Report

Heat network mapping and Masterplanning for Basingstoke and Deane Borough Council

Prepared for
Basingstoke and Deane Borough Council

Author
James Wayman

Date
November 2017

Reference
P3599

Basingstoke and Deane

Encraft Limited
Brandon House Courtyard, William Street, Leamington Spa CV32 4HJ
T: 01926 312 159 | F:01926 425481 | E: enquiries@encraft.co.uk

Document History

Role	Name	Date
Author	James Wayman	15/06/17
Updated	James Wayman	21/11/17
Checked/Authorised	Kate Ashworth	15/12/17

Design recommendations and specifications provided in this report are based on the best professional endeavours of the authors. All calculations are based on the best information available to us at the time of report production. Where third party equipment is referred to we rely on manufacturer performance statements, guarantees and warranties. We are not liable for any errors in calculations or omissions resulting from data provided by the customer or third parties.

Encraft works to all relevant professional standards and is accredited to ISO9001 and ISO14001 by Lloyds Register. We hold professional indemnity insurance as consulting engineers for design to the sum of £5 million.

Contents

Executive Summary

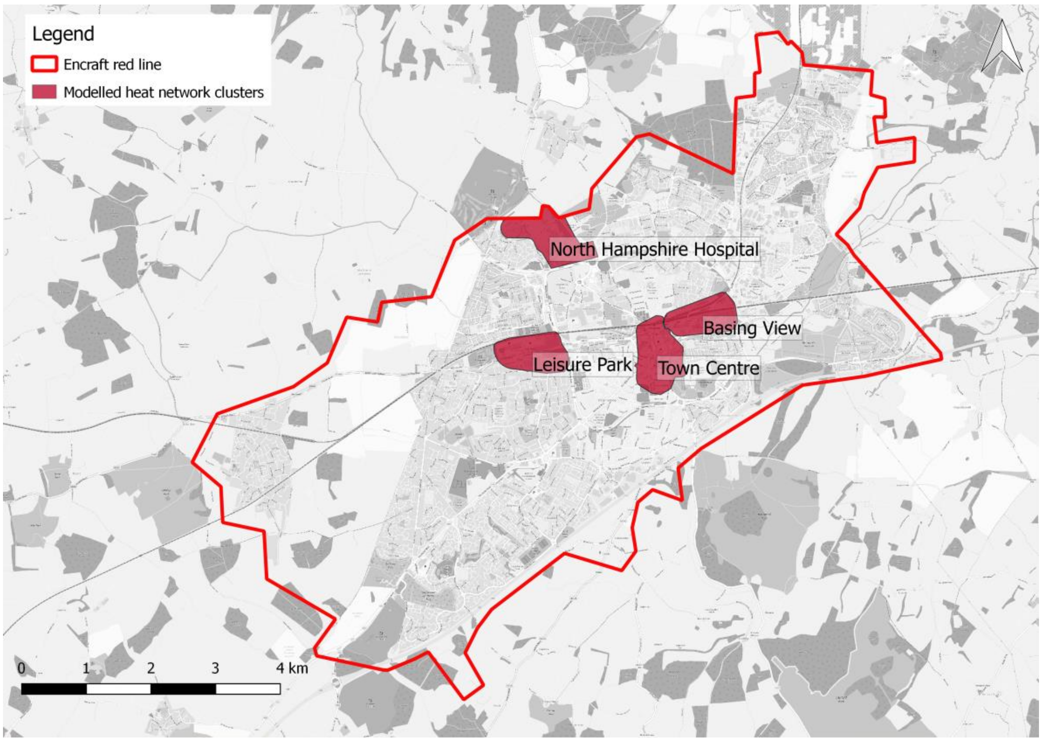
Encraft have been commissioned by Basingstoke and Deane Borough Council to explore the opportunity to provide district heating schemes for existing and new developments centred on Basingstoke, which generate revenue, support local business and deliver the Council's ambitions to meet national renewables and carbon reduction targets.

A district heating scheme comprises a network of insulated pipes used to deliver heat, usually in the form of hot water, from a central energy centre, to multiple end users. Heat networks also often include the parallel supply of electricity via a Private Wire network, and sometimes cooling. This offers the potential to provide lower carbon and lower cost heating and hot water, improve energy security for businesses and residents and improve price stability whilst helping to safeguard and grow employment opportunities.

The heat network mapping and Masterplanning study demonstrates that there are technical and financially viable heat network projects in Basingstoke.

This report provides a discussion paper to stimulate further consultation with stakeholders, and gives the Council an indication of possible future investment opportunities.

A study area (redline area) was defined that included a range of potential heat and electricity demands, and a heat mapping exercise was carried out that benchmarked all these loads to discover whether they were suitable for connection to a future network.



Indicative network designs were developed for four heat clusters, including the North Hampshire Hospital complex, Leisure park (existing), Basing View and Town Centre; each with a series of expanding phases.

Scheme configurations were developed that allowed techno-economic modelling of a number of possible network routes and served loads to understand potential business cases and commercial models.

The analysis has identified the following clusters, which have each been modelled over 25, 30 and 40 years. Modelling has shown that some clusters may work better with less extended connections (and not expand to include addresses across phases 2 and 3). This should be tested in a future more detailed study. Only the most financially attractive phases have been depicted in Table 9.

				25yr.	30yr.	40yr.
E13	Basing View	Phase 1 - 3	Village Hotel, Belvedere House, Northern Cross, Business Environment Offices & Adjacent Complex, Network House, Mountbatten House, Eni Engineering E & P House, Matrix House, Southern Cross, Unum House, Quantum House, Waitrose, John Lewis, Basingstoke Campus.	8.2%	9.2%	10.1%
E15	North Hampshire Hospital	Phase 1 only	North Hampshire Hospital including the Ward Block, The Firs, and Sherborne building, and Candover Clinic	11.2%	11.9%	12.5%
E14	Town Centre	Not currently financially viable	Civic Offices, Costello School, Magistrates Court, Indigo Business Centres	-7.3%	-1.2%	2.4%
E16	Leisure Park	Central leisure facilities only	Basingstoke Aquadrome, Ice Rink, Wessex Bowl, Odeon Cinema, Gala Clubs, Premier Inn Hotel	7.2%	8.2%	9.1%

Figure 1: IRRs for the optimum clusters and network phases, modelled over 25, 30 and 40 years

The findings of the techno-economic assessment are summarised below. All options have been modelled with a gas-CHP, including the sale of electricity via a private wire network. Models using biomass were not shown to be financially attractive, due to increased plant capital costs and the inability to cross subsidise the network through electricity sales.

- **Basing View:** The cluster is predominantly made up of office accommodation, with a new hotel development acting as a critical anchor load. Phase one offers an IRR of 5% at 25 years, and would be most appropriate for municipal investment at this rate.

  Response to stakeholder engagement attempts in Basing View has been limited, and further work would be needed to build relationships here if the Council decided to take this option to detailed feasibility.

- **North Hampshire Hospital:** The cluster comprises a mixture of public and private sector connections; dominated by the energy demands of the Hospital. The rate of return for phase 1 of above 10% at 25 years, making it an attractive option for private investment. Whilst the extension of the cluster to include phase 2 and 3 would be technically achievable and provide added social benefit, this would be to the detriment of the financial returns. There is a need to act quickly if the cluster is to be taken forward for detailed feasibility as the hospital has aging heat raising plant and is currently exploring replacement options.

- **Town Centre:** The low density of heat demand of the town centre means the lengths of pipework required to connect to customers is relatively high, and the returns are the least attractive across all clusters. Despite modelling suggesting returns of 5% are possible at phase 3, this is based on connecting a number of sizeable private customers; connecting the communal areas at Festival Place shopping centre, which could prove cost prohibitive upon further detailed investigation, given the lack of a central heat raising facility.

- **Leisure Park:** The leisure park cluster comprises predominantly of retail and leisure outlets, and has shown attractive IRRs of 7% at 25 years. Given the plans to redevelop this site, there is a timely opportunity to consider the integration of a local heat network. Where pipe trenching can be tied into the provision of new utilities and services, there would be scope to make capital cost savings, and strengthen the modelled IRRs.

Table 1: CAPEX and OPEX summary for the key clusters

		Phase	CAPEX	OPEX (Year 1)	Revenue (Year 1)
E13	Basing View	Phase 1 - 3	£3,948,400	£940,200	£1,328,600
E15	North Hampshire Hospital	Phase 1 only	£3,791,800	£1,601,500	£2,194,900
E14	Town Centre	Phase 1 only	£1,650,200	£90,470	£127,400
E16	Leisure Park	Central leisure facilities only	£2,205,400	£750,000	£1,007,400

The study suggests there are opportunities for the Council to move forward with the Hospital and Leisure Park schemes by commissioning a detailed feasibility study to further refine the business case on the preferred option. At the same time, maintain the stakeholder communication programme commenced during this study duration to keep potential heat customers engaged with the project.

1. Introduction

1.1 Project aims

The aims of the overall study are to:

- Undertake an energy mapping study of the proposed project area to identify potentially useful heating, cooling and power demand loads, and potentially useful heat supply opportunities for the purposes of District Heating Network (DHN) development.
- Use the outputs of energy mapping to inform the development of an energy master plan for the proposed area identifying, evaluating and prioritising any identified potential DHN scheme opportunities.
- Assess the opportunity for attracting potential further funding for detailed feasibility study and business case for investment in the focussed areas identified.
- Investigate the feasibility and deliverability of DHN at the Leisure Park, Manydown, and other potential sites including Chineham Energy Recovery Facility.

  This considers not only the financial viability of the opportunities but also the Council's priorities, timescales and deliverability of the schemes.

1.2 Project background

The area of focus is bounded by Chineham to the North, Old Basing to the East, Basingstoke Golf Course to the South, and Oakley to the West. The area is also directly intersected by the railway line which runs from east to west. See appendix 10 for full size maps.

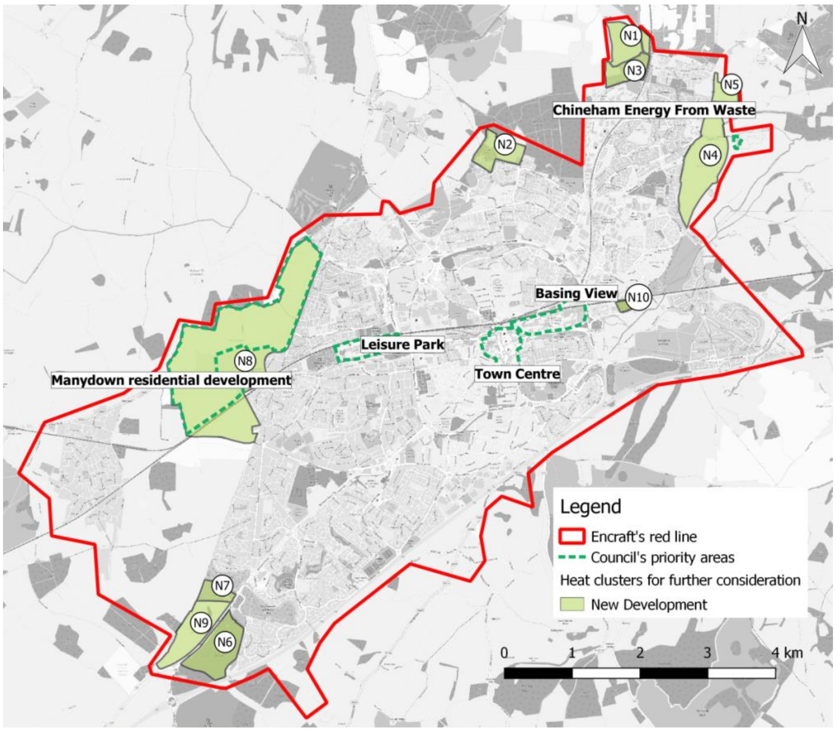


Figure 2: Red line boundary

Basingstoke is a mixed use development of leisure, medical, retail and academic facilities and industrial manufacturing units, including multiple schools, Leisure Park, and hospital complex.

The population of Basingstoke was recorded at 173,860 in 2014 according to figures released by the Office for National Statistics[1]. To meet local housing demands, Basingstoke and Deane has identified several possible future residential development opportunities. Ten of these sites fall within the study's boundary and have been summarised in Table 2.

New residential development provide an excellent opportunity to consider the use of district heat and may offer a better investment as the ground works can be completed whilst the utilities are being installed and the need for no retrofit works.

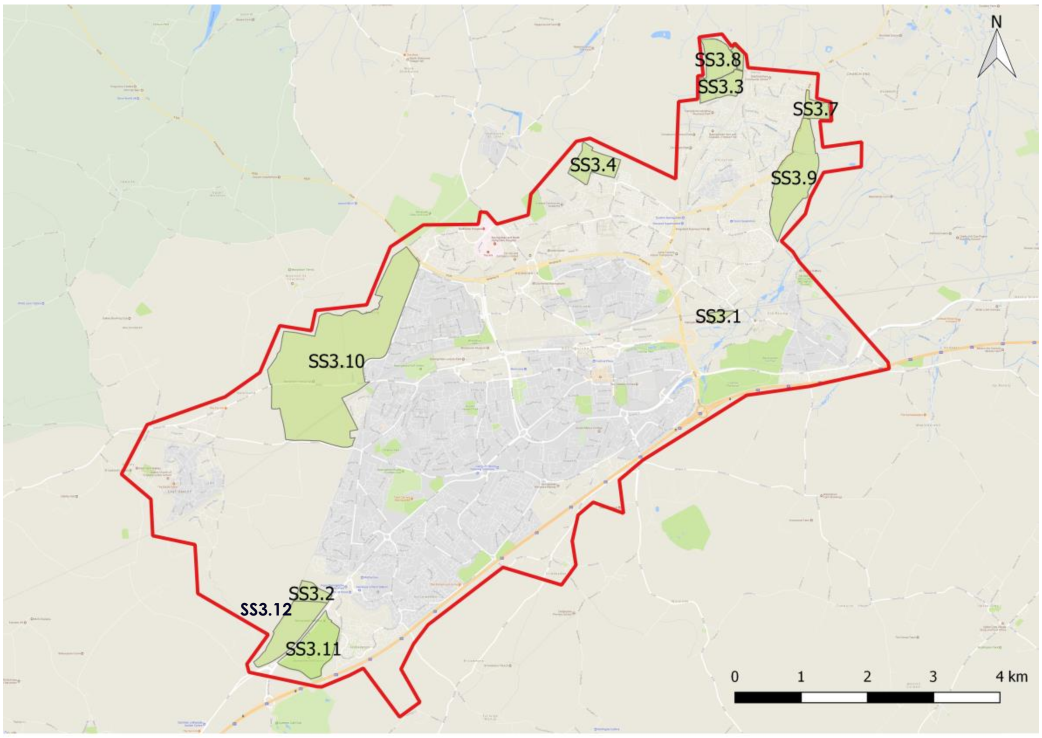


Figure 3: Map of site allocations

Table 2: Residential sites earmarked for development, listed against the Council's site reference code SSX

Immediate development opportunities (Commencing 2017/18)	Future development opportunities (Commencing 2020 onwards)
• SS3.1: Swing Swang • SS3.2: Kennel Farm • SS3.3: Razors Farm • SS3.4: North of Popley Fields • SS3.7: Redlands • SS3.9: East of Basingstoke • SS3.10: Manydown • SS3.12: Hounsome Fields	• SS3.8: Upper Cufaude Farm • SS3.11: Basingstoke Golf Course

[1] Basingstoke and Deane; available at: http://www.basingstoke.gov.uk/key-facts-and-figures *19/06/17)

2. Heat mapping

2.1 Redline boundary

The areas outlined by the Council in the project tender for inclusion in the study are marked by a dotted green line in Figure 4. The red line boundary which was consequently defined by Encraft is depicted in red. The red line incorporates Chineham to the North, Old Basing to the East, Basingstoke Golf Course to the South, and Oakley to the West, and includes all major local development sites referenced in the Adopted Plan[2]. Basingstoke Town Centre is situated almost centrally within the study boundary.

This new boundary follows major roads, railways and natural features where possible.

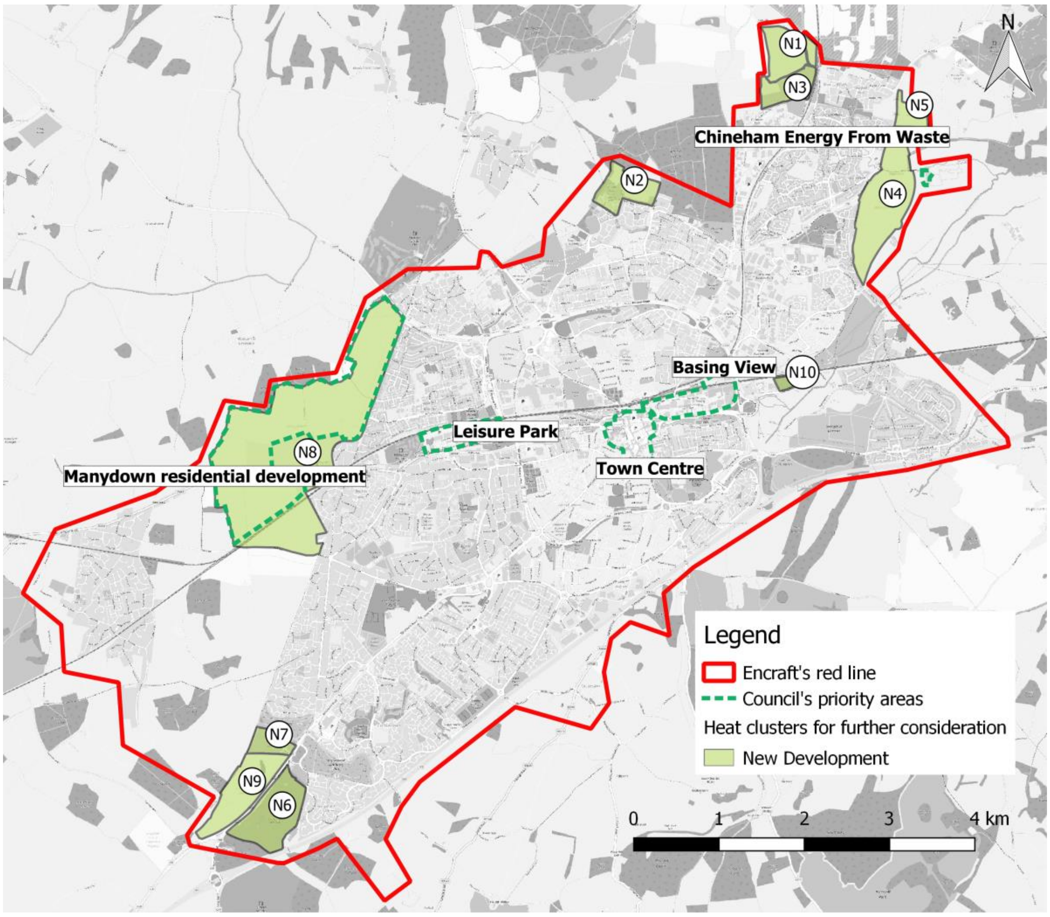


Figure 4: Basingstoke and Deane red line boundary

2.2 Initial demand mapping of existing loads

The establishment of a heat network generally relies on the addition of major loads which require a constant base load of energy use that can be met by the network. The identification of these loads is crucial to the operation of a successful network. Additional smaller loads can then be connected and can improve the economic case of a scheme.

[2] Basingstoke and Deane Adopted Plan 2011-2029 https://www.basingstoke.gov.uk/rte.aspx?id=275 (19/06/17)

This heat mapping does not necessarily indicate where heat networks may work due to a number of factors that will be examined in greater detail in the Masterplanning phase. These factors include connectivity potential of load, existing systems and existing plant room configurations.

The heat mapping methodology is covered in detail in the appendices, alongside full size copies of all key maps.

2.2.1 Total commercial and residential heat loads

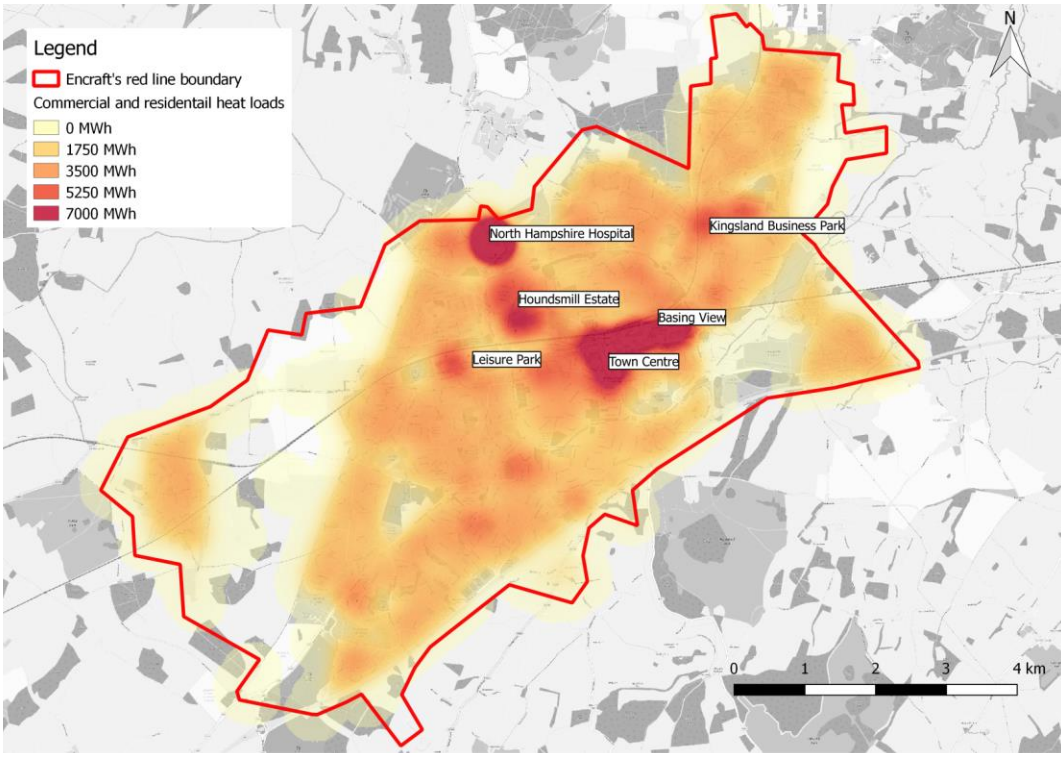


Figure 5: Total commercial and residential heat energy (MWh/year) [Benchmarked data]

2.2.2 Commercial heat loads

The initial pass of data has revealed that local commercial heat density is greatest towards the centre of Basingstoke, and the lowest at the westerly boundary of the red line near East Oakley. This pass has also identified a number of clusters of commercial buildings with potentially substantial heat demands, including the Leisure Park, Basingstoke Town Centre, Houndmills Estate, Kingsland Business Park and the North Hampshire Hospital complex.

These sites are particularly attractive as they contain multiple sizeable and diverse loads that lend themselves very well to a heat network. However, several of these clusters also comprise a high number of industrial addresses which include warehouses and workshops. These types of buildings tend to have large floor areas which result in significant benchmarked energy load figures, which from experience, tend to result in an overestimation of actual energy usage.

Maps of the local heat loads are shown in Figure 6 and Figure 7. The demand in every map is given in units of MWh/year. Each heat spot represents the heat demand of that location, and the colour of the spot gives an indication of the size of the load.

Key heat spots and clusters will be evaluated in further detail in the Masterplanning work package.

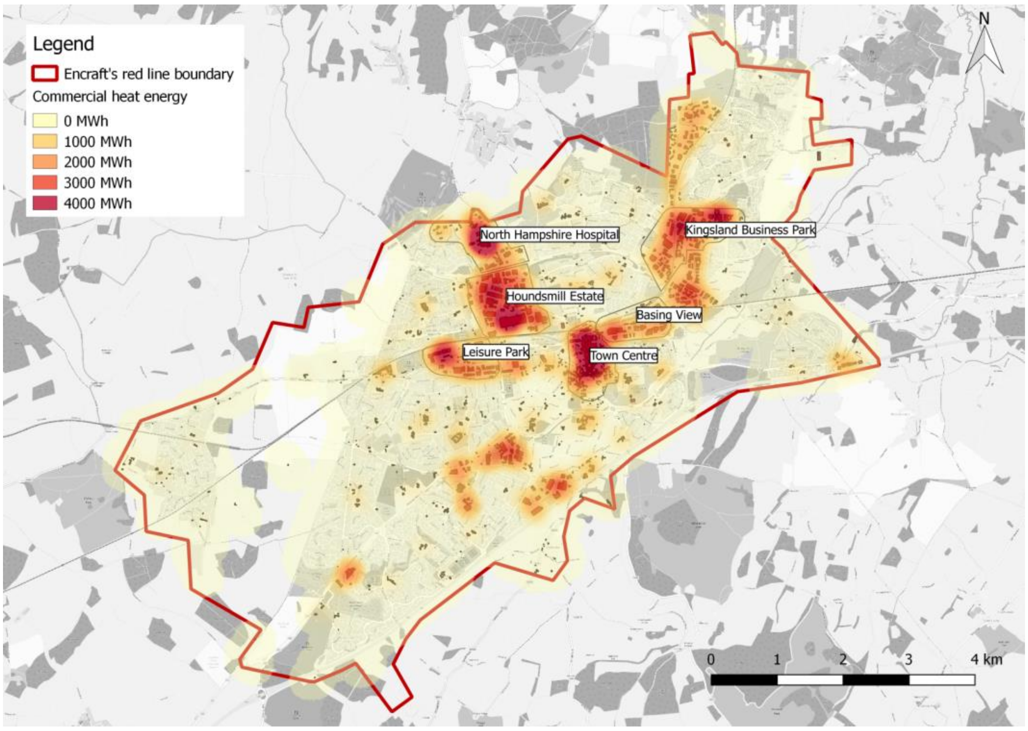


Figure 6: Commercial heat energy (MWh/year) [Benchmarked data]

2.2.3 Residential heat loads (existing)

Existing residential developments are widespread across the study boundary, and interspersed by local commercial and industrial estates. An initial sweep of the local area has revealed only a few existing sites comprising high density/rise housing appropriate for cost effective connection to a heat network, including within the Town Centre and also South of Houndsmill Estate off Churchill Way.

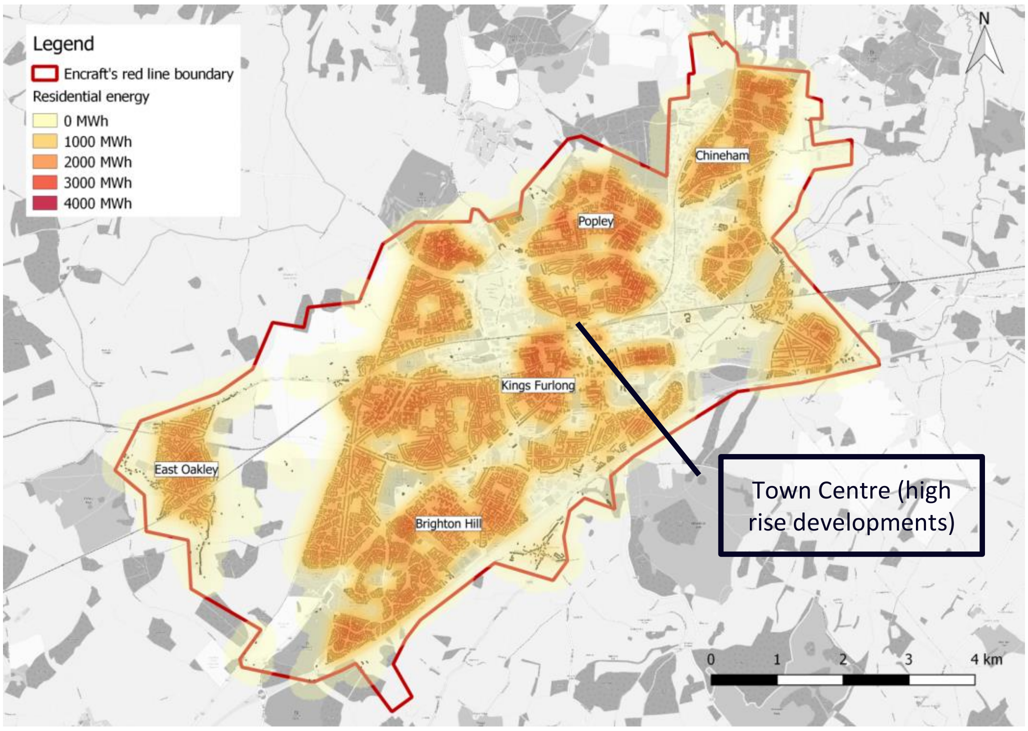


Figure 7: Residential heat energy (MWh/year) [Benchmarked data]

Existing residential buildings are not always appropriate for connection to a heat network as they are adversely affected by requiring significant amounts of pipework to access small loads, while also potentially requiring overhauls of the current building heating system.

2.2.4 Commercial electricity loads

Electricity demand mapping is set out in Figure 8, and like the heat mapping is based on CIBSE Guide F benchmarks for different types of businesses. The map largely aligns with the commercial heat map, with the highest electrical loads across the Town Centre, Houndmills Estate, Kingsland Business Park and Leisure Park.

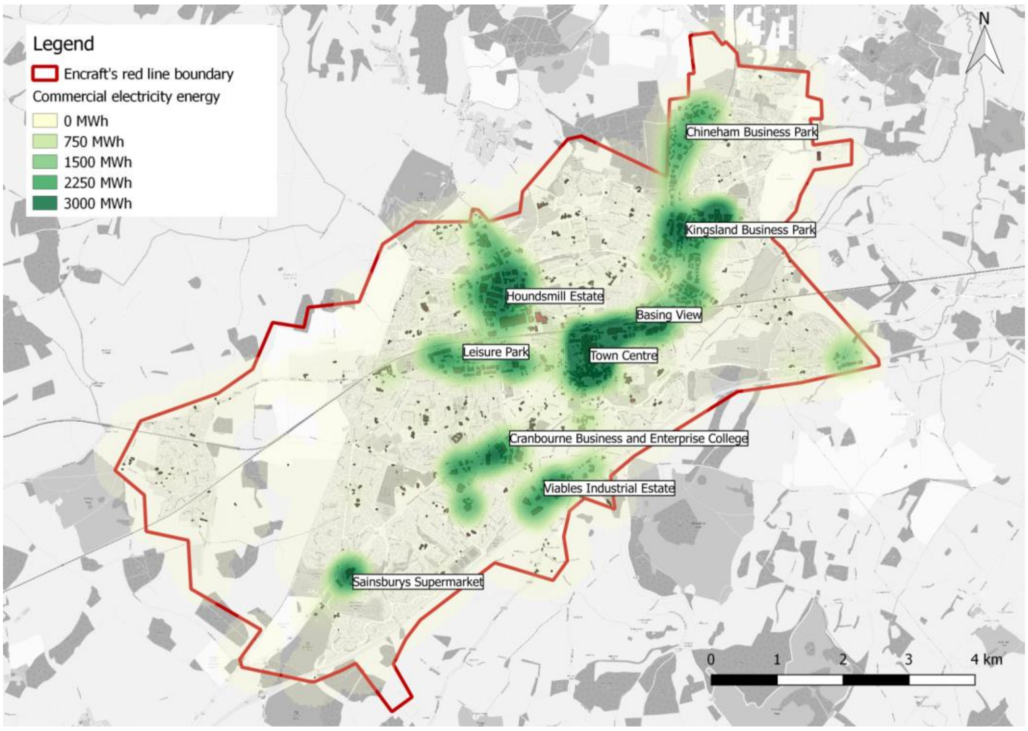


Figure 8: Commercial electricity energy (MWh/year) [Benchmarked data]

2.2.5 Commercial cooling loads

Cooling loads are very difficult to benchmark as the demand is hugely variable based on the individual buildings. Energy for space cooling data has been estimated as a sector specific fraction of the demand for heat for the non-residential sectors.

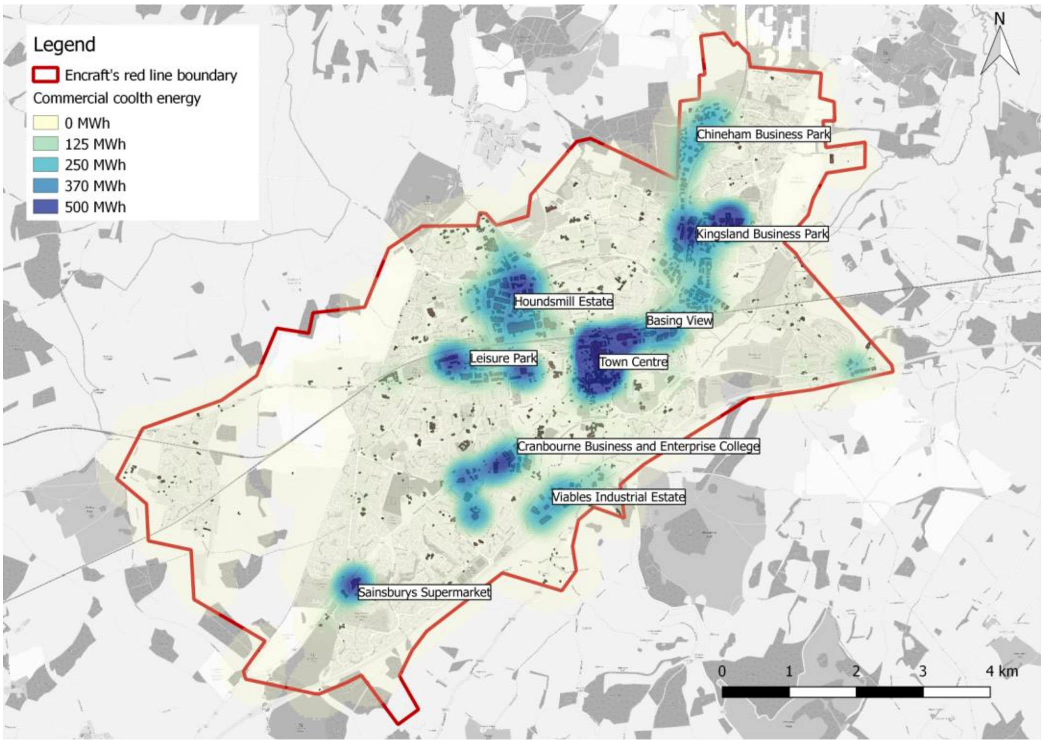


Figure 9: Commercial cooling energy (MWh/year) [Benchmarked data]

The provision of cooling requires dedicated equipment and also more network pipework. We were unable to identify any significant loads for cooling other than the ice rink within the area that could be connected to a network. The replacement of the existing plant with dedicated absorption chillers from the heat network was however dismissed as a viable option at this stage due to: the high capital cost of the plant, controls and pipe work; the limited demand from the potential users; and the newness of the existing air conditioning systems within the main buildings.

2.3 Demand mapping of key residential development areas

District heating schemes can provide an ideal opportunity to deliver low or zero carbon energy to communities as part of a decentralised energy system. Future residential developments may be appropriate to connect if pipe trenching costs can be minimised and integrated into construction works, and if energy dense loads can be appropriately clustered to optimise local energy density.

The strategic developments sites which have been earmarked for housing have been mapped separately using information provided by the Council and are depicted in Table 3 , Figure 10 and Figure 11. Opportunities across some of the new developments including East of Basingstoke, and Manydown have been addressed in more detail in a separate report.

New developments do not however play a role in the detailed clustering and modelling because they are not located close enough to the five most attractive clusters.

Table 3: Strategic development sites within project boundary

Development site	Development Timescales	Area (ha)	Allocation (number of dwellings)	Dwellings per hectare
SS3.1: Swing Swang	2017/18 – 2019/20	4	Approx. 100 homes	22
SS3.2: Kennel Farm	2016/17 – 2018/19	12	Approx. 310 homes	26
SS3.3: Razors Farm	2017/18 – 2022/23	19	Approx. 420 homes	22
SS3.4: North of Popley Fields	2015/16 – 2022/23	25	Approx. 450 homes and 1 school	18
SS3.7: Redlands	2017/18 – 2020/21	10	Approx. 165 homes	16
SS3.8: Upper Cufaude Farm	2020/21 – 2025/26	27	Approx. 390 homes and 2 schools	15
SS3.9: East of Basingstoke	2018/19 – 2022/23	67	Approx. 450 homes	7
SS3.10: Manydown	2017/18 – 2028/29	290	Approx. 3,400 homes	12
SS3.11: Basingstoke Golf Course	2020/21 – 2027/28	45	Approx. 1,000 homes	22
SS3.12: Hounsome Fields	2017/18 – 2027/28	41	Approx. 750 homes	18

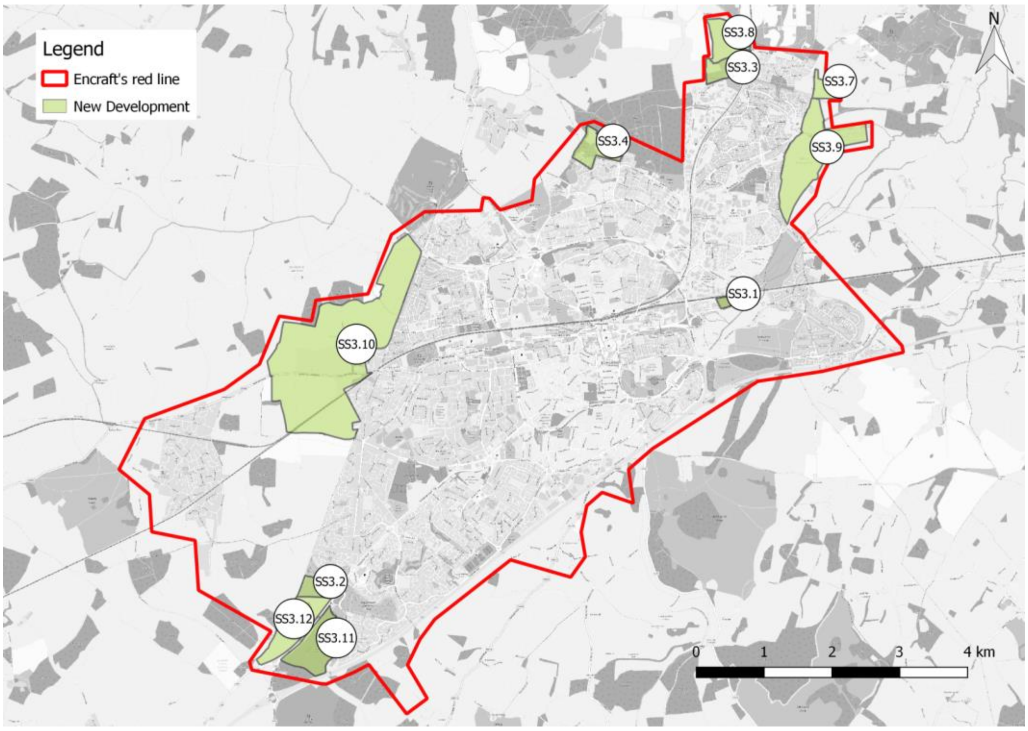


Figure 10: Strategic development sites

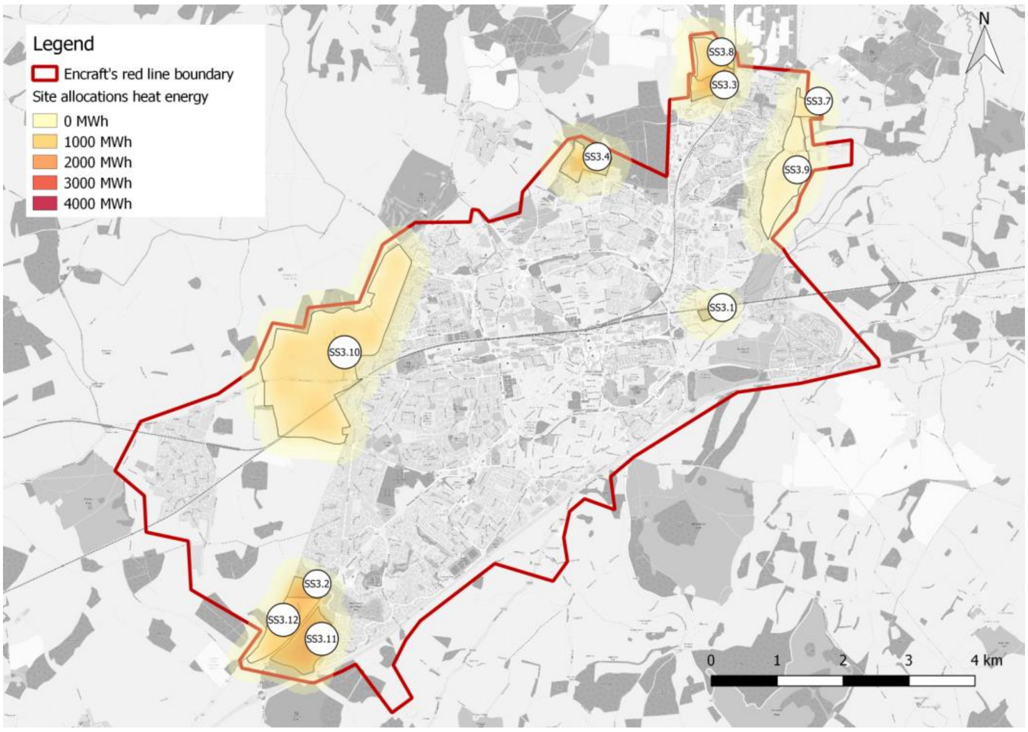


Figure 11: Heat energy density for the strategic development sites (MWh/year) [Benchmarked data]

2.4 Preliminary cluster analysis

Following the heat mapping a number of clusters were identified based on the grouping of potentially significant heating loads, the location of new developments, the location of existing or proposed Energy from Waste facilities, and council priority areas. These included a public and private sector facilities, and are depicted in Figure 12 with their associated reference code.

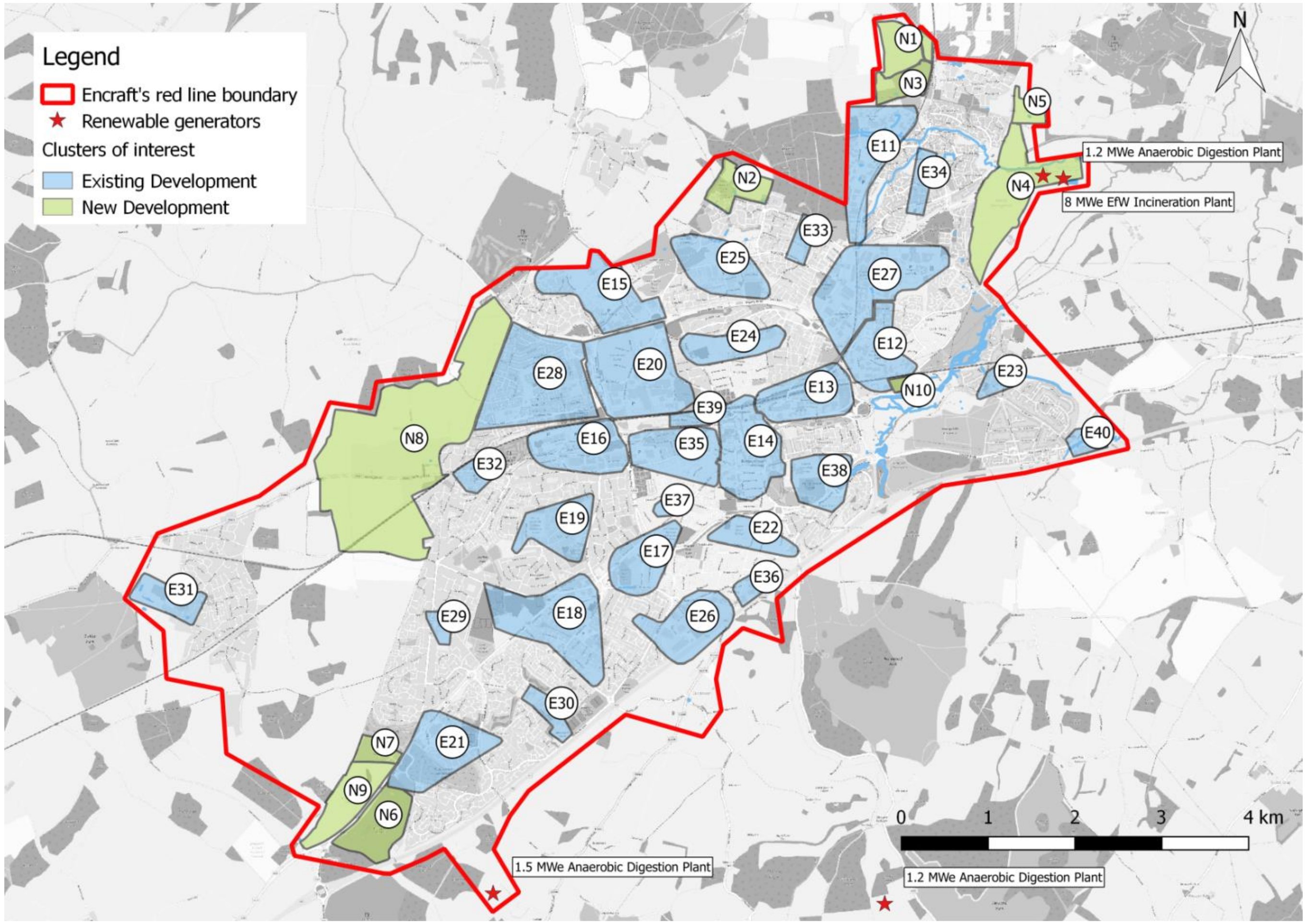


Figure 12: Heat clusters for prioritisation

In order to reduce the number of schemes considered for detailed techno-economic modelling, which is described later in the report, a high-level evaluation of each clusters was first undertaken (Table 4). The evaluation quantitatively assessed a range of attributes, including average building energy density and load diversity. A small selection of the results is depicted in Table 4. A comprehensive table is included in appendix 5.

Table 4: Evaluation of preliminary clusters considered for detailed techno-economic study

Cluster ID	Cluster Name	Cluster map area (m2)	Energy density per map square meter for top loads (MWh/m^2/yr.)	No. industrial addresses	Total No. addresses	Average building energy density (top loads) per GIFA kWh/m^2	No. municipal buildings	Anchor Load (Y:1; N:0)	Load Diversity of top loads (Distinct BLPU classes)	Local Priority Area (Y:1; N:0)	% addresses off gas	Major Constraint (Y:1; N:0)	Linear heat density for cluster top loads (MWh/m)	Viable heat network (Y:1; N:0; M:Micro cluster)
E13	Basing View	529,849	35	2	385	1,340	-		2	1	1	1	5	1
E14	Town Centre	672,563	12	8	2,340	456	6	3	6	1	4	1	1	1
E15	North Hampshire Hospital	666,451	17	20	1,101	690	5	6	7	-	22	-	2	1
E16	Leisure Park	564,608	4	36	159	400	2	4	4	1	1	1	1	1
E39	Railway high-rise housing	101,631	22	-	831	182	-		1	-	1	-	2	1

New developments do not play a role in the detailed clustering and modelling because they are not located close enough to the five most attractive clusters. Planning considerations are key to making the networks happen.

2.5 Connectivity

Connectivity is a measure of how likely a heat load is to connect to a heat network. Experience has shown that some loads such as shopping centres look great in terms of benchmark heat demand, but often use electrical heating systems rather than wet systems that are required by heat networks. The systems within potential customer's buildings can make a difference to the connectivity, as some systems such as steam and those with high return temperatures do not lend themselves to easy connection. Older systems can also cause difficulties and need to be taken into account when assessing the possible connections that can be made to a network.

This is examined in the Masterplanning phase in more detail (Section 3).

2.6 Heat supply opportunities and low carbon sources

There are a number of low carbon heat sources that may be connected to heat networks including but not limited to biomass boilers, heat pumps, mine water heat, deep geothermal and waste process heat. The suitability of each of these sources has been briefly outlined below. A comprehensive assessment of heat supply opportunities and energy supply technology options for each cluster will be carried out within the Masterplanning work packages. Supplementary information is available in appendix 6.

Table 5: Local suitability of a range of low carbon heat sources

Community Gas Boiler	Gas-fired CHP	Biomass boiler	Water source heat pumps	Ground source heat pumps	Industrial / commercial waste heat	Energy from waste incineration	Anaerobic Digestion	Mine Water heat	Deep geothermal
✔	✔	✔	✔	✔	✔	✔	✔	✗	✗

Biomass

Biomass can be used to create heat in a boiler, or heat and electricity in a Combined Heat and Power (CHP) plant, and is an attractive alternative to conventional fossil fuels where carbon reduction is important, or in areas off the gas grid. The Council owns 100 hectares of woodland across the borough and there may be scope to make use of this resource locally through its woodland management programme.

Discussions with Hampshire Woodfuel Cooperative suggest that they are able to supply up to 10,000m^3 wood chip/pellet at a cost of around 3p/kWh (£21/tonne + delivery). Given the price of natural gas of 2.03p/kWh, this option is most attractive in off-gas areas and will only be driven where a reduction in carbon emissions is a high priority.

There are however a number of potential constraints to the deployment of this technology including the visual impact of the biomass plant, fuel storage, and flue, and increased road traffic from bulk fuel deliveries. The location of biomass plant in Air Quality Management Areas (AQMA) can also sometimes pose challenges, though a check of local maps reveals that there are no AQMAs within the study boundary. The potential for AQMA's in the future will need to be assessed.

The use of biomass is a viable option for this study but the aforementioned constraints mean that it may be less suited to the highly populated areas like Basingstoke Town Centre and residential estates. Further work will be needed to fully explore this opportunity, taking into account the available space for energy centres.

Anaerobic Digestion (AD)
Where gas from anaerobic digesters is available, Combined Heat and Power plants can be a good match to produce electricity and heat. A search of the local area has revealed two AD plants including a 1.2MWe plant at Basingstoke Sewage Treatment Works and a 1.5MWe at Carousel Dairies.

The Sewage Treatment Works is situated within cluster N4, and connecting the on-site AD plant to this strategic development site (Redlands and East of Basingstoke) is technically feasible and warrants exploration in further detail during Masterplanning. The AD plant at Carousel Dairies is situated too far from any of the identified clusters to make it financially viable, and it is therefore not considering the use of this low carbon heat source in any further detail.

Process and waste heat
Low grade process and waste heat can be a good match to heat networks, acting as a base temperature injection on the return leg of the network depending on the system's design temperature.

An initial pass of data has revealed two possible sizeable sources of local heat including the Veolia Energy from Waste facility (EfW) in Chineham, and existing energy centre at Basingstoke Hospital. As communication with local stakeholders accelerates, local alternatives will continue to be explored.

The Veolia EfW is located within the strategic development site N4, and connecting the plant to residential dwellings within this cluster is technically feasible and warrants further exploration during Masterplanning.

The energy centre at Basingstoke Hospital incorporates a 1MWe CHP and is located within cluster E15, and also in close proximity to the strategic development sites N2 and N8. This presents a potentially attractive local heat source, and/or a possibly convenient site for the siting of a new energy centre if required.

Ground source heat
DECC published a report in February 2016 which recognises the value of using heat pumps in District Heating to lower carbon emissions in place of central gas boilers or gas based CHP. Heat pumps can be installed with heat sinks in boreholes, shallow 'slinky', or in a water body.

Ground source heat pumps use the ambient temperature of the ground as a heat sink/ source. There two types; borehole and surface.

- Boreholes can be expensive to install but provide the most reliable and effective heat sources. They are less prone to seasonal variation than other heat sinks, and are ideally suited to areas where the availability of undeveloped land is a premium.
- Surface heat sinks require coils of pipe to be installed in shallow trenches. They however require a large area to be effective. Municipal parks, grassland and school playing fields like those at the Costello School may be technically appropriate for this.

Water source heat

Water source heat pumps can be either open or closed systems. Where a large body of water is available, closed loop systems can be a cheaper alternative to shallow ground source sinks as the coils are dropped in open water (such as a canal). Open systems, where the water is extracted directly from the water source to be run through a heat exchanger, can be very effective and cheap, but can need to be designed and maintained very well.

Figure 16 and 17 depict two potential water sources including the Vyne Stream to the north, and the river Loddon, which dissects the Town Centre.

Whilst these sources both have a fairly low heat capacity, the proximity of the River Loddon to the strategic development sites N4 and N10, and the proximity of the Vyne Stream to strategic development site N2, present an opportunity to explore the use of this heat source in energy dense dwellings such as blocks of flats and high-rise developments. There may be scope to specifically explore the deployment of a low temperature heat network which uses heat pumps in each dwelling to capture the heat from filtered river water.

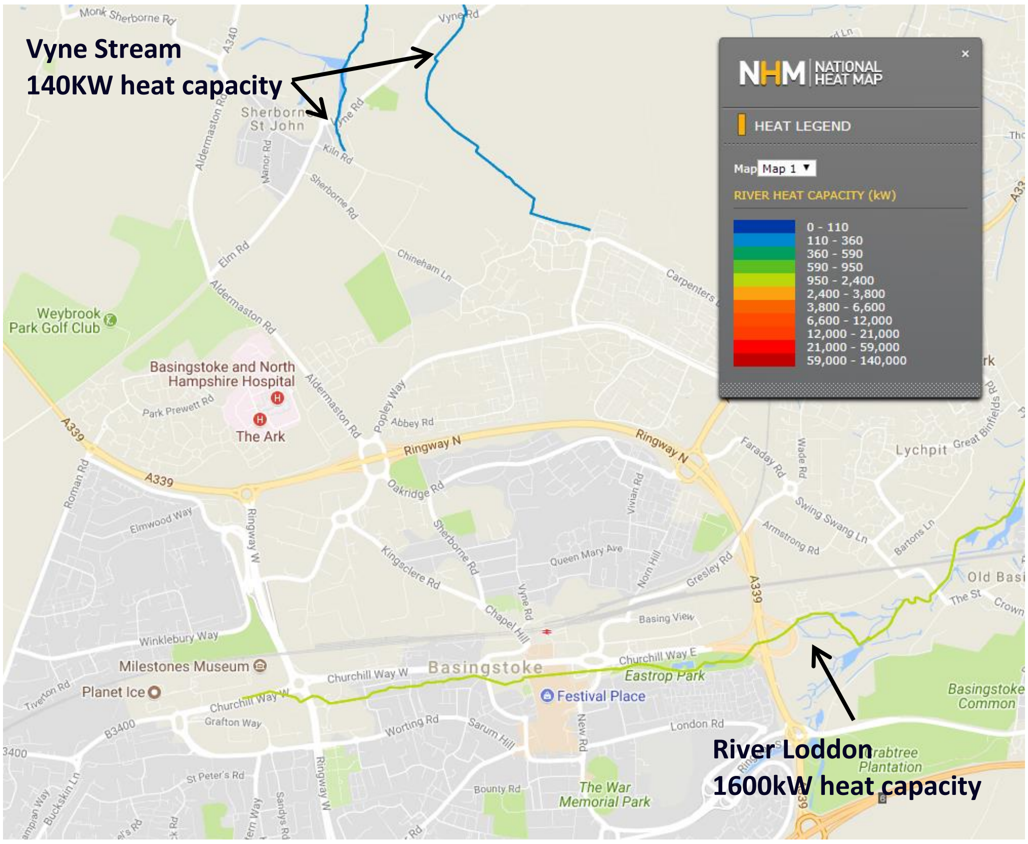


Figure 13: Centre for Sustainable Energy Water Source Heat Map

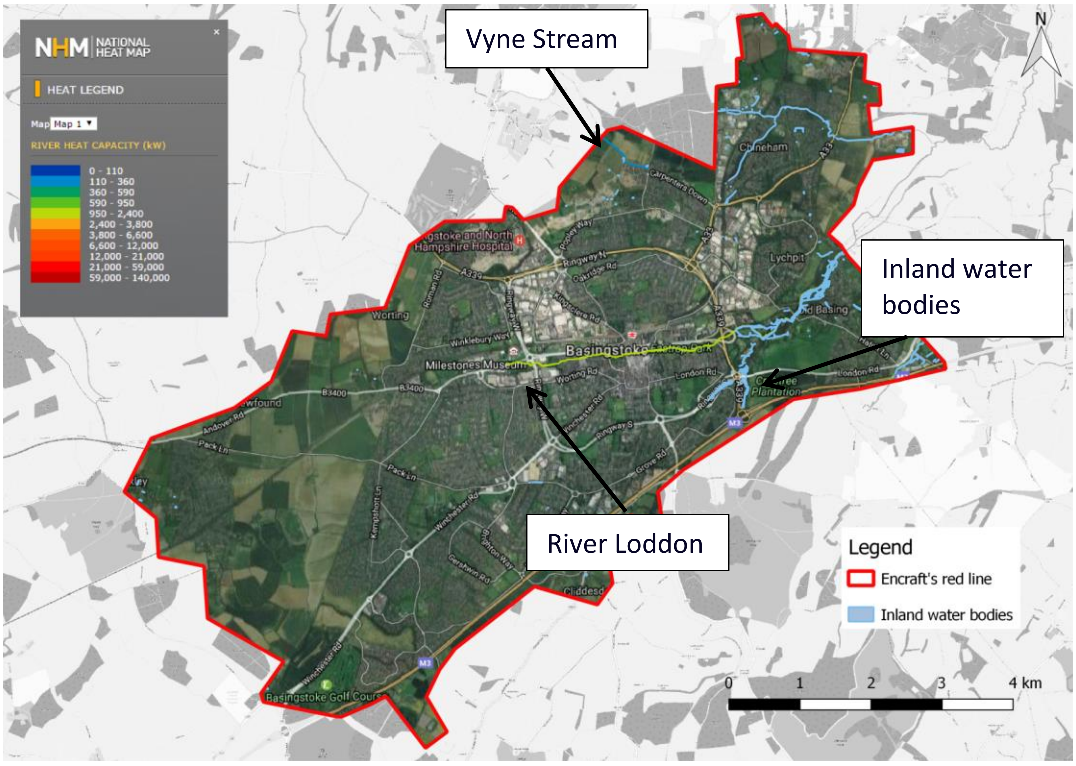


Figure 14: BEIS Water Source Heat Map (http://csembaa1.miniserver.com/index.html)

Mine water heating

The heat energy contained within mine water systems can in some circumstances be extracted and used in supplying heat to urban and rural areas. Analysis of the Coal Authority's map [Figure 15] indicates a lack of mine workings in the study area, and therefore this technology will not be considered in any further appraisal.

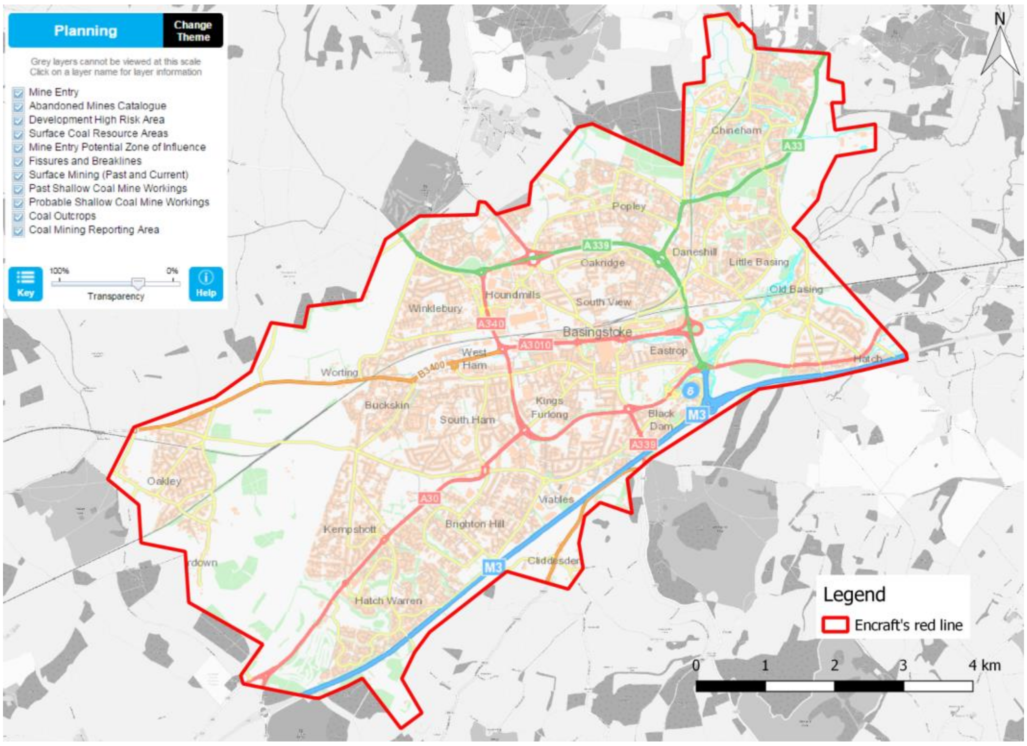


Figure 15: Coal authority map discounting the presence of mine water heat (http://mapapps2.bgs.ac.uk/coalauthority/home.html)

Deep Geothermal

Geothermal energy is the energy stored in the form of heat in the Earth. This can be made available by injecting water into a hot rock or aquifer and returning the heated water to the surface. The UK only has limited areas that have been identified as having deep geothermal potential.

Figure 16 shows that Basingstoke (identified by an orange circle) is not in an area identified by the British Geological Survey as having a deep geothermal potential. As such this has been written off as a possible technology in this case.

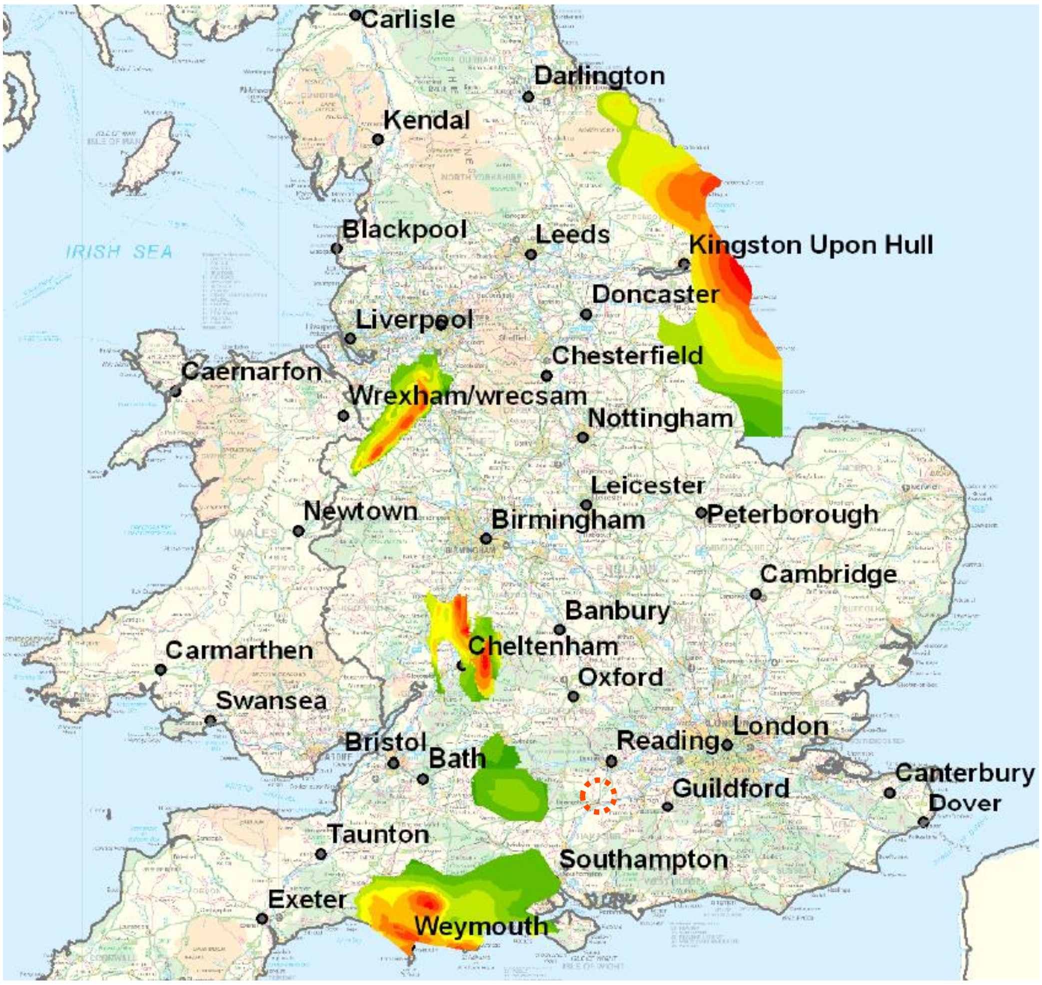


Figure 16: Geothermal resources in the UK mainland

3. Master Planning

3.1 Heat sinks (anchor loads)

In order for a heat network to be considered feasible there needs to be anchor loads. These are consistently high heat demand customers. Anchor loads are the commercial foundation of a heat and power network and thus need to be large and long-term contractual customers with a defined revenue stream and in close proximity to each other and the energy centre: typically anchor loads are in public ownership. These loads allow the heat sources to run at optimal operating conditions while supplying heat across the network. These tend to be industrial loads that run 24/7 or large municipal heat demands like hospitals or swimming pools. We have identified a number of significant loads within the constraint area, some of which could act as anchor loads.

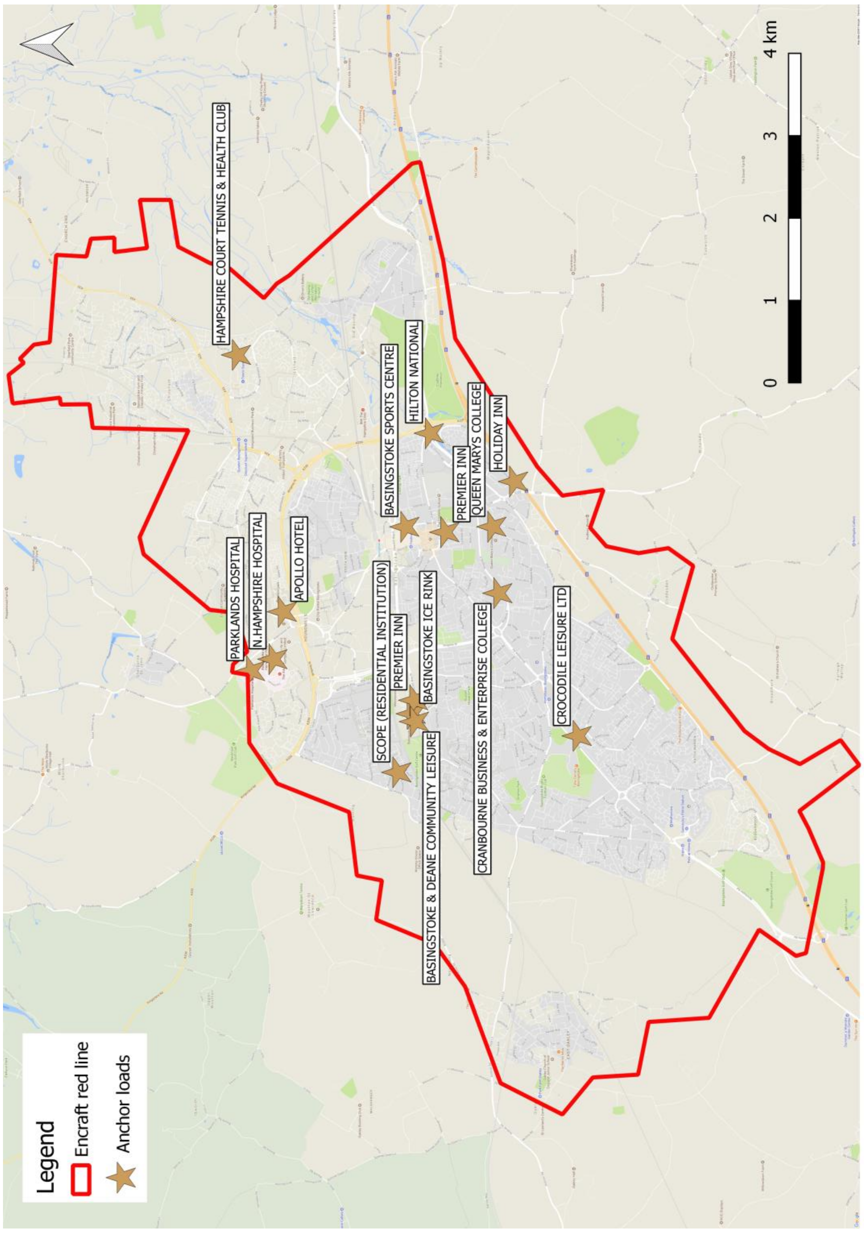


Figure 17: Major loads across study area

Organisation	Gross Floor Internal Area (m2)	Annual Cooling Demand (MWh)	Annual Heat Demand (MWh)	Annual Electrical Demand (MWh)	Energy data source	Anchor
N.HAMPSHIRE HOSPITAL (Sherborne, Firs, AAU, ARK, Lasham)	55,322	-	23,206	10,319	Meter data	Y
PARKLANDS HOSPITAL	6180	-	1,009	855	Meter data	N
BASINGSTOKE & DEANE COMMUNITY LEISURE (AQUADROME)	7,223	-	10,305	70	DEC	Y
BASINGSTOKE SPORTS CENTRE (SWIMMING POOL)	6,531	93	1,032	418	EPC / Benchmark	N
HILTON NATIONAL	3,857	74	926	309	Benchmark	N
APOLLO HOTEL (WITH SWIMMING POOL)	3,244	-	779	321	Benchmark	N
PREMIER INN (Town Centre)	2,886	-	693	231	EPC / Benchmark	N
PREMIER INN (Leisure Park)	2,881	55	691	230	EPC / Benchmark	N
BASINGSTOKE ICE RINK	3,915	272	672	272	EPC / Benchmark	N
HAMPSHIRE COURT TENNIS & HEALTH CLUB (WITH SWIMMING POOL)	8,112	29	641	260	Benchmark	N
HOLIDAY INN	2,513	48	603	201	Benchmark	N
CRANBOURNE BUSINESS & ENTERPRISE COLLEGE (WITH SWIMMING POOL)	2,907	3	314	73	Benchmark	N
QUEEN MARYS COLLEGE (WITH SWIMMING POOL)	455,610	5	305	5	Benchmark	N
CROCODILE LEISURE LTD (SWIMMING POOL)	1,364	23	258	105	Benchmark	N
SCOPE (RESIDENTIAL INSTITUTION)	952	-	235	42	Benchmark	N

Table 6: Major local energy loads, including anchor loads *(A communication log is available in appendix 15 and depicts all conversations Encraft have had with stakeholders.)*

3.2 Cluster prioritisation

The initial analysis in Work Package 1: Heat Mapping, led to the identification and preliminary review of forty possible opportunity clusters, which have been bought forward into Work Package 2 for further investigation and prioritisation.

These clusters each contain a mix of commercial and residential loads, and each is defined by geographic features or constraints such as main roads. These key areas were discussed and re-evaluated with the council during the heat mapping review meeting.

In order to reduce the number of schemes considered for detailed techno-economic modelling, a prioritisation exercise was carried out to help identify the most attractive opportunities for connection to a heat network. The analysis scored each cluster against a range of weighted attributes, including but not limited to:

- Size of heat loads
- Linear heat density
- Load diversity
- Number of anchor loads
- Waste heat availability
- Number of industrial addresses
- Number of municipal buildings
- Number of off-gas addresses

In prioritising potential loads the major physical network constraints specific to the core clusters had to be considered. These are discussed in more detail later in the report and in appendix 4.

These scores were normalised, and a weighting was applied according to the perceived importance, and political and technical impact of individual attributes on the success of a network, ensuring that those which could have a significant impact on success of a heat network, were appropriately scored. Attributes which were deemed to likely positively contribute to the success of a network were weighted positively; those which were deemed to have potential to detrimentally affect a network were weighted negatively.

Table 7 shows the final scores for the top ten clusters which is the sum of the scores across all of the reviewed attributes. A comprehensive breakdown of the scores is available in appendix 5.

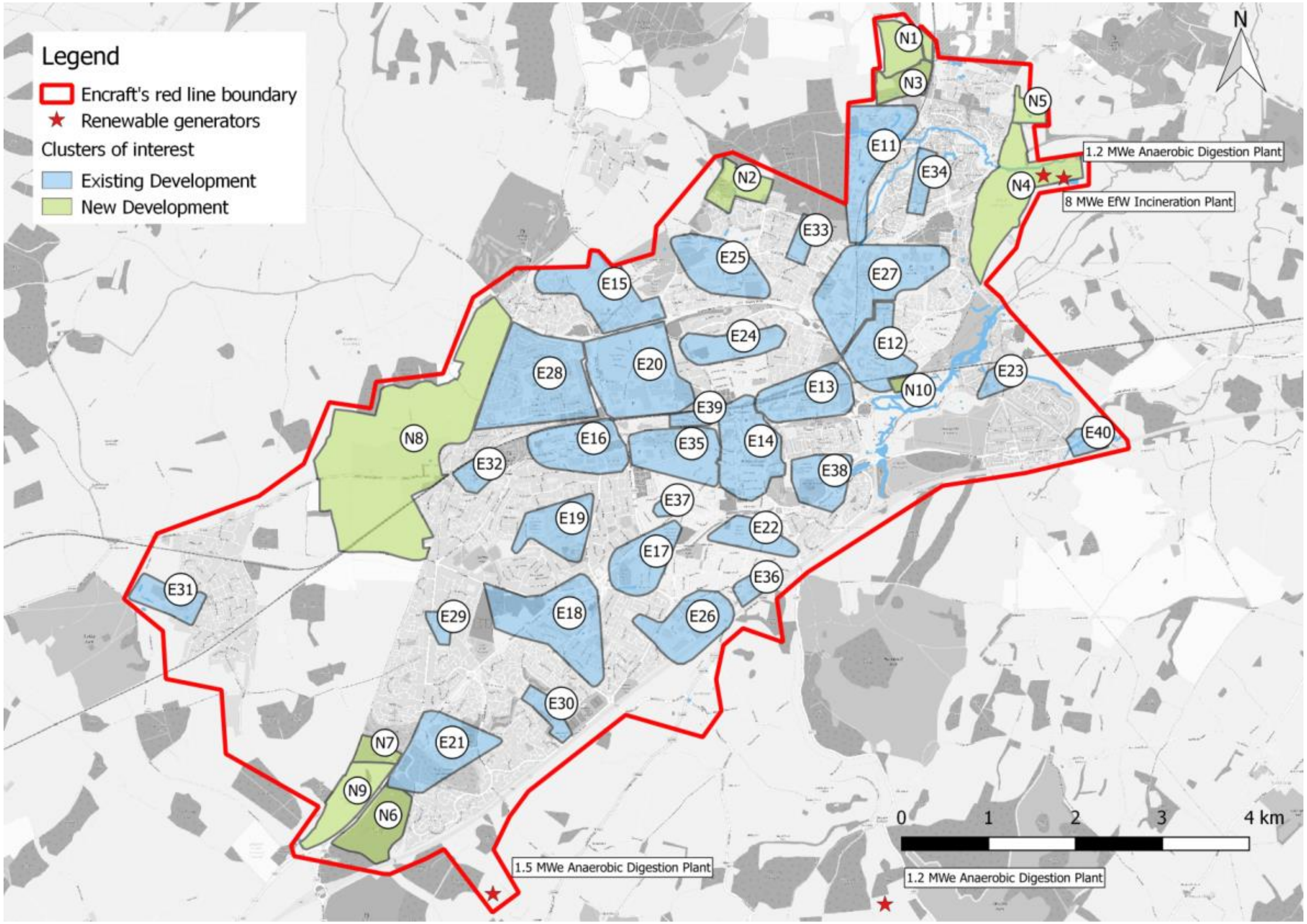


Figure 18: Map of identified heat clusters

Table 7: Weighted scoring matrix for the top ten clusters

Cluster		Energy density per map square meter for top heated loads	Average building energy density for top loads per GIFA	Linear heat density for top buildings	Anchor Load	Municipal buildings	Load Diversity (Distinct heated BLPU types)	No. of industrial addresses as a % of total addresses	% addresses off gas across cluster	Waste heat available	Major physical constraint	Local priority	Viable network	Score (Sum of totals)	Rank
E13	Basing View	*2,157*	*691*	*106*	*0*	*0*	*3*	*-3*	*1*	*0*	*-100*	*500*	*1*	*3356*	***1***
E15	North Hampshire Hospital	*1,009*	*356*	*41*	*200*	*100*	*13*	*-9*	*22*	*0*	*0*	*0*	*1*	*1732*	***2***
E14	Town Centre	*703*	*235*	*24*	*200*	*120*	*10*	*-2*	*4*	*0*	*-100*	*500*	*1*	*1695*	***3***
E39	Railway high-rise housing	*1,312*	*94*	*47*	*0*	*0*	*100*	*0*	*1*	*0*	*0*	*0*	*1*	*1554*	***4***
E16	Leisure Park	*216*	*206*	*22*	*200*	*40*	*9*	*-113*	*1*	*0*	*-100*	*500*	*1*	*980*	***5***
E36	Martins VW	*655*	*211*	*68*	*0*	*0*	*33*	*-3*	*0*	*0*	*0*	*0*	*1*	*963*	***6***
E38	Costello School	*332*	*259*	*37*	*200*	*60*	*67*	*0*	*0*	*0*	*-100*	*0*	*1*	*854*	***7***
E22	Queens Mary College	*378*	*210*	*27*	*200*	*20*	*9*	*0*	*0*	*0*	*0*	*0*	*1*	*843*	***8***
E24	The Vyne School	*355*	*103*	*12*	*200*	*140*	*11*	*-1*	*0*	*0*	*0*	*0*	*1*	*820*	***9***

E26	Viables Industrial Estate	*450*	*259*	*26*	*0*	*20*	*13*	*-44*	*1*	*0*	*0*	*0*	*1*	*724*	***10***
Weighting	***N/A***	***10***	***5***	***2***	**200**	***20***	***10***	**-5**	**1**	**1**	**-5**	***25***	**-**	**-**	**-**

*The figures in the following table are weighted scores, and not units of energy, area or otherwise. See appendices for raw data table.

Highest scoring clusters

The project prioritisation process led us to five final clusters to model in the local area. New developments do not play a role in the detailed clustering and modelling because they are not located close enough to the five most attractive clusters.

- **Cluster E13:** Basing View – A commercial cluster located slightly east of the centre of the study area, comprising a multitude of high rise office blocks. The small geographical footprint of the cluster, and presence of high rise buildings, leads to a cluster with a high energy density, which is well suited to district heating. Early investigations have also revealed that some of the offices rely on gas as their primary heating fuel, and therefore are likely to have wet systems compatible with heat networks.

  This River Loddon runs parallel to this cluster, and there may be potential here to use this to provide renewable heat.

- **Cluster E15:** Hospital complex – A cluster situated to the north of the Town Centre, comprising a multitude of sizeable and high density loads, many of which are under municipal control. Buildings include Homefield House residential care home, Candover Clinic Private Hospital and Apollo Hotel, which has a swimming pool, in addition to the main hospital. Importantly, the cluster comprises several excellent anchor loads, and there is plentiful surrounding space for a new energy centre if required.

  Cluster E15 offers an excellent opportunity and Encraft believes this warrants further detailed investigation.

- **Cluster E14:** Town Centre - The cluster is a mixture of retail, leisure and municipal buildings including the Civic offices, Premier Inn and Basingstoke sports centre with swimming pool.

  There may also be an opportunity here to supply heat and/or electricity to some of the larger retail outlets within the Malls, including Marks and Spencer, Debenhams and Next, though further investigation is required to understand the viability of this.

  Retail premises tend to be ‘hard to connect’ due to the existing infrastructure, tenancy and ownership arrangements, and low heat loads.

- **Cluster E39:** High rise residential dwellings off Winterthur Way – The cluster comprises a small group of all-electric high rise residential dwellings, constrained to a tight geographical footprint, leading to a high energy density.

  Despite this, the dwellings appear relatively new, meaning that the timeframe of this study is unlikely to align with the lifecycle of the existing heating systems. This does not however rule out an opportunity here, nor would it prevent this cluster being connected to a local network in the future; particularly where external funding could be sought.

- **Cluster E16:** Leisure Park - The cluster is a mixture of high energy leisure and commercial facilities including Basingstoke Aquadrome, ice rink, Odeon Cinema and Johnsons Apparelmaster (commercial laundry). The loads present within this cluster presents an interesting opportunity for trigeneration, where heat could be supplied to facilities including the swimming pool; cooling to the ice rink, and electricity to the indoor skydive centre.

The regeneration of these facilities (expected to open 2022) also presents a timely opportunity to possibly combine construction works with laying of heat pipe and construction of a purpose built energy centre, helping to minimise the cost of the necessary capital works.

Despite the merits of the top clusters having been discussed independently, the proximity of clusters E13, E14, E39 and E16 could make for a potentially attractive opportunity to connect the top loads across each, perhaps as part of a phased approach, to form what may be termed the 'Loddon Energy Corridor'. This may help enhance network load diversity and improve the base heat load, and needs to be considered for clusters taken forward to detailed feasibility.

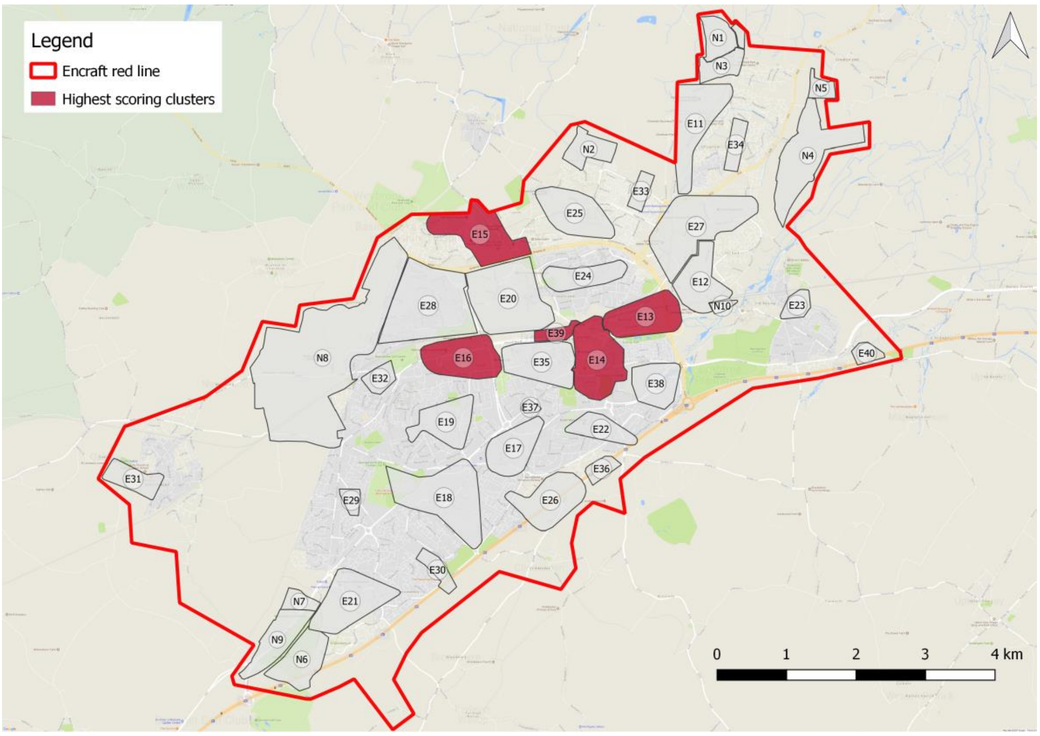


Figure 19: Cluster map depicting the five highest scoring clusters

Clusters excluded from further analysis

Further investigations have also revealed a number of clusters which Encraft do not believe represent attractive network opportunities, principally due to a lack of multiple and sizeable heat loads, and therefore which can be eliminated from the study altogether:

- **Cluster E21 -** A small cluster of retail and academic facilities including St Marks C of E Primary School, situated at the extremity of the study boundary, north of the Kennel Farm residential development site. The school is the only sizeable connectable load within this geographic area, and as such there is not a strong case for a heat network here. Further investigations could consider these loads in the context of new residential developments close by.
- **Cluster E32 -** A small cluster of commercial, industrial and retail premises including the Chiltern Primary School, situated south of the Manydown residential development site. Like in cluster E21, the school is the only sizeable connectable load within this geographic area, and as such there is not a strong case for a heat network here. Further investigations could consider these loads in the context of the Manydown residential development.

- **Cluster E40 -** A very small cluster of commercial, industrial and retail premises including Martins VW show room, situated on the outskirts of the study area, outside of the main retail and industrial core. The cluster comprises only a few small heating loads, many of which are electrically heated, and lacks an anchor load.

3.3 Heating options appraisal

3.3.1 Energy supply options appraisal

An assessment of appropriate heat options has been conducted and documented in Table 8 for each of the key clusters, and feeds into the financial modelling described later in the report. Each heating option is described in detail in the appendices.

Table 8: Table depicting the most suitable technologies for the main clusters

Cluster	E13: Basing View	E14: Town Centre	E15: Hospital	E16: Leisure Park	E39: High-rise residential	Comments
Community Gas Boiler	✗	✗	✗	✗	✗	Technically viable but not expected to generate any financial or carbon savings across any cluster compared to the decentralised systems currently in operation.
Gas-fired CHP	✔	✔	✔	✔	✗	Gas is available across all clusters except for E39. Gas CHP is a mature technology, and the simultaneous generation and sale of electricity would help subsidise network costs, and help improve price stability and energy security for Local-Authority owned estates, local businesses and residents.
Biomass boiler	✔	✔*	✔	✔	✗	Significant space is required for the plant, fuel storage, and auxiliary plant. Good road access is also required for frequent bulk deliveries, and consideration would have to be made if sited near residential dwellings. The price of biomass is typically greater than that of gas, making this solution most attractive in off gas areas. *Not clear if there would be space available that would not be of detriment to commercial activities.
Water source heat pumps	✔	✔	✗	✔	✗	The River Loddon cuts through the city centre from east to west, and provides a possible heat source for use in the neighbouring clusters: E13, E14 and E16. Heat pumps would need to be used in conjunction with back-up plant like gas boilers.
Ground source heat pumps	✗	✗	✗	✗	✗	The limitations of capturing secondary heat from the ground or air at the scale required for DHNs means these systems are not suitable. 'Heat only' networks may not be able to provide the same competitive heat tariff that is offered by gas-fired CHP plant.
Industrial / commercial waste heat	✗	✗	✗	✔ (?)	✗	The Johnsons Apparel laundry is the only likely suitable waste heat source which Encraft are aware of across the core clusters, though further research would be required here as attempts to engage with this stakeholder has been limited. This heat source would only be applicable to buildings within E16 given its location.
Energy from waste incineration	✗	✗	✗	✗	✗	There are no EfW plants within any cluster.
Energy from waste – Anaerobic Digestion	✗	✗	✗	✗	✗	There are currently no AD plants within any cluster.

Further investigation has revealed Cluster E39 (high-rise residential development off Winterthur Way) is in an off-gas area and space is extremely restricted, limiting the available community heating options. A site survey would be required where this opportunity is taken forward for detailed analysis. The costs of converting flats from electric heating systems can cost up to £11,000[3] and given they are relatively new (build date unknown), these costs will be prohibitive without funding like that available through HNIP[4] (Heat Networks Investment Project). Residents would also need to be surveyed and agree to the conversion, which could pose a significant challenge. For these reasons, they are not considered a viable connection and will not be considered in ongoing modelling.

Energy Supply Recommendation: Gas-fired combined heat and power (CHP)
Combined heat and power (CHP) integrates the production of usable heat and power (electricity), in one single, highly efficient process.

CHP is well suited for heat networks and is the recommended heat raising option across all clusters given gas is available and the electricity generated could be sold at a good profit, to cross subsidise the heat tariff to provide heat at a competitive rate. Given this, CHP heating options typically provide more attractive rates of return than heat only supply options like biomass boilers or heat pumps. CHP is a mature, efficient and very well understood technology, and is physically compact compared to something like biomass, where fuel storage must be considered; allowing its use where space is a premium.

CHP can also provide opportunities to provide grid capacity control, depending on scale and location. This is beyond the scope of this report.

Gas CHP produced electricity is regarded as low carbon because it is currently considerably less carbon intensive than grid electricity. This is due to the grid incurring losses through transmission and distribution, alongside the fact that carbon intensive sources such as coal are currently used in the production of grid electricity. This will not always be the case. Over the next ten years or so it is predicted that the carbon intensity of the grid will decrease dramatically as coal fired power stations are decommissioned, and more renewables and nuclear are commissioned.

A comprehensive analysis of energy supply options will need to be covered in greater detail for any clusters taken forward to detailed feasibility.

3.3.2 Compatible heating systems

District heating is only compatible with buildings fitted with wet systems. A traditional wet heating system comprises of a central boiler or heat exchanger, and a network of radiators and water pipes. In heat networks, heat interface units are used in the place of the traditional boiler; they are heat exchangers that bridge the gap between the buildings existing heating system and central energy centre.

The costs of retrofitting a wet system in a building to accommodate a heat network connection can inevitably add significant costs to a project; this is particularly true when retrofitting multiple residential dwellings.

[3] Pöyry. (2009). The Potential and Costs of District Heating Networks.
[4] HNIP, https://www.gov.uk/government/publications/heat-networks-investment-project-hnip (21/11/17)

3.4 Local priorities

A project prioritisation workshop was held in September 2017 where feedback was obtained on the ongoing modelling and analysis of heat network clusters, from both internal and external stakeholders; including representatives from the Council, North Hampshire Hospital and Veolia.

Attendees were presented with a criterion and asked to rank their priorities from 1 to 7, in small groups, to provide an indication of the direction of thinking. None of the scores were weighted; an average of the results is displayed below. The higher the average score, the higher the priority for those surveyed.

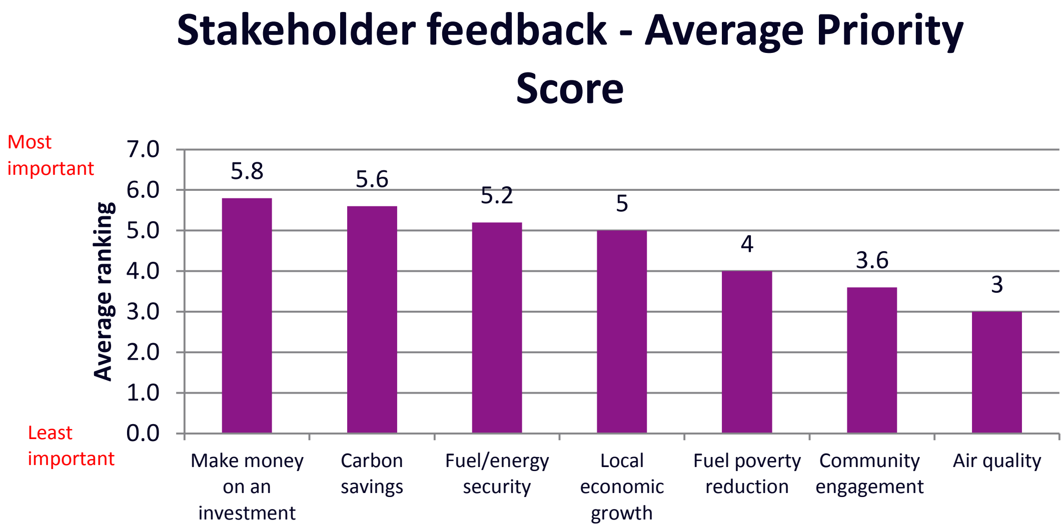


Figure 20: Stakeholder feedback

The most important drivers were economic: providing a return on investment for shareholders and creating financial savings for end users being the clear leading priorities. Carbon savings, and energy and fuel security were followed behind closely; fuel poverty reduction and local economic growth were seen as important but non-critical priorities.

4. Detailed Cluster Analysis

The project prioritisation process led us to five final clusters to model in the local area. The following section explores each cluster in detail, with a focus on cluster specific anchor loads, possible energy centre locations and local constraints. More detailed conversations with the stakeholders and Council, and more detailed plant rooms surveys would be needed for any clusters taken forward to detailed feasibility. High-level consideration has also been made to how a network could be phased, though optimisation would be required as part of a detailed feasibility study. Phases are depicted as circled single digit numbers on the cluster maps in this section.

New developments do not play a role in the detailed clustering and modelling because they are not located close enough to the five most attractive clusters.

Cluster E13: Basing View Cluster

The cluster is situated to the east of the Town Centre, comprising a multitude of sizeable offices and retail units.

Cluster E13: Basing View Cluster
Buildings within cluster and approach to phasing
• Heating and private wire connections: Village Hotel, Belvedere House, Northern Cross, Business Environment Offices & Adjacent Complex, Network House, Mountbatten House, Eni Engineering E & P House, Matrix House, Southern Cross, Unum House, Quantum House, Waitrose, John Lewis • Private-wire only connections: Network Rail Basingstoke Campus A comprehensive list of phased connected loads is available in appendix 9. • The first phase encompasses the highest energy loads that are closest proximity to the network anchor load – the future Village Hotel's swimming pool. Quantum House and Unum House have been included in phase 2; although these lay on the boundary of phase 1 and 2, these addresses have a significantly lower energy demand than the other buildings in phase 1 and would bring down the pipework linear heat density in the primary phase. The addresses which present the greatest challenge to connect across this cluster including Waitrose, John Lewis and Network Rail, are proposed to form part of the last phase, phase 3.The Waitrose and John Lewis store is very new, and the age of the heating plant and the type of customer make for a higher risk connection. The Network Rail Campus is located to the North and is separated by a major infrastructure barrier – the railway line, and there is therefore a greater risk that this connection could prove cost prohibitive upon detailed investigation. A list in the appendices shows the buildings which fall under each phase, against their energy load data. A technical summary is provided below.

Cluster	Total annual heat demand (MWh)	Total peak heat consumption (kW)	Total modelled CHP size (kWth)	Auxiliary heat raising plant size (kWth)	Total thermal store size (m^3)	Heat pipe (m)
Phase 1	7,948	1,921	770	1,689	111	561
Phase 2	12,276	3,063	1,230	2,691	172	1036
Phase 3	14,514	3,604	1,440	3,173	203	1045

Opportunities

- There are several regeneration opportunities across the site which presents a timely opportunity to consider the viability of connecting these loads to a local network.

  The construction of a new 153 bed hotel, with swimming pool, is expected (by December 2019) at the eastern end of the cluster. This would provide an excellent anchor load that would help to strengthen the case for a local network and improve the load diversity. Given the availability of undeveloped land is extremely limited, new developments provide an opportunity to design and integrate a purpose built energy centre.
- The Council holds the freehold for much of the site, and may be able to help leverage an opportunity here, where the financial returns are deemed to be attractive.

Constraints, and considerations and risks around the network and its expansion

- Phase 1:
  - The Village Hotels is a new development expected to be constructed by December 2019. Engaging with and connecting to this anchor load is important in strengthening the business case of a local network and to optimise load diversity.
  - Land is extremely limited across this cluster and setting aside a parcel of redevelopment land for the provision of an energy centre is central to the facilitation of a local network.
  - n.b. Following modelling, plans to demolish the AA building were placed aside, with no impact on the future Village Hotels site. A future detailed feasibility study would need to encompass the energy load of the AA building.
- Phase 2:
  - Many of the office premises are sub-let by multiple private tenants, with the energy needs being managed by a third party. Existing contracts may be seen by local stakeholders as a barrier to connection.
- Phase 3:
  - The John Lewis and Waitrose store to the east of the complex is a new retail outlet (2015); given this, the working life of the heating assets are likely to exceed 15 years, and the interest from this organisation to connect could therefore be limited. Further consultation with John Lewis and Waitrose would be required where this cluster is taken forward to detailed feasibility.
  - The railway line dissects the cluster, separating the Network Railway Basingstoke Campus in the north, from the bulk of the cluster in the south. The costs and complexity of crossing the

railway, even at the nearby bridge, could ultimately prove prohibitive.

Dig type and land ownership

- An initial assessment has revealed that the majority of the pipework within the cluster would have to be laid in hard-dig given the built-up city-centre environment, increasing dig costs and complexity. The cluster is however situated almost entirely on municipal land.
- Private wire connections from the final energy centre location may require complex negotiations to cross sites with varying land ownership

Energy centre location appraisal

Preferred Option: New Village Hotel development (A)
It is expected that the AA building will shortly be replaced by a new hotel. Given this, there may be the opportunity to utilise a small parcel of this land for the provision of an energy centre.
Space is extremely restricted across this cluster, and future development sites represent the most attractive opportunity for such facilities.

Further engagement with the Developer is required going forwards to understand the viability of this option. Fall back options, including the use of existing plant rooms need to be investigated in greater detail.

Major loads

- The future hotel (with swimming pool) is the key load within this cluster, and the modelling has assumed this load would be key to the first phase of a local network.

Existing plant

- Although yet to be built, discussions with the developer for the Village Hotel has revealed that their typical approach to the provision of heating and hot water is through gas boilers, air handling units and electric air condition units.
- Despite repeated attempts to engage with local stakeholders, no site visits could be organised to visit the plant rooms across this cluster. Energy Performance Certificates for buildings suggest that there is a mix of properties heated using both grid electricity and natural gas.
- Delayed connections to the district heat and power networks will reduce revenue streams in the early years and thus reduce the attractiveness to early-stage commercial investors

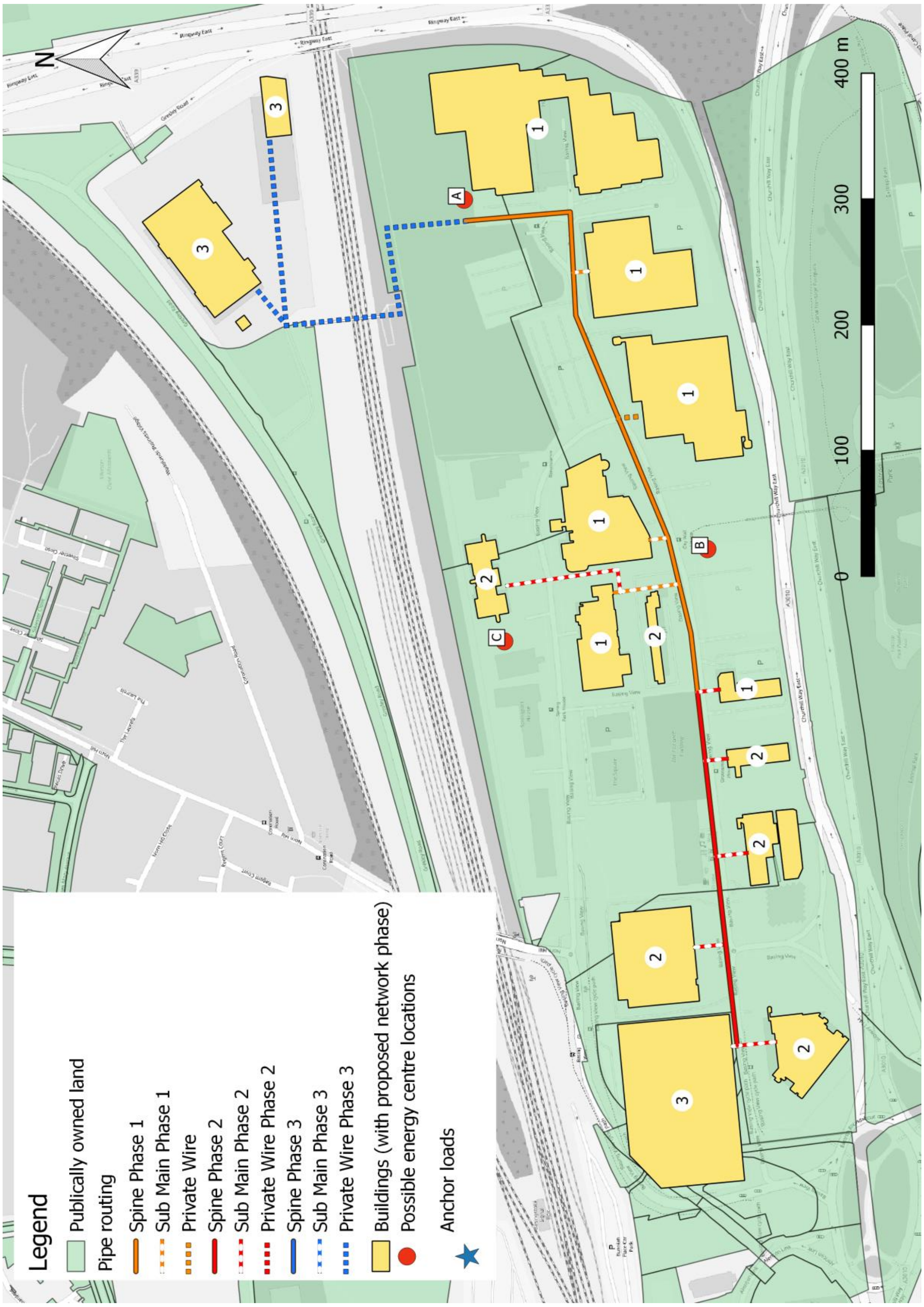


Figure 21: Basing View cluster map with pipe routing, possible energy centre locations and anchor load identification, and possible network phases (circled)

Building labels have been excluded from this map for clarity; they are referenced on the dig-type map for this cluster

N.B A building outline for the New Village Hotels development was not available at the time that the modelling was undertaken but it is anticipated the building would be situated adjacent to the AA Building.

Preferred energy centre location: Site of Village Hotel

Figure 22: Basing View cluster map showing dig type

Energy centre location options are labelled in order of preference from A-Z.

Cluster E15: Hospital Cluster

The cluster is situated to the north-east of the Town Centre, comprising a multitude of sizeable and very high density loads, many of which are under municipal control.

Cluster E15: Hospital Cluster

Buildings within cluster and approach to phasing

- Heating and private wire connections: North Hampshire Hospital including Sherborne building, The Firs, and Candover Clinic; Apollo Hotel, Eli Lilly, Castle Hill Primary, Optivo Keyworker Housing, Homefield House
- Private-wire only connections: St Michaels Hospice, NHS Property Services

  A comprehensive list of phased connected loads is available in appendix 9.
- The first phase incorporates the key municipal and anchor loads across this cluster including North Hampshire Hospital, as these represents the connections critical to the success of a scheme, and those which are most likely to connect.

  Phase 2 largely includes addresses under the ownership of Southern Health. These addresses were included under phase 2 for a number of reasons explained below and also because municipal customers tend to be easier to connect. Many technically-viable schemes can fail where the economics would work because the right partners have not positively engaged.

  The potential to add local economic benefit by reducing the Foundation's net operating costs is also likely to be seen as an extremely attractive opportunity.

  Phase 3 comprises the higher risk connections including Eli Lily, which from Encraft's understanding is currently largely vacant, and Apollo Hotel. Private customers tend to be the most challenging to engage with, as demonstrated by the limited response Encraft has had from these stakeholders. The connection of these addresses also requires a major infrastructure barrier to be crossed, which could add significant complexity and costs.

  A list in the appendices shows the buildings which fall under each phase, against their energy load data. A technical summary is provided below.

Cluster	Total annual heat demand (MWh)	Total peak heat consumption (kW)	Total modelled CHP size (kWth)	Auxiliary heat raising plant size (kWth)	Total thermal store size (m^3)	Heat pipe (m)
Phase 1	24,981	5,418	2,170	4,764	350	750
Phase 2	27,610	5,964	2,390	5,244	387	1916
Phase 3	30,442	6,588	2,640	5,792	426	3153

Opportunities

- North Hampshire Hospital Estates strategy is to centralise services and as part of this exercise may have space available for a new energy centre. It is not anticipated this will have any significant impact on the hospitals long term energy loads.

  The hospital is also exploring the replacement of its aging low temperature hot water (LTHW) and steam plant, and pipework, and is keen to explore all possible heating options.

- The cluster is made up of a diverse number of private and municipal owned buildings including a hospital, care home, hotel and school.

Constraints, and considerations and risks around the network and its expansion

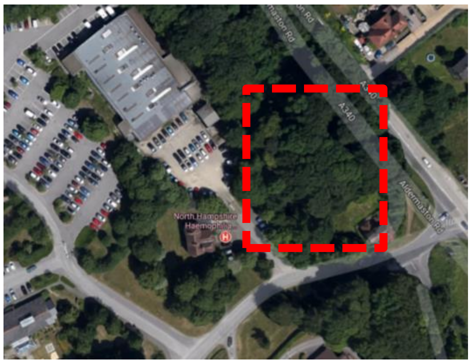
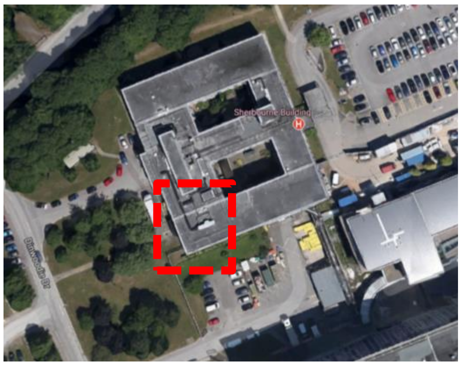
- Phase 1:
    - North Hampshire Hospital is central to the cluster and engaging with, and connecting to this is critical to the success of a local network.
    - The hospital utilises steam for sterilisation and catering, and the connectivity of this system to a local network will need careful consideration if taken forward to detailed feasibility, given the elevated temperatures involved. For the purposes of this study, the provision of heat for these services will be assumed to be delivered separately.
    - North Hampshire Hospital is an area which will be highly sensitive to noise.
    - North Hampshire Hospital is located in the centre of the cluster of buildings in the phase 1 proposal and some way from the other existing potential users
- Phase 2:
    - Reasonably significant lengths of pipework are required to reach relatively small energy loads across phase 2, and this may be deemed cost prohibitive were the cluster to be funded and operated by a private market operator.
- Phase 3:
    - The A340 intersects the cluster, separating the hospital complex from the Apollo Hotel, which may make this connection and further expansion both challenging and costly. There is however an underpass which could provide a possible pipe routing option.
    - Responses to engagement attempts with Eli Lilly and Apollo Hotel have been unsuccessful, and the connection of these stakeholders would need to be carefully evaluated at detailed feasibility.

This approach mitigates the capital requirement, manages risk and develops the energy service company ready for the later investment and network expansion.

Dig type and land ownership

- An initial assessment has revealed approximately 60% of the pipework within the cluster can be laid in soft-dig, which includes grass verges and grass land, and will minimise dig costs. A publically owned park situated north-west of the hospital ward block, also provides an excellent pipe routing option.

  Additionally, a duct run is situated parallel to the Sherbourne building (on the verge of the Dinwoodie Dr), which is within the main hospital complex, and could be uncovered and utilised to further minimise dig costs.

Energy centre location appraisal	
Preferred Option (A): North Hampshire Hospital - Purpose built centre North Hampshire Hospital Estates strategy is to centralise services, and as part of this have space earmarked for development, which they have suggested could potentially be used as land for a new energy centre. This is sited north-east of Parklands Hospital. This is situated away from the main ward block and Parklands Hospital, and has good road access.	
Option B: Undeveloped public land south-east of Parklands There is a large parcel of undeveloped grassland situated north of the Ward block and east of Parklands hospital that is in excess of 30,000m^2. This is publically owned land and appears to be used as a local park. Although there is plentiful space to allow for a purpose built energy centre, this may be politically sensitive given its current use.	
Option C: North Hampshire Hospital - Main energy centre The hospital has two existing sizeable plant rooms; the main energy centre is located at the south-east corner of the ward block. Although close to the anchor load, there is not currently enough space for new heat network plant within this energy centre. It is uncertain whether the hospital will retain this plant for redundancy where a wider heat network to be installed.	
Option D: North Hampshire Hospital - Sherbourne plant room The smaller of the two plant rooms at the hospital is situated on the south-east corner of the Sherbourne building and is home to a 1 MW gas-fired CHP. Space within the Sherbourne plant room is extremely limited and it does not have enough space that would allow for future expansion.	

Major loads

- The low temperature hot water heat demand of the hospital makes it by far the highest user within the cluster. This assessment excludes existing steam system used in the kitchens, sterilisation and laundry systems. The success of this network is reliant on positive early engagement with the hospital, which have they have shown during the duration of this heat mapping and Masterplanning study.

Existing plant

- The hospital has two steam boilers, supplying the catering and sterilisation departments and three 5MW Low Temperature Hot Water boilers located in the central plant room. The LTHW boilers are believed to be seriously oversized.

  A 1MW CHP unit is situated in the Sherborne building plant room, and is currently owned by Scottish power, although is out-of-use for the long-term due to a major breakdown. The exact operational agreements with Scottish Power will need to be understood at a further more detailed study. There may be an opportunity for the hospital to buy-back the PFI (private finance initiative) contract/plant and run it themselves, allowing the unit to play a part in a future heat network.

  The hospital is looking to replace their ageing heat raising plant and there is a need to act quickly with them to consider the implementation of a heat network.

  An old duct run is located along the verge of Dinwoodie Dr, and the hospital's estates team believes this could be utilised for sinking heat pipes.

Figure 23: Hospital LTHW gas boilers

Figure 24: Hospital duct run along verge of Dinwoodie Dr

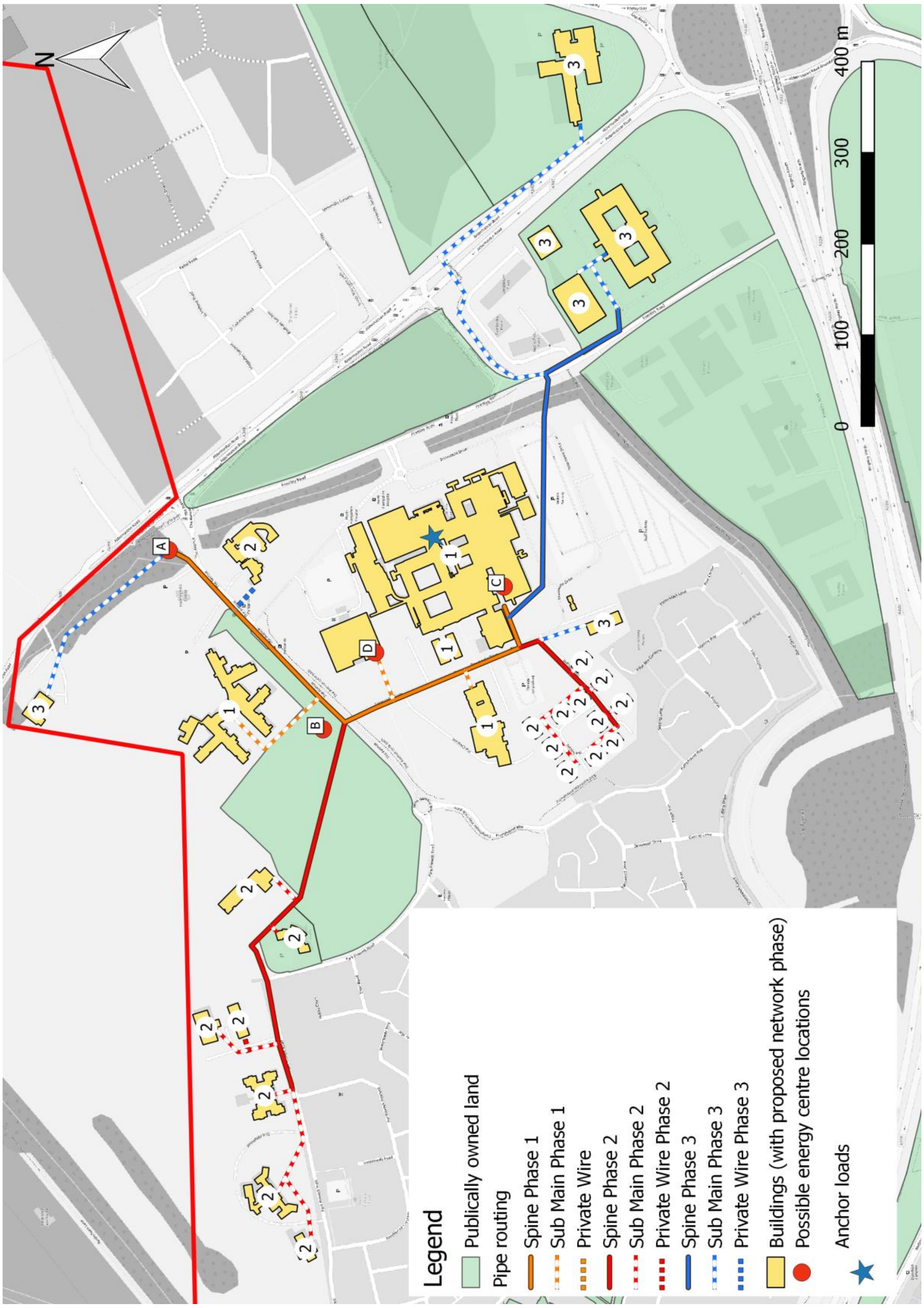


Figure 25: Hospital cluster map with pipe routing, possible energy centre locations and anchor load identification, and modelled possible phases (circled)

Building labels have been excluded from this map for clarity; they are referenced on the dig-type map for this cluster.

Preferred energy centre location: North East of North Hampshire Hospital ward block

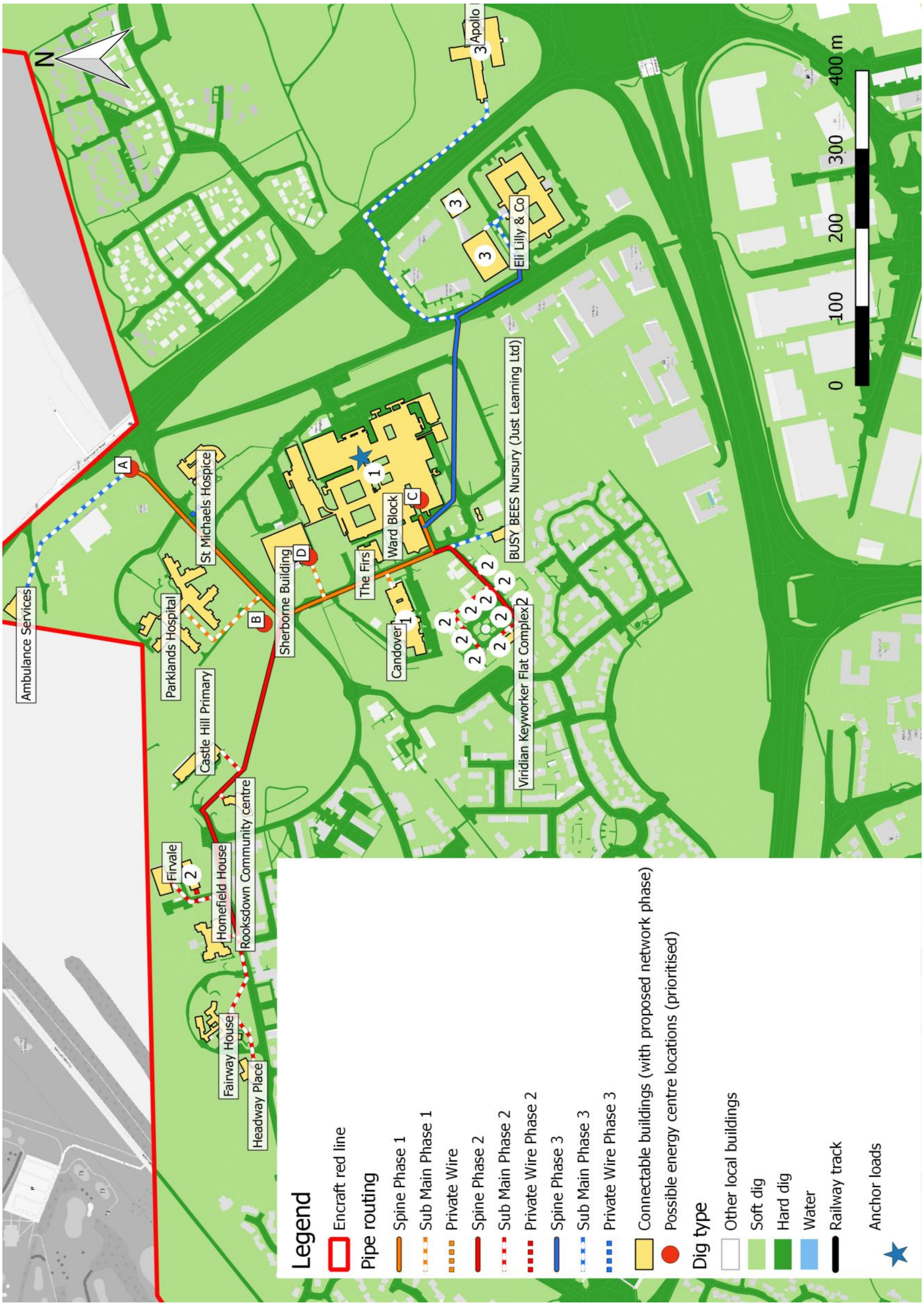


Figure 26: Hospital cluster map showing dig type

Energy centre location options are labelled in order of preference from A-Z.

Cluster E14: Town Centre

The cluster is a mixture of retail, leisure and municipal buildings including the Civic offices, Premier Inn and Basingstoke sports centre with swimming pool.

Cluster E14: Town Centre

Buildings within cluster and approach to phasing

- Heating and private wire connections: Axa Wealth, Scott House, Barclays (Glebe Farm), Anvil Conference Venue, Festival Place, Basingstoke Sports Centre, Haymarket Theatre, Civic Offices, Premier Inn, Costello School.
- Private-wire only connections: Lady Susan Court Retirement Living, Festival Place retail outlets including Debenhams, Marks and Spencer, and Next.

  A comprehensive list of phased connected loads is available in appendix 9.
- The first phase encompasses the key local municipal loads including the Civic Offices and Costello school because of their ease of connection and also because the currently preferred location for an energy centre is situated within Costello School.

  The proposed network extension to phase 3 encapsulates the more technically challenging connections including Festival Place, which has no central heat raising plant and operates gas-fired air handling units, which could prove technically challenging and cost prohibitive to retrofit. Also included within phase 3 are a number of private wire connections to several major retail outlets, and the Basingstoke Swimming Pool; responses to stakeholder engagement attempts have been limited.

  The spine pipework required to connect phase 1 and 3 is costly, and building connections at phase 2 serve to provide an additional income stream to help offset this expenditure and bridge this gap.

  Detailed modelling would be required at detailed feasibility to further understand the connectivity and technical challenges of the loads at phase 3, and optimisation of the pipework and building connections.

  A list in the appendices shows the buildings which fall under each phase, against their energy load data. A technical summary is provided below.

Cluster	Total annual heat demand (MWh)	Total peak heat consumption (kW)	Total modelled CHP size (kWth)	Auxiliary heat raising plant size (kWth)	Total thermal store size (m^3)	
Phase 1	1,303	390	160	339	18	900
Phase 2	2,634	675	270	594	37	1513
Phase 3	8,550	2046	820	1,799	120	2817

Opportunities

- Basingstoke Sports Centre is a major anchor load, located towards the centre of the cluster, and has a CHP installed which could be connected to a future network. The plant was installed in 2016 and has a remaining lifespan in the region of 15 years.
- The Chineham Incinerator is located approximately 5km from the Town Centre (direct connection). Despite this distance, and the associated pipe costs, where “free” or low cost waste heat can be

provided, there may be an opportunity for connection.

Constraints, and considerations and risks around the network and its expansion

The detailed modelling at the techno-economic stage has considered developing this network in phases to reduce the initial capital requirements and commercial risks:

- Phase 1 and 2:
  - The heat loads across this study area are low and the potential connections are spread out, leading to increased pipe dig costs and network losses which need to be reviewed as part of the economic analysis.
  - The lifecycle of Civic Office boiler plant is unlikely to align with the installation of a local heat network, though the plant could be retained for redundancy.
  - Land is extremely limited across this cluster and the preferred option for an energy centre based on current knowledge is on land at Costello School. Consultation with Costello School is required where this cluster is taken forward to detailed feasibility.
- Phase 3:
  - Basingstoke Sports Centre has a 15 year contract covering the operation of their CHP (thermal and electrical output unknown), and this contract could be seen as a potential obstacle to its integration with a network. The contractual situation with the CHP plant and the limited heat loads increase the risk that the network will take an excessive time to establish a critical revenue stream.
  - Encraft have had a mixed response from stakeholders at Basingstoke Sports Centre, in terms of their interest and engagement with the study. As a key load, continued engagement is paramount with the managing agent where this cluster is taken forward for further analysis.
  - Although technically feasible, connecting the heating systems at Festival Place to a local network may be cost prohibitive given the heating loads are relatively low, the plant rooms are not centrally located, and the heating is largely provided by gas-fired air handling units.

Dig type and land ownership

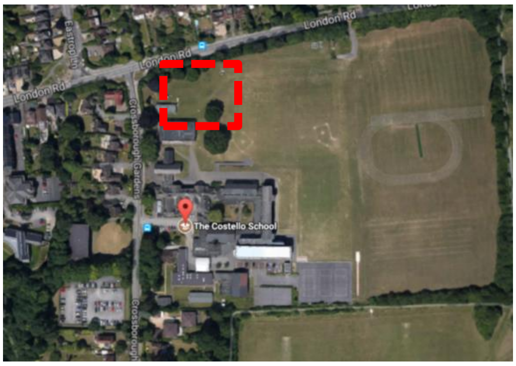
- Virtually all of the key loads across this cluster are sited on and connected by, publically owned land.
- An initial assessment has revealed that the majority of the pipework within the cluster would need to be laid in hard-dig, comprising roadways and/or paths. The cost of dig in high density areas like Town Centres is thus inherently high, and brings with it added complexity which needs to be given careful consideration if taken forward for detailed feasibility.
- There is scope to run a heat main through Festival Place; a site visit has revealed this could be hung from the ceiling alongside existing services and utilities. The majority of communal boiler plant at Festival Place is located on the upper level.

Energy centre location appraisal

Preferred Option (A): Land within Costello School

Undeveloped land within the town centre is extremely limited, and likely to be of high value given its locations. Given this, the preferred option would be to locate an energy centre on the site of Costello school. Political and noise sensitivity would need to be carefully considered to confirm the suitability of this site.

Whilst this is the currently preferred location, an energy centre in closer proximity to the Town Centre would be preferred, to minimise the required spine pipework. This should be further evaluated if taken forward for detailed feasibility.

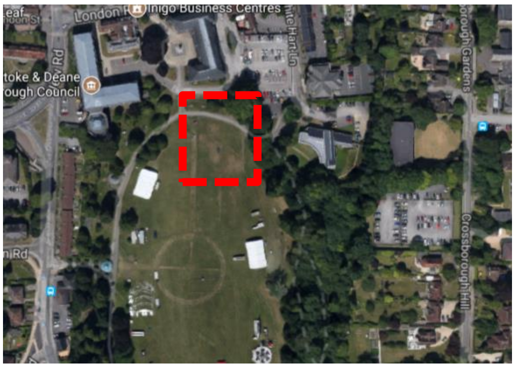


Option B: Civic offices (Deanes building) plant room

The Civic Offices has three on site plant rooms; the largest is located in the basement of the Deanes building. There is not enough space for additional plant to provide for a Town Centre wide network, with contingency to account for future expansion, and therefore this space is not deemed suitable.

Option C: Parkland adjacent civic offices

There is a large parcel of undeveloped grassland situated to the south of the civic offices. This is publically owned land and appears to be used as a local park. Although there is plentiful space to allow for a purpose built energy centre, conversations with the Council has deemed this to be inappropriate given the local political sensitivity.



Major loads

- Basingstoke Sports Centre and Premier Inn are two of the larger base loads across the cluster and represent ideal anchor loads.

Existing plant

- Basingstoke Sports Centre has a CHP (installed 2016); the size of the plant is not known. It is believed this is managed by a third party in a 15 year contract.

- Festival Place utilise a combination of small gas-fired boilers and air handling units to provide communal heating. All hot water is electrically heated.

  2 x 250kW gas-fired boilers, providing heating for Centre Management Suite offices

  Gas-fired Purewell Hammworthy VariHeat (Condensing), providing heating for shopping centre air curtain (Estimated 100-150kW)

  2 x 77kW gas-fired Proton boilers, providing heating for Wrote Street air curtains

  A selection of gas heated air handling units (AHU) are also spread across the shopping centre site, with many located on the roof.

Figure 27: Centre management suite boilers

Figure 28: Purewell gas boiler

- The Council offices are made up of three buildings which are each heated independently using separate plant:

  Deanes: 2 x 520kW Guillot-Ygnis gas-fired boilers (2003), providing space heating.

  Domestic hot water is provided using gas-fired water heaters.

  Chilled water is provided using two Dunham-Bush chiller units (1998)

  Goldings: 2 x 80kW Valiant gas-fired boilers (2007), operating one as a duty spare; located in the basement.

  Parklands: 2 x 350kW Hoval gas- boilers; operating one as a duty spare; located in the basement.

  The Parklands building also has two Calorifiers; one feeding the showers, and one providing domestic hot water.

  The Parklands plant room has space for fitting a heat network thermal substation.

Figure 29: Deanes 520kW gas boilers

Figure 30: Goldings 80kW gas boilers

Figure 31: Parklands 350kW gas boilers

- The Anvil conference venue has 4 x 300kW Potterton gas boilers, providing heating and domestic hot water, operating with two as duty spares (2010 est.). The boiler room is accessible from the road.

  Daikin split units are used for cooling; the external unit is located on the roof.

Figure 32: Anvil gas boilers

Figure 33: Town Centre map with pipe routing, possible energy centre locations and anchor load identification, and possible network phases (circled)

Building labels have been excluded from this map for clarity; they are referenced on the dig-type map for this cluster.

Preferred energy centre location: Land within Costello School (East of Civic Offices)

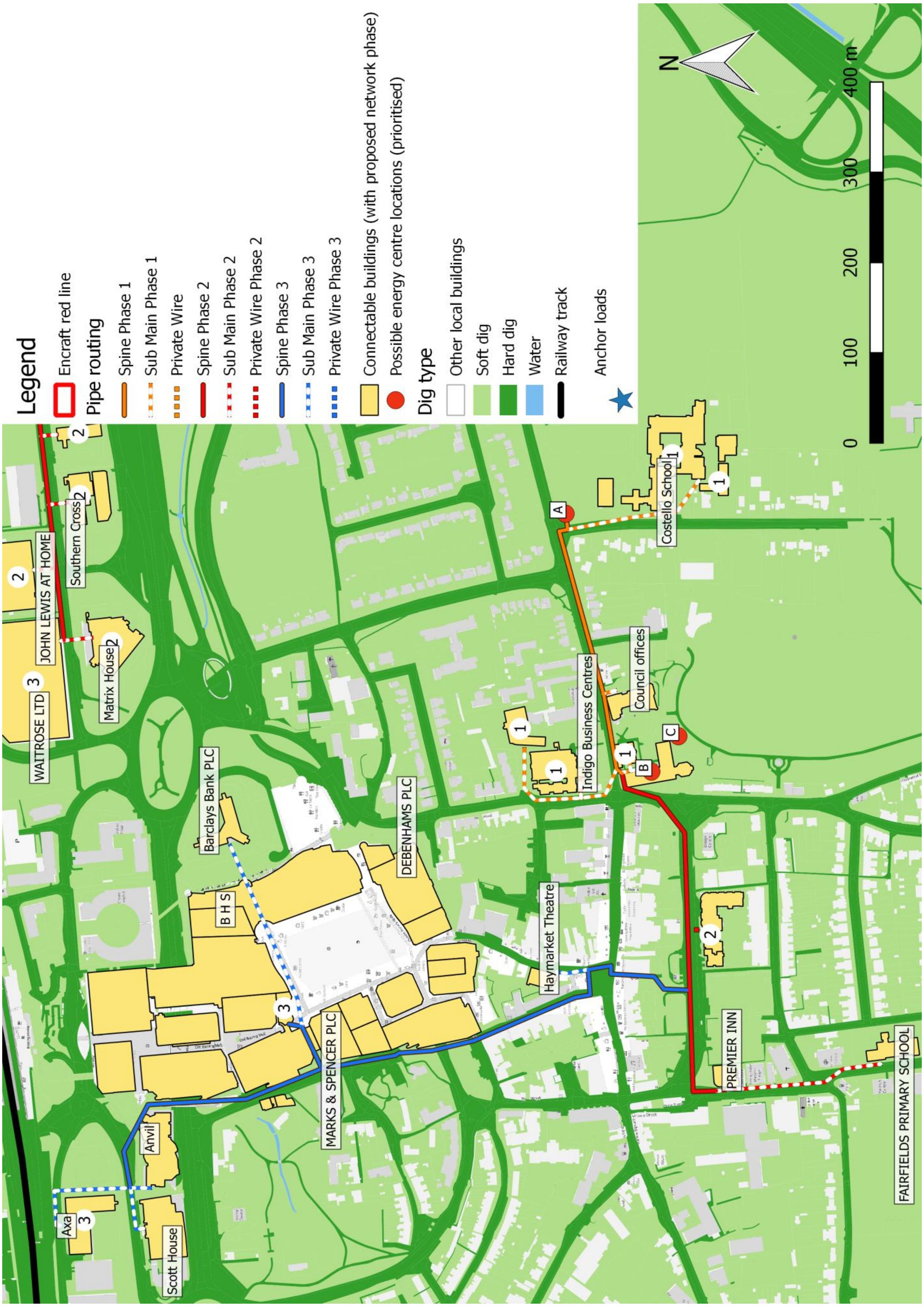


Figure 34: Town Centre map showing dig type

Energy centre location options are labelled in order of preference from A-Z.

Cluster E16: Leisure Cluster

The cluster is a mixture of high energy leisure and commercial facilities. The recommendations provided below are relevant to the existing leisure park, and are not based on future regeneration plans. The existing Leisure Park was modelled to identify whether further modelling could be warranted. This is explicitly explored under Work Package B as per the Council's request.

Cluster E16: Leisure Cluster (Existing)

Buildings within cluster and approach to phasing

- Heating and private wire connections: Basingstoke Aquadrome, Planet Ice, Wessex Bowl, Odeon Cinema, Premier Inn Hotel, Johnsons Apparel Master, Basingstoke Fire Station, Lidl Supermarket
- Private wire-only connections: Gala Clubs, Milestones Museum, Parcelforce Worldwide, Loddon Vale Indoor Bowling Club, iFly Indoor Skydiving

  A comprehensive list of phased connected loads is available in appendix 9.
- The first phase encompasses the core leisure facilities within this cluster and represents the area of highest energy density. The second phase includes several private wire connections on the extremities of the Leisure Park and private heat network customer connections outside of the boundary of the site. This type of customer are typically more challenging to engage with and connect to, and given the low pipework linear heat density at phase 2, it may not be a financially attractive opportunity.

  A list in the appendices shows the buildings which fall under each phase, against their energy load data. A technical summary is provided below.

Cluster	Total annual heat demand (MWh)	Total peak heat consumption (kW)	Total modelled CHP size (kWth)	Auxiliary heat raising plant size (kWth)	Total thermal store size (m^3)	Heat pipe (m)
Phase 1	11,567	2,441	980	2,144	162	693
Phase 2	15,225	3,778	1,130	3,705	213	1501

Opportunities

- Significant regeneration is expected at the Leisure Park, providing an excellent opportunity to integrate heat network piping with new utilities and services, and allowing for the construction of a purpose built and future-proofed energy centre with capacity for later expansion.
- The Leisure Park contains a diverse range of loads, requiring heating, cooling and electricity; potentially providing an opportunity to install a tri-generation system but this seems unlikely given the current configuration. The use of satellite absorption chillers to provide cooling and hence a summer heat load should be considered in greater detail during a future feasibility study. This early assessment however has dismissed this as a viable option due to: the high capital cost of the plant, controls and pipe work; the limited demand from the potential users; and the newness of the existing air conditioning systems within the main buildings.
- The cluster is located in close proximity to the Manydown development and represents a possible future connection opportunity where rates of return are attractive. Residential developments can prove challenging to connect to a heat network although are not unachievable. This should be

examined during a further detailed feasibility study.

Constraints, and considerations and risks around the network and its expansion

- Phase 1:
  - Land is extremely limited across this cluster and the preferred option for an energy centre based on current knowledge is on land adjacent to the Aquadrome. Consultation with local stakeholders is required where this cluster is taken forward to detailed feasibility
- Phase 2:
  - Reasonably significant lengths of pipework are required to reach relatively small energy loads across phase 2, and this may be cost prohibitive.
- Other:
  - The Leisure Park is isolated from the hospital and town centre clusters, and although the installation of heating pipework may be technically possible to link these systems, the capital costs may inhibit this.

Dig type and land ownership

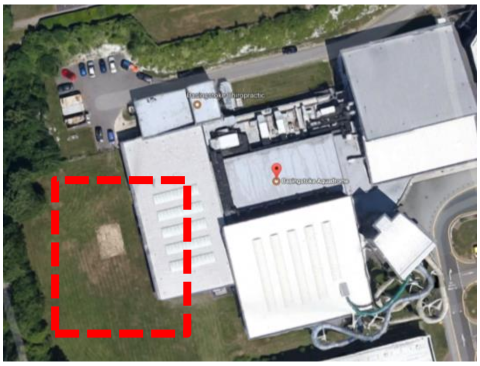
- An initial assessment has revealed that the majority of the pipework within the cluster can be laid in soft-dig. Almost all of the buildings across the cluster are entirely sited on publically owned land.

Energy centre location appraisal

Preferred Option (A): Rear of Aquadrome

The existing capacity for plant within the two major anchor loads (Planet Ice and Basingstoke Aquadrome) is unknown, however there is a small parcel of publically owned land with a footprint in excess of 1,000m^2 located at the rear of this address. This is in an area served by mains gas; is not overlooked by any residential developments, and has good road access.

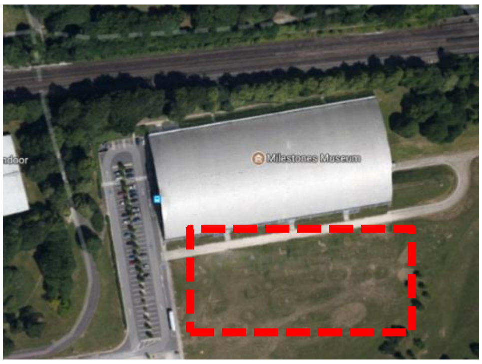
This land is adjacent several high-energy users and is strategically located to allow for easy connection to the future development site at Manydown.



Option B: Land adjacent to Milestones

The availability of undeveloped land is extremely restricted across the Leisure Complex; although there is a large parcel of publically owned undeveloped land adjacent to the Milestones museum.

Given the distance from this site to the local anchor loads and given Encraft believe it is located in an off-gas area, this site is not however well placed to be an energy centre.



Major loads

- The cluster contains several energy dense loads within a very small geographic footprint, including the Basingstoke Aquadrome (wet leisure centre), Planet Ice and Premier Inn Hotel, which could all act as excellent base loads for the development.

Existing plant

- The only plant room Encraft have been able to gain access to across this cluster is that for Hollywood bowl which uses air handling units for heating and cooling purposes, and a small gas boiler for domestic hot water.

  Display Energy Certificates for the Aquadrome and Ice Rink suggest these complexes are heated by natural gas.

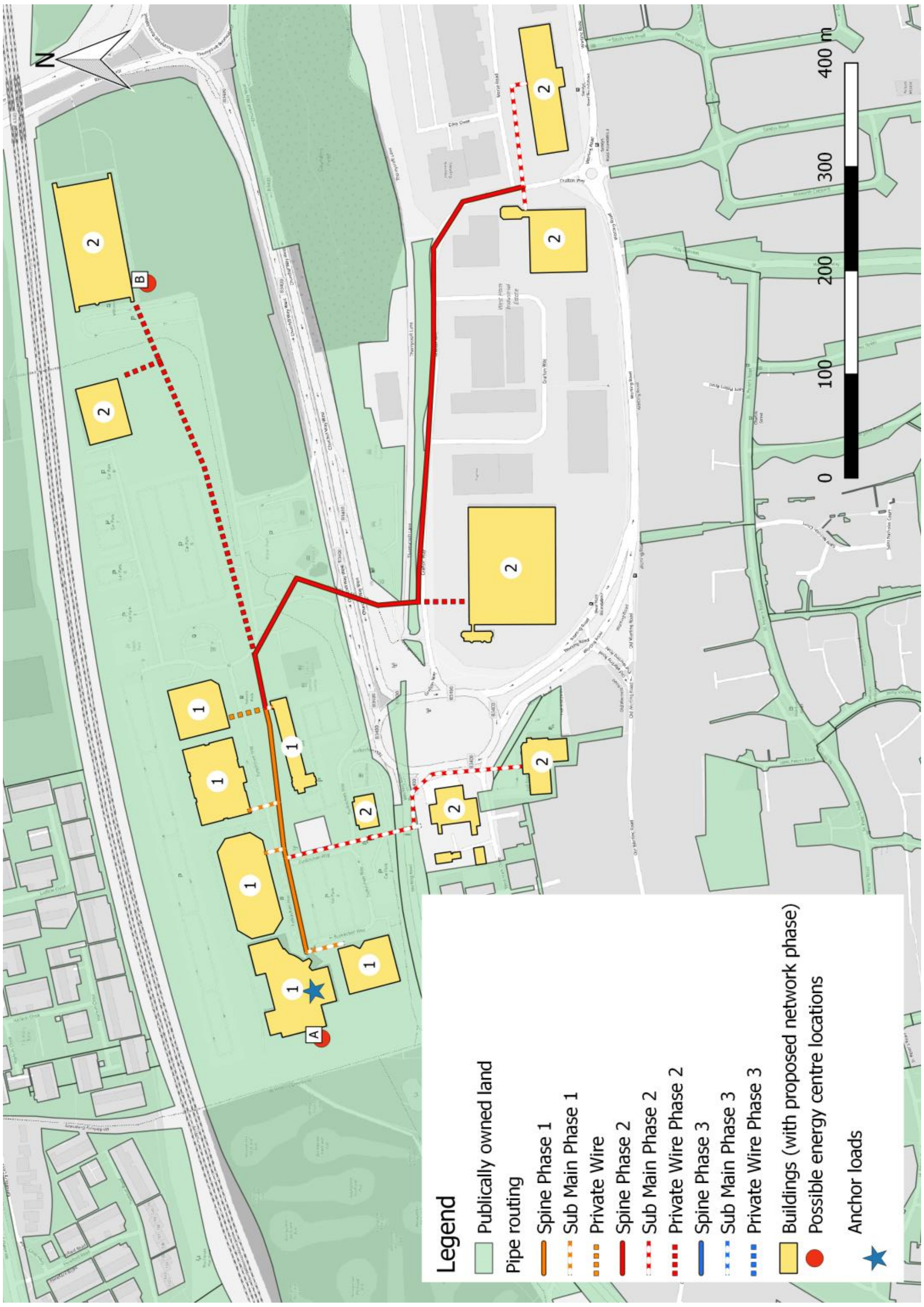


Figure 35: Leisure cluster map with pipe routing, possible energy centre locations and anchor load identification, and possible network phases (circled)

Building labels have been excluded from this map for clarity; they are referenced on the dig-type map for this cluster.

Preferred energy centre location: West of Aquadrome

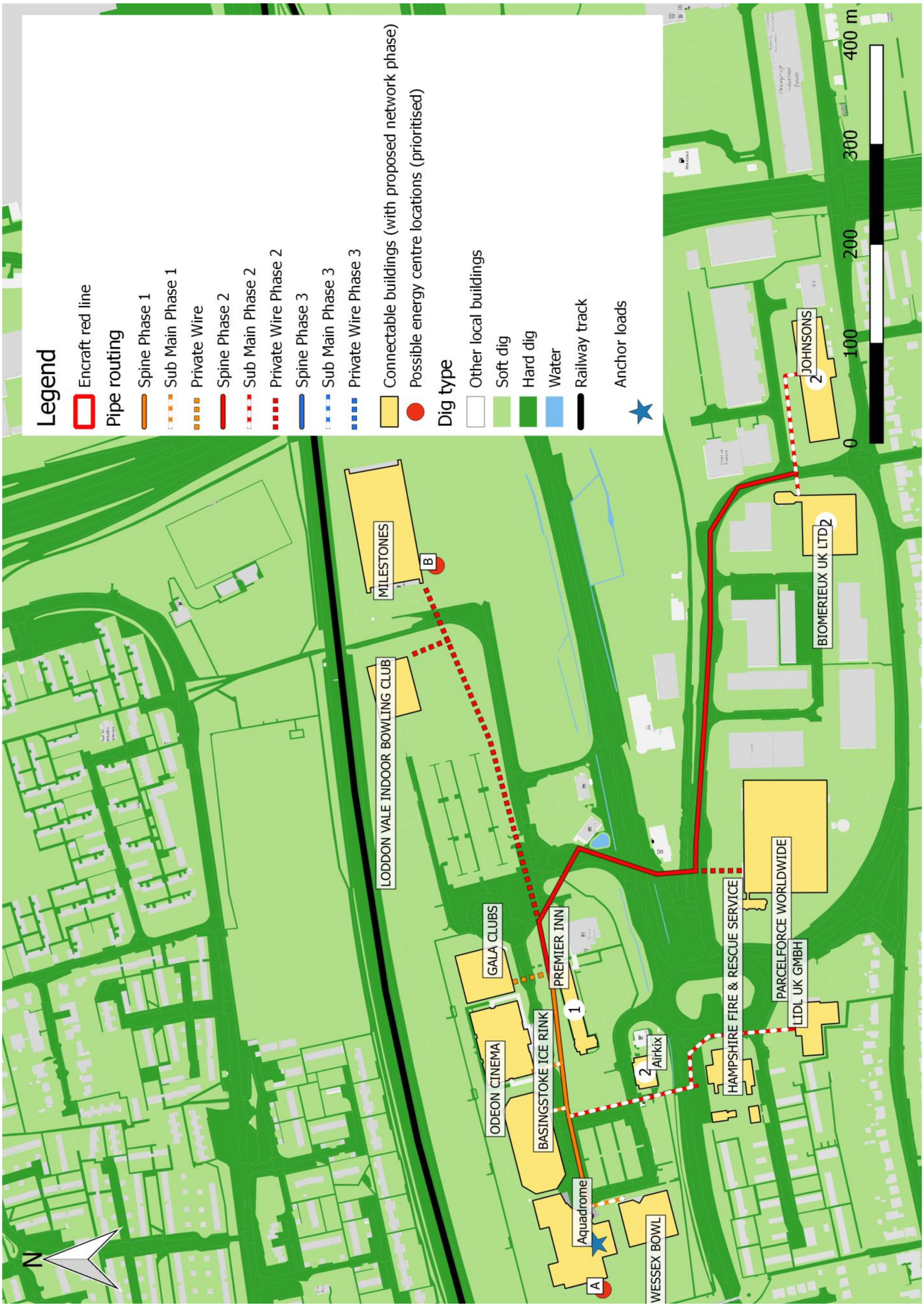


Figure 36: Leisure cluster map showing dig type

Energy centre location options are labelled in order of preference from A-Z.

5. Energy Modelling

5.1 Modelled summary of results

Earlier rounds of high level clustering, modelling and consultation have indicated four main groups of existing potential heat network clusters that warrant further investigation.

Indicative pipe and private wire lengths have been modelled to reach the boundary of the key buildings within the cluster only, and in most cases no account has been made for the need for any additional internal pipework. These details, alongside the annual heat demand, peak heat consumption and, CHP and auxiliary heat raising plant capacity for each of the three phases, and thermal storage requirements, is depicted in the appendices (appendix 11).

Modelling has been conducted assuming a system flow-return temperature differential of 70-40°C respectively.

Thermal storage has been included in the modelling at a size and capital cost that allows for a high level of resilience but not at a detailed half-hourly level. This would be part of a future more detailed techno-economic feasibility study.

The internal rate of return (IRR) and net present value (NPV) were evaluated for each cluster over 25, 30 and 40 years, with discount rates of 3.5%, 6.0%, 10% and 15%. CAPEX and OPEX breakdowns are available in appendix 12. The modelling has been undertaken for a simplistic pipe network with high-level pipe sizing, and indicative thermal storage sizing which gives conservative rates of returns. In reality, network optimisation undertaken during detailed feasibility would bring about cost reductions.

In order to understand how various factors will affect the IRR, NPV and therefore viability of a scheme, a simple sensitivity analysis has been carried out over a 25 year period. The sensitivity analysis considered the impact of the variation in gas costs, capital costs, heat sales revenue price, electricity revenue price and total head demand by up to +/-30%. A sensitivity analysis was also conducted for three capital grant scenarios, investigating the impact of an upfront cash injection equivalent to 10%, 20% and 30% of the initial capital costs.

Phasing

Implementation of a heat network and its connected users is a major undertaking and as such requires delivery over a long period of time.

Phasing will be an important part of ensuring the technical and commercial viability of any scheme. The pipework route would be built up over time as the connectable loads become available through construction or plant replacement, assuming the phase adds value, financially or otherwise. Considerations and risks to each phase are discussed in section 4.

We have assumed during modelling that key anchor loads and municipal loads would be the first to connect, and private customers would be the last to connect given the increased risk these connections represent, and the challenges around stakeholder engagement. Network phasing maps are provided in section 4.

For the purposes of modelling we have assumed the first phase of each cluster could commence as early as 2020; each phase thereafter would be installed and commissioned in two year intervals as per BEIS Heat Network Delivery Unit timelines [Figure 37]. These timescales are indicative and would be subject to further analysis.

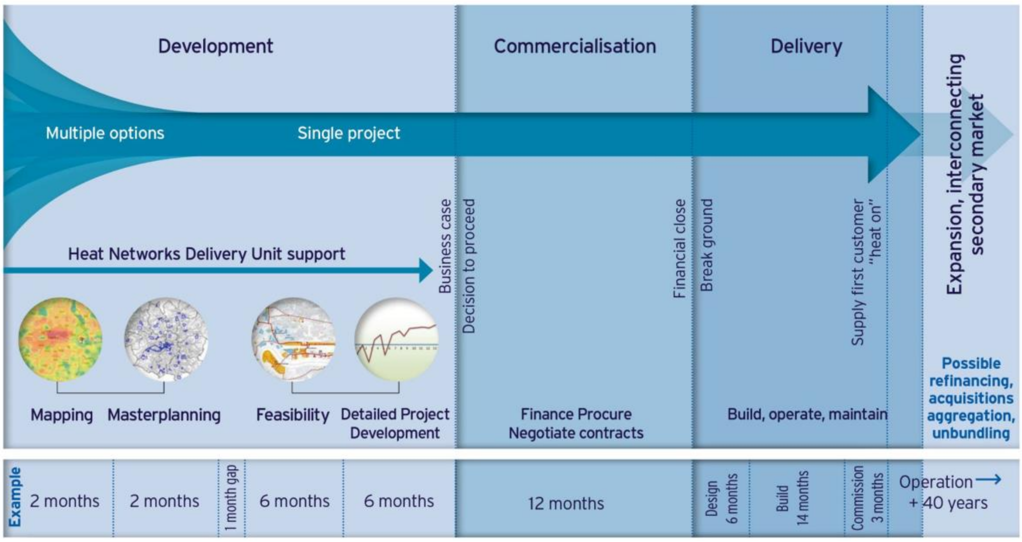


Figure 37: BEIS HNDU project lifecycle (CP1: Heat Networks: Code of Practice for the UK)

Pipe sizing for future expansion

If and when clusters are taken forward for detailed design, cluster phasing must be carefully considered to ensure plant, plant rooms and pipe sizes are aligned with future expansion plans. Key phasing considerations to allow for future network extensions include:

- Energy centre floor space
- Plant size (kWth / kWe)
- Local substation capacity
- Appropriate pipe sizes between energy centre
- Third party wayleaves for the laying of pipework

Low-carbon technology phasing

A strategic technology review should be conducted over a 20year cycle to evaluate replacement district heat generation plant as it reaches its end of life, including an assessment of operational characteristics to ensure the ongoing provision of low carbon heat and electricity.

6. Financial Outputs

This section summarises the key outputs from the modelling activities. Table 8 and 9 summarise the headline figures for the optimum clusters and phases at each of the three sites. A detailed breakdown of capital and operational costs for each of the clusters is shown in the appendices (appendix 11 and 12), as are the technical and operational characteristics including plant and thermal storage calculation assumptions.

These are based on fixed costs, and current best practice and our industry knowledge (appendix 8). Changes in these baselines (e.g. capex costs, fuel prices, discount rates) have the potential to significantly influence the financial returns; a sensitivity analysis has been carried out on these results to test this, and the outputs are available as an appendix.

Complex electricity tariffs have not been modelled including DUOS (Distribution Use of System) charges and TRIADS (Transmissions Network Use of System) which have a strong influence on cost effectiveness of CHP and Heat Pumps and overall take-up of the energy services. These would be part of a future more detailed techno-economic feasibility study.

Modelling has shown that some clusters may work better with less extended connections (and not instead expand to include addresses across phases 2 and 3). This should be tested in a future more detailed study. Only the most financially attractive phases have been depicted in Table 9.

The results depicted are for a gas-fired CHP heating option with gas back-up, and a private wire network for the supply of electricity. An analysis of alternative heating options including biomass and heat pumps did not find the returns to be attractive across any clusters, with sub 0% IRRs and sub £0 NPVs. This is largely due to the increased capital expenditure of the plant, the inability to cross subsidise the network through electricity sales, and the low value of heat. These outputs take into account the value attainable from the Renewable Heat Incentive. Modelling undertaken for the hospital cluster (phase 1) with biomass has shown this technology option would not payback across 40 years, with NPVs of (-£19,663,000). A further detailed study may consider the deployment of a combination of heating options.

Table 9: Headline IRR (%) for 25, 30 and 40 years for the best performing clusters

				25yr.	30yr.	40yr.
E13	Basing View	Phase 1 - 3	Village Hotel, Belvedere House, Northern Cross, Business Environment Offices & Adjacent Complex, Network House, Mountbatten House, Eni Engineering E & P House, Matrix House, Southern Cross, Unum House, Quantum House, Waitrose, John Lewis, Basingstoke Campus.	8.2%	9.2%	10.1%
E15	North Hampshire Hospital	Phase 1 only	North Hampshire Hospital including the Ward Block, The Firs, and Sherborne building, and Candover Clinic	11.2%	11.9%	12.5%
E14	Town Centre	Not currently financially viable	Civic Offices, Costello School, Magistrates Court, Indigo Business Centres	-7.3%	-1.2%	2.4%

E16	Leisure Park	Central leisure facilities only	Basingstoke Aquadrome, Ice Rink, Wessex Bowl, Odeon Cinema, Gala Clubs, Premier Inn Hotel	7.2%	8.2%	9.1%

Table 10: Headline NPV (£000) for 25, 30 and 40 years for the best performing clusters with a discount rate of 3.5%

				25yr.	30yr.	40yr.
E13	Basing View	Phase 1 - 3	Village Hotel, Belvedere House, Northern Cross, Business Environment Offices & Adjacent Complex, Network House, Mountbatten House, Eni Engineering E & P House, Matrix House, Southern Cross, Unum House, Quantum House, Waitrose, John Lewis, Basingstoke Campus	3,513	5,433	9,137
E15	North Hampshire Hospital	Phase 1 only	North Hampshire Hospital including the Ward Block, The Firs, and Sherborne building, and Candover Clinic	5,980	8,148	12,331
E14	Town Centre	Phase 1 only	Civic Offices, Costello School, Magistrates Court, Indigo Business Centres	-2,221	-1,704	-706
E16	Leisure Park	Central leisure facilities	Basingstoke Aquadrome, Ice Rink, Wessex Bowl, Odeon Cinema, Gala Clubs, Premier Inn Hotel	2,347	3,321	11,321

Key modelling assumptions, with reference to Table 9 and Table 10:

- All named heat and power loads are connected by the end of each phase and generate income in year 1.
- Inflation rate on income and costs (3%)
- Income based on prevailing simple commercial tariffs
- Treatment of any applicable RHI
- The NPV calculation is based on EBITDA (Earnings before Interest, Tax, Depreciation and amortisation).

Basing View

Modelling has shown this cluster has positive rates of return across all clusters. This results from the clusters small geographic footprint and high rise office accommodation, which leads to a high energy density and the need for only a short length of spine pipework required to connect the key loads.

North Hampshire Hospital

Modelling has shown this cluster has attractive rates of return across all clusters and particularly the primary cluster. The high heat and electrical energy demand of the hospital complex leads to a cluster with an excellent energy density, and it requires only short lengths of pipework to connect the key loads.

Town Centre

The rates of return across all phases at 25 years are very weak for a combination of reasons: the network connections are sparsely spread across the cluster leading to the need for significant lengths of heat pipe. Laying pipe in built-up environments where the options are limited to hard dig (e.g. tarmac) requires significant capital investment. The heat demands of buildings across this cluster are also relatively low, leading to a limited revenue stream. The heat demand profile is concentrated in the winter months meaning that a significant part of the network capacity will be unused during summer months with a detrimental impact on efficiency, NPV and revenue streams. It may be possible however with HNIP (Heat Network Investment Project) funding and a further more detailed optimisation of the pipework and connections, to bring about a model with returns which fall into the municipal venture range.

Leisure Park

The rates of return for phase 1 which incorporate only the core loads at the Leisure Park are within the hybrid commercial venture range. Given the expected regeneration here, there is a strong case to explore the viability of a heat network within the new complex. A 10% reduction in the capital works, which could at least partially be brought about through further network optimisation and by combining pipe trenching with the installation of other utilities and services required as part of the redevelopment, could bring about an increase in the IRR to 9.0% at 25 years.

The redevelopment of the leisure park area is an opportunity to develop a heat network that will depend on the implementation of planning policies and promotion of the network benefits to the developers.

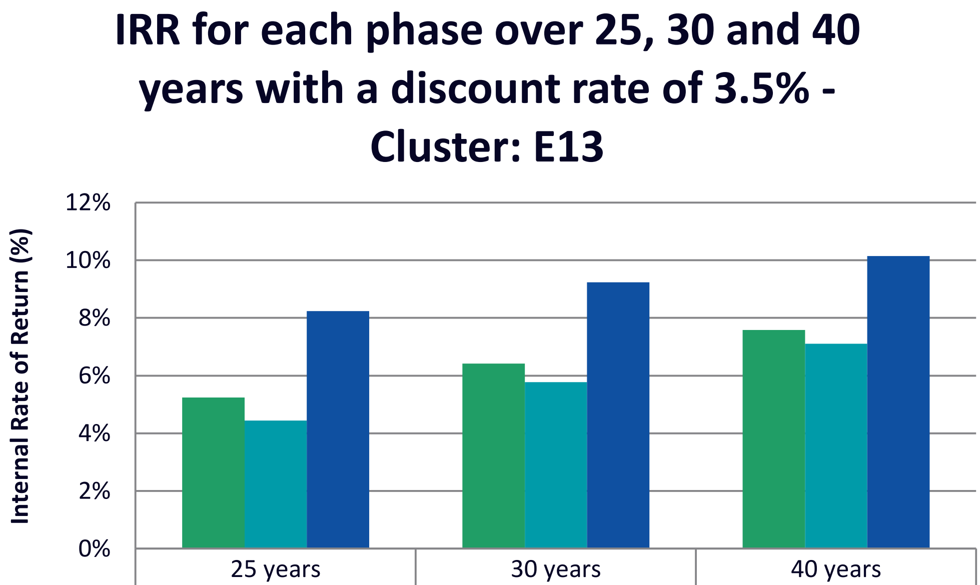
6.1.1 Basing View cluster

Figure 38 summarises the rates of return expected for each of the Basing View clusters over 25, 30 and 40 years.

The results show positive rates of return across all clusters, with phase 3 offering the greatest return of 8% at 25 years. The building connections across phase 3 however present the greatest risk; the lifecycle of the heating plant in the new Waitrose and John Lewis stores is unlikely to align with the timeframe of this study; the connection of the Network Rail Campus requires a major infrastructure barrier – the railway line, to be crossed, which could prove challenging and cost prohibitive.

Private investment is driven by the commercial rewards balanced against the commercial risk and a comparison with other competing investment opportunities. Long term infrastructure projects of this nature will require specialist long-term investors and detailed investment cases that demonstrates the resilience of the long term revenue stream and minimises any risks associated with delayed repayments. Public Sector projects can however operate down to 4-5% IRR, although the public sector would be required to fund and carry all of the financial risk.

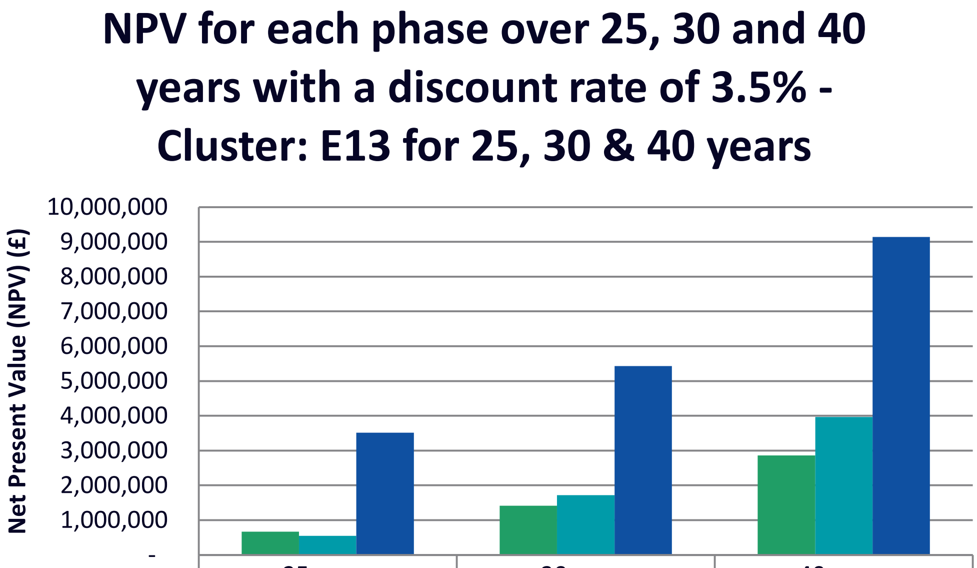
The reduction in IRR between phase 1 and 2 represents the need for significant lengths of pipework and capital expenditure needed to connect to smaller energy loads.



	25 years	30 years	40 years
Phase 1	5%	6%	8%
Phase 2	4%	6%	7%
Phase 3	8%	9%	10%

Figure 38: Internal Rates of Return (IRR) for the Basing View cluster

Figure 39 shows the whole life cost Net Present Value (NPV) for the Basing View clusters over 25, 30 and 40 years; using a discount rate of 3.5%. A positive NPV across all clusters suggests the value of the revenue exceeds the network costs, making the extension to phase 2 and 3 an attractive financial investment.



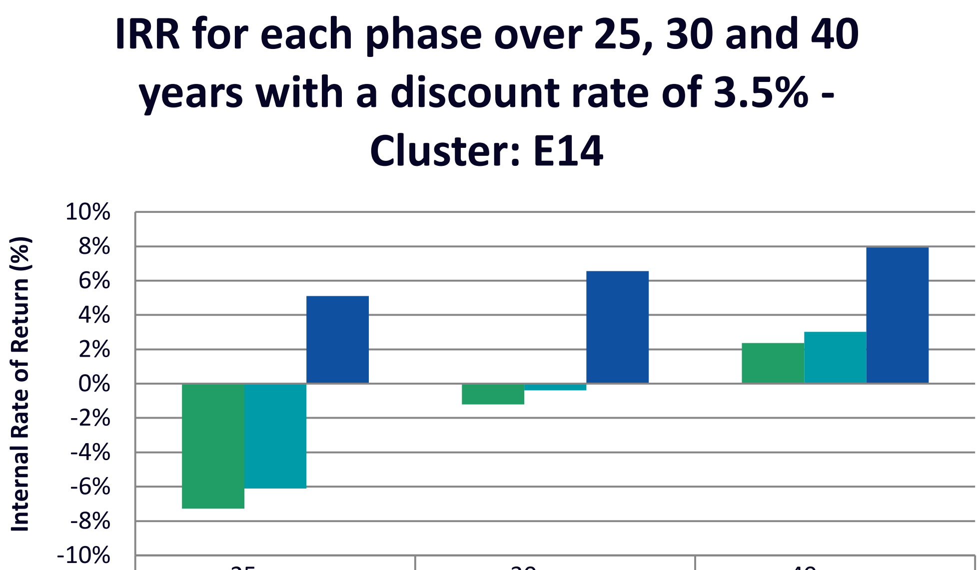
	25 years	30 years	40 years
Phase 1	668,549	1,417,185	2,861,158
Phase 2	553,197	1,719,480	3,969,012
Phase 3	3,512,837	5,433,403	9,137,801

Figure 39: Net present value (NPV) for the Basing View cluster

6.1.2 Town centre

Figure 40 summarises the rates of return expected for each of the Town Centre clusters over 25, 30 and 40 years. The returns across all phases at 25 and 30 years are extremely weak for a combination of reasons: the connections are sparsely spread across the cluster, leading to the need for significant lengths of heat pipe. Laying pipe in built-up environments where the options are limited to hard dig (e.g. tarmac) is extremely costly. The heat demands of buildings across this cluster are also relatively low, leading to a limited revenue stream.

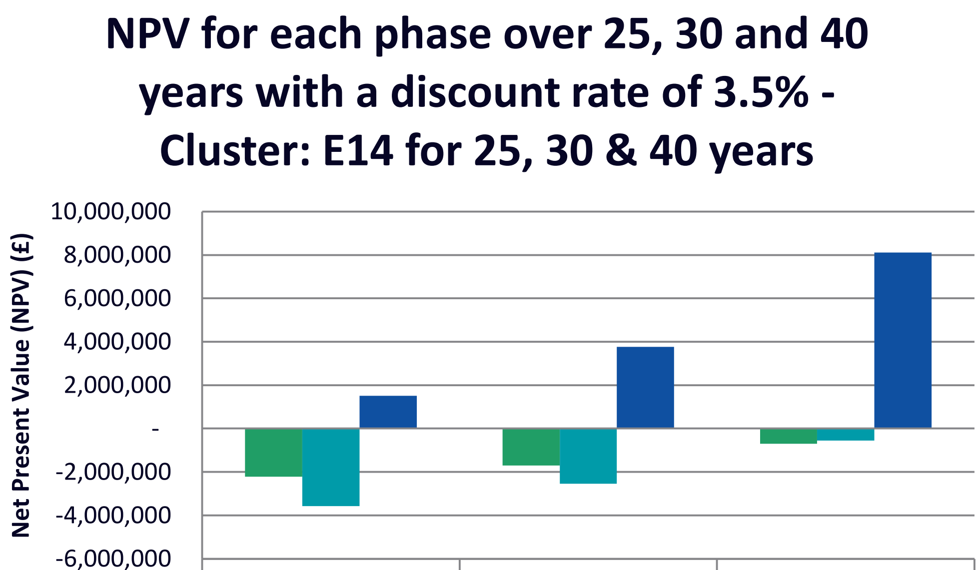
Despite the final phase (phase 3) offering the greatest return of 5% at 25 years, this phase also presents the greatest risk given the connections here are wholly private, and also the challenges around the connectivity of Festival Place and some of the larger retail outlets across this complex. This needs to be investigated if taken forward to detailed feasibility, as does the opportunity to connect this cluster to Basing View.



	25 years	30 years	40 years
Phase 1	-7%	-1%	2%
Phase 2	-6%	0%	3%
Phase 3	5%	7%	8%

Figure 40: Internal Rates of Return (IRR) for the Town Centre cluster

Figure 41 shows the whole life cost Net Present Value (NPV) for the Town Centre clusters over 25, 30 and 40 years; using a discount rate of 3.5%.



	25 years	30 years	40 years
Phase 1	-2,220,730	-1,703,573	-706,078
Phase 2	-3,566,076	-2,534,864	-545,858
Phase 3	1,512,455	3,767,033	8,115,675

Figure 41: Net present value (NPV) for the Town Centre cluster

6.1.3 North Hampshire Hospital cluster

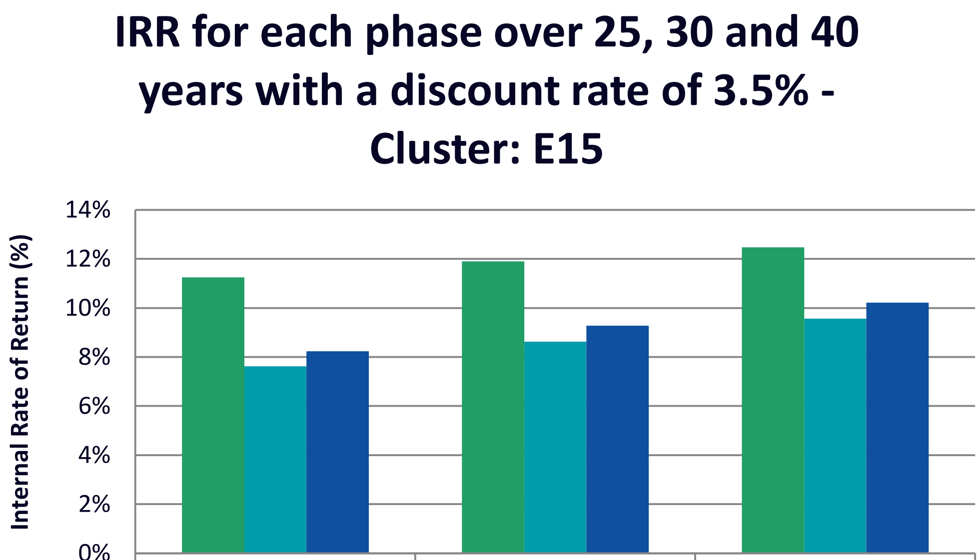
Figure 42 summarises the rates of return expected for each of the Hospital clusters over 25, 30 and 40 years.

The results show favourable rates of return across all clusters. The rate of return for phase 1 is above 10% at 25 years, making it a more attractive option for private investment, particularly if the risks associated with the longevity of the revenue stream can be mitigated. For the hospital the benefits also include the deferred replacement of aged plant and potential reinstatement of the existing PFI CHP plant.

Whilst the extension of the cluster to include phase 2 and phase 3 would be technically achievable and provide added social benefit, this would be to the detriment of the financial returns. Phase 2 and 3 requires extensive pipework and therefore capital investment to connect a number of smaller energy loads including the Ambulance Station, and also private customers including Apollo Hotel and Eli Lilley. From experience, private customers tend to be harder to engage with and to connect to.

Quantifying the value of the social benefit offered by phase 2 and 3 is important if the cluster is taken forward for detailed feasibility, to understand whether these extensions can be justified.

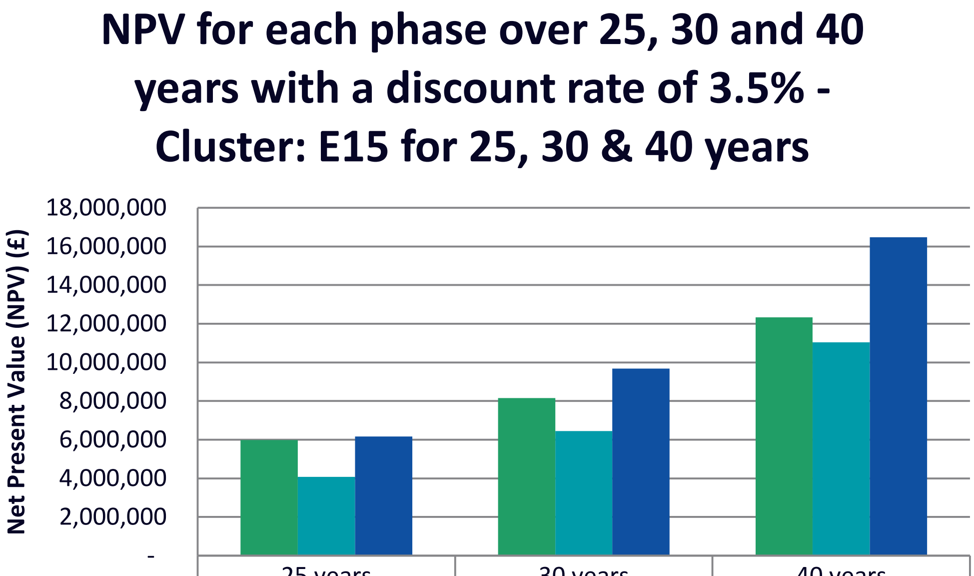
The different types of model are explained in more detail in a later section.



	25 years	30 years	40 years
Phase 1	11%	12%	12%
Phase 2	8%	9%	10%
Phase 3	8%	9%	10%

Figure 42: Internal Rates of Return (IRR) for the hospital cluster

Figure 43: Net present value (NPV) for the Hospital cluster. Figure 43 shows the whole life cost Net Present Value (NPV) for the Hospital clusters over 25, 30 and 40 years, using a discount rate of 3.5%.



	25 years	30 years	40 years
Phase 1	5,979,797	8,148,481	12,331,451
Phase 2	4,069,576	6,447,214	11,033,214
Phase 3	6,166,680	9,688,535	16,481,508

Figure 43: Net present value (NPV) for the Hospital cluster

6.1.4 Leisure Park (existing) cluster

Figure 44 summarises the rates of return expected for each of the Leisure Park clusters over 25, 30 and 40 years.

The rates of return for phase 1, which incorporates only the core loads at the Leisure Park, are within the hybrid commercial venture range which typically requires IRRs of 6-10%. Whilst the extension of the cluster to include phase 2 would be technically achievable, this would be to the significant detriment of the financial returns. Phase 2 would therefore not be recommended. Phase 2 requires extensive pipework and private wire connections to connect to a number of smaller energy loads, which includes private customers including Johnsons Apparelmaster and Lidl.

The IRRs presented here are for the existing leisure park and incorporate trenching costs, which represent a significant proportion of the total capital costs. Given the expected regeneration here, there is a strong case to explore the viability of a heat network within the new complex. If heat pipes can be laid as part of the capital works, there would be scope to significantly reduce trenching costs and significantly increase the already favourable IRRs. The sensitivity analysis depicted in the appendix demonstrates that a 10% reduction in capital costs would bring about an increase in the IRR to 9.0%.

When combined with a capital grant, this may even push the cluster from a hybrid commercial venture requiring part-public sector investment, to a wholly privately funded investment.

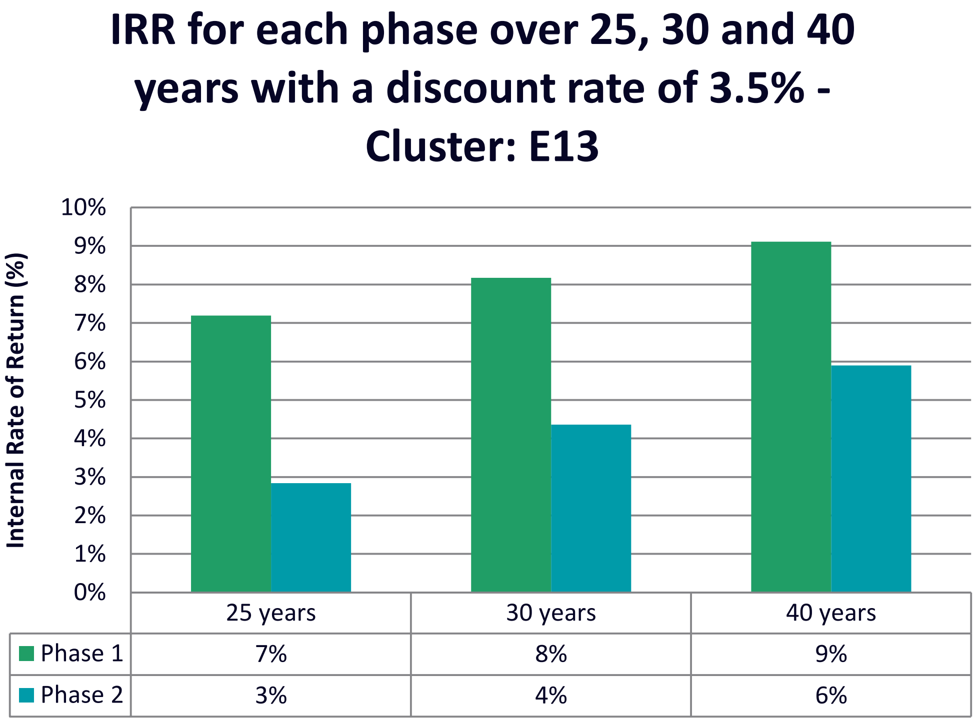


Figure 44: Internal Rates of Return (IRR) for the Leisure Park (existing) cluster

Figure 45 shows the whole life cost Net Present Value (NPV) for the Leisure Park clusters over 25, 30 and 40 years; using a discount rate of 3.5%. A negative NPV at 25 years for phase 2 suggests the value of the costs exceeds the present values of revenues, making the extension to phase 1 an unattractive financial investment.

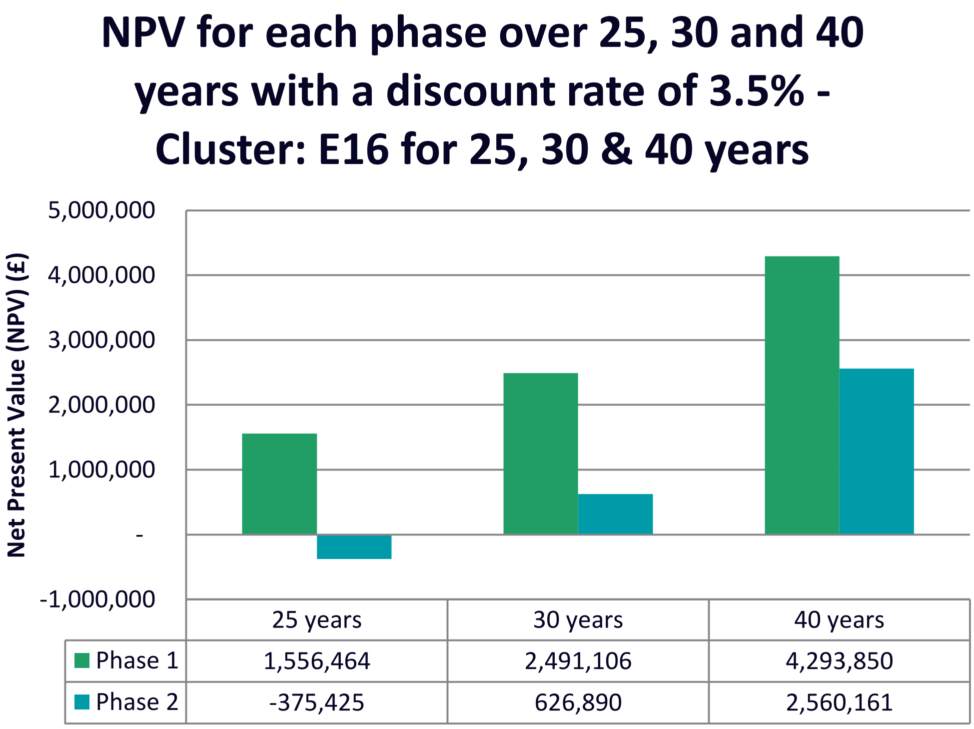


Figure 45: Net present value (NPV) for the Leisure Park cluster

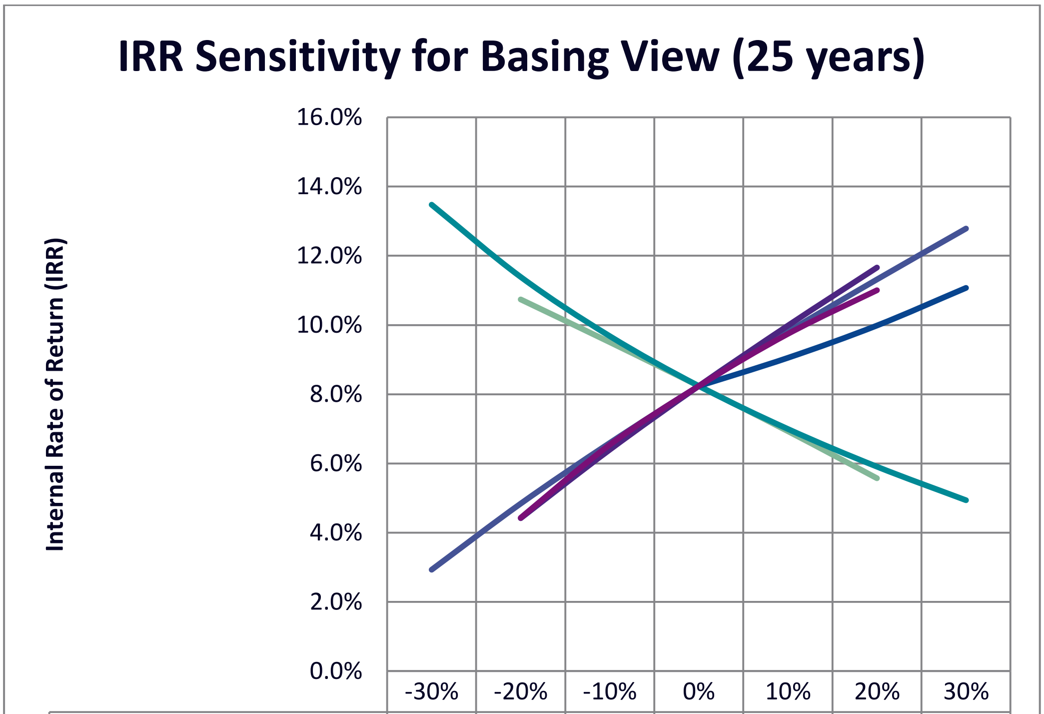
6.2 Sensitivity Analysis outputs

In order to understand how various factors will affect the IRR, NPV and therefore viability of a scheme, a simple sensitivity analysis has been carried out on the final phases of each cluster over a 25 year period, with the exception for the Leisure Park. The Leisure Park was modelled as is, to confirm whether a model of the regenerated Leisure Park could be warranted. Given the imminent plans to redevelop this site, a sensitivity analysis of the existing leisure park was not deemed to add any significant value at this stage.

A sensitivity analysis was also conducted to identify the impact of changes in operational and capital expenditure over a 25 year period. The sensitivity analysis considered the impact of the variation in gas costs, capital costs, heat sales revenue price, and electricity revenue price and total heat key demand by up to +/- 30%. A sensitivity analysis was also conducted for three capital grant scenarios, investigating the impact of an upfront cash injection equivalent to 10%, 20% and 30% of the initial capital costs. The sensitivity analysis considered the impact of change for individual variables whilst holding all other variables steady. The capital grant scenarios were applied to the baseline business case.

The sensitivity analysis using the data from the high level business modelling highlights that the commercial viability of each of the four networks is dependent on the following variables: capital costs and grants; cost and price of energy; annual heat sales; and to a greater or lesser extent can withstand small shocks in increasing costs or reducing revenues. The importance of capital grants to the viability of each network is highlighted by the sensitivity curves.

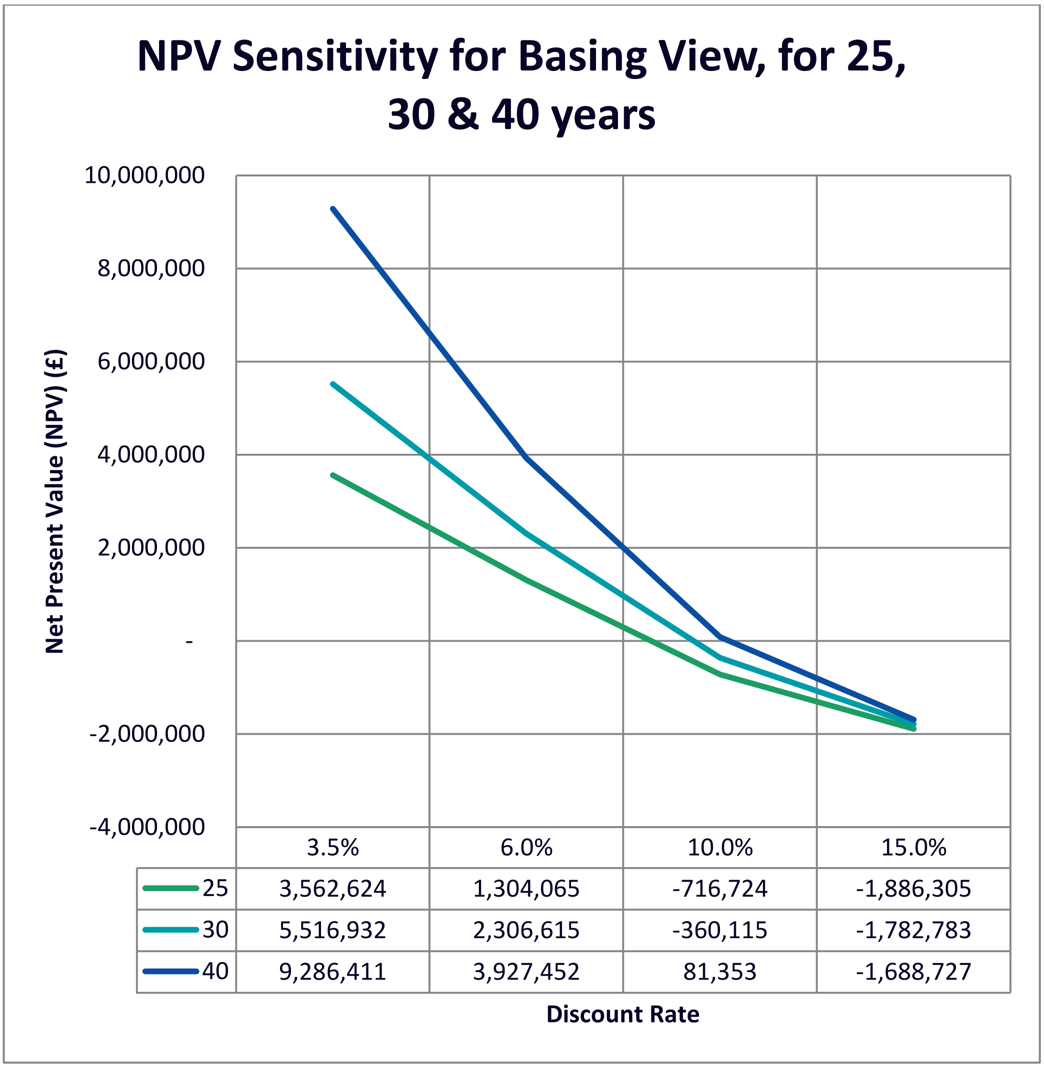
6.2.1 Basing View



	-30%	-20%	-10%	0%	10%	20%	30%
Gas costs (Energy purchase price)		10.7%	9.5%	8.24%	6.9%	5.6%	
Capital costs	13.5%	11.4%	9.7%	8.2%	7.0%	5.9%	4.9%
Capital Grant Sensitivity				8.2%	9.1%	10.0%	11.1%
Electricity revenue price	2.9%	4.8%	6.6%	8.2%	9.8%	11.3%	12.8%
Heat sales revenue price		4.4%	6.4%	8.2%	10.0%	11.7%	
Annual heat volume		4%	7%	8%	10%	11%	

Sensitivity (Change in input assumption)

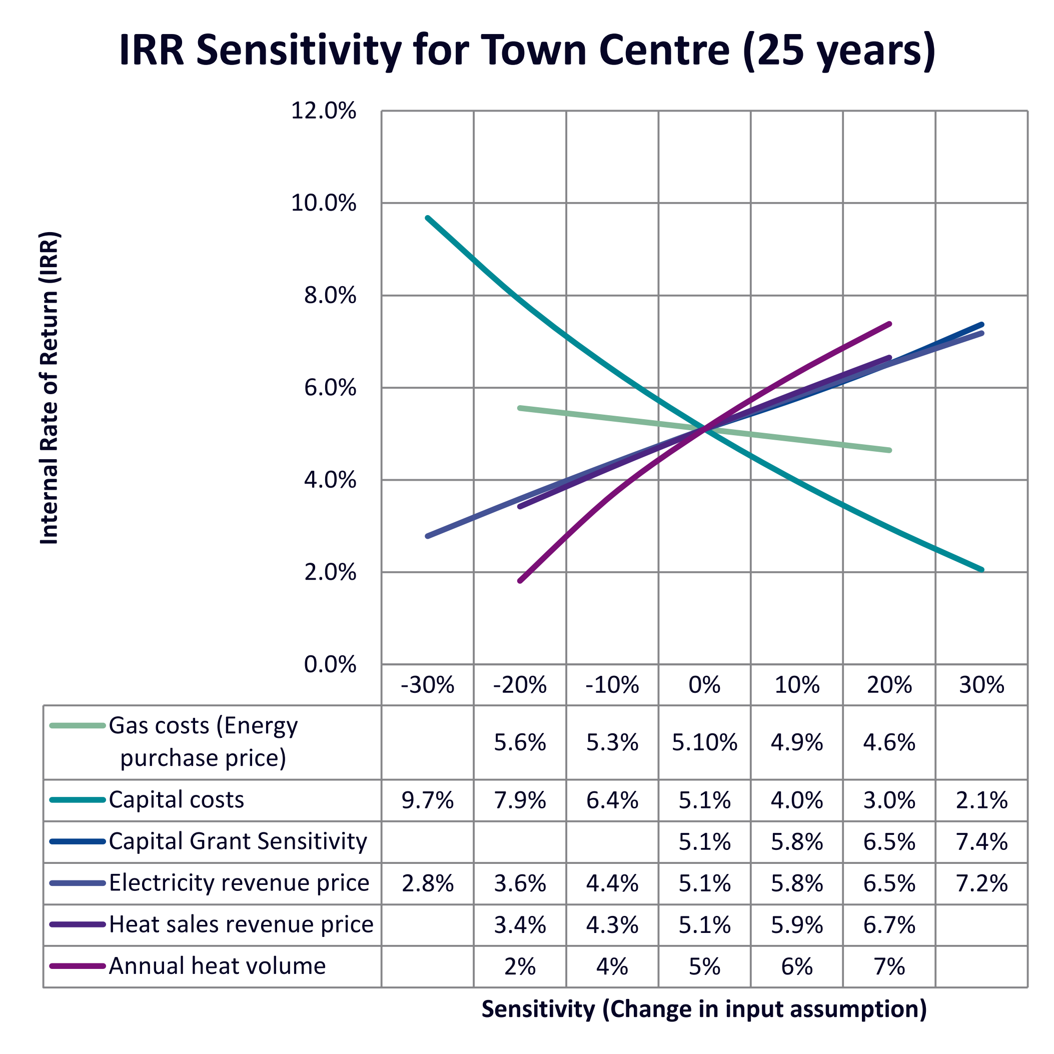
Figure 46: IRR sensitivity analysis for the Basing View cluster



	3.5%	6.0%	10.0%	15.0%
25	3,562,624	1,304,065	-716,724	-1,886,305
30	5,516,932	2,306,615	-360,115	-1,782,783
40	9,286,411	3,927,452	81,353	-1,688,727

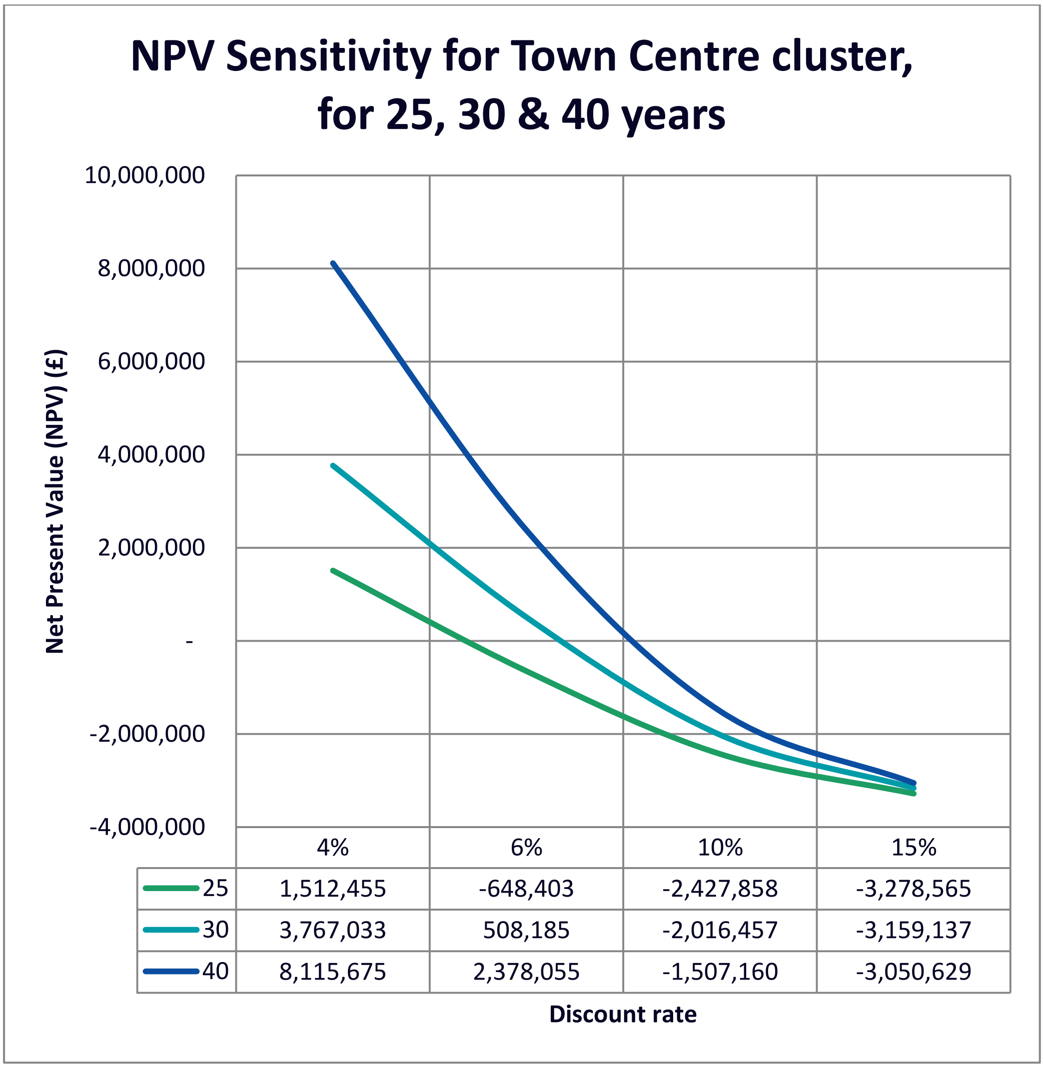
Figure 47: NPV sensitivity analysis for the Basing View cluster

6.2.2 Town Centre



	-30%	-20%	-10%	0%	10%	20%	30%
Gas costs (Energy purchase price)		5.6%	5.3%	5.10%	4.9%	4.6%	
Capital costs	9.7%	7.9%	6.4%	5.1%	4.0%	3.0%	2.1%
Capital Grant Sensitivity				5.1%	5.8%	6.5%	7.4%
Electricity revenue price	2.8%	3.6%	4.4%	5.1%	5.8%	6.5%	7.2%
Heat sales revenue price		3.4%	4.3%	5.1%	5.9%	6.7%	
Annual heat volume		2%	4%	5%	6%	7%	

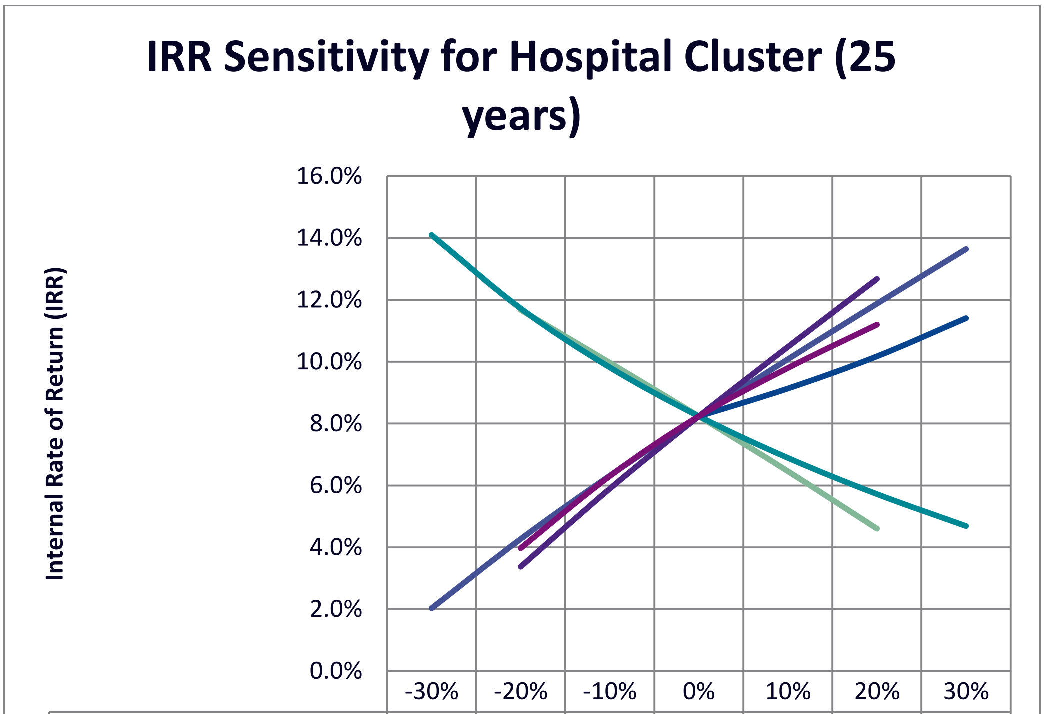
Figure 48: IRR sensitivity analysis for the Town Centre cluster



	4%	6%	10%	15%
25	1,512,455	-648,403	-2,427,858	-3,278,565
30	3,767,033	508,185	-2,016,457	-3,159,137
40	8,115,675	2,378,055	-1,507,160	-3,050,629

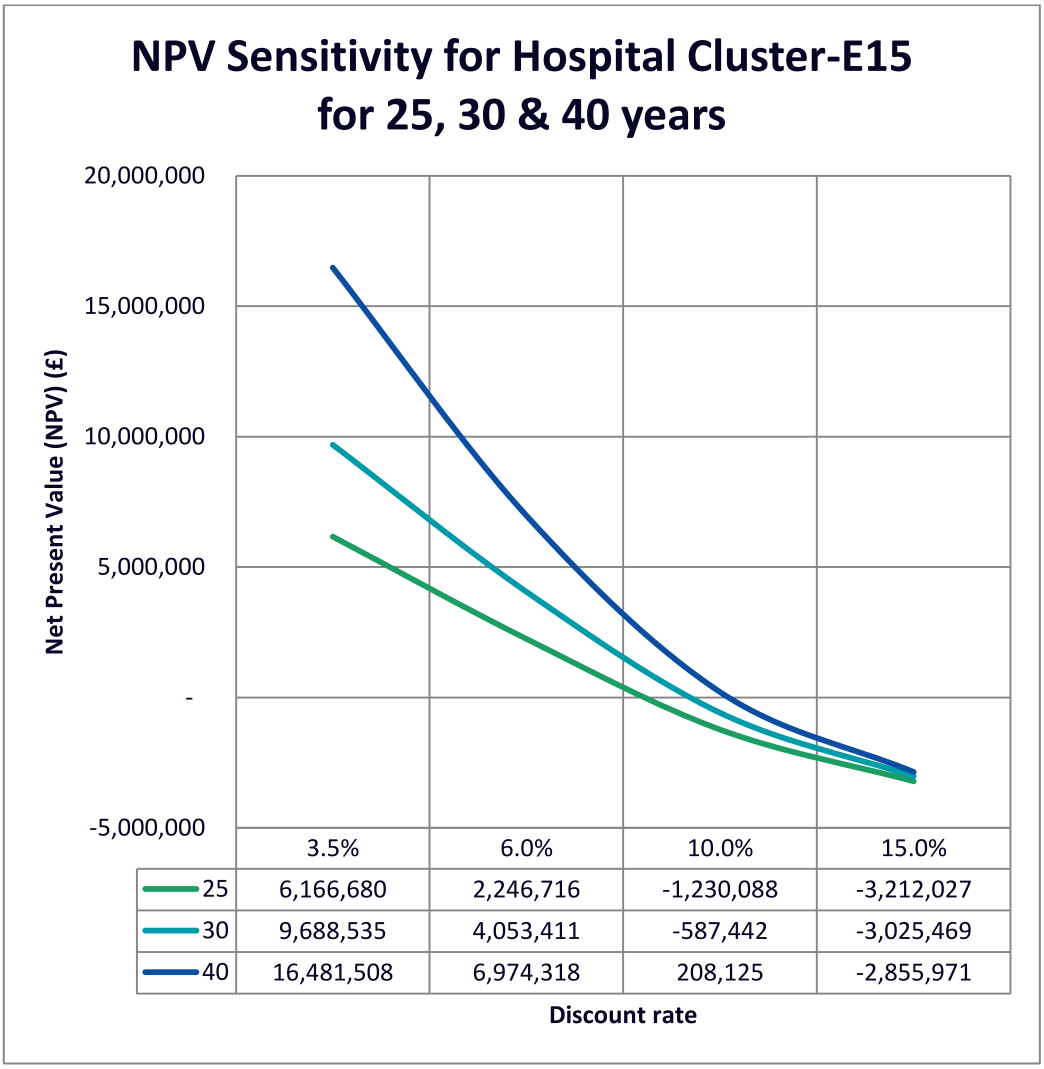
Figure 49: NPV sensitivity analysis for the Town Centre cluster

6.2.3 North Hampshire Hospital cluster



	-30%	-20%	-10%	0%	10%	20%	30%
Gas costs (Energy purchase price)		11.7%	10.0%	8.24%	6.5%	4.6%	
Capital costs	14.1%	11.7%	9.8%	8.2%	6.9%	5.7%	4.7%
Capital Grant Sensitivity				8.2%	9.1%	10.2%	11.4%
Electricity revenue price	2.0%	4.3%	6.3%	8.2%	10.1%	11.9%	13.6%
Heat sales revenue price		3.4%	5.9%	8.2%	10.5%	12.7%	
Annual heat volume		4%	6%	8%	10%	11%	

Figure 50: IRR sensitivity analysis for the Hospital cluster



	3.5%	6.0%	10.0%	15.0%
25	6,166,680	2,246,716	-1,230,088	-3,212,027
30	9,688,535	4,053,411	-587,442	-3,025,469
40	16,481,508	6,974,318	208,125	-2,855,971

Figure 51: NPV sensitivity analysis for the Hospital cluster

6.3 Environmental impacts and benefits

6.3.1 CO_2 emissions

"Carbon dioxide equivalent" or "CO2e" is a term for describing different greenhouse gases in a common unit. For any quantity and type of greenhouse gas, CO2e signifies the amount of CO2 which would have the equivalent global warming impact.[5]

To provide a fair benchmark for the comparison of the carbon emissions across the CHP and non-CHP technology options, the emissions associated with the supply of 100% of the network customer's electricity and heat/fuel has been considered [Table 11] across all clusters. For example, in the non-CHP options where electricity requirements must be met solely through imports, emissions associated with this have been taken into account.

Table 11: Carbon emissions attributed under each heat network technology options

Technology option	Carbon emissions associated with each technology option (and as presented in Figure 52)
Gas Boiler	• Natural gas • Imported grid electricity (100%)
Combined Heat and Power (CHP)	• Natural gas • Imported grid electricity (only to meet the deficit between CHP electricity generation and network electricity demand) • The emissions from natural gas that could be attributed to CHP electricity generation were apportioned between the electricity sold over the private wire network, and the exported electricity. Emissions attributed to exported electricity have been deducted from the total emissions.
Biomass	• Biomass • Imported grid electricity (100%)

The carbon emissions associated with each unit of energy consumed by the technology options discussed in this report have been calculated using the forecasted diminishing electricity carbon emission conversion factors from the Department for Business, Energy & Industrial Strategy Appendix 5] and the DEFRA carbon conversion factors for gas and biomass [Table 12].

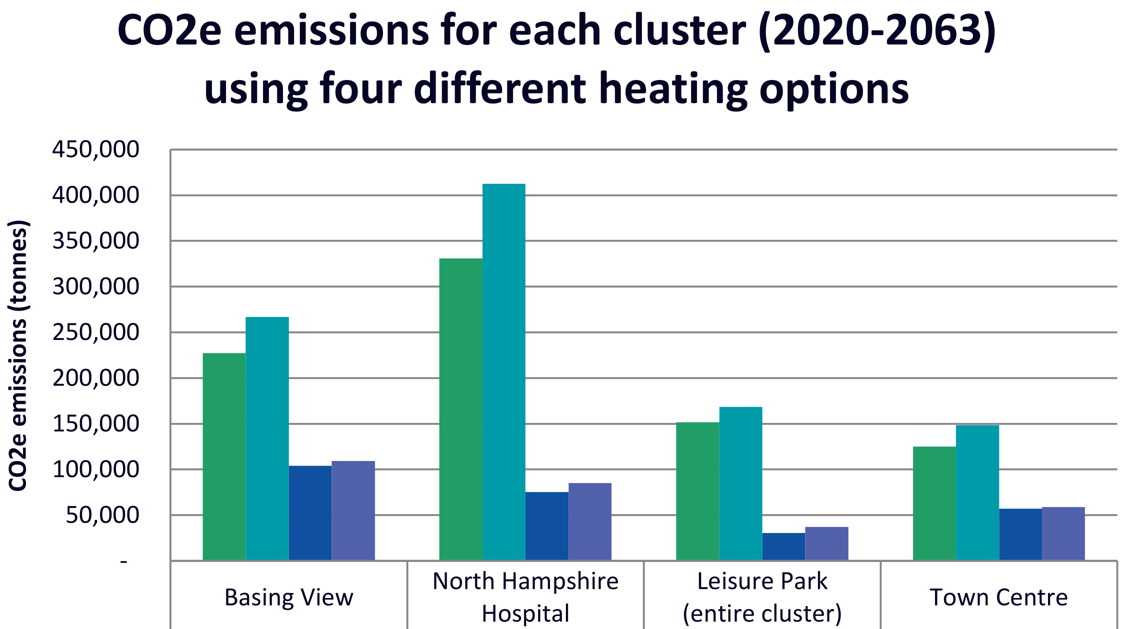
Table 12: Carbon conversion factors

Carbon conversion factors (Gross CV basis)		
Gas	0.00018	t CO2e/kWh
Biomass	0.00001	t CO2e/kWh
Electricity	See appendices.	-

[5] https://ecometrica.com/assets/GHGs-CO2-CO2e-and-Carbon-What-Do-These-Mean-v2.1.pdf

The calculation assumes no decarbonisation of the gas grid, for example, through the injection of renewable gas into the grid, which remains a possibility.

The carbon emissions for each technology option are shown in Figure 52 .



	Basing View	North Hampshire Hospital	Leisure Park (entire cluster)	Town Centre
Gas Boiler	227,320	331,015	151,493	125,073
CHP	266,966	412,279	168,338	148,506
Biomass	104,047	75,192	30,605	57,184
Heat Pump	109,266	84,961	37,303	58,840

Figure 52: CO2e emissions for each cluster up to 2060 using different technology options

Gas CHP produced electricity is regarded as low carbon because it is currently considerably less carbon intensive than grid electricity. This is due to the grid incurring losses through transmission and distribution, alongside the fact that carbon intensive sources such as coal are currently used in the production of grid electricity. This will not always be the case. Over the next ten years or so it is predicted that the carbon intensity of the grid will decrease dramatically as coal fired power stations are decommissioned, and more renewables and nuclear are commissioned. This will make heat only options like heat pumps and biomass boilers an attractive option in the future where carbons savings are a priority, and is also why gas boilers look more attractive from a carbon perspective over the long term, when compared to CHP. Figure 53 depicts the impact the CO2e (Carbon dioxide equivalent) emissions for three technology types based on the forecasted trends in emission factors.

There will still be a role for gas CHP but it may not be straightforward. If hydrogen is introduced to the gas network, this will provide more complexity to the picture.

Whilst CHP has been shown to be a financially attractive heating option in the modelling, Figure 52 shows that this option will become unfavourable over the long term where carbon emissions are concerned.

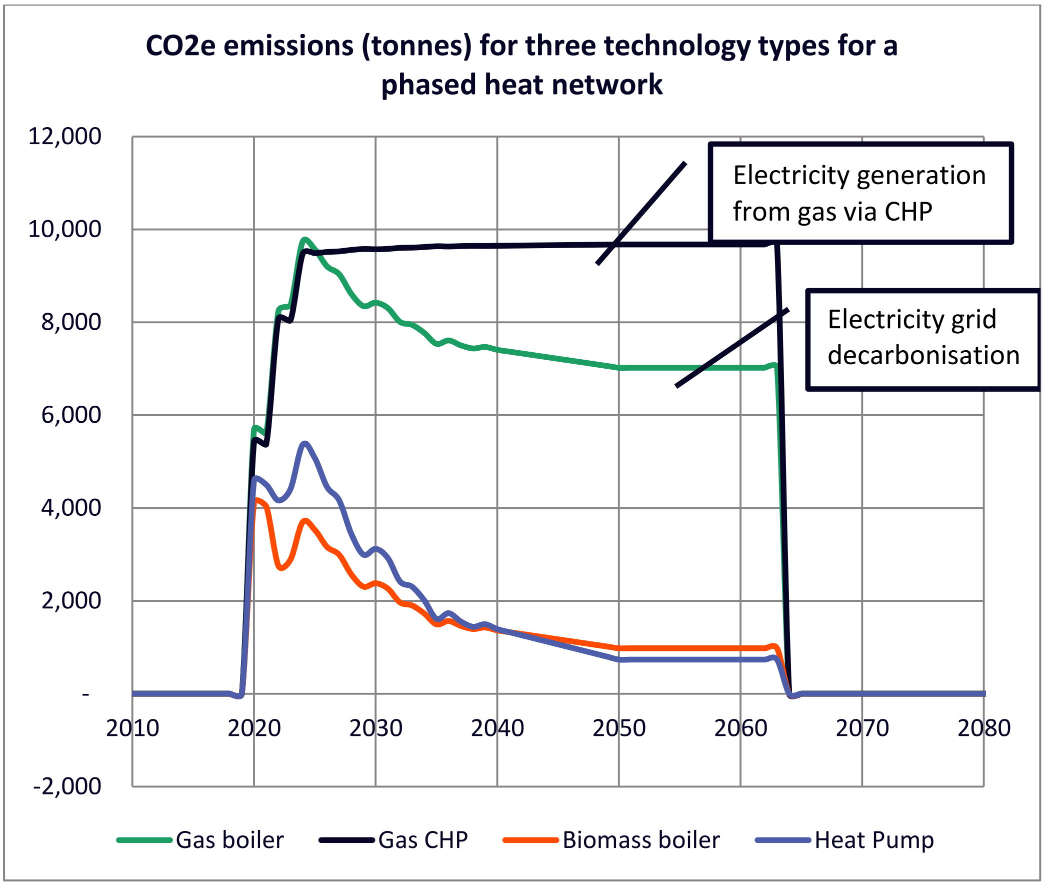


Figure 53: CO2e emissions for the North Hampshire Hospital cluster for different technology options up to 2063

7. Commercial Vehicle Review

This section details the various business models which can be employed in order to successfully develop a heat network. These tend to be complex enterprises with multiple stakeholders; different models will suit different project requirements.

Key stakeholders may be involved in separate facets of the overall project including overall ownership, finance, operations and maintenance and providing key heat demands.

7.1 Capital investment

District heat networks are long term investments and are extremely capital intense. Installing the heat network pipes can cost in excess of £1,000 per metre; costs can quickly build to multi-million pound projects. However, once installed returns are reliably recovered for the project duration. It is typical for projects to be financed over 25-40 year terms.

It is likely that a project will be constructed in a number of phases, thus requiring multiple funding rounds. Projecting these phases allowing for known risks around bringing on certain developments will be key to ensuring the business model is robust.

Initial capital can be obtained from a number of sources including investment capital, grants, local council budgets or loans from either public or private sector. Capital may be raised from issuing of shares, which is often the case with community owned schemes.

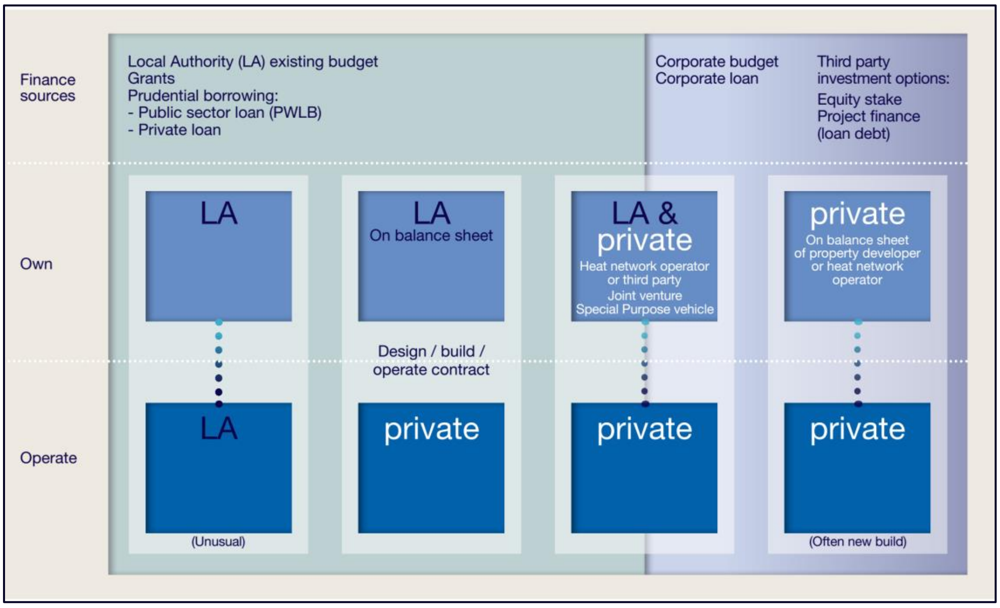


Figure 54 – Investment models (image courtesy of BEIS HNDU)

7.2 Types of operating models

There are multiple configurations of operating which can be employed depending on the attitudes of the key stakeholders around risk and control.

Each piece of an operating network can be owned and operated by different parties, although the more actors within the system the more risky a project can become.

The CIBSE Heat networks code of practice provides a comprehensive matrix of the potential combinations for running energy centres, the heat network and heat supply.

OPTION	Energy centre		Heat network		Heat supply
	Own	Operate	Own	Operate	
A	PSCo	PSCo	PSCo	PSCo	PSCo
B1	LA	LA	LA	LA	LA
B2	LA	PSCo	LA	PSCo	LA
C	SPV	SPV	SPV	SPV	SPV
D1	PSCo	PSCo	LA	LA	PSCo
D2	PSCo	PSCo	LA	LA	LA
D3	PSCo	PSCo	SPV	SPV	PSCo
E1	LA	LA	PSCo	PSCo	PSCo
E2	LA	LA	PSCo	PSCo	LA
F	COCo	COCo	COCo	COCo	COCo

LA = Local Authority
PSCo = private sector company
SPV = public-private special purpose vehicle
COCo = community owned company

Figure 55 Ownership matrix (CP1: Heat Networks: Code of Practice for the UK)

These broadly fall into the following categories;

- Public – a municipal approach or community owned company;
- Hybrid - usually a public/private joint venture or special purpose vehicle;
- Private – wholly owned and operated within the private sector. This can include community owned companies.

7.3 Types of Commercial Models

Public sector led heat networks
This was a traditional model; it used to be very common for public authorities to supply local utilities, and many older networks were set up in this way. Some more modern schemes also follow this model, such as the Bunhill Scheme in Islington, which is primarily driven by the requirement to maintain full control over the scheme and retain the generated income.

Table 13: Advantages and disadvantages of public sector led heat networks

Advantages	Disadvantages
Low cost of capital means financial marginal schemes can progress	Public sector lead must carry all the finance risk

Advantages	Disadvantages
Greater control is maintained within the public authority to maximise on its own objectives such as • Carbon savings • Fuel poverty reduction • Local economic growth	Public sector lead must resource the ongoing operation of the enterprise, and may have limited expertise

It is likely that a separate internal department of the public sector lead organisation would be needed to both develop and then operate the scheme. The project risks would sit with this department but there would not necessarily be a legal structure to protect the wider organisation. Some project risks can be mitigated with legally binding contracts, with contractors providing design and build services. Finance can be from the organisation's cash reserves or from the Public Works Loan Board (PWLB).

Public Sector projects can typically operate down to 4-5% IRR as profits may not be required if a project fulfils other local policy requirements.

Hybrid models

Hybrid models are becoming more common as LA's seek to facilitate the successful propagation of heat networks whilst sharing the risks and rewards with established market operators.

There are many different approaches; given a scheme is technically and economically viable, it is possible to flexibly configure a structure that incentivises all project partners to optimise the outcomes of the scheme.

Typically examples are;

- Establishing a Special Purpose Vehicle (SPV), a new legal entity external to the public authority which may be wholly owned by it
- Entering a Joint Venture (JV) with a private sector partner

Table 14: Advantages and disadvantages of Hybrid models

Advantages	Disadvantages
Sharing risk and rewards according to appetite; can be adapted to project requirements	Can be time-consuming to set up, a lot of thought and effort needs to be put in to ensure the structure is fit for purpose and all the necessary contracts are in place
Type of structure is very familiar to the market	Requires a minimum IRR to be commercially viable

A typical structure of an SPV to deliver heat network projects is given in Figure 56. It shows the range of roles to deliver the scheme which could all be managed by separate parties according to expertise/willingness to finance/willingness to hold risk.

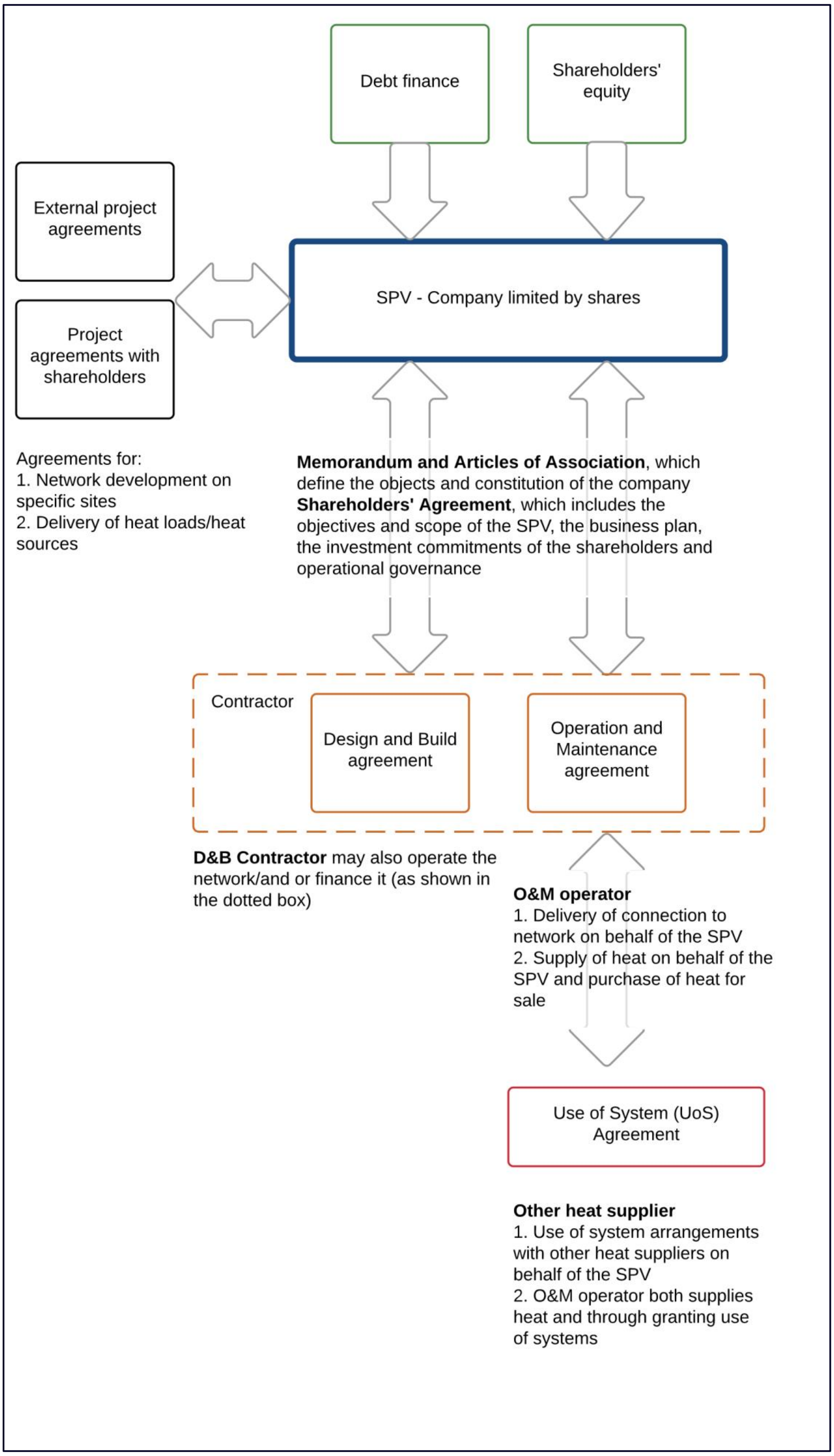


Figure 56 – SPV typical structure - Image courtesy of GLA

Due to the complexity and range of different structures available, further advice should be sought for each individual scheme to make sure the structure fits the particular circumstances. More general advice is given by HMRC in a guidance document for public bodies looking to enter joint ventures with the private sector.[6]

Hybrid vehicles or SPVs can accept lower Rates of return than purely commercial ventures, typically within a range of 6%-10% IRR.

Private sector led models

Where a scheme projects a high rate of return, the private sector may seek to develop a scheme independently of the local authority. This may be encouraged if the local authority is particularly risk averse or there are political reasons as to why a legally binding collaboration with the private sector would not be acceptable.

Table 15: Advantages and disadvantages of Private sector led models

Advantages	Disadvantages
Can be implemented relatively quickly as fewer stakeholders	The private sector developer will not necessarily have access to the facilitation assets of the local authority such as control over portfolio and regulatory powers
	Requires a minimum IRR to be commercially viable

Some of the downsides of a wholly private sector development can be mitigated by working in partnership with the local authority. Whilst the governance of this company will be down to the developer, they may invite key stakeholders such as local councillors to sit on the board in an advisory role to direct their efforts and identify areas of synergy where joint efforts could yield better results for both parties.

There have been some very successful examples of privately led models such as Birmingham District Energy. The separate company is owned and operated by Cofely with legally binding 25 year contracts with BCC (Birmingham City Council) to provide heat customers. BCC also sit within the corporate governance structure to influence decisions in key areas to ensure that their scheme requirements such as carbon targets are being met.

Private commercial models require returns of 8%+ to be viable and preferable over 10% IRR.

Community Owned Companies

Community energy projects have an emphasis on local engagement, local leadership and control and the local community benefiting collectively from the outcomes. They usually raise capital from issuing shares to local interested people that then get a return from their investment over the lifetime of the system.

Community owned companies may accept a slightly lower rate of return than purely private companies as the local stakeholders may include non-financial metrics in their requirements.

[6] Joint Ventures: a guidance note for public sector bodies forming joint ventures with the private sector https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/225321/06_joint_venture_guidance.pdf (09/11/17)

7.4 Project procurement and management

As shown in Figure 55 there are a number of functions that can be separated to be delivered by separate parties or contracted as a package. If these functions, such as development, design, build and operation are procured separately there may be some cost savings as a main contractor will take a management fee for the project, but there will need to be a lot more resource applied internally to manage the project.

Alternatively, it is possible to procure a full service package including design, build and operate. This will probably require a full OJEU compliant tender process but should require less internal resource to manage once secured.

7.5 Business Models for study area clusters

The clusters identified in this report provide a range of potential returns to an investor.

Table 16: Best performing clusters.

				25yr.	30yr.	40yr.
E13	Basing View	Phase 1 - 3	Village Hotel, Belvedere House, Northern Cross, Business Environment Offices & Adjacent Complex, Network House, Mountbatten House, Eni Engineering E & P House, Matrix House, Southern Cross, Unum House, Quantum House, Waitrose, John Lewis, Basingstoke Campus.	8.2%	9.2%	10.1%
E15	North Hampshire Hospital	Phase 1 only	North Hampshire Hospital including the Ward Block, The Firs, and Sherborne building, and Candover Clinic	11.2%	11.9%	12.5%
E14	Town Centre	Not currently financially viable	Civic Offices, Costello School, Magistrates Court, Indigo Business Centres	-7.3%	-1.2%	2.4%
E16	Leisure Park	Central leisure facilities only	Basingstoke Aquadrome, Ice Rink, Wessex Bowl, Odeon Cinema, Gala Clubs, Premier Inn Hotel	7.2%	8.2%	9.1%

The best performing phases across each cluster are depicted above. It shows that the first phase of the North Hampshire Hospital cluster, which connects the main hospital and Candover Clinic, offers the most attractive returns of all, of 11% IRR at 25 years. These returns make this cluster an attractive opportunity for private investment, and given the hospital are currently exploring the replacement of their ageing heating plant, this represents an interesting opportunity to take forward. A further detailed feasibility should consider the possibility of getting the hospitals CHP running again, and if and how this could be integrated into a local network. Whilst the extension of the cluster to include phase 2 and phase 3 would be technically achievable and provide added social value, this would be to the detriment of the financial returns of 8% IRR at 25 years.

Quantifying the value of the social benefit offered by phase 2 and 3 is important if the cluster is taken forward for detailed feasibility, to understand whether these extensions can be justified.

Phase 2 and 3 requires extensive pipework to connect a number of smaller energy loads, and includes private customers including Apollo Hotel and Eli Lilley; phase 3 also requires the Aldermaston Road to be crossed. Consultation with these private customers has been extremely limited, and further work would is needed to build relationships here going forward. Consultation with the highways agency would also be needed to validate the costs and complexities of crossing the Aldermaston Road at the identified subway.

A heat network connecting the core facilities at the Leisure Park including the Aquadrome, ice rink and hotel, could see returns of 7% at 25 years. This model falls within the hybrid commercial venture range. Whilst the extension of the cluster to include phase 2 would be technically achievable, this would again be to the significant detriment of the financial returns, and present a greater risk given the connections are largely non-municipal.

The IRRs presented here are for the existing leisure park and incorporate trenching costs, which represent a significant proportion of the total capital costs. Given the expected regeneration here, there is a strong case to explore the viability of a heat network within the regenerated complex. If heat pipes can be laid as part of the capital works, there would be scope to significantly reduce trenching costs and significantly increase the already favourable IRRs. When combined with a capital grant, this may even push the cluster from a hybrid commercial venture which may require part-public sector investment, to a wholly privately funded investment.

The Town Centre cluster offers unattractive returns of -7% IRR at 25 years. Despite this increasing to 2% at 40 years, this remains a weak match even for a municipal venture, which can typically accept lower returns where projects can fulfil other local policy requirements. These low returns come down to high capital infrastructure costs and low heat and electricity demands. The Council offices heat demand makes up a significant proportion of the total heat in phase 1; given this, and the young age of the heating plant, installing a heat network here does not make sense at this point in time.

The Basing View cluster is showing solid returns within the hybrid commercial venture range of 8% at 25 years. The majority of connections across this cluster are offices which are managed by third parties and may represent barriers to connection. Further engagement with stakeholders is required here if a scheme is to be taken forward, particularly with the new Village Hotels development as this represents a critical anchor load.

The types of commercial vehicles applicable to each cluster are summarised in Table 17.

Table 17 Potential Business Models (IRR over 25 years.)

Very Unlikely | Weak Match | Possible Match | Good Match

	Phase	IRR (25 years)	Municipal 4-5% IRR	Hybrid 6-10% IRR	Private 10%+ IRR
Basing View	1	5%			
Basing View	2	4%			
Basing View	3	8%			
Hospital	1	11%			

	Phase	IRR (25 years)	Municipal 4-5% IRR	Hybrid 6-10% IRR	Private 10%+ IRR
Hospital	2	7.6%			
Hospital	3	8.2%			
Town Centre	1	-7%			
Town Centre	2	-6%			
Town Centre	3	5%			
Leisure Park (Existing)	1	7%			
Leisure Park (Existing)	2	3%			

7.6 Energy Service Company's (ESCOs)

7.6.1 What is an Energy Service Company

The Energy Service Company (ESCO) is special purpose vehicle (SPV) that is a legally constituted corporate entity with the requirements, obligations, ability to make capital investments and create revenues associated with a limited company (e.g. limited by equity, guarantee, not-for-profit, CIC). The ESCO is a special purpose vehicle (SPV) in the energy sector and typically falls into two main categories:

- ESCO: Energy Performance Contract where investment in efficiency measures is repaid through recovering a share of the energy-related savings; and
- ESCO: Energy Service Contracts where the investment in energy generation and supply is repaid through operational sales.

In this case the ESCO is defined as a special purpose vehicle to design, fund, deliver and operate the delivery of utility services initially in the form of heat and power. An a legal entity the ESCO is a is a structure that limits risk for the stakeholders, usually by equity or guarantee and maybe a limited company, community interest company or a not-for-profit organisation.

The Legal Frameworks Report published by the Green Building Council in 2012 identifies the role of the 'Network Promoter' and three different ESCO scheme structures that are seen as relevant and adaptable to whatever commercial and financial framework is chosen for a particular project.

7.6.2 Considerations for Basingstoke and Deane

The structure and governance and the importance of tailoring the ESCO for the local Basingstoke and Deane area has been commented on above. The ultimate structure will be a balance between the objectives of the stakeholders, and in particular in managing and delivering the commercial and the socio-economic aspirations of different stakeholders.

The use of the ESCO models allows flexibility in outcomes and the opportunity to align the differing asset classes with different lenders and thus manage strategic risk and mitigate uncertainty.

‘There are many potential routes available involving ESCOs as follows:

- Energy Centre Development ESCO that designs, optimises, sources the capital, delivers and operates each energy centre and associated network connections and aligns with the aspirations and understanding of the investors in generation assets with life cycles of 20-30 years.
- Network Development ESCO that designs, optimises, sources the capital, delivers and operates each phase of the pipework and aligns with the aspirations and time scales of infrastructure investors
- Within each ESCO there will be investors that will be managing their risk, and the interest of the Council is seen as a key benefit in reducing delivery and long-term revenue risks
- The assets created by the two development ESCOs maybe procured and adopted by a specific operating ESCO that itself may be split into the heat and power generation and the network operator
- Charging the consumer through the operating ESCO will require the management of the end-user price often through equitable formulae, typically in commercial contracts or through the Heat Trust mechanisms
- Investment in network extensions and enhanced generation assets will be promoted by the operating ESCO in conjunction with the network promoter and the key stakeholders – recognising that the associated capital servicing costs will reflect the reduce risk of investing in an existing organisation

More information is provided in the appendix 13.

8. Implementation

8.1 Recommended next steps

We recommend the following steps be carried out:

With the exception for the Town Centre, all clusters, particularly the North Hampshire Hospital cluster and the Leisure Park cluster, represent attractive opportunities and further more detailed feasibility studies need to be carried out to assess the technical and economic potential in more detail. This would include:

- gather more detailed energy data
- establish final energy centre locations and heat sources
- undertake detailed plant room design
- undertake additional scenario modelling for each cluster to optimise building network connections
- investigate the longer term options including the connection of one or more of the following clusters: Basing View, Town Centre, Leisure Park
- optimise and firm-up pipework routes, and investigate the most effective phasing approach
- build/run more detailed techno-economic models which includes modelling of complex electricity tariffs including DUOS charges and TRIADS, for each phase
- undertake half-hourly analysis of thermal storage
- use these models to optimise the size of plant
- examine the benefit of replacing aged local heating plant in key customer sites
- establish lead options and conduct final sensitivity
- investigate additional revenue generation sources e.g. STOR.
- undertake a detailed assessment of land ownership and fuel delivery implications
- establish connection practicalities and costs
- review discount rates in detail as part of building the investment case
- understand the financial contributions a housing developer might be able to make to a heat network project
- where applicable, consult with National Grid and the Distributed Network Operator to ensure the gas and electricity networks have enough capacity to accommodate a heating network.
- develop risk register and delivery programme
- prepare draft heat contracts
- Review the options and establish the governance and structure of the ESCo(s) to develop energy centres and pipework.

Stakeholder engagement

- Hold discussions with potential local heat customers to get detailed heat usage and potential price points and services, and also a better understanding of connectivity options.
- Engagement with the Basing View cluster stakeholders if a network is to go ahead here, as only very limited consultations have been held to-date. Engaging with Village Hotels is particularly important given construction is due to be completed by December 2019.
- North Hampshire Hospital and Shaw Healthcare are currently reliant on aging boiler plant. As this plant is nearing the end of its working life, there is a need to act quickly with them to consider the implementation of a heat network to supply some or all of their energy needs.
- Work with developers to influence incorporation of district heating within new developments where this report has indicated potential
- Appoint the 'network promoter' and committee of key anchor load beneficiaries
- Much of this next phase of project development work could be funded through a HNDU grant. An application to round 7 of this funding programme should be highest priority going forward.

8.2 Issues and risks

Heat networks carry an inherent number of risks due to their nature. These have been documented and catalogued throughout the project duration. At a high level these can be broken into scheme development risks and scheme operational risks.

Key scheme development risks	Key scheme operational risks
Collecting and modelling robust data • Engaging with stakeholders Projecting demands of future strategic development	Scheme reliability including maintenance and redundancy of heat supply
Attracting anchor loads • Building a compelling proposition Timing connection plans to align with customers need to invest/reinvest in heating plant	The ability to drive down the heat price to attract new connections
Securing finance	Reduce carbon emissions to meet stakeholders requirements

A full risk register has been developed throughout the project and is available as part of the project deliverables package (see appendix 14).

Specific project risks

- Cost of crossing large roads, like the A340 (North Hampshire Hospital cluster), is greater than assumed.
- Cost of crossing the railway line is greater than assumed. Connecting the Network Rail Basingstoke Campus in Basing View to the local heat network has the potential to add significant cost and complexity to the network.
- North Hampshire Hospital and Shaw Healthcare boilers are in need of replacement shortly. If these are replaced sooner than expected, this could significantly reduce the potential for selling heat and/or electricity, and ultimately impact the viability of a network.
- The Basing View and Town Centre clusters are made up of significant numbers of private customers, which can be challenging to connect.
- Failure to connect all the buildings in each cluster reducing the heat demand; particularly in the Town Centre and at Basing View.
- Planning issues in relation to the energy centres or the thermal stores; particularly for the Town Centre where space is extremely limited and of high value.
- Possible regulatory issues from the Environment Agency – not seen as a major risk. This might regulations surrounding water abstraction or heat offtake with regards local water sources, and utilisation of water source heat pumps.
- A significant change to energy prices
- Risks around grid network capacity to connect large energy consumption devices such as a commercial heat pump or CHP.

8.3 Conclusion

The heat network mapping and Masterplanning study demonstrates that there are technical and financially viable heat network projects in Basingstoke.

The North Hampshire Hospital cluster comprises a mixture of public and private sector connections, dominated by the energy demands of the Hospital. Modelling has shown this cluster has the most attractive rates of return across all clusters studied, and particularly the primary cluster. This represents an attractive option for private investment, and a cluster to be considered for a further detailed feasibility study. There is a need to act quickly given the hospital is currently exploring the replacement of ageing heat assets.

The leisure park cluster comprises predominantly of retail and leisure outlets and has shown attractive rates of return. Given the expected regeneration here, there is a strong case to explore the viability of a heat network within the new complex. This represents a great opportunity to take forward to detailed feasibility.

The Basing View cluster is predominantly made up of office accommodation, with a new hotel development acting as a critical anchor load. The clusters small geographic footprint and high rise office accommodation leads to a cluster with a high energy density and the need for only a short length of spine pipework required to connect the key loads. Modelling has shown this cluster has positive rates of return across all clusters. Encraft see this as a lower priority when considering clusters to be taken forward for further investigation.

The low density of heat demand of the town centre means the lengths of pipework required to connect to customers is relatively high, and the returns are the least attractive across all clusters. Further optimisation is required here to test different building connection scenarios and to better understand the connectivity of Festival Place. This should be considered where a network at Basing View is taken forward for more detailed modelling, given its proximity to the Town Centre

In conclusion, the Hospital and Leisure clusters represent the two most interesting opportunities to be taken forward for further investigation. More detailed half-hourly techno-economic modelling is required to further understand and optimise these clusters, including building connections, phasing, pipe routing options and heating plant and thermal storage sizing. At the same time, the stakeholder communication programme commenced during this study should continue with the same momentum to keep potential heat customers engaged with the project.

9. Appendices

Appendices are available as a separate document: