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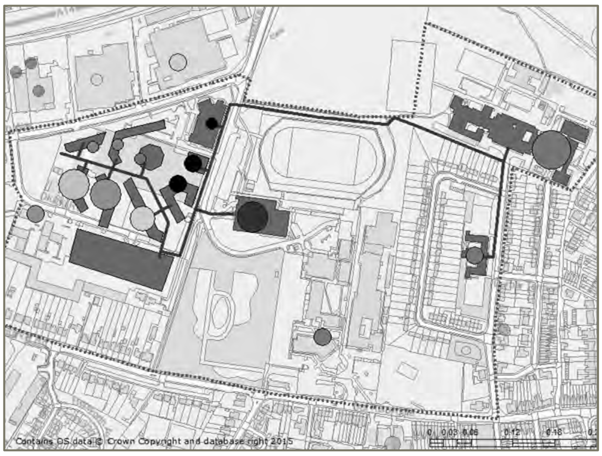
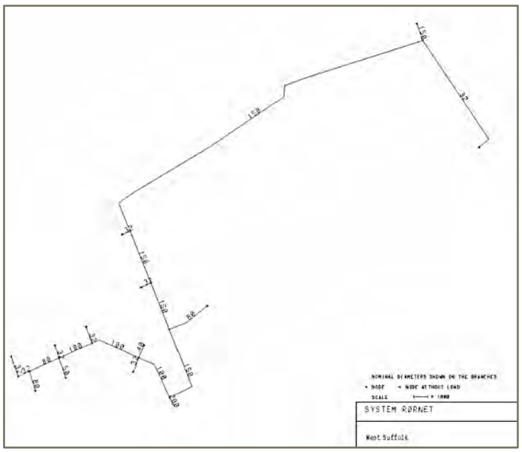
BURY ST EDMUNDS PUBLIC SERVICE VILLAGE HEAT NETWORK OPPORTUNITIES





RAMBØLL

BURY ST EDMUNDS PUBLIC SERVICE VILLAGE HEAT NETWORK OPPORTUNITIES

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GLOSSARY

AD	Anaerobic Digestion
AQMA	Air Quality Management Area
Bar_g	Gauge Pressure Unit (bar)
BaU	Business as Usual
BGS	British Geological Survey
CAPEX	Capital Expenditure
CEVAP	Church of England Voluntary Primary School
CHP	Combined Heat and Power
CHPA	Combined Heat and Power Association
CHPQA	Quality Assurance Scheme for Combined Heat and Power
CIBSE	Chartered Institution of Building Services Engineers
Coolth	Cooling delivered by chilled water loop
CoP	Coefficient of Performance
DECC	Department of Energy and Climate Change
DEFRA	Department for Environment, Food and Rural Affairs
Delta T	The temperature difference between water flowing in the flow and return sections of the network.
DHN	District Heating Network
DNO	Distribution Network Operators
EMP	Energy Masterplan
ESCo	Energy Services Company
FHDCLP	Forest Heath District Council Local Plan
FiT	Feed-In Tariffs
GFA	Gross floor area
GIS	Geographical Information System
GSHP	Ground Source Heat Pump
GWh	Gigawatt hour
HIU	Heat Interface Unit
HNDU	Heat Network Delivery Unit
HRSG	Heat Recovery Steam Generator
HTHW	High Temperature Hot Water
IES-VE	Integrated Environmental Studies - Virtual Environment
IRR	Internal Rate of Return
kWth	Kilowatts (thermal)
LECs	Levy Exemption Certificates
LLPG	Local Land and Property Gazetteer
LTHG	Low temperature heat generators
LTHS	Low Temperature Heating System
LTHW	Low Temperature Hot Water
MTHW	Medium Temperature Hot Water
MW_e	Megawatts (electrical)
MWh	Megawatt hour
MW_{th}	Megawatts (thermal)
NA	Not Applicable
NHM	National Heat Map
NPV	Net Present Value
O&M	Operation & Maintenance

OFGEM	Office of Gas and Electricity Markets
OPEX	Operational Expenditure
PSV2	Public Service Village 2
PV	Photovoltaic
REPEX	Reinvestment Expenditure
RHI	Renewable Heat Incentive
SAP	Standard Assessment Procedure
SBEM	Simplified Building Energy Model
WRAP	The Waste and Resources Action Programme
WSHP	Water Source Heat Pump

EXECUTIVE SUMMARY

Ramboll was commissioned by St Edmundsbury Borough Council and Forest Heath District Council to complete a study into the opportunity for heat networks and decentralised low carbon energy at two locations.

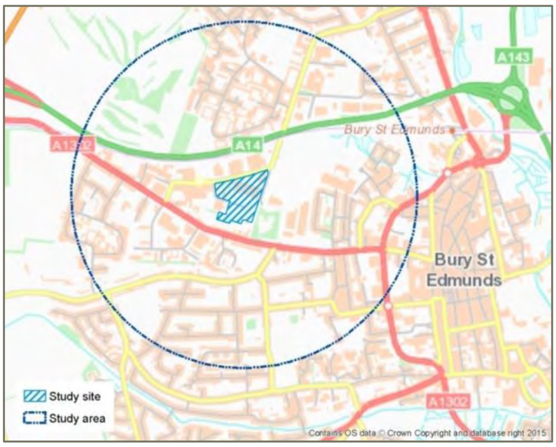
The two study areas are the Mildenhall Hub site in Mildenhall and the Public Service Village 2 (PSV2) site in Bury St Edmunds. This report was prepared on behalf of St Edmundsbury Borough Council and presents the results from the study into the PSV2 site and surrounding area.

The purpose of this study was to establish opportunities for district heating in and around the PSV2 development. The specific objectives were as follows:

- to identify and evaluate the feasibility of options for on-site low carbon heat and power
- to explore preferred options to gain support by key stakeholders
- to establish the outline financial cases to take forward preferred options to the next stage of wider project development

The work consisted of energy mapping, opportunity identification and techno-economic analysis of the preferred opportunity.

This report considers a 750 m "buffer area" around the PSV2 site as specified by the Council. This is shown in the figure below.



Map of Study Area

RECOMMENDATIONS AND CONCLUSIONS OF WORK UNDERTAKEN

The study concluded that there are opportunities for district heating in Bury St, Edmunds centred on the new Public Service Village development.

The results of the study suggest that, under the assumptions of the techno-economic model, the preferred supply option for economic viability depends predominantly on whether the scheme extends beyond a network on the PSV2 site.

The preferred option was found to be a DH network supplied by **gas combined heat and power (CHP)**, connected to all new buildings within the Public Service Village in addition to the existing West Suffolk House.

This was found to generate economic results that could be viable from the perspective of the Local Authority. Key metrics are presented below.

KEY METRICS
Gas CHP Preferred Option

25 Yr IRR: 4.9%
NPV@3.5% DR: £267 K
CAPEX: £2.1 M

If the network extends to a wider area, natural gas CHP technology is only likely to be viable for a wider network if capital grant funding is available equal to 30% of the initial project capital expenditure. Alternatively the case may be viable if the assumed heat and/or electricity sale prices can be improved by 10%.

Heat-only biomass was found to generate sufficient rates of return for a wider extended network and shown below:

KEY METRICS
Biomass Preferred Option

25 Yr IRR: 5.0%
NPV@3.5% DR: £722 K
CAPEX: £5.3 M

It should be noted that this technology presents a high level of risk due to the uncertainties surrounding RHI revenue.

For biomass, if the heat network is limited to a localised PSV2-only scheme then the economic case is poor with IRRs of only 0.5% over 25 years. And if the RHI reduces below current levels then the IRR would reduce significantly.

An assessment of the predicted carbon savings over time showed that the CHP option would only generate 26 tonnes/CO_2 net savings over a 25 year lifetime. This indicates that CHP provides a starting point for setting up a network, but it is not an effective long term solution for achieving zero carbon heat. It was recommended that at the end of the engine's lifetime, an alternative technology pathway should be explored.

The supply of waste heat from British Sugar was also considered as a potential opportunity in the case of a wider network. A high level assessment suggested that as a primary supply asset the network would require a capital investment of £1 M in order for the project to be viable. However, in terms of the future technology pathway for zero carbon heat, once the initial CAPEX of a CHP/biomass scheme had paid off, there may be a better economic case for a supply from British Sugar.

It is recommended that the Council conduct further investigation into a heat network supplied by natural gas CHP in the first instance. This is due to the fact that it presents the least risk for the PSV2 development and an extension could be viable under the circumstances stated above. Once a network has been established, further consideration should be given into connection to lower carbon sources such as British Sugar.

It is recommended that a presentation of the energy masterplanning results should be given to all relevant stakeholders including relevant Council members, the Leisure Centre, the Schools, and West Suffolk College. This would enable the Council to gauge interest in the proposed schemes and obtain feedback on how each technology might or might not be appropriate for their requirements. Stakeholder engagement is crucial at the earliest project stages to ensure opportunities or barriers are not overlooked.

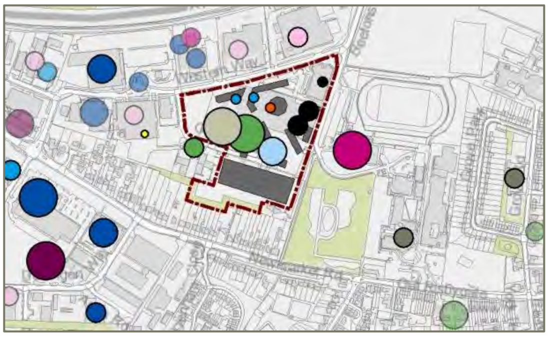
Further techno-economic modelling must be conducted when more accurate information is available regarding the final masterplan for PSV2. At present the energy demand information is not deemed to be accurate enough to clearly establish feasibility.

ENERGY MAPPING AND ASSESSMENT OF SUPPLY ASSETS

The first phase of the work was to map the major heat, cooling and electricity demands of PSV2 and the surrounding study area.

In addition to the buildings within the PSV2 site, the following key heat loads were identified:

- Abbeycroft Leisure Centre
- West Suffolk College
- Kind Edward VI Secondary School
- St Edmundsbury C of E Primary School



Extract from Heat Map

A cooling and electricity demand assessment was also carried out, predominantly using benchmarking.

An investigation was carried out into existing and planned supply assets within the study area that might be able to supply energy into a network. The most promising supply opportunity was found to be the potential for utilising waste heat from the British Sugar plant, located just outside the north east boundary of the buffer area.

A technology options appraisal was carried out in order to present a shortlist of energy supply technologies that would be suitable for the scale of demand and environmental conditions within the study area.

The technologies considered appropriate for inclusion in the next project phase were gas CHP, heat-only biomass and industrial waste heat from British Sugar.

IDENTIFIED OPPORTUNITIES

The process of opportunity identification involved a combination of qualitative and quantitative factors including:

- energy demand density
- proximity to identified supply assets
- number of public buildings
- potential anchor loads
- barriers to construction

Once opportunities were identified, possible heat network routes were assessed.

The PSV2 development and immediate surrounding area was deemed to be the most promising opportunity. The area presents several anchor loads in the form of large student accommodation and Government Buildings. The Leisure Centre also provides a large anchor load.

The high concentration of council owned and public buildings facilitates Local Authority led delivery of the scheme. Furthermore publicly led schemes are typically more straightforward to implement than those which are private.

In total, fourteen heat network opportunities were identified for high level modelling.

Project Ref.	Description	IRR
PS001a	PSV2 development only with gas CHP	10%
PS001b	PSV2 development only with biomass	7 %
PS002a	PSV2, Leisure Centre and Schools with gas CHP	8 %
PS002b	PSV2, Leisure Centre and Schools with biomass	14 %
PS003a	PSV2 development, Leisure Centre, Schools and new residential with gas CHP	3 %
PS003b	PSV2 development, Leisure Centre, Schools and new residential with biomass	8 %
PS003c	PSV2 development, Leisure Centre, Schools and new residential with industrial waste heat	3 %
PS004a	PSV2, Leisure Centre, Schools, new residential and retail with natural gas CHP	3 %
PS004b	PSV2, Leisure Centre, Schools, new residential and retail with biomass	6 %
PS004c	PSV2, Leisure Centre, Schools, new residential and retail with industrial waste heat	3 %
PS005a	PSV2, new non-residential and ASDA with gas CHP	2 %
PS005b	PSV2, new non-residential and ASDA with biomass	2 %
PS006a	PSV2, new non-residential, ASDA and light industrial with gas CHP	-5 %
PS006b	PSV2, new non-residential, ASDA and light industrial with biomass	0 %

List of Identified Opportunities

The project key performance indicators (KPIs) for the opportunities were presented to West Suffolk for comment and to confirm Ramboll's recommendations for preferred opportunities.

Following the initial opportunities appraisal, five opportunities were selected for further analysis. The opportunities are listed as follows:

- **PS001a** – PSV2 development only with gas CHP
- **PS001b** - PSV2 development only with biomass
- **PS002a** - PSV2 development, leisure centre and schools with gas CHP
- **PS002b** - PSV2 development, leisure centre and schools with biomass
- **PS003b** - PSV2 development, leisure centre, schools and new residential development with biomass

TECHNO-ECONOMIC ASSESSMENT OF PREFERRED OPPORTUNITY

The first stage in the techno-economic modelling process was to re-evaluate the energy demand assessment based on up to date information.

Following this, energy profiles were created using EnergyPRO software which enabled the sizing of various technology options. An economic assessment was then undertaken to determine the performance of each scenario. The non-discounted IRRs resulting from this assessment are shown below.

In order for a scheme to be considered viable under public sector leadership, the lowest hurdle IRR was set at 4%.

Scenario	25 Yr IRR	40 Yr IRR
PS001a	4.9%	6.4%
PS001b	0.5%	1.5%
PS002a	1.4%	3.7%
PS002b	4.5%	5.4%
PS003b	5.0%	5.9%

Resulting IRRs for All Scenarios

A sensitivity analysis was carried out to assess the impact any changes of key parameters have on the economics of each option.

The results showed that in the biomass cases, a reduction of RHI revenue of just 10% was sufficient to reduce the IRRs to a value below the hurdle rate in all cases. This indicates the criticality of this revenue source and indicates that reduction in RHI is a significant risk to the project.

The results showed that a 10% increase in heat sale revenue has the potential to affect the IRR by up to 2.5% in the case of the extended networks and up to 1.5% for the PSV2 only networks.

The electricity sale price was found to be a significant factor in the CHP scenarios, with the potential to affect the IRR by up to 3.2% when varied by +/- 10%.

It was found that that a change in the assumed total project CAPEX of +/- 10% can affect the 25 year IRR by over 1%.

Additionally, analysis was carried out whereby capital injections of 10%, 20% and 30% of initial project CAPEX were included in each model to demonstrate the effects of grant funding on the project economics over 25 and 40 years.

The results showed that in order for PS001b to be considered viable a capital injection of between 20% and 30% would likely be required. In order to bring the IRR of PS002a above the hurdle rate, a capital injection of just less than 20% would be required.

RISK ASSESSMENT

An outline risk assessment was undertaken for the preferred project opportunities. A number of key risks were identified;

- Accuracy of heat demand data
- PSV2 heating system design
- Operating costs higher than expected

These risks will require further consideration during the next phase of the project

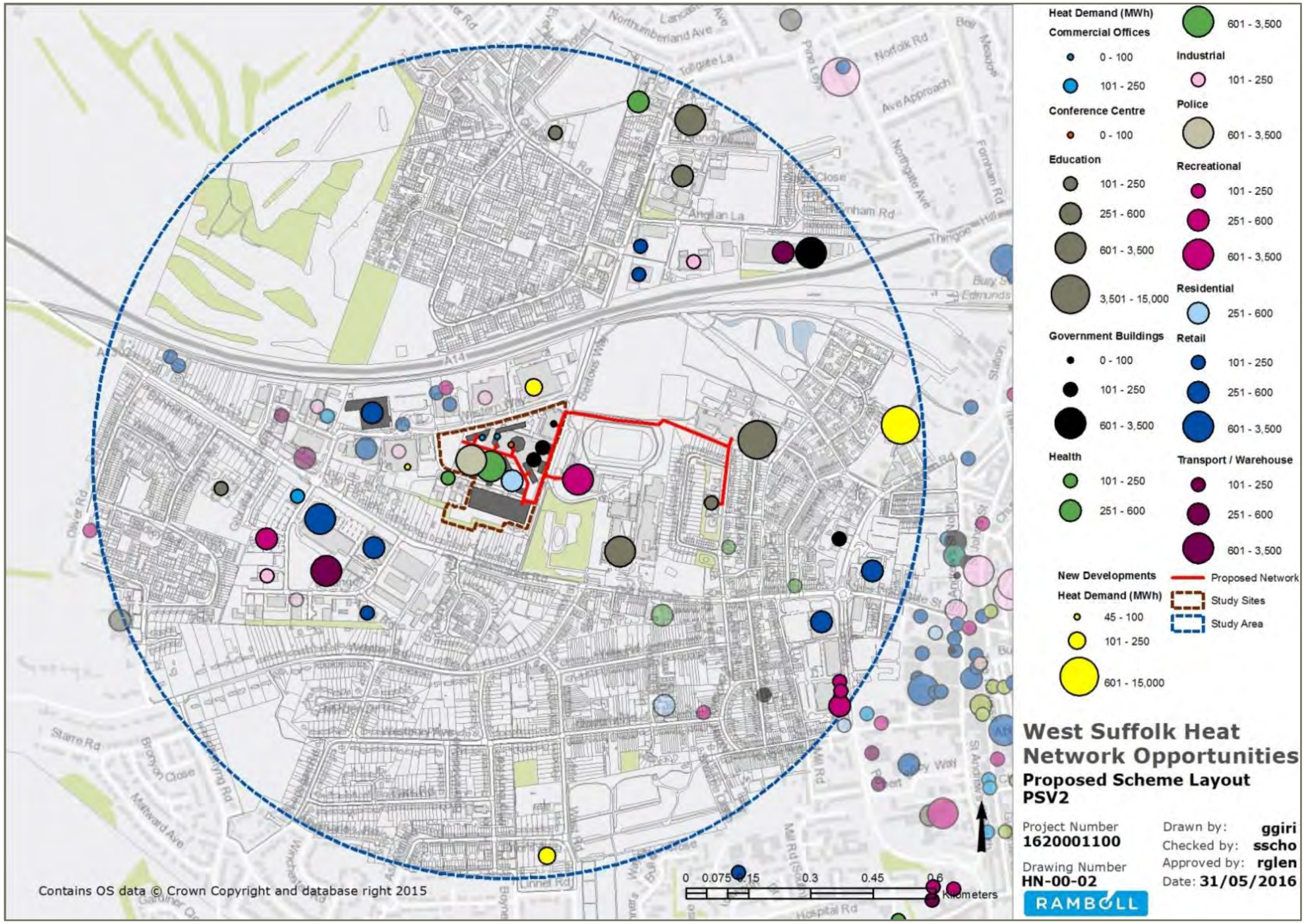
NEXT STEPS

Based on the final conclusions and recommendations of the study, a number of next steps can be identified as follows:

1. West Suffolk to **present the results of the study** to council members to ensure support for the proposed low carbon solution and to raise awareness of the project.

2. A **full business case** should be produced following a detailed feasibility exercise once there is more certainty regarding the design of PSV2.

3. The results of the study must be **provided to the PSV2 Design Team** to enable them to incorporate it into the designs and adopt appropriate heating systems.



Summary Heat Map and PS002 Network

1. INTRODUCTION AND BACKGROUND

Ramboll was commissioned by St Edmundsbury Borough Council ("the Council") and Forest Heath Council, known together as the West Suffolk partnership, to complete a study into the opportunity for heat networks and decentralised low carbon energy at two locations.

The West Suffolk partnership is planning to merge a number of public services, such as council offices, education and leisure, within the towns of Mildenhall and Bury St Edmunds into single sites. The two study areas are:

- Mildenhall Hub site in the town of Mildenhall. This development will be led by Forest Heath District Council
- Public Service Village 2 (PSV2) site in the town of Bury St Edmunds. This development will be led by St Edmundsbury Borough Council.

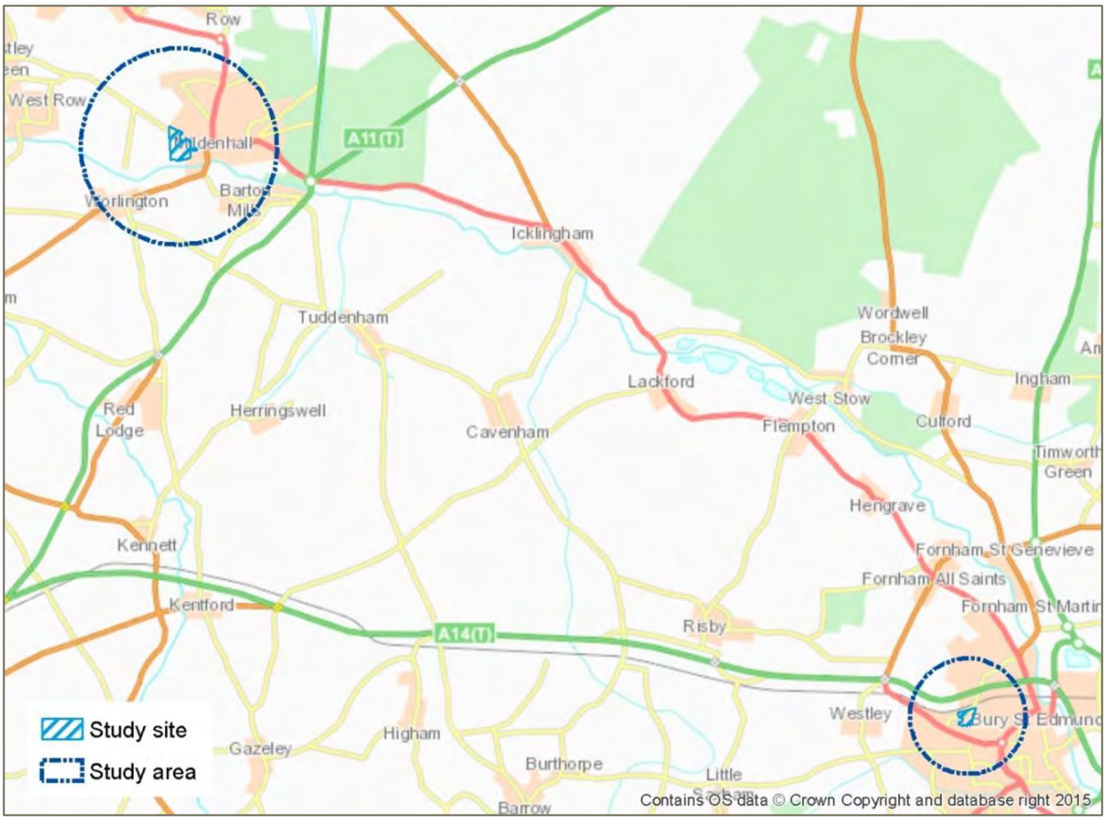


Figure 1: Two Study Areas Considered for Heat Network Opportunities

This report presents the results from the study into the PSV2 site and surrounding area.

The study was conducted taking into account the CIBSE Heat Network Code of Practice[1] (CoP). This document sets out the recommended methodology for implementation of heat networks in the UK from feasibility stage through to commissioning and operation. Although this study does not comprise a detailed feasibility study, and therefore not all CoP points are addressed at this stage, the methodology broadly follows the recommendations ready for progression to the later project stages.

[1] Heat Networks: Code of Practice for the UK, Raising Standards for Heat Supply, CIBSE and ADE, June2015.

1.1.1 Objectives

The aims of the study were set out in the invitation to quote as:

- to identify and evaluate the feasibility of options for **on-site low carbon heat and power**
- to **explore preferred options** to gain support by key stakeholders
- to establish the **outline financial cases** to take forward preferred options to the next stage of wider project development

These objectives were maintained throughout the course of the work.

Table 1 presents the contents of each of the report sections.

No.	Section Title	Contents
1	Introduction and Background	A summary of objectives, policy background and previous work undertaken.
2	Energy Demand Mapping	An overview of energy demands within the study area and mapping outputs. A summary of the methodology.
3	Energy Supply Mapping	An overview of existing, future and potential energy supply assets within the study area and technology options appraisal.
4	Heat Network Opportunity Appraisal	A high level review of potential decentralised energy opportunities including key metrics for each possible scheme.
5	Energy Masterplanning for Preferred Opportunity	A techno-economic assessment of the preferred heat network opportunity.
6	Project Outline Risk assessment	A risk register for the project to date, including potential mitigation measures.
7	Conclusions, Recommendations and Next Steps	A series of conclusions and recommended actions following the results of the study.

Table 1: Contents of Report Sections

1.1.2 Strategic Background and Policy

Heat networks projects can be highly complex to deliver due to many interrelated commercial, financial, technical and planning factors including:

1. inherent economic value and commercial risk
2. complexity of stakeholder relationships/appetites for involvement
3. Council's capacity and appetite for involvement as a delivery partner and in some cases conflicting commercial and strategic objectives for proposed projects
4. strength of local planning policy.

Successful delivery through to procurement will require a scheme that is aligned to the Council's drivers, aspirations and capacity, and ability to deliver. It must be financially viable and deliverable under the preferred delivery model as well as being attractive to a range of stakeholders including developments, existing key anchor load and potential delivery partners.

The Councils of St Edmundsbury and Forest Heath have created the partnership, West Suffolk, to deliver effective development to a high standard of sustainable design. At the time of writing, measures had already been taken in the form of two previous studies, one of which was conducted by Ramboll in 2013.

The successful bid to the Heat Network Delivery Unit (HNDU) demonstrates the will of the Councils to implement successful district heating schemes and meet their objectives for sustainable development. HNDU can support the Councils from heat mapping through to detailed project development and commercialisation.

The West Suffolk Strategic Plan 2014-2016 provides an indication of the main motivators for the Councils. District heating is relevant to two out of three of the priorities set out in the document:

- The promotion of energy efficiency measures is one of the actions listed to achieve Priority 1 – *Increased Opportunities for Economic Growth*.

- Alleviation of fuel poverty is encompassed in Priority 3 – *Homes for Our Communities*, which can often be achieved through district heating schemes.

In addition to the Strategic Plan priorities, the West Suffolk Sustainability Strategy (Dec 2013) sets out the range of issues which the Councils wish to influence at a local level through appropriate use of services.

A mixture of technical and social issues is identified in the Sustainability Strategy. The desire to contribute to the carbon reduction target of a 60% reduction in CO_2 by 2025 against the 2004 baseline can be assisted through use of district heating and cooling. We propose to refer back to this target when reporting the potential CO_2 savings of opportunities identified in the energy masterplanning exercise.


Forest Heath • St Edmundsbury
West Suffolk
working together

Sustainability Strategy
2013-2018

A sustainable future
for West Suffolk

Date Approved: December 2013

Social issues are also identified; primarily the problem around fuel poverty and the need for affordable warmth. It is proposed that reductions in the business as usual heat prices will be incorporated into the study to demonstrate economic viability whilst taking into account affordable energy prices.

Planning policies are recognised by the Councils as a tool to present the case for sustainability. Further ways in which planning policies can be used to help progress the identified district heating opportunities are outlined in section 7.

There is currently no specific mention of DH within the local planning or sustainability documents, but there is enthusiasm within the Council to do so.

1.1.3 Previous Work Undertaken

In July 2011, St Edmundsbury Borough Council commissioned a report titled 'Investigating Decentralised Energy in Bury St Edmunds'.

The report provided a technical evidence base to support local authority actions and planning policies for decentralised energy. It also provided a technical and financial options appraisal to help inform policy making and investment decisions in decentralised energy (heating, cooling and electricity) projects in Bury St Edmunds and their potential to be delivered to existing and planned mixed development in the town over the next 20 years.

The study did not constitute a complete technical and financial feasibility study; rather it identified which options were worth taking to the next stage. One of the identified options focused on Bury Leisure Centre in Western Way and proposed further investigation around the potential to develop a district heating scheme around anchor loads in close proximity to the Leisure centre.

On the basis of that study, St Edmundsbury Borough Council and its project partners decided to commission this feasibility study for a decentralised energy scheme based around Bury Leisure Centre which Ramboll undertook in 2013.

The objectives of the feasibility study were to evaluate options for a decentralised energy project opportunity based around Bury Leisure Centre. The brief was to identify an opportunity that was financially viable, capable of delivering CO_2 reductions in line with Suffolk's targets under its Creating the Greenest County programme and affordable to the project stakeholders.

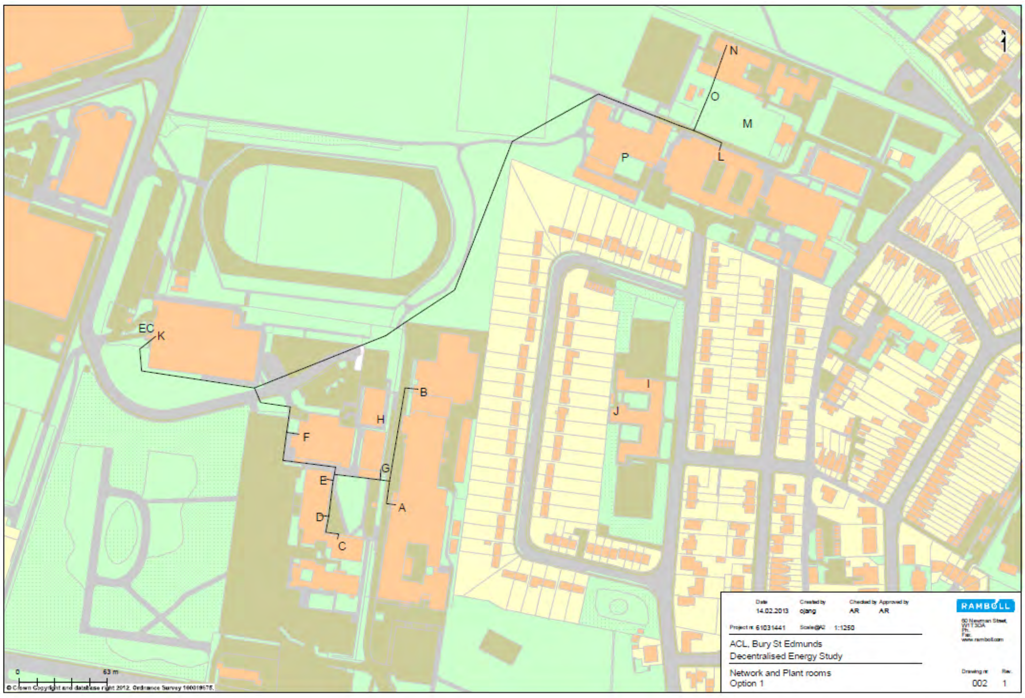


Figure 2 Network Route Diagram from 2013 Feasibility Study

The study found that:

- a potential case existed whereby Bury Leisure Centre exports heat to a network that is separately developed by the project stakeholders, but that the margin on buying and selling of heat for supply into the network was likely to be low, generating low IRR's for the project stakeholders.
- the economic case for connecting St Edmundsbury CEVAP school and King Edward IV school to the identified heat network opportunity was poor.
- options for implementing solar PV, biomass heating and solar thermal were worth further consideration, given that reasonably attractive IRRs were identified.

However, no further investigation was carried out following the study.

2. ENERGY DEMAND MAPPING

This section provides an overview of heat, cooling and power demand within the study area. The aim was to produce energy maps and databases suitable for use in identifying and assessing heat network and decentralised energy opportunities in the PSV2 site and surrounding area.

As heat supply strategy was the main objective of the study, developing heat maps was the primary focus of the energy mapping phase of work. Cooling was assessed at high level in order to identify any opportunities for combined heating and cooling networks. Finally the map of electricity demand was developed to establish any opportunities for private wiring of electricity that could be supplied by supply assets such as combined heat and power (CHP) engines or solar photovoltaic (PV) panels.

To support this phase of works the Council provided the following information:

In Excel format:

- National Heat Map (NHM) Data
- Gas and electricity billing records for municipal buildings
- Local Land and Property Gazetteer (LLPG).

ArcGIS Layers:

- Background Mapping – Ordnance Survey MasterMaps
- Planning Application information
- St Edmundsbury Borough Council Local Plan
- Council owned land.

To inform the estimation of future energy demands, a massing concept diagram and accommodation schedule for PSV2 were made available.

Links to the planning portal were also provided in addition to a number of general background documents.

The following sub-sections summarise the identified heat, cooling and power demands identified within the study area.

2.1 The Study Area

PSV2 represents the second phase of the Bury St Edmunds Public Service Village Project. The plans are to bring a range of public services onto the site including the Police, NHS and student accommodation.

The massing concept drawing shown in Figure 3 shows the proposed layout for the PSV2 site[2].

Figure 3: PSV2 Massing Concept Drawing (Courtesy of Pick Everard)

This report considers a 750 m "buffer area" around the PSV2 site. This was deemed by the Council and Ramboll to be an appropriate area to encompass major opportunities as it is sufficient to include key buildings such as Bury Leisure Centre and West Suffolk College which may be of interest to the project.

Figure 4 shows the location of the PSV2 site and surrounding buffer area. The boundary includes the leisure centre and college to the east and the industrial estate to the west.

[2] At the time of writing the design was still very much under development and therefore it should be noted that the layout was subject to change.

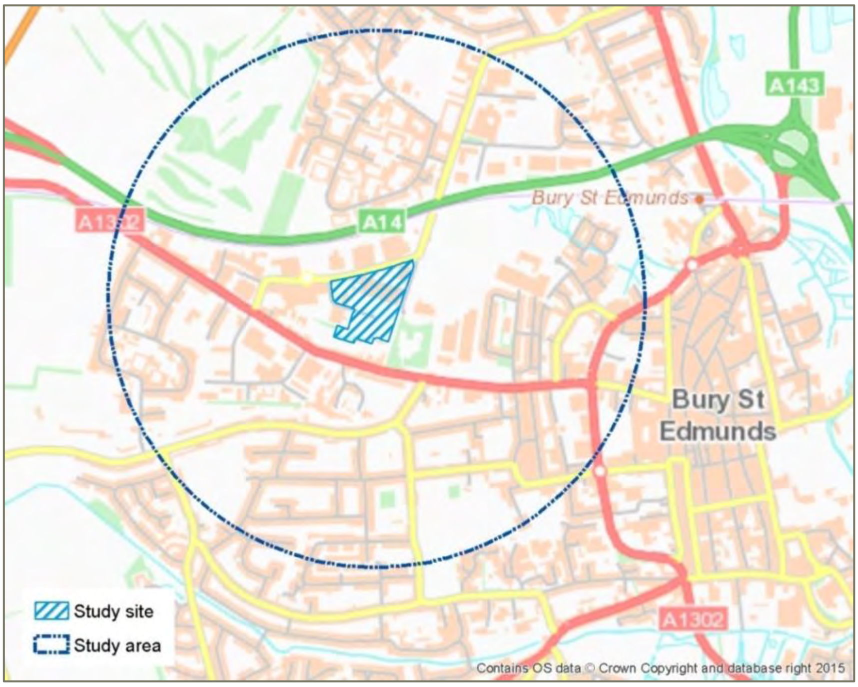


Figure 4: PSV2 Site and Study Area

2.2 Heat Demand

A heat demand map was created to include existing and planned buildings within the PSV2 site and buffer area. The sub-sections below outline the methodology used to map the heat demands for existing buildings, the PSV2 development and other planned developments.

2.2.1 Methodology

The National Heat Map (NHM) data formed the base layer for the project's heat map. The NHM includes annual heat demand figures for a number of building types in the study area which are divided into fourteen categories including, but not limited to Government Buildings, Commercial Offices, Education, Health, etc.

Due to the fact that the NHM data is defined within these building type categories, multiple records are often present for within the same building. For example where a shop and dwelling are present in the same building.

Therefore, the information provided by the NHM was aggregated by location; aggregating the multiple heat demands into a single point and assigning them the category with the highest heat demand of the building.

It is important to note that the NHM data is likely to be overestimating the industrial heat loads. This is due to the fact that the buildings often have large floor areas, but only localised heating which is not reflected in the benchmarks. This is explored further in section 4.

Any records below 100,000 kWh were then filtered out of the heat map. A load below this threshold would typically have a heat exchanger of the order of 50 kW, which is relatively small and from experience on other projects loads smaller than this will not in themselves form the basis for an energy network. These smaller loads could potentially be connected to a network already under development and depending on the proximity of the network connection they may serve to improve the project economics However, designing networks specifically to serve these loads may reduce the overall economic returns. These smaller connections should be considered on a case by case basis in the next phase of works.

The Council also provided gas and electricity billing data from 2014/2015 for Local Authority buildings in Bury St Edmunds, which was included in the heat map. When there were data points from both the NHM and billing data, the NHM records were replaced.

2014/15 in kWh

St Edmundsbury

Building	Utility Type	Apr-Jun	Jul-Sept	Oct-Dec	Jan-Mar	Total kWh	Total Cost
6 Angel Hill TIC	Elec	3957	4823	2959	8511	20,250	£2,309.81
91 Kings Road	Elec	1108	624	2446	3882	8,060	£1,042.84
66E Workshop Nursery (141 Eastgate Street)	Elec	24	56	1092	0	1,172	£297.54
Abbey Gardens Toilets	Elec	7964	8142	7584	6779	30,469	£3,834.00
Abbey Gardens Toilets	Gas	5821	-960	5511	13571	23,943	£1,214.54
APEX	Elec	154450	148608	182433	188388	673,879	£68,131.41
APEX	Gas	-3483	-6009	3537	20771	14,816	£2,225.21
Atheneaum	Elec	6923	7571	13864	8815	37,173	£5,363.59
Atheneaum	Gas	-29320	-35625	26205	55124	16,384	£3,520.35
Atheneaum Flat	Elec	673	718	3483	5452	10,326	£1,348.61
Bird Aviary	Elec	4196	2506	8581	12663	27,946	£3,439.74
Bus Terminus	Elec	10393	10202	14265	18097	52,957	£7,237.99
Bus Terminus	Gas	7195	312	13961	19204	40,672	£1,609.83
Camps Rd WC's	Elec	5903	3613	5214	6212	20,942	£2,776.84
Cattle Market - underground car park	Elec	22470	22470	25995	25995	96,930	£24,000.00
Cattle Market - underground car park back up meter	Elec	584	1246	247	0	2,077	£550.41
Cloister Gardens	Elec	879	1004	1630	1723	5,236	£691.71
East Town Park	Elec	3730	3217	8015	10450	25,412	£2,692.32

Figure 5: Screenshot of Local Authority Billing Data

The gas data was factored using an estimated boiler efficiency of 80%. The figures were degree day corrected based on the region's 20-year average in order to take account of annual weather variations.

Following the inclusion of the billing data an exercise was carried out to estimate the heat demand of existing buildings that appeared to be of interest, but were not included in the NHM or billing data. Buildings which may present significant heat demands such as hotels and nursing homes were identified through a desktop assessment of the study area maps. The heat demand was estimated using the floor areas extracted from the OS maps and CIBSE benchmarks[3].

Three benchmarking methods were applied to estimate the heat demand for the PSV2 development:

- **CIBSE benchmarks** for existing buildings were adjusted to take into account the potential higher energy efficiency of new buildings.

- A combination of **energy modelling outputs (SAP, SBEM and IES-VE)** from Ramboll's experience in energy strategies in addition to CIBSE data was used. This was corrected to reflect expected improvements under future updates to the building regulations. Benchmarks were formulated to reflect separately 2010 Building Regulations and the 2013 Building Regulations amendments.

- The **billing data for existing public buildings** which are due to be moved to the new site was assessed to give an indication of the likely requirements of the new buildings. Reduction in demand due to the improved thermal efficiency of buildings was taken into account during this exercise.

In a similar way to the proposed PSV2 buildings, heat demands for other planned developments within the buffer area were calculated using benchmarks including a combination of energy modelling outputs (SAP, SBEM and IES-VE) from Ramboll's experience in energy strategies in addition to CIBSE data which was corrected to reflect expected improvements under future updates to the building regulations. Government Buildings and Commercial Offices, although having different consumption profiles, are considered to have similar energy consumption and, consequently, the same benchmark was used.

Building Type	Energy Demand (kWh/unit)	Units
Government Buildings	12.3	m^2
Police	157	m^2
Health	110	m^2
Police Station	157	m^2
Residential	3,760	Room/Flat
Residential	5,840	House
Retail	8.8	m^2
Commercial Offices	12.3	m^2

Table 2: Benchmarks Used for PSV2 and other New Development Sites

A full table of point heat demands is presented as Appendix 1. The sections below outline a number of key heat load opportunities in further detail.

[3] Energy Efficiency in Buildings. CIBSE Guide F

2.2.2 Existing Buildings

2.2.2.1 Abbeycroft Leisure Centre

Figure 6: Photograph of Abbeycroft Leisure Centre taken during Ramboll Site Visit

Ramboll conducted a site survey of Abbeycroft Leisure Centre in November 2015. The Leisure Centre is operated under a charitable leisure trust, but the building is owned by the Council.

The site currently operates a 100 kW gas CHP engine which supplies heat and electricity to the leisure centre facility.

The annual gas demand according the billing data provided by the Council is 2,047 MWh.

According to the invoices from Aug 14 to Aug 15 the total gas demanded by the CHP was 1,507 MWh. This suggests that an additional 540 MWh was required for gas boilers.

Assuming 85% boiler efficiency this is 459 MWh of heat. 857 MWh of heat was generated by the CHP which suggests that the total heat demand is **1,316 MWh.**

2.2.2.2 West Suffolk College

West Suffolk College currently operates on a centralised heating system supplied by biomass boilers. The College is currently operating under a 20 year energy contract which is understood to have started in 2014.

Ramboll conducted a site survey of West Suffolk College in November 2015. Two separate biomass plant rooms are in operation at different locations on site. These systems supply separate hot water systems and it should be noted that in order to connect to district heating the systems would require centralising.

The annual heat demand according to the NHM was found to be 139 MWh. Following the site visit and observations of the buildings, this was thought to be too low and therefore benchmarking was carried out. This gave an annual heat demand figure of 2,220 MWh, which was considered to be more appropriate.

2.2.2.3 Schools

Two schools are located within the immediate vicinity of the PSV2 site: King Edward VI Secondary School and St Edmundsbury C of E Primary School. The heat demand was obtained through the NHM data as no actual data could be made available by the Council or through the stakeholder engagement process.

Further away, a number of additional schools are within the Study Area including Howard Primary School, Saint Benedict's Catholic School and Sexton's Manor Primary School. In these schools the heat demand was also obtained through the NHM data. It is worth noticing that Saint Benedict's Catholic School and Howard Primary School are located north of the A14.

School	Heat Demand (kWh)
King Edward VI School	7,784,666
St Edmundsbury C of E Aided Primary School	118,888
Howard Primary School	184,635
Saint Benedict's Catholic School	650,423
Sexton's Manor Primary School	194,072
Bury St Edmunds County Upper School	504,000
Total	**9,437,000**

Table 3: Schools Annual Heat Demand

It was noted that the heat demand of King Edward VI School seemed unusually high for the type and scale of building. However, the NHM stated that the data was "actual" and therefore it was retained for the purpose of this study. It is recommended that further engagement is undertaken at feasibility stage to confirm this value.

2.2.2.4 Bury St Edmunds County Upper School

North the A14, in Beestons Way and adjacent to Saint Benedict's Catholic School, Bury St Edmunds All-Through Trust has a campus that accommodates Bury St Edmunds County Upper School. The campus is about 600 m north of the PSV2 site, on the other side of the A14 main road.

The County Upper School has an estimated annual heat demand of 504 MWh.

2.2.2.5 Retail and recreational

There are a number of large retailers and restaurants towards the south east of the study buffer area on the outskirts of the Town Centre. These include, but are not limited to: supermarkets, , a shopping centre, the Abbeygate and Cineworld cinemas and restaurants.

To the west of the PSV2 site there are a number of large retailers such as Asda and Glasswells Ltd.

The heat demand for retail and recreational buildings was obtained through the NHM or benchmarking as described in section 2.2.1.

Building	Building Type	Heat Demand (kWh)
ASDA	Retail	270,288
Wilko	Retail	393,464
B&Q	Retail	478,338
Cineworld Complex	Recreational	904,381
Glaswells Ltd	Retail	939,778
Lookers Landrover	Retail	333,819
Total	**-**	**3,320,068**

Table 4: Retail and Recreational Annual Heat Demand

2.2.3 New Developments

2.2.3.1 Public Service Village

At the time of writing, limited information was available regarding the exact design of the PSV2 development. As a result of this assumptions were made regarding the allocation of building types to each building shown on the massing concept diagram. Figure 7 shows the assumed function for each building. The diagram was sent to the Council for comment in advance of the energy demand calculations.

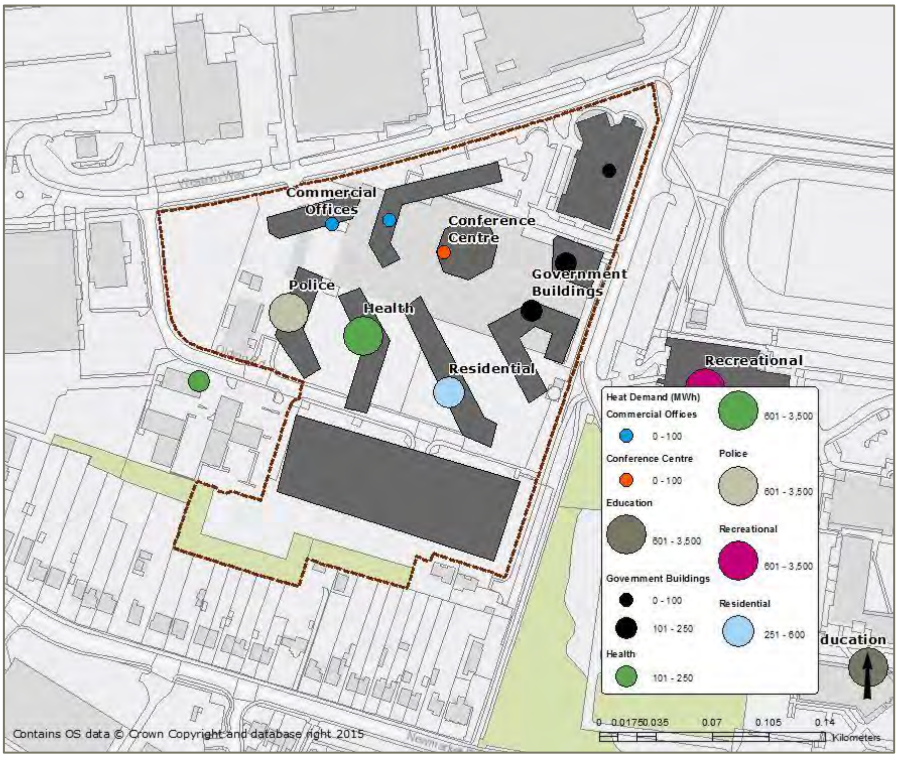


Figure 7: Assumed Building Function associated with Massing Concept Diagram

Table 5 shows the heat demand estimates by building function.

Building	Floor Area (m^2)	Estimated Heat Demand (kWh)
Offices	5,400	132,840
Government buildings	7,500	307,500
Police	2,100	992,085
Health	2,400	668,756
Residential (student accommodation)	3,800	752,000
Conference Centre	1,000	51,780

Table 5: Estimated Heat Demands for the PSV2 Development

At the time of writing the development was expected to come forward in four core phases as shown below.

Figure 8: Illustrative Phasing Plan (Courtesy of Pick Everard)

2.2.3.2 Other Planned Developments

In addition to the PSV2 site, a number of additional new developments were identified and are outlined in the sub-sections below.

2.2.3.3 Local Plan

SEBC Local Plan (SEBCLP) aims to reinforce the sub-regional status in the area alongside offering residential, educational and business and industrial development areas to strengthen opportunities.

The SEBCLP allocates two mixed use areas in the east of the study area. Figure 9 shows the principal allocations that SEBCLP includes. Across the study area, several general employment areas are present.

2.2.3.4 Planning Applications

Five planning applications were found to be of interest within the study area. At the time of writing two of the applications had been successful and two of them were pending a decision.

The largest proposed residential development (reference SEBCPA02), located in the east boundary of the study area, includes plans for up to 212 dwellings. This includes a mixture of houses and flats and also includes and a nursing home with 60 bedrooms. The application has not yet been granted but it was included within the heat map as it is deemed likely to come forward.

Table 6 summarises the main characteristics of the planning applications.

Code	Application Number	Application	Main characteristics
SEBCPA01	DC/15/1586/FUL	Pending Decision	Change of use from a general industrial facility to a further education teaching facility
SEBCPA02	DC/15/0689/OUT	Pending Decision	Redevelopment to provide up to 215 dwellings and a 60 bed care home (Use Class C2)
SEBCPA03	DC/15/0087/FUL	Pending Decision	Change of use from Class B2 (general industrial) to Class A1 (retail)
SEBCPA04	DC/14/0683/FUL	Application Granted	Erection of 33 affordable dwellings comprising of 12no. 2 bedroom houses, 9no. 2 bedroom chalet bungalows, 12no. 1 bedroom flats

Table 6: Planning Applications Considered within the Heat Map

Information was gathered from the planning documents to establish dwelling numbers and floor areas allocated to each use type within the developments as shown in Table 7.

Code	Residential		Retail (m^2)	Education (m^2)	Health (rooms)
	No Houses	No Flats			
SEBCPA01	0	0	0	9910	0
SEBCPA02	59	156	0	0	60
SEBCPA03	0	0	5125	0	0
SEBCPA04	21	11	0	0	0

Table 7: Summary of Key Figures of Planning Applications

The benchmarked heat demands are presented in Table 8 and Figure 9.

Code	Residential Heat (kWh)	Retail Heat (kWh)	Education Heat (kWh)	Health Heat (kWh)	Total Heat (kWh)
SEBCPA01	0	0	121,893	0	121,893
SEBCPA02	931,120	0	0	175,110	1,106,230
SEBCPA03	0	45,100	0	0	45,100
SEBCPA04	164,000	0	0	0	164,000

Table 8: Heat Demand for New developments

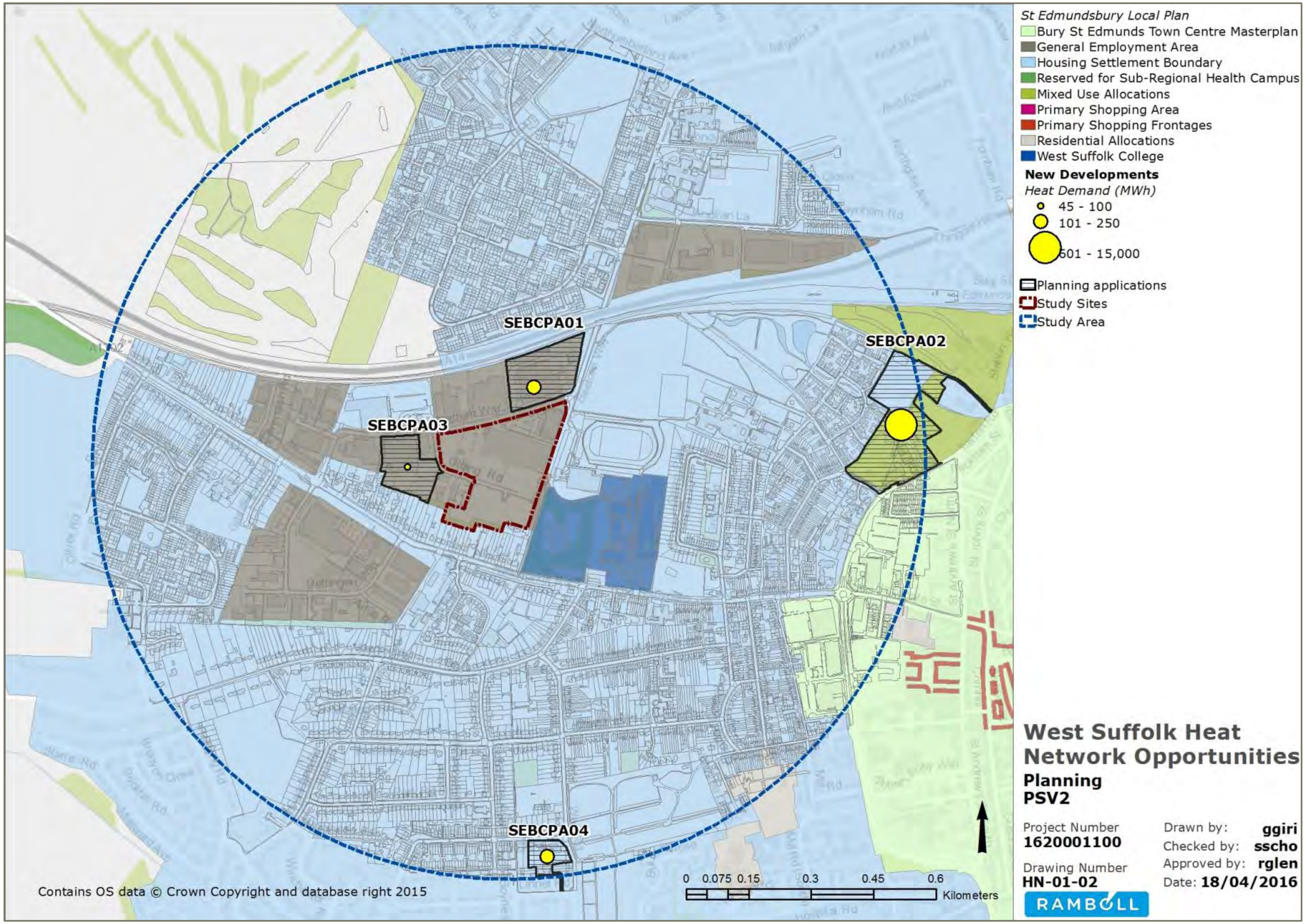


Figure 9: Estimated Heat Demand for Planned Developments

2.2.4 Heat Demand Summary

The figures below shows the magnitude of the heat demands identified within the study buffer area for existing and planned buildings respectively. It should be noted that, as previously stated, the data was filtered to include “significant” heat loads only.

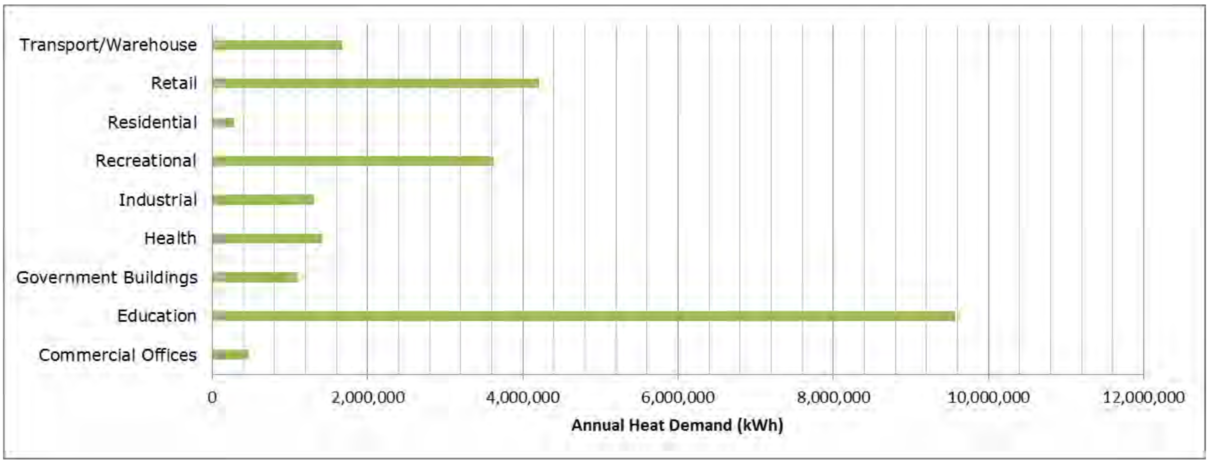


Figure 10: Existing Heat Demand Breakdown by Building Type

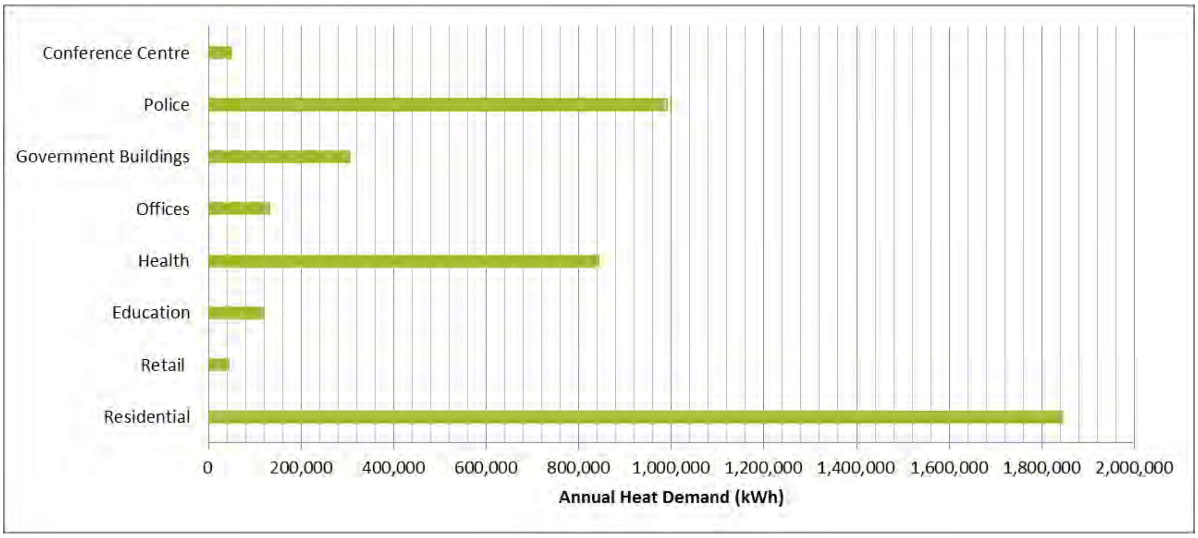


Figure 11: Planned Heat Demand (new developments and PSV2) Breakdown by Building Type

Figure 12 shows the heat map for PSV2 and surrounding study area including both existing buildings and heats loads estimated for PSV2 and the new development areas.

The quality of the data can be deduced by the proportion of billing data versus benchmarked or estimated figures. In this case the 3.33% of the total significant heat load within the study buffer area was based on actual data. This is due to two main factors: firstly there were difficulties in obtaining actual demand data for private buildings, secondly a large proportion of the heat load within the study area is for planned buildings and therefore the data does not exist.

Given this low value, it should be noted that there may be a margin of error between actual and predicted heat load.

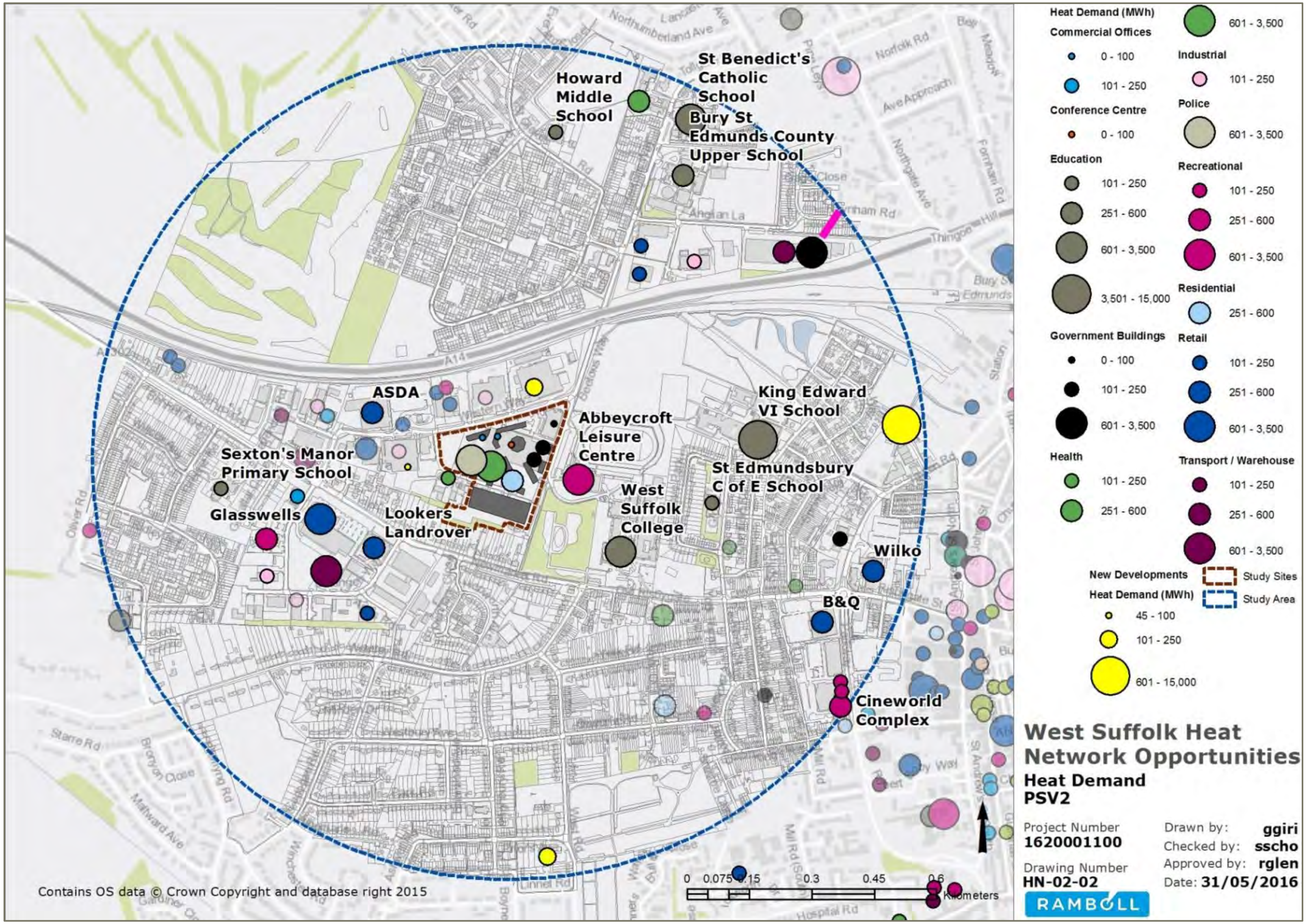


Figure 12: Point Heat Demand Map Bury St Edmunds Study Area

2.3 Cooling Demand

A cooling demand map was created including existing buildings, the PSV2 site and other planned developments, for the purpose of identifying the potential for combined heat and cooling networks.

2.3.1 Methodology

The potential cooling demands of existing buildings was primarily estimated by applying CIBSE cooling benchmarks[4] to floor areas extracted from the OS map data.

It is important to note that at this stage of energy assessment the cooling map shows the potential demands based on building type. The existing cooling technology within the buildings is not taken into consideration, but should be investigated as part of the next project stage.

The cooling demands of the buildings planned in the PSV2 development were estimated by applying cooling benchmarks to the quoted floor areas as established in the business case. The cooling benchmarks for new buildings include internal modelling (SAP, SBEM, and IES) and corrected CIBSE data to reflect expected improvements of the updates to the building regulations.

Cooling demand was estimated for the planned developments identified in section 2.2.3. The calculation methodology was similar to that used for the proposed buildings within the PSV2 development, using benchmarks based on floor area, internal modelling and adjusted CIBSE data. Since it is estimated that residential buildings do not have cooling demands, the new developments, which are mainly residential developments, do not present cooling demand.

2.3.2 Public Service Village 2

The cooling demands of the buildings planned in PSV2 were estimated by applying cooling benchmarks to the floor areas quoted in the accommodation schedule. The cooling benchmarks for new buildings include internal modelling results (SAP, SBEM, and IES) and corrected CIBSE data to reflect expected improvements of the updated to the building regulations.

2.3.3 Other Planned Developments

Cooling demand was estimated for the planned developments identified in section 2.2.3.2.

The calculation methodology was similar to that used for the proposed buildings within the PSV2 development, using benchmarks based on floor area, internal modelling and adjusted CIBSE data.

[4] Energy Efficiency in Buildings. CIBSE Guide F

2.3.4 Cooling Demand Summary

The summary of the estimated cooling demands for PSV2 and, other proposed and existing buildings within the study area are shown in Table 9 below.

Building Type	Number of Buildings	Sum of Cooling Demand (kWh)
Commercial Offices	26	839,231
Government Buildings	5	269,530
PSV2		
Commercial Offices	2	67,230
Conference Centre	1	6,225
Government Buildings	2	155,625

Table 9: Bury St Edmunds Cooling Demand

The Leisure Centre was found to have standalone cooling in the gym and studios, but no site wide system that would be attractive to a cooling scheme.

This information was used to generate the cooling demand map for the study area shown in Figure 13. As can be seen from Figure 13, there is no cluster of cooling demands present that could justify establishing a district cooling network. Therefore, cooling is not be considered during the masterplanning phase

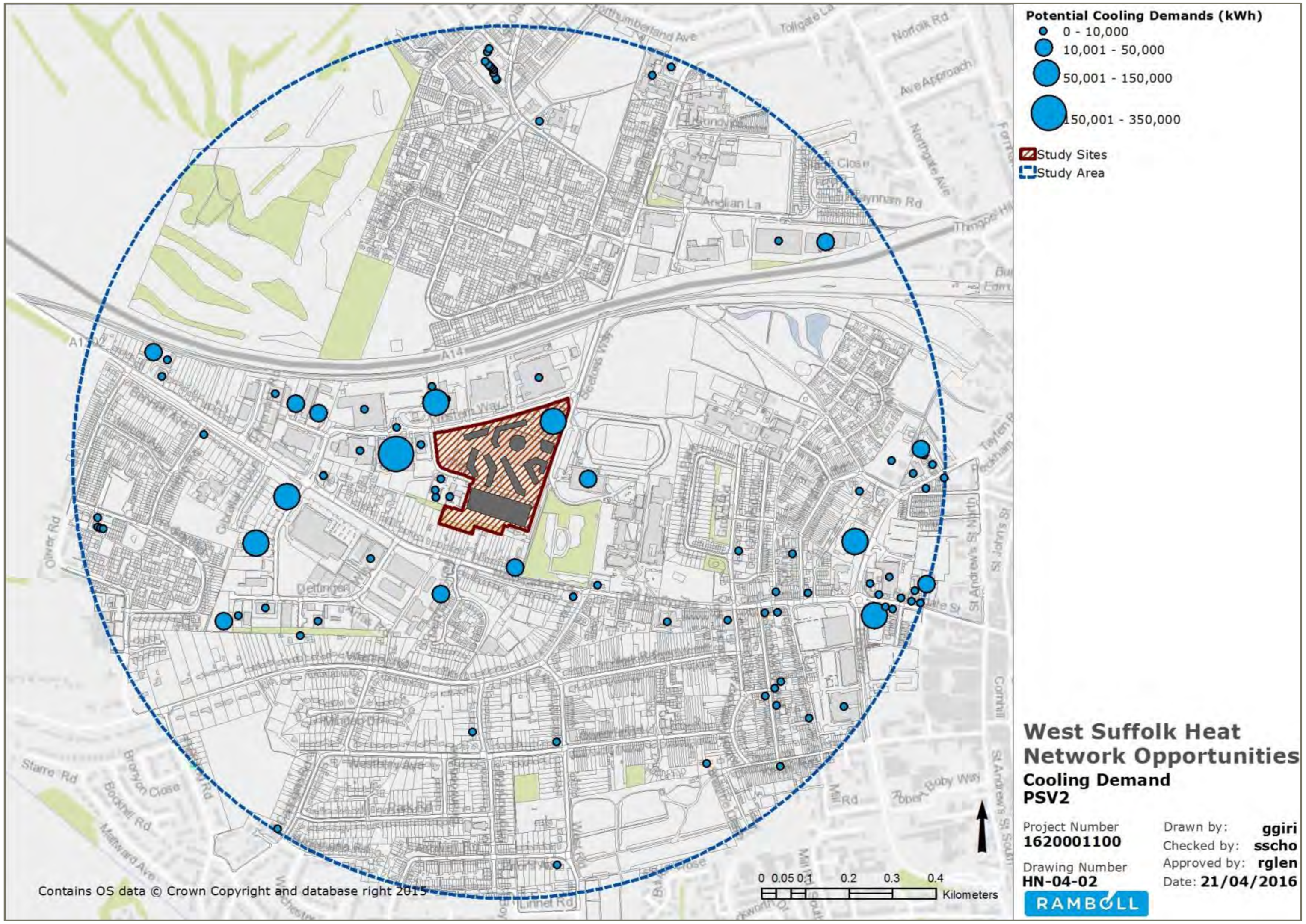


Figure 13: Estimated Cooling Demand of PSV2 Study Area

2.4 Power Demand

The power demand was considered due to the fact that the site electricity requirement is relevant to certain low carbon technologies such as CHP, where there is potential for electricity to be privately wired to buildings.

Private wiring involves the distribution of decentralised generated power to one or a number of consumers via a privately owned distribution network. Distribution of power via a private wire does not utilise infrastructure owned by National Grid or distribution network operators (DNOs).

For low voltage power generated by a CHP the electricity demand must be suitably close or the network losses become significant. This is due to the fact that the conductor (network) losses which arise from distribution of power are proportional to current and length of the network; for a fixed voltage, line resistance and therefore conductor losses increase with distance.

Conductor losses can be reduced by decreasing the current. This can be achieved by increasing the distribution voltage using a step-up transformer or a high voltage generator. However, the additional capital cost associated with both of these approaches would normally be inhibiting for small-scale CHP. As a result of this, throughout the analysis it was noted that private wire supply would only be viable in the immediate vicinity of supply assets.

2.4.1 Methodology

The electricity demand for each building within PSV2 was estimated using CIBSE benchmarks[5] and in-house estimations[6]. In a similar way to the heat demand estimates, when using CIBSE benchmarks, the electricity was factored down by 35 % to account for improvements to building standards, using a figure approximated through energy modelling in previous projects.

The electricity demand for other buildings in the study are was estimated according to CIBSE's benchmarks.

2.4.2 Existing Buildings

All buildings that were included in the final heat map were benchmarked and had their electricity demand estimated, with the exception of cases where actual data was available. The higher electricity demands correspond to retail buildings mostly located in the town centre and nearby the PSV2 site. A summary of the power demands excluding the new buildings in PSV2 in the study area is presented in Table 10.

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[5] [5] Energy Efficiency in Buildings. CIBSE Guide F and TM46
[6] Energy Efficiency in Buildings. CIBSE Guide F

Building	Number of Buildings	Annual Power Demand (kWh)
Commercial Offices	26	3,465,213
Education	7	11065,532
Government Buildings	5	800,719
Health	8	626,851
Hotels	7	230,265
Nursing home	1	138,780
Recreational	2	1,665,261
Retail[7]	45	31,070,124

Table 10: Summary of Existing Power Demands

2.4.3 PSV2 Development

The estimated power demand for the new PSV2 site is presented in Table 11.

Building	Annual Power Demand (kWh)
Commercial Offices	690,390
Conference Centre	63,925
Government Buildings	1,598,125
Health	210,600
Police	184,275
Residential	508,300

Table 11: Summary of Power Demands for PSV2

2.4.4 Electricity Demand Summary

Figure 14 shows the annual power demand map for PSV2 and the study area.

[7] Based on CIBSE Guide F "small food shops" category as this was deemed to be in the mid-range.

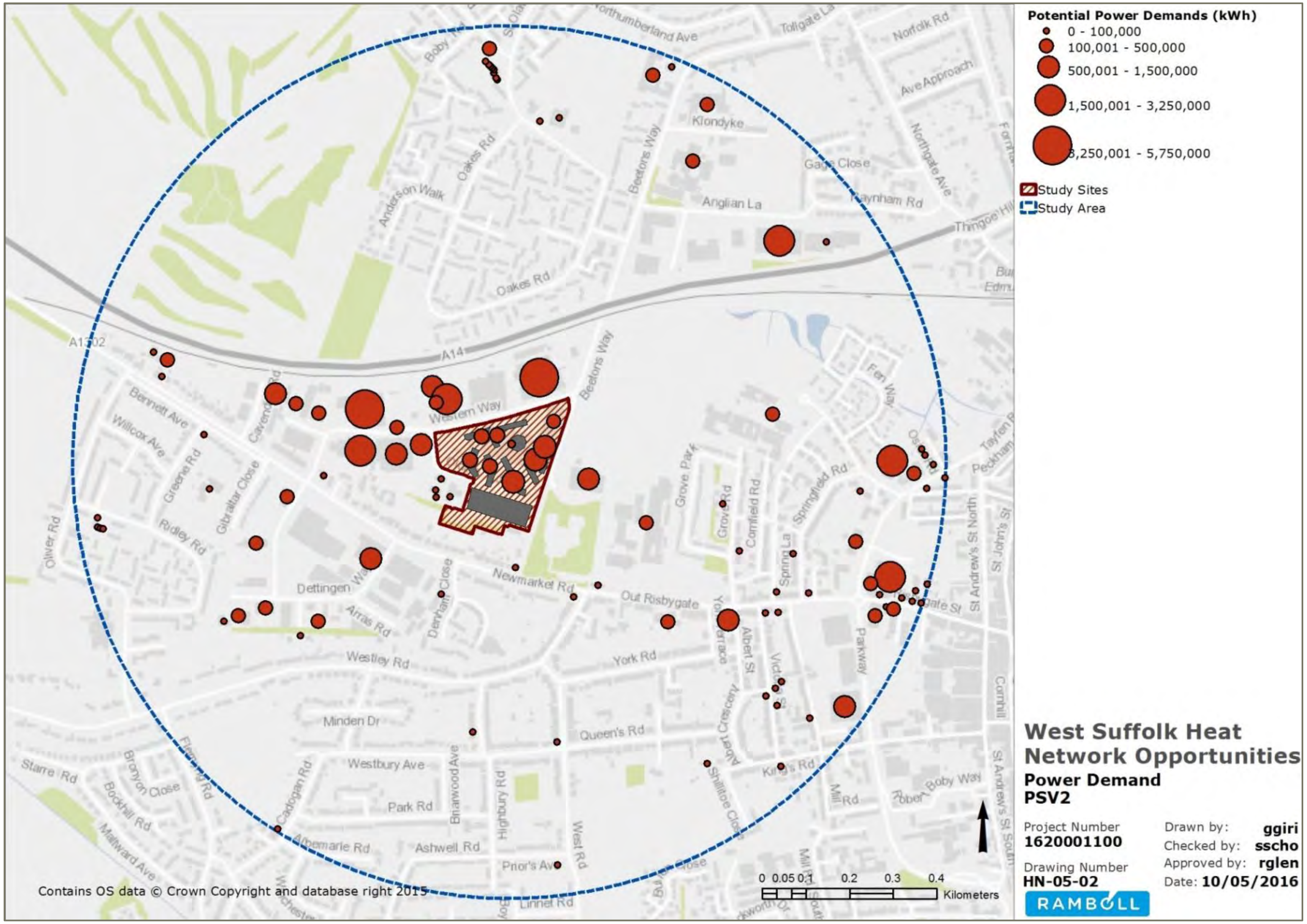


Figure 14: Estimated Power Demands in the PSV2 Study Area

3. ENERGY SUPPLY OPPORTUNITIES

This section presents the assessment of potential energy supply assets in the study area. The magnitude of heat and/or electricity available in combination with the location of the supply is taken into account in the assessment of potential DH opportunities.

The supply assets were considered in three categories:

- existing – operational supply assets
- future - planned supply assets
- potential – opportunities for the creation of new supply assets specifically to supply a decentralised energy network

A heat supply opportunity database was created which contains information about existing and future heat supply assets which could potentially feed into district heating networks within the study area. Each supply asset was identified through the use of one or more of the following resources as part of Ramboll's desktop research:

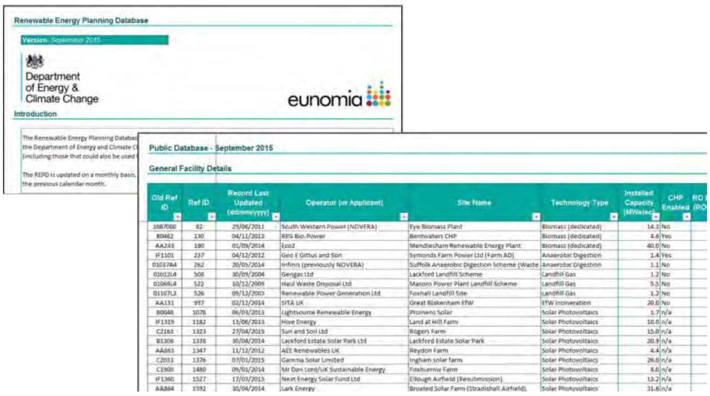
- DECC High Level Water Source Heat Map
- National Heat Map
- OFGEM accredited Renewable Obligation sites
- DECC CHP development map
- WRAP database for ERF's
- Biomass energy centre website
- DECC Restats website
- Environment Agency website
- ADE database of District Heating Installations
- Visual Inspection of the area on Bing and Google maps
- Reports from previous studies undertaken
- Local planning applications

Potential energy supplies were considered through a technology options appraisal, which is outlined in section 3.3.

3.1 Existing Supply Assets

The investigation into existing supply assets was carried out predominantly using the DECC public energy supply database and CHP Focus database. The data was filtered to show all installations within West Suffolk.

In particular, the assets that were of interest would be existing CHP or biomass installations with the potential for exporting heat. Additionally the presence of water treatment works or landfill sites may provide opportunities.



Renewable Energy Planning Database

Version: September 2015

Department of Energy & Climate Change

eunomia

Introduction

The Renewable Energy Planning Databas
the Department of Energy and Climate C
(including those that could also be used

The REPD is updated on a monthly basis,
the previous calendar month.

Public Database - September 2015

General Facility Details

Old Ref ID	Ref ID	Record Last Updated (dd/mm/yyyy)	Operator (or Applicant)	Site Name	Technology Type	Installed Capacity (MWelec)	CHP Enabled	RO
1087000	82	29/06/2011	South Western Power (NOVERA)	Eye Biomass Plant	Biomass (dedicated)	14.3	No	
B0462	130	04/11/2013	REG Bio-Power	Bentwaters CHP	Biomass (dedicated)	4.6	Yes	
AA243	180	01/09/2014	Eco2	Mendlesham Renewable Energy Plant	Biomass (dedicated)	40.0	No	
IF1101	237	04/12/2012	Geo E Gittus and Son	Symonds Farm Power Ltd (Farm AD)	Anaerobic Digestion	1.4	Yes	
01037A4	262	20/05/2014	Infinis (previously NOVERA)	Suffolk Anaerobic Digestion Scheme (Waste	Anaerobic Digestion	1.1	No	
01012L4	508	30/09/2004	Gengas Ltd	Lackford Landfill Scheme	Landfill Gas	1.2	No	
01069L4	522	10/12/2009	Haul Waste Disposal Ltd	Masons Power Plant Landfill Scheme	Landfill Gas	5.5	No	
01107L3	526	09/12/2003	Renewable Power Generation Ltd	Foxhall Landfill Site	Landfill Gas	1.2	No	
AA131	997	02/12/2014	SITA UK	Great Blakenham EfW	EfW Incineration	20.0	No	
B0048	1078	06/03/2013	Lightsource Renewable Energy	Promens Solar	Solar Photovoltaics	1.7	n/a	
IF1319	1182	13/06/2013	Hive Energy	Land at Hill Farm	Solar Photovoltaics	10.0	n/a	
C2163	1323	27/04/2015	Sun and Soil Ltd	Rogers Farm	Solar Photovoltaics	15.0	n/a	
B1306	1338	30/04/2014	Lackford Estate Solar Park Ltd	Lackford Estate Solar Park	Solar Photovoltaics	20.9	n/a	
AA863	1347	11/12/2012	AEE Renewables UK	Reydon Farm	Solar Photovoltaics	4.4	n/a	
C2033	1376	07/01/2015	Gamma Solar Limited	Ingham solar farm	Solar Photovoltaics	26.0	n/a	
C1900	1480	09/01/2014	Mr Don Lord/UK Sustainable Energy	Foxburrow Farm	Solar Photovoltaics	8.0	n/a	
IF1360	1527	17/03/2015	Next Energy Solar Fund Ltd	Ellough Airfield (Resubmission)	Solar Photovoltaics	13.2	n/a	
AA864	1592	30/04/2014	Lark Energy	Broxted Solar Farm (Stradishall Airfield)	Solar Photovoltaics	31.6	n/a	

Figure 15: Screenshot from DECC Public Database

Three existing assets were identified and are included in the table below. Ramboll engaged directly with the Leisure Centre and West Suffolk College to gain further understanding of the supply assets.

Supply Asset	Installed Capacity	Comments
Abbeycroft Leisure Centre CHP	200 kW_e CHP engine + back-up boilers	No available export capacity. In CHP contract with supplier for further 14 years. Contract could potentially be ended early but would result in a penalty charge.
West Suffolk College Biomass	2 No. 155 kW_{th} 2 No. 499 kW_{th}	Biomass boilers new and in good condition. Little/no opportunity for export or appetite for connection into a DHN.
Symonds Farm Power Ltd (Farm AD)	1.4 MW_e 1.4 MW_{th} (estimated)	Although the plant is understood to be rejecting 100% of its heat, this is not considered to be a viable supply asset its proximity to the PSV2 development (approximately 2 miles)

Table 12: Existing Heat Supply Assets

It was concluded that none of the supply assets was found to be appropriate for export of heat to a heat network.

3.2 Future Supply Assets

Through a review of the available data sources and an assessment of planning applications it became apparent that there are no planned energy supply assets within the study area. However, the British Sugar factory which is located approximately 1.2 miles to the North East (direct line distance) is currently constructing an anaerobic digestion plant.

British Sugar is currently constructing an anaerobic digestion (AD) plant which will utilise sugar beet to produce biogas. The biogas produced by the AD plant will be utilised in a gas engine CHP to generate heat and power for use on site. The CHP unit will have a thermal and electrical capacity of 5MW_{th} and 5MW_e respectively. The entire heat output from the biogas CHP is to be utilised on site by British Sugar in their process and there is no opportunity to export any of this heat.

The British Sugar site also includes a 67 MW_e CCGT CHP although there is currently no opportunity to export heat from this plant. However, there is scope to install a flue gas economiser on the CCGT to recover waste heat. This heat would potentially be available for export via a DNH and this opportunity is discussed in more detail in section 3.3.4.

The PSV2 project is within the early development phases and building types, use, size and design are subject to change. Therefore no proposals currently exist for heat supply assets for the PSV2 development.

3.3 Potential Supply Assets

Potential supply assets represent opportunities for the creation of new supply assets due to the presence of resources or the clear suitability of a site to a particular technology.

A full technology options appraisal was conducted and is presented as a table in Appendix 2. The list of criteria included in the appraisal included, but was not limited to:

- Fuel source and fuel risk
- Security of supply
- Site requirements
- Technology and planning risks
- CO_2 reduction potential
- Transportation
- Environmental impacts
- Timeframe for delivery
- Capital and operational costs
- Revenue potential
- Overall financial performance and funding opportunities.

Based on the assessment of each of these criteria for a number of supply technologies, a conclusion was drawn regarding whether the technology should be considered as part of the opportunity appraisal. A summary of the findings of this assessment is shown in Table 13 below.

Technology	CO_2 Abatement Potential	Revenue Potential	General	Opportunity Appraisal?
Gas Combined Heat and Power Plant	Medium as part of technology mix if operating on Natural Gas.	Heat and power sales	Low risk, well proven technology at the scale of the project. Reasonable financial performance expected.	Yes
Dual fuel boiler	Low	Heat sales only	Low risk and low cost, but low carbon reduction potential.	No
Biomass heating	High on individual technology basis. Medium as part of technology mix.	Heat sales and RHI	Reasonable financial performance expected. Low risk technology as long as fuel supply is secured.	Yes
Biomass CHP Steam cycle	High	Heat and power sales and RHI	Not considered commercially viable at this scale.	No
Organic Rankine Cycle	High	Heat and power sales and RHI	Marginal financial performance at this scale.	No
Gasification CHP	High	Heat and power sales and RHI	Technology not established at this scale.	No
Anaerobic Digestion with CHP	High on individual technology basis. Medium as part of technology mix.	FiT(<5MW), RHI, heat and power sales	Entire heat output from British Sugar AD plant earmarked for site's process needs. Dedicated plant for DHN unlikely to be commercially viable at this scale.	No
Waste Incineration CHP	High	Heat and power sales and RHI	Not an appropriate scale for the site.	No
Bio liquid CHP	High on individual technology basis. Medium as part of technology mix.	Heat and power sales	High fuel prices reduce economic viability.	No
Absorption chiller	Carbon emissions savings are sensitive depending on the fuel source of the heat production	Coolth sales	Requires low cost heat to be financially viable.	Yes
Solar Thermal Panels	High	Heat sales and RHI	Reasonable payback expected but very large area required.	No
Ground Source Heat Pump/Heat Store	Medium - as part of site wide heat network	Heat sales and RHI	Poor payback expected and can only deliver low grade heat.	No
Water source heat pumps	Medium - as part of site wide heat network	Heat sales and RHI	Reasonable paybacks expected. No nearby water source available.	No
Air source heat pumps	Medium - as part of site wide heat network	Heat sales and RHI	Poor payback expected.	No
Industrial heat recovery	Medium to high - as part of site wide heat network	Heat sales and RHI	Good payback if suitable source identified. British Sugar may present opportunity.	Yes
Deep geo borehole	Medium	Heat and power sales and RHI	Not suitable at this scale.	No

Table 13: Extract from Technology Options Appraisal

3.3.1 Gas CHP

Gas engine CHP has also been considered as a lower carbon heat source. CHP engines use natural gas from the gas network to generate electricity and make use of the remaining thermal energy. This technology can potentially reduce a building's carbon footprint resulting from energy use when compared to importing electricity from the grid and generating heat in fossil fuel fired boilers.

The engine would provide heat to the DH network in addition to generating electricity which can be sold to the grid or retailed through a bilateral contract.

CHP engines are available to suit a wide range of heat and electricity demands and can be installed on a modular basis to match the phased development of a heat network.

3.3.2 Heat-Only Biomass

Biomass fuel, in the form of wood chip or pellets may be a suitable fuel to generate heat for the site. Biomass boilers are becoming increasingly popular in the UK due to their strong green credentials, the simplicity of the technology and the relatively cheap fuel costs. Fuel should be sourced from sustainably grown trees / other biomasses which have been processed into either chip or pellet form.

Biomass CHP, using wood fuel to supply both heat and power, is a well proven technology. However, at the scale of this project it is not considered to be technically or economically viable.

The size of heat-only biomass boiler selected for the scheme is affected by two main factors:

- the base load heat demand of the network
- the optimisation of revenue through the Renewable Heat Incentive (RHI) scheme.

Consideration of thermal store / buffer vessel size should also be included when sizing biomass boilers.

The current levels of non-domestic RHI for biomass installations with an accreditation date on or after 1st January 2016 are shown in Table 14. Please note these figures are revised by the Government regularly and current trends suggest these could be reduced.

Installation Type	Applicable Size	Tier	RHI Support (p/kWh)
Small commercial biomass	Less than 200 kW_{th}	1	3.76
		2	1.00
Medium commercial biomass	≥200 kW_{th} <1 MW_{th}	1	5.18
		2	2.24
Large commercial biomass	≥1 MW_{th}	NA	2.03

Table 14: RHI Support for Biomass

The logistics of supply and storage of the biomass fuel are an important consideration. The fuel would be delivered by trucks which will impact on transport planning issues as well as limit the range of economic fuel supply. A brief desktop investigation suggested that there are a number of biomass suppliers within the area, for example Forest Fuels, but it will be necessary to engage with suppliers at the next project stage, should a biomass scheme be progressed to feasibility.

Sufficient secure storage space would be required at the site. Wood chips require a significantly greater storage area than pellets. A larger storage area will require a higher initial capital cost, but this may be offset by the difference in fuel cost per kWh. These issues must be considered in greater detail at feasibility stage.

Air quality management areas (AQMAs) can present a barrier to the implementation of biomass if restrictions to emissions are in place. However, an assessment of the study area using the DEFRA AQMA database[8] has shown the site does not fall into an AQMA.

It should be noted that the economic performance of biomass boilers is heavily dependent on support from the Renewable Heat Incentive (RHI). The level of support available for these technologies may be subject to change to future government budgets and spending reviews. This is a risk for project development as if there is a cut in support the projects may no longer achieve the economic results presented here.

3.3.3 Absorption Chillers

Absorption chillers produce coolth using high temperature water or steam to raise the temperature of a cooling circuit for heat rejection and lowers the temperature of a chilled water circuit used for cooling.

Several factors must be taken into account when considering this technology:

- Presence of a suitable heat source – coefficient of performance (CoP) are decrease with heat source temperature
- Nature of the load – A reasonably stable base load is required as absorption chillers are not suited to modulation
- Availability space – Absorption chillers are large
- Safety of refrigerant – Some absorption chillers use ammonia which will have stringent health and safety requirements

3.3.4 Industrial Heat Recovery

The Environment Agency interactive air pollution map[9] was used to identify buildings with particularly high emissions which might indicate the presence of a stack with the potential for heat recovery. For the Bury St Edmunds area the British Sugar Plant was identified as shown by the red circle in Figure 16 below.

[8] http://uk-air.defra.gov.uk/aqma/local-authorities?la_id=105

[9] http://maps.environment-agency.gov.uk/wiyby/wiybyController?x=357683.0&y=355134.0&scale=1&layerGroups=default&ep=map&textonly=off&lang=_e&topic=airpollution

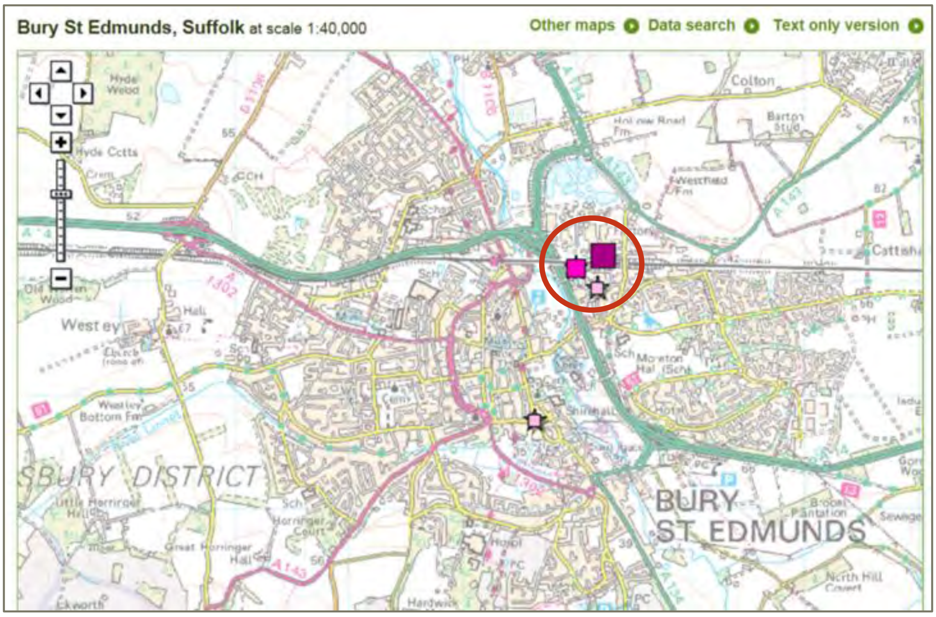


Figure 16: Environment Agency Air Pollution Map of Bury St Edmunds[10]

A natural gas fired 67 MW_e CCGT CHP plant is installed at the British Sugar site. The CHP can produce up to 110 tonnes of steam per hour at a pressure of 72 bar_g for use in the site's processes. The CCGT CHP plant is principally operated during the main processing periods at the British Sugar processing plant. These are from September to February and April to August. The CCGT is also occasionally operated outside of these periods if the spark gap between the gas purchase price and electricity sale price is economic.

British Sugar has previously assessed the possibility of installing a flue gas economiser on the CCGT plant. This would be similar to the unit installed at their Wissington site and recover waste heat from the hot flue gases produced by the CCGT. The previous study estimated potential flue gas heat recovery of:

- Approximately 9MW during September to February
- Approximately 5MW during April to July

The recovered heat would be available at a temperature of up 100 °C and potentially available for export to external customers via a district heating scheme. If a sufficient heat sale price and commercial arrangement could be agreed, British Sugar would potentially be interested in implementing the flue gas economiser project.

Due to the seasonal operational regime, a back-up heat supply asset would be required for the PSV2 DHN if the British Sugar CCGT is selected as the primary heat source. This would supply heat during periods where the CCGT plant is shut down or unavailable.

3.3.5 Energy Centre Options

Following the assessment of the potential to create new energy supply assets, a qualitative investigation was carried out into the potential locations for an energy centre. The locations assessed included both existing plant rooms and locations for purpose built energy centres.

A number of factors were considered as part of the investigation:

- Ownership – Council owned land is preferable as the need for stakeholder engagement and land purchase is minimised.
- Capital cost– A new purpose-built energy centre is likely to require a higher capital investment than the use of an existing building or plant room.
- Space availability – Depending on the chosen supply asset a significant amount of space may be required so a large area is preferable.
- Access – Both in the construction phase and for biomass fuel delivery, access is an important issue.
- Proximity to energy demand – Locating the energy centre in close proximity to the heat demand reduces heat losses and network infrastructure costs.
- AQMA restrictions – Air quality can affect the viability of certain technologies by increasing the costs spent on reducing emissions or by prohibiting the use of certain locations altogether.

The investigation showed that locating an energy centre at the new PSV2 car park would likely be the best solution. This is due to the fact that the site is owned and controlled by the Local Authority and there appears to be sufficient space available.

Location	Ownership	Capital Cost	Space Availability	Access for construction and maintenance	Proximity to energy demand	AQMA restrictions
PSV2 Car Park	St Edmundsbury Borough Council	Moderate capital cost if can be incorporated within the design stage.	High	Good	Central to new development heat demand	None
Abbeycroft Leisure Centre	St Edmundsbury Borough Council	No building cost required if existing plant room could be used, but some modifications to be made.	Low	Plant room located in basement	Adjacent to PSV2 site	None
West Suffolk College	West Suffolk College	No building cost required if existing plant room could be used, but some modifications to be made.	Possible space availability if existing supply is replaced	Plant rooms located within campus	Adjacent to PSV2 site	None
New Housing Development	Private developer	New energy centre building required and cost of land from Developer.	Depends if could be incorporated into plans	Unknown	Large distance from PSV2 site	None
British Sugar	Private organisation	New energy centre building required. Cost of land to be negotiated with British Sugar	High	Good	Large distance from PSV2 site	None

Table 15: Evaluation of Possible Energy Centre Locations

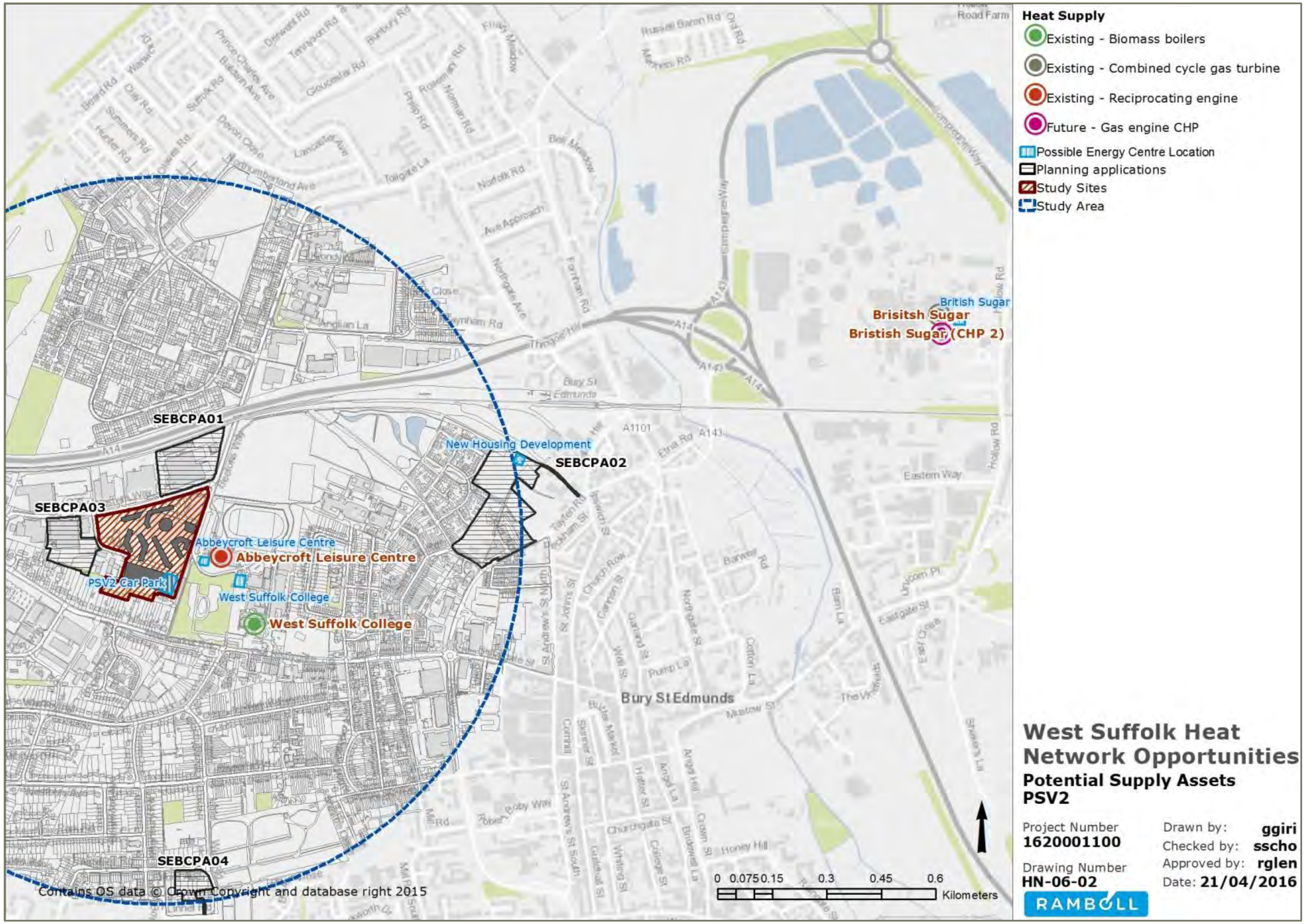


Figure 17: Energy Supply Opportunities

4. HEAT NETWORK OPPORTUNITY APPRAISAL

This section presents a series of opportunities for heat networks and decentralised energy which were identified using the energy maps created in section 2.

The heat demand and supply mapping was used to identify heat network opportunities. Potential opportunities were identified taking into account, but not limited to, the following criteria:

- energy demand density
- potential anchor loads
- proximity to existing or potential opportunities for supply assets
- number of public buildings vs. number of private buildings
- possible commercial arrangements
- stakeholders and appetite for leadership
- physical barriers or aids to heat network construction.

4.1 Identification of Opportunity Areas

A number of "opportunity areas" were identified. These represent parts of the town which were deemed to hold potential for district heating based on consideration of the factors listed above.

In the first instance, the energy demand maps were assessed to observe clusters of demand which would form the basis of a decentralised energy network. The map below presents the two key heat demand clusters that were identified within solid red boundaries. In addition, two other areas of interest were identified (indicated with dashed circles), which were not considered to be heat demand clusters as such, but were deemed to be of interest.

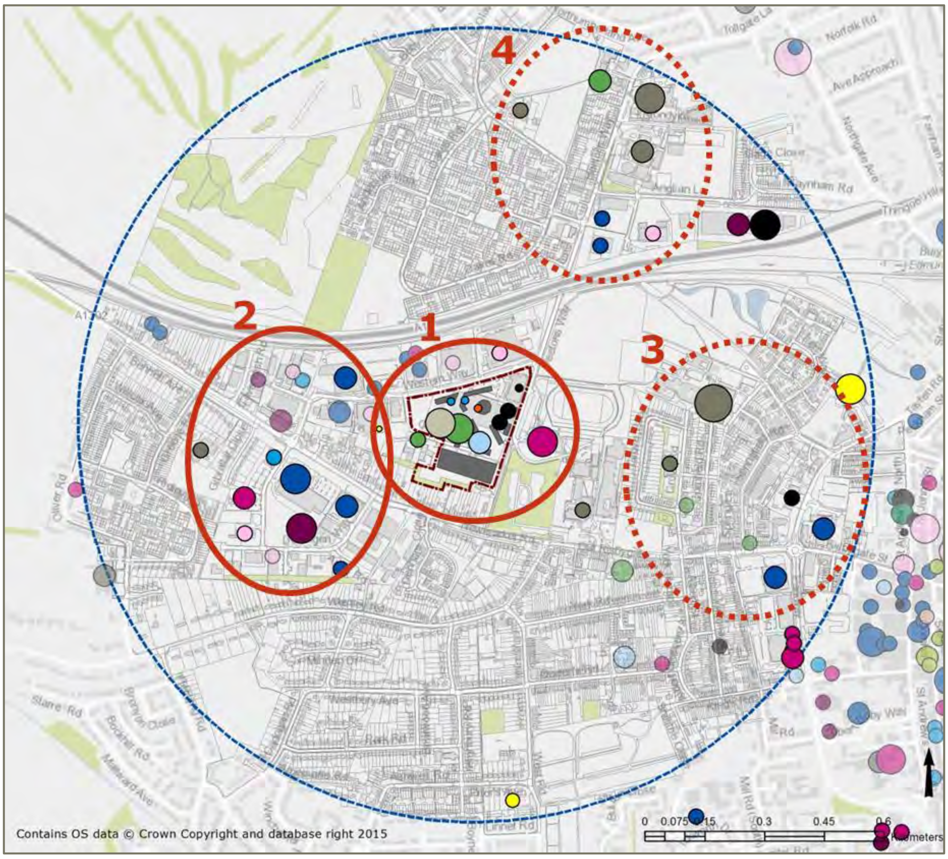


Figure 18: Opportunity Area Locations

4.1.1 PSV2 and Surrounding Area

The PSV2 development and immediate surrounding area presents several anchor loads in the form of large student accommodation and Government Buildings. The Leisure Centre also provides a large anchor load. The range of building types within this cluster is also likely to result in a diversified load profile.

The high concentration of council owned and public buildings facilitates Local Authority led delivery of the scheme, thereby allowing the Council to retain control over the future development of the network. Furthermore publicly led schemes are typically more straightforward to implement than those which are private.

Figure 19: Snapshot of Heat Map showing PSV2 and Surrounding Area

It should be noted that although the buildings are public, there are still a high number of stakeholders that would require coordination. This presents a risk to the project delivery and may complicate the commercial arrangement. Further difficulties may occur from a large number of public stakeholders in relation to the requirement for them to go out to tender for energy contracts. This could result in the heat network operator having to formally demonstrate low costs and high security of supply. This presents a further risk to the proposed project, particularly around electricity distribution.

Just north of Western Way there are a number of small commercial and light industrial retailers. These may also be considered as potential connections, but are considered to be a limited opportunity at this stage due to the limited energy data made available and the private ownership which increases the degree of commercial risk.

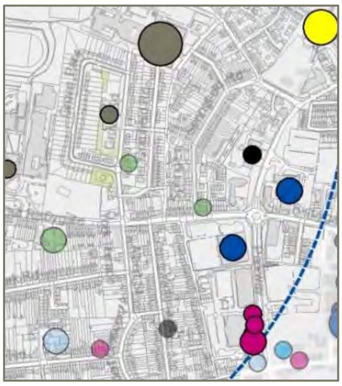
4.1.2 Light Industrial Area

The light industrial area adjacent to PSV2 also appears as a cluster of high heat loads on the heat map and may also present an opportunity for heat networks.

There is a risk in the fact that the buildings are all privately owned and therefore cannot easily be influenced to connect. Sufficient incentives would have to be provided in the form of low heat prices which would have a negative effect on the scheme economics.

Figure 20: Snapshot from Heat Map showing Light Industrial Area

4.1.3 Eastern Schools and Retail



The area of the Town shown in Figure 21 does not appear to feature a high heat demand density. However, there are a number of high individual loads which may present an opportunity.

The two schools (shown on the image in grey) are publicly owned and therefore present a significant opportunity.

The new housing development (yellow) may present an opportunity if the Council can influence the Developer's choice of heating system through planning conditions.

Figure 21: Snapshot of Heat Map showing Eastern Schools and Retail

The remainder of the loads are predominantly private commercial and retail organisations which are typically difficult to incentivise to connect.

4.1.4 Northern Schools and Retail

The area of the Town shown in Figure 22 also does not appear to feature a high heat demand density. However, there are a number of high individual loads which may present an opportunity.

The two schools (shown on the image in grey) are publicly owned and therefore present a significant opportunity. However, contact was not made with the schools for this phase of work and therefore the appetite for connection to a heat network was unknown.

Figure 22: Snapshot of Heat Map showing Northern Schools and Retail

4.2 Heat Network Routing Strategy

Once opportunities were identified, possible heat network routes were determined. Networks were routed through council owned green spaces, car parks and other available open areas wherever possible. Where this was not possible the network was routed along public roadways.

The Council provided GIS layers containing information regarding the constraints that needed to be taken into account and where possible avoided while developing potential network routes. This GIS data included information on:

- Conservation Areas
- Protected Areas (including Local Nature Reserves, Archaeological Sites, and Sites of Special Scientific Interest amongst others)
- Councils owned land
- Planning applications.

Other constraints and opportunities such as railway networks and the existence of underpasses on the routes were also considered in order to minimise cost and inconvenience. These barriers and opportunities were assessed as part of a desktop study using resources such as Google Maps and Bing Maps.

A site walkover was undertaken in November 2015 in order to gain a greater understanding of the potential heat network routes.

Figure 23: Map and Images of Key Points (Photographs courtesy of Ramboll and GoogleMaps)

A number of key areas were observed as follows:

1. View towards West Suffolk House – This shows the access road from the east of PSV2.
2. Industrial Estate – The industrial estate features relatively wide quiet roads with some grass verges.
3. Newmarket Road – The main road towards the Town Centre to the south of PSV2. This road would require significant traffic management if required for DH construction.
4. Parkway – The large busy road alongside the retail area.
5. Grove Park – The area surrounding the schools is residential with narrow roads and may present a challenge to DH construction.
6. View towards leisure centre – The Leisure Centre sits opposite West Suffolk House.
7. Bridge crossing over Beestons Way – There is a road bridge where the A14 crosses Beestons Way.

4.3 List of Identified Opportunities

Table 16 lists the opportunities identified and considered for initial assessment. There are six core network options (referenced as PS001 – PS006), each with two or three possible supply technologies (referenced as a, b and c). Network PS001 considers a network within the PSV2 development only; supplying all proposed buildings. The remaining options consider extensions of this network to the existing leisure centre and schools as well as the proposed new residential and commercial developments.

Although Abbeycroft Leisure Centre will not reach the end of its current CHP energy contract until 2029, it has been included in a number of scenarios due to the fact that it could connect approximately nine years into the project lifetime and they have expressed an interest in involvement in the project.

Project Ref.	Description
PS001a	PSV2 development only, supplied by natural gas CHP
PS001b	PSV2 development only, supplied by heat-only biomass boilers
PS002a	PSV2 development, Leisure Centre and Schools supplied by natural gas CHP
PS002b	PSV2 development, Leisure Centre and Schools supplied by heat-only biomass boilers
PS003a	PSV2 development, Leisure Centre, Schools and residential planning application supplied by natural gas CHP
PS003b	PSV2 development, Leisure Centre, Schools and residential planning application supplied by heat-only biomass boilers
PS003c	PSV2 development, Leisure Centre, Schools and residential planning application supplied by British Sugar waste heat
PS004a	PSV2 development, Leisure Centre, Schools, residential planning application and retail supplied by natural gas CHP
PS004b	PSV2 development, Leisure Centre, Schools, residential planning application and retail supplied by heat-only biomass boilers
PS004c	PSV2 development, Leisure Centre, Schools, residential planning application and existing retail supplied British Sugar waste heat
PS005a	PSV2 development, non-residential planning applications and ASDA supplied by natural gas CHP
PS005b	PSV2 development, non-residential planning applications and ASDA supplied by heat-only biomass boilers
PS006a	PSV2 development, non-residential planning applications, ASDA and light industrial supplied by natural gas CHP
PS006b	PSV2 development, non-residential planning applications, ASDA and light industrial supplied by heat-only biomass boilers

Table 16: List of Identified Opportunities

West Suffolk College is not included in the proposed scenarios. This is due to the fact that the existing standalone biomass solution will be in operation until around 2034, which is over half way through the 25 year project lifetime of the opportunity model. Although there is opportunity for substantial heat sale revenues of around £150 K, the connection to the College would require significant capital expenditure due to the number of decentralised plant rooms. Furthermore the capacity of the main heat network's energy centre would need to increase at the time of connection due to the fact that it would not be technically feasible to operate an initial supply sized to include the full College load before 2034 as it would be oversized.

The northern retail and schools were also excluded from the opportunities assessment. This was primarily due to the fact that at this initial stage, the long distance required to connect a small number of buildings was unlikely to be economically beneficial, especially given the absence of engagement with the schools and therefore the risk associated with the connections. However, a network route to this area is investigated as part of the sensitivity analysis in section 5.4.3.5.

4.4 Opportunity Appraisal

The following sub-sections present each of the fourteen opportunities in further detail and show estimated key metrics for each proposed scheme. Comparison of these metrics enables the prioritisation of opportunities for progression to masterplanning stage and more detailed analysis.

The opportunity appraisal was intended to narrow down the list of opportunities to the most viable options to take forward to techno-economic feasibility through a high level assessment of likely energy flows and costs. It is not intended to comprise a techno-economic analysis in itself.

It is important to note that the high level opportunity appraisal does not take project phasing into account.

All heat loads connections and capital expenditures are assumed to take place in project year 1. This is due to the fact that the opportunity appraisal is intended as an initial screening process.

The preferred option(s) taken forward to full masterplanning analysis in section 5 will include detailed phasing assumptions. It should be noted that this is likely to slightly reduce the IRR as all revenue will not be recognised in the first project years.

The key assumptions applicable in all cases are outlined in the table below.

Variable	Assumption
Heat Sale Prices	In each case the heat sale price for public buildings and general commercial was based on the Council's current gas costs[11] and an assumed boiler efficiency of 85%. The value used was **5.23 p/kWh** which encompasses both the unit rate and standing charge. This accounts for 5% incentive on current gas prices and avoided boiler maintenance costs. For the leisure centre, the heat price was set at **6.6 p/kWh** based on the current gas cost and a 10% incentive. For the new residential properties the heat price was set at **6 p/kWh** which was approximated based on Ramboll's previous experience.
Electricity Sale Prices	Were calculated depending on the assumed availability of private wire vs. grid sales. Private wire price was set at the Council's avoided electricity cost of 12 p/kWh[12]. Grid sale was set at 4.5 p/kWh.
RHI Revenue	The RHI does not account for degression over the project lifetime at opportunity modelling stage and is therefore considered to be a best case scenario. RHI is in accordance with 2016 tariffs[13] and is presented in Table 14 in section 3.3.

[11] Applying an assumed gas boiler efficiency of 80%.

[12] This figure was calculated by dividing the total annual bills provided by the Council and dividing by the total units consumed. This methodology was discussed with, and approved by the Council.

[13] Ofgem, "Tariffs that apply for Non-Domestic RHI for Great Britain", https://www.ofgem.gov.uk/environmental-programmes/non-domestic-renewable-heat-incentive-rhi/tariffs-apply-non-domestic-rhi-great-britain

CAPEX	Capital expenditure was based on Ramboll's supplier database which encompasses values from previous project experience.
Cost of Gas	The cost of gas figures for the CHP cases and for the top up boilers were taken from DECC's most recently published energy price figures[14]. At this stage energy price inflation was not taken into account.
OPEX	Operational costs for the plant, energy centre and heat network were based on Ramboll's supplier database which encompasses values from previous project experience.
REPEX	A value of 25 % every 20 years was assumed for gas boilers and a value of 20 % every 25 years for thermal storage. Reinvestment costs for primary supply technologies are stated within the sections below.
Carbon Factors	The carbon savings were calculated using DECC's most recent emissions factors[15]. At opportunity mapping level the predicted changes to electricity emissions over time was not taken into account and 2016 values were used. At masterplanning level in section 5 the emissions are modelled in further detail.
Thermal Storage	Thermal store sizes are based on an equivalent of 2.5 hours of the full output of the primary supply technology.

Table 17: Common Assumptions for Opportunity Models

Detailed hydraulic modelling was carried out for the preferred options as part of section 5, but it was not conducted as part of this phase of the project. Pipe costs for the purpose of opportunity assessment were based on an algorithm which distributes an equal portion of pipe sizes based on the largest size indicated by the peak heat load.

Supply asset sizing for the opportunities was based on a select number of asset capacities to achieve an appropriate degree of overall contribution to annual heat demand. At masterplanning stage, the technology sizing was then optimised.

In each case a single energy centre location is assumed. The reasons for this include:

- The scheme is not large enough to generate revenue to justify the additional cost of multiple energy centres.
- There would be marginal operational benefit to using multiple energy centres at this scale of project
- The ongoing O&M costs for multiple energy centres would be higher than for a single energy centre.

It should be noted that IRR estimates for this opportunity identification stage are based on simple economic calculations based on annual heat demands and high-level cost estimates.. Therefore it should be noted that the values are indicative only and subject to change at the next project

[14] DECC, "Gas and electricity prices in the non-domestic sector", https://www.gov.uk/government/statistical-data-sets/gas-and-electricity-prices-in-the-non-domestic-sector

[15] Table 1 and Table 2a. https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

stage once EnergyPRO modelling of the preferred options was carried out. Full techno-economic modelling was carried out for section 5, for which the calculations are based on hourly profiling.

The IRR estimate is calculated over a 25 year project lifetime.

4.4.1 PS001 – PSV2 Development Network

This scenario considers a heat network supplying the PSV2 development only. The total heat demand was estimated to be approx. 2,900 MWh per annum (see section 2.2.3.1) with a diversified peak demand of 1.3 MW.

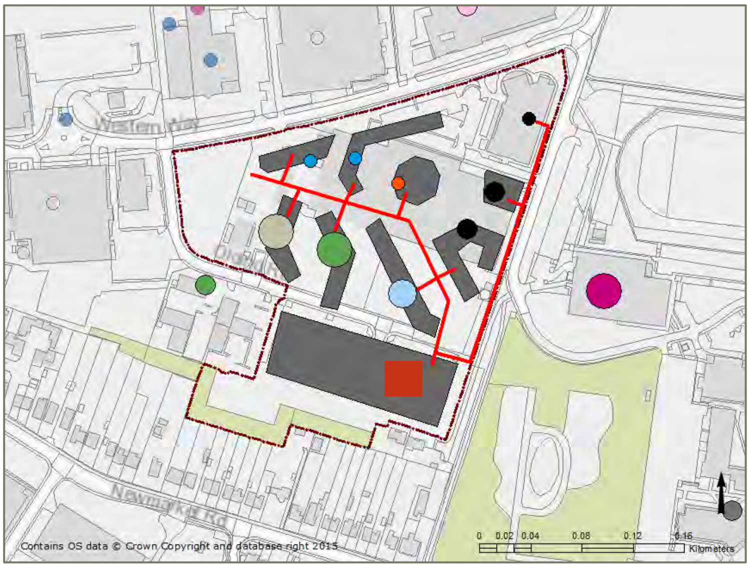


Figure 24: PS001 Network Layout

For the purposes of this assessment the energy centre is located in the proposed multi-storey car park as this was shown to be the most promising opportunity in section 3.3.5.

The proposed heat supply technology for this opportunity is either a gas fired CHP or biomass fired heat only boiler. Peaking and back up capacity will be provided by gas fired LTHW boilers.

The CHP was sized at 350 kW_e and is expected to contribute approximately 68% of the total network heat demand. It was assumed that 80% of the total power generated by the CHP is private wired to the PSV2 development.

The biomass boiler was sized at 600 kW_{th}. The estimated annual contribution to heat demand was 81%.

The key metrics for opportunities PS001a and PS001b are presented in Table 18 below.

Network Reference	PS001a	PS001b
Primary heat supply technology	Gas CHP	Biomass
Supply Asset Capacity	350 kW_e	600 kW_{th}
Total Network length	435 m	435 m
Total project CAPEX	£1.0 M	£0.8 M
Annual Operating Costs (incl. Fuel)	£190 K	£84 K
Annual revenue from heat sales	£160 K	£151 K
Annual revenue from electricity sales	£218 K	N/A
Annual revenue from RHI	N/A	£66 K
Annual CO_2 Savings	200 tonnes	600 tonnes
Estimated Simple Non-Discounted IRR	10 %	7 %

Table 18: PS001 Key Metrics

4.4.2 PS002 - PSV2 Development with extension to Leisure Centre and Schools

This scenario considers a heat network including the PSV2 development, leisure centre and two schools. The total heat demand was estimated to be 12,400 MWh per annum with a diversified peak demand of 5.6 MW.

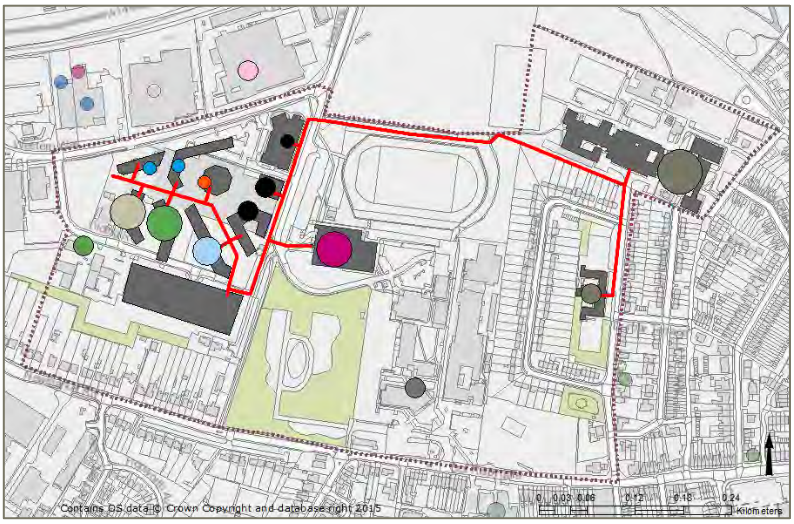


Figure 25: PS002 Network Layout

As per PS001, the energy centre is located in the proposed multi-storey car park.

The proposed heat supply technology for this opportunity is either a gas fired CHP or biomass fired heat only boiler. Peaking and back up capacity will be provided by gas fired LTHW boilers.

The CHP was sized at 1 MW_e and is expected to contribute approximately 59 % of the total network heat demand. It is assumed that approximately 20 % of the total power generated by the CHP is private wired[16]. This is based on a high level estimate of the PSV2 electricity demand as a proportion of the total output of the CHP engine. It is much lower than for PS001a due to the fact that the CHP engine is sized to meet the heat load, but the private wire opportunity is still only considered to be within PSV2 due to distance limitations for private wire at low voltage.

The biomass boiler was sized at 2.5 MW_{th}. The estimated annual contribution to heat demand was 75 %.

The key metrics for opportunities PS002a and PS002b are presented in Table 19.

[16] In the first instance it was assumed that the private wire network would be low voltage and therefore distances would be limited to approx. 200 m to reduce losses. However, a medium voltage (11 kV) network could be considered at feasibility stage. This would increase the CAPEX costs, but enable a greater proportion of electricity to be private wired.

Network Reference	PS002a	PS002b
Primary Heat Supply Technology	Gas CHP	Biomass
Supply Asset Capacity	1 MW_e	2.5 MW_{th}
Network length	1,158 m	1,158 m
Total project CAPEX	£3.1 M	£2.6 M
Annual Operating Costs (incl. Fuel)	£679 K	£361 K
Annual revenue from heat sales	£706 K	£706 K
Annual revenue from electricity sales	£380 K	N/A
Annual revenue from RHI	N/A	£203 K
Total CO_2 Savings over 25 Years	300 tonnes	2,000 tonnes
Estimated Simple Non-Discounted IRR	7 %	13 %

Table 19: PS002 Key Metrics

4.4.3 PS003 – Extension to New Residential Development

This scenario considers a heat network including the PSV2 development, leisure centre, two schools and proposed residential developments. The total heat demand was estimated to be 13,400 MWh per annum with a diversified peak demand of 6.1 MW.

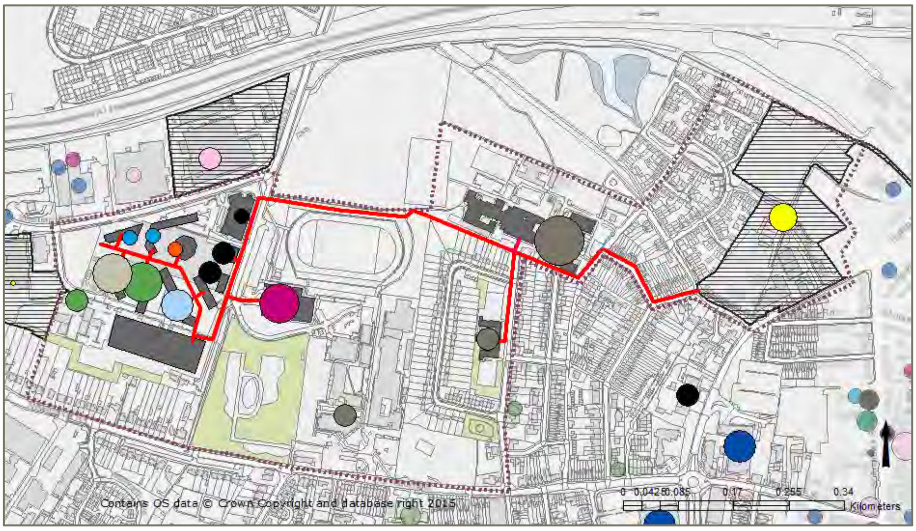


Figure 26: PS003a and 3b Network Layout

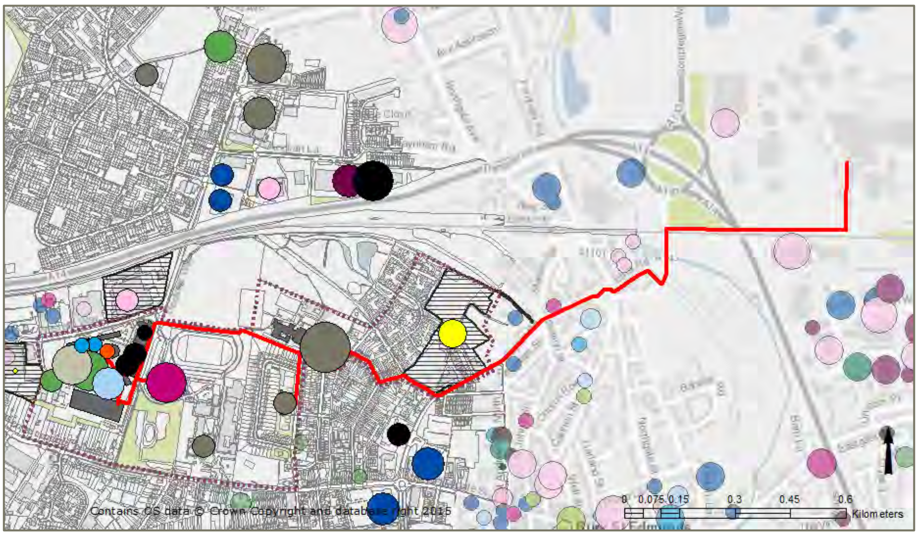


Figure 27: PS003cNetwork Layout

It is assumed that the energy centre is located in the proposed multi-storey car park at PSV2.

The proposed heat supply technology for this opportunity is either a gas fired CHP, biomass fired heat only boiler or industrial heat recovery from British Sugar. Peaking and back up capacity will be provided by gas fired LTHW boilers.

The CHP was sized at 1.5 MW_e and is expected to contribute approximately 65% of the total network heat demand. It is assumed that approximately 13% of the total power generated by the CHP is private wired. This is based on a high level estimate of the PSV2 electricity demand as a proportion of the total output of the CHP engine.

The biomass boiler was sized at 2.5 MW_{th}. The estimated annual contribution to heat demand was 69%.

For the purposes of this assessment in scenario PS003c it is assumed that British Sugar can provide up to 5 MW_{th} of heat into the DHN for 6,600 hours per annum. For the remainder of the year heat supply will be from the gas fired heat supply assets. It was assumed that the cost of the heat offtake equipment would be borne by British Sugar and this was reflected in the estimated heat purchase price of £6.41 per MWh supplied. It is important to note that this assumes that British Sugar recovers costs, but does not make any profit from the scheme and therefore it is considered to be a best case scenario.

The key metrics for opportunities PS003a, PS003b and PS003c are presented in Table 20 below.

Network Reference	**PS003a**	**PS003b**	**PS003c**
Primary heat supply technology	Gas CHP	Biomass	British Sugar
Primary Supply Asset Capacity	1.5 MW_e	2.5 MW_{th}	5 MW_{th}
Network length	2,012 m	2,012 m	3,692 m
Total project CAPEX	£5.0 M	£4.4 M	£7.9 M
Annual Operating Costs (incl. Fuel)	£801 K	£399 K	£141 K
Annual revenue from heat sales	£760 K	£760 K	£760 K
Annual revenue from electricity sales	£445 K	N/A	N/A
Annual revenue from RHI	N/A	£203 K	N/A
Annual CO_2 Savings	800 tonnes	2,500 tonnes	3,000 tonnes
Estimated Simple Non-Discounted IRR	2 %	7 %	2 %

Table 20: PS003 Key Metrics

4.4.4 PS004 - Extension to Existing Retail Areas

This scenario considers a heat network supplying buildings including the PSV2 development, leisure centre, two schools, proposed residential developments and retail in Bury St Edmunds town centre. The total heat demand was estimated to be 14,200 MWh per annum with a diversified peak demand of 6.5 MW.

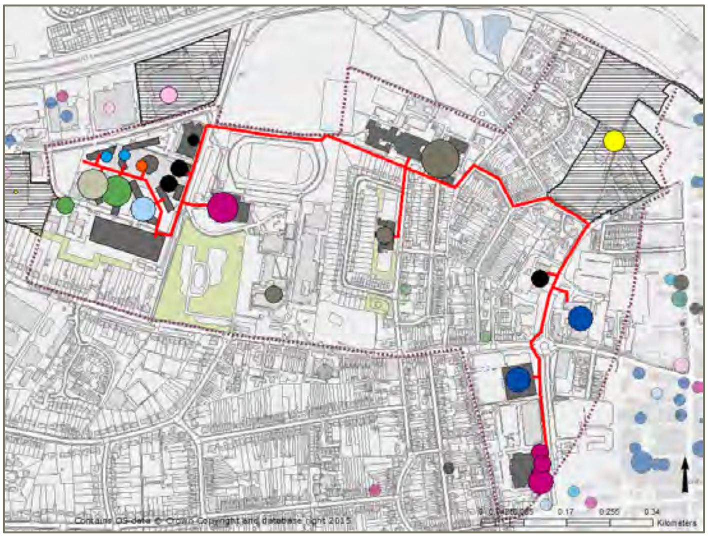


Figure 28: PS004a and 4b Network Layout

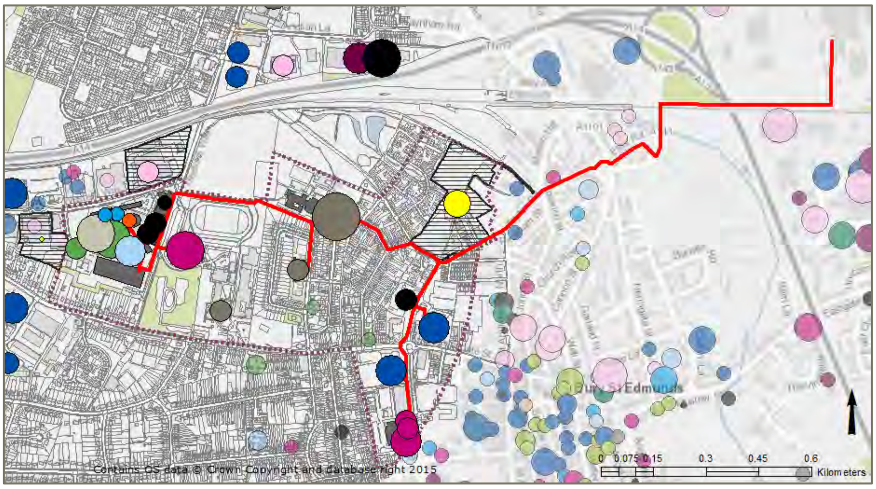


Figure 29: PS004a and 4b Network Layout

It is assumed that the energy centre is located in the proposed multi-storey car park at PSV2.

The proposed heat supply technology for this opportunity is either a gas fired CHP, biomass fired heat only boiler or industrial heat recovery from British Sugar. Peaking and back up capacity will be provided by gas fired LTHW boilers.

The CHP was sized at 1.5 MW_e and is expected to contribute approximately 61% of the total network heat demand. It is assumed that approximately 13% of the total power generated by the CHP is private wired.

The biomass boiler was sized at 2.5 MW_{th}. The estimated annual contribution to heat demand was 64%.

For the purposes of this assessment in scenario PS004c it is assumed that British Sugar can provide up to $5MW_{th}$ of heat into the DHN for 6,600 hours per annum. For the remainder of the year heat supply will be from the gas fired heat supply assets.

The key metrics for opportunities PS004a, PS004b and PS004c are presented in Table 21 Table 20.

Network Reference	**PS004a**	**PS004b**	**PS004c**
Primary heat supply technology	Gas CHP	Biomass	British Sugar
Primary Supply Asset Capacity	1.5 MWe	2.5 MWth	5 MWth
Network length	2,719 m	2,719 m	4,399 m
Total project CAPEX	£6.0 M	£5.4 M	£8.9 M
Annual Operating Costs (incl. Fuel)	£832 K	£430 K	£149 K
Annual revenue from heat sales	£804 K	£804 K	£804 K
Annual revenue from electricity sales	£488 K	N/A	N/A
Annual revenue from RHI	N/A	£203 K	N/A
Annual CO_2 Savings	800 tonnes	2,600 tonnes	3,400 tonnes
Estimated Simple Non-Discounted IRR	2 %	5 %	2 %

Table 21: PS004 Key Metrics

4.4.5 PS005 - PSV2 Development with extension to New Commercial Sites

This scenario considers a heat network supplying the PSV2 development and nearby retail (ASDA) / commercial / light industrial space. The total heat demand was estimated to be 3,200 MWh per annum with a diversified peak demand of 1.5 MW.

Figure 30: PS005 Network Layout

For the purposes of this assessment the energy centre is located in the proposed multi-storey car park.

The proposed heat supply technology for this opportunity is either a gas fired CHP or biomass fired heat only boiler. Peaking and back up capacity will be provided by gas fired LTHW boilers.

The CHP was sized at 350 kW_e and is expected to contribute approximately 57 % of the total network heat demand. It is assumed that approximately 70% of the total power generated by the CHP is private wired.

The biomass boiler was sized at 750 kW_{th}. The estimated annual contribution to heat demand was 86%.

The key metrics for opportunities PS005a and PS005b are presented in Table 22 below.

Network Reference	PS005a	PS005b
Primary heat supply technology	Gas CHP	Biomass
Primary Supply Asset Capacity	350 kWe	750 kWth
Network length	949 m	949 m
Total project CAPEX	£1.7 M	£1.6 M
Annual Operating Costs (incl. Fuel)	£206 K	£97 K
Annual revenue from heat sales	£170 K	£170 K
Annual revenue from electricity sales	£200 K	N/A
Annual revenue from RHI	N/A	£83 K
Annual CO_2 Savings	200 tonnes	800 tonnes
Estimated Simple Non-Discounted IRR	2.0 %	2.0 %

Table 22: PS005 Key Metrics

4.4.6 PS006 - Extension to Southern Light Industrial Area

This scenario considers a heat network supplying the PSV2 development, nearby retail / commercial / light industrial space and light industrial users to the south of the main cluster. The total heat demand was estimated to be 4,600 MWh per annum with a diversified peak demand of 2.1 MW.

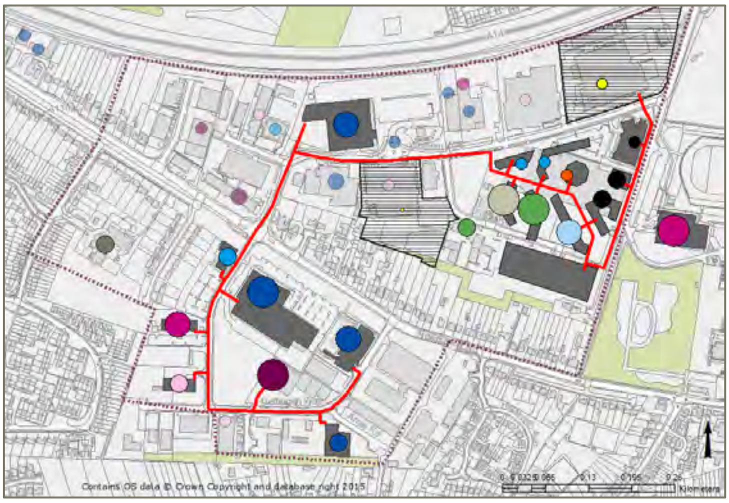


Figure 31: PS006 Network Layout

For the purposes of this assessment the energy centre is located in the proposed multi-storey car park.

The proposed heat supply technology for this opportunity is either a gas fired CHP or biomass fired heat only boiler. Peaking and back up capacity will be provided by gas fired LTHW boilers.

The CHP was sized at 500 kW_e and is expected to contribute approximately 61 % of the total network heat demand. It is assumed that approximately 35 % the total power generated by the CHP is private wired.

The biomass boiler was sized at 999 kW_{th}. The estimated annual contribution to heat demand was 78%.

The key metrics for opportunities PS006a and PS006b are presented in Table 23 below.

Network Reference	PS006a	PS006b
Primary heat supply technology	Gas CHP	Biomass
Primary Supply Asset Capacity	500 kW_e	999 kW_{th}
Network length	1,811 m	1,811 m
Total project CAPEX	£3.3 M	£3.0 M
Annual Operating Costs (incl. Fuel)	£313 K	£144 K
Annual revenue from heat sales	£251 K	£251 K
Annual revenue from electricity sales	£227 K	N/A
Annual revenue from RHI	N/A	£110 K
Annual CO_2 Savings	200 tonnes	1,000 tonnes
Estimated Simple Non-Discounted IRR	-5 %	0 %

Table 23: PS006 Key Metrics

4.4.7 Summary

Table 24 below shows a summary of the key indicators of the fourteen opportunities for the study area that have been assessed during the options appraisal. The simple payback field is highlighted to indicate the attractiveness of the estimated IRRs.

Opportunity	CAPEX	Annual Operating Margin[17]	Estimated IRR
PS001a	£1.0 M	£188 K	10%
PS001b	£0.8 M	£133 K	7 %
PS002a	£3.1 M	£407 K	8 %
PS002b	£2.6 M	£548 K	13 %
PS003a	£5.0 M	£404 K	3 %
PS003b	£4.4 M	£564 K	8 %
PS003c	£7.9 M	£619 K	3 %
PS004a	£6.0 M	£460 K	3 %
PS004b	£5.4 M	£577 K	6 %
PS004c	£8.9 M	£655 K	3 %
PS005a	£1.7 M	£164 K	2 %
PS005b	£1.6 M	£156 K	2 %
PS006a	£3.3 M	£165 K	-5 %
PS006b	£3.0 M	£217 K	0 %

Table 24: Options Appraisal Summary

The most attractive options appear to be the PS001 and PS002 networks. In the case of the smaller network, the CHP appears to be the preferable technology, whereas the larger network generates a better IRR with biomass as the primary supply technology.

It was recommended that the five most promising opportunities should be assessed in further detail as part of the energy masterplan:

- **PS001a** – PSV2 development only with gas CHP
- **PS001b** - PSV2 development only with biomass
- **PS002a** - PSV2 development, leisure centre and schools with gas CHP
- **PS002b** - PSV2 development, leisure centre and schools with biomass
- **PS003b** - PSV2 development, leisure centre, schools and new residential development with biomass

[17] In first full operational year.

Sensitivity of these initial results to RHI was deemed to be an important consideration due to the fact that there is some uncertainty regarding the future availability of the revenue stream. Therefore, each of the biomass options was assessed without the RHI revenue to illustrate a worst case scenario whereby the funding is unavailable. The resulting IRRs are shown in the table below:

Opportunity	IRR with RHI Revenue	IRR without RHI Revenue
PS001b	7 %	-3 %
PS002b	13 %	6 %
PS003b	7 %	2 %
PS004b	5 %	0 %
PS005b	2 %	-7 %
PS006b	0 %	-7 %

Table 25: Sensitivity of IRR to RHI Revenue

The results show that without the support from the RHI, only the PS002b scheme would likely be viable. Therefore the revenue can be considered a key risk to the projects. Only the best and worst cases were explored as part of the high-level opportunities appraisal. As part of the full energy masterplanning stage presented in section 5, varied levels of RHI reduction were assessed.

A full sensitivity on a broad range of variables is included for the techno-economic analysis in section 5.4.3.

5. ENERGY MASTERPLANNING FOR PREFERRED OPPORTUNITIES

The project key performance indicators (KPIs) of the opportunities were presented to St Edmundsbury Borough Council for comment and to confirm Ramboll's recommendations for preferred opportunities. This section explores the preferred opportunities in further technical and economic detail.

Five opportunities were selected for further analysis. The opportunities are listed as follows:

- PS001a – PSV2 development only with gas CHP
- PS001b - PSV2 development only with biomass
- PS002a - PSV2 development, leisure centre and schools with gas CHP
- PS002b - PSV2 development, leisure centre and schools with biomass
- PS003b - PSV2 development, leisure centre, schools and new residential development with biomass

The first stage in the analysis was to enter the energy demand data for the scenarios and establish the 'business as usual' (BaU) or 'do nothing' scenario, which enabled the calculation of relative carbon and cost savings of the four low carbon options against the scenario where only natural gas fired boilers are installed.

Following this, heat supply information for each of the five options low carbon energy supply options was entered into an EnergyPRO model to generate results which indicate the economic and carbon potential. EnergyPRO creates hourly annual demand and supply profiles to enable accurate calculation of economic and carbon results.

Due to the creation of hourly profiling, the plant sizing and costing exercise was developed from the opportunity identification stage. Also, a hydraulic analysis was conducted based on the updated results (see section 5.20). As a result of this, the network and plant parameters incorporated into the techno-economic analysis vary from those presented in section 4.4.

5.1 Energy Demand Assumptions

Before conducting further analysis the heat demand estimates were revised to ensure the highest possible degree of accuracy.

5.1.1 Heat Demand Assessment

The heat demand profiles for the networks were assessed in combination with degree day profiling to develop a detailed picture of heat demand across the year. Diversification of demand profiles was also accounted for at this stage.

No further changes were made to the plans for the PSV2 development at this stage and therefore the annual heat demands used were the same as those outlined in section 2.2.

Hourly energy demand profiles were constructed using EnergyPRO based on the various use types. It was assumed that the public offices would close at the weekend. Figure 32 illustrates the average daily profile across a typical year.

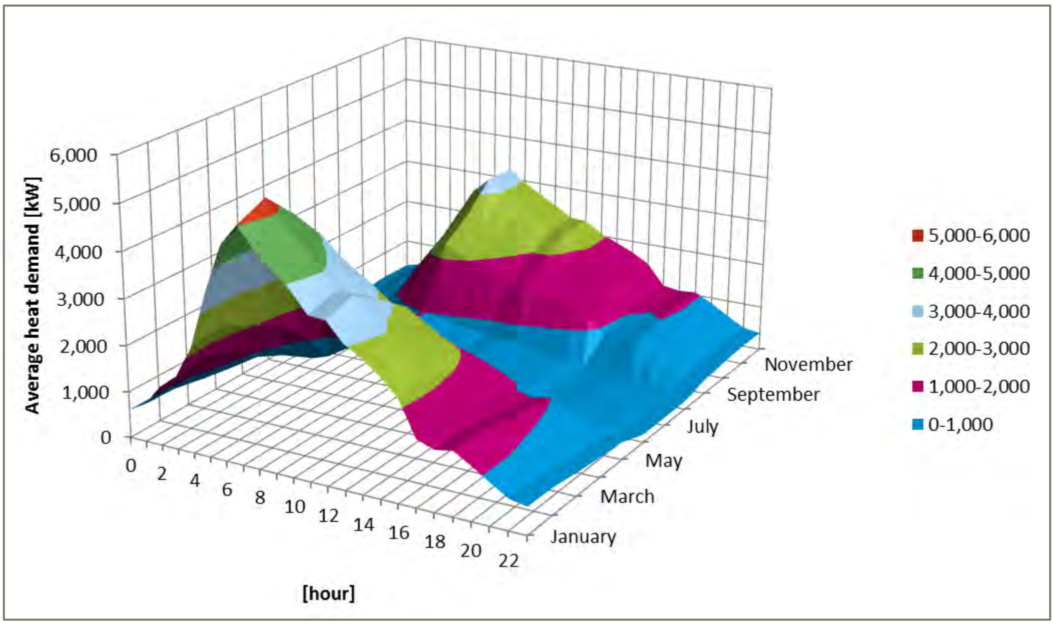


Figure 32: PS001 Daily Average Heat Demand Profile

5.1.2 Electricity Demand Assessment

As no predicted half hourly data was available from the Developer at the time of writing, a likely daily electricity profile was constructed based on actual half hourly data profiles obtained from Ramboll's other Local Authority masterplanning projects. Given that PSV2 is predominantly made up of public offices and educational facilities, the profile was taken from a similar large public facility.

The profile was then scaled in accordance with the difference in total electricity demand of the PSV2 offices/Council buildings and the sample building. The weekday profile is shown in Figure 33.

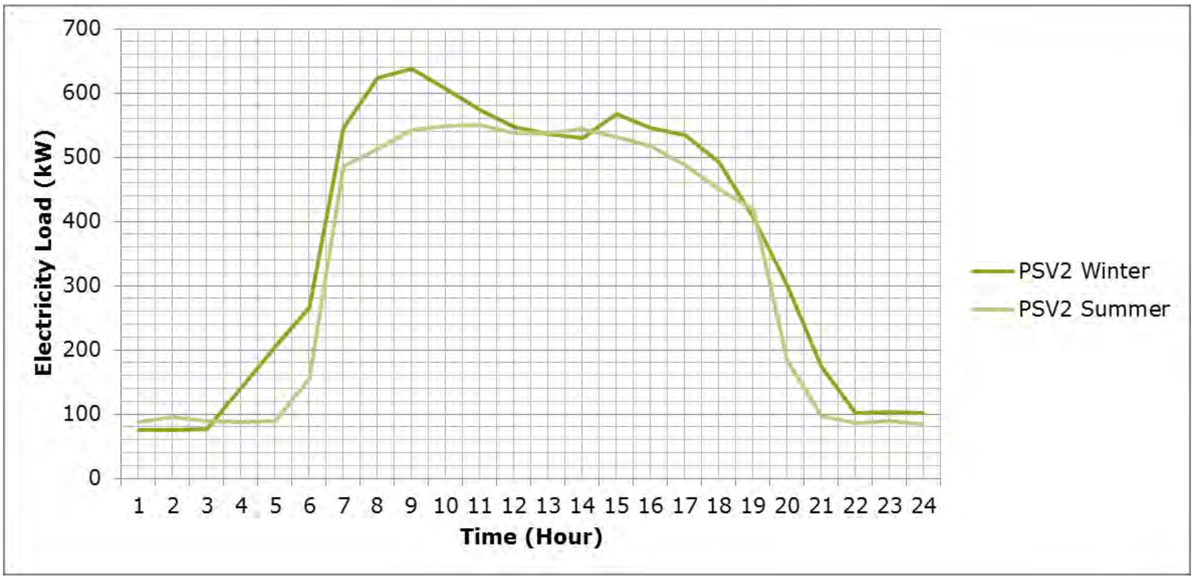


Figure 33: Predicted Daily Electricity Profile for PSV2 Offices and Council Buildings

The profile shows a steady daytime load of over 500 kW and an overnight base load of approximately 80 kW.

A similar exercise for the residential student accommodation was also carried out based on Ramboll's database of building energy profiles and the estimated magnitude of electricity demand obtained through benchmarking in section 2.4.

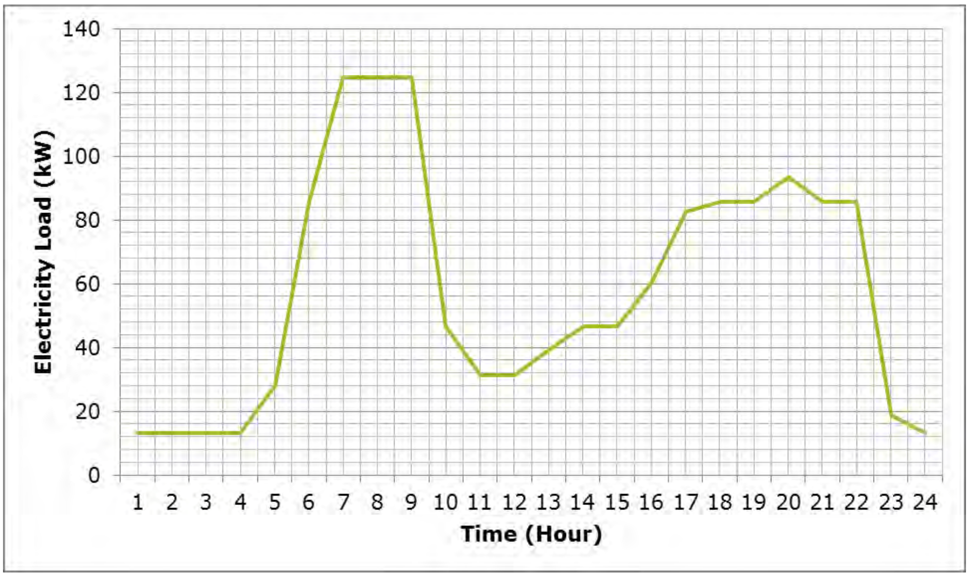


Figure 34: Predicted Daily Electricity Profile for Student Accommodation

The profile features more peaks than that of the office buildings. The morning peak is seen to be in excess of 120 kW. The overnight base load is estimated to be just 12 kW.

5.2 Heat Network Infrastructure

Hydraulic modelling was carried out for the three proposed heat network routes using Ramboll's in-house software, System Rørnet (SR).

The key inputs considered were:

- pipe length
- topography
- temperature
- pressure
- peak load conditions.

Table 26 presents the assumptions regarding network temperatures. In designing a district heating network it is common practice to maximise the temperature differential (ΔT) between the flow and return system as the diameter of the pipes is approximately inversely proportional to the square root of the ΔT. Thus the greater the ΔT, the smaller the pipes and the lower the capital cost.

Design Parameter	Value	Comment
Primary flow temperature at design condition	95°C	This is achievable from a CHP engine or biomass boiler with support from peaking boilers.
Primary return temperature for new developments at design condition	50°C	Assumes design return temperature that can be achieved from a new development is 40°C with 5°C margin applied.
Primary return temperature for existing buildings at design condition	65°C	Assuming design return temperature that can be achieved from an existing building is 60°C with retrofitting and rebalancing of existing systems.

Table 26: Heat Network Design Temperatures

The ΔT between the flow and return temperatures when supply to existing buildings was assumed to be 30 °C. The ΔT for new developments was assumed to be 45 °C.

A pipework pressure rating of 10 bar_g has been assumed, giving an allowable pressure drop of around 8 bar_g through the system, assuming a 2 bar_g static head.

Network diagram outputs from the SR program and pipe schedules are shown in the sub-sections below for each scenario. It should be noted that at this stage the draft network routes from the Opportunity Identification phase were refined and updated; therefore there is some variation between the values.

It was assumed that all routes would incur 100% hard dig/suburban civils costs. There may be potential to combine the heat network installation with other utilities in the case of the PSV2 site, which would lead to lower capital costs. However, in order to remain conservative at this high level, the full estimated civils and pipe costs were included.

Capital cost estimates for pipes and installation were based on a database provided by DH supplier Logstor on a per m basis for the full range of estimated sizes.

5.2.1 PS001a & PS001b

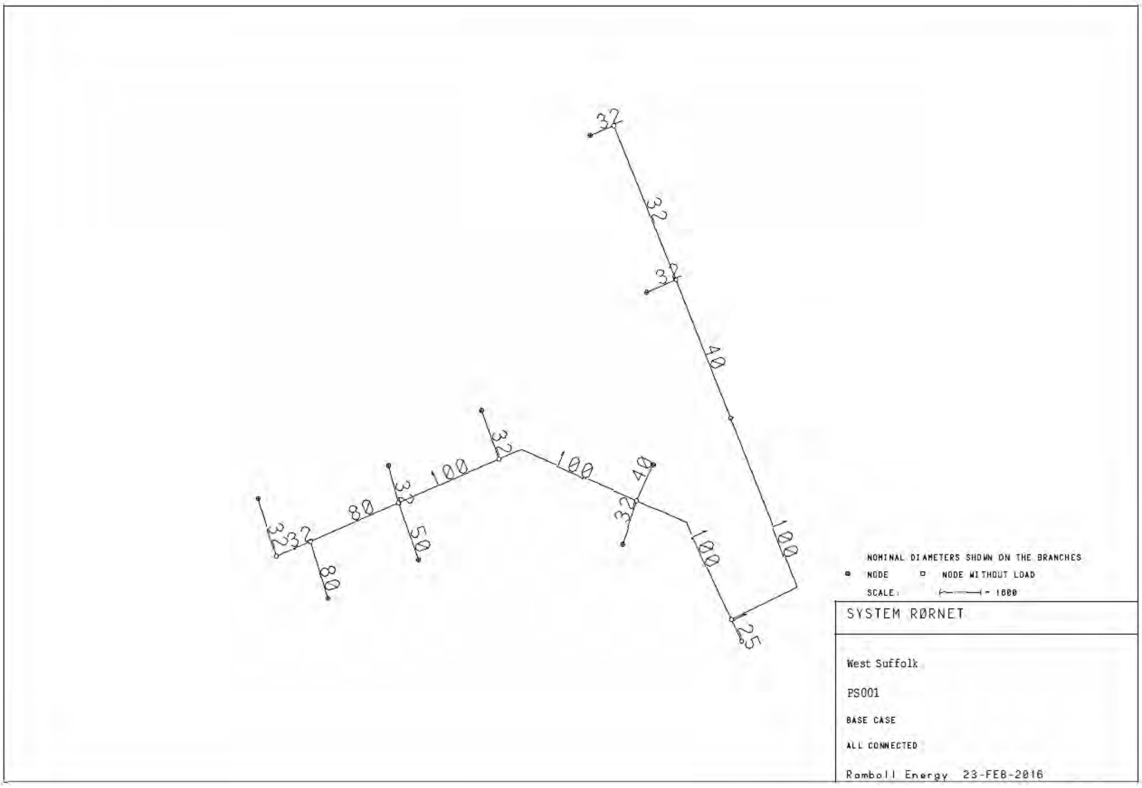


Figure 35: SR Network Diagram for PS001

DN	Pipe Length (m)
32	179
40	74
52	24
80	114
100	264
125	9
Total	**664**

Table 27: PS001 Pipe Schedule

5.2.2 PS002a & PS002b

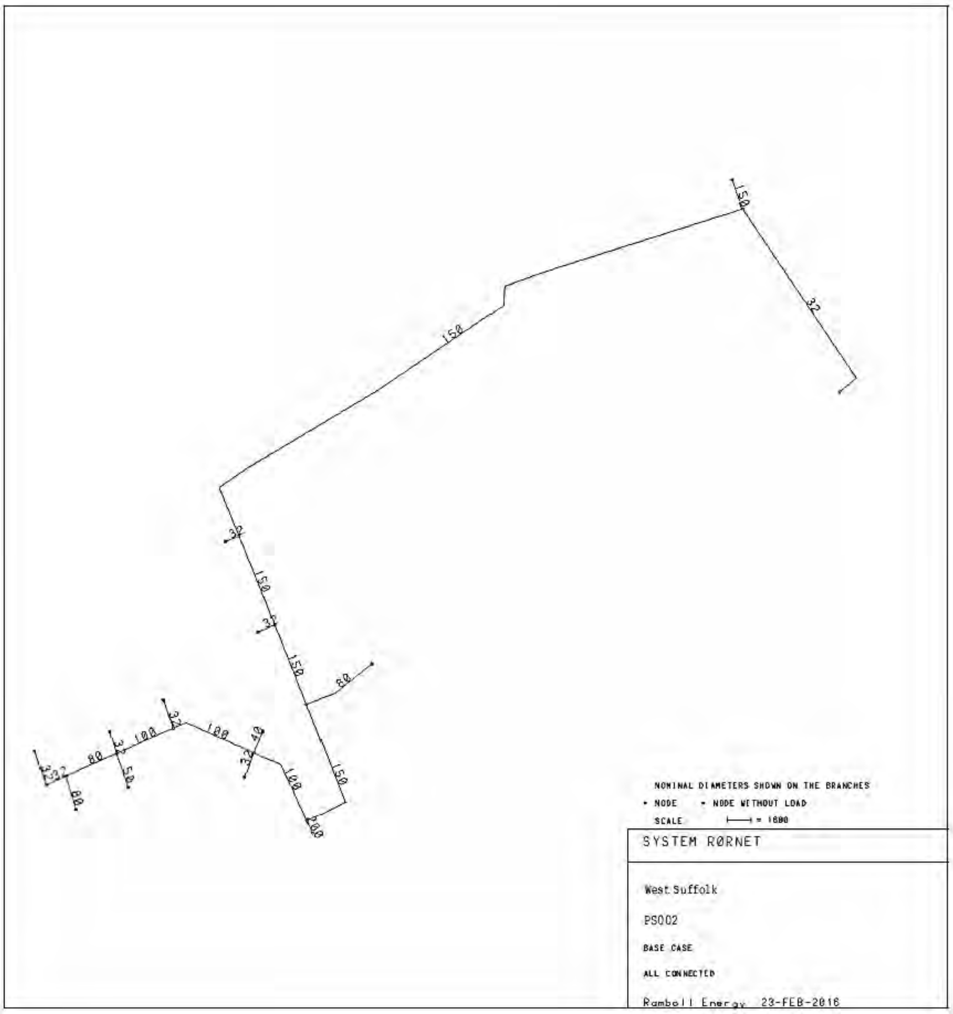


Figure 36: Network Diagram for PS002

DN	Pipe Length (m)
32	267
40	16
52	24
80	114
100	165
125	0
200	691
Total	**1,277**

Table 28: PS002 Pipe Schedule

5.2.3 PS003

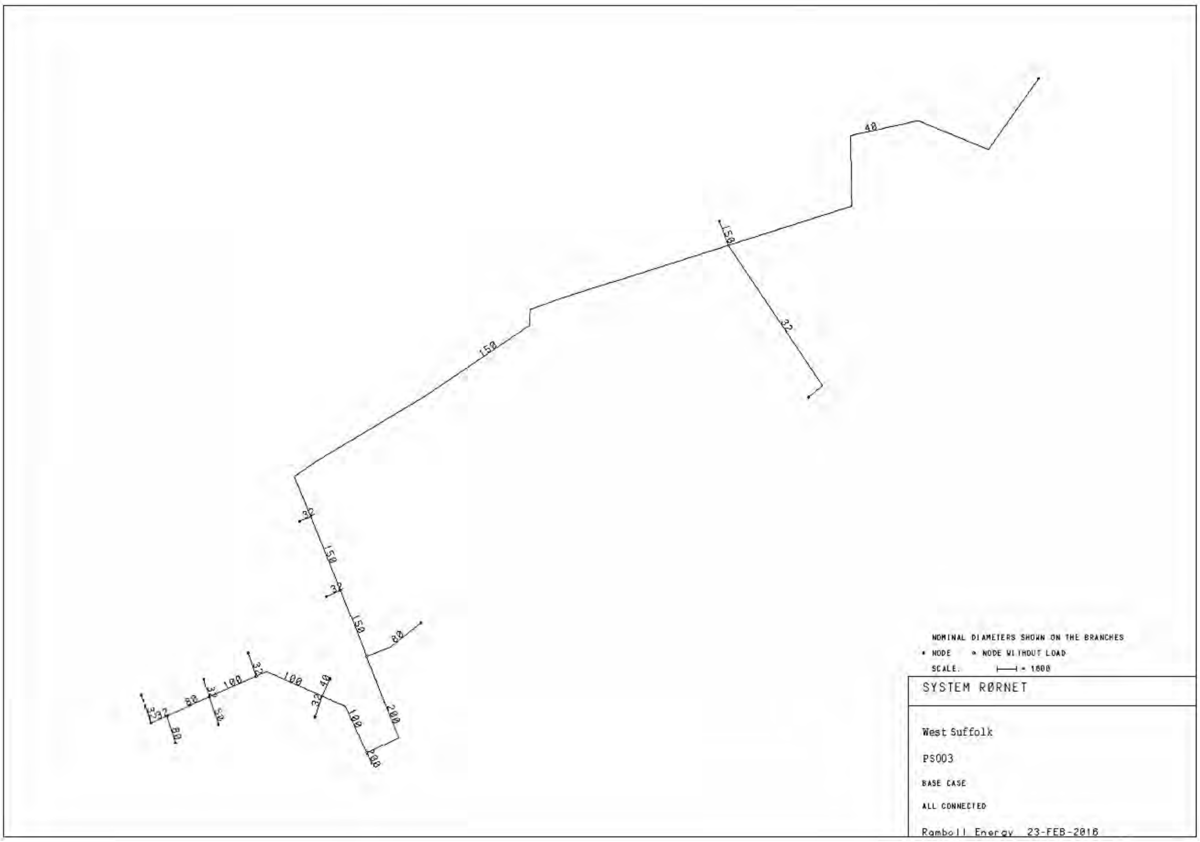


Figure 37: Network Diagram for PS003

DN	Pipe Length (m)
32	267
40	370
52	24
80	114
100	165
125	0
200	592
Total	**1,532**

Table 29: PS003 Pipe Schedule

5.2.4 Pipework Selection

District heating systems can employ a number of different pipe systems ranging from rigid steel pipes to flexible plastic produced as a pre-insulated bonded pipe system. Pipe systems have developed significantly over the last 30 years and now European standards for their construction (EN253) and installation (EN13941) are in place to ensure that the highest quality pipe systems are developed.

Figure 38: Rigid Steel Pipes for District Heating (Ramboll Image Bank)Different insulation options (typically "Series 1 to 3") are available and the selection is usually made on the basis of a cost benefit analysis at the design stage.

For the purpose of this study, Series 2 steel pipework was assumed in all cases for the techno-economic modelling.

The estimated heat losses as a percentage of annual heat demand at full network build out are presented in Table 30.

Scenario(s)	Heat Losses[18]
PS001a and PS001b	5%
PS002a and PS002b	4%
PS003b	4%

Table 30: Estimated Network Heat Losses

5.2.5 Accumulator Storage

Thermal stores were included as part of the techno-economic model in each scenario. Accumulator thermal storage can provide significant operational benefits to gas engine CHP and biomass schemes. It will be used to enable more efficient use of the primary supply assets and a greater amount of heat to be utilised.

The sizing of accumulators depends on the trade-off between capital and operational costs. The modelling carried out at masterplanning stage assumed that the thermal stores would be able to supply a total heat capacity equivalent to 2.5 hours of the primary supply asset running at full output. For example a 500 kW_{th} CHP engine would require a thermal store to supply 1,250 kWh of heat.

The accumulator volume associated with the required capacity in each case is dependent on the temperature difference across the network. Further work will be required at the design phase to optimize accumulator sizing.

[18] As a percentage of annual heat demand, not heat generated.

Thermal storage may be located within the energy centre building itself or as external standalone tanks. In this case, should the plant be located within the PSV2 car park, it is likely that the preferable solution will be to locate the thermal stores outside the main energy centre, adjacent to the car park.

5.2.6 Consumer Connections

Existing buildings and new single building developments can connect directly into the network. At such time, the heat network will connect into these buildings displacing or complementing the existing LTHW boilers in operation. Connection will take place at the point of supply from the existing LTHW boilers.

For the new buildings within PSV2, connection to a heat network can either be made directly (without heat exchanger stations) or indirectly (with heat exchanger stations) to the network. Direct connection offers a number of technical advantages and typically requires lower capital expenditure. However, it requires connecting customers’ systems to be designed to withstand prevailing operating pressures in the network and introduces the risk of leakages and contamination. It also complicates the contractual demarcation of ownership and operation. Indirect connections using HIUs are expected to be the predominant form of connection for this scheme and are the basis of the modelling assumptions used in this report

For West Suffolk House, the Leisure Centre and schools, the choice about whether to retain existing boilers and under whose ownership and control this should reside, is a matter of negotiation. The analysis presented in this report assumes that connecting customers do not maintain and operate existing boilers as back up to the heat network. This is considered to be the best practice approach for a scheme of this scale.

Allowing customers to keep and maintain their own boilers means that the district heating operator will not have control over plant that is impacting on their operation. Thus the operator would be carrying the risk that individual boilers will be incorrectly operated, controlled and maintained, leading to possible localised outages potentially higher return temperature than originally designed for. Additionally there is a risk that local boilers displace demand (and therefore reduce heat sales to the network operator) due to incorrect operating strategies being employed.

Heat sales will be metered at the point of connection through newly installed heat meters. These are typically located on the primary side of the connection.

5.2.6.1 Technical Safeguarding Measures

St Edmundsbury Borough Council should use any available planning power to require identified future customers to safeguard for future connection into a heat network by implementing a series of future proofing measures where feasible.

These measures may include factors such as:

- Wet centralised heating systems
- design of internal heating systems to operate at lower temperatures to ensure a low return temperature to the main network (low temperature radiator systems or underfloor heating)
- Allocation of space within plant rooms heat exchanger

5.2.6.2 Reducing Network Temperatures

A strategy for implementing measures to reduce building wet heating system operating temperatures should be implemented over the coming years, alongside development of the heat network.

This would help to reduce heat network losses, reduce pumping energy requirements and, if planned ahead of construction, could become a way of safeguarding capacity in the system without having to oversize the network from the outset.

The assumed flow/return temperatures for the network to and from existing buildings at this stage of analysis were assumed to be 95/65 °C. However, ideally over time through improvements to the secondary systems, the return temperature would be brought down to 55 °C in accordance with "best practice" guidelines in the CoP.

5.3 Energy Supply Assets

Two primary supply technologies were considered as part of the detailed modelling. The sub-sections below present the required sizing of the supply assets for each scenario, the corresponding costs and also the key practical considerations.

5.3.1 Overarching Assumptions

There are a number of overarching assumptions for each case:

The **"Business as Usual"** (**BaU case)** is inputted into the model for each customer type in order to calculate the relative CO_2 savings of the DH scenario. Table 31 shows the assumptions made for three main customer types.

Customer Type	BaU Case
Existing non-residential buildings where heating system info is available	Assume current system remains in place for foreseeable future. Where boiler efficiency is unknown assume 85%.
Existing non-residential buildings where heating system info is not available	Assume individual gas boilers with an efficiency of 85%.
New non-residential developments	Assume Regeneration Area uses individual gas boilers or a community heating system fed by gas boilers of 90% efficiency in either case.
New residential developments	Assume individual gas boilers with an efficiency of 85%.

Table 31: BaU Cases for Different Building Types

In each case the first operational year of the project is taken to be 2018, as this is the estimated earliest date that the project could be initialised. This assumption is based on discussions with the Council, taking into account all project development stages such as detailed feasibility, outline design, tender procurement and negotiation, contractor mobilisation etc.

It should be noted that specific cost quotations were not obtained for this analysis. The assumed **capital costs** were based on Ramboll's database of historic supplier data[19] and benchmarking and it is recommended that a cost consultant be commissioned to conduct a detailed evaluation of project costs.

It was assumed that the costs of construction for the **plant room/energy centre** at the PSV2 car park would be absorbed into the development costs (as it would be required in any case) and they are therefore not included in the capital costs for any scenario. The stated "energy centre and plant" costs for each option include major plant items, other equipment (pumps, heat exchangers, etc.) and balance of plant.

The BaU cost of gas in all cases was assumed to be the average value observed in the Bury St Edmunds billing data which was calculated to be 4.2 p/kWh. The **cost of heat** from each supply

[19] Detailed costing assumptions are presented in Appendix 2.

asset is based on this value with an applied boiler efficiency of 80% and was found to be 5.26 p/kWh.

Reinvestment costs for each system were also included in the model. They are based on Ramboll's previous experience on existing projects in the UK and Denmark. Plant reinvestment costs have been calculated based on:

- 50% reinvestment over a 20 year reinvestment cycle for the gas boilers
- 75% reinvestment over a 15 year reinvestment cycle for the CHP engines
- 50% reinvestment over a 20 year reinvestment cycle for the biomass boilers

Reinvestment for the balance of plant is assumed to be covered under the ongoing operation and maintenance costs.

The **electricity costs** were taken from DECC's most recently published energy price figures[20].

The **cost of gas** figures for the CHP cases and for the top up boilers were taken from DECC's most recently published energy price figures[21].

The **cost of wood chip** was taken to be £110 per tonne, which is representative of typical values provided by suppliers on a range of biomass projects.

The **sale price of heat** from each supply asset is based on the BaU gas value with an applied boiler efficiency of 80%. 5% of the cost was deducted to represent an incentive against the BaU. Avoided boiler maintenance and replacement costs were accounted for at a rate of 0.15 p/kWh. The resulting heat sale prices for each customer type were as follows:

- 5.23 p/kWh for buildings within the PSV2 development
- 5.23 p/kWh for schools
- 5.8 p/kWh for the Leisure Centre
- 7.7 p/kWh for new residential[22].

The **sale price of electricity** in the CHP cases is assumed to be 12 p/kWh and 4.5 p/kWh for private wire and grid sale respectively. The proportion of electricity private wired was estimated using the estimated electricity profiles shown in section 5.1.2 and the price was an average figure taken from the Council's billing data. The grid sale price is based on the Ofgem export tariff.

RHI revenue is set in accordance with 2016 tariffs[23]. In the first instance the 2016 tariff values are applied to the first 20 years of each of the relevant modelling scenarios. As part of the sensitivity analysis degression of the RHI over time is assessed.

Carbon emissions factors were taken from DECC's most recently published figures[24]. Gas was assumed to have a constant emissions factor of 0.184 kg.CO_2/kWh. Electricity was assumed to change over time in accordance with DECC's estimates, starting with a generation-based grid average value of 0.27 kg.CO_2/kWh in the first operational year of 2018.

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[20] DECC, "Gas and electricity prices in the non-domestic sector", https://www.gov.uk/government/statistical-data-sets/gas-and-electricity-prices-in-the-non-domestic-sector

[21] DECC, "Gas and electricity prices in the non-domestic sector", https://www.gov.uk/government/statistical-data-sets/gas-and-electricity-prices-in-the-non-domestic-sector

[22] Calculated based on the avoided cost of gas (including maintenance and annual replacement), with an incentive of 5%. BaU residential costs were obtained through USwitch website, https://www.uswitch.com/.

[23] Ofgem, "Tariffs that apply for Non-Domestic RHI for Great Britain", https://www.ofgem.gov.uk/environmental-programmes/non-domestic-renewable-heat-incentive-rhi/tariffs-apply-non-domestic-rhi-great-britain

[24] Table 1 and Table 2a. https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

5.3.2 PS001a – PSV2 Development Only with Gas CHP

As outlined in section 4.3, scenario PS001a considers a heat network supplying the PSV2 site only. The total annual heat demand at full build out was estimated to be 2,974 MWh with a diversified peak heat load of 1.6 MW.

It was assumed that the development connects to the network in two phases to represent the phased construction of the site. At the time of writing, PSV2 was expected to come forward in four phases as shown in Figure 8. It was assumed from the scale of development that it was reasonable to divide this into two construction phases, with the first being available for connection to a heat network in 2018.

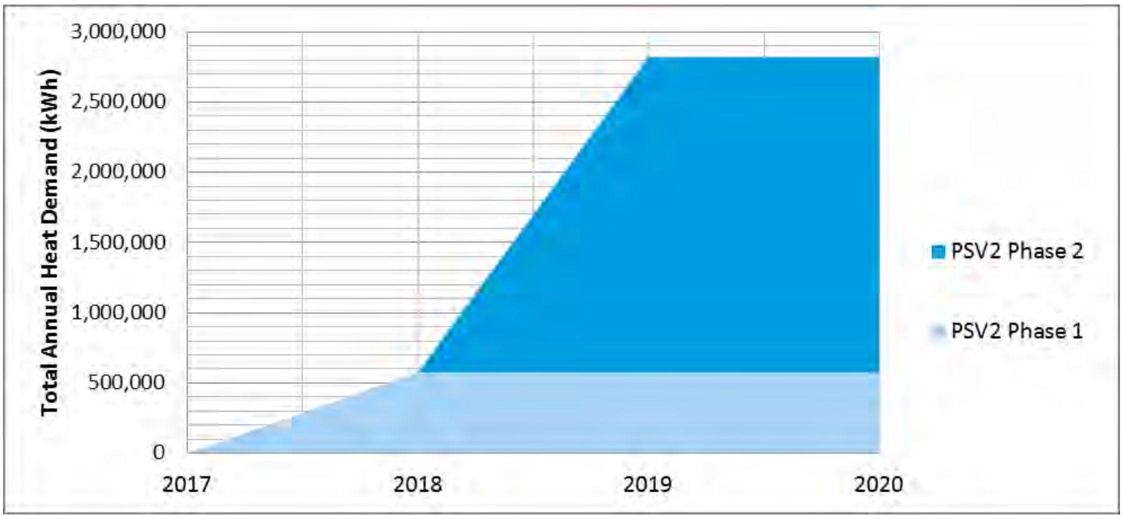

Figure 39: Heat Demand Phasing for Scenario PS001a

The CHP size was established to deliver a total contribution of at least 60% of the annual heat load, whilst achieving a minimum number of running hours of approximately 4,500 peak load hours per annum.

Table 32 shows the plant sizing for this scenario at full build out. The gas boiler capacity is such that there is sufficient back-up capacity included if the CHP and/or boilers should fail or be offline for maintenance. This capacity typically equates to approximately 1.2 times the peak heat load.

Item	Size
CHP Capacity	834 kW_{th}
Gas Boiler Capacity	1,920 kW_{th}
Thermal Store Capacity	2 MWh, 70 m^3

Table 32: Plant Sizing for PS001a

The contribution of the CHP engine and boilers to the heat demand for a sample week in January is shown in the figure below. The thermal store is not shown on the graph due to the fact that it acts to store and release energy, but it is not a supply asset.

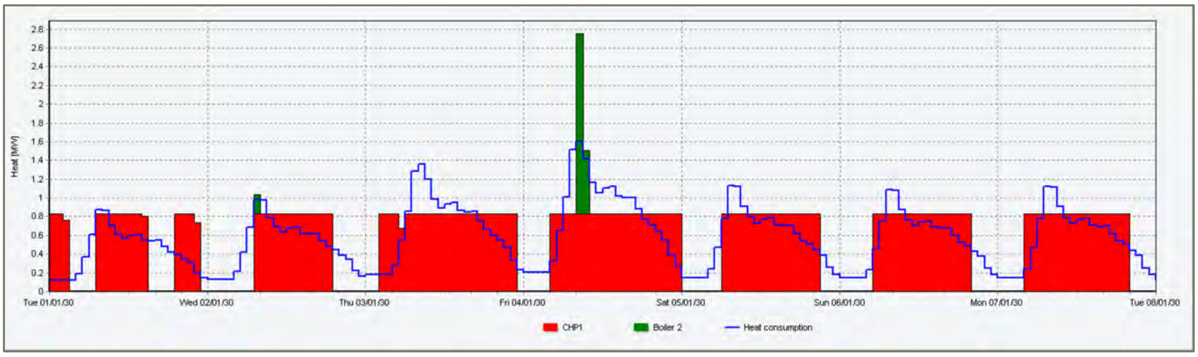

Figure 40: Example Weekly Profile of Supply Asset Contributions

The graph shows that during the winter the CHP engine is contributing almost all of the heat, with the exception of the highest peak times where the boilers fire up and charge the thermal store.

Figure 41 demonstrates the operation of the thermal store for the same week in January.

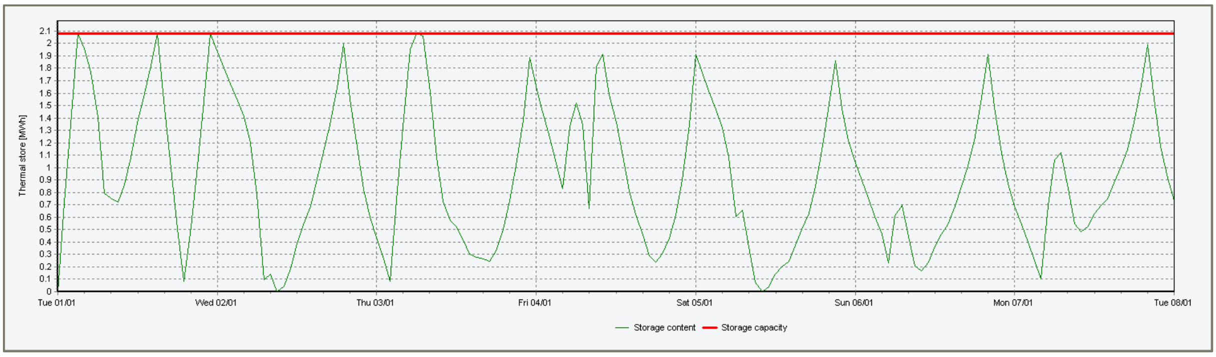

Figure 41: Example Week Operation for Thermal Store

A breakdown of the capital cost estimates are shown in Table 33. It should be noted that due to the improved accuracy of the heat demand profiles at this stage in comparison to the opportunity identification, the sizing and therefore cost of the plant and energy centre is different to those presented in section 4.

Item	Cost
Energy Centre and Balance of Plant	£448 K
Plant Items (CHP, boilers, etc.)	£631 K
Thermal Store	£65 K
Network and Connections	£355 K
Contractor and Design	£225 K
Total	**£1,724 K**

Table 33: CAPEX Breakdown for PS001a

The operational cost considerations for this scenario consist of the gas cost and on-going O&M. Annual O&M for the CHP was included at just over £27 K per annum.

Revenues are obtained through the sale of heat and electricity. The overall average electricity sale price per unit in this case was calculated to be 10.5 p/kWh, taking into account the prices stated in section 5.3.1 and the expected proportion of electricity private wired vs. grid sale.

5.3.3 PS001b - PSV2 Development Only with Biomass

The network phasing and heat loads in this case were the same as PS001a, outlined in section 5.3.2.

The model was run at numerous biomass capacities to establish the preferred option. It is recommended that full optimisation is conducted at feasibility stage once the PSV2 design has been confirmed.

Table 34 shows the technology sizing for this scenario:

Item	Size
Biomass Boiler Capacity	999 kW_{th}
Gas Boiler Capacity	1,920 kW_{th}
Thermal Store Capacity	2.5 MWh, 84 m^3

Table 34: Key Parameters for PS001b

The contribution of the biomass boiler to the heat demand for a sample week in January is shown in the figure below. The thermal store is not shown on the graph due to the fact that it acts to store and release energy, but it is not a supply asset.

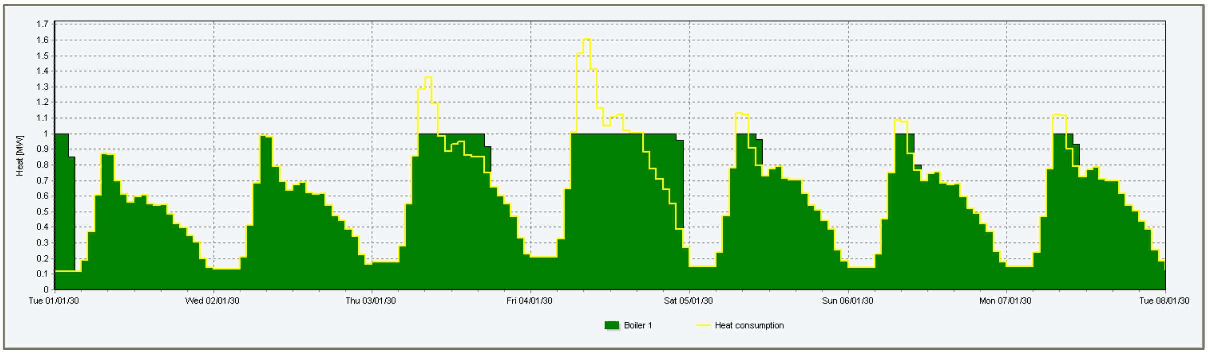

Figure 42: Example Weekly Profile of Supply Asset Contributions

A breakdown of the capital cost estimates are shown in Table 35.

Item	Cost
Energy Centre and Balance of Plant	£448 K
Plant Items (boilers, etc.)	£868 K
Thermal Store	£70 K
Network and Connections	£355 K
Contractor and Design	£260 K
Total	**£2,000 K**

Table 35: CAPEX Breakdown for PS001b

The operational cost considerations for this scenario consist of the gas cost and on-going O&M. Annual O&M for the energy centre and plant was included at just under £6 K per annum.

Revenues are obtained through the sale of heat and the RHI.

5.3.4 PS002a - PSV2 Development, Leisure Centre and Schools with Gas CHP

As outlined in section 4.3, scenario PS002a considers a heat network supplying the PSV2 site with an immediate extension to two schools, followed by a connection to the Leisure Centre following the expiry of its current energy contract.

The total annual heat demand was estimated to be 11,100 MWh with a diversified peak heat load of 8.5 MW.

The phased annual energy demands are shown in Figure 43.

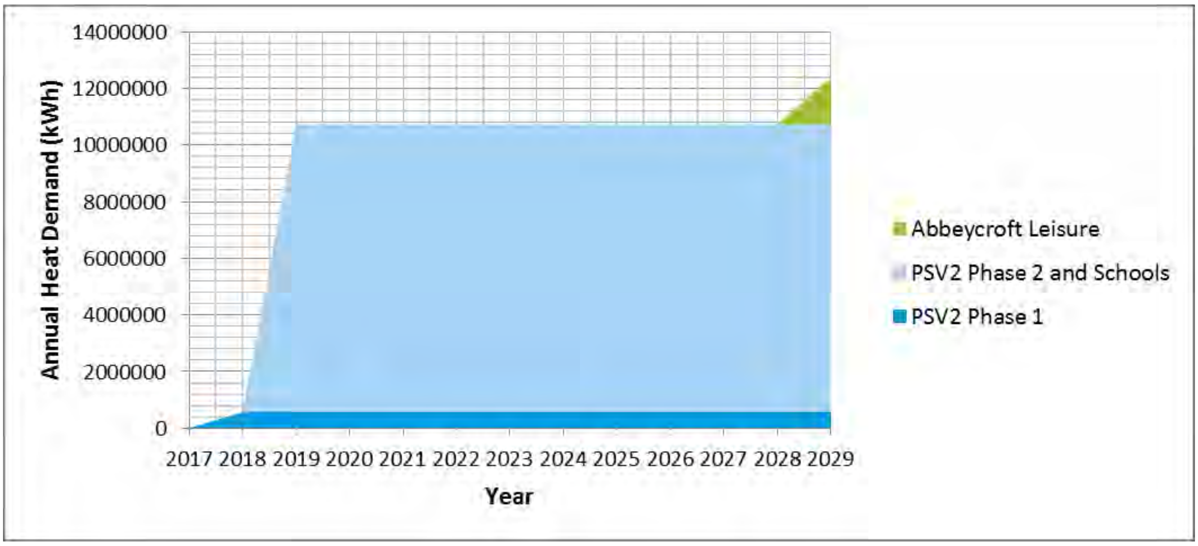

Figure 43: Heat Demand Phasing for Scenario PS002a

Table 36 shows the technology sizes for this scenario:

Item	Size
CHP Capacity	1,677 kW_{th}
Gas Boiler Capacity	10,200 kW_{th}
Thermal Store Capacity	4 MWh, 141 m^3

Table 36: Key Parameters for PS002a

The contribution of the CHP engine and boilers to the heat demand for a sample week in January is shown in the figure below. The thermal store is not shown on the graph due to the fact that it acts to store and release energy, but it is not a supply asset.

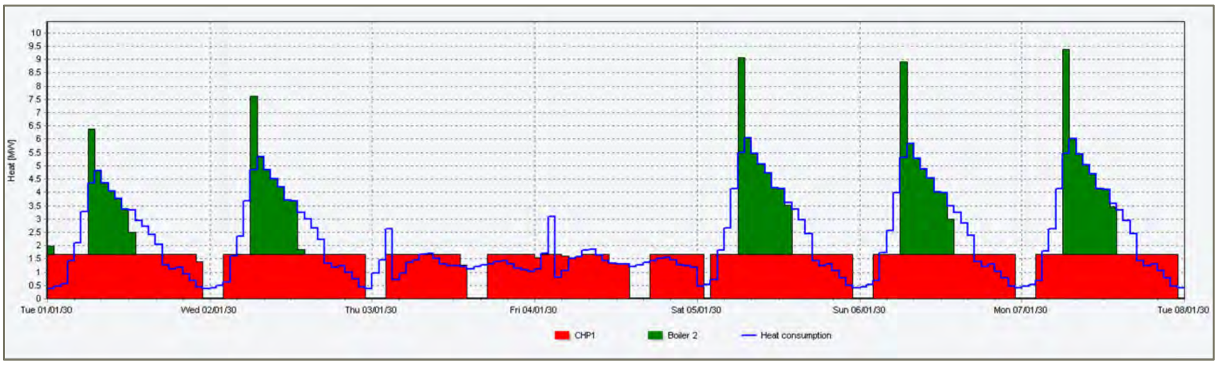

Figure 44: Example Weekly Profile of Supply Asset Contributions

Figure 45 demonstrates the operation of the thermal store for a week in January.

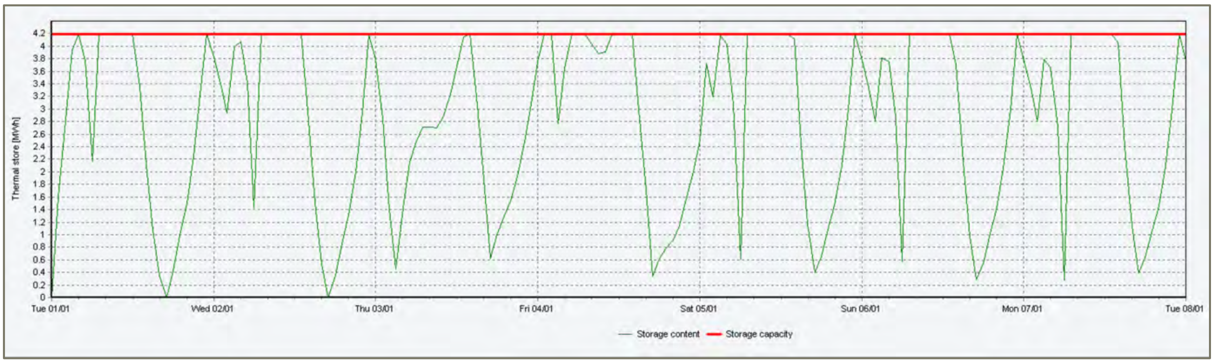

Figure 45: Example Week Operation for Thermal Store

A breakdown of the capital cost estimates are shown in Table 37.

Item	Cost
Energy Centre and Balance of Plant	£840 K
Plant Items (CHP, boilers, etc.)	£1,060 K
Thermal Store	£100 K
Network and Connections	£990 K
Contractor and Design	£450 K
Total	**£3,440 K**

Table 37: CAPEX Breakdown for PS002a

The operational cost considerations for this scenario consist of the gas cost and on-going O&M. Annual O&M for the energy centre and plant was included at just over £78 K per annum at full build out.

Revenues are obtained through the sale of heat and electricity. The overall average electricity sale price per unit in this case was calculated to be 7.4 p/kWh. This takes into account the prices stated in section 5.3.1 and the expected 34% proportion of electricity supplied via private wired vs. grid sale.

5.3.5 PS002b - PSV2 Development, Leisure Centre and Schools with Biomass

Scenario PS002b includes the same heat loads and phasing as outlined in section 5.3.4. The primary supply asset in this case is a heat only biomass boiler.

Table 38 shows the key operating parameters of this scenario:

Item	Size
Biomass Boiler Capacity	999 kW_{th}
Gas Boiler Capacity	10,200 kW_{th}
Thermal Store Capacity	2.5 MWh, 84 m^3

Table 38: Key Parameters for PS002b

The contribution of the biomass boiler and gas boilers to the heat demand for a sample week in January is shown in the figure below. The biomass boiler contributes approximately 58% of the total heat demand, which is considered to be low for this technology. However, at the time of writing a biomass capacity above 999 kW was eligible for considerably less RHI revenue than smaller boilers. Therefore increasing the size of the boiler was found to have a negative effect of the economic results.

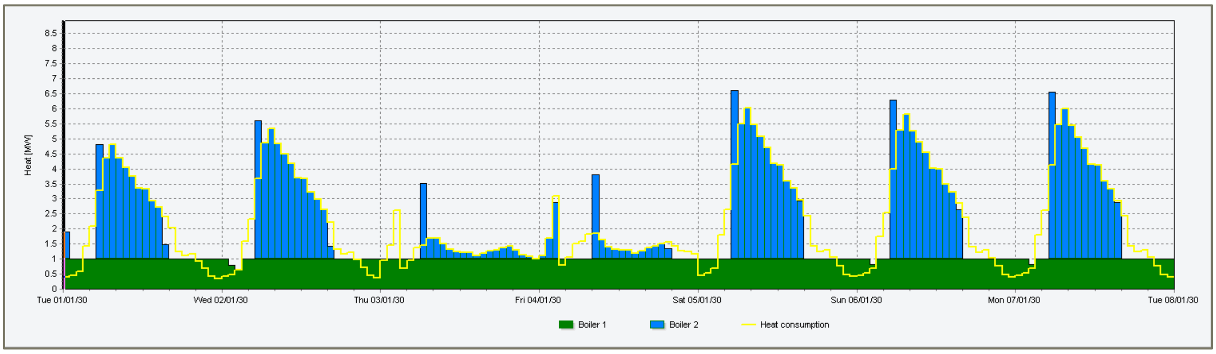

Figure 46: Example Weekly Profile of Supply Asset Contributions

Figure 47 demonstrates the operation of the thermal store for the same week in January.

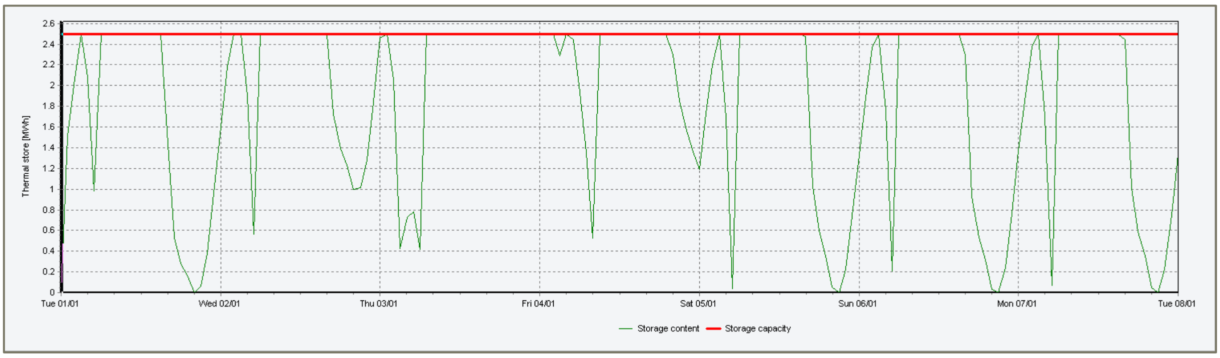

Figure 47: Example Week Operation for Thermal Store

A breakdown of the capital cost estimates are shown in Table 39.

Item	Cost
Energy Centre and Balance of Plant	£820K
Plant Items (boilers, etc.)	£1,080
Thermal Store	£70 K
Network and Connections	£990 K
Contractor and Design	£440 K
Total	**£3,400 K**

Table 39: CAPEX Breakdown for PS002b

The operational cost considerations for this scenario consist of the gas cost and on-going O&M. Annual maintenance costs for the energy centre and plant were included at just under £6 K per annum.

Revenues are obtained through the sale of heat and the RHI.

5.3.6 PS003 - PSV2 Development, Leisure Centre, Schools and New Residential Development with Biomass

In the final scenario, the scheme extends beyond the schools to include the planned residential development to the north east of the core network.

The annual heat demand at full build out was found to be 13,800 MWh with a diversified peak heat load of 8.9 MW. Figure 48 shows the phased annual heat demand of the network.

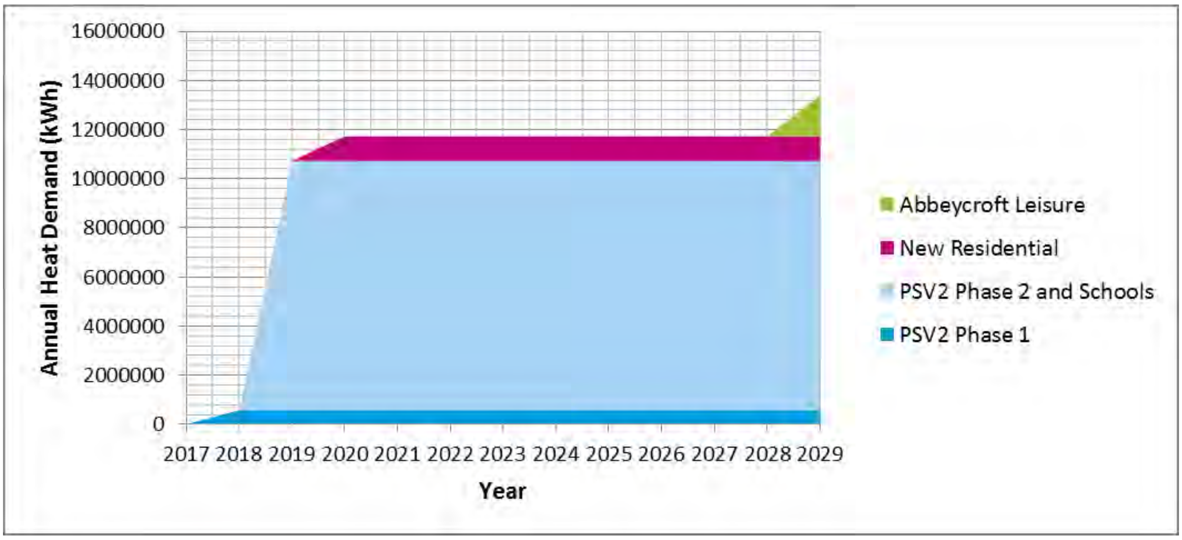

Figure 48: Heat Demand Phasing for Scenario PS003

Table 40 shows the sizing for the key plant items in this scenario:

Item	Size
Biomass Boiler Capacity	999 kW_{th}
Gas Boiler Capacity	10,680 kW_{th}
Thermal Store Capacity	9 MWh, 294 m^3

Table 40: Key Parameters for PS003

The contribution of the biomass boiler to the heat demand for a sample week in January is shown in the figure below. The thermal store is not shown on the graph due to the fact that it acts to store and release energy, but it is not a supply asset.

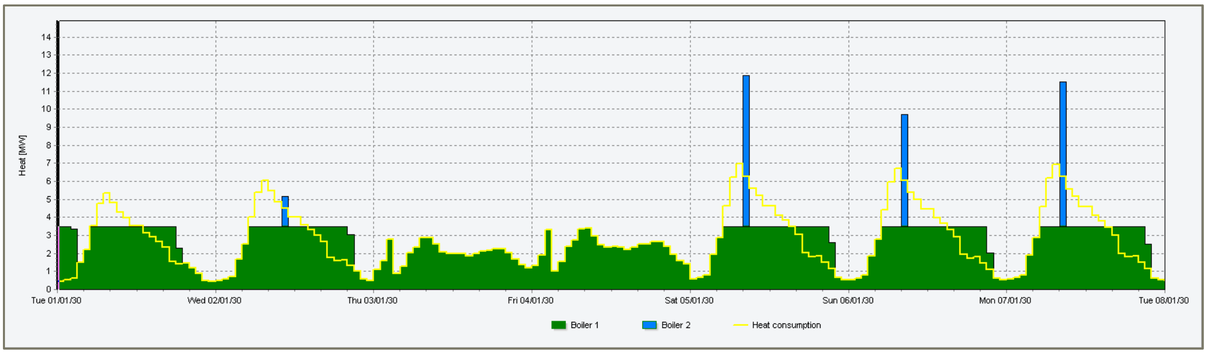

Figure 49: Example Weekly Profile of Supply Asset Contributions

A breakdown of the capital cost estimates are shown in Table 41.

Item	Cost
Energy Centre and Balance of Plant	£860 K
Plant Items (boilers, etc.)	£1,580 k
Thermal Store	£150 K
Network and Connections	£1,160 K
Contractor and Design	£560 K
Total	**£4,300**

Table 41: CAPEX Breakdown for PS003

5.4 Modelling Results

As previously stated, the techno-economic analysis was conducted using EnergyPRO software. A model was built for each of the five energy supply options.

The schemes were assessed in relation to three economic key performance indicators:

- **Internal Rate of Return (IRR)** – indicates the economic attractiveness of a scheme as it represents the interest rate at which the net present value of the cash flow equals zero.
- **Net Present Value (NPV)** - compares the amount invested to the future cash amounts after being discounted by specific rates of return (3.5%, 6% and 10%).
- **Annual operating margin** – the annual net cash flow for a particular year.

Each of these factors was considered over a 25 and 40 year project lifetime.

Additionally, the CO_2 savings were a project key performance indicator to enable the comparison of the environmental benefit associated with each scenario.

5.4.1 Economic Assessment

Table 42 presents the total lifetime capital expenditure (incl. REPEX) and IRRs for all scenarios over 25 and 40 year project lifetimes.

Opportunity	CAPEX 25 yrs	IRR 25 yrs	CAPEX 40 yrs	IRR 40 yrs
PS001a	£2.1 M	4.9%	£2.5 M	6.4%
PS001b	£2.4 M	0.5%	£2.4 M	1.5%
PS002a	£4.0 M	1.4%	£4.6 M	3.7%
PS002b	£3.9 M	4.5%	£3.9 M	5.4%
PS003	£5.3 M	5.0%	£5.3 M	5.9%

Table 42: CAPEX and IRRs for All Scenarios

The NPV for 25 and 40 year project lifetimes at a range of discount rates is shown in Table 43.

	Discount Rate	PS001a	PS001b	PS002a	PS002b	PS003
25 Yr	**3.5%**	£267 K	-£497 K	-£787 K	£368 K	£722 K
	6%	-£175 K	-£788 K	-£1,430 K	-£445 K	-£434 K
	10%	-£618 K	-£1,110 K	-£2,060 K	-£1,330 K	-£1,630 K
40 Yr	**3.5%**	£817 K	-£394 K	£91 K	£901 K	£1,530 K
	6%	£541 K	-£741 K	-£1,020 K	-£218 K	-£57 K
	10%	£77 K	-£1,090 K	-£1,930 K	-£1,250 K	-£1,520 K

Table 43: NPVs at Various Discount Rates

The results show that the PS001a scenario, gas CHP supplying the PSV2 site, produces an IRR of over 25 years exceeds the hurdle rate for public sector borrowing of 4% and is therefore considered to be viable.

Extending the PS001a CHP network to include the schools and eventually the Leisure Centre reduces the IRR to just 1.4% over 25 years and results in the project no longer being considered feasible. However, the scheme still achieves a positive rate of return and further investigation into conditions that might improve this case are presented in section 5.4.3.

When incorporating biomass as the primary supply opportunity, the economic results show the opposite pattern. The IRR was found to be below the hurdle rate for a PSV2 only network (scenario PS001b), but when extended to the schools, the IRR was found to increase to 4.6% over 25 years.

This pattern of results between CHP and biomass for PS001 and PS002 was found to be the same at the initial opportunities stage. The differences in patterns of results due to the extension, when considering the two supply technologies, is due to the primary revenue source in both cases. The CHP case benefits from heat sales and electricity revenues and when the scheme is extended the schools increase the total revenue by less than 30% (as they are not considered for private wire). This increase cannot compensate for the additional network CAPEX of £1.8 M.

However, in the biomass case, the increased heat sales are accompanied by a proportional increase in RHI revenue, doubling the annual revenue. This increase is sufficient to offset the additional CAPEX of £1.4 M and improves the IRR.

The extension to the planned housing development in the biomass case was found to increase the IRR slightly by 0.4% to 5.0% over the 25 year project lifetime. This result was believed to be heavily dependent on the assumption of developer contribution and participation and therefore the capital expenditure was explored in the sensitivity analysis.

It is noted that the values are less attractive than in the previous opportunity identification phase of the project in section 4. This is due to a number of changes that take place between the two methodologies primarily resulting from the hourly energy profiling and more detailed plant sizing exercise. This resulted in changes to capital and operational costs.

5.4.2 Carbon Savings Assessment

Table 44 presents the carbon savings for each scenario.

Opportunity	CO_2 Savings over 25 Yr Lifetime (tonnes)	CO_2 Savings over 40 Yr Lifetime (tonnes)	25 Yr Carbon Intensity (kg.CO_2/MWh)	25 Yr Cost of CO_2 Abatement[25] (£/tonne CO_2)
PS001a	26	-11,700	262	£80,800
PS001b	14,600	23,600	44	£164
PS002a	54	-37,500	269	NA
PS002b	34,800	57,300	131	£112
PS003	62,000	102,500	54	£85

Table 44: Carbon Results for All Scenarios

PS003 was found to generate the highest carbon savings due to the size of the scheme and use of biomass technology.

The results show that the natural gas CHP cases achieve relatively minor CO_2 savings over 25 years and negative savings over 40 years. This is due to recent carbon projections which predict a significant reduction in the benefits of gas CHP predominantly on account of decarbonisation of the electricity grid.

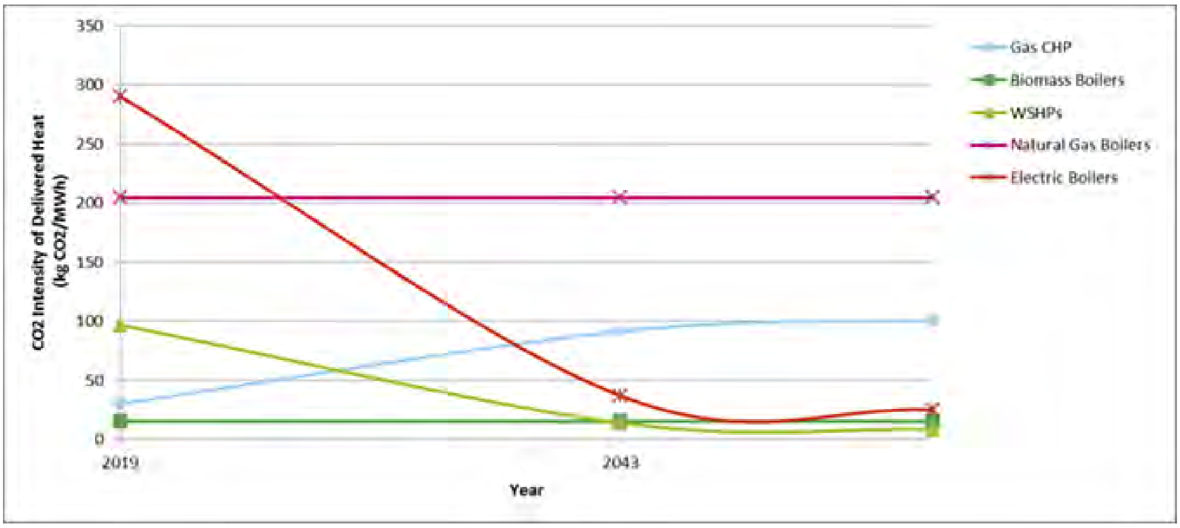

Figure 50: Carbon Emissions Projections for Various Supply Assets

The results suggest that whilst CHP is an effective initial start-up technology for a heat network, the operator might consider replacing it with a renewable technology once the plant has reached the end of its lifetime.

[25] Over 25 year lifetime

5.4.3 Sensitivity Analysis

The results of the PSV2 energy model are sensitive to a number of key assumptions. Consequently, the EnergyPRO model was re-run to assess the impact any changes of these key parameters on the economics of each option. The parameters assessed in the sensitivity analysis are discussed below.

5.4.3.1 Renewable Heat Incentive

There is currently uncertainty regarding the future of support for renewable heat technologies under the Renewable Heat Incentive. During the Governments Autumn Statement released on 25th November 2015 it was announced that the RHI scheme would be extended to 2020/21. However, the security of the current tariffs is still uncertain.

The economic success of biomass projects typically relies heavily on the availability of RHI revenue, therefore a detailed sensitivity analysis was carried out.

Firstly the best and worst cases were compared. These were considered to be the 2016 tariffs compared to no RHI whatsoever. The results are shown in Figure 51. The magenta bars show the IRR with no RHI revenue.

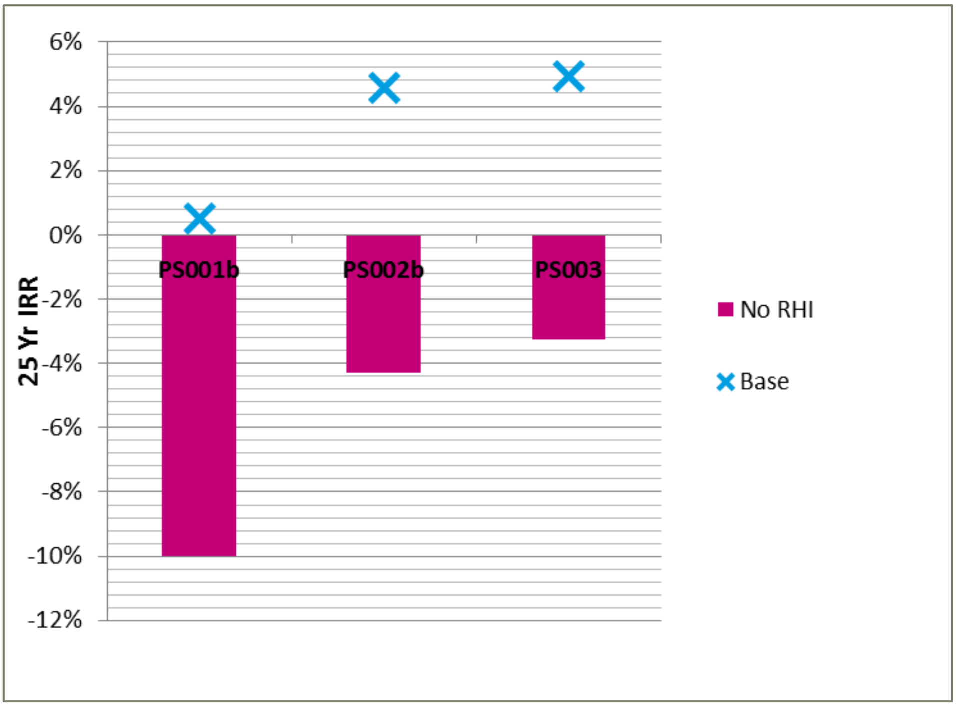

Figure 51: Sensitivity of Results to RHI (Worst Case)

The results show that in the absence of RHI revenue, none of the scenarios would be economically viable, or even achieve a positive IRR.

Given the dramatic difference in IRRs with and without RHI, the results were tested again with reductions in RHI revenue of 10% and 50%. The results for a 25 year project lifetime are presented in Table 45.

Scenario	Base Case IRR	-10 % RHI	-50 % RHI
PS001b	0.5%	-0.5%	-5.8%
PS002b	4.5%	3.8%	0.7%
PS003	5.0%	4.3%	1.4%

Table 45: Sensitivity of Results to RHI Reduction

The results show that a 10% reduction in the total annual RHI revenue reduces Scenario PS002b to a level which is just below the hurdle rate. PS003 is still considered to be viable at 4.3%.

A 50% reduction in total RHI revenue renders all three scenarios economically unfeasible.

5.4.3.2 Heat Sale Price

The assumed heat sale prices were varied by +/- 10% in order to observe the change in IRR. The variation was applied to the entire price on a per unit basis including standing charges.

Figure 52 presents the results of the analysis.

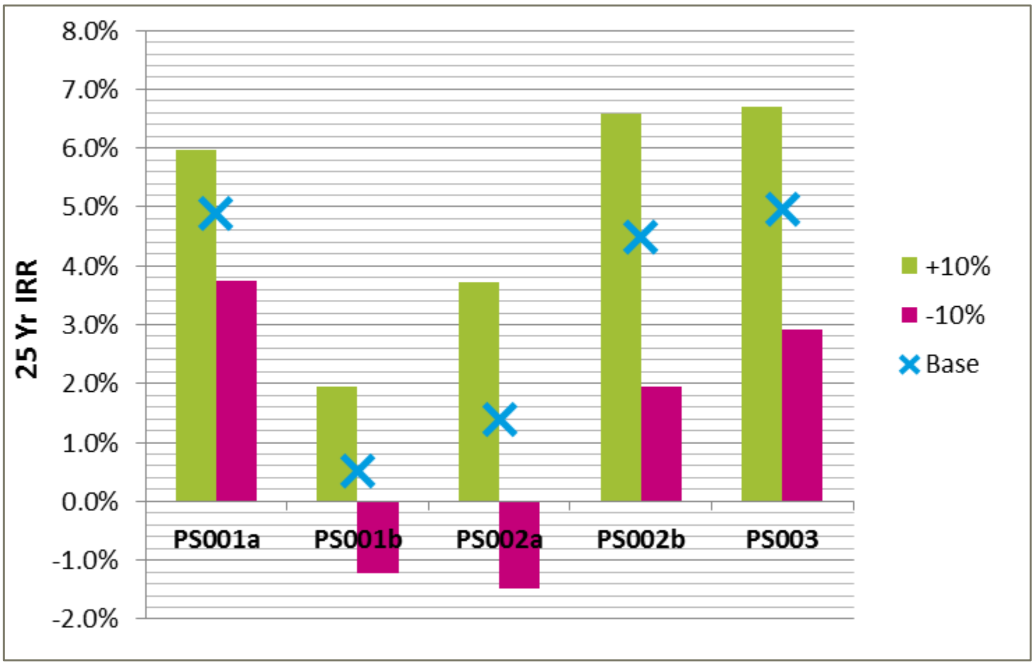

Figure 52: Sensitivity of Results to Heat Sale Price

The results show that a 10% increase in heat sale revenue has the potential to affect the IRR by up to 2.5% in the case of the extended networks and up to 1.5% for the PSV2 only networks.

The 10% reduction is significant in all cases as it reduces the IRR to a level below the hurdle rate.

A 10% increase is particularly significant for Scenario PS002a, as it takes the IRR up to 3.7%, which is bordering on economic viability.

5.4.3.3 Electricity Sale Price

The assumed average electricity sale price was varied by +/- 10% in order to observe the change in 25 year IRR for scenarios PS001a and PS002a.

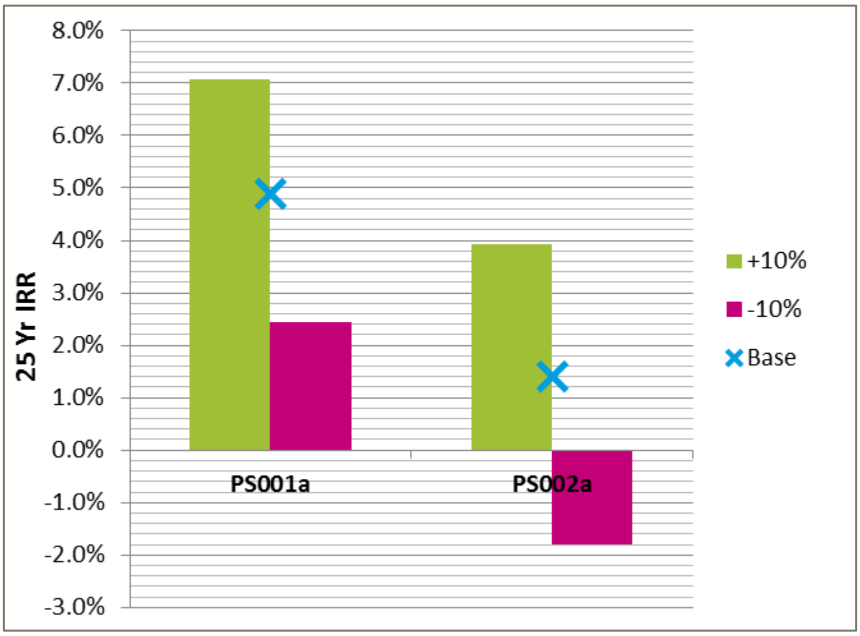

Figure 53: Sensitivity of Results to Electricity Sales Price

It was found that the 10% variation could affect the IRR between 2.2% and 3.2%, which clearly indicates the importance of the assumption. A 10% increase in the assumed average electricity sale price for Scenario PS002a brings the IRR very close to the 4% hurdle rate and thus significantly improves the case for viability.

A 10% reduction in average electricity sale price for Scenario PS001a was found to reduce the IRR to 2.4% and the project would no longer be considered feasible. Therefore the variable presents a significant risk to the project.

5.4.3.4 Project Capital Costs

All scenarios were tested with the total lifetime project CAPEX reduced and increased by 10% in order to observe the relative variation in IRR. Figure 54 presents the results:

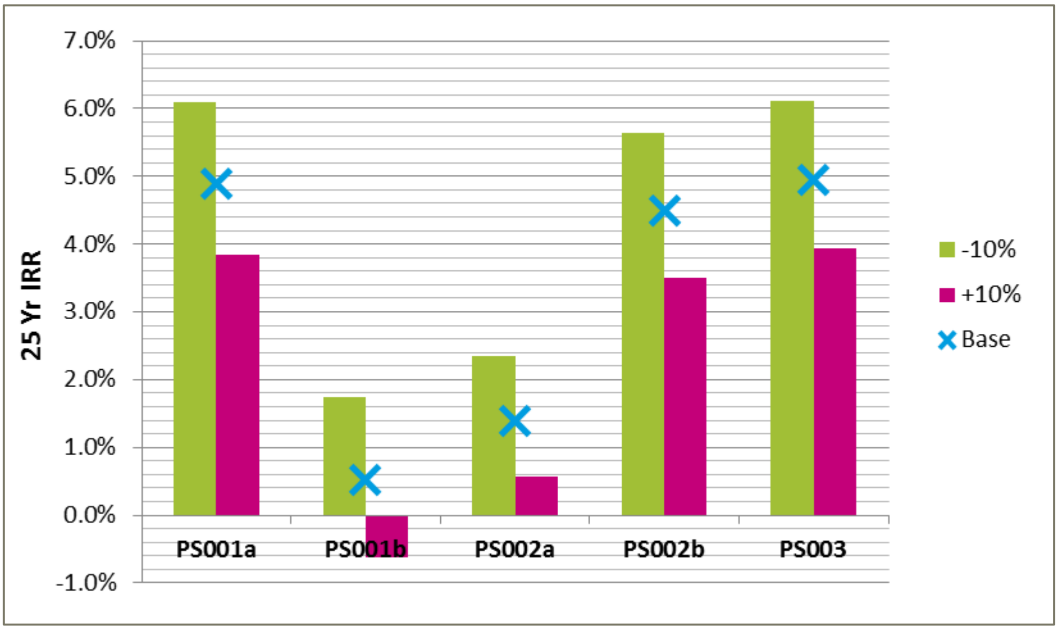

Figure 54: Sensitivity of Results to CAPEX

The results show that a change in capital costs of +/- 10% can affect the 25 year IRR by over 1%.

Additionally, analysis was carried out whereby capital injections of 10%, 20% and 30% of initial project CAPEX were included in each model to demonstrate the effects of grant funding on the project economics over 25 and 40 years.

When assessing the results, an IRR of 4% was considered to be the minimum hurdle rate for a Council-led project. However, it should be noted that figures closer to 10% were stated to be desirable by the Council.

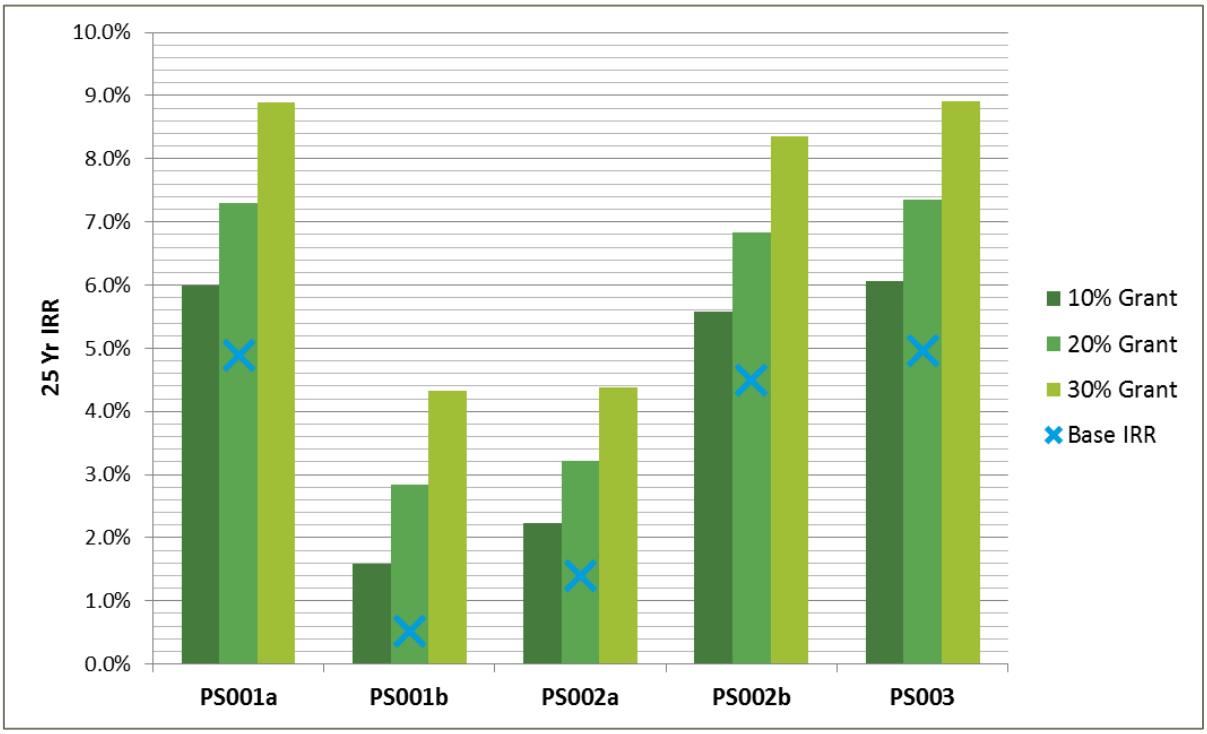

Figure 55: Effect of Capital Grant Funding on Project IRR

The results show that in order for PS001b to be considered viable a capital injection of between 20% and 30% would likely be required. In order to bring the IRR of PS002a above a hurdle rate of 4%, a capital injection of just less than 20% would be required.

5.4.3.5 Extension to Northern Schools and Retail

An additional high-level investigation was conducted into the effects of extending a DH network to the northern schools and retail area as outlined in section 4.1.4. Figure shows the proposed network route connecting Bury St Edmunds County Upper School and Saint Benedict's Catholic School. These were estimated to feature a combined heat load of 1,150 MWh per annum. At this stage the retail loads were not included as they were deemed to be commercially high risk.

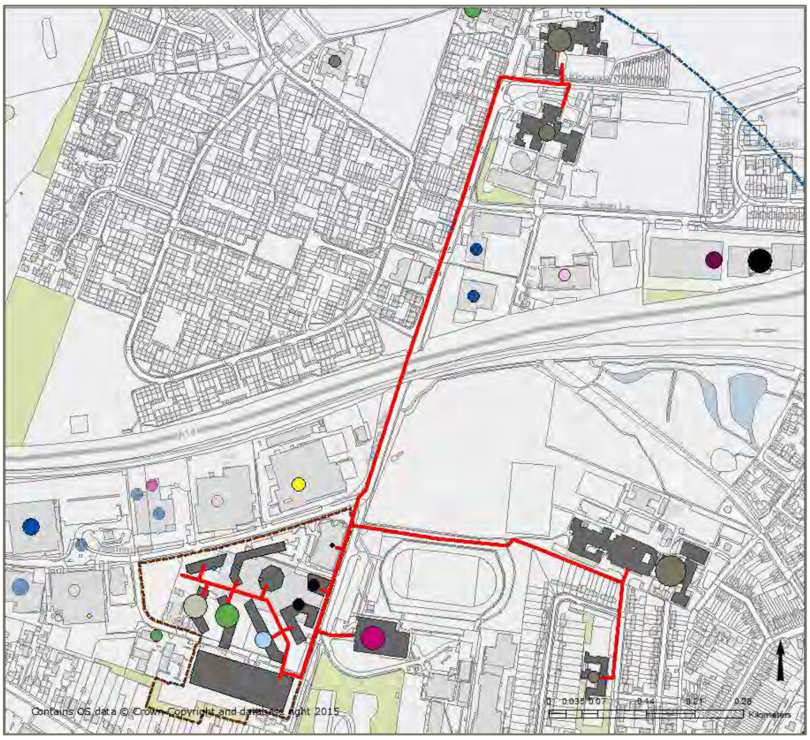

Figure 56: Possible Extension to North Schools

The key points were as follows:

- If the first operational year was 2018 (for PSV2 phase 1), the extension to the north could be constructed in 2019 for connection in 2020.
- The network operator would take on the cost of HIU connections to incentivise consumers to connect. This cost was estimated to be £38,500.
- Heat sale prices were assumed to be 5.2 p/kWh as for the other schools and Council buildings connected to the network. This would result in an additional heat sale revenue of £60,000 per annum.
- The network extension required would be approximately 800 m in length. The additional capital expenditure would be in the region of £800,000.
- A re-optimisation of the plant sizing was not conducted as part of this sensitivity analysis.

Given that the additional cost is around fourteen times greater than the additional heat sale revenue (not even taking into account the increased fuel costs at the energy centre); the extension was deemed to be unlikely to add benefit to the scheme.

The extension is, at masterplanning stage, considered to be too high risk to recommend as an alternative option. This is due to the high cost of extension for limited heat load; should either of the schools ever disconnect the business case would be significantly affected. It is recommended that further stakeholder engagement is conducted with the Schools at project feasibility stage and additional data collection must be carried out for the surrounding retail.

5.4.4 Summary of Techno-Economic Modelling Results

The key observations made during the techno-economic analysis are summarised as follows:

- Gas CHP was found to be a viable option for a localised network supplying PSV2 only, with base case IRRs of almost 5% over 25 years and an IRR of 6% with a 10% capital injection.
- An extension of the CHP network to the schools and Abbeycroft Leisure Centre significantly weakens the economic case.
- An extended CHP network would require capital grant funding of just less than 30% to be considered viable. Alternatively a 10% increase in either the assumed heat or electricity sale prices may also result in attractive results.
- Biomass was found to be a viable option for a wider network extending to the schools and Leisure Centre, with the 25 year IRR exceeding 4%. Capital funding of 20% could potentially increase this figure to over 6%.
- A local PSV2 biomass network was not found to generate an IRR above 4%, even over a 40 year lifetime.
- The success of the biomass option depends heavily on the availability of RHI revenue at the 2016 tariffs. A 10% reduction would render each of the scenarios unfeasible.

The implications of these results on the next steps for St Edmundsbury Borough Council are presented in section 7.

5.5 Pathway to Zero Carbon Heat

Each of the scenarios is analysed under the assumption that the primary supply asset will remain constant throughout the project lifetime. This is deemed to be a reasonable base case given the knowledge available at the time of writing. However, in reality the long term goal will be to achieve zero carbon heat within the network, which cannot be achieved by maintaining either CHP or Biomass supported by natural gas boilers.

Recent carbon forecasts for the CO_2 content of energy supply technologies in the UK predicts that gas CHP will not result in carbon savings in the later years of the specified 25 and 40 year project lifetimes. This is predominantly due to the expected increased decarbonisation of the electricity grid.

As a result of this, gas CHP is not considered to be an appropriate long term solution in achieving zero carbon heat. It is therefore important to consider how the schemes' primary supply technology might develop in future to move towards this goal. The stages for accomplishing zero carbon heat are referred to here as the "technology pathway".

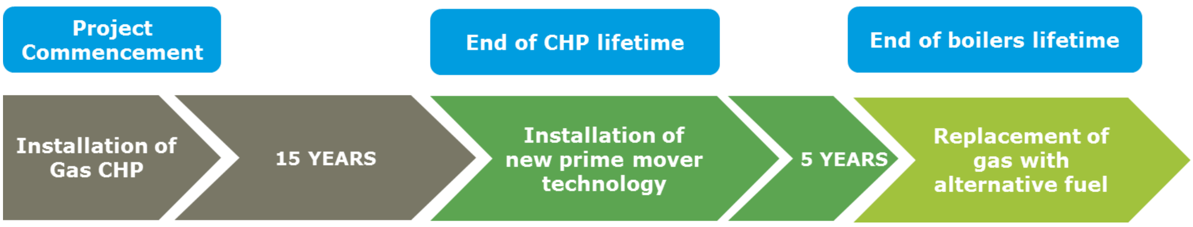

Table 46: CHP Example Technology Pathway Timeline

The principal points to consider during the project lifetime are when the installed supply assets reach the end of their operational lifetimes, as this provides a good opportunity for the integration of new technology types. For CHP the plant lifetime is typically around 15 years. For gas and biomass boilers the lifetime is likely to be longer at 20 years.

Once the CHP engine is in need of significant upgrade or replacement, the heat network operator should seek to replace it with a lower carbon or renewable technology such as biofuel CHP or biomass. Eventually the heat network operator would also look to replace the gas boilers to achieve full zero carbon status.

A key factor to consider is that once the project has been operational for 15 years it is likely that the bulk of the initial network costs will have paid back and pressure to generate revenue will be reduced. Therefore the replacement technology may not have to generate the same overall revenue to provide the same level of income for the network operator. This provides an increased number of options to the operator, as opposed to the project start up when the economic case is a primary driver of the technology options appraisal.

Taking this into account, a connection to British Sugar, for example, may be economically viable once the initial network and energy centre costs are no longer a factor.

6. PROJECT OUTLINE RISK ASSESSMENT

Risks were identified according to four categories:

- Technical risk
- Commercial risk
- Financial risk
- Planning risk

The key items within each of these categories are summarised in the sub-sections below. A risk register is included as Appendix 3.

6.1 Technical Risks

Design of the PSV2 Development

The Technical Risks category addresses factors such as energy load estimates, network design and energy centre assumptions.

A key risk is that the PSV2 project is within the early phases of the development process and the design, size and layout is potentially subject to significant change. The energy demand assessment was undertaken using the concept layout and floor areas current at the time of the analysis. Consequently, there is a significant risk that the energy demands of PSV2 will change which will jeopardise the validity of the assumptions, analysis and conclusions presented in this report.

In order to mitigate against this risk, the energy demand and supply assessment should be revisited in detail once the outline and detailed design for PSV2 has been fixed.

Further risks associated with the design of PSV2 are the assumptions regarding plant sizing and network design. Significant changes to these variables will affect the business case.

6.2 Commercial Risks

Commercial Arrangement and Delivery Vehicle

If the project developed into a wholly private sector based scheme, the Local Authority would not have any control over how scheme developed and there is a risk that the private sector may not grow the scheme to its full potential. If the project remains wholly Local Authority led, they remain in full control, but also take on full developmental and operational risk.

Whichever delivery route is taken forward, St Edmundsbury Borough Council will need to procure the scheme through the private sector since it won't have the necessary expertise to develop or operate the scheme alone. The Local Authority will need technical, commercial and legal support through this process so that it can secure the best partnering arrangement in its interests and those of the local community.

Policy

Assumptions made in the analysis were based on policy at the time of writing. The Government's policies and incentives are subject to change and this presents an on-going risk to the project.

A specific example of this is the uncertainty around RHI. There is a risk that the tariff may reduce or be removed completely over time thus providing the system operator with lower revenue.

Development Risk

Programme delay presents a further development risk, in addition to difficulties encountered by St Edmundsbury Borough Council in planning.

Operational Risk

The operating cost may be higher than expected due to the following issues occurring:

- high heat losses
- high return temps
- high heat purchase / generation costs
- high maintenance costs
- lower than expected operating margins
- lower volume of heat sales
- poor take up.

Consideration could also be given to adopting a tariff structure that incentivises retrofitting measures that address heating system return temperatures within existing buildings connecting to the proposed heat network.

6.3 Financial Risks

Development and operational costs

The development and operational costs presented in this report are derived from similar projects using Ramboll's database. These costs are highly project specific and will be dependent on how the energy system is designed, procured and operated.

There is a risk that these costs have been underestimated or overestimated which will affect the economic performance of the four options assessed. In order to mitigate this risk, a detailed assessment of the development and operational costs should be undertaken for the options taken forward to the detailed feasibility stage.

Capital Costs

The capital costs used within this study are based on Ramboll's database of historic supplier data and benchmarking. Specific quotations were not obtained and there is a risk that the stated capital costs are underestimated or overestimated. This will affect the validity of the analysis undertaken and the arrived conclusions.

In order to mitigate against this risk it is recommended that a cost consultant is commissioned to conduct a detailed evaluation of project costs as part of any future development phases.

Unknown Future Project Expansion

The extent and nature of the future developments surrounding PSV2 is unknown. It is therefore difficult to future proof PSV2's energy plant to supply a future district heating network of unknown size. Oversizing the energy centre for potential future demand will add significant risk to the economic performance of the PSV2 energy scheme.

6.4 Planning Risks

The planning risks associated with the project relate to both the impact of planning restrictions on the PSV2 site design and also the risk associated with the granting of permission to carry out the construction of a heat network.

Problems Associated with Permission for Energy Centre and Network

The project is at risk from delays in construction due to problems with temporary work permits. This may affect the build out rate of the scheme and ultimately affect the business case. As part of the study the assumed build out rates were based on previous experience in order to mitigate the risk.

Should the energy centre not be granted permission at the proposed location, the scheme cannot be developed in its current configuration and the business case is likely to be affected. In order to mitigate this risk going forward, it is recommended that the Local Authority and Consultant engage with Council Planners.

Planning Not Granted for New Developments

If the planning process has considerable effects on the assumed heat demand for PSV2 then the business case will be affected. This risk may be mitigated going forward through communication with the Council's planning department and by updating the business case as required.

7. CONCLUSIONS, RECOMMENDATIONS AND NEXT STEPS

This section outlines the conclusions, recommendations and next steps for West Suffolk, resulting from the techno-economic analysis and risk appraisal.

7.1 Conclusions

The results of the study suggest that, under the assumptions of the techno-economic model, there is an opportunity for a district heating in Bury St Edmunds to connect the buildings within the proposed Public Service Village development and an extension to nearby buildings.

The preferred supply option for economic viability depends predominantly on whether the scheme extends beyond a network on the PSV2 site.

A heat network supplied by a natural gas CHP engine was found to be viable for the localised network. However, it is only likely to be viable for a wider extended network if capital funding of just less than 30% can be made available. Alternatively, a 10% increase in the assumed electricity and/or heat sale prices may bring the IRR to viable levels.

In contrast to this, a heat network supplied by a heat-only biomass boiler was found to generate sufficient rates of return for a wider network extending to the Leisure Centre and schools. However, if the heat network does not extend beyond PSV2 and remains localised then the economic case is poor.

In the biomass cases it was concluded that if the RHI reduces below current levels then the IRR would reduce significantly and therefore the technology option currently presents a high degree of risk.

Although the majority of the economic results show marginal IRRs, it is important to note that under the business as usual case, the heating system installed within the PSV2 buildings will not generate revenue for the Council at all. Therefore any scenario showing positive returns over the project lifetime is comparably better than the base case provided sufficient capital can be made available by the Local Authority.

7.2 Recommendations

It is recommended that the Council conduct further investigation into a heat network supplied by natural gas CHP. This is due to the fact that it presents the least risk for the PSV2 development and an extension could be viable under the circumstances stated above.

It is recommended that a presentation of the energy masterplanning results should be given to all relevant stakeholders including the Developer, the Leisure Centre and the Schools. This would enable the Council to gauge interest in the proposed schemes and obtain feedback on how each technology might or might not be appropriate for their requirements. Stakeholder engagement is crucial at the earliest project stages to ensure opportunities or barriers are not overlooked.

Further techno-economic modelling must be conducted when more accurate information is available regarding the final masterplan for PSV2. At present the energy demand information is not deemed to be accurate enough to clearly establish feasibility.

7.3 Next Steps

The recommended next steps for St Edmundsbury Borough Council are summarised in the sub-sections below.

7.3.1 Business Model and Business Case

There is a great deal more work to be done around technical, financial and commercial analysis and de risking of the project before it can progress to business case. This would include, but is not limited to:

- further heat demand data collection
- plant room surveys to assess existing buildings' heating systems
- further optimisation of hydraulic design and plant sizing
- detailed assessment of customer BaU energy pricing structure
- engagement with each potential customer to understand preferable arrangement for supply of energy

To progress the project further, will require a detailed business case that should include financial modelling as stated above, and also consideration of appropriate procurement, delivery and governance options for the project. This should include the relative advantages and disadvantages of each option, together with identification of the preferred course of action.

7.3.2 Ensuring Correct Design Standards are adopted

The design of the internal heating systems at PSV2 will have a significant impact on the operational capacity and efficiency of the primary supply technology.

The final building designs should incorporate appropriate internal heating system designs to ensure flow and return temperatures are compatible with the primary supply technology. The Council, through their Planning and Building Control departments, should ensure that systems are being designed, installed and commissioned appropriately.

New developments may emerge in future within the vicinity of the network. If this is the case then appropriate design standards should be considered so that opportunities for connection are not missed.

7.3.3 Safeguarding Wider Network Demand

Since the extent and nature of the long term future development around the PSV2 site is not certain, it is difficult to future proof PSV2's energy plant to supply a future district heating network. Furthermore, oversizing the energy plant would add cost to the project and therefore will put the economic performance of PSV2's energy strategy at risk. The following measures will provide some flexibility and facilitate development of a district heating network.

1. Provide sufficient space within the Energy Centre to locate an additional future boiler. The headers within the energy centre should include blank connections for an additional heat supply asset. This will also facilitate the connection of temporary boilers for use during any major outage (major boiler or CHP service) or reworking of the energy centre.

2. The energy centre should be located and designed such that heat supply assets can be removed and relocated to a future energy centre.

7.3.4 Establish Pathway to Zero Carbon Heat

Although it has been concluded that has CHP is the preferable solution to kick-start the DH project and obtain a suitable revenue stream for the Council, in the long term the CO_2 savings will be minimal if not absent altogether. Therefore, as the business case develops, the pathway to zero carbon heat must be considered in greater detail at the next project stage.

APPENDIX 1 - ENERGY MAPPING DATA

HEAT

Name	Address	Postcode	Building Type	Source	Heat Demand (kWh)
Abbeycroft Leisure Centre	Beetons Way, Bury Saint Edmunds, Suffolk	IP333YE	Recreational	Billing data from the Council	2,046,987
ASDA	Asda Western Way	IP333SP	Retail	Stakeholder information	270,288
B&Q	43 48 Risbygate Street	IP333AA	Retail	National Heat Map filtered and aggregated	478,338
Bury St Edmunds County Upper School		IP333RE	Education	Estimated using CIBSE TM46	504,900
Cineworld Complex	2 Parkway North	IP333BA	Recreational	National Heat Map filtered and aggregated	218,310
Cineworld Complex	4 Parkway North	IP333BA	Recreational	National Heat Map filtered and aggregated	178,103
Cineworld Complex	1 Parkway North	IP333BA	Recreational	National Heat Map filtered and aggregated	277,331
Cineworld Complex	3 Parkway North	IP333BA	Recreational	National Heat Map filtered and aggregated	230,637
Dc/14/0683/FUL			New Developments	Benchmarked	16,400
Dc/15/0087/FUL			New Developments	Benchmarked	45,100
DC/15/0689/OUT			New Developments	Benchmarked	110,623
DC/15/1586/FUL			New Developments	Benchmarked	121,893
Glasswells	Glasswells Ltd Newmarket Road	IP333SS	Retail	National Heat Map filtered and aggregated	939,778
Howard Middle School	Howard County Primary School St Olaves Road	IP326RW	Education	National Heat Map filtered and aggregated	184,635
King Edward VI School	King Edward Vi Upper School Grove Road	IP333BH	Education	National Heat Map filtered and aggregated	7,784,666
Lookers Landrover	Lookers Landrover Newmarket Road	IP333TS	Retail	National Heat Map filtered and aggregated	333,819
PSV2			Health	Benchmarking draft proposals	668,756
PSV2			Commercial Offices	Benchmarking draft proposals	73,800

Name	Address	Postcode	Building Type	Source	Heat Demand (kWh)
PSV2			Police	Benchmarking draft proposals	992,085
PSV2			Residential	Benchmarking draft proposals	583,700
PSV2			Government Buildings	Benchmarking draft proposals	123,000
PSV2			Conference Centre	Benchmarking draft proposals	51,780
Sexton's Manor Primary School	Sextons Manor County Primary School Greene Road	IP333HG	Education	National Heat Map filtered and aggregated	194,072
St Benedict's Catholic School	St Benedicts Upper School Beetons Way	IP326RH	Education	National Heat Map filtered and aggregated	650,423
St Edmundsbury C of E School	St Edmundsbury C Of E Primary School Grove Road	IP333BJ	Education	National Heat Map filtered and aggregated	118,888
St Peters House	29 Out Risbygate,Bury Saint Edmunds	IP333RJ	Health	Estimated using CIBSE TM46	520,344
West Suffolk College	Rendezvous Community Education Centre West Suffolk College Out Risbygate	IP333RE	Education	National Heat Map filtered and aggregated	2,216,847
West Suffolk House	Western Way, Bury St Edmunds, Suffolk	IP333YU	Government Buildings	Billing data from the Council	85,221
Wilko	Roys Of Wroxham Risbygate Street	IP333AQ	Retail	National Heat Map filtered and aggregated	393,464
	Stotage Unit 3 Western Way	IP333SY	Retail	National Heat Map filtered and aggregated	130,626
	Havebury House Western Way	IP333LA	Commercial Offices	National Heat Map filtered and aggregated	219,338
	Dettingen House Dettingen Way	IP333TU	Recreational	National Heat Map filtered and aggregated	295,565
	Former 19 Queens Close	IP33 3ER	Residential	National Heat Map filtered and aggregated	281,092
	Petlife International Minster House Western Way	IP333SP	Retail	National Heat Map filtered and aggregated	110,823
	5 Dettingen Way	IP333TU	Warehouse	National Heat Map filtered and aggregated	760,442
	Vicon House Western Way	IP333SP	Retail	National Heat Map filtered and aggregated	518,234
	Haldo House Western Way	IP333SP	Industrial	National Heat Map filtered and aggregated	195,202
	Bury Spectrum Gym Club Western Way	IP333SP	Recreational	National Heat Map filtered	193,631

Name	Address	Postcode	Building Type	Source	Heat Demand (kWh)
				and aggregated	
	Desira Bury Ltd Western Way	IP333SP	Retail	National Heat Map filtered and aggregated	138,164
	Oystar Aerofill Newmarket Road	IP333SR	Warehouse	National Heat Map filtered and aggregated	474,208
	Celloglas Ltd Western Way	IP333SP	Industrial	National Heat Map filtered and aggregated	177,672
	2 B 2 C Cavendish Road	IP333TE	Transport	National Heat Map filtered and aggregated	132,279
	Anderson Centre Olding Road	IP333TA	Health	National Heat Map filtered and aggregated	204,512
	Blenheim House Dettingen Way	IP333TU	Commercial Offices	National Heat Map filtered and aggregated	187,580
	Unit E1 Sharon Road	IP333TZ	Industrial	National Heat Map filtered and aggregated	177,672
	Kent Blaxill And Co Ltd Arras Road	IP333TX	Retail	National Heat Map filtered and aggregated	200,572
	6 Grove Road	IP333BE	Health	National Heat Map filtered and aggregated	155,434
	75 Risbygate Street	IP333AQ	Health	National Heat Map filtered and aggregated	101,506
	Suffolk Fire Station Parkway North		Government Buildings	National Heat Map filtered and aggregated	248,177
	St Edmundsbury Borough Council St Edmundsbury House Western Way	IP333YU	Commercial Offices	Benchmarking draft proposals	59,040
	N H S Supplies North Thames Anglia Division Olding Road	IP333YE	Government Buildings	Benchmarking draft proposals	184,500
	Vinten (Camera Dynamics Ltd) Western Way	IP333TB	Industrial	National Heat Map filtered and aggregated	241,647
	Elton Works Western Way	IP333SZ	Industrial	National Heat Map filtered and aggregated	177,672
	122 Queens Road	IP333ES	Recreational	National Heat Map filtered and aggregated	186,065
	Neville Close Victoria Street	IP333DD	Government Buildings	National Heat Map filtered and aggregated	121,620
	Newmarket Open Door Ltd Dettingen Way	IP333TU	Industrial	National Heat Map filtered and aggregated	127,120

Name	Address	Postcode	Building Type	Source	Heat Demand (kWh)
	Unit 1 120 Phoenix House Newmarket Road	IP333TF	Retail	National Heat Map filtered and aggregated	152,967
	British Fittings Co Ltd 118 A Pipe Line Centre Newmarket Road	IP333TG	Retail	National Heat Map filtered and aggregated	185,868
	Beetons Lodge Beetons Way	IP326SX	Health	National Heat Map filtered and aggregated	434,079
	Cml Innovative Technologies Anglian Lane	IP326RA	Industrial	National Heat Map filtered and aggregated	206,087
	Units A3 To A6 Anglian Lane	IP326SR	Warehouse	National Heat Map filtered and aggregated	311,772
	Unit C - D Anglian Lane	IP326SR	Government Buildings	National Heat Map filtered and aggregated	643,623
	Texas Anglian Lane	IP326SR	Retail	National Heat Map filtered and aggregated	151,872
	Ridgeons Beetons Way	IP326TD	Retail	National Heat Map filtered and aggregated	207,912

COOLING AND ELECTRICITY

Name/Address	Postcode	Building Type	Coolth (kWh)	Power (kWh)
St Peters House 29 Out Risbygate,Bury Saint Edmunds	IP333RJ	Nursing home	-	138,780
Storage Unit 3 Western Way	IP333SY	Retail	-	1,081,728
Emg Ford Springfield Road	IP333AS	Retail	-	3,146,104
116 B Westbank House Bed And Breakfast Westley Road	IP333SD	Hotels	-	6,812
15 Office Flat Jankyns Place Chalk Road South	IP333BT	Commercial Offices	4,125	17,034
3 Parkway North	IP333BA	Recreational	-	620,107
Havebury House Western Way	IP333LA	Commercial Offices	49,115	202,796
Dettingen House Dettingen Way	IP333TU	Commercial Offices	59,190	244,396
Asda Western Way	IP333SP	Retail	-	4,572,728
Petlife International Minster House Western Way	IP333SP	Retail	-	390,076
30 Cadogan Road	IP333QJ	Retail	-	30,036
Blenheim Camp Newmarket Road	IP333SW	Government Buildings	36,319	98,413
Miden Rose Newmarket Road	IP333SN	Hotels	-	19,230
Vicon House Western Way	IP333SP	Retail	-	2,323,472
Isolve It Haldo House Western Way	IP333SP	Commercial Offices	341,724	1,410,988
Kingfisher Press Olding Road	IP333TA	Retail	-	692,080
Desira Bury Ltd Western Way	IP333SP	Retail	-	1,648,080
Miro Press Western Way	IP333SP	Commercial Offices	32,699	135,014
4 Cavendish Road	IP333TE	Retail	-	783,864
Easy Software Reflection House Olding Road	IP333YE	Commercial Offices	8,218	33,933
Unit 3 Western Way	IP333SY	Commercial Offices	66,118	273,004
Nasuwt St James House Olding Road	IP333TA	Commercial Offices	7,096	29,300
Insurance Marketing & Developement St Francis House Olding Road	IP333TA	Commercial Offices	9,297	38,388
St Peters House Olding Road		Commercial Offices	9,454	39,037
Blenheim House Dettingen Way	IP333TU	Commercial Offices	70,780	292,251
Coronation Filling Station Newmarket Road	IP333TF	Retail	-	42,484
The Annex 53 Bennett Avenue	IP333HF	Commercial Offices	2,441	10,077
6 Ridley Road Post Office The Parade Ridley Road	IP333HP	Retail	-	47,160
3 The Parade Ridley Road	IP333HP	Retail	-	42,832
2 The Parade Ridley Road	IP333HP	Retail	-	42,952
Flat 1 The Parade Ridley Road	IP333HP	Retail	-	42,408
Drover House Dettingen Way	IP333TU	Retail	-	419,828
Unit D2 Sharon Road	IP333TZ	Retail	-	231,308
Lee Gage Sales And Servicing Dettingen Way	IP333TU	Retail	-	111,432
1 Priors Inn Priors Avenue	IP333LT	Hotels	-	55,786

Name/Address	Postcode	Building Type	Coolth (kWh)	Power (kWh)
6 Grove Road	IP333BE	Health	-	12,022
63 Risbygate Street	IP333AZ	Retail	-	79,936
8 Dunston Guest House Springfield Road	IP333AN	Hotels	-	35,502
75 Risbygate Street	IP333AQ	Health	-	16,708
Suffolk Fire Station Parkway North		Government Buildings	65,768	178,209
Roys Of Wroxham Risbygate Street	IP333AQ	Retail	-	3,238,800
82 Risbygate Street	IP333AQ	Commercial Offices	5,966	24,634
Springfield Day Nursery 61 Springfield Road	IP333AS	Health	-	13,784
80 Parkway House Risbygate Street	IP333AQ	Health	-	152,181
2 Avery House Newmarket Road	IP333SN	Commercial Offices	11,287	46,605
Tracktec Ltd Vinten (Camera Dynamics Ltd) Western Way	IP333TB	Retail	-	5,711,080
Gibraltar Barracks Out Risbygate	IP333RN	Government Buildings	7,960	21,570
65 68 Kings Road	IP333DR	Retail	-	23,760
91 A Kings Road	IP333DT	Hotels	-	35,149
Unit 2 8 Out Risbygate	IP333RJ	Retail	-	879,144
90 Risbygate Centre Risbygate Street	IP333AA	Health	-	28,708
52 Victoria Street	IP333BD	Commercial Offices	5,444	22,477
53 Risbygate Street	IP333AZ	Health	-	21,970
Neville Close Victoria Street	IP333DD	Commercial Offices	1,415	5,844
17 Victoria Street		Retail	-	34,032
28 34 Risbygate Street	IP333AH	Commercial Offices	79,808	329,528
27 Risbygate Street	IP333AQ	Commercial Offices	5,806	23,972
23 Kitsch And Klutter Risbygate Street	IP333AA	Retail	-	290,120
Victoria Surgery Victoria Street	IP333BB	Health	-	22,789
12 Highbury Crescent	IP333RS	Commercial Offices	4,029	16,637
48 50 West Road	IP333EJ	Retail	-	56,900
1 Murco Newmarket Road	IP333HA	Retail	-	91,072
Hss Hire Service Tayfen Road	IP331TB	Retail	-	485,812
West Suffolk Probation Centre Dettingen Way	IP333TU	Commercial Offices	14,023	57,901
57 58 The Falcon Risbygate Street	IP333AZ	Hotels	-	6,386
Lookers Landrover Newmarket Road	IP333TS	Retail	-	900,996
Unit 3 120 Phoenix House Newmarket Road	IP333TF	Commercial Offices	10,918	45,080
British Fittings Co Ltd 118 A Pipe Line Centre Newmarket Road	IP333TG	Retail	-	229,700
Childrens Centre Howard County Primary School St Olaves Road	IP326RW	Commercial Offices	2,705	11,168
13 St Olaves Precinct	IP326SP	Retail	-	63,232
12 St Olaves Precinct	IP326SP	Retail	-	62,616
10 St Olaves Precinct	IP326SP	Retail	-	65,128

Name/Address	Postcode	Building Type	Coolth (kWh)	Power (kWh)
9 St Olaves Precinct	IP326SP	Retail	-	68,312
8 St Olaves Precinct	IP326SP	Retail	-	64,744
7 St Olaves Precinct	IP326SP	Retail	-	65,280
6 St Olaves Precinct	IP326SP	Retail	-	65,816
4 St Olaves Precinct	IP326SP	Retail	-	62,832
2 St Olaves Precinct	IP326SP	Retail	-	58,800
1 St Olaves Precinct	IP326SP	Retail	-	211,560
The Greengage Tollgate Lane	IP326DE	Hotels	-	71,400
Beetons Lodge Beetons Way	IP326SX	Health	-	358,690
Sellers & Batty Anglian Lane	IP326SR	Retail	-	2,312,792
Unit C - D Anglian Lane	IP326SR	Government Buildings	34,775	94,229
1 2 Osier Road	IP331TA	Commercial Offices	8,580	35,429
3 Driver Hire Osier Road	IP331TA	Commercial Offices	12,872	53,149
Tayfen Autopoint Tayfen Road	IP331TB	Retail	-	60,976
Springfield Garage Tayfen Road	IP331TB	Retail	-	71,656
27 A Blomfield Street	IP331TD	Commercial Offices	2,537	10,476
8 Elseys Yard Risbygate Street	IP333AA	Commercial Offices	13,585	56,095
Elseys Yard Risbygate Street	IP333AA	Retail	-	36,736
96 Risbygate Street	IP333AA	Retail	-	80,312
Unit 2 93 95 Risbygate Street	IP333AA	Retail	-	49,408
West Suffolk House	IP333YU	Government Building	124,708	408,299
Abbeycroft Leisure Centre		Recreational	12,378	1,045,154
Sexton's Manor Primary School	IP333HG	Education	-	61,859
St Edmundsbury Cofe Primary School	IP333BJ	Education	-	51,999
King Edward Vi School	IP333BH	Education	-	256,715
St Benedict's Upper School	IP326RH	Education	-	137,010
Howard Primary School	IP326RW	Education	-	49,406
Bury St Edmunds County Upper School	IP326RW	Education	-	134,639
West Suffolk College	IP333RE	Education	-	373,905
PSV2		Health	-	210,600
PSV2		Police	-	184,275
PSV2		Residential	-	508,300
PSV2		Commercial Offices	67,230	690,390
PSV2		Government Buildings	155,625	1,598,125
PSV2		Conference Centre	6,225	63,925

APPENDIX 2 - TECHNOLOGY OPTIONS APPRAISAL

Forest Heath & St Edmundsbury councils
West Suffolk
working together

PSV2 Heat Network Masterplanning
Energy Supply Options Appraisal

RAMBOLL

Technology	Description	Fuel Source	Fuel risk	LZC Policy compliance	Applicable at site wide infrastructure scale	Scale in relation to demand	Space requirement assuming construction on the Site	Technology risks / operational issues	Planning risk	CO2 abatement potential	Air Quality	Climate change and carbon emissions	Noise & Vibration	Water (groundwater, surface water and marine	Transportation	Waste	Geology and soils	Biodiversity and nature	Historic environment	Landscape and Townscape	Communities and Amenities	Capital cost	Operating cost	Revenue potential	Initial estimate of financial performance	Consider as part of opportunity appraisal?
Gas Combined Heat and Power Plant	Internal Combustion Engine working on Spark Ignition Cycle or gas turbine cycle employed. Internal Combustion Engine applicable at this scale. Electricity is generated through a generator directly coupled to the engine. Heat is extracted through cooling of the engine jacket, heat recovery from the exhaust and through an intercooler if fitted.	Natural gas and can be configured to operate on biogas	Fuel supply risk considered to be low in relation to security of supply. Price volatility and on-going price rises expected over medium and long term.	Gas CHP is understood to be acceptable to IBC as a LZC technology for heat supply	Yes, can be offered as low carbon heat to plot developers	Technology lends itself to modular build out over life of project. Individual units available at scale appropriate to the available demand for this project.	Compact technology on per kWe basis. No significant issue perceived.	Low risk - Well proven technology at the scale of the project. Readily available. Ability to stop start on a regular basis and to modulate to meet demand in conjunction with thermal store.	NOx emissions can be managed in a range of ways including specifying low NOX lean burn engines, configuring the unit through adjustments to injector timing, compression ratio, cylinder pressure and intercooling. Selective Catalytic Reduction is used in larger plant but this would not be suitable at this scale. No fuel transportation issues.	Medium as part of technology mix if operating on Natural Gas. Can be high if operating on biogas. CO2 savings arising include benefits from offsetting grid imported electricity	Medium to high. Emissions from Gas CHPs have high concentrations of NOx also contain CO and UHCs. Emissions would need to be considered in the light of any AQMA in the vicinity. Possible need for dispersion modelling.	Burning of hydrocarbon fuels contributes to climate change and does not minimise carbon emissions	Consideration needed of noise effects depending on proximity of sensitive receptors, in particular residential properties	Lubricating oil, coolant and ammonia could pollute water bodies if released. Possible issues during construction would need to be managed	Possible transportation issues during construction. Effects during operation small if gas is piped to site, might be greater if road or rail transportation is used.	Construction waste but little from operation (waste oil, coolant etc.)	Potential for direct impacts during construction but in urban area so no loss of agricultural soils, possibility of encountering contaminated land	Noise could effect biodiversity depending on proximity of receptors.	Direct effects possible during excavations for works, possible visual effects on historic setting	Visual effects heavily dependent on scale of plant, in particular stacks.	Potential employment opportunities during construction and operation	Medium ~ £150 - 500 / kWe for genset and ancillaries	Low - Medium Fuel costs approx. 5p/kWh of electricity and heat output. Maintenance costs approx. 1p/kWh of electricity output	Revenue from heat and power sales	Reasonable financial performance expected. Gas CHP benefits from the Carbon Price Support mechanism through a relief that maintains the status quo under CCL as a minimum position. Not eligible for ROCs, RHI. Key drivers on viability are spark gap and sales value of heat and electricity. Retailing of electricity through private wire on site or ability to offset imported landlord	Yes
Dual fuel boiler	Boiler able to combust a range of fuels often installed as natural gas peak and or backup heat provider	Natural gas, fuel oil or liquid biofuel	Fuel supply risk considered to be low risk in relation to security of supply. Price volatility and on-going price rises expected over medium and long term. Duel fuel capability allows some leverage of short term fuel price volatility.	Dual fuel boilers can form part of a technology mix acting as back up for the LZC technologies so long as their contribution does not exceed the carbon building standards/ planning policy emissions limits	Yes as part of low carbon heat technology mix	Technology lends itself to modular build out over life of project. Individual units available at scale appropriate to the available demand for this project.	Compact technology on per kWe basis. No significant issue perceived.	Low risk - Well proven technology at the scale of the project. Readily available in range of sizes applicable to the project.	Emissions can be managed by installing low NOx burners. No fuel transportation issues.	Low	Medium. NOx emissions from gas boilers gas be significant. Emissions would need to be considered in the light of any AQMA in the vicinity. Possible need for dispersion modelling. Low NOx or ultralow NOx burners are likely to be required	Burning of hydrocarbon fuels (gas or fuel oil) contributes to climate change and does not minimise carbon emissions. Use of biofuels would be preferable in this respect but would need to consider sustainability of biofuels.	Consideration needed of noise effects depending on proximity of sensitive receptors, in particular residential properties	Fuel oil could pollute water environment if spilt and lost. Issues during construction would need to be considered	Possible transportation issues during construction. Effects during operation small if gas or fuel oil is piped to site, might be greater if road or rail transportation is used and this could be particularly the case with biomass	Construction waste but little from operation	Potential for direct impacts during construction but in urban area so no loss of agricultural soils, possibility of encountering contaminated land. Fuel oil could cause soil pollution if spilt and lost.	Noise could effect biodiversity depending on proximity of receptors.	Direct effects possible during excavations for works, possible visual effects on historic setting	Visual effects heavily dependent on scale of plant, in particular stacks.	Potential employment opportunities during construction and operation	Very low relative to heat output. Approx. £20-50 / kW for DHN scale boilers	Low - Medium. Fuel costs approximately 4p/kWh heat output	Revenue from heat sales only	Capital and operating costs of centralised boilers lower than alternative of individual boilers due to economies of scale and improved efficiencies	No
Biomass heating	Biomass-only heating to raise water or steam. No electricity is generated. Can burn a variety of woody biomass based fuels .	Generally wood chip, wood pellet or wood logs	Good outlook for fuel availability. UK industry in production of biomass well defined - scope for imports remains high. Competition for fuel may drive prices up depending on number of schemes realised. As part of a technology mix, biomass heating represents medium fuel risk.	Biomass heating is an acceptable LZC technology to meet carbon emissions reductions set out in local planning policy and building standards	Yes, can be offered as low carbon heat to plot developers	Technology lends itself to modular build out over life of project. Individual units available at scale appropriate to the available demand for this project.	Boiler technology significantly larger than gas fired on a per kWth basis. Fuel storage requirement significant .	Low risk - Well proven technology at the scale of the project. Readily available. Ability to stop start on a regular basis and to modulate to meet demand in conjunction with thermal store. . Greater supervision requirement than fossil fuel fired technology	Several manufacturers' boilers are compliant under the Clean Air Act and are classified as Exempt Appliances. From October 2012 all biomass installations accredited under RHI will need to meet demanding emissions limits of 30 g/GJ for particulates and 150 g/GJ NOX. Particulate emissions levels (PM10 and PM2.5) can be reduced further as required to meet local air quality standards through variety of filtration methods. Stack height may be of concern to Planning Authority. Frequent fuel deliveries will be required, volume depends on energy density of fuel source	High on individual technology basis. Unlikely to be deployed to provide 100% of heat to scheme. Medium as part of technology mix.	Emissions would need to be considered in the light of any AQMA in the vicinity. Possible need for dispersion modelling and additional control measures (e.g. particulate filters)	Burning biomass contributes to reducing carbon emissions which would assist in climate change terms, sustainability of biomass source needs to be considered	Consideration needed of noise effects depending on proximity of sensitive receptors, in particular residential properties	Unlikely to be sign cant impacts, possible issues during construction would need to be managed	Possible transportation issues during construction. Effects during operation depend on transportation adopted to deliver biomass	Construction waste. bottom ash etc. from operation would require disposal which could contribute to other issues such as transportation	Potential for direct impacts during construction but in urban area so no loss of agricultural soils, possibility of encountering contaminated land	Noise could effect biodiversity depending on proximity of receptors.	Direct effects possible during excavations for works, possible visual effects on historic setting	Visual effects heavily dependent on scale of plant, in particular stacks.	Potential employment opportunities during construction and operation	Medium. Specific capital cost decreases with increasing capacity. Approx. £300-400/kW for DHN scale boilers	Medium to high. Fuel costs lower than fossil fuels (2p/kWh), depending on fuel type but other O&M costs are higher	Heat output from biomass boilers is eligible for RHI payments in addition to revenue from heat sales	Reasonable financial performance depending on-going availability and price of fuel source. Supported under RHI ~ tariff banding applies.	Yes
Biomass CHP Steam cycle	A biomass boiler heats a water to raise steam which operates a turbine under the steam cycle. Electricity is generated through a directly coupled generator during the expansion stage of the cycle and heat is extracted through the condensing phase of the cycle	Range of fuels including wood chip, sawdust, bark, treated wood, straw, green cuttings, rice husks	Good outlook for fuel availability. UK industry in production of biomass well defined - scope for imports remains high. Competition for fuel may drive prices up depending on number of schemes realised. As part of a technology mix, biomass heating represents medium fuel risk.	Biomass CHP is an acceptable LZC technology to meet carbon emissions reductions set out in local planning policy and building standards	Scale of application would not lend itself to site wide solution without a wider area being integrated into scheme. Economics would not justify this scale of application. It is assume d that the Council would not consider development of such a scheme on the required scale.	Not possible at required scale but requires larger scale to become commercially viable	Very large space requirement on a per kWe installed basis both for plant and for fuel storage and handling. Requires much larger fuel store than biomass heating only due to lower efficiencies and required scale of application. Volume of storage dependent on number of day's storage requirements. Footprint for plant alone is typically 0.3m2/kWe	Proven technology at MW scale - low risk. Greater supervision requirement than for gas CHP technology	As for biomass boilers, emissions can be managed to meet local air quality standards using variety of techniques. Frequent fuel deliveries will be required, volume depends on energy density of fuel source.	High	As biomass above								Direct effects possible during excavations for works, possible visual effects on historic setting, discussion of large scale plant could mean greater impacts	Visual effects heavily dependent on scale of plant, in particular stacks. Will be sited within industrial area. Discussion of large scale plants may mean greater impacts. May	As biomass above	Very high. Approx. £4000-6000 per kWe installed	Very High - Approx. £150 per kWe installed per year	Heat output supported under RHI amend through sales. Revenue from electricity sales/offsets with additional payments from CfDs where sale price is below strike price	Although supported by ROCs/RHI, not considered commercially viable on this scale. Investment cost and operating overheads too high at this scale.	No
Organic Rankine Cycle (ORC)	A biomass boiler heats an organic fluid which operates a turbine under the Rankine cycle. Electricity is generated through a directly coupled generator during the expansion stage of the cycle and heat is extracted through the condensing phase of the cycle	Range of fuels including wood chip, sawdust, bark, treated wood, dried sewage sludge, straw, green cuttings, rice husks, waste materials, waste heat	Good outlook for fuel availability. UK industry in production of biomass gearing up - scope for imports of some fuel sources remains high. Competition for fuel may drive prices up depending on number of schemes realised. Volume of fuel required for CHP applications is high. Represents appreciable risk. Opportunities for dual fuel can potentially reduce this.	Biomass ORC is an acceptable LZC technology to meet carbon emissions reductions set out in local planning policy and building standards	Yes, can be offered as low carbon heat to plot developers	Minimum base load of around 2.5 MWth required.	Very large space requirement on a per kWe installed basis both for plant and for fuel storage and handling. Requires much larger fuel store than biomass heating only due to lower efficiencies and required scale of application. Volume of storage dependent on number of day's storage requirements. Footprint for plant alone is typically 0.5m2/kWe	Less proven but has reasonably strong track record and operating experience - several plants in operation in Europe	As for biomass boilers, emissions can be managed to meet local air quality standards using variety of techniques. Frequent fuel deliveries will be required, volume depends on energy density of fuel source.	High	As biomass above												Very high. Approx. £800-2,000 per kWth installed	Low to medium. Fuel costs lower than fossil fuels (2p/kWh), Maintenance costs approx. £100 per kWe installed per year	Heat output supported under RHI amend through sales. Revenue from electricity sales/offsets with additional payments from CfDs where sale price is below strike price	Marginal financial performance expected due to support under ROCs/RHI and lower investment cost and operating overheads at the scale of application	No

Technology	Description	Fuel Source	Fuel risk	LZC Policy compliance	Applicable at site wide infrastructure scale	Scale in relation to demand	Space requirement assuming construction on the Site	Technology risks / operational issues	Planning risk	CO2 abatement potential	Air Quality	Climate change and carbon emissions	Noise & Vibration	Water (groundwater, surface water and marine)	Transportation	Waste	Geology and soils	Biodiversity and nature	Historic environment	Landscape and Townscape	Communities and Amenities	Capital cost	Operating cost	Revenue potential	Initial estimate of financial performance	Consider as part of opportunity appraisal?
Gasification CHP	Syngas is generated in a dedicated gasifier through the process of gasification. This is fed into an Internal Combustion Engine working on Spark Ignition Cycle. Electricity is generated through a generator directly coupled to the engine. Heat is extracted through cooling of the engine jacket, heat recovery from the exhaust and through an intercooler if fitted.	Range of fuels including wood chip, sawdust, bark, treated wood, waste materials, waste heat	Good outlook for fuel availability. UK industry in production of biomass gearing up - scope for imports of some fuel sources remains high. Competition for fuel may drive prices up depending on number of schemes realised. Volume of fuel required for CHP applications is high. Represents appreciable risk. Opportunities for dual fuel can potentially reduce this.	Gasification of biomass/waste is acceptable LZC technology to meet carbon emissions reductions set out in local planning policy and building standards	Yes, can be offered as low carbon heat to plot developers	Require large scale to operate successfully.	Very large space requirement on a per kWe installed basis both for plant and for fuel storage and handling. Requires much larger fuel store than biomass heating only due to lower efficiencies and required scale of application. Volume of storage dependent on number of day's storage requirements. Footprint for plant alone is typically 0.4m2/kWe	Well established at a larger scale (over 20MW) using fluidised bed technology - The scale proposed for this project, technology less proven. Gasification process is known to present operational and reliability issues - problems have included failure to ensure effective temperature control in the reactor preventing consistent generation of power, production of gas with highly variable calorific value and an excess of tars that have stopped prime movers from operating, fuel handling and fuel feed has also been a problem in a number of cases - considered to be a relative high risk for the project. Number of European companies have produced demonstration small scale gasification plants but few plants known to be in commercial	As for biomass boilers, emissions can be managed to meet local air quality standards using variety of techniques. Frequent fuel deliveries will be required, volume depends on energy density of fuel source.	High	As biomass above								As biomass though large space requirements could mean greater impacts.	As biomass though large space requirements could mean greater impacts	As biomass above	Very high. Approx. £3000 - £4000 for plants with gas engine prime mover. Higher for steam cycle based systems	Very High - Approx. £200 per kWe installed per year for gas engine based systems	Heat output supported under RHI amend through sales. Revenue from electricity sales/offsets with additional payments from CfDs where sale price is below strike price	Although supported by RHI/CfD, technology not yet established at this scale and therefore reliability issues expected to lead to poor financial performance	No
Anaerobic Digestion with CHP	Biogas is produced from controlled anaerobic decomposition of organic mater (waste energy crops etc.) undertaken in tanks. Biogas can be upgraded to natural gas quality (biomethane) or used directly in internal Combustion Engine working on Spark Ignition Cycle or boilers. Electricity is generated through a generator directly coupled to the engine. Heat is extracted through cooling of the engine jacket, heat recovery from the exhaust and through an intercooler if fitted	Food waste, organic fraction MSW, sewage, energy crops etc..	Organic waste is available in the local area but quantity is unknown. Additional sources of feed stock maybe required to make plant viable	Biogas CHP is an acceptable LZC technology to meet carbon emissions reductions set out in local planning policy and building standards	Scale of application assuming AD plant developed would not lend itself to site wide solution without wider area being integrated into scheme. Economics would not justify this scale of application. It is assumed that the Council would not consider development of such a scheme on the required scale.	Comparable to natural gas fired CHP	High - AD plants have a high space requirement. AD plant require large tanks, feedstock reception and storage as well as plant rooms to contain boiler, CHP and other auxiliary plant.	Low technology risk - standard IC SI technology. Reliable and proven technology.	Very high for urban environments due to scale of AD process plant, potential odour issues and perceived public opinion	High on individual technology basis. Unlikely to be deployed to provide 100% of heat to scheme. Medium as part of technology mix.	Emissions would need to be considered in the light of any AQMA in the vicinity. Possible need for dispersion modelling. GLA planning policy require gas engine CHP units > 400kWe to be fitted with selective catalytic reduction (SCR) to reduce NOx emissions	Anaerobic digestion contributes to reducing carbon emissions and reducing climate change	Consideration needed of noise effects depending on proximity of sensitive receptors, in particular residential properties	Storage of feedstock and digestate could have implications for pollution of water environment but it should be possible to manage this.	Possible transportation issues during construction. Effects during operation depend on the source of the biofuel or raw feedstocks for the plant. If transported by road/rail then impacts could arise	Construction waste. Digestate will require removal from site for use or disposal	Potential for direct impacts during construction but in urban area so no loss of agricultural soils, possibility of encountering contaminated land	Noise could effect biodiversity depending on proximity of receptors.	Direct effects possible during excavations for works, possible visual effects on historic setting	Visual effects heavily dependent on scale of plant though	Potential employment opportunities during construction and operation, may be perception of odour issues	Very high. AD plants comprise substantial number of plant items and equipment. Approx. £5000 per kWe installed depending on scale	Approx. 3.5p/kWh	AD is supported under FiT if less than 5MWe and supported under RHI. Revenue also from heat and power sales and potential gate fees. For plants >5MWe additional payments from CfDs where electricity sale price is below strike price	AD is supported under FiT if less than 5MWe and supported under RHI. Likely to be commercially viable at the required scale.	
Waste Incineration CHP	Large scale EfW plant consist of solid fuel steam boiler and steam turbine cycle	Municipal Solid Waste	Local resource currently sent to NLW EFW plant so any new plant would be in direct competition. Potential for waste volume to decrease with increased recycling rates.	Waste incineration is acceptable LZC technology to meet carbon emissions reductions set out in local planning policy and building standards	Scale of application would not lend itself to site wide solution without wider area being integrated into scheme. Economics would not justify this scale of application. It is assumed that IBC would not consider development of such a scheme on the required scale.	Only suitable on very large scale	Very large space requirement on a per kWe installed basis for plant and for incineration and handling. Similar to steam cycle biomass CHP in terms of space take.	Well proven technology at large scale above 10 - 20 MWe . Fewer applications at smaller scale application. However, not considered to be a technology related issue	Highly likely to receive significant local objection. Unlikely to be feasible to develop incineration facility in area (issues in relation to emissions, transportation of waste etc.).	High	Emissions would need to be considered in the light of any AQMA in the vicinity. Possible need for dispersion modelling and deployment of emission control measures	Use of waste contributes to reducing carbon emission and reducing climate change	Consideration needed of noise effects depending on proximity of sensitive receptors, in particular residential properties	Storage of waste could have implications for pollution of water environment but it should be possible to manage this.	Possible transportation issues during construction. Effects during operation depend on the source of the biofuel or raw feedstocks for the plant. If transported by road/rail then impacts could arise	Construction waste, bottom ash etc. from operation would require disposal which could contribute to other issues such as transportation	Potential for direct impacts during construction but in urban area so no loss of agricultural soils, possibility of encountering contaminated land	Noise could effect biodiversity depending on proximity of receptors.	Direct effects possible during excavations for works, possible visual effects on historic setting	Visual effects heavily dependent on scale of plant, in particular stacks. Discussion of large scale plants may mean greater impacts. May be possible to partly 'sink' plant into ground	Potential employment opportunities during construction and operation, may be public perception with regard to 'incinerator' issues	Very high. EFW plants comprise substantial number of plant items and equipment. Approx. £5000 - £10,000 per kWe installed depending on scale	Approx. 5p/kWh	Heat output supported under RHI (biomass element only) and through sales. Revenue from electricity sales/offsets with additional payments from CfDs where sale price is below strike price. Gate fee from waste received by the plant	Unlikely to be commercially viable at the scale appropriate for the site.	No
Bio liquid CHP	Internal Combustion Engine working on Compression Ignition cycle. Electricity is generated through a generator directly coupled to the engine. Heat is extracted through cooling of the engine jacket, heat recovery from the exhaust and through an intercooler if fitted.	Biofuels from energy crops and waste oil from industrial and catering	Uncertainty of future supply chain and price of fuel since transport sector is increasingly using the same source. There are also uncertainties relating to the sustainability nature of the fuel for grown crops.	Bio liquid CHP is an acceptable LZC technology to meet carbon emissions reductions set out in local planning policy and building standards	Yes, can be offered as low carbon heat to plot developers	Comparable to natural gas fired CHP	Compact technology on per kWe basis. Comparable to gas CHP	Low risk - Well proven technology at the scale of the project. Readily available	Emissions will be managed by installing flue to meet air quality standards. Frequent fuel deliveries required impacting local traffic and vehicle movements.	High on individual technology basis. Unlikely to be deployed to provide 100% of heat to scheme. Medium as part of technology mix.	Medium to high. Emissions from reciprocating engine CHPs have high concentrations of NOx also contain CO and UHCs. Emissions would need to be considered in the light of any AQMA in the vicinity. Possible need for dispersion modelling.	Use of biofuels has the capability of reducing carbon emissions though may need to demonstrate the sustainability of the biofuels.	Consideration needed of noise effects depending on proximity of sensitive receptors, in particular residential properties	Biofuels could pollute water environment if spilt and lost. Issues during construction would need to be considered	Possible transportation issues during construction. Effects during operation depend on the source of the wastes for the plant. If transported by road/rail then impacts could arise	Construction waste but little from operation	Potential for direct impacts during construction but in urban area so no loss of agricultural soils, possibility of encountering contaminated land	Noise could effect biodiversity depending on proximity of receptors.	Direct effects possible during excavations for works, possible visual effects on historic setting	Visual effects heavily dependent on scale of plant.	Potential employment opportunities during construction and operation	Similar to Gas CHP	Maintenance costs roughly double those of natural gas CHP. Fuel cost currently around £100/litre - equivalent to around 10 p/kWh of fuel input.	Heat and electricity sales	High fuel prices mean than technology is unlikely to be economic	No
Absorption chiller	Produces coolth. By using high temperature water or steam it raises the temperature of a cooling circuit for heat rejection and lowers the temperature of a chilled water circuit used for cooling.	Heat	Degree of fuel risk dependent on source of heat. Not an issue if integrated into heat network with low fuel risk.	Absorption chillers are acceptable as LZC technology if source of heat is based on LZC technology.	Can be used in selected buildings with sufficient cooling demand or feeding a communal cooling network	Potentially suitable in conjunction with CHP. Requires individual buildings to have sufficient demand so limited ability to deploy.	Would be deployed at plot level. Requires more space than conventional electric chillers and also larger heat rejection plant.	Best used as base load provider combined with electric chillers for supplement coolth - requires at least 95°C heat available. Unable to modulate rapidly in response to changes in demand.	Low	Carbon emissions savings are sensitive depending on the fuel source of the heat production	Dependent on heat source											Medium - £400 - £1,000 per kW installed. Decreases with increasing scale	Dependent on CoP and source of heat Maintenance costs approx. £50 - £100 per kW installed capacity per	Coolth sales	Requires low cost heat to be financially viable. Financial performance with gas CHP likely to be poor. Renewable heat supplying absorption chillers qualifies for RHI.	Yes

Technology	Description	Fuel Source	Fuel risk	LZC Policy compliance	Applicable at site wide infrastructure scale	Scale in relation to demand	Space requirement assuming construction on the Site	Technology risks / operational issues	Planning risk	CO2 abatement potential
Solar Thermal Panels	Water is pumped through a solar collector and sun raises the temperature of the water. Main solar heating technology options include evacuated tube collectors and flat plate. Evacuated tube collectors raise water to higher temperature and are more suited to district heating applications where the pre heating of return water is required.	Solar irradiation	Low - High degree of certainty around annual variation and long term future radiation level. The incident solar irradiance in Islington area is average relative to the rest of the UK. However, urban environments can be dusty with high concentrations of particulates present in the air. Regular cleaning of solar panels may be necessary to maintain efficiency	Solar thermal is an acceptable LZC technology to meet carbon emissions reductions set out in local planning policy and building standards	Potential to contribute towards site wide heat network.	Can be deployed as part of a technology mix. Unlikely to be able to meet entire site demand.	Very High - Solar thermal collectors require a large area relative to heat output. Large footprint required to install at scale of site-wide infrastructure unless acting as part of a technology mix. In that case can potentially be deployed on rooftop of any energy centre being developed on the site. Centralised application doesn't lend itself to widespread deployment across site. If deployed on site wide basis, will be more suitable being integrated at building level	Proven technology. Vandalism should be considered, especially when installed on ground level.	Low	High
Ground Source Heat Pump/Seasonal Heat Store	Raises the temperature of a heating circuit by taking energy from the ground. Usually uses electricity as energy input. Operates as refrigeration cycle. Open loop and closed loop technologies available.	Ground temperature is typically 14ºC at >2m below surface and relatively consistent.	Low risk - operates on electricity	Ground source heat pumps are an acceptable LZC technology to meet carbon emissions reductions set out in local planning policy and building standards	Potentially applicable at site wide basis as part of district heating network. However, only low grade heat will be delivered and this will require boosting to deliver across a heat network efficiently	Adequate heat capture can be expected. Will meet significant proportion of site heating demands. However, more suited to individual building scale applications due to poor efficiency of heat transportation across DH network.	Not an issue - below ground level	Proven technology. Potential Issues in relation to achievable seasonal energy efficiency ratios and constraints placed on grade of heat deliverable to plot developers	Low	Medium - as part of site wide heat network
Water source heat pumps	Raises the temperature of a heating circuit by taking energy from the water body (lake, river, canal, sea etc.). Usually uses electricity as energy input. Operates as refrigeration cycle. Open loop and closed loop technologies available.	Heat available in large water body	Water temperature and stability dependent on nature of water body and depth. The smaller the body the higher the dependency of water temperature (and therefore resource) on season. WSHPs perform better in the summer. Potential reduction of heat pump performance with silt build up on coil	WSHPs are an acceptable LZC technology to meet carbon emissions reductions set out in local planning policy and building standards	Potentially applicable at site wide basis as part of district heating network. However, only low grade heat will be delivered and this will require boosting to deliver across a heat network efficiently	Adequate heat capture can be expected. Will meet significant proportion of site heating demands.	Not an issue - collectors located underwater	Proven technology. Potential Issues in relation to achievable seasonal energy efficiency ratios and constraints placed on grade of heat deliverable to plot developers	Low	Medium - as part of site wide heat network
Air source heat pumps	Raises the temperature of a heating circuit by taking energy from air. Usually uses electricity as energy input. Operates as refrigeration cycle. Open loop and closed loop technologies available.	Heat available in air	Air temperature and therefore resource highly dependent on season. ASHPs perform better in the summer	ASHPs are an acceptable LZC technology to meet carbon emissions reductions set out in local planning policy and building standards	Potentially applicable at site wide basis as part of district heating network. However, only low grade heat will be delivered and this will require boosting to deliver across a heat network efficiently	Adequate heat capture can be expected. Will meet significant proportion of site heating demands. However, more suited to individual building scale applications due to poor efficiency of heat transportation across DH network.	Compact technology on per kWe basis. Comparable to gas boilers	Proven technology. Potential Issues in relation to achievable seasonal energy efficiency ratios and constraints placed on grade of heat deliverable to plot developers	Low	Medium - as part of site wide heat network
Industrial heat recovery using heat pumps	Raises the temperature of a heating circuit by taking waste heat from industrial process (cooling). Usually uses electricity as energy input. Operates as refrigeration cycle. Open loop and closed loop technologies available.	Waste heat available from industrial processes	Dependent on process parameters (temp profile, stability, annual running hours etc.). Normally very stable for continuous processes running on a 24/7 basis	IWHSHPs are an acceptable LZC technology to meet carbon emissions reductions set out in local planning policy and building standards	Potentially applicable at site wide basis as part of district heating network. Dependent on waste heat temperature low grade heat may be delivered and this will require boosting to deliver across a heat network efficiently	Adequate heat capture can be expected. Will meet significant proportion of site heating demands.	Dependent on process and heat recovery coil design. Heat pump units are compact	Proven technology. Potential Issues in relation to achievable seasonal energy efficiency ratios and constraints placed on grade of heat deliverable to plot developers	Low	Medium to high - as part of site wide heat network
Deep borehole into hot rocks	Open loop extraction of heat from ground accessing medium temperature underground by pumping water into deep boreholes	Underground geothermal heat	BGS Geological, Groundwater Vulnerability and Geothermal maps of UK indicate low potential for geothermal	Geothermal wells are an acceptable LZC technology to meet carbon emissions reductions set out in local planning policy and building standards	Yes, can be offered as low carbon heat and electricity to plot developers	Scale of application would not lend itself to site wide solution without wider area being integrated into scheme. Economics unlikely to justify this at scale of application. It is assumed that IBC would not consider development of such a scheme on the required scale.	Compact technology in terms of footprint requirement at ground level	well proven technology although UK experience is limited	Low	Medium

Technology	Air Quality	Climate change and carbon emissions	Noise & Vibration	Water (groundwater, surface water and marine	Transportation	Waste	Geology and soils	Biodiversity and nature	Historic environment	Landscape and Townscape	Communities and Amenities	Capital cost	Operating cost	Revenue potential	Initial estimate of financial performance	Consider as part of opportunity appraisal?
Solar Thermal Panels	Positive due to reduced dependence on heat from combustion of fossil or renewable fuels	Solar thermal low carbon emissions during operation which will contribute to reducing climate change	Unlikely to be significant effects associated with noise during operation, effects during construction would need to be managed but likely to be small	Unlikely to be sign cant impacts, possible issues during construction would need to be managed	Delivery to site would be the main transport issue, during operation transportation issues would be unlikely	Construction waste but little from operation	Potential for direct impacts during construction but in urban area so no loss of agricultural soils, possibility of encountering contaminated land	Loss of land area but this is likely to be previously developed or brownfield land.	Direct effects possible during excavations for works, possible visual effects on historic setting	Visual effects could arise dependent on the scale of the solar farm, reflection effects have been an issue at some developments	Possible employment opportunities during construction but limited opportunities in operation	High - £500 - £1,500 per kW installed. Decreases with scale	Very low	Revenue from heat sales and RHI	Reasonable payback expected due to low operating costs and technology is supported by RHI	
Ground Source Heat Pump/Seasonal Heat Store	Unlikely to be significant effects associated with emissions	Ground source heat can displace carbon intensive sources and contribute to reducing climate change	Unlikely to be significant effects associated with noise during operation. Effects during construction would need to be managed, drilling of boreholes could give rise to vibrations if there are sensitive receptors in the vicinity	Drilling of boreholes has the potential to cause pollution to groundwater, particularly if contaminated land is present	Delivery to site would be the main transport issue, during operation transportation issues would be unlikely	Construction waste but little from operation	Potential for direct impacts during construction but in urban area so no loss of agricultural soils, possibility of encountering contaminated land during drilling below ground would have to be considered	Possible limited impacts during installation, no impacts expected during operation	Possible limited impacts during installation, no impacts expected during operation	Possible limited impacts during installation, no impacts expected during operation	Possible employment opportunities during construction but limited opportunities in operation	High - £1,000 - £1,500 per kW installed. Decreases with scale	Dependent on CoP. Electricity costs of 2.5 - 3.5 p/kWh heat output typical. Maintenance costs approx. £40 - £50 per kW installed capacity per year	Revenue from heat sales and RHI	Supported under RHI. However, poor payback expected if deployed on site wide basis as part of a heat network.	No
Water source heat pumps	Unlikely to be significant effects associated with emissions	Water source heat can displace carbon intensive sources and contribute to reducing climate change	Unlikely to be significant effects associated with noise during operation. Effects during construction would need to be managed	Potential to cause pollution during construction and during operation through coolant leakage	Delivery to site would be the main transport issue, during operation transportation issues would be unlikely	Construction waste but little from operation	Potential for direct impacts during construction but in urban area so no loss of agricultural soils,	Possible impacts during installation, and during operation from possible leaks	Possible limited impacts during installation, no impacts expected during operation	Possible limited impacts during installation, no impacts expected during operation	Possible employment opportunities during construction but limited opportunities in operation	High - £3,000 - £2,000 per kW installed. Decreases with scale	Dependent on CoP. Electricity costs of 2.5 - 3.5 p/kWh heat output typical. Maintenance costs approx. £50 - £100 per kW installed capacity per year	Revenue from heat sales and RHI	Reasonable payback expected if suitable heat source can be identified due to low operating costs and technology is supported by RHI	No
Air source heat pumps	Unlikely to be significant effects associated with emissions	Air source heat can displace carbon intensive sources and contribute to reducing climate change	Unlikely to be significant effects associated with noise during operation. Effects during construction would need to be managed	Unlikely to be sign cant impacts, possible issues during construction would need to be managed	Delivery to site would be the main transport issue, during operation transportation issues would be unlikely	Construction waste but little from operation	Potential for direct impacts during construction but in urban area so no loss of agricultural soils,	Possible limited impacts during installation, no impacts expected during operation	Possible limited impacts during installation, no impacts expected during operation	Possible limited impacts during installation, no impacts expected during operation	Possible employment opportunities during construction but limited opportunities in operation	Medium - £400 - £1,100 per kW installed. Decreases with scale	Dependent on CoP. Electricity costs of 3 - 5 p/kWh heat output typical. Maintenance costs approx. £40 - £50 per kW installed capacity per year	Revenue from heat sales and RHI	Supported under RHI. However, poor payback expected if deployed on site wide basis as part of a heat network.	No
Industrial heat recovery using heat pumps	Unlikely to be significant effects associated with emissions	Industrial heat source heat can displace carbon intensive sources and contribute to reducing climate change	Unlikely to be significant effects associated with noise during operation. Effects during construction would need to be managed	Unlikely to be sign cant impacts, possible issues during construction would need to be managed	Delivery to site would be the main transport issue, during operation transportation issues would be unlikely	Construction waste but little from operation	Potential for direct impacts during construction but in urban area so no loss of agricultural soils,	Possible limited impacts during installation, no impacts expected during operation	Possible limited impacts during installation, no impacts expected during operation	Possible limited impacts during installation, no impacts expected during operation	Possible employment opportunities during construction but limited opportunities in operation	Medium to high - £500 - £3,000 per kW installed. Dependent on heat recovery equipment requirements. Decreases with scale	Dependent on CoP. Electricity costs of 2.5 - 3.5 p/kWh heat output typical. Maintenance costs approx. £40 - £60 per kW installed capacity per year	Revenue from heat sales and RHI	Reasonable payback expected if suitable heat source can be identified due to low operating costs and technology is supported by RHI	Yes if suitable heat source can be identified
Deep borehole into hot rocks	Unlikely to be significant effects associated with emissions	Ground source heat can displace carbon intensive sources and contribute to reducing climate change	Unlikely to be significant effects associated with noise during operation. Effects during construction would need to be managed, drilling of boreholes could give rise to vibrations if there are sensitive receptors in the vicinity	Drilling of boreholes has the potential to cause pollution to groundwater, particularly if contaminated land is present. Deeper boreholes could represent a greater risk of affecting horizons not currently impacted by contamination	Delivery to site would be the main transport issue, deeper boreholes could require larger plant than for underground thermal heath, during operation transportation issues would be unlikely	Construction waste but little from operation	Potential for direct impacts during construction but in urban area so no loss of agricultural soils, possibility of encountering contaminated land during drilling below ground would have to be considered	Possible limited impacts during installation, no impacts expected during operation	Possible limited impacts during installation, no impacts expected during operation	Possible limited impacts during installation, no impacts expected during operation	Possible employment opportunities during construction but limited opportunities in operation	Approx. £1000 per kW for heat only plant	Approx. 0.5 p/kWh	Heat output supported under RHI amend through sales. Revenue from electricity sales/offsets with additional payments from CfDs where sale price is below strike price	Supported under RHI. However, Suited to larger scale applications. Unlikely to be commercially viable at the scale appropriate for the site. Would need to be integrated into a larger scheme to become viable.	No

APPENDIX 3 - RISK REGISTER

Risk Identification			Risk Assessment			Mitigation & Action		
Risk No.	Risk description	Potential impact (including on cost and schedule)	Impact	Likelihood	Current Risk Rating	Mitigation to date	Further Action	Action Owner
				Technical				
1	Energy Centre Location not appropriate, an alternative is required	Technical design of the network will need to be reconsidered. Business case impact if EC must be located on private land - costs for land purchase or lease may diminish the project business case	2	2	*4*	EC location is proposed as council plant room or council land.	Continued engagement with the council	Consultant
3	Building system incompatibility with District Heating	Increase cost of conversion or reduced revenue through reduced connections leads to dimished business case	2	3	*6*	Connections are based on assumptions that new developments will comply with CP1 (CIBSE code of Practice for Heat Networks). For existing buildings data collected by CT has been incorporated where relevant	Investigate in more detail at feasibility stage. Engage directly with consumers. Local Authority role as planning authority crucial to ensure appropriate design standards are implamented for new developments	Local Authority
4	Planned route cannot be achieved, due to utility congestion in roadways	Route restrictions may mean that certain buildings cannot be connected, may result in increased costs, reduced revenues	2	3	*6*	We have requested information on bariers and constraints from the Council, these have been incorporated where possible.	Further engagement with planning and Highways to de-risk route. Risk for utilities should ultimately be borne by the contractor who should de-risk the project during detailed design stage, if the project is procured as DB / DBO contract. That said utility searches should be performed as project moves to detailed design	Local Authority / Consultant
5	Network lengths and sizing incorrect for new developemnt due to high level nature of information available	Business Case. Cost for pipework increases.	2	2	*4*	Model based on other similar developments and Ramboll's experience	Network design to be re-assessed at feasibility stage as site information becomes more certain	Consultant
6	Gas CHP and/or biomass ruled out as an option during subsequent investigative work - alternative heat supply required	Business Case. Alternative suply options are limited	3	2	*6*	Technology options appraisal conducted.	Further engagement at feasibility stage to continue de risking process.	Consultant
7	Heat demand assessment for new development is based on estimated data, the demand assessment will be inaccurate and consequently network and plant sizing strategy is provisional.	Cost impact associated with incorrectly sized plant / network	2	2	*4*	All estimated values have been sense-checked against industry benchmarks and local planning applications, where available billing data has been used.	Re-visit assessment as developer's plans become more concrete at feasibility stage	Local Authority / Consultant

Risk No.	Risk description	Potential impact (including on cost and schedule)	Impact	Likelihood	Current Risk Rating	Mitigation to date	Further Action	Action Owner
8	Uncertainty around capacity to reduce building return temperatures has impact on network sizing strategy	Cost and capacity. Network may be undersized, reducing the capital cost of project but also the ability to supply all customers	2	3	*6*	The network is provisionally sized for building return temperatures of 65 ˚C in line with the code of practice for existing buildings. It is also assumed that new developments would achieve return temperarures of 45 ˚C.	De risking of plantroom connections for existing buildings to be progressed at feasibility stage. Options for financing retrofitting works should be investigated as part of the developing business model. For new developments, planning policy should be strengthened and should reference technical requirements for connection. Local Authority could consider developing a connection guide for potential customers to ensure that these are in line with network requirements. Requiring all new developments to comply with CP1 (CIBSE Code of Practice for heat Networks) would significantly de-risk this.	Local Authority / Consultant
9	Planned developments do not come forward / are held up.	Business Case. Inaccurate cost and revenue assumptions	3	3	*9*	Assessment is based on best available information, however this risk cannot be entirely mitigated until there is some more concrete information available from developers	Continued engagement with developers	Local Authority / Consultant
10	Ground conditions	Unexpected dificulties in laying network and energy centre construction, impacting on capital cost and programme	2	2	*4*	Costs are based on UK quotations for hard dig, city centre locations, factored to account for regional labour cost variations	Risk for ground conditions should ultimately be borne by the contractor who should de-risk the project during detailed design stage, if the project is procured as DB / DBO contract	Local Authority
				Commercial				
11	Weak business delivery model	Insufficient incentive for key project partners to participate. Council's risk / reward profile does not match project requirements. Stakeholder relationships not sufficienctly robust to drive project forward.	4	3	*12*	Project opportunities have been formulated in within commercial delivery context. Initial discussions have been held with the Council to establish appetite for engagement as project participant / developer.	Build relationships with key stakeholders. Develop the business model, identifying viable commercial delivery structures and preferred delivery route.	Local Authority / Consultant
12	Heat uptake risk - customers not connecting to the scheme or choosing to disconnect at a later time, particularly for later phases	loss of revenue, impacting business case	3	3	*9*	Project has been tested at 100 % uptake and then at varying volumes of heat sales to understand the project risk	Build relationships with key stakeholders (Developers and public buildings). Develop and operate the scheme under best practice guidelines including adoption of Heat Trust scheme and CIBSE code of practice for heat networks.	Local Authority / Consultant
13	Assumptions around developer contributions incorrect	Business Case. Loss of capital contribution and ongoing contribution to O&M costs.	3	2	*6*	Sensitivity has been assessed on with and without developer contributions, level set at a rate equivalent to the installation of a gas boiler.	Ongoing engagement with developers to understand their appetite to connect and contribute	Local Authority / Consultant

Risk No.	Risk description	Potential impact (including on cost and schedule)	Impact	Likelihood	Current Risk Rating	Mitigation to date	Further Action	Action Owner
				Financial				
14	Uncertainty around energy price forecasts	Lower revenue from energy sales, higher costs from energy purchases ~ impact on financial case for the project.	4	2	*8*	Consumer websites and DECC energy price forecasts have been adopted. Sensitivity has been carried out to test the case under a variety of energy prices	Further investigation as part of feasibility stage. Obtain more detailed customer pricing information	Local Authority / Consultant
15	Assumptions around heat and electricity selling prices to customers are inaccurate	Business case, impacts on economic results and viability of the project.	2	4	*8*	Assessment is based on BAU , following industry best practice. Sensitivity analysis conducted.	Further engagement with developers and public buildings required.	Consultant
16	Assumptions around RHI tariffs	Lower revenue from the RHI impacts business case	2	4	*8*	Assessment incorporates most recent available information and sensitivity analysis was carried out.	Continued revision of policy changes as the project moves forward.	
17	Development, investment and operational costs are subject to uncertainty and will change as the project develops	Business case, impact on NPVs, IRRs	3	3	*9*	Costs based on data from previous projects	Continued refinement of design assumptions and improved cost estimates at feasibility stage. Engage a cost consultant at delivery stage.	Local Authority / Consultant
18	Capital cost are typically high for DH projects. Project may be perceived as high risk by financiers.	Project fails to get funding, not developed, opportunity lost	2	4	*8*	We have assumed a phased project development based on information from similar projects	Feasibility work should further consider phasing issues	Local Authority / Consultant
19	Current assumptions don't allow for future expansion of network i.e. to new developments which are not currently known and planned. This may reduce the long-term business case for investment beyond what has been proposed here.	Business case. Project is limited in its ability to expand beyond the masterplan vision, new developments cannot connect.	2	3	*6*	Expansion possibilities have been considered at a high level	More detailed assessment of potential expansion as project moves to EMP finalisation	Local Authority / Consultant
				Planning				
20	Temporary works permits	Delays in network construction with cost implications	3	2	*6*	Realistic build out rates, based on other Ramboll projects assumed in implementation plan	Highlight as risk for contractors, transfer risk to contractor in procurement phase	Local Authority / Consultant
21	Planning not granted for new developments	Business Case. Inaccurate cost and revenue assumptions	3	3	*9*	Assessment is based on best available information, however this risk cannot be entirely mitigated until there is some more concrete information available from developers	Continued engagement with developers	Local Authority / Consultant
22	Existing planning policy too weak to require new developments to connect or safeguard for future connection.	Business Case. Inaccurate cost and revenue assumptions, lost opportunity.	4	3	*12*	Assessment is based on best available information and assumption that new developments would connect and would adopt suitably designed wet heating systems.	Engagement with developers to explain benefits of DH and encourage participation. Local Authority to strengthen local policy wording to support growth of heat networks.	Local Authority / Consultant
23	New energy centre ~ complications in achieving planning permission.	Scheme cannot be developed in current configuration	3	2	*6*	Assessment is based on best available information including discussions with the council.	Engagement with council planners to identify development risk factors and establish requirements/strategies for mitigation.	Local Authority / Consultant