4 Opportunities for District Heating & CHP

The energy demand of buildings has traditionally been met by electricity supplied by the national grid, heating supplied with individual boilers and cooling supplied through chillers. The PPS1 Supplement supports the development of networks to supply electricity, heating and in some cases cooling at a community scale from local sources (referred to as decentralised energy).

Additionally, the draft PPS on Planning for a Low Carbon Future in a Changing Climate (currently out to consultation) places further emphasis on district heating (DH) and the role of local authorities. The main points relating to DH in the consultation PPS are summarised below:

- Public buildings are most suited for DH and are key for reducing risk for developers.
- Local planning authorities (LPAs) will be expected to assess opportunities for decentralised energy, focusing on opportunities "at a scale which could supply more than an individual building".
- Greater emphasis will be placed on LPAs, particularly in urban areas, having up to date heat mapping as part of their evidence gathering so that maximum efficiency can be achieved through siting of plant.
- Benefits of connecting DH in new developments to existing buildings are identified. This allows for developers to gain economies of scale by building bigger plants than required for their own projects and is "a more cost-effective way of meeting zero carbon targets".
- There is a table showing that "in most cases it is cheaper (to meet renewable targets using DH)".
- The draft confirms the PPS1 Supplement position that new developments can be mandated to connect to a district heating scheme.

This chapter discusses the opportunities in Hertfordshire for establishing DH networks.

4.1 District Heating

District heating is an alternative method of supplying heat to buildings, using a network of super insulated pipes to deliver heat to multiple buildings from a central heat source. Heat is generated in an energy centre and then pumped through underground pipes to the building. Building systems are usually connected to the network via a heat exchanger (also known as a heat interface unit (HIU)), which replaces individual boilers for space heating and hot water. Whilst there is some amount of thermal loss from the heat distribution infrastructure, the aggregation of small heat loads from individual buildings into a single large load allows the use of large scale heat technologies, including the capture of waste heat from industrial processes or power generation, or other large scale heat generation technologies which are not viable at a smaller scale. Of particular interest is combined heat and power (CHP).

4.2 Combined Heat and Power (CHP)

The traditional method of generating electricity at power stations is relatively inefficient, with at least 50% of the energy in the fuel being wasted in the form of heat. Whilst this could be used for a district heating scheme, power generation is often not close enough to heat demand centres, and there are significant challenges in establishing large scale (town and city-wide) heat networks for connection to power stations in the UK.

A CHP plant is essentially a local, smaller version of a power station but by being combined with heat extract, the overall efficiency is much higher (typically 80% – 85%). Whilst the electrical efficiency of smaller CHP systems is lower than large scale power generation, the overall efficiencies with heat use are much higher resulting in significant CO_2 reductions. An additional benefit can be the reduced need for major grid reinforcement through the integration of smaller local power generation. A standard, gas-fired CHP based on a spark ignition engine typically achieves a 35% reduction in fuel use compared with conventional power stations and gas boilers. There are many other CHP technologies available based on gas or steam turbines, or gasification. The use of bio-fuels in these systems can provide almost 100% reductions in CO_2 from electricity and heat generation.

4.3 Local Potential for District Heating and CHP

For existing development, DH is suited to areas of high heat density where a large amount of heat can be distributed over a relatively small amount of network infrastructure. This typically limits schemes to high density areas. Hertfordshire has a number of urban centres with relatively high density and which have potential for the development of heat networks. To help identify potential locations where networks may be viable, this study has produced a heat map of the County which visually shows the level of heat demand. We are not aware of any DH schemes currently installed in the County.

4.3.1 Heat Mapping of Hertfordshire

Heat demand in Hertfordshire has been mapped to identify locations with high heat demand which may be suitable for DH and CHP (Figure 2.7 on page 19). Further details of the heat mapping process are provided in Appendix B.

The viability of heat networks and CHP in new developments differs from that of existing areas, as the level of heat demand in new buildings is much lower due to the Building Regulations improving thermal efficiency. The high standards required for CO_2 emissions mean that alternative lower cost options may not be available, and the economic basis for selecting CHP and DH is significantly different.

4.3.2 Locations with Potential for CHP

It is theoretically possible to develop a DH network with CHP anywhere that there are multiple heat consumers; however the basic economics of schemes limit viable schemes to higher density areas as discussed. The main driver of the cost of a new heat network is the length of underground pipework required. It is therefore preferable to limit the distance between heat customers, by prioritising areas of higher density development.

The economics of district heating networks and CHP are also determined by technical factors including the size of the CHP engine and annual hours of operation (or base load). Ideally, a system would run for at least 4,500 hours per year for a reasonable return on investment which is around 17.5 hours per day, five days per week, or 12.5 hours every day of the year. CHP is therefore most effective when serving a mixture of uses, to guarantee a relatively constant heat load. High energy demand facilities such as hospitals, leisure centres, public buildings and schools can act as anchor loads to form the starting point for a district heating and CHP scheme. These also use most heat during the day, at a time when domestic demand is lower.

Another contributory factor to the economic viability of CHP is the difference between the cost of electricity and gas, referred to as the "spark gap". The greater the cost of electricity compared to gas, the more likely a CHP installation is to be viable due to increased revenues from the sale or use of electricity.

The potential for district heating powered by CHP can be assessed at a high level by setting a threshold heat density above which schemes become viable. Previous research into the economics of district heating and CHP has suggested that a threshold of 3,000 kW/ km^2 can give financial returns of 6%, which is below typical commercial rates of return but greater than the discount rate applied to public sector financial appraisal.[17] (Refer to Figure 2.8 on page 24 for areas which achieve this threshold)

For a threshold of 5,000 kW/ km^2, the existing heat demand that could be served by district heating is estimated at 37% of existing building heat demand and for a threshold of 7,000kW/ km^2, this is estimated to be 22% of existing building heat demand

Assuming a district heating viability threshold of 3,000 kW/ km^2 (see Figure 2.8), it can be surmised that urban areas such as Watford, Hemel Hempstead, Welwyn Garden City, Hatfield, Cheshunt, Hitchin, Letchworth, Hoddesdon, Hertford and Bishop Stortford all have large areas with district heating potential.

It should be noted that the discussion around viability presented here is very high level, and all potential CHP and district heating schemes should be assessed on a case by case basis, taking into account local conditions and heat users, and financial models. For this reason, the viability level of 3,000 kW/ km^2 should be used as a first level pass and the actual level may fall below or above this, with potentially large implications on the overall viable heat loads. Figure 2.8 on page 24 illustrates the relation of overall heat load in Hertfordshire to the viability level.

At lower heat densities, the overall level of heat demand is extremely sensitive to the viability level. For example, for a threshold level of greater than 3,000 kW/km^2 per year of heat demand, district heating is estimated to be viable for 78% (100%-22%) of existing building heat demand, but this reduces to about 37% of heat demand if the viability level is 5000 kW / km^2. At the higher viability levels (essentially the heavily urbanised areas) the sensitivity is much less (the graph is less steep) and determining the exact viability level is less critical.

In new development, targets for CO_2 reductions mean that the economic viability level changes because "business as usual" is no longer an option. Therefore the viability of district heating and CHP schemes depends on what the alternative options are to achieve the required CO_2 reductions.

[17] The potential and costs of district heating networks (Faber Maunsell & Poyry, April 2009)

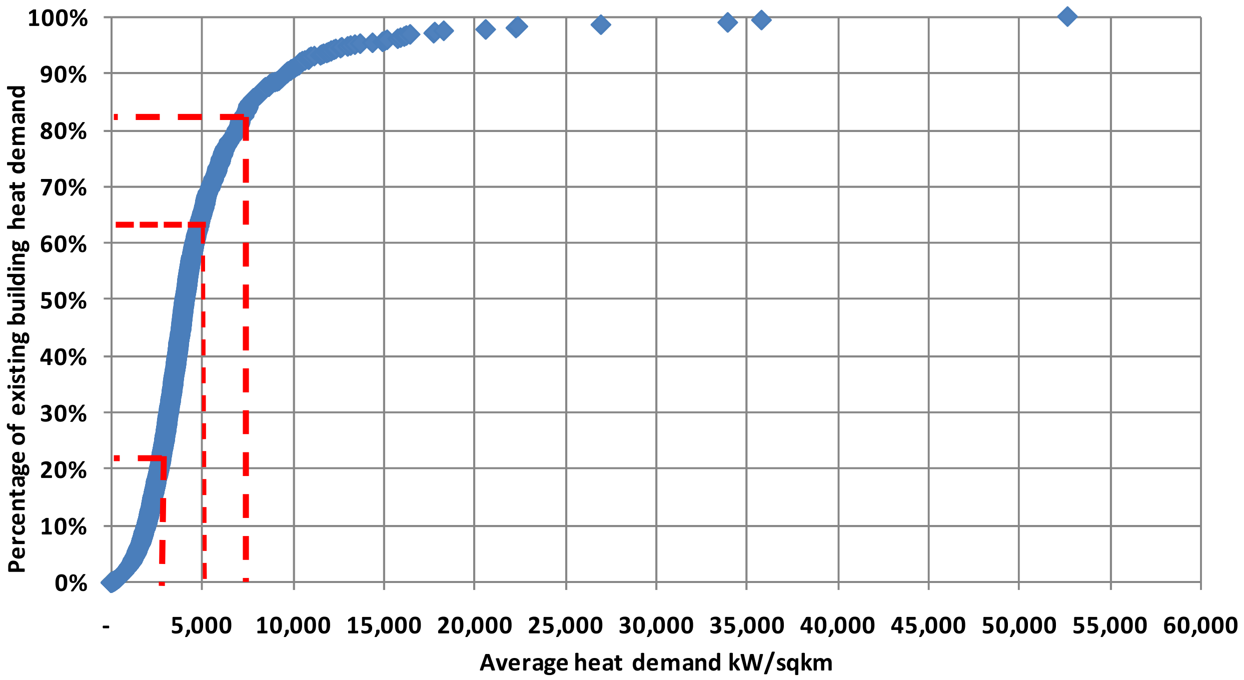

Figure 4.1 Sensitivity chart showing relation of overall heat load in Hertfordshire to the viability level

For new development, the improving insulation standards mean the requirement for space heating is relatively low and demand is only present during the winter months. Therefore hot water is the most consistent year round load and schemes are often sized on hot water demand to prevent heat dumping in summer months. For higher CO_2 reduction targets, such as those in Code 4 upwards, and building regulations from 2013 (for homes), District Heating may be one of the more economic methods of achieving targets, especially in mixed use and higher density developments. Whilst planning policy can not specify technologies or systems where supporting infrastructure (such as a local source of waste heat or neighboring DH scheme) is not available, the planning process should encourage the development of DH schemes in new development where viable.

One method of maximising the benefits of CHP and DH in new developments is to link smaller developments together, maximizing the load and potential efficiencies; another is to link the new development to existing areas. This includes development within both built-up areas, such as town centres, and urban extensions. Local planning authorities and other public stakeholders have a key responsibility to ensure that this can happen by the following:

- Ensuring that planning encourages the linking of development and use of heat networks where viable.
- The provision of public sector anchor loads to act as catalysts for heat networks to which new development can connect. This can include the creation of long term heat contracts to provide some degree of financial security to the network operator.
- The provision of financial support in the form of grant or low cost finance to assist with infrastructure costs.

In general it is unlikely that heat networks will develop in existing areas on a purely commercial basis without some form of support from the public sector.

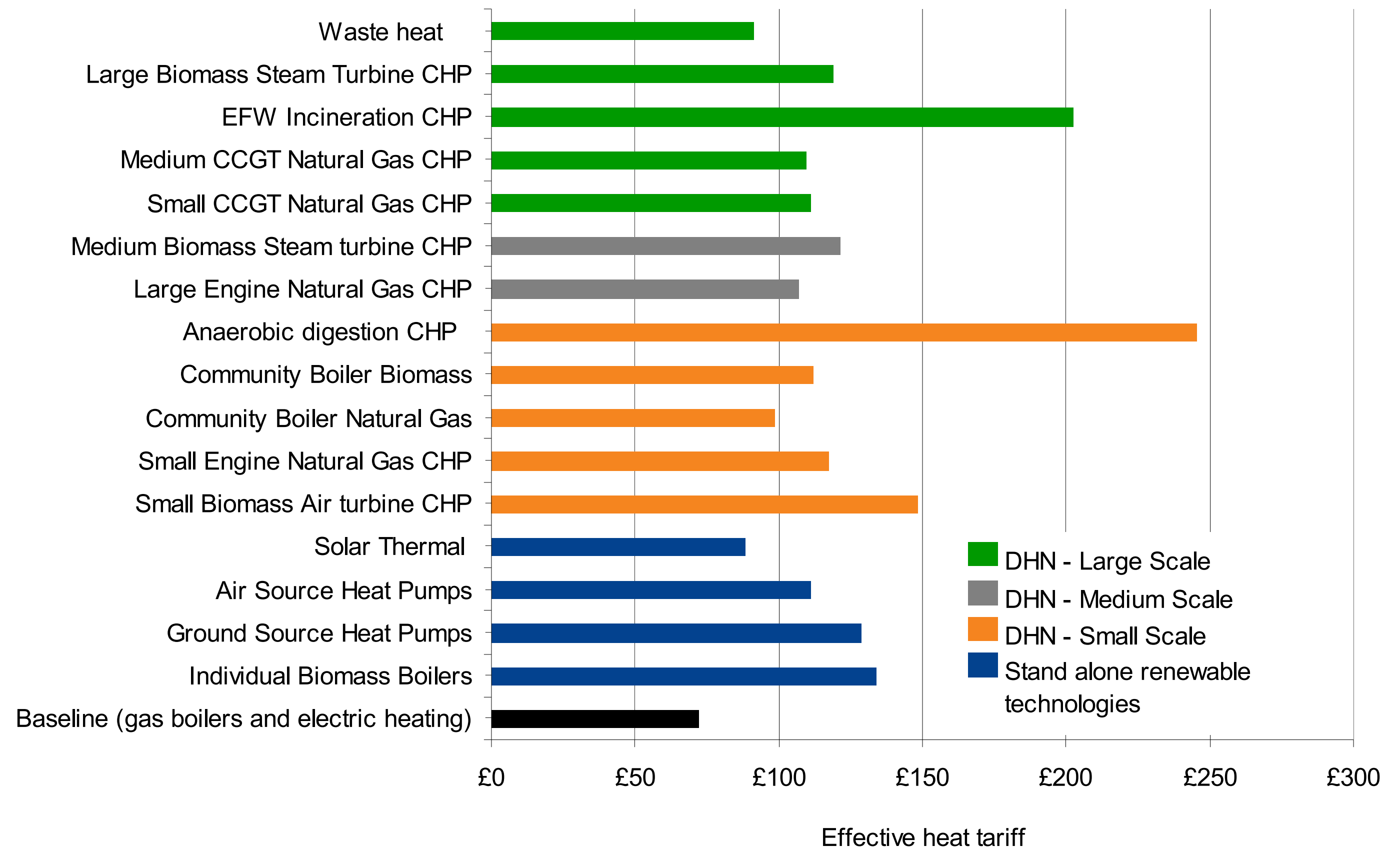

Figure 4.2 Cost of heat provision by technology in £/MWh, based on current market conditions.* Waste heat is heat obtained at very low wholesale cost from power plants or industrial processes. Community Boiler refers to district heating, DHN in legend refers to District Heating Network. Solar thermal heating provides domestic hot water only. (Source: The potential and costs of district heating networks, Faber Maunsell AECOM and Poyry)[17]

4.4 Financial Implications of District Heating with CHP

Figure 4.2 compares the capital cost of a range of renewable and low carbon heat technologies with gas and electric heating. Full infrastructure costs of converting existing homes to district heating can vary from about £5,000 per dwelling for flats, to around £10,000 per dwelling for detached or semi-detached properties; details can be seen in Table 4.1. These costs assume no prior district heat network infrastructure in the area and that existing dwellings are fitted with individual heating systems. Table 4.2 provides the cost of providing district heating with CHP to non-domestic buildings.

The main benefit of moving to district heating networks is the carbon savings that they can deliver. Figure 4.3 shows the potential cost per tonne of CO_2 saved for a range of heat generating technologies. The figures are based on carbon factors that reflect today's grid mix. District heating with CHP is cheaper in terms of cost per tonne of CO_2 saved than heat pumps; air source heat pumps can actually result in a net increase in CO_2 emissions.

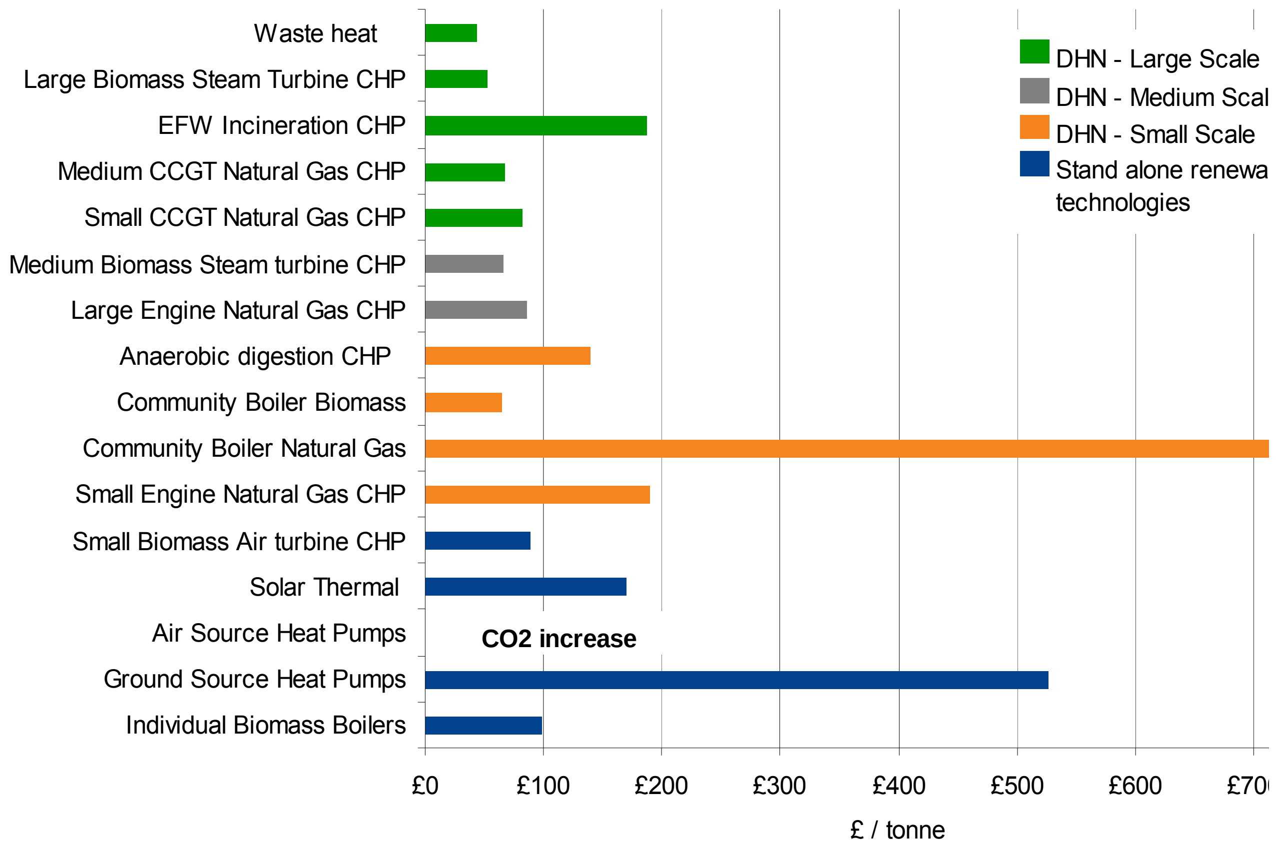

Figure 4.3: Cost compared to CO_2 saved by heat provision technology, in £/tonneCO_2 saved. Waste heat is heat obtained at very low wholesale cost from power plants or industrial processes. Community Boiler refers to District Heating, DHN in legend refers to District Heating Network. Solar thermal heating applies to water-heating only. (Source: The potential and costs of district heating networks, Faber Maunsell AECOM and Poyry) [17]

Type of Area	Total District Heating Network mechanical and civil costs of distribution pipework Cost	Heat Interface Unit (HIU) and Heat Meter Cost
City Centre	£8.40 per m^2	£20.00
Other urban area	£16.50 per m^2	£20.00

Table 4.2: District heating network costs for non-domestic buildings. The Hydraulic Interface Unit (HIU) is the exchanger device that replaces the boiler and transfers heat from the district heating network into the home. (Source: The potential and costs of district heating networks, Faber Maunsell AECOM and Poyry)

Dwelling Type	District Heating mechanical and civil costs of distribution pipework Cost	District Heating Branch mechanical and civil costs of distribution pipework Cost	Heat Interface Unit (HIU) and Heat Meter Cost	Total Cost
Small terrace	£2,135 Based on outline network design and costing	£1,912 Based on outline network design and costing plus additional costs for HIU and metering.	£2,300 (includes £1,600 HIU, £200 for heat meter, and £500 for installation)	**£6,347**
Medium / Large terrace	£2,135 Based on outline network design and costing	£2,255 Based on outline network design and costing plus additional costs for HIU and metering.	£2,300 (includes £1,600 HIU, £200 for heat meter, and £500 for installation)	**£6,690**
Semi-detached	£2,719 Based on outline network design and costing	£2,598 Based on outline network design and costing plus additional costs for HIU and metering.	£2,300 (includes £1,600 HIU, £200 for heat meter, and £500 for installation)	**£7,617**
Semi detached	£2,719 Based on outline network design and costing	£3,198 Based on outline network design and costing plus additional costs for HIU and metering.	£2,300 (includes £1,600 HIU, £200 for heat meter, and £500 for installation)	**£8,217**
Converted flat	£712 Assumes that infrastructure costs for a 3-story converted terrace are split between 3 flats.	£752 Assumes that branch costs for a terrace are split between 3 flats with an HIU and heat meter for each flat.	£2,300 (includes £1,600 HIU, £200 for heat meter, and £500 for installation)	**£3,764**
Low rise flat	£1,500 Estimate	£1,500 Internal pipework	£2,300 (includes £1,600 HIU, £200 for heat meter, and £500 for installation)	**£5,300**
High rise flat	**£1,000** **Estimate**	**£1,500** **Internal pipework**	**£2,300** **(includes £1,600 HIU, £200 for heat meter, and £500 for installation)**	**£4,800**

Table 4.1: District heating costs for homes. The Heat Interface Unit is the exchanger device that replaces the boiler and transfers heat from the district heating network into the home. (Source: The potential and costs of district heating networks, Faber Maunsell AECOM and Poyry) [17]

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4.5 Key Considerations Emerging from this Chapter

The sections above have considered the opportunities for reducing CO_2 emissions through the supply of low carbon heat. Key considerations emerging from this chapter are:

- District heating and CHP increases the efficiency of heat and power generation compared with conventional generation resulting in significant CO_2 reductions, and can contribute to renewable energy targets if powered by biomass or biogas
- Heat mapping suggests that there could be a significant potential for CHP and district heating in Hertfordshire based on a heat density viability analysis. In all cases this needs further analysis on a case by case basis using the heat mapping of potentially viable areas in this study as a starting point.
- Further opportunities will be presented by proposed new development, but their extent will be affected by a range of factors, including future heating demands. CHP and district heating are most viable when there is a mix of uses with a high and stable heat demand
- Opportunities for district heating will be greater where new developments can be physically linked to buildings in existing developments
- District heating with CHP is many cases offers lower cost CO_2 savings than smaller scale alternatives such as heat pumps; air source heat pumps can actually result in a net increase in CO_2 emissions
- Full infrastructure costs of converting existing homes to district heating can vary from about £5,000 per dwelling for flats, to around £10,000 per dwelling for detached or semi-detached properties. It is likely that the roll out of district heating in existing areas will require some form of public sector support.