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Stratford-on-Avon District Council Heat Mapping and Masterplanning Study

Prepared for: Stratford-on-Avon District Council & Department for Business, Energy & Industrial Strategy

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List of Abbreviations

ADE	Association for Decentralised Energy
BIES	Department of Business Energy and Industrial Strategy (incorporating DECC)
BSRIA	Building Services Research and Information Association
CHP	Combined heat and power
CoP	Code of Practice
CIBSE	Chartered Institute of Building Services Engineers
CAPEX	Capital expenditure
DEN	District energy network
DPH	Dwellings per hectare
EfW	Energy from Waste
GSHP	Ground source heat pump
HNDU	Heat Network Delivery Unit
IRR	Internal rate of return
kWh	Kilowatt hour
LTHW	Low temperature hot water
LDF	Local development framework
LDO	Local development order
MTHW	Medium temperature hot water
MWh	Megawatt hour
NPV	Net present value
PPA	Power purchase agreement
RHI	Renewable heat incentive
RSC	Royal Shakespeare Company
SDC	Stratford-on-Avon District Council
SEL	Sustainable Energy Limited
SHLAA	Strategic Housing Land Availability Assessment
SPD	Supplementary planning document
SPF	Seasonal performance factor (for heat pumps)
WCC	Warwickshire County Council
WSHP	Water source heat pump

Glossary

Area electricity density	The total electricity demand of an area divided by the area (MWh/m^2). This allows for comparison of electricity demand between different areas when exact building location is unknown
Area heat density	The total heat demand of an area divided by the area (MWh/m^2). This allows for comparison of electricity demand between different areas when exact building location is unknown
Electricity demand	The electricity requirements of a building or site, usually shown as an annual figure in megawatt hours (MWh) or kilowatt hours (kWh)
Energy demand	The heat and electricity demand of a building or site
Electricity export	Electricity generated by a CHP that is not utilised in via private wire arrangements is exported to the national grid (usually at a lower tariff than would be available for private wire arrangements)
Heat clusters	A group of buildings/sites based on heat demand, location, barriers, ownership and risk
Heat demand	The heat requirements of a building or site, usually shown as an annual figure in megawatt hours (MWh) or kilowatt hours (kWh)
Heat load	
Heat offtake opportunity	An opportunity to utilise waste heat from an industrial process
Hurdle rate	The minimum internal rate or return that is required for a network to be deemed financially viable
Linear heat density	Total cluster heat demand divided by indicative pipe trench length between buildings/sites within the cluster, although linear heat density does not consider pipe diameter it provides a high level indicator for the potential viability of network options and phases
Peak and reserve plant	Gas boilers which produce heat to supply the network at times when heat demand is greater than can be supplied by the renewable or low carbon technology or when the renewable or low carbon technology is undergoing maintenance (also called auxiliary boilers)
Private wire	Electricity generated by a CHP that is supplied to network connections as part of private wire arrangements where underground cables connect the buildings to the energy centre
Renewable technologies	Technologies that produce energy from resources which are naturally replenished such as sunlight, wind, geothermal heat, or water source heat
Strategic site	A planned development site of strategic importance to the Local Authority

EXECUTIVE SUMMARY

This report presents the findings of the Stratford-on-Avon District Council Heat Mapping and Masterplanning Study (2016). The project is funded and supported by Stratford-on-Avon District Council and the Heat Network Delivery Unit (HNDU) of the Department for Business, Energy and Industrial Strategy. The purpose of the project is to identify and evaluate opportunities to develop new district heating networks as part of an energy mapping and masterplanning study. The study was delivered by Sustainable Energy in partnership with the Carbon Trust.

Stratford-on-Avon District Council's objectives and drivers for this project include:

- Reducing domestic and commercial carbon emissions
- Reducing fuel poverty and improving health, wellbeing and independence of local communities
- Reducing operational / energy costs for key public sector buildings
- Assessing the potential for utilising local energy sources
- Improve energy security and resilience against rising energy prices
- Generating revenue
- Identify, validate or confirm district heating priority areas as set out in Policy CS.3

Data Collection and Review

The first stage of the work involved a detailed data collection exercise that required site visits, meetings with Stratford-on-Avon District Council and teleconferences and email correspondence with key stakeholders. Building energy data and other relevant information was sought from existing building operators, potential developers and other stakeholders.

The Town area includes a number of key stakeholders including: Stratford-on-Avon District Council, Warwickshire County Council, Orbit Heart of England Housing Association, South Warwickshire NHS Foundation Trust, Coventry and Warwickshire Partnership NHS Trust and the Royal Shakespeare Company. The project team contacted, and where possible, met and liaised with all key stakeholders. Numerous attempts were made to obtain information from Jaguar Land Rover, Aston Martin Lagonda and Stratford-upon-Avon College but the consultant team received limited information on their energy consumption/generation and future development plans.

Key planning documents were reviewed and Council planning officers were consulted to establish the nature of developments and the likelihood of them being brought forward. As expected, more detailed information was available for developments due to be brought forward and built out in the short term, as opposed to those planned for the medium and long term.

Energy Demand and Supply Assessment

Energy demand models were produced for existing buildings and future developments and the heat demand profiles were combined to assess the overall demand for development areas, heat clusters and various network options. Electricity demands were assessed in order to investigate options for private wire arrangements.

Within the Stratford-upon-Avon Town heat map area, the largest heat demand was Bordon Hill Nursery. Other key heat loads include the Holiday Inn and the Canal Quarter development area. The majority of the heat demand required by planned developments arises from residential use with the exception of Gaydon / Lighthorne Heath village centre and the employment area at SUA.2.

The majority of electricity demand arises from retail buildings including Morrisons, Tesco, Marks and Spencer and the Maybird Shopping Park. The Royal Shakespeare and Swan Theatres account for the 5th largest electricity demand within the Stratford-upon-Avon Town heat map area. Electricity demands were relatively low at the majority of strategic sites due to the small number of non-domestic buildings. Few significant cooling demands were identified within heat map areas, with the exception of Morrisons and Tesco supermarkets within the Stratford-upon-Avon Town heat map area.

Due to the high level nature of information currently available for the majority of strategic sites, it was not possible to identify the location and energy demand for each building. In most cases, the heat and electricity demands for strategic sites were displayed as area heat and electricity density, based on building use, housing density and an assumed average dwelling size based on the types of dwellings for each area.

Energy Supply Assessment

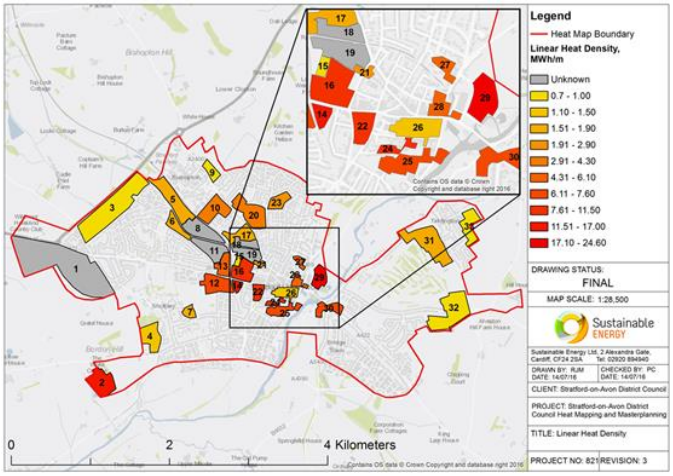
Existing and future heat sources with potential to supply networks at the subject sites were investigated, but no viable schemes were identified. There may be potential for heat offtake from Jaguar Land Rover or Aston Martin Lagonda Ltd, near the Gaydon / Lighthorne Heath development site, however no information was received and offtake opportunities from

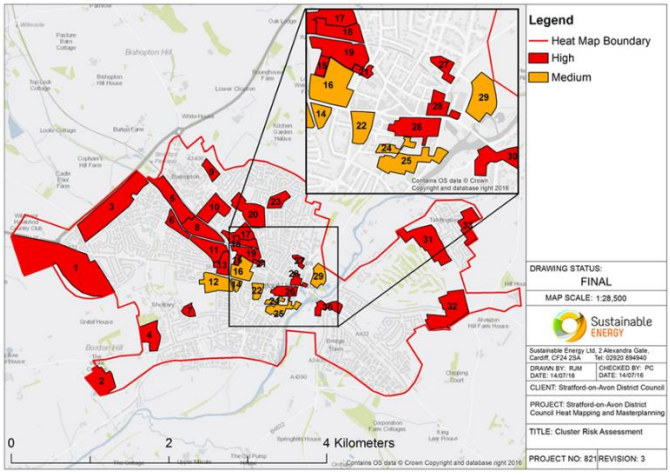
existing from current processes are likely to be limited. If Jaguar Land Rover are planning to generate electricity at their site, then this may provide the catalyst for developing a substantial heat network at the Gaydon Lighthorne Heath strategic site.

Assessment of Energy Demand Clusters

The existing buildings and development sites within the Stratford-upon-Avon town heat map area were considered in order to identify thirty-three potential heat demand clusters (see Figure 40). The clusters were selected based on physical barriers, building type, development plans, connection risk, heat demand and location. The majority of cluster linear heat densities away from the town centre are low (see below). Ten clusters within the heat map area had high linear heat densities. Twenty-six clusters have been classed as high risk due to physical barriers and/or connection risk issues and seven clusters have been classed as medium risk.

Cluster summary for Stratford-upon-Avon town





Technology Assessment

Anaerobic digestion, biomass heat, biofuel CHP, EfW, gas CHP, deep geothermal, GSHP and WSHP were assessed for technical suitability. Biomass heating, gas CHP, WSHP and GSHP were selected for more detailed assessment for potential network options for both Stratford-upon-Avon Town and the strategic sites.

High Level Financial Assessment of Potential Schemes and Networks

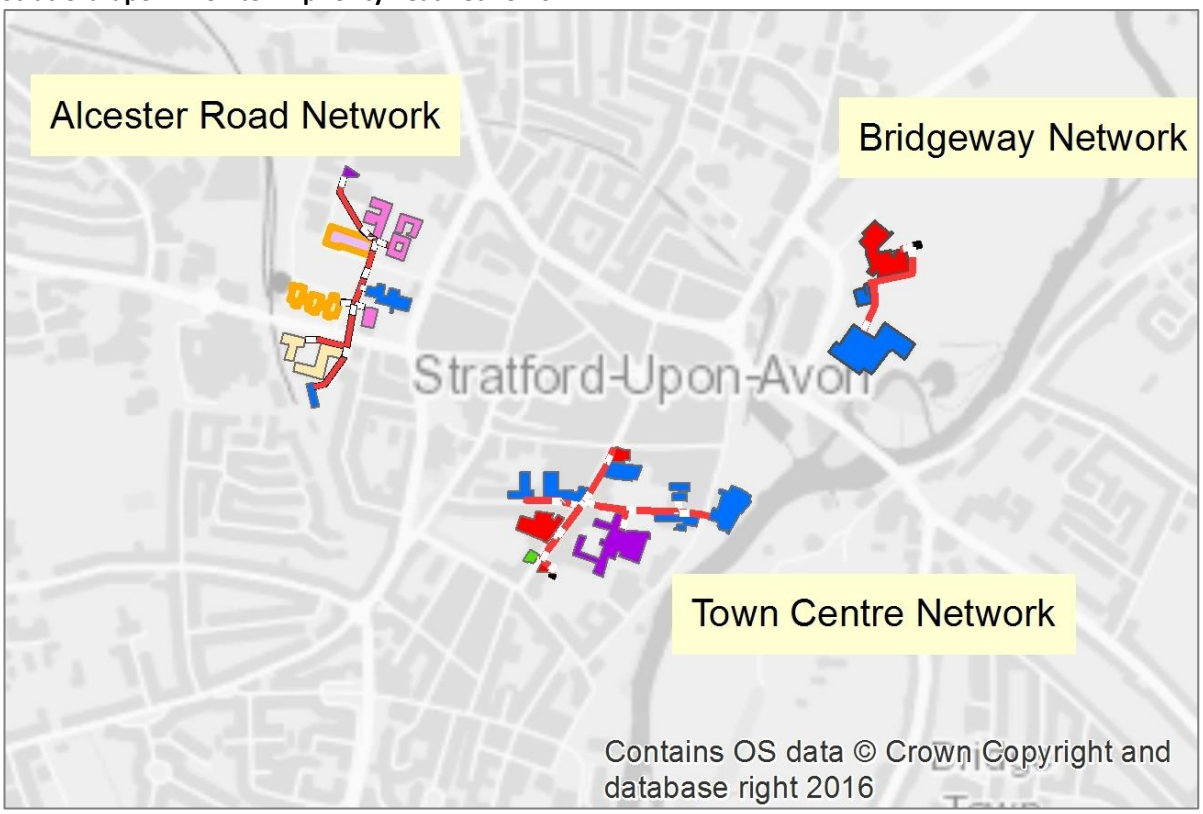
Initial network options were considered for all potentially viable Stratford-upon-Avon town clusters and strategic sites where layout plans were available. Potentially viable network options, that may potentially exceed (or were close to) the 5 % assumed Stratford-on-Avon District Council hurdle rate, were then identified and these priority schemes are shown below.

Stratford-upon-Avon Town Priority Heat Networks

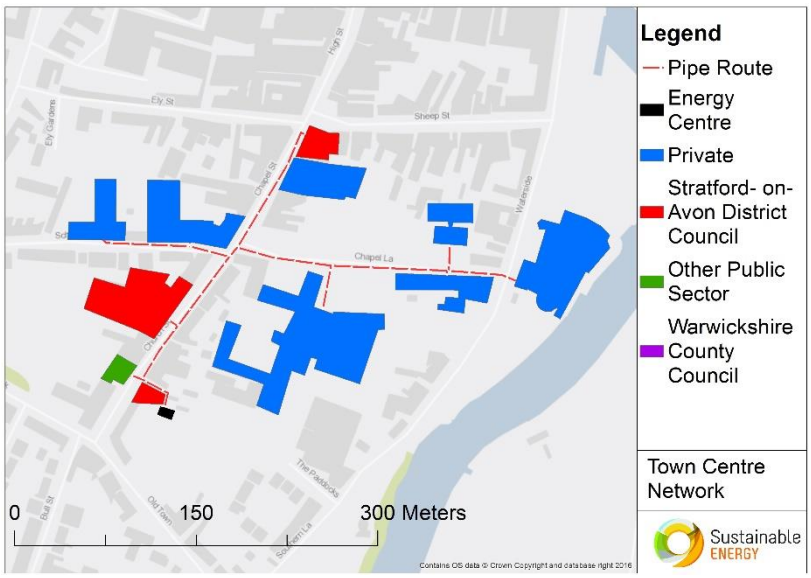
Three priority networks have been identified within Stratford-upon-Avon town (see below), namely:

- The Town Centre Network - connecting a number of buildings including those owned by Stratford-on-Avon District Council, privately owned hotels and the Royal Shakespeare and Swan Theatres
- The Bridgeway Network – connecting Bridgeway House, Holiday Inn and the Council-owned Leisure Centre
- The Alcester Road Network – connecting the Hospital (South Warwickshire NHS Foundation Trust), Coventry and Warwickshire NHS Foundation Trust and Orbit Heart of England Housing Association buildings, the Stratford Hotel and The Limes (private care home).

Stratford-upon-Avon town priority heat networks



Town Centre Network
The layout of the Town Centre network is shown below:



Total network heat demand	6,078 MWh
Estimated number of building connections	11
Network heat loss	5 %
Key heat loads: - The Falcon Hotel - Royal Shakespeare Theatre / Swan Theatre	

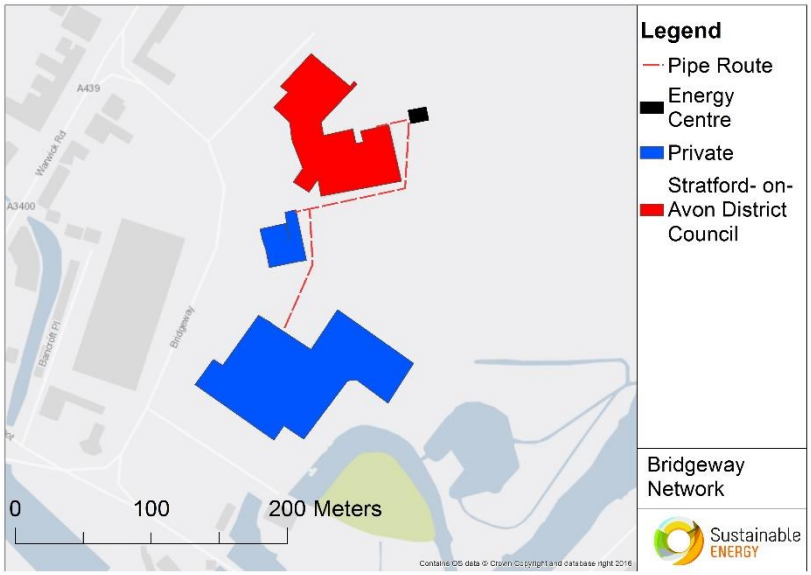
The following table summarises the high level financial assessment and key sensitivity parameters and risks:

Technology	Network trench length	Estimated CAPEX	Carbon savings	Timing	25 year financial case			40 year financial case		
					Discounted payback	IRR	NPV	Discounted payback	IRR	NPV
Gas CHP 380 kWth	0.7 km	£2,513,011	539 tonnes per annum	0-3 years	23.4 years	4.2 %	£200,154	26.5 years	5.2 %	£767,469

Key sensitivity parameters	- Electricity private wire sales - Gas input tariff - Heat sales tariff - Capital cost	
Key opportunities	- Network includes Council owned offices, register office and Town Hall - Royal Shakespeare Company and King Edward VI school engaged at this stage - Energy centre located on Council owned land - Likely to be financially viable achieving the assumed hurdle rate required for public sector development and investment (>5 %) with a grant of ~10 % or small increase in revenue - Risk would be reduced if key stakeholders can be engaged - £4,662/tCO_2 (CAPEX per tonne of carbon saving)	
Key risks and issues	- Engagement with diverse range of private sector stakeholders including Royal Shakespeare Company, King Edward VI school, Mercure Royal Shakespeare Hotel, the Arden Hotel (building leased by Royal Shakespeare Company) and the Falcon Hotel - Archaeological sensitivity of town centre (all connections are listed buildings with the exception of Avon Court Care Home and RSC offices) - Potential disruption to town centre - Energy centre location has narrow access and in busy car park - Unlikely to achieve the hurdle rate required to be developed by the private sector (>~10 %) - Only likely to be viable if developed with a grant, or with a mix of grant funding and public sector borrowing - Presents a medium risk opportunity	**Risk Rating**

Bridgeway Network

The layout of the Bridgeway network is shown below:



Total network heat demand	5,876 MWh
Estimated number of building connections	3
Network heat loss	2 %
Key heat loads: - Stratford Leisure Centre - Holiday Inn	

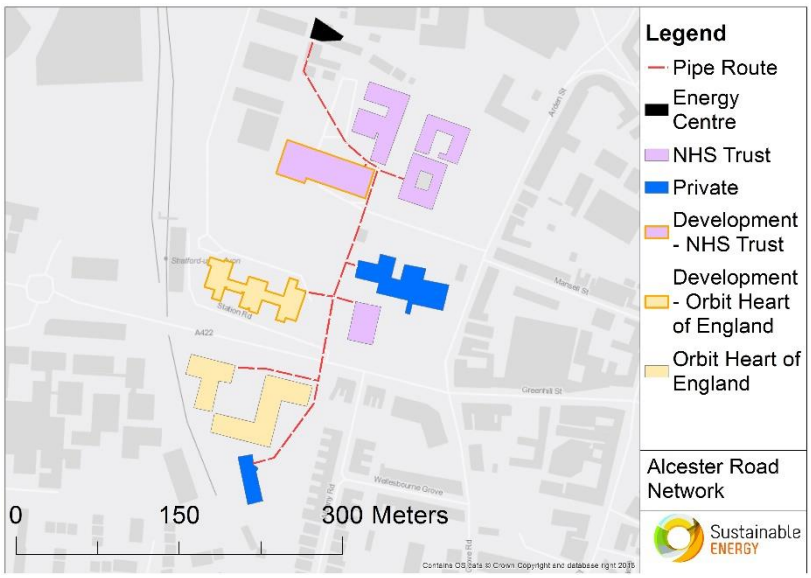
The following table summarises the high level financial assessment and key sensitivity parameters and risks:

Technology	Network trench length	Estimated CAPEX	Carbon savings	Timing	25 year financial case			40 year financial case		
					Discounted payback	IRR	NPV	Discounted payback	IRR	NPV
Gas CHP 450 kWth	0.3 km	£1,610,735	621 tonnes per annum	0-3 years	13.9 years	8.7 %	£1,128,115	15.5 years	8.8 %	£1,676,283
WSHP 750kWh		£2,387,536	537 tonnes per annum	0-3 years	18.2 years	4.8 %	£310,168	20.9 years	3.3 %	-£33,020

Key sensitivity parameters	Gas CHP - Electricity private wire sales - Gas input tariff - Heat sales tariff - Capital cost	WSHP - Electricity input tariff - Heat sales tariff - Capital cost
Key opportunities	- High linear heat density cluster - Gas CHP option is likely to be financially viable achieving the hurdle rate required for public sector development and investment (>5 %) - £2,594/tCO_2 for gas CHP - £2,225/tCO_2 for WSHP	
Key risks and issues	- Engagement not achieved with Stratford Leisure Centre and the Holiday Inn at this stage - Flooding risk - Location of energy centre (local wildlife site and conservation area) - RHI tariffs may change following RHI consultation (in relation to WSHP option) - Gas CHP option unlikely to achieve the hurdle rate required to be developed by private sector partners (>~10 %) without significant increases in heat or private wire sales (>10 %) - WSHP network option may not be financially viable as it does not achieve the hurdle rate required for public sector development and investment (>5 %) without significant increases in heat sales (>10 %) or RHI (>5 %) - Only likely to be viable if developed with a grant, or with a mix of grant funding and public sector borrowing - Until the Holiday Inn and Leisure Centre are engaged, presents a high risk opportunity	**Risk Rating**

Alcester Road Network

The layout of the Bridgeway network is shown below:



Total network heat demand	7,078 MWh
Estimated number of building connections	8
Network heat loss	4 %
Key heat loads: - Cattle Market Extra Care Facility - Stratford Hospital Ambulatory Care Centre	

The following table summarises the high level financial assessment and key sensitivity parameters and risks:

Technology	Network trench length	Estimated CAPEX	Carbon savings	Timing	25 year financial case			40 year financial case		
					Discounted payback	IRR	NPV	Discounted payback	IRR	NPV
Gas CHP 650 kWth	0.6 km	£2,147,111	998 tonnes per annum	0-3 years	14.4 years	8.3 %	£1,378,760	15.7 years	8.6 %	£2,162,795
Key sensitivity parameters	- Electricity private wire sales - Gas input tariff - Heat sales tariff - Capital cost									
Key opportunities	- Energy data received from Stratford Hospital and Orbit Heart of England Housing Association - Risk would be reduced if key stakeholders can be engaged - £2,151/tCO_2									
Key risks and issues	- Engaging with Stratford Hospital, NHS Trusts, Orbit Heart of England Housing Association, Stratford Hotel and The Limes care home - A422 barrier - Location of energy centre - Likely to be financially viable achieving the hurdle rate required for public sector development and investment (>5 %) - Unlikely to achieve the hurdle rate required to be developed by private sector partners (>~10 %) without significant increases in heat or private wire sales (>10 %) - Presents medium to high risk opportunity - Only likely to be viable if developed with a grant, or with a mix of grant funding and public sector borrowing									**Risk Rating**

Strategic Site Priority Heat Network Areas

At this stage, only two district heating priority areas can be identified at the strategic sites, namely:

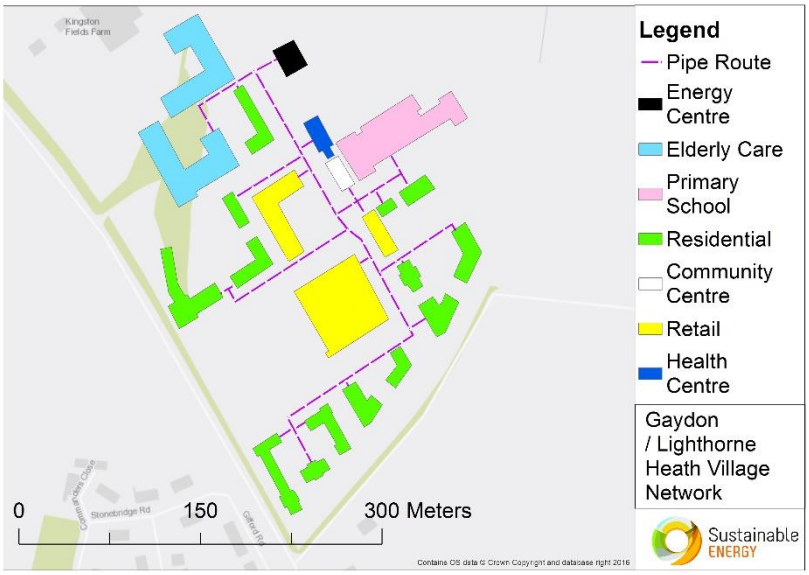
- The Canal Quarter
- Gaydon / Lighthorne Heath village centre

However, if development plans change to increase building density or heat demand at the strategic sites then this should be reassessed. For example: If Jaguar Land Rover engage with the project and indicate they plan to generate electricity at the site then the extent of the district heating priority area at Gaydon / Lighthorne Heath should be re-evaluated (to potentially increase in size); or if the industrial units (likely to be replaced) at Meon Vale / Long Marston Depot are rebuilt to accommodate more energy intensive businesses.

For sites where detailed masterplans have not been produced, example networks have been assessed and assumptions clearly stated in order to give an indication of the technical and financial viability of district energy networks. It was found that networks at Meon Vale and SOU.3 - South of Daventry Road are unlikely to be financially viable (and be allocated as priority heat network areas) even with significant levels of grant funding. There may be a marginal opportunity for a network at Gaydon / Lighthorne Heath village centre if grant funding and/or increased levels of revenue can be secured.

For Long Marston Airfield, it has been found that a significant capital grant is likely to be required for a network to be financially viable at this stage. However, this site is of strategic importance to Stratford-on-Avon District Council due to a current bid for Garden Village funding. If this bid is successful or if development plans change then the viability of district heating in this area should be reassessed.

Gaydon / Lighthorne Heath village centre network



Total network heat demand	6,152 MWh
Estimated number of building connections	22
Network heat loss	6 %
Key heat loads: - Elderly care housing - Retail - Primary school	

Technology	Network trench length	Estimated CAPEX	Carbon savings	Timing	25 year financial case			40 year financial case		
					Discounted payback	IRR	NPV	Discounted payback	IRR	NPV
Gas CHP 580 kWth	1.0 km	£2,411,020	923 tonnes per annum	2-10 years	22.0 years	4.6 %	£319,307	23.8 years	5.8 %	£1,006,168
Biomass 550 kW		£1,882,598	876 tonnes per annum		> 25 years	1.5 %	-£342,329	> 40 years	0.3 %	-£549,491
GSHP 1,000 kW		£3,709,697	598 tonnes per annum		> 25 years	3.2 %	-£121,985	> 40 years	0.7 %	-£859,939

	Gas CHP	Biomass	GSHP
Key sensitivity parameters	- Electricity private wire sales - Gas input tariff - Heat sales tariff - Capital cost	- Wood fuel costs - Gas input tariff - Heat sales tariff - Capital cost	- Electricity input tariff - Heat sales tariff - Capital cost

Key opportunities	- Gas CHP network option likely to be financially viable achieving the hurdle rate required for public sector development and investment (>5 %) with a small grant (~10 %) or an increase in revenue - A larger network at Gaydon / Lighthorne Heath may be viable if Jaguar Land Rover are planning to generate electricity at their site and are interested in heat offtake arrangements (i.e. selling heat to a network) - £2,612/tCO_2 for gas CHP - £2,149/tCO_2 for biomass - £2,963/tCO_2 for GSHP	
Key risks and issues	- Assessment based on high level development plans which are likely to change - Network reliant on engagement with developers - Likely to require grant funding and/or increased revenue - Unlikely to achieve the hurdle rate required to be developed by private sector partners (>~10 %) even with significantly increased heat and private wire sales and or connection charges - This network presents a high risk opportunity and may require a grant, or a mix of grant funding and public sector borrowing - Developer engagement and planning conditions critical to drive network development	**Risk Rating**

The Canal Quarter

The high density housing areas to be developed at the Canal Quarter site may present the best opportunity to develop a heat network in the Stratford-Upon-Avon district. It was not possible to complete full network assessments for the Canal Quarter development due to the very high level plans that are currently available. However, the heat densities for areas of this site are likely to be high and district energy networks may be financially viable. There may be an opportunity to utilise the Stratford-upon-Avon Canal as a water source for a WSHP or provide heat and power to the developments from Gas CHP. If high density housing is to be located alongside the canal then this could present a technically and financially viable network option. There is also the potential to extend the Alcester Road network to the Western Road area of the Canal Quarter development. The table below summaries the key sensitivity parameters and risks for the Canal Quarter network options:

Network	Technology	Key sensitivity parameters	Key opportunities and risks	Risk rating
Canal Quarter	Gas CHP WSHP	Due to high level nature of assessment, not assessed at this stage	Key opportunities: - Development likely to incorporate high density housing - It is likely that the highest density of housing (low rise flats) will be alongside the Canal which may provide a viable option for a network served by a WSHP - May be potential to extend the Alcester Road network to the Western Road area of the Canal Quarter development Key risks: - Assessment based on very high level development plans which are likely to change - Reliant on engagement with developers - Canal and railway line barriers to larger network	

Planning

Planning policy and planning teams play a crucial role in the development of heat network projects. The role of planners in district heating includes providing appropriate policy and supporting guidance to developers in the development or extension of networks. Planners should work with developers to guide them on the layout of their buildings and the design of their heating infrastructure to maximise the benefits of connecting to the heat network. The technical and financial work undertaken for this study will provide an evidence base for planning policy across the District.

The development requirement SPD for Stratford-on-Avon is currently being drafted and hence will have a strategic role to play in delivering district energy schemes and presents a valuable opportunity to include more detailed policy around heat networks.

However, because of the more advanced timing of this development, the most effective way to implement a heat network at this site would be to adopt a cooperative approach between the Council, HCA and the developers to establish informed discussions to highlight the benefits of this approach and strengthen developers' willingness to investigate connection to a future network.

The SPD for the Canal Quarter is in its infancy and represents an opportunity for the Council to set a planning context for the development and relate it to district heating. The document will guide developers and the Council in respect of environmental, social and economic design. The SPD should include a decentralised energy hierarchy, details on technical requirements for future-proofing and an outline of what should be included within energy statements which assess whether connection to a heat network is considered viable.

The Council should focus on building a positive evidence base, using Heat Mapping, Energy Masterplanning and techno-economic feasibility studies to demonstrate to a developer that connection to / or construction of a district heat network is technically and financially viable in the local context.

Next Steps

Stratford-on-Avon Council have a number of options to consider and these include doing nothing, funding the scheme (or elements of the scheme) or playing a supporting and facilitating role. As the options considered are high risk propositions and the high level financial cases for the presented schemes have IRRs of <10 %, this would restrict financing opportunities and development opportunities. Networks are only likely to be a viable proposition if developed by, or with financial support from developers, with a grant, or with a mix of grant funding and public sector borrowing.

Public sector ownership would be more suitable for the schemes proposed within the town centre, as there is a high proportion of council-owned and public sector buildings. Whereas the private sector led schemes would be more appropriate for the new development schemes, with support provided through planning policy and potential grant funding.

Stratford-on-Avon District Council may undertake a series of corporate actions to promote and enable a scheme including:

- Encouraging high density housing development for areas of the Canal Quarter
- Facilitating engagement with key stakeholders including Jaguar Land Rover, Aston Martin Lagonda, Royal Shakespeare Company, South Warwickshire NHS Foundation, Coventry and Warwickshire Partnership NHS Trust and Holiday Inn (to reflect network opportunities selected to be taken forward)
- Provision of Council-owned land for construction of peak and reserve energy centres and pipe routes including the Leisure Centre car park and Church Street car park (to reflect network opportunities selected to be taken forward)
- Commitment to long term purchasing contracts with a network operator for Council buildings included on Town Centre and Bridgeway networks (if selected to be taken forward)
- Engagement and support with planning consents and highways activities for networks in the town centre area, namely Town Centre, Bridgeway and Alcester Road networks (to reflect network opportunities selected to be taken forward)
- Providing resource and financial assistance to deliver feasibility and design work for potentially viable networks that may be taken forward namely Town Centre, Bridgeway, Alcester Road, Gaydon Lighthorne Heath Village Centre and the Canal Quarter

The most viable option for a District Heat network within the Stratford-on-Avon area is likely to be the Canal Quarter planned development. The viability of this should be reassessed once further development information becomes available.

1 INTRODUCTION

1.1 General

This report presents the findings of the Stratford-on-Avon District Council Heat Mapping and Masterplanning Study (2016). The project is funded and supported by Stratford-on-Avon District Council (SDC) and the Heat Network Delivery Unit (HNDU) of Department for Business, Energy and Industrial Strategy.

The purpose of the project is to identify and evaluate opportunities to develop new district heating networks through energy mapping and masterplanning.

The work was conducted by Sustainable Energy in partnership with the Carbon Trust. Sustainable Energy managed the project and undertook the majority of analysis and report writing. Carbon Trust provided key inputs addressing stakeholder engagement, prioritisation, planning, financial modelling and governance and contracting options. They also provided strategic support and review services. The contract for the study was issued following a tender process by Stratford-on-Avon District Council. The consultant team were commissioned to complete the work and the project was initiated on 4th February 2016.

1.2 Project Scope

The consultant team were commissioned to undertake the following:

- An energy mapping study to identify potential key energy demands and potentially useful heat supplies
- Development of a district energy masterplan to identify, evaluate and prioritise potential district energy schemes and priority areas and consider all potential opportunities and constraints
- Identify viable network and scheme options
- Provide key economic, governance, planning and development advice to enable Stratford-on-Avon District Council to determine the best approach to deliver priority district energy network opportunities
- Identify key stakeholders with a role to play in the delivery of district energy
- Identify priority areas within strategic sites where district energy schemes may be viable; these development sites include Gaydon / Lighthorne Heath, SOU. 3 - South of Daventry Road, Long Marston Airfield and Meon Vale / Long Marston Depot

1.3 Project Background

Stratford-on-Avon District Council received funding from the Heat Network Delivery Unit, to identify and evaluate opportunities to develop new district heating networks. The Council commissioned Sustainable Energy Ltd to a deliver an energy mapping and masterplanning study.

This study will consider district energy opportunities by undertaking heat mapping and masterplanning for Stratford-upon-Avon Town and a number of key development sites in the Stratford-on-Avon District. At the start of the project a number of key stakeholders were identified and these included internal stakeholders at Stratford-on-Avon District Council, Warwickshire County Council, South Warwickshire NHS Foundation Trust, Royal Shakespeare Company, Jaguar Land Rover, Holiday Inn, Aston Martin Lagonda Ltd, Orbit Heart of England, CALA Homes and St Modwen.

1.4 Project Drivers and Objectives

Stratford-on-Avon District Council's objectives and drivers for this project include:

- Reducing domestic and commercial carbon emissions
- Reducing fuel poverty and improving health, wellbeing and independence of local communities
- Reducing operational / energy costs for key public sector buildings
- Assessing the potential for utilising local energy sources
- Improve energy security and resilience against rising energy prices
- Generating revenue
- Identify, validate or confirm district heating priority areas (these areas will be the focus of district heating requirements for new developments in line with the District Council's Submission Core Strategy Policy CS.3 'Sustainable Energy') which states:

"The Council will encourage the use of decentralised energy systems, which incorporate either heating (District Heating) or heating, power and cooling (Combined Heat and Power) or power (micro-grid) into new developments. Large developments should supply decentralised energy to the site, or provide for future connection to a decentralised scheme where it is viable to do so."

1.4.1 Generating Revenue

Local Authorities can generate revenue from owned or part-owned district energy projects in a number of ways, including:

- Sales of heat and power – energy can be generated from a centralised energy centre or centres and heat can be sold via hot water in underground pipe networks with electricity sold back to the grid and/or to network buildings as part of private wire arrangements where underground cables connect the buildings to the energy centre
- Income from the RHI – in most cases every unit of useful renewable heat[1] generated and delivered via the network will be eligible under the RHI (the technology is eligible to receive RHI payments for 20 years)
- Business rate revenues – district energy schemes are rateable assets (under business rates), and local authorities can potentially collect and retain 100% of rates from renewable energy schemes (there is a review underway, applying from 2017)

[1] The heat generated via gas CHP is classed as low carbon heat and so is not eligible for RHI.

2 HEAT MAPPING

2.1 Review of the Heat Map Areas

The consultant team reviewed and provided advice regarding Stratford-on-Avon District Council's proposed heat map areas. After investigations and site visits the red line boundaries shown in Figure 1 were confirmed (see Figure 2, Figure 3, Figure 4, Figure 5 and Figure 6 for individual heat map boundaries).

The following strategic sites (outside of the Town area) were considered for energy network opportunities as stated in the project scope and confirmed in discussion with Stratford-on-Avon District Council:

- Gaydon / Lighthorne Heath
- SOU. 3 - South of Daventry Road
- Long Marston Airfield
- Meon Vale / Long Marston Depot

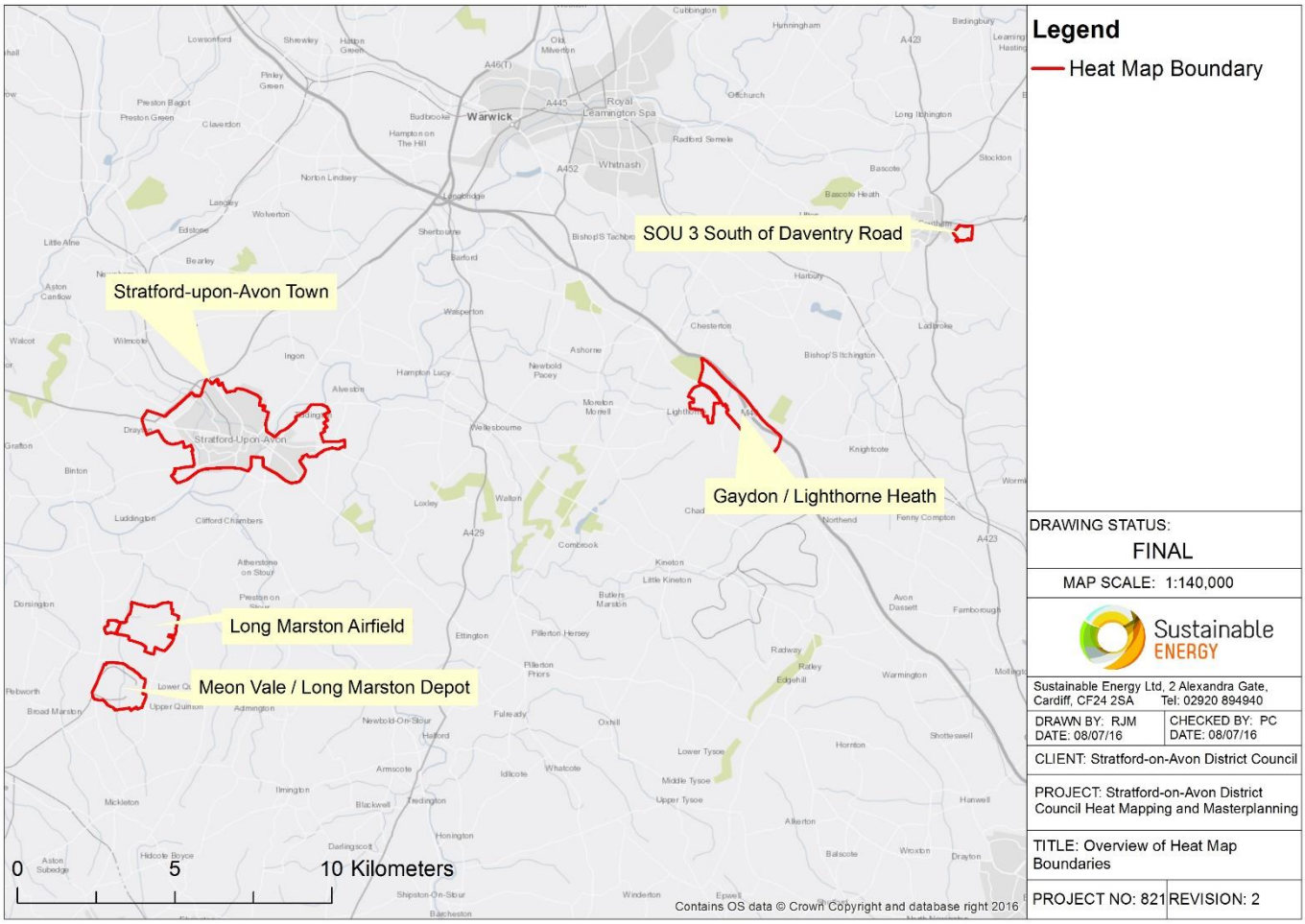


Figure 1: Stratford-on-Avon District heat map areas

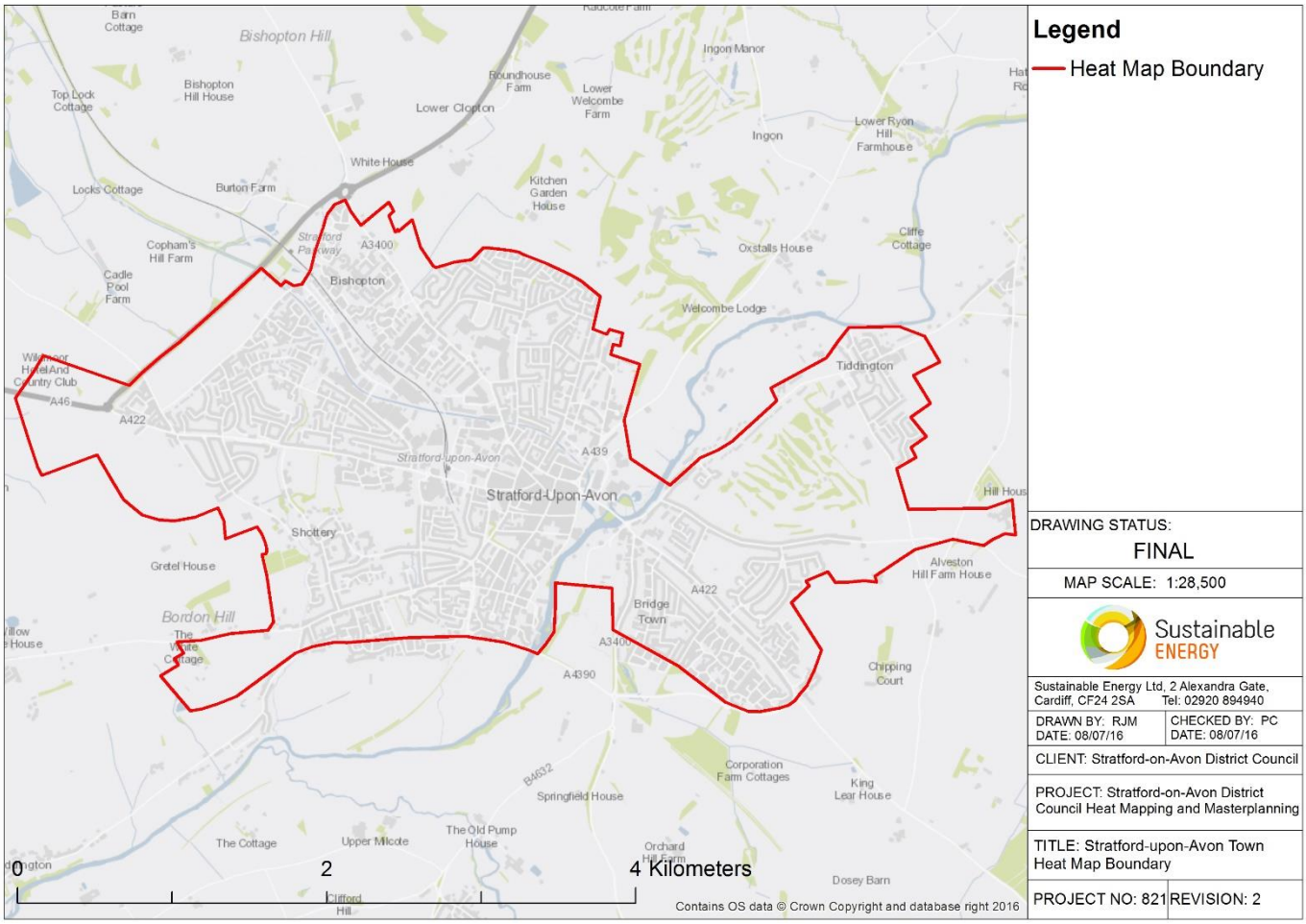


Figure 2: Stratford-upon-Avon Town heat map area

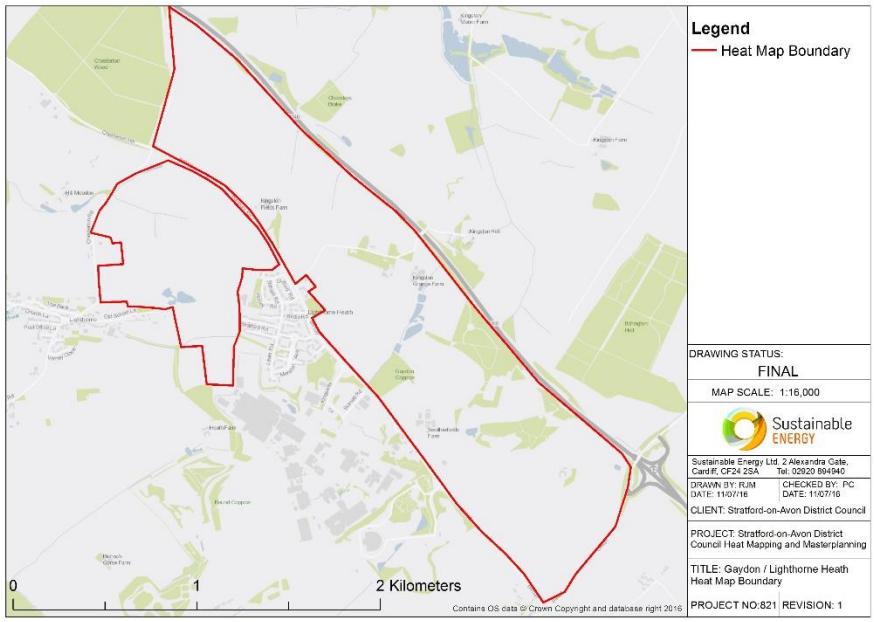


Figure 3: Gaydon / Lighthorne Heath heat map area

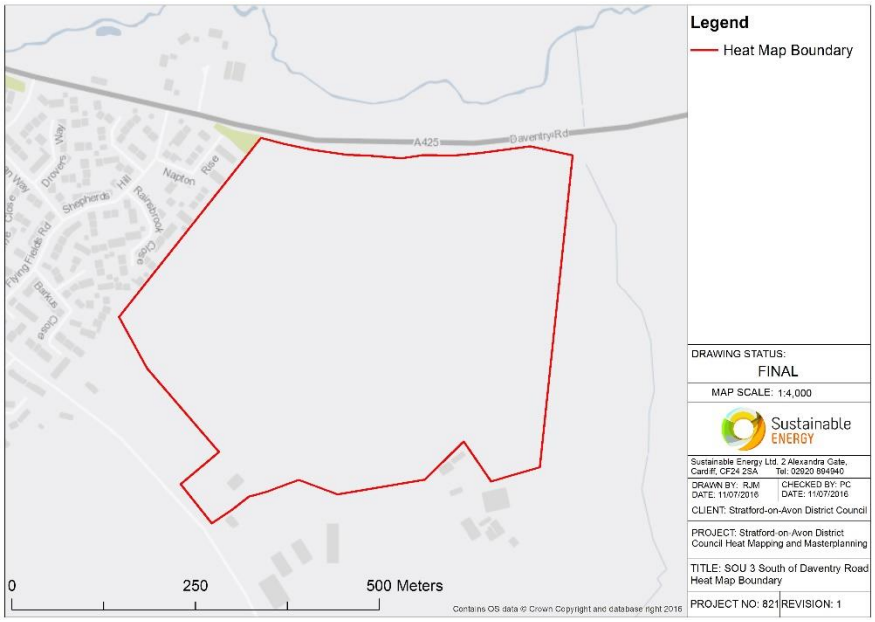


Figure 4: SOU. 3 - South of Daventry Road heat map area

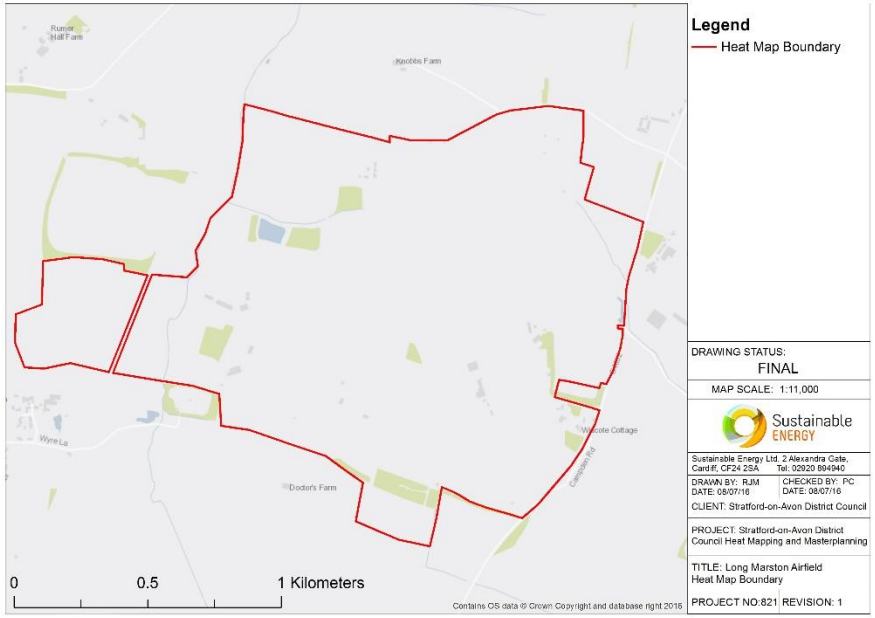


Figure 5: Long Marston Airfield heat map area

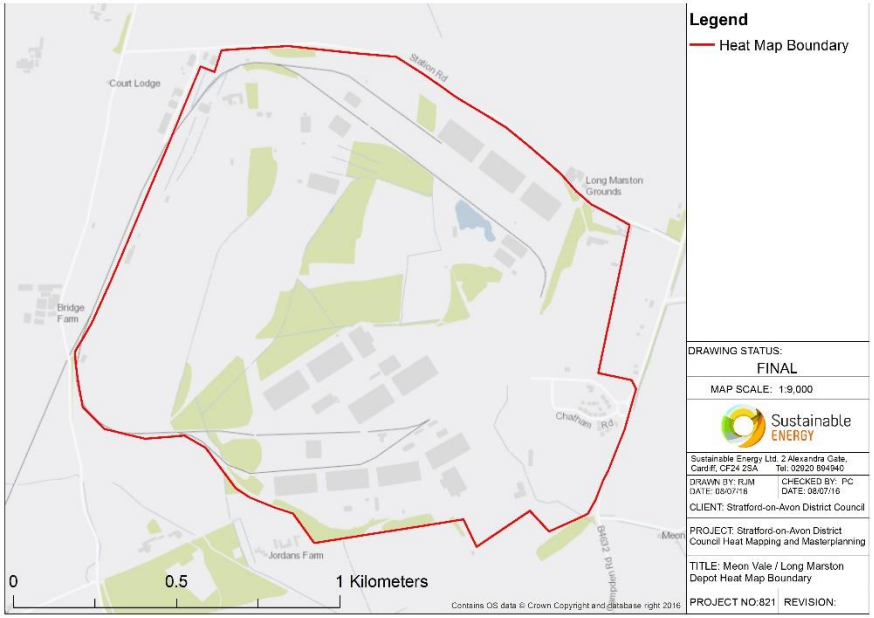


Figure 6: Meon Vale / Long Marston Depot heat map area

2.2 Data Collection

The purpose of the data collection exercise was to enable detailed energy mapping of existing and future energy demands and potential sources. An extensive list of potential heat loads and key energy sources within the heat map area was compiled. This was completed in discussion with clients and stakeholders and followed external site inspections.

2.2.1 Planned Developments

Planned developments may provide significant energy demands that should be considered when assessing district energy scheme options. There are opportunities to safeguard and futureproof layout and design to allow compatibility with and connection to existing or planned district energy networks. Engagement with developers is discussed further in section 5.

One of the main risks associated with the energy mapping exercise was the accessibility of accurate and up to date development information from a diverse range of developers and manufacturing companies such as Jaguar Land Rover. The consultant team met with Stratford-on-Avon District Council planners and this was followed up with emails and telephone calls to request and discuss available data. As the earlier development phases were more advanced, then more accurate information was made available via planning applications.

The consultant team reviewed strategic documents and development plans to ensure that all future heat demands inform network development, phasing and future proofing. This involved liaison with relevant individuals within Stratford-on-Avon District Council's planning department and included assessment of density, timeframe and phasing. It also included a review of Stratford-on-Avon District Council's planning policy.

The key documents reviewed were the:

- Emerging Core Strategy
- Strategic Housing Land Availability Assessment (SHLAA) 2012
- District Housing Strategy 2015-2020
- Local Development Framework
- Development briefs
- Planning applications
- Recent planning permissions

There are a number of risks associated with energy mapping and basing network assumptions around planned developments, these include:

- The planned development not coming forward - there is no certainty as to whether all of the sites will come forward or that planning permission will be granted for development
- Permitted developments not being built out
- Changes to the density, scale and timing of particular developments
- Connection risk - the developers not engaging with the heat network process and/or the potential network provider so that new buildings are not 'network-ready' or do not connect to an existing network

Conversely, there may be potential for the density of developments to increase and this higher linear heat density could improve the viability of networks. The majority of the strategic site developments are made of low density housing with some mixed used buildings and employment areas. The highest density housing developments will be located in the Canal Quarter.

Risks are considered further in section 4.3.

Stratford-upon-Avon Town Planned Developments

The majority of developments in the heat map area are planned to be brought forward in the next ten years. However developments in the Canal Quarter may be brought forward over the next twenty years. Figure 7 shows the planned developments identified within the Stratford-upon-Avon town heat map area. Further details of these are shown in Table 1.

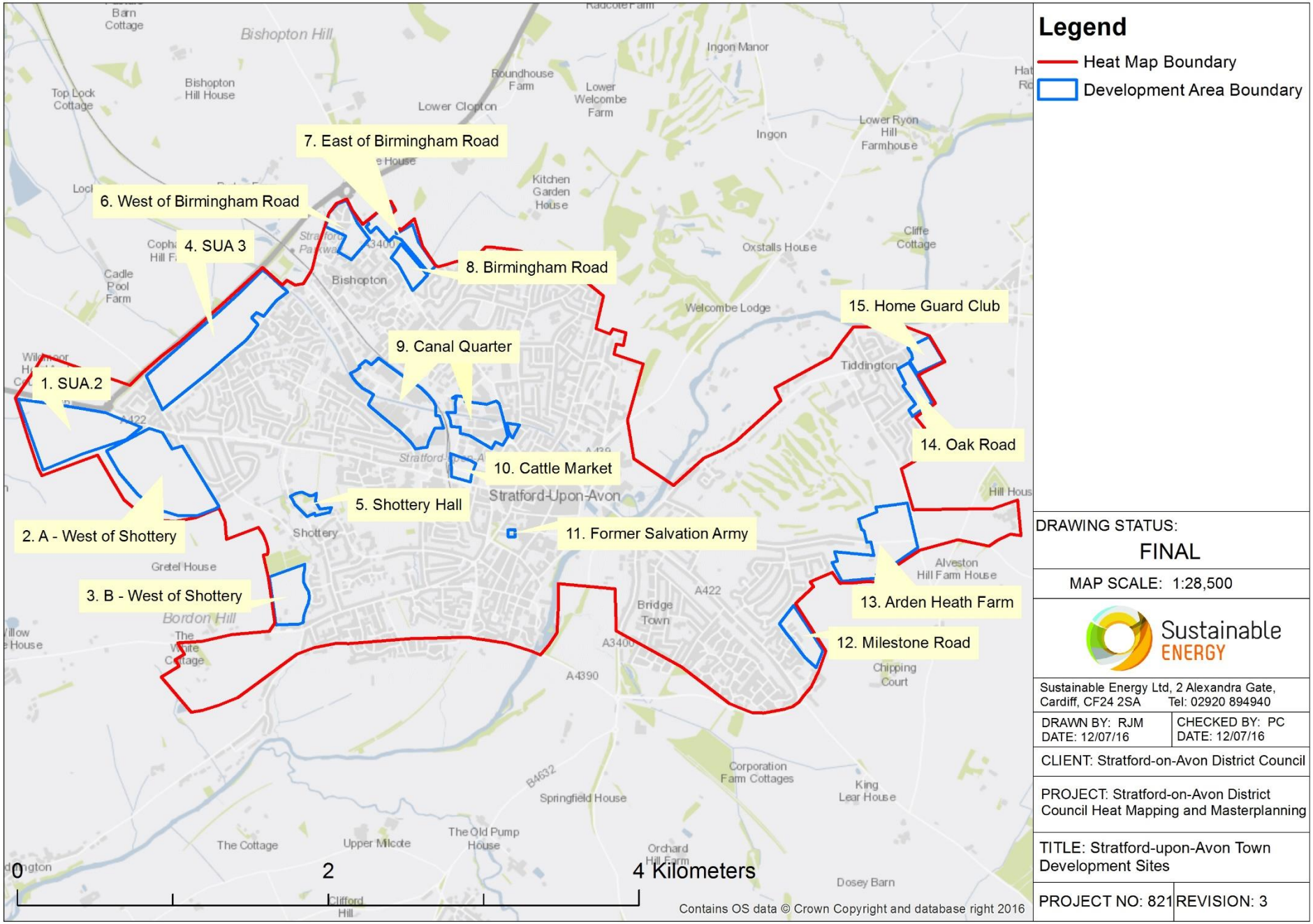


Figure 7: Stratford-upon-Avon Town planned developments

Table 1: Current planning information and housing trajectory for Stratford-upon-Avon Town planned developments

No.	Name	Location	Housing Trajectory Timings (number of dwellings)				Source	Available information	Planning details
			Phase 1 2011/2016	Phase 2 2016/2021	Phase 3 2021/2026	Phase 4 2026/2031			
1	SUA. 2 - South of Alcester Road	Land fronting Alcester Road		68			Core Strategy and 'Canal Quarter and Two Associated Employment Sites'	- Full application for residential for eastern section of site - 20 hectare employment area to potentially accommodate relocated business from the Canal Quarter (no current planning applications or detailed plans)	15/03408/FUL Permission with conditions – 19/01/2015
2	A – West of Shottery	Land S W of Alcester Road		450	350		Core Strategy	- Approval of reserved matter for residential	15/03842/REM Pending Consideration
3	B – West of Shottery	Land S W of Alcester Road						- Approval of reserved matter for residential	16/00737/REM Pending Consideration
4	SUA. 3 – North of Bishopton Lane	Land to the North and West of Bishopton Lane		280	170		Core Strategy	- Outline application for residential	15/04499/OUT Pending Consideration
5	Shottery Hall	Church Lane	27	5			Housing Sites Schedule 2015/16	- Full application for residential - Construction started	13/02784/FUL Permission with conditions – 31/10/2014
6	West Birmingham Road	Land to the west of Birmingham Road	86	74			Housing Sites Schedule 2015/16	- Approval of reserved matters for residential - Construction started	13/01361/REM Approval of reserved matters – 17/09/2013
7	East Birmingham Road	Land to the east of Birmingham Road		60			Housing Sites Schedule 2015/16	- Approval of reserved matters for residential - Phase 1 construction started	Phase I: 15/02400/REM Phase II: Approval of reserved matters – 06/10/2015
8	Birmingham Road	Land between 256 and 346 Birmingham Road		67			Housing Sites Schedule 2015/16	- Full application for residential - Construction started	15/03383/VARY Variation permitted with conditions

No.	Name	Location	Housing Trajectory Timings (number of dwellings)				Source	Available information	Planning details
			Phase 1 2011/2016	Phase 2 2016/2021	Phase 3 2021/2026	Phase 4 2026/2031			
9	Canal Quarter	Western Road		80	270	300	Core Strategy and discussion with policy planner from Stratford-on-Avon District Council	- No current planning applications - See Figure 8 and Table 2	No current planning applications
10	Cattle Market	Alcester Road		189			Housing Sites Schedule 2015/16	- Full planning application for the erection of extra care apartments and residential - Full planning application for new community hospital building	15/04283/FUL Permission with conditions – 11/07/2016 14/01996/FUL Permission with conditions – 13/01/2015
11	Former Salvation Army	Scholars Lane		5			Housing Sites Schedule 2015/16	- Demolition of existing former Salvation Army buildings and construction of five new two-bedroom apartments	15/03090/FUL Permission with conditions
12	Milestone Road	Rear of 42 Avon Crescent and Banbury Road	51	75			Housing Sites Schedule 2015/16	- Full application for residential	Phase I: 13/01342/FUL Allowed on appeal – 30/04/2014 Phase II: 15/00390/FUL Permission with conditions – 03/02/2016
13	Arden Heath Farm	Loxley Road		174	96		Housing Sites Schedule 2015/16	- Outline planning permission for residential	14/00262/OUT Allowed on appeal – 30/12/2015
14	Oak Road	Land off Oak Road, Tiddington		60			Housing Sites Schedule 2015/16	- Outline planning application for residential	15/02057/OUT Outline permitted – 08/02/2016
15	Home Guard Club			32			Housing Sites Schedule 2015/16	- Planning permission for residential and demolition and replacement of existing Home Guard Club and Scout Hut	14/03250/FUL Permission with conditions -18/06/2015

Canal Quarter

The Canal Quarter is a major planned development in Stratford-upon-Avon town covering 4 main areas alongside the Stratford-upon-Avon Canal, shown by number 9 in Figure 7 and Table 1. The proposed development area is shown in more detail in Figure 8 and details for the planned development for each site are shown in Table 2. The pale pink shaded areas in Figure 8 show the areas proposed for inclusion within the Canal Quarter development. Construction commenced at the Warwick House area, to the east of the Canal Quarter, in February 2016 with the aim of building an 82 apartment residential block (with individual heating systems). As construction has already started this development area has not been considered further in this study.

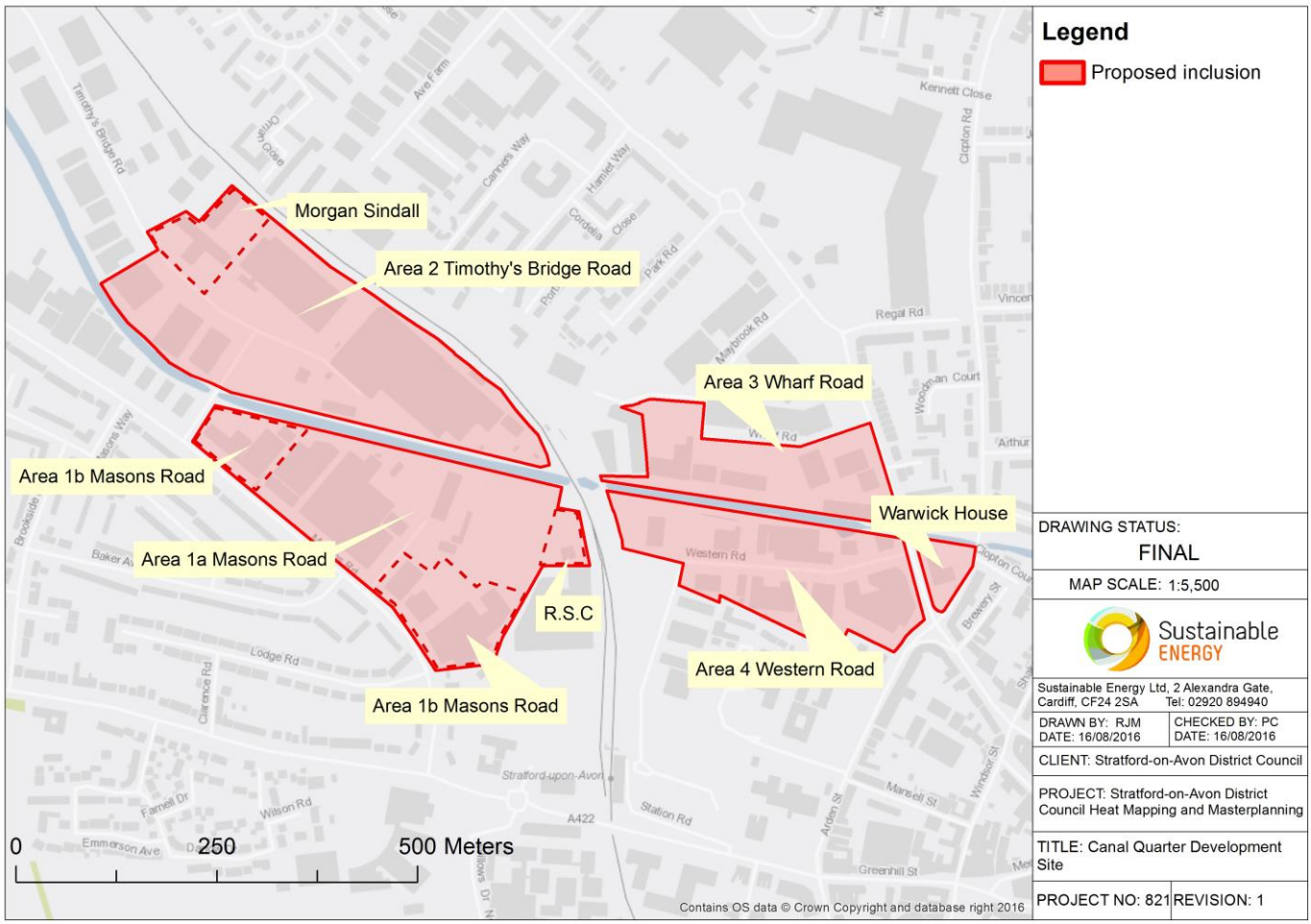


Figure 8: Canal Quarter planned development

Table 2: Canal Quarter planned development details

Area	Net development area (hectares)	Dwellings per hectare	Estimated number of dwellings	Dwelling type
Masons Road (Area 1a)	3.5	50	175	Apartments and individual dwellings
Masons Road (Area 1b – Western part)	Unlikely to be developed			
Masons Road (Area 1b – Eastern part)	1.7	35	60	Individual dwellings
Timothy's Bridge Road (Area 2)	7.5	50	375	Apartments and individual dwellings
Wharf Road (Area 3)	2.1	70	147	Apartments
Western Road (Area 4)	4.0	50	200	Apartments and individual dwellings

Strategic Sites
Table 3 shows the information currently available for each of the planned developments at each of the strategic sites.

Table 3: Current information for planned developments at strategic sites

Name	Potential building uses	Planning details	Source of information
Gaydon / Lighthorne Heath	- 3,000 dwellings (2,300 by 2031) - Extra care for the elderly - Retail and services - Community hub - Primary school	- 15/00976/OUT (south) Pending decision - 15/04200/OUT (north) Pending consideration	- Land at Gaydon / Lighthorne Heath: Supplementary Planning Document, November 2015
Meon Vale / Long Marston Depot	- Holiday homes and self-catering lodges - Leisure facilities - Community hub - Rail heritage building	- Outline planning application: 14/01186/OUT Permission with conditions – 02/04/2015	- Long Marston Estate: Design and Access Statement, April 2009
Long Marston Airfield	- 3,500 dwellings (by 2037) - Leisure facilities - Primary and secondary schools - Health centre - Technology, research and development park	- Outline planning application for South Eastern corner: 14/03579/OUT Pending decision	- Proposed Mixed Use Development at the Long Marston Estate: Planning Statement, April 2009
SOU.3 South of Daventry Road	- 32 dwellings per hectare - Local shop - Community hall/sports pavilion	- Outline planning application for residential, local shop and community hall/sports pavilion: 15/04473/OUT Pending Decision	- Land between Daventry Road and Welsh Road East, Southam: Design and Access Statement, December 2015 - Land between Daventry Road and Welsh Road East, Southam: Planning Statement, December 2015

2.2.2 Existing Heat Demands and Key Stakeholder Engagement

The consultant team contacted all potential key heat load stakeholders, in order to obtain information such as site contact lists, building and site plans showing locations and floor areas, building use and potential occupancy levels and patterns (see Appendix 1 – Key Organisations Contacted). Information requests were presented to stakeholders by email, where possible, after telephone calls or meetings (where stakeholders were amenable) to engage with the relevant site contacts. A summary of this activity is shown in Table 4.

Table 4: Summary of stakeholder engagement (for key stakeholders only)

Potential key heat load stakeholder	Sector	Comments	Engaged at heat mapping stage
Warwickshire County Council	Public	Information received via Stratford-on-Avon District Council	Yes
South Warwickshire NHS Foundation Trust	Public	Information received via Stratford-on-Avon District Council	Yes
Orbit Heart of England	Public	Contact established and information received	Yes
Stratford-upon-Avon College	Private	Contact not established	No
Holiday Inn	Private	Contact not established	No
Royal Shakespeare Company	Private	Information received via Stratford-on-Avon District Council	Yes
Jaguar Land Rover	Private	Contact established but information not received	No
Aston Martin Lagonda Ltd	Private	Contact not established	No
CALA Homes	Private	Contact established and information not received	No
St Modwen	Private	Contact not established	No

2.2.3 Existing Energy Sources

Existing energy sources were discussed with the Council and research was conducted by the consultant team. Two potential energy sources were identified for the Stratford-upon-Avon town area and site operators were contacted in order to discuss the nature and scale of schemes and energy resources. Neither Tappex Thread Inserts nor Bordon Hill Nurseries responded to information requests. No existing energy sources were identified for any of the strategic sites. There may be potential for heat offtake from Jaguar Land Rover or Aston Martin Lagonda Ltd, near the Gaydon / Lighthorne Heath development site, however no information was received and offtake opportunities from existing processes are likely to be limited[2]. This will require further investigation if this site is progressed to the feasibility stage.

2.2.4 Fossil Fuel Consumption Benchmarking

Where actual energy data was not available, domestic, non-domestic and industrial benchmarks were used to verify the expected fossil fuel consumption to be used in energy profiling (the source of all data has been identified in Appendix 2 – Energy Data and in section 3.6 in relation to priority network options; this has also been considered in section 4.3). The fossil fuel consumption value was calculated; using gross floor area determined from the building plans or masterplans (where available) and assumed areas where no data exists. A tried and tested approach was then used to generate demand profiles verified by the benchmarked fossil fuel consumption, building type and use. The consultant team has a database of hundreds of hourly annual demand profiles for a wide range of building types and these were adapted to provide an indicative heat demand profile for each site. Any buildings or sites with an annual heat demand found to be less than 15 MWh where not taken forward for further consideration in this study, however it was ensured that all buildings and sites which are of strategic importance to Stratford-on-Avon District Council where included.

CIBSE Guide F, Energy Efficiency in Buildings (2008), *CIBSE TM46* (2008), heat loss calculations and previous consultant experience were used for non-domestic benchmarks.

Consultant experience indicates that standard industry heat consumption benchmarks for domestic buildings are often high and do not consider building type and size in sufficient detail. In accordance with the CIBSE Heat Networks: Code of Practice for the UK, the consultant team developed site specific benchmarks that considered the size of each house taken from buildings plans and produced models for different building types (namely 2-bed bungalow, 3-bed detached, 3-bed detached with garage, 3-bed semi, 3-bed terraced, 4-bed detached, 4-bed detached with garage, 4-bed semi, 5-bed detached, 5-bed detached with garage), see Appendix 4 – Domestic Benchmarks.

For each building type, U-values for the building elements were used to generate modelled benchmarks using building plans and 2013 Part L regulations. Fabric heat loss was calculated using hourly temperature data, direct hot water demand was based on assumed number of occupants and solar/electrical/occupancy gains were considered. An hourly heat demand profile was generated to show peak demand (kW/m²) and an annual demand benchmark (kWh/m²). Boiler efficiency was then considered to yield a consumption benchmark in kWh/m².

Proposed housing layout plans were obtained for some developments and these included dwelling types, numbers and locations for each building type, therefore, each dwelling was allocated an appropriate benchmark. For developments where only high level plans were made available, an average benchmark was used.

Area Heat Density

For the majority of the strategic sites, where only high level plans are currently available, the location and size of individual buildings is currently unknown. For this reason, heat demands for individual buildings cannot currently be calculated. For these sites, an area heat density has been calculated (MWh/m^2) to allow comparison between development sites and to identify areas of high heat demand. The overall heat demand for each area has been calculated based on dwellings per hectare figures and an assumed industry standard average dwelling size for planned developments in the Stratford-on-Avon area.

2.2.5 Electrical Consumption Benchmarking

Electricity profiles for key electricity loads were derived. Where data was unavailable benchmarks from *CIBSE Guide F, Energy Efficiency in Buildings* (2008) and *CIBSE TM46* (2008) were used to verify consumption.

[2] In this case, heat offtake opportunities relate to the potential for a network to receive waste heat from a process or processes operated by Jaguar Land Rover and Aston Martin Lagonda Ltd.

Area Electricity Density

As with the area heat density (discussed above) it was not possible to calculate the electricity demands for individual buildings in all strategic sites due to the current high level nature of development plans. For this reason, an area electricity density has been calculated (MWh/m^2) to allow comparison between strategic sites and to identify areas of high electricity demand.

2.3 Energy Demands

Annual fossil fuel consumption values from historical data and benchmark values were used to determine an annual heat demand value for each potential key heat load within the heat map areas. The calculated annual heat demand values are listed in Appendix 2 – Energy Data.

2.3.1 Heat Demand Profiling

In order to further analyse heat demands for network options, hourly heat demand profiles were constructed. The profiles were generated using in-house modelling software which apportions the annual heat demand figure into hourly loads over the year, taking into account degree day data[3] and building use and occupancy.

For each building/phase, the annual demand model was then used to identify the average, maximum and minimum hourly demand throughout the year. An example average, maximum and minimum heat demand profile is shown in Figure 9 (for King Edward VI School).

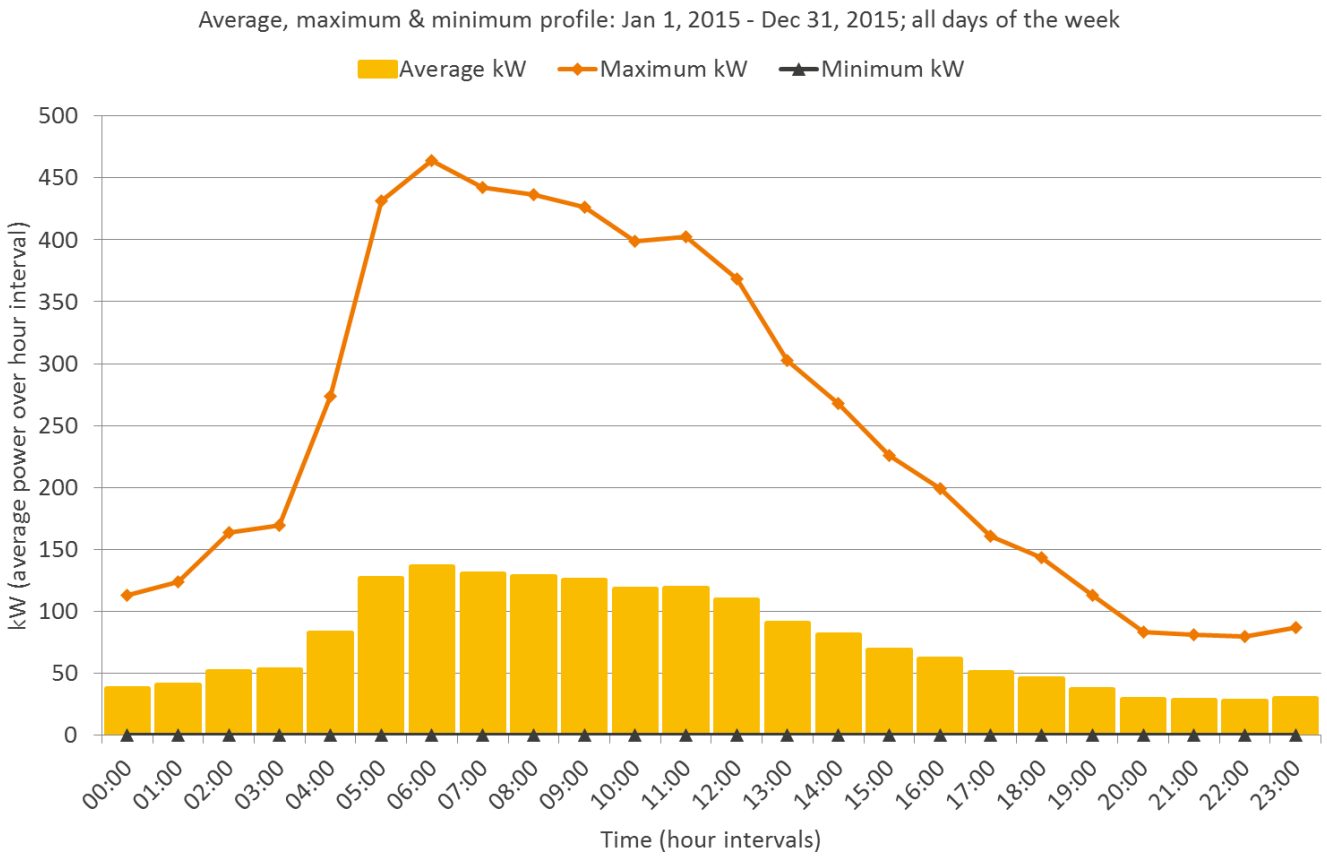


Figure 9: Annual heat demand profile for King Edward VI School

The profiles of typical winter and summer days were also produced to identify the demand variation on both a day-by-day and seasonal basis. The typical winter and summer profiles for King Edward VI School are shown in Figure 10 and Figure 11. The yellow area shows the average daily heat demand, the orange and black lines correspond with the maximum and minimum demands respectively.

[3] Degree days are a type of weather data calculated from outside air temperature readings. Heating degree days and cooling degree days are used extensively in calculations relating to building energy consumption. They are used to determine the heating requirements of buildings, representing a fall of one degree below a specified average outdoor temperature (15.5°C) for one day.

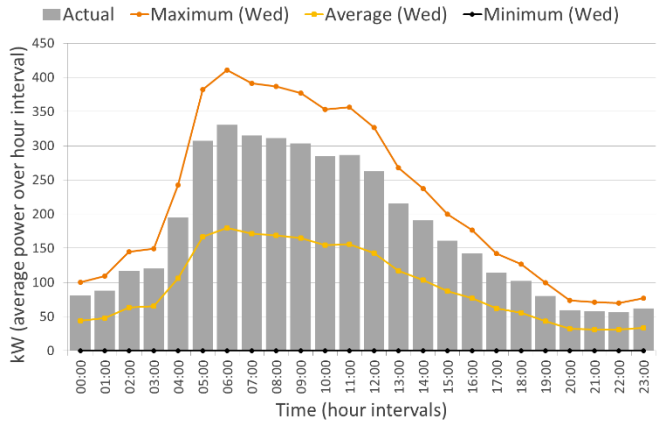


Figure 10: Daily heat demand profile for King Edward VI School – Wednesday 14th January 2015

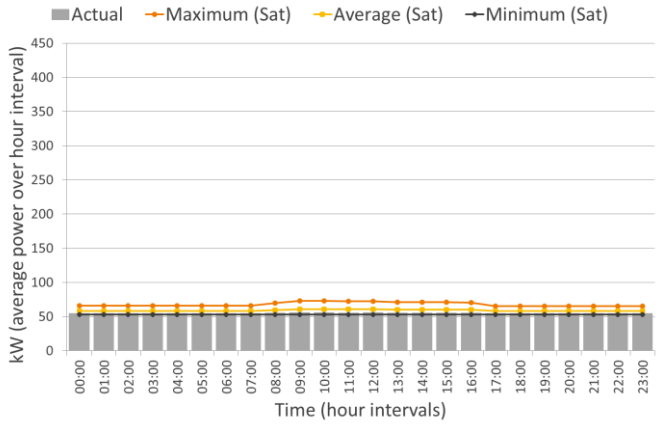


Figure 11: Daily heat demand profile for King Edward VI School – Saturday 18th July 2015

2.3.2 Electricity Demand Profiling

To allow analysis of significant potential energy demands for network options, hourly heat electricity demand profiles were constructed. The profiles were generated using in-house modelling software which apportions the annual electricity demand figure into hourly loads over the year, taking into account building use and occupancy.

For each key non-residential electricity load, the annual demand model was then used to identify the average, maximum and minimum hourly demand throughout the year. An example average, maximum and minimum heat demand profile is shown in Figure 12 (for King Edward VI School).

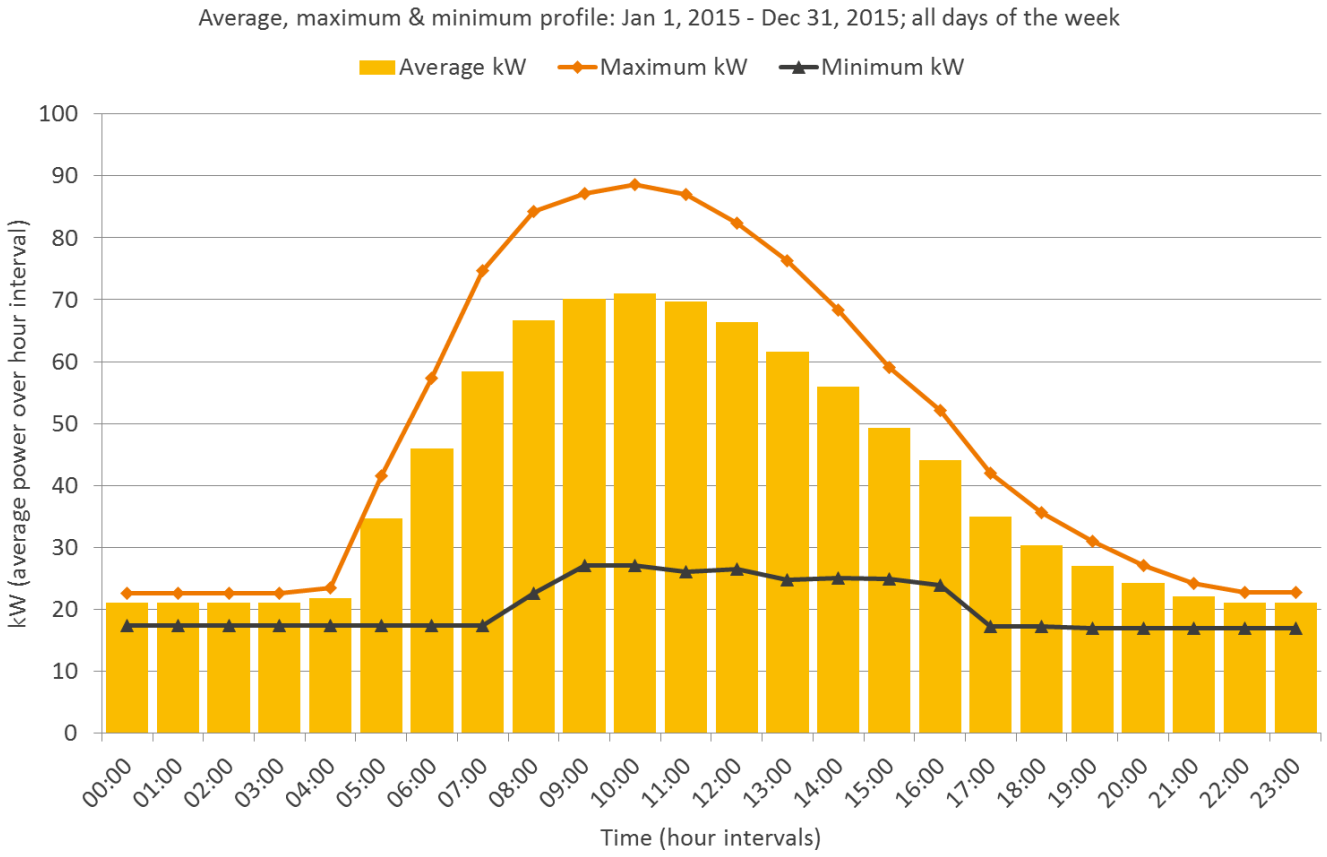


Figure 12: Annual electricity demand profile for King Edward VI School

2.4 Energy Mapping Results

Geographic Information System (ArcGIS) software was used to map the identified heat demands and key electricity demands across Stratford-upon-Avon town heat map area (see Section 2.4.1) and for the strategic sites (see Section 2.4.2). The symbols show the site location and graduate in size according to energy demand to depict the nature of the energy loads within the heat map area. The larger the symbol, the greater the energy demand. The demands for all buildings/sites are shown in Appendix 2 – Energy Data.

2.4.1 Energy Mapping Results: Stratford-upon-Avon Town

Heat Demands

The key heat demands within the Stratford-upon-Avon town heat map area are shown in Figure 13. The largest existing heat demand within the Stratford-upon-Avon town heat map area arises from Bordon Hill Nursery (4,686 MWh) located to the south west of the heat map area. Other large private sector heat demands include Holiday Inn, Alveston Manor Hotel, Maybird Shopping Park, The Falcon Hotel, Premier Inn Central, The Stratford Hotel and the Royal Shakespeare and Swan Theatre.

The largest existing public sector heat demand arises from Stratford Leisure and Visitor Centre (2,053 MWh) located to the east of the heat map area. Other large public sector heat demands include Stratford-upon-Avon College, Warwickshire Police, Stratford Healthcare and Stratford-upon-Avon High School.

Of the planned developments, the Canal Quarter developments are likely to have the largest heat demands; the largest heat demand (5,092 MWh) arises from the proposed residential development at Timothy's Bridge Road. Other planned developments which are likely to have a large heat demand include the Cattle Market and SUA. 2 – South of Alcester Road.

The top 20 key heat loads within the heat map area are shown in Figure 14 and detailed in Table 5.

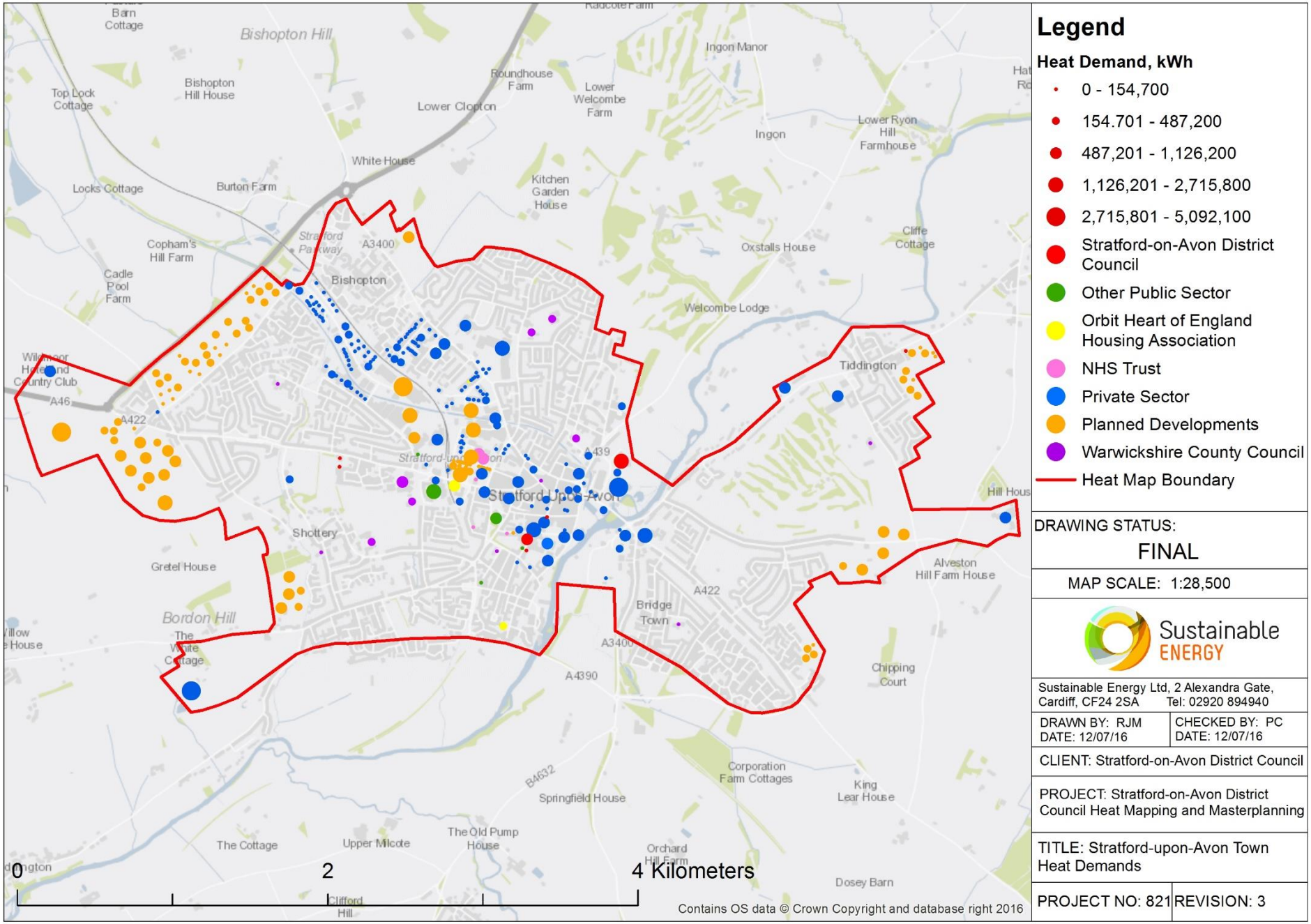


Figure 13: Stratford-upon-Avon town key heat demands

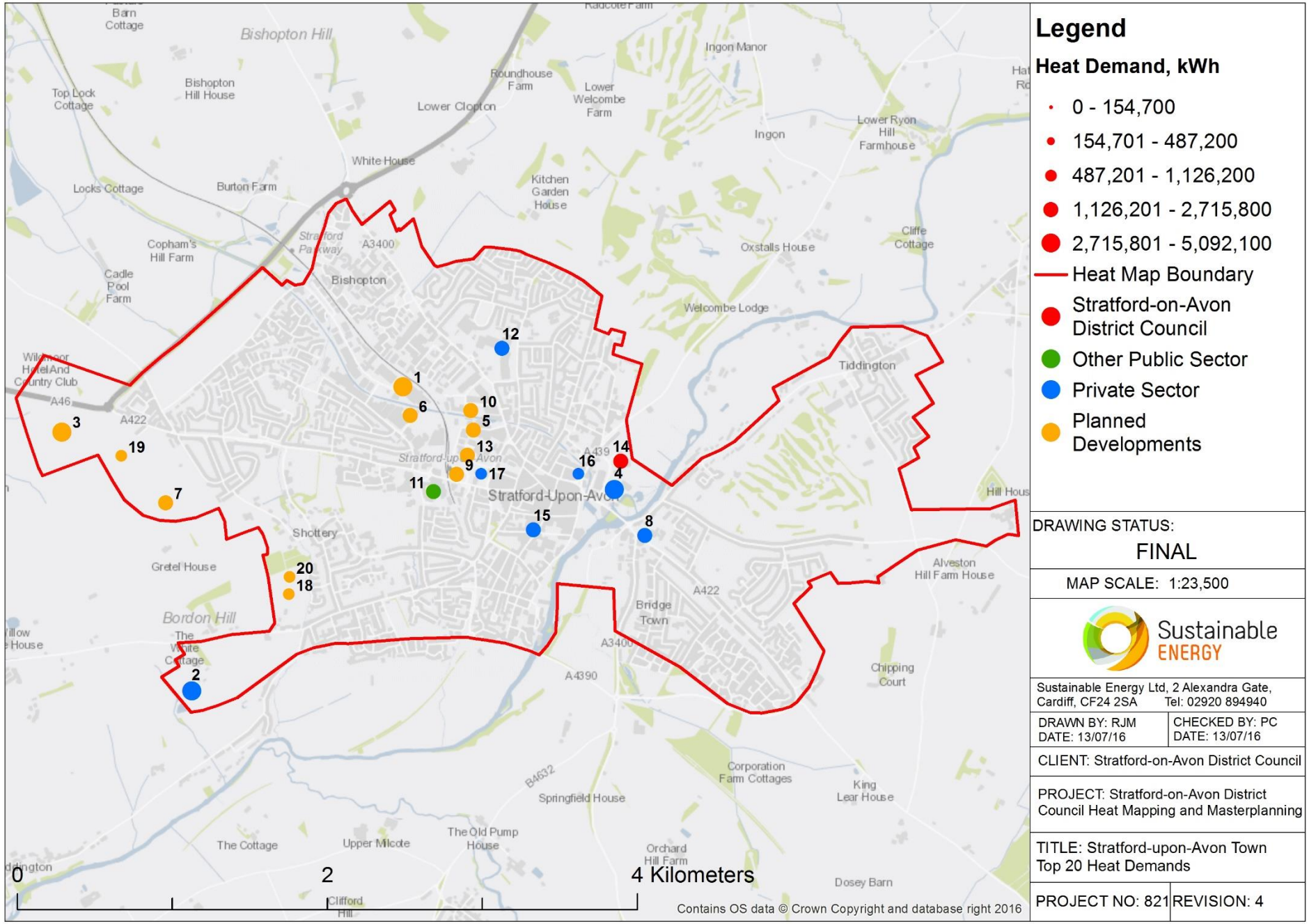


Figure 14: Stratford-upon-Avon town top 20 heat demands

Table 5: Stratford-upon-Avon Town top 20 heat demands

Top 20 Ref	Name	Building use	Category	Heat Demand, kWh
1	Canal Quarter - Timothy's Bridge Road (Area 2)	Residential	Planned development	5,092,031
2	Bordon Hill Nursery	Plant nursery	Private sector	4,686,270
3	SUA.2 Employment Development Western Area	Employment	Planned development	4,088,585
4	Holiday Inn	Hotel	Private sector	3,518,012
5	Canal Quarter - Western Road (Area 4)	Residential	Planned development	2,715,750
6	Canal Quarter - Mason Road (Area 1a)	Residential	Planned development	2,376,281
7	A - West of Shottery Southern Area Housing Development	Residential	Planned development	1,855,237
8	Alveston Manor Hotel	Hotel	Private sector	1,831,533
9	Cattle Market development extra Care apartments	Sheltered housing	Planned development	1,776,918
10	Canal Quarter - Wharf Road (Area 3)	Residential	Planned development	1,661,835
11	Stratford-upon-Avon College	Education	Other public sector	1,577,313
12	Maybird Shopping Park	Retail	Private sector	1,538,195
13	Stratford-upon-Avon Hospital, ambulatory care centre development	Healthcare	Planned development	1,394,963
14	Stratford Leisure & Visitor Centre	Leisure centre (with pool)	Stratford-on-Avon District Council	1,353,594
15	The Falcon Hotel	Hotel	Private sector	1,350,765
16	Premier Inn Central	Hotel	Private sector	1,126,125
17	The Stratford Hotel	Hotel	Private sector	1,099,800
18	B - West of Shottery Housing Development 3	Residential	Planned development	1,054,179
19	A - West of Shottery Northern Area Housing Development 1	Residential	Planned development	1,018,973
20	B - West of Shottery Housing Development 5	Residential	Planned development	990,619

Categorisation of Heat Demands
Figure 15 shows the heat demands for Stratford-upon-Avon town by building use category.

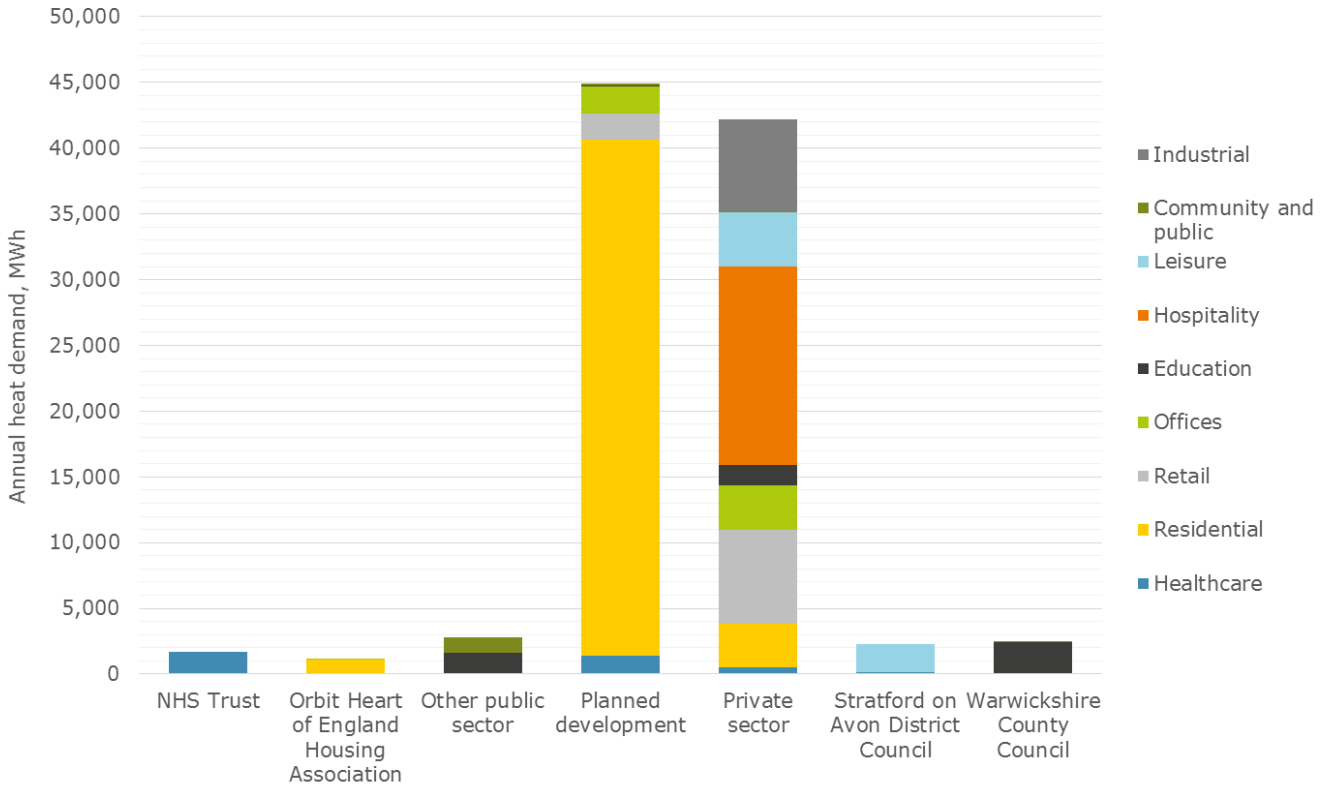


Figure 15: Categorisation of Stratford-upon-Avon town heat demands

Planned developments have the largest overall heat demand with residential buildings making up the majority; this category includes the Canal Quarter development. The private sector has the second highest overall heat demand with hospitality (mostly hotels and restaurants) making up the majority. Buildings owned by Stratford-on-Avon District Council, Warwickshire County Council and other public sector make up a small proportion of the overall heat demand.

Key Non-Domestic Electricity Demands
The key non-domestic electricity loads, shown in Figure 16, have been assessed to allow potential private wire opportunities to be investigated. The largest existing electricity demand arises from Morrisons (3,646 MWh) located close to the centre of the heat map area. Other large private sector electricity demands include Tesco Superstore, Marks and Spencer, Maybird Shopping Park, Royal Shakespeare and Swan Theatre, Holiday Inn, Town Square Shopping Centre and Alveston Manor Hotel.

The largest existing public sector electricity demand arises from Stratford-upon-Avon High School (954 MWh) located close to the centre of the heat map area. Other large public sector electricity demands include Stratford Leisure and Visitor Centre, District Council Offices (Elizabeth House), Stratford-upon-Avon College and Stratford Healthcare.

Of the planned developments the SUA 2 employment development is likely to have the largest electricity demand (923 MWh). The other planned development which is likely to have a large electricity demand is the Cattle Market.

The top 20 key electricity loads within the heat map area are shown in Figure 17 and detailed in Table 6.

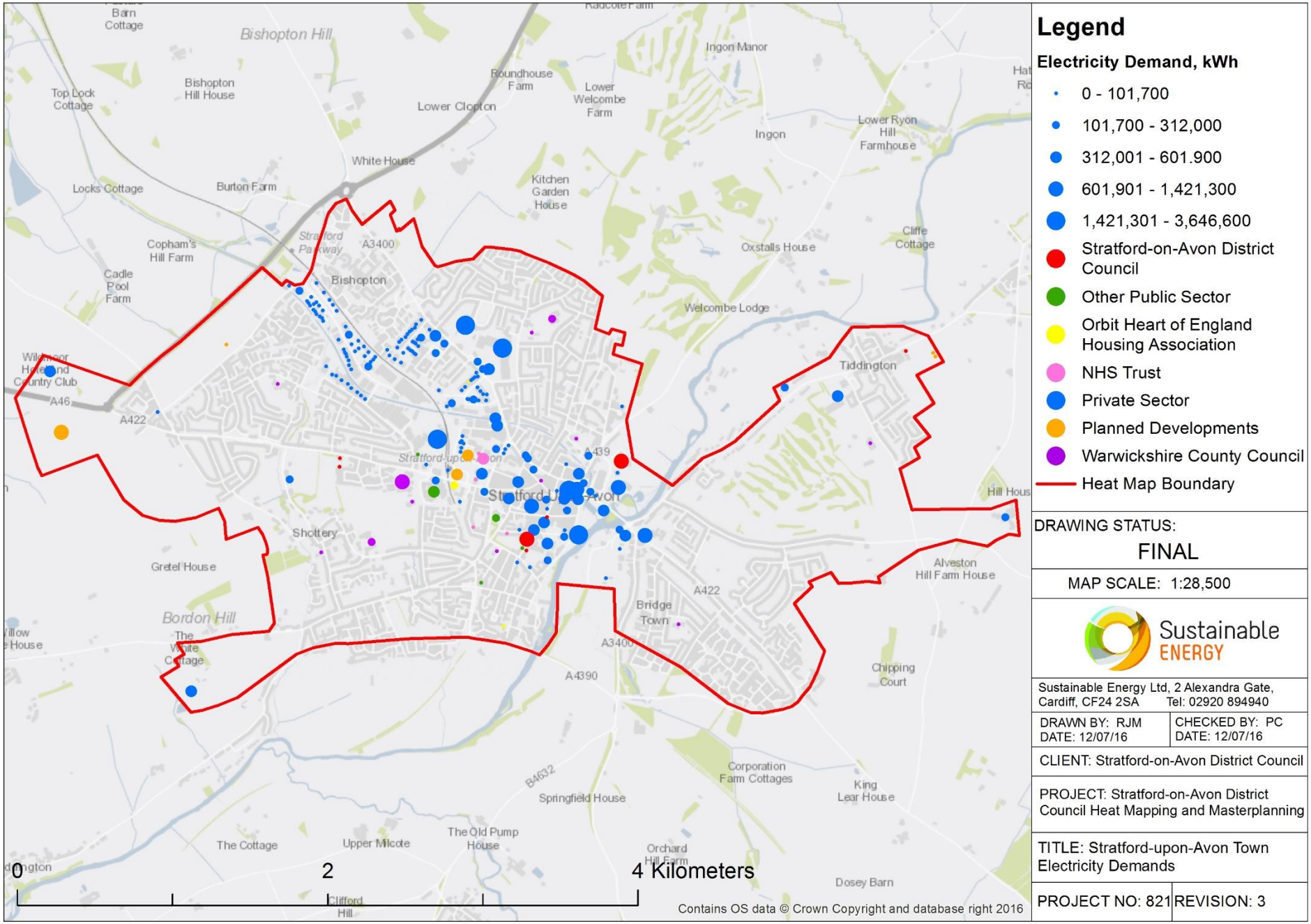


Figure 16: Stratford-upon-Avon town key non-domestic electricity demands

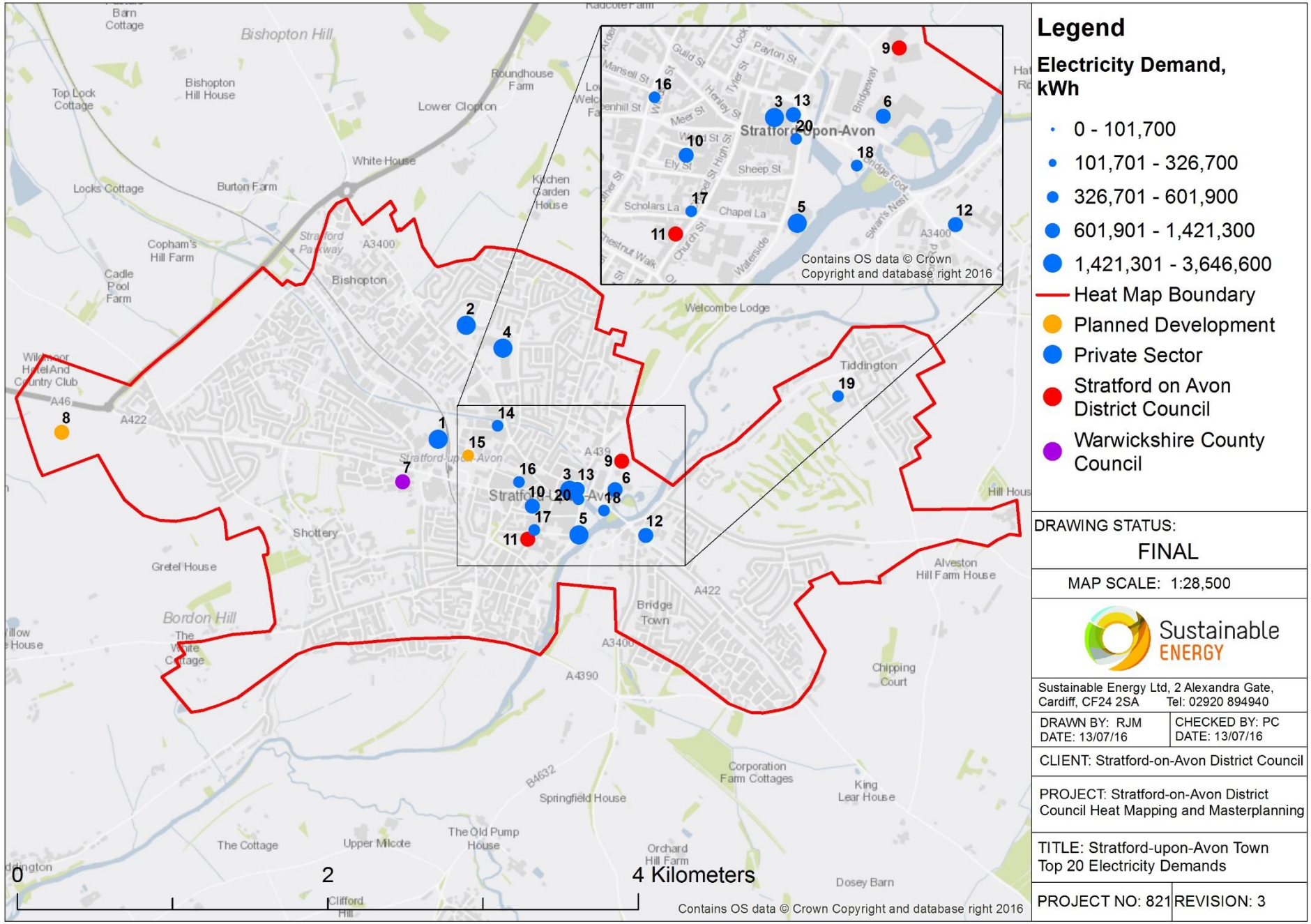


Figure 17: Stratford-upon-Avon town top 20 key non-domestic electricity demands

Table 6: Stratford-upon-Avon town top 20 key non-domestic electricity demands

Top 20 Ref	Name	Building use	Category	Electricity Demand, kWh
1	Morrisons	Supermarket	Private sector	3,646,531
2	Tesco Superstore	Supermarket	Private sector	3,482,380
3	Marks and Spencer	Retail	Private sector	2,971,846
4	Maybird Shopping Park	Retail	Private sector	2,505,514
5	Royal Shakespeare and Swan Theatre	Theatre	Private sector	2,400,000
6	Holiday Inn	Hotel	Private sector	1,421,244
7	Stratford-upon-Avon High School	Secondary school	Warwickshire County Council	954,026
8	SUA.2 Employment Development Western Area	Employment	Planned development	923,183
9	Stratford Leisure & Visitor Centre	Leisure centre (with pool)	Stratford-on-Avon District Council	791,549
10	Town Square Shopping Centre	Retail	Private sector	742,196
11	District Council Offices (Elizabeth House)	Offices	Stratford-on-Avon District Council	736,403
12	Alveston Manor Hotel	Hotel	Private sector	735,792
13	BHS	Department store	Private sector	683,882
14	McDonalds, Canal Quarter	Restaurant	Private sector	601,880
15	Stratford-upon-Avon Hospital, ambulatory care development	Healthcare	Planned development	590,568
16	Picturehouse Cinema	Cinema	Private sector	568,560
17	The Falcon Hotel	Hotel	Private sector	554,160
18	Cox's Yard	Restaurant	Private sector	525,850
19	NFU Mutual	Offices	Private sector	518,202
20	The Encore	Restaurant	Private sector	507,000

Categorisation of Key Non-Domestic Electricity Demands
Figure 18 shows the electricity demands for Stratford-upon-Avon town by building use category.

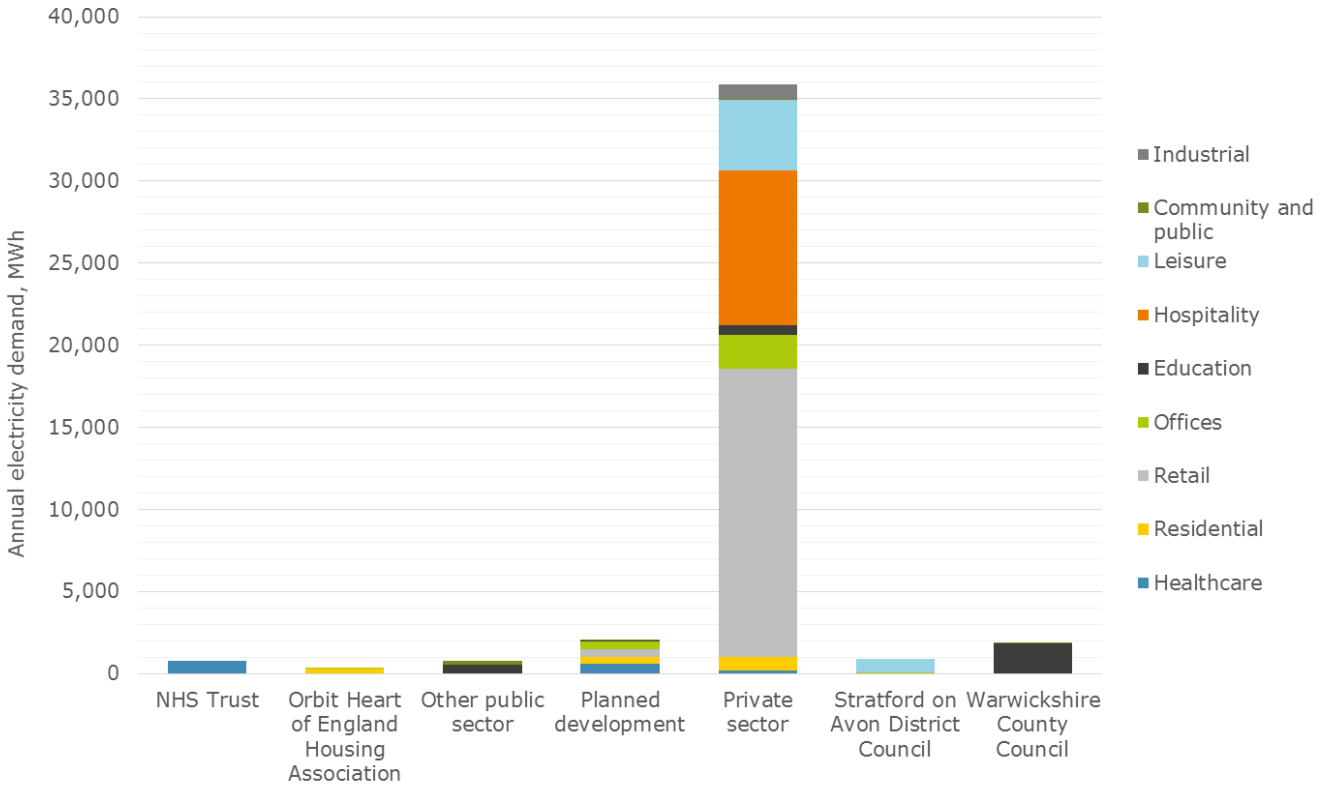


Figure 18: Stratford-upon-Avon town categorisation of key non-domestic electricity demands

The private sector has the largest electricity demand with retail and hospitality buildings making up the majority of demand.

Cooling Demands
The key non-domestic cooling loads are shown in Figure 19 and detailed in Table 7. The private sector has the largest cooling demand with retail making up the majority of demand. There is also small cooling demand for Stratford-on-Avon Hospital.

Morrisons has the largest cooling demand although, as detailed information was not received, this has been estimated as a percentage of overall electricity consumption using benchmark figures.

No large telephone exchanges or data centres are located in the heat map area. A small telephone exchange was identified, although external inspection revealed no major cooling plant. The supermarkets are likely to have high cooling demands although these are estimated based on a percentage of benchmark electricity consumption and so will require further verification if successful engagement can be achieved. To assess cooling requirements the larger businesses with specialist processes were contacted, however a low number of responses was received.

The hospital and supermarket-type businesses may have cooling, refrigeration and chilling requirements that could be met or contributed to by indirect fired absorption chillers that utilise hot water from a heat network, although this is unknown at this stage.

No significant future cooling demands have been identified at any of the strategic development sites. The majority of development sites are mainly residential, however, there is potential for businesses with cooling requirements to be located as part of the employment area in SUA.2 – South of Alcester Road, although this is currently unknown as plans are of a high level and there is no indication as to the cooling requirements of currently unidentified businesses. Cooling demand for strategic sites is discussed in section 2.4.2.

If the project is progressed to the feasibility stage, and more detailed development plans and planning applications identifying building use and location are made available, then the opportunity to supply cooling to large retail units in the vicinity of potential networks should be further investigated.

Table 7: Stratford-upon-Avon town cooling demands

Map Ref	Name	Building use	Category	Cooling Demand, kWh
1	Morrisons	Supermarket	Private sector	2,552,571
2	Tesco Supermarket	Supermarket	Private sector	2,437,666
3	Marks and Spencer	Department store	Private sector	693,430
4	Aldi	Supermarket	Private sector	290,428
5	Telephone Exchange	Telephone exchange	Private sector	21,548
6	Stratford Hospital	Hospital	NHS Trust	7,833

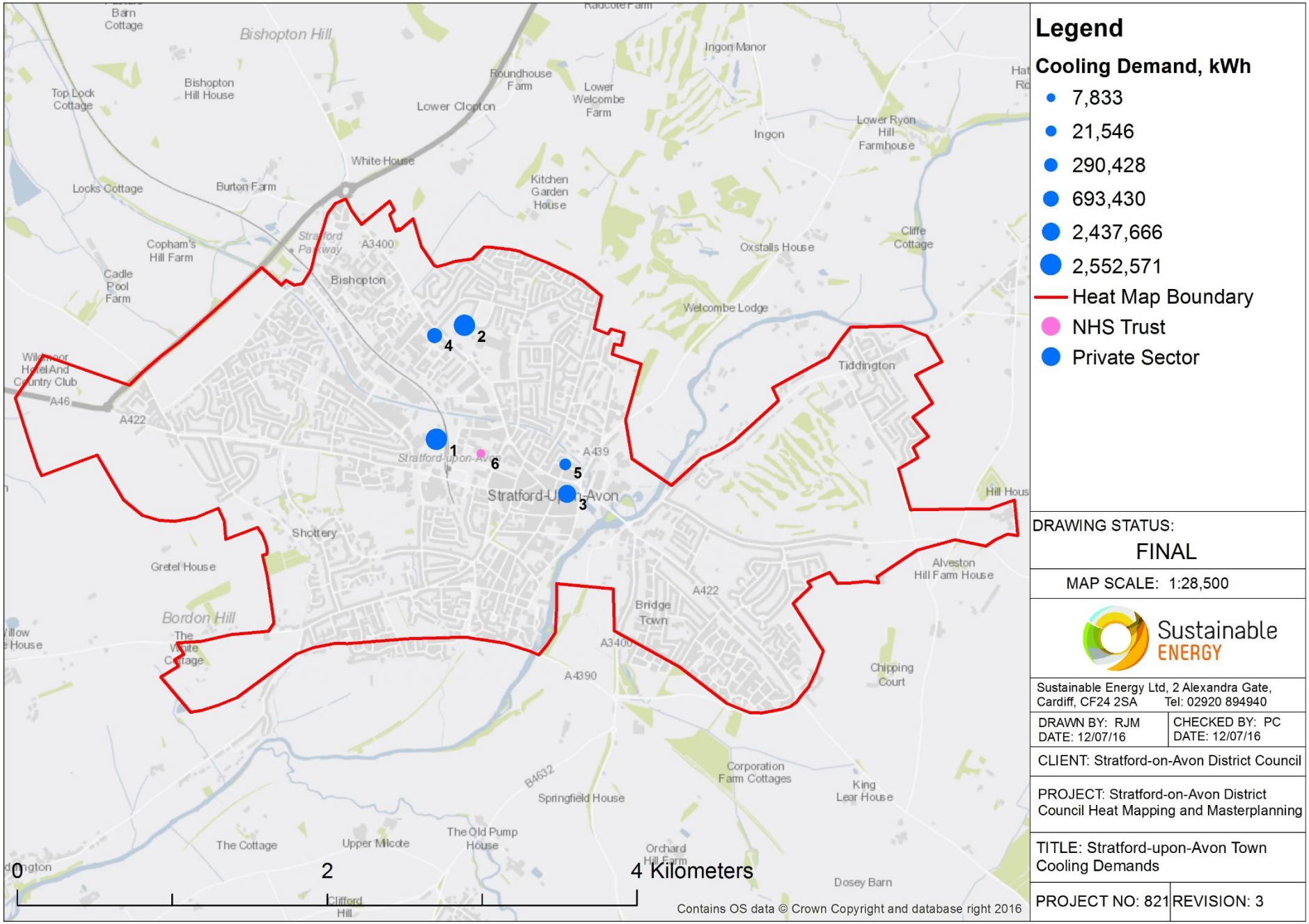


Figure 19: Stratford-upon-Avon town cooling demands

Categorisation of Cooling Demands

Figure 20 shows the non-domestic cooling demands assessed for Stratford-upon-Avon town by building use category.

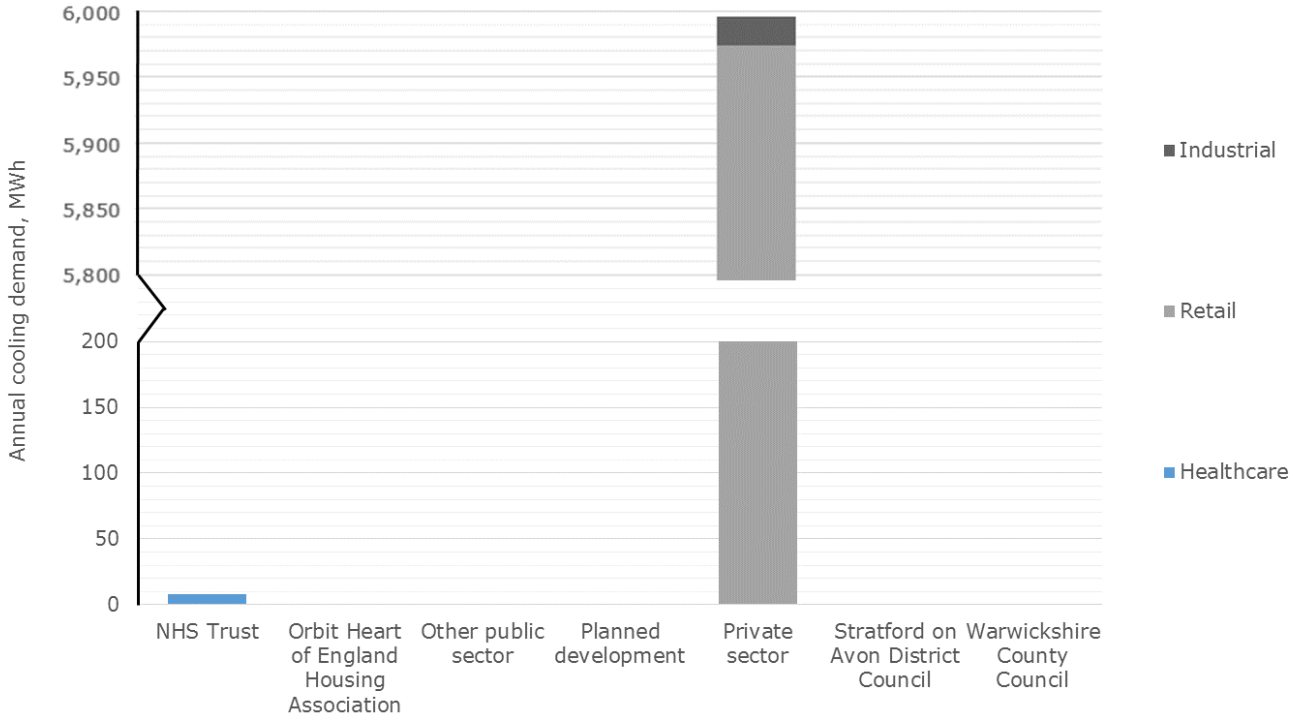


Figure 20: Stratford-upon-Avon town categorisation of key cooling demands

2.4.2 Energy Mapping Results: Strategic Sites

At this stage, for the majority of strategic sites, it was not possible to display graduated symbols showing energy demands for each building. This was due to the high level nature of information currently available that did not include sufficient information (such as building location, floor area, building height etc.). The heat and electricity demands for these strategic sites have been displayed as an area heat density and area electricity density, in MWh/m² based on building use, housing density and an assumed average dwelling size based on the types of dwellings for each area. As the exact size of individual dwellings is currently unknown, benchmarks and floor areas have been based on industry standard average dwelling sizes for residential developments for the local area[4] which were verified using data received for some the developments.

Gaydon / Lighthorne Heath

High level development plans are currently available for the majority of the site showing potential building use and dwellings per hectare. More detailed plans are available for the village centre area showing potential building locations, building footprint and number of storeys. The area heat density was modelled (using benchmark figures and the assumptions stated in Table 3) for the whole development area as building location and sizes are currently unknown for the majority of the site. This allows comparison between the site as a whole as well as comparisons with other strategic sites. For the village centre, where more detailed plans are available, energy demands have been modelled for each individual building shown in the village centre masterplan (shown in Appendix 3 – Development Site Plans).

Figure 21 shows the area heat density for the entire development area as well as heat demands for individual buildings within the village centre. The largest heat demand within the village centre is the elderly care residential properties to the north west of the planned village centre, with a combined annual heat demand of 2,166 MWh. The largest area heat density occurs from the village centre (0.0922 MWh/m²).

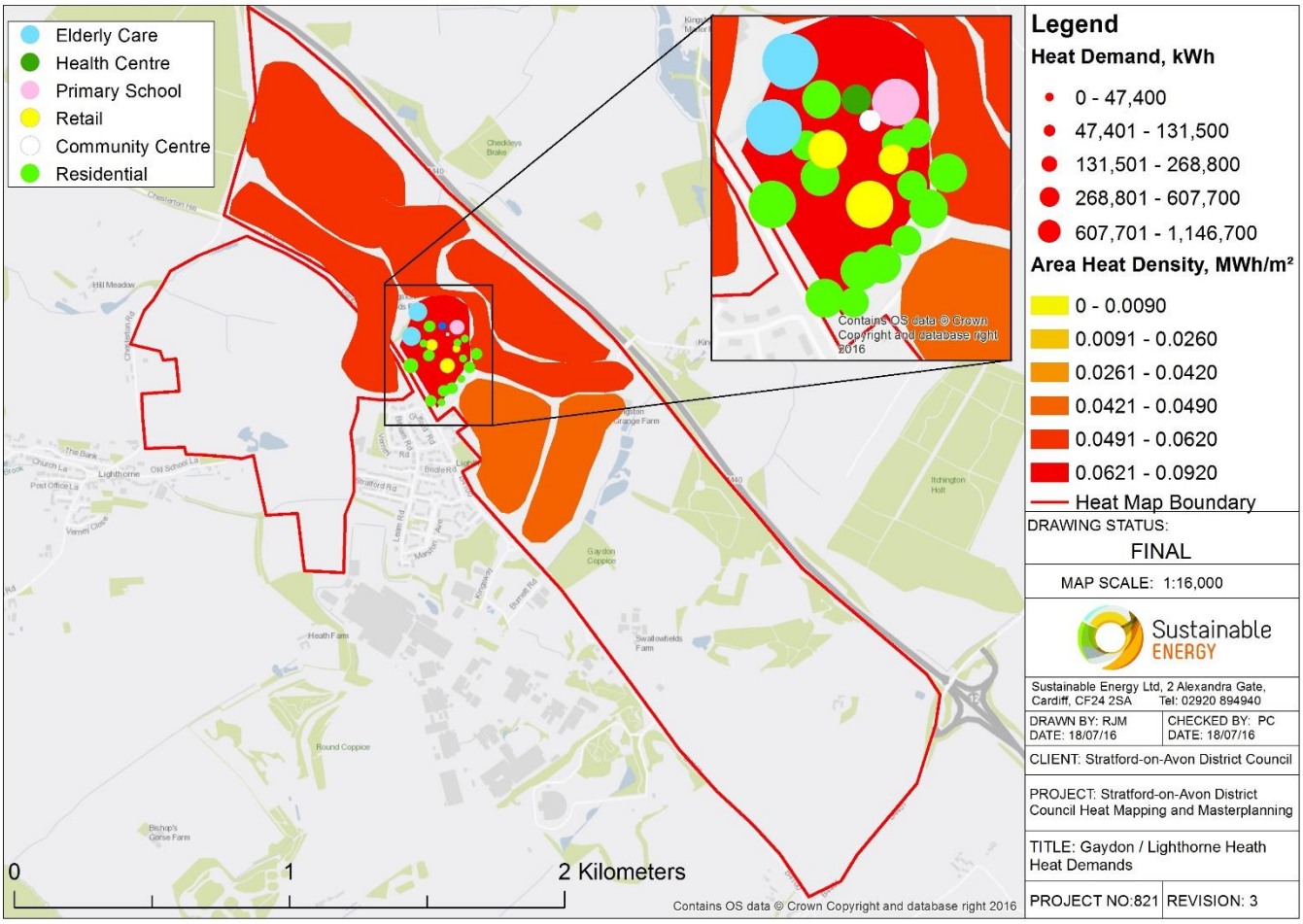


Figure 21: Gaydon / Lighthorne Heath heat demands

[4] 113 m² taken from 'How big are our houses? Savills, May 2015; this above the UK average and has been discussed with the client group.

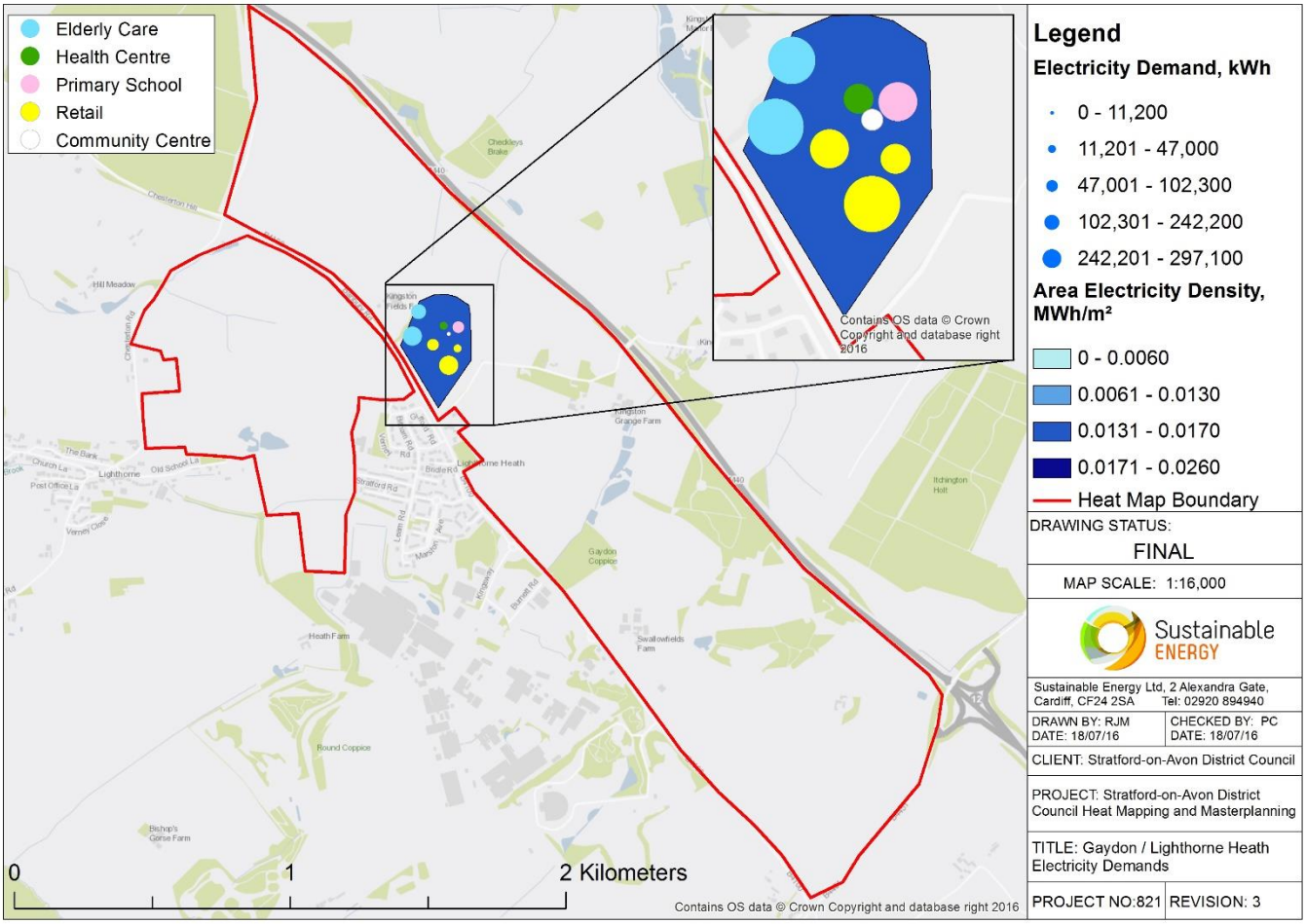


Figure 22: Gaydon / Lighthorne Heath electricity demands

Figure 22 shows the key non-domestic electricity demands. The largest electricity demands are from the retail developments located in the centre of the planned village centre, with a combined annual electricity demand of 438 MWh. This retail building may consist of individual shops once developed, however the demands have been modelled based on the whole floor area shown on the illustrative village centre plan with the assumption that one building connection could be used to supply all retail units.

SOU. 3 - South of Daventry Road

High level development plans are available for the majority of the site showing potential building use and dwellings per hectare. The area heat density has been modelled, using benchmarked figures, for the whole development area as building location and sizes and currently unknown. Heat demands for individual buildings have been modelled including the local shop and community hall / sports pavilion using locations shown on the high level masterplan (see Appendix 3 – Development Site Plans).

Figure 23 shows the area heat density for the whole development area as well as heat demands for the local shop and community hall / sports pavilion buildings. The largest annual heat demand is attributed to the local shop located to the north of the development site and is relatively low at 79 MWh.

Figure 24 shows the key non-domestic electricity demands. The largest annual electricity demand arises from the local shop located to the north of the development site (39 MWh).

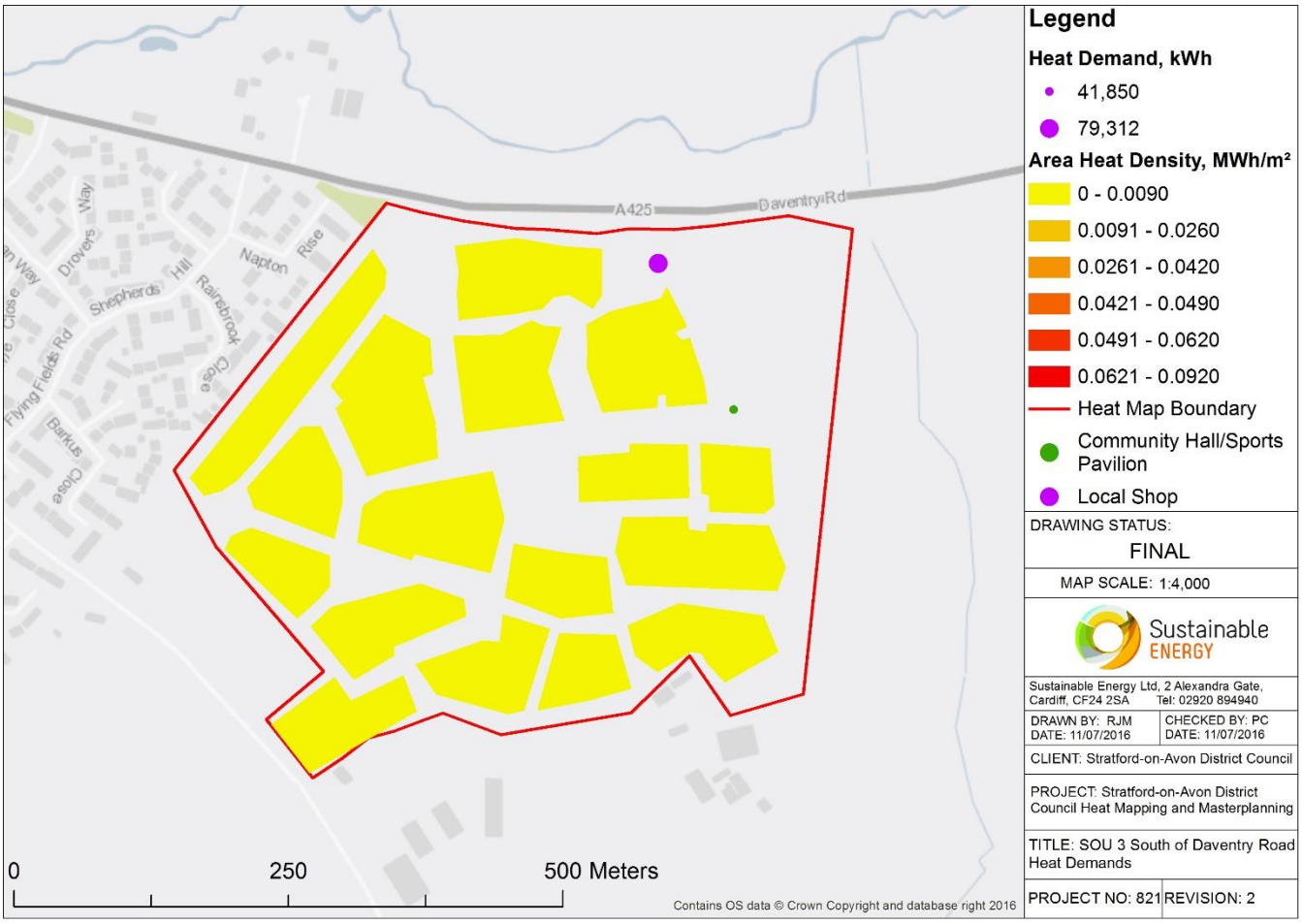


Figure 23: SOU. 3 - South of Daventry Road heat demands

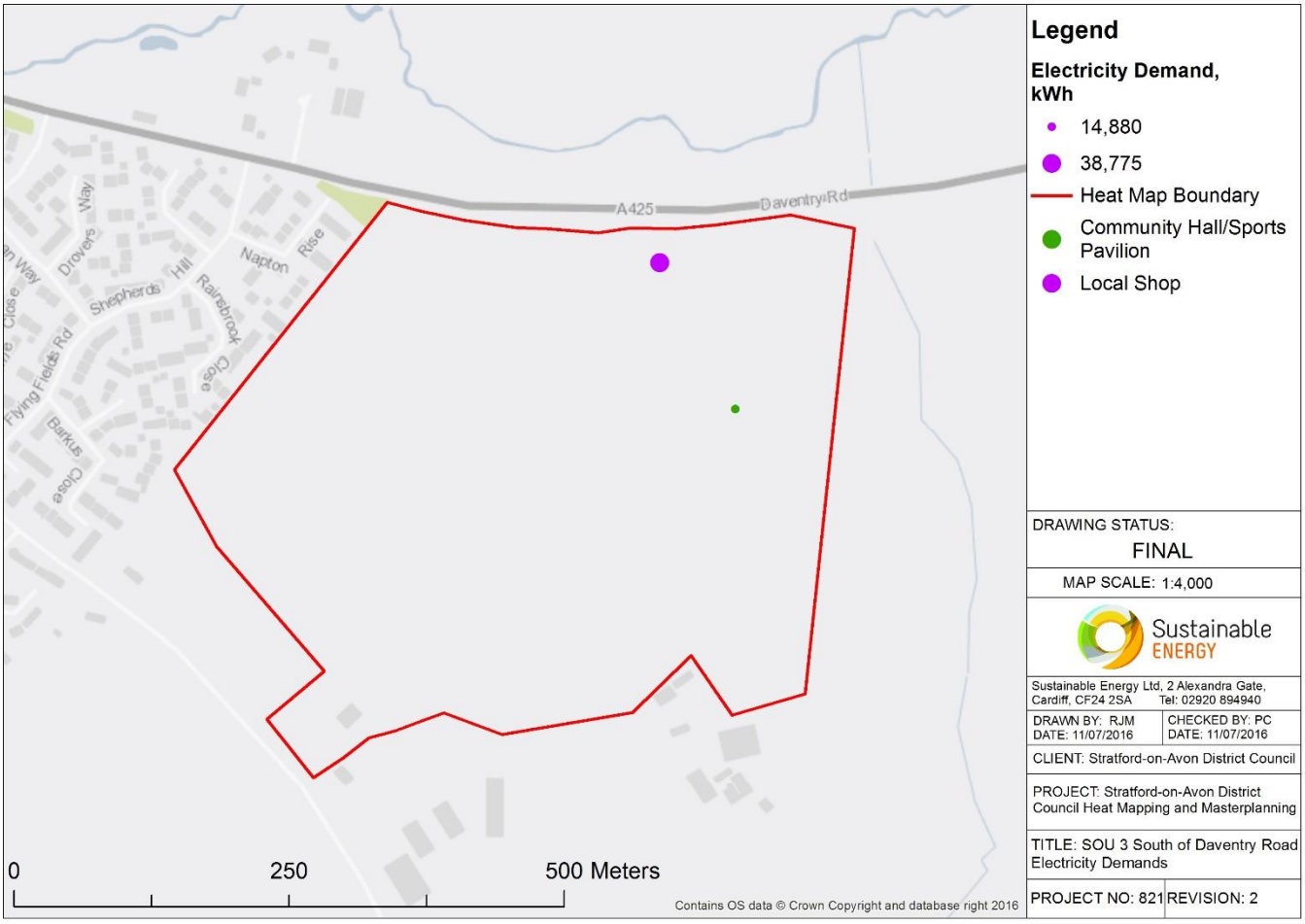


Figure 24: SOU. 3 - South of Daventry Road key electricity demands

Meon Vale / Long Marston Depot

High level development plans are available for the majority of the site showing potential building use and dwellings per hectare. The area heat density has been modelled, using benchmarked figures, for the whole development area as building location and sizes and currently unknown. Heat demands have also been modelled for existing buildings.

Figure 25 shows the area heat density for the whole development area as well as heat demands for existing individual buildings. The largest heat demand is from the existing Wanzl Ltd unit located in the Meon Vale business park (1,202 MWh). The future of the existing buildings within the development area is currently unknown.

Figure 26 shows the key non-domestic electricity demands. The largest annual electricity demand is modelled for the existing Paul Matthews Transport Ltd unit located in the Meon Vale business park (212 MWh).

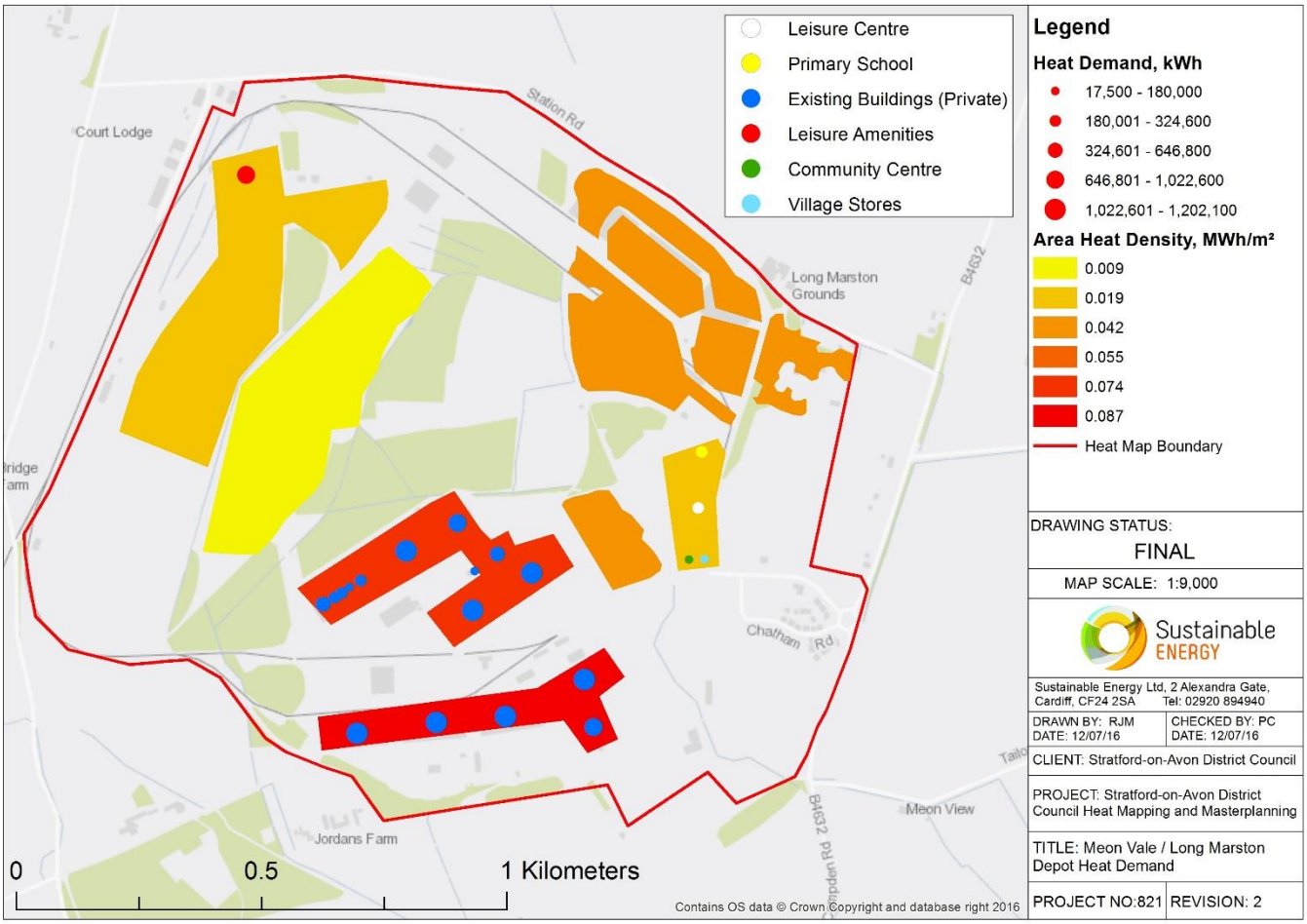


Figure 25: Meon Vale / Long Marston Depot heat demands

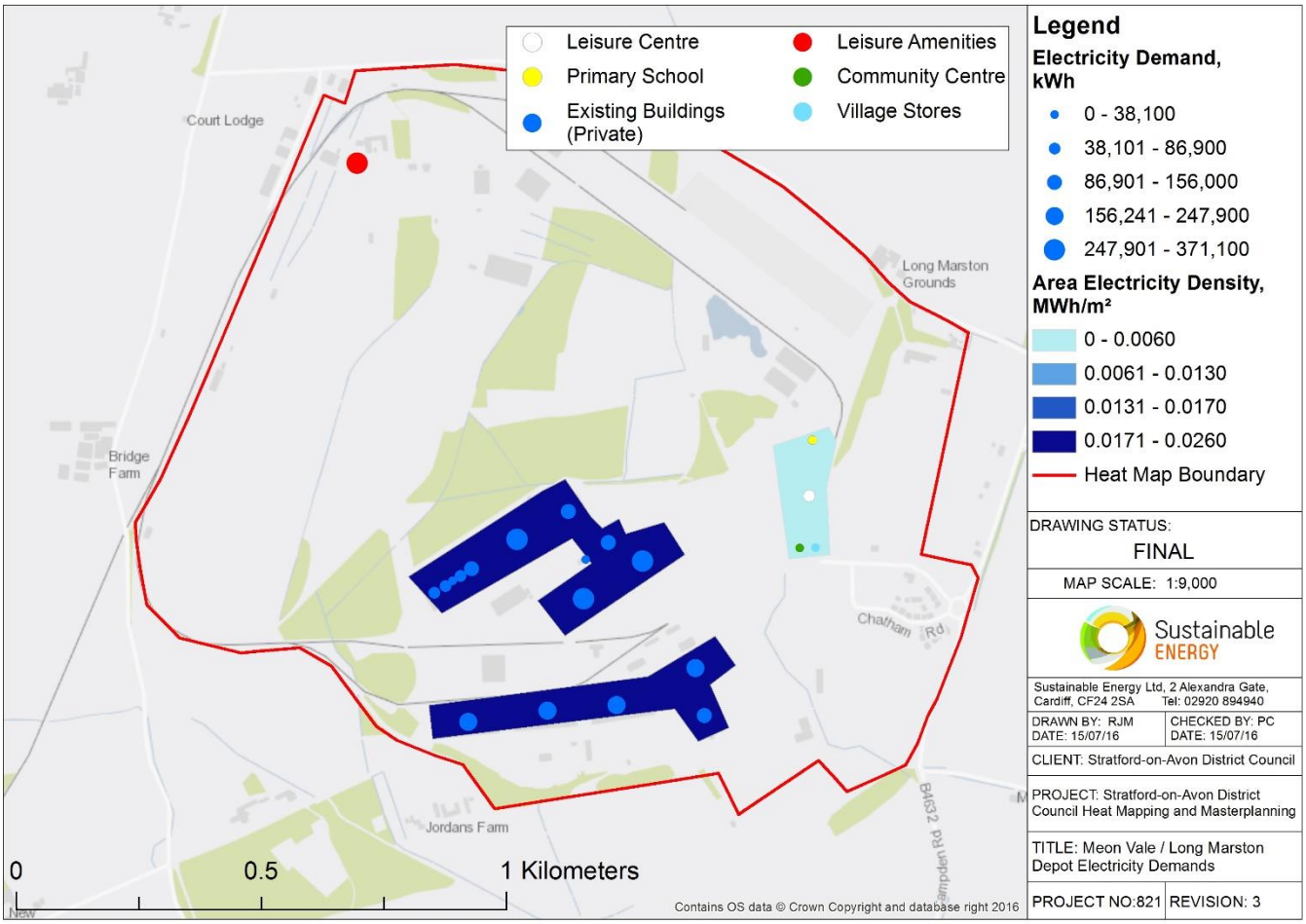


Figure 26: Meon Vale / Long Marston Depot key electricity demands

Long Marston Airfield

High level development plans are available for the majority of the site, showing potential building use and dwellings per hectare. The area heat density has been modelled, using benchmarked figures, for the whole development area as building location and sizes and currently unknown. Heat demands have been modelled for the primary and secondary schools using locations shown on the high level masterplan (see Appendix 3 – Development Site Plans).

Figure 27 shows the area heat density for the whole development area, as well as heat demands for the primary and secondary school buildings. The largest annual heat demand has been modelled for the secondary school located to the east of the development site (506 MWh).

Figure 28 shows the key non-domestic electricity demands. The largest annual electricity demand has been modelled for the secondary school located to the east of the development site (156 MWh).

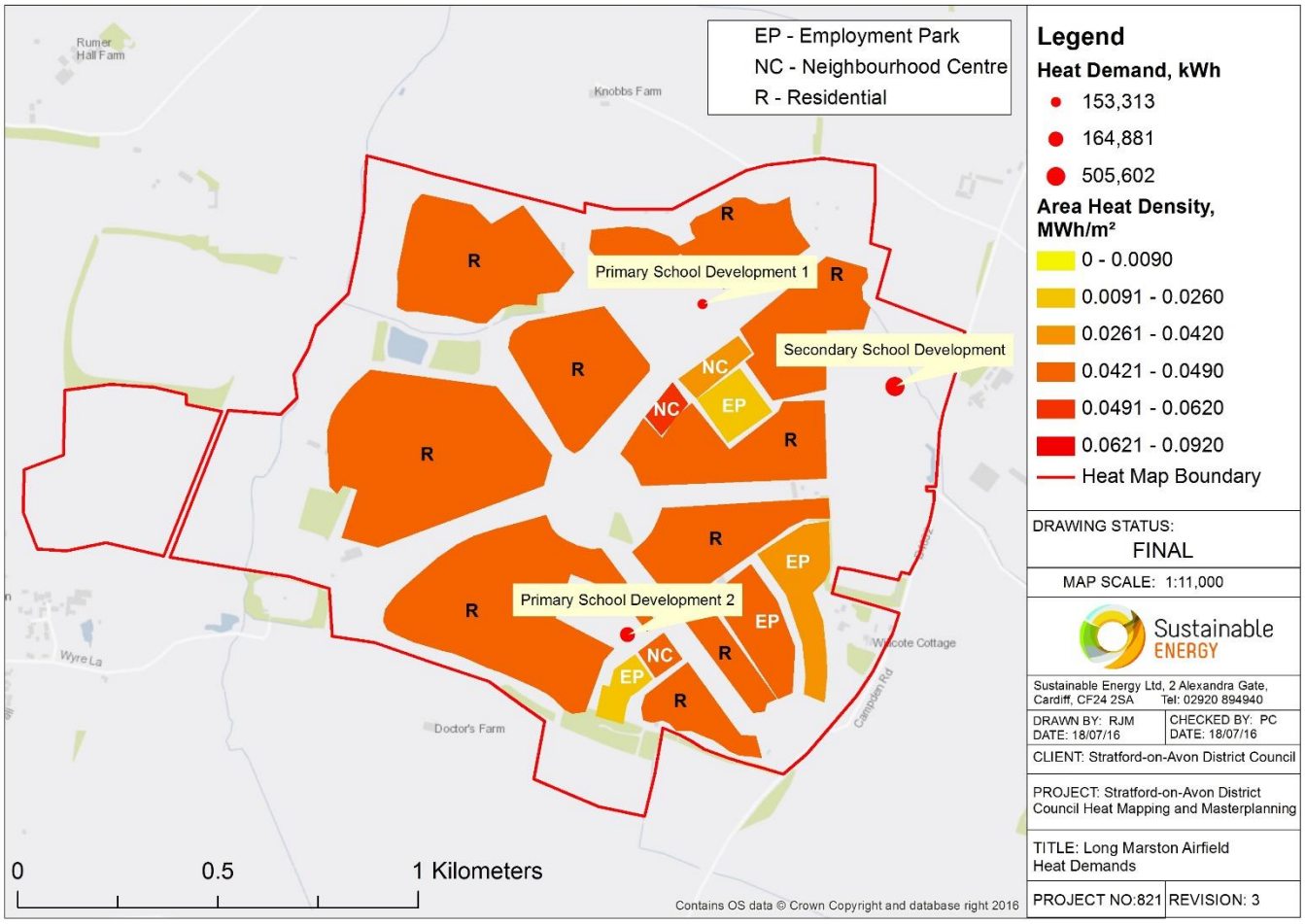


Figure 27: Long Marston Airfield heat demands

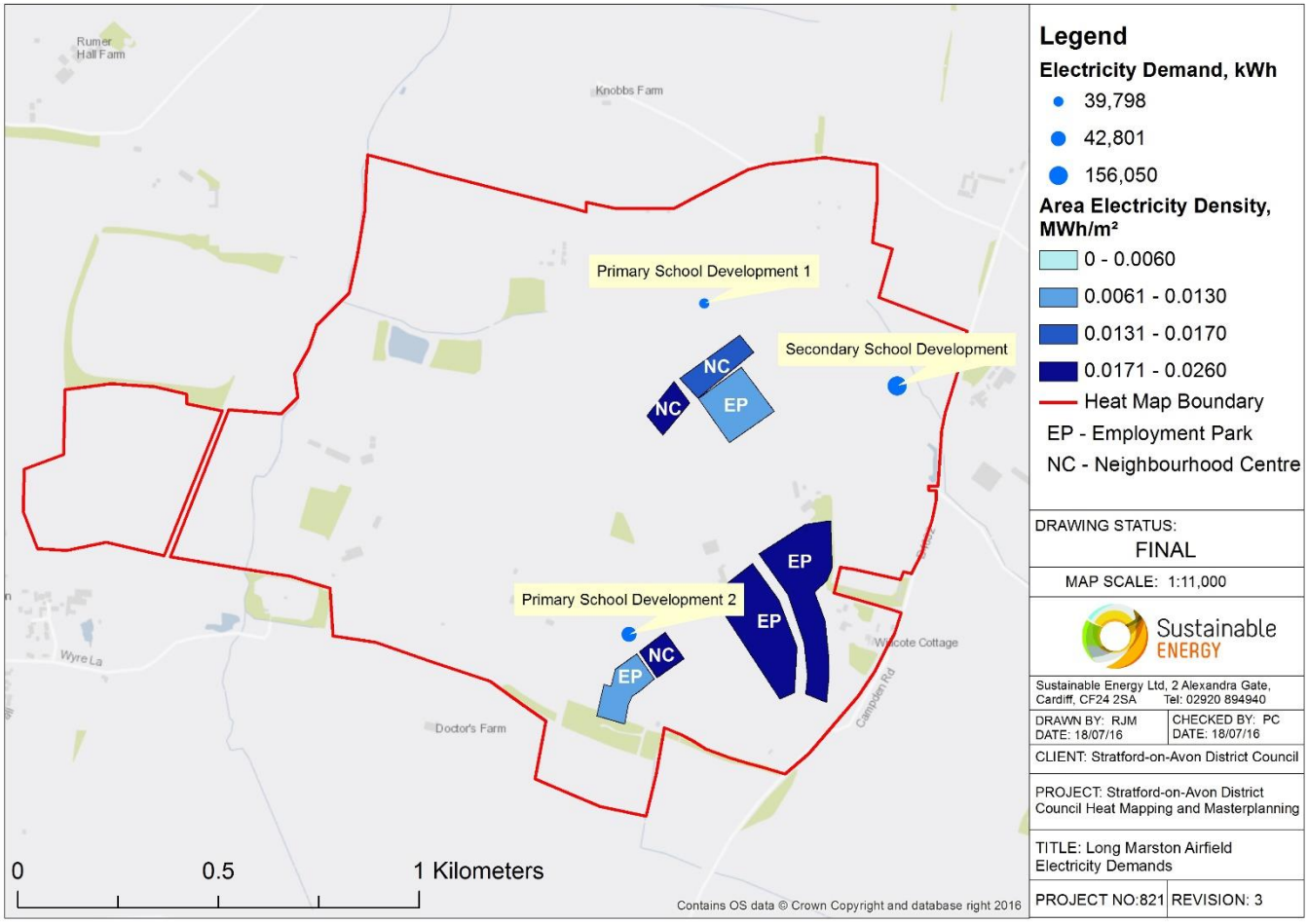


Figure 28: Long Marston Airfield key electricity demands

Cooling Demands

No significant cooling demands were quantified for any of the strategic sites (particularly as the data available for the non-residential areas of developments is very high level). Some businesses may be located in the employment and retail areas for Gaydon / Lighthorne Heath, Meon Vale / Long Marston Depot and Long Marston Airfield strategic sites and will potentially have refrigeration requirements that could be contributed to by indirect fired absorption chillers using hot water from a heat network; although this is unknown at this stage. There may also be cooling requirements from the elderly care residential properties within Gaydon / Lighthorne Heath Village Centre, however the specific building type is unclear and cooling demands are likely to be relatively low. The electricity demand for air conditioning in these properties has been considered within the electricity demand assessment. If more detailed plans are made available, then the opportunity in relation to large retail, employment units, elderly care units and any other likely cooling demands in these development areas should be further investigated and discussed with developers.

2.5 Existing and Planned Energy Sources

Existing and future heat sources with potential to supply networks in Stratford-on-Avon District were investigated. Figure 29 shows the existing heat sources identified for Stratford-upon-Avon Town.

No existing or potential heat sources were identified in, or sufficiently near to, any of the strategic sites. No viable heat offtake opportunities were identified for any of the heat map areas. There may be potential for heat offtake from Jaguar Land Rover or Aston Martin Lagonda Ltd, near the Gaydon / Lighthorne Heath development site, however no information was received and offtake opportunities from existing processes are likely to be limited.

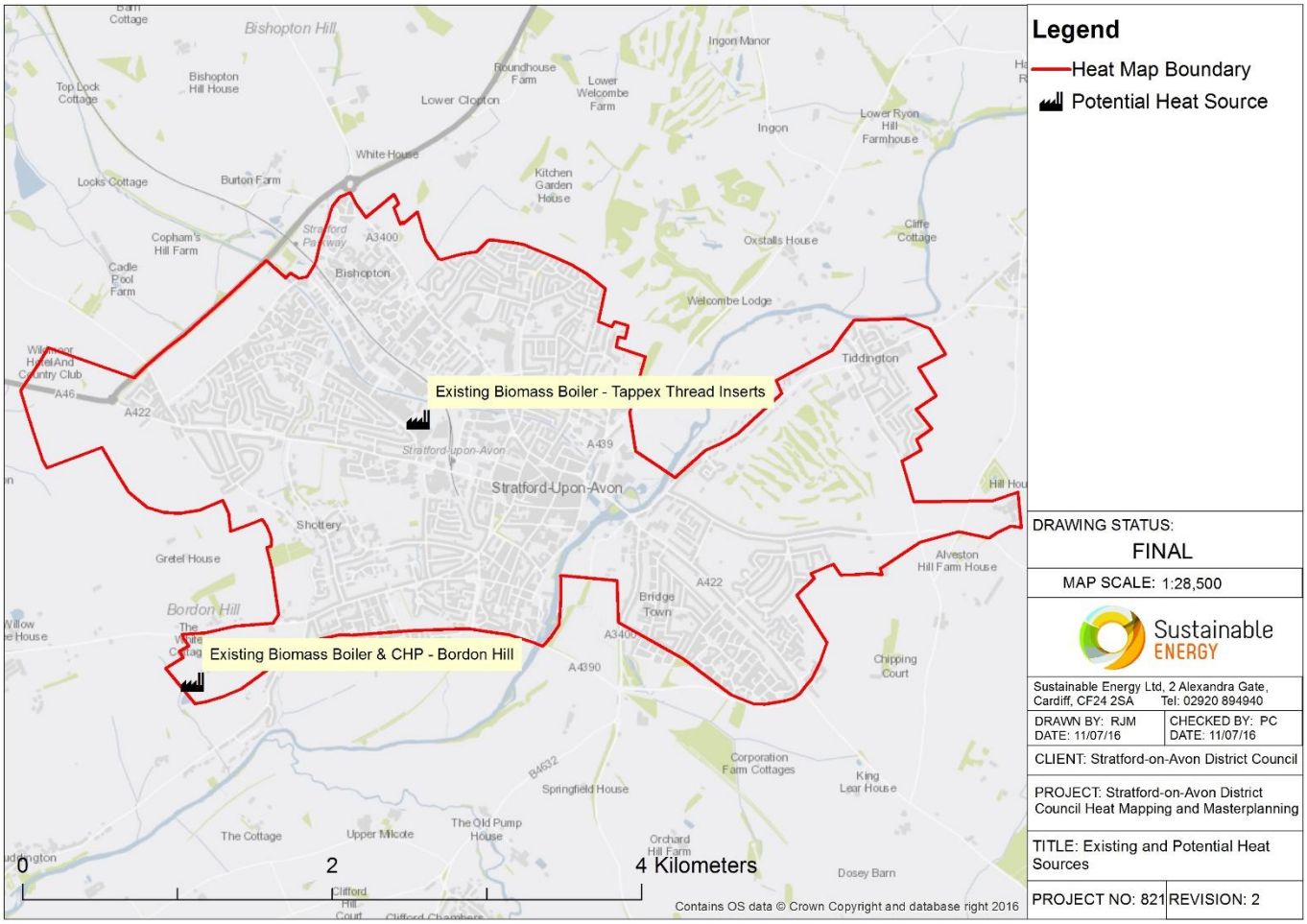


Figure 29: Existing and potential heat sources

A summary of these potential energy sources is shown in Table 8. Following an initial assessment, none of these potential energy sources have been chosen to be taken forward for further consideration. Stratford-upon-Avon Hospital originally planned to install a small gas CHP to supply the existing building and ambulatory care centre planning development. This was not brought forward and anecdotal evidence from conversions with Hospital staff indicate that there are no plans for a gas CHP to be installed at this site.

Table 8: Summary of potential energy sources

Potential Energy Source	Ownership	Status	Assessment of potential to supply energy to network	Further consideration?
Biomass boiler (unknown capacity)	Tappex Thread Inserts	Existing	• 3no. Fröling P4 wood pellet boilers installed in 2015 • Exact size and spare capacity unknown, although likely to be small and have been sized to meet building requirements • Located within Canal Quarter development area (discussions with client reveal that future of site uncertain)	No
2 MW Biomass boiler	Bordon Hill Nurseries	Existing	• Isolated site, significant distance from areas of medium and high linear heat density • Spare capacity unknown	No
Small Gas CHP (unknown capacity)	Bordon Hill Nurseries	Existing	• Isolated site, significant distance from areas of medium and high linear heat density • Exact size and spare capacity unknown	No

2.6 Potential Site Barriers

2.6.1 Potential site barriers: Stratford-upon-Avon Town

Existing key utilities and other infrastructure (including planned upgrades), local designations (such as Conservation Areas and Listed Buildings), site topography, areas of Stratford-on-Avon District Council owned land and landscape and development barriers were investigated to determine whether they pose any potentially significant risks to the development of district energy networks.

Figure 30 highlights potential site barriers, risks and issues for network development, pipe routes and energy centre locations.

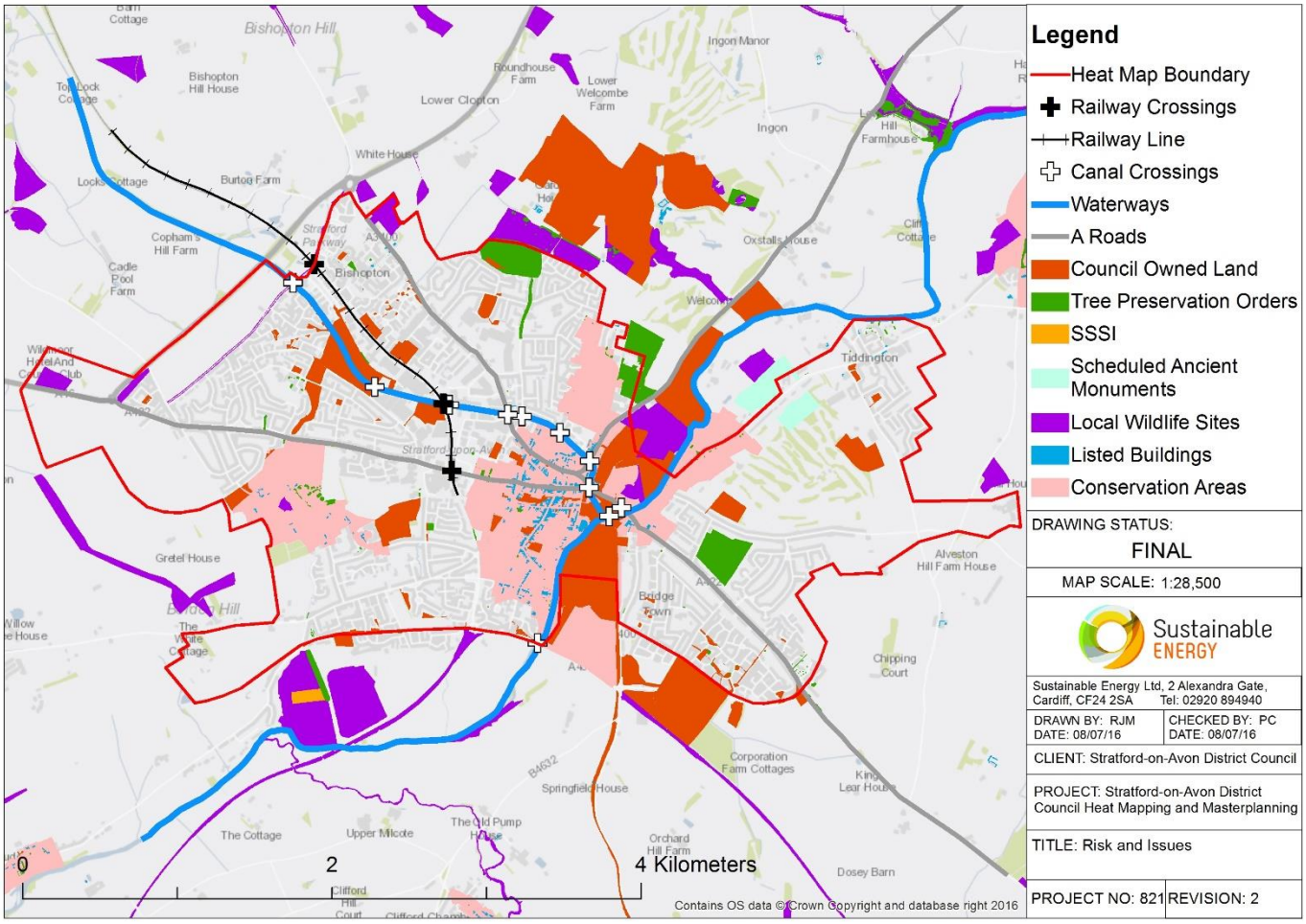


Figure 30: Potential site barriers, risks and issues for district energy network development

Potential site barriers include the Stratford-upon-Avon to Henley-in-Arden railway line, Stratford-upon-Avon canal, the River Avon and main roads including the A46, Alcester Road, Birmingham Road and Warwick Road. Railway crossings are marked in Figure 30 by black crosses and canal crossings marked by white crosses. In the majority of cases these underpasses and bridges are likely to be already crowded with services. It can be seen that the town centre lies within a conservation area with a high number of listed buildings. This increases the difficulty for locating an energy centre within the town centre area.

Figure 30 also highlights areas of Stratford-on-Avon District Council-owned land. This information was used to inform both the pipe routes and potential energy centre locations.

Figure 31 shows the high level terrain for the Stratford-on-Avon town heat map area. It can be seen that gradient is unlikely to pose a significant risk to the development of a heat network or the location of the energy centre in the areas of higher heat density. The changes in elevation in the areas of highest energy density present no significant technical challenge to the pumping requirements of a district heat network.

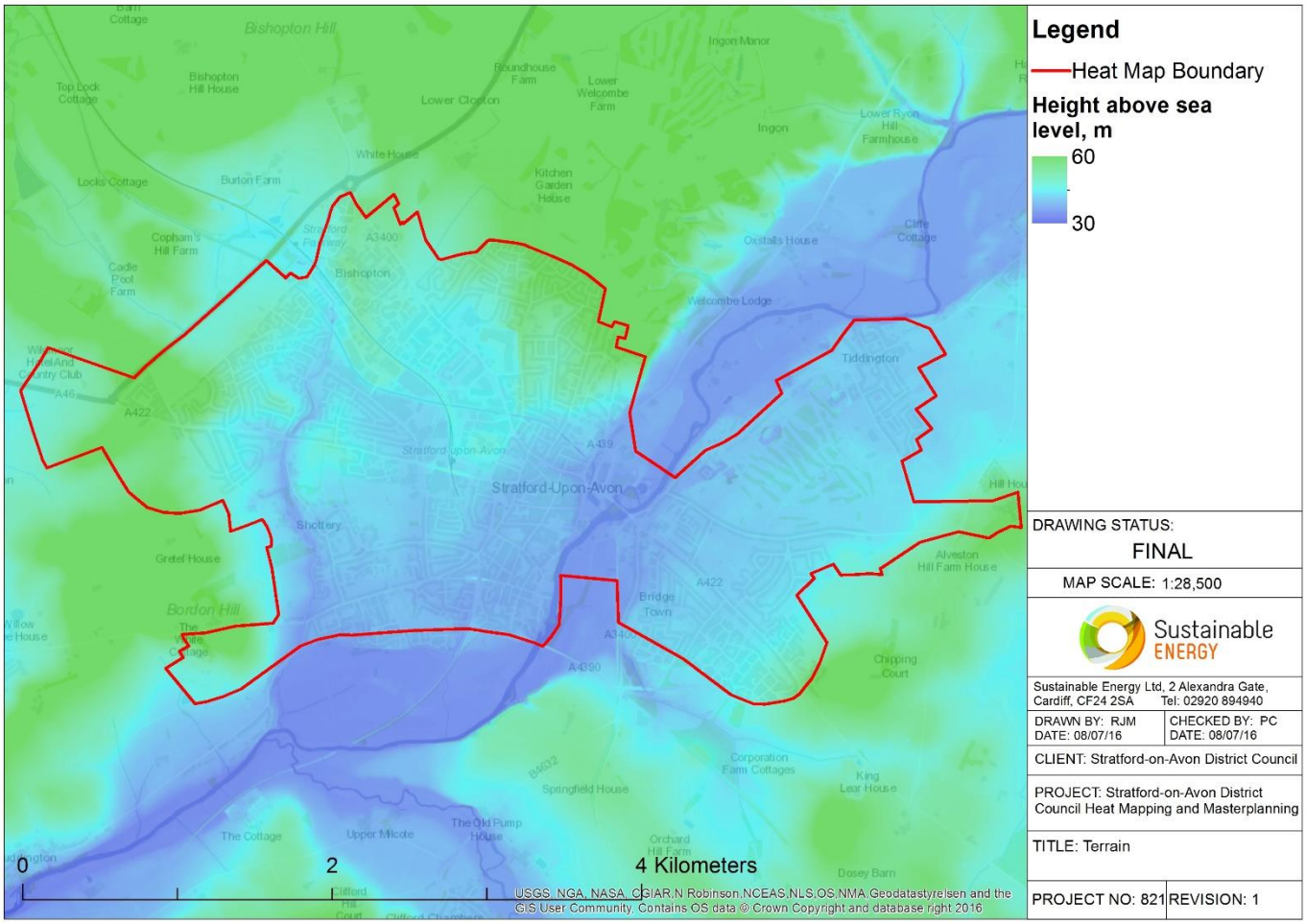


Figure 31: Terrain map for Stratford-upon-Avon Town heat map area

2.6.2 Potential Site Barriers: Strategic Sites

Figure 32, Figure 33, Figure 34 and Figure 35 show the site barriers, risks and issues considered for each development site. Figure 36, Figure 37, Figure 38 and Figure 39 show the terrain for each of these areas. It can be seen that there are no significant barriers or variations in terrain for any of the strategic sites.

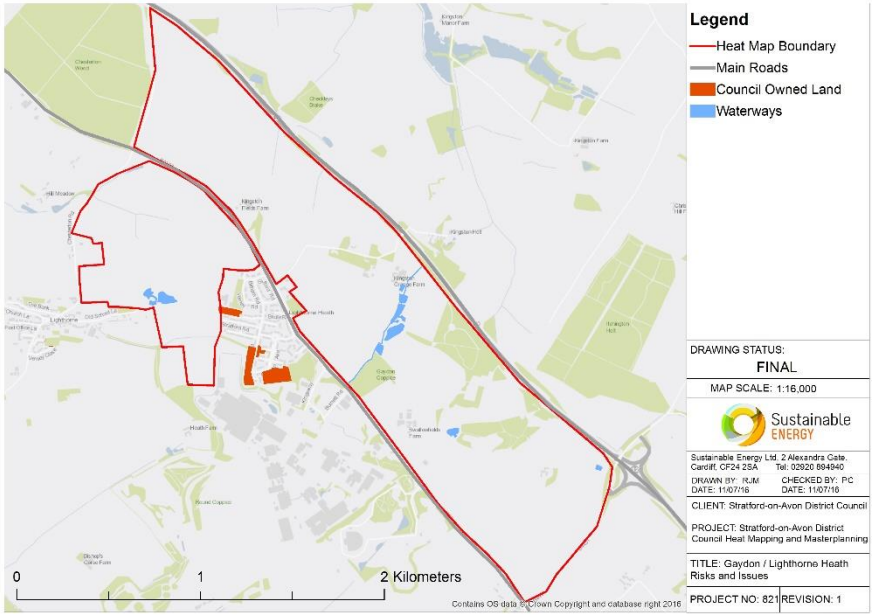


Figure 32: Site barriers, risks and issues for Gaydon / Lighthorne Heath

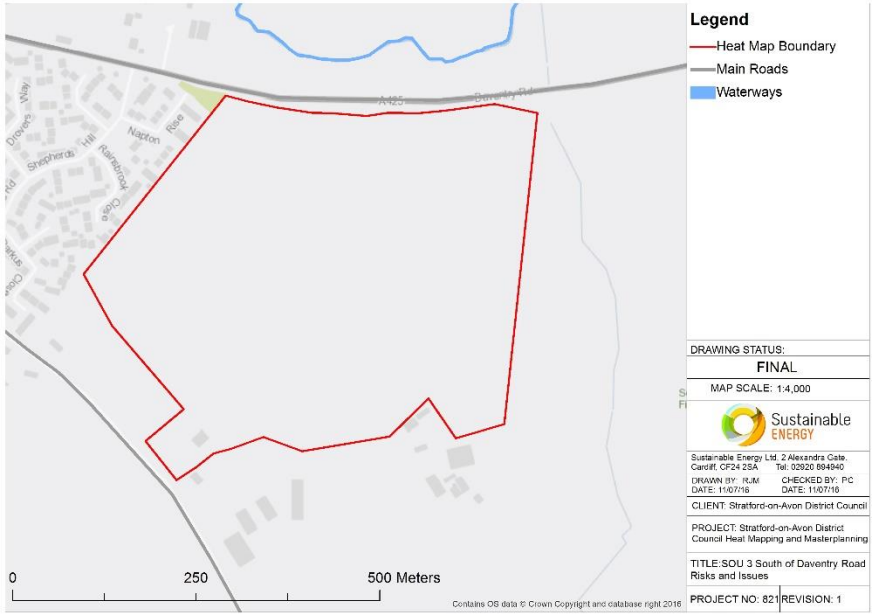


Figure 33: Site barriers, risks and issues for SOU. 3 - South of Daventry Road

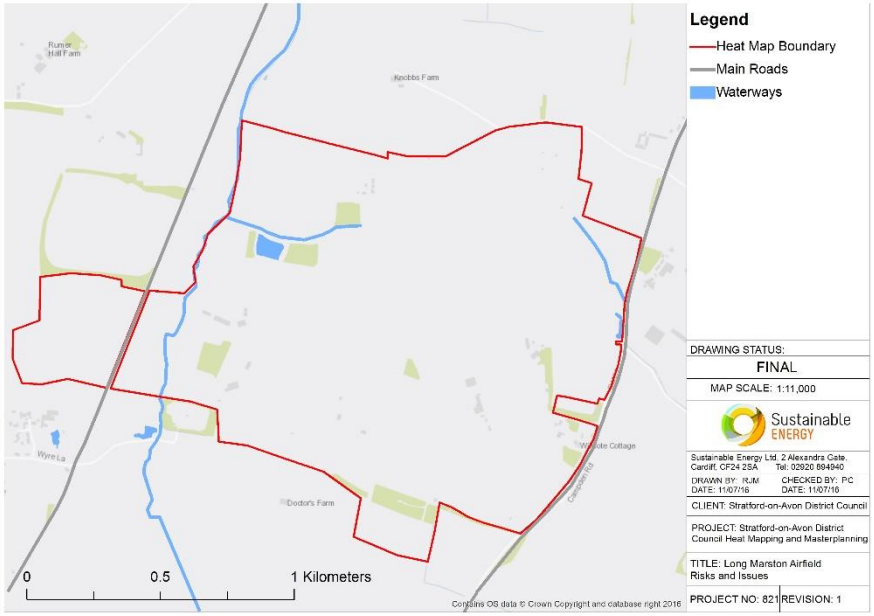


Figure 34: Site barriers, risks and issues for Long Marston Airfield

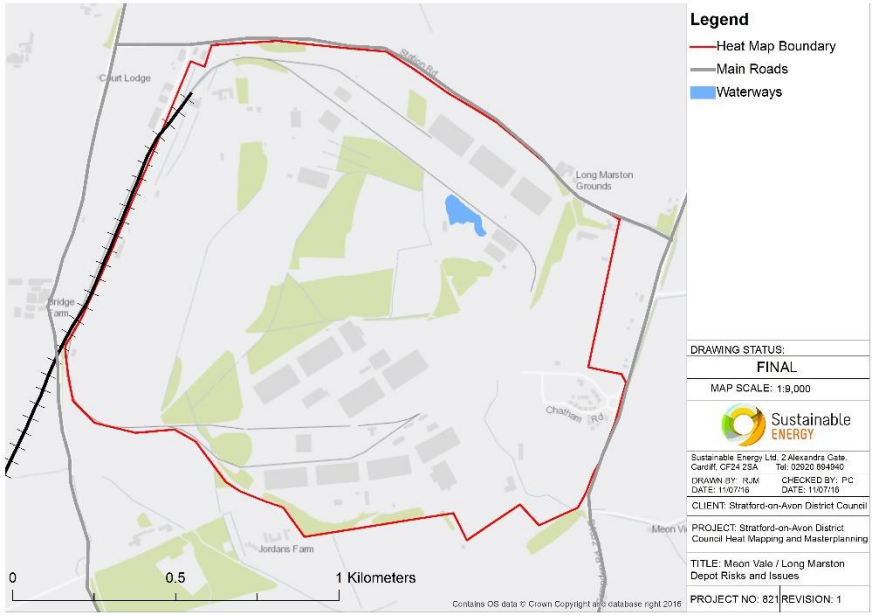


Figure 35: Site barriers, risks and issues for Meon Vale / Long Marston Depot

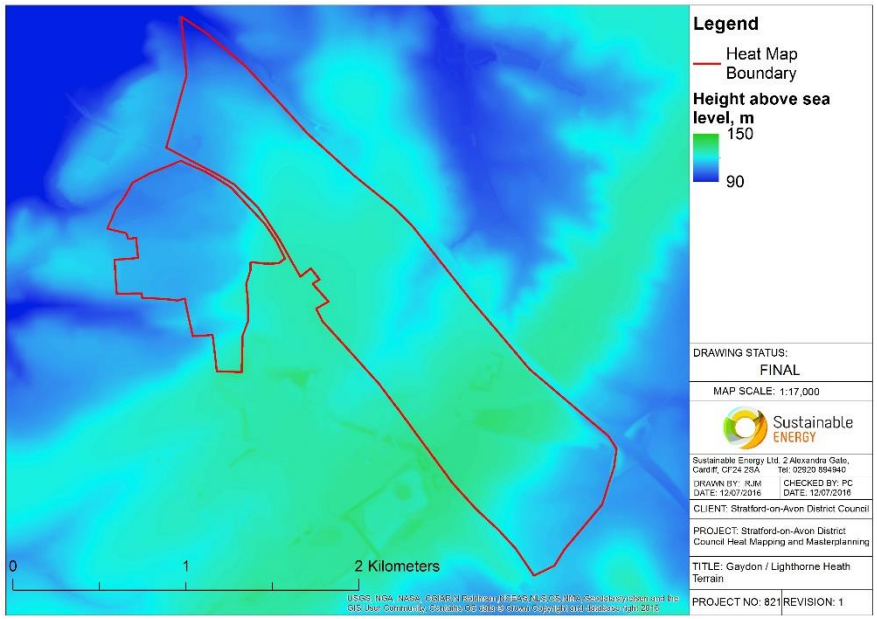


Figure 36: Terrain map for Gaydon / Lighthorne Heath

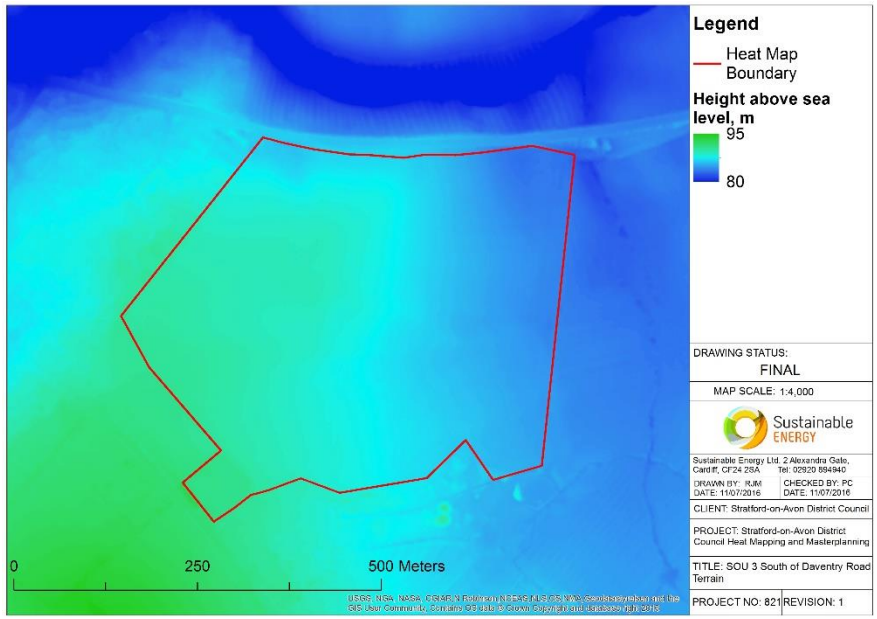


Figure 37: Terrain map for SOU. 3 - South of Daventry Road

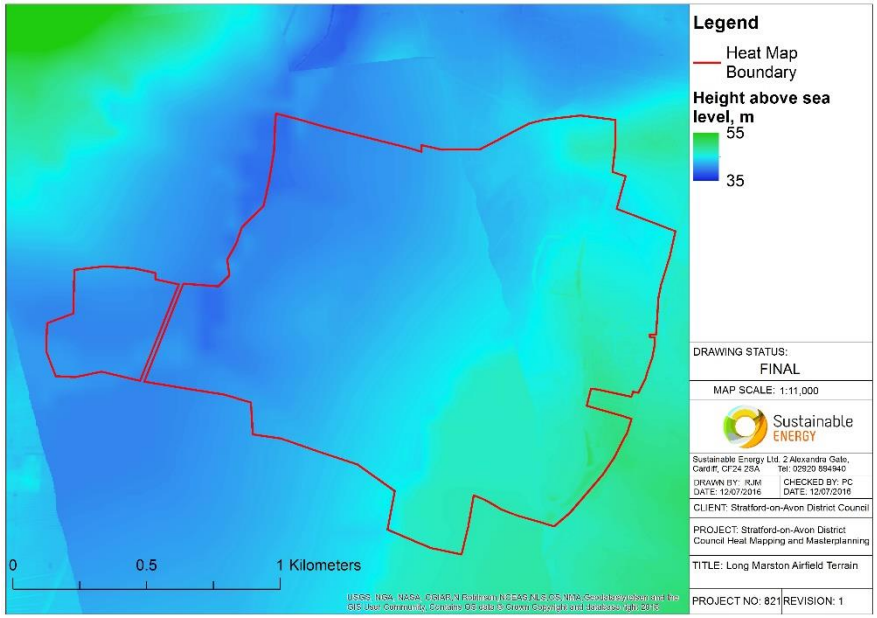


Figure 38: Terrain map for Long Marston Airfield

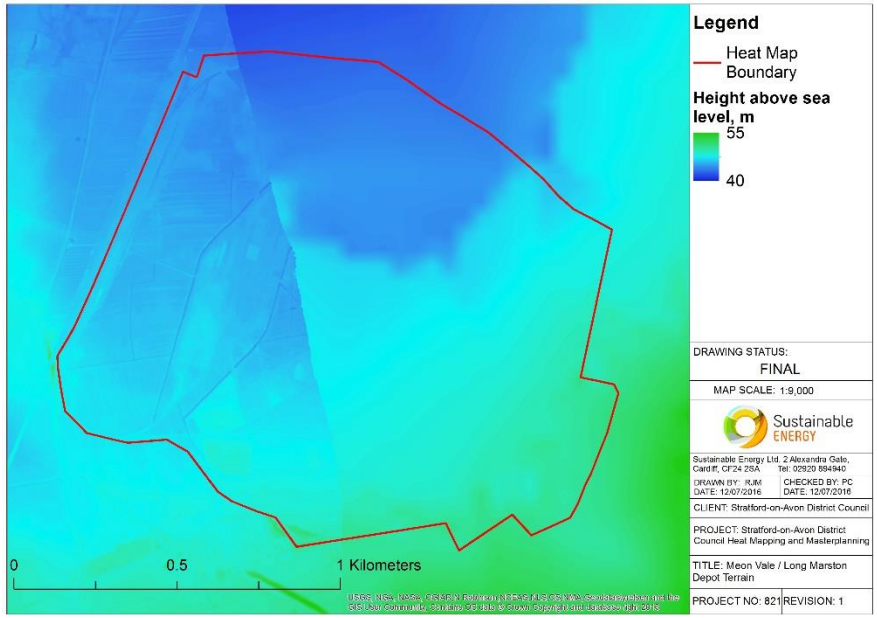


Figure 39: Terrain map for Meon Vale / Long Marston Depot

2.7 Identification of Clusters

Existing heat demands and development phases were considered to identify potential heat demand clusters for Stratford-on-Avon Town. This assessment was based on a number of factors such as the timing of developments, heat density, proximity to potential energy centre locations, building use and ownership, grouping of similar energy profile buildings, proximity to heat sources, potential barriers and risks and indicative pipe routes.

Figure 40 shows the heat demand clusters identified for further assessment for Stratford-on-Avon town.

Clusters have not been identified for all of the strategic sites as, for the majority of sites, building locations and individual energy demands are currently unknown.

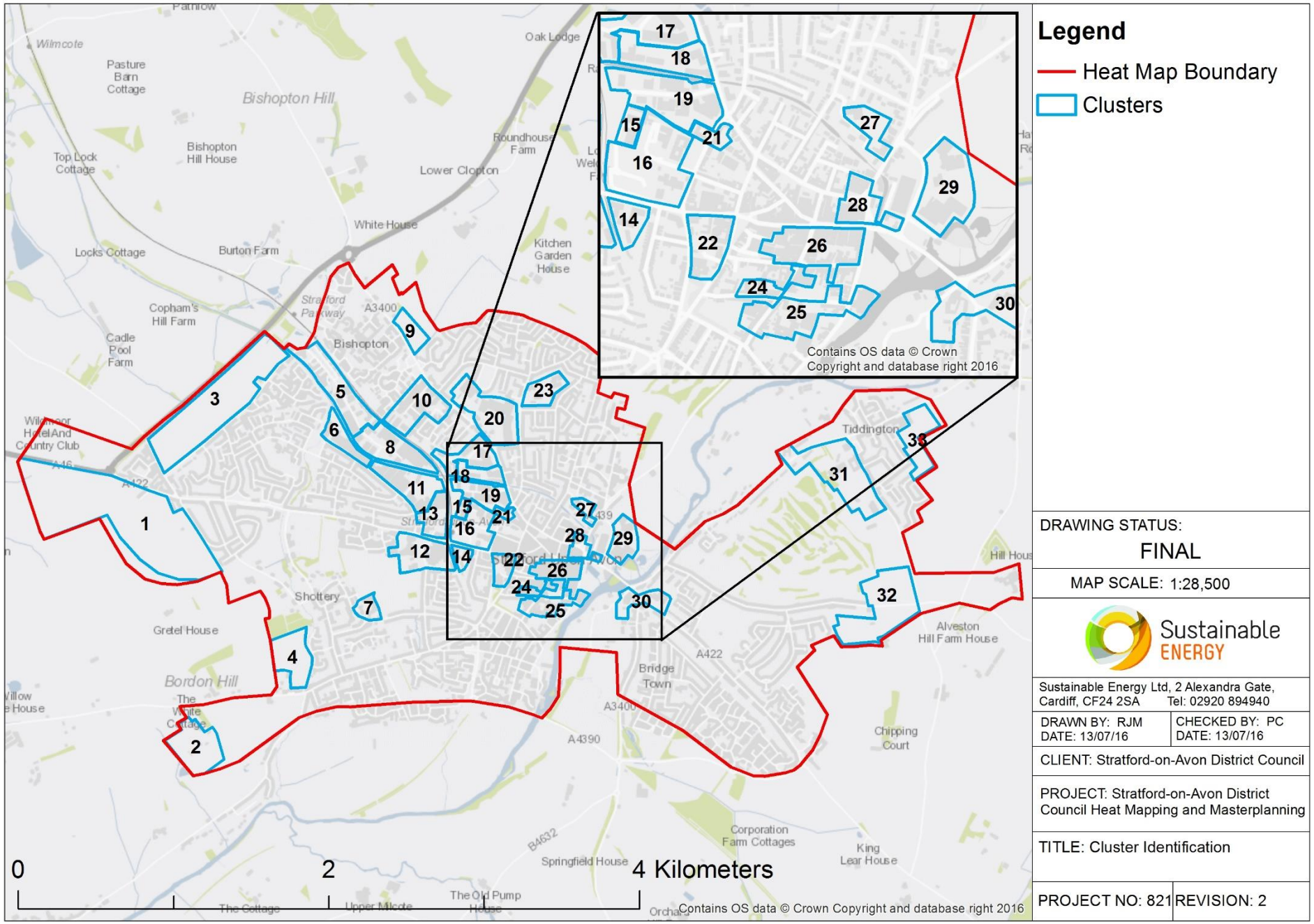


Figure 40: Stratford-upon-Avon town cluster identification

Table 9: Stratford-upon-Avon town cluster identification

No.	Cluster name	Est no. buildings	Key potential heat loads	Heat demand, MWh	Electricity demand, MWh	Cooling demand, MWh
1	West of Shottery A	Unknown	- Employment (Planned development) - Residential (Planned development)	15,333	923	-
2	Bordon Hill Nursery	18	- Bordon Hill Nurseries Ltd (Private sector)	4,686	322	-
3	Bishopton	500	- Residential (Planned development)	5,491	64	-
4	West of Shottery B	200	- Residential (Planned development)	3,409	-	-
5	Timothy's Bridge Road, North	42	- Royal Shakespeare Company warehouse (RSC) - Victoria Spa Lodge (Private sector)	2,974	1,553	-
6	Masons Road, West	10	- AGD Equipment Ltd (Private sector) - Pashley Cycles (Private sector)	1,179	487	-
7	Stratford Girls' Grammar School	4	- Stratford Girls' Grammar School (WCC)	244	272	-
8	Canal Quarter - Timothy's Bridge Road	375	- Residential (Planned development)	4,619	-	-
9	Birmingham Road	60	- Residential (Planned development)	920	-	-
10	Avenue Farm	30	- Travelodge (Private sector) - Canning Court Nursing Home (Private sector)	3,477	1,658	290
11	Canal Quarter - Masons Road	235	- Residential (Planned development)	3,051	-	-
12	Stratford High School and College	16	- Stratford-upon-Avon High School (WCC) - Stratford-upon-Avon College (Public sector)	3,009	1,677	-
13	Morrisons, Alcester Road	3	- Morrisons (Private sector)	817	3,760	2,553
14	Briar Croft and The Limes	3	- Briar Croft (Orbit Heart of England)	992	72	-
15	Brunel Way	4	- Avon Support Ltd (Private sector)	417	109	-
16	Hospital and Cattle Market	95	- Stratford Hospital, ambulatory care (Planned development) - Extra care apartments (Planned development - Orbit Heart of England)	6,771	2,186	8
17	Maybrook Road	20	- B&M Bargains (Private sector) - Carpet Right (Private sector)	1,281	1,195	-
18	Canal Quarter - Wharf Road	147	- Residential (Planned development) - Premier Inn (Private sector)	2,364	401	-
19	Canal Quarter - Western Road	200	- Residential (Planned development) - McDonalds (Private sector)	2,728	602	-
20	Maybird Retail Park	22	- Maybird Shopping Park (Private sector) - Tesco (Private sector)	2,420	6,743	2,438
21	Arden Court and Conrad House	4	- Arden Court (Private sector)	300	303	-
22	Civic Hall and Stratford Police Station	2	- Stratford Police Station (Warwickshire Police) - Civic Hall (Private sector)	1,271	519	-
23	Thomas Jolyffe and Welcombe Hills School	6	- Welcombe Hills School (WCC) - Thomas Jolyffe Primary School (WCC)	526	178	-
24	Scholars Lane and Chapel Street	7	- The Falcon Hotel (Private sector) - Mercure Shakespeare hotel (Private sector)	2,770	1,053	-

No.	Cluster name	Est no. buildings	Key potential heat loads	Heat demand, MWh	Electricity demand, MWh	Cooling demand, MWh
25	Church Street and Chapel Lane	7	- Royal Shakespeare Theatre (RSC) - King Edward VI School (WCC) - Elizabeth House (SDC)	2,941	3,796	-
26	High Street	6	- Debenhams (Private sector) - The Encore restaurant (Private sector)	760	2,081	-
27	Grosvenor Hotel and St Gregory School	2	- Grosvenor Hotel (Private sector) - St Gregory Catholic Primary School (WCC)	706	257	-
28	Guild Street and Bridge Foot	6	- Premier Inn Central (Private sector) - Marks & Spencer (Private sector)	2,278	4,725	693
29	Leisure Centre and Holiday Inn	3	- Stratford Leisure and Visitor Centre (SDC) - Holiday Inn (Private sector)	5,742	2,308	-
30	Swans Nest and Alveston Manor	6	- Alveston Manor Hotel (Private sector) - Swans Nest Hotel (Private sector)	2,953	1,348	-
31	NFU Mutual	4	- NFU Mutual (Private sector) - Reading Court, retirement housing (Private sector)	1,653	1,401	-
32	Arden Heath Farm	270	- Residential (Planned development)	3,411	-	-
33	Oak Road	95	- Oak Road residential development (Planned development)	1,705	40	-

Categorisation and Summary of Cluster Heat and Electricity Demands

Figure 41 shows the heat and electricity demand for each cluster categorised by building use. The total cluster heat demand can be seen on the right and total annual electricity demand on the left.

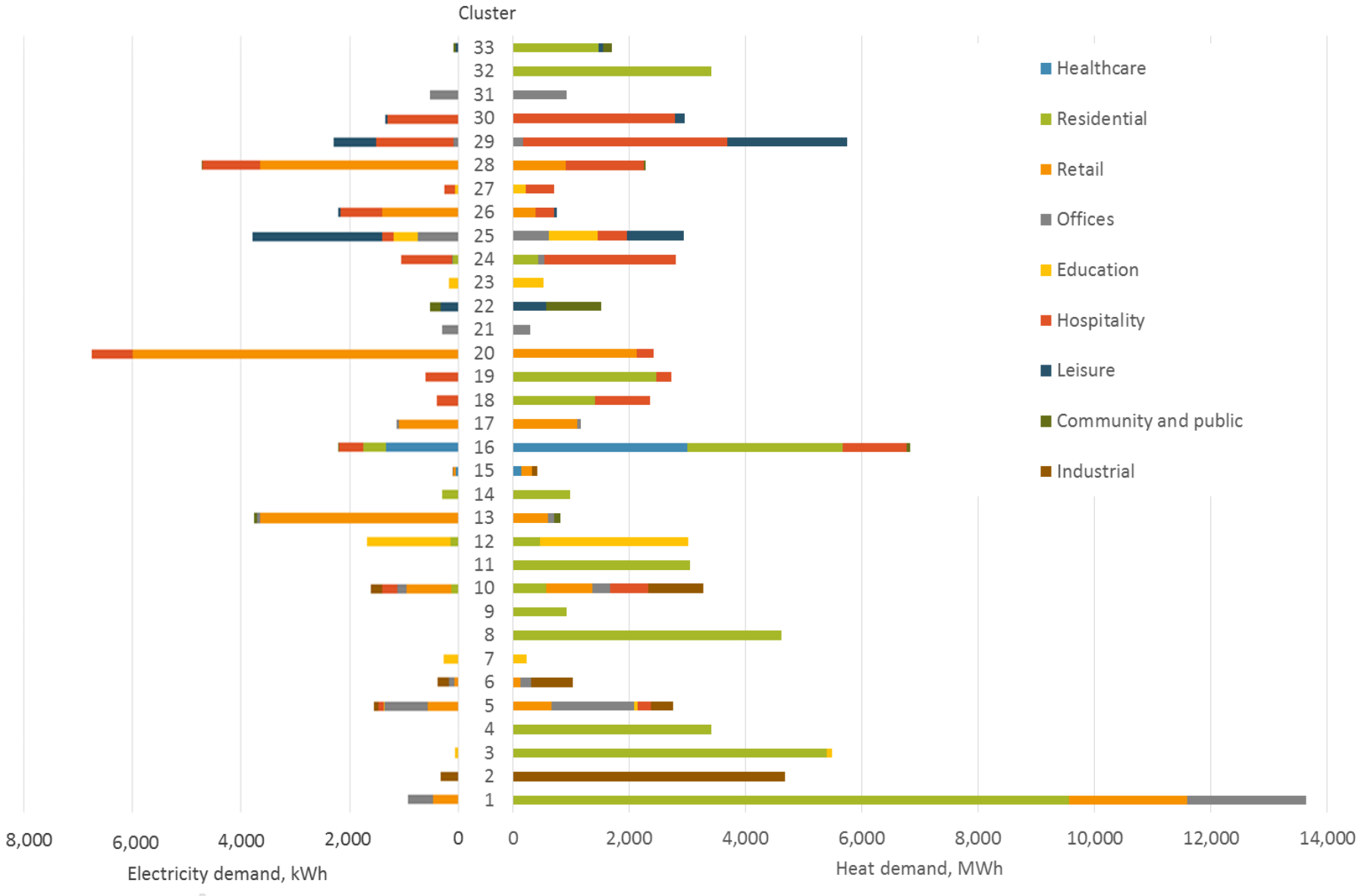


Figure 41: Stratford-upon-Avon town categorisation of cluster heat and electricity demands

Cluster 1 – West of Shottery A has the largest annual heat demand (>13,000 MWh), over double that of the heat demand of the next largest cluster, cluster 16 – Hospital and Cattle Market (>6,000 MWh). The majority of the heat demand for Cluster 1 arises from the residential planned developments at West of Shottery A and at SUA.2. There is a low non-residential electricity demand.

Cluster 16 includes the Cattle Market planned development, Stratford-upon-Avon Hospital, planned ambulatory care centre, Stratford-upon-Avon Train Station, Rother Medical Centre, The Stratford Hotel and Stratford Healthcare. Gas CHP may be viable for this cluster as there is a high heat demand and relatively high electricity demand.

Cluster 20 – Maybird Retail Park has the largest annual non-domestic electricity demand (>6,700 MWh) with a lower heat demand.

Cluster 25 – Church Street and Chapel Lane (>2,000 MWh total heat demand) is of strategic importance as it includes key heat loads such as Stratford-on-Avon District Council offices at Elizabeth House, King Edward VI school, the Royal Shakespeare and Swan Theatres and the Arden Hotel. It has the third highest non-domestic electricity demand (>3,700 MWh) the majority of this arises from the Royal Shakespeare and Swan Theatres.

Cluster 28 – Guild Street and Bridge Foot has the second largest annual non-domestic electricity demand (>4,700 MWh) which is also mostly attributed to retail (with some hospitality use).

Cluster 29 – Leisure Centre and Holiday Inn (>5000 MWh) has the third largest heat demand and a high electricity demand, potentially increasing the viability of gas CHP for this cluster.

3 MASTERPLANNING & PRIORITISATION

The outputs from the heat and electricity mapping exercise were assessed to inform the development of a low carbon district energy network options for the Stratford-on-Avon District. This energy masterplan identifies, evaluates and prioritises potential district energy scheme opportunities and constraints. All work meets the objectives and sub-objectives within Section 2 of the CIBSE/ADE Heat Networks Code of Practice (relevant to this stage of work).

The clusters identified in section 2.7 for Stratford-upon-Avon town have been assessed based on linear heat density and risk to determine potentially viable clusters to take forward for further consideration. This is discussed in section 3.1 and the full cluster assessment shown in Table 11.

An assessment of technology options has been undertaken to establish potentially technically viable heat sources for the Stratford-upon-Avon town area and the strategic sites. This is shown in 3.2 and the full technology assessment shown in Table 13.

Following the cluster and technology assessments, initial network options have been considered for the prioritised clusters and technically viable technologies. This involved assessment of networks for individual clusters, where clusters were made up of >2 buildings and appropriate energy centre locations could be identified, as well as networks connecting adjacent prioritised clusters. Network route selection methodology involved consideration of the linear heat density of clusters and the impact that pipe routes and connections have on the high level financial and technical viability (considering heat demand, peak, pipe size, diameter and length, losses, ground conditions and physical barriers). Hourly heat demand profiles for each of the initial network options were added together to produce a combined heat demand for each hour of the year. An hourly heat loss figure (based on pipe size and heat loss rates for pre-insulated pipe) was added to the combined profile, with the assumption of constant heat loss through the network.

Indicative pipe routes were outlined to consider maximum cost-efficiency, by minimising pipe length, following routes with easier digging conditions where possible and in consultation with planning officers from Stratford-on-Avon District Council. At this stage it was assumed that the trench used by the distribution pipe could also contain the cable for electricity distribution for private wire arrangements[5].

Potential locations for standalone energy centres were identified considering proximity to heat demands, environmental constraints, topography, archaeological sensitivity, site infrastructure for fuel deliveries, minimising of heat distribution losses and standing losses, Stratford-on-Avon District Council and other public sector owned land and proximity to future areas of expansion.

Existing key utilities and other infrastructure were considered to determine whether they pose any potentially significant risks to the development of district energy networks. Site topography was also considered in relation to potential energy centre locations and to consider any landscape or development barriers.

The initial network options are discussed in section 3.5 and the high level 25 year IRR for each option shown in Table 16. The assessments of initial network options highlighted 3 potentially viable networks within the Stratford-upon-Avon town heat map area to be taken forward for further consideration. Further details of these prioritised networks are shown in section 3.6.

For the strategic sites it was only possible to conduct network assessments for sites where building locations have been presented in development plans. These sites were Gaydon / Lighthorne Heath village centre and the north-eastern section of Meon Vale / Long Marston Depot. The high level 25 year IRR for both of these networks is shown in Table 16 and further details of the Gaydon / Lighthorne Heath village centre network discussed in section 3.7.3.

Full details of high level financial cases for each of the initial network options and the prioritised networks as well as pipe sizes and pipe specifications are show in Appendix 7 – Financial Viability Assessments.

[5] This would usually be in ducts that allow cables to be pulled after the excavation work is complete.

3.1 Assessment of Clusters

The heat mapping exercise identified heat demand clusters that were assessed for their potential to become part of a network. Linear heat density was assessed as areas of higher linear heat density provide a greater annual load whilst minimising capital costs and heat loss on distribution pipework. The cluster boundaries were also influenced by obvious physical obstructions such as the Stratford-upon-Avon to Henley-in-Arden railway line, the River Avon, the Stratford-upon-Avon Canal, major roads, archaeological sensitivity, listed buildings and any other areas with special engineering difficulty.

3.1.1 Linear Heat Density

Figure 42 shows the linear heat demand density for the identified heat demand clusters within Stratford-upon-Avon town. This calculation is based on cluster heat demand divided by indicative pipe trench length. Although linear heat density does not consider pipe diameter it provides a high level indicator for the potential viability of network options and phases.

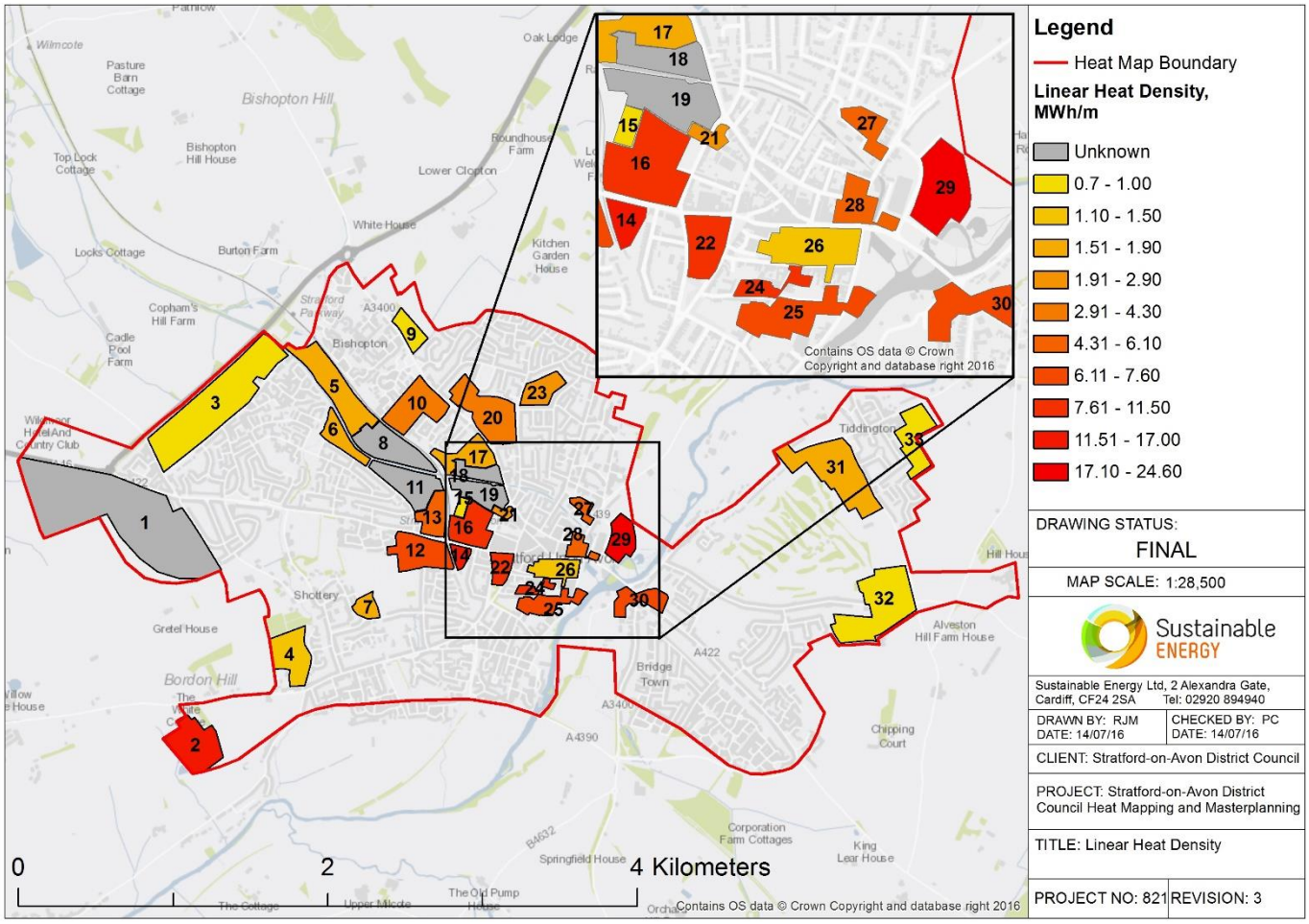


Figure 42: Linear heat density for the heat map area

Within the Stratford-upon-Avon town heat map area, 33 heat demand clusters were identified. Table 11 shows the heat demands, associated trench lengths and linear heat densities for the identified clusters. Clusters 1, 8, 11, 18 and 19 do not have a linear heat density because theses clusters include developments where the building locations are unknown, therefore it is not possible to create an indicative pipe route.

The majority of cluster linear heat densities are low. Cluster 29 – Leisure Centre and Holiday Inn has the highest heat density (24.6 MWh/m) and 14 - Briar Croft and The Limes, 2 – Bordon Hill Nursery and 22 – Civic Hall and Warwickshire Police have high heat densities.

Cluster 8 – Timothy's Bridge Road, South, cluster 10 – Avenue Farm, cluster 11 – Masons Road, east, cluster 13 Morrisons, Alcester Road, cluster 18 – Wharf Road, cluster 20 – Maybird Retail Park, cluster 21 – Arden Court and Conrad House, cluster 23 – Thomas Jolyffe, 27 – Grosvenor Hotel and St Gregory School have been classed as having medium heat densities.

Table 10: Cluster identification

Cluster no.	Cluster name		Cluster no.	Cluster name
1	West of Shottery A		18	Canal Quarter - Wharf Road
2	Bordon Hill Nursery		19	Canal Quarter - Western Road
3	Bishopton		20	Maybird Retail Park
4	West of Shottery B		21	Arden Court and Conrad House
5	Timothy's Bridge Road, North		22	Civic Hall and Stratford Police Station
6	Masons Road, West		23	Thomas Jolyffe and Welcombe Hills School
7	Stratford Girls' Grammar School		24	Scholars Lane and Chapel Street
8	Canal Quarter -Timothy's Bridge Road		25	Church Street and Chapel Lane
9	Birmingham Road		26	High Street
10	Avenue Farm		27	Grosvenor Hotel and St Gregory School
11	Canal Quarter - Masons Road		28	Guild Street and Bridge Foot
12	Stratford High School and College		29	Leisure Centre and Holiday Inn
13	Morrisons, Alcester Road		30	Swans Nest and Alveston Manor
14	Briar Croft and The Limes		31	NFU Mutual
15	Brunel Way		32	Arden Heath Farm
16	Hospital and Cattle Market		33	Oak Road
17	Maybrook Road			

3.1.2 Cluster Risk Assessment

Table 11 and Figure 43 outline risks and issues for all Stratford-upon-Avon town clusters. This includes details of the types of buildings within each cluster, linear heat density and risks, barriers and potential issues and concludes which clusters have been taken forward for further consideration.

Clusters 12, 14, 16, 22, 24, 25 and 29 are taken forward for further consideration. Due to their strategic importance to Stratford-on-Avon District Council, Clusters 8, 11, 18 and 19 cover the Canal Quarter development area and are also taken forward for further consideration, although at a higher level due to the limited information currently available on this planned development.

Clusters 2, 27 and 28 have a high linear heat density and have been classed as high risk or unviable and have not been taken forward for further consideration at this stage. For cluster 2 (Bordon Hill Nursery) this is due to the significant distance from other areas of high heat density. For clusters 27 and 28, this is due to the high risks associated with potential barriers, building ownership and marginally high linear heat density.

Table 11: Cluster risk assessment

No.	Cluster name	Total heat demand, MWh	Total electricity demand, MWh	Trench length, m	Linear heat density, MWh/m	Est. No. Buildings	Key building uses	Risks and issues	Risk	Taken forward for further consideration?
1	West of Shottery A	15,333	923	Unknown	Unknown[6]	202 + employment	- Employment (Planned development) - Residential (Planned development) - Primary School (Planned development)	- Low linear heat density - Low density housing development - A46 and A422 potential barrier - Full planning permission for 68 dwellings approved January 2016 - Limited details available for employment development (approximately 20 hectares) - Employment area likely to be used to relocate existing businesses from Canal Quarter development area (low linear heat density) - Developers not currently engaged in project - Land privately owned - Significant distance from areas of high linear heat density - High number of potential connections for individual dwellings (i.e. increase in connection costs and pipe length)	High	No, due to low linear heat density and high risk
2	Bordon Hill Nursery	4,686	322	334	14.0	18	- Greenhouses/ nursery (Private sector)	- High linear heat density - Significant distance from other areas of high linear heat density - Contact has not been established with Bordon Hill Nurseries - Currently have 2 MW biomass and small CHP (exact size unknown) supplying heat network connecting buildings - B439 potential barrier	High	No, due to high risk and significant distance from other high heat demands
3	Bishopton	5,491	64	7,618	0.7	500	- Residential (Planned development)	- Low linear heat density - Low density housing development - Significant distance from areas of high linear heat density - A46 potential barrier - Stratford-upon-Avon Canal potential barrier - Outline planning permission for 500 dwellings submitted December 2015 - Housing developers (Miller Homes and Taylor Wimpey) not currently engaged in project - High number of potential connections	High	No, due to low linear heat density and high risk
4	West of	3,409	NA	2,209	1.5	200	- Residential	- Low linear heat density		No, due to low

[6] Location of buildings currently unknown so unable to calculate linear heat density, for SUA.2 residential area in isolation, linear heat density is low (1.7 MWh/m^2)

No.	Cluster name	Total heat demand, MWh	Total electricity demand, MWh	Trench length, m	Linear heat density, MWh/m	Est. No. Buildings	Key building uses	Risks and issues	Risk	Taken forward for further consideration?
	Shottery B						(Planned development)	- Significant distance from areas of high linear heat density - Shottery Brook potential barrier - Application for approval of reserved matters submitted March 2016 - Housing developer (Hallam Land Management Limited) not currently engaged in project - High number of potential connections - B439 potential barrier	High	linear heat density and high risk
5	Timothy's Bridge Road, North	2,974	1,553	1,770	1.7	42	- Offices (Private sector) - Warehouses (Private sector) - Workshops (Private sector)	- Low linear heat density - Significant distance from areas of high linear heat density - Diverse range of private sector building owners - Stratford-upon-Avon Canal potential barrier - Stratford-upon-Avon to Henley-in-Arden railway line potential barrier	High	No, due to low linear heat density and high risk
6	Masons Road, West	1,179	487	624	1.9	10	- Warehouses (Private sector) - Workshops (Private sector) - Offices (Private sector)	- Low linear heat density - Significant distance from areas of high linear heat density - Diverse range of private sector building owners - Stratford-upon-Avon Canal potential barrier	High	No, due to low linear heat density and high risk
7	Stratford Girls' Grammar School	244	272	135	1.8	4	- Grammar School (Warwickshire County Council)	- Low linear heat density - Significant distance from areas of high linear heat density - Owned by Warwickshire County Council	High	No, due to low linear heat density and high risk
8	Canal Quarter - Timothy Bridge Road	4,619	NA	Unknown	Unknown	375	- Residential planned development (apartments and individual dwellings)	- Strategically important Canal Quarter development area - Heat demand estimated from high level development information - Linear heat density cannot be calculated at this stage (detail development plans showing building locations not currently available therefore pipe routes for linear heat density cannot be plotted) - Stratford-upon-Avon Canal potential barrier - Stratford-upon-Avon to Henley-in-Arden railway line potential barrier - Risk could reduce to medium once more detailed development plans are made available and potential heat demands revised	High	Yes

No.	Cluster name	Total heat demand, MWh	Total electricity demand, MWh	Trench length, m	Linear heat density, MWh/m	Est. No. Buildings	Key building uses	Risks and issues	Risk	Taken forward for further consideration?
9	Birmingham Road	920	NA	802	1.1	60	- Residential (Planned development)	- Low linear heat density - A3400 potential barrier - Significant distance from areas of high linear heat density - A3400 potential barrier - Full planning for 67 dwellings approved in March 2015 - Housing developer (Miller Homes) not currently engaged in project - High number of potential connections	High	No, due to low linear heat density and high risk
10	Avenue Farm	3,477	1,658	883	3.9	30	- Retail (Private sector) - Warehouses (Private sector) - Offices (Private sector) - Workshops (Private sector) - Hotel (Private sector) - Care home (Private sector)	- Medium linear heat density - Significant distance from areas of high linear heat density - Diverse range of private sector building owners - Stratford-upon-Avon to Henley-in-Arden railway line potential barrier - A3400 potential barrier	High	No, due to high risk and significant distance from other high heat demands
11	Canal Quarter - Masons Road	3,051	NA	Unknown	Unknown	235	- Residential development (apartments and individual dwellings)	- Strategically important Canal Quarter development area - Heat demand estimated from high level development information - Linear heat density cannot be calculated at this stage (detail development plans showing building locations not currently available therefore pipe routes for linear heat density cannot be plotted) - Stratford-upon-Avon Canal potential barrier - Stratford-upon-Avon to Henley-in-Arden railway line potential barrier - Risk could reduce to medium once more detailed development plans are made available and potential heat demands revised	High	Yes
12	Stratford	3,009	1,677	422	7.1	16	- Primary School	- High linear heat density		Yes

No.	Cluster name	Total heat demand, MWh	Total electricity demand, MWh	Trench length, m	Linear heat density, MWh/m	Est. No. Buildings	Key building uses	Risks and issues	Risk	Taken forward for further consideration?
	High School and College						(Warwickshire County Council) - Secondary School (Warwickshire County Council) - College (Other public sector)	- College did not respond to information request and are not currently engaged in project. If College were to be engaged, cluster would become low risk - Unknown if College buildings connected by single heating system - Stratford-upon-Avon to Henley-in-Arden railway line potential barrier - A422 potential barrier	Medium	
13	Morrisons, Alcester Road	817	3,760	148	5.5	3	- Supermarket (Private sector) - Firestation (Warwickshire County Council) - Job centre (UK Government Department of Work and Pensions)	- Medium linear heat density - A422 potential barrier - Stratford-upon-Avon to Henley-in-Arden railway line potential barrier - Significant distance from areas of high linear heat density	High	No, due to high risk and significant distance from other high heat demands
14	Briar Croft and The Limes	992	72	58	17.0	3	- Sheltered housing (Orbit Heart of England) - Care home (Private sector)	- High linear heat density - Low number of buildings, however cluster in close proximity to clusters 12 and 16 (separated by railway and A422 respectively) - Stratford-upon-Avon to Henley-in-Arden railway line potential barrier - A422 potential barrier	Medium	Yes
15	Brunel Way	417	109	369	1.1	4	- Retail (Private sector) - Warehouses (Private sector) - Day care centre (Private sector)	- Low linear heat density - Diverse range of private sector building owners - Stratford-upon-Avon to Henley-in-Arden railway line potential barrier	High	No, due to low linear heat density and high risk
16	Hospital and	6,771	2,186	684	9.9	95	- Hospital (South	- High linear heat density		Yes

No.	Cluster name	Total heat demand, MWh	Total electricity demand, MWh	Trench length, m	Linear heat density, MWh/m	Est. No. Buildings	Key building uses	Risks and issues	Risk	Taken forward for further consideration?
	Cattle Market						Warwickshire NHS Foundation Trust) - Stratford Healthcare (Coventry and Warwickshire Partnership NHS Trust) - Hotel (Private sector) - Extra care facility (Planned development to be owned by Orbit Heart of England)	- Stratford-upon-Avon to Henley-in-Arden railway line potential barrier - A422 potential barrier - Diverse range of stakeholders - Full planning permission for 102 extra care apartments, 87 dwellings, retail, hair salon and café submitted December 2015 - Stratford-upon-Avon Hospital and Orbit Heart of England engaged at this stage - Full planning permission for hospital ambulatory care granted January 2015 - Conservation area covering Stratford Hotel and Rother House Medical Centre - Borderline medium risk	Medium	
17	Maybrook Road	1,281	1,195	683	1.9	20	- Retail (Private sector) - Warehouses (Private sector) - Offices (Private sector and Orbit Heart of England)	- Low linear heat density - Significant distance from areas of high linear heat density - Diverse range of private sector building owners - Stratford-upon-Avon to Henley-in-Arden railway line potential barrier - Stratford-upon-Avon Canal potential barrier - A3400 potential barrier	High	No, due to low linear heat density and high risk
18	Canal Quarter - Wharf Road	2,364	401	Unknown	Unknown	147	- Residential development (apartments)	- Strategically important Canal Quarter development area - Heat demand estimated from high level development information - Linear heat density cannot be calculated at this stage (detail development plans showing building locations not currently available therefore pipe routes for linear heat density cannot be plotted) - A3400 potential barrier - Stratford-upon-Avon to Henley-in-Arden railway line potential barrier - Stratford-upon-Avon Canal potential barrier - Risk could reduce to medium once more detailed development plans are made available and potential heat demands revised	High	Yes
19	Canal	2,728	602	NA	NA	200	- Residential	- Strategically important Canal Quarter development area		Yes

No.	Cluster name	Total heat demand, MWh	Total electricity demand, MWh	Trench length, m	Linear heat density, MWh/m	Est. No. Buildings	Key building uses	Risks and issues	Risk	Taken forward for further consideration?
	Quarter - Western Road						development (apartments and individual dwellings)	- Heat demand estimated from high level development information - Linear heat density cannot be calculated at this stage (detail development plans showing building locations not currently available therefore pipe routes for linear heat density cannot be plotted) - A3400 potential barrier - Stratford-upon-Avon to Henley-in-Arden railway line potential barrier - Stratford-upon-Avon Canal potential barrier - Risk could reduce to medium once more detailed development plans are made available and potential heat demands revised	High	
20	Maybird Retail Park	2,420	6,743	566	4.3	22	- Supermarket (Private sector) - Retail (Private sector) - Restaurants (Private sector)	- Medium linear heat density - A3400 potential barrier - Significant distance from areas of high linear heat density - Diverse range of private sector building owners	High	No, due to high risk and significant distance from other high heat demands
21	Arden Court and Conrad House	300	303	118	2.5	4	- Offices (Private sector)	- Medium linear heat density - Diverse range of private sector building owners - A4390 barrier	High	No, due to high risk and medium/low linear heat density
22	Civic Hall and Stratford Police Station	1,271	519	111	11.5	2	- Theatre (Private sector) - Police station (Warwickshire Police)	- High linear heat density - Warwickshire Police did not respond to information request and are not currently engaged in project - Significant distance from other areas of high linear heat density - Greenhill Street and A4390 potential barrier - Conservation area and listed Civic Hall building	Medium	Yes
23	Thomas Jolyffe and Welcombe Hills Schools	526	178	182	2.9	6	- Primary Schools (Warwickshire County Council)	- Medium linear heat density - Significant distance from areas of high linear heat density	High	No, due to high risk and significant distance from other high heat demands
24	Scholars	2,770	1,053	285	9.7	7	- Hotels (Private	- High linear heat density		Yes

No.	Cluster name	Total heat demand, MWh	Total electricity demand, MWh	Trench length, m	Linear heat density, MWh/m	Est. No. Buildings	Key building uses	Risks and issues	Risk	Taken forward for further consideration?
	Lane and Chapel Street						sector) - Town Hall (Stratford on Avon District Council) - Care home (Private sector) - Medical Centre (South Warwickshire NHS Foundation Trust)	- Conservation area and listed buildings - Diverse range of private sector building owners - Likely to encounter difficult ground conditions - Borderline medium risk - High number of listed buildings	Medium	
25	Church Street and Chapel Lane	2,941	3,796	449	6.5	7	- Elizabeth House (Stratford on Avon District Council) - Grammar school (Private sector) - Hotel (Private sector) - Theatre (Royal Shakespeare Company)	- High linear heat density - Conservation area and listed buildings - Diverse range of private sector building owners - Likely to encounter difficult ground conditions - Royal Shakespeare Company responded to information request but are not currently engaged in project - Borderline medium risk - High number of listed buildings	Medium	Yes
26	High Street	760	2,081	527	1.4	6	- Retail (Private sector) - Restaurants (Private sector) - Tudor World tourist attraction (Private sector)	- Low linear heat density - Diverse range of private sector building owners - Conservation area and listed buildings - Likely to encounter difficult ground conditions - High number of listed buildings	High	No, due to low linear heat density and high risk
27	Grosvenor Hotel and St Gregory School	706	257	124	5.7	2	- Primary School (Warwickshire County Council) - Hotel (Private sector)	- Medium linear heat density - Significant distance from areas of high linear heat density - A3400 potential barrier - Conservation area	High	No, due to high risk and significant distance from other high heat demands
28	Guild Street	2,278	4,725	338	6.7	6	- Hotel (Private	- High linear heat density		No, due to

No.	Cluster name	Total heat demand, MWh	Total electricity demand, MWh	Trench length, m	Linear heat density, MWh/m	Est. No. Buildings	Key building uses	Risks and issues	Risk	Taken forward for further consideration?
	and Bridge Foot						sector) - Retail (Private sector) - Restaurants (Private sector)	- A3400 barrier - Stratford-upon-Avon Canal barrier - Bridge Street potential barrier - Diverse range of private sector building owners - Conservation area and listed buildings	High	significant barriers
29	Leisure Centre and Holiday Inn	5,742	2,308	234	24.6	3	- Leisure centre (Stratford on Avon District Council) - Hotel (Holiday Inn) - Offices (Private sector)	- High linear heat density - Low number of buildings, although proximity to clusters 28 and 30 and viability of connection is assessed below - Holiday Inn did not respond to information request and are not currently engaged in project - Initial information received from Leisure Centre, however contact not amenable to site visit or providing further information - Conservation area	Medium	Yes
30	Swans Nest and Alveston Manor	2,953	1,348	386	7.6	6	- Hotels (Private sector) - Restaurant (Private sector) - Butterfly Farm (Private sector)	- High linear heat density - Significant distance from other areas of high linear heat density - A3400 and A422 barrier - River Avon potential barrier - Diverse range of private sector building owners - Conservation area and listed buildings - High number of listed buildings	High	No, due to high risk and significant distance from other heat demands
31	NFU Mutual	1,653	1,401	913	1.8	4	- Offices (NFU Mutual) - Primary School (Warwickshire County Council) - Retirement/ sheltered housing (Private sector)	- Low linear heat density - Significant distance from areas of high linear heat density - B4086 barrier	High	No, due to low linear heat density and high risk
32	Arden Heath Farm	3,411	NA	3,297	1.0	270	- Residential (Planned development)	- Low linear heat density - Significant distance from areas of high linear heat density - Outline planning permission for 270 dwellings granted December 2015 - Arden Heath Farm developer (Gallagher Estates) is not currently engaged in project - High number of potential connections	High	No, due to low linear heat density and high risk

No.	Cluster name	Total heat demand, MWh	Total electricity demand, MWh	Trench length, m	Linear heat density, MWh/m	Est. No. Buildings	Key building uses	Risks and issues	Risk	Taken forward for further consideration?
33	Oak Road	1,705	40	1,897	0.9	95	- Residential (Planned development) - Community centre (Charity)	- Low linear heat density - Significant distance from areas of high linear heat density - Oak Road developer (Gallagher Estates) is not currently engaged in project - Home Guard Club and Sports Ground developer (CALA Homes) not currently engaged in project - Full planning permission granted for Home Guard Club and Sports Ground in June 2015 - Outline planning permission granted for Oak Road development in February 2016	High	No, due to low linear heat density and high risk

Figure 43 provides a visual summary of the level of risk associated with each of the identified heat demand clusters within Stratford-upon-Avon town becoming part of an energy network (as assessed in Table 11).

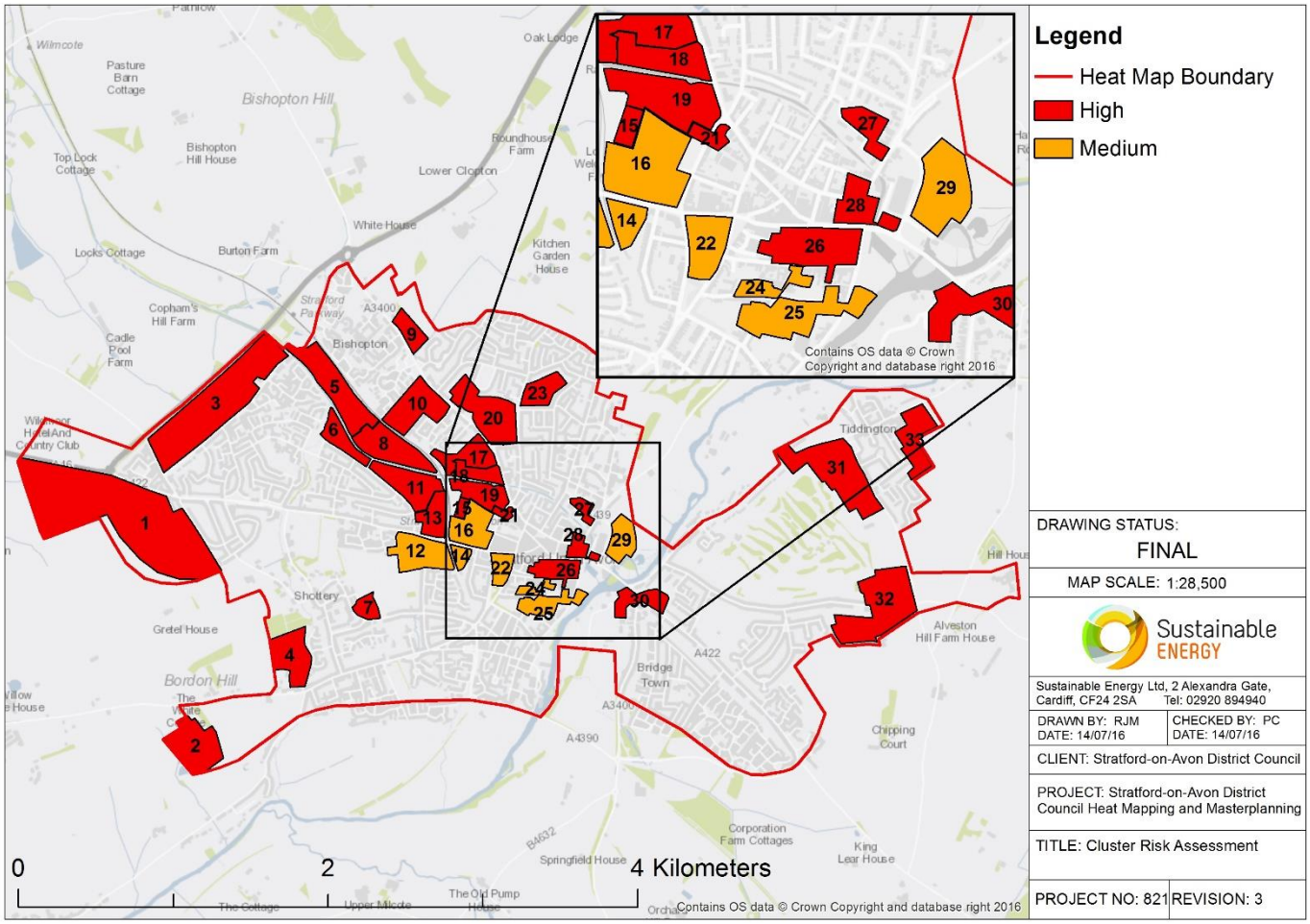


Figure 43: Cluster risk assessment

Table 12: Cluster identification

Cluster no.	Cluster name		Cluster no.	Cluster name
1	West of Shottery A		18	Canal Quarter - Wharf Road
2	Bordon Hill Nursery		19	Canal Quarter - Western Road
3	Bishopton		20	Maybird Retail Park
4	West of Shottery B		21	Arden Court and Conrad House
5	Timothy's Bridge Road, North		22	Civic Hall and Stratford Police Station
6	Masons Road, West		23	Thomas Jolyffe and Welcombe Hills School
7	Stratford Girls' Grammar School		24	Scholars Lane and Chapel Street
8	Canal Quarter -Timothy's Bridge Road		25	Church Street and Chapel Lane
9	Birmingham Road		26	High Street
10	Avenue Farm		27	Grosvenor Hotel and St Gregory School
11	Canal Quarter - Masons Road		28	Guild Street and Bridge Foot
12	Stratford High School and College		29	Leisure Centre and Holiday Inn
13	Morrisons, Alcester Road		30	Swans Nest and Alveston Manor
14	Briar Croft and The Limes		31	NFU Mutual
15	Brunel Way		32	Arden Heath Farm
16	Hospital and Cattle Market		33	Oak Road
17	Maybrook Road			

There are no low risk heat demand clusters in Stratford-upon-Avon town. Cluster 12 – Stratford High School and College, Cluster 14 – Briar Croft, 16 – Hospital and Cattle Market, 22 – Civic Hall and Stratford Police Station, 24 – Scholars Lane and Chapel Street, 25 – Church Street and Chapel Lane and 29 – Leisure Centre and Holiday Inn are classed as medium risk heat demand clusters.

Of these medium risk clusters, clusters 12, 14, 22 and 29 could be re-classed as low risk if key stakeholders could be engaged in the project (Stratford-upon-Avon College, The Limes nursing home, Civic Hall and Holiday Inn respectively). Cluster 16 – Hospital and Cattle Market has been classed as borderline medium risk. Stratford-upon-Avon Hospital have engaged in the project at this stage, however if this was to change then this cluster would be classed as high risk due to the diverse range of stakeholders.

The medium risk clusters shown in Figure 43 have been taken forward for further consideration in an initial network assessment. This is shown in section 3.5.

3.2 Technology Options Assessment

Potential existing and planned energy sources within the Stratford-upon-Avon town heat map area are shown in Figure 29. The consultant team assessed the identified energy supply opportunities in relation to the technical suitability, key requirements and the cost implications on potential heat networks viability. No existing or planned energy sources were identified within or near any of the strategic sites. High level technical viability considerations for potential heat sources for all heat map areas are summarised in Table 13. As space is at a premium in the Town Centre areas, the energy centre size is an important consideration.

Table 13 shows that biomass heat and biofuels CHP may be technically viable for Stratford-upon-Avon Town away from the town centre area. Biomass has been found to be not technically viable for the town centre area due to emissions, congestion of the town centre area for woodfuel deliveries and insufficient space available for a biomass energy centre and woodfuel delivery area. Gas CHP has been taken forward for further consideration for all areas and WSHP may be viable for clusters 25 and 29 using the River Avon as a water source. WSHP may also be viable for the Canal Quarter development using the Stratford-upon-Avon Canal as a water source.

Table 13 indicates biomass heat, gas CHP and GSHP could be technically viable for all strategic sites. WSHP is not technically viable for Long Marston Airfield or Meon Vale / Long Marston Depot as no water source of sufficient capacity has been identified at these sites but may be viable for SOU. 3 – South of Daventry Road. WSHP may also be viable for the southern area of Gaydon / Lighthorne Heath, however, the ponds are currently small so would have limited capacity as a heat source. These may be suitable for planned developments in close proximity to the ponds but are unlikely to be viable for the village centre due to the distance (0.6 km).

Table 13: Summary of potential heat sources

Technology	High level technical viability considerations	Taken forward for further consideration?				
		Stratford-upon-Avon Town	Gaydon / Lighthorne Heath	SOU 3 – South of Daventry Road	Long Marston Airfield	Meon Vale / Long Marston Depot
Anaerobic digestion	• Compatible with operating conditions and delivers required water temperatures to buildings (up to 85 °C) • No plans for AD plants within a feasible distance • Availability of feedstocks unclear • No available area for plant footprint • Unsuitable for town centre location	No	No	No	No	No
Biomass heat	• Compatible with operating conditions and delivers required water temperatures to buildings (up to 85 °C) • No potential for self-supply of wood fuel • Potentially cost effective carbon reduction technology (£ per tonne carbon) • Air quality issues • Not suitable to town centre location due to planning issues relating to sensitivity of conservation area • Limited space within the town centre area for energy centre and woodfuel delivery area • Large number of fuel deliveries not suited to congested town centre area	Yes, outside of congested town centre area	Yes	Yes	Yes	Yes
Biofuel CHP	• May be compatible with operating conditions and delivers required water temperatures to buildings (up to 85 °C) • No plans for large biofuel CHP plants / power stations within a feasible area • Low electricity demand at strategic sites • Potentially improved financial viability achieved through private wire sales • Air quality issues • Potentially cost effective carbon reduction technology (£ per tonne carbon) • Uncertainty of long term future of RHI (ORC conditions recently changed) • No potential for self-supply • Not suitable to town centre location due to planning issues relating to sensitivity of conservation area • Limited space within the town centre area for energy centre and woodfuel delivery area • Large number of fuel deliveries not suited to congested town centre area	Yes, outside of congested town centre area	Yes	Yes	Yes	Yes

Technology	High level technical viability considerations	Taken forward for further consideration?				
		Stratford-upon-Avon Town	Gaydon / Lighthorne Heath	SOU 3 – South of Daventry Road	Long Marston Airfield	Meon Vale / Long Marston Depot
Energy from Waste	• No plans for EfW within a feasible area • *Potentially* compatible with existing operating conditions • Air quality issues • Planning issues relating to location - likely to be public opposition • No available area for plant footprint	No	No	No	No	No
Gas CHP	• Potentially suited to town centre location • Compatible with existing operating conditions and delivers required water temperatures to buildings (up to 85 °C) • Low electricity demand at strategic sites • Potentially improved financial viability achieved through private wire sales • Potentially available space for Energy Centre • Anecdotal evidence suggests that 65kW gas CHP was investigated as an option to serve the Stratford-upon-Avon Hospital ambulatory care development, although there are currently no development plans in place	Yes	Yes	Yes	Yes	Yes
Deep geothermal	• The geothermal heat flow value for the Stratford-on-Avon area is approximately 30-40mW/m^2 and is unlikely to present a viable opportunity[7] • Deep drilling unsuitable for Stratford-upon-Avon town centre location	No	No	No	No	No
Ground source heat pump	• Archaeological sensitivity of Stratford-upon-Avon town • Very limited land availability for horizontal array in town location	No	Yes	Yes	Yes	Yes
Water source heat pump	• River Avon and Stratford-upon-Avon Canal within feasible proximity to clusters 25 and 29 • Stratford-upon-Avon Canal within close proximity to all Canal Quarter development areas • No sufficiently large water sources identified at Long Marston Airfield or Meon Vale • River Stowe within feasible proximity to SOU 3 – South of Daventry Road • Small ponds within Gaydon/Lighthorne Heath planned development	Yes, for Clusters 25 and 29 and Canal Quarter	Yes, for southern area	Yes	No	No

[7] Figure from British Geological Survey heat flow map http://www.bgs.ac.uk/research/energy/geothermal/

Technology	High level technical viability considerations	Taken forward for further consideration?				
		Stratford-upon-Avon Town	Gaydon / Lighthorne Heath	SOU 3 – South of Daventry Road	Long Marston Airfield	Meon Vale / Long Marston Depot
	• Lower water temperatures may not be initially suitable for existing buildings, however will be suitable for planned developments					

Table 14 provides a summary of the technology options to be further assessed to potentially serve the Stratford-upon-Avon town clusters which have been taken forward for further consideration. The options that are potentially technically viable for each cluster are shown in orange.

Table 14: Summary of technology options for Stratford-upon-Avon town

Technology	8. Timothys Bridge Road, Canal Quarter	11. Masons Road, Canal Quarter	12. Stratford High School and College	14. Briar Croft and The Limes	16. Hospital and Cattle Market	18. Wharf Road, Canal Quarter	19. Western Road, Canal Quarter	22. Civic Hall and Warwickshire Police	24. Scholars Lane and Chapel Street	25. Church Street and Chapel Lane	29. Leisure Centre and Holiday Inn
Biomass heat											
Gas CHP											
Biomass CHP											
GSHP											
WSHP											

3.3 Potential Energy Centre Locations

Figure 44 shows the potential energy centre locations that have been identified for Stratford-upon-Avon town. These have been considered based on land ownership (prioritising Council-owned land), planned development sites and discussion with planning officers from Stratford-on-Avon District Council. The sites taken forward for further consideration are discussed in Table 15.

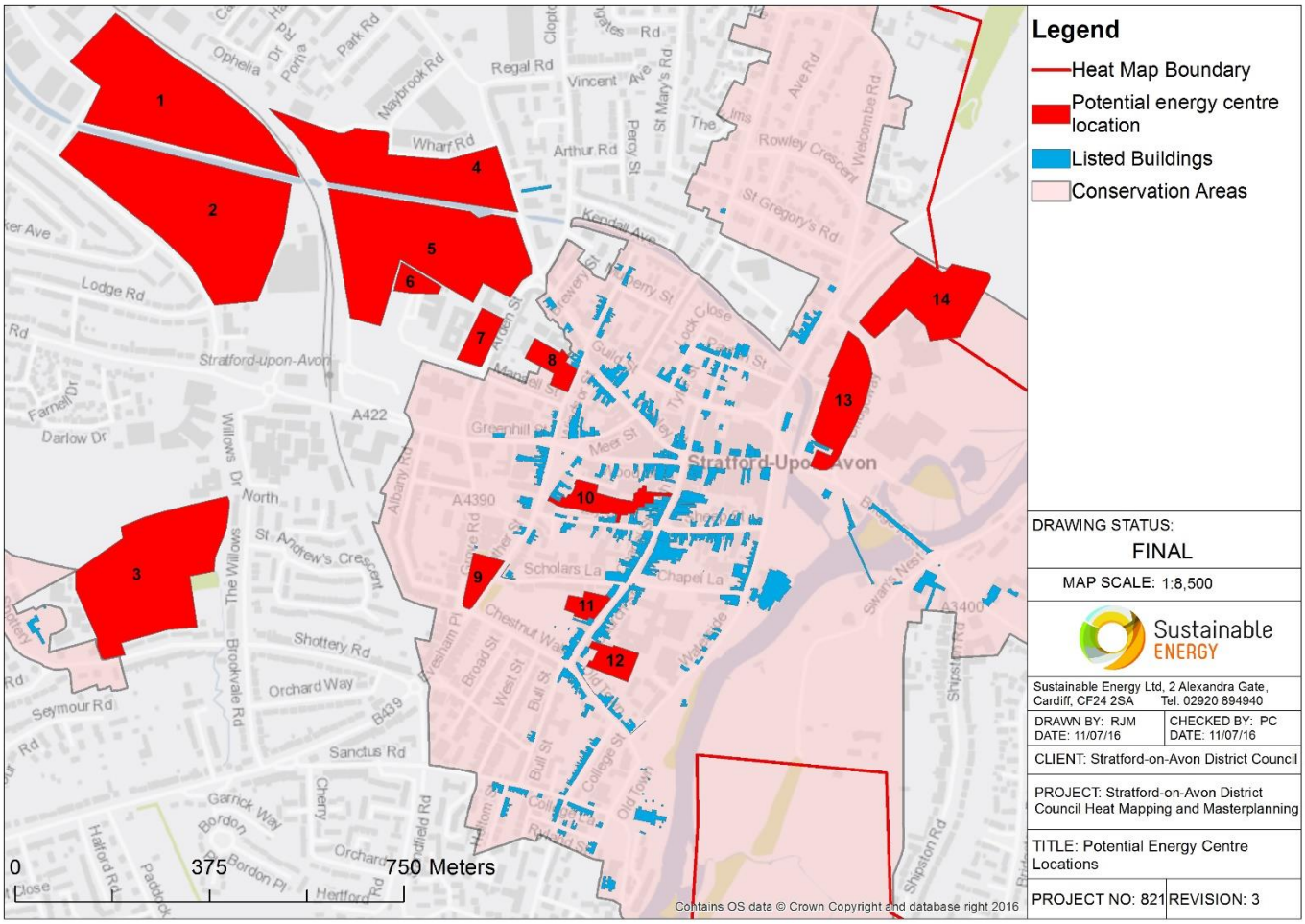


Figure 44: Potential energy centre locations for Stratford-upon-Avon town

Table 15: Potential energy centre locations for Stratford-upon-Avon town

Map ref.	Site name	Approximate area	Council Owned	Comments	Consideration for potential energy centre?
1	Timothy's Bridge Road, Canal Quarter	58,000 m^2	No	- Current use: industrial and employment area - Part of Canal Quarter development area	Yes, dependant on Canal Quarter development plans for this site
2	Masons Road, Canal Quarter	72,000 m^2	Partly	- Current use: football pitch and Royal Shakespeare Company warehouse - Part of Canal Quarter development area	Yes, dependant on Canal Quarter development plans for this site
3	Shottery Fields	52,900 m^2	Yes	- Current use: green space - No current planning applications - Planning permission unlikely due to green space	No
4	Wharf Road, Canal Quarter	38,000 m^2	No	- Current use: employment area - Part of Canal Quarter development area	Yes, dependant on Canal Quarter development plans for this site

Map ref.	Site name	Approximate area	Council Owned	Comments	Consideration for potential energy centre?
5	Western Road, Canal Quarter	60,000 m^2	No	- Current use: retail and employment area - Part of Canal Quarter development area	Yes, dependant on Canal Quarter development plans for this site
6	Stratford-upon-Avon Hospital energy centre	420 m^2	No	- Recently constructed to supply existing hospital building and ambulatory care development - Available space unknown, although discussions with hospital suggests space for CHP	Yes
7	Arden Street car park	5,000 m^2	Yes	- Current use: car park - No current planning applications	Yes
8	Windsor Street car park	4,000 m^2	Yes	- Current use: multi-storey car park - No current planning applications - Within conservation area	Yes
9	Firs Garden	5,200 m^2	Yes	- Current use: Park - Planning permission unlikely due to green space - Within conservation area	No, due to green space
10	NCP car park / Former town square	6,500 m^2	Yes	- Current use: Multi-storey car park and access routes for shopping centre - No current planning applications - Unlikely to be sufficient space for energy centre other than multi-storey car park - Within conservation area	Yes, potential within multi-story car park area
11	Elizabeth House plant room	130 m^2	Yes	- Current use: Basement plant room for Elizabeth House - No current planning applications - Limited access routes - Listed building - Within conservation area	No, due to limited space and access
12	Church Street car park	4,100 m^2	Yes	- Current use: car park - No current planning applications - Narrow access routes (unsuitable for biomass deliveries) - Within conservation area	Yes
13	Bridgeway car park	15,300 m^2	Yes	- Current use: multi-storey car park and surrounding area - No current planning applications - Within conservation area	Yes
14	Leisure Centre car park	25,700 m^2	Yes	- Current use: Leisure centre car park and coach park - Large area of land with no existing buildings - No current planning applications - Edge of town location - Within conservation area	Yes

3.4 Key Parameters for High Level Viability Assessment

3.4.1 Hydraulic Modelling

High level optimisation of the distribution network routes was assessed along with energy centre locations and considered issues such as:

- Routing through public owned land as much as possible
- Trench excavation, backfilling and reinstatement costs for different ground conditions
- Routing to avoid/overcome site barriers such as major utilities, large roads and rivers
- Routing to avoid environmentally sensitive areas
- Hydraulic modelling of the network to generate a high level indicative network specification and calculation of heat distribution losses throughout the network
- Best practice and in accordance with the Heat Networks Code of Practice

The high level technical requirements for proposed developments were also considered to allow connection to the potential district energy network options including temperature, flow rates and other relevant requirements.

3.4.2 Technology / Heat Source Assessment

A high level technology assessment was conducted to assess technical, financial, sustainability and environmental criteria of potential heat sources. These criteria include:

- Technology suitability/risk
- Financial performance including key sensitivities
- Availability of financial support
- Availability and sustainability of fuel and security of supply
- CO2 reduction potential
- Cost per tonne of CO2 saved (initial and potential) and other environmental impacts
- Development risk
- Timeframe for deliverability
- Cost savings to Council, customers and developers
- Potential investment leverage including grant funding opportunities

Following a review of technical viability of selected technologies to serve heat demand clusters and combinations of clusters, the specific energy supply options that would be viable for both short term and long term for each specific option was identified.

3.4.3 Plant Sizing and Thermal Storage

For each viable technology supply option, an indicative plant sizing exercise was undertaken to allow the hourly energy outputs from heating and CHP plant and thermal storage to be linked and modelled against the hourly heat and electricity demand profiles developed during the heat mapping stage. The outputs from the plant sizing software include a financial model that outlines savings on energy costs against base case, income from government incentives (taking into account ineligible distribution losses), indicative plant servicing and maintenance costs, alternative fuel costs, cost of parasitic electrical loads and carbon savings.

Following identification of viable technology options, and plant sizing for each initial network option, indicative locations were identified for energy centres were considered and discussed with the client, based on a number of factors including:

- Proximity to largest heat demands within the cluster to minimise heat losses
- Available space for identified technology type, size and ancillary equipment including auxiliary heating plant where required, and thermal storage
- Proximity to utility supplies such as mains cold water, electricity, natural gas and telecommunications (for controls functionality)
- Ground conditions
- Site infrastructure, particularly with regards to road access for fuel deliveries and vehicle manoeuvres
- Consideration of pipe route
- Environmental sensitivity
- Architectural constraints

- Space for additional plant, thermal storage and fuel storage capacity for future development of network

3.4.4 Private Wire Opportunities

In order to determine the potential for electricity supply via a private wire, the consultant team assessed the findings from the energy mapping and plant sizing exercises to identify the electrical demand within the key identified buildings and the anticipated output from a CHP plant within the designated networks. The identified network distribution route was then assessed for suitability to run a private wire alongside (in order to minimise costs). Indicative cable sizing will be undertaken based on supply capacity, length of distribution route and indicative costs sought for electrical connection and metering. The economic and technical advantages of a private wire versus exporting to the grid were then investigated.

3.4.5 High Level Financial Assessment

The high level financial assessment for each network option is presented to assess the financial case for building the entire network option presented. The financial case for extending the network, in isolation, is discussed in the relevant key network risks and considerations sections.

The capital costs for all identified opportunities were investigated and this includes costs for plant and equipment supply and installation, energy centre construction, distribution pipe work supply and installation, trench excavation and re-instatement. Indicative costs were also identified for the necessary integration works within buildings to connect to a district heating network. Network costs were varied in accordance with identified network constraints, e.g. increased connection costs to account for architectural constraints for listed buildings, decreased trenching costs for planned developments.

Energy sale prices for network options are based on a 5 % reduction on current customer tariffs (specific to customer category). Gas and electricity purchase prices for energy centres are derived from current tariffs for the area taken from existing bills and utility company quotes.

Woodfuel costs are derived from previous consultant experience (for self-supply) and current costs from a nearby project (for third party supply).

3.5 Initial Network Options

An assessment of initial network options has been undertaken for potentially viable clusters and technology options identified in sections 3.1 and 3.2. Initial network options were assessed for strategic sites where sufficient development details were available (Gaydon / Lighthorne Heath and Meon Vale / Long Marston Depot). For the remaining strategic sites where sufficient development details were not available, such as Long Marston Airfield, example network assessments can be found in section 3.7. Table 16 summarises the initial network options with the network options taken forward for further consideration shown in orange, networks with less favourable financial viability shown in light grey and options that were not technically viable or not assessed in isolation shown in dark grey.

Table 16: Initial network options

Area	Network option	High level 25 yr IRR -gas CHP	High level 25yr IRR -biomass heat	High level 25yr IRR -biomass CHP	High level 25yr IRR - WSHP	High level 25yr IRR - GSHP
Town Centre	Cluster 22	Not assessed in isolation				
	Cluster 24	Not assessed in isolation due to insufficient space for energy centre				
	Cluster 25	3.2 %	Not technically viable	Not technically viable	-4.4 %	Not technically viable
	Clusters 24 and 25	4.2 %	Not technically viable	Not technically viable	-2.1 %	Not technically viable
	Clusters 22, 24 and 25	3.2 %	Not technically viable	Not technically viable	-5.3 %	Not technically viable
Bridgeway	Cluster 29	8.7 %	-6.2 %	-1.2 %	4.8 %	-1.1 %
Alcester Road	Cluster 12	-3.3 %	No IRR	No IRR	Not technically viable	Not technically viable
	Cluster 14	Not assessed in isolation				
	Cluster 16	5.8 %[8]	No IRR	-0.9 %	Not technically viable	Not technically viable
	Clusters 12 and 14	-1.4 %	No IRR	No IRR	Not technically viable	Not technically viable
	Clusters 14 and 16	8.3 %	No IRR	0.0 %	Not technically viable	Not technically viable
	Clusters 12, 14 and 16	0.9 %	No IRR	No IRR	Not technically viable	Not technically viable
Gaydon Lighthorne Heath village centre		4.6 %	1.5 %	-0.1 %	Not technically viable	3.2 %
Meon Vale / Long Marston Depot		-10.8 %	No IRR	No IRR	Not technically viable	-7.9 %

At this stage it was not possible to conduct a full high level viability assessment for the Canal Quarter development area (clusters 8, 11, 18 and 19) due to the high level nature of planning details that are currently available. However, viability of district energy networks in this area is discussed further in section 3.7.2. Cluster 14 – Briar Croft and The Limes and cluster 22 – Civic Hall and Stratford Police Station consist of 2 buildings, for this reason networks for these clusters in isolation have not been considered, but these clusters have been considered for connection to networks along with adjacent clusters. Cluster 24 - Church Street and Chapel Lane has also not been assessed in isolation as a suitable energy centre location cannot be identified.

Of the remaining Stratford-upon-Avon town clusters, 3 potential network areas have been identified:

- Clusters 22, 24 and 25 (Town centre)
- Cluster 29 (Bridgeway)

[8] Not taken forward as small priority network as viability is improved with connection to cluster 14.

- Clusters 12, 14 and 16 (Alcester Road)

For the Town Centre area, WSHP technologies are less technically and financially viable. This is due to the significant costs incurred to upgrade the heating systems of existing buildings to enable them to meet the requirements for connection to a network served by a heat pump. There are also significant risks associated with this network options including identifying a suitable energy centre location in close proximity to the River Avon as well as flooding risks and planning and development risks relating to the sensitive nature of potential heat pump and collector locations.

Biomass CHP has not been taken forward for further consideration for any site as it has been found to be less financially viable due to the cost of technology (including operation and maintenance) and the cost of woodfuel when compared with gas. Biomass heat has only been considered further for Gaydon / Lighthorne Heath Village Centre in order to show increase or decrease in key parameters required for this network option to become financially viable. This is discussed further in sections 3.7.3 and 4.2.2.

Of the strategic sites, it was only possible to conduct high level financial assessments for initial network options where plans were available showing building locations (i.e. for Gaydon / Lighthorne Heath Village Centre and Meon Vale / Long Marston Depot). The potential viability of installing district energy networks at the other strategic sites (i.e. Long Marston Airfield and SOU. 3 - South of Daventry Road) is discussed further in section 3.7.

Any assessments that do not meet the assumed 5 % Stratford-on-Avon District Council hurdle rate are deemed not to be financially viable. However, network options with marginal financial viability, or specific technologies at Gaydon / Lighthorne Heath village centre, have been taken forward for further consideration in order to identify requirements for these to reach the hurdle rate (e.g. grant funding requirements, increase in heat sales tariffs, decrease in wood fuel costs, etc.).

The priority networks, shown in orange in Table 16, are discussed further in section 3.6. High level financial cases for less favourable network options can be found in Appendix 7 – Financial Viability Assessments.

3.6 Stratford-upon-Avon Town Priority Network Options

Following the initial network assessments, three areas within the Stratford-upon-Avon town heat map area were prioritised to be taken forward for further consideration. These are:

- Town Centre
- Bridgeway
- Alcester Road

For these networks, gas CHP is technically and financially viable for all three network areas. WSHP technologies are also technically and financially viable for the Bridgeway network. These three network areas are discussed in sections 3.6.1, 3.6.2 and 3.6.3 respectively.

3.6.1 Town Centre Network

The Town Centre network is shown in Figure 45 and Table 18. The network connects a number of buildings including those owned by Stratford-on-Avon District Council, privately owned hotels and the Royal Shakespeare and Swan Theatres. A summary of the network is provided in Table 17.

Table 17: Town Centre network summary

No. connections	Trench length	Total heat demand	Peak heat demand	Heat losses	Key heat loads	Time scale
11	0.7 km	6,078 MWh	3.3 MW	5 %	- The Falcon Hotel - Royal Shakespeare Theatre / Swan Theatre	0 - 3 years

Table 18: Town Centre network connections

Map ref.	Name	Ownership	% overall heat demand	% overall private wire demand	Source of energy data
1	Avon Court Care Home	Private sector	7 %	2 %	Benchmarked (CIBSE Guide F)
2	The Falcon Hotel	Private sector	23 %	11 %	Benchmarked (CIBSE Guide F)
3	Elizabeth House	Stratford-on-Avon District Council	10 %	15 %	Actual (annual)
4	Shakespeare Institute	University of Birmingham	<1 %	<1 %	Benchmarked (CIBSE Guide F)
5	Winton House (Register Office)	Stratford-on-Avon District Council	<1 %	<1 %	Actual (monthly Jan 2014 - Dec 2014)
6	Mercure Shakespeare Hotel	Private sector	16 %	7 %	Benchmarked (CIBSE Guide F)
7	Town hall	Stratford-on-Avon District Council	2 %	<1 %	Actual (annual)
8	King Edward VI School	Private sector	11 %	7 %	Actual (annual Jan 2014 – Dec 2014)
9	The Arden Hotel	Private sector[9]	9 %	8 %	Benchmarked (CIBSE Guide F)
10	Royal Shakespeare Company	Royal Shakespeare Company	2 %	<1 %	Benchmarked (CIBSE Guide F)
11	Royal Shakespeare Theatre / Swan Theatre	Royal Shakespeare Company	17 %	47 %	Actual (annual March 2015 - Feb 2016)

[9] The Arden Hotel is owned by the Royal Shakespeare Company but leased to a private organisation which is responsible for the energy supply to the building

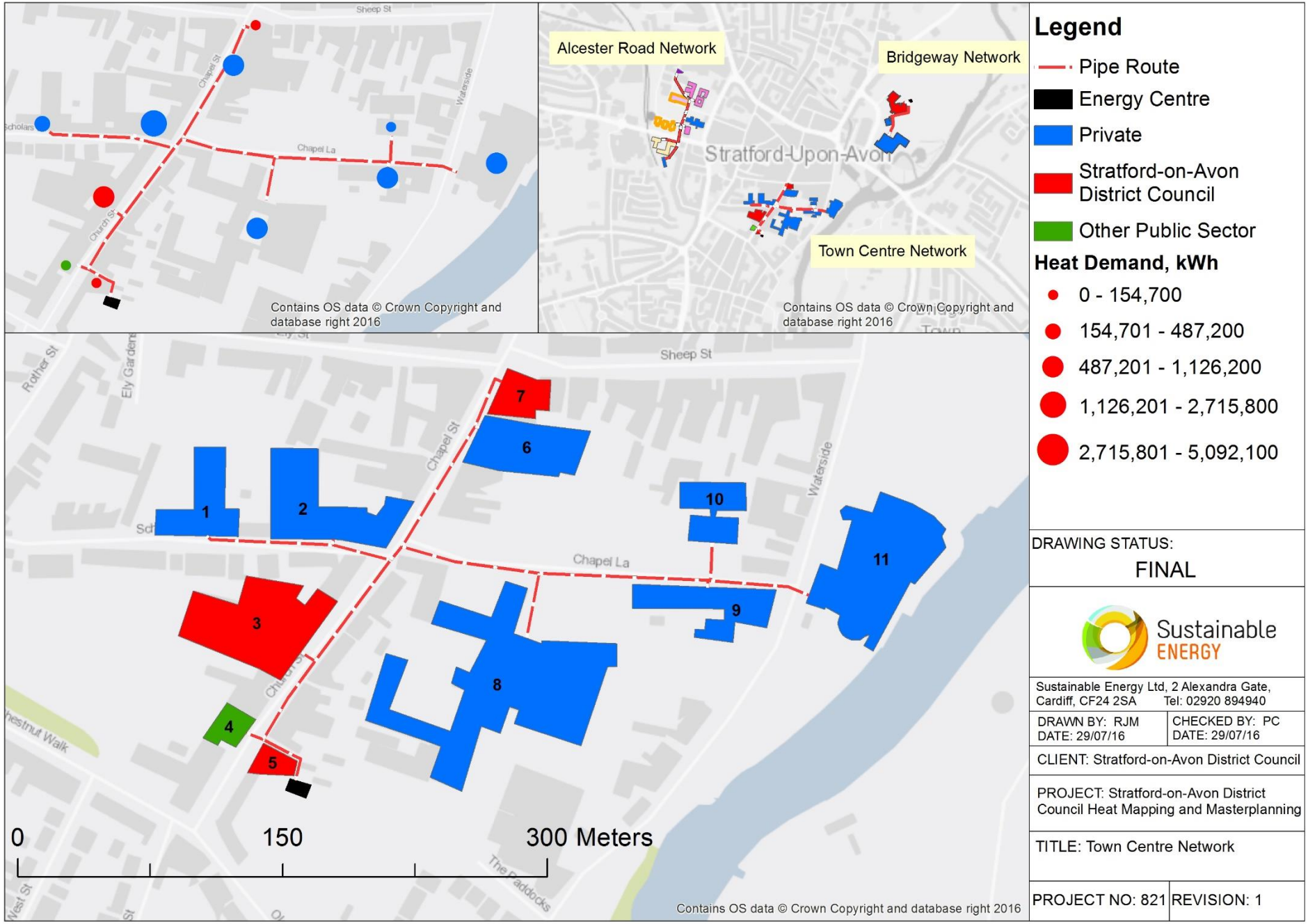


Figure 45: Town Centre network

Heat Demand Categories

Figure 46 categorises the nature and ownership of key heat loads within the network based on the total heat demand. 67 % of the heat demand arises from the private sector and 13 % Stratford-on-Avon District Council. The majority of the heat demand (48 %) arises from hotels (classed as hospitality in Figure 46).

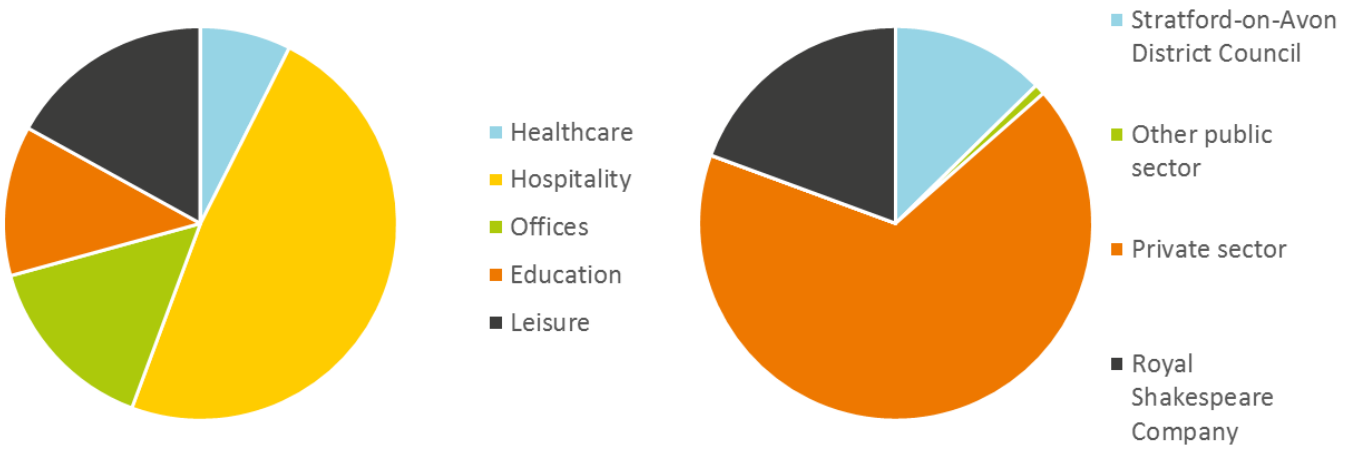


Figure 46: Town Centre network building use and ownership heat demand categories

Hourly Heat Demand Profile

The hourly heat demand profile showing the average, maximum and minimum heat demands for the network over 24 hours is shown in Figure 47. The peak heat demand can be seen as approximately 3.4 MW occurring at 08:00 am. Daily profiles for a winter and summer month are shown in Appendix 6 – Heat Demand Modelling.

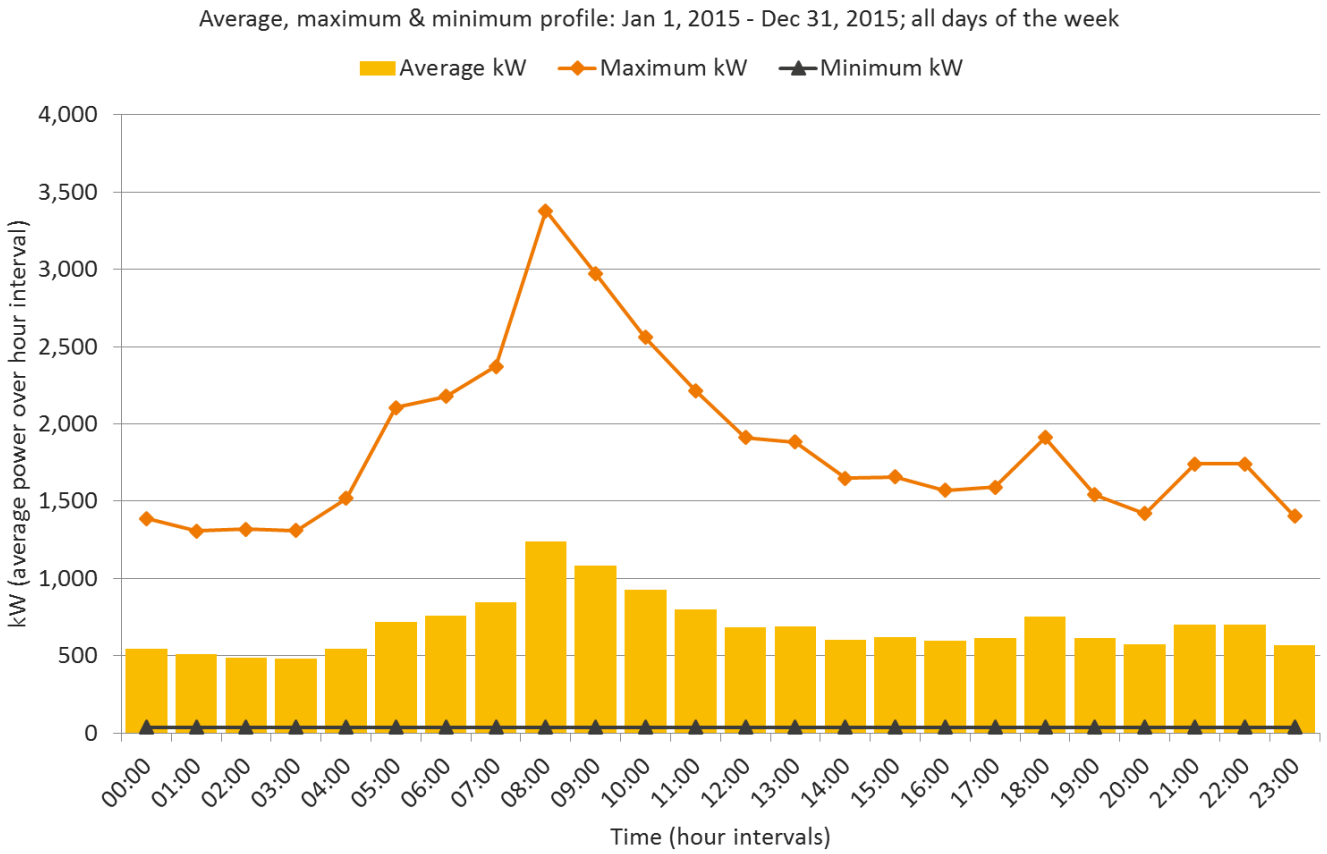


Figure 47: Town Centre network average daily heat demand

Figure 48 shows the hourly network heat demand for every hour of a year ordered from highest to lowest. The orange line shows the maximum output from the gas CHP; the demand above the orange line will be met by the thermal storage and

peak and reserve gas boilers. The gas CHP (with thermal storage) will be able to meet over 70 %[10] of the total network heat demand, including heat losses in the network. This financial case has been modelled with 2 gas CHP units (both single and multiple unit CHP options have been assessed, the most viable option has been presented here). This enables the gas CHP engines to meet a higher proportion of the network heat demand (50 % modulation assumed) and one engine can be turned off at times of low demand. A thermal store size of 75,000 litres has been assumed based on previous project experience and high level thermal store sizing. Thermal store sizing should be reassessed at the feasibility stage.

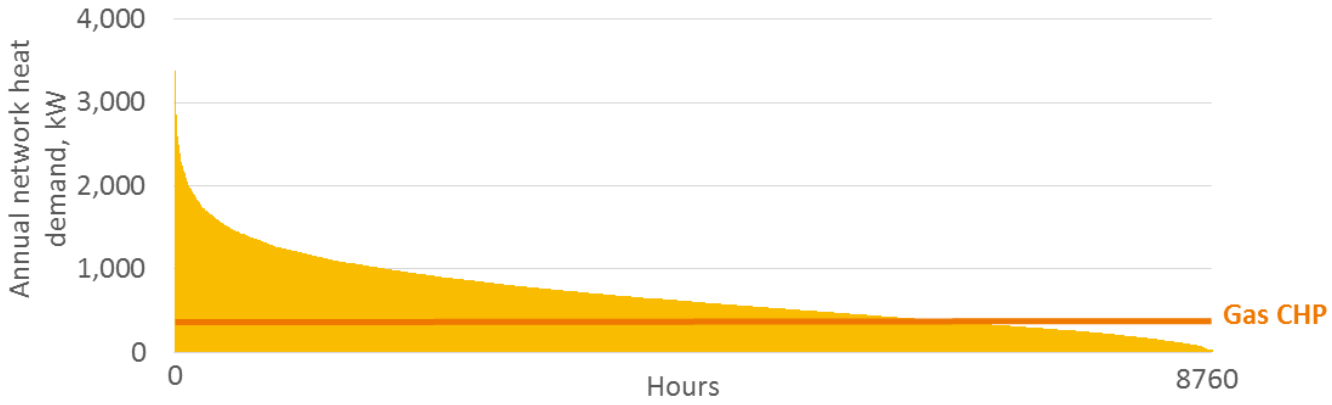


Figure 48: Load duration curve for town centre network

Operating conditions

Operating conditions assume that the network is a LTHW system. As the network is comprised of existing buildings, target network distribution flow temperatures in peak demand periods are likely to be 85 °C and return temperatures may be optimised to a maximum of 55 °C (maintaining ΔT 30 °C), whereas summer demands could be met with reduced flow temperatures of 75 °C and average return temperatures of 45 °C. Design for the system network would be that seasonal heat losses to not exceed 10 % of the sum of the estimated annual heat consumption of all the buildings connected[11].

The buildings considered for connection incorporate calorifiers, some ageing heat distribution plant and AHUs that will impact on the target flow and return temperatures. If this project is progressed to the feasibility stage then detailed plant room and building surveys should be conducted to assess these issues, highlight potential impacts upon network operation and make practical recommendations to minimise potential impacts (such as replacing calorifiers with plate heat exchangers). As buildings are modified to improve efficiency, network temperatures should be lowered.

Energy Centre

An energy centre to accommodate 380 kWth gas CHP (2 units) and 3.3 MW gas fired auxiliary plant would require a land area of over 200 m^2. The energy centre for the Town Centre network has been located in the Stratford-on-Avon District Council owned car park on Chapel Street. This is a busy car park for the Council offices at Elizabeth House with narrow access. This location presents a high risk option however, is the most suitable energy centre location identified within the town centre area (in consultation with the Council).

High Level Financial Appraisal

If the majority of potential heat demands connect to the network then, under the assumptions stated in Table 62 in Appendix 7 – Financial Viability Assessments, there may be a marginal financial case for the network served by gas CHP. The 25 year and 40 year high level financial cases for a CHP are shown in Table 19.

Higher connection costs have been included for listed buildings (all network connections are listed building with the exception of Avon Court Care Home and the Royal Shakespeare Company offices on Chapel Lane). Trench costs have been varied in accordance with digging conditions. For this network they have been increased where the network crossing hard dig conditions. Project management costs have also been increased due to the archaeological sensitivity of the area and due to the potential disruption of town centre traffic that is likely to occur during construction of a network.

[10] CIBSE Heat Networks Code of Practice states that best practice would be for the primary low carbon heat source to deliver 75 to 80% of the annual heat demand

[11] The CIBSE/ADE Heat Networks Code of Practice states that the calculated annual heat loss from the network up to the point of connection to each building when fully built out is typically expected to be less than 10 %

Table 19: 25 and 40 year high level financial cases for the Town Centre network

Financial case period		25 years	40 years
Gas CHP heat output		380 kWth	
Number of units		2	
% network heat demand supplied by gas CHP		>70 %	
Annual electricity generated		2,671 MWh	
% generated electricity sold via private wire[12]		97 %	
Capital expenditure	**Energy source costs**	£831,880	
	Network costs	£1,262,296	
	Contingency	20 %	
	Total	£2,513,011	
IRR		4.2 %	5.2 %
Net present value		£200,154	£767,469
Discounted payback		23.4 years	26.5 years
Annual carbon saving		539 tonnes	

Key Network Risks and Considerations

This network option is likely to be financially viable achieving the hurdle rate required for public sector development and investment (>5 %). However, it is unlikely to achieve the hurdle rate required to be developed by the private sector (>~10 %).

There are risks associated with developing the network including:

- Engagement with public and private sector organisations (largest heat demands include the hotels and theatre)
- Conservation and planning issues relating to the historical nature of the Town and listed buildings on, and in close proximity to, the network
- Securing support, resources and finance to develop the network
- Identifying and agreeing a suitable (preferably Council-owned) land area for an energy centre within close proximity to the network
- The potential disruption caused to the Town Centre by developing the network and energy centre

Until all key heat loads are engaged in the project, and an energy centre location can be agreed, this phase presents a medium to high risk opportunity and is only likely to be viable if developed with a grant, or with a mix of grant funding and public sector borrowing. High level financial case sensitivity and risk for this option are further assessed in Chapter 4.

[12] Percentage of power generated by CHP plant supplied to network via private wire arrangements, the remainder of the power generated is exported to the grid

3.6.2 Bridgeway Network

The Bridgeway network option is shown in Figure 49 and Table 21. A summary of the network is also provided in Table 20. This network is reliant on successful engagement with the Holiday Inn and Council-owned Leisure Centre and could be developed within the next three years. No viable expansion opportunities have been identified.

Table 20: Bridgeway network summary

No. connections	Trench length	Total heat demand	Peak heat demand	Heat losses	Key heat loads	Time scale
3	0.3 km	5,876 MWh	2.3 MW	2 %	- Leisure Centre - Holiday Inn	0-3 years

Table 21: Bridgeway network connections

Map ref.	Name	Ownership	% overall heat demand	% overall private wire demand (for gas CHP option)	Source of energy data
1	Leisure Centre	Stratford-on-Avon District Council	27 %	34 %	Actual (quarterly Jan 2015 – Dec 2015)
2	Bridgeway House	Private Sector	3 %	4 %	Benchmarked
3	Holiday Inn	Private Sector	70 %	62 %	Benchmarked

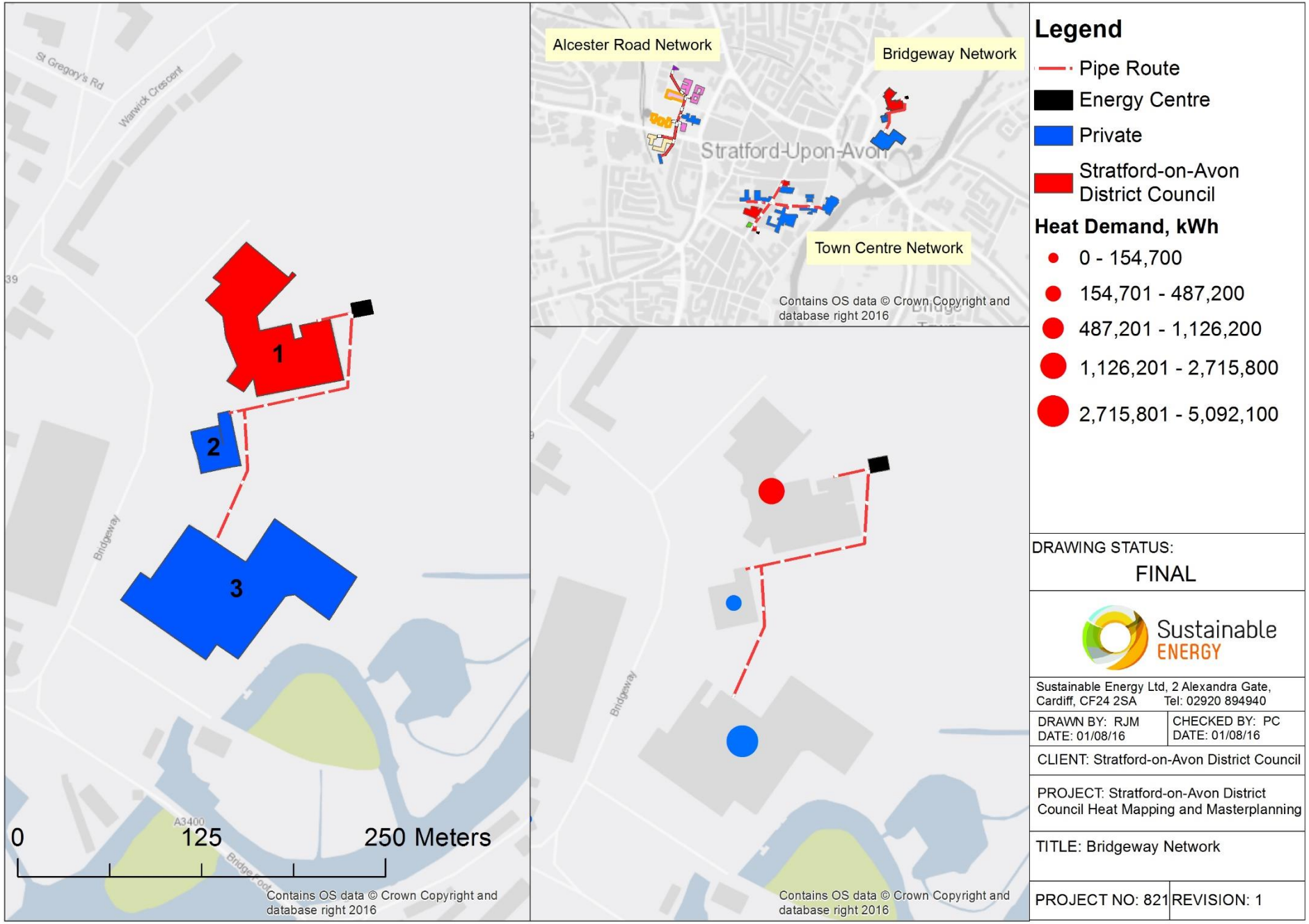


Figure 49: Bridgeway network

Heat Demand Categories

Figure 50 categorises the nature and ownership of heat loads within the network based on the total heat demand. 27 % of the heat demand arises from Stratford-on-Avon District Council buildings with 73 % arising from private sector owned buildings. 3 % of the heat demand arises from offices (Bridgeway House).

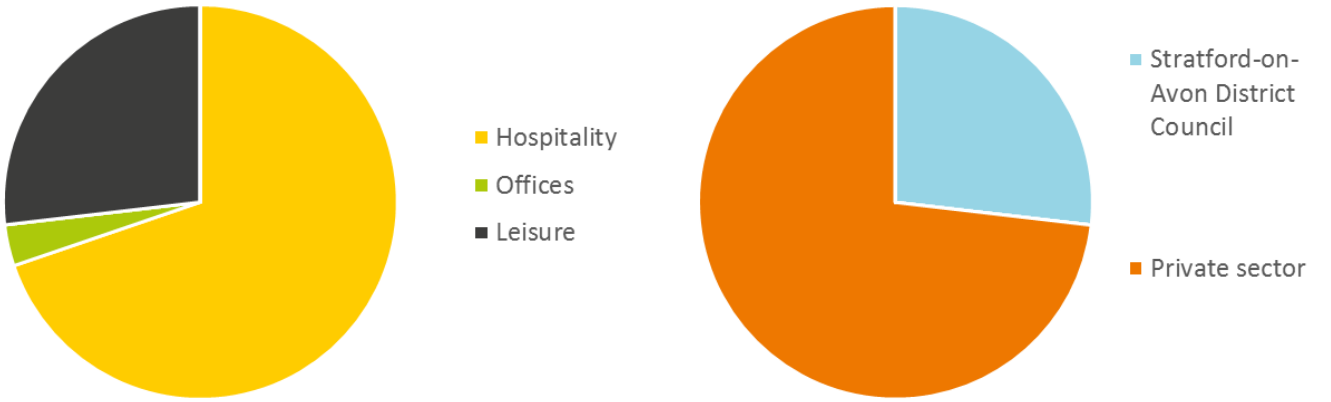


Figure 50: Bridgeway network building use and ownership heat demand categories

Hourly Heat Demand Profile

The hourly heat demand profile showing the average, maximum and minimum heat demands for the network over 24 hours is shown in Figure 51. The peak heat demand can be seen as approximately 2.2 MW occurring at 08:00 am. Daily profiles for a winter and summer month are shown in Appendix 6 – Heat Demand Modelling.

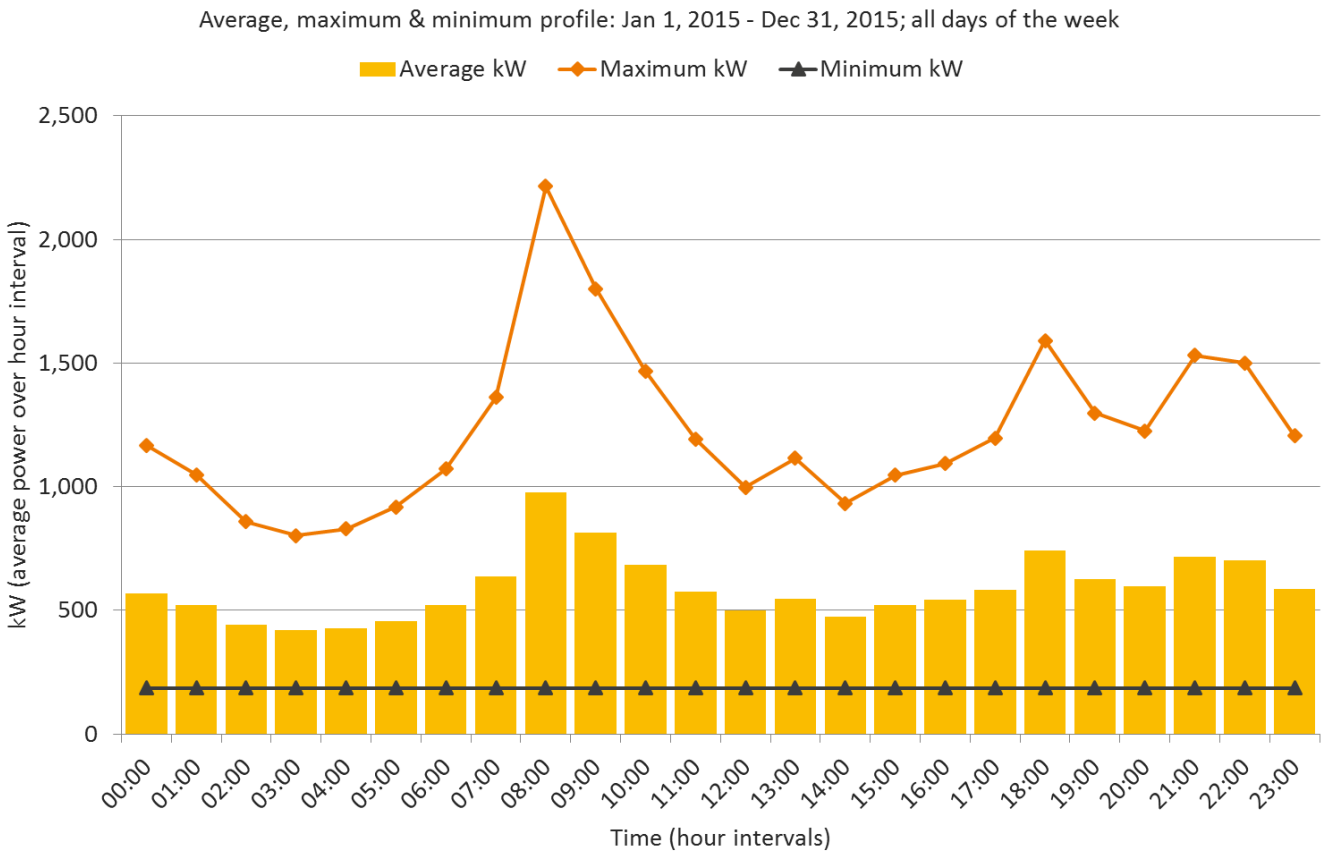


Figure 51: Bridgeway network average daily heat demand

Figure 52 shows the hourly network heat demands for every hour of a year ordered from highest to lowest. The horizontal lines indicate the maximum output from the low carbon generation; the demand above these lines is met by the peak and reserve gas boilers and thermal storage. The gas CHP (with thermal storage) will be able to meet over 75 % of the total network heat demand, including heat losses in the network. This financial case has been modelled with 2 gas CHP units (both

single and multiple unit CHP options have been assessed, the most viable option has been presented here). The WSHPs will be able to meet over 90 % of the total network heat demand, including heat losses in the network. This financial case has been modelled with 2 units. A thermal store size of 50,000 litres has been assumed based on previous project experience and high level thermal store sizing. Thermal store sizing should be reassessed at the feasibility stage.

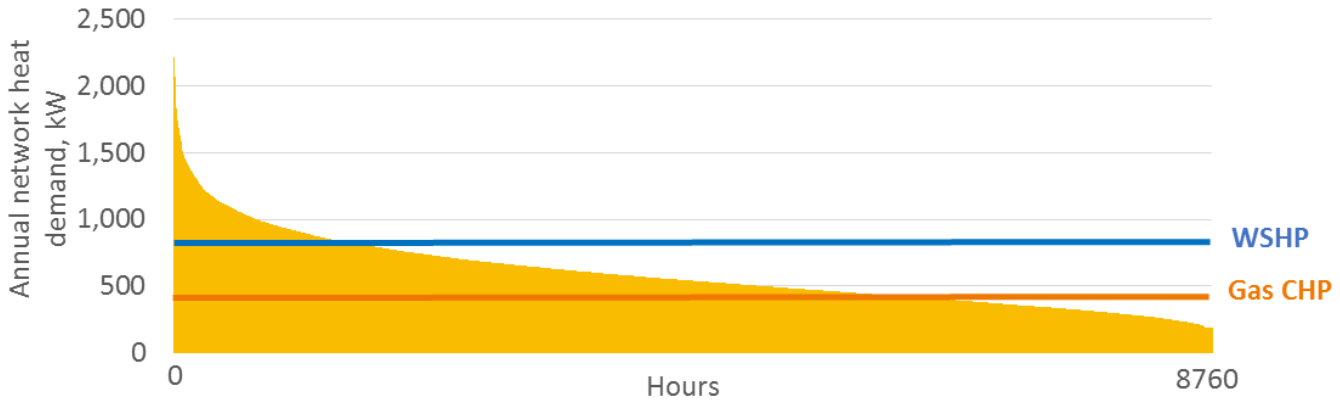


Figure 52: Load duration curve for Bridgeway network

Operating conditions

Operating conditions assume that the network is a LTHW system. As the network is comprised of existing buildings, target network distribution flow temperatures in peak demand periods are likely to be 85 °C and return temperatures may be optimised to a maximum of 55 °C (maintaining ΔT 30 °C), whereas summer demands could be met with reduced flow temperatures of 75 °C and average return temperatures of 45 °C. Design for the system network would be that seasonal heat losses to not exceed 10 % of the sum of the estimated annual heat consumption of all the buildings connected[13].

The buildings considered for connection incorporate calorifiers, some ageing heat distribution plant and AHUs that will impact on the target flow and return temperatures. If this project is progressed to the feasibility stage then detailed plant room and building surveys should be conducted to assess these issues, highlight potential impacts upon network operation and make practical recommendations to minimise potential impacts (such as replacing calorifiers with plate heat exchangers). As buildings are modified to improve efficiency, network temperatures should be lowered.

Energy Centre

An energy centre to accommodate 450 kW gas CHP and 2.2 MW gas fired auxiliary plant would require a land area of over 200 m^2. Early stage assessment of network options and consultation with Stratford-on-Avon District Council indicates that the most appropriate energy centre locations maybe to the north east of the Leisure Centre at the edge of the Leisure Centre car park. For a WSHP, the energy centre would be located closer to the River Avon and would require a land area of approximately 160 m^2.

High Level Financial Appraisal

Under the assumptions stated in Table 62 in Appendix 7 – Financial Viability Assessments, there may be a viable financial case for the network served by gas CHP. The 25 year and 40 year high level financial cases for gas CHP are shown in Table 22.

Trench costs have been varied in accordance with digging conditions. For this network they have been decreased where the network crosses soft dig conditions (the grass area by the energy centre). Project management costs have also been decreased as the majority of the network route is on Council owned land with limited potential disruption. Additional building connection costs have been included for the WSHP option to allow for alterations to existing heating systems to allow for a low temperature network. The WSHP network option includes RHI tariffs proposed for 2017.

[13] The CIBSE/ADE Heat Networks Code of Practice states that the calculated annual heat loss from the network up to the point of connection to each building when fully built out is typically expected to be less than 10 %

Table 22: 25 and 40 year high level financial cases for Bridgeway network – gas CHP

Financial case period		Gas CHP		WSHP	
		25 years	40 years	25 years	40 years
Heat output from low carbon technology		450 kWth		750 kW	
Number of units		2		2	
% network heat demand supplied by low carbon technology		~75 %		~90 %	
Annual electricity generated		3,379 MWh		-	
% generated electricity sold via private wire[14]		64 %		-	
Capital expenditure	**Energy source costs**	£879,150		£1,056,000	
	Network costs	£463,129		£933,613	
	Contingency	20 %		20 %	
	Total	£1,610,735		£2,387,536	
IRR		8.7 %	8.8 %	4.8 %	3.3 %
Net present value		£1,128,115	£1,676,183	£310,168	-£33,020
Discounted payback		13.9 years	15.5 years	18.2 years	20.9 years
Annual carbon saving		621 tonnes		537 tonnes	

Key Network Risks and Considerations

The gas CHP network option is likely to be financially viable achieving the hurdle rate required for public sector development and investment (>5 %). However, it is unlikely to achieve the hurdle rate required to be developed by private sector partners (>~10 %) without significant increases in heat or private wire sales (>10 %).

The small WSHP network option may not be financially viable as it does not achieve the hurdle rate required for public sector development and investment (>5 %) without significant increases in heat sales (>10 %) or RHI (>5 %).

There are risks associated with developing the network including:

- Engagement with public and private sector organisations (largest heat demand is the Holiday Inn)
- Securing support, resources and finance to develop the network
- Identifying and agreeing a suitable land area for an energy centre within close proximity to the network
- The future of the RHI (for the WSHP)

Until the Holiday Inn and Leisure Centre are engaged, and an energy centre location agreed, this phase presents a high risk opportunity and is only likely to be viable if developed with a grant, or with a mix of grant funding and public sector borrowing. High level financial case sensitivity and risk for this option are further assessed in Chapter 4.

[14] Percentage of power generated by CHP plant supplied to network via private wire arrangements

3.6.3 Alcester Road Network

The Alcester Road Network is shown in Figure 53 and Table 24. A summary of the network is provided in Table 23. This network is reliant on successful engagement with South Warwickshire NHS Foundation Trust, Coventry and Warwickshire NHS Foundation Trust and Orbit Heart of England Housing Association and could be developed within the next three years. It is assumed that all buildings apart from Briar Croft and The Limes benefit from private wire arrangements.

Futureproofing measures have been considered however potential network extensions to Stratford College and High School have been found to be less financially viable. There is potential for extension to the Western Road section of the Canal Quarter development, this is discussed in section 3.7.2. Futureproofing measures to allow for connection to the Canal Quarter development have not been included in the financial case presented for the Alcester Road Network due to the high level nature of details currently available for the Canal Quarter development. If this network was to be extended to the Canal Quarter development, a larger energy centre would be required (this could potentially be located adjacent to the hospital energy centre as part of the development site). The Alcester Road network route and pipe sizes would not require futureproofing as a network for the Canal Quarter would be connected straight to the energy centre.

Table 23: Alcester Road network summary

No. connections	Trench length	Total heat demand	Peak heat demand	Heat losses	Key heat loads	Time scale
8	0.6 km	7,078 MWh	2.5 MW	4 %	- Cattle Market extra care apartments - Stratford Hospital Ambulatory Care Centre Development	0 - 3 years

Table 24: Alcester Road network connections

Map ref.	Name	Ownership	% overall heat demand	% overall private wire demand	Source of energy data
1	Stratford Hospital	South Warwickshire NHS Foundation Trust	8 %	2 %	Actual (annual)
2	Stratford Hospital Ambulatory Care Centre planned development	South Warwickshire NHS Foundation	20 %	29 %	Benchmarked, CIBSE Guide F
3	Stratford Healthcare	Coventry and Warwickshire Partnership NHS Trust	13 %	23 %	Benchmarked, CIBSE Guide F
4	The Stratford Hotel	Private Sector	16 %	22 %	Benchmarked CIBSE Guide F
5	Cattle Market extra care apartments planned development	Orbit Heart of England Housing Association	26 %	21 %	Benchmarked CIBSE Guide F
6	Rother House Medical Centre	NHS Trust	2 %	3 %	Benchmarked CIBSE Guide F
7	Briar Croft	Orbit Heart of England Housing Association	10 %	-	Benchmarked CIBSE Guide F
8	The Limes	WCS Care Group	4 %	-	Benchmarked CIBSE Guide F

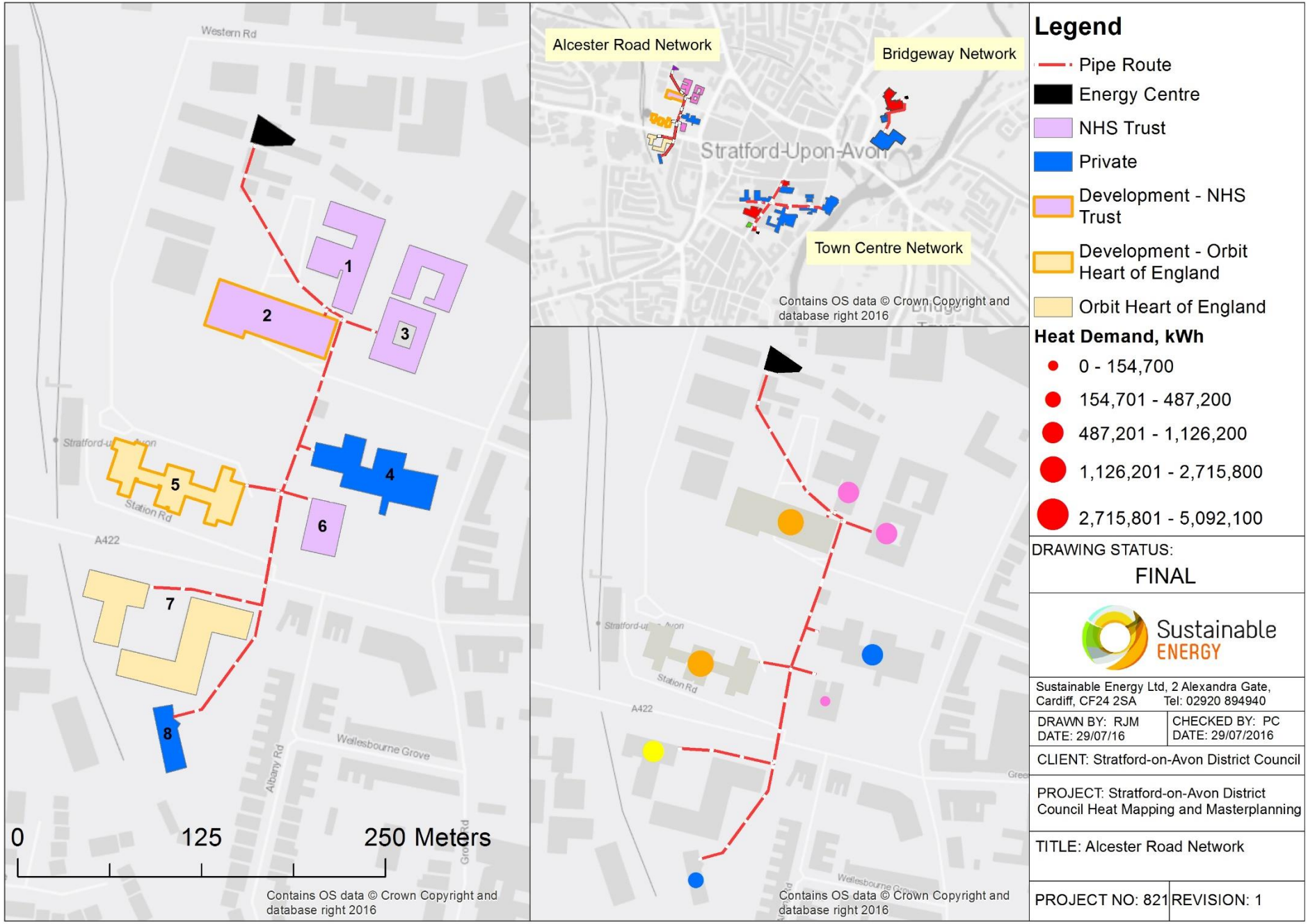


Figure 53: Alcester Road network

Heat Demand Categories

Figure 54 categorises the nature and ownership of key heat loads within the network based on the total heat demand. 47 % of the heat demand arises from planned developments (to be owned by Orbit Heart of England Housing Association and NHS Trust) and 21 % from privately owned buildings. There are no Stratford-on-Avon District Council buildings. The majority of the heat demand arises from healthcare buildings (48 %) and sheltered housing (36 %).

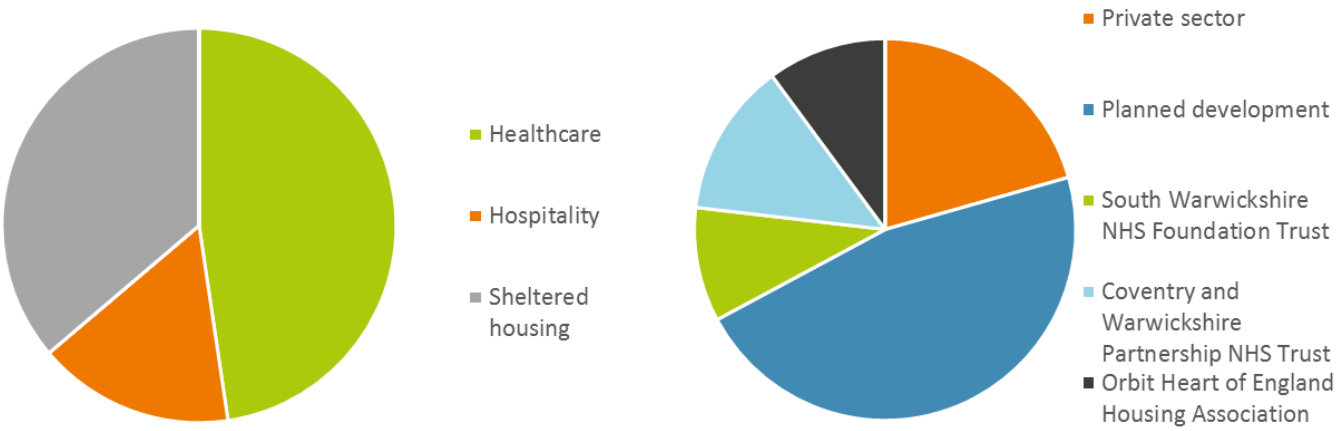


Figure 54: Alcester Road network building use and ownership heat demand categories

Hourly Heat Demand Profile

The hourly heat demand profile showing the average, maximum and minimum heat demands for the network over 24 hours is shown in Figure 55. The peak heat demand is approximately 2.5 MW occurring at 08:00 am. Daily profiles for a winter and summer month are shown in Appendix 6 – Heat Demand Modelling.

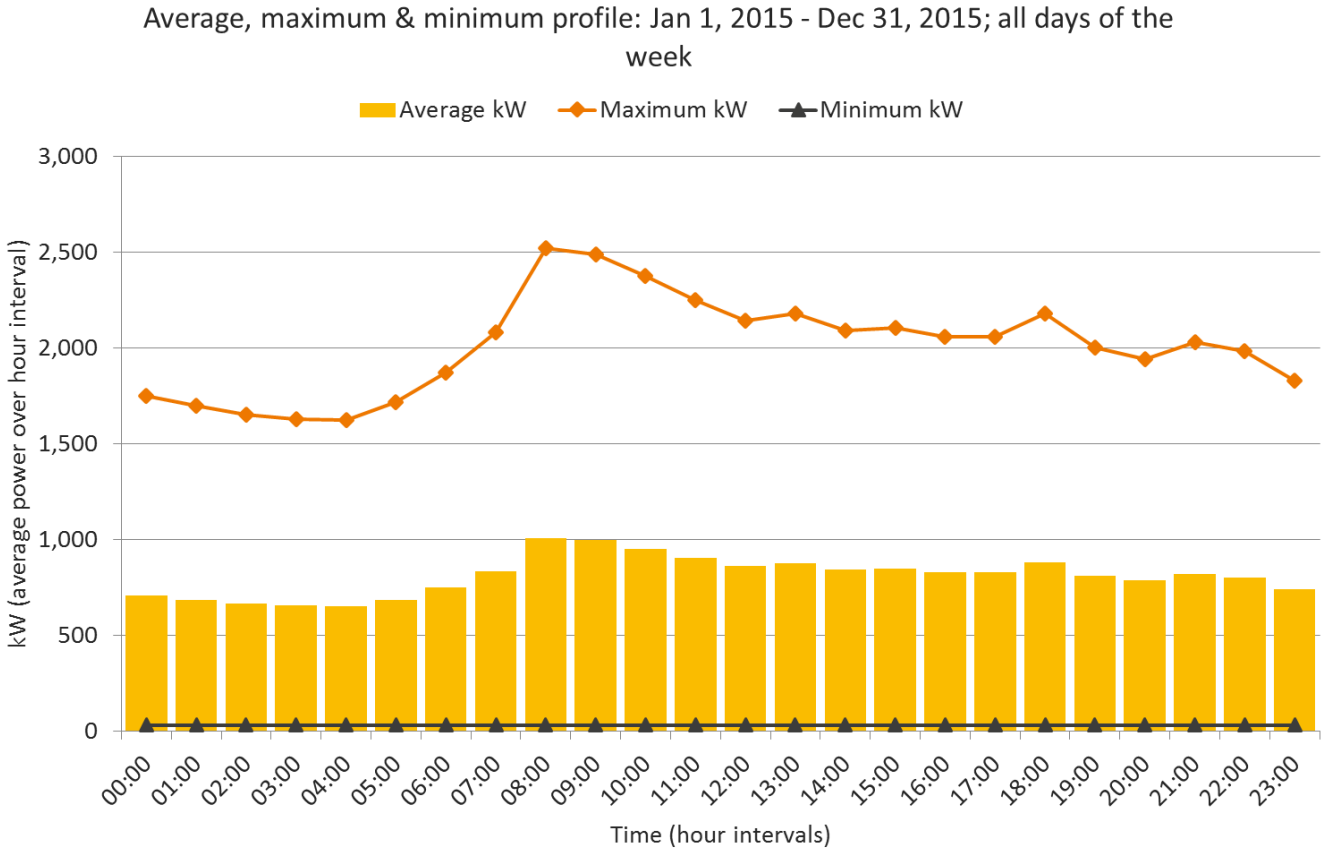


Figure 55: Alcester Road network average daily heat demand

Figure 56 shows the hourly network heat demands for every hour of a year ordered from highest to lowest. The horizontal line indicate the maximum output from the low carbon generation; the demand above the line is met by the peak and reserve gas boilers and thermal storage. The gas CHP (with thermal storage) will be able to meet approximately 75 % of the

total network heat demand, including heat losses in the network. This financial case has been modelled with 2 gas CHP units (both single and multiple unit CHP options have been assessed, the most viable option has been presented here). A thermal store size of 75,000 litres has been assumed based on previous project experience and high level thermal store sizing. Thermal store sizing should be reassessed at the feasibility stage.

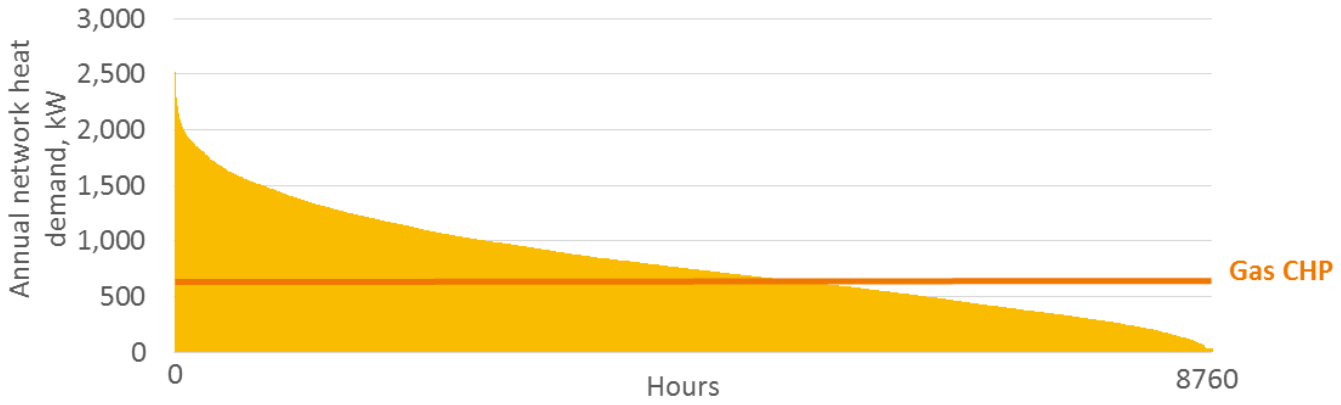


Figure 56: Load duration curve for Alcester Road network

Operating Conditions

Operating conditions assume that the network is a LTHW system. As the network is comprised of existing buildings, target network distribution flow temperatures in peak demand periods are likely to be 85 °C and return temperatures may be optimised to a maximum of 55 °C (maintaining ΔT 30 °C), whereas summer demands could be met with reduced flow temperatures of 75 °C and average return temperatures of 45 °C. Design for the system network would be that seasonal heat losses to not exceed 10 % of the sum of the estimated annual heat consumption of all the buildings connected[15].

The buildings considered for connection incorporate calorifiers, some ageing heat distribution plant and AHUs that will impact on the target flow and return temperatures. If this project is progressed to the feasibility stage then detailed plant room and building surveys should be conducted to assess these issues, highlight potential impacts upon network operation and make practical recommendations to minimise potential impacts (such as replacing calorifiers with plate heat exchangers). As buildings are modified to improve efficiency, network temperatures should be lowered.

Energy Centre

An energy centre to accommodate 650 kW gas CHP and 2.5 MW gas fired peak and reserve plant would require a land area of over 270 m^2. A high level assessment has been undertaken to establish the viability of utilising the recently constructed energy centre at Stratford Hospital and it has been assumed that there is sufficient space to do so. This has been based on detailed plans from the planning application approved in January 2015. Information was not received from Stratford Hospital to confirm available space within the energy centre or whether the hospital would be interested in this. If it was not possible to utilise the hospital energy centre for this network then the most viable alternatives would be either the Canal Quarter development area at Western Road or the Council-owned Arden Street car park, see section 3.3.

High Level Financial Appraisal

If the majority of potential heat demands connect to the network then, under the assumptions stated in Table 62 in Appendix 7 – Financial Viability Assessments, there may be a viable financial case for the network served by gas CHP. The 25 year and 40 year high level financial cases for a CHP are shown in Table 25.

Trench costs have been varied in accordance with digging conditions. For this network they have been decreased where the network crosses the Cattle Market planned development and the hospital land. Project management costs have been increased for the section of the network that crosses Alcester Road. There are no listed buildings on the network. It has been assumed that developer contributions will cover building connection costs for the extra care facility and Stratford Hospital ambulatory care centre planned developments.

[15] The CIBSE/ADE Heat Networks Code of Practice states that the calculated annual heat loss from the network up to the point of connection to each building when fully built out is typically expected to be less than 10 %

Table 25: 25 and 40 year high level financial cases for Alcester Road network

Financial case period		25 years	40 years
Gas CHP heat output		650 kW	
Number of units		2	
% network heat demand supplied by gas CHP		~75 %	
Annual electricity generated		4,254 MWh	
% generated electricity sold via private wire[16]		45 %	
Capital expenditure	**Energy source costs**	£920,950	
	Network costs	£868,309	
	Contingency	20 %	
	Total	£2,147,111	
IRR		8.3 %	8.6 %
Net present value		£1,378,760	£2,162,795
Discounted payback		14.4 years	15.7 years
Annual carbon saving		998 tonnes	

If it is not possible to connect to the Cattle Market extra care apartments, due to the timing of the development as construction is nearing completion, then the 25 year IRR would be reduced to approximately 5 %.

Key Network Risks and Considerations

This network option is likely to be financially viable achieving the hurdle rate required for public sector development and investment (>5 %). However, it is unlikely to achieve the hurdle rate required to be developed by private sector partners (>~10 %) without significant increases in heat or private wire sales (>10 %).

The risks associated with developing the network include:

- Engagement with and between the public and private sector organisations (only the hospital provided energy data for this study)
- Securing support, resources and finance to develop the network
- The potential disruption caused to Alcester Road by developing the network
- Location of energy centre

This phase presents a medium to high risk opportunity and is only likely to be viable if developed with a grant, or with a mix of grant funding and public sector borrowing. High level financial case sensitivity and risk for this option are further assessed in Chapter 4.

[16] Percentage of power generated by CHP plant supplied to network via private wire arrangements, the remainder of the power generated is exported to the grid

3.7 Assessment of Heat Network Priority Areas for Strategic Sites

As extremely high level and limited information is available for the majority of the strategic sites, as discussed with and at the request of the client, the financial assessments for the following network opportunities are included as examples only to inform discussions around the viability of energy networks associated with future developments at specific sites. For Gaydon / Lighthorne Heath village centre, where more detailed development plans are available, a high level network has been undertaken, this is shown in section 3.7.3.

3.7.1 High Level Technology Options Assessment

A summary of the technology options assessment discussed in section 3.2 is shown in Table 26 for the strategic sites.

Table 26: Summary of technology options assessment

Technology	Potentially technically viable?				
	Canal Quarter	Gaydon / Lighthorne Heath	SOU 3 South of Daventry Road	Long Marston Airfield	Meon Vale / Long Marston Depot
Biomass heat	Yes	Yes	Yes	Yes	Yes
Biomass CHP	Yes	Yes	Yes	Yes	Yes
Gas CHP	Yes	Yes	Yes	Yes	Yes
GSHP	Yes	Yes	Yes	Yes	Yes
WSHP	Yes	Yes	Yes	No	No

3.7.2 Canal Quarter

Barriers, Risks and Issues

There are significant barriers to the development of a network to connect all four Canal Quarter development areas (Area 1 – Masons Road, Area 2 – Timothy's Bridge Road, Area 3 – Wharf Road and Area 4 – Western Road) as these are divided by the Stratford-upon-Avon Canal and the Stratford-upon-Avon to Henley-in-Arden railway line. There are two railway bridges crossing the canal to the centre of the Canal Quarter, however these may already be crowded with services. Detailed liaison with Network Rail and the Canal and River Trust would be required. The Canal and River Trust have recently completed a strategic study assessing the potential of utilising waterways and tow paths within district energy networks. If additional railway or canal crossings are incorporated into the development plans then these could be used for a network route to connect the four Canal Quarter development areas.

Technology Options Assessment

Table 26 shows that biomass heat, biofuel CHP, gas CHP, GSHP and WSHP may be technically viable for the Canal Quarter.

Biomass heat and biofuel CHP are more suited to the Masons Road and Timothy's Bridge Road development areas due to space requirements and distance away from the town centre area. There is an existing biomass boiler at Tappex Threads (Masons Road development area) which was installed in 2015. Any spare capacity is currently unknown, however, it has been sized to meet heat requirements for the Tappex Threads buildings.

Gas CHP is also likely to be technically viable for all four of the Canal Quarter development areas, however, there is planned to be a low non-domestic electricity demand within the sites for private wire arrangements therefore reducing the financial viability. There are, however, several large electricity (and potentially cooling) users adjacent to the Canal Quarter development areas such as Premier Inn, McDonalds, Morrisons and Ragdoll Productions.

GSHP technology is also more suited to the north western areas due to space availability. A significant area of land would be required for a horizontal array. Lower network temperatures from a ground source heat pump may not be suitable for existing buildings but may be suitable for safe guarded/future proofed planned developments.

WSHP technology may be technically viable for all four of the Canal Quarter development areas utilising the Stratford-upon-Avon Canal as a water source. Lower network temperatures from a water source heat pump may not be suitable for existing buildings but may be suitable for safe guarded/future proofed planned developments. *It is likely that the highest density of housing will be alongside the Canal which may provide a viable option for a network served by a WSHP.*

There is also potential for a network served by both gas CHP and WSHP/GSHP. The electricity generated by the gas CHP could be used to supply the pumps required for a heat pump. This combination may be viable where there are high heat demands and low potential for private wire arrangements.

Connection to Alcester Road Network (see section 3.6.3)

The Western Road section of the Canal Quarter development area is adjacent to the potential Alcester Road Network as shown in Figure 57. This area of the development is likely to have high density housing with apartments alongside the canal and a range of individual dwellings on the remainder of the site. Although the layout of the development is currently unknown, a high level financial assessment for the Alcester Road network extended to the Western Road Canal Quarter development area has been undertaken. This has been based on the following assumptions for the Western Road area:

- Approximately 200 dwellings (based on an average of 50 dph)
- Average pipe length based on similar nearby developments for a mix of apartments and individual dwellings (160 m trench length per hectare)
- Average pipe sizes to allow for larger pipe size required from energy centre and to apartment buildings and smaller pipe size to individual dwellings
- Developer to cover cost of building connections
- Energy centre located adjacent to Stratford-upon-Avon Hospital energy centre

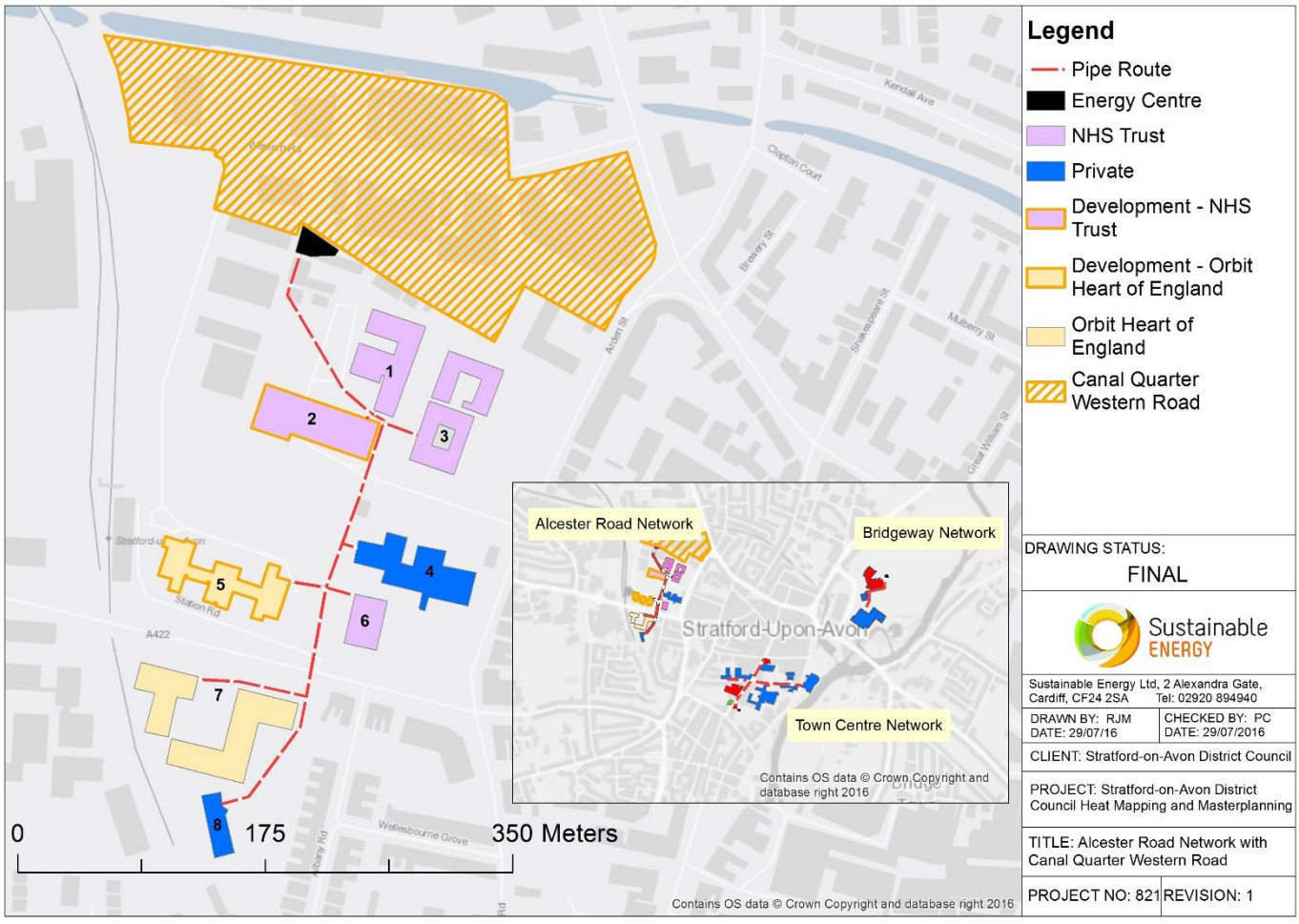


Figure 57: Canal Quarter Western Road and Alcester Road network

A high level summary for a potential extension to the Alcester Road network is shown in Table 27.

Table 27: High level Alcester Road and Canal Quarter Western Road network summary

Estimated trench length	Total heat demand	Peak heat demand	Heat losses	Time scale
1.4 km	9,830 MWh	4.0 MW	6 %	2 - 12 years

An example of a high level financial assessment is shown in Table 28 for a gas CHP.

Table 28: Example of high level financial assessment for extension of Alcester Road network to Western Road

Financial case period		25 years	40 years
Total gas CHP heat output		1 MWth	
% network heat demand supplied by gas CHP		~75 %	
Total electricity generated		5,920 MWh	
% generated electricity sold via private wire[17]		30 %	
Capital expenditure	**Energy source costs**	£1,302,145	
	Network costs	£1,514,101	
	Contingency	20 %	
	Total	£3,379,495	
IRR		7.0 %	7.6 %
Net present value		£1,500,266	£2,545,405
Simple payback		12 years	13 years
Annual carbon saving		1,163 tonnes	

Based on the above assumptions and very high level information available for the development a district heat network served by gas CHP may be financially viable.

Canal Quarter Western Road WSHP

A high level network assessment has been undertaken for the Western Road Canal Quarter area, shown in Figure 57, in isolation served by a WSHP using the Stratford-upon-Avon canal as a water source using the assumptions stated above. A summary for this example network is shown in Table 29.

Table 29: High level Canal Quarter Western Road network summary

Estimated trench length	Total heat demand	Peak heat demand	Heat losses	Time scale
0.6 km	2,663 MWh	1.5 MW	8 %	2 - 12 years

An example of a high level financial assessment is shown in Table 30 for a WSHP.

Table 30: Example of high level financial assessment for Canal Quarter Western Road WSHP

Financial case period		25 years	40 years
Total WSHP heat output		350 kWth	
% network heat demand supplied by WSHP		~80 %	
Capital expenditure	**Energy source costs**	£532,000	
	Network costs	£479,374	
	Contingency	20 %	
	Total	£2,070,510	
IRR		5.3 %	4.4 %
Net present value		£219,581	£122,136
Simple payback		13 years	14 years
Annual carbon saving		212 tonnes	

Based on the above assumptions and very high level information available for the development a district heat network served by WSHP may be financially viable.

3.7.3 Gaydon / Lighthorne Heath

As more detailed development plans are currently available for the village centre area, a high level financial assessment has been undertaken for this site. The remainder of this development site has been found to have a lower area heat density and will require a significant increase in pipe length to connect individual dwellings. The residential developments are therefore likely to be less financially viable than the village centre area. An example network is shown below to show the potential viability for an extension to the village centre network to the southern residential development area.

[17] Percentage of power generated by CHP plant supplied to network via private wire arrangements, the remainder of the power generated is exported to the grid

Technology Options Assessment
Table 26 shows that biomass heat, biofuel CHP, gas CHP, GSHP and WSHP may be viable technologies for the Gaydon / Lighthorne Heath development area.

Biomass heat and biomass CHP are suited to the out of town location and are likely to be suitable away from residential areas.

Gas CHP may be technically viable for entire site, however, there is a low non-domestic electricity demand within the site away from the village centre area for private wire arrangements therefore reducing the financial viability. There may, however, be the potential to supply electricity to Aston Martin or Jaguar Land Rover whose buildings lie adjacent to the Gaydon / Lighthorne Heath site and if engagement with these organisations can be achieved this should be discussed further.

GSHP technologies may be technically viable for the entire site, were sufficient space for a horizontal array or boreholes can be located. The school playing fields to the north of the village centre may provide a suitable site for this. Lower network temperatures from a GSHP may not be suitable for existing buildings but may be suitable for safe guarded/future proofed planned developments. The large ponds to the south of the development site may be a suitable water source for a WSHP of limited capacity.

There is also potential for a network served by both gas CHP and WSHP/GSHP. The electricity generated by the gas CHP could be used to supply the electricity required for a heat pump. This combination may be viable where there are high heat demands and low potential for private wire arrangements.

Gaydon / Lighthorne Heath Village Centre Network
This network is reliant on successful engagement with the site developers and could be developed within 2 to 10 years as the development is brought forward. It is assumed that all non-domestic buildings within the Village Centre benefit from private wire arrangements.

Futureproofing measures have not been included in this high level financial assessment. Extension of this network to include the southern residential development area is discussed in section 3.7.3. Heat losses do not exceed 10 % of the sum of the estimated annual heat consumption of all the buildings connected[18].

Table 31: Gaydon / Lighthorne Heath village centre network summary

No. connections	Trench length	Total heat demand	Peak heat demand	Heat losses	Key heat loads	Time scale
22	1 km	6,152 MWh	2.8 MW	6 %	- Elderly Care Housing 1 - Elderly Care Housing 2	2-10 years

[18] The CIBSE/ADE Heat Networks Code of Practice states that the calculated annual heat loss from the network up to the point of connection to each building when fully built out is typically expected to be less than 10 %

Table 32: Gaydon / Lighthorne Heath village centre network connections

Map ref.	Name	% overall heat demand	% overall private wire demand
1	Elderly Care Housing Development 1	17 %	22 %
2	Elderly Care Housing Development 2	19 %	25 %
3	Residential Development 1	3 %	-
4	Health Development	1 %	4 %
5	Primary School Development	6 %	9 %
6	Community Development	<1 %	1 %
7	Retail Development 2	1 %	2 %
8	Residential Development 2	2 %	-
9	Residential Development 3	3 %	-
10	Residential Development 4	7 %	-
11	Residential Development 6	2 %	-
12	Residential Development 5	<1 %	-
13	Retail Development 1	3 %	9 %
14	Residential Development 8	4 %	-
15	Residential Development 7	2 %	-
16	Retail Development 3	10 %	27 %
17	Residential Development 9	4 %	-
18	Residential Development 10	2 %	-
19	Residential Development 11	3 %	-
20	Residential Development 12	3 %	-
21	Residential Development 13	2 %	-
22	Residential Development 14	4 %	-

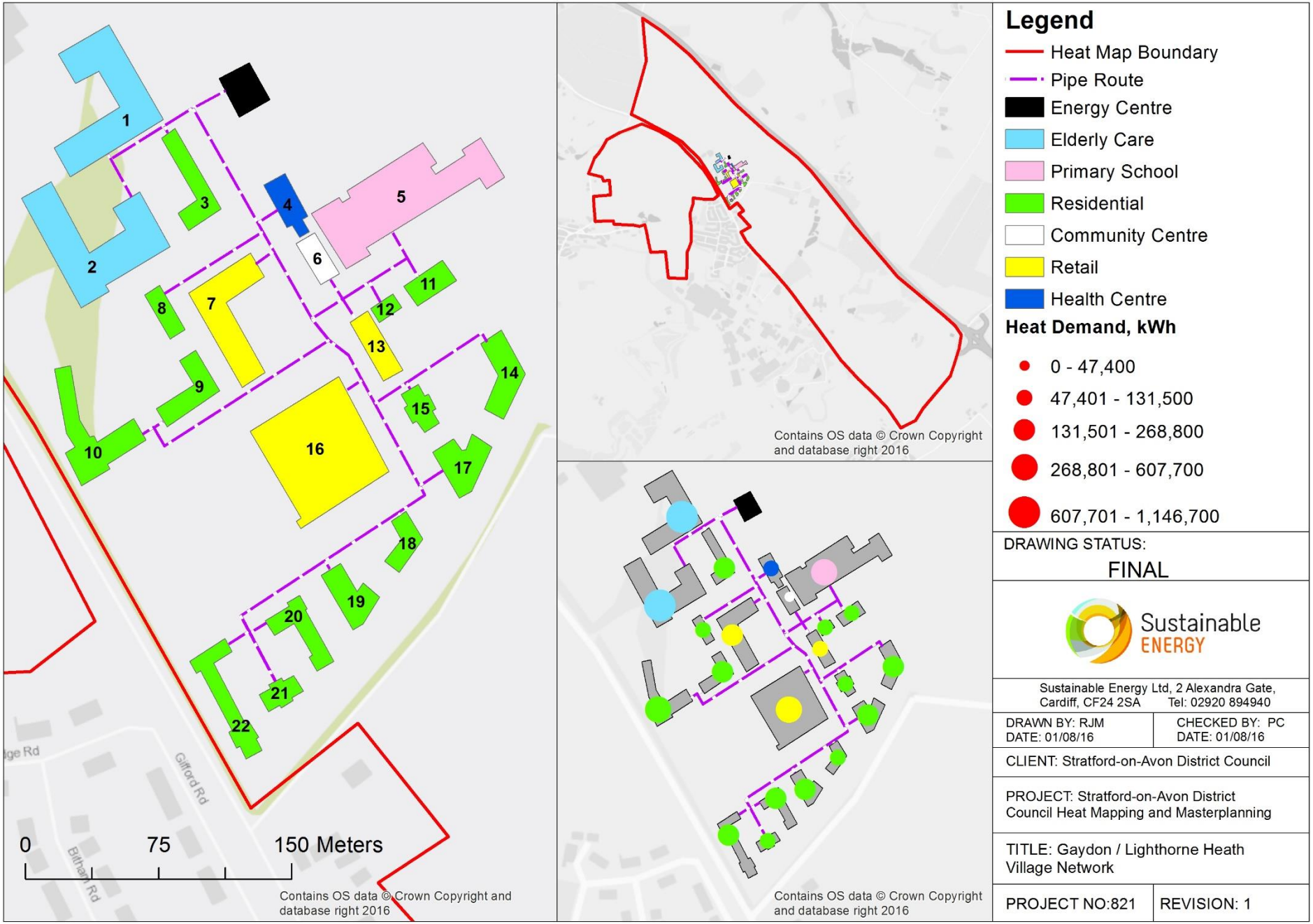


Figure 58: Gaydon / Lighthorne Heath village centre network

Heat Demand Categories

Figure 59 categorises the building use of key heat loads within the network based on the total heat demand. All buildings are planned developments, therefore the ownership of buildings once developed is currently unknown. The majority of the heat demand arises from low density residential buildings (42 %) and sheltered housing (35 %).

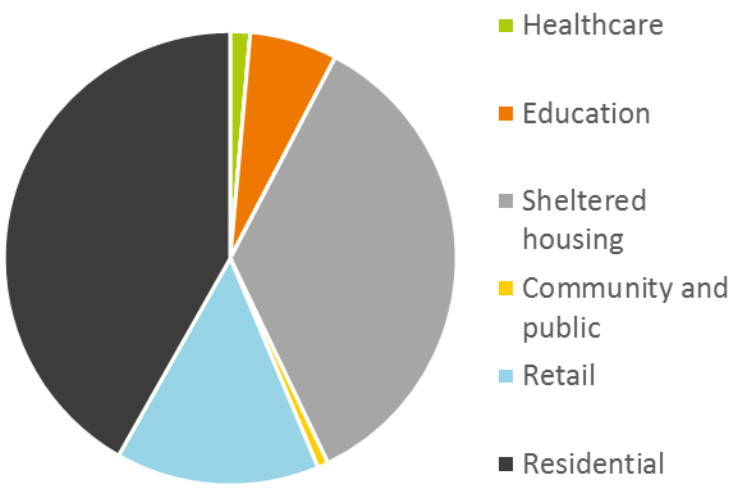


Figure 59: Gaydon / Lighthorne Heath village centre network building use heat demand categories

Hourly Heat Demand Profile

The hourly heat demand profile showing the average, maximum and minimum heat demands for the network over 24 hours is shown in Figure 60. The peak heat demand can be seen as approximately 2.8 MW occurring at 08:00 am. Daily profiles for a winter and summer month are shown in Appendix 6 – Heat Demand Modelling.

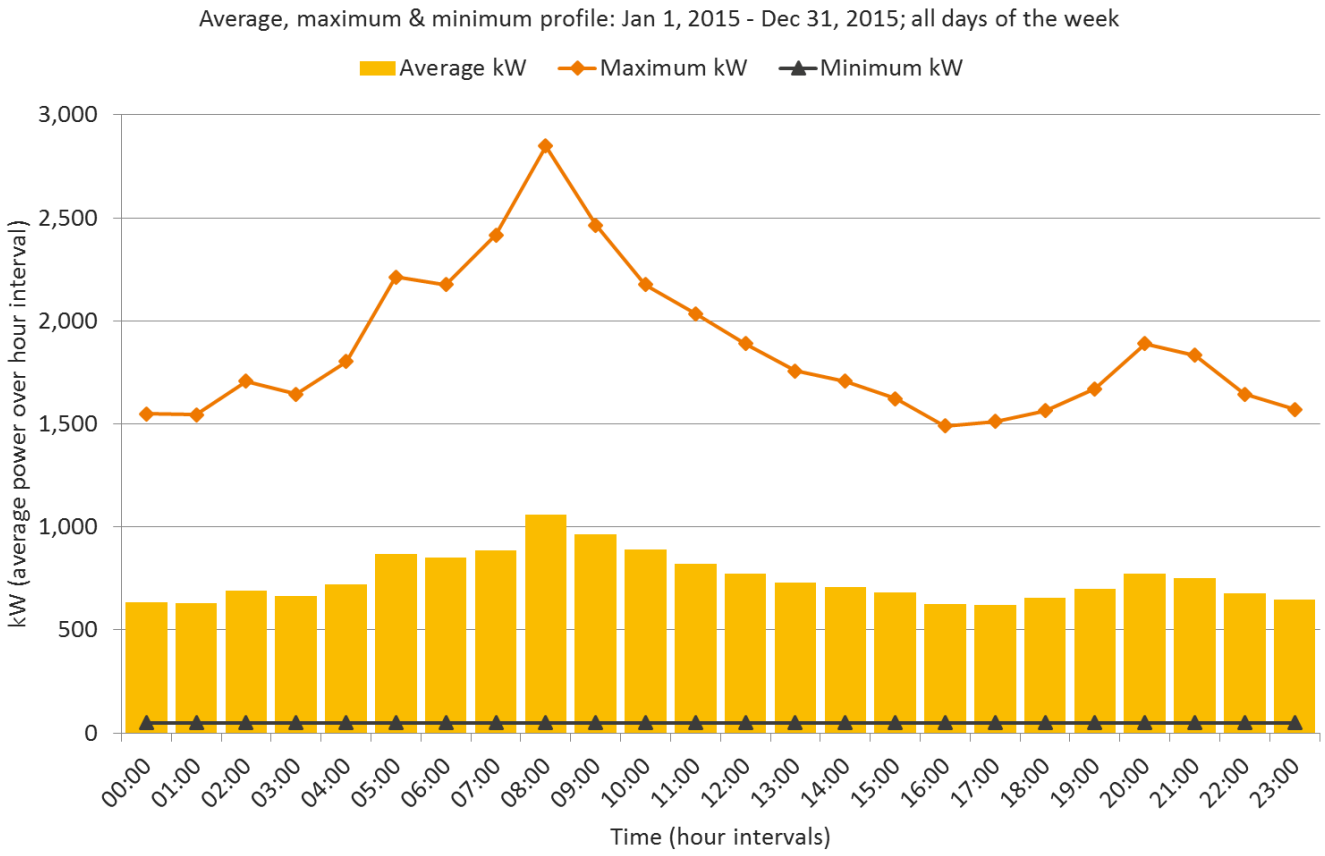


Figure 60: Gaydon / Lighthorne Heath village centre network average daily heat demand

Figure 61 shows the hourly network heat demands for every hour of a year ordered from highest to lowest. The horizontal line indicate the maximum output from the low carbon generation; the demand above the line is met by the peak and reserve gas boilers and thermal storage. The gas CHP (with thermal storage) will be able to meet approximately 75 % of the total network heat demand, including heat losses in the network. This financial case has been modelled with 2 gas CHP units (both single and multiple unit CHP options have been assessed, the most viable option has been presented here). The biomass boiler will be able to meet approximately 70 % of the network heat demand and approximately 85 % could be met by the GSHP. A thermal store size of 50,000 litres has been assumed based on previous project experience and high level thermal store sizing. Thermal store sizing should be reassessed at the feasibility stage.

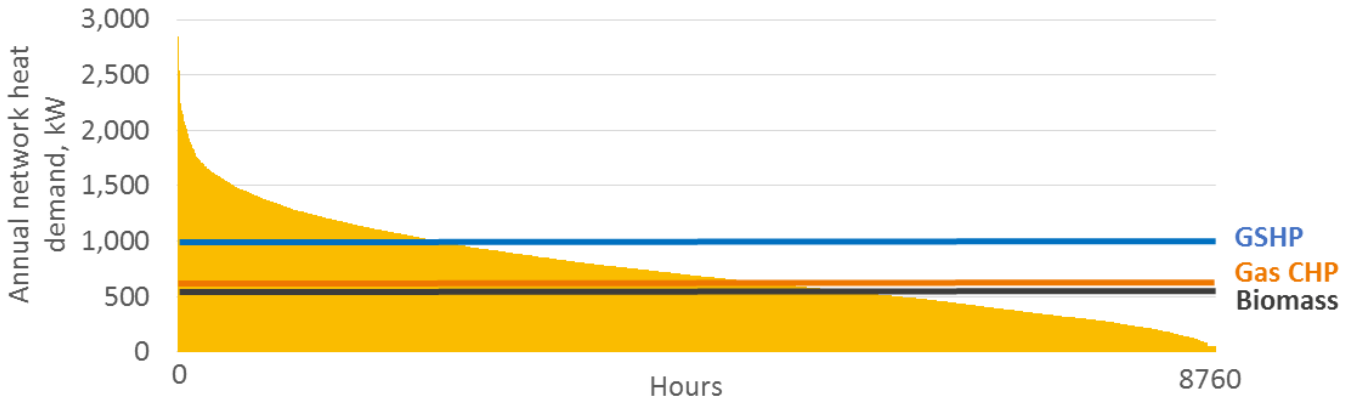


Figure 61: Load duration curve for Gaydon / Lighthorne Heath village centre network

Operating Conditions

Operating conditions assume that the network is a LTHW system. As the network includes connection to planned developments, target network distribution flow temperatures are likely to be 70 °C and return temperatures may be optimised to a maximum of 40 °C (maintaining ΔT 30 °C).

Energy Centre

An energy centre to accommodate 580 kW gas CHP and 2.8 MW gas fired peak and reserve plant would require a land area of approximately 250 m^2. It has been assumed that an energy centre could be located in close proximity to the village centre in order to minimise pipe length. A significantly larger area of land (1,200 m^2) would be required for the biomass boiler, this includes land for the energy centre as well as space requirements for wood fuel deliveries and storage. An energy centre to accommodate 1 MW GSHP and 2.8 MW gas fired peak and reserve plant would require a land area of approximately 200 m^2. In addition to this, a significant area of land would be required for boreholes, these could be positioned under the near the primary school playing fields adjacent to the energy centre location shown in Figure 58.

High Level Financial Appraisal

If the majority of potential heat demands connect to the network then, under the assumptions stated in Table 62 in Appendix 7 – Financial Viability Assessments, there may be a marginal financial case for the network served by gas CHP or GSHP. The 25 year and 40 year high level financial cases are shown in Table 33.

Trench costs have been varied in accordance with digging conditions. For this network they have been decreased due to soft dig conditions with the assumption that a network could be constructed at the same time as the development is built out. Project management costs have also been decreased as there are no listed buildings, busy roads or other key network constraints. It has been assumed that developer contributions will cover building connection costs.

Table 33: 25 and 40 year high level financial cases for Gaydon / Lighthorne Heath village centre network

Financial case period		Gas CHP		Biomass heat		GSHP	
		25 years	40 years	25 years	40 years	25 years	40 years
Heat output from low carbon technology		580 kWth		550 kW		1,000 kW	
Number of units		2		1		2	
% network heat demand supplied by low carbon technology		~75 %		~70 %		~85 %	
Annual electricity generated		4,123 MWh		-		-	
% generated electricity sold via private wire[19]		26 %		-		-	
Capital expenditure	**Energy source costs**	£1,029,880		£800,000		£2,322,583	
	Network costs	£979,303		£768,831		£768,831	
	Contingency	20 %		20 %		20 %	
	Total	£2,411,020		£1,882,598		£3,709,697	
IRR		4.6 %	5.8 %	1.5 %	0.3 %	3.2 %	0.7 %
Net present value		£319,307	£1,006,168	-£342,329	-£549,491	-£121,985	-£859,939
Discounted payback		22.0 years	23.8 years	>25 years	>40 years	>25 years	>40 years
Annual carbon saving		923 tonnes		876 tonnes		598 tonnes	

Key Network Risks and Considerations

The CHP network option is likely to be financially viable achieving the hurdle rate required for public sector development and investment (>5 %). It does not achieve the hurdle rate required to be developed by private sector partners (>~10 %) even with significantly increased heat and private wire sales and or connection charges.

The risks associated with developing this network include:

- Engagement with developers
- The planned development not being brought forward or being developed by a party not engaged in process
- The plans for the development are currently at a high level and may change
- Securing support, resources and finance to develop the network

This network presents a high risk opportunity and is only likely to be viable if developed with a grant, or with a mix of grant funding and public sector borrowing. High level financial case sensitivity and risk for this option are further assessed in Chapter 4.

Potential Extension to Village Centre Network

Although the exact location of buildings within the development is currently unknown, an example financial assessment for the village centre network extended to the residential developments of village core north, village core south and Lakeside has been undertaken. This has been based on the following assumptions for the village core north, village core south and Lakeside area:

- Approximately 1,240 dwellings (based on an average of 35, 40 and 45 dph for village core north, village core south and Lakeside respectively)
- Average pipe length based on potential road locations in high level development plan (268 m trench per hectare)
- Average pipe size to allow for larger pipe size required from energy centre and smaller pipe size to individual dwellings
- Developer to cover cost of building connections
- Energy centre located adjacent to primary school in village centre

An example summary for the village centre network extended to the southern residential development is shown in Table 34.

Table 34: Example of Gaydon / Lighthorne Heath village centre network extension summary

Estimated trench length	Total heat demand	Peak heat demand	Heat losses	Time scale
8.2 km	24,747 MWh	12.6 MW	11 %	0 – 12 years

[19] Percentage of power generated by CHP plant supplied to network via private wire arrangements, the remainder of the power generated is exported to the grid

The example financial assessment is shown in Table 35 for a gas CHP.

Table 35: Example financial assessment for Gaydon / Lighthorne Heath village centre network extension

Financial case period		25 years	40 years
Total gas CHP heat output		2.7 MWth	
% network heat demand supplied by gas CHP		~75 %	
Total electricity generated		16,197 MWh	
% generated electricity sold via private wire[20]		6 %	
Capital expenditure	**Energy source costs**	£3,208,676	
	Network costs	£5,552,456	
	Contingency	20 %	
	Total	£10,513,358	
IRR		-0.2 %	1.6 %
Net present value		-£3,787,986	-£2,924,631
Simple payback		>25 years	30 years
Annual carbon saving		2,998 tonnes	

This example network may have potential to become financially viable if significant grant funding and / or change in key parameters can be secured. The requirements for this example network to become financially viable are discussed in section 4.2.4.

Connecting to Adjacent Manufacturing Sites

As stated, the viability of a network in this area is likely to be significantly increased if Jaguar Land Rover and/or Aston Martin Lagonda were to become key network anchor loads and / or private wire customers. Both companies have been approached to discuss network opportunities however, neither expressed interest (nor engaged with the study process). There is a significant area of development land owned by these private sector companies, at this stage no development plans have been made available. Anecdotal evidence suggests that Jaguar Land Rover are developing an energy strategy for the site and this is likely to be focussed on increasing electrical capacity; heat from arising from electrical generation could supply a large heat network at the site offering significant benefits to the company. This should be reassessed at the feasibility stage or once further information is available.

3.7.4 Meon Vale / Long Marston Depot

As shown in Table 16, an initial network assessment indicated a high level 25 year IRR of -10.8 %.

3.7.5 SOU. 3 – South of Daventry Road

The SOU. 3 - South of Daventry Road development site has a significantly lower area heat density than the other strategic sites considered in this study. There is also a significantly lower electricity demand within the site which reduces the viability of CHP due to limited private wire opportunities. It is unlikely that a network would be technically or financially viable unless the housing density of the development increased significantly.

3.7.6 Long Marston Airfield

The development site at Long Marston Airfield has a lower area heat density than the residential areas of the Gaydon / Lighthorne Heath site, where a network may be potentially viable with grant funding, but a higher area heat density than Meon Vale and SOU. 3, where it is unlikely that a heat network will be financially viable.

The plans currently available for this site are of a high level nature and do not show sufficient detail to calculate the energy demands for individual buildings or to plot potential network routes. There is however, potential for this development site to be built out with a similar layout to that shown in development plans for the Meon Vale site (due to similarities in the mix of domestic and non-domestic buildings). As an example network for this development site, the Meon Vale heat network (average pipe size and trench length per hectare) has been used to develop a high level financial assessment in order to give an indication of potential financial viability.

[20] Percentage of power generated by gas CHP plant supplied to network via private wire arrangements, the remainder of the power generated is exported to the grid

Technology Options Assessment
Table 26 shows that biomass heat, biofuel CHP, gas CHP and GSHP may be technically viable technologies for the Long Marston Airfield development area.

Biomass heat and biomass CHP are suited to the out of town location and are likely to be suitable away from high density residential areas.

Gas CHP is likely to be technically, however, it should be located near areas of non-domestic electricity demand (retail, employment and education areas) in order to maximise private wire arrangements.

GSHP technologies are likely to be technically viable for the entire site, were sufficient space for a horizontal array or boreholes can be found within development plans. The central green, school playing fields or green corridors may provide a suitable site for this. Lower network temperatures from a GSHP may not be suitable for existing buildings but may be suitable for safe guarded/future proofed planned developments.

There is also potential for a network served by both gas CHP and GSHP. The electricity generated by the gas CHP could be used to supply the pumps required for a heat pump. This combination may be viable where there are high heat demands and low potential for private wire arrangements.

Trench costs have been varied in accordance with digging conditions. For this network they have been decreased due to soft dig conditions with the assumption that a network could be constructed at the same time as the development is built out. Project management costs have also been decreased as there are no listed buildings, busy roads or other key network constraints. It has been assumed that developer contributions will cover building connection costs.

Long Marston Airfield Example Network
The exact location and energy demands of individual buildings is currently unknown due to the high level development plans that are currently available. An example financial assessment has been undertaken for a section of this site based on the Meon Vale network assessed for the initial network options assessment in section 3.5.

This is shown in Table 36 and has been based on the following assumptions:

- An increased area heat density (from 0.042 MWh/m^2 for Meon Vale to 0.048 MWh/m^2 for Long Marston Airfield)
- Average pipe length based on Meon Vale network route (248 m trench per hectare)
- Average pipe size to allow for larger pipe size required from energy centre and smaller pipe size to individual dwellings
- Developer to cover cost of building connections
- Energy centre located near the centre of the network (to minimise pipe lengths and sizes)
- Electricity generated sold via private wire arrangements to educational, retail and employment buildings

Table 36: Example financial assessment for gas CHP at Long Marston Airfield

Financial case period		25 years	40 years
Total gas CHP heat output		400 kWth	
% network heat demand supplied by gas CHP		~60%	
Total electricity generated		2,148	
% generated electricity sold via private wire[21]		~60 %	
Capital expenditure	**Energy source costs**	£339,080	
	Network costs	£2,337,714	
	Contingency	20 %	
	Total	£3,212,153	
IRR		-1.7 %	0.9 %
Net present value		-£1,564,531	-£1,182,362
Simple payback		>25 years	34 years
Annual carbon saving		316 tonnes	

This example network may have potential to become financially viable if significant grant funding and / or change in key parameters can be secured. The requirements for this example network to become financially viable are discussed in section 4.2.4.

[21] Percentage of power generated by CHP plant supplied to network via private wire arrangements, the remainder of the power generated is exported to the grid

3.8 Summary

A summary of the network options assessed is shown in Table 37. Three priority networks have been identified within the Town Centre area, namely:

- The Town Centre Network - connecting a number of buildings including those owned by Stratford-on-Avon District Council, privately owned hotels and the Royal Shakespeare and Swan Theatres
- The Bridgeway Network – connecting Bridgeway House, Holiday Inn and the Council-owned Leisure Centre
- The Alcester Road Network – connecting the Hospital (South Warwickshire NHS Foundation Trust), Coventry and Warwickshire NHS Foundation Trust and Orbit Heart of England Housing Association buildings, the Stratford Hotel and The Limes (private care home).

Two district heating priority areas have been identified at the strategic sites, namely:

- The Canal Quarter
- Gaydon / Lighthorne Heath village centre

However, if development plans change to increase building density or heat demand at the strategic sites then this should be reassessed. For example: If Jaguar Land Rover engage with the project and reveal energy generation plans then the extent of the district heating priority area at Gaydon / Lighthorne Heath should be re-evaluated (to potentially increase in size); or if the industrial units (likely to be replaced) at Meon Vale / Long Marston Depot are rebuilt to accommodate more energy intensive businesses.

There may also be a network opportunity at Long Marston Airfield, however, this is likely to require significant grant funding to be financially viable. This development is of strategic importance to Stratford-on-Avon District Council due to a current Garden Village Funding bid for this site.

Sensitivity analysis for network options can be found in section 4.2. The associated risks and approach to engaging with developers are further assessed in sections 4.2 and 5 respectively.

Table 37: Summary of Stratford-upon-Avon town priority network options

Network	Technology	Heat output of low carbon technology	Network trench length	Estimated CAPEX	Carbon savings	£/tCO₂	Timing	25 year financial case			40 year financial case		
								Discounted payback	IRR	NPV	Discounted payback	IRR	NPV
Town Centre	Gas CHP	380 kWth	0.7 km	£2,513,011	539 tpa	£4,662/tCO₂	0-3 years	23.4 years	4.2 %	£200,154	26.5 years	5.2 %	£767,469
Bridgeway	Gas CHP	450 kWth	0.3 km	£1,610,735	621 tpa	£2,594/tCO₂	0-3 years	13.9 years	8.7 %	£1,128,115	15.5 years	8.8 %	£1,676,283
	WSHP	750 kW		£2,387,536	537 tpa	£2,225/tCO₂	0-3 years	18.2 years	4.8 %	£310,168	20.9 years	3.3 %	-£33,020
Alcester Road	Gas CHP	650 kWth	0.6 km	£2,147,111	998 tpa	£2,151/tCO₂	0-3 years	14.4 years	8.3 %	£1,378,760	15.7 years	8.6 %	£2,162,795

Table 38: Summary of strategic site network options

Network	Technology	Heat output of low carbon technology	Network trench length	Estimated CAPEX	Carbon savings	£/tCO₂	Timing	25 year financial case			40 year financial case		
								Discounted payback	IRR	NPV	Discounted payback	IRR	NPV
Gaydon / Lighthorne Heath village centre	Gas CHP	580 kWth	1.0 km	£2,411,020	923 tpa	£2,612/tCO₂	2-10 years	22.0 years	4.6 %	£319,307	23.8 years	5.8 %	£1,006,168
	Biomass heat	550 kW		£1,882,598	876 tpa	£2,149/tCO₂		>25 years	1.5%	-£342,329	>40 years	0.3 %	-£549,491
	GSHP	1,000 kW		£3,709,697	598 tpa	£2,963/tCO₂		>25 years	3.2 %	-£121,985	>40 years	0.7 %	-£859,939

4 ASSUMPTIONS, RISK AND SENSITIVITY ANALYSIS

4.1 Assumptions and Operating Parameters

Key operating parameters, financial values and assumptions used in this report are shown in Table 39 and Table 40. All proposals and assumptions are in line with available information the CIBSE/ADE Heat Networks: Code of Practice for the UK.

Table 39: Parameters used in financial assessments

Parameter	Value	Source of Data
Electricity price day for energy centre operation (p/kWh)	9.0	Average market value for local area
Electricity price night for energy centre operation (p/kWh)	6.0	
Electricity price export (p/kWh)	4.0	Current market rate
Cost for biomass fuel (p/kWh)	2.6	Conservative current market value for local area
Cost for gas for CHP and auxiliary fuel (p/kWh)	2.2	Average gas tariff for local area 2016
CCL exemption (p/kWh)	0.00195	It has been assumed that the CHP will meet CHPQA good quality CHP criteria and therefore be exempt from CCL. Natural Gas CCL rate from 1 April 2016.
Efficiency of biomass	80%	Experience of operating plant
Efficiency of auxiliary gas	85%	Experience of operating plant
Plant parasitic load (as % of Σ heat generated)	2%	Experience of operating plant
RHI value	Proposed 2017 tariffs	Non-domestic RHI tariffs, Ofgem
Discount rate (%)	3.5%	Treasury Green Book
Cost of land for energy centre (£/m^2)	0	Assumed no cost if located on Council-owned land

Table 40: Heat and private wire electricity tariffs

Category	Price of heat sales, p/kWh	Private wire electricity day, p/kWh	Private wire electricity night, p/kWh
Education	2.92	9.41	5.5
Community and public	4.00	9.50	6.00
Hospitality	3.50	9.50	6.00
Recreation	2.76	8.95	5.86
Healthcare and care homes	4.54	10.00	8.00
Private residential	4.34	-	-
Retail	3.50	9.50	6.00
Sheltered housing	3.50	9.50	6.00
Private offices	4.00	9.50	6.00

Table 41: Financial interest rate assumptions and sources of data

Financial interest rates	Value	Reference/Justification
Natural gas tariff	Varies annually	Department for Business, Energy and Industrial Strategy Central Scenario – all electricity prices (private wire, export and grid) linked to the electricity services indexation All gas prices and heat tariffs linked to gas (services) indexation
Grid electricity tariff		
Electricity sales (private)		
Electricity sales (export)		
Value of heat sales		
NPV	3.5 %	Treasury Green Book
RPI	NA	Not used in this analysis. Prices are shown in real values

4.2 Sensitivity Analysis

The sensitivity of the high level financial cases for the network options presented in Masterplanning & Prioritisation are shown below. Key parameters for analysis include capital cost, operating cost, heat sales tariff, gas input tariff, electricity input tariff and private wire tariffs.

This sensitivity analysis will provide further insight into key risks (assessed in 4.3) and inform the overall conclusions and recommendations of the study.

4.2.1 Heat Demand and Connection Risk for Priority Networks

The figures below summarise the effect of a change in the total network heat demand on the financial viability of the network. A change in the network heat demand may arise if buildings do not connect to the network or future heat demand values differ from those used in this study. The figures show the total network heat demand required to achieve a 25 year IRR of 5 % as well as the total network heat demand broken down to show the demands of key heat loads on the network.

Town Centre Network

Figure 62 shows the heat demand sensitivity analysis for the Town Centre Network for the 25 year business case for gas CHP. It can be seen that a small increase in total network heat demand would be required to achieve an IRR of 5 % if all other parameters remained the same. The key heat loads for this network are the Falcon Hotel, the Mercure Shakespeare Hotel and the Royal Shakespeare and Swan Theatres. It can be seen in Figure 62 that if any of these key heat loads were not to connect to the network, the 25 year IRR would be reduced further below 5 %.

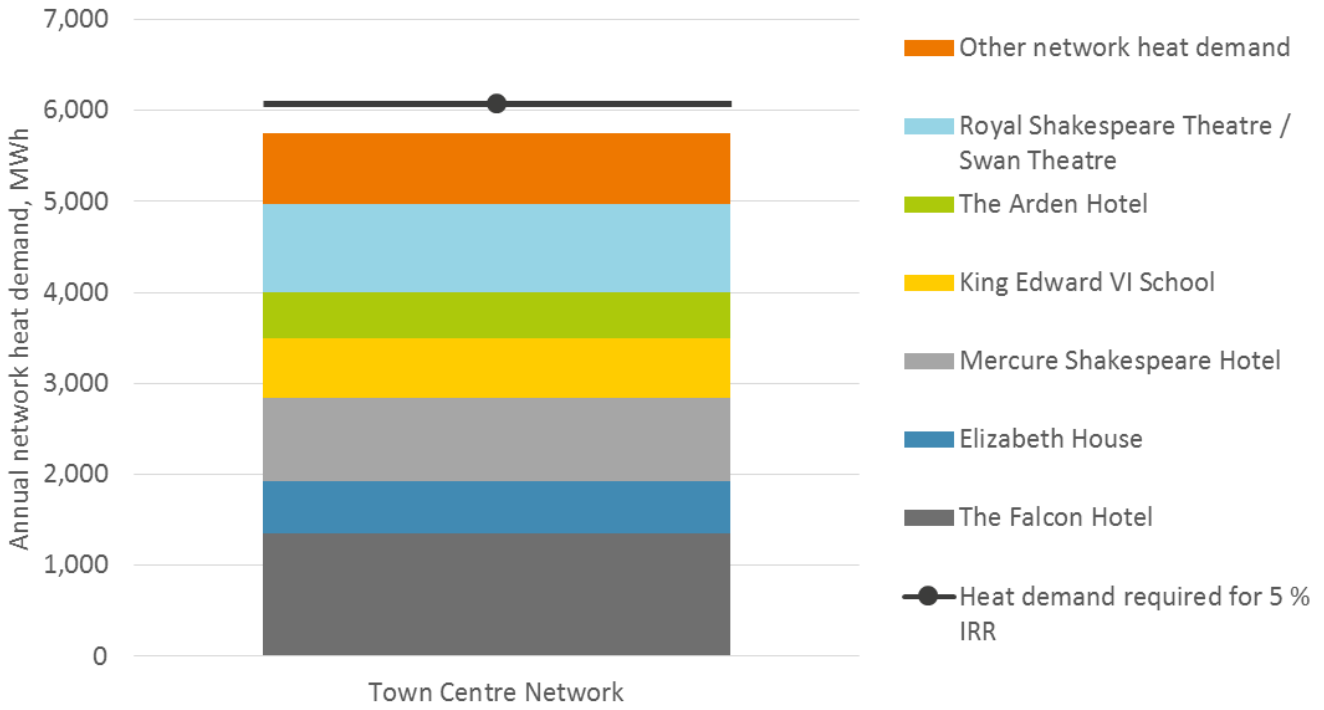


Figure 62: Sensitivity analysis for key heat demands for the Town Centre Network

Bridgeway Network

Figure 63 shows the heat demand sensitivity analysis for the Bridgeway Network for the 25 year business case for gas CHP and for WSHP. It can be seen that a small increase in heat demand would be required to achieve an IRR of 5 % for a network served by a WSHP if all other parameters remained the same. For a network served by gas CHP, a 25 % reduction in total network heat demand would still achieve a 25 year IRR of 5 %. The majority of the total network heat demand arises from the Holiday Inn. If they are not engaged in the project and do not connect to the network then the network will not be financially viable.

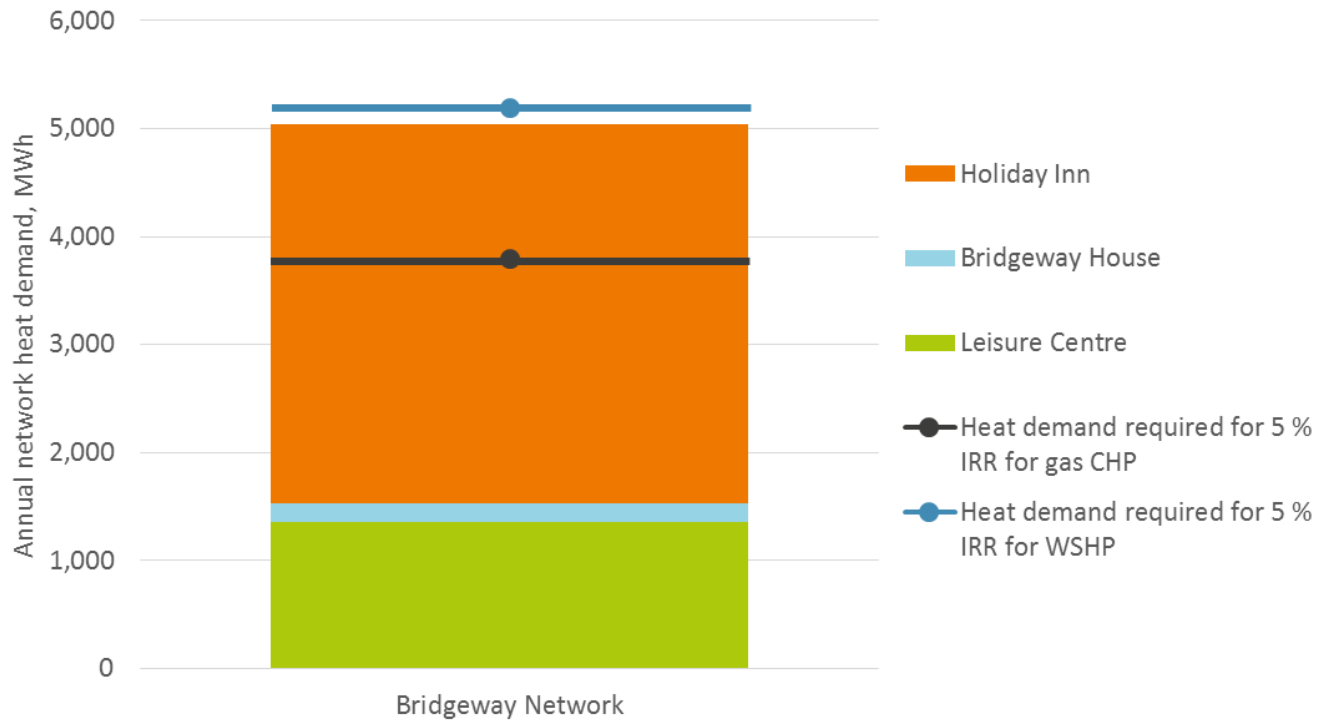


Figure 63: Sensitivity analysis for all heat demands for the Bridgeway Network

Alcester Road Network

Figure 64 shows the heat demand sensitivity analysis for the Alcester Road Network for the 25 year business case for gas CHP. It can be seen that a 5 % IRR could still be achieved with a decrease in total network heat demand of 25 %. The key heat load for this network is the extra care apartment development with 26 % of the total network heat demand. If this planned development did not connect to the network, then the 25 year IRR would be reduced below 5 %.

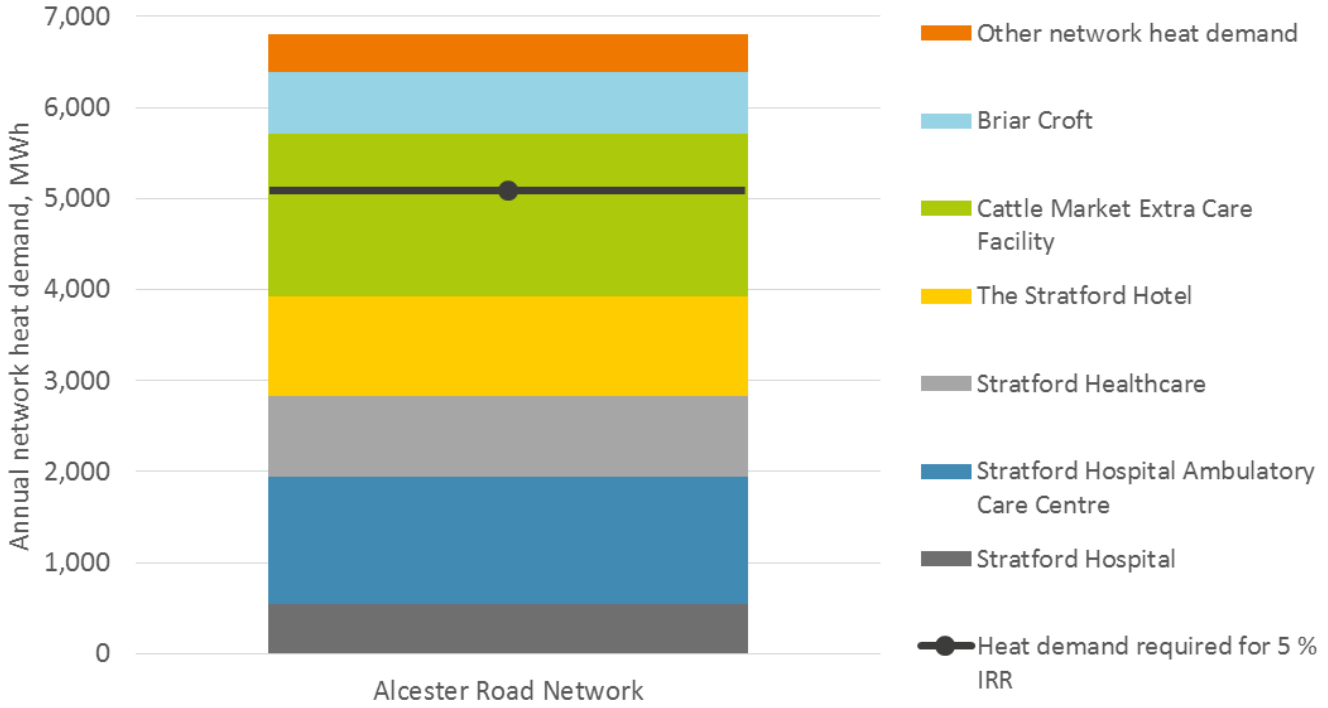


Figure 64: Sensitivity analysis for key heat demands for the Alcester Road Network

Gaydon / Lighthorne Heath Village Centre Network

Figure 65 shows the heat demand sensitivity analysis for the Gaydon / Lighthorne Heath Network for the 25 year business case for gas CHP, biomass and GSHP. It can be seen that a significant increase in total network heat demand would be required to achieve a 25 year IRR of 5 % for a network served by either biomass or GSHP. For these technology options to

become financially viable, it is likely that a significant change in other key parameters would be required, this is discussed in section 4.2.2.

A small increase in total network heat demand would be required to achieve an IRR of 5 % for a network served by gas CHP if all other parameters remained the same. The key heat loads for this network are the residential apartments and the elderly care housing. It can be seen in Figure 65 that if any of these key heat loads were not to connect to the network, the 25 year IRR would be reduced further below 5 %.

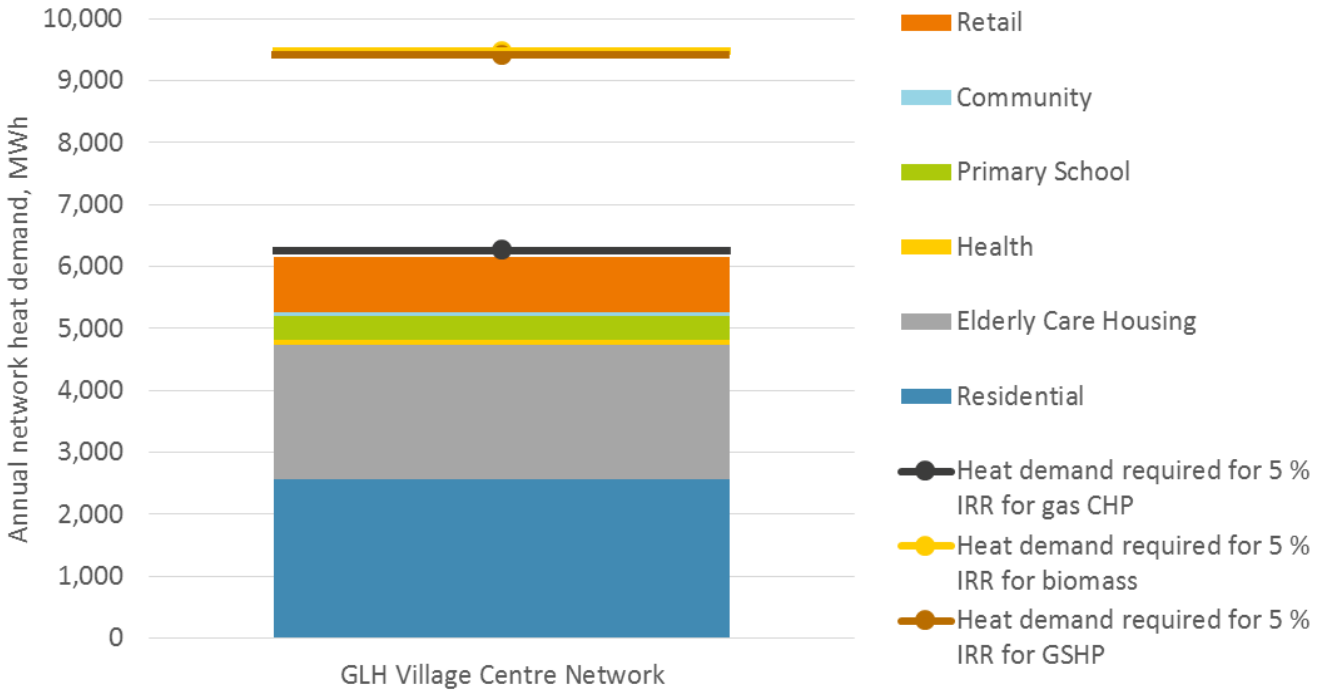


Figure 65: Sensitivity analysis for key heat demands for the Gaydon / Lighthorne Heath Village Centre Network for gas CHP, biomass and GSHP

4.2.2 Identification of Key Variables for Priority Networks

This section considers the effect that key variables namely capital cost, operating cost, gas input cost, electricity input cost, heat sales tariff and electricity private wire sales tariff have on project IRR.

Town Centre Network

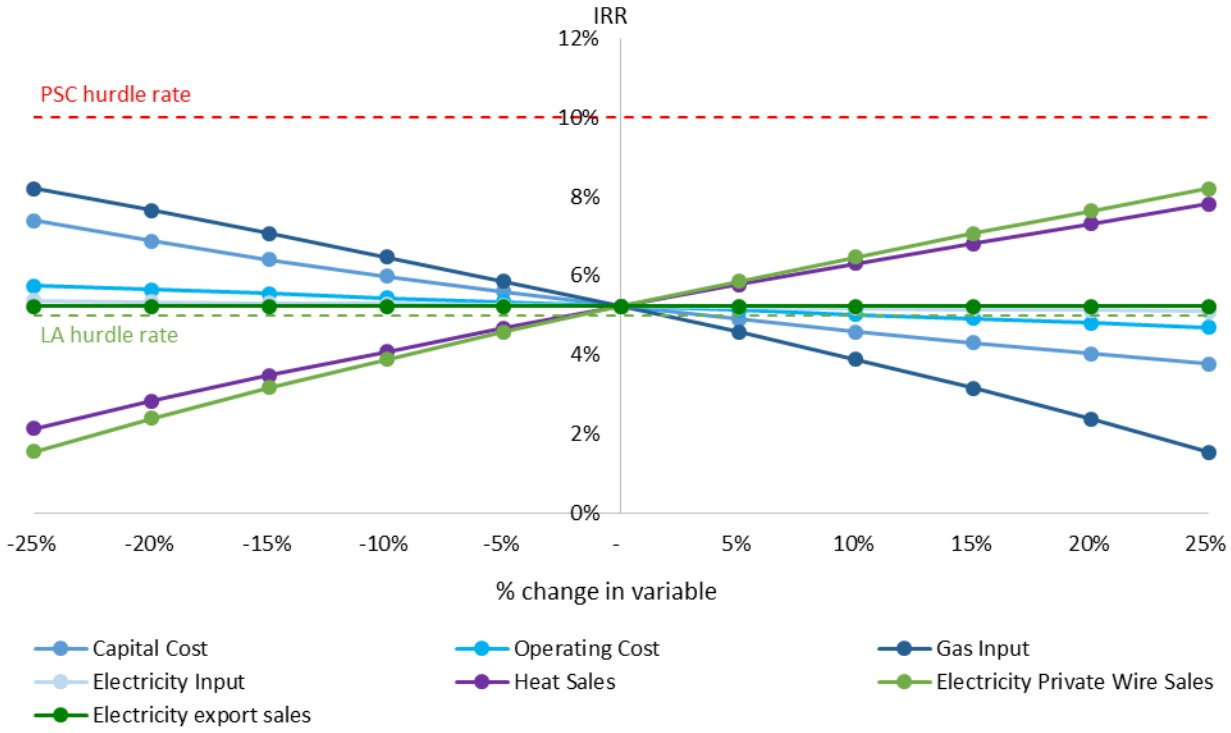


Figure 66: Town Centre network sensitivity analysis for gas CHP

Figure 66 shows the sensitivity analysis of the key variables for the town centre network. Electricity private wire sales, gas input tariff, heat sales and capital cost are the variables that have the most significant effect on the financial case. For example, the high level 40 year IRR for the project has been assessed to be 5.2 %, if the electricity private wire sales tariff is increased by 25 % the high level IRR for the project is increased to ~8 %; and if the heat sales tariff is reduced by 25 % then the high level IRR for the project is decreased to ~2 %.

The impact of grant funding can be evaluated by assessing the impact of reduced capital cost for example, reducing the capital cost by 25 %, the equivalent of receiving a 25 % capital grant, increases the high level IRR to over 7 %. The impact of grant funding is assessed in more detail in section 4.2.3.

The local authority hurdle rate has been assumed to be 5 % and the private sector hurdle rate is assumed to be 10 %.

Bridgeway Network

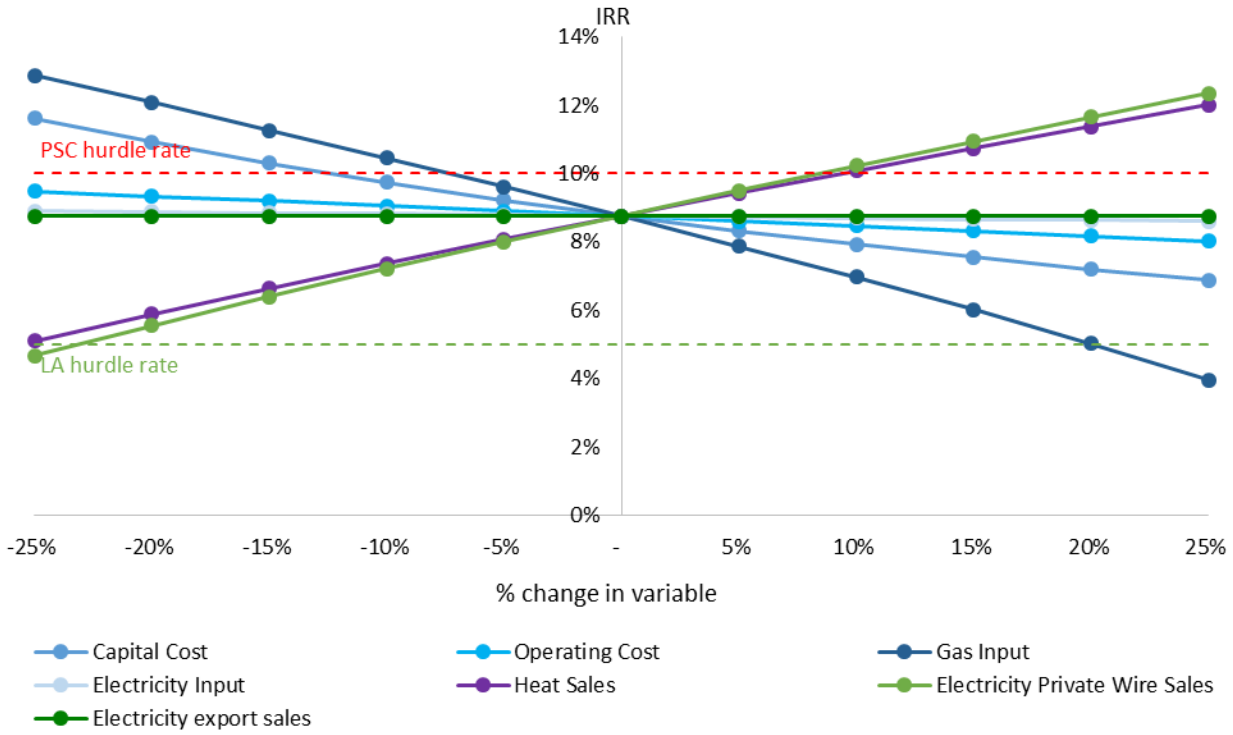


Figure 67: Bridgeway network sensitivity analysis for gas CHP

Figure 67 shows the sensitivity analysis of the key variables for the Bridgeway network served by gas CHP. Electricity private wire sales, gas input tariff, heat sales and capital cost are the variables that have the most significant effect on the financial case.

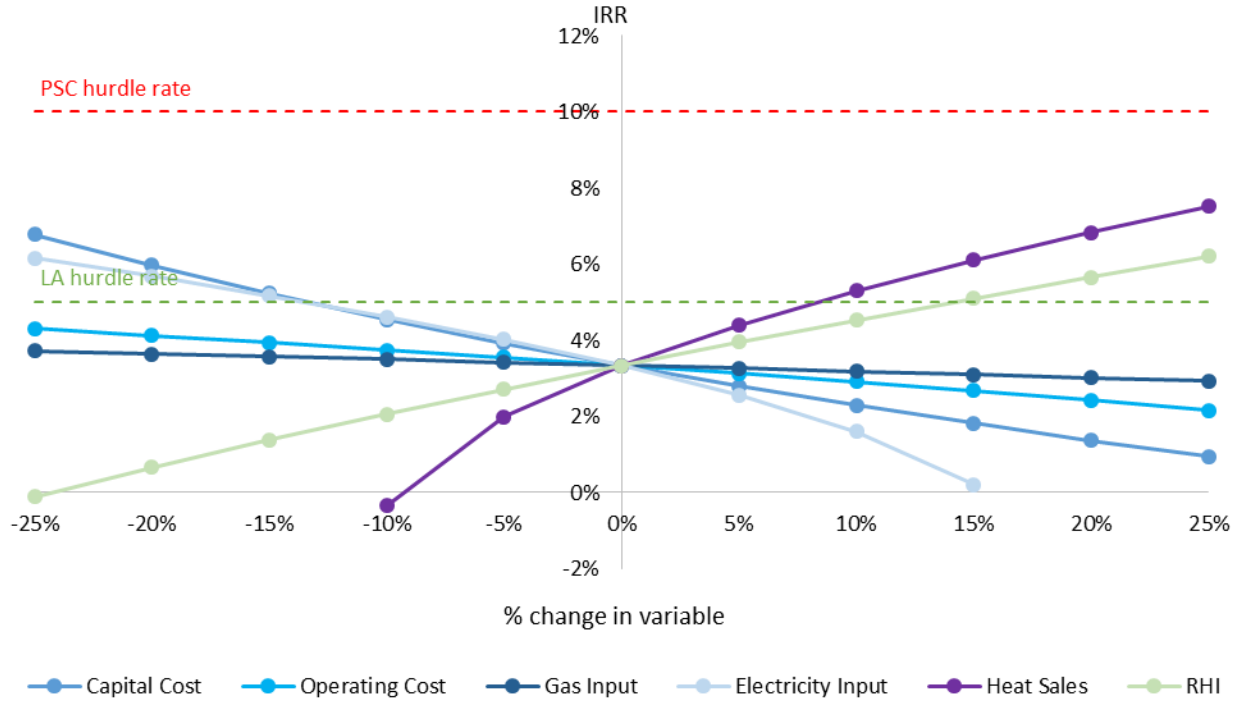


Figure 68: Bridgeway network sensitivity analysis for WSHP

Figure 68 shows the sensitivity analysis of the key variables for the Bridgeway network served by WSHP. Electricity input tariff, gas input tariff, heat sales, capital cost and RHI are the variables that have the most significant effect on the financial case.

Alcester Road Network

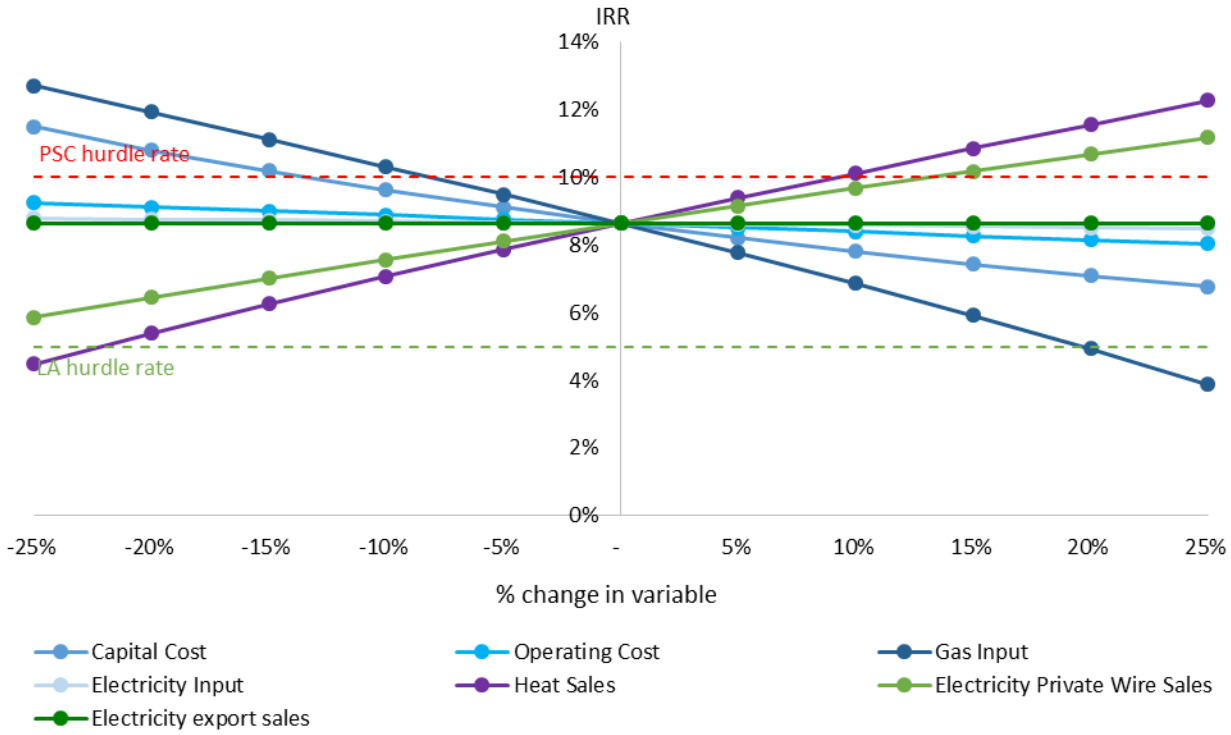


Figure 69: Alcester Road network sensitivity analysis for gas CHP

Figure 69 shows the sensitivity analysis of the key variables for the Alcester Road network. Electricity private wire sales, gas input tariff, heat sales and capital cost are the variables that have the most significant effect on the financial case.

Gaydon / Lighthorne Heath Village Centre Network

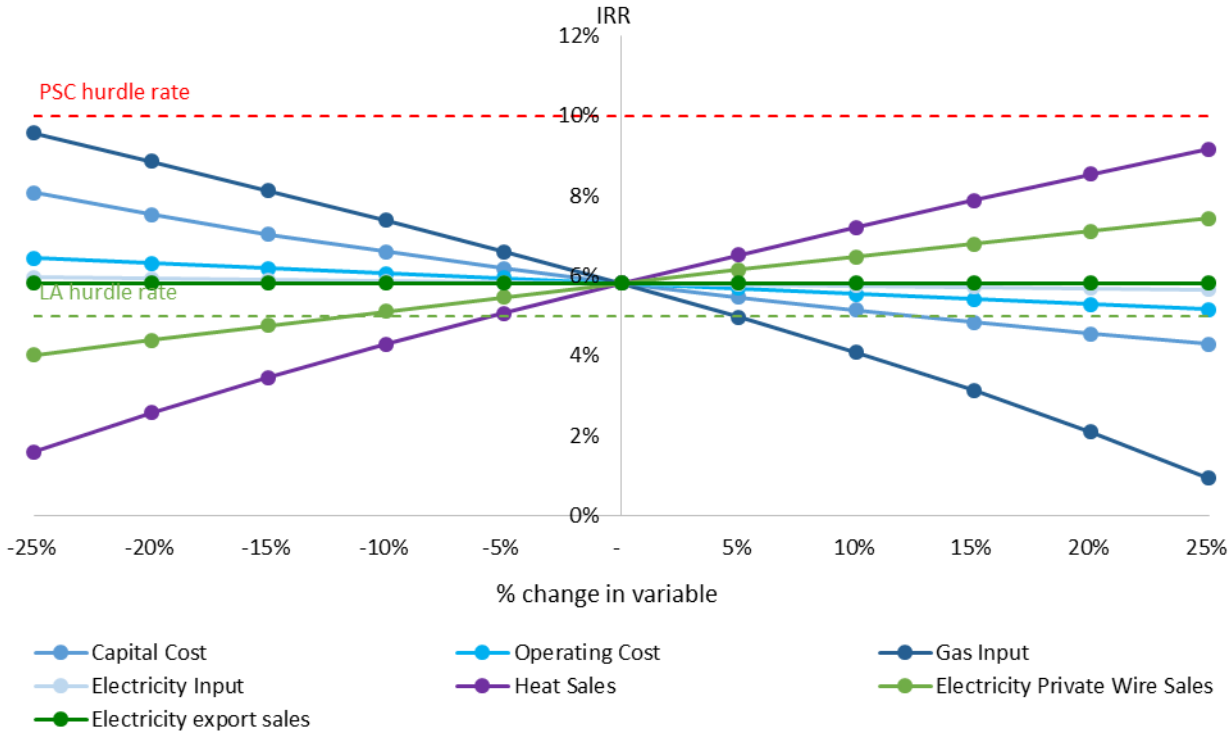


Figure 70: Gaydon / Lighthorne Heath Village Centre network sensitivity analysis for gas CHP

Figure 70 shows the sensitivity analysis of the key variables for the Gaydon / Lighthorne Heath Village Centre network served by gas CHP. Electricity private wire sales, gas input tariff, heat sales and capital cost are the variables that have the most significant effect on the financial case.

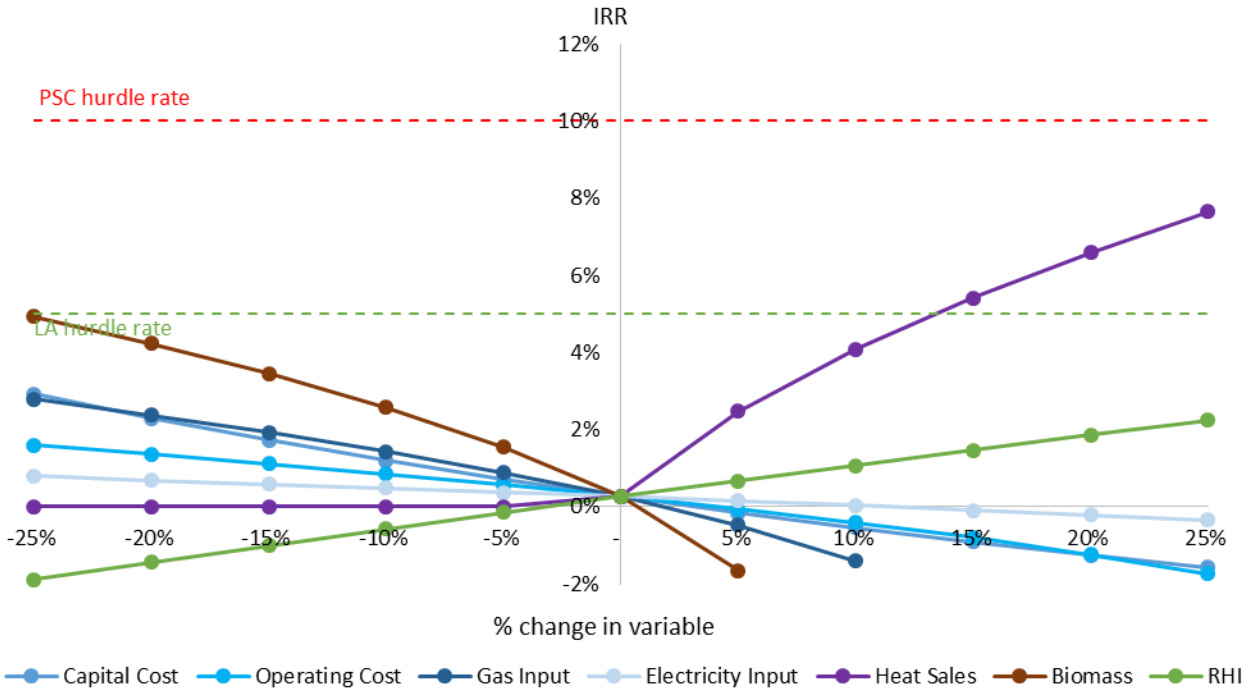


Figure 71: Gaydon / Lighthorne Heath Village Centre network sensitivity analysis for biomass heat

Figure 71 shows the sensitivity analysis of the key variables for the Gaydon / Lighthorne Heath Village Centre network served by biomass heat. Wood fuel costs, gas input tariff, heat sales, capital cost and RHI are the variables that have the most significant effect on the financial case.

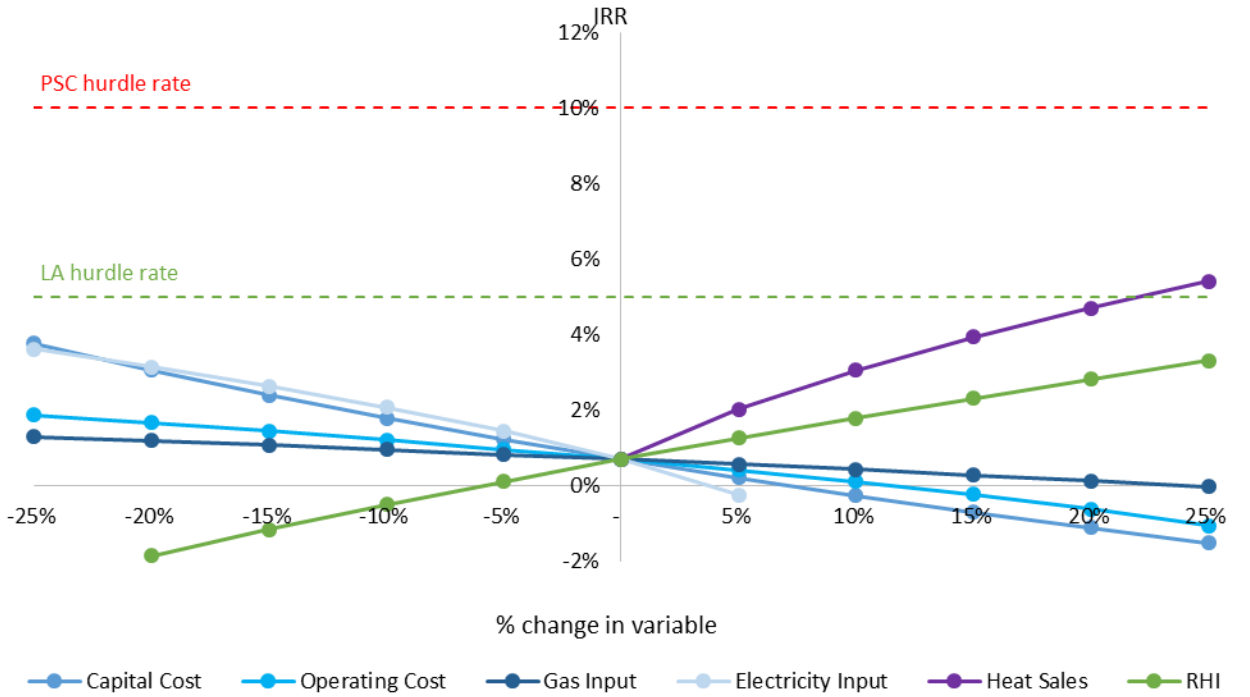


Figure 72: Gaydon / Lighthorne Heath Village Centre network sensitivity analysis for GSHP

Figure 72 shows the sensitivity analysis of the key variables for the Gaydon / Lighthorne Heath Village Centre network served by GSHP. Electricity input tariff, gas input tariff, heat sales, capital cost and RHI are the variables that have the most significant effect on the financial case.

4.2.3 Impact of grant funding for priority networks

Table 42 shows the 25 year and 40 year IRR for priority networks for a 10, 20 and 30 % capital grant.

Table 42: Grant funding for Stratford-upon-Avon town priority networks

Network	Financial case term	Grant funding, % of CAPEX			
		0 %	10 %	20 %	30 %
Town Centre gas CHP	25 year IRR	4.2 %	5.1 %	6.3 %	7.6 %
	40 year IRR	5.2 %	6.0 %	6.9 %	8.0 %
Bridgeway gas CHP	25 year IRR	8.7 %	9.9 %	11.3 %	13.1 %
	40 year IRR	8.8 %	9.7 %	10.9 %	12.4 %
Bridgeway WSHP	25 year IRR	4.8 %	6.0 %	7.4 %	9.2 %
	40 year IRR	3.3 %	4.3 %	5.8 %	7.5 %
Alcester Road gas CHP	25 year IRR	8.3 %	9.5 %	11.0 %	12.8 %
	40 year IRR	8.6 %	9.6 %	10.8 %	12.2 %

Table 43: Grant funding for strategic sites priority networks

Network	Financial case term	Grant funding, % of CAPEX			
		0 %	10 %	20 %	30 %
Gaydon / Lighthorne Heath Village Centre gas CHP	25 year IRR	4.6 %	5.5 %	6.7 %	8.1 %
	40 year IRR	5.8 %	6.6 %	7.5 %	8.4 %
Gaydon / Lighthorne Heath Village Centre biomass heat	25 year IRR	1.5 %	2.3 %	3.5 %	5.0 %
	40 year IRR	0.3 %	1.2 %	2.3 %	3.4 %
Gaydon / Lighthorne Heath Village Centre GSHP	25 year IRR	3.2 %	4.7 %	6.4 %	8.5 %
	40 year IRR	0.7 %	1.8 %	3.1 %	4.4 %

4.2.4 Impact of Key Variables for Strategic Sites

A key parameter for all networks is the CAPEX. Table 44 shows the 25 year and 40 year IRR for the 3 example development site networks, discussed in section 3.7, for a 10, 20 and 30 % capital grant. It can be seen that neither the Gaydon / Lighthorne Heath Village Centre network extension nor the example network for Long Marston Airfield achieve a 25 year IRR of 5 % with a 30 % capital grant.

Table 44: Grant funding for example networks for strategic sites

Network	Financial case term	Grant funding, % of CAPEX			
		0 %	10 %	20 %	30 %
Alcester Road Network extension to Canal Quarter	25 year IRR	7.0 %	8.2 %	9.5 %	11.2 %
	40 year IRR	7.6 %	8.5 %	9.6 %	11.0 %
Gaydon / Lighthorne Heath Village Centre Network extension	25 year IRR	-5.1 %	-4.5 %	-3.8 %	-2.9 %
	40 year IRR	-1.8 %	-1.3 %	-0.8 %	-0.2 %
Long Marston Airfield	25 year IRR	-1.7 %	-1.0 %	-0.1 %	0.9 %
	40 year IRR	0.9 %	1.4 %	2.1 %	2.9 %

Another key parameter is the heat sales tariff. Table 45 shows the increase in average heat sales tariff required to achieve a 25 year IRR of 5 % with and without a 30 % capital grant. It can be seen that a significant increase in heat sales tariff would be required for the GLH village centre network extension to reach an IRR of 5 % even with a 30 % capital grant. For Long Marston Airfield, a heat sales tariff of 5.5 p/kWh and a 30 % capital grant would be required to achieve a 25 year IRR of 5 %. The Long Marston Airfield development is of strategic importance to Stratford-on-Avon District Council due to a current bid for Garden Village funding. If this bid is successful this funding would increase the viability of a district heat network at this site.

Table 45: Heat sales tariff sensitivity (for 25 year financial case)

Network	Average heat sales tariff used in financial assessments	Average heat sales tariff required for 5 % IRR with no grant funding	Average heat sales tariff required for 5 % IRR with 30 % grant funding
Alcester Road Network extension to Canal Quarter	3.9 p/kWh	3.4 p/kWh	2.8 p/kWh
Gaydon / Lighthorne Heath Village Centre Network extension	4.3 p/kWh	10.7 p/kWh	8.2 p/kWh
Long Marston Airfield	4.3 p/kWh	6.9 p/kWh	5.5 p/kWh

4.2.5 Summary

The key variables for the priority networks are electricity private wire sales, gas input tariff, heat sales and capital cost. Small changes in the price of electricity export, electricity input and operating costs are less significant for the high level financial case.

For the strategic sites, an extension of the GLH village centre network to include the southern residential area is unlikely to achieve a 25 year IRR of 5 % even with a 30 % grant. There may be potential for this to become financially viable if Jaguar Land Rover or Aston Martin Lagonda can be used as an anchor loads or if JLR develop an energy generation scheme.

A network at Long Marston Airfield may be financially viable with an increase in heat sales tariff and a 30 % capital grant.

The conclusions from the sensitivity analysis inform the key risks and issues examined in section 4.3.

4.3 Issues and Risks

The main barriers, issues and constraints to the implementation of district heating networks within the heat map areas were considered and risks assessed. Table 47 outlines potential risks and issues that apply to all networks. A key showing the level of risk is shown in Table 46.

Table 46: Risk level key

Low risk	
Medium risk	
High risk	

Table 47: Summary of risks and issues that apply to Stratford-upon-Avon Town networks

	Risk/Issue	Risk level	Rationale	Mitigating measure/action
1	Where organisations were unresponsive, or not open to consultation, heat demands are verified using industry benchmarks.		For the existing potential heat loads where data was not available heat demands were developed from heat profile modelling verified using CIBSE benchmark data and data for similar buildings. Heat demand modelling of key heat loads was undertaken according to best practice and best available information. The hourly, daily and annual heat demand of the individual buildings was calculated and the distribution losses based on proposed pipe routes, specification and operating parameters to gauge heat demand identified.	CIBSE provide industry benchmarks that are widely used for heat demand modelling. However as they are derived from building energy data prior to 2008, there is a risk that they are less accurate for heat demands for modern buildings (due to more efficient thermal performance, increased use of electrical equipment etc). 'Good practice' benchmark figures have been used (as opposed to 'typical practice'). The consultant team has a database of hundreds of hourly annual demand profiles for a wide range of building types and these were adapted to provide an indicative heat demand profile for each site and to verify the benchmark data used.
2	Future domestic heat demands have been modelled.		Consultant experience indicates that standard industry heat consumption benchmarks for domestic buildings are high and do not include data from houses built to latest Building Regulations or consider building type and size in sufficient detail.	In accordance with the CIBSE Heat Networks: Code of Practice for the UK, the consultant team developed specific benchmarks that considered the size of each house taken from buildings plans and produced models for different building types (namely 2-bed bungalow, 3-bed detached, 3-bed detached with garage, 3-bed semi, 3-bed terraced, 4-bed detached, 4-bed detached with garage, 4-bed semi, 5-bed detached, 5-bed detached with garage). Proposed housing layout plans were obtained for some development sites and these included dwelling types, numbers and locations for each building type, therefore, each dwelling was allocated an appropriate heat demand. For each building type, Building Regulations, Part L 2013 were considered and U-values for the building elements were used to generate modelled benchmarks for the 10 building types. Fabric heat loss was calculated using hourly temperature from local weather data, direct hot water demand was based on assumed number of occupants and solar/electrical/occupancy gains were considered. An hourly heat demand profile was generated to show peak demand (kW/m²) and an annual demand benchmark (kWh/m²). Boiler efficiency was then considered to yield a consumption benchmark in kWh/m².

	Risk/Issue	Risk level	Rationale	Mitigating measure/action
				High level plans were available for the majority of the development sites detailing housing density and type (apartments, individual dwellings, etc). For these sites, an averaged benchmark was used based on the likely type of dwelling for each area.
3	Changes to planned developments will change the modelled heat demand		Heat demands for proposed developments were assessed according to latest knowledge, information and development plans including planning applications, outline planning applications and consultation with planning officers from Stratford-on-Avon District Council. E.g. as the Canal Quarter development plans are currently at an early stage changes to the existing development plans are likely.	If plans change, the impact upon the findings of this study should be assessed. E.g. as developments are brought forward for the Canal Quarter, the Alcester Road and Canal Quarter network should be re-assessed. Stratford-on-Avon District Council should undertake detailed consultation with all potential developers. The approach to engaging with developers and utilising the planning system is discussed in Chapter 5.
4	Complex strategic priorities for heat networks due to numerous and diverse project partners.		A wide range of strategic priorities were identified from various project partners and stakeholders. Stakeholders include: - Stratford-on-Avon District Council - Royal Shakespeare Company - Orbit Heart of England Housing Association - South Warwickshire NHS Foundation Trust - Coventry and Warwickshire Partnership NHS Trust - Holiday Inn	The consultant team has reviewed policy and strategic documentation and, wherever possible, undertaken consultation with project partners in order to review and discuss network priorities.
5	Accessing mains gas supplies for CHP and peak and reserve boilers.		Insufficient gas supply to energy centres will hinder the viability for gas CHP and peak and reserve boilers.	GIS layers of main gas routes were reviewed and showed main gas supplies to the Alcester Road, Bridgeway and Town Centre areas. If this project is progressed to the feasibility stage, this should be further investigated with initial applications made to National Grid.
6	Network options presented do not allow		Consideration should be given to future-proofing to ensure that the network has the capacity to serve future phases. Very	All future potential energy loads identified by Stratford-on-Avon District Council and land allocated for potential development in

	Risk/Issue	Risk level	Rationale	Mitigating measure/action
	connection of key future developments.		limited expansion opportunities were identified for the Town Centre or Bridgeway networks. There may be potential for expansion of the Alcester Road network to the Canal Quarter development at Western Road.	local plans have been considered in the heat-mapping and careful consideration is given to future proofing, whilst not at the expense of efficient operation in the short and medium term. As there is currently limited information available for the Canal Quarter development, futureproofing has not been included for the Alcester Road network. No expansion opportunities were identified for any of the other network options. This should be further considered if progressed to the feasibility stage.
7	Difficult ground conditions and archaeologically sensitive areas are likely to be encountered within Stratford-upon-Avon Town.		There are likely to be areas of the town with difficult ground conditions, archaeological sites and listed buildings, especially in the town centre area. Overall risk is medium, but for the Town Centre Network it is high.	Project management and network costs have been adjusted to take account of difficult ground conditions and archaeologically sensitive areas. These issues will require detailed consideration at the project feasibility stage.
8	Physical barriers identified at master planning stage prevent implementation of scheme or lead to CAPEX increase and viability issues.		Potential barriers include key utilities infrastructure, main roads, hard digging conditions, areas of non-Council owned land and the Stratford-upon-Avon to Henley-in-Arden railway line and the Stratford-upon-Avon Canal (for the Canal Quarter development area).	The main physical barriers, issues and constraints within the study area have been considered and, where possible, avoided during the masterplanning process. GIS layers including Council owned land and main gas routes were reviewed and heat map area surveyed (on foot) for obvious barriers. At the feasibility stage, the client's representatives will also need to further liaise with local Highways, Environmental Health and Planning Departments and utilities companies.
9	Engagement with developers is not achieved or developers are not interested in network offer.		The viability of the Alcester Road Network and Gaydon Lighthorne Heath networks is reliant upon planned developments and the Canal Quarter development site has been identified as an area for potentially viable heat networks.	Effective early engagement with developers is essential and the benefits of connecting new buildings to a network need to be made clear. Discussions have been undertaken with Orbit Heart of England Housing Association, owners of the Cattle Market extra care facility planned development. Developers for the Canal Quarter development are currently unknown. The approach to engaging with developers and utilising the planning system is discussed in Chapter 5.

	Risk/Issue	Risk level	Rationale	Mitigating measure/action
10	The capital costs for installation of scheme and network are higher than estimated within the high level financial viability assessment.		Sensitivity analysis indicates that the impact of higher capital costs would be significant for all network options. If the financial model does not provide a representative picture of the true cost of the network, and the likely financial benefits or the high level financial assessment does not provide sufficient information to secure funding, then the network plan will not progress.	Optimism bias[22] has been considered when deriving project costs and a contingency sum of 20 % of total CAPEX has been included in all financial assessment.
11	Heat sales tariffs significantly affect the high level financial case.		The income from heat sales is particularly significant for networks that are less financially viable. The high level financial assessment assumes that heat is sold to end users at tariffs bespoke to specific building categories. These values are calculated based on the current cost of heat to end users minus 5% (as requested by the client to reflect one of the key priorities for this work i.e. reducing energy costs for public sector organisations, businesses and domestic users). The values are based on figures for current energy costs (taken from current quotes and tariffs paid by similar users in the area) for each of the consumer categories and include standing charges, efficiency losses, maintenance and replacement costs and carbon taxes.	If any projects are progressed to the feasibility stage, this should be updated. Heat sales tariffs are affected by gas costs that are based on current gas tariffs for similar categories of consumer and quotes for the Stratford-upon-Avon area.
12	Changes in gas input tariffs affect financial case for gas CHP.		Gas input tariffs have a significant impact on the financial model and the operating viability relies upon the 'spark gap' i.e. the difference in price between gas and electricity. If gas prices rise faster than those of electricity, then the viability is reduced.	Gas tariffs are based on current prices for large scale purchase and future increases are based on Department for Business, Energy and Industrial Strategy's central cost scenario. Heat sale tariffs used in the financial model are linked to current gas costs and so if gas costs increase it may be feasible to also increase heat sales tariff.

[22] All project costs are based on a combination of supplier quotes, industry costing tools and previous project experience. The consultant team hold a broad knowledge of the actual costs of installing a district heating scheme including costs for plant and equipment supply and installation, energy centre construction, distribution pipe work supply and installation, trench excavation and re-instatement.

Table 48: Risks and issues for networks at strategic sites

	Risk/Issue	Risk level	Rationale	Mitigating measure/action
1	Future domestic heat demands have not been accurately modelled.		See Table 47 above	See Table 47 above
2	Changes to planned developments will change the modelled heat demand		Heat demands for proposed developments were assessed according to latest knowledge, information and development plans including outline planning applications, development briefs, masterplans and consultation with planning officers from Stratford-on-Avon District Council. As the majority of development plans are currently at an early stage changes to the existing development plans are likely.	If plans change, the impact upon the findings of this study should be assessed. Stratford-on-Avon District Council should undertake detailed consultation with all potential developers. The approach to engaging with developers and utilising the planning system is discussed in Chapter 5.
3	Accessing mains gas supplies for CHP and peak and reserve boilers.		Insufficient gas supply to energy centres will make gas CHP and peak and reserve boilers unviable.	There are plans to serve all development sites with main gas. If this project is progressed to the feasibility stage, this should be further investigated via discussions with developers and National Grid.
4	Network options presented do not allow connection of key future developments.		Consideration should be given to future-proofing to ensure that the network has the capacity to serve future phases.	All future potential energy loads identified by Stratford-on-Avon District Council and land allocated for potential development in local plans have been considered in the heat-mapping and careful consideration is given to future proofing, whilst not at the expense of efficient operation in the short and medium term. Futureproofing measures have not been included in the Gaydon / Lighthorne Heath Village Centre network due to the high level nature of development plans for the remainder of the site. Future proofing will need to be further considered if progressed to the feasibility stage once more detailed development plans are available.
5	Engagement with developers is not achieved or developers are not interested in network offer.		The viability of networks at all development site is reliant upon successful engagement with developers.	Effective early engagement with developers is essential and the benefits of connecting new buildings to a network need to be made clear. The approach to engaging with developers and utilising the planning system is discussed in Chapter 5.

	Risk/Issue	Risk level	Rationale	Mitigating measure/action
6	The capital costs for installation of scheme and network are higher than estimated within the high level financial viability assessment.		See Table 47 above	See Table 47 above
7	Reduced heat sales tariffs significantly affect the high level financial case.		See Table 47 above	See Table 47 above
8	Changes in gas input tariffs affect financial case for gas CHP.		See Table 47 above	See Table 47 above

5 PLANNING CONSIDERATIONS

Stratford-on-Avon District Council commissioned the Carbon Trust to review its Core Strategy and planning policy documentation, with a specific focus on its ability to enable the implementation of heat network infrastructure. The following section outlines our findings and recommendations.

INTRODUCTION TO PLANNING FOR DECENTRALISED ENERGY

Planning policy and planning teams play a crucial role in the development of heat network projects. The role of planners in district heating is to provide appropriate policy and supporting guidance to developers in the development or extension of networks. Planners should work with developers to guide them on the layout of their buildings and the design of their heating infrastructure to maximise the benefits of connecting to the heat network. The technical and financial work undertaken for this study will provide an evidence base for planning policy across the authority areas.

Whilst Heat Network development has been consistently supported by government, there are currently unknowns around whether planning policy; and tools like use of Section 106 Agreements; and the Community Infrastructure Levy (CIL) can take a lead role on driving delivery of heat networks. Uncertainty has been generated by initiatives such as the Housing Standards Review and consequent emphasis on 'viability', the removal of the Zero Carbon aspiration for housing, and Allowable Solutions. However, Government has repeatedly expressed support for heat network delivery through the planning system, as stated in the Written Ministerial Statement (Planning Update March 2015) and the Productivity Plan 'Fixing the Foundations'. Since the publication of the Housing Standards Review the Carbon Trust has successfully defended heat network policies at planning hearings in Horsham and Crawley. The Horsham policy, which was also drafted by the Carbon Trust, is therefore taken as a template for some of the recommendations below.

Heat networks are strategic, enabling infrastructure. As such, appropriate planning policy can help ensure they are implemented in the right place, at the right time, and achieve the desired outcomes. Getting planning policy wording right is a crucial element in laying the foundations for successful implementation of district heating schemes. It is also important that planning authorities are equipped to support negotiations with developers to secure effective heat network implementation and connection.

A summary of key planning issues and actions is shown below.

Issue	Action
Safeguarding network routes	Identify any immediate threats to imminent or longer-term future network routes. Safeguard identified routes from developments that would compromise use of the route, and consider opportunities arising from development on network routes, such as multi-utility trenches.
Safeguarding energy centre sites	Where extra land is needed to accommodate energy centres or peaking and reserve plant, sites should be identified and safeguarded in order to avoid compromising the development or expansion of networks.
District heating hierarchy	This could include a requirement to connect to an existing network, provide a network on-site, design buildings to be connection-ready, or install communal rather than individual heating systems.
Waste heat sources	Ensure any sources of significant waste heat are identified and flagged up to establish whether heat can feed into a new or existing network. Consider requirements to recover heat as well as electricity from relevant facilities. Encourage location of heat sources near heat users.
Developer contributions	Developer contributions could come from Community Infrastructure Levy charges or from Section 106 Agreements. If using CIL, be aware that a policy forcing a developer to install an on-site network and a CIL charge could constitute 'double-counting'.
Technical standards	The CIBSE Heat Networks Code of Practice (CoP) is the best-available source of technical standards to reference in planning policy. However, bear in mind that referencing the CoP will not achieve anything unless its implementation is supervised and enforced through planning policy. The CoP only contains high-level technical guidance and an outline of design principles which will have to be built on in the case of the connection to an operating network.
Local Development Orders (LDOs)	LDOs for district heating have not been widely used outside London and a careful cost-benefit analysis should be undertaken before deciding to develop an LDO. However, they do offer an opportunity to make network installation easier and are a public statement of a council's commitment.

A. OVERVIEW OF RELEVANT PLANNING POLICIES

The following section outlines the current planning policies that are in place in Stratford-on-Avon and how they can be used to support the development of heat networks. Specific policy wording recommendations are subsequently presented in Section B.

1. Core Strategy

The Core Strategy for Stratford-on-Avon Council seeks to promote sustainable development, a central theme that underpins all policies in the plan. The Core Strategy was adopted in July 2016, and therefore no new policies will be incorporated in the short term. However, there is scope for the inclusion of heat network policy within Supplementary Planning Documents (SPDs) which are under development, building on existing policy "hooks" within the Core Strategy.

The following policy hooks have been identified within the recently adopted Core Strategy:

Policy CS.2

In Section A of Policy CS.2, the Council refers to promoting decentralised low carbon and renewable energy schemes as a strategic measure to mitigate the impacts of climate change.

"At a strategic level, measures to mitigate the impacts of climate change will include:

- *Promoting decentralised low carbon and renewable energy schemes."*

Linking decentralised energy with carbon reduction is a positive basis for futureproofing new developments.

In Section B of Policy CS.2 the Council mentions the promotion of an 'energy hierarchy' to encourage the achievement of carbon dioxide emissions reductions, and promotes both energy efficient and decentralised energy supply.

"The Council will promote an 'energy hierarchy' in seeking to achieve carbon dioxide emissions reduction, as follows:

1. *reduce energy demand through energy efficiency measures;*
2. *supply energy efficiently and give priority to decentralised energy supply; and*
3. *provide energy from renewable or low carbon energy sources."*

We advise that this hierarchy is referred to and further extended in development-specific SPDs.

In Section B subsection 3.1.5 the Council stresses that planning has a key role in achieving fuel poverty targets through promoting decentralised and renewable or low-carbon energy.

"Although energy savings in buildings will be achieved through the Building Regulations, planning has a key role in achieving these targets through promoting decentralised and renewable or low-carbon energy and ensuring that new development uses layout, landform and building orientation to minimise CO2 emissions."

This gives support for heat networks as a mean to achieve one of the Council's strategic objectives: tackling fuel poverty.

Policy CS.3

This policy is considered as the strongest reference to heat networks within the Core Strategy. The addition of subsection 3.2.10 in Section A to explain district heating schemes is also seen as very positive. We welcome the main modification of Section A of Policy CS.3 that now states:

"The Council will encourage the use of decentralised energy systems, which incorporate either heating (District Heating) or heating, power and cooling (Combined Heat and Power) or power (micro-grid) into new developments. The Council is commissioning a study to identify 'district heating priority areas'.

All new developments in district heating priority areas will be encouraged to incorporate infrastructure for district heating, and will be expected to connect to existing systems where and when it is available, unless demonstrated that this would render development unviable."

Considering that the Energy Masterplanning (EMP) study is near to completion, the Council should consider identifying district heating priority areas.

"Elsewhere in the district there may be the opportunities for small scale schemes to serve local communities."

Reference to other areas outside the district heating priority ones is also seen as positive, as to avoid the premature rule out of connection to district heating by developers without having considered the opportunity to future proof their developments. Setting thresholds for investigation into heat networks in development-specific SPDs will help to future proof policy and capture a wider range of heat network opportunities.

"All new developments in other areas will be encouraged to incorporate infrastructure for district heating, and will be expected to connect to any existing suitable systems (including systems that will be in place at the time of construction), unless it is demonstrated that this would render development unviable."

Lastly, it is wise to refer to the SPD for Developments and Requirements which is currently still being scoped and hence can be modified. More detail on the use of the Development Requirements SPD is presented in Section 3.

"Detailed advice on district heating will be provided in Development Requirements Supplementary Planning Document."

2. Core Strategy Infrastructure Delivery Plan

Stratford-on-Avon's Infrastructure Delivery Plan (IDP) is a key document in that it sets out the main infrastructure items necessary to facilitate both the level and distribution of growth set out in the Core Strategy. Generally speaking, it forms part of an evidence base to support the Local Plan.

District heating is identified as an infrastructure item in the IDP. The IDP in Stratford-on-Avon has recently undergone a consultation process and hasn't received any objection or scrutiny in relation to DH.

The IDP identifies several funding sources for DH, and it is our understanding that this section of funding options will be modified only once further evidence is made available to the Council identifying preferred method.

Section 3 outlines the capital costs for heat network infrastructure that have been calculated for the heat network opportunities presented in this study. We recommend that these costs are used when identifying the funding gap for heat network infrastructure within Stratford-on-Avon.

Section 7.3.3 on Renewable and Low Carbon Energy refers back to Policy CS.2 on Climate Change and Sustainable Construction to encourage the development of renewable and low carbon energy infrastructure. ***"Policy CS.2 Climate Change and Sustainable Construction encourages the development of renewable and low carbon energy infrastructure."***

However it is worth noting that it would be beneficial to also refer back to Policy CS.3 Sustainable Energy which promotes the use of decentralised energy systems and identifies district heating priority areas.

3. Development Requirement SPD

The development requirement SPD for Stratford-on-Avon is currently being developed and hence has a strategic role to play to foster DH schemes and presents a valuable opportunity to include more detailed policy around heat networks. Currently the document is being drafted and the consultation should take place around the fourth quarter of 2016 and the first quarter of 2017, before being adopted in the second or third quarter of 2017.

Considering that this document will set out detailed requirements and guidelines against which future planning applications will be judged, it has the potential to be tailored around district heating, based on the evidence supplied in this study. The Carbon Trust supports the Council's approach to include a detailed section on Heat Networks in this document.

It is anticipated that the SPD will include a Policy Matrix which will show links between different policies as well as highlight those policies and standards that have been either modified, replaced, or removed.

In addition to the Matrix, we advise that the Council include a section which specifies what should be included in energy statements prepared by developers to accompany their planning application, and demonstrate whether district heating is considered viable for the development. Providing upfront information regarding expectations will help to avoid situations in which energy statement are deemed non-compliant with local energy and sustainability policies.

In addition to the standard aspects that shall be covered in an energy statement (e.g. CO_2 emissions and energy costs), we advise the Council to seek to include technical requirements for futureproofing as well as a decentralised energy hierarchy.

It is our understanding that the SPD will include an implementation section to support Policy CS.26 on Developer Contributions. We therefore advise the Council include DH networks amongst the types of infrastructure that will be delivered through Section 106 (S106) or Community Infrastructure Levy (CIL).

It is important to stress that although outcomes of the EMP (e.g. identified networks and their viability) can be a valuable input to the development of this SPD, this is a high level evidence base and the conclusions drawn could be subject to change with the introduction of further detail, the Council should therefore carefully consider the appropriate level of detail. For example, whilst specifics around network routes and high level information on where heat networks are deemed to be financially viable could be included in the SPD as evidence base, we advise not to include detailed financial modelling outputs.

Wording advice for SPDs is provided in the Section B: Planning Policy Recommendations.

4. Canal Quarter Regeneration Zone SPD

As referred to in Policy CS.16 Section B, the Canal Quarter Regeneration Zone is one of Stratford-on-Avon's strategic allocations for housing development, with an expected 650 homes within the plan period from a total of approximately 1,010 homes.

Individual stakeholder meetings to discuss this SPD have already taken place, involving landlords, tenants and other key stakeholders. Seeking to create a new community in the Canal Quarter, the internal support for the work seems to be high. Several meetings have been undertaken at the Cabinet, Local Policy Advisory Group and Executive Director Level. It is anticipated that a public consultation on an initial draft could be launched in October/ November 2016, and that the examination and final adoption would occur by August 2017.

Detail on exactly what development is likely to come forward in the Canal Quarter is currently high level, however 3.7.2 outlines a potential viable opportunity that could link the high density housing with the Alcester Road network using WSHP or Gas CHP.

Considering that the SPD for this regeneration zone is in its infancy, it represents a perfect opportunity for the Council to set a planning context for the development and relate it to DH. The document will guide developers and the Council in respect of environmental, social and economic design. We hence advise that the SPD should include a decentralised energy hierarchy, details on technical requirements for future-proofing and an outline of what should be included within energy statements which assess whether connection to a heat network is considered viable.

SPDs set the context for development prior to knowing if connection to a scheme is economically viable, so it is important to stress that where viability hasn't been demonstrated yet, wording shall be softened.

Wording advice for SPDs is provided in the Section B: Planning Policy Recommendations.

5. Gaydon / Lighthorne Heath New Settlement SPD

As referred to in Policy CS.16 Section B, the Gaydon/Lighthorne Heath New Settlement (GLH) has been identified as a strategic allocation site for housing, with an expected 2,300 homes within the plan period from a total of approximately 3,000 homes.

3.7.3 outlines that a heat network could be viable within the village centre of the GLH site. There is also an opportunity to link this with plans for electricity generation at the nearby JLR site. JLR may be undergoing Masterplanning which includes an options appraisal for delivery of their energy strategy.

The agreed SPD only superficially refers to DH and hence the Council cannot impose stringent conditions to require developers to investigate viability of connecting to a scheme. Suggested wording for these conditions is presented in Section B.

Given initial results from the EMP study concluded that the GLH Village centre network only has a high level IRR of 5.8 %, it is likely that the developments with a lower heat density would require contributions from developers or capital grant to be viable. S106 agreements could be a potential route to raise capital contributions, however given that both the SPD and S106 have already been agreed for this development, we see little room for modification at this stage.

Another way of potentially securing a DH scheme within the core of this new settlement is to include reference to decentralised energy in the conditions for pre-reserved matters. Reserved matter applications can be used after an outline planning application has been approved and they focus on those details that were outstanding in the initial outline planning proposal.

However, because of the more advanced timing of this development, we recommend that the most effective way to implement a heat network at this site would be to adopt a cooperative approach between the Council, HCA and the developers to establish informed discussions to highlight the benefits of this approach and strengthen developers' willingness to investigate connection to a future network.

6. Long Marston Airfield New Settlement SPD

As referred to in Policy CS.16, Section B of the Core Strategy, the Long Marston Airfield New Settlement (LMA) is the largest strategic allocation site for Stratford-on-Avon's housing development, with an expected 2,100 homes within the plan period from a total of approximately 3,500 homes.

Initial meetings between CALA homes and the Council have been taken place, and external bodies including HCA are expected to participate in the development of the SPD. It is our understanding that CALA homes have expressed mixed views regarding district heating.

The SPD for this new development will set out broad principles to show how the policy requirements established by the core strategy in Policy CS.2 and CS.3 should be delivered. In particular it will meet the Council's environmental, social, design and economic objectives as the Council seeks to create a new community at LMA.

Initial results from the EMP study suggest (see 3.7.6) a very low linear heat density and resulting low financial viability. Nevertheless, some very high level sensitivity analysis on this LMA site shows that a network may reach a 25 year IRR of 5% with a 30% capital grant and a small increase in heat sales tariff.

Therefore, a potential heat network is not being ruled out at this stage and there might still be some information unknown to us which could render a DH scheme viable in pockets. If this was true, we would advise the Council to include reference to decentralised energy in the SPD. For reference, one can refer to possible wording for the Canal Quarter Regeneration Zone SPD in Section B, as the two programmes of delivery are broadly aligned.

As highlighted for the Canal Quarter SPD, we recommend some light touch wording until more information on the development will be available.

B. PLANNING POLICY RECOMMENDATIONS

The developer requirement SPD for Stratford-on-Avon is currently being developed and hence has a strategic role to play to foster DH schemes and presents a valuable opportunity to include some more detailed policy around heat networks.

It is recommended that the Planning authority requires proposed developments to connect to a network where it exists, or for the development to be designed so that it can connect to a future network where a viable network is identified.

It is also recommended that the policy includes a heating and cooling hierarchy to require that developers select technologies in accordance with this hierarchy. Applying a hierarchical approach to the selection of heating and cooling technologies offers a reasoned method through which to make the most appropriate choice and to ensure that solutions are appraised logically. This has been implemented successfully in local authorities including Horsham District Council and Guildford Borough Council.

Some policy wording is suggested below:

Possible wording for Stratford-on-Avon Development Requirement SPD guidance

Decentralised Energy
All new developments must connect to (C)CHP distribution networks where they exist, or incorporate the necessary infrastructure for connection to future networks, unless it can be clearly demonstrated that doing so is not feasible or that utilising a different energy supply would be more sustainable.

*Proposals for development within in **heat priority areas,** as defined in the Stratford-on-Avon Energy Masterplanning Study (201**6**) and sufficiently large or intensive developments must demonstrate that heating and cooling technologies have been selected in accordance with the following **heating and cooling hierarchy**;*

1: Connection to existing Combined Cooling Heat and Power (CCHP) distribution networks
2: Site wide renewable distribution networks, including renewable CCHP
3: Site wide gas-fired CCHP distribution networks
4: Renewable communal heating
5.Gas-fired communal heating
6: Individual dwelling renewable heating
7. Individual dwelling heating, with the exception of electric heating

All CCHP must be of a scale and operated to maximise the potential for carbon reduction. Developments that do not connect to or implement (C)CHP or communal heating networks should be 'connection-ready'.

Energy Statements
Developments in the priority areas and strategic developments should demonstrate and quantify how the development will comply with the heating and cooling hierarchy. Stratford-on-Avon District Council will work proactively with applicants on major developments to ensure these requirements can be met.

Reference to the heating and cooling hierarchy should also be included in energy statements that accompany planning applications.

Possible wording for Stratford-on-Avon Development Requirement SPD guidance

Energy Statements
Developments in heat priority areas, sufficiently large or intensive developments should demonstrate and quantify how the development will comply with the heating and cooling hierarchy as part of their energy statements. Stratford-on-Avon District Council will work proactively with applicants on major developments to ensure these requirements can be met.

Assessments of heat network viability should:

- *be compliant with the CIBSE Heat Networks Code of Practice for the UK;*
- *include baseline energy consumption and carbon emissions calculations for regulated and non-regulated energy use;*
- *assess the potential to connect both residential and non-residential buildings to a heat network;*
- *assess whether there are opportunities for heat offtake from nearby sites;*
- *compare the economics of a heat network solution against a "business-as-usual" scenario (e.g. individual gas boilers);*
- *present Internal Rate of Return, Capital Expenditure, cost and carbon savings as outputs.*

We recommend that thresholds are set in order to future proof the policy and ensure that new developments that come forward investigate district heating should the makeup of the development be appropriate for district heating. These developments would be termed "Sufficiently large or intensive developments" and defined as:

(a) residential only developments of at least 55 dwellings per hectare and/or 300 dwellings

(b) All mixed use developments

Moreover, it is useful to incorporate technical requirements for connection to existing networks, planned networks or those networks under construction.

Possible wording for Stratford-on-Avon Development Requirement SPD guidance

Technical specifications for connection to an existing network, to a planned network or a network under construction
All buildings connecting to an existing heat network, or all those required to be 'connection ready' must adhere to the relevant guidelines set out in Chapter 3 – Design – of the CIBSE Heat Networks Code of Practice for the UK. The Council or their representatives will monitor compliance with the following CIBSE Heat Networks Code of Practice objectives:

Objective 3.3 *– to select suitable building interfaces, direct or indirect connection*
Objective 3.4 *- to design or modify suitable space heating and domestic hot water services systems*
Objective 3.9 *– to achieve an efficient heat distribution system within a multi-residential building and to reduce risk of over-heating*

The developer and their subcontractors will be required to work with the Council and their representatives to ensure heat demand is correctly calculated and that the Code of Practice requirements are correctly understood and implemented.

Technical specifications are included to ensure that connecting buildings or buildings being constructed as 'connection-ready' or 'future-proofed' are appropriately designed and built to connect to a heat network. If a building is not correctly constructed then the network operator will be unable to connect it without costly

remedial work, or it may be connected and adversely affect the operation and technical and financial performance of the network.

At a high level, developments will be 'connection-ready' if they have a communal wet heating system with variable flow controls and a safeguarded pipe route to allow future connection. Further requirements on pipework insulation requirements, size of heat emitters, temperature of the system, number of port valves etc. are outlined in the CIBSE Heat Networks Code of Practice.

Possible wording for Stratford-on-Avon Development Requirement SPD guidance

Technical specifications for connection to an existing network, to a planned network or a network under construction

All buildings connecting to an existing heat network, or all those required to be 'connection ready' must use a centralised communal wet heating system rather than individual gas boilers or electric heating.

Buildings must allow adequate plant room space to allow for connection at a later date (the exact requirement to be agreed with the Council and their representatives).

The developer must identify, with the support of the Council or their representatives, and safeguard a pipe route to allow connection between the building and the highway or identified network route where available.

The developer must ensure that sufficient space for energy centre is safeguarded if considered appropriate.

The developer must not in any other way compromise or prevent the potential connection of the building to a planned network.

For every new development, and in particular for those developments in the identified DH priority areas, it is recommended that the Council includes a heating and cooling hierarchy in SPDs with reference to Core Strategy Policy CS.3: ***"developments will be encouraged to incorporate infrastructure for district heating"***.

It should also refer to Policy CS.2 and expand on the energy hierarchy presented in Section B. The energy hierarchy would ensure that developers consider connecting to an existing network or carrying out future-proofing measures.

To help secure a District Heating Scheme within the core of the new Canal Quarter regeneration zone or the LMA new settlement for instance, we recommend the following wording:

Possible wording for Canal Quarter SPD guidance

District Heating

Results from a recently undertaken Energy Masterplan study indicate that there is a viable opportunity for heat networks within the Canal Quarter.

Based on these findings, the developer shall use reasonable endeavours to connect all buildings within [insert development name here] to the District Heating Facility unless it can be demonstrated that it is not economically viable. The developer should recognise that the point at which economically viability can be demonstrated may arise in the future, for example, at the end of the economic life of a stand-alone CHP plant.

Development should demonstrate that the heating systems have been selected in accordance with the

following heating and cooling hierarchy;

1: Connection to existing Combined Cooling Heat and Power (CCHP) distribution networks
2: Site wide renewable distribution networks, including renewable CCHP
3: Site wide gas-fired CCHP distribution networks
4: Renewable communal heating
5.Gas-fired communal heating
6: Individual dwelling renewable heating
7. Individual dwelling heating, with the exception of electric heating

All CCHP must be of a scale and operated to maximise the potential for carbon reduction. Developments that do not connect to or implement (C)CHP or communal heating networks should be 'connection-ready'.

Energy Statements
Developments in this areas should demonstrate and quantify how the development will comply with the above mentioned energy hierarchy. Stratford-on-Avon District Council will work proactively with applicants on major developments to ensure these requirements can be met.
Developers will be given access to the Energy Masterplan study and will hence have the opportunity to review the outputs and highlight the proposed approach they intend to take in their energy statements.

CIL Charging Schedule

Regulation 123 list accompanies the Charging Schedule and outlines the types of infrastructure that may be funded by CIL. Currently Regulation 123 in Stratford-on-Avon includes district heating networks as a potential route to be financed through CIL, with the omission being that the adaptability and futureproofing of these networks need to be secured through individual Section 106 agreements.

Section 106 Agreements

There are a range of potential applications of Section 106 Agreements to support heat network developments. Current views of the effectiveness of these applications is mixed and they have not been widely tested in this context. At a high level, Section 106 agreements can be used to oblige developers to connect to an existing or planned network, including to set detailed technical standards for the connection of specific buildings where they meet the tests outlined above.

These technical specifications should be developed with the network operator to ensure they are consistent with the existing or under construction network to which the building will connect. These should include detailed specifications for:

- Exact space requirements in plant room
- Flow and return temperatures, particularly the return temperature
- The exact route of pipework between the building point of connection and the heat main
- Internal building systems

It is recommended that Section 106 Agreements are used to oblige developers to connect to planned networks that are being taken forward as a result of the current EMP study and to ensure that developments are future proofed and 'connection ready'. Some further detail is outlined below:

To oblige developers to connect to a planned network

Section 106 agreements can be used to require that new developments are designed and built to be connection-ready, if they fall within proximity to an identified heat network. For example, Islington Borough Council specify in a S106 Supplementary Planning Guidance document that major developments should be connection ready if they are located within 500 metres of an existing/planned heat network and that minor developments should connect if they are located within 100 metres of an existing network. The outputs of this Heat Mapping study could be used to identify a list of postcode areas that fall within proximity to an identified heat network, defined as a Heat Priority Area.

Islington Borough Council Planning Obligations (Section 106), November 2013

7.37. All development will be required to contribute to the development of these DENs, including by connecting to networks where these exist in their vicinity (CS 10) unless it is demonstrated that this is either not feasible or not viable. In the case of minor development, whether or not a development will be required to assess the viability of a connection is decided by location of the development (A list of postcodes will be provided on our decentralised energy webpage www.islington.gov.uk/heatnetwork for minor developments to assess opportunities for connection).

7.38 The requirements for connection to DENs are as follows (DM7.3):

Major Developments are required to be designed to be able to connect to a DEN and, unless a feasibility assessment demonstrates this is not reasonably possible,

- *if located within 500 metres of an existing DEN will be required to connect and meet associated charges,*
- *if located within 500 metres of a planned future DEN (likely to be operational within 3 years of planning permission), will be required to provide a means to connect and meet associated charges,*
- *if connection is possible, are required to detail a preferred energy strategy and an alternative energy strategy within their Energy Statements, and*
- *if connection is not possible, should develop and/or connect to a Shared Heating Network (developers will be obliged to look at the neighbouring buildings to assess the applicability of expanding a site wide communal energy network beyond the site to the local neighbourhood)*

Minor developments, if located within 100 metres of an existing DEN (see postcode list on our website at www.islington.gov.uk/heatnetwork), unless it can be demonstrated that this is not reasonably possible, will be required to be designed to be able to connect to a DEN.

This should also include detailed technical requirements to enable future connection, including that developments install a communal wet heating system with variable flow controls and safeguard a pipe route to allow future connection. This should use guidance from the CIBSE Heat Networks Code of Practice for the UK

It is recommended that Section 106 Agreements are used to oblige developers to connect to planned networks that are being taken forward as a result of the current Energy Masterplanning study.

To future proof connections

Section 106 Agreements can be used to future-proof connections within proximity to an identified heat network to ensure that development makes provision for connection to a future DHN expected to be built in the area. As these requirements will be relating to a network that has not yet been constructed (and whose construction may not be guaranteed), they cannot be as specific as requirements for connection to an existing network or a network under construction. Possible paragraphs could include the following:

- Heat in the building must be delivered through a centralised, communal wet system
- Heat in the building should operate at an appropriate temperature for future connection to a heat network. The targeted difference between flow and return temperatures on the primary heat network under peak demand conditions shall be greater than 30°C for supply to new buildings and greater than

25°C for existing buildings. Objective 2.4 of the CIBSE Heat Networks Code of Practice for the UK outlines the preferred temperature design for varying heating systems in further detail.

- Plant rooms should be situated to consider potential future-pipe routes and sufficient space must be allowed for building/network interface equipment (such as heat exchangers). For example, see Stockport Council's Guidance for District Heating Feasibility23
- Pipe runs from the plant room to the highway or proposed heat main route [specify if possible] must be protected and remain accessible for future installation

OR

- A pipe run must be provided between the plant room to the highway or proposed heat main route [specify if possible]. Nb. This has proved difficult to implement elsewhere due to the cost involved

C. USING PLANNING CONDITIONS TO SECURE SUCCESSFUL HEAT NETWORKS

As previously mentioned, the SPD and S106 for GLH have already been agreed on. In order to future-proof the development for possible future JLR development to the east of the site, we suggest cooperative discussions between HCA, the Council and developers. Moreover, there is the possibility to include pre-reserved matters conditions to the planning application. Some wording is presented hereafter:

Possible pre-reserved matters condition wording for Gaydon Lighthorne Heath new settlement

Initial results from an on-going Energy Masterplanning study have identified possible financial viability for a district heating scheme at the GLH new settlement. Developers having received planning applications for a new development within this area are required to comply with the following conditions which are part of a Site Wide Phasing Strategy and Programme of delivery for:

(k) A site wide strategy for mitigating and adapting to climate change including measures for:

i. Designing buildings to cope with more extreme temperatures;
ii. Reducing energy demand through efficiency;
iii. The efficient supply of energy, including ~~where appropriate~~ decentralised energy systems such as a District Heating Scheme unless it is demonstrated that this would render development unviable.
iv. The provision of energy from renewable or low carbon sources, following an energy hierarchy as indicated in Policy CS.2
v. Minimising water consumption and accommodating 'grey' water recycling.

There are several ways in which planning conditions could be used to secure the successful delivery of heat networks in Stratford-on-Avon. The following are recommended:

Condition to ensure connection to an existing network / network under construction

Where connection to an existing network is viable, planning conditions can be used to ensure the connection is implemented. This has been used successfully throughout London and within Exeter.

Determining whether it would be feasible and viable for a developer to implement a site-wide heat network or to connect the development to an existing network or network under construction should occur before planning

[23] Stockport MB Council. (2013). Guidance for District Heating Feasibility.
http://www.stockport.gov.uk/2013/2994/developmentcontrol/planningpolicy/dhguidance

permission has been granted and consequently it would not be necessary to include "if feasible or viable" within the wording for a planning condition. This assessment would be carried out by the developer before planning permission is granted and included within the Energy Statement submission.

Condition to require connection before a development has been occupied

Where it has been agreed that a development will connect to an existing network / network under construction, planning conditions can be used to require that the developer establishes a physical connection to the network before the development has been occupied. This has been used successfully throughout London and within Bristol.

"The developer shall install and commission a physical connection for each dwelling to the District Heating Facility before the development is occupied."

Condition to require connection to future networks

Where it is has been agreed that a development will connect to a planned network in the future, planning conditions can be used to require that a developer provides provision for future connection.

"The developer shall use reasonable endeavours to connect all buildings within [insert development name here] to the District Heating Facility unless it can be demonstrated that it is not economically viable. The developer should recognise that the point at which economically viability can be demonstrated may arise in the future, for example, at the end of the economic life of a stand-alone CHP plant.

A decision regarding network connection at this development should be made by [define cut-off date]. If at this time it is not possible to agree connection to the District Heating Facility, due to the network being incomplete, the Developer shall submit an Alternative Energy Strategy for agreement."

This phrase "reasonable endeavours" has been taken from the London Plan and represents the fact that a condition to require connection to a planned network brings about an element of uncertainty, both from the point of view of the network operator and the developer. At the time of issuing such a planning condition, it would be unlikely that the network operator could supply the developer with exact details on the heat tariff structures or cost of connection. This would mean that the accuracy of the developer assessment of economic viability cannot be guaranteed.

The reality is that there would be an element of risk associated with the likelihood of future connection, and circumstances could arise which mean that it is not viable for the development to connect. For instance, the network route could change, meaning that the cost of connection is greater. Or the connected heat demand could decrease, meaning that the network operator has to ramp up the heat prices leading to uncompetitive prices.

There has been lots of discussion within the heat network industry regarding the legal enforceability of this type of planning condition. Some state that you can legally enforce connection but you cannot force a development to purchase heat. As highlighted, this is an uncertain and evolving policy and so we cannot guarantee the effectiveness of this type of planning condition.

However, to cite a recent example, Exeter City Council included a requirement for a development to connect to a planned heat network within a Section 106 agreement, stating that it must connect "unless it would unreasonably delay construction". This led to an issue where the developer decided to implement individual boiler solutions,

arguing that the implementation of a heat network connection was going to take too long and the council was forced to take out an injunction on the developer. This dispute was recently settled and the development has now been connected to the network.

D. ADVICE FOR DEVELOPER NEGOTIATIONS

Local Authorities should focus on building a positive evidence base, using Heat Mapping, Energy Masterplanning and techno-economic feasibility studies to demonstrate to a developer that connection to / or construction of a district heat network is technically and financially viable in the local context.

Before beginning discussions with a developer it is important to understand the developer business model - different developers will use different forms of financing from different sources and some will take a longer / shorter term interest in the development. If possible, also find out who their tenants will be - some developers are realising that heat network connection can help them meet the carbon targets of some high-profile tenants to whom they wish to sell or lease space.

Where developers seek to further investigate the viability of a district heating scheme in their energy statement submission, it should be ensured that testing has been carried out to industry best practice as outlined in the CIBSE Heat Networks Code of Practice. Developers tend to prefer to discount district heating using the technical and consumer argument rather than viability.

Considering advantages beyond cheaper heat or power can also pay dividends in making a developer more willing to engage. For instance:

- Focussing on the reputational benefits that connection to a low-carbon district heat network will interest some developers more than others
- Connection to a district heat network removes the need for individual gas boilers and large plant rooms as heat is provided to a building through a Heat Interface Unit which requires less space. The space gains translate to real financial gains for the developer, who can make use of the additional lettable space.
- A developer can collaborate with an Energy Services Company (ESCo) to implement site-wide district heating. This could enable the developer to offload a proportion of capital costs for heating / cooling plant to the ESCo, who will be incentivised to contribute capital because of the return on investment through the sale of heat.
- Depending on the carbon content of the heat provided, connection to a heat network can provide a lower cost way of meeting carbon reduction targets than the equivalent deployment of microrenewables.

However, planners should note that when only future-proofing measures are required then connection to a future network is not guaranteed. Also, depending on contractual requirements, some buildings may choose to disconnect in future.

6 CONTRACTING AND GOVERNANCE

This section assesses the potential contracting and governance models for network options identified. There are a range of contracting models in the UK district heating market. The following section provides a high level introduction to the most relevant opportunities potentially available.

Some companies offer the full spectrum of design, build, own, operate, and maintain roles while others may specialise only in offering subsets of those services under contract. Works include scheme design, energy centre installation, network construction and connection of premises, all of which need to be financed. Services include energy purchase, generation, O&M, metering and billing and customer service and management. Property agreements include sale or lease of operational land and buildings, easements and wayleaves.

Three models have been introduced and explored: public sector ownership with outsourced network operation, private sector led ESCo scheme and Design, Build, Finance and Operate. This covers the range of options that are considered appropriate for the opportunities identified, but there are many variations within each and this requires further consideration as more information becomes available.

6.1 Public sector ownership of network with outsourced network delivery and operation

In this model the public sector remains the asset owner and contracts to supply heat to consumers. The build and operation is outsourced, with design either completed by consultants or included in the contractor package. The main strengths of this approach are that it can make the best use of the Public Sector's access to lower cost capital, it allows the public sector to retain some control over customer prices and service and allows the strategic development of the scheme in future years. However, the retail relationship with the customers would usually be with the operator and so it is unlikely that the public sector will have complete control of the heat price. A further benefit is that the public sector partnership would procure experts to operate the network reducing the requirement to up-skill in house.

Under this arrangement the public sector would take the majority of operating risk of the service. The owner may also retain responsibility for new connections and the expansion of the network, though these functions could also be assigned to the contractor. Risk associated with appropriate design and operation of the system would be carried by the supplier.

This may be an attractive model where a significant amount of the demand comes from public sector buildings Bridgeway, Town Centre and Alcester Road Networks.

In this model, the council will be required to make an investment. A potential option to aid this would be to use CIL to raise capital contributions from the developers, to secure a grant from HNIP or to secure investment from other public sector partners.

6.2 Energy Services Company (ESCo)

If the public sector does not wish to own or operate a district energy scheme then a specialist service provider can bring expertise and risk management services to deliver the scheme. Energy Service Companies (ESCos) are private companies, which provide varying levels of input to District Heating/CHP schemes and other types of energy service contracts. Typically, these services include project design, capital finance, construction, management, fuel purchasing, billing, plant operation, maintenance, long-term plant replacement and risk management.

ESCo arrangements work where an organisation is seeking to deliver the project for the lowest possible capital cost (with associated energy demand guarantees and so this is not risk free for the Council). The ESCo could potentially finance the Energy Centre plant and network and recover this investment by owning and operating the scheme under long-term energy supply contracts with consumers. The ESCo would be responsible for the performance and operation of the plant, for all maintenance and for any capital replacement costs over the term of the contract. Under this arrangement, the Whole Life Cost savings would essentially be shared between the ESCo and the consumers. The ESCo's element of the benefit is used for repayment of its initial investment and profit, whilst the consumers benefit is apparent through reduced energy costs.

An ESCo will seek a return on its investment that is greater than 10-12% IRR. As this return on investment is unlikely to be available for the network options presented for Stratford-on-Avon, the ESCo will expect a capital contribution to meet this shortfall. In addition, Stratford-on-Avon Council may have little influence over the pricing across the scheme unless upfront contractual agreements are made. Where pricing caps are agreed these will be at the cost of having to manage other project risks such as demand security.

6.3 Design, Build, Finance and Operate (DBFO)

Under this arrangement the developer (potentially the Council or a developer of one of the sites identified in this study) would appoint a single contractor to finance, design, build, operate and supply wholesale heat and electricity to the network. The contractor has full liability for the provision of heat and power to the network. The price at which heat will be supplied, given the required level of availability and standards of performance, is the key commercial consideration on which procurement would be focussed. The time taken in negotiating this and the associated Service Level Agreements should not be underestimated.

Where the DBO contractor finances the design and installation of the project the contract period would normally be in excess of twenty-five years, so that this initial investment can be paid back. The length of this contract is often determined by the available project returns, as determined in the financial viability assessment. At the end of the contract, the assets would normally be handed over to the sponsor.

Given that the public sector partners recognise the reputational risk around pricing, this model could reduce this risk. The public sector partners could also have more influence over the supplied heat price and the end cost to the consumer. If customers believe that the public sector partners carry influence over the scheme then this model gives them more control over customer pricing and indexation.

6.4 Procurement

The iterative process of determining the best blend of financial structure, technical design and operation, and ownership of the scheme will inform the procurement process and will be dependent on the partner's appetite for risk and reward.

The most successful approach is likely to involve procuring a first phase which can be expanded over time. It is often more realistic to go to market with a first phase rather than the entire large network. Incentives/requirements on network expansion may then be built into the contract.

Most public sector district energy schemes are subject to OJEU procurement processes, whether they are procured as a service or through capital expenditure. The capital expenditure associated with this scheme and service investment would take this project well over the works or services threshold irrelevant of the delivery model chosen.

The procurement route will depend upon the business model selected and additional work would be required based on the ownership model chosen. The negotiation period with an ESCo can be significant, often 2 years or more, and will require the appointment of specialist advisors in OJEU procurement, legal and technical advice.

If a public sector / public-private SPV ownership model is pursued then the scheme can be consultant designed or packaged as part of a design and build contract. Each carries its own risk and benefits and these will need to be carefully considered in developing a procurement strategy. The Carbon Trust would only advise pursuing the consultant led approach for smaller schemes due to the project development costs involved. Often the chosen procurement route is an open or restricted tender.

6.5 Summary

Stratford-on-Avon Council have a number of options to consider and these include doing nothing, funding the scheme (or elements of the scheme) or playing a supporting and facilitating role.

As the options considered are high risk propositions and the high level financial cases for the presented schemes have IRRs of <10%, this would restrict financing opportunities and development opportunities. Networks are only likely to be a viable

proposition if developed by, or with financial support from developers, with a grant, or with a mix of grant funding and public sector borrowing.

Public sector ownership would be more suitable for the schemes proposed within the town centre, as there is a high proportion of council-owned and public sector buildings. Whereas the private sector led schemes would be more appropriate for the new development schemes, with support provided through planning policy and potential grant funding.

7 CONCLUSIONS

This report details the results of the Stratford-on-Avon District Council Heat Mapping and Masterplanning Study. The district energy network options assessed have the potential to contribute to the regeneration of the Stratford-on-Avon District, deliver low carbon developments for the area, generate revenue (business model dependant), improve energy security, reduce fuel poverty (business model dependant) and reduce domestic and commercial carbon emissions.

Data Collection and Review

An extensive list of potential heat loads and key energy sources within the heat map area was compiled. This was completed following external site inspections and in discussion with stakeholders. One of the main risks associated with the energy mapping exercise was the accessibility of accurate data for existing buildings and up to date development information from a diverse range of developers for the strategic sites. The consultant team met and liaised with planning officers from Stratford-on-Avon District Council and reviewed key planning documents and development masterplans.

Numerous attempts were made to obtain information from Jaguar Land Rover, Aston Martin Lagonda and Stratford-upon-Avon College but the consultant team received limited information on their energy consumption and future plans.

Energy Demand Assessment

Within the Stratford-upon-Avon Town heat map area, the largest heat demand was Bordon Hill Nursery. Other key heat loads include the Holiday Inn and the Canal Quarter development area. The majority of the heat demand required by planned developments arises from residential use with the exception of Gaydon / Lighthorne Heath village centre and the employment area at SUA.2.

The vast majority of electricity demand arises from retail buildings including Morrisons, Tesco, Marks and Spencer and the Maybird Shopping Park. The Royal Shakespeare and Swan Theatres account for the 5th largest electricity demand within the Stratford-upon-Avon Town heat map area. Electricity demands were relatively low at the majority of strategic sites due to the small number of non-domestic buildings.

A low number of significant cooling demands were identified within heat map areas, with the exception of Morrisons and Tesco supermarkets within the Stratford-upon-Avon Town heat map area. At this stage, no significant cooling demands have been quantified at the strategic sites. The majority of development sites are mainly residential, however, some businesses may be located in the employment and retail areas for Gaydon / Lighthorne Heath, Meon Vale / Long Marston Depot and Long Marston Airfield strategic sites and will potentially have cooling requirements although this is unknown at this stage. There may also be cooling requirements from the elderly care residential properties within Gaydon / Lighthorne Heath Village Centre, however the specific building type is unclear and cooling demands are likely to be relatively low (the electricity demand for air conditioning in these properties has been considered within the electricity demand assessment). When more detailed plans are made available, then the opportunity in relation to large retail, employment units, elderly care units and any other likely cooling demands in these development areas should be further investigated, as part of further masterplanning or feasibility assessment, and discussed with developers.

Due to the high level nature of information currently available for the majority of strategic sites, it was not possible to identify the location and energy demand for each building. In most cases, the heat and electricity demands for strategic sites were displayed as area heat and electricity density, based on building use, housing density and an assumed average dwelling size based on the types of dwellings for each area.

Existing and Planned Energy Sources

Existing and future heat sources with potential to supply networks at the subject sites were investigated; the biomass boiler at Tappex Threads and biomass and small gas CHP at Bordon Hill Nursery were ruled out as potential energy sources. A potential gas CHP scheme at Stratford-upon-Avon Hospital was considered to serve the Ambulatory Care Centre planned development, however, after discussion with NHS Trust representatives it was found that there are no current plans to implement scheme.

No potential existing energy sources were identified for the strategic sites. There may be potential for heat offtake from Jaguar Land Rover or Aston Martin Lagonda Ltd, near the Gaydon / Lighthorne Heath development site, however no information was received and offtake opportunities from existing from current processes are likely to be limited. If Jaguar Land Rover are planning to generate electricity at their site, then this may provide the catalyst for developing a substantial heat network at the Gaydon Lighthorne Heath strategic site.

Potential Site Barriers

Potential site barriers for Stratford-upon-Avon town include the Stratford-upon-Avon to Henley-in-Arden railway line, the Stratford-upon-Avon Canal, the River Avon, the A422 and A3400. There are also a significant number of listed buildings, archaeological sites and conservation areas surrounding the town centre and these were considered when assessing and costing the various network options. No major barriers were identified for the strategic sites.

Assessment of Clusters

The existing buildings and development sites within the Stratford-upon-Avon town heat map area were considered in order to identify thirty-three potential heat demand clusters (see Figure 40). The clusters were selected based on physical barriers, building type, development plans, connection risk, heat demand and location.

The majority of cluster linear heat densities away from the town centre are low (see below). Ten clusters within the heat map area had high linear heat densities. Twenty-six clusters have been classed as high risk due to physical barriers and/or connection risk issues and seven clusters have been classed as medium risk. At this early stage, there are no low risk clusters (see Figure 73 below).

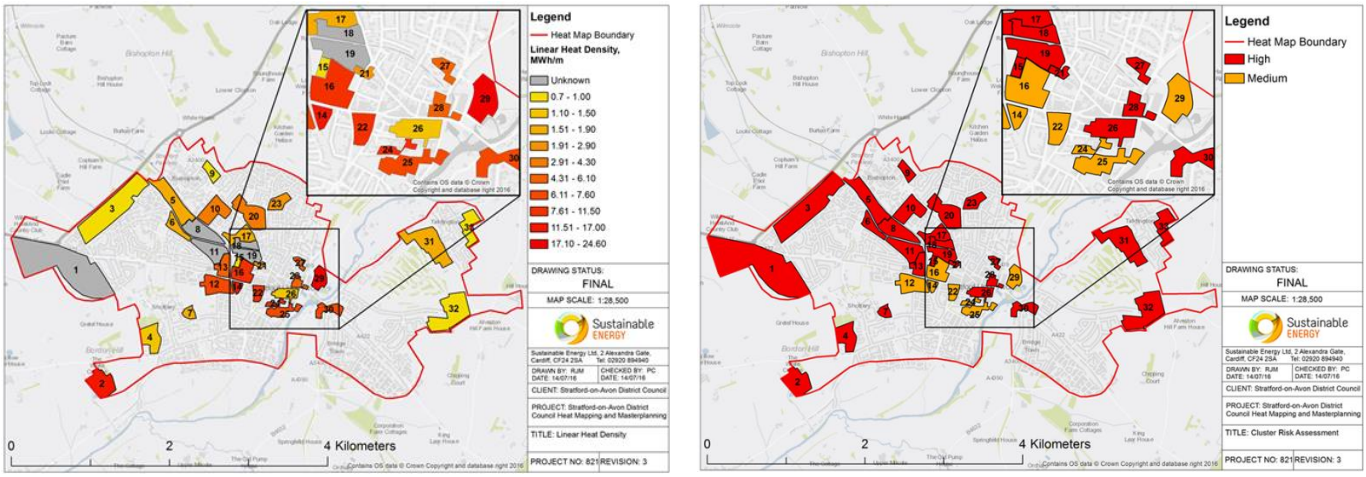


Figure 73: Cluster summary for Stratford-upon-Avon town

Technology Assessment

Anaerobic digestion, biomass heat, biofuel CHP, EfW, gas CHP, deep geothermal, GSHP and WSHP were assessed for technical suitability. Biomass heating, gas CHP, WSHP and GSHP were selected for more detailed assessment for potential network options for both Stratford-upon-Avon Town and the strategic sites.

Stratford-upon-Avon Town Priority Heat Networks

Three priority networks have been identified within Stratford-upon-Avon town (see Figure 74), namely:

- The Town Centre Network - connecting a number of buildings including those owned by Stratford-on-Avon District Council, privately owned hotels and the Royal Shakespeare and Swan Theatres
- The Bridgeway Network – connecting Bridgeway House, Holiday Inn and the Council-owned Leisure Centre
- The Alcester Road Network – connecting the Hospital (South Warwickshire NHS Foundation Trust), Coventry and Warwickshire NHS Foundation Trust and Orbit Heart of England Housing Association buildings, the Stratford Hotel and The Limes (private care home).

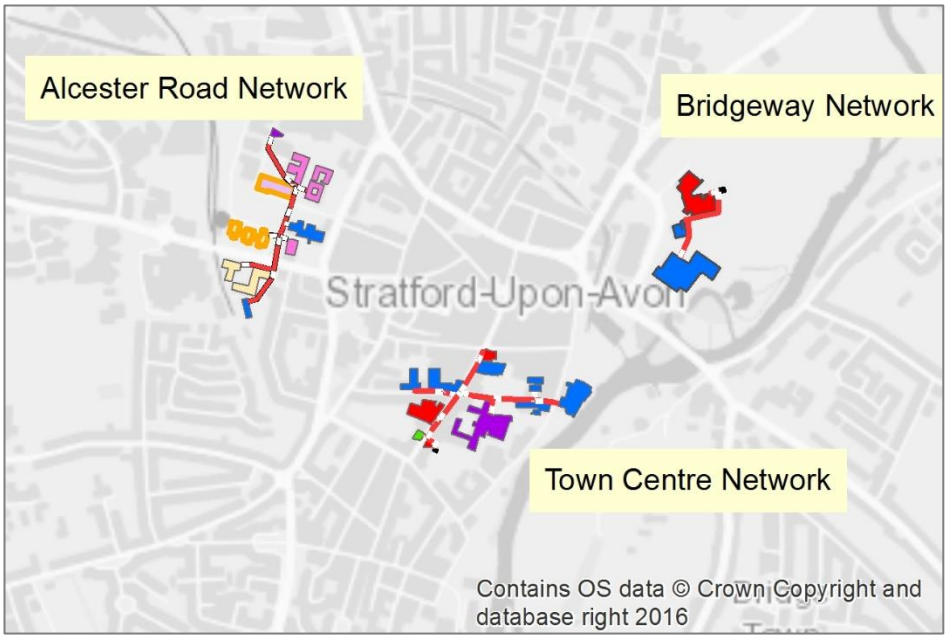


Figure 74: Stratford-upon-Avon town priority heat networks

Table 49, Table 50 and Table 51 summarise the high level financial assessment and key sensitivity parameters and risks for the Town Centre, Bridgeway and Alcester Road networks respectively.

Table 49: Town Centre network summary

Technology	Network trench length	Estimated CAPEX	Carbon savings	Timing	25 year financial case			40 year financial case		
					Discounted payback	IRR	NPV	Discounted payback	IRR	NPV
Gas CHP 380 kWth	0.7 km	£2,513,011	539 tonnes per annum	0-3 years	23.4 years	4.2 %	£200,154	26.5 years	5.2 %	£767,469

Key sensitivity parameters	- Electricity private wire sales - Gas input tariff - Heat sales tariff - Capital cost	
Key opportunities	- Network includes Council owned offices, register office and Town Hall - Royal Shakespeare Company and King Edward VI school engaged at this stage - Energy centre located on Council owned land - Likely to be financially viable achieving the assumed hurdle rate required for public sector development and investment (>5 %) with a grant of ~10 % or small increase in revenue - Risk would be reduced if key stakeholders can be engaged - £4,662/tCO_2 (CAPEX per tonne of carbon saving)	
Key risks and issues	- Engagement with diverse range of private sector stakeholders including Royal Shakespeare Company, King Edward VI school, Mercure Royal Shakespeare Hotel, the Arden Hotel (building leased by Royal Shakespeare Company) and the Falcon Hotel - Archaeological sensitivity of town centre (all connections are listed buildings with the exception of Avon Court Care Home and RSC offices) - Potential disruption to town centre - Energy centre location has narrow access and in busy car park - Unlikely to achieve the hurdle rate required to be developed by the private sector (>~10 %) - Only likely to be viable if developed with a grant, or with a mix of grant funding and public sector borrowing - Presents a medium risk opportunity	**Risk Rating**

Table 50: Bridgeway network summary

Technology	Network trench length	Estimated CAPEX	Carbon savings	Timing	25 year financial case			40 year financial case		
					Discounted payback	IRR	NPV	Discounted payback	IRR	NPV
Gas CHP 450 kWth	0.3 km	£1,610,735	621 tonnes per annum	0-3 years	13.9 years	8.7 %	£1,128,115	15.5 years	8.8 %	£1,676,283
WSHP 750kWh		£2,387,536	537 tonnes per annum	0-3 years	18.2 years	4.8 %	£310,168	20.9 years	3.3 %	-£33,020

Key sensitivity parameters	Gas CHP - Electricity private wire sales - Gas input tariff - Heat sales tariff - Capital cost	WSHP - Electricity input tariff - Heat sales tariff - Capital cost	
Key opportunities	- High linear heat density cluster - Gas CHP option is likely to be financially viable achieving the hurdle rate required for public sector development and investment (>5 %) - £2,594/tCO_2 for gas CHP - £2,225/tCO_2 for WSHP		
Key risks and issues	- Engagement not achieved with Stratford Leisure Centre and the Holiday Inn at this stage - Flooding risk - Location of energy centre (local wildlife site and conservation area) - RHI tariffs may change following RHI consultation (in relation to WSHP option) - Gas CHP option unlikely to achieve the hurdle rate required to be developed by private sector partners (>~10 %) without significant increases in heat or private wire sales (>10 %) - WSHP network option may not be financially viable as it does not achieve the hurdle rate required for public sector development and investment (>5 %) without significant increases in heat sales (>10 %) or RHI (>5 %) - Only likely to be viable if developed with a grant, or with a mix of grant funding and public sector borrowing - Until the Holiday Inn and Leisure Centre are engaged, presents a high risk opportunity		**Risk Rating**

Table 51: Alcester Road network summary

Technology	Network trench length	Estimated CAPEX	Carbon savings	Timing	25 year financial case			40 year financial case		
					Discounted payback	IRR	NPV	Discounted payback	IRR	NPV
Gas CHP 650 kWth	0.6 km	£2,147,111	998 tonnes per annum	0-3 years	14.4 years	8.3 %	£1,378,760	15.7 years	8.6 %	£2,162,795
Key sensitivity parameters	- Electricity private wire sales - Gas input tariff - Heat sales tariff - Capital cost									
Key opportunities	- Energy data received from Stratford Hospital and Orbit Heart of England Housing Association - Risk would be reduced if key stakeholders can be engaged - £2,151/tCO_2									
Key risks and issues	- Engaging with Stratford Hospital, NHS Trusts, Orbit Heart of England Housing Association, Stratford Hotel and The Limes care home - A422 barrier - Location of energy centre - Unlikely to achieve the hurdle rate required to be developed by private sector partners (>~10 %) without significant increases in heat or private wire sales (>10 %) - Presents medium to high risk opportunity - Only likely to be viable if developed with a grant, or with a mix of grant funding and public sector borrowing									**Risk Rating**

Strategic Site Priority Heat Network Areas

At this stage, only two district heating priority areas can be identified at the strategic sites, namely:

- The Canal Quarter (see section 3.7.2)
- Gaydon / Lighthorne Heath village centre (see section 3.7.3)

However, if development plans change to increase building density or heat demand at the strategic sites then this should be reassessed. For example: If Jaguar Land Rover engage with the project and indicate they plan to generate electricity at the site then the extent of the district heating priority area at Gaydon / Lighthorne Heath should be re-evaluated (to potentially increase in size); or if the industrial units (likely to be replaced) at Meon Vale / Long Marston Depot are rebuilt to accommodate more energy intensive businesses.

For sites where detailed masterplans have not been produced, example networks have been assessed and assumptions clearly stated in order to give an indication of the technical and financial viability of district energy networks. It was found that networks at Meon Vale and SOU.3 - South of Daventry Road are unlikely to be financially viable (and be allocated as priority heat network areas) even with significant levels of grant funding. There may be a marginal opportunity for a network at Gaydon / Lighthorne Heath village centre if grant funding and/or increased levels of revenue can be secured.

For Long Marston Airfield, it has been found that a significant capital grant is likely to be required for a network to be financially viable at this stage. However, this site is of strategic importance to Stratford-on-Avon District Council due to a current bid for Garden Village funding. If this bid is successful or if development plans change then the viability of district heating in this area should be reassessed.

Gaydon / Lighthorne Heath Village Centre Network
A summary of the Gaydon / Lighthorne Heath village centre network is shown in Table 52.

Table 52: Gaydon / Lighthorne Heath village centre network summary

Technology	Network trench length	Estimated CAPEX	Carbon savings	Timing	25 year financial case			40 year financial case		
					Discounted payback	IRR	NPV	Discounted payback	IRR	NPV
Gas CHP 580 kWth	1.0 km	£2,411,020	923 tonnes per annum	2-10 years	22.0 years	4.6 %	£319,307	23.8 years	5.8 %	£1,006,168
Biomass 550 kW		£1,882,598	876 tonnes per annum		> 25 years	1.5 %	-£342,329	> 40 years	0.3 %	-£549,491
GSHP 1,000 kW		£3,709,697	5981 tonnes per annum		> 25 years	3.2 %	-£121,985	> 40 years	0.7 %	-£859,939

	Gas CHP	Biomass	GSHP
Key sensitivity parameters	- Electricity private wire sales - Gas input tariff - Heat sales tariff - Capital cost	- Wood fuel costs - Gas input tariff - Heat sales tariff - Capital cost	- Electricity input tariff - Heat sales tariff - Capital cost
Key opportunities	- Gas CHP network option likely to be financially viable achieving the hurdle rate required for public sector development and investment (>5 %) with a small grant (~10 %) or an increase in revenue - Likely to require grant funding and/or increased revenue - A larger network at Gaydon / Lighthorne Heath may be viable if Jaguar Land Rover are planning to generate electricity at their site and are interested in heat offtake arrangements (i.e. selling heat to a network) - £2,612/tCO_2 for gas CHP - £2,149/tCO_2 for biomass - £2,963/tCO_2 for GSHP		
Key risks and issues	- Assessment based on high level development plans which are likely to change - Network reliant on engagement with developers - Likely to require grant funding and/or increased revenue - Unlikely to achieve the hurdle rate required to be developed by private sector partners (>~10 %) even with significantly increased heat and private wire sales and or connection charges - This network presents a high risk opportunity and may require a grant, or a mix of grant funding and public sector borrowing - Developer engagement and planning conditions critical to drive network development		**Risk Rating**

The Canal Quarter
The high density housing areas to be developed at the Canal Quarter site may present the best opportunity to develop a heat network in the Stratford-Upon-Avon district. It was also not possible to complete full network assessments for the Canal Quarter development due to the very high level plans that are currently available. However, the area heat density for this site is likely to be high and district energy networks may be financially viable. There may be an opportunity to utilise the Stratford-upon-Avon Canal as a water source for a WSHP or provide heat and power to the developments from Gas CHP. If high density housing is to be located alongside the canal as current development plans suggest then this could present a technically and financially viable network option. There is also the potential to extend the Alcester Road network to the Western Road area of the Canal Quarter development. Table 53 summaries the key sensitivity parameters and risks for the Canal Quarter network options.

Table 53: Key sensitivity parameters and risks for Canal Quarter

Network	Technology	Key sensitivity parameters	Key opportunities and risks	Risk rating
Canal Quarter	Gas CHP WSHP	Due to high level nature of assessment, not assessed at this stage	Key opportunities: - Development likely to incorporate high density housing - It is likely that the highest density of housing (low rise flats) will be alongside the Canal which may provide a viable option for a network served by a WSHP - May be potential to extend the Alcester Road network to the Western Road area of the Canal Quarter development Key risks: - Assessment based on very high level development plans which are likely to change - Reliant on engagement with developers - Canal and railway line barriers to larger network	

Planning Considerations

Planning policy and planning teams play a crucial role in the development of heat network projects. The role of planners in district heating includes providing appropriate policy and supporting guidance to developers in the development or extension of networks. Planners should work with developers to guide them on the layout of their buildings and the design of their heating infrastructure to maximise the benefits of connecting to the heat network. The technical and financial work undertaken for this study will provide an evidence base for planning policy across the District.

Core Strategy

The Core Strategy for Stratford-on-Avon Council seeks to promote sustainable development, a central theme that underpins all policies in the plan. The Core Strategy was adopted in July 2016, and therefore no new policies will be incorporated in the short term. However, there is scope for the inclusion of heat network policy within Supplementary Planning Documents (SPDs) which are under development, building on existing policy "hooks" within the Core Strategy.

SPDs

The development requirement SPD for Stratford-on-Avon is currently being drafted and hence will have a strategic role to play in delivering district energy schemes and presents a valuable opportunity to include more detailed policy around heat networks. Consultation should take place around the fourth quarter of 2016 and the first quarter of 2017, before being adopted in the second or third quarter of 2017.

Gaydon / Lighthorne Heath

Initial assessment suggests that GLH Village centre network only has a marginal financial viability, it is likely that the developments with a lower heat density would require contributions from developers or capital grant to be viable. S106 agreements could be a potential route to raise capital contributions, however given that both the SPD and S106 have already been agreed for this development, there is little room for modification at this stage.

Another way of potentially securing a DH scheme within the core of this new settlement is to include reference to decentralised energy in the conditions for pre-reserved matters. Reserved matter applications can be used after an outline planning application has been approved and they focus on those details that were outstanding in the initial outline planning proposal. However, because of the more advanced timing of this development, the most effective way to implement a heat network at this site would be to adopt a cooperative approach between the Council, HCA and the developers to establish informed discussions to highlight the benefits of this approach and strengthen developers' willingness to investigate connection to a future network.

Canal Quarter

The SPD for the Canal Quarter is in its infancy and represents an opportunity for the Council to set a planning context for the development and relate it to district heating. The document will guide developers and the Council in respect of environmental, social and economic design. The SPD should include a decentralised energy hierarchy, details on technical requirements for future-proofing and an outline of what should be included within energy statements which assess whether connection to a heat network is considered viable.

Long Marston Airfield

Initial meetings between CALA homes and the Council have been taken place, and external bodies including HCA are expected to participate in the development of the SPD. It is our understanding that CALA homes have expressed mixed views regarding district heating. The SPD for this new development will set out broad principles to show how the policy

requirements established by the core strategy in Policy CS.2 and CS.3 should be delivered. In particular it will meet the Council's environmental, social, design and economic objectives as the Council seeks to create a new community at LMA.

Initial results suggest a low linear heat density and resulting poor financial case. Very high level sensitivity analysis on this shows that a network may reach a 25 year IRR of 5 % with a 30 % capital grant and a small increase in heat sales tariff. Therefore, a potential heat network is not being completely ruled out at this stage and there may be new information or changes brought forward that could make a scheme at viable in pockets. In this case the Council should include reference to decentralised energy in the SPD. As highlighted for the Canal Quarter SPD, some light touch wording should be included until more information on the development is made available.

Planning Policy
It is recommended that the Planning authority requires proposed developments to connect to a network where it exists, or for the development to be designed so that it can connect to a future network where a viable network is identified. It is also recommended that the policy includes a heating and cooling hierarchy to require that developers select technologies in accordance with this hierarchy. Applying a hierarchical approach to the selection of heating and cooling technologies offers a reasoned method through which to make the most appropriate choice and to ensure that solutions are appraised logically. Thresholds should be set in order to future proof the policy and ensure that new developments that come forward investigate district heating should the makeup of the development be appropriate for district heating.

The Council should focus on building a positive evidence base, using Heat Mapping, Energy Masterplanning and techno-economic feasibility studies to demonstrate to a developer that connection to / or construction of a district heat network is technically and financially viable in the local context.

Governance and Corporate Actions
Stratford-on-Avon Council have a number of options to consider and these include doing nothing, funding the scheme (or elements of the scheme) or playing a supporting and facilitating role. As the options considered are high risk propositions and the high level financial cases for the presented schemes have IRRs of <10 %, this would restrict financing opportunities and development opportunities. Networks are only likely to be a viable proposition if developed by, or with financial support from developers, with a grant, or with a mix of grant funding and public sector borrowing.

Public sector ownership would be more suitable for the schemes proposed within the town centre, as there is a high proportion of council-owned and public sector buildings. Whereas the private sector led schemes would be more appropriate for the new development schemes, with support provided through planning policy and potential grant funding.

Stratford-on-Avon District Council may undertake a series of corporate actions to promote and enable a scheme including:

- Encouraging high density housing development for areas of the Canal Quarter
- Facilitating engagement with key stakeholders including Jaguar Land Rover, Aston Martin Lagonda, Royal Shakespeare Company, South Warwickshire NHS Foundation, Coventry and Warwickshire Partnership NHS Trust and Holiday Inn (to reflect network opportunities selected to be taken forward)
- Provision of Council-owned land for construction of peak and reserve energy centres and pipe routes including the Leisure Centre car park and Church Street car park (to reflect network opportunities selected to be taken forward)
- Commitment to long term purchasing contracts with a network operator for Council buildings included on Town Centre and Bridgeway networks (if selected to be taken forward)
- Engagement and support with planning consents and highways activities for networks in the town centre area, namely Town Centre, Bridgeway and Alcester Road networks (to reflect network opportunities selected to be taken forward)
- Providing resource and financial assistance to deliver feasibility and design work for potentially viable networks that may be taken forward namely Town Centre, Bridgeway, Alcester Road, Gaydon Lighthorne Heath Village Centre and the Canal Quarter

The most viable option for a District Heat network within the Stratford-on-Avon area is likely to be the Canal Quarter planned development. The viability of this should be reassessed once further development information becomes available.

8 NEXT STEPS AND RECOMMENDATIONS

The following next steps and recommendations should be considered by Stratford-on-Avon District Council.

8.1 Summary of Recommendations

Table 54 summarises the recommendations made in this report.

Table 54: Table of recommendations

Recommendations	Indicative Timeline
General	
1. Consider the findings of this study to decide how best to support district energy developments at the Stratford-on-Avon District	*Immediate*
2. Discuss the district energy proposition and seek engagement with the priority network stakeholders	
3. Engage with Jaguar Land Rover at senior level in order to establish their energy strategy for the site and develop project buy-in	
4. Set clear objectives on what a network is attempting to achieve, linked to corporate priorities, and ensure senior management support by effectively communicating the project benefits	*Short term*
5. Ensure effective early engagement and continue to work with developers to further understand the nature of the development phases being brought forward and to outline the potential benefits of viable district heat networks	
6. When the developments are brought forward and, more detailed information made available, the network options and priority heat network areas should be reassessed and refined and the high level business cases revised	*Short, medium and long term*
Corporate	
7. If projects are progressed, provide resource and financial assistance in delivering feasibility and design work	*Short and medium term*
8. Consider the governance options and models suggested in this report	
9. Provide and/or secure land for construction of peak and reserve energy centres and pipe routes	*Medium term*
10. Engage with and support planning consents and highways activities	
Project development	
11. Undertake detailed consultation with developers in potentially viable network areas and identify business cases for planned developments to connect to the network (from the developer's perspective)	*Immediate and as developments are brought forward*
12. Develop an external stakeholder engagement plan to support the project development process	*Short term*
13. Update heating / cooling demand and supply assessment to consider updated/more detailed development plans and planning applications	
Planning	
14. Ensure the technical and financial work undertaken in this study will provide an evidence base for planning policy	*Short term*

15. Stratford-on-Avon District Council should continue to build a positive evidence base to demonstrate to developers that connection to / or construction of a district heat network is technically and financially viable in relation to specific developments	
16. Local requirements should be set for decentralised energy which relate to the network options identified in this report	

APPENDIX 1 – KEY ORGANISATIONS CONTACTED

List of contacts of key organisations where owners were contacted by Sustainable Energy to request information.

Table 55: Key organisations contacted

Organisation	Site contact	Job Description	Date of first contact	Contact Established
Alveston Manor Hotel	Sam Aziz	Regional General Manager	29/02/2016	No
Aston Martin Lagonda	Jamil Ahmed	Facilities & Site Services Manager	29/02/2016	No
Bordon Hill Nurseries	Paul Kimbrey	Operations Manager	29/02/2016	No
Butterfly Farm	James Ship	Entomologist	29/02/2016	No
Cox's Yard	Craig Mayes	Director	29/02/2016	No
DCS Manufacturing	Paul Myatt	Production Manager	29/02/2016	No
Holiday Inn	Peter Godfrey	Property Manager	29/02/2016	No
Jaguar Land Rover Ltd	Caroline Holman	Operational Carbon Strategy	29/02/2016	Yes[24]
Maybird Shopping Park	Tracey Hutchinson	Property Manager	29/02/2016	No
NFU Mutual	Edward Wheaton	Senior Partner	29/02/2016	No
Orbit Heart of England Housing Association	John Barnham	Head of Sustainable Investment	25/04/2016	Yes
Picturehouse Cinema	Laura Young	Duty Manager	29/02/2016	No
Ragdoll Productions	Mark Hollingsworth	Business Affairs Consultant	29/02/2016	No
Royal Shakespeare Company	Jenny Pullman	Project and Energy Manager	29/02/2016	Yes
SiTel	Karl Brough	Regional Director	29/02/2016	No
Stratford-upon-Avon College	Laurence Hill	Site Services Manager	29/02/2016	No
Stratford-upon-Avon Hospital	Abbey Morris	NHS Energy Manager	29/02/2016	Yes
Stratford-upon-Avon Leisure Centre	Simon Young	Duty Manager	19/04/2016	Yes
Tappex Threads Ltd	Andrew Fitzpatrick	Manager	29/02/2016	No
The Arden Hotel	Josefine Blomqvist	General Manager	29/02/2016	No
The Falcon Hotel	Jason Mayglothing	General Manager	29/02/2016	No
The Limes Nursing Home	Karen Hall	Manager	29/02/2016	Yes
The Mercure Shakespeare Hotel	John Swift	Hotel Manager	29/02/2016	No
The Stratford Hotel	Chris Steadman	General Manager	29/02/2016	No
The Swan's Nest Hotel	Sam Aziz	Regional General Manager	29/02/2016	No
Victoria Spa Lodge	Paul Tozer	Owner	29/02/2016	No
Warwickshire Police	John Cashmore	Mechanical and Electrical Lead	29/02/2016	No

[24] Initial contact established, information not received

APPENDIX 2 – ENERGY DATA

Table 56: Key heat loads within the Stratford-upon-Avon heat map area

Building Name	Existing site / Planned development	Building Use	Ownership	Heat Demand, kWh	Electricity Demand, kWh	Cooling Demand, kWh	Energy data source for heat modelling and profiling
A - West of Shottery Northern Area Housing Development 1	Planned development	Residential	Planned development	1,018,973	-	-	SEL residential benchmark
A - West of Shottery Northern Area Housing Development 10	Planned development	Residential	Planned development	520,706	-	-	SEL residential benchmark
A - West of Shottery Northern Area Housing Development 2	Planned development	Residential	Planned development	885,153	-	-	SEL residential benchmark
A - West of Shottery Northern Area Housing Development 3	Planned development	Residential	Planned development	428,923	-	-	SEL residential benchmark
A - West of Shottery Northern Area Housing Development 4	Planned development	Residential	Planned development	661,491	-	-	SEL residential benchmark
A - West of Shottery Northern Area Housing Development 5	Planned development	Residential	Planned development	797,790	-	-	SEL residential benchmark
A - West of Shottery Northern Area Housing Development 6	Planned development	Residential	Planned development	593,536	-	-	SEL residential benchmark
A - West of Shottery Northern Area Housing Development 7	Planned development	Residential	Planned development	434,611	-	-	SEL residential benchmark
A - West of Shottery Northern Area Housing Development 8	Planned development	Residential	Planned development	661,663	-	-	SEL residential benchmark
A - West of Shottery Northern Area Housing Development 9	Planned development	Residential	Planned development	642,778	-	-	SEL residential benchmark
A - West of Shottery Southern Area Housing Development	Planned development	Residential	Planned development	1,855,237	-	-	SEL residential benchmark
AGD Equipment Ltd	Existing	Workshop	Private sector	102,967	63,718	-	CIBSE Guide F - Workshop
Aldi	Existing	Retail	Private sector	68,016	414,898	290,429	CIBSE Guide F - retail (supermarket)
Alveston C of E Primary School	Existing	Education	Warwickshire County Council	105,749	57,696	-	Actual
Alveston Manor Hotel	Existing	Hotels	Private sector	1,831,533	735,792	-	CIBSE Guide F - hotels (holiday)
Apex	Existing	Offices	Private sector	98,785	55,019	-	CIBSE Guide F - offices (naturally ventilated, cellular)
Arden Court	Existing	Offices	Private sector	112,617	198,144	-	CIBSE Guide F - offices (naturally ventilated, cellular)
Arden Garages	Existing	Retail	Private sector	97,726	53,654	-	CIBSE Guide F - retail (large non-food shop)
Arden Heath Housing Development 1	Planned development	Residential	Planned development	919,961	-	-	SEL residential benchmark
Arden Heath Housing Development 2	Planned development	Residential	Planned	551,977	-	-	SEL residential benchmark

Building Name	Existing site / Planned development	Building Use	Ownership	Heat Demand, kWh	Electricity Demand, kWh	Cooling Demand, kWh	Energy data source for heat modelling and profiling
			development				
Arden Heath Housing Development 3	Planned development	Residential	Planned development	636,896	-	-	SEL residential benchmark
Arden Heath Housing Development 4	Planned development	Residential	Planned development	849,195	-	-	SEL residential benchmark
Arden Heath Housing Development 5	Planned development	Residential	Planned development	452,904	-	-	SEL residential benchmark
Audi	Existing	Retail	Private sector	73,466	40,334	-	CIBSE Guide F - retail (large non-food shop)
Avon Court Care Home	Existing	Residential	Private sector	428,113	101,684	-	CIBSE Guide F - residential (residential and nursing home)
Avon Support Ltd	Existing	Council	Private sector	147,987	49,572	-	CIBSE Guide f - day centres
B - West of Shottery Housing Development 1	Planned development	Residential	Planned development	606,851	-	-	SEL residential benchmark
B - West of Shottery Housing Development 2	Planned development	Residential	Planned development	310,247	-	-	SEL residential benchmark
B - West of Shottery Housing Development 3	Planned development	Residential	Planned development	1,054,179	-	-	SEL residential benchmark
B - West of Shottery Housing Development 4	Planned development	Residential	Planned development	446,622	-	-	SEL residential benchmark
B - West of Shottery Housing Development 5	Planned development	Residential	Planned development	990,619	-	-	SEL residential benchmark
B & D Electromedical	Existing	Retail	Private sector	21,117	14,488	-	CIBSE Guide F - retail (distribution warehouse)
B & M Bargains	Existing	Retail	Private sector	165,297	90,752	-	CIBSE Guide F - retail (large non-food shop)
B & M Bargains, deliveries	Existing	Warehouse	Private sector	16,767	1,242	-	CIBSE Guide F - stores/warehouse, unoccupied
Bailey Flooring and Heating	Existing	Workshop	Private sector	73,763	16,298	-	CIBSE Guide F - workshop
Baldwins Repair	Existing	Workshop	Private sector	195,038	43,094	-	CIBSE Guide F - workshop
Barbers Flooring	Existing	Retail	Private sector	67,685	76,921	-	CIBSE Guide F - retail (DIY store)
BDR Voice & Data	Existing	Offices	Private sector	18,687	10,408	-	CIBSE Guide F - offices (naturally ventilated, cellular)
Bed Company	Existing	Retail	Private sector	45,446	24,951	-	CIBSE Guide F - retail (large non-food shop)
Bennett printers	Existing	Retail	Private sector	57,802	65,689	-	CIBSE Guide F - retail (DIY store)
BHS	Existing	Retail	Private sector	419,852	683,882	-	CIBSE Guide F - retail (department store)
Big Red Recruitment	Existing	Offices	Private sector	93,437	52,041	-	CIBSE Guide F - offices (naturally ventilated, cellular)

Building Name	Existing site / Planned development	Building Use	Ownership	Heat Demand, kWh	Electricity Demand, kWh	Cooling Demand, kWh	Energy data source for heat modelling and profiling
Bishopton Housing Development 1	Planned development	Residential	Planned development	183,285	-	-	SEL residential benchmark
Bishopton Housing Development 10	Planned development	Residential	Planned development	366,569	-	-	SEL residential benchmark
Bishopton Housing Development 11	Planned development	Residential	Planned development	307,126	-	-	SEL residential benchmark
Bishopton Housing Development 12	Planned development	Residential	Planned development	252,636	-	-	SEL residential benchmark
Bishopton Housing Development 13	Planned development	Residential	Planned development	242,728	-	-	SEL residential benchmark
Bishopton Housing Development 14	Planned development	Residential	Planned development	113,934	-	-	SEL residential benchmark
Bishopton Housing Development 15	Planned development	Residential	Planned development	108,980	-	-	SEL residential benchmark
Bishopton Housing Development 16	Planned development	Residential	Planned development	173,377	-	-	SEL residential benchmark
Bishopton Housing Development 17	Planned development	Residential	Planned development	183,285	-	-	SEL residential benchmark
Bishopton Housing Development 18	Planned development	Residential	Planned development	168,424	-	-	SEL residential benchmark
Bishopton Housing Development 19	Planned development	Residential	Planned development	135,871	-	-	SEL residential benchmark
Bishopton Housing Development 2	Planned development	Residential	Planned development	227,867	-	-	SEL residential benchmark
Bishopton Housing Development 20	Planned development	Residential	Planned development	186,823	-	-	SEL residential benchmark
Bishopton Housing Development 21	Planned development	Residential	Planned development	131,625	-	-	SEL residential benchmark
Bishopton Housing Development 22	Planned development	Residential	Planned development	144,363	-	-	SEL residential benchmark
Bishopton Housing Development 23	Planned development	Residential	Planned development	174,085	-	-	SEL residential benchmark
Bishopton Housing Development 24	Planned development	Residential	Planned development	157,101	-	-	SEL residential benchmark
Bishopton Housing Development 25	Planned development	Residential	Planned development	169,839	-	-	SEL residential benchmark
Bishopton Housing Development 26	Planned development	Residential	Planned development	183,285	-	-	SEL residential benchmark
Bishopton Housing Development 27	Planned development	Residential	Planned development	128,795	-	-	SEL residential benchmark
Bishopton Housing Development 28	Planned development	Residential	Planned development	108,980	-	-	SEL residential benchmark

Building Name	Existing site / Planned development	Building Use	Ownership	Heat Demand, kWh	Electricity Demand, kWh	Cooling Demand, kWh	Energy data source for heat modelling and profiling
Bishopton Housing Development 29	Planned development	Residential	Planned development	123,841	-	-	SEL residential benchmark
Bishopton Housing Development 3	Planned development	Residential	Planned development	89,165	-	-	SEL residential benchmark
Bishopton Housing Development 30	Planned development	Residential	Planned development	108,980	-	-	SEL residential benchmark
Bishopton Housing Development 4	Planned development	Residential	Planned development	208,053	-	-	SEL residential benchmark
Bishopton Housing Development 5	Planned development	Residential	Planned development	282,357	-	-	SEL residential benchmark
Bishopton Housing Development 6	Planned development	Residential	Planned development	108,980	-	-	SEL residential benchmark
Bishopton Housing Development 7	Planned development	Residential	Planned development	178,331	-	-	SEL residential benchmark
Bishopton Housing Development 8	Planned development	Residential	Planned development	252,636	-	-	SEL residential benchmark
Bishopton Housing Development 9	Planned development	Residential	Planned development	203,099	-	-	SEL residential benchmark
Bishopton Primary School	Existing	Education	Warwickshire County Council	86,217	63,806	-	Actual
Bishopton Safeguarded Primary School	Planned development	Education	Planned development	86,217	63,806	-	CIBSE Guide F - education (primary school)
Boots	Existing	Retail	Private sector	64,506	393,487	-	CIBSE Guide F - retail (supermarket)
Bordon Hill Nursery	Existing	Other	Private sector	4,686,270	322,496	-	CIBSE Guide F - other (nursery - green house)
Brewers	Existing	Retail	Private sector	26,430	30,037	-	CIBSE Guide F - retail (DIY stores)
Briar Croft (Assisted Living)	Existing	Residential	Orbit Heart of England Housing Association	688,722	226,218	-	Actual
Bridge House Medical Centre	Existing	Health	NHS Trust	60,552	32,480	-	CIBSE Guide F - Health (general practitioners' surgeries and dental practice)
Bridgetown Primary School	Existing	Education	Warwickshire County Council	114,072	78,803	-	Actual
Bridgeway House	Existing	Offices	Private sector	170,551	94,991	-	CIBSE Guide F - offices (naturally ventilated, cellular)
Brookbank Complex Needs Centre	Existing	Council	Stratford on Avon District Council	36,841	9,213	-	Actual
Building Profile Ltd	Existing	Retail	Private sector	169,062	192,133	-	CIBSE Guide F - retail (DIY stores)
Butterfly Farm	Existing	Workshop	Private sector	169,282	41,038	-	CIBSE Guide F - stores/warehouse, occupied

Building Name	Existing site / Planned development	Building Use	Ownership	Heat Demand, kWh	Electricity Demand, kWh	Cooling Demand, kWh	Energy data source for heat modelling and profiling
C.A Rookes Wine Merchants	Existing	Workshop	Private sector	33,731	7,453	-	CIBSE Guide F - workshop
Canning Court Nursing Home	Existing	Residential	Private sector	569,829	135,344	-	CIBSE Guide F - residential (residential and nursing home)
Carpetright	Existing	Retail	Private sector	117,032	64,253	-	CIBSE Guide F - retail (large non-food shop)
Carphone Warehouse	Existing	Retail	Private sector	19,371	9,470	-	CIBSE Guide F - retail (large non-food shop)
Cattle Market Apartment Development 1	Planned development	Residential	Planned development	218,217	-	-	SEL residential benchmark
Cattle Market Apartment Development 2	Planned development	Residential	Planned development	176,564	-	-	SEL residential benchmark
Cattle Market Apartment Development 3	Planned development	Residential	Planned development	140,112	-	-	SEL residential benchmark
Cattle Market Extra Care Apartment	Planned development	Residential	Planned development	1,776,918	422,048	-	CIBSE Guide F - residential (residential and nursing home)
Cattle Market Housing Development 1	Planned development	Residential	Planned development	10,902	-	-	SEL residential benchmark
Cattle Market Housing Development 10	Planned development	Residential	Planned development	10,992	-	-	SEL residential benchmark
Cattle Market Housing Development 11	Planned development	Residential	Planned development	10,992	-	-	SEL residential benchmark
Cattle Market Housing Development 12	Planned development	Residential	Planned development	10,992	-	-	SEL residential benchmark
Cattle Market Housing Development 13	Planned development	Residential	Planned development	10,992	-	-	SEL residential benchmark
Cattle Market Housing Development 14	Planned development	Residential	Planned development	10,992	-	-	SEL residential benchmark
Cattle Market Housing Development 15	Planned development	Residential	Planned development	11,622	-	-	SEL residential benchmark
Cattle Market Housing Development 16	Planned development	Residential	Planned development	11,622	-	-	SEL residential benchmark
Cattle Market Housing Development 17	Planned development	Residential	Planned development	11,622	-	-	SEL residential benchmark
Cattle Market Housing Development 18	Planned development	Residential	Planned development	11,622	-	-	SEL residential benchmark
Cattle Market Housing Development 19	Planned development	Residential	Planned development	11,622	-	-	SEL residential benchmark
Cattle Market Housing Development 2	Planned development	Residential	Planned development	10,646	-	-	SEL residential benchmark
Cattle Market Housing Development 20	Planned development	Residential	Planned development	13,729	-	-	SEL residential benchmark

Building Name	Existing site / Planned development	Building Use	Ownership	Heat Demand, kWh	Electricity Demand, kWh	Cooling Demand, kWh	Energy data source for heat modelling and profiling
Cattle Market Housing Development 21	Planned development	Residential	Planned development	13,408	-	-	SEL residential benchmark
Cattle Market Housing Development 22	Planned development	Residential	Planned development	13,729	-	-	SEL residential benchmark
Cattle Market Housing Development 23	Planned development	Residential	Planned development	13,729	-	-	SEL residential benchmark
Cattle Market Housing Development 24	Planned development	Residential	Planned development	13,408	-	-	SEL residential benchmark
Cattle Market Housing Development 25	Planned development	Residential	Planned development	13,729	-	-	SEL residential benchmark
Cattle Market Housing Development 26	Planned development	Residential	Planned development	16,335	-	-	SEL residential benchmark
Cattle Market Housing Development 27	Planned development	Residential	Planned development	16,335	-	-	SEL residential benchmark
Cattle Market Housing Development 28	Planned development	Residential	Planned development	16,335	-	-	SEL residential benchmark
Cattle Market Housing Development 29	Planned development	Residential	Planned development	16,335	-	-	SEL residential benchmark
Cattle Market Housing Development 3	Planned development	Residential	Planned development	10,902	-	-	SEL residential benchmark
Cattle Market Housing Development 4	Planned development	Residential	Planned development	10,902	-	-	SEL residential benchmark
Cattle Market Housing Development 5	Planned development	Residential	Planned development	10,646	-	-	SEL residential benchmark
Cattle Market Housing Development 6	Planned development	Residential	Planned development	10,646	-	-	SEL residential benchmark
Cattle Market Housing Development 7	Planned development	Residential	Planned development	10,902	-	-	SEL residential benchmark
Cattle Market Housing Development 8	Planned development	Residential	Planned development	10,992	-	-	SEL residential benchmark
Cattle Market Housing Development 9	Planned development	Residential	Planned development	10,992	-	-	SEL residential benchmark
CCL Group Ltd	Existing	Offices	Private sector	79,534	44,298	-	CIBSE Guide F - offices (naturally ventilated, cellular)
Chi Technology Limited	Existing	Offices	Private sector	25,780	14,358	-	CIBSE Guide F - offices (naturally ventilated, cellular)
City Plumbing Supplies	Existing	Retail	Private sector	84,306	95,811	-	CIBSE Guide F - retail (DIY store)
Civic Hall	Existing	Entertainment	Private sector	571,725	326,700	-	CIBSE Guide F - entertainment (theatres)
Conrad House 1	Existing	Offices	Private sector	47,619	26,522	-	CIBSE Guide F - offices (naturally ventilated, cellular)

Building Name	Existing site / Planned development	Building Use	Ownership	Heat Demand, kWh	Electricity Demand, kWh	Cooling Demand, kWh	Energy data source for heat modelling and profiling
Conrad House 2	Existing	Offices	Private sector	41,090	22,886	-	CIBSE Guide F - offices (naturally ventilated, cellular)
Costa	Existing	Catering	Private sector	77,040	175,480	-	CIBSE Guide F - catering (fast food restaurant)
Courtyard Theatre	Existing	Entertainment	Private sector	520,039	294,563	-	CIBSE Guide F - entertainment (theatres)
Cox's Yard	Existing	Catering	Private sector	200,228	525,850	-	CIBSE Guide F - catering (restaurant, with bar)
Currys	Existing	Retail	Private sector	73,450	83,473	-	CIBSE Guide F - retail (DIY store)
Cygnet Court 1	Existing	Offices	Private sector	74,637	41,570	-	CIBSE Guide F - offices (naturally ventilated, cellular)
Cygnet Court 2	Existing	Offices	Private sector	40,302	22,447	-	CIBSE Guide F - offices (naturally ventilated, cellular)
Cygnet Court 3	Existing	Offices	Private sector	97,490	54,298	-	CIBSE Guide F - offices (naturally ventilated, cellular)
D H M Wynchwood LLP	Existing	Offices	Private sector	22,628	12,603	-	CIBSE Guide F - offices (naturally ventilated, cellular)
Debenhams	Existing	Retail	Private sector	165,626	269,782	-	CIBSE Guide F - retail (department store)
Dennis Fossett	Existing	Workshop	Private sector	49,219	10,875	-	CIBSE Guide F - workshop
District Council Offices (Elizabeth House)	Existing	Offices	Stratford on Avon District Council	570,920	736,404	-	Actual
Evesham Bathrooms	Existing	Retail	Private sector	4,183	12,512	-	CIBSE Guide F - retail (catalogue store)
Eyre & Elliston Ltd (Electrical Distributors)	Existing	Retail	Private sector	23,809	27,059	-	CIBSE Guide F - retail (DIY store)
Fatboys Catering	Existing	Retail	Private sector	19,927	13,671	-	CIBSE Guide F - retail (distribution warehouse)
Fire Station	Existing	Public	Other public sector	107,845	51,367	-	Actual
First Stop Auto Centre	Existing	Workshop	Private sector	121,800	26,912	-	CIBSE Guide F - workshop
Footsteps Nursery	Existing	Education	Private sector	56,952	14,784	-	CIBSE Guide F - education (primary school)
Former Salvation Army	Planned development	Residential	Planned development	50,381	-	-	SEL Residential benchmark
Furniturewise	Existing	Retail	Private sector	108,640	123,466	-	CIBSE Guide F - retail (DIY store)
GAME	Existing	Retail	Private sector	16,206	7,923	-	CIBSE Guide F - offices (naturally ventilated, cellular)
Greenstar	Existing	Offices	Private sector	25,161	14,013	-	CIBSE Guide F - offices (naturally ventilated, cellular)
Grosvenor Hotel	Existing	Hotels	Private sector	478,140	196,160	-	CIBSE Guide F - hotels (holiday)

Building Name	Existing site / Planned development	Building Use	Ownership	Heat Demand, kWh	Electricity Demand, kWh	Cooling Demand, kWh	Energy data source for heat modelling and profiling
Hall's Croft	Existing	Public	Private sector	54,000	42,750	-	CIBSE Guide F - public (museums and art galleries)
Harmoni Personal Care Ltd	Existing	Retail	Private sector	41,381	25,607	-	CIBSE Guide F - retail (distribution warehouse)
Hatton Electrical	Existing	Retail	Private sector	10,973	7,528	-	CIBSE Guide F - retail (distribution warehouse)
Hire Centre	Existing	Offices	Private sector	15,029	8,370	-	CIBSE Guide F - offices (naturally ventilated, cellular)
Holiday Inn	Existing	Hotels	Private sector	3,518,012	1,421,244	-	CIBSE Guide F - hotels (holiday)
Home Guard Club Housing Development 1	Planned development	Residential	Planned development	189,505	-	-	SEL residential benchmark
Home Guard Club Housing Development 2	Planned development	Residential	Planned development	123,507	-	-	SEL residential benchmark
Home Guard Club Housing Development 3	Planned development	Residential	Planned development	199,177	-	-	SEL residential benchmark
HSBC	Existing	Retail	Private sector	17,010	25,560	-	CIBSE Guide F - retail (bank and building societies)
JMC Stratford	Existing	Retail	Private sector	34,341	18,854	-	CIBSE Guide F - retail (large non-food shop)
Jobcentre Plus	Existing	Offices	Private sector	110,999	61,822	-	CIBSE Guide F - offices (naturally ventilated, cellular)
King Edwards VI School	Existing	Education	Warwickshire County Council	658,652	357,831	-	Actual
Kingston Engineering	Existing	Offices	Private sector	29,382	16,365	-	CIBSE Guide F - offices (naturally ventilated, cellular)
Land East of Birmingham Road Phase 2	Planned development	Residential	Planned development	919,961	-	-	SEL residential benchmark
Land Rover	Existing	Retail	Private sector	62,873	34,518	-	CIBSE Guide F - retail (large non-food shop)
Leamoco Car Parts	Existing	Workshop	Private sector	54,600	12,064	-	CIBSE Guide F - workshop
Lloyds TSB	Existing	Retail	Private sector	38,556	57,936	-	CIBSE Guide F - retail (bank and building societies)
Majectic Wine Warehouse	Existing	Retail	Private sector	12,810	85,400	-	CIBSE Guide F - retail (small food shop)
Maplin	Existing	Retail	Private sector	22,537	25,612	-	CIBSE Guide F - retail (DIY store)
Marks and Spencer	Existing	Retail	Private sector	487,188	2,971,847	693,431	CIBSE Guide F - retail (supermarket)
Mash-B Ltd	Existing	Offices	Private sector	19,701	10,973	-	CIBSE Guide F - offices (naturally ventilated, cellular)
Mason Road (Area 1a)	Planned development	Residential	Planned development	2,376,281	-	-	SEL residential benchmark

Building Name	Existing site / Planned development	Building Use	Ownership	Heat Demand, kWh	Electricity Demand, kWh	Cooling Demand, kWh	Energy data source for heat modelling and profiling
Masons Road (Area 1b)	Planned development	Residential	Planned development	917,936	-	-	SEL residential benchmark
Maybird Shopping Park	Existing	Retail	Private sector	1,538,195	2,505,514	-	CIBSE Guide F - retail (department stores)
McDonalds, Canal Quarter	Existing	Catering	Private sector	264,240	601,880	-	CIBSE Guide F - catering (fast food restaurant)
Melville House	Existing	Residential	Orbit Heart of England Housing Association	396,967	61,245	-	Actual
Mercure Shakespeare Hotel	Existing	Hotels	Private sector	917,280	376,320	-	CIBSE Guide F - hotels (holiday)
MHA Cedar Lawn Care Home	Existing	Residential	Private sector	313,443	74,448	-	CIBSE Guide F - residential (residential and nursing home)
Milestone Road Housing Development 1	Planned development	Residential	Planned development	147,544	-	-	SEL residential benchmark
Milestone Road Housing Development 2	Planned development	Residential	Planned development	168,014	-	-	SEL residential benchmark
Milestone Road Housing Development 3	Planned development	Residential	Planned development	243,629	-	-	SEL residential benchmark
Milestone Road Housing Development 4	Planned development	Residential	Planned development	234,810	-	-	SEL residential benchmark
Montague Capital Ltd	Existing	Offices	Private sector	31,746	17,681	-	CIBSE Guide F - offices (naturally ventilated, cellular)
Morrisons	Existing	Retail	Private sector	597,792	3,646,531	2,552,572	CIBSE Guide F - retail (supermarket)
Nationwide Crash Repair	Existing	Workshop	Private sector	70,744	15,631	-	CIBSE Guide F - workshop
NFU Mutual	Existing	Offices	Private sector	930,410	518,203	-	CIBSE Guide F - offices (naturally ventilated, cellular)
No.1 (Bar)	Existing	Catering	Private sector	76,230	200,200	-	CIBSE Guide F - catering (restaurant, with bar)
NW of Shottery Brook Office Park	Existing	Offices	Private sector	231,342	128,849	-	CIBSE Guide F - offices (naturally ventilated, cellular)
Oak and Willows House	Existing	Residential	Private sector	466,830	144,144	-	CIBSE Guide F - residential (low rise flats)
Oak Road Housing Development 1	Planned development	Residential	Planned development	185,224	-	-	SEL residential benchmark
Oak Road Housing Development 2	Planned development	Residential	Planned development	219,916	-	-	SEL residential benchmark
Oak Road Housing Development 3	Planned development	Residential	Planned development	126,580	-	-	SEL residential benchmark
Oak Road Housing Development 4	Planned development	Residential	Planned development	180,778	-	-	SEL residential benchmark

Building Name	Existing site / Planned development	Building Use	Ownership	Heat Demand, kWh	Electricity Demand, kWh	Cooling Demand, kWh	Energy data source for heat modelling and profiling
Oak Road Housing Development 5	Planned development	Residential	Planned development	248,739	-	-	SEL residential benchmark
Orbit Heart of England	Existing	Offices	Orbit Heart of England Housing Association	58,877	32,792	-	CIBSE Guide F - offices (naturally ventilated, cellular)
Oxalis Group	Existing	Offices	Private sector	144,096	80,256	-	CIBSE Guide F - offices (naturally ventilated, cellular)
Pashley Cycles	Existing	Workshop	Private sector	191,231	42,253	-	CIBSE Guide F - workshop
Pen & Parchment	Existing	Catering	Private sector	118,800	312,000	-	CIBSE Guide F - catering (restaurant, with bar)
Picturehouse Cinema	Existing	Entertainment	Private sector	630,360	568,560	-	CIBSE Guide F - entertainment (cinema)
Pizza Hut	Existing	Catering	Private sector	128,453	337,350	-	CIBSE Guide F - catering (restaurant, with bar)
Plumb Centre	Existing	Retail	Private sector	29,350	33,355	-	CIBSE Guide F - retail (DIY store)
Plumbase	Existing	Retail	Private sector	20,515	23,315	-	CIBSE Guide F - retail (DIY store)
PMC Flooring	Existing	Workshop	Private sector	68,644	15,167	-	CIBSE Guide F - workshop
PMD Magnetics	Existing	Workshop	Private sector	51,056	11,281	-	CIBSE Guide F - workshop
Polkadot Day Nursery	Existing	Education	Private sector	21,781	5,654	-	CIBSE Guide F - education (primary school)
Porter Precision Punch Ltd	Existing	Workshop	Private sector	129,938	28,710	-	CIBSE Guide F - workshop
Premier Inn	Existing	Hotels	Private sector	955,563	400,602	-	CIBSE Guide F - hotels (holiday)
Premier Inn Central	Existing	Hotels	Private sector	1,126,125	462,000	-	CIBSE Guide F - hotels (holiday)
Pressavon	Existing	Workshop	Private sector	172,200	38,048	-	CIBSE Guide F - workshop
Quantum Plus	Existing	Offices	Private sector	20,714	11,537	-	CIBSE Guide F - offices (naturally ventilated, cellular)
Ragdoll Productions 1	Existing	Offices	Private sector	374,030	208,321	-	CIBSE Guide F - offices (naturally ventilated, cellular)
Reading Court	Existing	Residential	Private sector	616,883	146,520	-	CIBSE Guide F - residential (residential and nursing home)
Rose and Crown	Existing	Catering	Private sector	128,040	252,200	-	CIBSE Guide F - catering (restaurant, with bar)
Rother House Medical Centre	Existing	Health	NHS Trust	111,839	59,990	-	CIBSE Guide F - health (general practitioners' surgeries and dental practice)
Royal Mail	Existing	Retail	Private sector	46,996	32,243	-	CIBSE Guide F - retail (distribution warehouse)
Royal Shakespearce Company Warehouse	Existing	Workshop	Private sector	245,044	54,143	-	CIBSE Guide F - stores/warehouse, occupied

Building Name	Existing site / Planned development	Building Use	Ownership	Heat Demand, kWh	Electricity Demand, kWh	Cooling Demand, kWh	Energy data source for heat modelling and profiling
Royal Shakespeare and Swan Theatre	Existing	Entertainment	Private sector	975,000	2,400,000	-	Actual
Royal Shakespeare Company	Existing	Education	Private sector	138,916	44,097	-	CIBSE Guide F - education (secondary school)
Scholars Court	Existing	Residential	Private sector	601,877	142,956	-	CIBSE Guide F - residential (residential and nursing home)
Scout Hut	Planned development	Recreation	Planned development	142,699	38,053	-	CIBSE Guide F - council (community centres)
Shakespeare Institude (University of Birmingham)	Existing	Education	Other public sector	49,950	44,622	-	CIBSE Guide F - education (lecture rooms, art)
Shottery Brook Office Park 1	Existing	Offices	Private sector	54,937	30,598	-	CIBSE Guide F - offices (naturally ventilated, cellular)
Shottery Brook Office Park 2	Existing	Offices	Private sector	14,860	8,276	-	CIBSE Guide F - offices (naturally ventilated, cellular)
Shottery Brook Office Park 3	Existing	Offices	Private sector	16,436	9,154	-	CIBSE Guide F - offices (naturally ventilated, cellular)
Shottery Brook Office Park 4	Existing	Offices	Private sector	23,978	13,355	-	CIBSE Guide F - offices (naturally ventilated, cellular)
Shottery Brook Office Park 5	Existing	Offices	Private sector	16,886	9,405	-	CIBSE Guide F - offices (naturally ventilated, cellular)
Shottery Brook Office Park 6	Existing	Offices	Private sector	18,687	10,408	-	CIBSE Guide F - offices (naturally ventilated, cellular)
Shottery St Andrew's CE Primary School	Existing	Education	Warwickshire County Council	45,680	19,549	-	Actual
Sims Garden Machinery 1	Existing	Retail	Private sector	135,519	154,013	-	CIBSE Guide F - retail (DIY store)
Sims Garden Machinery 2	Existing	Retail	Private sector	73,675	83,729	-	CIBSE Guide F - retail (DIY store)
Si-Plan electronics research ltd	Existing	Offices	Private sector	46,043	25,644	-	CIBSE Guide F - offices (naturally ventilated, cellular)
Solo Trading	Existing	Retail	Private sector	73,375	83,388	-	CIBSE Guide F - retail (DIY store)
Sports Pavilion/Home Guard Club	Planned development	Entertainment	Planned development	8,672	1,652	-	CIBSE Guide F - community centre
SPP	Existing	Offices	Private sector	62,254	34,673	-	CIBSE Guide F - offices (naturally ventilated, cellular)
St Gregorys Catholic Primary School	Existing	Education	Warwickshire County Council	227,654	60,682	-	Actual
Stagecoach	Existing	Retail	Private sector	165,347	58,285	-	CIBSE Guide F - retail (distribution warehouse)
Staples	Existing	Retail	Private sector	88,842	48,776	-	CIBSE Guide F - retail (large non-food shop)
Stratford Glass	Existing	Workshop	Private sector	28,613	6,322	-	CIBSE Guide F - workshop
Stratford Healthcare	Existing	Health	NHS Trust	888,053	476,350	-	CIBSE Guide F - health (general

Building Name	Existing site / Planned development	Building Use	Ownership	Heat Demand, kWh	Electricity Demand, kWh	Cooling Demand, kWh	Energy data source for heat modelling and profiling
							practitioners' surgeries and dental practises)
Stratford Leisure & Visitor Centre	Existing	Recreation	Stratford on Avon District Council	1353594	791549	-	Actual
Stratford Preparatory School	Existing	Education	Private sector	133,736	34,716	-	CIBSE Guide F - education (primary school)
Stratford Primary School	Existing	Education	Warwickshire County Council	105,116	56,462	-	CIBSE Guide F - education (primary school)
Stratford Registration Office (Winton House)	Existing	Offices	Stratford on Avon District Council	42,906	5,786	-	CIBSE Guide F - offices (naturally ventilated, cellular)
Stratford Sports Club Ltd	Existing	Recreation	Private sector	92,743	81,561	-	CIBSE Guide F - recreation (sports ground changing facility)
Stratford Tile	Existing	Retail	Private sector	83,433	57,242	-	CIBSE Guide F - retail (distribution warehouse)
Stratford Tourist Information Centre	Existing	Public	Private sector	19,584	15,504	-	CIBSE Guide F - council (community centres)
Stratford-upon-Avon College	Existing	Education	Other public sector	1,577,313	486,825	-	CIBSE Guide F - education (secondary school)
Stratford-upon-Avon Grammar School For Girls	Existing	Education	Warwickshire County Council	244,295	271,817	-	Actual
Stratford-upon-Avon High School (Academy)	Existing	Education	Warwickshire County Council	781,839	954,026	-	Actual
Stratford-upon-Avon Hospital	Existing	Hospitals	NHS Trust	547,991	31,334	7,833	Actual
Stratford-upon-Avon Hospital, ambulatory care centre development	Planned development	Hospitals	Planned development	1,394,963	590,568	-	CIBSE Guide F - health (general practitioners' surgeries and dental practises)
Stratford-upon-Avon Hospital, multi-storey car park development	Planned development	Car park	NHS Trust	-	135,168	-	CIBSE Guide F - recreation (car park)
Stratford-upon-Avon Library and Information Centre	Existing	Public	Warwickshire County Council	96,334	68,236	-	Actual
Stratford-upon-Avon Train Station	Existing	Other	Private sector	58,950	19,650	-	Actual
SUA.2 Employment Development Western Area	Planned development	Offices	Planned development	4,088,585	923,183	-	CIBSE Guide F - offices (naturally ventilated, cellular)
SUA.2 Housing Development 1	Planned development	Residential	Planned development	329,116	-	-	SEL residential benchmark
SUA.2 Housing Development 2	Planned development	Residential	Planned development	191,159	-	-	SEL residential benchmark
SUA.2 Housing Development 3	Planned development	Residential	Planned development	195,087	-	-	SEL residential benchmark
SUA.2 Housing Development 4	Planned development	Residential	Planned development	212,389	-	-	SEL residential benchmark

Building Name	Existing site / Planned development	Building Use	Ownership	Heat Demand, kWh	Electricity Demand, kWh	Cooling Demand, kWh	Energy data source for heat modelling and profiling
SUA.2 Housing Development 5	Planned development	Residential	Planned development	128,817	-	-	SEL residential benchmark
Swan's Nest Hotel	Existing	Hotels	Private sector	870,480	357,120	-	CIBSE Guide F - hotels (holiday)
Telephone Exchange	Existing	Offices	Private sector	39,401	21,945	21,546	CIBSE Guide F - office (naturally ventilated, cellular)
Territorial Army Centre	Existing	Council	Other public sector	91,406	21,450	-	CIBSE Guide F - community centres
Tesco Superstore	Existing	Retail	Private sector	570,882	3,482,380	2,437,666	CIBSE Guide F - retail (department stores)
Thai Boathouse	Existing	Catering	Private sector	81,675	214,500	-	CIBSE Guide F - catering (restaurant, with bar)
The Arden Hotel	Existing	Hotels	Private sector	504,270	206,880	-	CIBSE Guide F - hotels (holiday)
The Arden Medical Centre	Existing	Health	NHS Trust	50,634	27,160	-	CIBSE Guide F - health (general practitioners' surgeries and dental practice)
The Big Fish	Existing	Catering	Private sector	89,348	234,650	-	CIBSE Guide F - catering (restaurant, with bar)
The Courtyard 1	Existing	Offices	Private sector	47,957	26,710	-	CIBSE Guide F - offices (naturally ventilated, cellular)
The Courtyard 2	Existing	Offices	Private sector	27,243	15,173	-	CIBSE Guide F - offices (naturally ventilated, cellular)
The Courtyard 3	Existing	Offices	Private sector	45,480	25,331	-	CIBSE Guide F - offices (naturally ventilated, cellular)
The Courtyard 4	Existing	Offices	Private sector	70,697	39,376	-	CIBSE Guide F - offices (naturally ventilated, cellular)
The Courtyard 5	Existing	Offices	Private sector	68,220	37,996	-	CIBSE Guide F - offices (naturally ventilated, cellular)
The Croft Preparatory School	Existing	Education	Private sector	520,026	134,992	-	CIBSE Guide F - education (primary school)
The Encore	Existing	Catering	Private sector	193,050	507,000	-	CIBSE Guide F - catering (restaurant, with bar)
The Falcon Hotel	Existing	Hotels	Private sector	1,350,765	554,160	-	CIBSE Guide F - hotels (holiday)
The Limes Nursing Home	Existing	Residential	Private sector	303,069	71,984	-	CIBSE Guide F - residential (residential and nursing home)
The Mill, Retail Warehouse Unit	Existing	Offices	Private sector	214,793	119,632	-	CIBSE Guide F - offices (naturally ventilated, cellular)
The Oddfellow Arms	Existing	Catering	Private sector	55,380	98,548	-	CIBSE Guide F - catering (restaurant, with bar)
The One Elm (Bar)	Existing	Catering	Private sector	69,053	181,350	-	CIBSE Guide F - catering (restaurant, with bar)

Building Name	Existing site / Planned development	Building Use	Ownership	Heat Demand, kWh	Electricity Demand, kWh	Cooling Demand, kWh	Energy data source for heat modelling and profiling
The Red Lion Pub	Existing	Catering	Private sector	106,673	280,150	-	CIBSE Guide F - catering (restaurant, with bar)
The Saltway Centre & Stratford Family Centre	Existing	Council	Stratford on Avon District Council	90,715	20,715	-	Actual
The Shakepeare Centre	Existing	Public	Private sector	184,464	146,034	-	CIBSE Guide F - public (museums and art galleries)
The Shakepeare Hospice	Existing	Residential	Private sector	391,248	147,840	-	CIBSE Guide F - residential (residential and nursing home)
The Shakespeare Hospice Furniture Store	Existing	Retail	Private sector	119,394	58,370	-	CIBSE Guide F - retail (high street agencies)
The Stratford Hotel	Existing	Hotels	Private sector	1,099,800	451,200	-	CIBSE Guide F - hotels (holiday)
The Willows C of E Primary School	Existing	Education	Warwickshire County Council	183,215	92,176	-	Actual
Thomas Jack Limited	Existing	Retail	Private sector	19,720	13,529	-	CIBSE Guide F - retail (distribution warehouse)
Thomas Jolyffe Primary School	Existing	Education	Warwickshire County Council	225,435	58,520	-	CIBSE Guide F - education (primary school)
Tiddington Community Centre	Existing	Recreation	Stratford on Avon District Council	80,343	43,392	-	CIBSE Guide F - recreation (dry sports centre)
Timothy's Bridge Road (Area 2)	Planned development	Residential		5,092,031	-	-	SEL residential benchmark
To let, Timothy Bridge Road	Existing	Offices	Private sector	97,377	54,236	-	CIBSE Guide F - offices (naturally ventilated, cellular)
Topps Tiles	Existing	Retail	Private sector	38,185	43,396	-	CIBSE Guide F - retail (DIY store)
Town Hall	Existing	Council	Stratford on Avon District Council	112,809	20,450	-	Actual
Town Square Shopping Centre	Existing	Retail	Private sector	154,624	742,197	-	CISBE Guide F - retail (clothes shop)
Travelodge Hotel	Existing	Hotels	Private sector	664,170	272,480	-	CIBSE Guide F - hotels (holiday)
Travis Perkins	Existing	Retail	Private sector	78,392	89,089	-	CIBSE Guide F - retail (DIY store)
Tudor World	Existing	Public	Private sector	54,216	42,921	-	CIBSE Guide F - public (museums and art galleries)
Unknown Unit 1	Existing	Workshop	Private sector	107,100	23,664	-	CIBSE Guide F - workshop
Unknown Unit 2	Existing	Workshop	Private sector	74,156	16,385	-	CIBSE Guide F - workshop
Unknown Unit 3	Existing	Workshop	Private sector	35,963	7,946	-	CIBSE Guide F - workshop
Unknown Unit 4	Existing	Workshop	Private sector	149,888	33,118	-	CIBSE Guide F - workshop
Unknown Units 5	Existing	Workshop	Private sector	143,588	31,726	-	CIBSE Guide F - workshop
Unknown Units 6	Existing	Workshop	Private sector	99,094	21,895	-	CIBSE Guide F - workshop
Unknown, Masons Road	Existing	Offices	Private sector	42,666	23,763	-	CIBSE Guide F - offices (naturally

Building Name	Existing site / Planned development	Building Use	Ownership	Heat Demand, kWh	Electricity Demand, kWh	Cooling Demand, kWh	Energy data source for heat modelling and profiling
							ventilated, cellular)
Unknown, Maybrook Road	Existing	Retail	Private sector	39,458	44,842	-	CIBSE Guide F - retail (DIY stores)
Unknown, Timothy Bridge Road 1	Existing	Retail	Private sector	30,019	20,596	-	CIBSE Guide F - retail (distribution warehouse)
Unknown, Timothy Bridge Road 2	Existing	Retail	Private sector	30,019	20,596	-	CIBSE Guide F - retail (distribution warehouse)
Vauxhaul	Existing	Retail	Private sector	78,933	43,336	-	CIBSE Guide F - retail (large non-food shop)
Verdant Group (Household Waste)	Existing	Warehouse	Private sector	177,697	43,078	-	CIBSE Guide F - stores/warehouse, occupied
Victoria Spa Lodge	Existing	Hotels	Private sector	230,850	92,340	-	CIBSE Guide F - hotels (holiday)
Warwickshire Police	Existing	Public	Other public sector	944,295	192,060	-	CIBSE Guide F - public (police station)
We Buy Any Car	Existing	Retail	Private sector	184,945	101,539	-	CIBSE Guide F - retail (large non-food shop)
Welcombe Garage	Existing	Workshop	Private sector	88,069	19,459	-	CIBSE Guide F - workshop
Welcombe Hills School	Existing	Education	Warwickshire County Council	300,794	119,935	-	Actual
Western Road (Area 4)	Planned development	Residential		2,715,750	-	-	SEL residential benchmark
Western Road Unit	Existing	Workshop	Private sector	64,444	14,239	-	CIBSE Guide F - workshop
Wharf Road (Area 3)	Planned development	Residential		1,661,835	-	-	SEL residential benchmark
Wildmoor Spa and Health Club	Existing	Recreation	Private sector	803,498	344,880	-	CIBSE Guide F - recreation (dry sports centre)
Wright Manufacturing Services Ltd	Existing	Workshop	Private sector	60,113	13,282	-	CIBSE Guide F - workshop

Table 57: Key heat loads within the Gaydon / Lighthorne Heath heat map area

Building / Site Name	Existing site / Planned development	Building Use	Ownership	Heat Demand, kWh	Electricity Demand, kWh	Area Heat Density, MWh/m²	Area Electricity Density, MWh/m²	Energy data source for heat modelling and profiling
Gaydon/Lighthorne Elderly Care Housing Development 1	Planned development	Residential	Planned development	1,199,221	242,110	-	-	CIBSE Guide F - residential (residential and nursing home)
Gaydon/Lighthorne Elderly Care Housing Development 2	Planned development	Residential	Planned development	1,349,056	272,360	-	-	CIBSE Guide F - residential (residential and nursing home)
Gaydon/Lighthorne Heath Primary School Development	Planned development	Education	Planned development	453,462	100,056	-	-	CIBSE Guide F - education (primary school)
Gaydon/Lighthorne Residential Development 1	Planned development	Residential - apartments/ townhouse	Planned development	233,545	-	-	-	SEL residential benchmark
Gaydon/Lighthorne Residential Development 2	Planned development	Residential - apartments/ townhouse	Planned development	120,608	-	-	-	SEL residential benchmark
Gaydon/Lighthorne Residential Development 3	Planned development	Residential - apartments/ townhouse	Planned development	233,545	-	-	-	SEL residential benchmark
Gaydon/Lighthorne Residential Development 4	Planned development	Residential - apartments/ townhouse	Planned development	489,251	-	-	-	SEL residential benchmark
Gaydon/Lighthorne Residential Development 5	Planned development	Residential - apartments/ townhouse	Planned development	62,648	-	-	-	SEL residential benchmark
Gaydon/Lighthorne Residential Development 6	Planned development	Residential - apartments/ townhouse	Planned development	154,702	-	-	-	SEL residential benchmark
Gaydon/Lighthorne Residential Development 7	Planned development	Residential - apartments/ townhouse	Planned development	133,393	-	-	-	SEL residential benchmark
Gaydon/Lighthorne Residential Development 8	Planned development	Residential - apartments/ townhouse	Planned development	277,867	-	-	-	SEL residential benchmark
Gaydon/Lighthorne Residential Development 9	Planned development	Residential - apartments/ townhouse	Planned development	270,622	-	-	-	SEL residential benchmark
Gaydon/Lighthorne Residential Development 10	Planned development	Residential - apartments/ townhouse	Planned development	147,457	-	-	-	SEL residential benchmark
Gaydon/Lighthorne Residential Development 11	Planned development	Residential - apartments/ townhouse	Planned development	239,085	-	-	-	SEL residential benchmark
Gaydon/Lighthorne Residential	Planned	Residential -	Planned	227,578	-	-	-	SEL residential benchmark

Building / Site Name	Existing site / Planned development	Building Use	Ownership	Heat Demand, kWh	Electricity Demand, kWh	Area Heat Density, MWh/m²	Area Electricity Density, MWh/m²	Energy data source for heat modelling and profiling
Development 12	development	apartments/ townhouse	development					
Gaydon/Lighthorne Residential Development 13	Planned development	Residential - apartments/ townhouse	Planned development	116,772	-	-	-	SEL residential benchmark
Gaydon/Lighthorne Residential Development 14	Planned development	Residential - apartments/ townhouse	Planned development	316,223	-	-	-	SEL residential benchmark
Gaydon/Lighthorne Community Development	Planned development	Community Centre	Planned development	55,754	11,121	-	-	BRE 2005 - community centres
Gaydon/Lighthorne Retail Development 1	Planned development	Retail	Planned development	245,978	102,218	-	-	CIBSE Guide F - retail (high street agencies)
Gaydon/Lighthorne Retail Development 2	Planned development	Retail	Planned development	93,309	38,775	-	-	CIBSE Guide F - retail (high street agencies)
Gaydon/Lighthorne Retail Development 3	Planned development	Retail	Planned development	714,904	297,083	-	-	CIBSE Guide F - retail (high street agencies)
Gaydon/Lighthorne Health Development	Planned development	Health	Planned development	102,941	46,935	-	-	CIBSE Guide F - health (general practitioners' surgeries and dental practises)
A Central Green Spine	Planned development	Residential	Planned development	-	-	0.0538	-	SEL residential benchmark
Lakeside	Planned development	Residential	Planned development	-	-	0.0485	-	SEL residential benchmark
Park Edge	Planned development	Residential	Planned development	-	-	0.0619	-	SEL residential benchmark
Village Core North	Planned development	Residential	Planned development	-	-	0.0538	-	SEL residential benchmark
Village Core South	Planned development	Residential	Planned development	-	-	0.0489	-	SEL residential benchmark
Woodland Rise	Planned development	Residential	Planned development	-	-	0.0492	-	SEL residential benchmark
Village Centre	Planned development	Various	Planned development	-	-	0.0922	0.0167	SEL residential benchmark

Table 58: Key heat loads within the Meon Vale / Long Marston Depot heat map area

Building / Site Name	Existing site / Planned development	Building Use	Ownership	Heat Demand, kWh	Electricity Demand, kWh	Area Heat Density, MWh/m²	Area Electricity Density, MWh/m²	Energy data source for heat modelling and profiling
Leisure Amenities	Planned development	Recreation	Planned Development	687,063	371,072	-	-	CIBSE Guide F - recreation (dry sports centre)
Primary School	Planned development	Education	Planned Development	133,397	34,628	-	-	CIBSE Guide F - education (primary school)
Community Centre	Existing	Recreation	Planned Development	34,088	12,120	-	-	BRE 2005 - community centres
Village Store	Existing	Retail	Planned Development	34,088	16,665	-	-	CIBSE Guide F - retail (high street agencies)
Leisure Centre	Existing	Recreation	Private	160,805	86,848	-	-	CIBSE Guide F - recreation (dry sports centre)
Premier Components UK Limited 1	Existing	Warehouse	Private	583,300	141,406	-	-	CIBSE Guide F - stores/warehouse, occupied
Premier Components UK Limited 2	Existing	Warehouse	Private	1,174,033	284,614	-	-	CIBSE Guide F - stores/warehouse, occupied
Premier Components UK Limited 3	Existing	Offices	Private	17,597	16,038	-	-	CIBSE Guide F - office (naturally ventilated, open plan)
Paul Mathew Transport Limited	Existing	Retail	Private	179,993	123,490	-	-	CIBSE Guide F - retail (distribution warehouse)
D W Clark	Existing	Retail	Private	89,765	61,586	-	-	CIBSE Guide F - retail (distribution warehouse)
Motorail	Existing	Warehouse	Private	157,080	38,080	-	-	CIBSE Guide F - stores/warehouse, occupied
Harrison Antique Furniture	Existing	Retail	Private	137,955	75,740	-	-	CIBSE Guide F - retail (large non-food shop)
Reddipak Limited	Existing	Warehouse	Private	324,539	78,676	-	-	CIBSE Guide F - stores/warehouse, occupied
Hardscape Products Limited	Existing	Retail	Private	284,580	156,240	-	-	CIBSE Guide F - retail (large non-food shop)
Wanzl Limited 1	Existing	Warehouse	Private	1,202,083	291,414	-	-	CIBSE Guide F - stores/warehouse, occupied
Norbert Dentressangle Logistics	Existing	Warehouse	Private	1,186,515	287,640	-	-	CIBSE Guide F - stores/warehouse, occupied
DCS Europe Plc	Existing	Warehouse	Private	985,958	239,020	-	-	CIBSE Guide F - stores/warehouse, occupied
Warehouse 1	Existing	Warehouse	Private	999,422	242,284	-	-	CIBSE Guide F - stores/warehouse, occupied
Wanzel Limited 2	Existing	Warehouse	Private	1,022,563	247,894	-	-	CIBSE Guide F - stores/warehouse, occupied
Warehouse 2	Existing	Warehouse	Private	992,690	240,652	-	-	CIBSE Guide F - stores/warehouse, occupied

Building / Site Name	Existing site / Planned development	Building Use	Ownership	Heat Demand, kWh	Electricity Demand, kWh	Area Heat Density, MWh/m²	Area Electricity Density, MWh/m²	Energy data source for heat modelling and profiling
Robert Welch Design Limited	Existing	Warehouse	Private	585,404	141,916	-	-	CIBSE Guide F - stores/warehouse, occupied
Village Hub	Planned development	Primary School/ Community Centre/ Village store/ Leisure Centre	Planned Development	-	-	0.0144	0.00599	CIBSE Guide F - High Street Agencies/community centre/leisure centre/primary school
Meon Vale Business Park 1	Planned development	Various Warehouses/ Offices	Planned Development	-	-	0.0737	0.0215	CIBSE Guide F – retail (distribution warehouse)/Office
Meon Vale Business Park 2	Planned development	Various Warehouses/ Offices	Planned Development	-	-	0.0872	0.0211	CIBSE Guide F – retail (distribution warehouse)/Office
Meon Vale/Long Marston Depot Self Catering Lodges Development	Planned development	Residential/ Recreation	Planned Development	-	-	0.0186	-	SEL residential benchmark
Meon Vale/Long Marston Depot Holiday Homes Development	Planned development	Residential	Planned Development	-	-	0.0087	-	SEL residential benchmark
Meon Vale/Long Marston Depot Housing Development 1	Planned development	Residential	Planned Development	-	-	0.0425	-	SEL residential benchmark

Table 59: Key heat loads within the Long Marston Airfield heat map area

Building / Site Name	Existing site / Planned development	Building Use	Ownership	Heat Demand, kWh	Electricity Demand, kWh	Area Heat Density, MWh/m²	Area Electricity Density, MWh/m²	Energy data source for heat modelling and profiling
Long Marston Airfield Primary School Development Area 1	Planned development	Education	Planned Development	505,602	156,050	-	-	CIBSE Guide F - education (primary school)
Long Marston Airfield Primary School Development Area 2	Planned development	Education	Planned Development	153,313	39,798	-	-	CIBSE Guide F - education (primary school)
Long Marston Airfield Secondary School Development Area	Planned development	Education	Planned Development	164,881	42,801	-	-	CIBSE Guide F - education (secondary school)
Long Marston Airfield Housing Developments	Planned development	Residential	Planned Development	-	-	0.0481	-	SEL residential benchmark
Long Marston Airfield Neighbourhood Centre Development Area 1	Planned development	Neighbourhood Centre	Planned Development	-	-	0.0554	0.0255	CIBSE Guide F - High Street Agencies/community centre
Long Marston Airfield Neighbourhood Centre Development Area 2	Planned development	Neighbourhood Centre	Planned Development	-	-	0.0356	0.0164	CIBSE Guide F - High Street Agencies/community centre
Long Marston Airfield Neighbourhood Centre Development Area 3	Planned development	Neighbourhood Centre	Planned Development	-	-	0.0446	0.0206	CIBSE Guide F - High Street Agencies/community centre
Long Marston Airfield Employment Park Development Area 1	Planned development	Employment Park	Planned Development	-	-	0.0259	0.0130	CIBSE Guide F – retail (distribution warehouse)/Office
Long Marston Airfield Employment Park Development Area 2	Planned development	Employment Park	Planned Development	-	-	0.0414	0.0209	CIBSE Guide F – retail (distribution warehouse)/Office
Long Marston Airfield Employment Park Development Area 3	Planned development	Employment Park	Planned Development	-	-	0.0456	0.0229	CIBSE Guide F – retail (distribution warehouse)/Office
Long Marston Airfield Employment Park Development Area 4	Planned development	Employment Park	Planned Development	-	-	0.0213	0.0107	CIBSE Guide F – retail (distribution warehouse)/Office

Table 60: Key heat loads within the SOU 3 - South of Daventry Road heat map area

Building / Site Name	Existing site / Planned development	Building Use	Ownership	Heat Demand, kWh	Electricity Demand, kWh	Area Heat Density, MWh/m²	Area Electricity Density, MWh/m²	Energy data source for heat modelling and profiling
SOU.3 South of Daventry Road Proposed Local Shop	Planned development	Retail	Planned development	79,313	38,775	-	-	CIBSE Guide F - retail (high street agencies)
SOU.3 South of Daventry Road Proposed Community hall/pavilion	Planned development	Community Centre	Planned development	41,850	14,880	-	-	CIBSE Guide F - community centre
SOU.3 South of Daventry Road Housing Development	Planned development	Residential	Planned development	-	-	0.045	-	SEL residential benchmark

APPENDIX 3 – DEVELOPMENT SITE PLANS

Stratford-upon-Avon Town

Figure 75: Bishopton development site plan

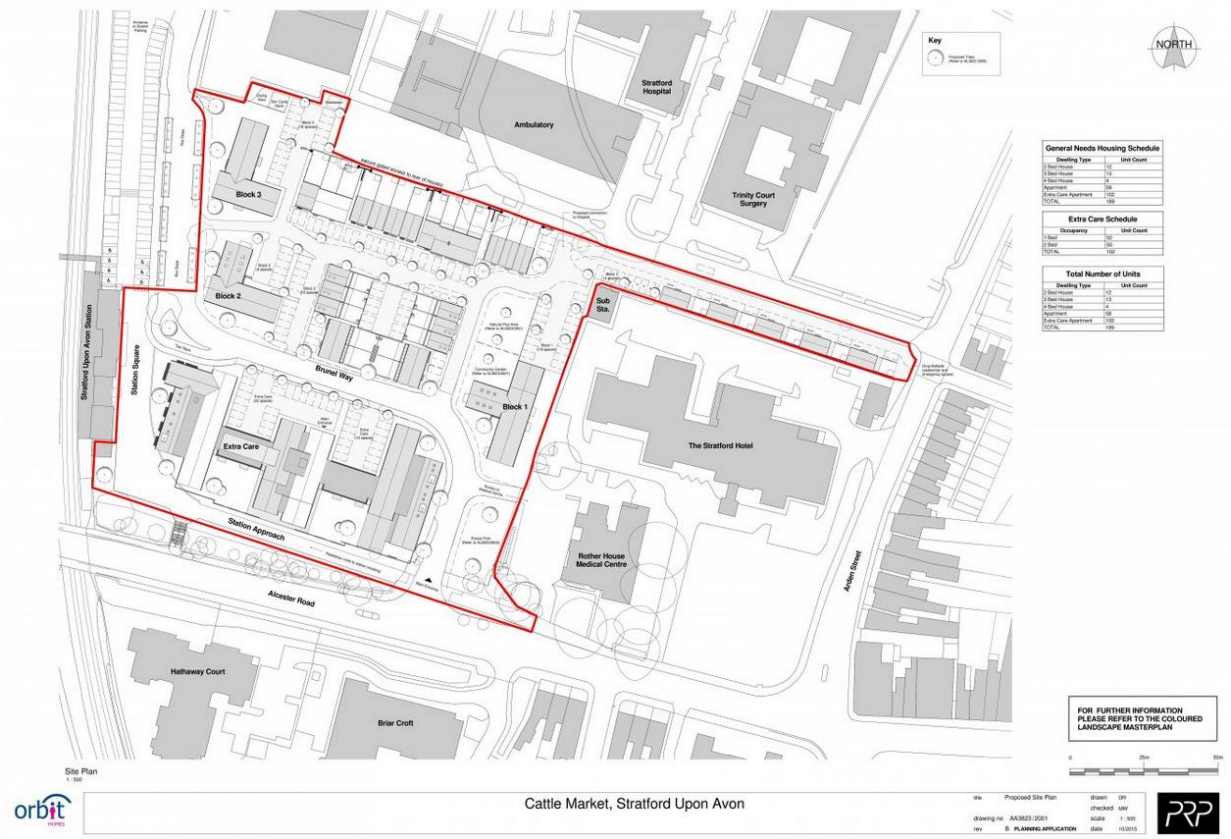


Figure 76: Cattle Market development site plan

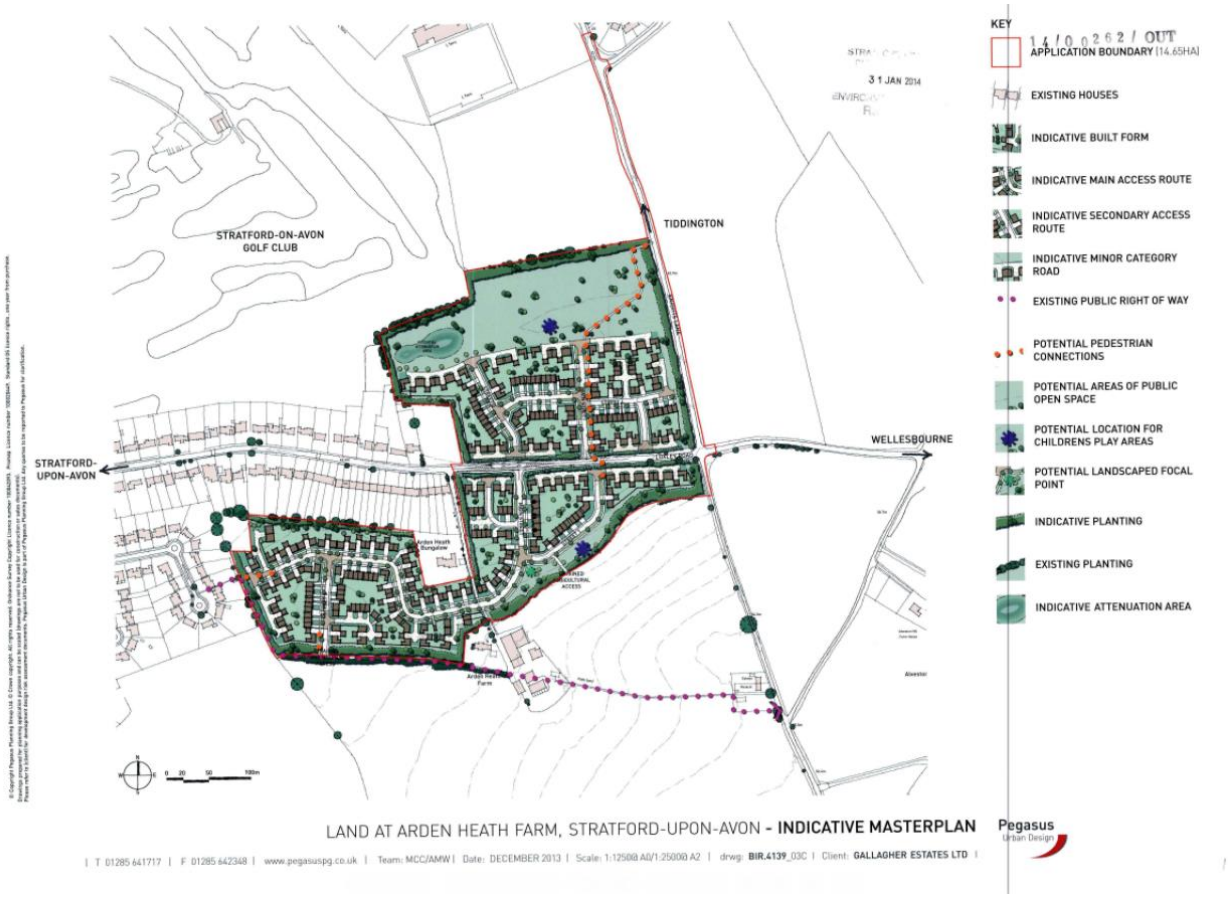


Figure 77: Arden Heath Farm site development

Figure 78: SUA. 2 development site plan

Figure 79: Oak Road development site plan

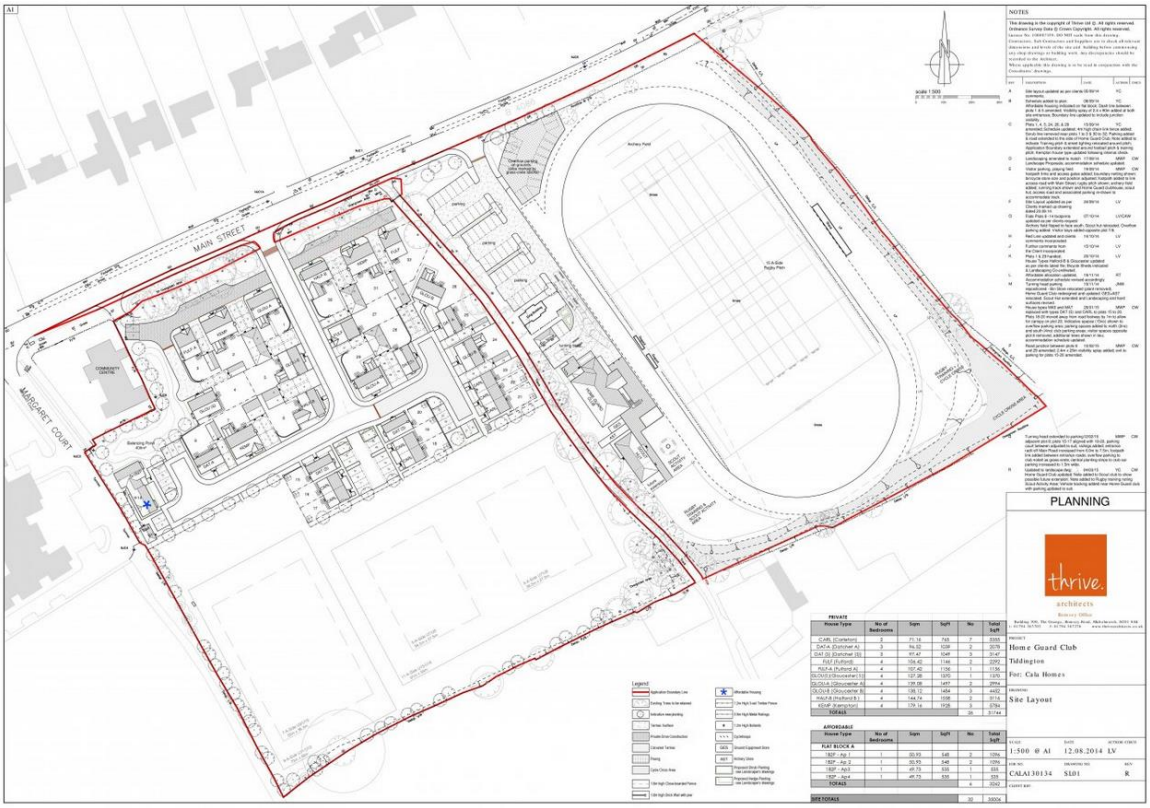


Figure 80: Home Guard Club development site plan

Meon Vale / Long Marston Depot

Figure 81: Meon Vale / Long Marston Depot development site plan

Long Marston Airfield

Figure 82: Long Marston Airfield development site plan

SOU 3 South of Daventry Road

Figure 83: SOU 3 South of Daventry Road development site plan

Gaydon / Lighthorne Heath

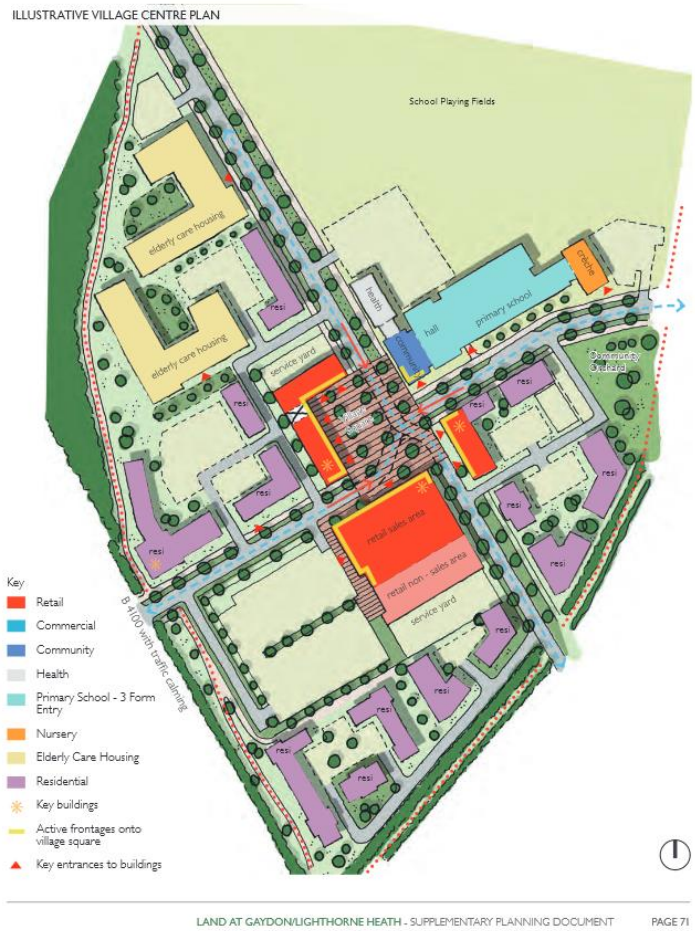


Figure 84: Gaydon / Lighthorne Heath Village development site plan

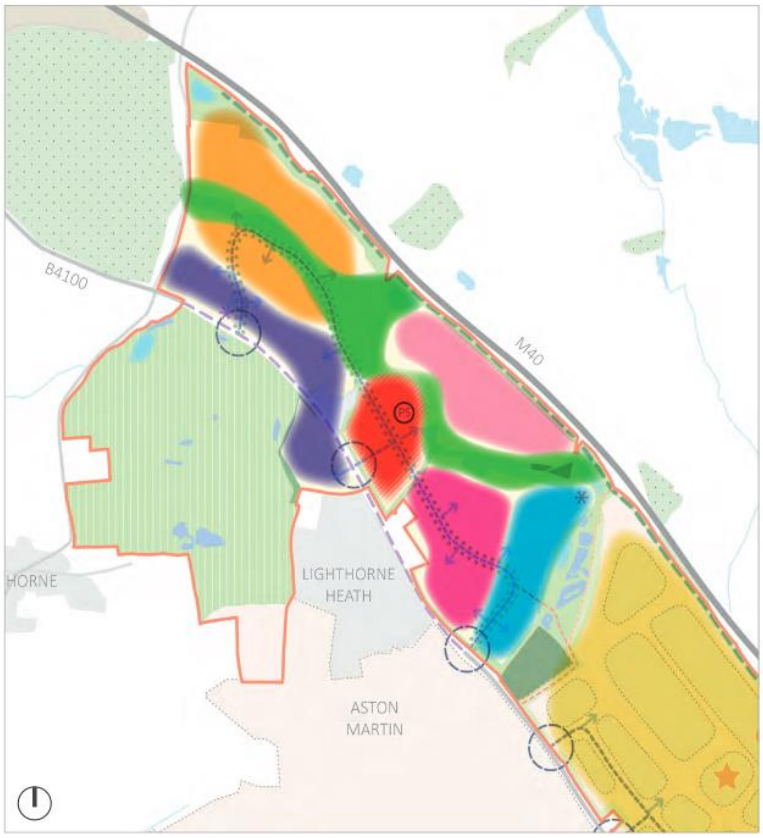


Figure 85: Gaydon / Lighthorne Heath development site plan

APPENDIX 4 – DOMESTIC BENCHMARKS

Domestic benchmarks were derived from heat modelling using building plans at 2013 Part L regulations.

Table 61: Domestic benchmarks

House Name	House Type	Gross Floor Area, m²	Modelled Benchmark, kWh/m²
Bede	2 bed disabled bungalow	64	195
Buchan	4 bed detached house	138	159
Buttermere	5 bed detached house	197	159
Calder	4 bed detached house	157	161
Carron	3 bed detached house	131	175
Coniston	4 bed detached house	166	161
Crompton	4 bed detached house	167	161
Darwin	3 bed detached house	103	166
Esk	4 bed detached house	128	159
Glenmuir	4 bed detached house	152	161
Greene	4 bed detached house	131	161
Hardy	4 bed semi-detached townhouse	129	167
Hawthorne	3 bed terraced house	91	171
Huxley	5 bed detached house	81	145
Jura	5 bed detached house	115	159
Kipling	3 bed detached house	104	166
London	5 bed detached house	134	145
Mitford	4 bed detached house	160	159
Nevis	3 bed terraced house	84	167
Orwell	3 bed detached house	134	171
Rolland	4 bed semi-detached house	124	171
Shakespeare	5 bed detached house	134	159
Stevenson	4 bed detached house	151	159
Stretton	3 bed terraced house	91	171
Sutton	3 bed disabled bungalow	114	195
Tolkien	3 bed terraced house	103	171
Warwick	3 bed detached house	103	166
Wharton	5 bed detached house	134	159
Yare	2 bed terraced house	74	171

APPENDIX 5 - INTRODUCTION TO TECHNOLOGIES ASSESSED

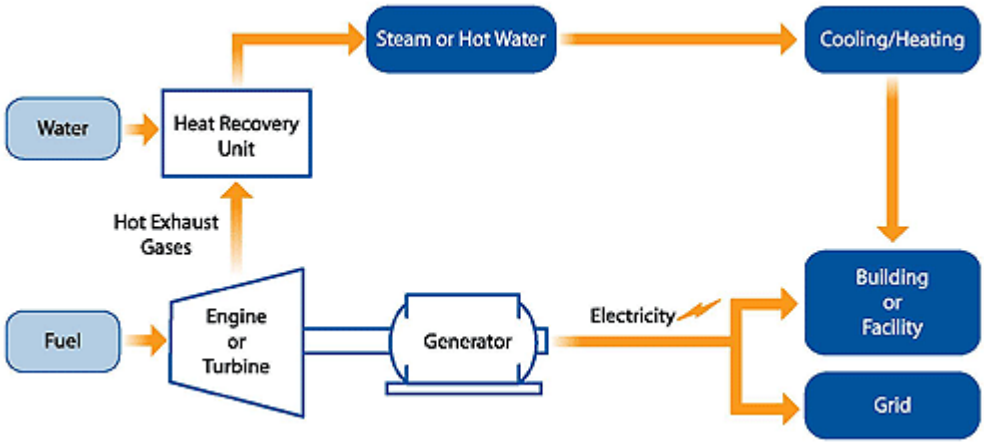
Biomass Boiler – a biomass boiler burns wood fuel in the form of wood pellets, chips or logs to provide heat in the form of low temperature, medium temperature hot water or steam. A biomass boiler comprises two main parts, the combustion chamber where wood fuel is combusted with unrestricted oxygen and the boiler tubes which transfer heat from the combustion chamber to the water or steam medium. The heated water or steam is then distributed around the heating system as required.

6MW Wood Chip Boiler at Sawmill Site in Mid-Wales, Photo Courtesy of Sustainable Energy Ltd

Wood Chip Delivery to Wood Chip Store for 6MW Biomass Boiler, Photo Courtesy of Sustainable Energy Ltd

Natural Gas Combined heat and power (CHP) – CHP is an efficient way of generating electricity and useful thermal energy from a single fuel source (natural gas). CHP is used to either replace or supplement conventional separate heat and power;

instead of purchasing electricity from the local utility and burning fuel in a boiler to produce heat, a CHP plant provides both energy services in one step. CHP involves the recovery of otherwise-wasted useful thermal energy. Normally, fuel is combusted in a prime mover such as a gas turbine or reciprocating gas engine to generate electricity. Energy normally lost in the prime mover's hot exhaust and cooling systems is instead recovered to provide heating for applications such as space heating, cooling, hot water and industrial processes. CHP plants are normally located at or near the electricity consumers, whereas conventional generation takes place in large centrally located power plants. CHP's higher efficiency comes from recovering the heat normally lost in power generation to provide heating or cooling on site. CHP's inherent higher efficiency and elimination of transmission and distribution losses from the central power plant results in reduced primary energy use and lower greenhouse gas emissions.

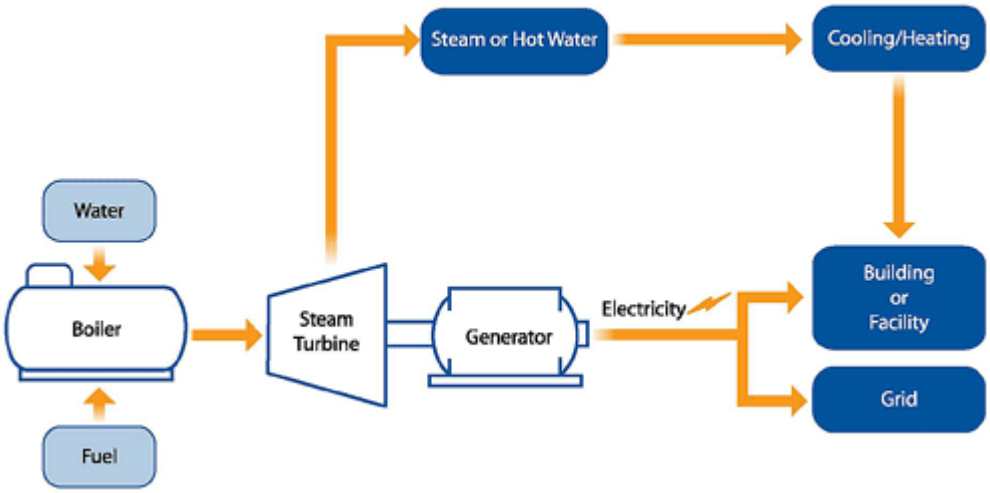


Picture courtesy of www.epa.gov

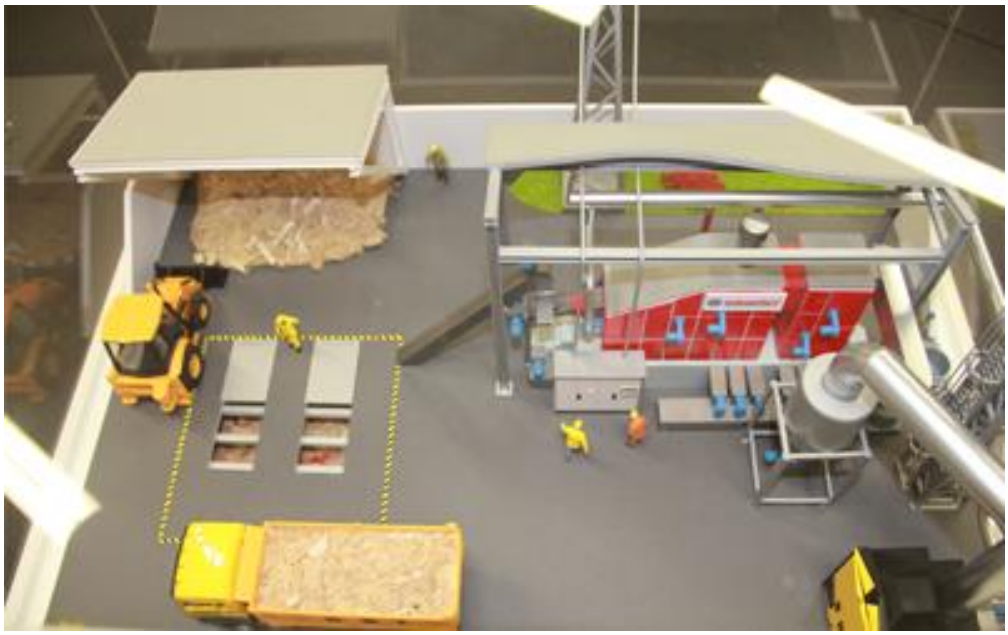
400kWe Natural Gas CHP Plant. Photo Courtesy of www.viessmann.co.uk

Biofuels CHP - Cogeneration from biomass fuels can be achieved by three means, medium to large scale steam turbine systems; smaller scale ORC systems and advanced thermal conversion with gas engines systems.

Biomass Steam Turbine CHP – This utilises biomass in the form of wood chip, wood pellet or bio oils as a fuel source for a boiler which is then used to raise steam which drives a steam turbine to generate electricity, with heat recovered from the steam turbine's exhaust and cooling systems to provide useable heat.



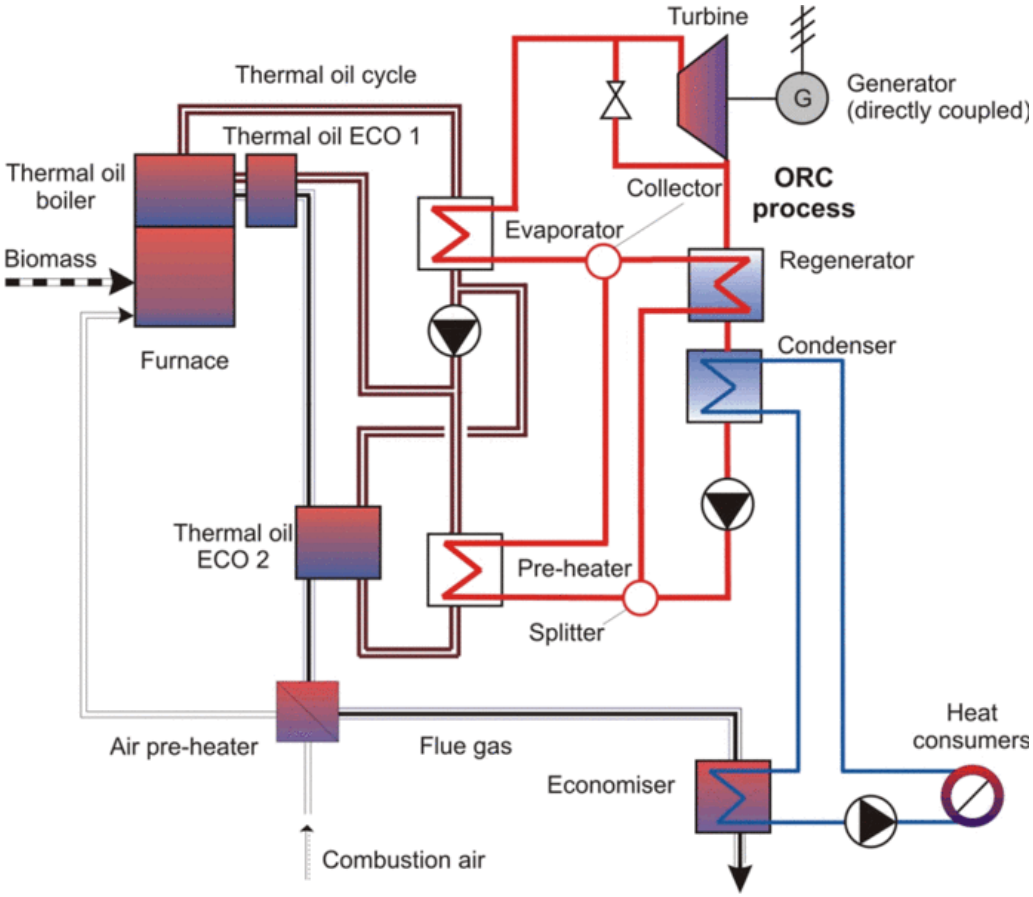
Picture courtesy of www.epa.gov



130kWe Biomass CHP Plant, Photo Courtesy of www.environltd.co.uk

Biomass Organic Rankine Cycle CHP (ORC) – Reciprocating steam engines and steam turbines use a thermodynamic process called the Rankine Cycle. At small scale, this is inefficient due to the high temperatures and pressures involved. However, it is possible to replace water as the working medium with an organic compound with a lower boiler point, such as a silicone oil or organic solvent. This allows the system to work at much lower temperatures, pressures and at smaller scale. The working medium is usually less corrosive than water to components such as turbine blades and the turbine can operate at a lower speed which can improve reliability. CHP systems where biomass fuel is used to produce heat in order to evaporate an organic compound to drive a turbine are known as Organic Rankine Cycle systems.

Picture courtesy of www.endswasteandbioenergy.com



Picture Courtesy of www.bios-bioenergy.at

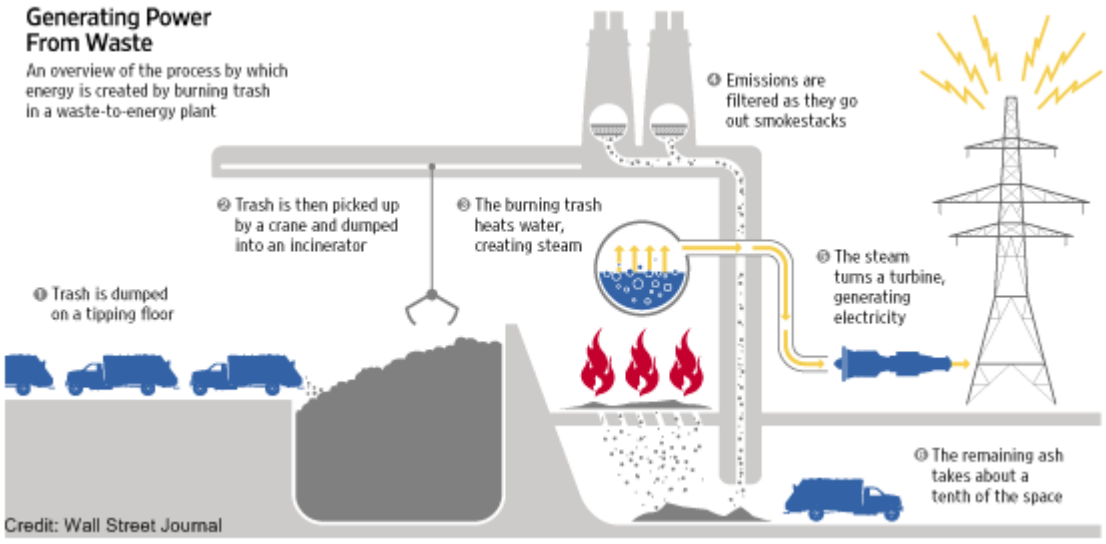
Biomass Gasification CHP – For Biomass Gasification CHP, instead of wood fuel being combusted to raise steam to generate electricity via a steam turbine, the wood fuel is burned with restricted oxygen levels to produce a wood gas which is then combusted within an internal combustion engine. The engine is then used to generate electricity, with heat recovered from the engine's exhaust and cooling systems to provide useable heat.

250kWe Wood Gasification System, Photo Courtesy of Sustainable Energy Ltd

The temperatures of the usable heat available from different CHP systems depends on the type of prime mover used. Higher flow temperatures can be achieved from engines for gas CHP and biomass gasification CHP or ORC systems whereas fully condensing steam turbines will not generate temperatures suitable for district heat systems unless electrical efficiency is sacrificed to achieve higher flow temperatures. Indicative flow temperatures for different CHP technologies are shown below:

	Internal Combustion Engine	ORC	Steam turbine – full condensing
Flow Temperature	80°C to 90°C	80°C to 90°C	40°C to 50°C
Potential Thermal efficiency	55%	50% to 60%	60% to 70%
Use as LTHW	Yes	Yes	No

Energy from Waste – Energy from Waste plants burn waste to generate electricity via a prime mover such as steam turbine or engine. The waste normally combusted in such plants is the residual waste from Municipal Solid Waste which is left over after all recycling possible has been done. This waste is normally a mix of items made from oil such as plastics and items that are biodegradable such as paper, wood and food. The most common thermal treatment for waste is incineration; waste is incinerated and the heat produced is used to heat water to raise steam which then drives a turbine and generates electricity. Significant amounts of heat are generated in this process which are often dumped, but this could be used to provide a heat source for a district heating scheme by recovering the heat from the exhaust and cooling systems of the steam turbine. Advanced thermal conversion processes such as gasification and pyrolysis can also be used to generate electricity from waste; by converting the waste into a product such as oil or gas that can then be burnt directly in gas engines or turbines. Advanced thermal conversion systems are potentially more efficient but are technically difficult and relatively unproven at commercial scale.



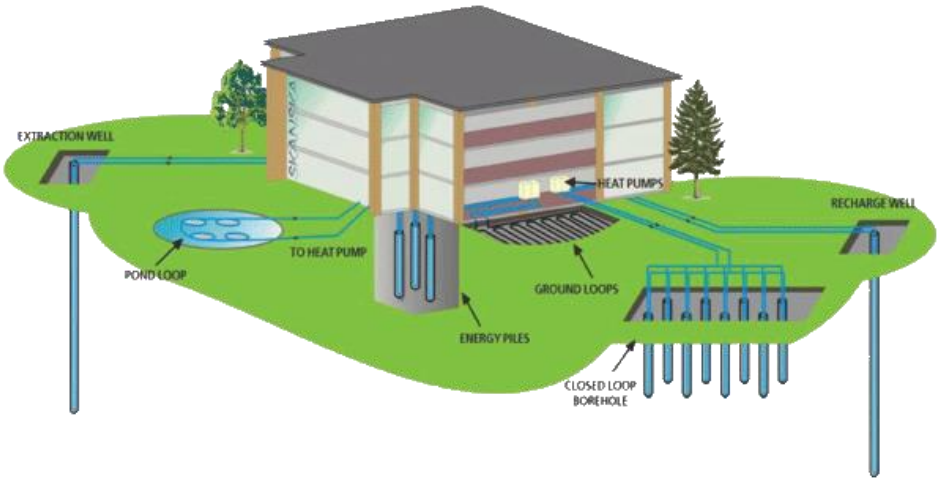
Picture courtesy of www.edouardstenger.com

Heat Pump Technologies[25] **-** Ground and Water Source Heat Pumps take heat from the ground or water and transfer it into buildings or a district heating system. The technology used is the same as that used in refrigerators. Just as a fridge extracts heat from the food and transfers it into the kitchen, so a ground source heat pump extracts heat from the earth and transfers it into a building. For every unit of electricity used to power the heat pump, approximately 3-4 units of heat are captured and distributed. At this efficiency level there will usually be less carbon dioxide emissions than for a gas boiler heating system.

A Ground or Water Source Heat Pump system comprises three basic elements - a ground loop / collector array, the heat pump itself and the heat distribution system. The ground loop is a pipe buried underground in a horizontal trench, in a vertical borehole or immersed in water.

Horizontal trenches can be dug >2 m below ground level and, although covering more land surface than a borehole, they are usually cheaper for smaller systems. Boreholes are drilled to a depth of between 15-150 m and benefit from higher ground temperatures than trenches. However, there are a variety of types of pipe (e.g. the coiled pipe known as a 'slinky') which can be used in a trench instead of a straight one, which increase the amount of heat absorbed from the ground and so enhance performance. The ground area required for trenches will vary with the location, the property and the heat output required. A water/anti-freeze mixture is circulated through the pipe where it absorbs heat from the surrounding medium. A heat exchanger then extracts the absorbed heat and transfers it to the heat pump.

The third basic element of a ground or water source heat pump, the heat distribution system, can be either low temperature radiators or, preferably, underfloor heating. If the heat pump is asked to produce higher temperatures, for a conventional radiator circuit, then its efficiency will significantly reduce.



Picture courtesy of www.esru.strath.ac.uk

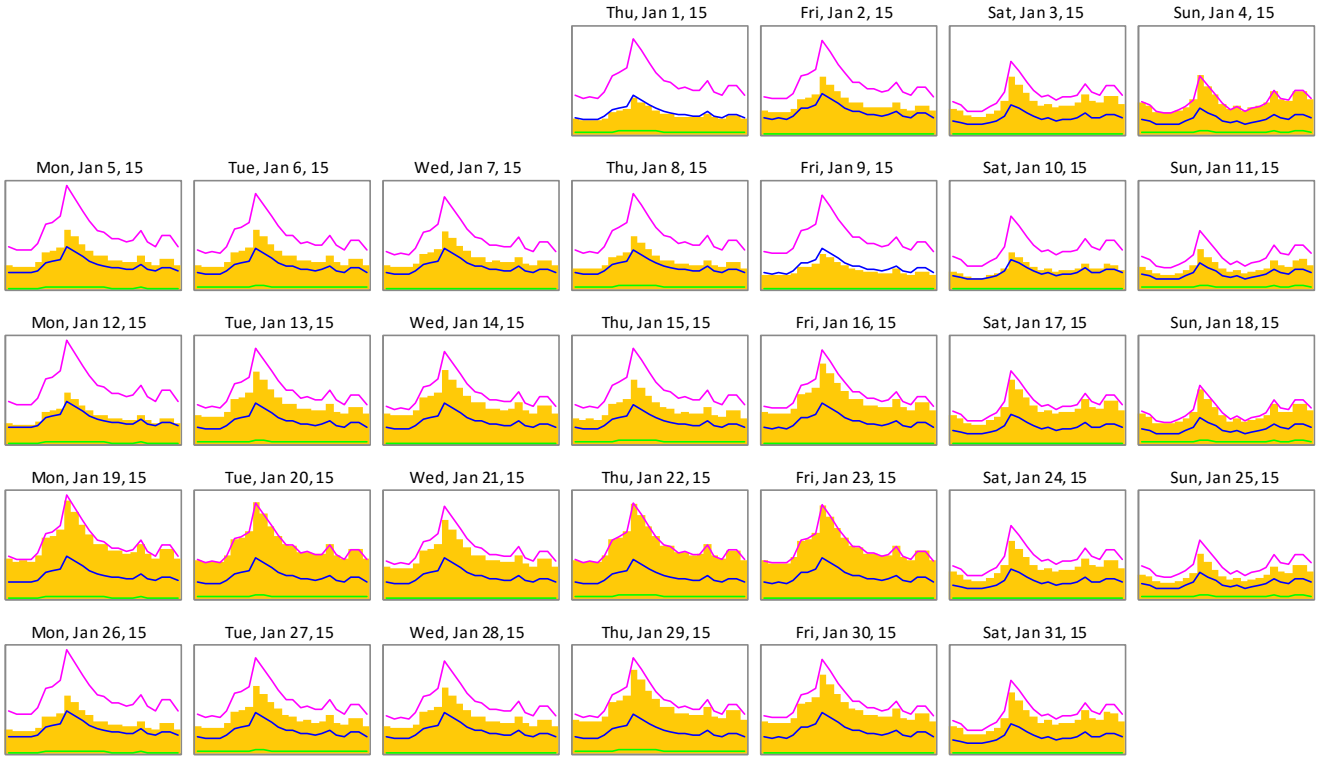
[25] Summarised from GSHP Association

APPENDIX 6 – HEAT DEMAND MODELLING

Seasonal Demand Profiles

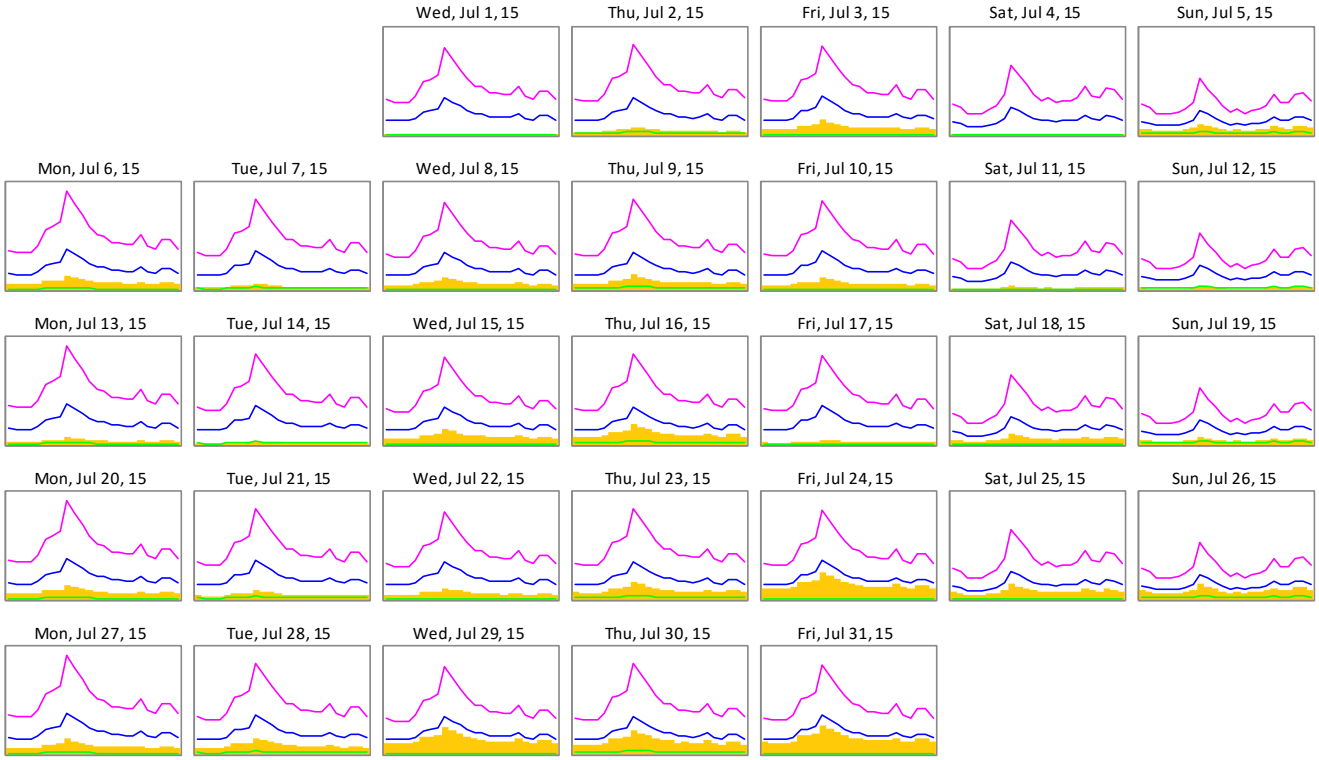
The heat demand profiles for priority networks for each day of the week, for two separate months, are shown in the figures below. The pink, blue and green lines indicate minimum, average and maximum respectively. The yellow shaded area shows the heat demand profile for each specific day.

Town Centre Network



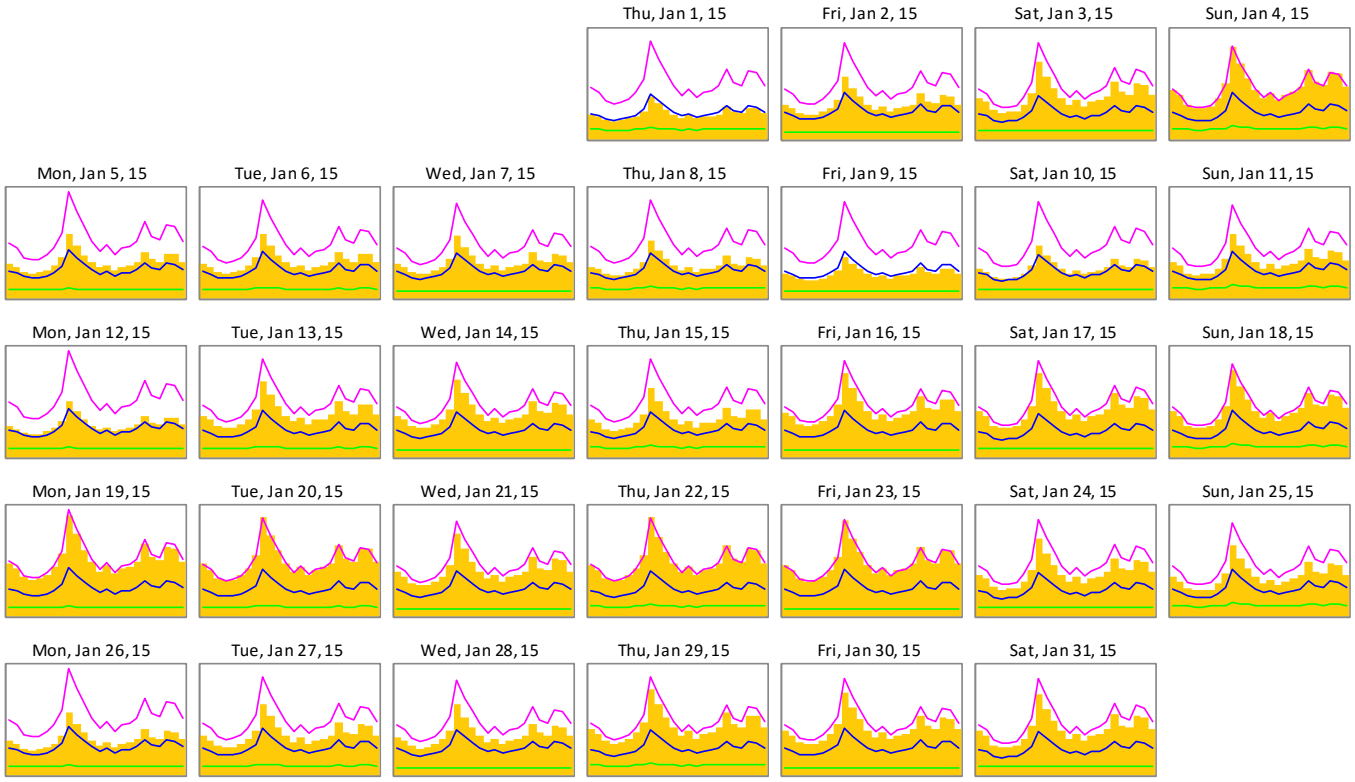
All chart scales run from 0 to 3,522.95 kW (average power over hour interval). Maximum, average, and minimum profiles are included for each day of the week.

Figure 86: Town Centre Network daily profiles - January 2015



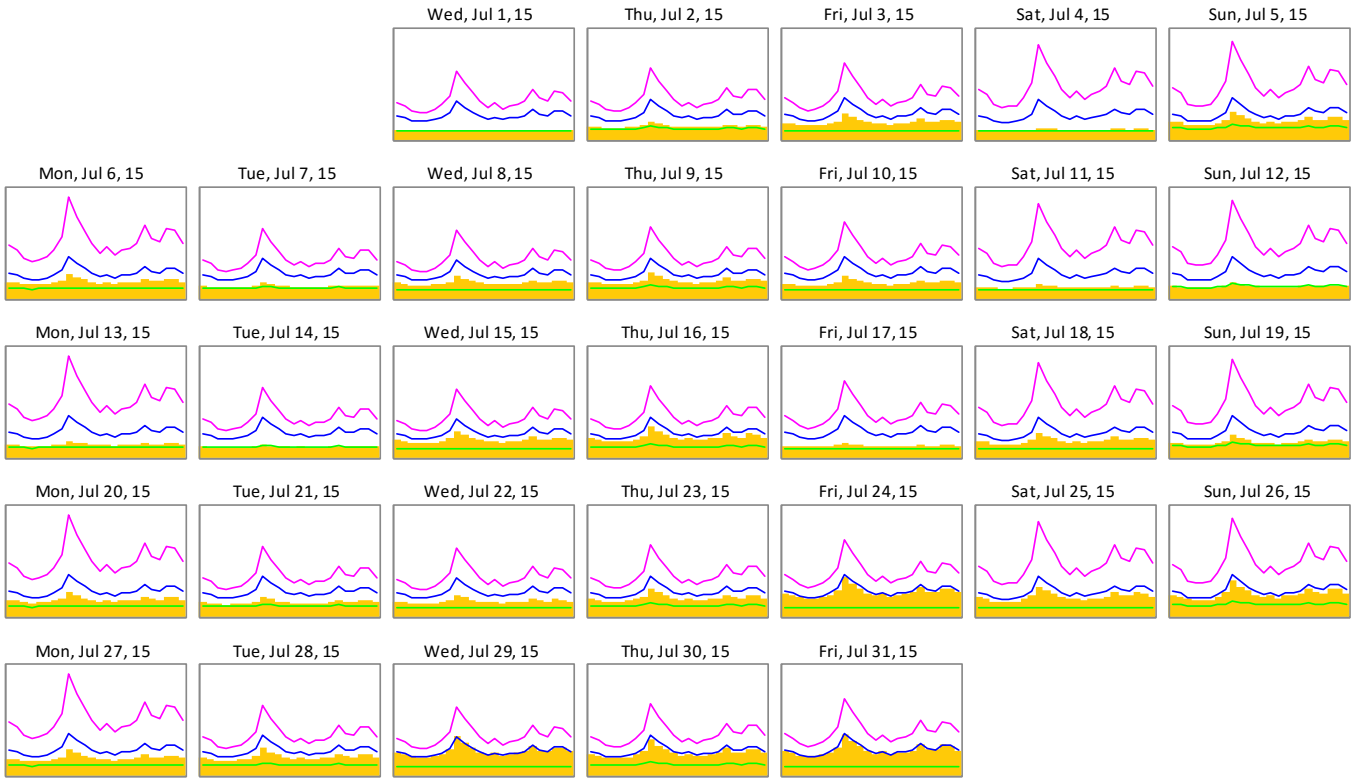
All chart scales run from 0 to 3,715.27 kW (average power over hour interval). Maximum, average, and minimum profiles are included for each day of the week.

Figure 87: Town Centre Network daily profiles - July 2015



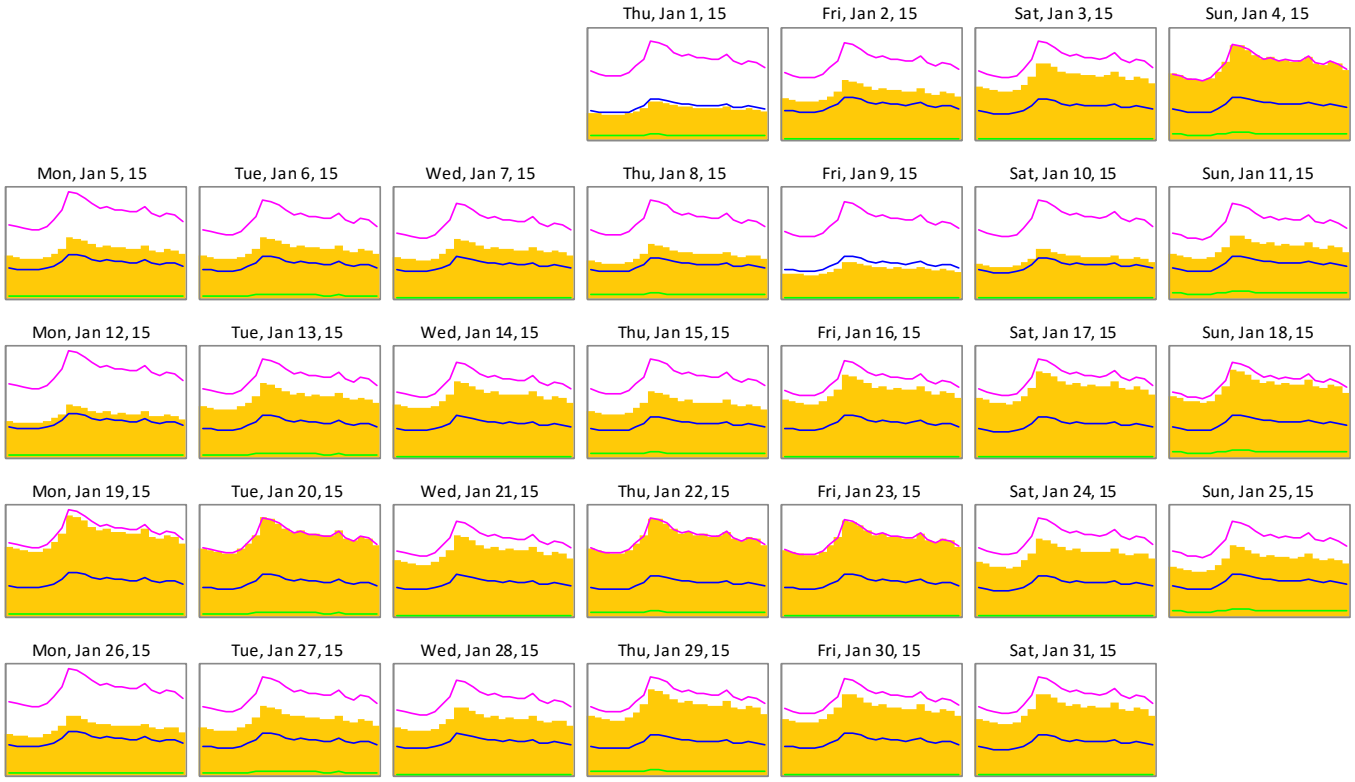
All chart scales run from 0 to 2,319.93 kW (average power over hour interval). Maximum, average, and minimum profiles are included for each day of the week.

Figure 88: Bridgeway Network daily profiles - January 2015



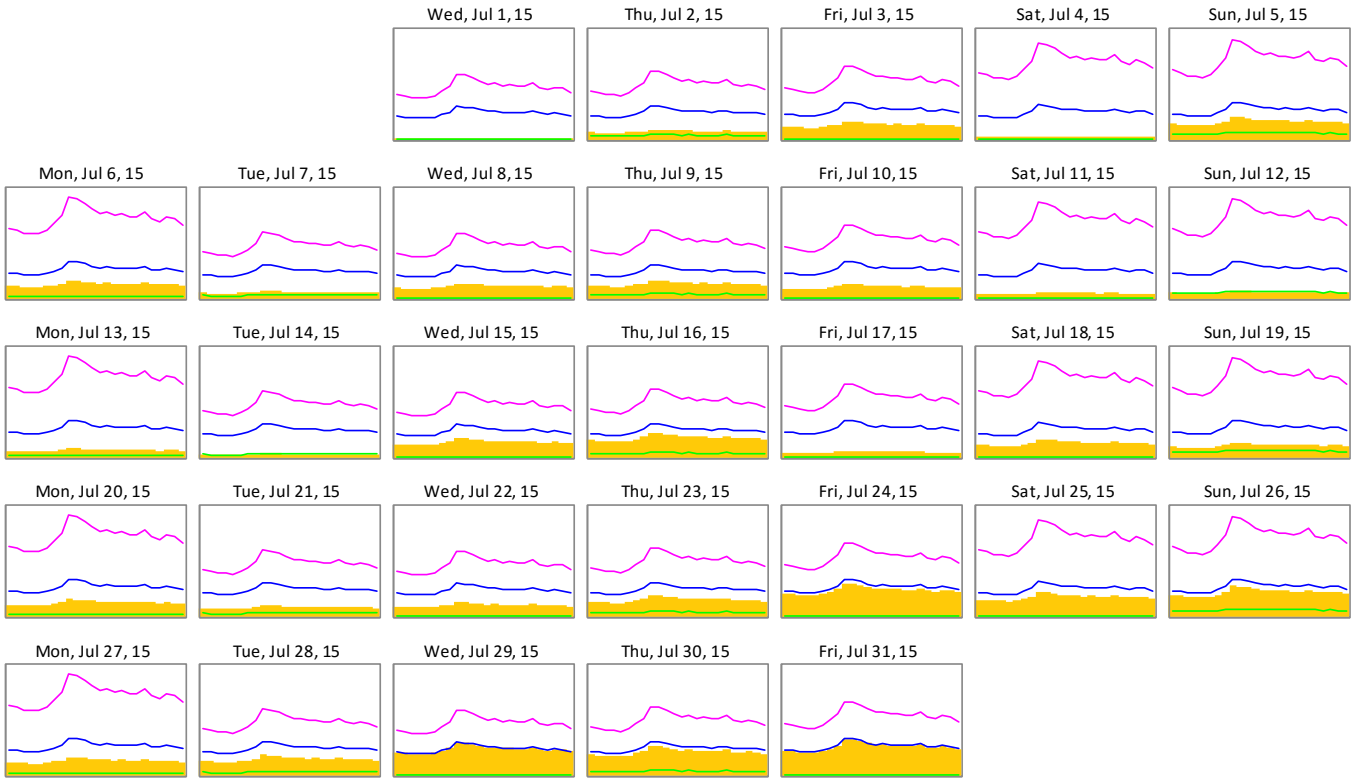
All chart scales run from 0 to 2,086.06 kW (average power over hour interval). Maximum, average, and minimum profiles are included for each day of the week.

Figure 89: Bridgeway Network daily profiles - July 2015



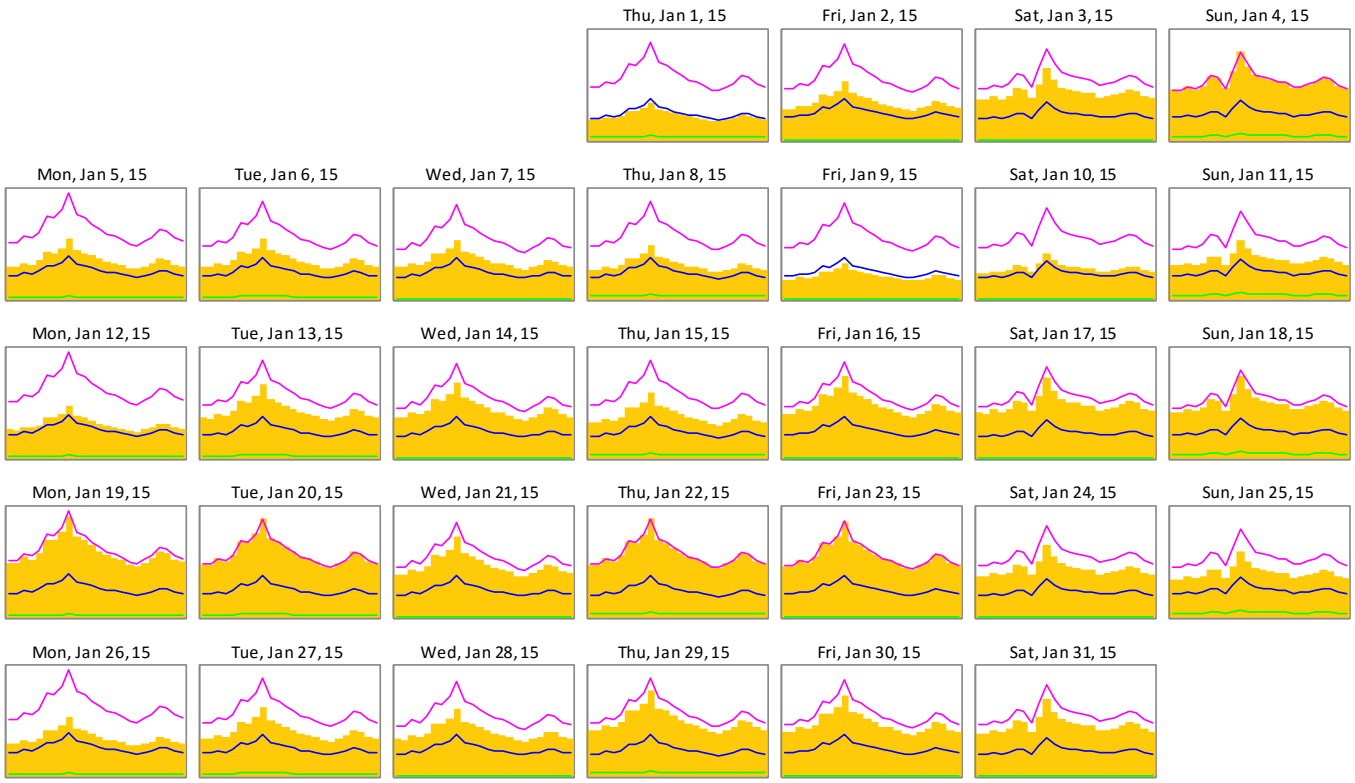
All chart scales run from 0 to 2,631.93 kW (average power over hour interval). Maximum, average, and minimum profiles are included for each day of the week.

Figure 90: Alcester Road Network daily profiles - January 2015



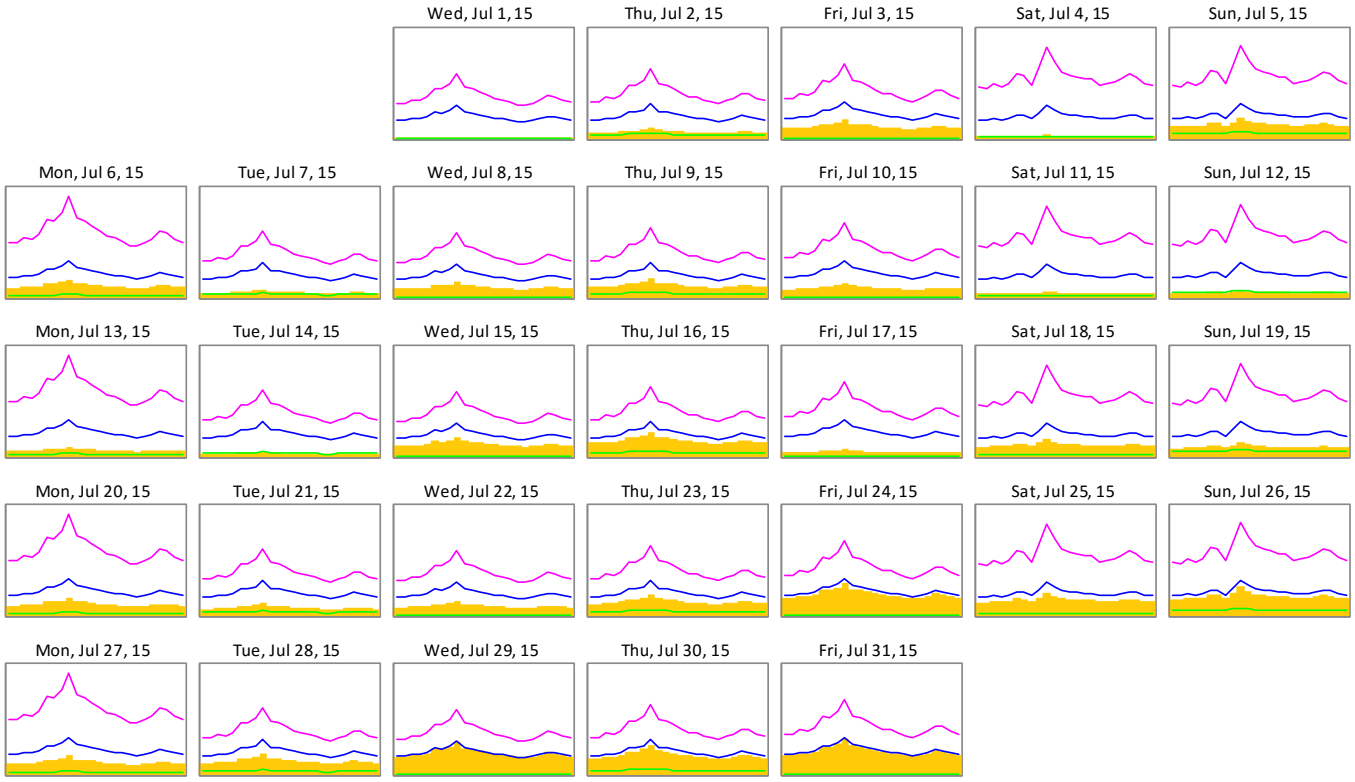
All chart scales run from 0 to 2,344.82 kW (average power over hour interval). Maximum, average, and minimum profiles are included for each day of the week.

Figure 91: Alcester Road Network daily profiles- July 2015



All chart scales run from 0 to 2,971.13 kW (average power over hour interval). Maximum, average, and minimum profiles are included for each day of the week.

Figure 92: Gaydon / Lighthorne Heath Village Centre Network daily profiles- January 2015



All chart scales run from 0 to 2,648.76 kW (average power over hour interval). Maximum, average, and minimum profiles are included for each day of the week.

Figure 93: Gaydon / Lighthorne Heath Village Centre Network daily profiles - July 2015

APPENDIX 7 – FINANCIAL VIABILITY ASSESSMENTS

Assumptions

Technology Efficiencies

Table 62 shows the assumed efficiencies used in technology assessments for peak and reserve gas boilers, biomass heat and the average SPF used for a GSHP. Efficiencies for gas and biomass CHP technologies vary according to the size of the plant. These can be seen in the full business cases shown below for each network option.

Table 62: Technology details assumptions and sources of data

Technology details	Value	Reference/Justification
Peak and reserve gas boiler efficiency	85 %	Expected efficiency of new boiler
Average annual SPF for WSHP	3.5	Previous experience for good practice
Average annual SPF for GSHP	3.5	Previous experience for good practice

Emissions Factors

Table 63 shows the emissions factors used to calculate carbon savings.

Table 63: Emissions factor assumptions and sources of data

Emissions factors	Value	Reference/Justification
Grid electricity	0.41205 $kgCO_2/kWh$	DEFRA 2016 Carbon factors
Natural gas	0.18400 $kgCO_2/kWh$	DEFRA 2016 Carbon factors
Woodchip	0.01307 $kgCO_2/kWh$	DEFRA 2016 Carbon factors
Wood pellet	0.01307 $kgCO_2/kWh$	DEFRA 2016 Carbon factors

Technology Replacement Costs

Technology replacement costs have been modelled on an annualised basis and take into account the expected lifetime of the technology, fractional repairs and the length of the business term.

Pipe Sizing and Specifications

All pipe specifications and costs are based on previous experience including a schedule of rates for a district heating project on Bristol for an installed network for which SEL acted as client's engineer. Pipe costs shown are the average (cost per meter of trench) for all priority networks and include costs for pipe, insulation, trench excavation and backfill. These costs have been varied for a range of dig conditions (including concrete, tarmac, grass top and grass seed).

Table 64: Pipe sizes for priority networks

Pipe Size	Pipe length, m			
	Town Centre	Bridgeway	Alcester Road	Gaydon / Lighthorne Heath Village Centre
DN40	70	-	267	1,017
DN50	212	-	155	-
DN80	398	49	409	389
DN100	261	-	-	108
DN150	494	451	393	228
DN200	-	-	-	313

Table 65: Pipe specifications and heat loss

Pipe Size	Internal diameter, mm	Outer diameter, mm (including insulation)	Trench width, mm	Trench depth, mm	Heat loss, kW/m	Average cost per metre, £/m
DN40	41	160	820	960	19.0	358
DN50	53	180	860	980	20.6	329
DN80	78	225	950	1,025	24.4	551
DN100	102	280	1,080	1,080	25.3	694
DN150	154	355	1,210	1,155	31.1	854
DN200	203	450	1,400	1,250	32.4	830

Private Wire

It has been assumed that the private wire network for each network option will be installed in the heat network trench during network construction. Trenching costs have therefore not been included in private wire costs. A costs of £200/m has been included in financial assessment for the costs of the wire only. This figure is based on experience from previous projects.

Financial Viability Assessments – Priority Networks

Town Centre Network – Gas CHP

Table 66: Estimated capital costs town centre network

Cost of CHP plant (incl. controls, M&E, emissions abatement)	£485,380
Cost of auxiliary & plant equipment (incl. thermal store, energy centre, M&E)	£346,500
Cost of DH network (incl. trenching costs, project management, designs and surveys)	£986,010
Cost of building connections for existing buildings (heat network)	£122,882
Cost of private wire network	£143,404
Cost of building connections for existing buildings (private wire)	£10,000
Cost of land for energy centre	-
Contingency	20 %
Total cost of scheme	**£2,513,011**

Table 67: Financial assessment town centre network

Phase heat demand (MWh)	5,750
District heat network losses (MWh)	327
Total amount of heat generated (MWh)	6,077
Size of CHP (kWth)	380
Size of CHP (kWe)	242
CHP modulation limit	50 %
Size of auxiliary (kW)	3,300
Heat generation CHP (MWh)	4,201
Heat generation auxiliary gas (MWh)	1,890
CHP electrical generation per annum (MWh)	2,671
Value of heat sales	£196,968
Electricity sales (private wire)	£215,647
Electricity sales (export)	£3,694
Total Income	**£416,309**
Cost of gas for CHP	£180,861
Cost of operation for CHP	£30,451
CHP replacement costs for 25 year business case	£16,179
CHP replacement costs for 40 year business case	£25,280
Cost of fuel for auxiliary (gas)	£48,919
Cost of CCL for auxiliary gas	£3,686
Cost of operation for auxiliary	£5,670
Auxiliary replacement costs for 25 year business case	-
Auxiliary replacement costs for 40 year business case	£5,198
Cost of energy centre operation	£10,052
Cost of network operation and maintenance	£4,841
Total costs of generation for 25 year business case	**£300,659**
Total costs of generation for 40 year business case	**£314,957**
Net income for 25 year business case	**£115,650**
Net income for 40 year business case	**£101,352**

Table 68: Town centre network 25 year financial case

Internal rate of return	4.2 %
Net present value	£200,154
Discounted payback	23.4 years

Table 69: Town centre network 40 year financial case

Internal rate of return	5.2 %
Net present value	£767,469
Discounted payback	26.5 years

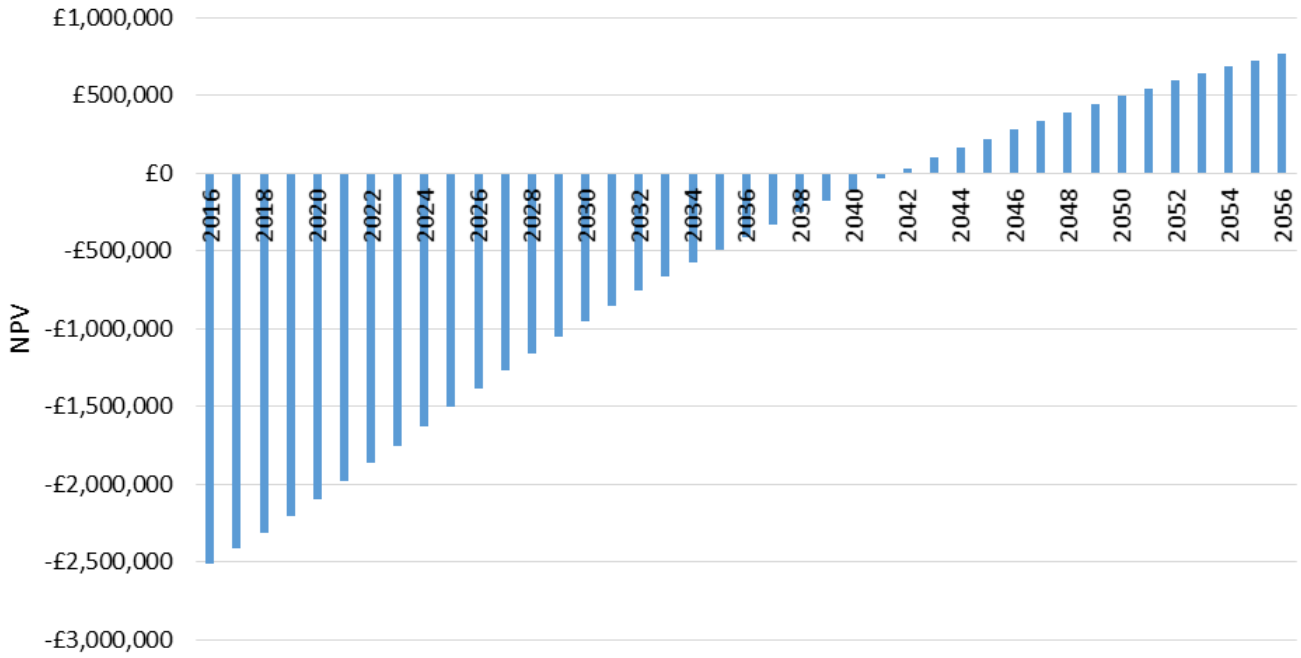


Figure 94: Discounted cash flow for Town Centre network over 40 years

Bridgeway Network – Gas CHP

Table 70: Estimated capital costs Bridgeway network – gas CHP

Cost of CHP plant (incl. controls, M&E, emissions abatement)	£648,150
Cost of auxiliary & plant equipment (incl. thermal store, energy centre, M&E)	£231,000
Cost of DH network (incl. trenching costs, project management, designs and surveys)	£364,184
Cost of building connections for existing buildings (heat network)	£43,886
Cost of private wire network	£50,060
Cost of building connections for existing buildings (private wire)	£5,000
Cost of land for energy centre	-
Contingency	20 %
Total cost of scheme	**£1,610,735**

Table 71: Financial assessment Bridgeway network – gas CHP

Phase heat demand (MWh)	5,042
District heat network losses (MWh)	133
Total amount of heat generated (MWh)	5,176
Size of CHP (kWth)	450
Size of CHP (kWe)	382
CHP modulation limit	50 %
Size of auxiliary (kW)	2,200
Heat generation CHP (MWh)	3,991
Heat generation auxiliary gas (MWh)	1,191
CHP electrical generation per annum (MWh)	3,379
Value of heat sales	£184,096
Electricity sales (private wire)	£192,421
Electricity sales (export)	£48,401
Total Income	**£424,919**
Cost of gas for CHP	£204,207
Cost of operation for CHP	£41,583
CHP replacement costs for 25 year business case	£21,605
CHP replacement costs for 40 year business case	£33,758
Cost of fuel for auxiliary (gas)	£30,815
Cost of CCL for auxiliary gas	£2,322
Cost of operation for auxiliary	£3,572
Auxiliary replacement costs for 25 year business case	-
Auxiliary replacement costs for 40 year business case	£3,465
Cost of energy centre operation	£8,581
Cost of network operation and maintenance	£1,151
Total costs of generation for 25 year business case	**£313,837**
Total costs of generation for 40 year business case	**£329,455**
Net income for 25 year business case	**£111,082**
Net income for 40 year business case	**£95,464**

Table 72: Bridgeway network 25 year financial case – gas CHP

Internal rate of return	8.7 %
Net present value	£1,128,115
Discounted payback	13.9 years

Table 73: Bridgeway network 40 year financial case – gas CHP

Internal rate of return	8.8 %
Net present value	£1,676,283
Discounted payback	15.5 years

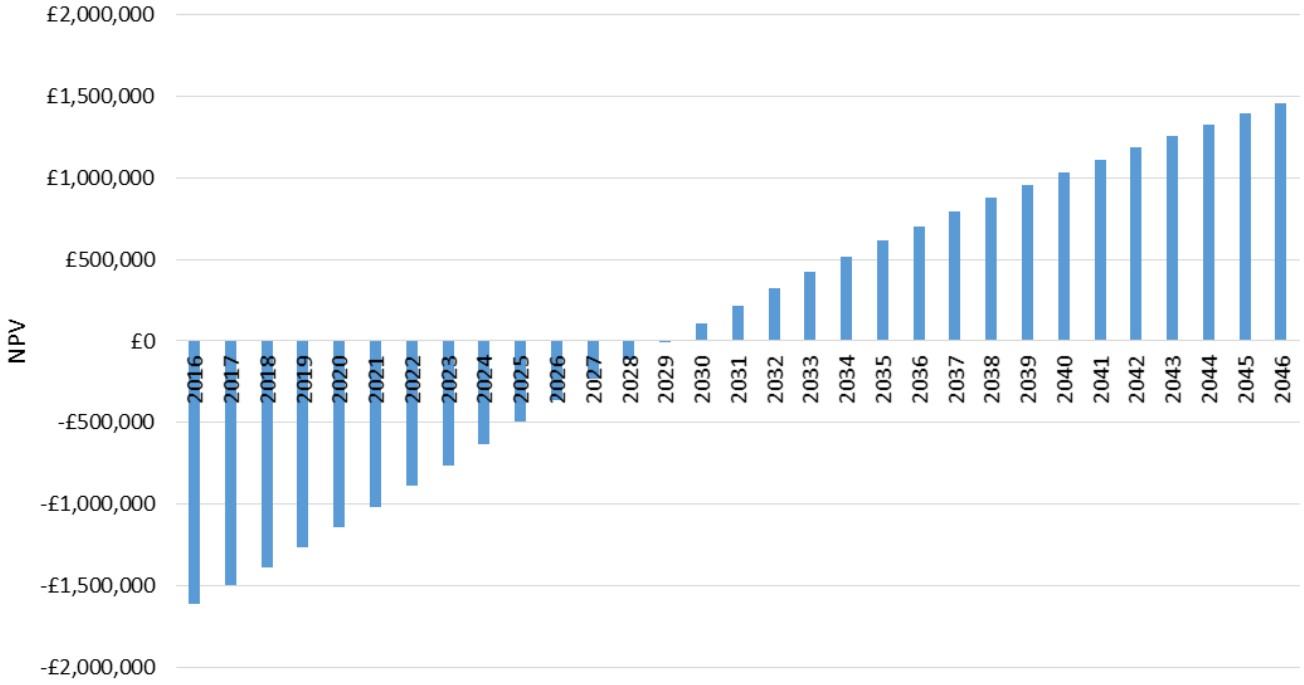


Figure 95: Discounted cash flow for Bridgeway network gas CHP over 40 years

Bridgeway Network - WSHP

Table 74: Estimated capital costs Bridgeway network - WSHP

Cost of WSHP (incl. controls, M&E)	£825,000
Cost of auxiliary & plant equipment (incl. thermal store, energy centre, M&E)	£231,000
Cost of DH network (incl. trenching costs, project management, designs and surveys)	£714,184
Cost of building connections and conversion of existing heating systems	£219,430
Cost of land for energy centre	-
Contingency	20 %
Total cost of scheme	**£2,387,536**

Table 75: Financial assessment Bridgeway network - WSHP

Phase heat demand (MWh)	5,042
District heat network losses (MWh)	264
Total amount of heat generated (MWh)	5,306
Size of WSHP (kWth)	750
Size of auxiliary (kW)	2,200
Heat generation WSHP (MWh)	4,702
Heat generation auxiliary gas (MWh)	474
Value of heat sales	£184,096
Value of RHI	£184,192
Total Income	**£369,289**
Cost of electricity for WSHP	£110,626
Cost of operation for WSHP	£37,615
WSHP replacement costs for 25 year business case	£10,313
WSHP replacement costs for 40 year business case	£25,781
Cost of fuel for auxiliary (gas)	£12,261
Cost of CCL for auxiliary gas	£924
Cost of operation for auxiliary	£1,421
Auxiliary replacement costs for 25 year business case	-
Auxiliary replacement costs for 40 year business case	£3,465
Cost of energy centre operation	£8,581
Cost of heat network operation and maintenance	£851
Total costs of generation for 25 year business case	**£182,593**
Total costs of generation for 40 year business case	**£201,526**
Net income for 25 year business case	**£185,696**
Net income for 40 year business case	**£166,762**

Table 76: Bridgeway Network WSHP 25 year financial case

Internal rate of return	4.8 %
Net present value	£310,168
Discounted payback	18.2 years

Table 77: Bridgeway Network WSHP 40 year financial case

Internal rate of return	3.3 %
Net present value	-£33,020
Discounted payback	20.9 years

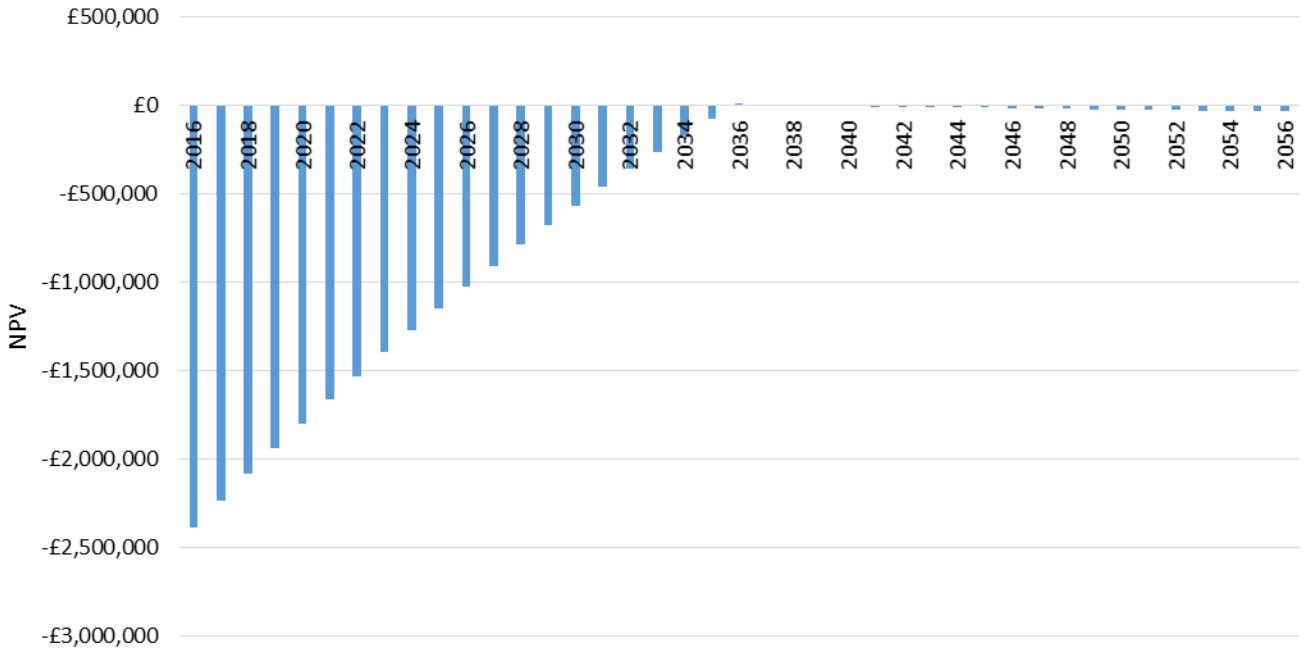


Figure 96: Discounted cash flow for Bridgeway network WSHP over 40 years

Alcester Road Network – Gas CHP

Table 78: Estimated capital costs Alcester Road network – gas CHP

Cost of CHP plant (incl. controls, M&E, emissions abatement)	£658,450
Cost of auxiliary & plant equipment (incl. thermal store, energy centre, M&E)	£262,500
Cost of DH network (incl. trenching costs, project management, designs and surveys)	£734,200
Cost of building connections for existing buildings (heat network)	£58,549
Cost of private wire network	£70,560
Cost of building connections for existing buildings (private wire)	£5,000
Cost of land for energy centre	-
Contingency	20 %
Total cost of scheme	**£2,147,111**

Table 79: Financial assessment Alcester Road network – gas CHP

Phase heat demand (MWh)	6,811
District heat network losses (MWh)	267
Total amount of heat generated (MWh)	7,078
Size of CHP (kWth)	650
Size of CHP (kWe)	410
CHP modulation limit	50 %
Size of auxiliary (kW)	2,500
Heat generation CHP (MWh)	5,245
Heat generation auxiliary gas (MWh)	1,834
CHP electrical generation per annum (MWh)	4,254
Value of heat sales	£272,155
Electricity sales (private wire)	£177,383
Electricity sales (export)	£93,592
Total Income	**£543,130**
Cost of gas for CHP	£259,968
Cost of operation for CHP	£43,375
CHP replacement costs for 25 year business case	£21,948
CHP replacement costs for 40 year business case	£34,294
Cost of fuel for auxiliary (gas)	£47,456
Cost of CCL for auxiliary gas	£3,575
Cost of operation for auxiliary	£5,501
Auxiliary replacement costs for 25 year business case	-
Auxiliary replacement costs for 40 year business case	£3,938
Cost of energy centre operation	£11,692
Cost of operation and maintenance	£2,998
Total costs of generation for 25 year business case	**£396,514**
Total costs of generation for 40 year business case	**£412,797**
Net income for 25 year business case	**£146,616**
Net income for 40 year business case	**£130,333**

Table 80: Alcester Road network 25 year financial case

Internal rate of return	8.3 %
Net present value	£1,378,760
Discounted payback	14.4 years

Table 81: Alcester Road network 40 year financial case

Internal rate of return	8.6 %
Net present value	£2,162,795
Discounted payback	15.7 years

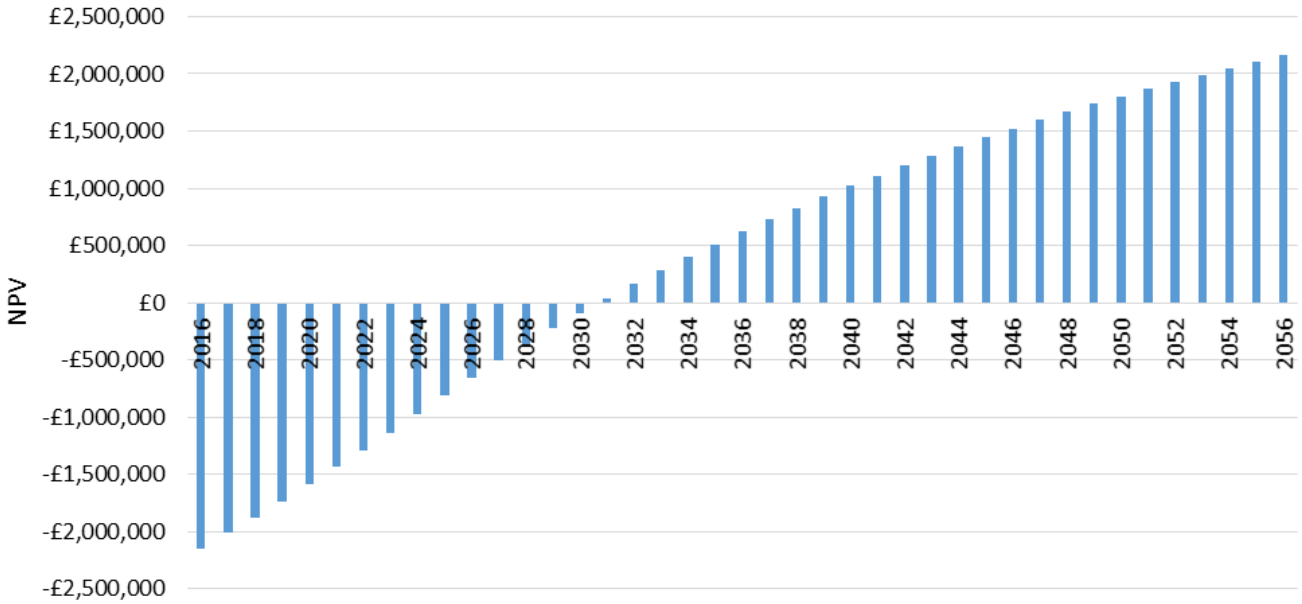


Figure 97: Discounted cash flow for Alcester Road network gas CHP over 40 years

Gaydon / Lighthorne Heath Village Centre Network - Gas CHP

Table 82: Estimated capital costs Gaydon / Lighthorne Heath Village Centre Network – gas CHP

Cost of CHP plant (incl. controls, M&E, emissions abatement)	£735,880
Cost of auxiliary & plant equipment (incl. thermal store, energy centre, M&E)	£294,000
Cost of DH network (incl. trenching costs, project management, designs and surveys)	£768,831
Cost of building connections for existing buildings (heat network)	-
Cost of private wire network	£205,472
Cost of building connections for existing buildings (private wire)	£5,000
Cost of land for energy centre	-
Contingency	20 %
Total cost of scheme	**£2,411,020**

Table 83: Financial assessment Gaydon / Lighthorne Heath Village Centre Network – gas CHP

Phase heat demand (MWh)	6,152
District heat network losses (MWh)	427
Total amount of heat generated (MWh)	6,579
Size of CHP (kWth)	580
Size of CHP (kWe)	291
CHP modulation limit	50 %
Size of auxiliary (kW)	2,800
Heat generation CHP (MWh)	4,693
Heat generation auxiliary gas (MWh)	2,800
CHP electrical generation per annum (MWh)	4,123
Value of heat sales	£258,116
Electricity sales (private wire)	£113,677
Electricity sales (export)	£121,709
Total Income	**£493,501**
Cost of gas for CHP	£241,231
Cost of operation for CHP	£40,000
CHP replacement costs for 25 year business case	£19,263
CHP replacement costs for 40 year business case	£30,098
Cost of fuel for auxiliary (gas)	£49,179
Cost of CCL for auxiliary gas	£3,705
Cost of operation for auxiliary	£4,000
Auxiliary replacement costs for 25 year business case	-
Auxiliary replacement costs for 40 year business case	£4,410
Cost of energy centre operation	£10,734
Cost of network operation and maintenance	£6,717
Total costs of generation for 25 year business case	**£374,828**
Total costs of generation for 40 year business case	**£390,074**
Net income for 25 year business case	**£118,673**
Net income for 40 year business case	**£103,428**

Table 84: Gaydon / Lighthorne Heath Village Centre Network 25 year financial case

Internal rate of return	4.6 %
Net present value	£319,307
Discounted payback	22.0 years

Table 85: Gaydon / Lighthorne Heath Village Centre Network 40 year financial case

Internal rate of return	5.8 %
Net present value	£1,006,168
Discounted payback	23.8 years

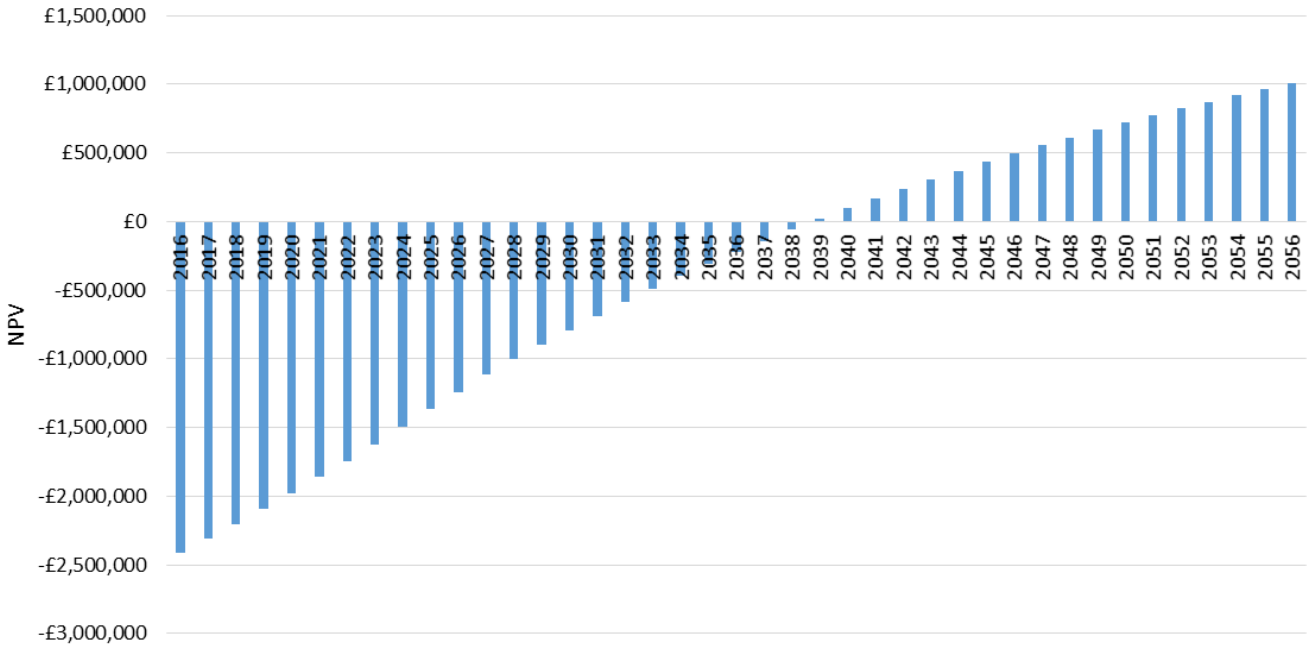


Figure 98: Discounted cash flow for Gaydon / Lighthorne Heath village centre network gas CHP over 40 years

Table 86: Estimated capital costs Gaydon / Lighthorne Heath Village Centre Network – biomass heat

Cost of biomass boiler (incl. controls, M&E, emissions abatement)	£506,000
Cost of auxiliary & plant equipment (incl. thermal store, energy centre, M&E)	£294,000
Cost of DH network (incl. trenching costs, project management, designs and surveys)	£768,831
Cost of building connections for existing buildings	-
Cost of land for energy centre	-
Contingency	20 %
Total cost of scheme	**£1,882,598**

Table 87: Financial assessment Gaydon / Lighthorne Heath Village Centre Network – biomass heat

Phase heat demand (MWh)	6,152
District heat network losses (MWh)	427
Total amount of heat generated (MWh)	6,579
Size of biomass boiler (kWth)	550
Biomass modulation limit	30 %
Size of auxiliary (kW)	2,800
Heat generation biomass (MWh)	4,223
Heat generation auxiliary gas (MWh)	2,356
Value of heat sales	£258,116
Value of RHI	£94,835
Total Income	**£352,951**
Cost of woodfuel for biomass	£135,746
Cost of operation for biomass	£20,000
Biomass replacement costs for 25 year business case	£6,325
Biomass replacement costs for 40 year business case	£15,813
Cost of fuel for auxiliary (gas)	£60,985
Cost of CCL for auxiliary gas	£4,595
Cost of operation for auxiliary	£2,000
Auxiliary replacement costs for 25 year business case	-
Auxiliary replacement costs for 40 year business case	£4,410
Cost of energy centre operation	£10,734
Cost of network operation and maintenance	£5,917
Total costs of generation for 25 year business case	**£246,302**
Total costs of generation for 40 year business case	**£260,200**
Net income for 25 year business case	**£106,649**
Net income for 40 year business case	**£92,751**

Table 88: Gaydon / Lighthorne Heath Village Centre Network 25 year financial case

Internal rate of return	1.5 %
Net present value	-£342.329
Discounted payback	>25 years

Table 89: Gaydon / Lighthorne Heath Village Centre Network 40 year financial case

Internal rate of return	0.3 %
Net present value	-£549,491
Discounted payback	>40 years

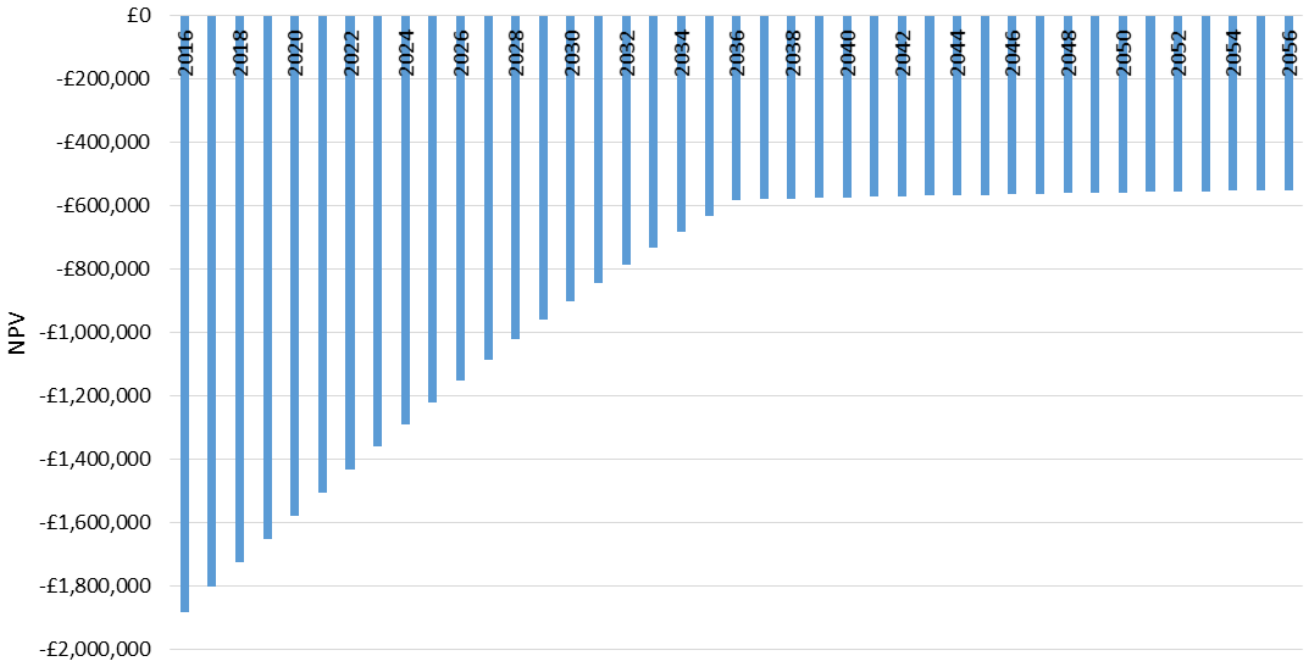


Figure 99: Discounted cash flow for Gaydon / Lighthorne Heath village centre network biomass heat over 40 years

Gaydon / Lighthorne Heath Village Centre Network – GSHP

Table 90: Estimated capital costs Gaydon / Lighthorne Heath Village Centre Network – GSHP

Cost of GSHP (incl. controls, M&E)	£2,028,583
Cost of auxiliary & plant equipment (incl. thermal store, energy centre, M&E)	£294,000
Cost of DH network (incl. trenching costs, project management, designs and surveys)	£768,831
Cost of building connections for existing buildings	-
Cost of land for energy centre	-
Contingency	20 %
Total cost of scheme	**£3,709,697**

Table 91: Financial assessment Gaydon / Lighthorne Heath Village Centre Network – GSHP

Phase heat demand (MWh)	6,152
District heat network losses (MWh)	427
Total amount of heat generated (MWh)	6,579
Size of GSHP (kWth)	1,000
GSHP modulation limit	25 %
Size of auxiliary (kW)	2,800
Heat generation GSHP (MWh)	5,741
Heat generation auxiliary gas (MWh)	838
Value of heat sales	£258,116
Value of RHI	£225,859
Total Income	**£483,975**
Cost of electricity for GSHP	£133,582
Cost of operation for GSHP	£45,931
GSHP replacement costs for 25 year business case	£25,357
GSHP replacement costs for 40 year business case	£63,393
Cost of fuel for auxiliary (gas)	£21,692
Cost of CCL for auxiliary gas	£1,634
Cost of operation for auxiliary	£2,514
Auxiliary replacement costs for 25 year business case	-
Auxiliary replacement costs for 40 year business case	£4,410
Cost of energy centre operation	£10,734
Cost of network operation and maintenance	£5,917
Total costs of generation for 25 year business case	**£247,362**
Total costs of generation for 40 year business case	**£289,808**
Net income for 25 year business case	**£236,613**
Net income for 40 year business case	**£194,167**

Table 92: Gaydon / Lighthorne Heath Village Centre Network 25 year financial case - GHSP

Internal rate of return	3.2 %
Net present value	-£121,985
Discounted payback	>25 years

Table 93: Gaydon / Lighthorne Heath Village Centre Network 40 year financial case - GSHP

Internal rate of return	0.7 %
Net present value	-£859,939
Discounted payback	>40 years

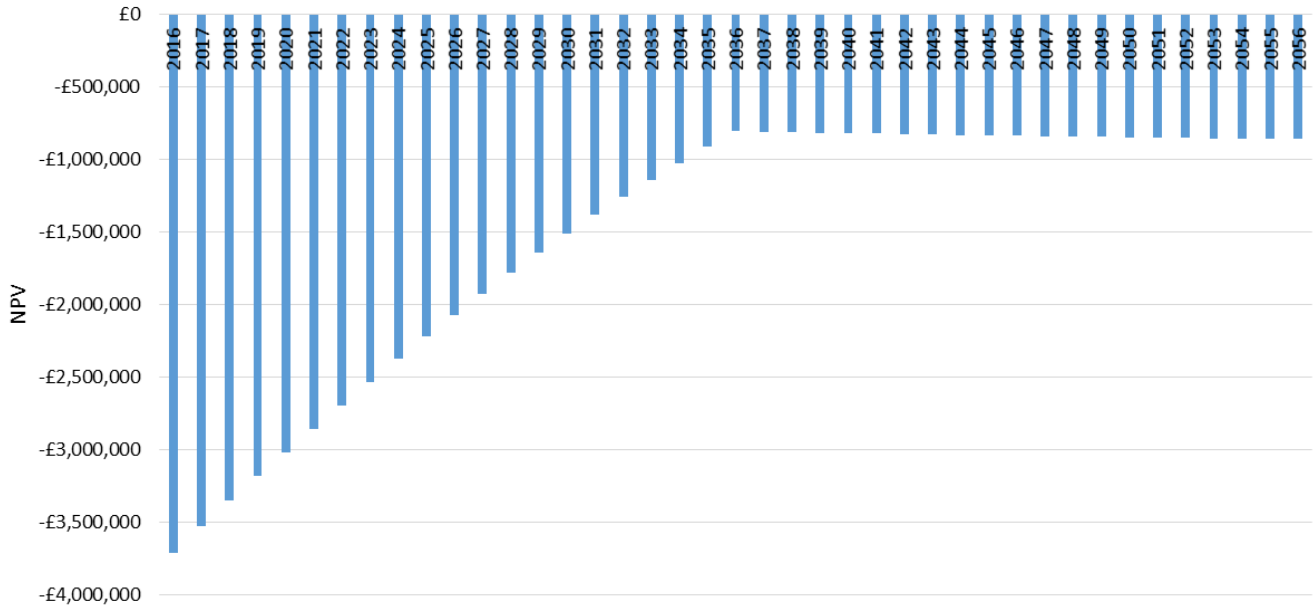


Figure 100: Discounted cash flow for Gaydon / Lighthorne Heath village centre network GSHP over 40 years

Financial Viability Assessments – Initial Network Options

Town Centre Network – WSHP

Table 94: Estimated capital costs Town Centre Network – WSHP

Cost of WSHP (incl. controls, M&E)	£825,000
Cost of auxiliary & plant equipment (incl. thermal store, energy centre, M&E)	£346,500
Cost of DH network (incl. trenching costs, project management, designs and surveys)	£1,077,010
Cost of building connections and conversion of existing heating systems	£1,105,934
Cost of land for energy centre	-
Contingency	20 %
Total cost of scheme	**£4,025,333**

Table 95: Financial assessment Town Centre Network – WSHP

Phase heat demand (MWh)	5,750
District heat network losses (MWh)	327
Total amount of heat generated (MWh)	6,077
Size of WSHP (kWth)	750
WSHP modulation limit	25 %
Size of auxiliary (kW)	3,300
Heat generation WSHP (MWh)	4,723
Heat generation auxiliary gas (MWh)	1,354
Value of heat sales	£196,968
Value of RHI	£181,203
Total Income	**£378,171**
Cost of electricity for WSHP	£110,770
Cost of operation for WSHP	£37,784
WSHP replacement costs for 25 year business case	£10,312
WSHP replacement costs for 40 year business case	£25,781
Cost of fuel for auxiliary (gas)	£35,040
Cost of CCL for auxiliary gas	£2,640
Cost of operation for auxiliary	£4,061
Auxiliary replacement costs for 25 year business case	-
Auxiliary replacement costs for 40 year business case	£5,198
Cost of energy centre operation	£10,052
Cost of network operation and maintenance	£3,541
Total costs of generation for 25 year business case	**£214,200**
Total costs of generation for 40 year business case	**£234,866**
Net income for 25 year business case	**£163,971**
Net income for 40 year business case	**£143,305**

Table 96: Town Centre Network 25 year financial case

Internal rate of return	-2.1 %
Net present value	-£1,734,319
Simple payback	>25 years

Table 97: Town Centre Network 40 year financial case

Internal rate of return	No IRR
Net present value	-£2,240,920
Simple payback	>40 years

Bridgeway Network – biomass heat

Table 98: Estimated capital costs Bridgeway Network – biomass heat

Cost of biomass boiler (incl. controls, M&E, emissions abatement)	£644,000
Cost of auxiliary & plant equipment (incl. thermal store, energy centre, M&E)	£231,000
Cost of DH network (incl. trenching costs, project management, designs and surveys)	£364,184
Cost of building connections for existing buildings	£43,886
Cost of land for energy centre	-
Contingency	20 %
Total cost of scheme	**£1,539,683**

Table 99: Financial assessment Bridgeway Network – biomass heat

Phase heat demand (MWh)	5,042
District heat network losses (MWh)	133
Total amount of heat generated (MWh)	5,176
Size of biomass boiler (kWth)	700
Biomass CHP modulation limit	30 %
Size of auxiliary (kW)	2,200
Heat generation biomass (MWh)	4,668
Heat generation auxiliary gas (MWh)	508
Value of heat sales	£184,096
Value of RHI	£110,983
Total Income	**£295,079**
Cost of woodfuel for biomass	£150,034
Cost of operation for biomass	£15,000
Biomass replacement costs for 25 year business case	£8,050
Biomass replacement costs for 40 year business case	£20,125
Cost of fuel for auxiliary (gas)	£13,146
CCL for auxiliary gas	£990
Cost of operation for auxiliary	£2,500
Auxiliary replacement costs for 25 year business case	-
Auxiliary replacement costs for 40 year business case	£3,465
Cost of energy centre operation	£8,581
Cost of heat network operation and maintenance	£851
Total costs of generation for 25 year business case	**£199,153**
Total costs of generation for 40 year business case	**£214,693**
Net income for 25 year business case	**£95,926**
Net income for 40 year business case	**£80,386**

Table 100: Bridgeway Network 25 year financial case

Internal rate of return	-6.2 %
Net present value	-£483,343
Simple payback	18 years

Table 101: Bridgeway Network 40 year financial case

Internal rate of return	No IRR
Net present value	-£1,557,027
Simple payback	>40 years

Bridgeway Network – biomass CHP

Table 102: Estimated capital costs Bridgeway Network – biomass CHP

Cost of CHP plant (incl. controls, M&E, emissions abatement)	£1,787,000
Cost of auxiliary & plant equipment (incl. thermal store, energy centre, M&E)	£231,000
Cost of DH network (incl. trenching costs, project management, designs and surveys)	£390,320
Cost of building connections for existing buildings (heat network)	£43,886
Cost of private wire network	£50,060
Cost of building connections for existing buildings (private wire)	£5,000
Cost of land for energy centre	-
Contingency	20 %
Total cost of scheme	**£3,008,720**

Table 103: Financial assessment Bridgeway Network – biomass CHP

Phase heat demand (MWh)	5,042
District heat network losses (MWh)	133
Total amount of heat generated (MWh)	5,176
Size of biomass CHP (kWth)	720
Size of biomass CHP (kWe)	65
Biomass CHP modulation limit	30 %
Size of auxiliary (kW)	2,200
Heat generation biomass CHP (MWh)	4,774
Heat generation auxiliary gas (MWh)	571
Biomass CHP electrical generation per annum (MWh)	332
Value of heat sales	£177,328
Electricity sales (private wire)	£28,465
Electricity sales (export)	-
Value of RHI	£110,634
Total Income	**£316,428**
Cost of woodfuel for biomass CHP	£170,515
Cost of operation for biomass CHP	£20,000
Biomass CHP replacement costs for 25 year business case	£17,870
Biomass CHP replacement costs for 40 year business case	£44,675
Cost of fuel for auxiliary (gas)	£14,769
CCL for auxiliary gas	£1,113
Cost of operation for auxiliary	£1,712
Auxiliary replacement costs for 25 year business case	-
Auxiliary replacement costs for 40 year business case	£3,465
Cost of energy centre operation	£8,581
Cost of heat network operation and maintenance	£1,151
Total costs of generation for 25 year business case	**£235,711**
Total costs of generation for 40 year business case	**£265,981**
Net income for 25 year business case	**£80,716**
Net income for 40 year business case	**£50,446**

Table 104: Bridgeway Network 25 year financial case

Internal rate of return	-1.2 %
Net present value	-£1,254,647
Simple payback	>25 years

Table 105: Bridgeway Network 40 year financial case

Internal rate of return	-4.8 %
Net present value	-£1,772,240
Simple payback	>40 years

Bridgeway Network – GSHP

Table 106: Estimated capital costs Bridgeway Network – GSHP

Cost of GSHP (incl. controls, M&E)	£2,042,772
Cost of auxiliary & plant equipment (incl. thermal store, energy centre, M&E)	£231,000
Cost of DH network (incl. trenching costs, project management, designs and surveys)	£714,184
Cost of building connections and conversion of existing heating systems	£219,430
Cost of land for energy centre	-
Contingency	20 %
Total cost of scheme	**£3,848,862**

Table 107: Financial assessment Bridgeway Network – GSHP

Phase heat demand (MWh)	5,042
District heat network losses (MWh)	264
Total amount of heat generated (MWh)	5,306
Size of GSHP (kWth)	750
GSHP modulation limit	25 %
Size of auxiliary (kW)	2,200
Heat generation GSHP (MWh)	4,702
Heat generation auxiliary gas (MWh)	474
Value of heat sales	£184,096
Value of RHI	£184,192
Total Income	**£368,289**
Cost of electricity for GSHP	£110,626
Cost of operation for GSHP	£37,615
GSHP replacement costs for 25 year business case	£25,535
GSHP replacement costs for 40 year business case	£63,837
Cost of fuel for auxiliary (gas)	£12,261
Cost of CCL for auxiliary gas	£924
Cost of operation for auxiliary	£1,421
Auxiliary replacement costs for 25 year business case	-
Auxiliary replacement costs for 40 year business case	£3,465
Cost of energy centre operation	£8,581
Cost of network operation and maintenance	£851
Total costs of generation for 25 year business case	**£197,815**
Total costs of generation for 40 year business case	**£239,582**
Net income for 25 year business case	**£170,474**
Net income for 40 year business case	**£128,707**

Table 108: Bridgeway Network 25 year financial case

Internal rate of return	-1.1 %
Net present value	-£1,414,410
Simple payback	>25 years

Table 109: Bridgeway Network 40 year financial case

Internal rate of return	No IRR
Net present value	-£2,337,031
Simple payback	>40 years

Alcester Road Network – biomass CHP

Table 110: Estimated capital costs Alcester Road Network – biomass CHP

Cost of biomass CHP plant (incl. controls, M&E, emissions abatement)	£1,787,000
Cost of auxiliary & plant equipment (incl. thermal store, energy centre, M&E)	£262,500
Cost of DH network (incl. trenching costs, project management, designs and surveys)	£734,200
Cost of building connections for existing buildings (heat network)	£58,549
Cost of private wire network	£70,560
Cost of building connections for existing buildings (private wire)	£5,000
Cost of land for energy centre	-
Contingency	20 %
Total cost of scheme	**£3,501,371**

Table 111: Financial assessment Alcester Road Network – biomass CHP

Phase heat demand (MWh)	6,811
District heat network losses (MWh)	267
Total amount of heat generated (MWh)	7,078
Size of biomass CHP (kWth)	720
Size of biomass CHP (kWe)	65
Biomass CHP modulation limit	30 %
Size of auxiliary (kW)	2,500
Heat generation biomass CHP (MWh)	5,179
Heat generation auxiliary gas (MWh)	2,031
Biomass CHP electrical generation per annum (MWh)	65
Value of heat sales	£254,627
Electricity sales (private wire)	£40,052
Electricity sales (export)	-
Value of RHI	£118,527
Total Income	**£413,206**
Cost of woodfuel for biomass CHP	£184,976
Cost of operation for biomass CHP	£20,000
Biomass CHP replacement costs for 25 year business case	£17,870
Biomass CHP replacement costs for 40 year business case	£44,675
Cost of fuel for auxiliary (gas)	£52,568
CCL for auxiliary gas	£3,961
Cost of operation for auxiliary	£6,093
Auxiliary replacement costs for 25 year business case	-
Auxiliary replacement costs for 40 year business case	£3,938
Cost of energy centre operation	£11,692
Cost of heat network operation and maintenance	£2,998
Total costs of generation for 25 year business case	**£300,158**
Total costs of generation for 40 year business case	**£330,901**
Net income for 25 year business case	**£113,048**
Net income for 40 year business case	**£82,305**

Table 112: Alcester Road Network 25 year financial case

Internal rate of return	0.0 %
Net present value	-£1,138,713
Simple payback	25 years

Table 113: Alcester Road Network 40 year financial case

Internal rate of return	-0.7 %
Net present value	-£1,512,987
Simple payback	>40 years

Cluster 16 Network – gas CHP

Table 114: Estimated capital costs Cluster 16 Network – gas CHP

Cost of CHP plant (incl. controls, M&E, emissions abatement)	£738,910
Cost of auxiliary & plant equipment (incl. thermal store, energy centre, M&E)	£231,000
Cost of DH network (incl. trenching costs, project management, designs and surveys)	£620,180
Cost of building connections for existing buildings (heat network)	£42,554
Cost of private wire network	£76,560
Cost of building connections for existing buildings (private wire)	£5,000
Cost of land for energy centre	-
Contingency	20 %
Total cost of scheme	**£2,057,044**

Table 115: Financial assessment Cluster 16 Network – gas CHP

Phase heat demand (MWh)	5,820
District heat network losses (MWh)	188
Total amount of heat generated (MWh)	6,007
Size of CHP (kWth)	500
Size of CHP (kWe)	465
CHP modulation limit	50 %
Size of auxiliary (kW)	2,200
Heat generation CHP (MWh)	3,862
Heat generation auxiliary gas (MWh)	2,225
CHP electrical generation per annum (MWh)	3,590
Value of heat sales	£217,652
Electricity sales (private wire)	£179,166
Electricity sales (export)	£67,268
Total Income	**£464,086**
Cost of gas for CHP	£204,128
Cost of operation for CHP	£45,000
CHP replacement costs for 25 year business case	£24,630
CHP replacement costs for 40 year business case	£38,485
Cost of fuel for auxiliary (gas)	£57,576
Cost of CCL for auxiliary gas	£4,338
Cost of operation for auxiliary	£10,000
Auxiliary replacement costs for 25 year business case	-
Auxiliary replacement costs for 40 year business case	£3,465
Cost of energy centre operation	£9,952
Cost of heat network operation and maintenance	£2,155
Total costs of generation for 25 year business case	**£357,780**
Total costs of generation for 40 year business case	**£375,099**
Net income for 25 year business case	**£106,306**
Net income for 40 year business case	**£88,986**

Table 116: Cluster 16 Network 25 year financial case

Internal rate of return	5.8 %
Net present value	£587,252
Simple payback	14 years

Table 117: Cluster 16 Network 40 year financial case

Internal rate of return	6.3 %
Net present value	£1,063,135
Simple payback	15 years

Gaydon / Lighthorne Heath Village Centre Network – biomass CHP

Table 118: Estimated capital costs Gaydon / Lighthorne Heath Village Centre Network – biomass CHP

Cost of biomass CHP plant (incl. controls, M&E, emissions abatement)	£1,787,000
Cost of auxiliary & plant equipment (incl. thermal store, energy centre, M&E)	£294,000

Cost of DH network (incl. trenching costs, project management, designs and surveys)	£768,831
Cost of building connections for existing buildings (heat network)	-
Cost of private wire network	£205,472
Cost of building connections for existing buildings (private wire)	£5,000
Cost of land for energy centre	-
Contingency	20 %
Total cost of scheme	**£3,672,364**

Table 119: Financial assessment Gaydon / Lighthorne Heath Village Centre Network – biomass CHP

Phase heat demand (MWh)	6,152
District heat network losses (MWh)	427
Total amount of heat generated (MWh)	6,579
Size of biomass CHP (kWth)	720
Size of biomass CHP (kWe)	65
Biomass CHP modulation limit	30 %
Size of auxiliary (kW)	2,800
Heat generation biomass CHP (MWh)	5,077
Heat generation auxiliary gas (MWh)	1,660
Biomass CHP electrical generation per annum (MWh)	353
Value of heat sales	£258,116
Electricity sales (private wire)	£36,342
Electricity sales (export)	-
Value of RHI	£113,319
Total Income	**£407,777**
Cost of woodfuel for biomass CHP	£181,313
Cost of operation for biomass CHP	£20,000
Biomass CHP replacement costs for 25 year business case	£17,870
Biomass CHP replacement costs for 40 year business case	£44,675
Cost of fuel for auxiliary (gas)	£42,970
Cost of CCL for auxiliary gas	£3,237
Cost of operation for auxiliary	£4,981
Auxiliary replacement costs for 25 year business case	-
Auxiliary replacement costs for 40 year business case	£4,410
Cost of energy centre operation	£10,734
Cost of network operation and maintenance	£6,717
Total costs of generation for 25 year business case	**£287,822**
Total costs of generation for 40 year business case	**£319,037**
Net income for 25 year business case	**£119,955**
Net income for 40 year business case	**£88,740**

Table 120: Gaydon / Lighthorne Heath Village Centre Network 25 year financial case

Internal rate of return	-0.1 %
Net present value	-£1,220,165
Simple payback	>25 years

Table 121: Gaydon / Lighthorne Heath Village Centre Network 40 year financial case

Internal rate of return	-0.5 %
Net present value	-£1,562,222
Simple payback	>40 years

Meon Vale / Long Marston Depot Network – gas CHP

Table 122: Estimated capital costs Meon Vale / Long Marston Depot Network – gas CHP

Cost of CHP plant (incl. controls, M&E, emissions abatement)	£160,580
Cost of auxiliary & plant equipment (incl. thermal store, energy centre, M&E)	£157,500
Cost of DH network (incl. trenching costs, project management, designs and surveys)	£1,621,474
Cost of building connections for existing buildings (heat network)	-
Cost of private wire network	£711,240
Cost of building connections for existing buildings (private wire)	£5,000
Cost of land for energy centre	-
Contingency	20 %
Total cost of scheme	**£3,186,953**

Table 123: Financial assessment Meon Vale / Long Marston Depot Network – gas CHP

Phase heat demand (MWh)	3,883
District heat network losses (MWh)	1,371
Total amount of heat generated (MWh)	5,254
Size of CHP (kWth)	400
Size of CHP (kWe)	259
CHP modulation limit	50 %
Size of auxiliary (kW)	1,500
Heat generation CHP (MWh)	3,286
Heat generation auxiliary gas (MWh)	1,967
CHP electrical generation per annum (MWh)	2,124
Value of heat sales	£167,958
Electricity sales (private wire)	£13,458
Electricity sales (export)	£78,959
Total Income	**£260,374**
Cost of gas for CHP	£138,571
Cost of operation for CHP	£25,491
CHP replacement costs for 25 year business case	£5,393
CHP replacement costs for 40 year business case	£8,364
Cost of fuel for auxiliary (gas)	£50,916
Cost of CCL for auxiliary gas	£3,836
Cost of operation for auxiliary	£5,902
Auxiliary replacement costs for 25 year business case	£4,200
Auxiliary replacement costs for 40 year business case	£6,563
Cost of energy centre operation	£8,564
Cost of network operation and maintenance	£4,374
Total costs of generation for 25 year business case	**£247,206**
Total costs of generation for 40 year business case	**£252,580**
Net income for 25 year business case	**£13,168**
Net income for 40 year business case	**£7,795**

Table 124: Meon Vale / Long Marston Depot Network 25 year financial case

Internal rate of return	-10.8 %
Net present value	-£2,827,421
Simple payback	>25 years

Table 125: Meon Vale / Long Marston Depot Network 40 year financial case

Internal rate of return	-6.4 %
Net present value	-£2,841,120
Simple payback	>40 years

Meon Vale / Long Marston Depot Network – GSHP

Table 126: Estimated capital costs Meon Vale / Long Marston Depot Network – GSHP

Cost of GSHP (incl. controls, M&E)	£2,587,186
Cost of auxiliary & plant equipment (incl. thermal store, energy centre, M&E)	£157,500
Cost of DH network (incl. trenching costs, project management, designs and surveys)	£1,621,474
Cost of building connections for existing buildings	-
Cost of land for energy centre	-
Contingency	20 %
Total cost of scheme	**£5,239,392**

Table 127: Financial assessment Meon Vale / Long Marston Depot Network – GSHP

Phase heat demand (MWh)	3,883
District heat network losses (MWh)	1,371
Total amount of heat generated (MWh)	5,254
Size of GSHP (kWth)	1,000
GSHP modulation limit	25 %
Size of auxiliary (kW)	1,500
Heat generation GSHP (MWh)	5,073
Heat generation auxiliary gas (MWh)	181
Value of heat sales	£167,958
Value of RHI	£182,620
Total Income	**£350,578**
Cost of electricity for GSHP	£118,124
Cost of operation for GSHP	£30,436
GSHP replacement costs for 25 year business case	£51,744
GSHP replacement costs for 40 year business case	£129,359
Cost of fuel for auxiliary (gas)	£5,322
Cost of CCL for auxiliary gas	£353
Cost of operation for auxiliary	£543
Auxiliary replacement costs for 25 year business case	£4,200
Auxiliary replacement costs for 40 year business case	£6,563
Cost of energy centre operation	£8,564
Cost of heat network operation and maintenance	£3,974
Total costs of generation for 25 year business case	**£223,260**
Total costs of generation for 40 year business case	**£303,238**
Net income for 25 year business case	**£127,318**
Net income for 40 year business case	**£47,340**

Table 128: Meon Vale / Long Marston Depot Network 25 year financial case

Internal rate of return	-7.9 %
Net present value	-£3,540,273
Simple payback	>25 years

Table 129: Meon Vale / Long Marston Depot Network 40 year financial case

Internal rate of return	No IRR
Net present value	-£5,493,094
Simple payback	>40 years