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NEWHAVEN TOWN COUNCIL
ENERGY MASTERPLAN

RAMBOLL

Newhaven Town Council

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Made by	**Luca Giunta, Alexia Gonin, Gemma Giribet and Steven Wright**
Checked by	**Sophie Cator**
Approved by	**Anthony Riddle**
Description	**Opportunity Mapping Report**

Ref

Version 1

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GLOSSARY

ADE	Association of District Energy
bar_a	Absolute Pressure Unit (bar)
bar_g	Gauge Pressure Unit (bar)
BAU	Business As Usual
CfD	Contract for Difference
CHP	Combined Heat and Power
CHPQA	Quality Assurance Scheme for Combined Heat and Power
CoP	Coefficient of Performance
coolth	Cooling delivered by chilled water loop
CSH	Code for Sustainable Homes
DECC	Department of Energy and Climate Change
Delta T	The temperature difference between water flowing in the flow and return sections of the network.
DF	Discount Factor
DHN	District Heating Network
EIA	Environmental Impact Assessment
ERF	Energy Recovery Facility
FEES	Fabric Energy Efficiency Standard
GFA	Gross floor area
GWh	Gigawatt hour
HIU	Heat Interface Unit
HP	High pressure
HRSG	Heat Recovery Steam Generator
HSE	Health and Safety Executive
HTHW	High Temperature Hot Water
IP	Intermediate Pressure
IRR	Internal Rate of Return
LECs	Levy Exemption Certificates
LP	Low Pressure
LTHW	Low Temperature Hot Water
MTHW	Medium Temperature Hot Water
MW_e	Megawatts (electrical)
MWh	Megawatt hour
MW_{th}	Megawatts (thermal)
NFFO	Non Fossil Fuel Obligation
NPV	Net Present Value
OCGT	Open Cycle Gas Turbine
PED	Pressure Equipment Directive
PROW	Public Right of Way
PV	Photovoltaic
QI	Quality Index
RAMSAR	Area of Conservation for wetlands
RERF	Recycling and Energy Recovery Facility
RHI	Renewable Heat Incentive
ROC	Renewable Obligation Certificate
Service pipe	Connections from the distribution network to HIUs in connected buildings
SSSI	Site of Special Scientific Interest
tee	Tee shaped connection in a section of pipe
tph_e	tonnes per hour equivalent (steam)

EXECUTIVE SUMMARY

Ramboll has been commissioned by Newhaven Town Council ("the Council") to undertake a an energy mapping and masterplanning study in order to establish the technical and commercial feasibility of heat network opportunities across the Town Centre and surrounding area.

Ramboll has collaborated with the Council and Bioregional to:

- understand current and future energy demands in Newhaven
- identify potential opportunities to develop heat networks
- select the most promising opportunities in line with the Council's aspiration as well as commercial, environmental and financial considerations.

Two opportunities have been identified for a high level technical and commercial assessment. For these opportunities Ramboll has assessed a number of Key Performance Indicators (KPIs) and used the results to establish the overall potential for a heat network and the next steps towards implementation.

Opportunities

Two potential heat network opportunities have been identified:

1 A Main Network, with an existing Energy Recovery Facility (ERF) located in the North Quay Area utilised as the primary heat supply asset;

2 A small scheme, located in the West Newhaven Marina area (West Quay) which could be supplied by a purpose built local energy centre fitted with gas boilers and a water source heat pump.

In the wider view the Newhaven Marina scheme could potentially connect to the main network and expand towards a nearby housing allocation area. Both schemes are described below.

The schemes were assessed in relation to two economic key performance indicators and CO_2 savings:

- **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.
- **CO_2 savings** – reviewed against business-as-usual

Considering that public borrowing can potentially achieve interest rates as low as 3.5%, this would be indicative of the minimum hurdle rate IRR required by the Council to take any scheme forward, therefore results are compared to this figure as a base line. For a fully private sector led scheme only IRRs in the region of at least10% would be considered to be acceptable, with 12% to 15% being typical.

The Main Network

Several scenarios have been modelled to assess the KPIs of a heat network supplied by the ERF. The analysis carried out by Ramboll suggests that new developments (notably: the Eastside, the Parker Penn and the Marco Trailer Developments) as well as a new asphalt manufacturer (notably FM Conway), which could potentially move to Newhaven in the short term, could create the conditions for a heat network scheme supplied by the ERF.

NPV (3.5% D.R., 25 years): £ -1.41M

NPV (6% D.R. 25 years): £ -2.6M

IRR (25 years): 1.48%

CAPEX: £7.5M

The scheme reported in , connecting mainly new development and other commercial stakeholder was found to deliver an estimated project IRR of 1.48% and 3.4% over 25 and 40 years respectively (pre-financing). Due to this low IRR, implementation of this scheme could be challenging.

It should be noted, though, that almost all consumers within the light industrial area have been excluded from the analysis due to the lack of reliable data and information on their heat demand and heating system. Bioregional and the Council have supported Ramboll in collecting data, but no responses have been received from stakeholders located in this area. The impact of connecting these stakeholders have though been assessed in a separate analysis.

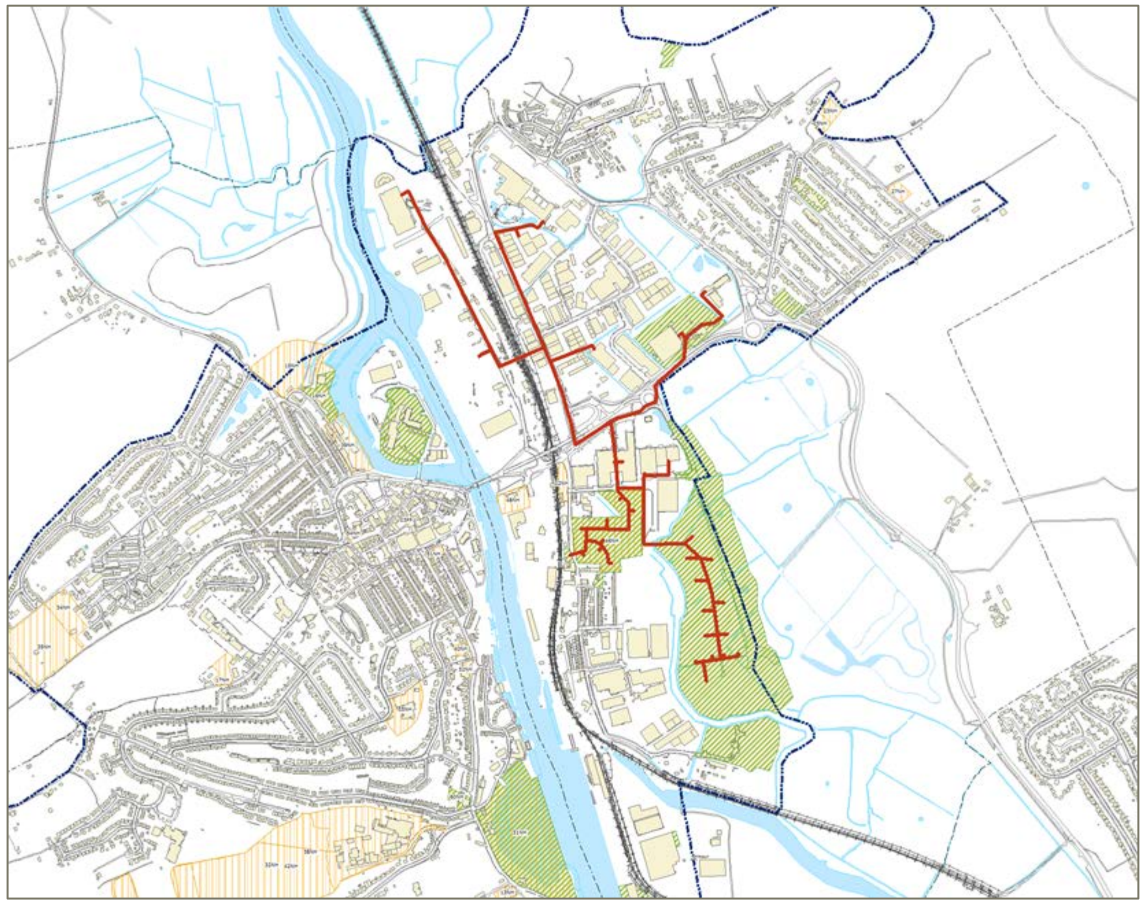


Figure 1: The Main Network Scheme

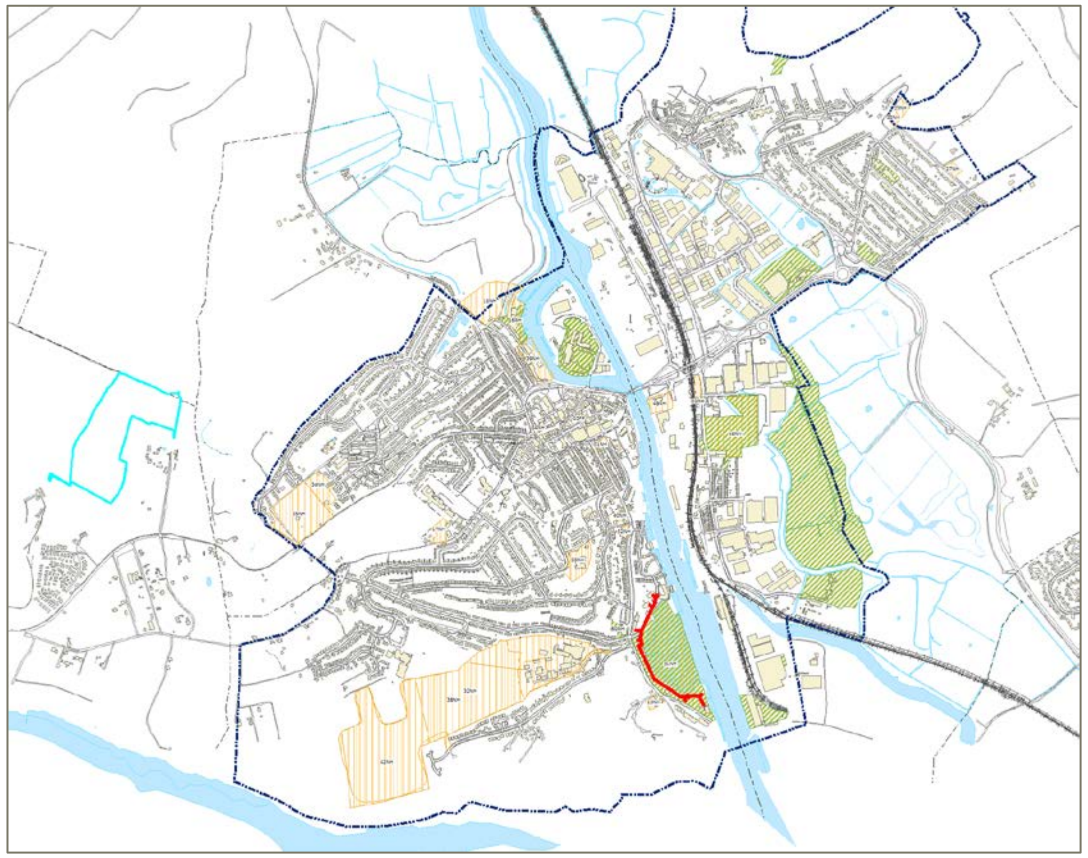


Figure 2: The Newhaven Marina Scheme

Connection of these stakeholders, where reasonable (e.g. after considerations done on their annual heat demand, heating system, risk etc.), would improve the financial and environmental KPIs of the scheme.

For instance by connecting approximately an additional 3.3 GWh of annual heat demand (i.e. an additional 38%), the IRR was found to increase to approximately 4.4% over 25 years and 5.9% over 40 years. This assessment is based on the assumption that this demand is shared by a maximum of 15 stakeholders located within a maximum distance of 45 meters from the main spine of the network. Should the same volume of demand be connected through a lower number of connections then the scheme would benefit of an increased IRR as a result of the reduced pipework and infrastructure requirements.

Furthermore, the Council has indicated that there could potentially be an increased level of occupation in the Enterprise Zone (EZ) over the coming years. The Local Enterprise partnership and Lewes District Council have both employed Enterprise Zone managers to help steering the desired businesses to come to Newhaven. This could possibly result in an increased heat demand and, potentially, an IRR greater than 3.5% over 25 years could be achieved.

Moreover, engagement with FM Conway indicates that this stakeholder could open a factory in the EZ over the next years. This stakeholder could represent a good opportunity to start developing a network with the aim of future expansion, and could in fact act as a catalyst towards the development of a scheme.

Due to the low rates of return it is unlikely to be attractive to implement even under private sector leadership. However, there may be potential to apply for grant funding including BEIS Heat Network Investment Programme, which could improve the economic case for a heat network and/or provide potential for leveraging additional income such as the Energy Companies Obligation (ECO). In fact, a capital injection of 10%, 20% and 30% of the total capital cost associated with the scheme may increase the IRR over 25 years to 2.3%, 3.5% and 4.9% respectively. Finally a capital injection of roughly £2.74M would result in an IRR of 6%.

The Newhaven Marina Scheme

NPV (3.5% D.R., 25 years): £ 460K

NPV (6% D.R., 25 years): £ 33K

IRR (25 years): 6.24%

CAPEX: £1.7M

Another separate heat network opportunity (Figure 2) has been identified in the West Quay area, where a relatively high dwelling density, together with a planned new residential development could create favourable conditions for the implementation of a small heat network scheme.

This scheme, although small, could potentially deliver an IRR in the region of 6.24 % over 25 years and a discounted (3.5% discount rate.) net present value (NPV) of approximately £460k.

With a relatively modest capital cost, estimated in the order of £1.7M, and an average annual operating margin of £135K, this scheme was found to pay back after approximately 10 years of operation.

The Wider Vision

Forward thinking will be needed, should the two schemes be developed, in order to allowing their further extension and, eventually, interconnection.

There may be potential to extend the Main Network towards Denton Island and the Town Centre in the future, whilst the Newhaven Marina could expand towards nearby housing.

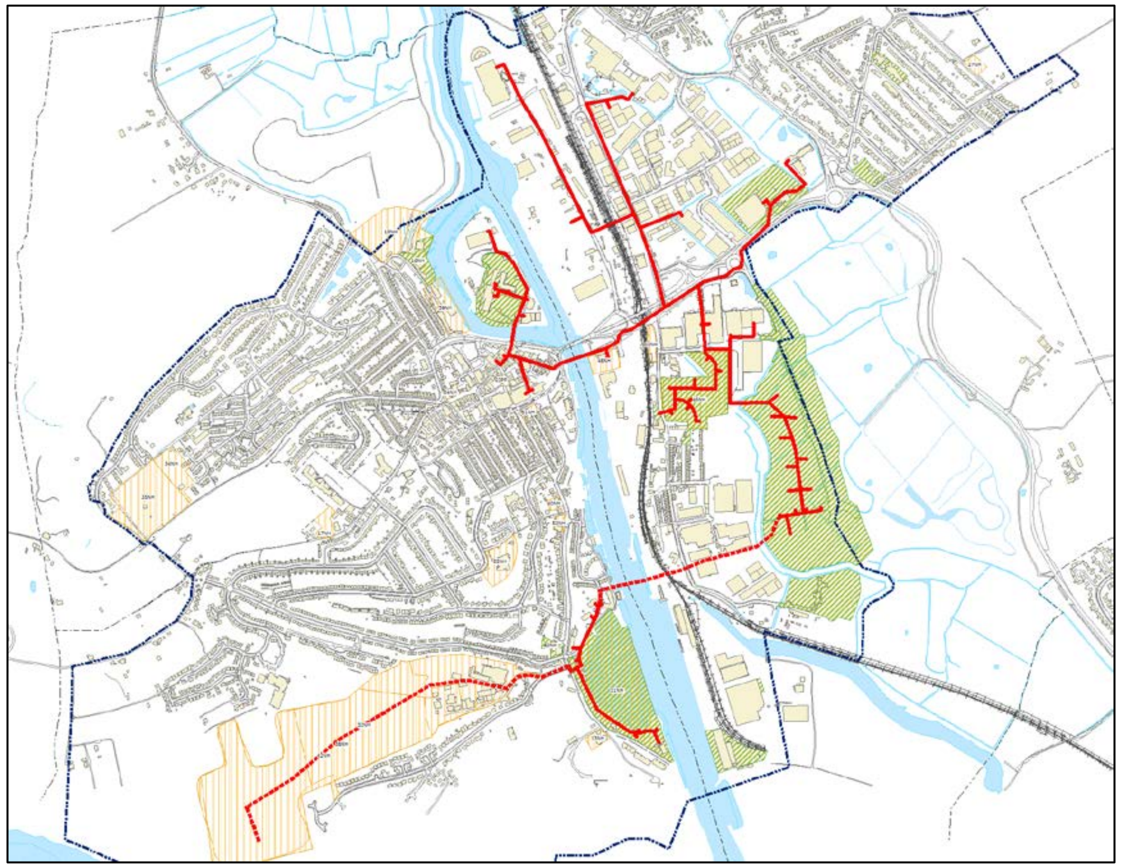


Figure 3: The Wider Vision

Conclusions and Recommendations

The results presented in section 6 indicates that there could be a potential to implement a heat network supplied by the ERF i.e. the "Main Network" under the assumption that:

- Newhaven Town Could would receive grant funding of the value of at least 20% of the initial project capital cost
- An investigation carried out on the light industrial area confirms that a there is a potential to connect at least 3GWh of demand. This volume of heat demand could in fact bring the IRR just above the 3.5% hurdle rate for public sector investment.

The Newhaven Marina scheme appears potentially viable, if led by the local authority. However it does not meet all the key drivers the council is seeking, such as supporting local business in the EZ and potentially attract new one.

It is recommended that further investigation in the technical and economic assumptions is carried out prior to progress to feasibility study to:

- Increase the accuracy of the heat demand data
- Establish the potential for additional stakeholders in the light industrial area to connect to a potential scheme

Benefits to Stakeholders

- **Veolia**: their participation to a potential scheme would need to result in a financial benefit, potentially through the revenues stream associated with heat sales to the Network Company and/or the full, or part of the, RHI revenue stream.
- **Developers**: The analysis carried out in this study assumes the developers would contribute to the development of a heat network through a financial contribution which though should not increase the overall capital expenditure required under a BaU scenario. In reality though there could be scope to actually create a financial benefit that could incentives their participation to the project. In fact, the development of a heat network in the area could eliminate the need for a local gas distribution network and its connection to the national grid. Electric hobs and ovens could be installed within each property (providing additional fossil fuel savings). By replacing the distribution gas grid within the area, and within each building, with a heat network and sharing its costs with a third party (the network company) the scheme could actually benefit the developers
- **The Council** could consider investing in the Newhaven Marina scheme and benefits of the revenues streams, with a view of expanding the network towards the housing allocation site in the future. For all other schemes it appears difficult to recover the cost of borrowing, although there would be others embedded benefits that the Council could benefit from (e.g. economic boost, jobs creation, carbon emission reduction etc.). The Council could apply for capital grants from the national Heat Networks Investment Project (HNIP), which could make the wider network a profitable scheme.
- **FM Conway** could potentially benefit of lower cost of heat compared to its BAU and potentially save in carbon taxes (if applicable)
- **Existing buildings** could benefit of lower cost of heat.

1. INTRODUCTION

Ramboll has been commissioned by Newhaven Town Council ("the Council") to assess the potential for district energy opportunities in Newhaven.

A key focus for this project was the possibility of utilising waste heat from Veolia's Energy from Waste (EfW) facility in the north of the town, which processes 210,000 tonnes of waste per year and produces 16 MW of electrical energy.

The principal outcomes of this project as set out in the original invitation to tender were:

- *"Provide a wide and comprehensive understanding of the current and future heat demands and loads within Newhaven.*
- *Understand whether Veolia's EfW plant could provide the primary heat source for the development of a District Heat Network in the town.*
- *Provide a high level technical and commercial assessment of the source viability and determine the potential for a heat network(s) in Newhaven.*

Newhaven's mantra for development is 'Green, Clean, Marine'. A 20-year vision for Newhaven will see the number of houses in the town increase by around 40% along with the construction of new industrial, commercial and recreational facilities. Newhaven Town Council is committed to reducing area-wide carbon emissions, decreasing the number of residents living in fuel poverty and increasing energy security."

The project is split across two phases of work;

- **Heat Mapping –** Based on actual and predicted future data, demand for heat (and potential cooling and electrical demands) and potential sources of provision in the town,

- **Energy Masterplanning** – Using the outputs of energy mapping to inform the development of an energy masterplan which identifies, evaluates and prioritises any potential DH scheme opportunities including options for heat offtake from the EfW and counterfactual heat network supply and demand opportunities.

The projects were prioritised at the end of the technical and economic study to understand if it would be suitable to progress to subsequent detailed technical and economic modelling as part of a potential future study.

The Council and Bioregional proposed five prioritisation criteria that should be considered to select opportunities to take forward:

I. Supporting local and national policy in reducing CO_2 emissions
II. Minimizing risks
III. Supporting local business in the enterprise zone
IV. Potentially attracting new investments and boost economic growth
V. Addressing fuel poverty

District energy solutions can be very beneficial in enabling large scale carbon emissions reductions by increasing the penetration of low carbon and renewable energy solutions into the local energy supply chain. This can help to increase resilience of the system, particularly for new developments where an integrated energy system can be developed at an early stage. There is an excellent opportunity in Newhaven to develop smart energy systems, given 20-year vision for Newhaven.

The study area for this project as set out by Newhaven Town Council is shown in Figure 4.

Figure 4: Project Study boundary

2. ENERGY DEMAND APPRAISAL

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 opportunities in Newhaven.

The Energy Masterplan focused on Newhaven Town Centre and neighbouring areas. The boundaries of the core study area were set so as to include the whole town.

As heat networks were the main objective of the study, developing heat maps was the primary focus of the energy mapping phase of work. Cooling and electricity demand maps were assessed at a higher level.

To support this phase of works Newhaven Town Council and Lewes District Council provided the following information:

In Excel format:

- National Heat Map (NHM) Data

ArcGIS Layers:

- Planning Application information
- Lewes District Local Plan
- Council owned land
- OS Mastermap

2.1 Stakeholder Engagement

Following analysis of National Heat Map data in May 2016, Ramboll produced a list of businesses and organisations in Newhaven who were expected to be the bigger users of heat and power. The list included industrial, manufacturing and engineering businesses, large retailers, hoteliers, University buildings and public services and facilities like the police station and leisure centre.

It was decided that information on each user's demand for heat and power would be requested by Newhaven Town Council, to maximise the likely rate of response. The list of organisations was passed to Bioregional, who called each business to request the name and contact details of the facilities manager, or other appropriate person within the company dealing with energy contracts, and introduce them to the project over three sessions.

Bioregional were able to obtain the contact details for and speak to the facilities managers of 19 of the 50 organisations listed by Ramboll. Of the other 31;

- 10 had shut down or relocated and the unit/premises was vacant;
- 8 were not interested in taking part in the project;
- 10 could not be reached by phone or by other means;
- 14 were interested in the project

The contacts were then passed to Newhaven Town Council with a Request for Information (RFI) sheet produced by Ramboll and a cover text produced by Bioregional.

The Council emailed each stakeholder on the 11th May 2016, with the deadline for information submission two weeks later.

By the end of May, information had been received from only a small number of those contacted. On 1st June, Bioregional got back in touch to remind them of the request.

By mid-June, data had been received from 4 stakeholders, which was passed to Ramboll for assessment within the study. A number of reasons for the low take-up have been identified:

- Some premises were small, provincial branches of large organisations, such as Premier Inn or Sainsburys, were energy is dealt with at head office level and data is not routinely shared;

- People dealing with requests in smaller companies were administrators rather than dedicated facilities managers and did not feel qualified to fill out the RFI;

- Day-to-day business took priority over our data request.

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

2.2 Heat Demand

The sub sections below outline the methodology used to map the heat demands for the study area and the results of the mapping exercise are presented.

2.2.1 Outline Methodology

The NHM data formed the base layer for the project's heat map. The NHM includes data on 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.

The NHM was, in the first instance, aggregated on a building level basis with the heat demand for all points at the same location aggregated and the resultant point given the reference ID and use class of the largest heat user at that location.

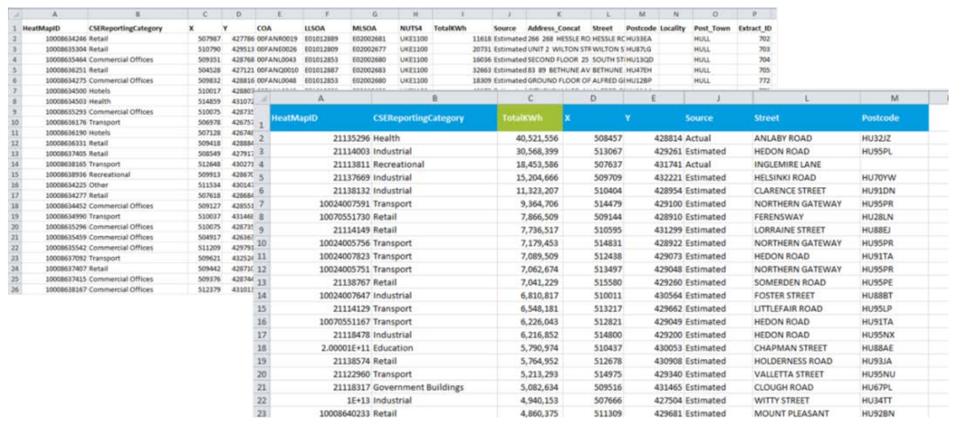


Figure 5: Screenshots of Raw and Filtered Databases

Each heat demand point of the aggregated data was then assigned all the relevant information contained within the National Heat Map (such as building name, address and use class). Since each record would present multiple matches, this process was carried out on the bases of the annual heat demand. Specifically, it was assumed that the record having the highest heat demand would be representative of the whole building.

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.

Where no billing data or NHM data were available, heat demand benchmarks for existing buildings were applied on a kWh per m^2 floor area basis. Benchmarks for existing buildings were taken from CIBSE Guide F and TM46[1] benchmarks. Floor areas were taken from OS Open Map-Local and GIS calculations. Other existing buildings with high heat demands according to the NHM were also checked against Ramboll's benchmarks to increase accuracy.

Table 1 shows the heat demand benchmarks used for existing buildings. The figures were degree day corrected for Region 2 (South Eastern). Benchmarks were also adjusted to reflect heat demand as opposed to fossil fuel consumption by assuming a boiler efficiency of 85%. Appropriate percentages of treated floor area, following CIBSE Guide F factors, were used to increase the accuracy of the benchmarks.

Building Type	Heat Demand Benchmark (kWh/m^2)
Hotels	260
Leisure Centre with Pool	573
Secondary Education – Science laboratories	110
Secondary Education – Lecture Rooms	105[2]
Supermarket	200
Dry Sports Centre	158

Table 1: Heat Demand Benchmarks per Building Type for Existing Buildings

The heat demands for new non-residential developments were calculated using benchmarks including a combination of energy modelling outputs (SAP, SBEM and IES-VE) from Ramboll's experience in energy strategies and CIBSE data which was corrected to reflect expected improvements under future updates to the building regulations.

For residential buildings Ramboll has used data gathered during SAP modelling in conjunction with Part L1A 2013 regulation.

Building Type	Unit	Heat Demand Benchmark (kWh/unit)
Residential – Flats	Dwelling	2,918
Residential – Houses	Dwelling	6,264
Offices	m^2	53.6
Supermarkets	m^2	110.5
Retail (small shops)	m^2	36
Workshop	m^2	99
Storage facilities	m^2	88

Table 2: Heat Demand Benchmarks per Building Type for New Developments

For the light industrial buildings in the vicinity of the EfW facility, a different approach has been used as outlined below.

Use classes such as Transport, Industrial and Retail are, in Ramboll's experience, typically overestimated within the NHM due to the relatively large ratio of floor area to space conditioning requirements. Moreover, industrial buildings tend to use heating systems other than wet systems, which makes these buildings more reluctant to connect to district heating schemes.

For these, Ramboll selected a number of warehouses for which a stack was identified through a desktop investigation using publicly available tools such as Google and Bing Maps, which were deemed likely to use a wet heating system. Bioregional then contacted the relative stakeholder in order to collect energy consumption data and information relative to the heating system. The same exercise has been carried out for other major heat consumers within Newhaven Town Council. Where data has been provided, this has been incorporated within the study and has superseded heat demand data from the National Heat Map. In some cases it has been found that stakeholders identified from the National Heat Map data have closed their business in the area.

Where no response was received, Ramboll has selected a limited number of buildings in the area that are believed to be offices which, from desktop investigation, appear to have a stack, and that therefore could potentially:

- have a wet heating system
- add a relatively low risk to a potential heat network scheme

All other warehouses have been excluded from the study in order to establish the economic viability of a relatively low-risk district heating scheme.

As it will be discussed in section 6.6.1, though, a sensitivity analysis has been carried out to establish the volume of the heat demand associated with these buildings that would make the scheme economically viable if connected to the heat network.

[1] Energy benchmarks. TM46: 2008

[2] This is an average between the Science and Arts Lecture Rooms benchmarks from CIBSE's Guide F

2.2.2 Heat Demand of Existing Buildings

Buildings considered to be of significance to the project are described in the sub-sections below.

It is important to note that some of the stakeholders reported in the next-sub sections may have low-carbon generating assets already installed (e.g. natural gas CHP engines), which could result in a reduced interest in connecting to a heat network, or into a reduced volume of heat that they would be willing to purchase.

Information on the installed generating assets have been requested as part of the data collection exercise, though no low carbon technologies have been reported in the responses received.

2.2.2.1 Denton Island

The man-made island, in the Ouse River and Newhaven Harbour, is home to several business and education centres (see Figure 6).

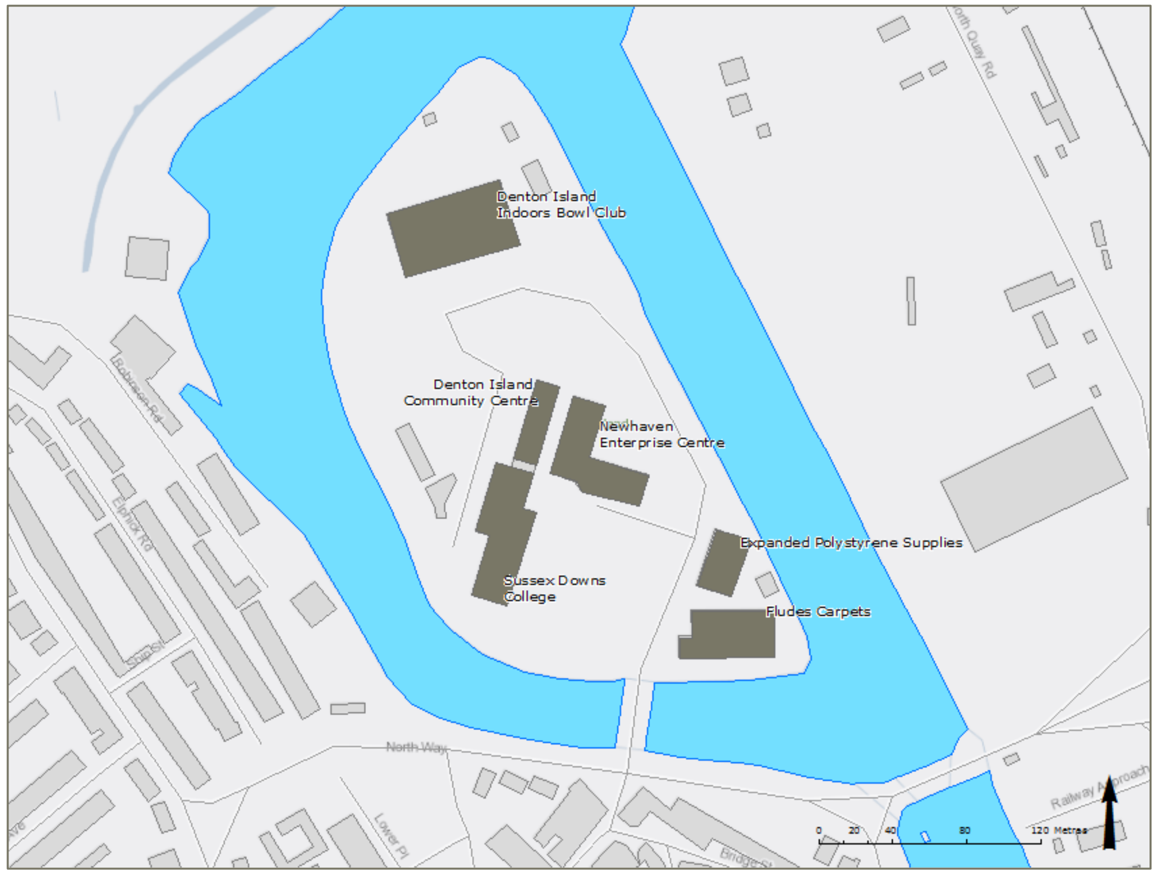


Figure 6: Denton Island Main Buildings Schematic Location

Among them it is worth highlighting the presence of the Denton Island Community Centre, which includes the Denton Island Nursery, Sussex Downs College, the Newhaven Enterprise Centre and the Denton Island Indoors Bowls Club.

Building	Annual Heat Demand (kWh)	Source
Denton Island Community Centre	44,420	Actual (Stakeholder Engagement)
Sussex Downs College	124,504	Benchmarked
Newhaven Enterprise Centre	552,453	Estimated by the NHM
Denton Island Indoors Bowls Club	276,188	Benchmarked
Fludes Carpet	112,399	Estimated by the NHM
Expanded Polystyrene Supplies	167,929	Estimated by the NHM

Table 3: Annual Heat Demands of Significant Buildings in Denton Island

2.2.2.2 The Drove Retail Park

Alongside the south of Drove Road a cluster of retail and light industrial buildings are located. Among them large retailers such as Lidl, Cash Bases and Halfords Autocentre stand out as presenting large heat demands.

Building	Annual Heat Demand (kWh)	Source
Lidl	560,873	Estimated by the NHM
Cash Bases	1,075,266	Actual (Stakeholder engagement)
B&Q	384,379	Estimated by the NHM
Halfords Autocentre	1,231,592	Estimated by the NHM
MacDonald's	191,917	Estimated by the NHM

Table 4: Annual Heat Demands of the Main Buildings Located in the Drove Retail Park

Cash Bases, a cash drawer manufacturer, is located in a building constructed in 1981. The manufacturing plant needs energy for space heating and the manufacturing process. The main processes that require heat are a paint pre-treatment heated tank and two inline curing ovens. Both, space heating and processes use natural gas as the main fuel. The pre-treatment tank temperature is 40 °C while the curing ovens work around 210 °C.

The total annual heat demand for Cash Bases was found to be 1,075 MWh. It is estimated that approximately 30% of this could be delivered via a district heating scheme since the space heating is around 20% of the total heat demand and it is assumed that the paint pre-treatment tanks use 10% of the total annual heat demand. This would result in a total annual connected heat demand of 319 MWh.

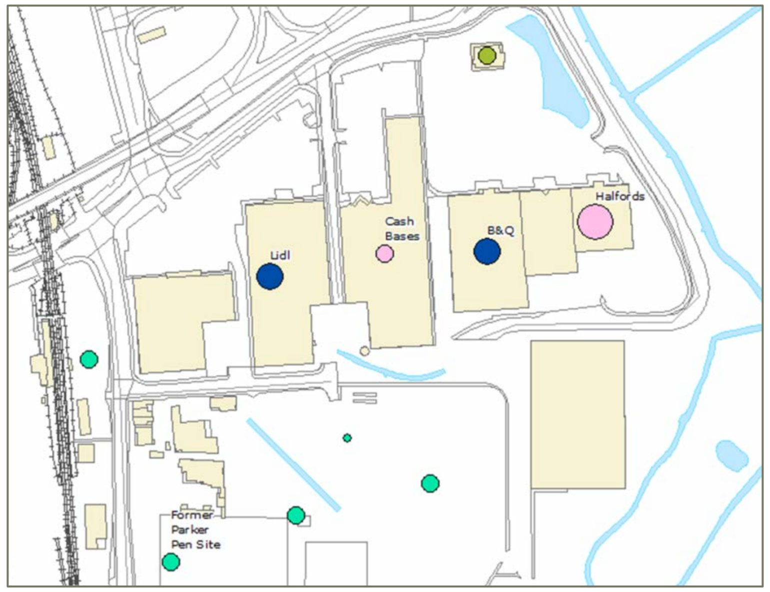


Figure 7: The Drove Retail Park

2.2.2.3 Light Industrial Area

Enclosed between New Road, Drove Road (A259) and Avis Road (B2109) a mix of retail, light industrial, warehouses and other buildings types are located in a triangle-shaped area.

The main buildings identified in the area are the Paradise Park (privately owned), Sainsbury's, Premier Inn Newhaven, Harwood King Printmakers and the Hawthorn Estate.

Building	Annual Heat Demand (kWh)	Source
Paradise Park Centre[3]	983,934	Estimated by the NHM
Harwood King Printmakers	223,717	Benchmarked
SBFI Furniture in the Hawthorne Estate	164,900	Benchmarked
Sainsbury's	1,078,445	Estimated by the NHM
Premier Inn	320,848	Benchmarked

Table 5: Annual Heat Demands of Relevant Buildings in the Light Industrial Area

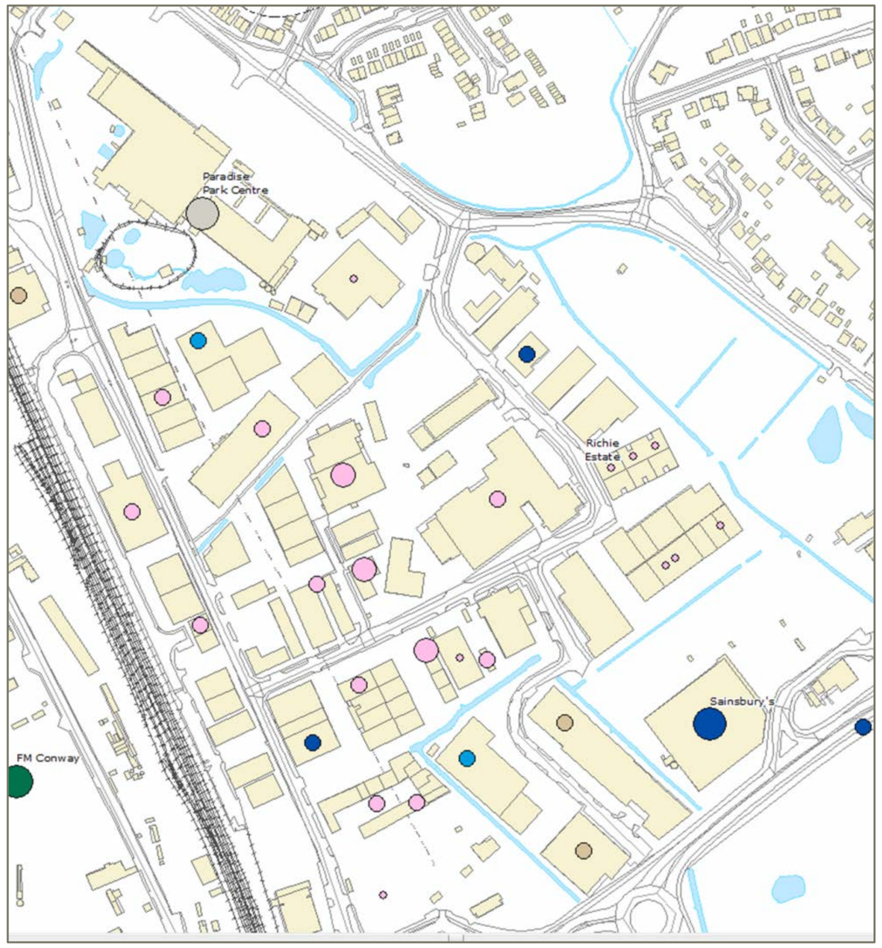


Figure 8: The light Industrial Area

[3] Paradise Park Centre is an attraction park focused on families that includes an earth museum, indoor and outdoor gardens and a playzone for kids. Paradise Park is located in Newhaven industrial area, east of the Ouse River and North Quay.

2.2.2.4 Town Centre

The A259 circle ring creates a delimited town centre near the Ouse River with a high proportion of business, shops and services. It's in this town centre where the Ship Hotel, Alworths and the Seahaven Swim and Leisure Centre[4] are located.

Building	Annual Heat Demand (kWh)	Source
The Ship Hotel	113,471	Estimated by the NHM
Alworths	119,077	Estimated by the NHM
Seahaven Swim and Leisure Centre	1,317,155	Stakeholder Engagement – Based on Energy Targets

Table 6: Annual Heat Demand of Relevant Buildings in the Town Centre

Next to the Seahaven Swim & Leisure Centre (owned by Lewes District Council), The Co-operative Food used to have a superstore that shut down in February 2016. The building has a floor area of approximately 2,000 m^2 and is currently empty.

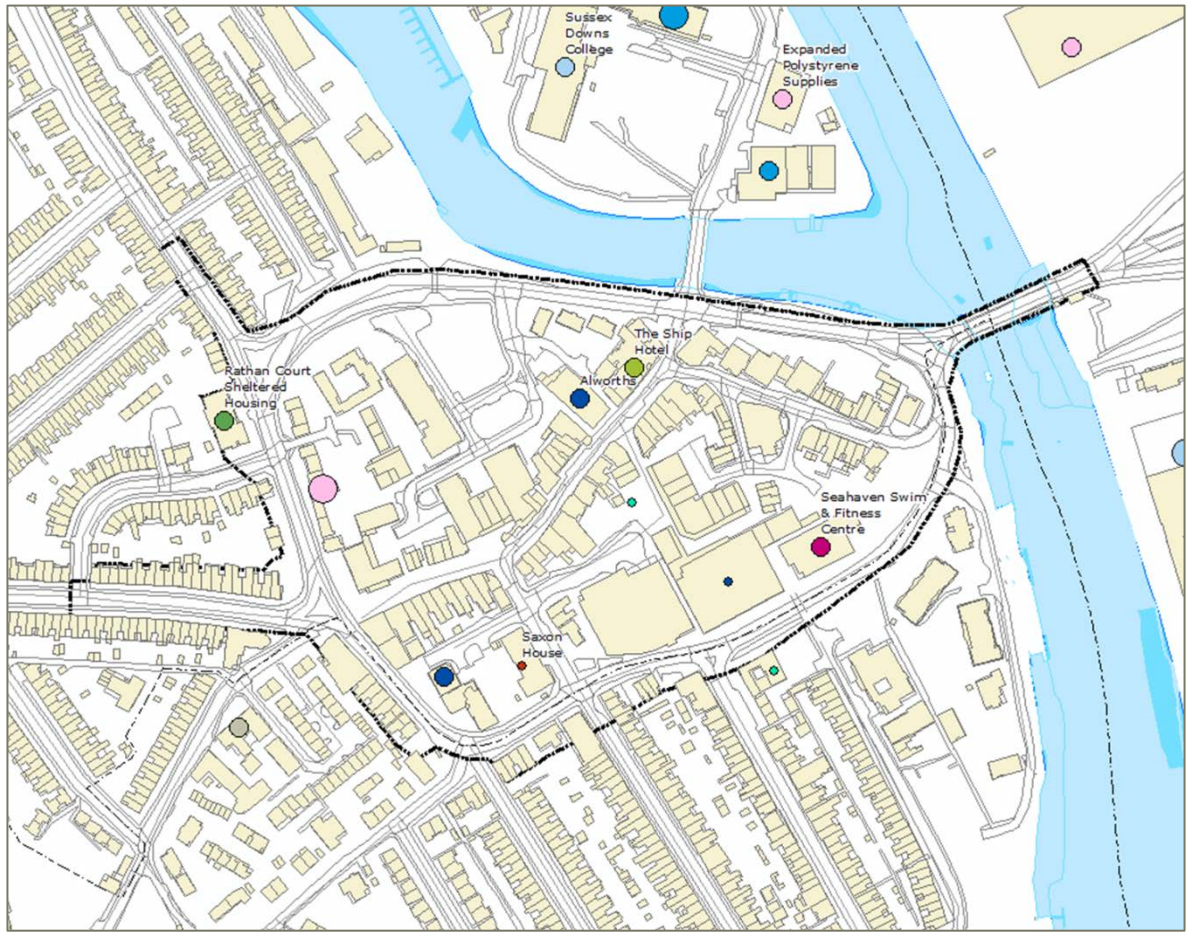
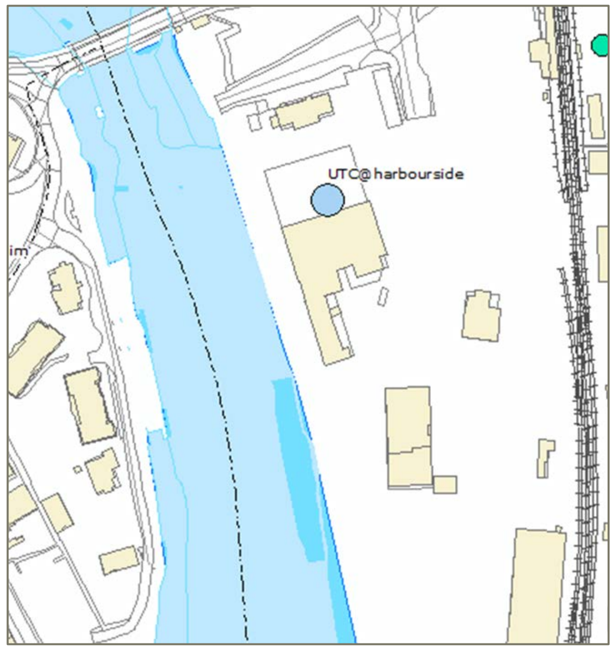


Figure 9: The Town Centre

[4] The Seahaven Swim and Leisure Centre facilities are composed by a gym that offers exercise classes, a 25m swimming pool, a toddler/teaching pool and sunbed.

2.2.2.5 UTC@harbourside



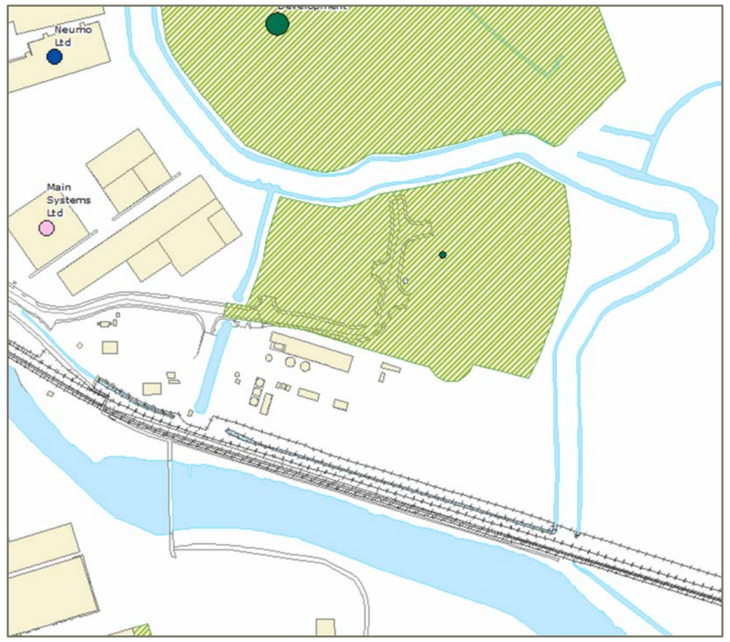
The recently renovated UTC is located in Railway Quay, at the eastern bank of the River Ouse south of Denton Island, in the historic Grade II listed marine and carpenters' workshops. The new university technical college offers 14 to 18 years-old students classes focused on engineering, science and environment. Newhaven UTC can accommodate up to 600 students in a three-floor building.

The new UTC joined two pre-existing listed buildings: a Marine Workshop and a Carpenters Workshop. A refurbishment of the Workshop finished in December 2015 and resulted in a B EPC rating. A gas boiler with a 465 KW output supplies the energy for space heating and domestic hot water. The building also has installed solar PV.

The total annual heat demand of the UTC@harbourside was estimated to be of 473 MWh. Billing data was provided, but not for a complete year and therefore the demand figure was based on a combination of actual data and estimates.

2.2.2.6 Warehouses southeast

A mix of retail, light industrial and warehouses are located along Beach Road. The heat demands of the main buildings identified in this area are provided by the National Heat Map. Four main buildings were identified and are listed below.



Building	Annual Heat Demand (kWh)	Source
SBFI LTD	201,264	Estimated by the NHM
We Fit Service Centre Ltd	223,717	Estimated by the NHM
Main Systems Ltd	293,770	Estimated by the NHM
Neumo LTD	265,495	Estimated by the NHM

Table 7: Annual Heat Demand of the Industrial / Warehouses Located Southeast of River Ouse Selected for the Analysis

2.2.2.7 Existing Heat Demand Summary

Table 8 summarises the total estimated heat demand within the study area following the data filtering process.

Building Type	Number of Buildings	Estimated Annual Heat Demand (kWh)
Commercial Offices	5	981,460
Education	7	1,568,174
Fire Station	1	55,843
Government Buildings	2	354,111
Health	1	247,558
Hotels	4	820,572
Industrial	40	11,196,414
Other	2	1,312,092
Recreational	4	702,381
Residential	7	1,028,660
Retail	13	4,607,723
Transport	6	1,207,218

Table 8: Summary of Existing Large Heat Demands within Study Area Selected for the Analysis

2.2.3 Heat Demand of New Developments

At the time of writing, there were a number of future developments planned for the town of Newhaven. These are described in the following sections with regard to the size, use and estimated heat demand of the developments.

The location of new developments is shown in Figure 19.

2.2.3.1 FM Conway

Newhaven Town Council informed Ramboll that FM Conway, an infrastructure company, may build a factory in North Quay centred on the production of asphalt.

Ramboll has contacted this stakeholder and it appears that FM Conway could potentially open a facility in the next couple of years and would be very interested in the opportunity of buying heat from a heat network. From communication with FM Conway it appears that:

- The process would be heating approximately 45,000 tonnes p.a. of aggregates from ambient temperature to 250°C. The use of aggregate could be expected in the range of 4,000 tonnes per month, except during December and January, where it would be in the range of 4,000/5,000 tonnes in total.
- In addition to the above, the process is anticipated to use significant quantities of Reclaimed Asphalt Pavement (RAP), which would be heated at a maximum temperature of 150°C. RAP consumption could be expected in the range of 15,000 tonnes p.a., giving a monthly consumption of roughly 1,400 tonnes per month, except during the months of December and January, when a total consumption of 1,400 tonnes could be expected.
- A heat network could potentially offset about 20% of their annual heat demand, which would be in the order of 80/120 kWh per tonne of aggregate processed.

Based on this information Ramboll has estimated the proportion of the annual heat demand, which could be offset by a potential heat network, in the range of 1,069 MWh. Depending on the temperature at which heat could be supplied, a greater or lower proportion of the annual heat demand could be displaced.

Further investigation at feasibility stage would be required to establish:

- The potential of supplying steam to this stakeholder
- The actual displaceable heat demand

At present it has been assumed that the heat demand associated with this stakeholder would be in the range of 1 GWh that would potentially materialise in 2019.

2.2.3.2 Eastside Development

The development site lies on the Eastern edge of the East Bank area, with the Eastside Recreation Ground and adjacent housing to the west and the Ouse Estuary Nature Reserve, now part of the South Downs National Park, to the east. This can be seen in Figure 10.

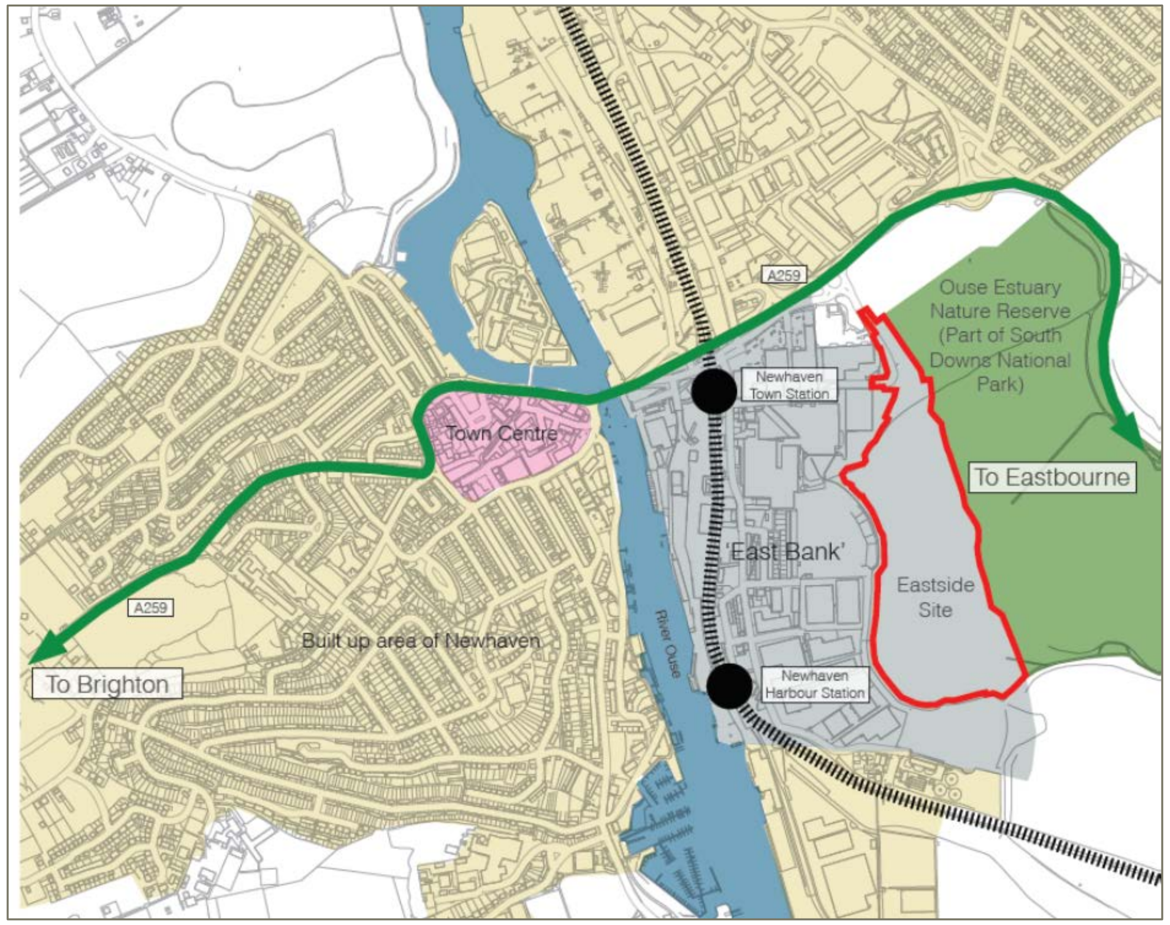


Figure 10: Location of Eastside site in Newhaven extracted from the outline planning application

The Eastside site is located approximately 1.2 km from Newhaven town centre. Access to the site is available by road from the southern arm of the roundabout junction of the A259 Drove Road.

In total, the development will cover a plot of land 14.22 ha in size. At present, this is divided in the following manner:

- 3,307 m^2 for a food store at the south of the site
- 4.37 ha of net residential development providing a total of 190 dwellings (28 flats and 162 houses) with a medium density of 43 dwellings/ha
- 0.61 ha of net commercial development providing 14 commercial units with gross internal area of 929 m^2

An illustration of the developed site and the food store are shown below in Figure 11.

Figure 11: Illustration of developed Eastside Site extracted from the outline planning application

In order to obtain heat demand data for this development, benchmarks were applied in combination with floor areas of the proposed buildings as described in section 2.2.1. The resulting heat demands are shown in the following table:

Building Type	Estimated Annual Heat Demand (kWh)
Residential (flats)	81,718
Residential (houses)	1,014,768
Commercial	37,277
Total	**1,133,763**

Table 9: Estimated heat demand of Eastside site development

The last reserved matter in the planning application was approved in May of 2016 and construction will then need to start before 2019, as per latest decision notice. It has been assumed that construction would start in May 2019 at a construction rate of 50 dwellings per year, pro-rated in 2019 to 33 dwellings.

The proposed energy strategy for this development include a wide range of recommendations (including low-energy rated glazing and high levels of insulation within their external envelopes and party walls) to exceed Part L 2010. To further reduce carbon rooftop renewable technologies are to be installed 'in-roof' in optimal locations for the generation of heat and/or electricity

2.2.3.3 West Quay Newhaven Marina Development

The Phase 3 Marina of the Newhaven Riverside Regeneration Project is a development proposed for the area of Newhaven Marina called West Quay and involves its regeneration as a mixed use development. The proposal would see a rebuilding of the marina pontoons and berths at the centre of a large space defined on three sides by a series of new buildings and public routes designed to create a major new leisure focus for the Town.

The site has a total area of 5.7 hectares, and is located on the western bank of the River Ouse, 300 m north of its mouth with the English Channel. Southwest of the site is a significant public open space, which includes recreation space, the Napoleonic fort, historic woodlands, and the cliffs and beaches open to the sea. Figure 12 shows the location of the development site.

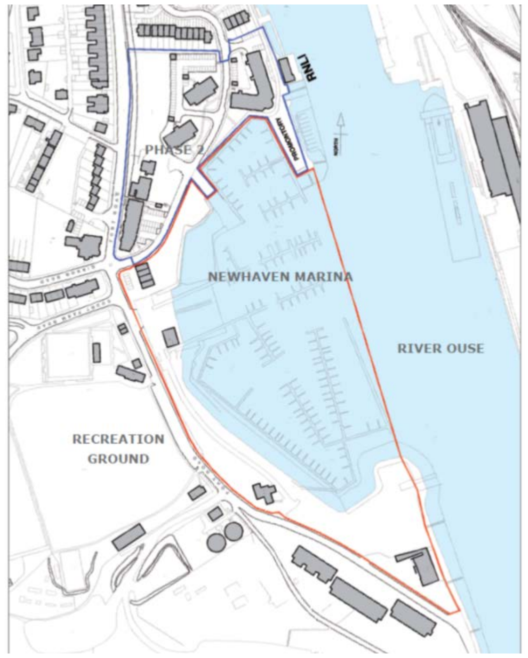


Figure 12: Location of West Quay new development extracted from the outline planning application

The residential development will comprise of 321 apartments and 12 town houses collected in 11 blocks spread around the banks of the marina. The blocks will range between 3 and 8 storeys high and also be provided with parking spaces. In addition, 973 m^2 of commercial buildings will be present and include a restaurant and marine-based retail area. Finally, buildings will be developed for marine facilities, such as workshops, storage and showering facilities – these will be 415 m^2 in total. An impression of the developed site at West Quay is shown in Figure 13.

According to the suistanibility report "a feasibility study is on-going regarding the possibility of incorportaing renewable technologies in the development. These may include ground or water source heat pumps and solar panels."

Figure 13: Aerial view of proposed layout for West Quay development extracted from the outline planning application

Once again, heat demands were estimated for this proposed development through the use of benchmarks and building floor areas. These are presented in Table 10.

Building Type	Estimated Annual Heat Demand (kWh)
Residential (apartments)	936,839
Residential (town houses)	75,168
Commercial	8,562
Industrial (marine facilities)	46,438
Total	**1,067,007**

Table 10: Estimated annual heat demands for the West Quay Newhaven Marina development

This site was granted permission in July 2012 and due to begin construction and development three years after the approval date provided a series of conditions are met.

2.2.3.4 Former Parker Pen Site Development

This development is based at the former Parker Pen Factory Site, which is located on Railway Road on the east side of Newhaven.

The application site measures 3.1 ha. It forms part of a wider area that extends to approximately 4.9 hectares, which is broadly split into two parts, Phase 1 and Phase 2. This summary relates only to Phase 1, which can be seen in Figure 14 within the orange border.

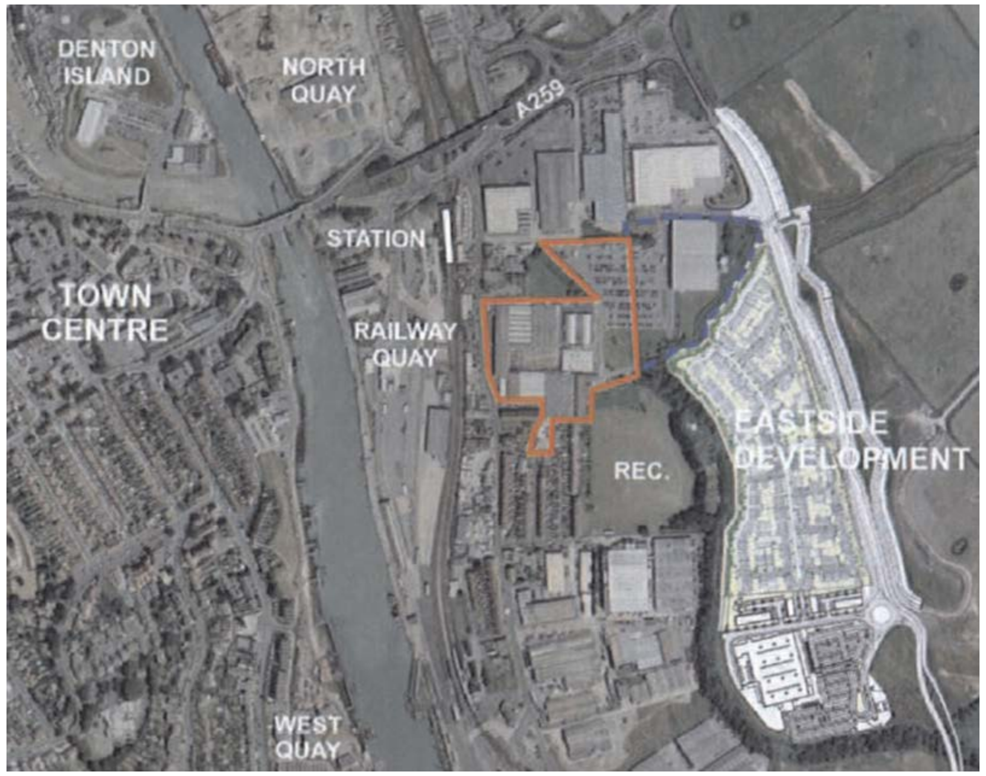


Figure 14: Location of phase 1 of Former Parker Pen Site development extracted from the outline planning application

The site is east of the River Ouse and is well served by local amenities. Newhaven Town railway station is situated approximately 2 minutes' walk away across Railway Road. The town centre is within a 5 to 10 minute walk via the A259 bridge.

The proposed layout of the development can be seen in Figure 15. It consists of a total of 145 dwellings with an average dwelling density of 47 dwellings per hectare. These dwellings are divided into 107 houses and 38 apartments.

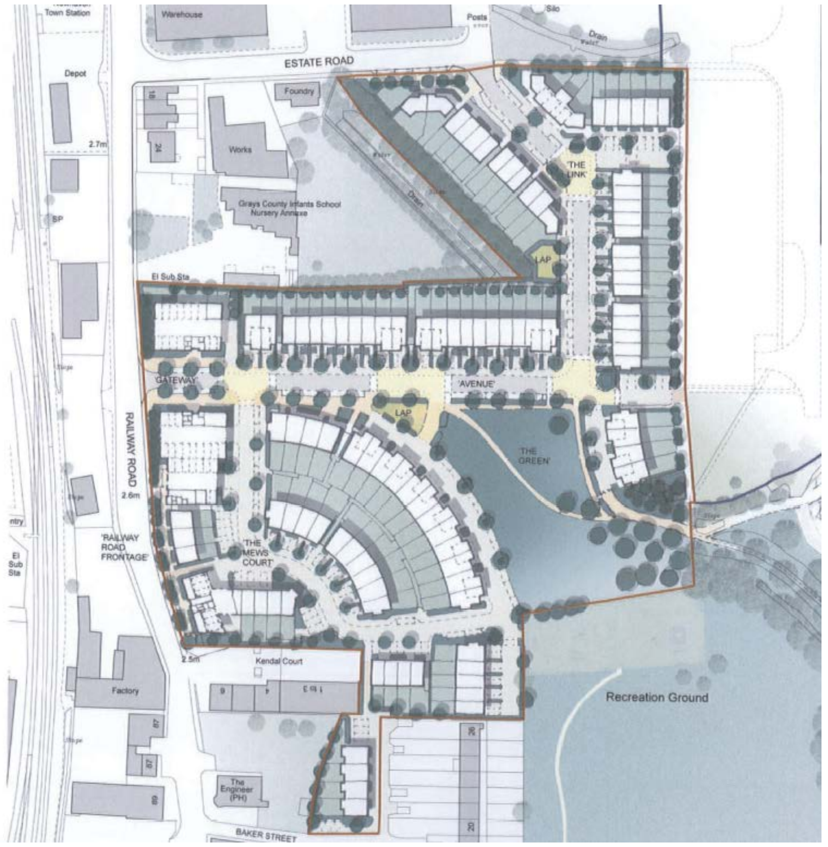


Figure 15: Proposed layout of future development of the former Parker pen site extracted from the outline planning application

Benchmarks were applied to the number of proposed dwellings in order to estimate the total annual heat demand from the development; these results are presented in Table 11.

Building Type	Estimated Annual Heat Demand (kWh)
Residential (apartments)	110,903
Residential (town houses)	670,248
Total	**781,151**

Table 11: Estimated annual heat demands for the Former Parker Pen Site Development

Assuming that by 2018 the awaiting reserved matter would be given a decision notice and the planning application would be complete, then according to the Town and Country Planning Act the developer will have a maximum of two years before starting construction. Therefore it has been assumed that construction would start in 2020 with a construction rate of 50 dwelling per year.

At the time of writing, no energy strategy was submitted as part of the planning application.

2.2.3.5 Marco Trailers

The site is currently occupied by Marco Trailers Railway, a company manufacturing trailers for sales and storage for various purposes. The location of the Marco Trailers planned development area can be seen in Figure 16

The new development[5] consists of the erection of a three storey building for use as shops and offices in a brownfield with a total gross internal floor space of 890 m^2.

The application has a provision of air conditioning for the shops and offices.

The total annual heat demand was estimated to be around 61 MWh.

Application for the reserved matters must be complete by 2017 and the developer will then require about two years before starting construction. Therefore it has been assumed that this heat load would materialise in 2019.

At the time of writing, no energy strategy was submitted as part of the planning application.

Figure 16 - Planning Applications - Marco Trailers

2.2.4 Data Quality

Benchmarked data can result in an increased risk associated with a district heating scheme, and therefore a review of the overall quality of data included in the heat map was carried out.

The figure below is colour coded to show the proportion of billing data, benchmarked data and NHM data.

[5] Planning application reference LW/13/0892

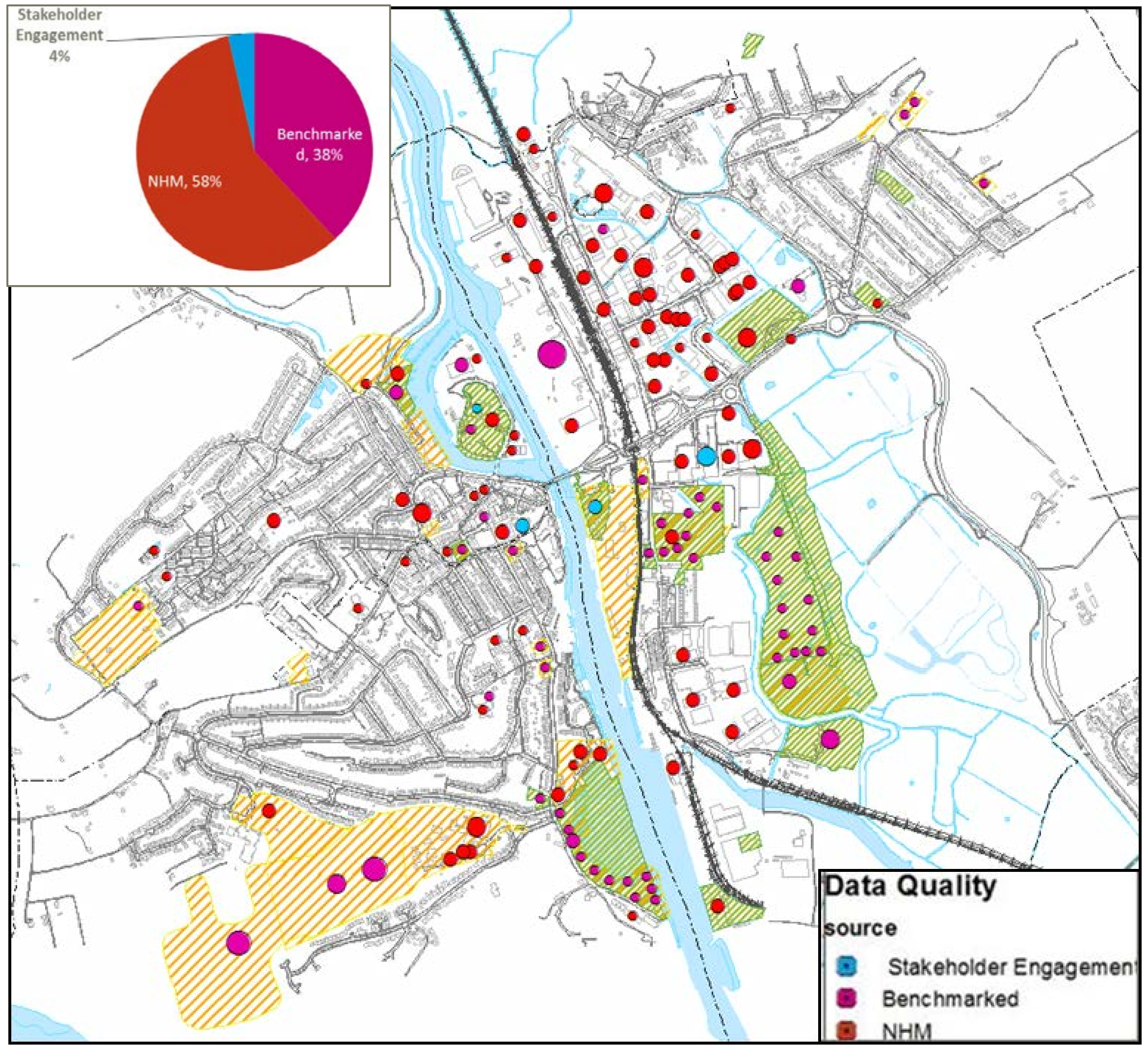


Figure 17: Map Indicating Quality of Heat Map Data

2.2.5 Summary

Figure 18 shows the total heat demand broken down by building type.

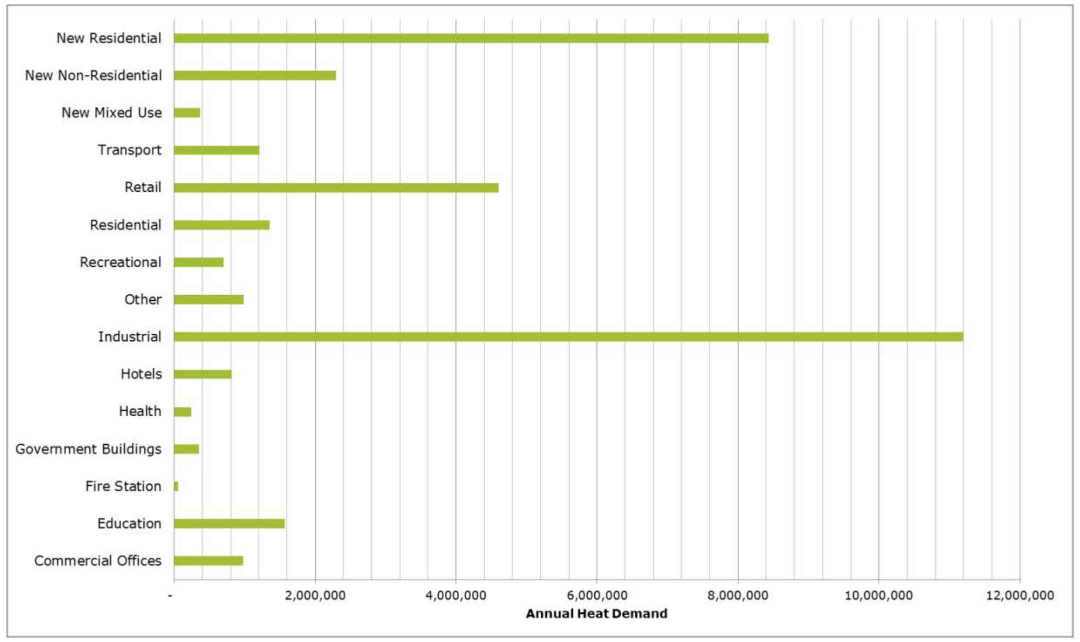


Figure 18: Heat Demand Breakdown by Building Type

As can be seen in Figure 19, the majority of the heat demand is concentrated in 4 areas: the light industrial zones east of the River Ouse, the Drove Retail Park, Denton Island and the town centre.
The higher demands are related to the industrial loads mainly concentrated in the east of River Ouse. These may require heat at higher temperatures for industrial processes or being supplied electrically as it is normally the case in warehouses. However, it should be noted that the NHM was the primary source of information and, as stated in the methodology, has been seen to overestimate industrial heat loads.

There is also a high heat demand related to the new residential developments although this demand is spread geographically and, therefore, not discernible in the heat density map.

It should be noted that in the Town Centre the high heat density is built up by many small loads, and that therefore would add risk to a potential heat network scheme and whose demand could potentially not financially justify the cost of connection.

Figure 20 presents the point load heat demand map, showing the magnitude of the heat demands identified within the study area.

As previously stated, the data was filtered to include heat loads greater than 100 MWh with the exception of selected buildings.

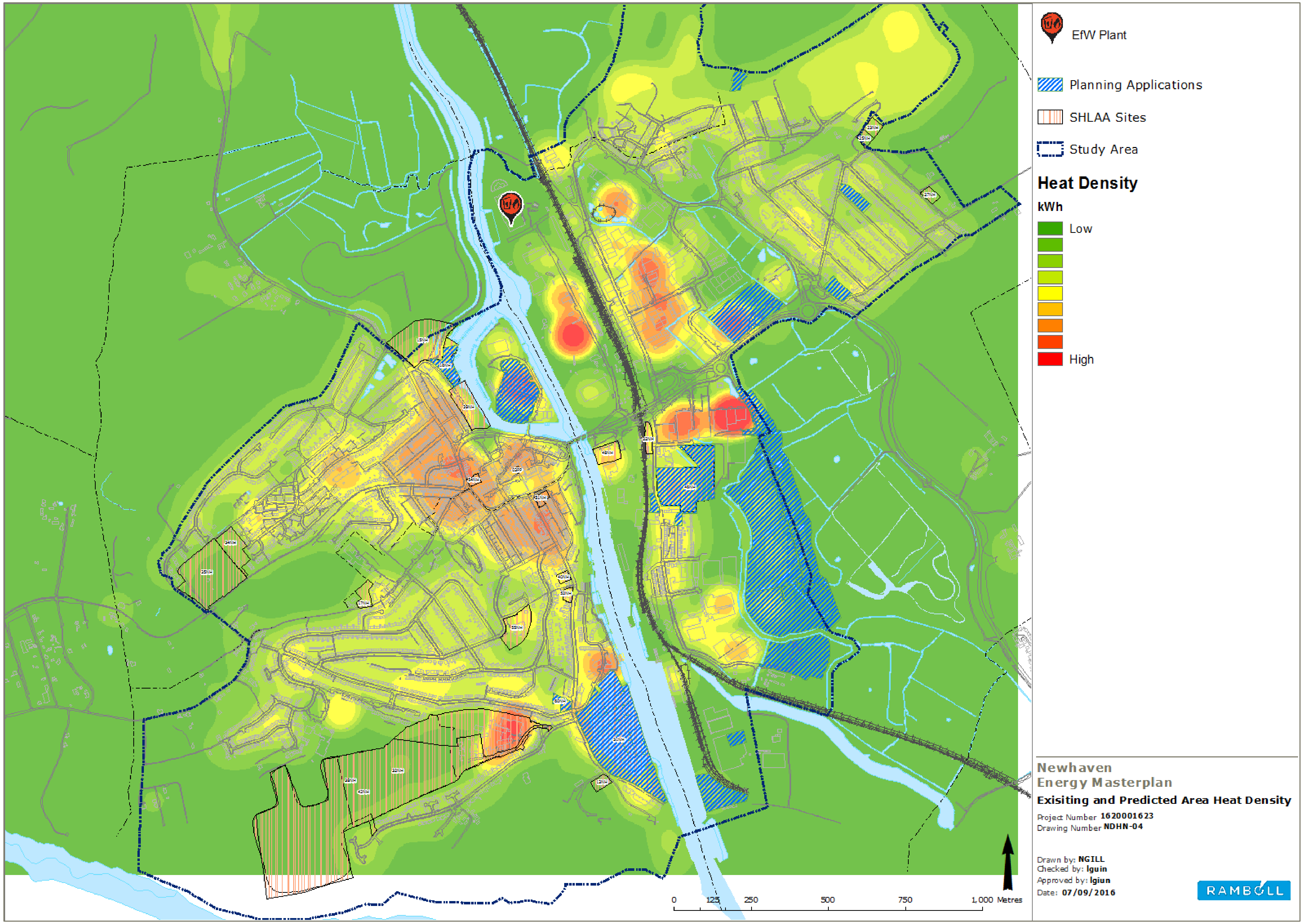


Figure 19: Newhaven Heat Density Map

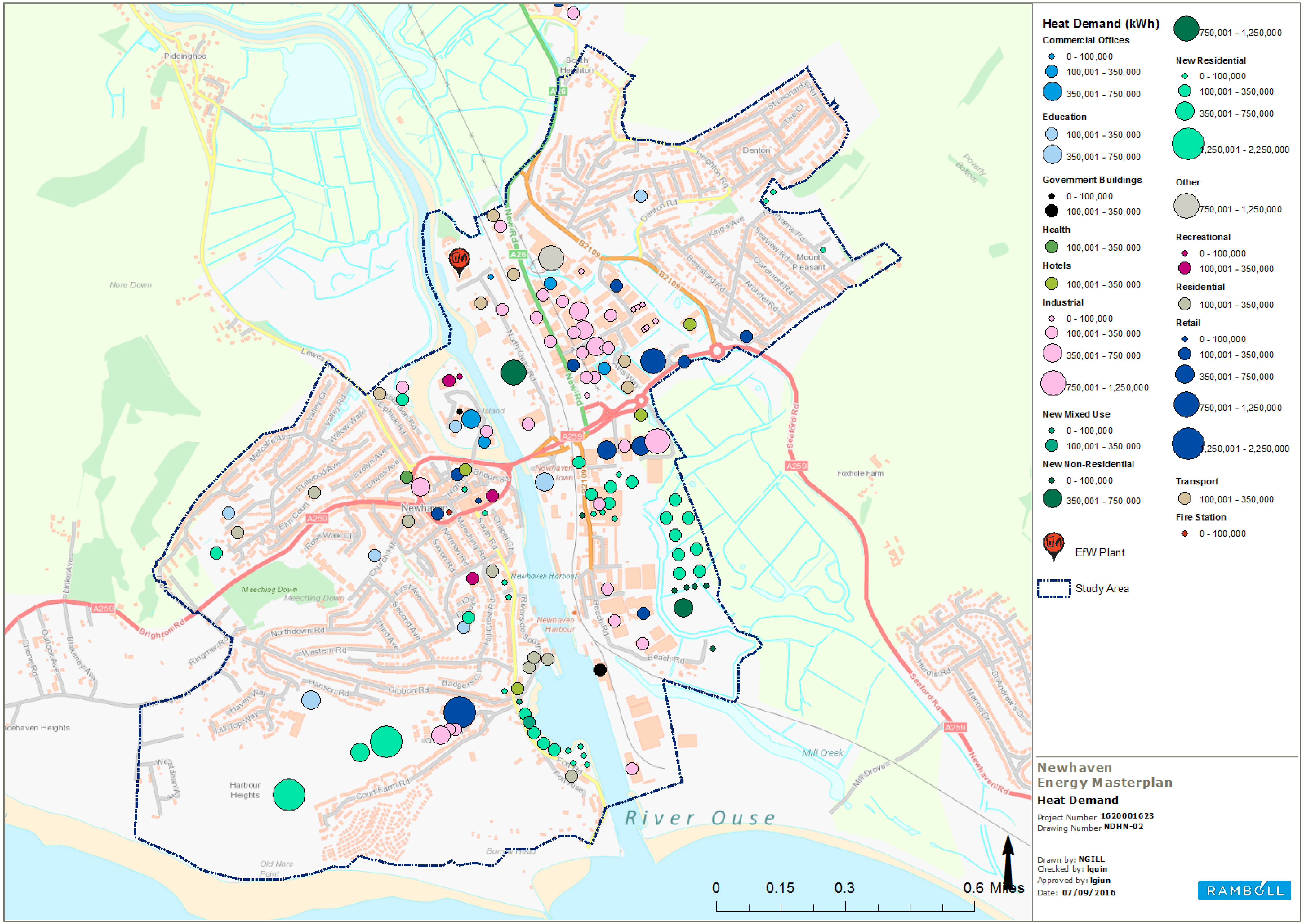


Figure 20: Newhaven Heat Map

2.3 Cooling demand

A cooling demand map was created for the study area. The purpose of this was to establish whether parts of the town might benefit from a district cooling network, or whether any buildings might have a sufficient cooling demand to benefit from absorption chillers.

As no actual data was forthcoming, the potential cooling demands of buildings was estimated by applying CIBSE cooling benchmarks to floor areas extracted from the OS Master Map data.

Focus was placed on benchmarking private communal offices and public/government building types due to the fact that these are often seen to present the greatest opportunity for cooling supply in Newhaven. Commercial arrangements for supply to private organisations can be very difficult and for demands at this level are unlikely to constitute a viable opportunity for a chilled water network.

Table 5 shows the total estimated cooling load that was mapped within the study area.

Building Type	Number of Buildings	Estimated Annual Cooling Demand (kWh)
Commercial Offices	5	129,904
Government Buildings	2	29,154
New Non-Residential	8	38,003
Retail	12	182,868

Figure 21: Estimated annual cooling demands within the study area

A district cooling network is not considered to be viable for the area, since there is inadequate cooling demand within the study area to provide sufficient return on investment.

It is recommended that further engagement regarding cooling be carried out at project feasibility stage once a heat network opportunity area has been clearly identified.

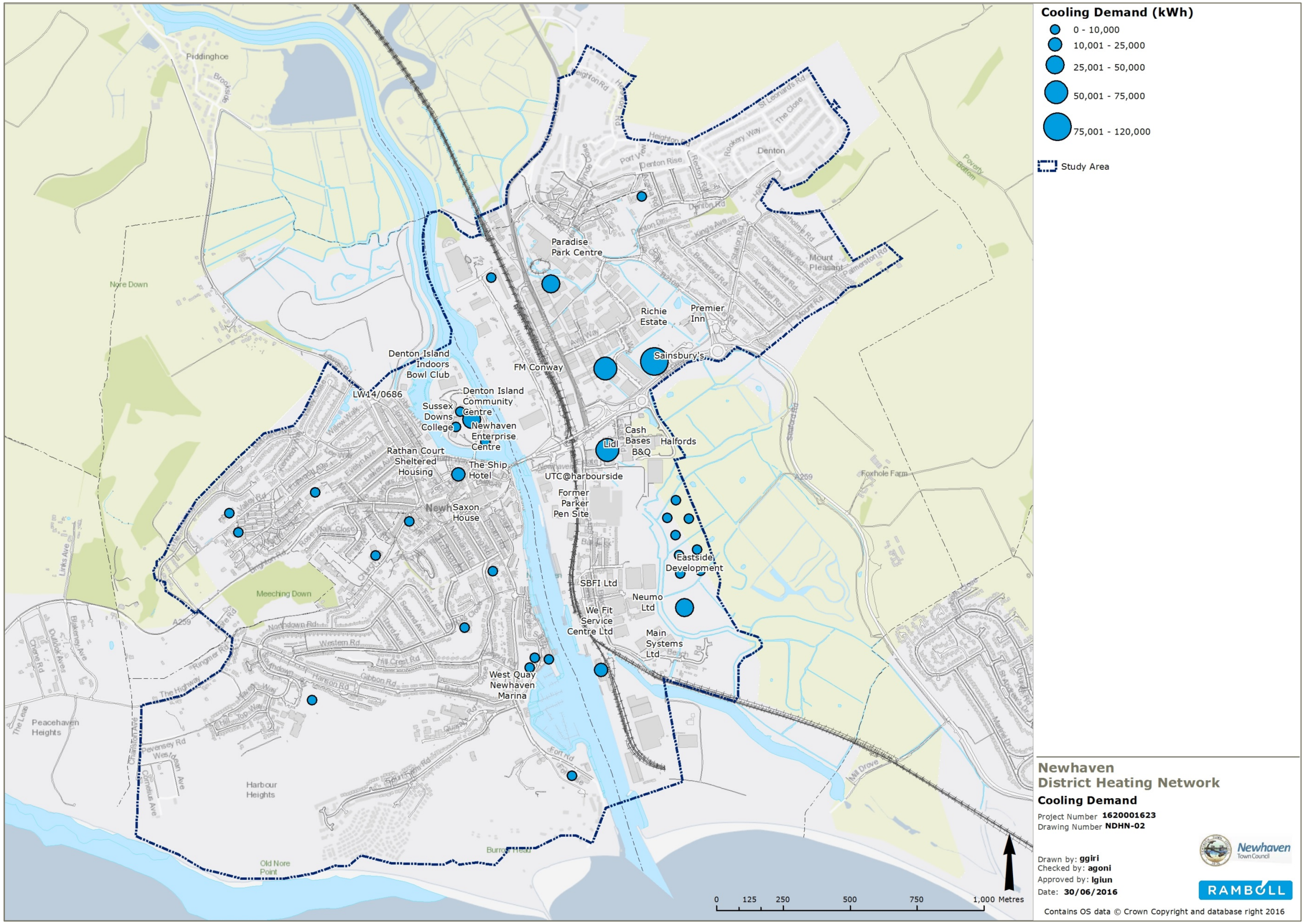


Figure 22: Newhaven cooling map

2.4 Power demand

The power demand was considered as 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).

A power map was realised based on information available from the stakeholders or electricity demand benchmarks for existing buildings. The benchmarks were applied on a kWh per m^2 floor area basis and were taken from CIBSE Guide F and TM46. The applied floor areas were taken from OS Master Maps and GIS calculations.

Building Type	Electricity Benchmark (kWh/m^2)
Commercial Offices	128
Education	25
Government Buildings	45
Fire station	55
Hotels	80
Retail – small food shop	400
Retail – supermarkets	915
Residential	44
Recreational	64
Workshops and Storage	34

Table 12: Electricity Benchmarks for Existing Buildings

The Business Park, on the East side of the railway was not benchmarked due to the fact that in Guide F the demand is based on key information such as the age of buildings, which was not available during the study.

The annual electricity demands in the study area obtained from benchmarked data and actual billing data are presented in Table 13.

Building Type	No of Buildings	Annual Electricity Demand (kWh)
Commercial Offices	5	1,187,691
Education	7	1,092,370
Fire Station	1	78,326
Government Buildings	2	113,951
Hotels	4	221,788
Industrial	38	962,068
New Mixed Use	2	334,765
New Non-Residential	8	1,722,263
New Residential	38	1,855,076
Recreational	4	257,347
Residential	8	756,956
Retail	12	20,230,339

Table 13: Electricity Demands

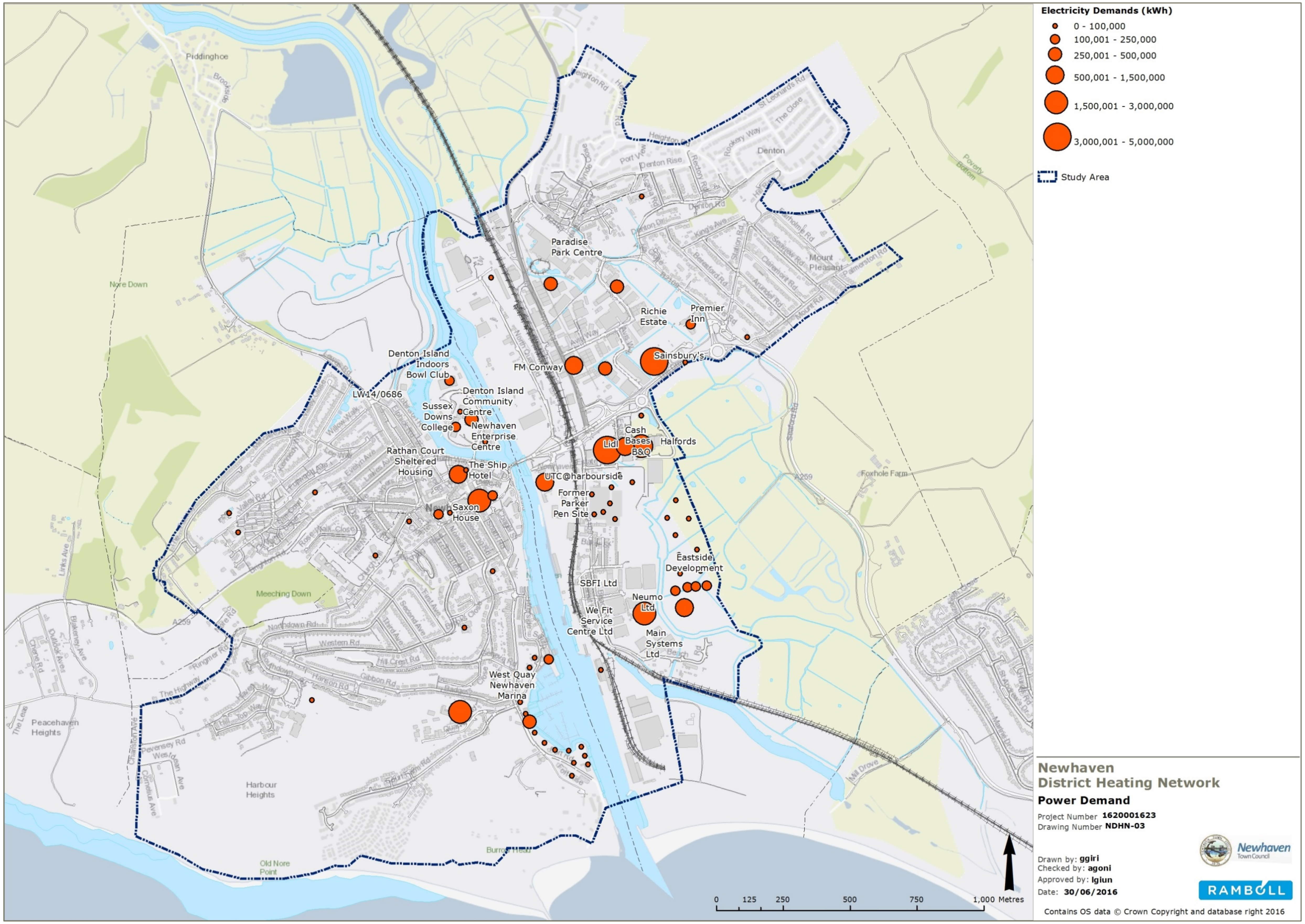


Figure 23: Newhaven Power Map

3. IDENTIFICATION OF POTENTIAL SUPPLY ASSETS

A heat supply opportunity database was created. This database contains information about existing, planned and potential future heat supply opportunities across the study area.

Potential supply assets were broken into three groups:

- Existing supply assets that are independent of heat network opportunities. That is supply assets that already exist irrespective of heat network development. These supply assets are reported in Section 3.1.

- Planned supply assets that are planned for development irrespective of heat network development. These supply assets are reported in Section 3.1.

- Supply assets that would only come forward as part of a proposed district energy project as identified in this study.

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
- Local planning applications

Each supply asset that was assumed to have potential to act as a supply asset for a heat network was characterised according to:

- type
- capacity
- load factor
- availability
- potential annual heat production capacity
- development cost of connection to a heat network
- operation and maintenance costs
- cost and carbon content of heat production (taking into account fuel costs, forfeited electricity generation where relevant, ROCs, RHI)
- development status
- age of supply assets
- residual operating life etc.

3.1 Existing and Planned Supply Assets

The potential heat supply opportunities that were identified within the Newhaven area include the Newhaven Energy Recovery Facility (ERF) to the north of the town and the Southern Water Treatment Plant to the south.

The results of this heat asset identification process were incorporated into the opportunity maps which can be seen in Figure 24.

Figure 24: Heat Supply Location Map

3.1.1 North Quay Energy ERF

The North Quay ERF is owned and operated by Veolia ES South Downs, a local company established in 2003 by Veolia UK to deliver an integrated waste management service on a 30-year contract for East Sussex County Council and Brighton & Hove City Council. The ERF is responsible for processing approximately half the household waste in the South Downs area. Figure 24 shows the location of the plant.

The electricity generating turbine selected by Veolia has been designed to be CHP ready with a specific steam off-take for district heating.

The ERF turbine has four steam extraction points, three of which are designed to meet the requirements of the internal generation process, the fourth is not utilised and is currently blanked at the flange to the turbine. This allows possible steam extraction at this point to supply a heat exchanger that would be connected to a DH network – there is no need for a grid valve. The design extraction steam conditions at full load are a pressure of 2.1 bar and temperature of 122 °C; this gives a specific enthalpy of 2,644 kJ kg^{-1}. The design maximum extraction flow is 24 $t.h^{-1}$; this creates the potential to deliver around 15 MW into a DH network.

However, in order to make North Quay ready for CHP mode, the ERF control system will need to be modified and the current water treatment capacity will require an upgrade. Also, according to Veolia there is no space for additional heat exchangers or back up boilers within the current building footprint but it is possible to install these process units within the site boundary area. This will be subject to a site feasibility study.

Figure 25: The Veolia ERF

Further to the availability for steam extraction, the process emits flue gases at a temperature of 140 °C without any further heat recovery. This could serve as a potential additional heat supply, however, Veolia failed to supply information regarding the flue gas flowrates that would enable this heat supply capability to be quantified.

All waste processed at the plant is municipal solid waste or similar, the biogenic energy content of the waste stream, based on representative spot sampling is around 50 – 55%. As the plant is not new, however, it would not be eligible to receive the non-domestic renewable heat incentive (RHI).

As the electrical generation of the ERF is already in place, any heat production can be seen as a by-product; therefore the abatement of CO_2 would be moderate to high. Producing the heat results in a reduction in electrical production; this forfeited electricity would need to be produced on the national grid instead and so it is the carbon emissions associated with this electricity production that are attributed to the heat generation for the network. This would be considerably lower than the carbon emissions of producing the same quantity of heat from traditional gas-fired technology. In addition, DECC have released projections for the decarbonisation of the national grid and so as time progresses, the CO_2 emissions associated with the forfeited electricity would continuously reduce.

Furthermore, as the plant already exists and the heat supply can be achieved with relatively minor adaptations to the plant, the cost of this CO_2 abatement would be low.

There would be no environmental impact of using the ERF to supply heat to the network as the ERF is already in operation and any adjustments to extract heat from the plant would not alter the emissions of the plant.

As the plant is already operating, there would be no additional disruption in the town from fuel deliveries via road if the plant were used to supply heat.

The ERF achieves an average Z factor of 5.5 throughout the year, which means that for every MWh of heat extracted, about 0.18 MW_e of electricity would be forfeited.

In order to estimate the cost of the heat from the ERF, a lifecycle cost analysis was conducted to establish the heat price required whereby Veolia would not lose or gain from the heat offtake. This took into account the Z-factor and energy content of the fuel in order to consider the energy balance at a range of outputs and to estimate the proportion of lost electricity revenue. The model is run over a period of 25 years. The estimated cost of the heat was found to be in the range of 10.45 £/MWh. A discussion around the commercial implications of various assumptions, including this, is reported in section 6.3.1.

3.1.2 Planned Supply Assets

A desktop investigation has been carried out using a range of websites and online tools to identify new potential supply assets. No planned supply assets have been identified.

3.2 Proposed New Supply Opportunities

A technology options appraisal was carried out for Newhaven. Issues such as environmental impact, CO_2 abatement potential, cost of CO_2 abatement, revenue potential and risk were assessed.
A full technology options appraisal was conducted. 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
- Carbon dioxide (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. The full technology options appraisal is included as Appendix 2. Table 14 shows a brief summary.

Technology	CO_2 Abatement Potential	Revenue Potential	General	Consider Opportunity?
Gas Combined Heat and Power Engine	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 considering the presence of private wire opportunities.	Yes
Dual fuel boiler	Low	Heat sales only	Can switch to burn two types of fuel, (biomass); 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 economic performance expected. Low risk technology as long as fuel supply is secured.	No
Biomass CHP Steam cycle	High	Heat and power sales and RHI	No existing facility in operation. 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	No existing facility in operation. 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	No existing facility in operation. Unlikely to be commercially viable at this scale. No current secured or identified feedstock.	No
Waste Incineration CHP	High	Heat and power sales and RHI	Existing facility identified in previous section.	Yes
Bio liquid CHP	High on individual technology basis. Medium as part of technology mix.	Heat and power sales	No existing facility in operation. High fuel prices reduce economic viability. Not applicable at this scale of project.	No
Absorption chiller	Carbon emissions savings are sensitive depending on the fuel source of the heat production	Coolth sales	Generally requires waste heat to be financially viable and beneficial in carbon terms.	No
Solar Thermal Panels	High	Heat sales and RHI	Reasonable payback expected with RHI. Large area required.	Yes
Ground Source Heat Pump/Heat Store	Medium - as part of site wide heat network	Heat sales and RHI	Reasonable payback expected with RHI.	Yes
Water source heat pumps	Medium - as part of site wide heat network	Heat sales and RHI	Reasonable paybacks expected. Nearby river presents opportunity	Yes
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 paybacks typically observed, but no existing suitable source identified.	No
Deep geo borehole	Medium	Heat and power sales and RHI	Geographic Location	No

Table 14: Summary Technology Options Appraisal

In addition to the ERF , the potential supply opportunities that have been selected for consideration, , depending on the location of the energy centre, the size of network, opportunities for private wiring, available land etc. are:

- Ground and Water Source Heat Pump
- Natural Gas CHP engine
- Solar Thermal

3.2.1 Air Quality Management

The existence of Air Quality Management Areas (AQMA) is an important consideration in the assessment of the potential for energy supply assets due to the fact that limitations on emissions can significantly reduce the viability of technologies such as biomass.

Newhaven Town Council provided information on existing and proposed AQMAs in and around the study area.

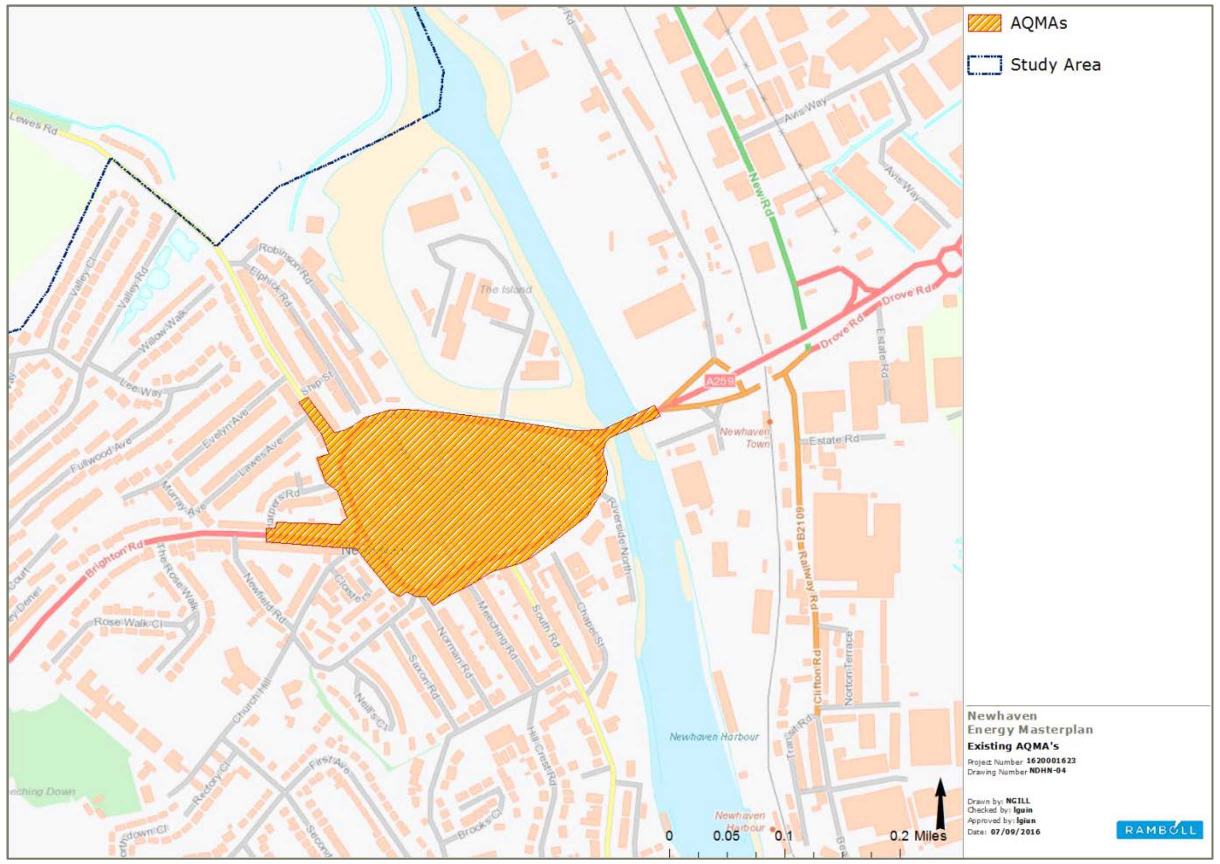


Figure 26: Illustration of Existing Newhaven AQMA

These areas were taken into account as part of the technology options appraisal.

3.2.1.1Water Source Heat pump

The NHM water source heat layer indicated that there is a good heat resource in the coastal area around Newhaven. The NHM provides a high level indication of the potential for water source heat pumps in Newhaven coast compared to the rest of the UK. The NHM water source heat layer does not include the River Ouse estuary in Newhaven although it seems that it equally has a good heat capacity. In order to fully quantify the heat resource for a project, information on depths and flow rates are required. This should be progressed at the next stage of works.

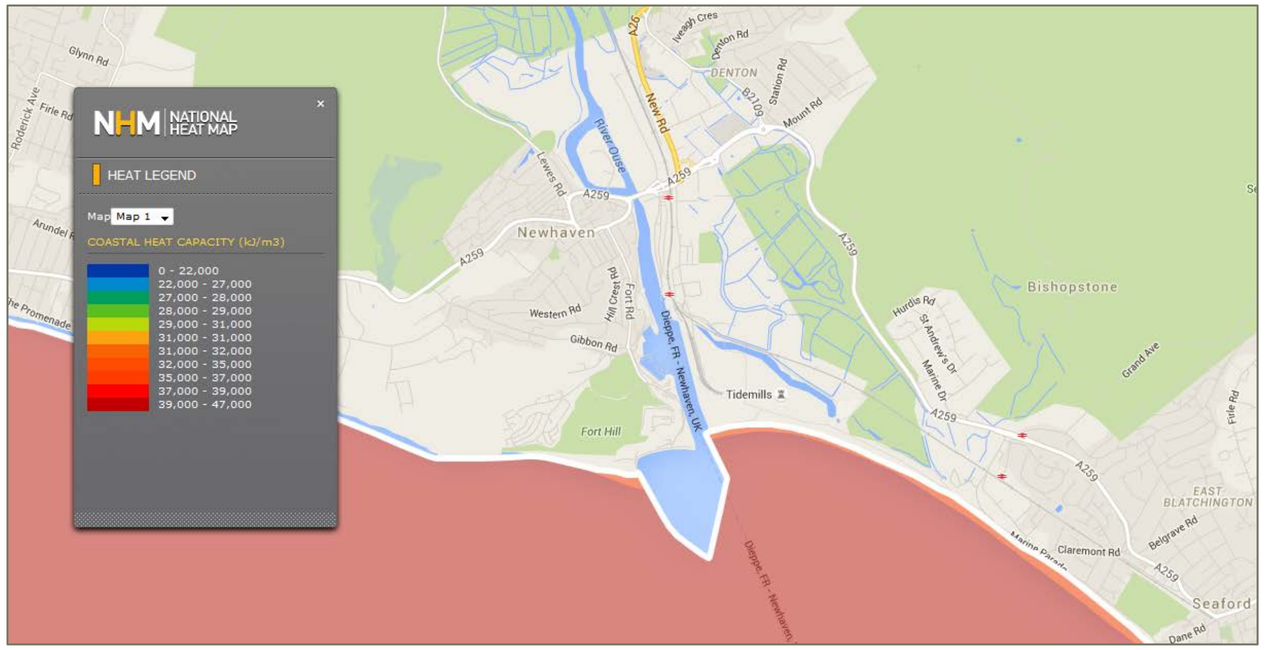


Figure 27: National Heat Map Water Source Heat Resource (image courtesy of National Heat Map 2016)

The permitting requirements for WSHPs are dependent on the type of heat pump system (open or closed loop). Closed loop schemes do not need environmental permits whereas open loop schemes need an abstraction license (if abstracting more than 20 cubic metres per day) and a discharge permit from the Environment Agency. If these schemes are to be located within 500 metres from a protected site such as a Site of Special Scientific Interest or similar there is need for an assessment of the potential impact of the heat pump system on the site.

WSHP schemes can benefit significantly from the availability of revenue through the Renewable Heat Incentive (RHI). The current available tariffs for WSHPs under the RHI are 8.95 p/kWh and 2.7 p/kWh for tier 1 and tier 2 respectively[6]. These figures were taken into account as part of the economic modelling in section 5.4.1.

[6] "Tariffs that apply for installations with an accreditation date on or after 1 July 2016", Ofgem, https://www.ofgem.gov.uk/environmental-programmes/non-domestic-rhi/contacts-guidance-and-resources/tariffs-and-payments-non-domestic-rhi

4. OPPORTUNITY AREAS IDENTIFICATION

This section presents a series of opportunities for heat networks and decentralised energy which were identified using the energy maps. GIS layers showing anchor heat loads, new development polygons, existing and known planned supply assets and constraints layers were overlaid on top of one another to identify areas where conditions were favourable for a district heating network.

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
- new developments
- 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 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 identified potential opportunities are shown in **Figure 28** and described in the next sub-sections.

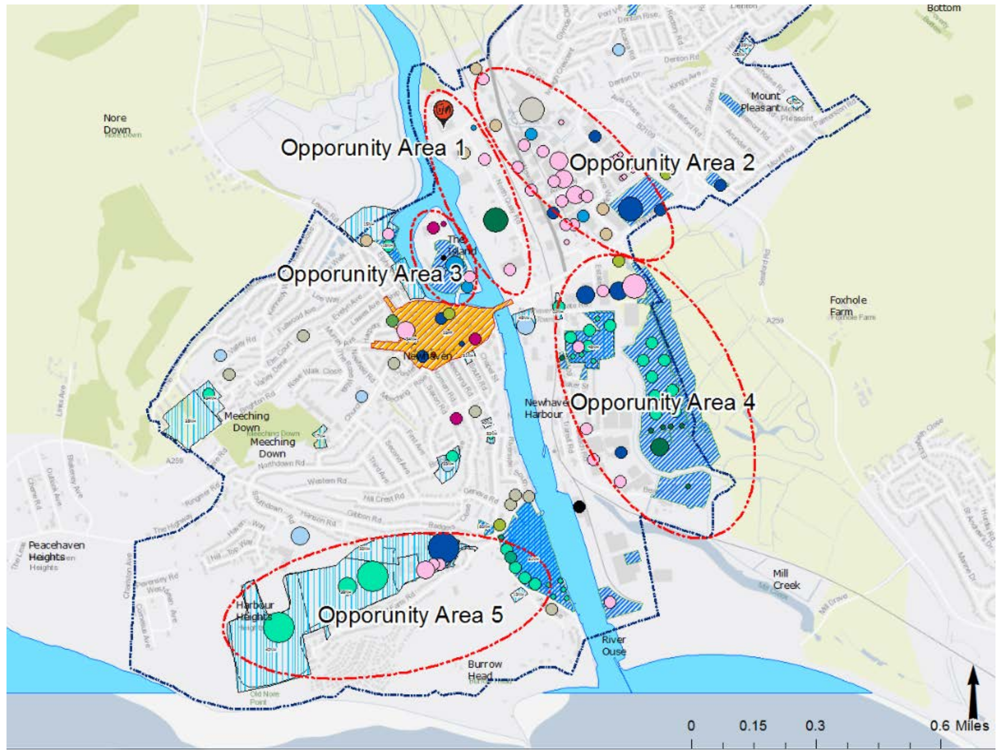


Figure 28: Opportunity Area Locations

4.1.1 Newhaven Business Enterprise Zone (EZ)

This land, owned by the American Investment Bank, could present a significant opportunity to catalyse the development of a heat network fed by the ERF in North Quay.

From a desktop investigation it does not appear that currently there are existing significant heat consumers.

A new plant, manufacturing asphalt, could move here in the short term, which is anticipated to have a significant demand. Although this potential stakeholder would require heat at very high temperature, there could be a potential to supply part of its demand.

Heat could be supplied in the form of steam to the stakeholder, potentially offsetting a greater portion of its demand, or using water as a medium. Given the vicinity of this stakeholder to the ERF and its predicted thermal demand, this stakeholder could potentially initiate and catalyse the development of a wider heat network.

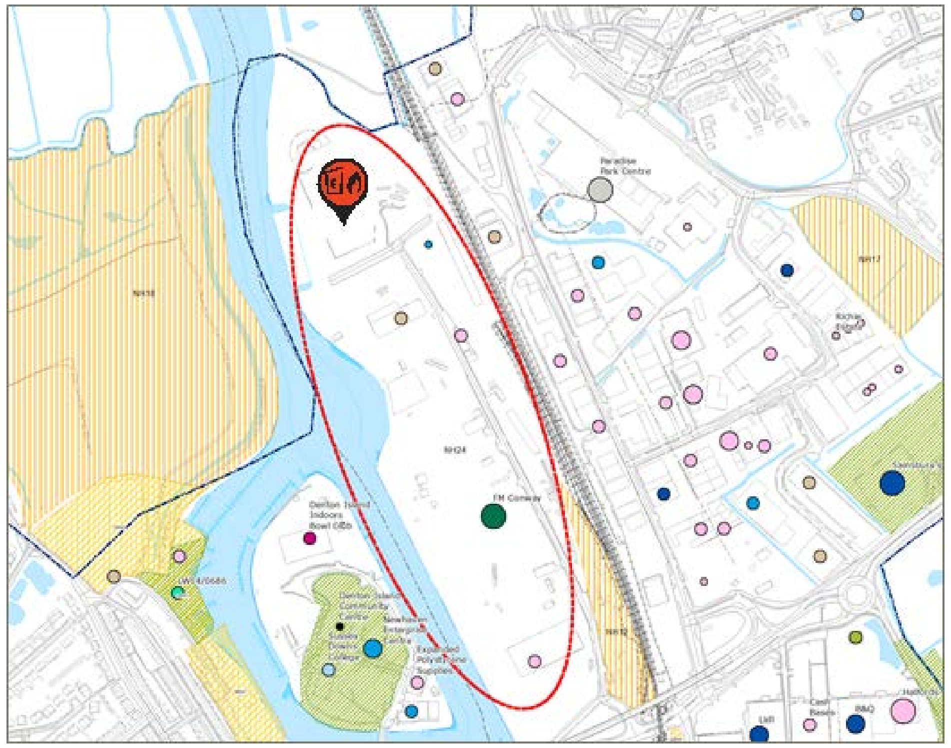


Figure 29: Opportunity Area 1 - The Enterprise Zone

4.1.2 The light Industrial Area

This area could potentially have a limited number of relatively big heat consumers that could help establish a heat network fed by the nearby ERF.

At the time of writing insufficient information or data was available regarding the buildings in the area. Ramboll believes that the risk associated to the lack of data together with the nature of these buildings (mainly warehouses) could impose a significant risk a potential heat network scheme.

In testing the viability of a heat network scheme through techno-economic analysis in section 5.4.1, the majority of the buildings in this area were excluded. It should be noted, though, that further investigation in the area is recommended at ongoing project stages to identify potential stakeholders that could boost the potential viability of a heat network in the area.

Ramboll has carried out a separate analysis (reported in section 6.6.1.1) around the inclusion of stakeholders in this area to a potential heat network.

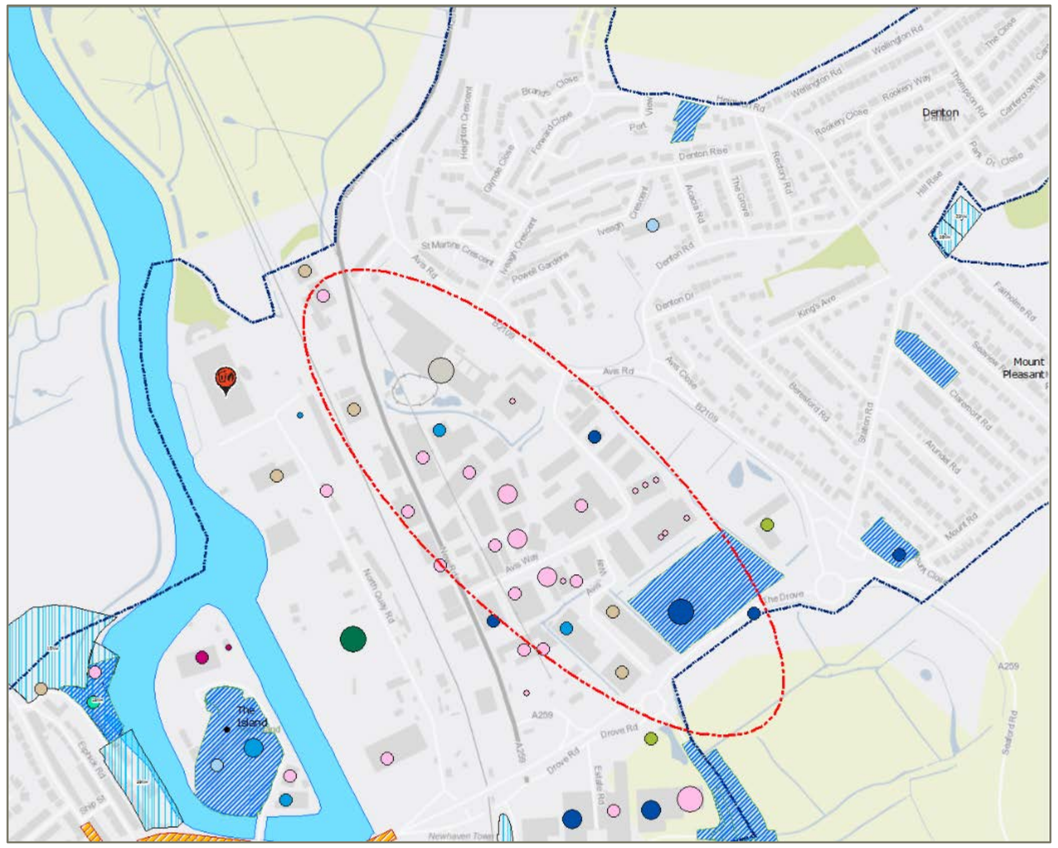


Figure 30: Opportunity Area 2 - The light Industrial Area

4.1.3 Denton Island

Denton Island appears to have a significant high area heat density due to a limited number of relatively high consumers being concentrated in a small area.

A small heat network here, possibly fed by a water source heat pump, could potentially prove economically viable. However, it is likely to be commercially difficult to establish a district heating arrangement due to the private nature of the building ownership. A significant incentive may be required to ensure connection and initial engagement would be challenging.

Moreover, in a wider view, the cost of establishing an energy centre in the island could be comparable to the cost of crossing the river Ouse and connecting these consumers to a larger heat network.

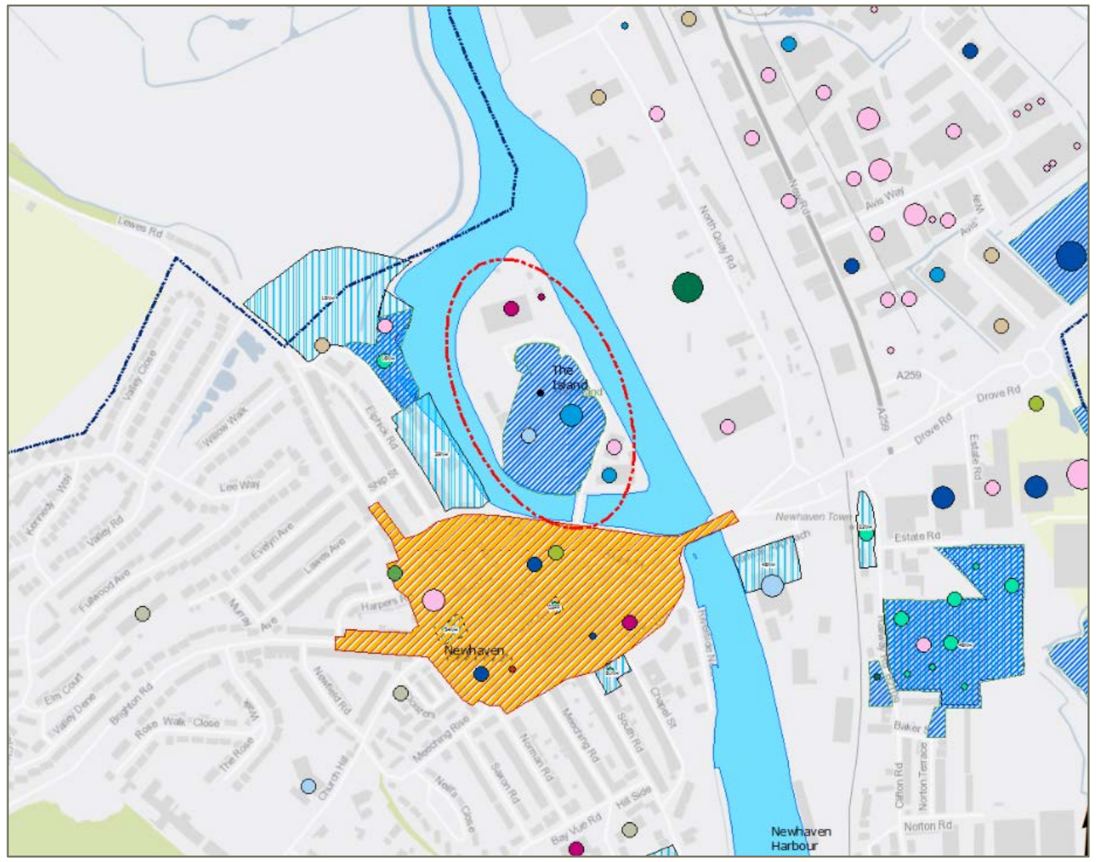


Figure 31: Opportunity Area 3 - Denton Island

4.1.4 Eastside, Parker Penn and Marco trailers Railway Road

In the area to the East of the river Ouse and South of the A259 two new mixed used developments, Eastside and Parker Penn, could provide the potential to establish a heat network. Under Ramboll's assumptions the two developments could potentially be developed between 2020 and 2023. Additional to these a new single block with offices and shops could be developed in the area in proximity of the Parker Penn site.

There could be a potential to establish a local heat network in the area, which construction could be coordinated with these developments resulting in reduced capital cost associated with the civil works required to install the network. This network could potentially be fed by a local energy centre, potentially fitted with a water source heat pump.

This option, though, has not been considered for further analysis given that the cost of the heat from the ERF would be lower and have greater environmental benefits (please see section 5.4.1). Moreover connecting a potential local network to the ERF could help the case of a wider scheme (i.e. greater environmental benefits).

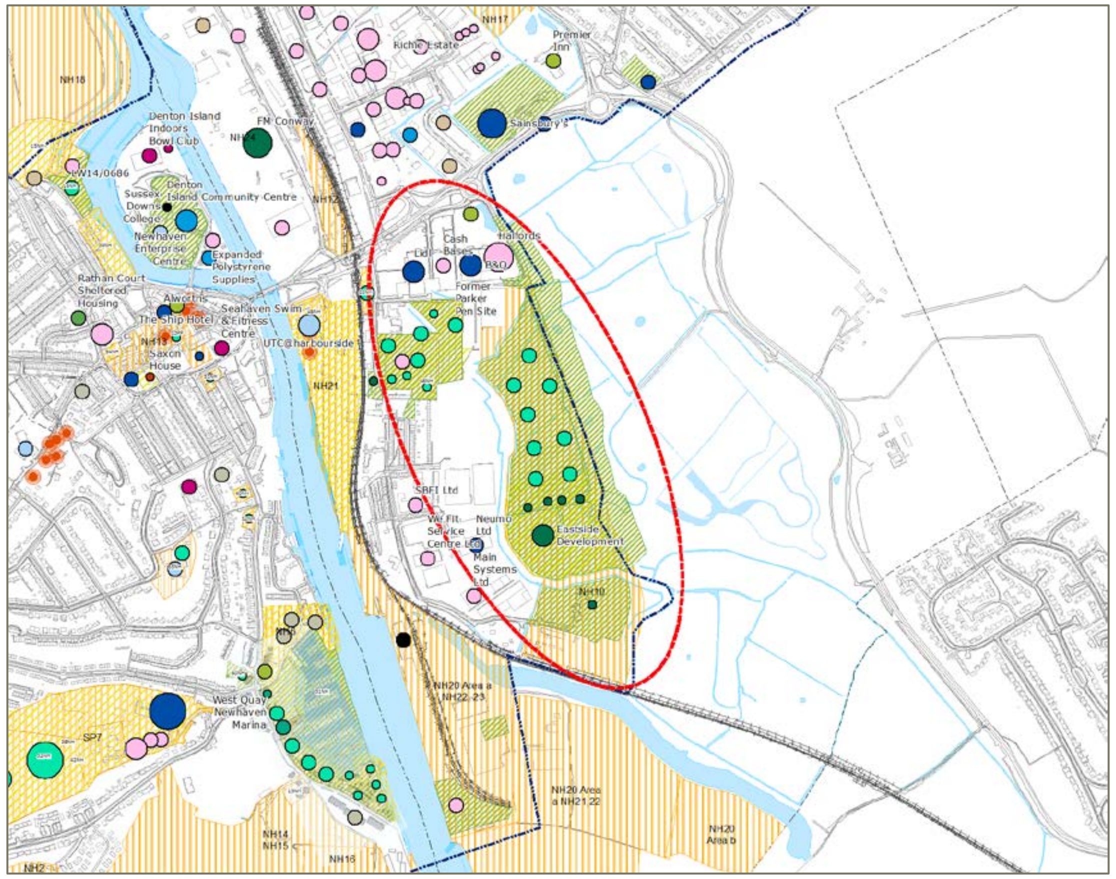


Figure 32: Opportunity Area 4 - New Developments

4.1.5 West Quay

This area is located to the West of the river Ouse and compromises a planning application for a new residential development together with an extensive housing allocation area.

The new residential development, referred to as Newhaven Marina has already completed its first two phases and should deliver 11 residential blocks during its third phase. The high dwelling density could potentially prove a local network viable.

Establishing a local heat network here could lead to a wider scheme in the area, which presents the potential of expanding in the near housing allocation area in the future. A network here could be fed by a local energy centre fitted with a water source heat pump and connect to a wider scheme in the future (e.g. a housing allocation site is located nearby), should this come forward. This has been selected above other supply options from the analysis carried out in section 3.2.2.

Alternatively this development could be connected to a wider scheme fed by the ERF, without the need of building a local energy centre. There could be a potential to connect other existing apartment blocks in the area, depending on whether there is a communal wet heating system in place.

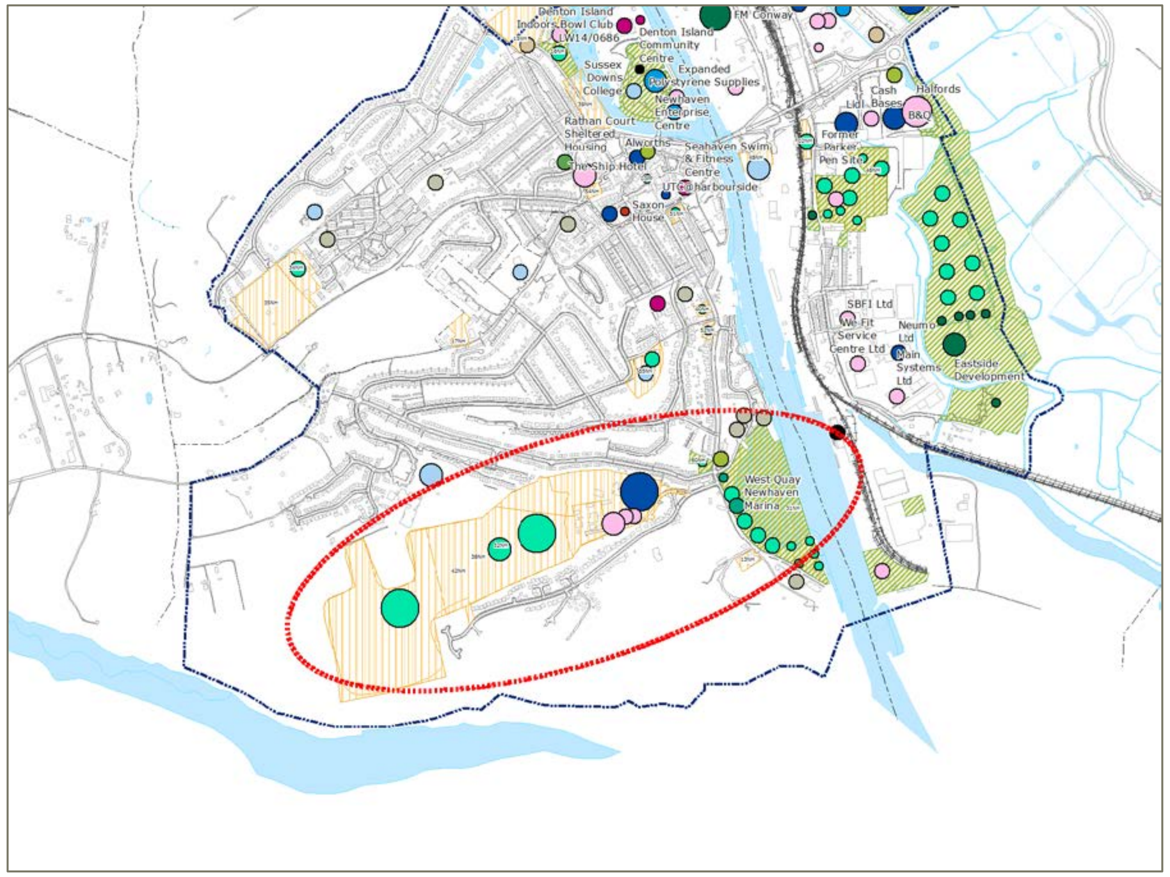


Figure 33: Opportunity Area 5 – West Quay

5. NETWORK STRATEGY

This section discusses the potential heat networks identified during this study, as well as the infrastructural barriers and opportunities along the potential routes.

5.1 Potential Heat Networks

This sub-section describes the identified potential heat networks.

Two potential heat networks have been identified that could be connected in the future:

- The main network, fed by the ERF for which two routing options have been identified;
- The Newhaven Marina cluster, fed by a local energy centre.

Both schemes are discussed in the next paragraphs in greater detail. There could be a potential to connect the small cluster to the wider scheme, the main network, in the future.

At present, given that there are uncertainties about the Newhaven Marina Phase 3 coming forward and the fact that there would a need of crossing the river near the estuary, it has been deemed preferable to analyse the two schemes separately. This would also result in a lower risk to the main network. Nevertheless, future proofing should be considered, in order to potentially allow for future connection of the two schemes, should the main network scheme come forward.

5.1.1 The Main Network –Option 1

This network, shown in Figure 34, would connect the following opportunity areas:

- The Eastside and the Penn Parker developments
- Denton Island
- The light industrial area

A few major heat loads in the city centre could also be captured together with the UTC College, Sainsbury and the Premier INN.

5.1.2 The Main Network – Option 2

This network, shown in Figure 35, would connect the following opportunity areas:

- The Eastside and Penn Parker developments
- Denton Island

As per option 1 a few major heat loads in the city centre could also be captured together with the UTC College, Sainsbury and the Premier Inn.

5.1.3 Qualitative comparison of the two main network options

The two network options differentiate not only because of the potential route but also for the philosophy behind them.

As previously discussed (see section 2.2.2.3), there are uncertainties relative to the heat demand, the heating systems and the use of the heat (i.e. space heating, industrial processes) that would be associated with the warehouses located within the light industrial area. It could be greatly beneficial, financially and environmentally, to route the heat network through this area, should there actually a number of significant heat consumers that could potentially be supplied by a heat network.

Moreover, the presence of a heat network in an industrial area could also potentially boost local economies attracting new business, for instances those that would have significant heat consumption and could see a heat network as a mean of reducing their energy bills and potentially the cost associated with carbon taxes.

If there could be a potential of capturing a number of major consumers in the light industrial area, route option 1 could be potentially preferable as this could be achieved through a shorter network.

Route option 2, in fact, does not preclude connection of business in the light industrial area, but it would require a longer route to do so. It should be noted, on the other side, that route option 2 would only need to cross the railway only once. This advantage could potentially result in a similar capital cost associated with the civil works required to install the heat network than those associated with option 1.

If there should not be a number of heat consumers in the industrial area sufficient enough to justify routing the network through this area, then, should a potential scheme come forward, option 2 should be preferred.

For the above reasons, Ramboll has excluded the industrial area from option 2 when assessing financial and environmental Key Performance Indicators (KPIs) associated with this scheme, because route option 1 could potentially prove a better option to connect the industrial area. Nevertheless, it should be noted that:

- further investigation would be needed to optimise the route and establish the optimum option
- should option 2 prove a better option, this would not preclude inclusion of the industrial area to the scheme.

5.1.4 The Newhaven Marina Cluster

A small network could potentially be developed in the Newhaven Marina Phase 3, which could connect new and existing residential blocks in the area. As discussed in section 4.1.5, the network would offer a potential to both expand towards the site housing allocation, when new developments would come forward, and also to connect to the main network in the future. The network, shown in Figure 34, would be fed by a local energy centre fitted with a water source heat pump.

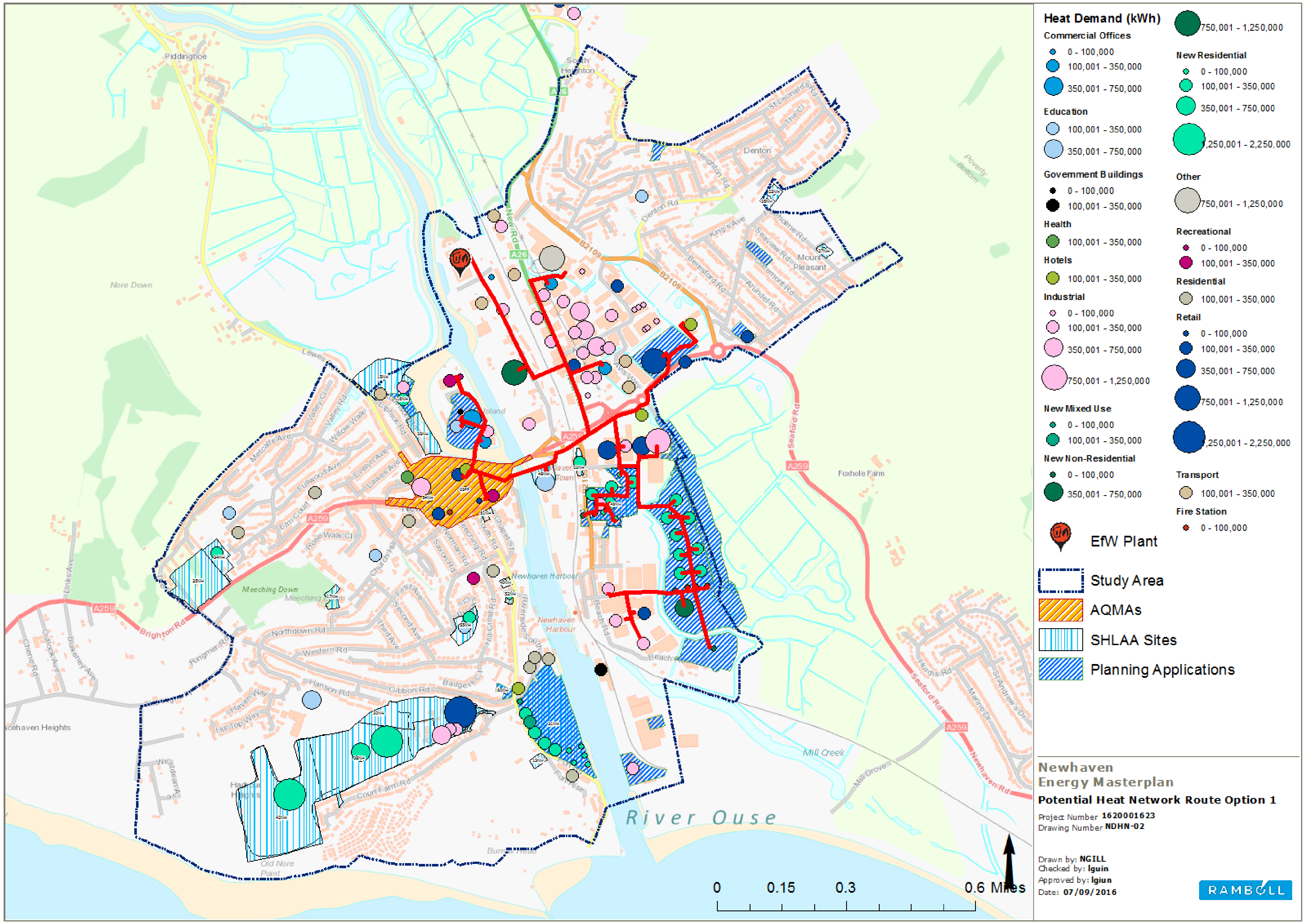


Figure 34: Potential Heat Network Route – Option 1

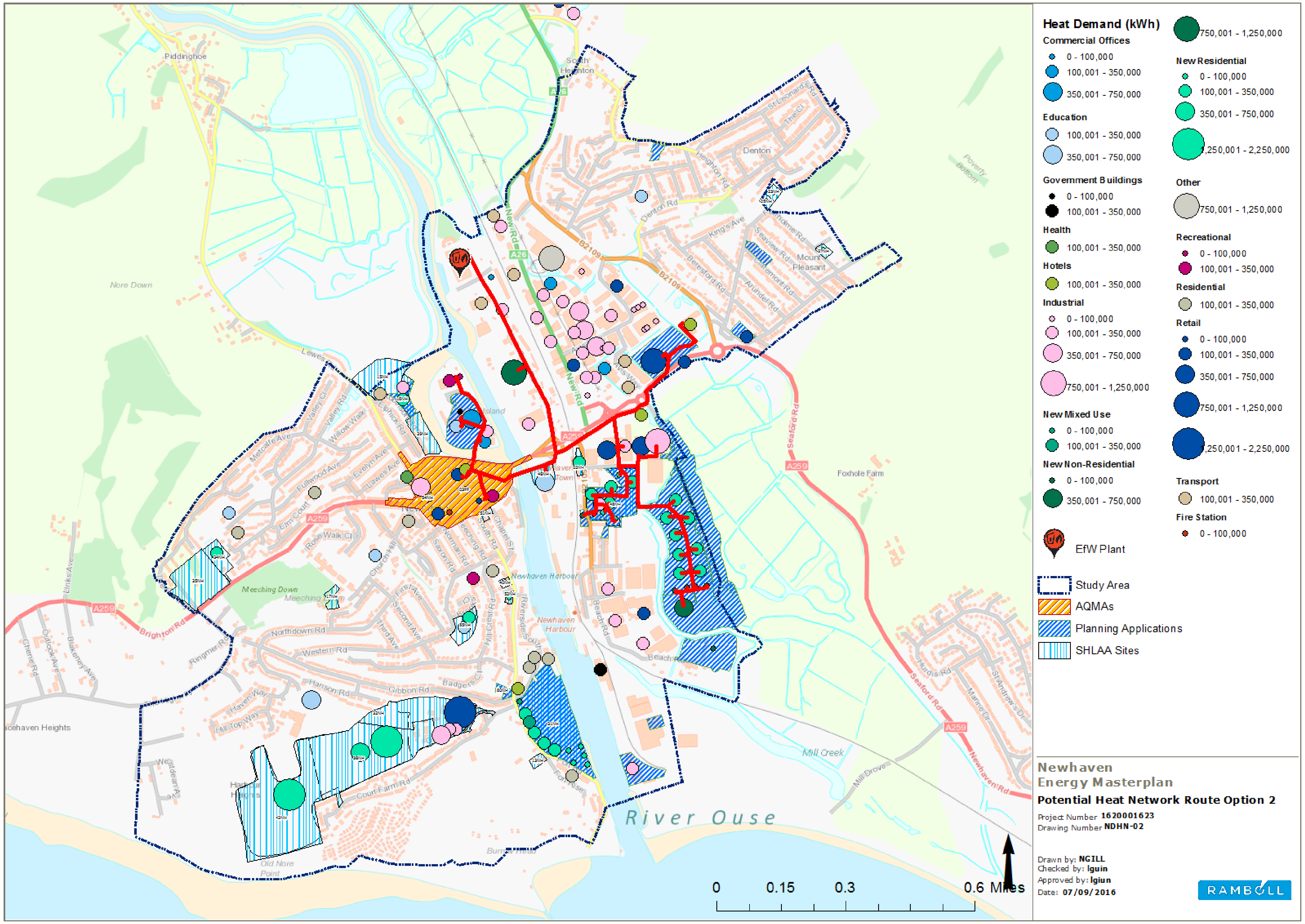


Figure 35: Potential Heat Network - Option 2

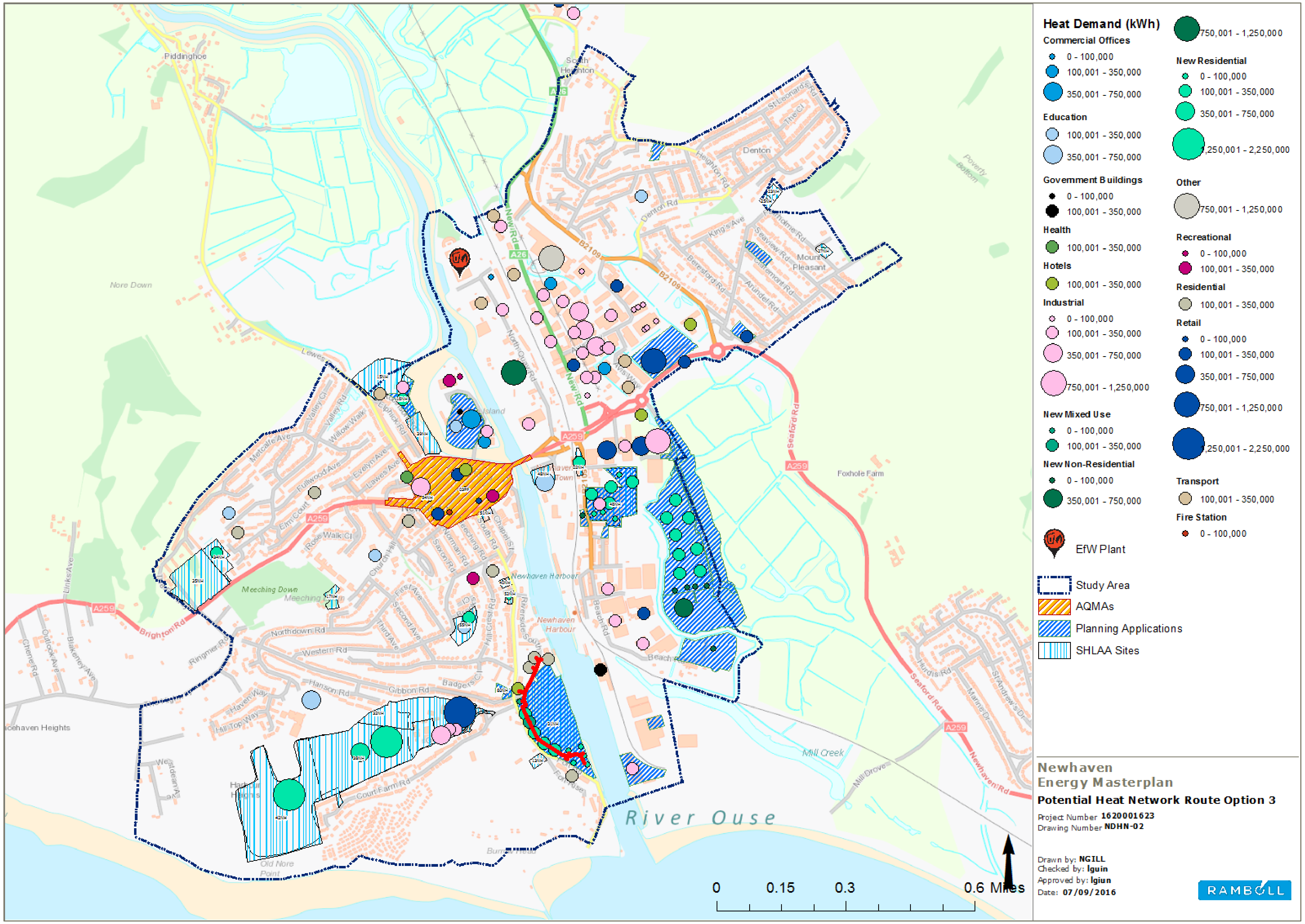


Figure 36: Potential Heat Network – Option 3

5.2 Main Network routing strategy

The Council provided information and GIS layers regarding proposed works and new developments that were used to inform the routing of the networks. This information included:

- New development areas
- Government owned land

Where possible networks have been routed through council owned green spaces, car parks and other available open areas. Where this has not been possible the network is routed along public roadways.

GIS layers provided by the council or data layers from the Environment Agency containing information regarding the constraints that needed were taken into account. This GIS data included information on:

- Conservation areas
- Contaminated land areas
- Flood warning areas
- National Parks
- Local nature reserves
- Site of special scientific interest (SSSI)

In general flooding areas and some of the key public transport routes were not avoidable. However as part of the process of de-risking of the network route which should be undertaken on an on-going basis throughout the development of the project these have been highlighted here.

Other constraints and opportunities such as railway networks, river crossings 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.

Where possible the network has been routed so as to minimise disruption and potential costs by using existing underpasses, bridges and avoiding major road crossings, i.e. crossings of single lane carriageways have been preferred over larger road crossings.

A number of key areas were observed as follows[7]:

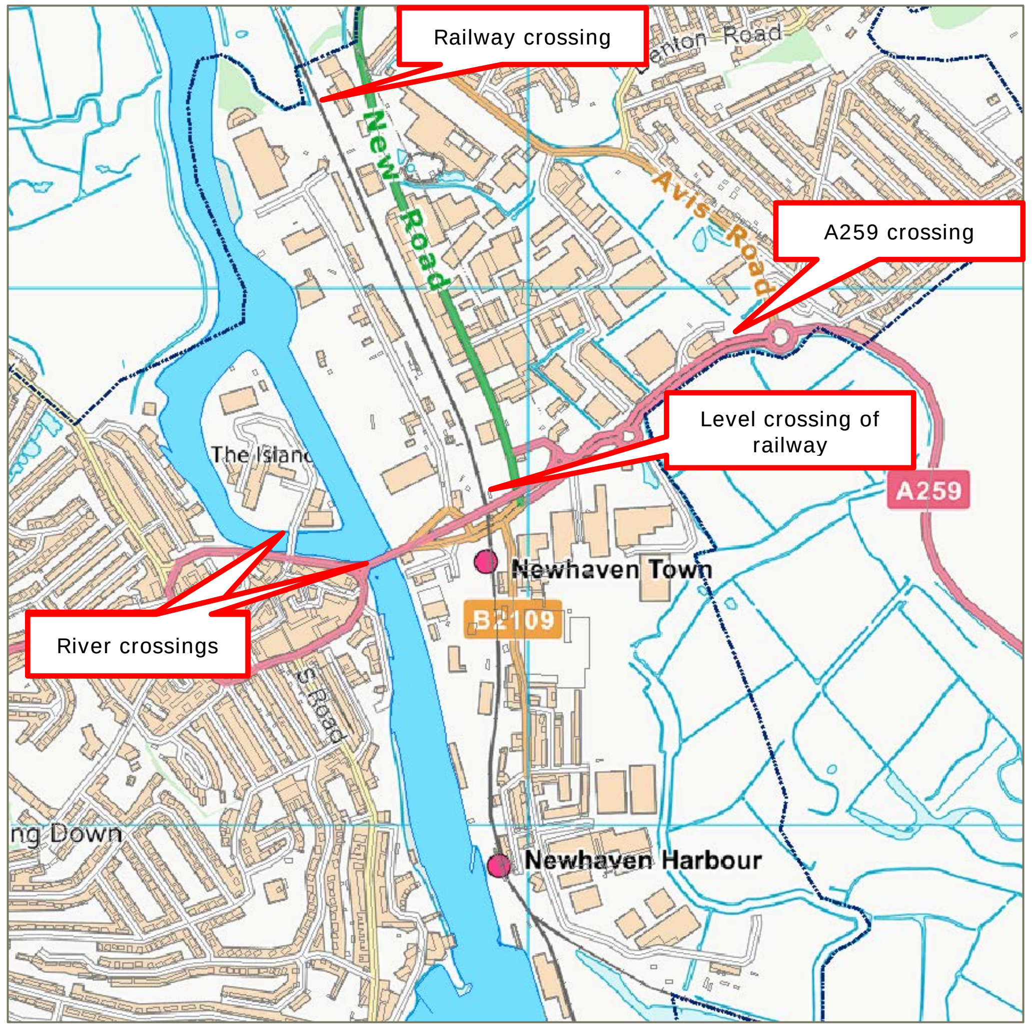


Figure 37: Network constraints

Figure 38: Railway crossing

As can be seen in Figure 38 a crossing of the railway opposite the North Quay ERF would be necessary in order to reach New Rd. This would involve either the construction of a pipe bridge, directional drilling or pipe jacking under the railway, or the lifting of the rails and installing into a dug trench before reinstalling the rails. All of these involve planning and agreement with Network Rail for permission. Also, fees would have to be paid to Network Rail for the crossing. This would be in the form of a one-off payment and an annual rent. In the case of lifting and reinstalling the rails, Network Rail engineers would need to carry out the reinstallation and necessary checks to confirm the railway is safe for use.

[7] Photographs courtesy of GoogleMaps

Figure 39: Under bridge crossing to access Drove Road

Figure 39 shows the bridge of the A259 busy two-lane road. To access Drove Road from New Road, it would be necessary to cross the bridge with the district heating pipework in order to supply the south or the boundary area. The option is to install the network in a dug trench below the bridge but it will be necessary to confirm this solution is safe to use.

Figure 40: Level crossing of the railway

Figure 40 shows the level crossing of the railway on Drove Rd. It would be necessary to cross the railway here with the district heating pipework in order to supply the UTC@harbourside campus. The options for crossing the railway are the same as previously described for the previous Route Issue. The cost of this would have to be balanced with the financial benefit that a connection to the college campus would bring to the district heating scheme.

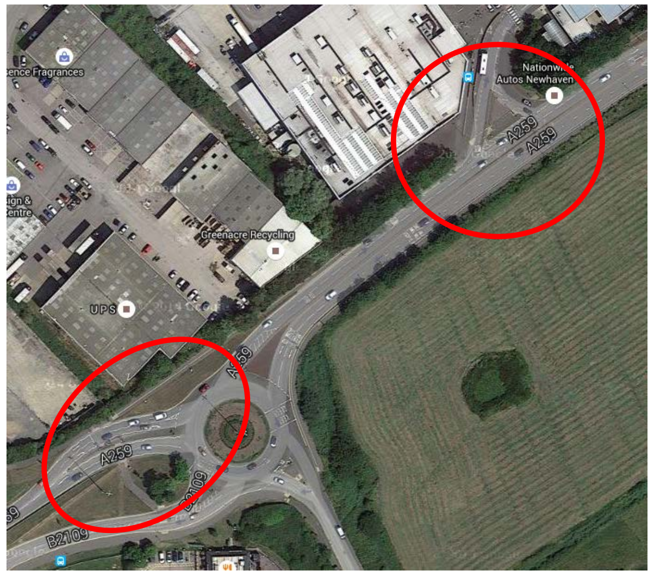


Figure 41: A259 Crossing

Figure 41 shows the points where it will be necessary for the network to cross the A259 in order to supply the Sainsbury's supermarket and Premier Inn hotel. This is a major road and closure apart of it or of the roundabout in order to install the piping will incur a cost and may cause considerable disruption. Nonetheless, the supermarket is one of the largest loads on the network.

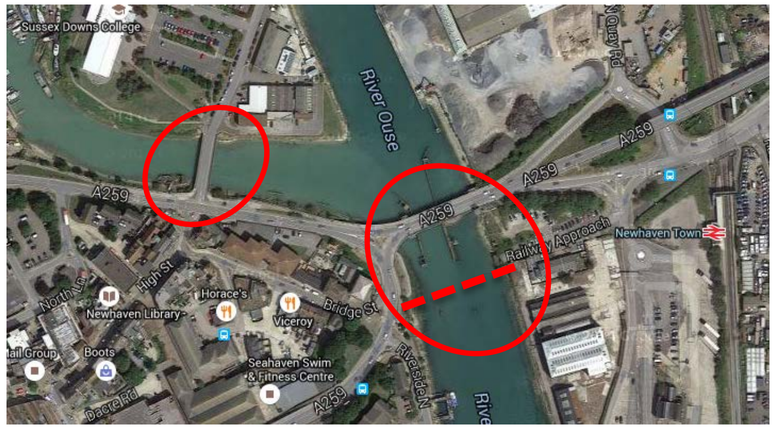


Figure 42: River crossings

As showed in Figure 42, two River Ouse crossings are required to connect the town centre and Denton Island. The first crossing is parallel to Newhaven Swing Bridge which carries the A259 over the River Ouse and the second is to access Denton Island. In the first case, as Newhaven Swing Bridge is scheduled to be opened every day, the crossing would likely entail the use of directional drilling under the river. This presents significant cost and difficulty to the project.

The second river crossing coincides with an existing bridge and this may not be suitable to take the additional load associated with the weight of the pipes as well as the horizontal stress induced by the cyclical expansion and contraction of the pipes. Therefore, a pipe bridge may be required although this would have a visual impact and may prohibit some river traffic and so opposition may be encountered from residents and river trusts when trying to secure necessary planning permission. If this is the case then directional drilling may be used, although this option is likely to incur a high capital cost.

5.3 Heat Networks Design Strategy

This sub section presents the main assumption around the initial design philosophy that has been adopted to size the network and estimate capital costs.

5.3.1 The Main Network

For the main network it was assumed that an energy centre would be installed nearby the ERF facility. Initial communication with this stakeholders suggested that there could be potentially space available depending on the land requirement.

The network would compromise a sub-station installed in proximity of the Eastside and Parker Penn developments or nearby the EZ. This substation would effectively split the network in two sections:

- A high temperature, high pressure network
- A low temperature high pressure network

The reasons behind this design strategy are the following:

1. Providing higher temperature heat to consumers in the light industrial area. This would potentially be beneficial for industrial consumers such as FM Conway and could potentially result in a higher proportion of their heat demand being displaced.

2. Providing heat at lower temperature to residential consumers, ensuring a higher level of safety and compliance with the recommendations set up in the CIBSE/ADE's Code of Practice for Heat Networks.

It is desirable to reduce diameters in the network, and therefore capital cost associated with the civil and M&E installation works. This could be achieved by maximising 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.

Table 15 presents the assumptions regarding network temperatures, which should be revisited at feasibility to investigate opportunities to reduce both capital and operating costs.

Design Parameter	Temperature	Comment
Primary flow temperature for existing buildings connected to the high temperature network	110°C	Supplying FM Conway and other potential stakeholders in the light industrial area
Primary return temperature for **existing buildings** at design condition	65°C	temperature that can be achieved from an existing building is 60°C with retrofitting and rebalancing of existing systems with 5°C heat exchanger losses.
Primary flow temperature for **new developments** at design condition	75°C	Assumes design flow temperature for new development is 70°C with 5°C heat exchanger losses.
Primary return temperature for new developments at design condition	45°C	Assumes design return temperature that can be achieved from a new development is 40°C with 5°C heat exchanger losses.

Table 15: Heat Network Design Temperatures

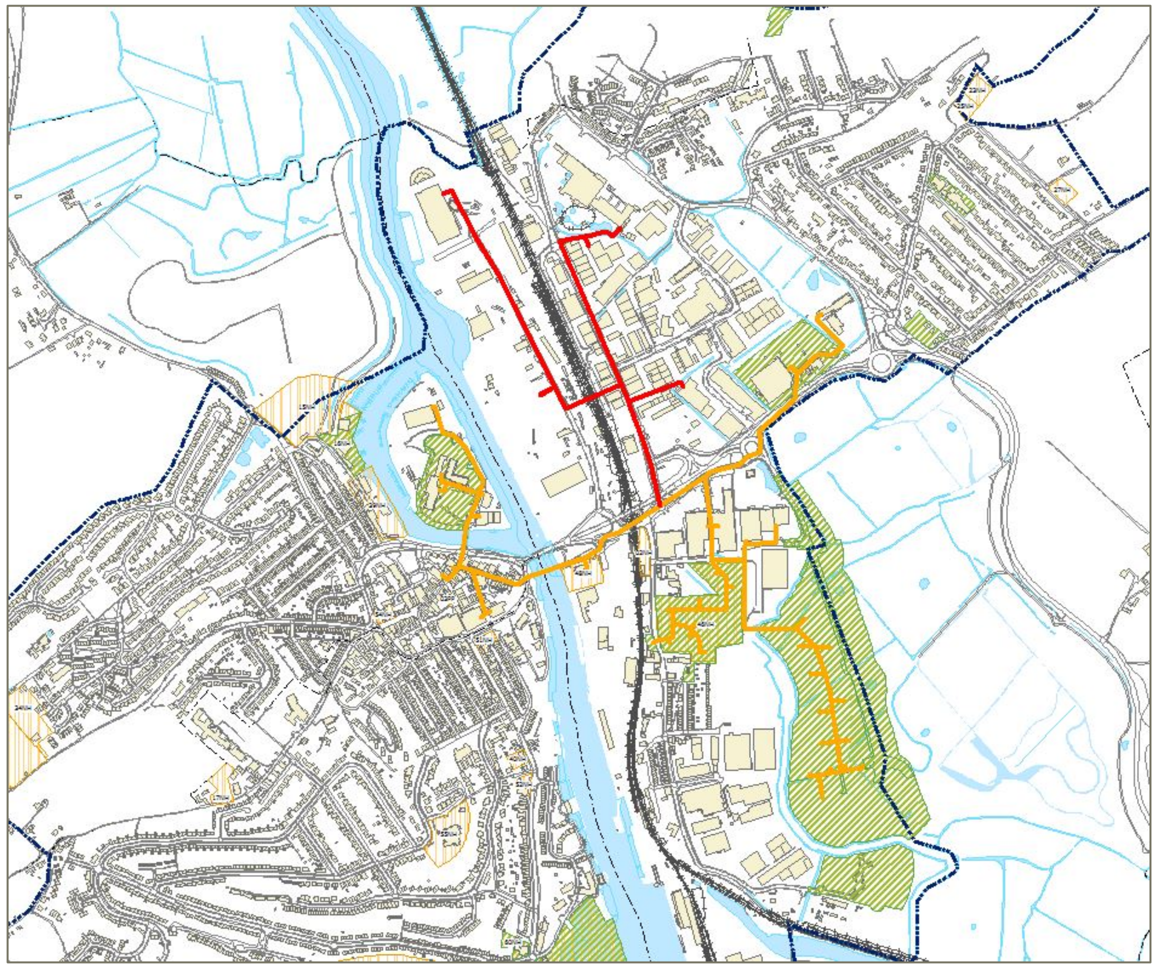


Figure 43: The high (red line) and low (orange) temperature network

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

A pipework pressure rating of 16 bar_g has been assumed, giving an allowable pressure drop of around 14.5 bar_g through the system, assuming a 1.5 bar_g static head.

Each network scenario identified in section 4 has been modelled using Ramboll's in-house hydraulic modelling software, System Rørnet (SR) in order to determine pipe sizes and heat losses in the proposed DH network. The software takes into account the various pipe lengths and topography, temperatures and heat loads to generate size, velocity and pressure outputs for each branch of the network.

The network diagram output from the hydraulic analysis and pipe schedules is shown in the figure below for the two options.

DN	Pipe Length (m)
32	1039
40	120
50	463
65	1329
80	641
100	451
125	620
150	971
Total	**5633**

Table 16: Pipe Schedule for the Main Network - Route Option 1

DN	Pipe Length (m)
32	275
40	96
50	427
65	152
80	33
100	451
125	1153
150	507
Total	**3094**

Table 17: Pipe Schedule for the Main Network - Route Option 2

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

It was assumed that the routes for the new developments would incur soft dig civils costs (reduced by 20% to reflect the cost savings that could be achieved by coordinating the installation of the network with the construction of the developments) whilst the rest of the network would incur 100% hard dig/suburban civils costs.

5.3.2 Location of Energy Centres

For the main network there are two potential locations for the energy centre:

- **The land occupied by the ERF**. Veolia has indicated that depending on the footprint of the energy centre there could be an opportunity to build the energy centre within the plot of land that they have on a long lease. Ramboll has indicated initial estimates of the energy centre (250 m^2) and Veolia has indicated that this space could be available. Another opportunity would be design the energy centre to make use of two storeys to reduce its footprint.

- There appear to be **vacant yard plots available near the ERF**. Some of these are owned by the council whether others (as communication with the owner suggests) these are currently on short leases so at least one is almost always vacant. For these the owner has also indicated that the land value in this industrial area is typically £300,000 to £500,000 per hectare (although purchasing smaller plots could result in a higher cost).

Another opportunity would be represented by the plot of land shown in Figure 45. Communication with the council has indicated that this land could be used for an energy centre.

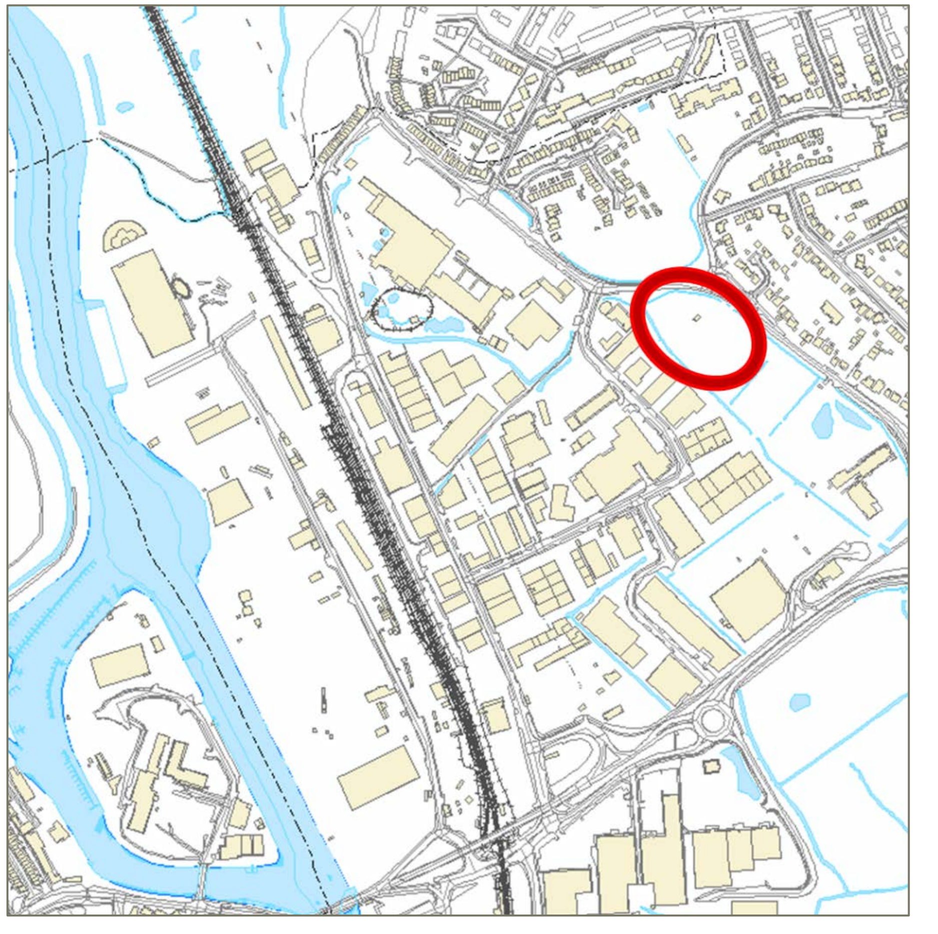


Figure 44: A potential location for the EC

Other opportunities include buying/renting an empty warehouses in the light industrial area. As discussed in section 2.1 some of the warehouses in the area appear empty and there could be an opportunity to re-utilise them as energy centres, reducing the cost of building a new energy centre.

At this stage it has been assumed that the energy centre would be built within the land occupied by the ERF.

For the Newhaven Marina Scheme, locations of the energy centre should be investigated with the developer, although given the modest amount of space that is expected to be required (roughly 150 square meters.) opportunities could include:

- The basement of one of the residential blocks that will be built
- Installing the Water Source Heat pump on floating platforms
- Making use of land available within the development

5.3.2.1 Connection to FM Conway

It has been assumed that heat would be transmitted to this consumer using water as media.
It should be noted, though, that there could be a benefit in transferring heat to this consumer in the form of steam, which should be investigated further at feasibility stage.

If heat is transferred to FM Conway in the form of steam then there could be at least two options:

- Transferring steam through a branch that would connect FM Conway to the ERF, which would be separated from the rest of the network
- Transferring steam through a branch that would connect FM Conway to the ERF, and from here a steam-to-water heat exchanger would effectively change the transmission media to the rest of the network. This option could though create potential commercial complications, since an agreement (covering more than just the provision of heat) would have to be put in place between the network company and this stakeholder. Moreover such arrangement would add a risk to the scheme since the network would rely on the presence of this stakeholder to operate. (i.e. risk associated with the factory closing down).

5.3.3 Newhaven Marina

For the Newhaven Marina, Ramboll has retained the same temperature assumptions used for the new developments in the main network, presented in Table 15.

5.4 Potential Implementation Strategies

The implementation strategy for the heat network would depend primarily on two factors:

- The timescale for FM Conway and how this compare to that of the Eastside, Parker Penn and Marco Trailer developments;
- The potential of establishing first a small local heat network in the Eastside, Parker Penn and Marco Trailer developments.

Depending on the factors above at least four scenarios could be projected. These are discussed below and the corresponding implementation strategy is shown graphically in Table 18.

In **scenario one** FM Conway would move to Newhaven prior to the new developments coming forward. This could represent an opportunity to start the implementation of a potential scheme which could connect other stakeholders in the light industrial area and extend in the next phases.

In **scenario two**, FM Conway establishes its plant in synchrony with the construction of the new developments. In this case the network could be developed in its first phase so to connect FM Conway, existing heat loads in the light industrial area and the Parker Penn, the Eastside and the Marco Trailer developments as they come forward.

In **scenario three**, the construction of the Eastside, Parker Penn and Marco Trailer developments commences prior to FM Conway establishing a plant in the Enterprise Zone. In this scenario it could be possible to initially connect these as they come forward, as well as other existing loads in the light industrial area. This scenario, though, could be perceived risky by the project company, which would have to bear the risk associated with new developments not coming forward and their actual implementation programme (i.e. construction delays). This would lead to a fourth scenario.

In **scenario four** the network company, could try to de-risk the scheme by establishing first a local network in the land (or in very proximity) of the Eastside, Parker Penn and Marco Trailer developments. This would be supplied by a local energy centre fitted with gas boilers, which could then be retained for peaking and/or back-up purposes. The local network would then connected to the ERF and expand towards other areas (e.g. the light industrial area, Denton Island, etc.).

In each of the scenarios above the Newhaven Marina could be developed as an independent scheme, depending on the timescale associated with this development. This is being shown as happening on Phase 1 to indicate that this scheme could be implemented independently of the phases of the main network. This could potentially connect to the main network in the future and expand towards the West, connecting future developments that could come forward in the housing allocation area.

The Eastside and Parker Penn could potentially be developed between 2020 and 2023, whilst communication with FM Conway indicates that this stakeholder could potentially move to Newhaven in the next couple of years. Therefore, these three major opportunities to trigger the development of a scheme could potentially happen within reasonable synchronisation.

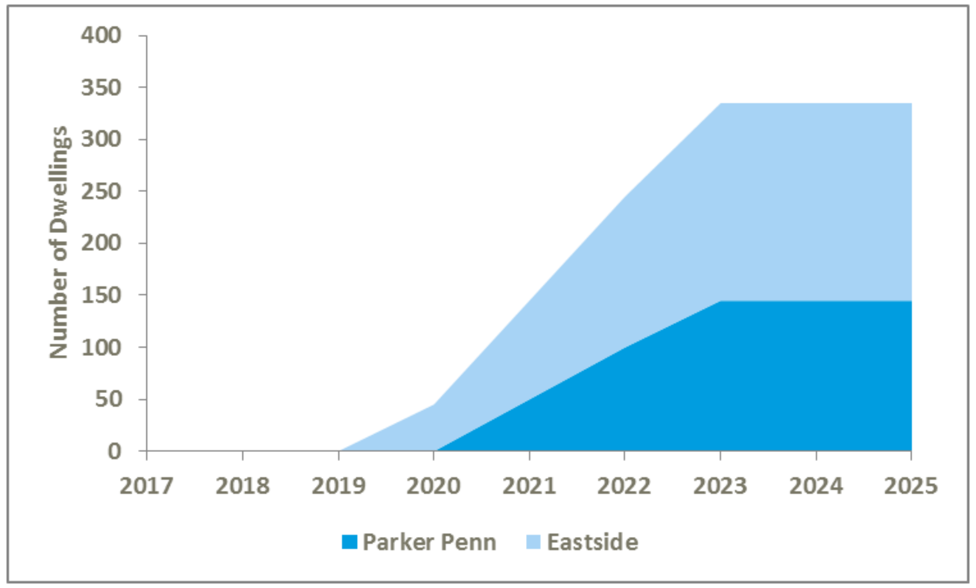


Figure 45: Assumed Phasing of New Developments

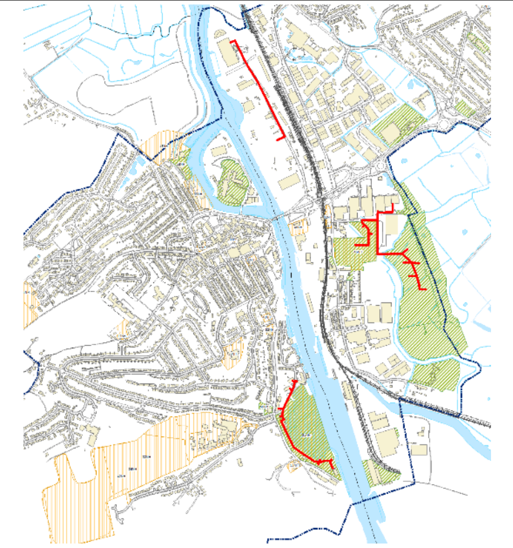
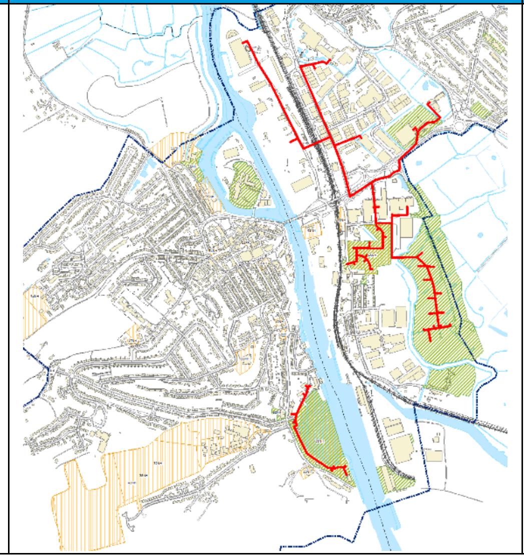
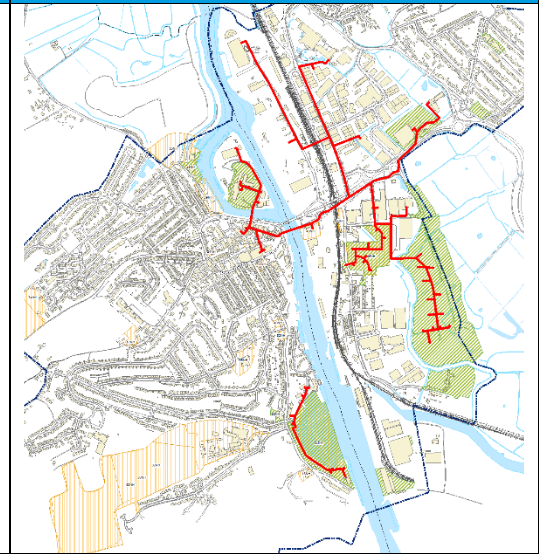
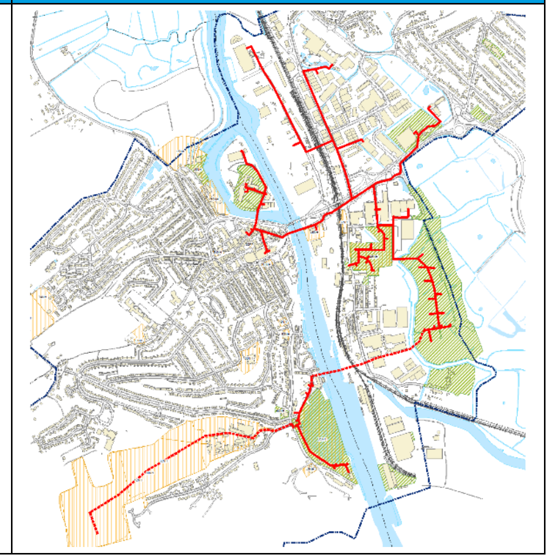
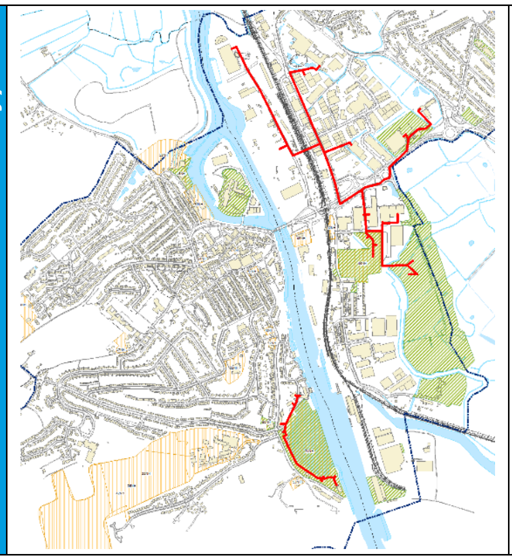
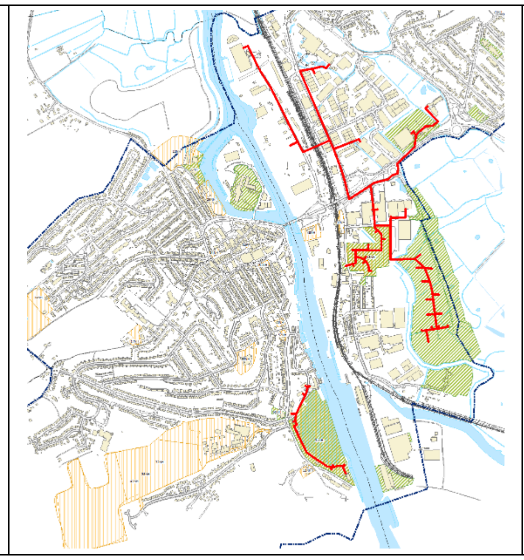
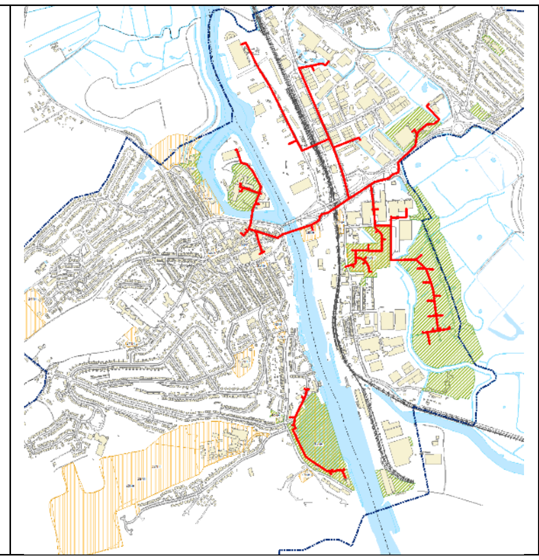
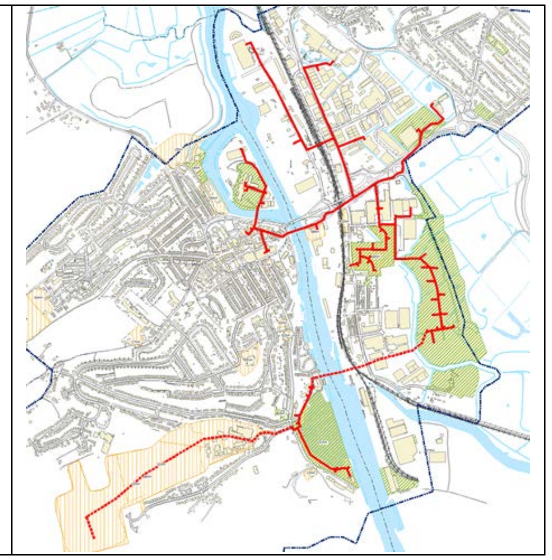
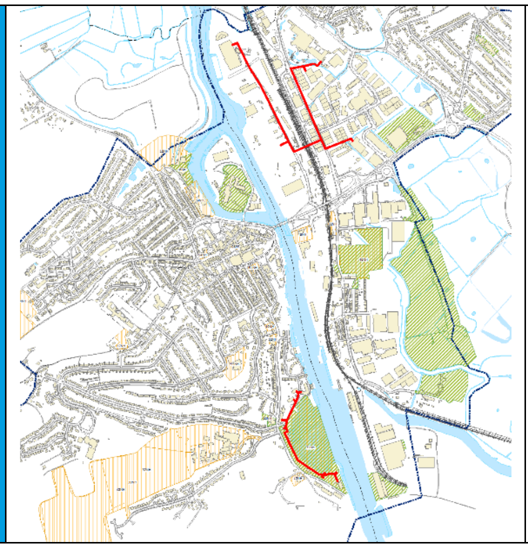
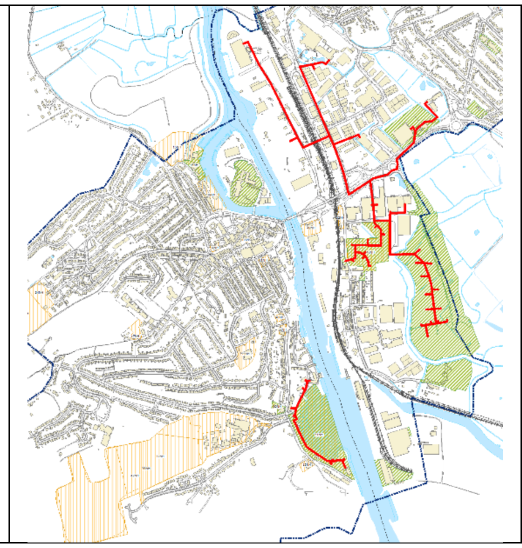
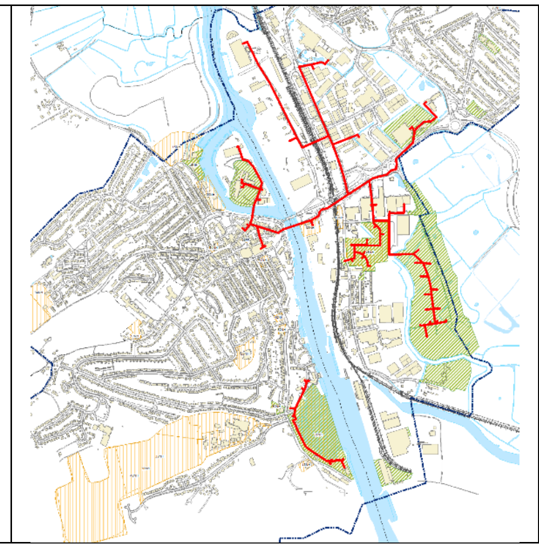
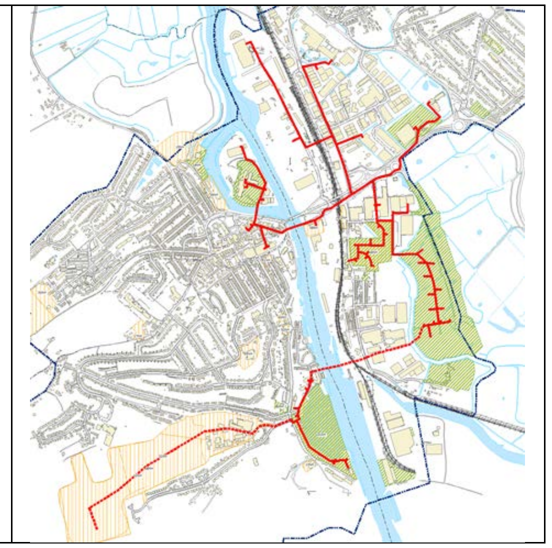
	Phase 1	Phase 2	Phase 3	Phase 4
Scenario 1				
Scenario 2 and 3 (differ only for year of connection to FM Conway)				
Scenario 4				

Table 18: Indicative Potential Implementation Strategy of Heat Network Opportunities

5.4.1 High Level Analysis of Supply Assets

A high level analysis has been carried out on to establish which supply asset could offer most benefits (financially and environmentally) to a scheme involving both the main network and the Newhaven Marina schemes.

For the Main network the ERF has been selected for further analysis since:

1. **It is likely to require a lower capital cost associated with the generating asset**, even accounting for the heat off-take equipment. Further refinement of cost assumptions would be needed to confirm this potential particularly in comparison with an alternative such as a solar thermal powered scheme (which would also bore the value of the land covered by the array). If replacement costs are taken into account, then the ERF may result even a cheaper option.

2. **It has a relatively low cost of heat**

   CHP gas engines can generate heat at a negative cost of heat in a private-wiring scheme, although this does not appear easily implementable. This is because the electrical loads that could be theoretically connected in each scenario would either be residential, therefore high risk or with no mechanisms to implement it such as the license lite, and/or commercial (all other scenarios) adding commercial complications and risk to any potential scheme. Moreover, the size of the electrical load connected to the CHP should be comparable to the size of the demand to achieve a potential negative generating cost. The higher the volume of exported electricity the higher the resulting cost of the heat. For a typical CHP engine, exporting all of its generated electricity, the cost of the heat (net of the monetary value of the electrical generation) was estimated to be in the range of 25-35 £/MWh, and therefore higher than £10.45 per MWh (assumed cost of heat from Veolia).

   For a given electricity price, the cost of the heat per MWh generated through a water source heat pump would depend on the SPF and could vary between £ 2.4 (SPF of 3.3) and £ 3.2 (SPF of 2.5, minimum required by Ofgem for RHI eligibility). This cost is higher than that associated with the heat generated by the ERF. Both estimate exclude subsidies. In both cases the generating cost associated with peaking boilers is excluded (please note that the ERF supply the full demand except during period of maintenance outage). The cost of generating heat through gas boilers (estimated £31 per MWh) would result in an overall higher cost of heat associated with both a CHP engine and a WSHP scheme.

   Solar thermal has virtually a zero cost of heat. Although the overall cost of the heat would very much depends on the installed peak capacity of the solar array. Assuming an annual supply proportion of 60% of the total annual demand of a potential scheme, the overall cost of the heat would be about £ 12.4 per MWh, which is comparable with the overall cost of a scheme supplied by the ERF.

3. **It offer the potential to achieve the greatest amount of carbon savings**

   The carbon content of the heat from the ERF could be taken equal to the carbon content of the electricity in the national grid and scaled down by the Z factor, which would be in the range of 5.5. Same would apply to a WSHP technology, which is likely to have an average scaling factor in the range 2.5-3.3 (the heat pump COP). Therefore the ERF would save a greater amount of carbon emission than the WSHP.

   The carbon savings of a CHP engine would also depend on the carbon content of the electricity in the national grid but, in contrast to the ERF and the WSHP options, the carbon savings delivered are related to this in a direct proportionality (i.e. the higher the carbon intensity of the electricity the greater the CO_2 savings). If grid decarbonisation is taken into account, then this technology could actually provide negative savings over its lifetime. This would of course depend on the decarbonisation rate of the electricity. A study, published in the CIBSE technical Symposium (An Operational lifetime assessment of the Carbon Performance of Gas Fired CHP led district heating, April 2016) suggests that this may be already happening.

   Finally, for a given volume of demand the carbon savings delivered by a solar thermal array would depend on the proportions of supply (i.e. solar and gas boilers). A rough estimate indicates that roughly 73% of the annual supply would have to be provided by a solar thermal array to achieve overall carbon intensity comparable to that associated to the ERF in 2019 (assuming a 97% proportion of annual supply). Grid decarbonisation could raise this figure to about 85% by 2029. Even though these proportions of supply could in theory be achieved, through seasonal and daily storage, in practise it would be quite challenging, requiring an extensive solar array accompanied by very large seasonal heat store. Therefore in practise an 85% heat fraction may prove not viable technically and/or financially. Another common practise in the industry is using solar thermal to back-up other generating plants (commonly CHP). This option though has been excluded at this stage from further analysis given that it is likely to affect negatively the financial KPIs of the scheme (the ERF has the potential to supply the full load). Indeed, this option should be looked at in the future, if a scheme will be developed and established, for backing-up purpose, diversity and flexibility of operations which could potentially lower the cost of the heat (particularly during periods where the electricity generated by the ERF has a higher value).

In Conclusion:

- The ERF has been selected for further analysis as it is believe to maximise financial and environmental benefits.

- Solar thermal for backing-up purpose should be considered in the future if a network will be developed, to reduce operating cost and offer diversity of supply.

For the Newhaven Marina scheme the WSHP option has been preferred. Taking into account the discussion presented earlier in this section, the solar thermal and the WSHP would be the best technologies for this scheme. The solar thermal option could prove better than the WSHP, although green lands located in proximity of this development are occupied for recreation purpose or allocated to housing. Therefore, considering that the solar array would have to be located off-site, heat would need to be transmitted over longer distances, leading to higher capital cost. For this reason, the WSHP has been preferred for this scheme. It is recommended though that the potential of implementing a solar thermal array would be assessed at feasibility stage.

6. TECHNO-ECONOMIC ANALYSIS

This section summarises the main Key Performance Indicators (KPIs) of the techno-economic analysis that has been carried out for the schemes that were identified as the key project opportunities.

6.1 Outline Methodology

Energy modelling and economic model for the scenarios were undertaken using EnergyPRO software. EnergyPRO produces hourly energy demand and supply profiles in order to produce a detailed map of energy flows across each year of the project. Plant sizing and operational constraints were optimised by Ramboll to determine the most effective configuration. The software also takes into account the cost phasing over time to show the economic performance of the project over its specified lifetime.

The first stage in the analysis was to establish the 'business as usual' (BaU) or 'do nothing' scenario, which enabled the calculation of relative carbon and cost savings of the DH network against the scenario where the DH scheme is not progressed.

Following this, the energy demand, heat supply and infrastructure information for the three scenarios was inputted into the model to generate the technical results which show the likely operation of the plant. Finally cost information was included and the model calculates the project cash flow for each year of the specified project lifetime.

A sensitivity analysis was conducted whereby the key variables were independently altered to enable observation of their effects on overall project economics.

6.2 Summary of Key Economic and Carbon Performance Indicators for Modelled Scenarios

The schemes were assessed in relation to two economic key performance indicators and CO_2 savings:

- **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.
- **CO_2 savings** – reviewed against business-as-usual

The IRR and NPV calculations are presented in real terms, i.e. inflation is not modelled. NPVs are presented in terms of real discount factors of 3.5%. Energy price increases have not been taken into account.

Each of these factors was considered over a 25 and 40 year project lifetime. The IRRs reported are in real terms and exclude the effect of energy price increment (i.e. increased spark gap over time) unless otherwise stated.

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

6.3 Overarching Assumptions

6.3.1 Assumptions around the commercial arrangement and their implications

It is important to note that the commercial arrangement that would be put in place, should a heat network scheme come forward, could affect significantly the economic KPIs presented within this report.

Given that a detailed assessment of the commercial delivery of a scheme was outside the scope of this report, a number of assumptions were made regarding the buying and selling of heat.

The economic success of scheme would vary according to the following key factors:

- The RHI available to the ERF and the division of the revenue between Veolia and the heat network operator
- The agreed division of capital cost between Veolia and the heat network operator
- The cost of the Heat from the ERF

It should be noted that "the heat network operator" could refer to a Local Authority or private investor, such as an ESCo. This will depend on the preferred delivery vehicle as discussed in section 8.1.

Veolia has expressed interest in financing a low-risk and financially viable scheme. Should the heat network operator and Veolia become the same entity (i.e. Veolia is financing the entire scheme), the cost of the heat could potentially be lower than that borne by a separate operator (such as a private ESCo), as Veolia would not require a mark-up on the actual cost of generating heat.

In order to address the uncertainties around the commercial arrangement, the economic KPIs (IRR and NPV) have been assessed for the scheme as a whole (i.e. with no division of cost between Veolia and heat network operator) under the following assumptions:

- the scheme would benefit from the full revenue stream associated with the RHI
- the cost of the heat from the ERF would not include any mark-up to Veolia
- the capital cost would be fully borne by the operator.

This option is more likely to be representative of a scenario in which Veolia is investing in a potential scheme. Should this not be the case (e.g. a private organisation such as an ESCo invests in the scheme) then the value of the revenues would likely be lower than those reported for each of the scheme that have been modelled. This is because Veolia is likely to require a financial benefit from the scheme.
A sensitivity analysis has been carried out on capital cost, cost of the heat and RHI revenues to the scheme, which would reflect in effect how the IRR and the NPV of the scheme would vary depending on the commercial agreement between the heat network operator and Veolia.

6.3.2 Connection Costs and Financial Contribution from Developers

The economic model assumes that developers would contribute towards the scheme in a proportion that would not penalise them. They would effectively contribute towards the scheme by:

- bearing the capital and installation costs for HIUs, as they would have financial savings associated with the capital and installation cost of natural gas boilers in residential buildings.
- in commercial buildings thy would bear the cost of purchasing and installing a heat exchanger, as they would have savings associated with the capital and installation costs associated with natural gas boilers.
- financially contributing towards the scheme proportionally to the savings associated with the avoided cost of on-site renewables (further explained below).

Developers are required (under Part L) to reduce carbon emissions associated with their developments. In order to do so, they would need first to meet a minimum standard for Fabric Energy Efficiency (FEE) and, thereafter, increasing the carbon savings through implementation of on-site renewable energy technologies.

The implementation of a heat network scheme would help developers in meeting their carbon savings targets which in effect, has an intrinsic value embedded. This would be the savings associated with the on-site renewable technologies that the developer would avoid investing in.

To estimate this financial benefit, Ramboll has first assessed the CO_2 saving that would be required by typical residential buildings after the implementation of FEE. This has been done by comparing SAP modelling that Ramboll has undertaken in other projects. Ramboll has then assumed that the remaining carbon emission would be off-set by on-site PV. The financial savings have then been estimated estimating the cost of the required solar PV array to offset the remaining carbon emission.

Finally, the installation of a local heat network could result in additional savings given that developers may opt to install electric hobs and ovens in order to avoid the need to install a distribution gas network and connect it to the national grid. These benefits to developers could be used to incentive them in participating in the implementation of a potential scheme, given that they may show little interest particularly because they have already secured planning permissions. There could be scope to ask for a higher contribution than that assumed within this study if the equivalent monetary value of these savings would be shared between developers and the network operator.

6.3.3 Assumed Programme and implications

As discussed in section 5.4 there could be at least four implementation strategies, which would depend on the timescale associated with the new developments coming forward.

Based on the assumptions made for the timescale of new developments (0) it seems that it would be possible to start the implementation of a heat network in 2019 using the strategy outlined in scenario 2 in section 5.4.

Establishing a local network in the Eastside, Parker Penn and Marco Trailer developments (as outlined in section 5.4.) could reduce the risk associated with the project and improve economic KPIs of a potential scheme.

Ramboll has not modelled this approach since:

- Temporary boilers will have to be installed within either the Eastside or Parker Penn developments, which may or may not be possible.

- The capital cost associated with both the heat network and the temporary boilers would be borne by the network company, with a contribution to be provided by the developer (see section 6.3.2). This network company could potentially run the scheme under financial losses until connection to the ERF would actually happen, given that the cost of generating the heat would be higher.

It is recommended that this option is reviewed at feasibility stage.

6.2.3 Summary of Economic and Carbon Assumptions

The key economic and carbon assumptions are summarised in Table 19 for all scenarios that have been analysed. APPENDIX 1 contains a more detailed summary of assumptions for each of the scenarios modelled.

Variable	Assumption
BaU cost of gas to consumers	Taken from table 3.4.2[8], excluding domestic consumers. For these a desktop investigation has been done to assess the average prices that the big 6 charge for gas in the area.
Cost of gas to energy centre	Extracted from table 3.4.2[9].
Cost of Heat from the ERF	A lifecycle cost analysis was conducted to establish the heat price required whereby Veolia would not lose or gain from the heat offtake. This took into account the z-factor, financial incentives (RHI,ROCsand CFD as applicable) and biogenic and energy contents of the fuel in order to consider the energy balance at a range of outputs and to estimate the proportion of lost electricity revenue. The capital cost of the heat off-take is included as capex item in the techno-economic model.The model is run over a period of 25 years.
Heat Sale Price	Based on the consumers' BAU and reduced by a 5% incentive. Reported in Appendix 1 for each of the schemes modelled and for each customer type connected to the scheme.
Carbon content of gas	Table 2a: Converting fuel types to CO2 and CO2e (emissions factors), DECC 2016
Carbon Content of Electricity	Table 1: Electricity emissions factors to 2100, kgCO2e/kWh, (Grid Average Generation based), DECC 2016
CAPEX	Based on a database of supplier data gathered by Ramboll in previous DH design projects and scaled according to size. Breakdown reported in Appendix 1 for each of the schemes modelled.
REPEX	Gas boilers – every 20 years WSHP - every 20 years

[8] Table 3.4.2 Prices of fuels purchased by non-domestic consumers in the United Kingdom (including Climate Change Levy), DECC 2016

Variable	Assumption
	Specific figures reported in Appendix for each of the schemes modelled.
O&M	Based on a database of supplier data gathered by Ramboll in previous DH design projects. Breakdown reported in Appendix for each of the schemes modelled.
Peaking and Back-up Boilers	Total capacity assumed to be equal to the peak demand of the scheme (reported in Appendix 1) and increased by 50% for resilience purposes.

Table 19: Summary of Key Assumptions

6.4 Scenarios Modelled

6.4.1 Modelling Philosophy

Ramboll has chosen a modelling strategy that would establish the economic and environmental KPIs at different risk levels.

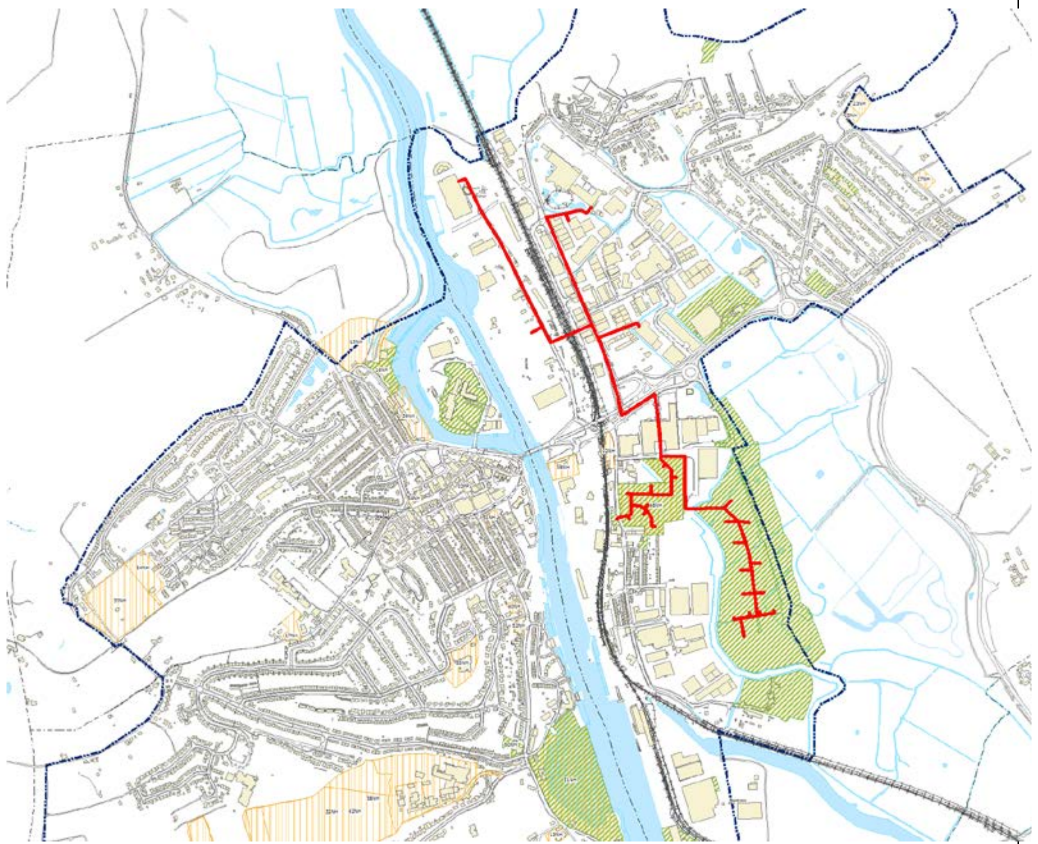
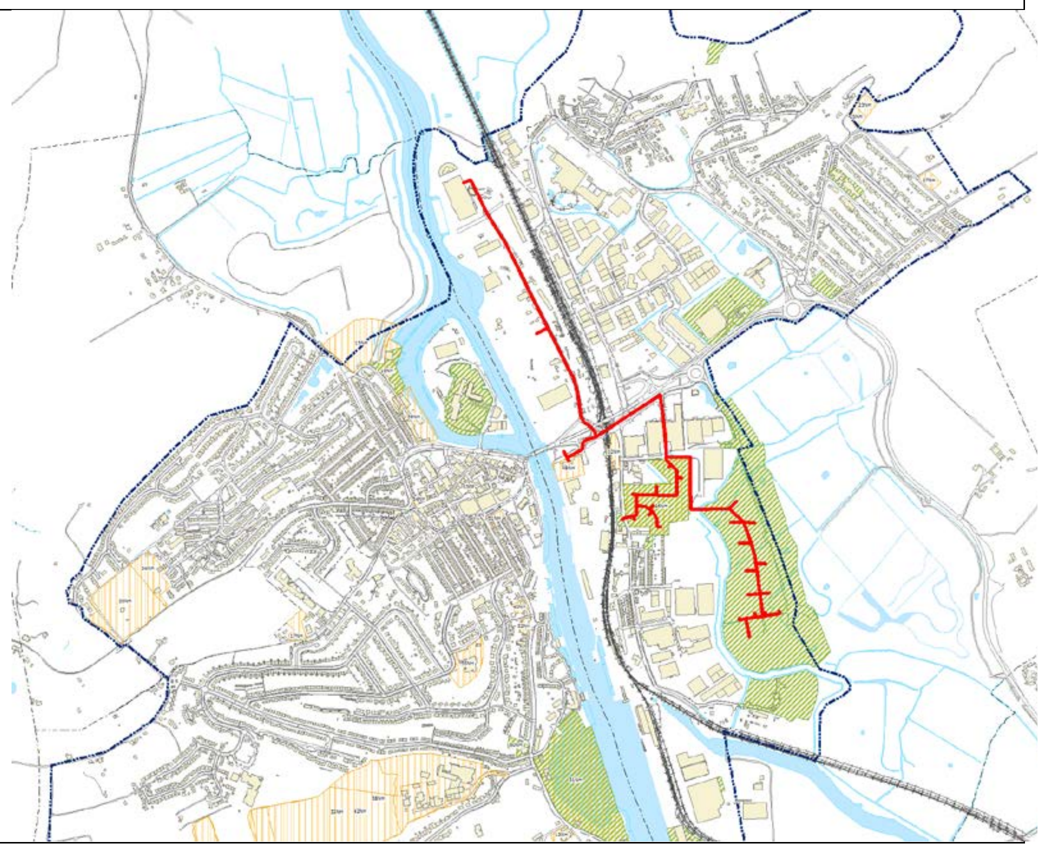
Moreover, the scenarios modelled aimed to establish the impact that certain opportunity areas, or stakeholders, have in the overall performance of the scheme. Therefore, in certain scenarios the main heat network (see sections 5.1.1 and 5.1.2) would result shorter due to the fact that a certain area or certain stakeholders have been excluded. 6.5 presents a summary of the scenarios modelled together with the corresponding heat network.

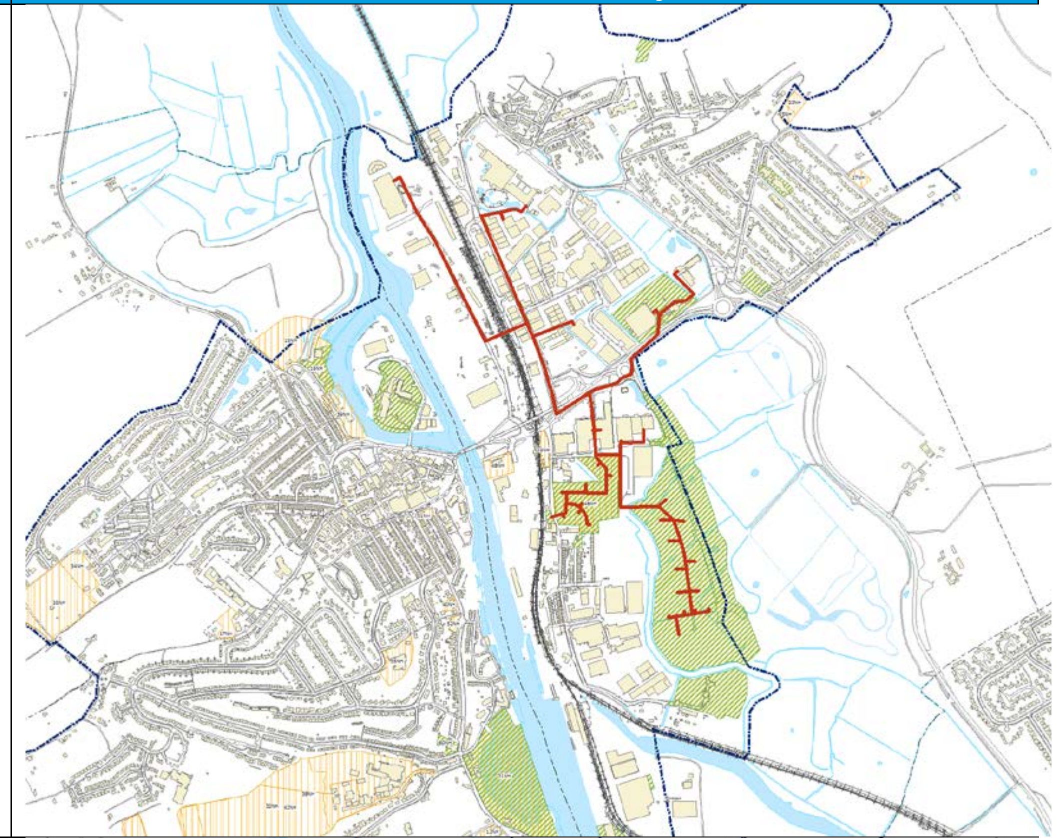
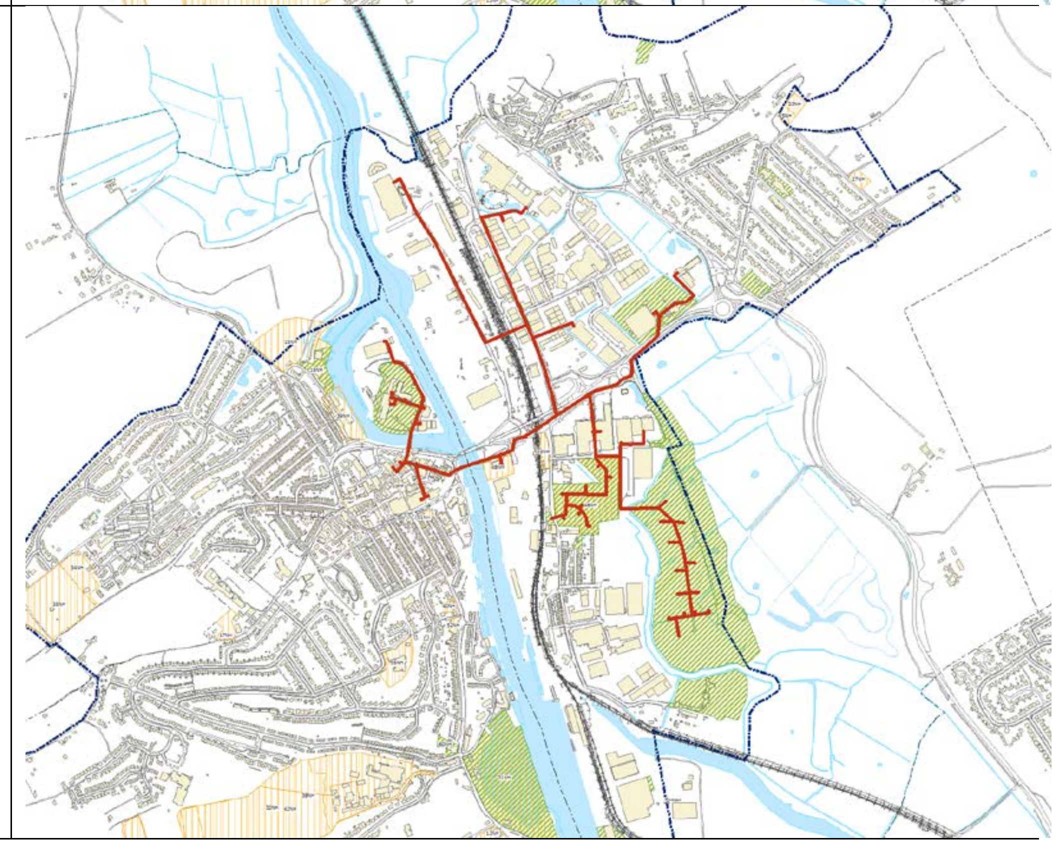
Given the uncertainties associated with the energy demand and the heating system of buildings in the light industrial area, these have been excluded from all the scenarios modelled. Ramboll recognises that connecting as many major heat consumers as possible in the light industrial area would benefit any potential scheme financially and environmentally. For this reason, a separate analysis has been done to establish the impact that connecting different volumes of heat demand has on the IRR.

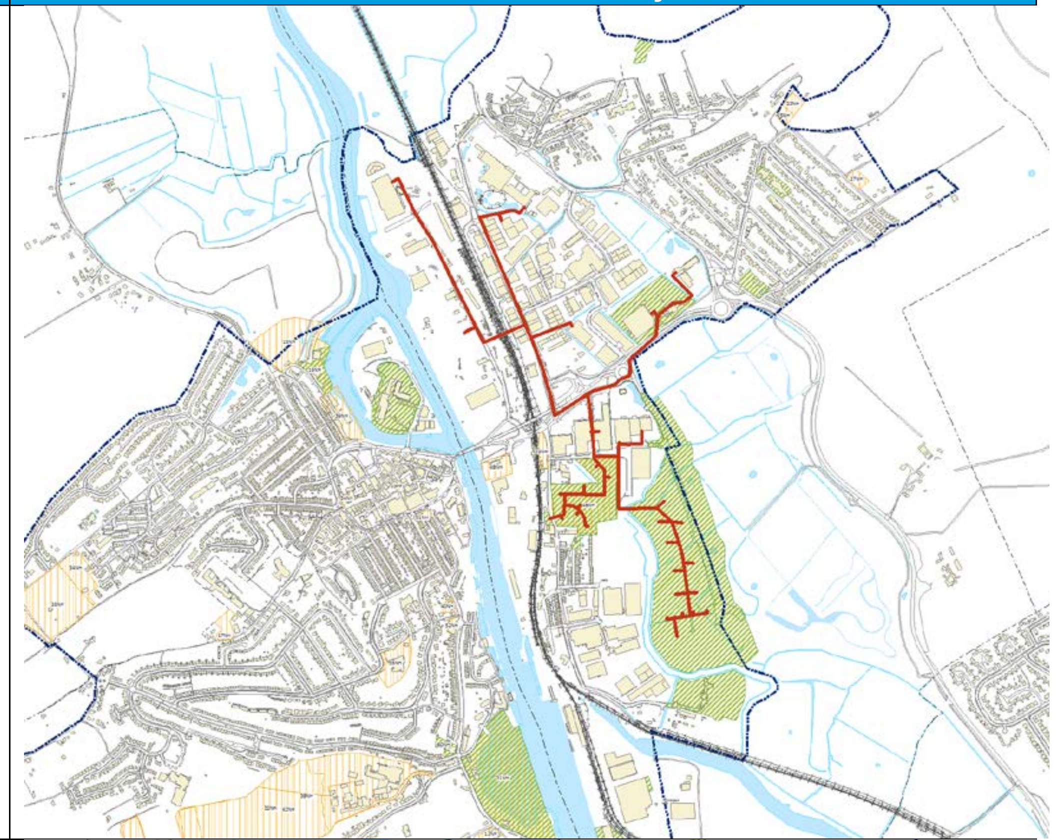
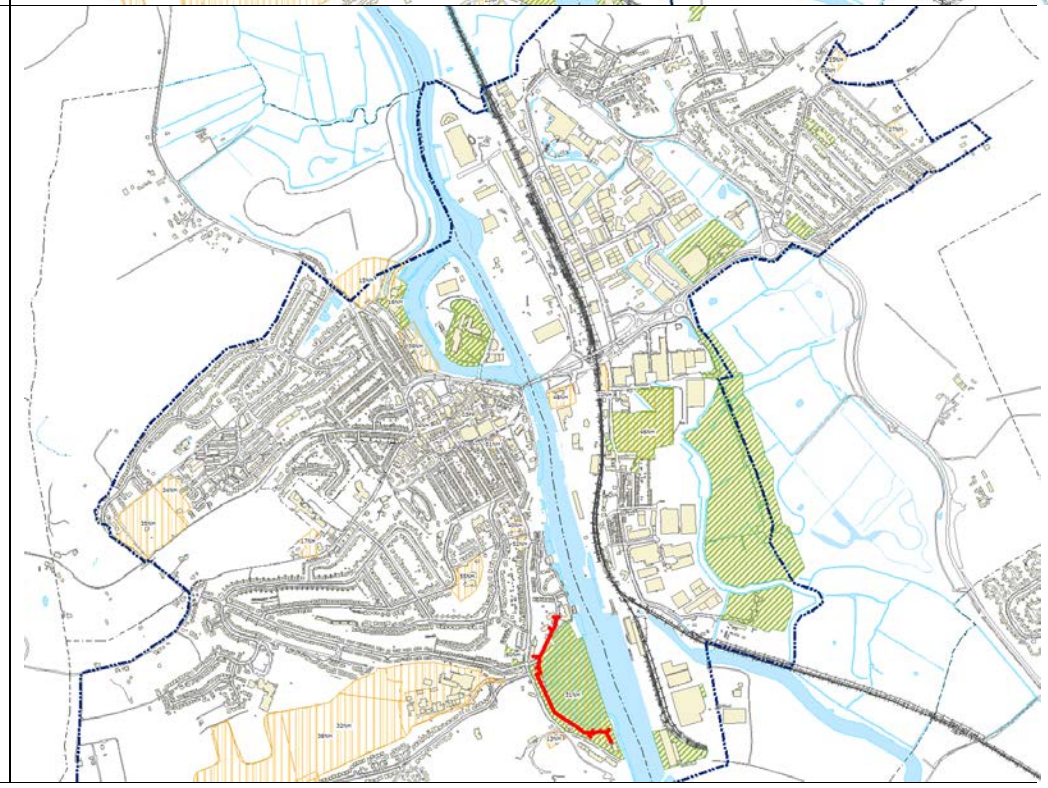
6.4.2 Scenarios Description

The scenarios that have been modelled are presented on the next page.

A breakdown of capital cost, energy demand and other assumptions are reported in APPENDIX 1 for each scenario.

Scheme	Scenario	Description	Scheme Summary
MAIN NETWORK OPTION 1	Scenario 1	**Primary Supply Asset: Newhaven ERF** **Peaking / Back Up Boilers Total Capacity: 5MW** (about 2.5% contribution to supply) **EC Size (assumed one level): 190m^2** This scenario assumes that a heat network, supplied by the Newhaven Energy from Waste (EfW) facility, would supply mainly the East Side, the Parker Penn and Marco Trailers developments. Additionally, the network would connect two commercial offices and the Paradise Park Centre. Further investigation on their demand and their likelihood to connect is needed. The network would be routed in the vicinity of the Enterprise Zone as well as the light industrial area. The route would provide a potential to connect additional heat loads both areas. The scenario includes a capital cost allowance to cross the railway (£250k assuming directional drilling) and an additional annual fee that the National Railway could potentially claim (£10k, assumed). The scheme compromises a new Energy Centre, assumed located in the land leased by Veolia as well as a new substation, potentially located in proximity of the Eastside and Parker Penn developments. It is assumed that the connection cost of new residential and commercial buildings would be paid by the developers, given that they would avoid the cost of installing new boilers. Developers would also provide a contribution to the scheme equal to The value of renewable that he would have to pay under a BAU scenario to comply with Part L legislation (see section 6.3.2) The ESCo would also benefit of the RHIs (£10 per MWh supplied net of heat losses).	
MAIN NETWORK OPTION 2	Scenario 1a	**Primary Supply Asset: Newhaven ERF** **Peaking / Back Up Boilers Total Capacity: 3MW** (about 2.4% contribution to supply) **EC Footprint (assumed one level): 175m^2** This scenario is an alternative of scenario 1, where the network is routed along the Enterprise Zone to connect the UTC college as well as the Eastside, the Parker Penn and the Marco Trailers developments. As discussed in section 5.1.3, this option would have a advantages and drawbacks over the route option in scenario 1. Extension to Danton Island and the city centre would require crossing the railway only once, resulting in lower capital costs. On the other side, a potential extension to the light industrial area would result in a longer route. Except for the route and the heat loads connected, all other parameters and assumptions are identical to those presented in scenario 1a.	

Scheme	Scenario	Description	Scheme Summary
MAIN NETWORK OPTION 1	Scenario 2	**Primary Supply Asset: Newhaven ERF** **Peaking / Back Up Boilers Total Capacity: 9MW** (about 2.8% contribution to supply) **EC Size (assumed one level): 342m^2** This scenario is a variation of scenario 1, which assumes that some additional heat consumers would connect to the network (mainly relatively big retails, a supermarket and a hotel). As such the scheme implies a higher risk than that presented in scenario 1. The scheme includes also an industrial load, for which energy consumption figures have been collected. It is believed that a heat network could supply part of its thermal demand, including the portion of the gas consumption used for heating purpose and that used within a pre-heat tank. Except for the heat loads connected and the network extension, all other parameters and assumptions are identical to those presented in scenario 1.	
MAIN NETWORK OPTION 1	Scenario 3	**Primary Supply Asset: Newhaven ERF** **Peaking / Back Up Boilers Total Capacity: 12MW** (about 3% contribution to supply) **EC Size (assumed one level): 409m^2** This scenario is a variation of scenario 2, which tests the impact of connecting Denton Island as well as a few consumers in the city centre. The route would imply crossing twice both the railway and the river, which would result in a significant capital cost needed to overcome these infrastructural and natural barriers. Except for the heat loads connected and the network extension, all other parameters and assumptions are identical to those presented in scenario 1 and 2.	

Scheme	Scenario	Description	Scheme Summary
MAIN NETWORK OPTION 1	Scenario 4	**Primary Supply Asset: Newhaven ERF** **Peaking / Back Up Boilers Total Capacity: 10MW** (about 3 % contribution to supply) **EC Size (assumed one level): 344m^2** This scenario is identical to scenario 2, although in this option it is assumed that the thermal load associated with FM Conway would materialise in 2019 and connect to the scheme. Initial communication with this stakeholder suggest that there is an interest from this party in connecting to a potential heat network and that the portion of its demand that could be supplied by the network would be in the range of roughly 1 GWh per year. More investigation will be needed to establish the proportion of the heat demand that could be supplied by the scheme. It is important to note that the materialisation of this load could potentially act as a catalyst in the development of a network.	
Newhaven Marina	Scenario 1N	**Primary Supply Asset: Water Source Heat Pump (WSHP)** **WSHP Size: 300 kW** **Peaking / Back Up Boilers Total Capacity: 2MW** (about 30 % contribution to supply) **EC Size (assumed one level): 150m^2** This is a different scheme than those presented earlier. The scheme would imply a small local network being developed during the Newhaven Marina Phase 3. The scheme would connect also existing residential blocks in the area and would offer: • The opportunity to extend towards the near housing allocation area in the future; • A potential to connect to the main network in the future.	

6.5 Results

The results of the techno-economic analyses for each scenario are presented in the sub-sections below.

Considering that public borrowing can potentially get interest rates as low as 3.5%, this would be indicative of the minimum IRR required by the council to take any scheme forward, therefore results are compared to this figure as a base line. For a fully private sector led scheme IRRs of at least 10% or above, preferably 12-15%, would be considered to be acceptable.

In the first instance the results are presented without the predicted effects of energy prices changes over time, in line with DECC 2015 energy price forecasts. This is considered to be a conservative approach.

CO_2 savings are presented in line with the most recent DECC forecasts(as outlined in Table 19).

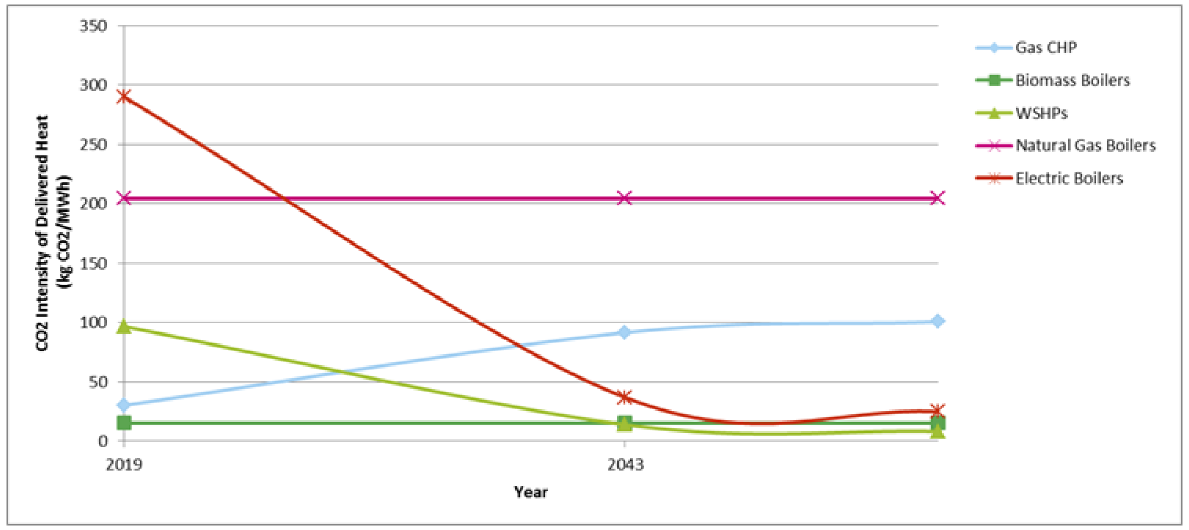


Figure 46: CO_2 Intensity by Technology Type over Time

6.5.1 Scenario 1

The KPIs for this scheme are reported in Table 20, whereas the cash flow for the scheme is shown in Figure 47.

With an average annual operating margin of £ 226k the scheme would hardly recover, even over 40 years of operation, the capital cost invested in the scheme. The Net Present Cost per tonne of CO_2 saved (over 25 years and at 3.5% discount rate) would be in the range of 127 £/Tonne CO_2. A more detailed list of assumptions and result is reported in APPENDIX 1. The IRR for the scheme was observed in the range of -1.5% over 25 years.

For this scenario the impact of not connecting Paradise Park and the Harwood Print Makers has also been tested. It was observed that the IRR would drop to -2.6% over 25 years, and therefore connection of these two stakeholders, although it results in a longer network, would be beneficial.

Scheme KPIs			
Finance			
CAPEX	£	6.02 M	
Average Annual Operating Margin	£	226,715	
NPV (3.5% Discount Rate) - 25 years	-£	2,574,083	
IRR (25 Years)		-1.51%	
NPV (3.5% Discount Rate) - 40 years	-£	1,789,785	
IRR (40 Years)		1.14%	
Developers Contribution Over 25 years	£	653,250	(£ 1,950/dwelling)
CO2 NPV per tonne of CO2 saved (25 yrs):	-£	**139**	
CO2 Saving over Lifetime (25 Years)		18,499	tonnes
CO2 Saving over Lifetime (40 Years)		30,592	tonnes

Table 20: Scenario 1 - Scheme KPIs

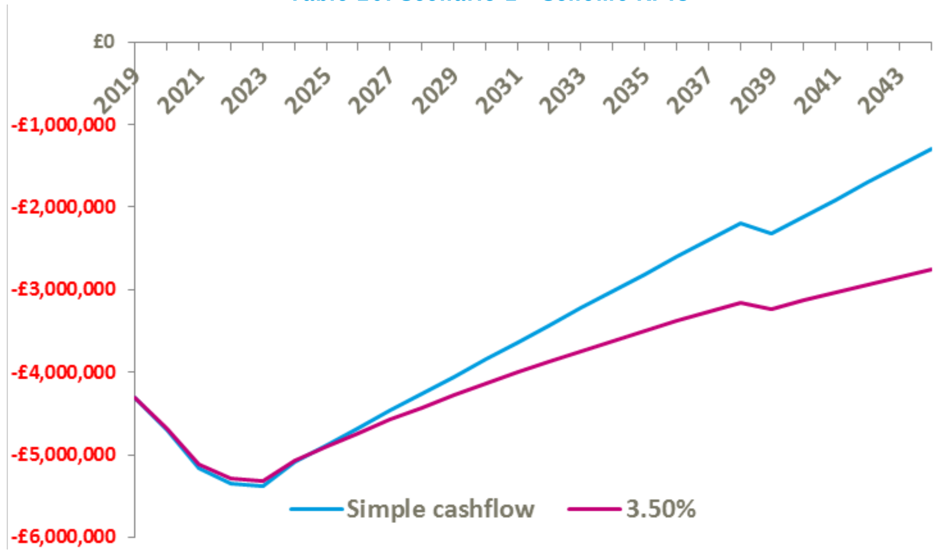


Figure 47 : Scenario 1 – Simple and Discounted (3.5%) Cash Flows Over 25 Years

6.5.2 Scenario 1a

The KPIs for scenario 1a are reported in Table 21.

In comparison with scenario 1, this scheme produces a lower IRR, -3.4% £/tonneCO_2 against 134 £/tonneCO_2 for scenario 1).

This is due to the lower volume of heat demand connected to the scheme and the resulting loss of revenues (and an associated reduction in carbon savings) which does not outweigh the savings associate with a shorter route. However, as discussed in section 5.1.3, more investigation is needed to establish the feasibility of connecting stakeholders in the light industrial area to the scheme. Depending on the outcome of this investigation and the potential to expanding the network to the city centre and Denton Island, the route associated with this scenario could be preferable.

Scheme KPIs			
Finance			
CAPEX		£ 5.5M	
Average Annual Operating Margin		£ 175,535	
NPV (3.5% Discount Rate) - 25 years		-£ 2,846,018	
IRR (25 Years)		-2.89%	
NPV (3.5% Discount Rate) - 40 years		-£ 2,259,779	
IRR (40 Years)		0.07%	
Developers Contribution Over 25 years		£ 653,250	(£1950/dwelling)
CO2	**NPV per tonne of CO2 saved (25 yrs):**	**-£ 194**	
CO2 Saving over Lifetime (25 Years)		14.685	tonnes
CO2 Saving over Lifetime (40 Years)		24,505	tonnes

Table 21: Scenario 1a - Scheme KPIs

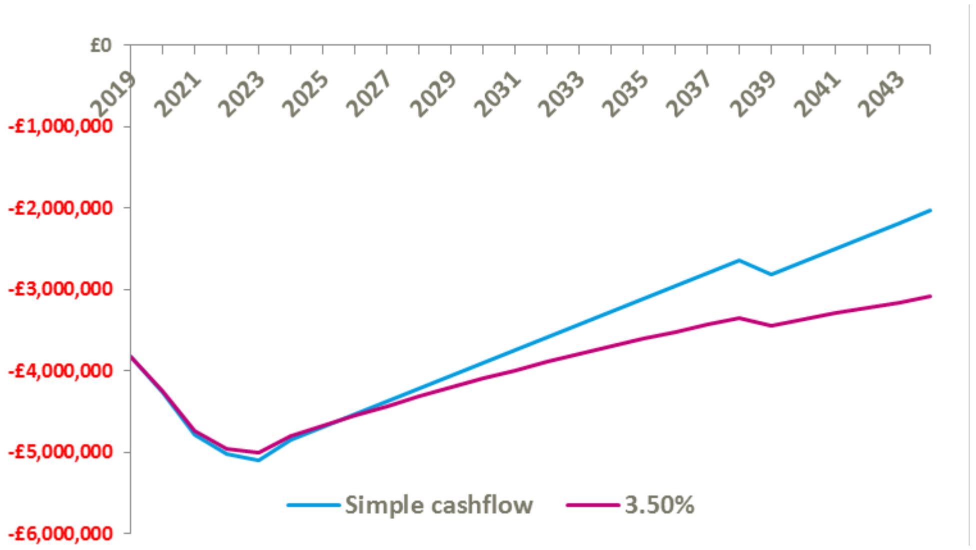


Figure 48: Scenario 1a – Simple and Discounted (3.5%) Cash Flows Over 25 Years

6.5.3 Scenario 2

The KPIs for scenario 2 are reported in Table 22. The additional loads that have been assumed to connect to the scheme (in comparison with scenario 1) would lead to higher carbon savings and economic KPIs (i.e. IRR and NPV) resulting in a lower net present cost associated with the carbon savings delivered by the scheme, roughly £50.

With an average annual operating margin of approximately £ 356k, the scheme could potentially break even after roughly 23 years of operation and could return an IRR of approximately 2.7% over 40 years.

The Net Present value of the scheme, at 3.5% discount factor, would be approximately £ -2 M and £ -756k over 25 and 40 years respectively.

Scheme KPIs			
Finance			
CAPEX		£ 7.4M	
Average Annual Operating Margin		£ 356,385	
NPV (3.5% Discount Rate) - 25 years		-£ 2,003,985	
IRR (25 Years)		0.52%	
NPV (3.5% Discount Rate) - 40 years		-£ 756,860	
IRR (40 Years)		2.74%	
Developers Contribution Over 25 years		£ 653,250	(£1950/dwelling)
CO2	**NPV pet Tonne of CO2 Saved (25 yrs)**	**-£ 50**	
CO2 Saving over Lifetime (25 Years)		39,706	tonnes
CO2 Saving over Lifetime (40 Years)		64,750	tonnes

Table 22: Scenario 2 - Scheme KPIs

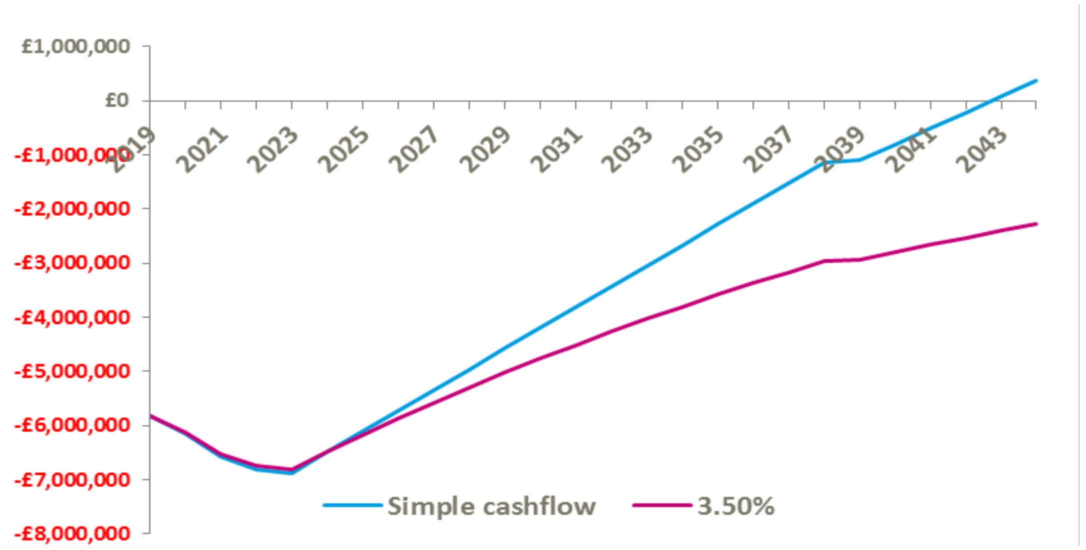


Figure 49: Scenario 2 – Simple and Discounted (3.5%) Cash Flows Over 25 Years

6.5.4 Scenario 3

The KPIs for this scenario are reported in Table 23. The scheme benefits of a higher operating margin than the other scenarios, due to the larger volume of revenues associated with heat sales and standing charges. These though would not suffice to outweigh the higher capital cost associated with the additional crossing of the railway and the two river crossings, which result in reduced economic KPIs (i.e. IRR and NPV) in comparison with, scenario 2.

The net present cost per tonne of carbon saved would be in the range of £ 52.3.

Scheme KPIs			
Finance			
CAPEX	£	10.2M	
Average Annual Operating Margin	£	488,014	
NPV (3.5% Discount Rate) - 25 years	-£	2,836,702	
IRR (25 Years)		0.44%	
NPV (3.5% Discount Rate) - 40 years	-£	1,088,717	
IRR (40 Years)		2.71%	
Developers Contribution Over 25 years		£653,250	(£1950/dwelling)
CO2 **NPV pet Tonne of CO2 Saved (25 yrs)**	**-£**	**52.35**	
CO2 Saving over Lifetime (25 Years)		54,192	TonnesCO2
CO2 Saving over Lifetime (40 Years)		93,930	TonnesCO2

Table 23: Scenario 3 - Scheme KPIs

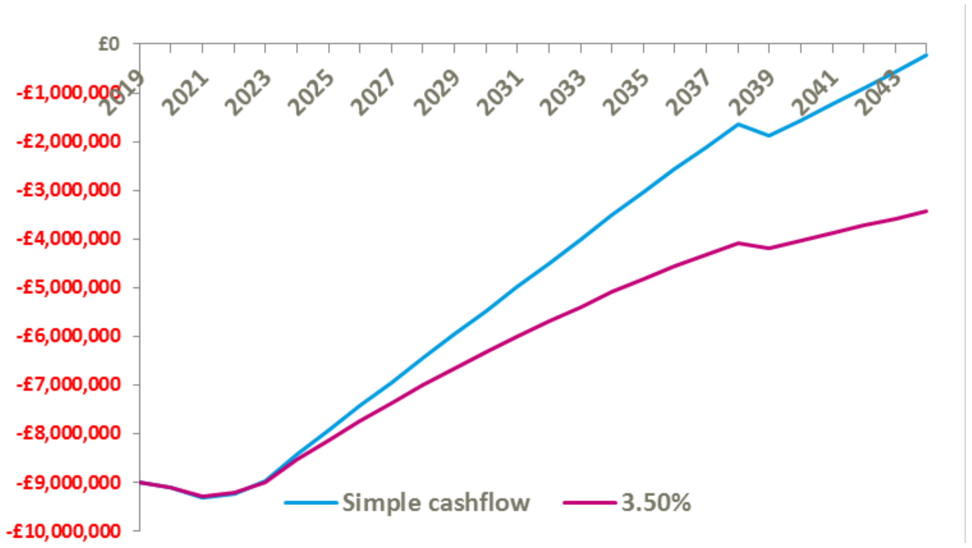


Figure 50: Scenario 3 – Simple and Discounted (3.5%) Cash Flows Over 25 Years

6.5.5 Scenario 4

The KPIs for this scenario are reported in Table 24. Connection of FM Conway would result in a higher IRR (approximately 1.5% over 25 years) in comparison with scenario 2 (approximately 0.5% IRR over 25 years) where it was assumed that FM Conway would not connect to the scheme.

This scenario could break even after approximately 20 years of operation, and could lead to an IRR of approximately 3.4% over 40 years. The associated net present cost per tonne of carbon saved would be in the range of £32.6.

Scheme KPIs			
Finance			
CAPEX	£	7.5M	
Average Annual Operating Margin	£	400,843	
NPV (3.5% Discount Rate) - 25 years	-£	1,418,774	
IRR (25 Years)		1.48%	
NPV (3.5% Discount Rate) - 40 years	-£	12,574	
IRR (40 Years)		3.49%	
Developers Contribution Over 25 years	£	653,250	(£1950/dwelling)
CO_2 **NPV pet Tonne of CO2 Saved (25 yrs)**	**-£**	**32.64**	
CO2 Saving over Lifetime (25 Years)		43,464	TonneCO2
CO2 Saving over Lifetime (40 Years)		72,473	TonneCO2

Table 24: Scenario 4 - Scheme KPIs

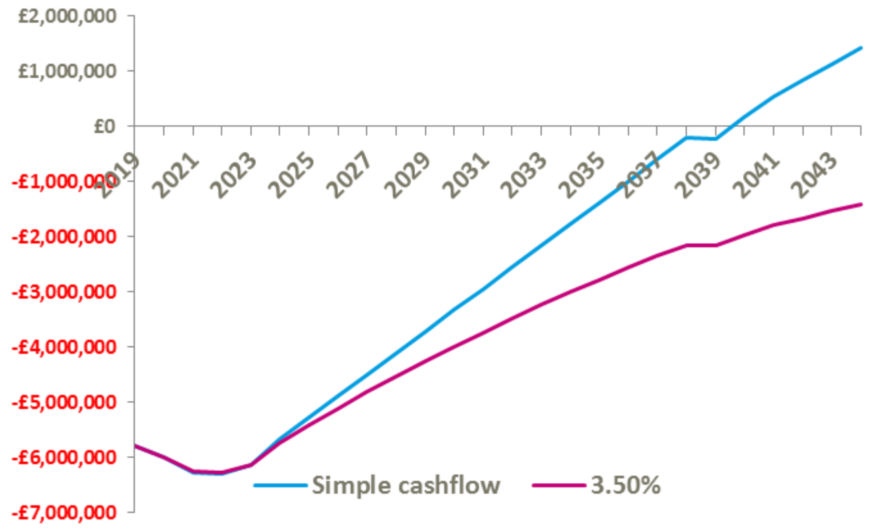


Figure 51: Scenario 4 – Simple and Discounted (3.5%) Cash Flows Over 25 Years

6.5.6 Scenario 1N

The KPIs for this scenario are reported Table 25. This scheme, although small, could potentially deliver an IRR of 6.24% over 25 years and a discounted (3.5% D.R.) NPV of approximately £460k. The net present value per carbon of tonne saved is approximately £ 36.6 therefore the scheme could potentially produce positive economic benefits for each tonne of carbon saved.

With a modest capital cost, estimated in the order of £1.7M, and an average annual operating margin of £135 K, the scheme could break-even after roughly 10 years of operation.

Scheme KPIs			
Finance			
Average Annual Operating Margin	£	135,237	
NPV (3.5% Discount Rate) - 25 years	£	460,112	
IRR (25 Years)		6.24%	
NPV (3.5% Discount Rate) - 40 years	£	1,134,856	
IRR (40 Years)		7.71%	
Developers Contribution Over 25 years	£	645,450	(£ 1950/ dwelling)
CO2 **NPV pet Tonne of CO2 Saved (25 yrs)**	**£**	**36.6**	
CO2 Saving over Lifetime (25 Years)		14,728	TonneCO2
CO2 Saving over Lifetime (40 Years)		20,422	TonneCO2

Table 25: Scenario 1N – Scheme KPIs

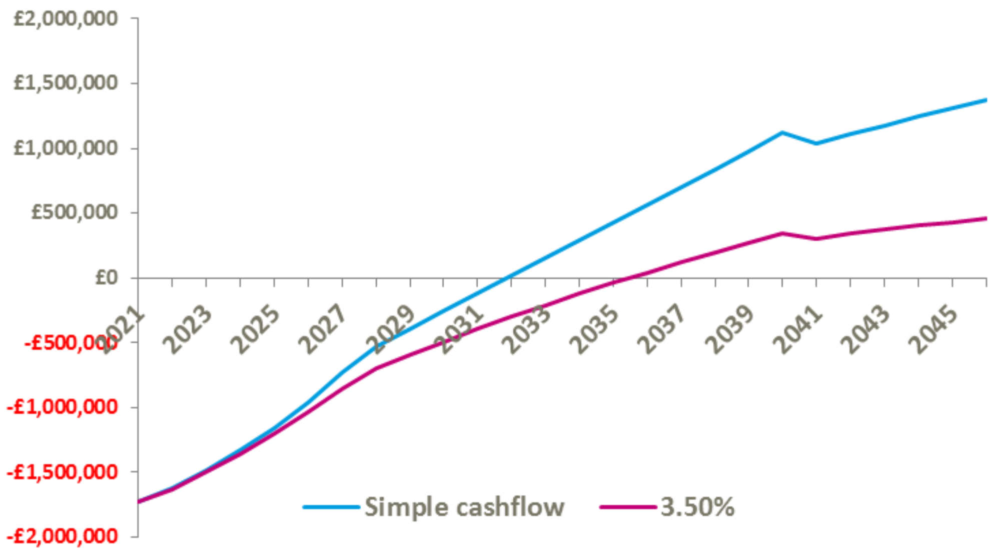


Figure 52: Scenario 1N– Simple and Discounted (3.5%) Cash Flows Over 25 Years

6.6 Sensitivity Analysis

A sensitivity analysis has been done on the following scenarios:

- Scenario 4
- Scenario 1a
- Scenario 1N

In Ramboll's experience, and as shown in section 6.6.2, the impact that a variable has on the IRR does not vary appreciably among similar scenarios, and therefore the sensitivity analysis has not been performed on each scenario.

The outcome of the sensitivity analysis is reported in the next sub-sections.

6.6.1 Scenario 4

6.6.1.1 Sensitivity of Additional Connections

As previously mentioned, connecting additional loads in the light industrial area could improve significantly the economic and environmental performance of a potential heat network scheme. The network in scenario 4 is routed through this area, but many stakeholders have been excluded due to the uncertainties related to these buildings.

A sensitivity analysis has been carried out to estimate the impact that connection of stakeholders in the light industrial area could have to this scheme. Figure 53 shows the main spine of the network and the surrounding area highlighted in different colours, which are representative of the max distance (straight line) of each stakeholder from the main spine (red: less than 90 meters, orange: less than 180 meters, yellow less: than 270 meters). As it possible to observe the major stakeholders fallow within the red area. These are listed in Table 26. As it is possible to observe a few stakeholders appear to have the same annual heat demand associated with. This proves that further refinement of heat demand data is needed, particularly for these stakeholders.

The median heat demand of stakeholders in the red area is roughly 223 MWh. The IRR and NPV (for 25 and 40 years) have been assessed by assuming the 5, 10 and 15 stakeholders (out of a total of 17) would connect to the scheme (scenario 4). The resulting IRR and NPV curves are reported in Figure 4. It appears that for each additional GWh of heat demand added to the scheme the IRR would increase of approximately an average of 1%. If roughly 3.3 GWh of heat demand could be connected to the scheme, though connection of the stakeholders reported in Table 25 (or Table 27), then the scheme could present an IRR of roughly 4.5% over 25 years.

It is important to note that the estimated cost associated with connection and service pipes (assumed 45 meters) was included in the analysis. Hydraulic analysis was not conducted for service pipes; the diameters were estimated by averaging the length across the pipe diameters between the distribution pipe and building connections..

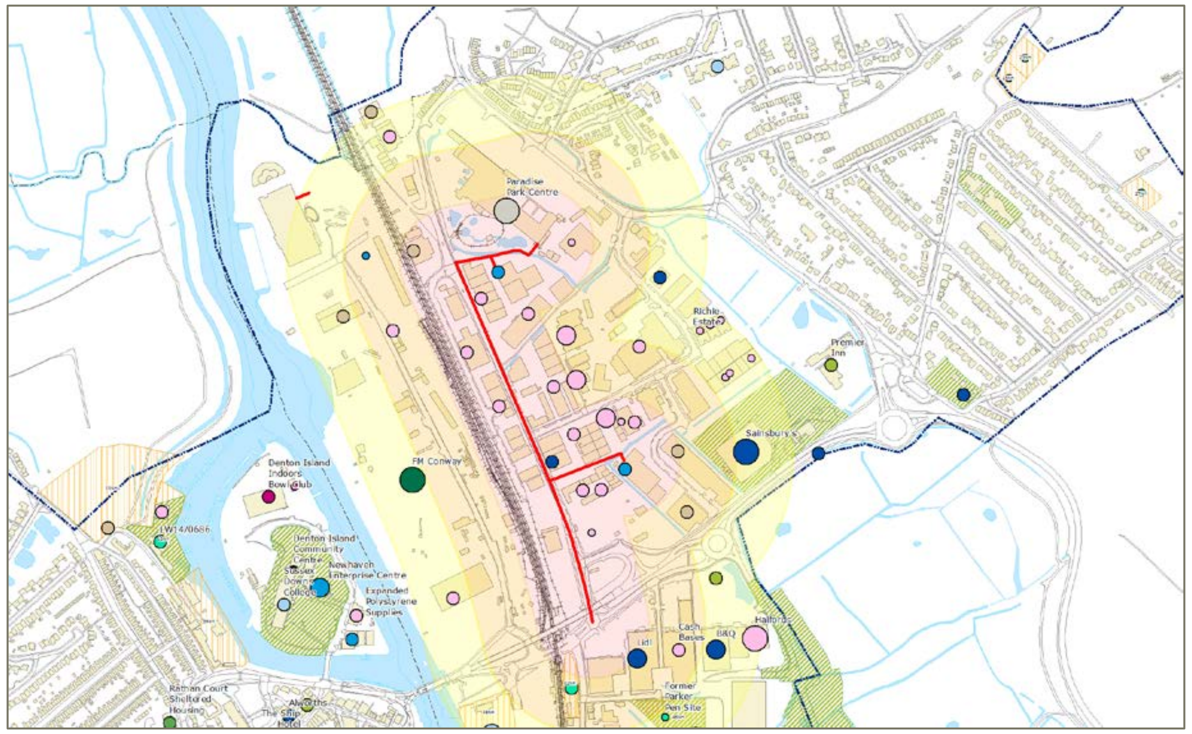
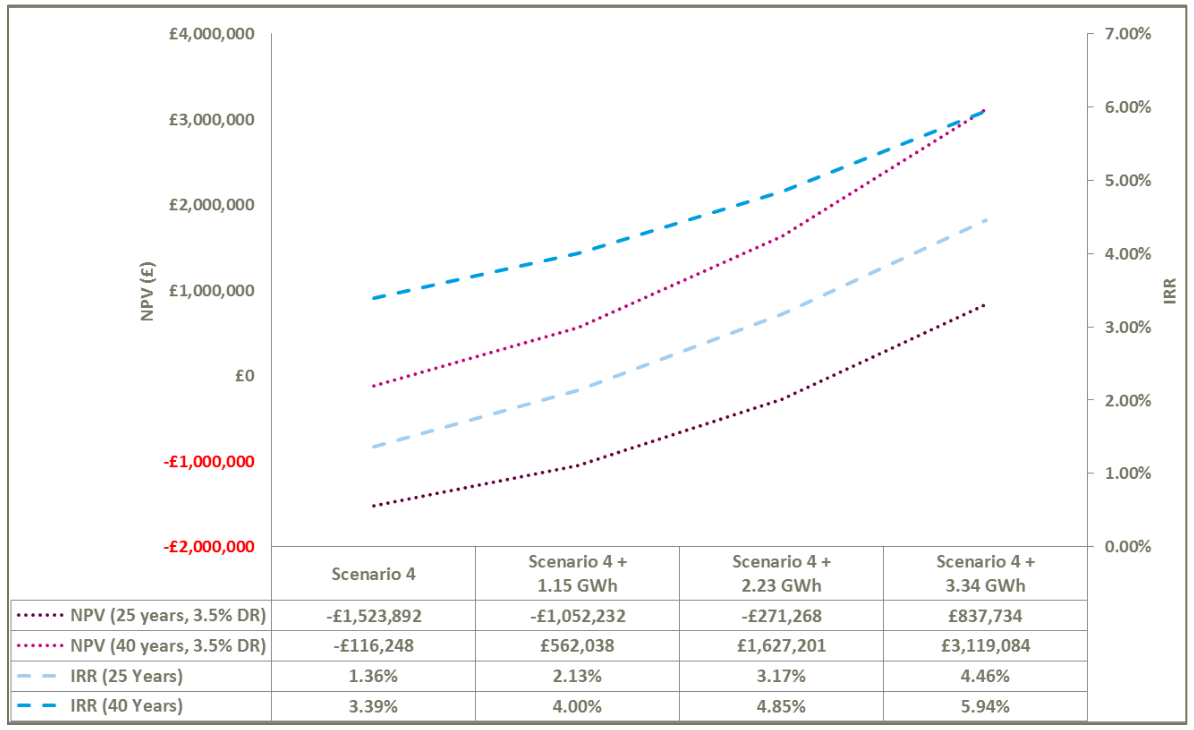


Figure 53: Stakeholders in the Vicinity of the Main Spine (red area: 90 meter, orange are: 180 m, yellow area 270m)



	Scenario 4	Scenario 4 + 1.15 GWh	Scenario 4 + 2.23 GWh	Scenario 4 + 3.34 GWh
NPV (25 years, 3.5% DR)	-£1,523,892	-£1,052,232	-£271,268	£837,734
NPV (40 years, 3.5% DR)	-£116,248	£562,038	£1,627,201	£3,119,084
IRR (25 Years)	1.36%	2.13%	3.17%	4.46%
IRR (40 Years)	3.39%	4.00%	4.85%	5.94%

Figure 54: IRR and NPV Variation Curves for different additional volumes of demand

Stakeholders List (<90 meters from main spine)	Use Class	Annual Heat Demand from NHM (kWh)
TOPPS TILES UNITS B AND C RANALAH ESTATE NEW ROAD	Retail	105,972
BRITANNIA BECKWITH OF SUSSEX EUROPA BUILDING EURO BUSINESS PARK	Transport	170,578
STORE 5 BROSS ESTATE NEW ROAD	Industrial	206,087
THOR UK PLASTICS LTD UNIT E RANALAH ESTATE NEW ROAD	Industrial	206,087
FERRYFIELD INJECTION MOULDERS UNIT 20 AVIS WAY	Industrial	206,087
ELECTRICITY SUB STATION 1 AVIS WAY	Industrial	218,481
KING & MCGAW PRINTMAKERS UNITS 9 - 11 E PLAN ESTATE NEW ROAD	Industrial	223,717
BIG BOX SELF STORAGE UNIT 15 E PLAN ESTATE NEW ROAD	Industrial	223,717
CEF UNIT 15 EURO BUSINESS PARK NEW ROAD	Industrial	223,717
BRIGHTWELL DISPENSERS LTD UNIT 9 EURO BUSINESS PARK	Industrial	223,717
BEESTORED STORAGE UNIT 31 AVIS WAY	Industrial	232,407
TATES LTD AVIS WAY	Industrial	234,796
BROSS ESTATE NEW ROAD	Industrial	242,137
UNIT 7 PINE ESTATE PINE CLOSE	Industrial	447,434
THE WILLOW ESTATE AVIS WAY	Industrial	472,430
TOMSETTS TRANSPORT NORTH QUAY ROAD	Transport	183,928
FISH CONTEMPORARY WORKSHOP NORTH QUAY ROAD	Industrial	201,264

Table 26: List of Stakeholders within 90 meters from the man spine (straight line)

Stakeholders List (> 90 and <180 meters from main spine)	Use Class	Annual Heat Demand from NHM (kWh)
MASONA PLASTICS INJECTION MOULDERS UNITS 12 AND 12A PINE ESTATE PINE CLOSE	Industrial	685,345
CONCORD MARLIN AVIS WAY	Industrial	223,717
Units 2B to 2D Hawthorn Estate, Avis Way	Transport	153,643
Unit D Hawthorn Estate, Avis Way	Transport	268,101

Table 27: List of Stakeholders within 90 and 180 meters from the main spine (straight line)

6.6.1.2 Sensitivity Analysis for Key Variables

As it is possible to see in Figure 55, the capital cost of the scheme has a great impact on the scheme's IRR, with approximately 0.7% IRR variation for every 10% variation in capital cost.

The heat sales revenues are also crucial for the scheme: approximately a 10% variation on the heat selling price correspond to a 0.5% variation in IRR. The standing charge also affect the IRR, although not as significantly as the heat selling price, although it has to be noted that standing charges are often seen as having lower risk than the revenues associated with heat sale, since they are independent of buildings occupation and heat consumption.

Interestingly, the capital contribution of developers to the scheme does not appear to significantly affect the scheme for small variations. As discussed in section 6.3.2, it has also been assumed that developers would bear the connection cost. This cost has not been included within the sensitivity analysis, which only includes the contribution of developers towards the scheme, and not the savings associated with HIUs in residential dwellings and heat exchangers in commercial buildings. However, Ramboll has estimated the impact of these costs on the scheme IRR. Should the network operator bear the connection cost then the IRR of scenario 4 would drop from 1.39% to 0.1%. This means that the involvement of developers in a potential heat network scheme is crucial.

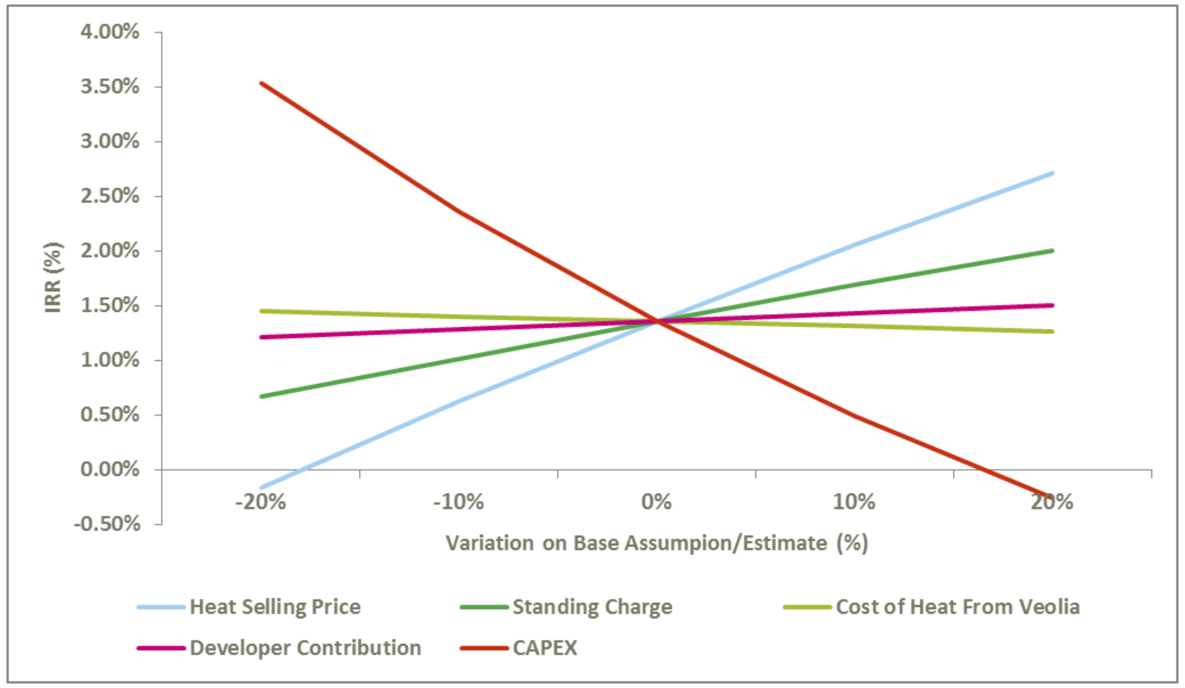


Figure 55: Scenario 4 - IRR Curves by Variable

The cost of the heat from the ERF is certainly of interest, given that all scenarios have been modelled without including a mark-up from Veolia (see section 6.3.1). Therefore, the variation of this variable is representative of how the economic KPIs of the scheme would be affected dependent on the commercial arrangement that would be put in place, if a heat network scheme will be developed. For a 20% (approximately an additional £ 2 per MWh) mark-up on the value of the heat generated, which could for instance be claimed by Veolia, would result in about 0.1% loss in IRR.

6.6.2 Scenario 1a

The chart in Figure 56 shows the impact that the variation of a given parameter has on the IRR.

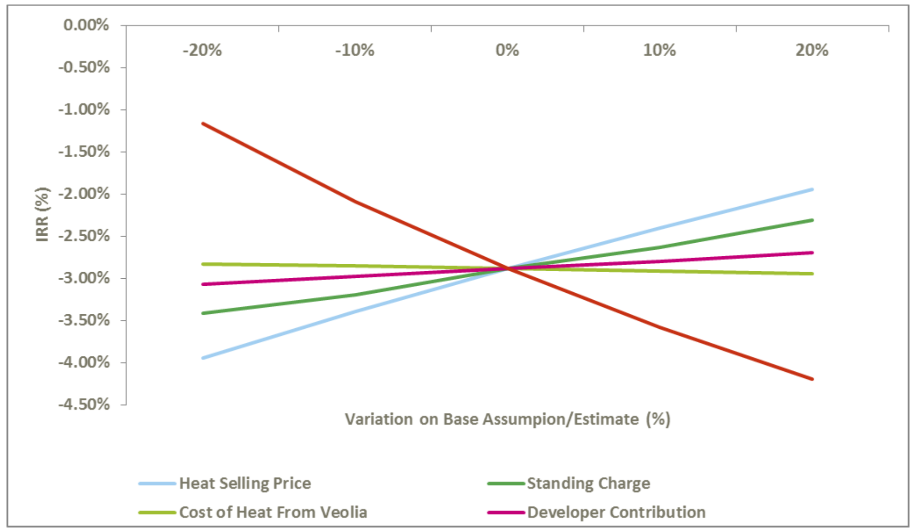


Figure 56: Scenario 1a IRR Curves by Variable

As it is possible to observe, the curves have a similar trend to those shown in Figure 46, and therefore the observations reported in section 6.6.1.2 still apply. The two charts have been overlapped as shown in Figure 57. The variation in the slope of a given IRR curve does not vary significantly between scenario 4 and scenario 1a. Ramboll believes that the impact on the IRR of the analysed variable would be similar also for scenario 1, 2 and 3.

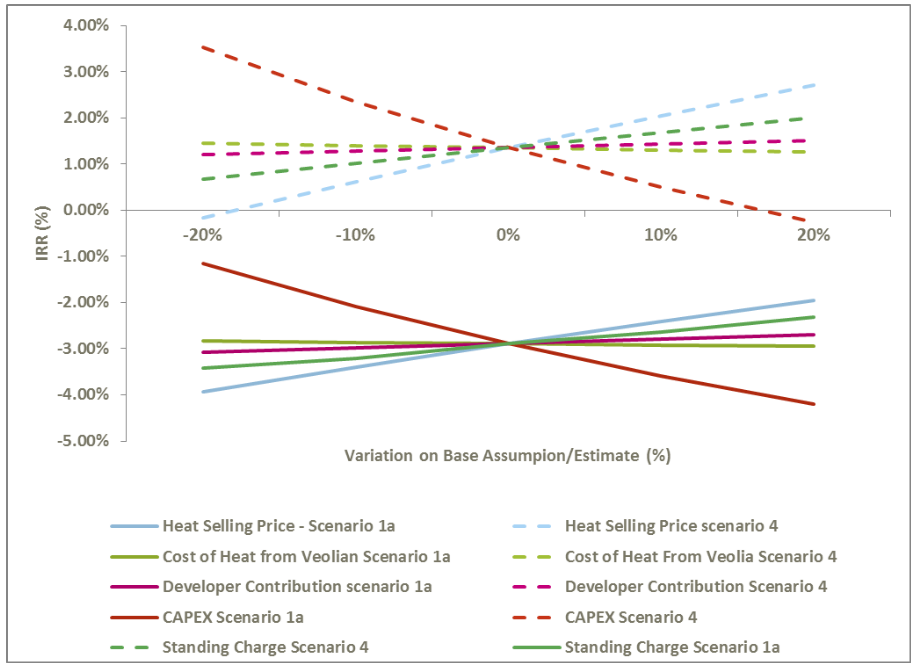


Figure 57: Comparison of Sensitivity Analysis for Scenarios 1 and 4

6.6.3 Scenario 1N

The IRR curves for each of the main variables are shown in Figure 58. There appear to be roughly a 1.2% variation on the IRR for each 10% variation on CAPEX.

Variation on the cost of the heat has a greater impact on this scenario than for those analysed on the main network scheme. Although the cost of the heat is directly (scenario 1N) or indirectly (all other scenarios) related to the cost of the electricity, higher efficiency could well be expected by forfeiting electricity from a steam turbine (all scenarios except 1N) than by extracting heat from a river through a heat pump (scenario 1N). This means that the volume of fuel consumed is higher for this scenario leading to a greater impact of the fuel cost on the overall IRR.

The developer contribution also has a greater impact on the IRR than that observed in the other scenarios. This is because the proportion of the developer contribution, in comparison to the total capital cost associated with the scheme, is higher. This is because this scheme connects almost entirely new developments and has a lower capital cost associated with the network, due to the apparent lack of infrastructural barriers and the need of transmitting heat over a relatively long distance.

Finally, a 10% (roughly £2 per MW on the weigh-averaged heat selling price) variation on the heat selling price could lead to about 0.6% variation on the scheme's IRR.

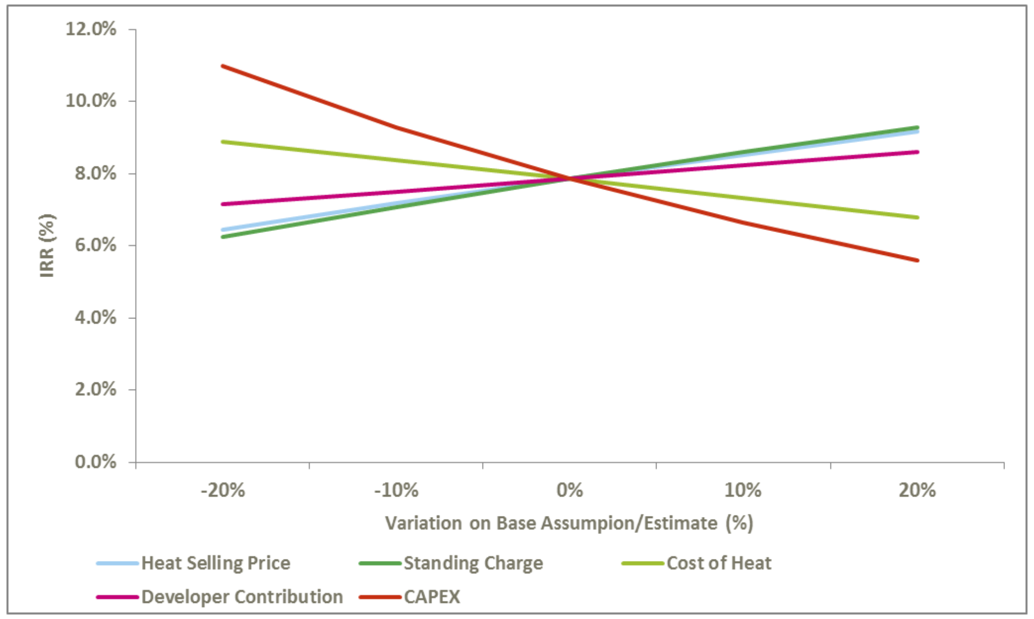


Figure 58: Scenario 1N - IRR Curves by Variable

6.6.4 Capital Grants

Figure 31 shows capital injection and its effect on the IRR on the 25 and 40 year IRRs on scenario 1a and scenario 4. Scenarios are compared against a 3.5% IRR baseline (red dotted line) which is the potential minimum IRR required to recover the cost of borrowing by the council.

For scenario 1a, even a capital injection of 30% would result in a poor IRR (0.3% and 1.8% over 25 and 40 years respectively. This is due to the low operating margin associated with the small volume of heat demand that the scheme involves. To achieve a null NPV at 3.5% and 6% discount rates a capital grant of roughly £ 2.8 M and £ 3.3 M respectively would be required.

For scenario 4, a capital injection of £1.4M would result in an IRR of 3.52% over 25 years and 5.15% over 40 years, which could suffice to repay the cost of borrowing and could result in a profit over 40 years. A capital injection of £ 2.6M would be required to achieve a null NPV at 6% discount rate over 25 years.

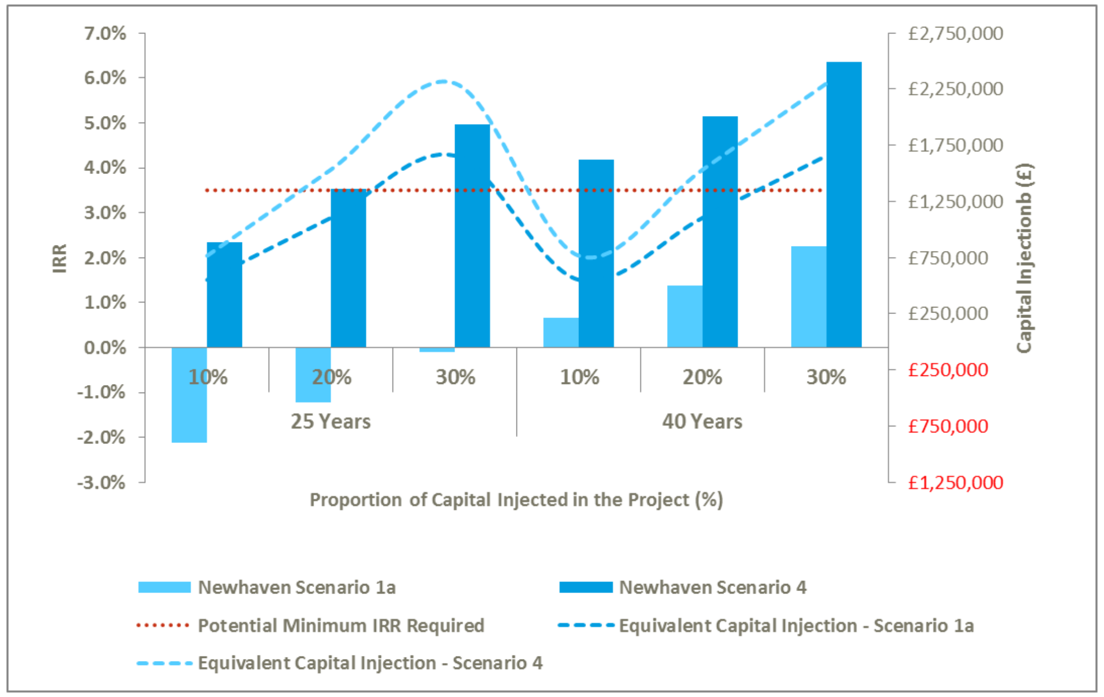


Figure 59: Effect of Capital Injection on the IRR

6.7 Summary of Results

Scenario	Summary of Scenario	25/40 yrs IRR	NPV @ 3.5% DR 25/40 yrs	Total CAPEX
1	Supply Asset: ERF Annual Demand: 1.5GWh Peak Load: 2.5MW Network: Main Option 1	-1.5% / 1.1%	-£2.5M / -£1.78M	£6 M
1a	Supply Asset: ERF Annual Demand: 1.5GWh Peak Load: 2.5MW Network: Main Option 2	-2.8% / 0.07%	-£2.8M / -2.25M	£5.7 M
2	Supply Asset: ERF Annual Demand: 7.5GWh Peak Load: 6MW Network: Main Option1	0.5% / 2.7%	-£2.0/ /-£756k	£7.4 M
3	Supply Asset: ERF Annual Demand: 11GWh Peak Load: 8.7MW Network: Main Option1	0.4% / 2.7%	-£2.8M / -£1.08M	£10.2 M
4	Supply Asset: ERF Annual Demand: 8.6GWh Peak Load: 6.1MW Network: Main Option1	1.3% / 3.3%	-£1.5M / -£116k	£7.6 M
1N	Supply Asset: WSHP Annual Demand:2 GWH Peak Load:1.5MW Network: Main Option1	6.2% / 7.7%	£0.4M / £1.1M	£1.7 M

Table 28: Summary of Results for Core Modelling Scenarios

From the analysed scenarios it appears that in the case of the core scenarios:

- The Main Network could result more beneficial economically and environmentally if routed through the light industrial area. This route could increase the linear heat density of the scheme resulting in higher carbon savings, IRR and NPV.

- There are uncertainties regarding the heat loads in the light industrial area, and their potential to connect to a heat network (i.e. heating system type, main use of heat etc.). Further investigation could result in route option 2 preferable to route option 1 (see section 5.1) although such option would reduce the economic and environmental benefit of a potential scheme.

  Connection to Denton Island and the city centre would reduce the IRR, at least during the initial phase/s of a potential scheme. Expansion to these areas should be considered as part of future phases. Astand-alone scheme developed in the island, could prove potentially financially viable, though it would be challenging to deliver commercially and would not benefit the council.

- The Newhaven marina appears to offer an IRR well above the 3.5% threshold as well as the potential connect to the main network, should this be developed, in the future. Expansion of this scheme towards the housing allocation area should also be considered in the view of a town wide heat network.

- All schemes analysed would be unlikely to attract investors from the private sector given the risk they would bear in comparison with the economic benefit they could provide (lower than 10% IRR).

- There is a need to establish the real potential of stakeholders in the light industrial area to connect to the scheme.

- The cost per tonne of carbon saved could be reduced to approximately £ 31 (scenario 4) and could return an IRR of roughly 3.4% over 25 years. This appears currently the best option from an economic perspective.

When considering the sensitivity of the schemes to changes in key variables, the following conclusions can be drawn:

- For each additional GWh of heat demand (located in the light industrial area) added to scenario 4 the IRR would increase of approximately an average of 1%.

- Financial contribution from developers as well as their participation to the scheme by installing HIUs in domestic units and heat exchanger in commercial properties, would be crucial for any of the analysed schemes

- The heat sales price is also a critical parameter, and assumptions made will needs further refinement. Ramboll estimates are based on consumers' BaU and allowing for a 5% incentive.

- Capital grants of roughly £ 1.5M and of £ 2.76M, could suffice to make scenario 4 achieving an IRR of about 3.5% and 6% respectively over 25 years.

Scenario 1a would need more heat demand connected to improve its financial parameters, and under current assumption, it appears challenging to be implemented, even with a capital grant of 30% of the capital cost and over 40 years of operation (-0.1% and 2.3% IRR over 25 and 40 years respectively) .
It is important to note that this study aimed to carry out a high level assessment of a potential heat network in Newhaven and, as such, the outcome of the analysis is subject to many assumptions that have been made during the assessment.

The capital cost affects significantly the financial KPIs of the analysed scheme. This has been assessed by a mixture of costs that Ramboll has gathered in similar projects (scaled accordingly) and experience. With regards to the capital cost associated with the heat network,

Ramboll has refined the accuracy of the estimated capital associated with the heat network by performing hydraulic modelling and making use of cost data provided by manufactures on a per meter basis.

Nevertheless, estimates of cost will have to be refined at feasibility stage and their purpose in this study is only to provide an indicative ides of the financial KPIs that the scheme could in principle deliver.

The uncertainties in costs are not the only risk: heat demand, commercial arrangements, and timeline of new developments can all significantly affect the IRRs presented within this study.
A table listing all potential risks is reported in Appendix and it is recommended to mitigate them during feasibility stage.

6.8 Project Outline Risk Assessment

A risk register is included as Appendix 1. 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.

Technical Risk

There is uncertainty around the ability to reduce building return temperatures within new developments to levels assumed in this report (as set out in the Code of Practice[10]). This in turn presents a financial risk to the project.

There is a risk associated with the heating system installed within existing buildings which, if not wet, could result in additional costs associated to its conversion that would affect the finance of the scheme.

Commercial Risk

The high number of privately owned properties increases risk to the heat network developer/operator by reducing the level of 'secure' revenue and increases complexity in negotiating connections and phasing them in such a way as to maximise payback. This implies very high transaction costs associated with heat sales and also a higher risk of customer handling / management issues in operation.

All schemes are subject to new developments coming forward at a given construction rate. The There would be a risk associated with the construction of the Eastside, the Parker Penn, the Newhaven Marina and the Marco Trailer developments.

The indicated IRRs represent global values within the project as a whole. The individual parties to any partnering arrangement will each need to realise some financial benefit (broadly speaking in proportion to the risk that they take on) and it is not immediately clear that there is enough 'value' in the project as a whole to realise this to the advantage of all parties.

Financial Risk

Financial risk at energy masterplanning stage is primarily associated with uncertainty in capital and operating cost forecasts. In particular the following uncertainties are significant:

1) uncertainty in the project capital cost can be significant for example where unforeseen barriers are present (such as existing utilities, unexpected ground conditions etc.) or where complex commercial arrangements need to be put into place.

2) dwelling density. The low dwelling density results in a very high investment cost per unit of heat sale and introduces high heat losses per unit of heat sale.

3) future value and cost of energy including the cost of heat from the ERF, which is currently based on high level information provided by Veolia.

4) achievable build out rates and rate of connection which affects cash flow (also a commercial risk, see above).

5) assumptions around financial contributions from developers to the project.

6) The technical and commercial basis on which the cost of heat production from Veolia has been valued has not been investigated in detail. The resulting price forecast could increase or decrease.

7) Uncertainty in assumptions around future incentive support (i.e. policy risk)

8) Uncertainty around compatibility and quantities of heat demands forming the basis of the techno-economic model.

Planning Risk

Planning approval would be required for an energy centre for all schemes and potentially a substation for a network fed by the ERF.

Planning permission would not necessarily be required for installation of the heat network although permits and permissions would be required under the New Roads and Street Works Act (NRSWA). The process could potentially be streamlined through a Local Development Order type approach.

[10] Heat Networks: Code of Practice for the UK, CIBSE, ADE, 2015

6.9 Benefits to Stakeholders

In order to achieve the successful implementation of a DH project, involvement from numerous parties will be required. Understanding the benefits to each of these stakeholders will be an essential part of progressing the project to the next stages.

A summary of the key stakeholders identified and the potential benefits of DH are presented as follows:

- **Veolia**: has already stated that their participation to a potential scheme would need to result in a financial benefit, potentially through the revenues stream associated with heat sales to the Network Company and/or RHI.

- **Developers** have already been granted planning permission (exception made for FM Conway) and therefore the Council have little power on pushing developers in connecting to a heat network and to make a capital contribution towards a potential scheme. The analysis carried out in this study assumes the developers would contribute to the development of a heat network through a financial contribution which though should not increase the overall capital expenditure required under a BaU scenario (please refer to section 6.3.2). In reality though there could be scope to actually create a financial benefit that could incentives their participation to the project. In fact, the development of a heat network in the area could eliminate the need for a local gas distribution network and its connection to the national grid. Electric hobs and ovens could be installed within each property (providing additional fossil fuel savings). By replacing the distribution gas grid within the area, and within each building, with a heat network and sharing its costs with a third party (the network company) the scheme could actually benefit the developers

- **The Council** could consider investing in the Newhaven Marina scheme and benefits of the revenues streams, with a view of expanding the network towards the housing allocation site in the future. For all other schemes it appears difficult to recover the cost of borrowing, although there would be others embedded benefits that the Council could benefit from (e.g. economic boost, jobs creation, carbon emission reduction etc.). The Council could apply for capital grants from the national Heat Networks Investment Project (HNIP), which could make the wider network a profitable scheme.

- **FM Conway** has indicated its intentions to move to Newhaven, although no planning application has been yet submitted. Therefore the council has more power in requesting connection of this stakeholder to the ERF or, at the least to require the plant to be future-proof, by designing and constructing the plan to so that it could be easily connected to the ERF, once a heat network would be developed.

- **Existing buildings** are likely to connect to the scheme only if this would result in a financial benefit for them, which could be linked to lower heat price and/or savings associated with carbon taxes.

In all cases cost savings or revenue streams are expected to be the primary potential benefit and therefore driver of the scheme. Therefore it can be concluded that without high returns, a scheme is unlikely to be considered viable unless the Council is willing to lead the project to gain from additional benefits such as CO_2 reduction.

7. PROJECT PRIORITISATION

In order to assess the relative viability and benefit of these projects a set of assessment criteria was agreed between Ramboll, Newhaven Town Council and Bioregional. The council's key drivers are:

1. Supporting local and national policy in reducing CO_2 emissions
2. Minimising risk
3. Supporting local business in the Enterprise Zone
4. Potentially attracting new investments and boost economic growth
5. Addressing fuel poverty

Among the scenarios and schemes analysed, scenario 4 is the option that most covers the criteria above in that:

- it creates an opportunity to reduce the carbon emission of existing and newly developed domestic and non-domestic units, saving potentially an average of 2,100 tonnes of CO_2 per year.
- it present a relatively low risk, given that connection to Denton Island and the City centre are assumed to be developed in future phases. Connection to these areas involves two river crossing and, potentially, an additional railway crossing. Also, there could be a potential to further de-risking the scheme. For instance the risk of new developments not coming forward at a certain rate (agreed with developers) could be passed from the network operator to the developers.
- the network offer potential for existing and new businesses (e.g. FM Conway) in the Enterprise Zone to connect to a heat network, which could be financially beneficial to them in terms of, for instance, lower carbon emission and therefore carbon taxes or lower cost of heat.
- the heat network, as routed in scenario 4, offers a potential to attract in the light industrial area and the Enterprise Zone business that are intensive-heat consumers, as they could benefit from low carbon-low cost heat. FM Conway, for instance, has expressed interest in the scheme.
- there would be a benefit associated with lower heat price to consumers (a 5% incentive has been assumed).

It should be noted that scenario 4 is dependent on whether there are actually connectable heat loads in the light industrial area. Should the contrary be proved, scenario 1a would be preferable.

From an economic (and risk) perspective, Ramboll recognises that scenario 4 would hardly recover the cost of borrowing, even over 40 years of operation.

However, the Council has indicated there is a potential of increased occupation over the coming years in the Enterprise Zone and Ramboll has also provided a list of additional stakeholders which could be connected to the scheme. Both offer potential to increase the volume of demand that could be connected to the scheme and, therefore, its economic KPIs.

Finally, the council could apply for grant funding with HNIP, which may improve the economic viability of the scheme.

A local heat network in the Newhaven Marina (scenario 1N) should also be considered together with the scheme proposed in scenario 4. Although modest, this scheme appears to possibly deliver a discounted NPV of roughly £870k over 25 years. Although this scheme has been analysed separately from the main network, its economic benefits could possibly be diverted towards the implementation of a wider scheme.

For instance, the council could develop both schemes simultaneously. This would virtually result in the financial benefits of the Newhaven Marina heat network, being transferred to the main network scheme. Effectively the Newhaven Marina could create a revenue stream that could be diverted towards the main network. Given the different scale of the two schemes, such arrangement would not have a great impact on the KPIs of the main network (arranged as a stand-alone scheme) but appear to have the potential to provide an IRR at least greater than 3.5% (over 40 years).

Figure 60: Scenario 4

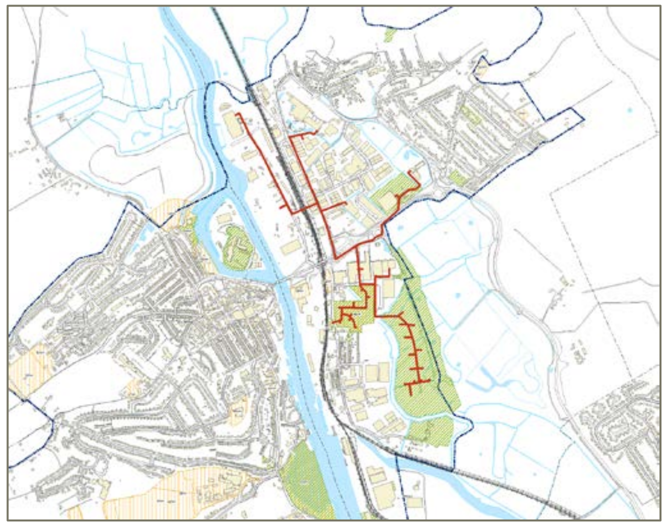
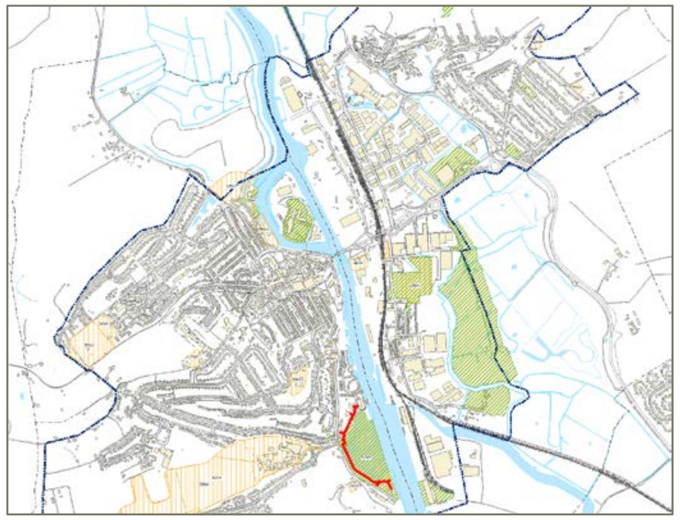


Figure 61: Scenario 1N



8. RECOMMENDATIONS AND NEXT STEPS

The results presented in section 5.4.1 indicates that there could be a potential to implement a heat network supplied by the ERF under the assumption that:

- Newhaven Town Could may receive at least 20% capital grant from the HNIP scheme or similar (scenario 4);

- An investigation carried out on the light industrial area, confirms that a there is a potential to connect at least 3GWh of demand. This volume of heat demand could in fact bring the IRR just above the 3.5% threshold (Scenario 4) and be beneficial for any other scenario (except 1N)

Finally, there appear to be a potential of new business coming to the EZ. The Local Enterprise partnership and Lewes District Council have both employed EZ managers which will help steer the desired businesses to come to Newhaven. This option would benefit all the scenarios analysed (Except scenario 1N)

The Newhaven Marina scheme appears potentially viable, if led by the local authority. However it does not meet all the key drivers the council is seeking, such as supporting local business in the EZ and potentially attract new one.

It is recommended that further investigation in the technical and economic assumption is carried out prior to progress to feasibility study to:

- Increase the accuracy of the heat demand data

- Increase accuracy of capital and operating cost

- Establish the potential for additional stakeholders in the light industrial area to connect to a potential scheme

8.1 Implementation and Delivery

Following the assessment of the techno-economic factors, the likely model for implementation of the project was considered. This included issues such as ownership, risk and financing.

There are currently numerous business model structures for the delivery of DH in the UK. These range from external ESCos taking responsibility for all financing and design risk, to the simple adoption of a pre-established scheme:

- Finance, design, build and operate completed in by an ESCo or similar
- LA ownership with outsourced network delivery and operation
- Operation and Maintenance only contracts where the full scheme is handed over to an ESCo after completion.

Fully private sector option: In order for a private ESCo to take full ownership of the scheme including financing, the IRRs would need to be in excess of 10% and therefore the public sector involvement appears to be a necessity in this case.

Partnership option: This preference of a partnership between Newhaven Town Council and a private company is also not likely to be suitable given the economic results. Under a partnering arrangement, the IRR available to the Council would reduce if the private sector co-founded the scheme.

Fully public option: Given the economic results, a fully public business model is considered to be only viable option. The Council could invest in scheme and later divest the assets by selling it on as a going concern once loans are paid back. This option appears possible should the council secure a capital grant to support the scheme

However, under this option in order to manage risk, it would likely be in the Council's best interests to procure the scheme through the private sector and potentially to operate it as well.

8.2 Recommendations

8.2.1 Stakeholder Engagement

Effective stakeholder engagement is a key aspect in moving the project forward, due to the differing commercial interests, drivers and timescales of key stakeholders. Ramboll and Bioregional established contact with external stakeholders as part of the initial opportunity identification work and will work with Newhaven Town Council to continue the data collection process for the project

In order to obtain full support from within their organisation, Newhaven Town Council may wish to hold additional internal presentations / workshops with council members, outlining:

- the benefits within the Local Authority
- the potential contributions to meeting carbon targets
- the potential benefits to local residents, businesses and industry
- the councils objectives for being involved in a scheme
- roles the council and other stakeholders could/should take in taking the project(s) forward.

It would be beneficial for Newhaven Town Council to set up a steering group for the project and incorporate a key member of each stakeholder party within the group. The initial objectives of the steering group would be to:

- de-risk barriers and uncertainties identified in the EMP report and arising from subsequent detailed technical feasibility and business case

- Further engagement with stakeholders

- establish detailed technical feasibility and business case for the project

- take the business case back to stakeholder governance committees and obtain senior approval and sign off.

In the event that positive conclusions are drawn from the detailed feasibility study (i.e. IRR would result inviting to the private sector), engagement with potential ESCos should take place at the earliest possible stage of the project through soft market testing led by the project steering group. This will gauge the level of market interest, and help refine costs. In such case it may be appropriate for Newhaven Town Council to lead the procurement of the ESCo and bring them into the steering group. In the case of a negative o insufficient (i.e. IRR lower that interest rates) IRR, then a potential scenario would be the council taking forward the scheme contacting design, construction, operation and maintenance.

The establishment of a project steering group could also help with capacity building in Newhaven Town Council in terms of Officer's and Councillor's knowledge of district energy systems. This will be particularly important for planning officers responsible for implementing some of the recommendations set out for planning in this report, particularly when reviewing new applications in light of the proposed changes to planning policy.

8.2.2 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.

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.

8.2.3 Updating local Planning Policy Documents

Effective planning controls enforced by Newhaven Town Council could have a significant effect on the project viability, particularly for the wider strategic opportunity, which could embrace lands currently allocated to housing development.

The outcomes of this study should be cross referenced to existing council policies and strategies and local planning documents should be updated where and when possible to reflect the heat network opportunities identified in this report.

The proposals should be disseminated to relevant departments within the Council to raise awareness of the planned infrastructure proposals.

This will involve cross-departmental co-operation and careful consideration of the key drivers for district heating in Newhaven.

Technical safeguarding measures set out in this report should be complimented by recommendations set forward in the GLA's District Heating Manual for London and the CIBSE Code of Practice for heat networks. For instance new buildings should be designed to lower temperature than normal practice and at least to a 60/40 design temperatures. Further work is required to align policies and policy levers to support the growth of the DH network opportunity. For instance Lewes District Council and Newhaven Town Council could implement policies that encourage new developments to connect to existing heat networks or to implement design that would ease future connection to a heat network.

Lewes District Council should consider adopting a Local Development Order (LDO) to facilitate deployment of the future DH network. This would allow the Council to create a blanket planning permission to a future Project Company for constructing heat networks without the need for specific planning applications at each stage of development of the heat network. This approach has already been adopted by the London Borough of Newham in the District Heat Network Local Development Order[11], issued in 2013.

8.2.4 Technical Safeguarding Measures

There are several technical measures that can be implemented to safeguard the future of the project.

8.2.4.1 Safeguarding Energy Centre Locations

Initial communication with Veolia, indicates that there could be a potential for an energy centre on their site, depending on the energy centre footprint. This will need to be confirmed.

There is a land requirement for a small substation in the vicinity of the Parker Penn and Eastside developments. This could be potentially developed on the land of one of the two developments or possibly in the South area of the EZ.

Locations must be confirmed and safeguarded.

8.2.4.2 Ensuring Correct Design Standards are Adopted for New Developments

The design of customer connections and internal heating systems for new developments will have a significant impact on the operational capacity and efficiency of a future DH network. Although all developments identified as part of this EMP have been granted planning permission, new developments may emerge in the near 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.

Developers should be required to implement appropriate internal heating system designs to ensure flow and return temperatures are compatible with the heat network. Newhaven Town Council, through their planning and Building Control departments, should ensure that systems are being designed, installed and commissioned appropriately.

As a minimum the following future proofing measures should be adopted.

- Requiring 'wet' heating systems to be installed and prohibiting electrical heating systems;

- Requiring the incorporation of communal heating systems instead of individual boilers. Communal heating systems should be fed from plant rooms producing low temperature hot water for space heating and domestic hot water. Future proofing should include for providing 'tees' and isolation valves to facilitate future connection of heat exchangers. Space should be reserved for heat exchangers, or it should be planned for heat exchangers to replace heat-only boilers at time of connecting to the heat network;

[11] London Borough of Newham District Heat Network Local Development Order, March 2013, https://www.newham.gov.uk/Documents/Environment%20and%20planning/District%20Heat%20Network%20LDO_adopted_20%203%2013.pdf

- Ensuring internal heating systems are designed so that they can be connected to supply a district heating network with minimum retrofit. This should be achieved through measures such as built-in penetrations allowing pipes to be pushed through into plant rooms without structural alterations or significant works, designing heating systems to minimise return water temperatures and allowing provision in the building fabric to facilitate the installation of district heating pipework at a later time;

- External buried pipework routes should be safeguarded to the boundary of the plot where connection to the heat network will be made.

Further engagement with FM Conway will be needed to secure that technical compatibility is would be guaranteed by appropriate design.

8.2.4.3 Programme of heating system operating temperature reductions in existing and any local authority controlled buildings

Newhaven Town Council should consider initiating a programme of heating system operating temperature reductions in both existing buildings and any Local Authority controlled buildings – this will improve operating efficiencies (reduce network losses, reduce pumping requirements, improving heat pump efficiency where implemented and also free up capacity in the network for additional connections.

8.3 Next Steps

There are a number of key next steps which stakeholders will be required to take to support growth and investment in the identified opportunities.

The next steps identified here outline the main stages required to take a project from masterplanning to construction and successful operation.

- Set up a project steering group
- Establish the appetite of Major Stakeholders following completion of the EMP
- Developing a better understanding of the potential of connecting businesses in the light industrial area

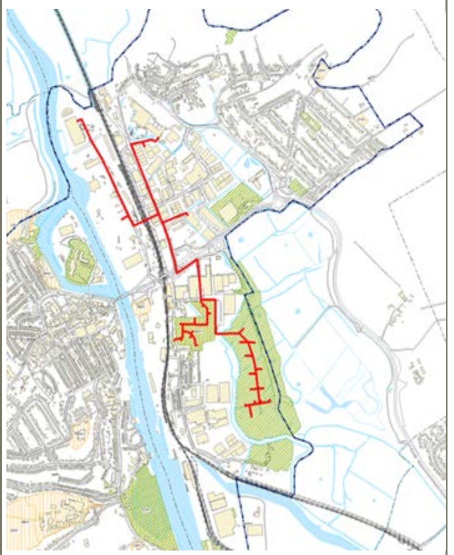
- Commision a Feasibility Study for the preferred case/cases, including funding options and delivery vehicles, resulting in the formation of a full business case.
- Liase with FM Conway and Veolia
- Begin Soft Market testing and engagement with potential system operators

- Secure the necessary funding to take the project forward
- Safeguarding of areas allocated to energy centres and/or substations
- Detailed Design and Procurement

- Construction
- Commsioning
- Operation and Maintenance

APPENDIX 1 – PROJECT OPPORTUNITY SHEETS

Network Route



Scenario Description

This scenario assumes that a heat network, supplied by the Newhaven Energy from Waste (EfW) facility, would supply mainly the East Side and the Parker Penn developments. It is assumed that other three commercial loads would connect, which are considered to have a lower risk among those currently existing in the industrial area nearby the EfW plant. Futher investigation on their demaned and their likelihood to connect is needed.

Under this scenario the network would need to cross the railway. The network has been routed along the Enterprise Zone (EZ), so that it could attract businees within the area. Moreover, it is understood that a relatively significant heat consumer could potentially move within the EZ in the short term. Ramboll recognises the risk associated with this load and, under this scenario, it is assumed that this load would not materialise or decide to connect.

It is assumed that the connection cost of new residential and commercial buildings would be paid by the developers, given that they would avoid the cost of installing new boilers. Developers would also provide a contribution to the scheme equal to the value of the carbon savings that the network would deliver to the new developemnts (assumed a £60 per tonne of carbon saved). The scheme would also benefit of RHI (£10 per MWh supplied net of heat losses).

Although relatively low-risk, this scheme is likely to not recover the cost of borrowing, providing roughly an IRR of 0.87% over 40 years of operation.

Scheme KPIs

Finance			
Average Annual Operating Margin	£	226,715	
NPV (3.5% Discount Rate) - 25 years	-£	2,574,083	
IRR (25 Years)		-1.51%	
NPV (3.5% Discount Rate) - 40 years	-£	1,789,785	
IRR (40 Years)		1.14%	
Developers Contribution Over 25 years	£	653,250	(£60/tonneCO2)
CO2 **NPV per tonne of CO2 saved (25 yr**	**-£**	**139**	
CO2 Saving over Lifetime (25 Years)		18,499	tonnes
CO2 Saving over Lifetime (40 Years)		30,592	tonnes

Stakeholders and Heat Demands

	Building Name	Annual Demand (MWh)	Peak Load (kW)
1	East Side Resid. Development	1495	1091
2	Parker Pen Development Phase 1	781	866
3	Marco Trailers - Office Building	61	36
4	Paradise Park Centre	984	576
5	Harwood Print Makers	152	89
6	SBFI Furniture	165	97
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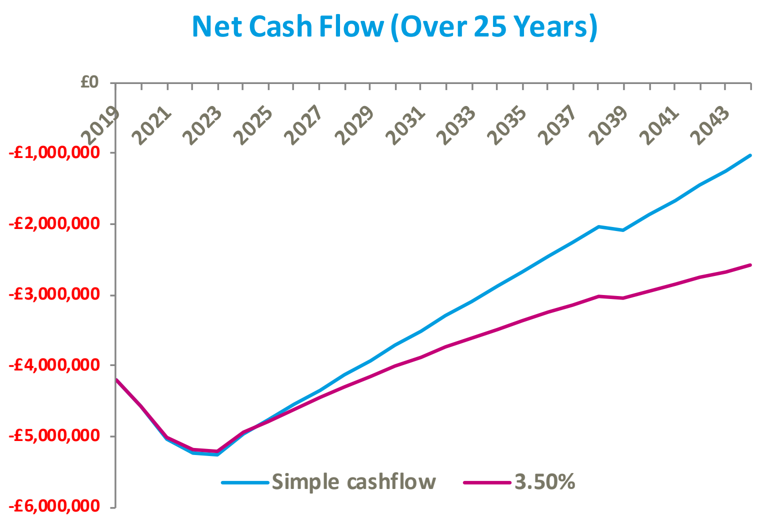
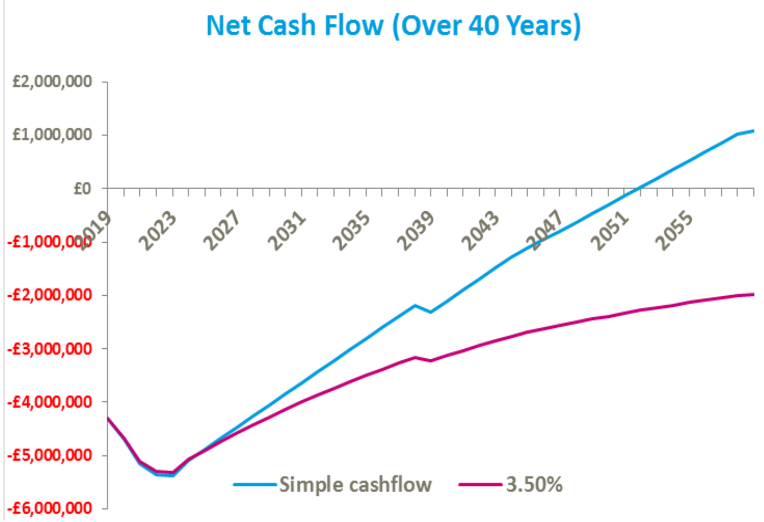




Costs and Revenues Assumptions

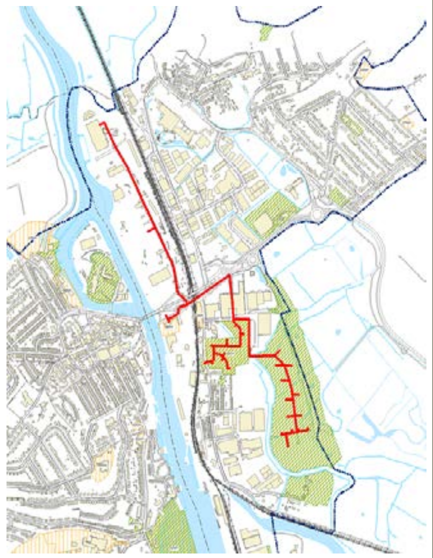
Fuel Cost	**Unit Rate(£/MWh)**
Heat From Veolia	10.45
Natural Gas	19.83

Heat Revenues	**Unit Rate(£/MWh)**			
RHI	10 £ MWh equal to an average of 0 £/year			
		Heat Selling Price (£/MWh)		**Standing Charge (£/year)**
Industrial Htg & DHW	£	-	£	-
Mining Htg & DHW	£	-	£	-
NonResi Htg & DHW	£	-	£	-
Other Htg & DHW	£	29.93	£	4,053
Commercial Offices Htg & DI	£	48.19	£	558
Postal Htg & DHW	£	-	£	-
Recreational Htg & DHW	£	-	£	-
Retail Htg & DHW	£	-	£	-
Science Htg & DHW	£	-	£	-
Transport Htg & DHW	£	-	£	-
New Mixed Use Htg & DHW	£	-	£	-
New Resi Htg & DHW	£	50.01	£	358
New NonResi Htg & DHW	£	29.93	£	1,204
Custom Htg&DHW	£	-	£	-
Internal Heat Losses	£	-	£	-
Office Cooling Demand	£	-	£	-
Hotel Cooling Demand	£	-	£	-
Data Centre Cooling Deman	£	-	£	-
Civic Building Cooling Dema	£	-	£	-
Custom Cooling Demand	£	-	£	-
0 6	£	-	£	-

Item		CAPEX (£)		Maintenance (£/Year)		Annualised REPEX
Heat Offtake from Veolia	£	427,021	£	13,373	£	5,349
Energy Centre (Structure)	£	241,613	£	57,474		
Back-Up Boilers	£	245,744				Every 20 year
Balance of Plant	£	373,721			£	2,990
Heat Network	£	3,417,840	£	9,808		
Crossing The Railway	£	250,000	plus £10k Annual Charge			
New Substation	£	300,000				
Design	£	232,121				
ESCo Metering and Billing			£	3,440		
Contractor	£	536,773				
TOTAL	**£**	**6,024,832**	**£**	**94,095**	**£**	**8,339**

Figure 62: Scenario 1 -Summary of Assumptions

Network Route



Scenario Description

This scenario is an alternative of scenario 1, where the network is routed along the Enterprise Zone to connect the UTC college as well as the Eastside, the Parker Penn and the Marco Trailers developments.

As discussed in section 5.1.3, this option would have a advantages and drawbacks over the route option in scenario 1. Extension to Danton Island and the city centre would require crossing the railway only once, resulting in lower capital costs. On the other side, a potential extension to the light industrial area would result in a longer route.

Except for the route and the heat loads connected, all other parameters and assumptions are identical to those presented in scenario 1a.

In comparison with scenario 1, this scheme present a lower IRR, -2.89% compared to -1.51%, and a higher Net Present Cost per tonne of carbon saved (194 £/tonneCO2 against 139 £/tonneCO2 for scenario 1).

This is due to the lower volume of heat demand connected to the scheme and the resulting loss of revenues (and an associated reduction in carbon savings) which does not outweigh the savings associate with a shorter route. However, as discussed in section 5.1.3, more investigation is needed to establish the feasibility of connecting stakeholders in the light industrial area to the scheme. Depending on the outcome of this investigation and the potential to expanding the network to the city centre and Denton Island, the route associated with this scenario could be preferable.

Scheme KPIs

Finance

Average Annual Operating Margin	£ 177,535	
NPV (3.5% Discount Rate) - 25 years	-£ 2,846,018	
IRR (25 Years)	-2.89%	
NPV (3.5% Discount Rate) - 40 years	-£ 2,259,779	
IRR (40 Years)	0.07%	
Developers Contribution Over 25 years	£ 653,250	(£60/tonneCO2)
CO2 **NPV per tonne of CO2 saved (25 yr**	**-£ 194**	
CO2 Saving over Lifetime (25 Years)	14,685	tonnes
CO2 Saving over Lifetime (40 Years)	24,505	tonnes

Costs and Revenues Assumptions

Fuel Cost	**Unit Rate(£/MWh)**
Heat From Veolia	10.45
Natural Gas	19.83

Heat Revenues	**Unit Rate(£/MWh)**
RHI	10 £ MWh equal to an average of 0 £/year

	Heat Selling Price (£/MWh)	**Standing Charge (£/year)**
Education Htg & DHW	£ 3.15	£ 1,664
Mining Htg & DHW	£ -	£ -
NonResi Htg & DHW	£ -	£ -
Other Htg & DHW	£ 29.93	£ 1,645
Commercial Offices Htg & DI	£ 48.19	£ 558
Postal Htg & DHW	£ -	£ -
Recreational Htg & DHW	£ -	£ -
Retail Htg & DHW	£ -	£ -
Science Htg & DHW	£ -	£ -
Transport Htg & DHW	£ -	£ -
New Mixed Use Htg & DHW	£ -	£ -
New Resi Htg & DHW	£ 50.01	£ 358
New NonResi Htg & DHW	£ 29.93	£ 1,204
Custom Htg&DHW	£ -	£ -
Internal Heat Losses	£ -	£ -
Office Cooling Demand	£ -	£ -
Hotel Cooling Demand	£ -	£ -
Data Centre Cooling Deman	£ -	£ -
Civic Building Cooling Dema	£ -	£ -
Custom Cooling Demand	£ -	£ -
0	£ -	£ -

Item	**CAPEX (£)**	**Maintenance (£/Year)**	**Annualised REPEX**
Heat Offtake from Veolia	£ 406,183	£ 12,568	£ 5,027
Energy Centre (Structure)	£ 222,199	£ 57,322	
Back-Up Boilers	£ 219,032		Every 20 years
Balance of Plant	£ 366,120		£ 2,929
Heat Network	£ 3,062,111	£ 8,921	
Crossing The Railway	£ 250,000	plus £10k Annual Charge	
New Substation	£ 300,000		
Design	£ 209,836		
ESCo Metering and Billing		£ 3,420	
Contractor	£ 491,072		
TOTAL	**£ 5,526,552**	**£ 92,231**	**£ 7,956**

Stakeholders and Heat Demands

	Building Name	Annual Demand (MWh)	Peak Load (kW)
1	East Side Resid. Development	1495	1091
2	Parker Pen Development Phase 1	781	866
3	Marco Trailers - Office Building	61	36
4	UTC College	473	234
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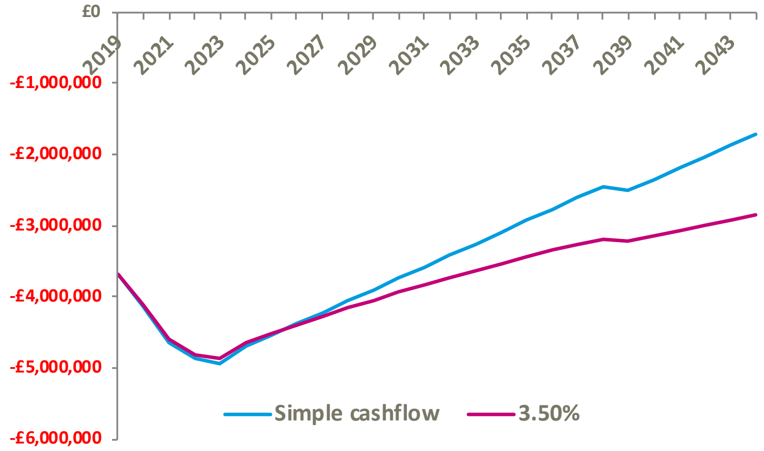
Net Cash Flow (Over 25 Years)



Net Cash Flow (Over 40 Years)

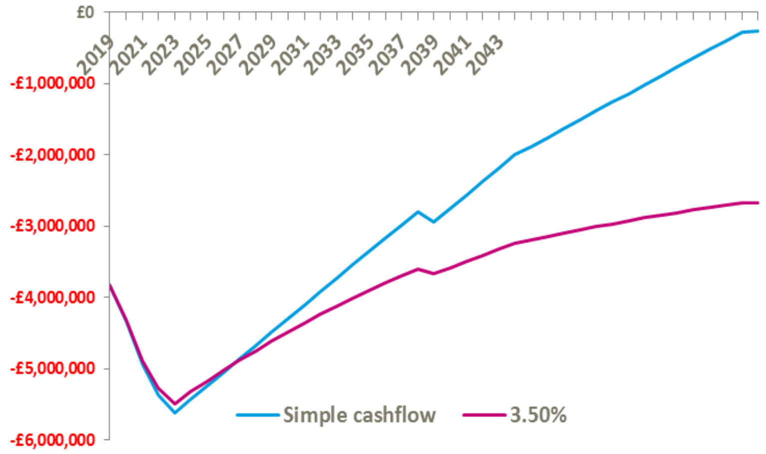
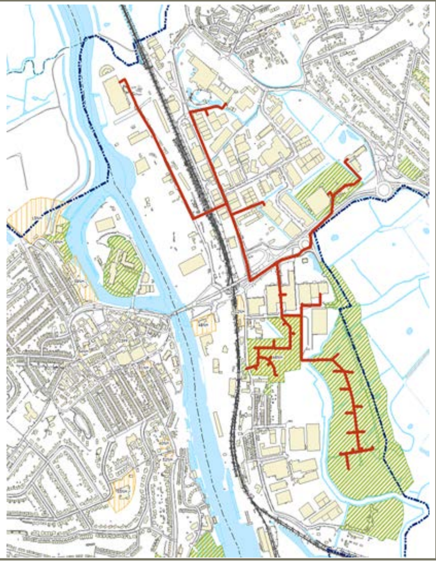


Figure 63: Scenario 1a- Summary of Assumptions

Network Route and Loads



Scenario Description

This scenario is an alternative of scenario 1, where the network is routed along the Enterprise Zone to connect the UTC college as well as the Eastside, the Parker Penn and the Marco Trailers developments.

As discussed in section 5.1.3, this option would have a advantages and drawbacks over the route option in scenario 1. Extension to Danton Island and the city centre would require crossing the railway only once, resulting in lower capital costs. On the other side, a potential extension to the light industrial area would result in a longer route.

Except for the route and the heat loads connected, all other parameters and assumptions are identical to those presented in scenario 1a.

The additional loads that have been assumed to connect to the scheme (in comparison with scenario 1) would lead to higher carbon savings and financial KPIs (i.e. IRR and NPV) resulting in a lower net present cost associated with the carbon savings delivered by the scheme, roughly £50.

With an average annual operating margin of approximately £ 356k, the scheme could potentially break even after roughly 23 years of operation and could return an IRR of approximately 2.7% over 40 years.

Scheme KPIs

Finance		
Average Annual Operating Margin	£	356,385
NPV (3.5% Discount Rate) - 25 years	-£	2,003,985
IRR (25 Years)		0.52%
NPV (3.5% Discount Rate) - 40 years	-£	756,860
IRR (40 Years)		2.74%
Developers Contribution Over 25 years	£	653,250 (£1950/dwelling
CO2 — NPV pet Tonne of CO2 Saved (25 yı	-£	50
CO2 Saving over Lifetime (25 Years)		39,706 tonnes
CO2 Saving over Lifetime (40 Years)		64,750 tonnes

Heat Loads

	Building Name	Annual Demand (MWh)	Peak Load (kW)
1	East Side Resid. Development	1495	1091
2	Parker Pen Development Phase 1	781	866
3	Marco Trailers - Office Building	61	36
4	Paradise Park Centre	984	576
5	Harwood Print Makers	152	89
6	SBFI Furniture	165	97
7	3 DROVE ROAD	560.9	285.9
8	CASH BASES LTD DROVE ROAD	318.8	186.8
9	UNIT A THE DROVE	384.4	195.9
10	HALFORDS UNIT B THE DROVE	1231.6	721.4
11	SAINSBURY SUPERMARKET THE DROV	1078.4	549.7
12	Premier Inn	320.8	115.3
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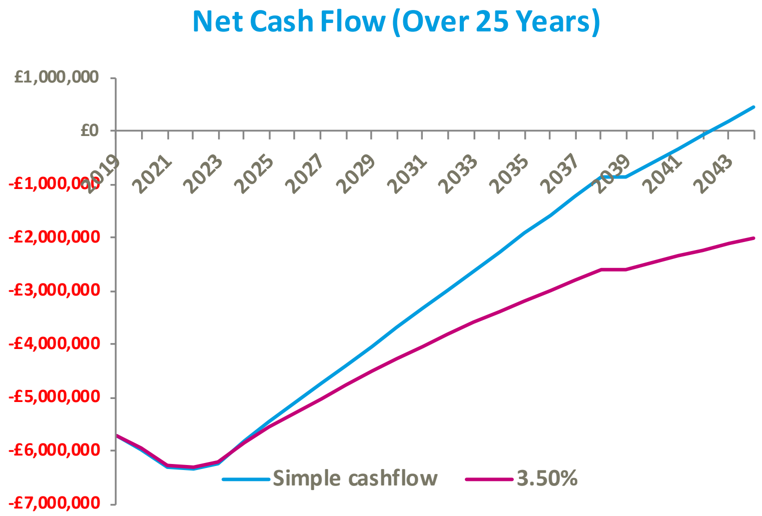
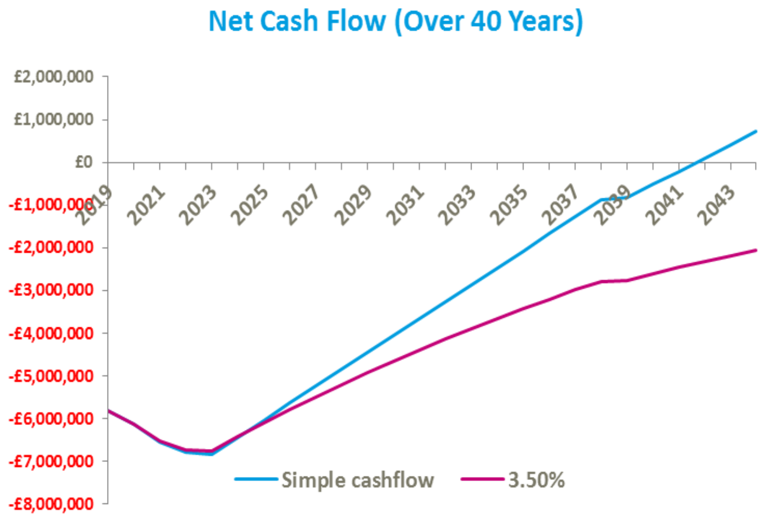




Costs and Revenues Assumptions

Fuel Cost	Unit Rate(£/MWh)
Heat From Veolia	10.45
Natural Gas Boilers	19.83

Heat Revenues

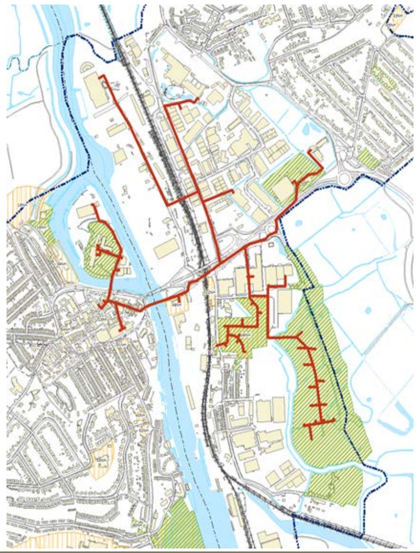
RHI — 10 £ MWh equal to an average of 84920 £/year

	Heat Selling Price (£/MWh)		Standing Charge (£/year)	
Hotel Htg & DHW	£	29.93	£	1,128
Industrial Htg & DHW	£	29.93	£	2,724
Mining Htg & DHW	£	-	£	-
NonResi Htg & DHW	£	-	£	-
Other Htg & DHW	£	29.93	£	4,053
Commercial Offices Htg & DI	£	48.19	£	558
Postal Htg & DHW	£	-	£	-
Recreational Htg & DHW	£	-	£	-
Retail Htg & DHW	£	29.93	£	2,371
Science Htg & DHW	£	-	£	-
Transport Htg & DHW	£	-	£	-
New Mixed Use Htg & DHW	£	-	£	-
New Resi Htg & DHW	£	50.01	£	358
New NonResi Htg & DHW	£	29.93	£	1,204
Custom Htg&DHW	£	-	£	-
Internal Heat Losses	£	-	£	-
Office Cooling Demand	£	-	£	-
Hotel Cooling Demand	£	-	£	-
Data Centre Cooling Deman	£	-	£	-
Civic Building Cooling Dema	£	-	£	-
Custom Cooling Demand	£	-	£	-

Item	CAPEX (£)		Maintenance (£/Year)		Annualised REPEX	
Heat Offtake from Veolia	£	722,064	£	23,118	£	9,247
Energy Centre (Structure)	£	433,856	£	59,712		
Back-Up Boilers	£	339,904			Every 20 years	
Balance of Plant	£	485,609			£	3,885
Heat Network	£	3,972,320	£	11,191		
Crossing The Railway	£	250,000	plus £10k Annual Charge			
New Substation	£	300,000				
Design	£	298,423				
ESCo Metering and Billing			£	3,500		
Contractor	£	672,924				
TOTAL	**£**	**7,475,101**	**£**	**107,522**	**£**	**13,132**

Figure 64: Scenario 2 – Summary of Assumptions

Network Route and Loads



This scenario is a variation of scenario 2, which tests the impact of connecting Denton Island as well as a few consumers in the city centre.

The route would imply crossing twice both the railway and the river, which would result in a significant capital cost needed to overcome these infrastructural and natural barriers.

Except for the heat loads connected and the network extension, all other parameters and assumptions are identical to those presented in scenario 1 and 2.

The scheme benefits of a higher operating margin than the other scenarios, due to the larger volume of revenues associated with heat sales and standing charges. These though would not suffice to outweigh the higher capital cost associated with the additional crossing of the railway and the two river crossings, which result in reduced financial KPIs (i.e. IRR and NPV) in comparison with, scenario 2.

The net present cost per tonne of carbon saved would be in the range of £ 52.3.

Scheme KPIs

Finance			
Average Annual Operating Margin	£	488,011	
NPV (3.5% Discount Rate) - 25 years	-£	2,836,702	
IRR (25 Years)		0.44%	
NPV (3.5% Discount Rate) - 40 years	-£	1,088,717	
IRR (40 Years)		2.71%	
Developers Contribution Over 25 years	£	653,250	(£1950/dwelling)
CO2 **NPV pet Tonne of CO2 Saved (25 yı**	**-£**	**52.35**	
CO2 Saving over Lifetime (25 Years)		54,192	TonnesCO2
CO2 Saving over Lifetime (40 Years)		93,930	TonnesCO2

Heat Loads

	Building Name	Annual Demand (MWh)	Peak Load (kW)
1	East Side Resid. Development	1,495	1,091
2	Parker Pen Development Phase 1	781	866
3	Marco Trailers - Office Building	61	36
4	Paradise Park Centre	984	576
5	Harwood Print Makers	152	89
6	SBFI Furniture	165	97
7	3 DROVE ROAD	561	286
8	CASH BASES LTD DROVE ROAD	319	187
9	UNIT A THE DROVE	384	196
10	HALFORDS UNIT B THE DROVE	1,232	721
11	SAINSBURY SUPERMARKET THE DROV	1,078	550
12	Premier Inn	321	115
13	14 WOOLWORTHS HIGH STREET	119	61
14	NEWHAVEN NEIGHBOURHOOD NURSE	44	22
15	UNIT 2 NEWHAVEN ENTERPRISE CENT	552	324
16	GROUND FLOOR 8 HIGH STREET	113	41
17	DENTON ISLAND BOWLING CLUB	276	107
18	10 NEWHAVEN SQUARE	368	188
19	FLUDES CARPETS LTD DENTON ISLAND	112	66
20	EXPANDED POLYSTYRENE SUPPLIES DE	168	98
21	Swimming Pool	1,317	511
22	UTC@harbourside, Railway Quay, Ne	473	234
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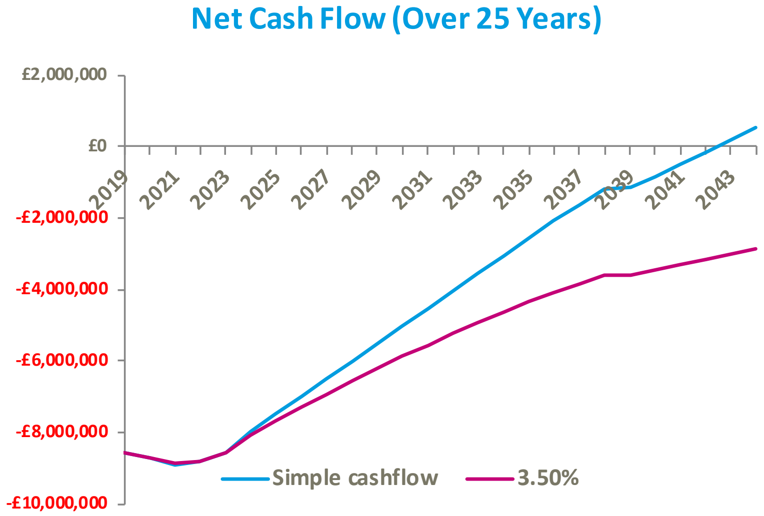
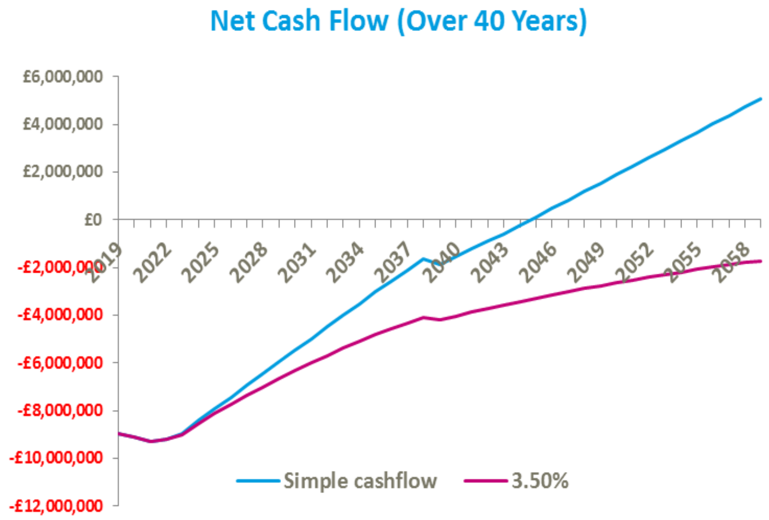




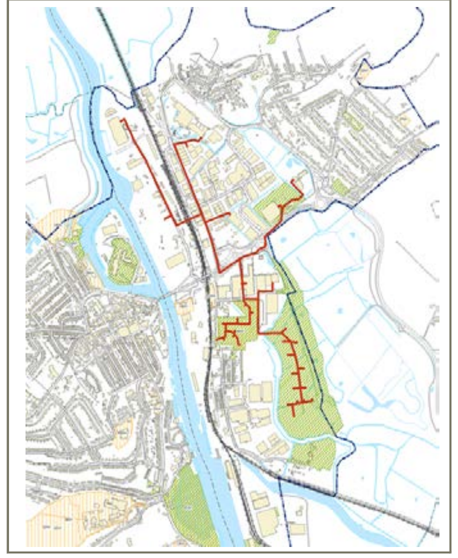
Costs and Revenues Assumptions

Fuel Cost		**Unit Rate(£/MWh)**		
Heat From Veolia		10.45		
Natural Gas Boilers		19.83		
Heat Revenues				
RHI	10 £ MWh equal to an average of 125649 £/year			
		Heat Selling Price (£/MWh)		**Standing Charge (£/year)**
Hotel Htg & DHW	£	29.93	£	1,128
Industrial Htg & DHW	£	29.93	£	2,724
Mining Htg & DHW	£	-	£	-
NonResi Htg & DHW	£	-	£	-
Other Htg & DHW	£	29.93	£	4,053
Commercial Offices Htg & DI	£	48.19	£	558
Postal Htg & DHW	£	-	£	-
Recreational Htg & DHW	£	29.93	£	692
Retail Htg & DHW	£	29.93	£	2,371
Science Htg & DHW	£	-	£	-
Transport Htg & DHW	£	-	£	-
New Mixed Use Htg & DHW	£	-	£	-
New Resi Htg & DHW	£	50.01	£	358
New NonResi Htg & DHW	£	29.93	£	1,204
Custom Htg&DHW	£	-	£	-
Internal Heat Losses	£	-	£	-
Office Cooling Demand	£	-	£	-
Hotel Cooling Demand	£	-	£	-
Data Centre Cooling Deman	£	-	£	-
Civic Building Cooling Dema	£	-	£	-
Custom Cooling Demand	£	-	£	-

Item		CAPEX (£)		Maintenance (£/Year)		Annualised REPEX
Heat Offtake from Veolia	£	902,395	£	28,432	£	11,373
Energy Centre (Structure)	£	519,213	£	61,174		
Back-Up Boilers	£	393,764				Every 20 years
Balance of Plant	£	558,722			£	4,470
Heat Network	£	4,780,375	£	16,393		
Crossing The Railway Twice	£	500,000	plus £15k Annual Charge			
Crossing the River Twice	£	1,000,000				
New Substation	£	300,000				
Design	£	394,453				
ESCo Metering and Billing			£	3,600		
Contractor	£	**932,637**				
TOTAL	£	**10,281,559**	£	**119,599**	£	**15,843**

Figure 65: Scenario 3 -Summary of Assumptions

Network Route and Loads



This scenario is identical to scenario 2, although in this option it is assumed that the thermal load associated with FM Conway would connect to the scheme.

Initial communication with this stakeholder suggest that there is an interest from this party in connecting to a potential heat network and that the portion of its demand that could be supplied by the network would be in the range of roughly 1 GWh per year. More investigation will be needed to establish the proportion of the heat demand that could be supplied by the scheme.

It is important to note that the materialisation of this load could potentially act as a catalyser in the development of a network.

Connection of FM Conway would result in a higher IRR (approximately 1.5% over 25 years) in comparison with scenario 2 (approximately 0.5% IRR over 25 years) where it was assumed that FM Conway would not connect to the scheme.

This scenario could break even after approximately 20 years of operation, and could lead to an IRR of approximately 3.5% over 40 years. The associated net present cost per tonne of carbon saved would be in the range of £32.6.

Scheme KPIs

Finance		
Average Annual Operating Margin	£ 400,843	
NPV (3.5% Discount Rate) - 25 years	-£ 1,418,774	
IRR (25 Years)	1.48%	
NPV (3.5% Discount Rate) - 40 years	-£ 12,574	
IRR (40 Years)	3.49%	
Developers Contribution Over 25 years	£ 653,250	(£ 1950/dwelling)
CO2	**NPV pet Tonne of CO2 Saved (25 y -£**	**32.64**
CO2 Saving over Lifetime (25 Years)	43,464	TonneCO2
CO2 Saving over Lifetime (40 Years)	72,473	TonneCO2

Heat Loads

	Building Name	Annual Demand (MWh)	Peak Load (kW)
1	East Side Resid. Development	1495	1091
2	Parker Pen Development Phase 1	781	866
3	Marco Trailers - Office Building	61	36
4	Paradise Park Centre	984	576
5	Harwood Print Makers	152	89
6	SBFI Furniture	165	97
7	3 DROVE ROAD	561	286
8	CASH BASES LTD DROVE ROAD	319	187
9	UNIT A THE DROVE	384	196
10	HALFORDS UNIT B THE DROVE	1232	721
11	SAINSBURY SUPERMARKET THE DROV	1078	550
12	Premier Inn	321	115
13	FM Conway	1069	626
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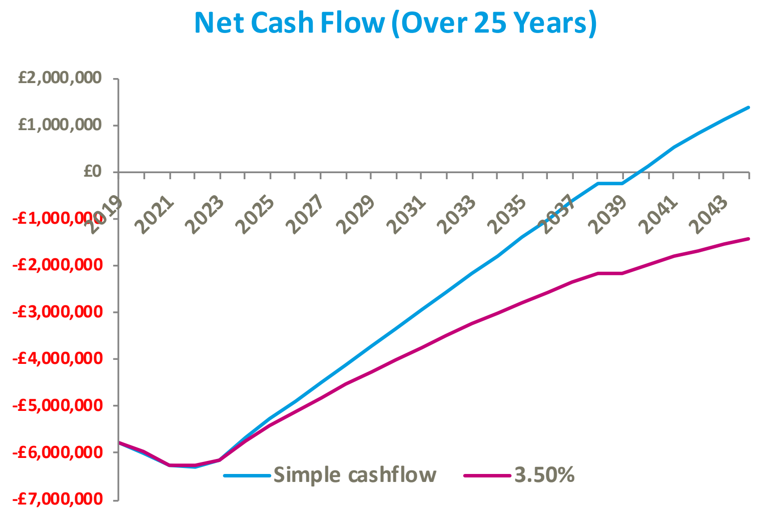
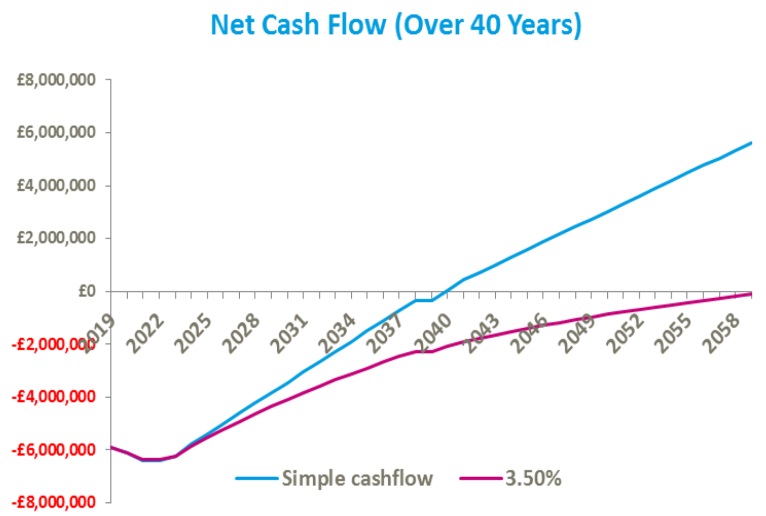




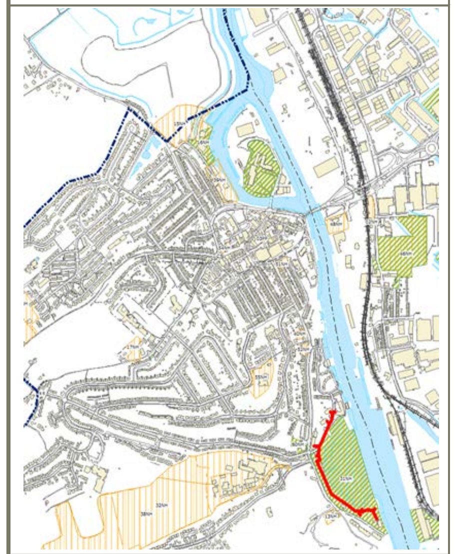
Costs and Revenues Assumptions

Fuel Cost	**Unit Rate(£/MWh)**	
Heat From Veolia	10.45	
Natural Gas Boilers	19.83	
Heat Revenues		
RHI	10 £ MWh equal to an average of 97260 £/year	
	Heat Selling Price (£/MWh)	**Standing Charge (£/year)**
Hotel Htg & DHW	£ 29.93	£ 1,128
Industrial Htg & DHW	£ 29.93	£ 2,724
Mining Htg & DHW	£ -	£ -
NonResi Htg & DHW	£ -	£ -
Other Htg & DHW	£ 29.93	£ 4,053
Commercial Offices Htg & DI	£ 48.19	£ 558
Postal Htg & DHW	£ -	£ -
Recreational Htg & DHW	£ -	£ -
Retail Htg & DHW	£ 29.93	£ 2,371
Science Htg & DHW	£ -	£ -
Transport Htg & DHW	£ -	£ -
New Mixed Use Htg & DHW	£ -	£ -
New Resi Htg & DHW	£ 50.01	£ 358
New NonResi Htg & DHW	£ 29.93	£ 811
FM Conway	£ 27.82	£ 3,149
Internal Heat Losses	£ -	£ -
Office Cooling Demand	£ -	£ -
Hotel Cooling Demand	£ -	£ -
Data Centre Cooling Deman	£ -	£ -
Civic Building Cooling Dema	£ -	£ -
Custom Cooling Demand	£ -	£ -

Item	**CAPEX (£)**	**Maintenance (£/Year)**	**Annualised REPEX**
Heat Offtake from Veolia	£ 729,261	£ 23,329	£ 10,031
Energy Centre (Structure)	£ 437,167	£ 59,769	
Back-Up Boilers	£ 354,535		Every 20 years
Balance of Plant	£ 488,452		£ 3,908
Heat Network	£ 3,995,937	£ 11,250	
Crossing The Railway	£ 250,000	plus £10k Annual Charge	
New Substation	£ 300,000		
Design	£ 329,420		
ESCo Metering and Billing		£ 3,510	
Contractor	£ 678,397		
TOTAL	**£ 7,563,168**	**£ 107,858**	**£ 13,939**

Figure 66: Scenario 4 - Summary of Assumptions

Network Route and Loads



This scheme would imply a small local network being developed during the Newhaven Marina Phase 3. The scheme would connect also existing residential blocks in the area and would offer:

• The opportunity to extend towards the near housing allocation area in the future;

• A potential to connect to the main network in the future.

It is assumed that the network would be fed by a 300 kW water source heat pump.

This scheme, although small, could potentially deliver an IRR of 6.24% over 25 years and a discounted (3.5% D.R.) NPV of approximately £460k. The net present value per carbon of tonne saved is approximately £ 67.2 over 25 years, therefore the scheme could potentially produce positive financial benefits for each tonne of carbon saved.

With a modest capital cost, estimated in the order of £1.7M, and an average annual operating margin of £135 K, the scheme could break-even after roughly 10 years of operation.

Scheme KPIs

Finance			
Average Annual Operating Margin	£	135,237	
NPV (3.5% Discount Rate) - 25 years	£	460,112	
IRR (25 Years)		6.24%	
NPV (3.5% Discount Rate) - 40 years	£	1,134,857	
IRR (40 Years)		7.71%	
Developers Contribution Over 25 years	£	645,450	(£ 1950/ dwellir
CO2 **NPV pet Tonne of CO2 Saved (25 yı**	**£**	**81.07**	
CO2 Saving over Lifetime (25 Years)		5,676	TonneCO2
CO2 Saving over Lifetime (40 Years)		10,911	TonneCO2

Heat Loads

	Building Name	Annual Demand (MWh)	Peak Load (kW)
1	FLAT 1 VILLANDRY FORT ROAD	194	70
2	5 VERSAILLES WEST QUAY	107	54
3	4 VALENCAY WEST QUAY	208	104
4	FALAISE WEST QUAY	328	164
5	Block A Non-Residential West Quay	19	11
6	Block A Residential West Quay Newh	50	25
7	Block B West Quay Newhaven Marina	114	57
8	Block C Non-Residential West Quay I	124	72
9	Block C Residential West Quay Newh	175	87
10	Block D West Quay Newhaven Marina	114	57
11	Block E West Quay Newhaven Marina	111	55
12	Block F West Quay Newhaven Marina	111	55
13	Block G West Quay Newhaven Marina	64	32
14	Block H West Quay Newhaven Marina	93	47
15	Block I West Quay Newhaven Marina	50	25
16	Block J West Quay Newhaven Marina	50	25
17	Block K West Quay Newhaven Marina	92	46
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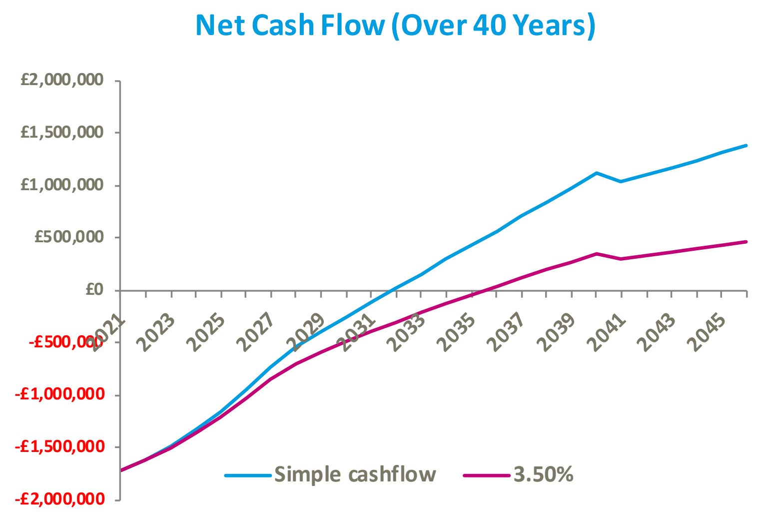

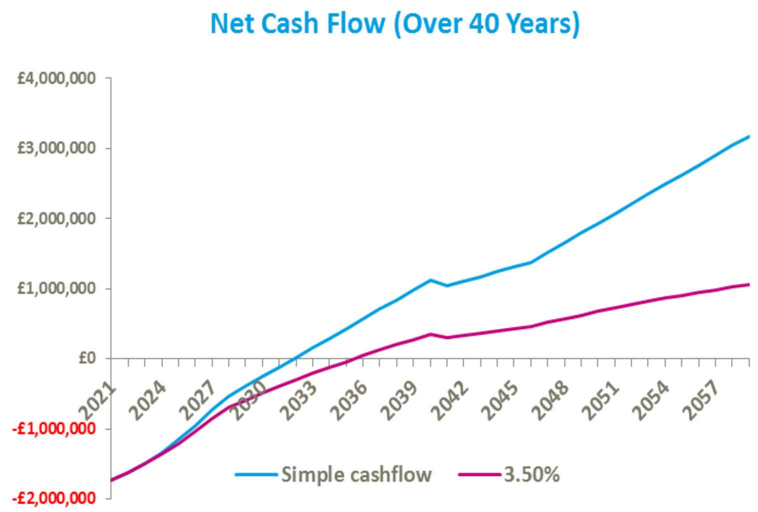

Costs and Revenues Assumptions

Fuel Cost		**Unit Rate(£/MWh)**		
Heat From Veolia		109.09		
Natural Gas Boilers		24.89		
Heat Revenues				
RHI	10 £ MWh equal to an average of 67290 £/year			
		Heat Selling Price (£/MWh)		**Standing Charge (£/year)**
Hotel Htg & DHW	£	29.93	£	546
Industrial Htg & DHW	£	-	£	-
Mining Htg & DHW	£	-	£	-
NonResi Htg & DHW	£	-	£	-
Other Htg & DHW	£	-	£	-
Commercial Offices Htg & DI	£	-	£	-
Postal Htg & DHW	£	-	£	-
Recreational Htg & DHW	£	-	£	-
Retail Htg & DHW	£	-	£	-
Science Htg & DHW	£	-	£	-
Transport Htg & DHW	£	-	£	-
New Mixed Use Htg & DHW	£	-	£	-
New Resi Htg & DHW	£	50.01	£	287
New NonResi Htg & DHW	£	29.93	£	199
FM Conway	£	-	£	-
Internal Heat Losses	£	-	£	-
Office Cooling Demand	£	-	£	-
Hotel Cooling Demand	£	-	£	-
Data Centre Cooling Deman	£	-	£	-
Civic Building Cooling Dema	£	-	£	-
Custom Cooling Demand	£	-	£	-

Item		**CAPEX (£)**		**Maintenance (£/Year)**		**Annualised REPEX**
Heat Offtake from Veolia	£	77,850	£	5,364	£	-
Energy Centre (Structure)	£	190,350	£	35,576		
Back-Up Boilers	£	186,239				Every 20 years
Balance of Plant	£	469,131			£	2,230
Heat Network	£	604,493	£	1,351		
Crossing The Railway	£	-	plus £10k Annual Charge			
New Substation	£	-				
Design	£	82,423				
ESCo Metering and Billing			£	3,370		
Contractor	£	150,159				
TOTAL	**£**	**1,760,646**	**£**	**55,661**	**£**	**2,230**

APPENDIX 2 – SUPPLY OPTIONS APPRAISAL

Technology	Environmental Impact, CO_2 Abatement Potential and cost of CO_2 abatement	Revenue Potential	Risk	Consider as Opportunity?
Gas Combined Heat and Power Plant (Open Cycle)	Medium/ High local environmental impact, although low to negligible when considering heat stack heat recovery Medium abatement potential and medium to low cost of abatement due to efficiency of extraction process.	Heat sales, heat can provide coolth through absorption chillers	Low risk, well proven technology. Very high capital investment required. The development potential would rest on a third party with separate business case structured around electricity sales (or offsetting) to a local electricity demand (typical installations include hospitals, industry, and manufacturing). Potential for flue gas heat recovery to be implemented. Good financial performance expected on this basis, dependent on location in relation to demand and grade and quantity of heat available. Plant not commercially viable without the applications as described above (third party developer, electricity sales). Heat supply risk associated with the fact that heat supplier would be a third party outside of control of network operator. Future longevity and price of heat from plant outside of control of network developer. No third party applications identified.	No Not considered further.
Biomass heating	High abatement potential. Medium cost of abatement. Local air quality impact is high (NOx, particulates). Although, scrubbing technology can be applied and is not cost prohibitive if constructed at scale,	Heat sales and RHI	Well proven, low risk technology. There is an AQMA for nitrogen dioxide in Newhaven that includes the whole city centre, which is the main study area[12]. Reasonable financial performance expected under RHI. Increasing the distance from the plant to the demand will significantly reduce financial viability. Uncertainty around fuel supply chain presents a financial and operating risk. Larger energy centre space requirement than for other options to allow for fuel and process residue storage, larger land take. Transport of fuel to and from the plant can be problematic, as this would require large HGV type vehicles for deliveries once a week or smaller vehicles with more frequent deliveries (this would increase operating costs). Policy risk associated with future incentive support. Planning / permitting risk associated with local air quality.	No Not considered further.
Biomass CHP	Local air quality impact is high (NOx, particulates). However, scrubbing technology can be applied and	Heat sales and RHI. Private wire of electricity produced	Steam cycle (including with Gasification technology) is considered relatively low risk subject to a number of caveats outlined below. Steam cycle plants tend to be much larger in scale than would be required for local district heating systems and similar to open cycle gas CHP would require third party investment and development with a business case based around electricity sales.	No Not considered further.

Technology	Environmental Impact, CO_2 Abatement Potential and cost of $C0_2$ abatement	Revenue Potential	Risk	Consider as Opportunity?
	is not cost prohibitive if constructed at scale. High abatement potential and medium to low cost of abatement, if heat treated as by product of power production.	also a possibility	Internal combustion gasification technology represents a much higher risk due to reliability issues. The technology is not commercially proven; there is currently one engine in operation in the UK at the manufacturer's plant. Not considered to be commercially viable to develop at relevant scale as the driver for developing a heat network. Heat supply risk associated with the fact that heat supplier would be a third party outside of control of network operator. Future longevity and price of heat from plant out of control of network developer. Finance risk associated with poor bankability of heat. No third party applications identified.	
Organic Rankine Cycle	High abatement potential. Relatively high cost of abatement, due to low electrical efficiency.	Heat and power sales RHI on heat sales, CFD on power sales.	Technology relatively well proven. A number of projects in operation across Europe and beyond. Financial performance dependent on fuel source. Not considered economically attractive if fuel source is primary fuel such as biomass. Applications involving industrial waste heat are preferable. Not considered to be commercially viable to develop at relevant scale as the driver for developing a heat network. Would require a third party developer to progress this under a separate business case. No known third party schemes in development.	No Not considered further.
Gas engine CHP	Low / medium abatement potential Medium cost of carbon abatement due to high capital cost of technology.	Heat and Power sales, possibly coolth through absorption chillers	Low technology risk, well proven. Financial case likely to rest on ability to private wire or embed the generator within a large existing (electrical) demand centre such as a hospital or major industrial customer. The scale and proximity of this electricity demand may be inappropriate to deliver a financially viable heat network and there is inherent risk with a private wire arrangement since the customer's continued connection cannot be guaranteed over the life of finance package. Furthermore gas engine CHP is increasingly uncommon for industrial customers and the most likely scenario would be for the industrial customer (or hospital) to sell heat from plant that it owns to a third party heat network rather than vice versa. In this way it would be less exposed to third party risk by being able to retain control over its energy 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. Local air quality impact likely to be high (NO_x)[13]. Scrubbing technology can be applied and is not cost prohibitive. Noise from gas CHP engines, particularly larger ones can be problematic from a planning point of view and can restrict running hours of the plant. This can be mitigated through reduced running hours or through attenuation of the CHP enclosure. An acoustic survey of the background noise levels in the area will be required for CHP projects prior to planning, this will determine the requirement for attenuation or reduced operating hours.	Yes Considered further.
Anaerobic Digestion with CHP	High abatement potential, medium cost of abatement.	Heat and power sales	Concept assumes taking heat from a third party developer of such a scheme. Unlikely to be commercially viable at this scale unless this is the case.	No No realistic

Technology	Environmental Impact, CO_2 Abatement Potential and cost of CO_2 abatement	Revenue Potential	Risk	Consider as Opportunity?
		FIT(<5MW) and RHI	For a scenario whereby the local authority was also looking to operate as waste manager in the area there may be potential to integrate both functions to make the best possible use of resources. AD plants often have issues with gas quality, if the system is not correctly managed and monitored, gas can become too "sour" (high concentrations of H_2S) which can be a health hazard and required gas to be flared rather than burned in an engine. AD plants also re-use a proportion of the heat generated by the CHP in the AD process, thus not all heat is available for a network. Location and quantity of heat available relative to demand will determine economic viability.	opportunity for Newhaven identified.
Energy Recovery Facility	Local air quality impact is high although scrubbing technology can be applied and is not cost prohibitive if constructed at scale. As ERF already exists, no further air quality impact will result from heat supply. High abatement potential and medium to low cost of abatement, if heat treated as by-product of power production.	Heat and RHI although potential also exists for private wire arrangement.	Steam cycle (including with Gasification technology) relatively low risk. Steam cycle plants tend to be much larger in scale than would be required for local district heating systems and similar to open cycle gas CHP would require third party investment and development with a business case based around electricity sales. The presence in the town of the Veolia energy from waste facility, North Quay ERF, reduces the risks associated with the implementation of a new facility. Significant third party investment would not be required as the ERF is already in existence and operates on a business case based solely around electrical sales. Veolia would need to invest in modifying the control system for the ERF and upgrade the water treatment capacity. This would mean they could then provide heat supply at a cost suitable to cover the loss in electrical generation and incentivise their cooperation. Heat supply risk associated with the fact that heat supplier would be a third party outside of control of network operator. Future longevity and price of heat from plant out of control of network developer. Finance risk associated with poor bankability of heat.	Yes Considered further.
Bio liquid CHP	High on individual technology basis. Medium as part of technology mix.	Heat and power sales	Low risk, well proven technology. High fuel prices due to pressure from transportation sector reduce economic viability. Applications uncommon.	No Not considered further.
Solar Thermal Panels	High abatement potential, medium cost of abatement as part of a heat network with seasonal storage included.	Heat sales and RHI	Low technology risk. Many plants in operation in Denmark. Most likely to be deployed as secondary source as part of a heat network. Large area required for ground mounted array likely to prohibit application in Newhaven City centre, potential locations may include the roofs of car parks or other public buildings. Given the low temperatures available through solar thermal, it is more likely to be suitable to provide solely hot water or be used just as a secondary source. Could be deployed at remote location although commercial viability likely to be low, particularly given expected insolation levels and inability to construct seasonal store within vicinity.	Yes Considered further.
Ground Source Heat Pumps	Low/medium abatement potential as part of site wide heat network. High cost of abatement as part of site wide heat network.	Heat sales and RHI, coolth.	Low technology risk. Many applications. Relatively high installation cost, low yield and requirement to upgrade heat. To be used to supply a network, existing buildings would likely have to undergo retrofit works to reduce return temperatures, in order to ensure that heat can be efficiently transferred to buildings. This can increase project costs, further reducing the level of payback	No Not considered further.

Technology	Environmental Impact , CO_2 Abatement Potential and cost of CO_2 abatement	Revenue Potential	Risk	Consider as Opportunity?
			expected. There is an aquifer in Newhaven at a depth of less than 50 m with a potential abstraction rate of >6 l/s according the British Geological Survey's (BGS) GSHP screening tool. To confirm this resource on a local level a groundwater investigation would be required, for this a Groundwater Investigation Consent would be required. Risks associated to chalk bedrock and aquifer presence. Furthermore requirements for water abstraction and discharge permits are to be considered. Closed Loop GSHPs could simplify the permits requirements. Policy risk associated with future incentive support Poor payback expected.	
Water source heat pumps	Medium abatement potential as part of site wide heat network. Medium cost of abatement- as part of site wide heat network.	Heat sales and RHI, coolth	Low technology risk. Many applications. Considerably lower investment cost per kW installed than for ground source. Reasonable payback expected particularly if coupled to gas engine CHP and in receipt of RHI. Nearby resource in the River Ouse is a good opportunity. Policy risk associated with future incentive support. Planning / permitting risk associated with extraction from the River Ouse estuary due to the proximity to the Brighton to Newhaven Cliffs SSSI and the South Downs National Park. To be used to supply a network, existing buildings would likely have to undergo retrofit works to reduce return temperatures, in order to ensure that heat can be efficiently transferred to buildings. This can increase project costs, further reducing the level of payback expected.	Yes Considered for opportunities with network routes within a sensible distance of the water source and located further away from the ERF.
Air source heat pumps	Medium to low abatement potential as part of site wide heat network. Medium to high cost of abatement- as part of site wide heat network.	Heat sales and RHI	Low technology risk. Many applications. Technology not well suited to district heating, since energy capture and efficiency of energy production are low. To be used to supply a network, existing buildings would likely have to undergo retrofit works to reduce return temperatures, in order to ensure that heat can be efficiently transferred to buildings. This can increase project costs, further reducing the level of payback expected. Poor payback expected.	No Not considered further.
Industrial heat recovery	Medium to high abatement potential, depending on grade of heat. Medium to low on cost of abatement - as part of site wide heat network. Typically no or low local emissions impact	Heat sales and RHI	Low technology risk. Many applications. No identified potential sources within industrial sites.	No Not considered further.
Deep geo borehole	High abatement potential. High cost of abatement.	Heat sales and RHI.	Low technology risk. Many applications. No significant resource identified in this area. Risks related to chalk bedrock and aquifer presence.	No Not considered

Technology	Environmental Impact, CO_2 Abatement Potential and cost of $C0_2$ abatement	Revenue Potential	Risk	Consider as Opportunity?
	Typically no local emissions impact.	Power production is also possible.	Poor payback expected due to limited resource and high development cost.	further.

APPENDIX 3 – RISK LOG

Risk Identification			Risk Assessment			Mitigation & Action		
Risk No.	Risk description	Potential impact (including on cost and schedule)	Impact (low 1-high 4)	Likelihood (low 1-high 4)	Current Risk Rating *(auto-calc)*	Mitigation to date	Further Action	Action Owner
Technical								
1	Heat Demand	Heat demand comes mostly from the National Heat Map. There are uncertainties associated with accuracy and potential for connecting (e.g. scondary side heating system type and temperatures). This has an impact on sizing of generating asstets and ditribution infrustructures, heat sales revenues and operating costs etc.	2	3	*6*	Ramboll and Bioregional have requested energy, billing data and other relevant information to major consumers. Where responses have been received the data has been incorporated it in the study. The source of the data is listed in the report for major consumers. A more comprehensive database has been provided in ArcGIS.	Further refinement of the heat demand data.	Consultant
2	New developments	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 implemented for new developments	Local Authority
3	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*	The network route in new developments has been established by overlapping in ArcGIS impression of authors/drawings contained within the planning applications to a map of Newhaven.	Network design to be re-assessed at feasibility stage as site information becomes more certain	Consultant
4	Heat demand assessment for new developments 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 come from SAP modelling of similar dwellings, and IES modelling of similar buildings for commercial properties.	Re-visit assessment as developer's plans become more concrete at feasibility stage	Local Authority / Consultant

5	Uncertainty around capacity to reduce building return temperatures has impact on network sizing strategy	Reduction on the the capital cost of project but inability of the scheme to supply all customers	2	3	*6*	The network is provisionally sized for building return temperatures of 60 ˚C in line with the code of practice for existing buildings. It is also assumed that new developments would achieve return temperarures of 40 ˚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
6	Planned developments do not come forward / are held up and assumptions around contribution from developers	Business Case. Inaccurate streams rate of cost and revenues.	2	3	*6*	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
7	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				
8	Weak business delivery model	Insufficient incentive for key project partners to participate. An agreement around a financial contribution from developers to the network company may never be achieved or may no be Stakeholder relationships not sufficiently robust to drive project forward.	3	3	*9*	Project opportunities have been formulated in within commercial delivery context. Incentives for stakeholders have been included, though these are assumed. Financial contribution from developers was estimated assuming a no-better/no worse scenario for these stakeholders. There could be a potential for developers (or the network company) to benefit of financial savings associated with a potential decision to not install a distribution network within new developments.	Build relationships with key stakeholders. Develop the business model, identifying viable commercial delivery structures and preferred delivery route.	Local Authority / Consultant
9	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	2	*6*	A 5% incentive for customers have been applied to their cost of heat under a BaU scenario (centralised natural gas boilers).	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

Financial								
10	Uncertainty around energy price forecasts	Lower revenue from energy sales, higher costs from energy purchases ~ impact on financial case for the project.	2	2	*4*	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
11	Assumptions around heat selling price to customers are inaccurate	Business case, impacts on economic results and viability of the project.	2	2	*4*	Assessment is based on BAU , following industry best practice.	Further engagement with developers and public buildings required.	Consultant
12	Development, investment and operational costs are subject to uncertainty and will change as the project develops	Business case, impact on NPVs, IRRs	3	4	*12*	Costs for generating assets/energy centre/BoP/substation are based on data gathered during previous projects and scaled through a power relationship. Cost for the heat network is based on hydraulic modelling and typical cost per meters from manufacturer Logstor. Cost for river-crossing is based on experience gained in previous project.	Continued refinement of design assumptions and improved cost estimates at feasibility stage. Engage a cost consultant at delivery stage.	Local Authority / Consultant
13	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	3	*6*	It seems unlikely that the project would get funding from bodies in the private sector, due to its low financial performances together with high capital required and risk involved. Potential to get public capital grants through	Feasibility work should further consider phasing issues	Local Authority / Consultant
14	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								
21	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
22	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
23	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

24	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

APPENDIX 4 – STAKEHOLDERS LOG

(yellow)	Doesn't exist anymore
(red)	Not interested
(blue)	No phone contact possible
(purple)	Interested
(green)	Sent data

Organisation	Contact made	Response
The co - operative food	18/04/2016	
Seahaven Swim & Fitness Centre	18/04/2016	Positive
Police Station	18/04/2016	
Solent Aggregates		
Paradise Park Centre		
Tates Ltd		
Thor UK Plastics Ltd		
Concord Marlin	20/04/2016	
BOC Edwards CME Ltd		
Sainsbury's	26/04/2016	
Premier Inn	27/04/2016	
UTC College	19/04/2016	Positive
Unit 5 Avis Way		
Euro Bussiness Park		
Unit 9: Brightwell Dispensers Ltd	19/04/2016	
E Plan Estate		
Unit 15:		
Pine Estate		
Unit 7: F & C Automatic Production Ltd	26/04/2016	Positive
Unit 12: Prime Care Community	19/04/2016	
Unit 12A:		
Ranalah Estate		
Unit A (North): Howden Joinery Co.	19/04/2016	NO
Unit B: Topps Tiles		
Unit D2: Authentic Stone Ltd	19/04/2016	
Unit D3: City Plumbing supplies	20/04/2016	NO
Unit E: Brighton Vehicle Rentals	19/04/2016	NO
Hawthorne Estate:		
Unit 2B:		
Unit 2C:		
Unit 2D:		
The Willow Estate		
Unit 2: Flotec Environmental Ltd	26/04/2016	Maybe positive

Unit 3: TH Smith Engineering Co Ltd	19/04/2016	NO
Unit 4: Liston Products		
Unit 5: Rainbow International Ltd	20/04/2016	Negative
Unit 6: Daniel James Cars Ltd		
Unit 7: Just Print It Ltd	26/04/2016	Positive
Unit 8: Newhaven Car Services	19/04/2016	NO
Denton Island		
Indoor Bowling Centre	19/04/2016	
Denton Island Community Centre	27/04/2016	Positive
Denton Island Nursery	27/04/2016	Positive
Sussex Downs College	28/04/2016	
Enterprise Business Centre	26/04/2016	
The Drove Retail Park		
Lidl	18/04/2016	NO
Cash Bases	26/04/2016	
B&Q		
Halfords		