversion Factors. These factors are often used to calculate carbon for strategies, plan and policies on planning and non planning matters.

Details of these carbon emissions factors are provided in Appendix D. A summary of the methodology for calculating carbon is provided below.

Section 6 Conclusions

Conclusion 1: Looking forward, LPA development management teams will have a central role in dealing with planning applications for the creation of heat networks. As with planning policy there will need to be corporate level support to ensure that the determination of planning applications for proposed schemes are not unnecessarily constrained. A coordinated approach to the resourcing, monitoring and reporting of district heating schemes from strategic planning through to the delivery, operation and maintenance will be required in order maximise the implementation of good CHP/ district heating.

Conclusion 2: LCR will need to fully consider the role and scope of LDOs for improving the deliverability of district heating schemes. LDO can be an effective tool for attracting developers to an area, whilst maintaining control type, scale, mix and phasing of energy infrastructure development. A key resource that should be used for developing an LDO is the Planning Advisory Service (PAS) guidance LDOs and localism - can local development orders contribute to the new planning agenda?

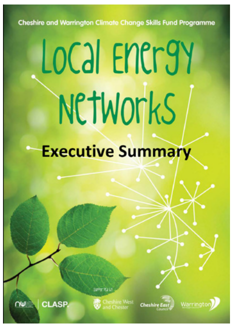
Conclusion 3: There are opportunities to produce more detailed heat mapping across LCR through the development of a GIS model. In doing so, local authorities will need to carefully consider the benefits of this approach against the resource implications it would have on local authority services. One option could be to develop a DeMap for the City Region and use this as a tool to ensure that detailed heat mapping can be undertaken and updated in a consistent way, using shared resources (physical and / or financial).

Conclusions 4: There are existing tools that can and should be used across LCR to inform planning of district heating. This includes the UK CHP Development Map (http://chp.decc.gov.uk/developmentmap) and the heat mapping and District Heating Viability Tool developed as part of the LCR Renewable Energy Capacity Study Stage 2 Report.

Conclusion 5: There remains varying levels of understanding and confidence throughout local authority officers on district heating and energy infrastructure delivery matters. There continues to be a need for learning on this subject area in the short to medium term at all levels of the Council. There are a number of examples of best practice starting to emerge in the City Region such as plans for a second CHP plant for Liverpool University and detailed feasibility work for CHP in Knowsley Industrial Park. These examples provide opportunities for knowledge sharing and joint learning between local authorities.

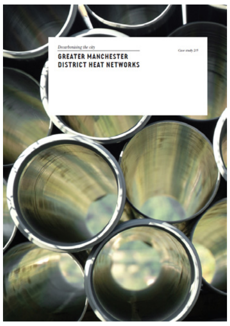
APPENDIX A: USEFUL GUIDANCE, DATA & TOOLS

Heat Network Guidance



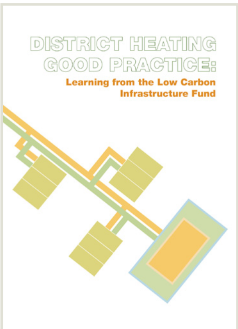
Delivering Local Energy Networks: Cheshire and Warrington recently completed a project to demonstrate a step-by-step approach to delivering energy networks, using real example projects from the area.

http://www.claspinfo.org/cheshire-and-warrington



Greater Manchester District Heating Networks case Study: Greater Manchester has produced a summary document setting out the basic principles and benefits of district heating projects in local authorities.

http://www.claspinfo.org/resources/greater-manchester-district-heat-network



District Heating Good Practice: Learning from the Low Carbon Infrastructure Fund: The HCA has produced a lessons learned report as part of the LCIF programme on how to link housing schemes to new and existing low carbon energy plants.

http://www.homesandcommunities.co.uk/district-heating-good-practice-learning-low-carbon-infrastructure-fund

Local Government Improvement and Development

Compare Renewable This resource provides an overview of eight sustainable energy technologies to help you assess whether they are appropriate for your area.

http://www.idea.gov.uk/idk/core/page.do?pageId=23051802

chpa Bringing Energy Together

Combined Heat & Power Association - The Knowledge Centre: This is intended to serve as a comprehensive resource for people who want to know more about CHP, district heating, energy services and energy issues more generally.

http://www.chpa.co.uk/knowledge-centre_13.html

Data Sources for Planning Heat Networks

The Energy Saving Trust, together with DECC, have developed a database which contains a selection of data sources that have been identified being useful for analysis at local level. Some of these datasets cover the UK as a whole, while some are more specific, at local level.

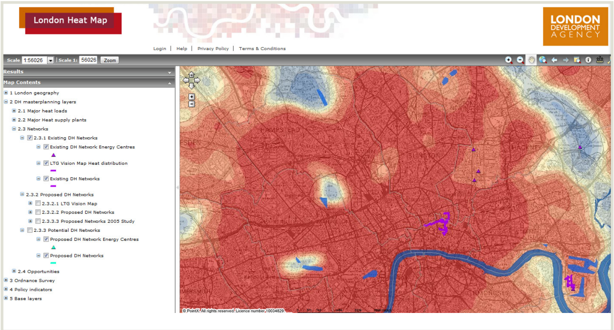
The data, captured in a spreadsheet, cover energy generation, transport, area wide emissions and buildings. The spreadsheet also contains some high level information such as ownership of the data, the latest release, a brief description of the dataset, coverage, type of activity the data can support, limitations, further information and the location on the web.

In summary the relevant data for the planning and analysis of district heating includes:

- Renewable Obligation Certificate (ROC) register
- Low Carbon Network Fund (LCNF)
- CIBSE Guides
- NHS Energy Data Management Service
- Analysis of the UK potential for Combined Heat and Power
- DECC Middle Layer Super Output Area (MLSOA) on Electricity and Gas
- DECC CHP Focus CHP Database
- Restats interactive map and supporting data
- Display Energy Certificate (DEC) Register for all public buildings in England and Wales
- Opportunity Area Planning Frameworks (OAPFs)
- DECC Renewable Energy Assessments

Full details of each data source can be found at: http://www.decc.gov.uk/en/content/cms/statistics/local_auth/other_data/other_data.aspx.

Energy Mapping & Viability Tools



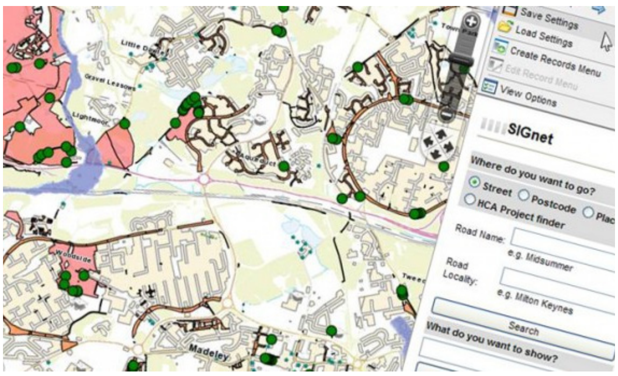
The London Heat Map Tool

The Decentralised Energy and Energy Masterplanning (DEMaP) Programme has been developed to assist both public and private sector to identify Decentralised Energy (DE) opportunities in London. This will contribute towards the Mayor's target of providing 25% of London's energy supply from decentralised energy sources by 2025.

There is currently a lack of information and certainty surrounding London's heat loads. The programme addresses these barriers and enables the market to make informed investment decisions without risking significant development costs.

The Decentralised Energy and Energy Masterplanning (DEMaP) Programme is delivered by the LDA and is divided into two work-streams: Strategic Decentralised Energy Masterplanning and CHP Feasibility Studies. Energy Masterplanning Support Packages to Boroughs

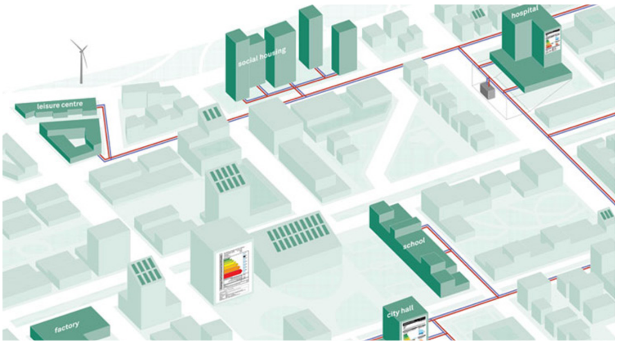
http://www.londonheatmap.org.uk



SIGnet

SIGnet – the Spatial Intelligence Geographic network – is a free resource developed by the HCA to bring together data from organisations such as Ordnance Survey, the Office for National Statistics, Local Authorities, and the Environment Agency in a single place, allowing it to be viewed on a map and printed as plans or spreadsheet tables.

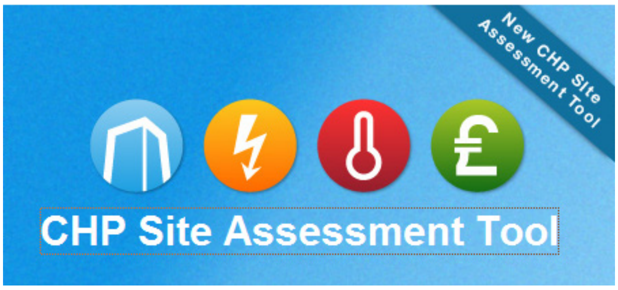
http://www.homesandcommunities.co.uk/news/new-spatial-analysis-tool-launched-hca



DeNet

DeNet is a pre-feasibility stage assessment tool designed to help local authorities and other stakeholders spot the areas that will enjoy the best returns from the installation or extension of a district heating system.

http://www.arup.com/Projects/DENet.aspx



DECC CHP Site Assessment Tool

DECC have produced a free tool allowing users to get an indicative assessment and review potential options for installing CHP on a particular site. The tool has been developed for users that have limited knowledge of CHP. It guides a user through the information required to carry out an indicative assessment showing whether a particular site warrants further investigation into CHP.

For a given site it provides the 5 best options showing their:

1. CHP capacity,
2. Capital cost,
3. Payback period,
4. Net Present Value,
5. Cost savings &
6. Primary energy savings

The site can be accessed at the DECC CHP Focus website: http://chp.decc.gov.uk/cms/

APPENDIX B: GUIDE TO DISTRICT HEATING PRESENTATION

A Guide to District Heating Schemes

Planner Capacity Building Project

4 July 2011

Delivered by: ARUP

- Inform how DPD policies and allocations can be prepared
- Understand the district heating:
  - Technical feasibility
  - Financial viability
  - Barriers / constraints
  - Deliverability
- Ownership of certain aspects in relation to planning and development process

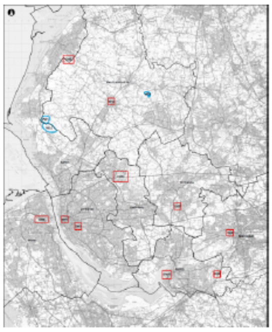
2 Purpose

Context: Planning

- National policy in a state of some transition
- New PPS1 Supplement, expected with. stronger and more direct guidance on how climate change should be addressed in planning policy document
- CHP / district heating is a key part of the carbon reduction agenda

4 Planning policy: Keeping track of a moving target

- LDDs have significant role to play to deliver national commitments to carbon reduction
- Safeguarding areas for development of renewable energy and associated infrastructure
- Identifying opportunities for district heating is key



5 Planning policy: Making sure your plans provide certainty

CLASP. ARUP

- ***Evidence bases:*** Local Development Documents must contain a 'reasoned justification' for policies and allocations
- ***Sustainability Appraisal:*** SAs often fail to address climate change related issues adequately
- ***Compliance with national policy:*** DPD are expected to consistent with national policy
- ***Deliverability and flexibility:*** Key to adoption of targets and identification of significant energy infrastructure projects

6 Planning policy

CLASP. ARUP

Context: Efficient energy generation

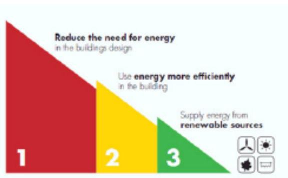
CLASP. ARUP

- CHP plant that does not 'dump' heat into the atmosphere
- Dumping heat reduces the operational efficiency of CHP plant
- "Good quality CHP" is defined in CHPA quality indexing system

8 What is Good Quality CHP?

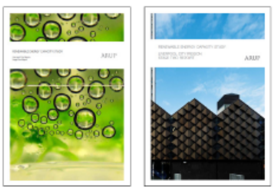
CLASP. ARUP

- Introduction of the Energy Efficiency Directive (EED)
- Replaces the Cogeneration Directive
- Promotes greater efficiency in energy generation
- Identifies district heating as a the default option
- Ideal fit for Liverpool City Region work undertaken to date

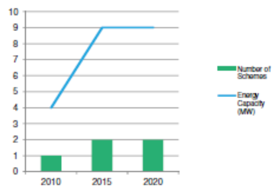


Context: The City Region

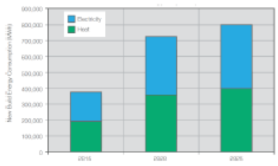
- **Stage 1:** Capacity
- **Stage 2:** Strategic opportunities
- **Stage 3:** Identification of mechanisms for delivering opportunities
- **Stage 4:** SEAP coordinate all energy issues and attract funding / investment



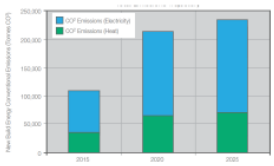
- As at 2009 targets identified:
  - A total of 3 schemes were required generating 9MW by 2020
  - One scheme had been delivered (Mossborough Hall Farm) with capacity of 0.3MW
  - 4 planning applications submitted that could generate up to 27MW.
  - EfW accounted for 5 applications generating over 400MW
- 2010 study identified 14MW of biomass heat capacity in Merseyside
- Stage 2 report identifies 23.2 MW of CHP capacity from 8 Priority Zones



- Understanding of net energy demand and carbon emissions from growth
- Growth projections used to inform analysis of heat loads

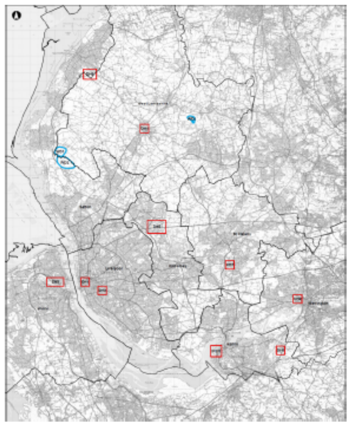


Total Energy Trajectory

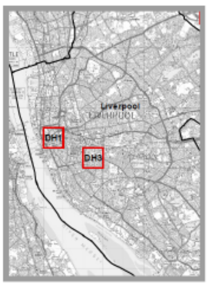


Total Emissions Trajectory

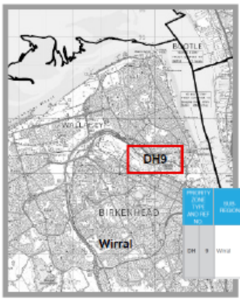
- 10 District Heating priority Zones identified (27.8MW)
- 8 Priority Zones in Merseyside (22.3 MW)



PRIORITY ZONE TYPE AND REF NO.		SUB-REGION	STATUS	LOCATION DESCRIPTION	MIX OR SPACE TYPES - POTENTIAL CUSTOMERS/ PARTNERS	APPROX. VIABLE CHP CAPACITY	POTENTIAL CONSTRAINTS	COMMENTS
DH	6	Knowsley	Emerging	Knowsley Business Park & South of Industrial Park	**Existing** • Commercial buildings • Light Industry **Emerging** • New employment land build out • Energos energy from waste plant	≈ 8 MWe proposed by Energos	• Potential requirement to cross East Lancashire road to access emerging Industrial Park load centres	• Significant benefit offered by the commitment of Energos to install generation plant • Heat availability not necessarily limited by emergence of related demands

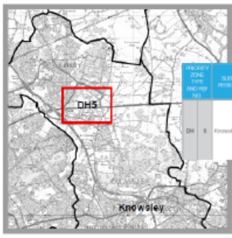


PRIORITY ZONE TYPE AND REF NO.		SUB-REGION	STATUS	LOCATION DESCRIPTION	MIX OR SPACE TYPES - POTENTIAL CUSTOMERS/ PARTNERS	APPROX. VIABLE CHP CAPACITY	POTENTIAL CONSTRAINTS	COMMENTS
DH	1	Liverpool	Existing	City centre area to West of Lime Street station and East of Prince's Dock	• Commercial buildings • Retail (shopping centres) • Hotels • Town Hall • Law Courts and prisons • Leisure facilities • Residential buildings (flats)	≈ 3 MWe	• Likely costs of pipework installation in dense urban area • Mix of land ownership • Built heritage • Air quality	• Any CHP capacity will depend heavily on take-up within identified area • SHLAA plans feature new build-out areas in close proximity to priority zone • Need to identify potential energy centre sites
DH	3	Liverpool	Existing	Royal Liverpool Hospital & University of Liverpool	• Hospital • University Campus	≈ 3.5 MWe	• Requirement to cross Lime Street rail cutting to link to South of University Campus	• Royal Liverpool Hospital represents key anchor load



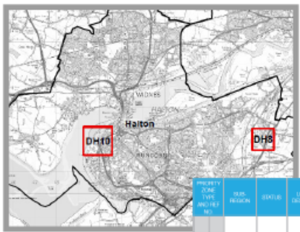
PRIORITY ZONE TYPE AND REF NO.		SUB-REGION	STATUS	LOCATION DESCRIPTION	MIX OR SPACE TYPES - POTENTIAL CUSTOMERS/ PARTNERS	APPROX. VIABLE CHP CAPACITY	POTENTIAL CONSTRAINTS	COMMENTS
DH	9	Wirral	Potential	Wirral Waters	**Planned** • Commercial/Office space • Retail and Leisure • Residential • Hotels	≈ 3.5 MWe	• Extent to which heat network could serve entirety of site could depend on timing and phasing of scheme • Any anchor load(s) would ideally emerge early within scheme build-out	• Potential to size plant against sizeable and mixed heat loads • New-build scheme providing opportunity to introduce DH from the start

17 Strategic Opportunities: Wirral



PRIORITY ZONE TYPE AND REF NO.		SUB-REGION	STATUS	LOCATION DESCRIPTION	MIX OR SPACE TYPES - POTENTIAL CUSTOMERS/ PARTNERS	APPROX. VIABLE CHP CAPACITY	POTENTIAL CONSTRAINTS	COMMENTS
DH	5	Knowsley	Emerging	Knowsley Business Park & South of Industrial Park	**Existing** • Commercial buildings • Light Industry **Emerging** • New employment land build-out • Energos energy from waste plant	≈ 8 MWe proposed by Energos	• Potential requirement to cross East Lancashire road to access emerging Industrial Park load centres	• Significant benefit offered by the commitment of Energos to install generation plant • Heat availability not necessarily limited by emergence of related demands

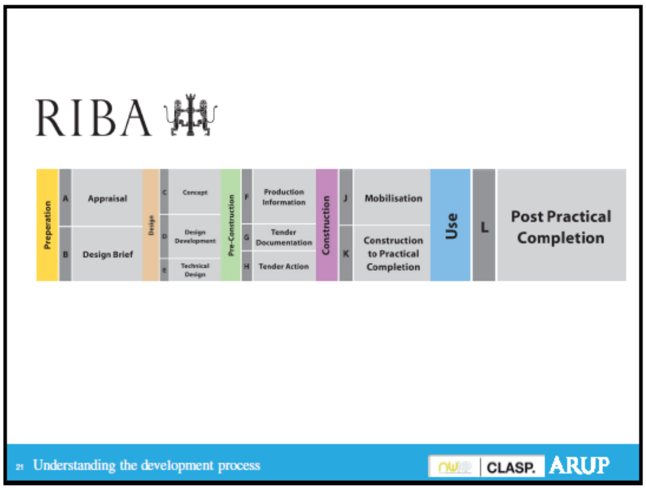
18 Strategic Opportunities: Knowsley

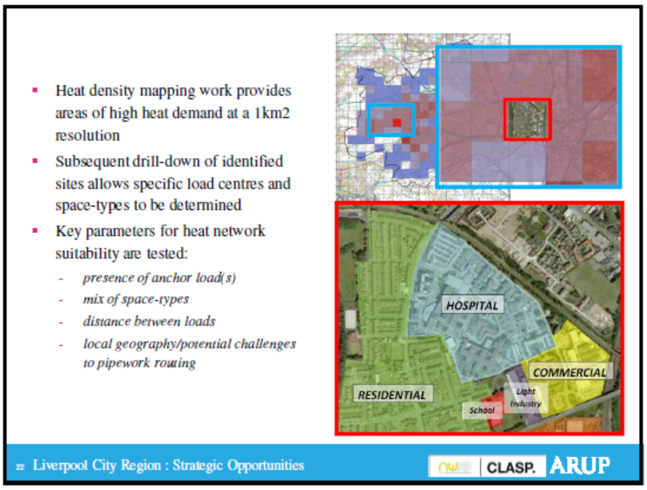


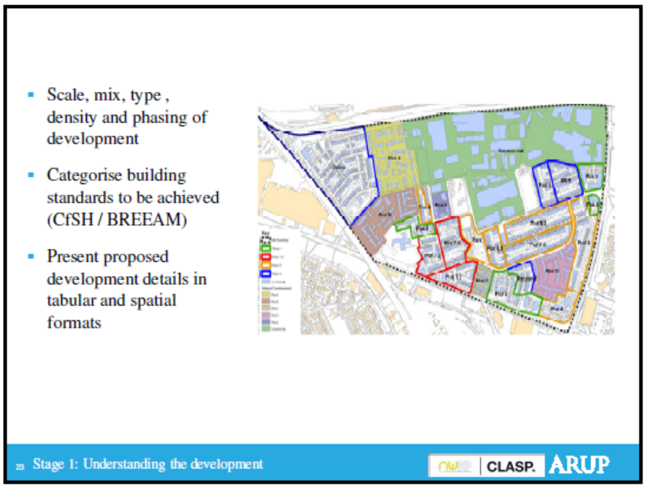
PRIORITY ZONE TYPE AND REF NO.		SUB-REGION	STATUS	LOCATION DESCRIPTION	MIX OR SPACE TYPES - POTENTIAL CUSTOMERS/ PARTNERS	APPROX. VIABLE CHP CAPACITY	POTENTIAL CONSTRAINTS	COMMENTS
DH	8	Halton	Emerging	Green-field area in Daresbury to West of A56	**Existing** • Business Park • Science Park **Emerging** • New employment land built-out • New residential	≈ 0.6 MWe	• Planned build-out area is relatively large at approx 2km in length	• Existing load centres are at either end of planned development area, with feasibility of connection dependent upon new-build elements and precise types • New-build scheme providing opportunity to introduce DH [illegible]
DH	10	Halton	Potential	Runcorn Docks	**Planned** • Large residential area • Likely requirement for complementary non-residential spaces	≈ 0.2-0.7 MWe (based solely on residential build-out of between 1,200-2,000 homes)	• Pure residential would not provide suitable mix to maximise plant size	• Scheme at this scale is likely to require provision of associated additional Community, Commercial and Retail spaces • New-build scheme providing opportunity to introduce DH from the start

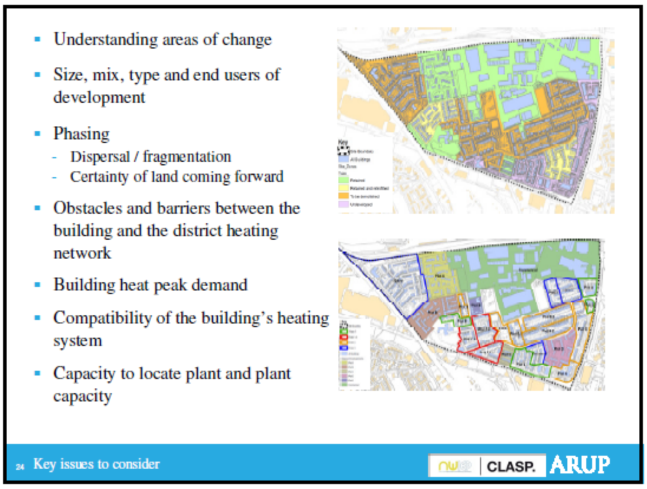
19 Strategic Opportunities: Halton

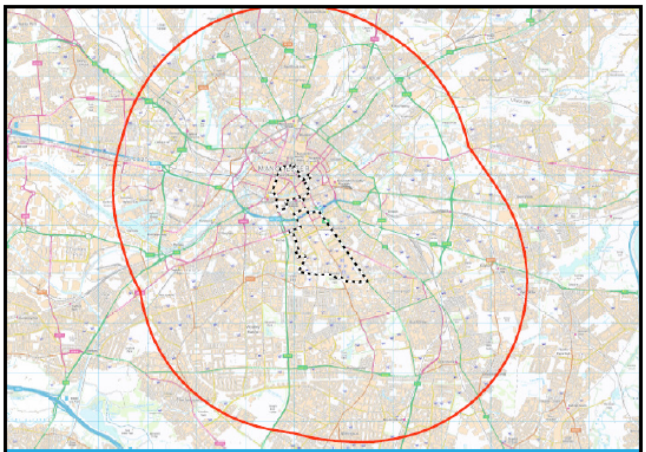
Stage 1: Analysis of areas, sites and buildings


RIBA
Preparation
A Appraisal
B Design Brief
Design
C Concept
D Design Development
E Technical Design
Pre-Construction
F Production Information
G Tender Documentation
H Tender Action
Construction
J Mobilisation
K Construction to Practical Completion
Use
L
Post Practical Completion
21 Understanding the development process
CLASP. ARUP


Heat density mapping work provides areas of high heat demand at a 1km2 resolution
Subsequent drill-down of identified sites allows specific load centres and space-types to be determined
Key parameters for heat network suitability are tested:
- presence of anchor load(s)
- mix of space-types
- distance between loads
- local geography/potential challenges to pipework routing
HOSPITAL
COMMERCIAL
RESIDENTIAL
School
Light Industry
22 Liverpool City Region : Strategic Opportunities
CLASP. ARUP

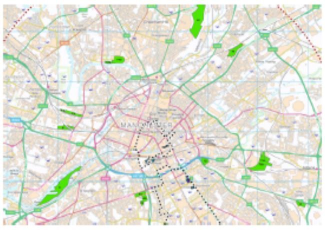

Scale, mix, type, density and phasing of development
Categorise building standards to be achieved (CfSH / BREEAM)
Present proposed development details in tabular and spatial formats
23 Stage 1: Understanding the development
CLASP. ARUP


Understanding areas of change
Size, mix, type and end users of development
Phasing
- Dispersal / fragmentation
- Certainty of land coming forward
Obstacles and barriers between the building and the district heating network
Building heat peak demand
Compatibility of the building's heating system
Capacity to locate plant and plant capacity
24 Key issues to consider
CLASP. ARUP



Cross boundary issues; Connecting networks

- Overall land area
- Proximity of the site to demand locations
- Vehicular access to the site
- Availability of utilities on/in proximity to the site
- Ability to erect buildings to house plant, with necessary permits and consents
- Ground conditions including contamination and presence of water

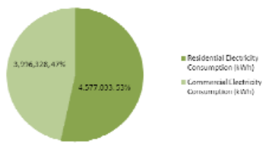


Cross boundary issues: Identifying suitable locations for plant

Stage 2: Energy Consumption & Profiling

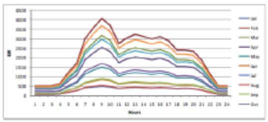
- Types of energy:
  - Grid Electricity
  - Natural Gas
  - Renewables
- Assess plots by development type, size and building standard
- Regulated / unregulated energy

Utility	Energy Consumption		Cost	
	kWh/year	%	£/year	%
Electricity	8,600,000	44%	£930,200	73%
Gas	11,100,000	56%	£338,100	27%
Total Energy	19,700,0000		£1,268,300	

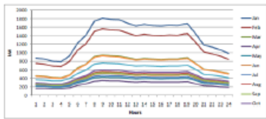


Stage 2: Calculating energy demand / consumption

- Understanding the nature of energy demand ie, electricity and heat demand
- Development of profiles:
  - Total energy consumption
  - Total demand profile
  - Plot / individual building profiling
  - Assessment across the year
- Profiles used to identify energy peak requirements.
- Provide indication of size of plant needed to meet estimated demand



Heat Demand Profile of a Town Hall Complex



Heat Demand Profile of a Hotel

29 Understanding energy profiles

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Assessing District Heat Options

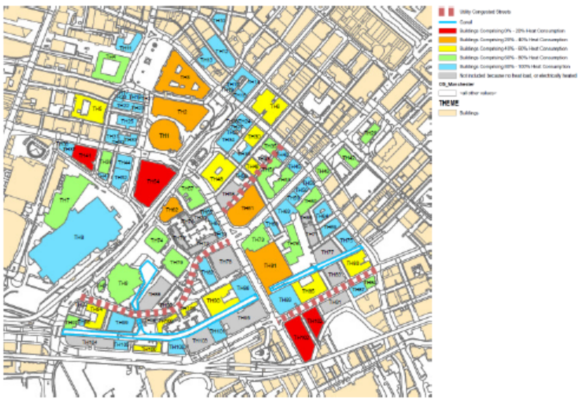
ARUP

- First step towards to detailed design of CHP / District Heating
- Identifying sites and buildings and building users
- Significant stakeholders engagement required
- Collection of detailed metered energy information
- Accuracy of data is very important to understand business case

Ref	Heat Consumption (kWh/year)	Electricity Consumption (kWh/year)
TH1	5,280,061	4,284,089
TH2		3,072,061
TH3	4,611,399	1,711,968
TH4	1,450,372	1,154,767
TH6	1,776,281	2,479,697
TH9	1,202,888	2,271,131
TH54	4,947,097	4,278,734

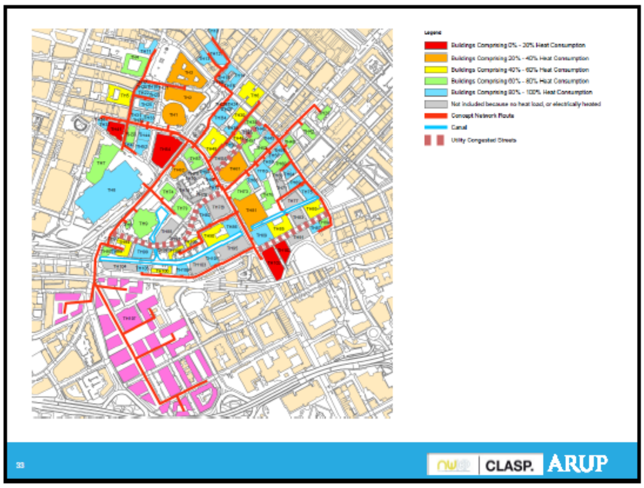
31 Identifying clusters

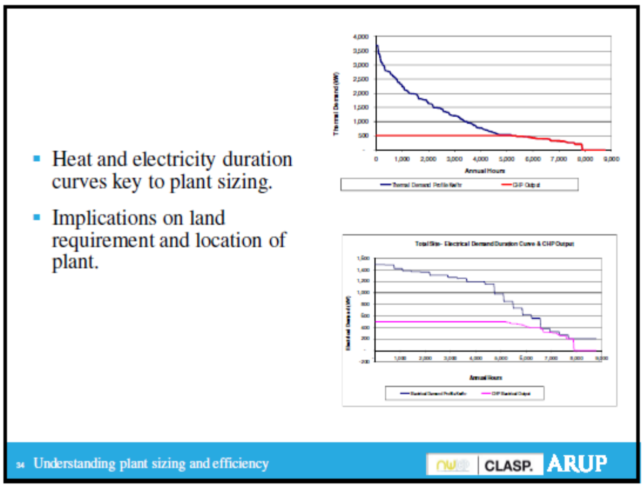
CLASP. ARUP



32 Data sources

CLASP. ARUP


Legend
Buildings Comprising 0% - 20% Heat Consumption
Buildings Comprising 20% - 40% Heat Consumption
Buildings Comprising 40% - 60% Heat Consumption
Buildings Comprising 60% - 80% Heat Consumption
Buildings Comprising 80% - 100% Heat Consumption
Not included because no heat load, or electrically heated
Concept Network Route
Canal
Utility Congested Streets
33
CLASP.
ARUP


Heat and electricity duration curves key to plant sizing.
Implications on land requirement and location of plant.
Annual Hours
34 Understanding plant sizing and efficiency
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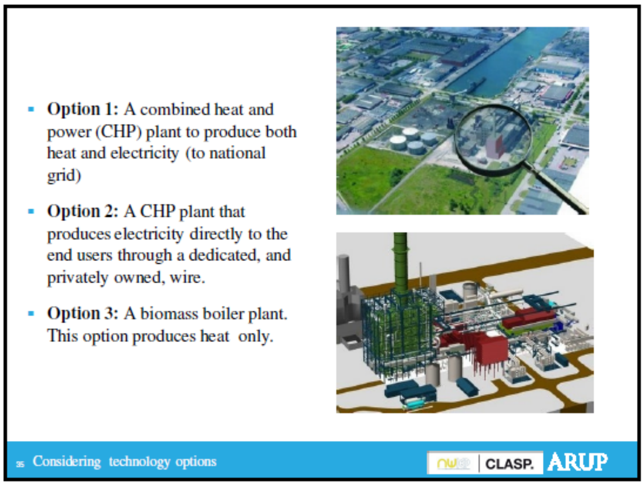
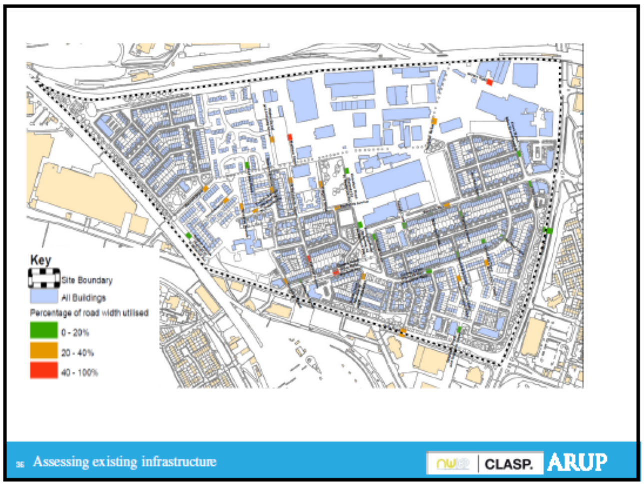
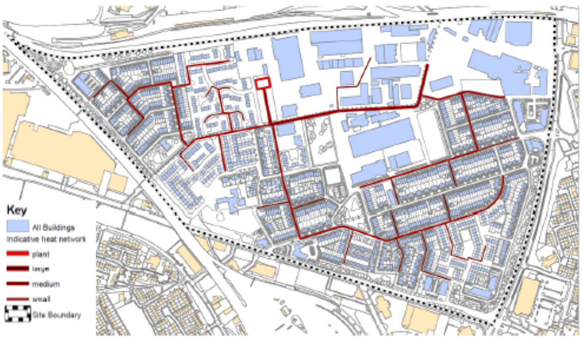
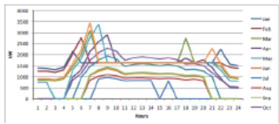
ARUP


Option 1: A combined heat and power (CHP) plant to produce both heat and electricity (to national grid)
Option 2: A CHP plant that produces electricity directly to the end users through a dedicated, and privately owned, wire.
Option 3: A biomass boiler plant. This option produces heat only.
35 Considering technology options
CLASP.
ARUP

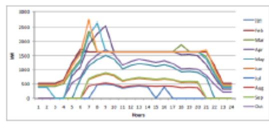

Key
Site Boundary
All Buildings
Percentage of road width utilised
0 - 20%
20 - 40%
40 - 100%
36 Assessing existing infrastructure
CLASP.
ARUP



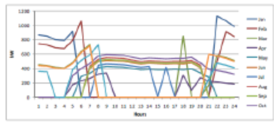
37 Planning for networks



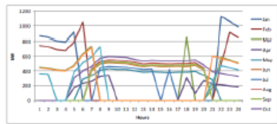
Profile of how the CHP and thermal store deliver heat to the buildings opposite:



This graph shows much of the heat generated by the CHP is used by the Town Hall complex.



Graph shows the remaining available heat after the Council use what they can.



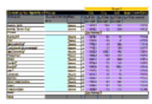
Graph shows that all the remaining available heat can be used by the hotel according to their demand profile. This is due to how the CHP is operating in accordance to the combined heat demand of all the buildings connected. In the model, no surplus heat is generated by the CHP.

38 Example of Assessing CHP Generation Capacity

Stage 4: Calculating Carbon

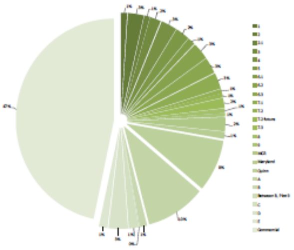
- National Calculation Methodology - Standard Assessment Procedure (SAP)
- Other sources DEFRA / Carbon Trust

SAP



40 Stage 3: Calculating carbon emissions

- Uses calculations for electricity and thermal demand.
- Two ways of calculating for developments:
    1. Based on energy efficiency standard of building only. CO_2 produced through the conversion of fuel to electricity and heat
    2. Taking full account of building standards and the 'offsetting' through energy infrastructure that will be required to meet standards
- Assess at individual plots levels in addition to overall development



41 Calculating Carbon

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Stage 5: Deliverability and Viability

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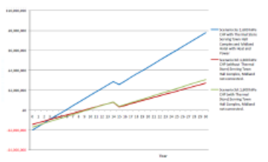
- Simple Payback
- Net Present Value
- Internal Rate of Return
- Other measures:
    - Discount factor
    - Cost of connecting buildings to the heat network
    - Cost of the heat network
    - Biomass and Gas Fuel Price
    - Electricity price

Economic Viability Ranking	Scenario	CHP Capacity (kWe)	Capital Cost (£)	Simple Annual Cash Flow (£/year)	Simple Payback (years)
1	Scenario 3a with thermal storage	1,600	£1,954,000	£293,000	6.7
2	Scenario 3b with thermal storage	1,600	£1,954,000	£183,000	10.7
3	Scenario 3a without thermal storage	1,600	£1,823,000	£146,000	12.5
4	Scenario 2 with thermal storage	2,000	£3,632,000	£290,000	12.5
5	Scenario 3b without thermal storage	1,600	£1,823,000	£138,000	13.2
6	Scenario 1a with thermal storage	400	£1,142,000	£80,000	14.3
7	Scenario 1b with thermal storage	400	£1,142,000	£77,000	14.7



43 Performance measures and assumptions

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Connection costs	Cost of heat network	Fuel Costs
Obstacles and barriers between the building and the district heating network	Extension of the district heating network	Market value Length of contract
Compatibility of the building's heating system with the district heating heat supply (temperatures, pressure)	Obstacles and barriers between the buildings and the district heating network	Quantity
Space available in the plant room	Heat peak demand	Operator credit risk
Accessibility to the plant room in the building	Construction risk	Recourse limitations

44 Deliverability and viability

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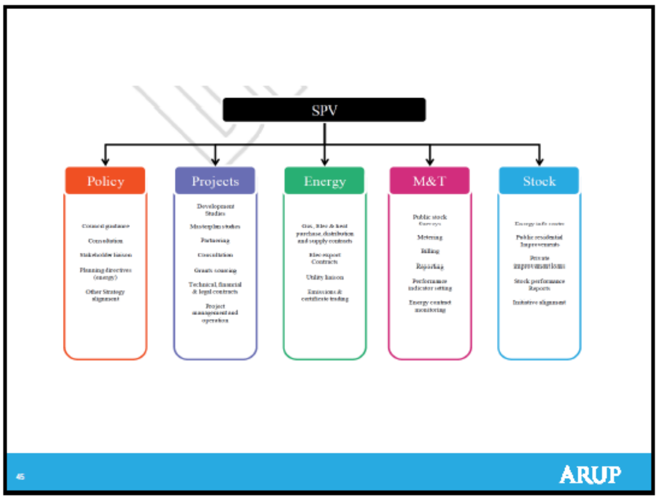
SPV
Policy
Projects
Energy
M&T
Stock
Consultation
Stakeholder liaison
Planning directives (energy)
Other Strategy alignment
Development Studies
Partnering
Consultation
Grants sourcing
Technical, financial & legal contracts
Project management and operation
Elec export Contracts
Utility liaison
Emissions & certificate trading
Public stock
Metering
Billing
Reporting
Performance indicator setting
Energy contract monitoring
Public residential Improvements
Stock performance Reports
Initiative alignment
ARUP

APPENDIX C: HEAT MAPPING METHODOLOGIES

Heat Mapping Methodologies

Introduction

This appendix provides an outline of approaches to heat mapping based on a review of three heat mapping methodologies. The methodologies are:

- Herefordshire County Council: Local Development Framework, Herefordshire Renewable Energy Study, Appendix 1, Energy Demand Methodology – Domestic and Non Domestic heat mapping, Wardell Armstrong, 2008
- Heat Mapping in the Highland Methodology, The Highland Council & AECOM, 2011
- Westminster Heat Mapping Methodology Report, Sustainable Centre for Energy, 2010

Figure 1 provides a brief overview of the three sources.

Methodology	Overview
Herefordshire County Council LDF Herefordshire Renewable Energy Study	Energy Demand Assessment Methodology Residential and non Residential Heat Mapping Methodology for 83,080 residential property records and 8,013.
All Energy Conference 2011: Mapping Heat in The Highlands	The model developed is supported by a series of tools which were created for use by Highland Council staff providing functions such as scenario development, development proposals summary, search ares of High/ Low demand.
Westminster Heat Mapping Methodology Report	The new approach consists of modelling space and water heating demand for each individual buildings in the City of Westminster – this is in contrast with the London Heat Map, which modelled demand on a 50m x 50m grid (itself an improvement on earlier methods). enhanced approach to heat mapping, in support of the pilot Westminster Energy Masterplanning process.

Overview of Key Steps

This section provides a summary of key steps and issues in undertaking more detailed heat mapping. The stages identified are based on the three methodologies considered in this appendix and consist of two main stages.

- Stage 1: Identification and Classification of the Built Environment
- Stage 2: Heat Demand Modelling.

Stage 1: Identification and Classification of the Built Environment

This stage requires a comprehensive 'matching' exercise to be undertaken that focuses on identifying accurate address data and matching this with a wide range of other sources (eg, VOA data, Housing Stock Condition data etc) to get a better understanding of the type of properties registered, their size and the uses that are being undertaken in them. Local Authorities will need to develop an address database of premises and buildings using the Liverpool's Local NLPG.

Match the address-descriptor datasets to the NLPG master address each property in the NLPG can be assigned a classification and then energy consumption data would applied to estimate the heat demand of that property.

This is achieved by matching the various address-descriptor datasets to the NLPG master address dataset, using record-linkage techniques that makes positive matches between different datasets. Where the addresses in the two datasets are the same, attribute data is transferred from the various descriptor datasets to the NLPG address dataset.

By developing a Heat Map on GIS and number of reporting functions can be developed including:

- Scenario development
- Development Proposals Summary
- Search – Areas of High/ Low demand
- Search – Skills/ Suppliers
- Postcode reporting
- Data updates

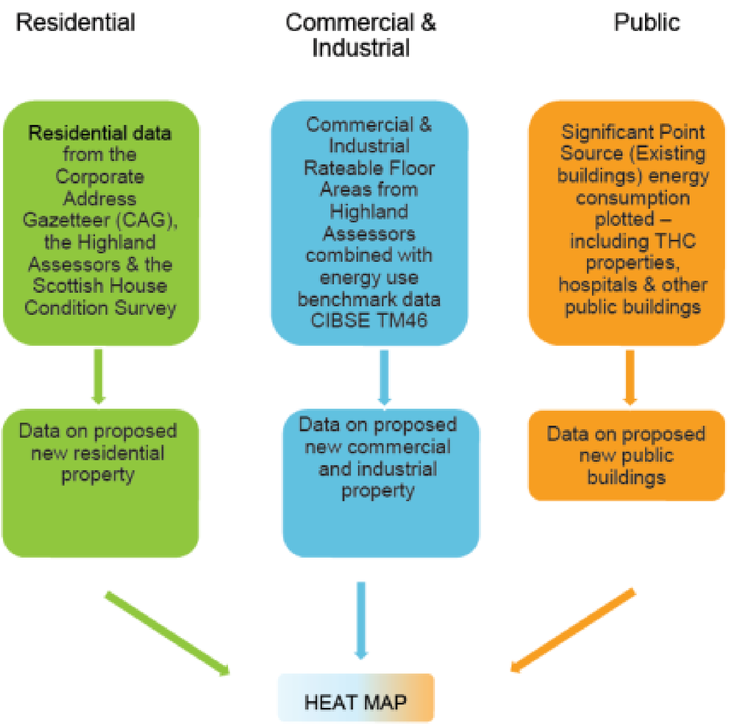

Figure 2 Example of Key Information for Residential, Non Residential and Public buildings are used to Create a Heat map (Source: All Energy Conference 2011 : Mapping Heat in The Highlands)

Heat Map Example

For residential premises, Residata database (2005) was used: (this describes the typical built form, tenure, age and size of housing) for every unit postcode. As a result, postcode level information is assumed to be representative of the population of residential premises sharing that postcode.

To improve this project team created additional classification routines which detect multiple premises at the same location, and reclassified these as either converted or purpose built flats, depending on the number of premises.

The classification information available on non-residential premises comes from multiple sources – the richest and most reliable of these is the Valuation Office Agency's rateable floorspace database, which gives detailed information both on the activity (office, retail, workshop etc), and total floor area.

Other sources, such as Town Centre Intelligence, or the NLPG's own classification schema, only provided classification data (office, school, hospital etc), making estimation of heat demand a more complex task with assumptions having to be developed by the project team on the size, condition and type of buildings.

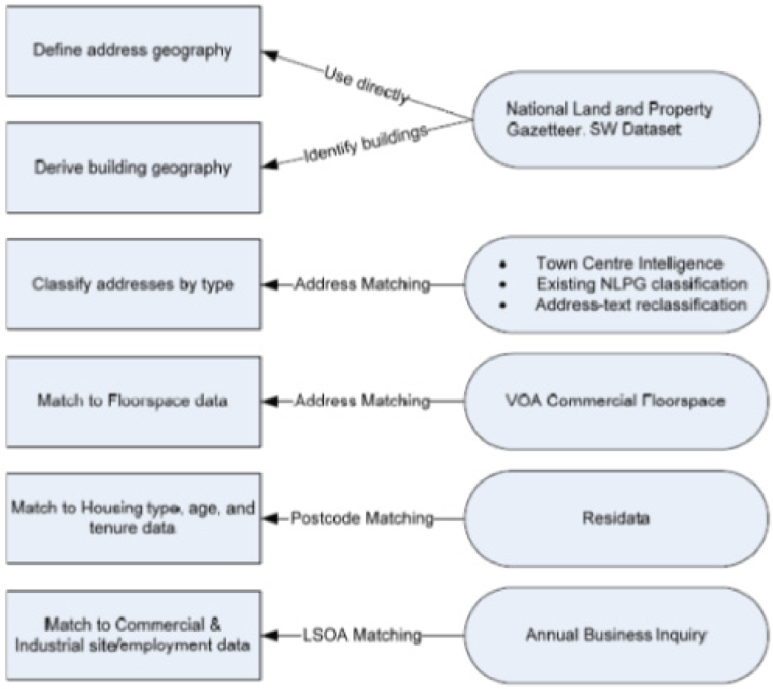

Figure 3 Stage 1 'matching' exercises (Source: London Heat Map Centre for Sustainable Energy model)

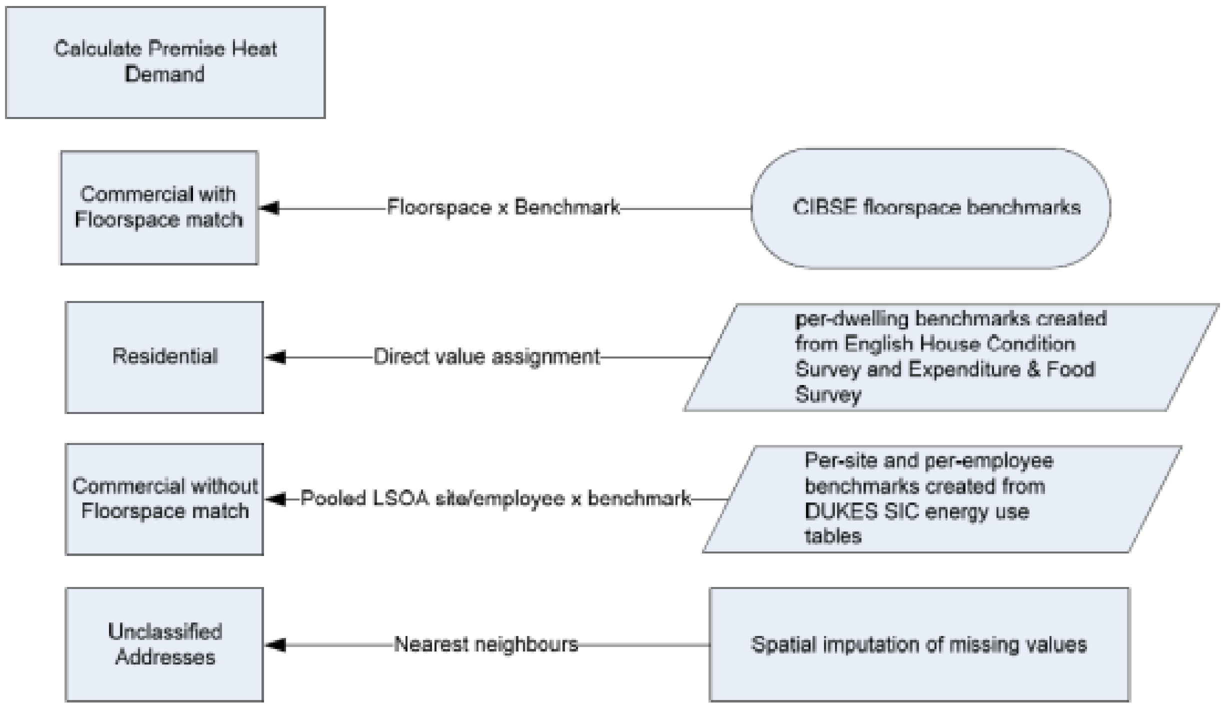

Figure 4 Stage 1 'matching' exercises to apply energy consumption / demand data to floorspace data in Stage 1 (Source: London Heat Map Centre for Sustainable Energy model)

Stage 2: Heat Demand Modelling.

For Stage 2 the estimated heat demand is calculated for each property in the database. It is likely that in undertaking this stage there will be variances in the level of information available for some premises compared to others.

Residential

For residential properties, heat demand would estimate using a set of constant values developed using data such as the Liverpool Housing Stock Condition Survey and the Expenditure and Food Survey. This would contain a distinct annual heat demand value for each combination of housing tenure, age, built form and size (number of bedrooms).

Non-residential with floorspace data

Where address records were successfully matched to the VOA floorspace dataset, the combination of floorspace and activity type would be used to estimate heat demand, based on the appropriate CIBSE Guide F floorspace benchmark ("Typical" values would be used).

Non-residential without floorspace data

Where premise records are not matched to the VOA floorspace dataset (either because the premise category is not within the scope of the VOA dataset, or because a positive match was not obtained in the record-linkage process), a secondary approach will need to be undertaken to estimate heat demand. This would involve the use of ONS area-based statistics on employment and site counts grouped by Standard Industrial Classification (SIC) code. For each LSOA (Lower-level super output area), the total number of sites and employees in the premise's activity category would be used from a Annual Business Inquiry dataset.

The LSOA total heat demand in that category would be calculated from per-site and per-employee benchmarks developed by LCC. These would be based on national energy use, employment and site data split by SIC code, and obtained from DECC. Once the overall category heat demand was calculated for that LSOA, the total was split pro-rata among the premises in that category and LSOA.

Unclassified Premises

There are two categories of unclassified premise. The first includes data where the overall category is known (e.g. the property is Residential or Commercial), but no other records are available. In these cases a spatial imputation is performed using an appropriate subset of neighbouring addresses as known datapoints. For example heat demand for "Commercial-Unclassified" premises would calculated as the modal average of the non-residential neighbouring premises. Conversely for "Residential-Unclassified" premises, a filter would need to be developed to exclude non-residential premises.

For remote areas where there is a very small number of addresses and there are insufficient neighbours within the defined radius / cluster to perform the imputation then the average value would be calculated for addresses in the same category across the dataset.

The second category of unclassified address is data where there is nothing known about the address, other than the address itself and its location. For this data spatial imputation criterion would need to be relaxed in order to account of all neighbouring addresses for which there was a known heat demand and an average used for those addresses.

APPENDIX D: CARBON CONVERSION FACTORS

Methodology for Calculating the Equivalent Annual Carbon Emissions

Energy consumption is measured in kWh. This is referred to as ‘Q’ in the calculation.

The efficiency of the plant converts heat consumption into fuel used. This is referred to as ‘E’ in the calculation.

The emissions factor converts energy of fuel used into CO_2 produced. This is referred to as ‘F’ in the calculation.

Units are in square brackets [-].

The Carbon produced is calculated **as:**

[kg(CO2)] = Q [kWh] x E [-] x F [kg(CO2)/kWh)]

Energy source*	Units	Carbon Factor Kg CO2 per unit
Grid electricity	kWh	0.54522
Natural gas	kWh	0.18523
LPG	kWh	0.21445
	litres	1.492
Gas oil	kWh	0.27533
	litres	3.0212
Fuel oil	kWh	0.26592
	tonnes	3219.7
Burning oil	kWh	0.24683
	tonnes	3164.9
Diesel	kWh	0.25301
	litres	2.672
Petrol	kWh	0.24176
	litres	2.322
Industrial coal	kWh	0.32227
	tonnes	2336.5
Wood pellets	kWh	0.03895
	tonnes	183.93

Table 1 DEFRA Carbon Conversion Factors

Fuel / Energy Type	Carbon Factor Kg CO_2 per unit
Mains Gas	0.206
LPG	0.251
Domestic Heating Oil (Burning Oil / Kerosene)	0.284
Gas Oil / Diesel	0.290
Fuel Oil	0.306
Appliances that Specifically Use FAME(biodiesel)sourced from Biomass Source	0.0098
Appliances that Specifically Use FAME(biodiesel)sourced from used cooking oil (1)	0.019
Appliances that Specifically Use Rape Seed Oil	0.058
Appliances able to Use Domestic Heating oil or Liquid Biofuel	0.284
Appliances able to use Gas Oil or Liquid Biofuel	0.290
B30K(2) (3)	0.205
House Coal	0.382
Anthracite	0.365
Coal (Non Domestic)	0.391
Manufactured Smokeless Fuel (Domestic)	0.404
Manufactured Smokeless Fuel (Non Domestic)	0.386
Wood Logs	0.018
Wood Pellets	0.037
Wood Chips	0.015
Duel Fuel Appliance (Mineral and Wood)	0.243
Grid Electricity – All Tariffs	0.591
Electricity Displaced from Grid	0.591
Electricity Generated by CHP	0.591
Gas used to Generate Heat or Heat and Power	0.391
Coal used to Generate Heat or Heat and Power	0.391
LPG used to Generate Heat or Heat and Power	0.251
Oil used to Generate Heat or Heat and Power	0.291
Electricity used to Generate Heat or Heat and Power	0.591
Waste used to Generate Heat or Heat and Power	0.047
Biomass used to Generate Heat or Heat and Power	0.019
Biogas used to Generate Heat or Heat and Power	0.024
Waste From Power Stations	0.058
Geothermal heat Sources	00.41

Table 2 National Calculation Methodology Carbon Factors

north west improvement and efficiency partnership

CLASP. Climate Change Local Area Support Programme

ARUP