Newhaven Heat Network Feasibility Study

Report prepared by: Huw Blackwell, Jamie Cara-Southey, Romain Lambert, Jonathan Pont

Report Approved by: H. Blackwell

Date: 23/10/2020

Disclaimer

Detailed Project Development

Newhaven Town Council

Prepared for:

Susie Mullins

Head of Strategic Development

Newhaven Town Council

Report written by:

Huw Blackwell

Huw.Blackwell@anthesisgroup.com

Website: www.anthesisgroup.com

Tel: 01865 250818

Company Registration: 08425819

Analysts:

Romain Lambert

Jamie Cara-Southey

Quality Assurance

Huw Blackwell

Report checked by:

Ben Lynch

Report approved by:

+44(0)782 450 5552

huw.blackwell@anthesisgroup.com

Signature ……………………………………………………………………

Anthesis Consulting Group

Anthesis is the sustainability activator. We seek to make a significant contribution to a world which is more resilient and productive. We do this by working with cities, companies, and other organisations to drive sustainable performance. We develop financially driven sustainability strategies, underpinned by technical expertise and delivered by innovative collaborative teams across the world.

The company combines the reach of big professional services groups with the deep expertise of boutiques. Anthesis has clients across industry sectors from corporate multinationals such as Reckitt Benckiser, Cisco, Tesco, The North Face and Target, and also supports early stage companies through Anthesis Ventures.

The company brings together 500 experts operating in 40 countries around the world and has offices in Andorra, Brazil, Canada, China, Colombia, Finland, France, Germany, Ireland, Italy, the Middle East, the Philippines, Spain, Sweden, the UK, and the US.

Executive summary

This report explores and updates the feasibility of a District Heating Network in the town of Newhaven. It explores various scenarios of delivering a district heating and private wire networks to the local area focusing on energy, particularly waste heat energy available from two Energy from Waste plants in the vicinity, namely the Veolia plant on the North Quay and the CTEC plant on the East Quay.

A critique of the September 2016 technical report produced by Ramboll, *Newhaven Town Council Energy Masterplan*, was undertaken and the subsequent findings have been addressed herein. Predicted energy consumption figures have been calculated and compared to the Middle Layer Super Output Area (MSOA), a geospatial statistical unit used in England and Wales to facilitate the reporting of small area statistics. This includes energy consumption figures for different fuel types.

It is highlighted that in previous studies, some electrical demand assessments for the Newhaven area may be overestimates owing to the utilisation of historic benchmarks. Concerns are also raised regarding the financial viability of crossing key geographical constraints, in particular the commercial harbour with heat network infrastructure.

The feasibility of Four Scenarios, one comprising two distinct phases are investigated in greater detail:

- Scenario 1a: Veolia Energy from waste plant serving North Quay
- Scenario 1b: Second phase of scenario 1, extending to a light industrial estate across a railway
- Scenario 2: CTEC shipping heat to new housing development in Eastside
- Scenario 3: New CTEC plant supplying new residential development at Harbour Heights and the Mariner

The study highlights some key opportunities and risks for the local and regional government in delivering a district heat network in Newhaven.

A key consideration is the future commercial agreement with the Municipal Energy from Waste facility (Veoila) plant. The current arrangement is anticipated to expire by 2033. Any extension to this arrangement may result in a commitment for use beyond 2050, the current UK statutory commitment to achieve zero carbon emissions. Therefore, the strategic implications on achieving this target in this timeframe utilising the existing plant are recommended to be reviewed. The Energy from Waste facility represents a significant potential low carbon source of heat, which will likely provide a supply solution to some of the regional energy demands. However, there is a lower economic opportunity to deploy this heat across the Newhaven area owing to the low development density, and resulting low heat density. The commercial harbour adds an additional barrier to such a system. Additionally, retaining this location may lock in a requirement for future waste transportation by harder to decarbonise Heavy Good Vehicles in the region, unless a modal transfer to rail or equivalent may be arranged. These factors may be offset by reduced embodied carbon emissions from retaining the existing asset in comparison to the construction of new facilities. These aspects require consideration in the round in line with the local or regional governments decarbonisation pathway to assess the future strategic direction of the facility.

There is a key opportunity to make use of waste heat from the existing facility in adjacent industrial plants, particularly two Asphalt production facilities. This is dependent on the greatest utilisation of heat within the manufacturing assets, which requires further engineering input from process engineers to ensure there are no technical barriers for either facility as a result of transferring high grade industrial heat between them. This specialist input is required as the technical parameter lie outside the normal operating characteristic of modern District heating. The potential outcome is a strong financial benefit to both facilities, as well as large environmental outcomes in reducing carbon emissions and improving air quality locally.

Extending this system to the adjacent light industrial facility depresses the economic case, therefore should the long term future of this energy from waste asset be within Newhaven it is recommended other large process heat consuming industries are encouraged to the industrial area to make best use of this source. This may then form the initial part of a wider heat network serving the community.

Aside from the large municipal energy from waste facility, an additional medical Energy from waste facility (CTEC) exists in Newhaven. The smaller scale of this facility appears to better suit deployment in the local area, allowing for example the installation of a unit on the west bank in Newhaven, eliminating the need of a complex infrastructure crossing of the commercial harbour.

Two additional scenarios were investigated, with the existing CTEC plant serving proposed new development in Eastside (Scenario 2), and a new plant serving new development at Harbour Heights and the Mariner on the west side of Newhaven (scenario 3).

Both scenarios appear to have a business and environmental case in comparison to a counterfactual of individual (in housing) or communal (for apartment blocks) heat pumps. Scenario 3 is marginally more economically attractive owing to greater heat density and larger heat sales. However, Scenario 2 may be easier to commercially achieve as a plant is already constructed and operating at this location. Both are likely to depend on the quantum of development agreed upon for connection to the facility.

All scenarios are assumed to be backed up, and potentially have a portion of peak energy supplied by biomass systems as a long-term low carbon solution. There are multiple modal routes to supply the fuel require via the railway and harbour at Newhaven, and the economic case for the use of heat pumps to meet residual heat demand is poorer owing to increased CAPEX requirements. There may be an argument, particularly with the industrial process heat to retain existing oil and electrical systems as a backup in the event of Energy plant shut down considering the additional cost requirements and limited carbon benefit of new low carbon backup systems. An alternative with the industrial process heat supply is to co-ordinate planned plant shut down times for maintenance and accept the joint risk that unplanned maintenance may impact the facilities, in return for a cost saving on backup equipment.

It is recommended that the integration of the existing plant with the adjacent industrial facilities is investigated in detail utilising appropriate process engineering expertise. An appealing business case may exist in the current concession timeframe to be taken forward. This would be aided with further clarification of the positioning of the EfW plant within the region's wider decarbonisation strategy.

A secondary scheme should be investigated with CTEC with detailed design and costings developed around proposed future development as this is instigated.

Table of contents

Introduction

Anthesis have been requested by Newhaven council to review the feasibility of new Decentralised Energy networks within Newhaven, including heat, cooling and Private Wire opportunities. The following report summarises this exercise in two work packages, an initial review of previous work (Work Package 1) and a detailed review of opportunities identified and agreed with the council Work Package 2). Supporting analysis and information is provided within Appendices at the rear of the document, for the readers reference.

Energy mapping

An energy mapping assessment was carried out using several data sources. Heating, cooling and electrical demand was investigated and compared with the previous exercise.

Approach

To classify Newhaven's building stock building footprints from Ordnance Survey's open data repository. AddressBasePlus® data was then used to allocate each footprint to a CIBSE TM46 building category from AddressBase® address classification. Since there are usually multiple addresses per building, allocation to a TM46 benchmark (which is the same classification used for display energy certificates), allocation is done by selecting the dominant archetype(s) for the selected footprints as shown in Figure 1.

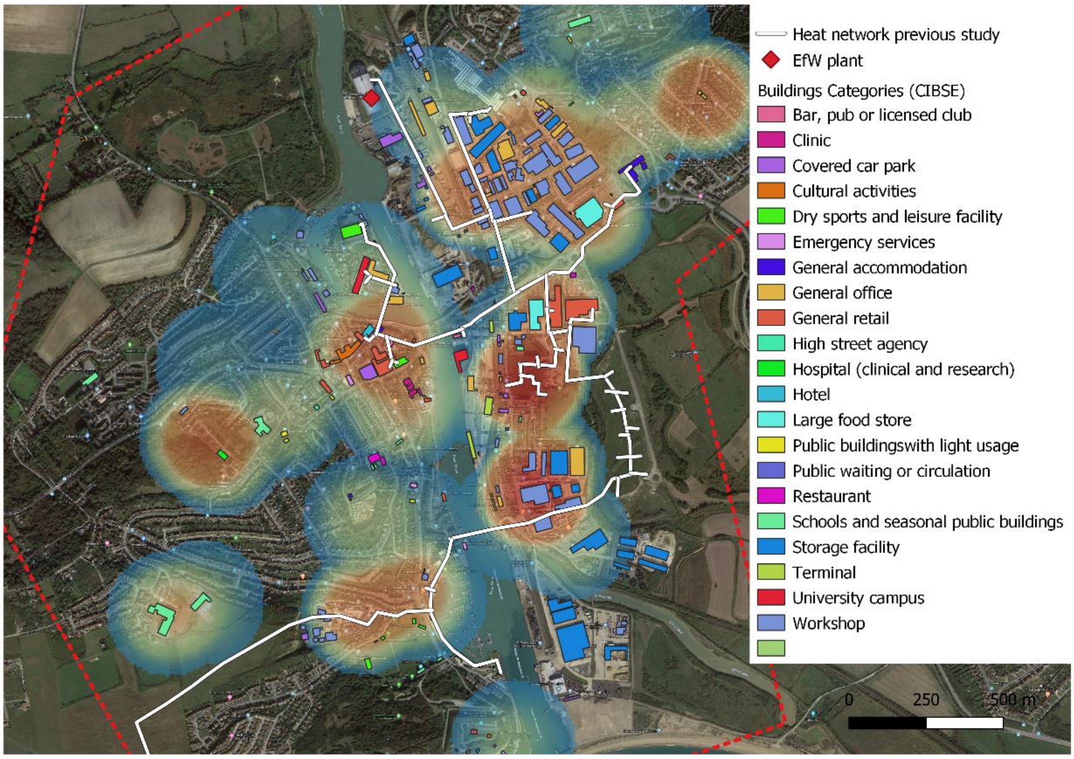


Figure 1: Non-commercial buildings in Newhaven classified by archetype

Footprint GIS vector data is then used to calculate the area of the building by multiplying the area of the footprint (correcting to exclude external walls) by the number of storeys which is derived from height data generated from LiDAR DSM and DTM datasets shown in Figure 2.

Figure 2: Height data derived from LiDAR DSM and DTM data.

Once a gross internal area (GIA) has thus been calculated, it can then be multiplied by a benchmark value (kWh/m^2/year) to obtain an annual heat (or electricity) demand value for the building. Benchmarks are provided in the CIBSE TM46 guide or can be calculated as a statistical average for each archetype using DEC certificates. In this study we used both CIBSE TM46 and DEC averages (using records for buildings in the South East local authorities of England).

Cooling

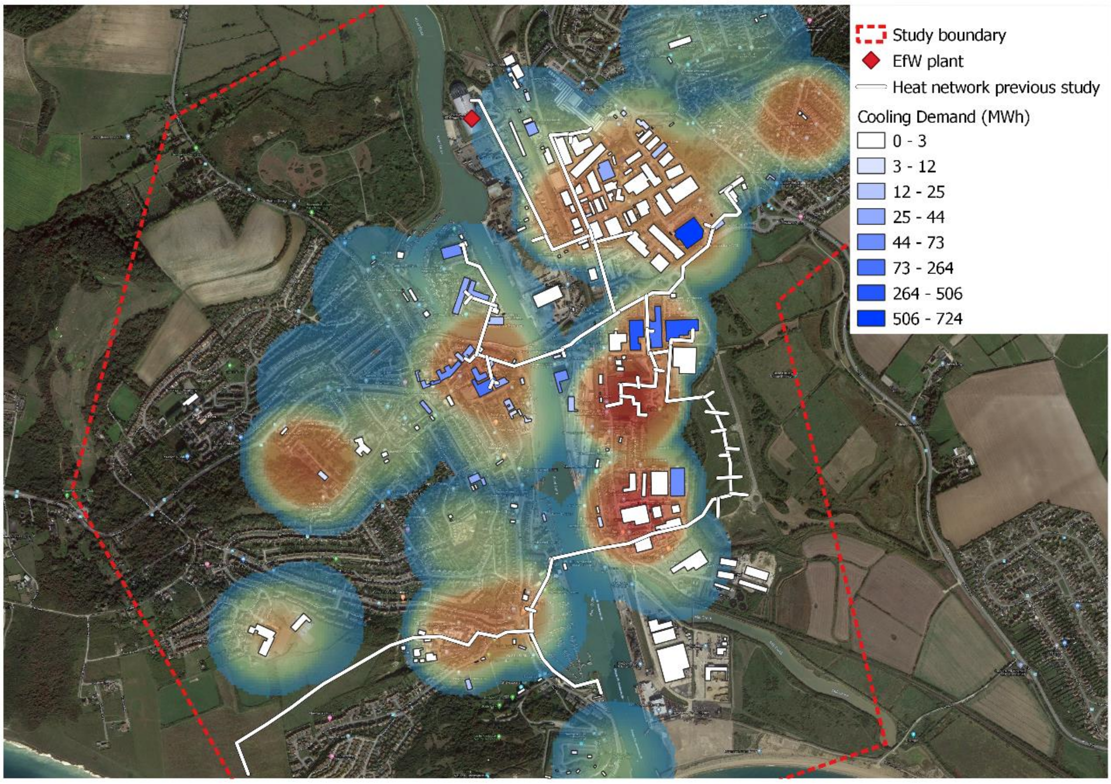


Figure 3: Cooling loads in Newhaven overlaid with density heat map

Based on our analysis of publicly available energy usage data there is very limited cooling consumption estimated across Newhaven. The low density of development results in low to non-existent cooling demand in domestic properties. Commercial buildings are also deployed at a low density, with few multi-storey buildings. Some commercial properties are likely to have a cooling need met by local cooling systems. The most substantial appear to be some retail areas, for example a large Sainsbury's where cooling is likely to be linked to chilled or frozen food storage. However, relatively few of these are estimated to be substantial, many are likely to be only seasonal (i.e. occurring in the hottest summer months only), therefore it is unlikely a cooling network would be a valuable infrastructure investment in Newhaven.

To review this, we have undertaken a high-level Linear Heat density analysis for cooling loads. Using previous work undertaken by Ramboll we have estimated a hypothetical cooling network (shown in Figure 4) selecting the most important cooling loads (with a demand greater than 10 MWh/year) from Figure 3. This results in a total cooling load of 2450 MWh divided by a network length of 1.91 km with a linear heat density of 1.28 MWh/m/yr. This is too low for a heating network (assumed minimum 2-4 MWh/year, and as this is a cooling network, which typically requires bigger pipework infrastructure owing to lower temperature differentials (between flow and return), this indicates that such a scheme would be unviable. Therefore, a cooling network will not be taken forward as part of the WP2 study.

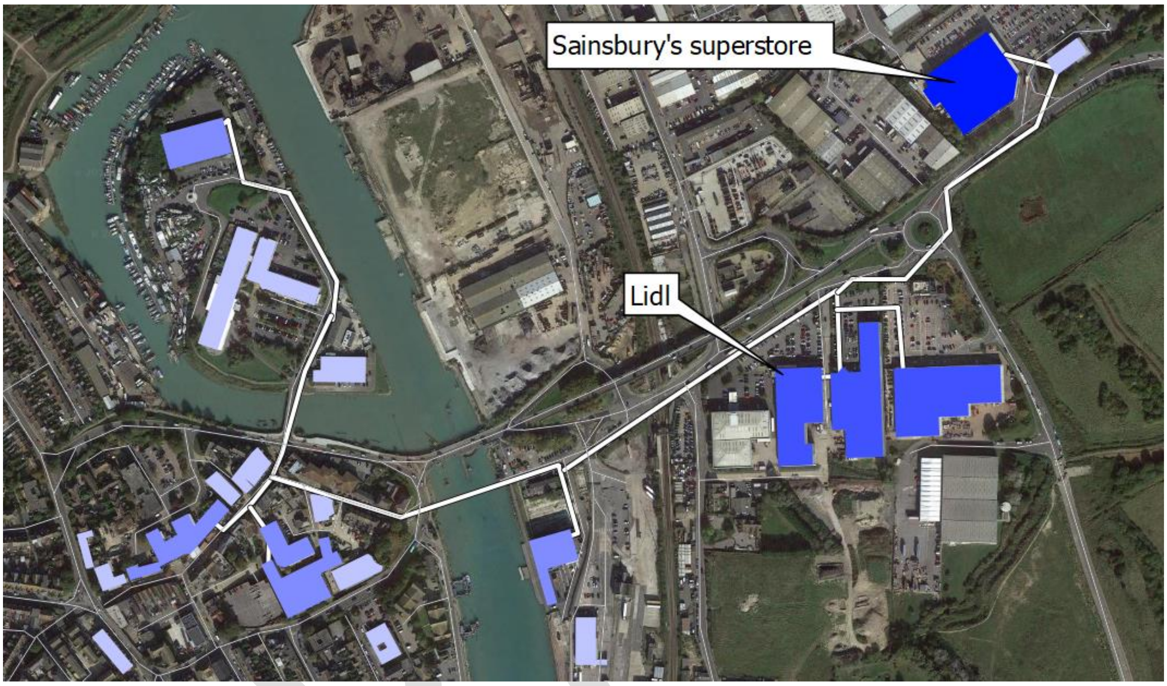


Figure 4: Hypothetic cooling network in the centre of Newhaven

Electricity

The previous Ramboll report brought together electrical consumption figures provided by the 19 out of 50 stakeholders who responded to the questionnaires; benchmark figures were used to plug the missing information gaps to produce a power map. The benchmarks were taken from CIBSE Guide F and TM46 and the areas applied to the benchmarks were taken from Ordnance Survey Master Maps and GIS calculations. An extract from their report shows the following annual electricity demand in **Error! Reference source not found.**.

Table 1 Summation of local loads excluding light industrial zone to East of railway line

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
Total		**28,812,940**

It is interesting to note that Ramboll's estimate of the entire annual demand comes to 28.8 GWh and this does not take into account the business park to the East of the railway line because information on building age, required for benchmarking, was unavailable during the time of the study. Yet, that number is greater than the 26.64GWh demand recorded in the MSOA level subnational electricity Government statistics for the entirety of Newhaven (Figure 5, overleaf). We therefore conclude in the historic study there has been an overestimation of electrical demand in this area.

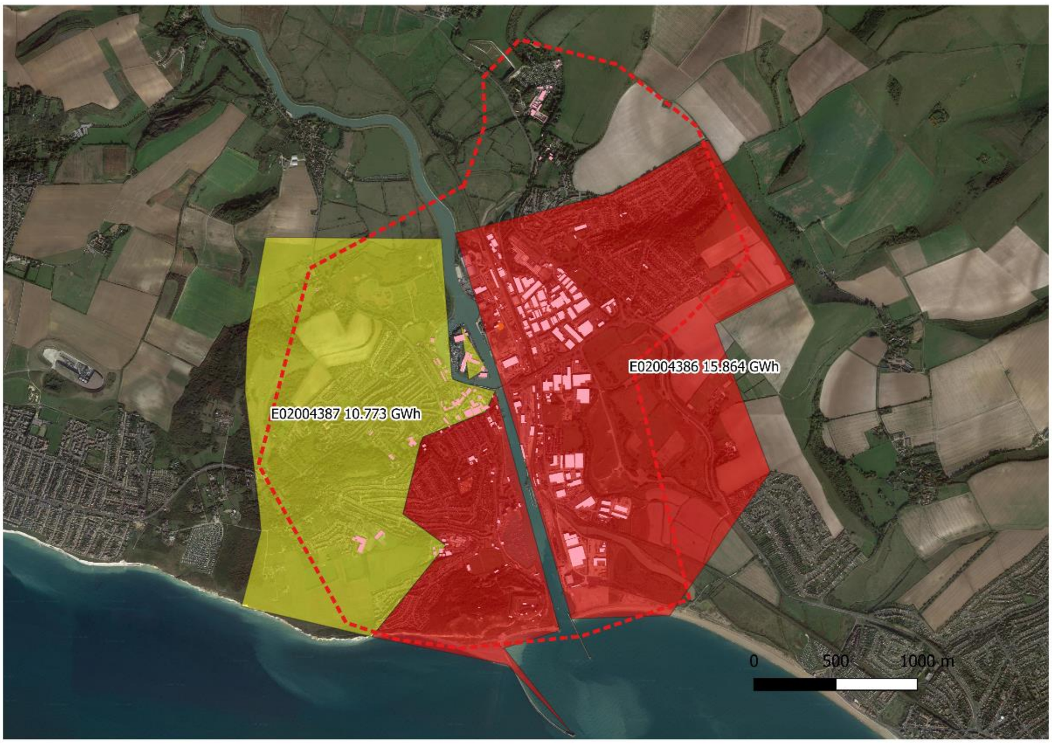


Figure 5: Using the geospatial statistical unit, Middle Layer Super Output Area (MSOA), overall demand for the Newhaven area could be determined

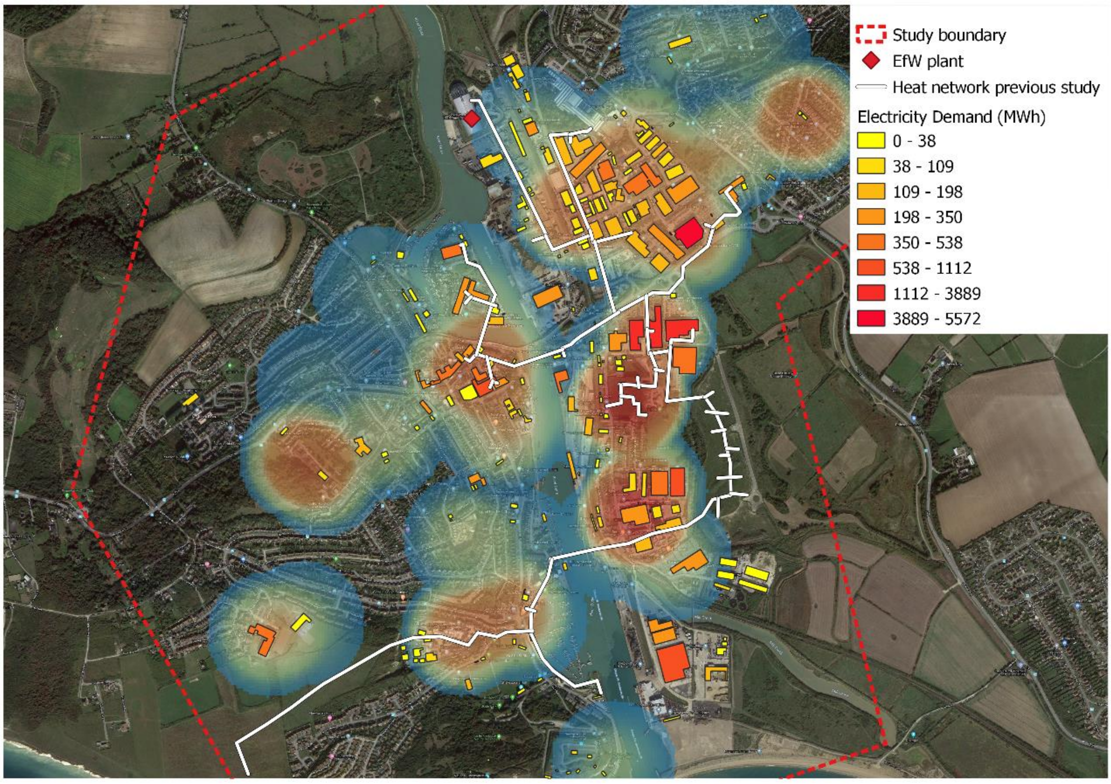


Figure 6: Electricity loads in Newhaven overlaid with density heat map

The colour coded map (Figure 6) shows the distribution of electrical power around the town of Newhaven. The hotspots are identified by the intensity of red. The map shows the highest power density around the railway station and commercial port. Other areas of relative power density are around the light industrial zone, retail park, Denton island and small pockets around the centre of town.

Heating

Initially, the mapping was also extended to the neighbouring towns of Peacehaven and Seaford. An examination of subnational gas statistics (Figure 7) indicated there does not appear to be sufficient large anchor non-domestic heat demands to warrant further investigation for a larger multi-town heat network.

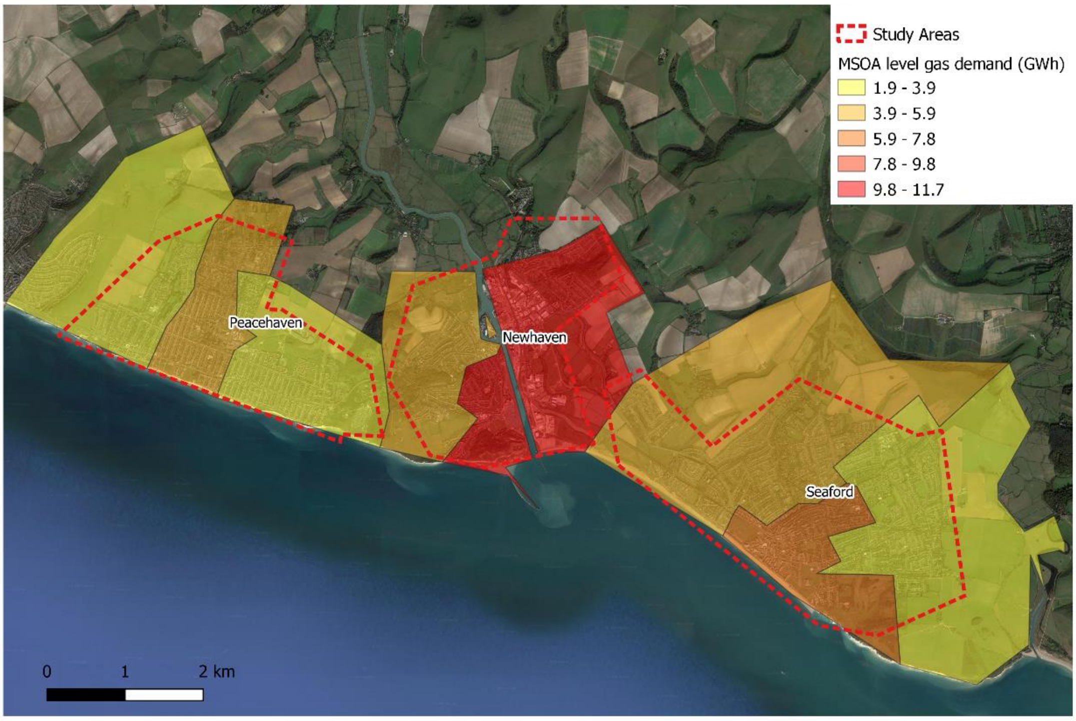


Figure 7: Non-domestic gas demand in the middle-layer super output areas covering Peacehaven, Newhaven and Seaford.

Figure 8: Cartograph (Heat map) generated from non-domestic DEC and EPC data, for Peacehaven, Newhaven and Seaford (west to east).

A similar conclusion emerges from Figure 8 which displays a heat map generated from geolocated DEC and EPC certificate demand estimates. The MSOA areas of Peacehaven and Seaford with the most concentration of potential anchor loads are located within a straight line distance greater than 3.5 km from the EfW plant (Figure 9). The main hubs are Peacehaven community and primary schools Peacehaven Leisure centre, and Seaford Town Centre and Seaford Head

School. These are shown in

Figure 8: Cartograph (Heat map) generated from non-domestic DEC and EPC data, for Peacehaven, Newhaven and Seaford (west to east)..Figure 8.

For a multi-town network to be viable with a linear heat density of 4MWh/m/year, these hubs would need to each have a minimum total demand of at least 14 GWh assuming a straight-line connection. However, we know from subnational gas statistics that the total non-domestic gas demand of the entire of Peacehaven and Seaford is 8.9 GWh and 14.4 GWh. Therefore, it is unlikely that such a heat network would be viable even with the assumption of every non-domestic load being connected. As for the inclusion of the domestic loads, even though the leftmost MSOA covering Seaford has a total (non-domestic and domestic) gas demand greater than 50 GWh (Figure 9), this area comprises mostly terraced and detached homes and a fully connected network in this area is estimated to have a linear heat density lower than 1.4 MWh/m/year (calculated by dividing the total demand in the MSOA by the length of the road network in the same area). It is therefore considered unlikely that including Peacehaven and Seaford will be beneficial to a feasibility stage analysis, and this is not proposed to be taken beyond the WP1 stage.

Figure 9: Total (non-domestic and domestic) gas demand in the middle-layer super output areas covering Peacehaven, Newhaven and Seaford.

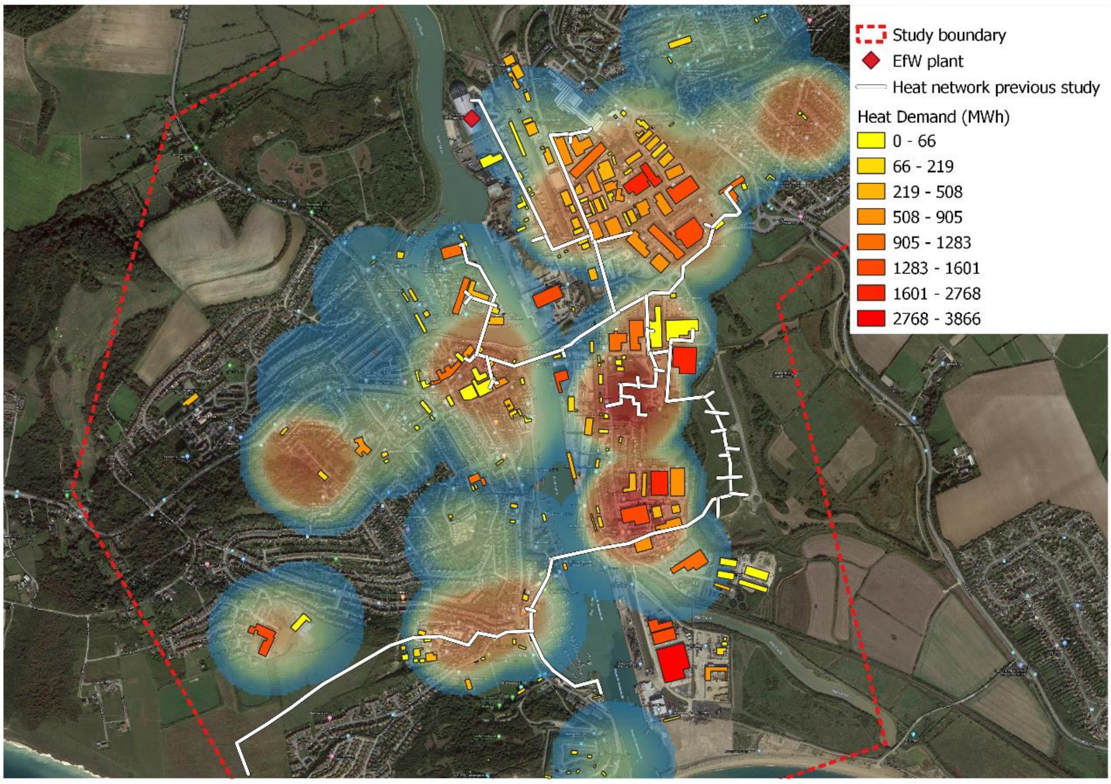


Figure 10: Heating loads (TM46 benchmarks) in Newhaven overlaid with density heat map

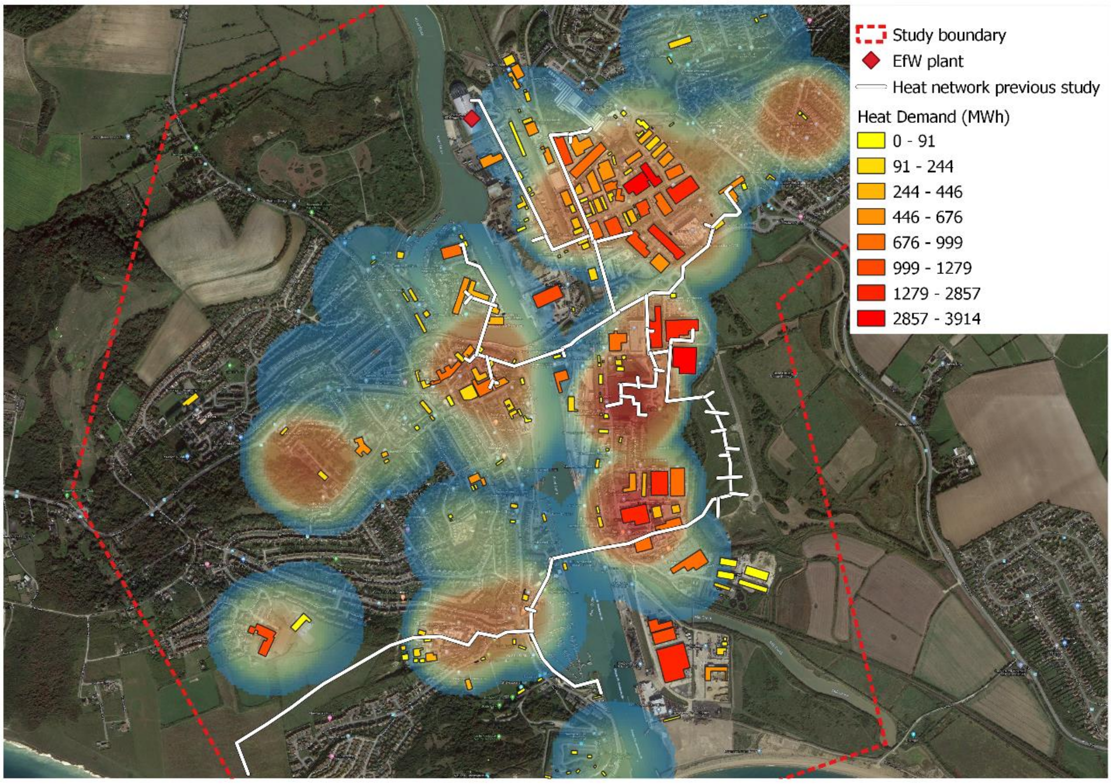


Figure 11: Heating loads (DEC averages) in Newhaven overlaid with density heat map

Figure 10 and Figure 11 overlay the heat density mapping (Cartographs) with estimates of loads from 2 sources, CIBSE benchmarks and averages from Display Energy Certificates (DECS) reported to government. Also included is the location of the Energy from Waste Plant and the previous network routing given in the Ramboll Study. When combined with the Geographic restrictions, and Areas of New development this allows the determination of the potential opportunity areas.

Geographic restrictions

In terms of natural and built barrier, the main difficulties for an area wide heat network roll-out are the River Ouse and the railway tracks alongside it on the East bank. Denton Island presents an additional difficulty as well as the industrial area located south of Mill Creek. In Figure 12, these barriers are shown together with the fully built-out heat network routing from the Ramboll energy masterplan study.

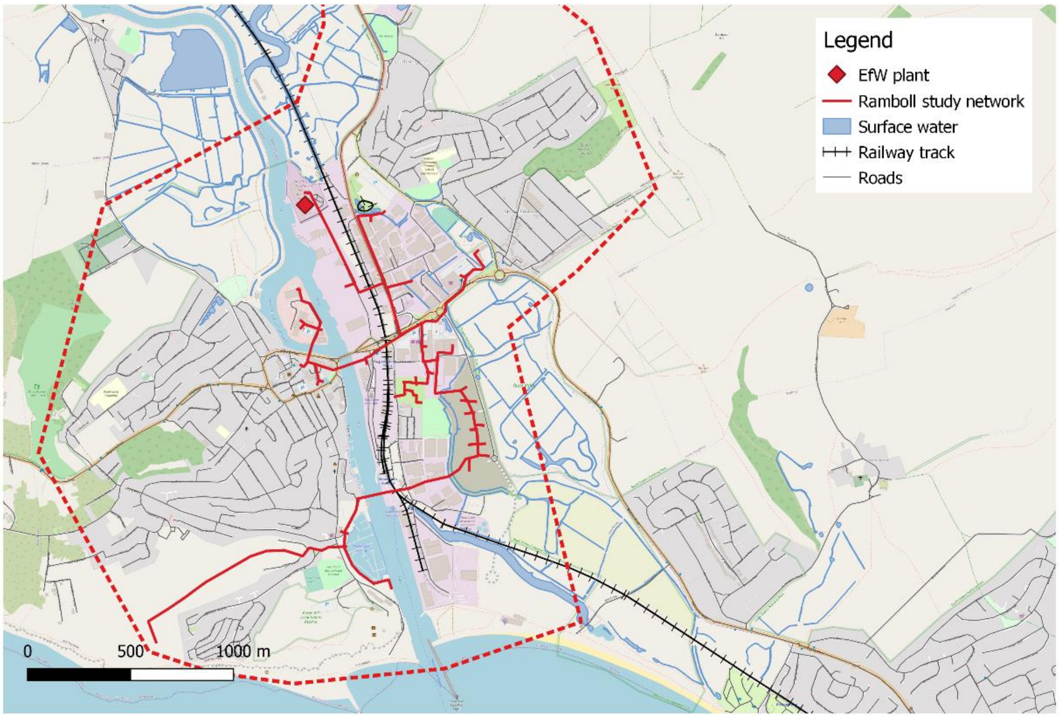


Figure 12: Natural and man-made barriers in Newhaven.

A number of key geographical constraints exist through Newhaven. These include:

- Newhaven Harbour – a functional deep water commercial port with active bulk freight handling, offshore marine and ferry operations
- Railway – a functioning Network rail line with operational port freight rail head
- Mill Creek – a historic tidal mill water channel
- A259 Coastal road – with functioning swing bridge

These have the effect of restricting access to certain elements of the town and sub-diving land areas through the town centre. Crossing or deploying infrastructure in these areas is likely to be costly and may have other short-term ancillary effects, e.g. temporary increase in traffic whilst works take place.

It should also be noted that the major road crossing of the harbour is an opening bridge structure, therefore cannot contain any fixed utilities for crossing the harbour.

The effective remaining land parcels are detailed in Figure 13, The North Quay, South Quay, Eastside, industrial and residential zones in east and west bank.

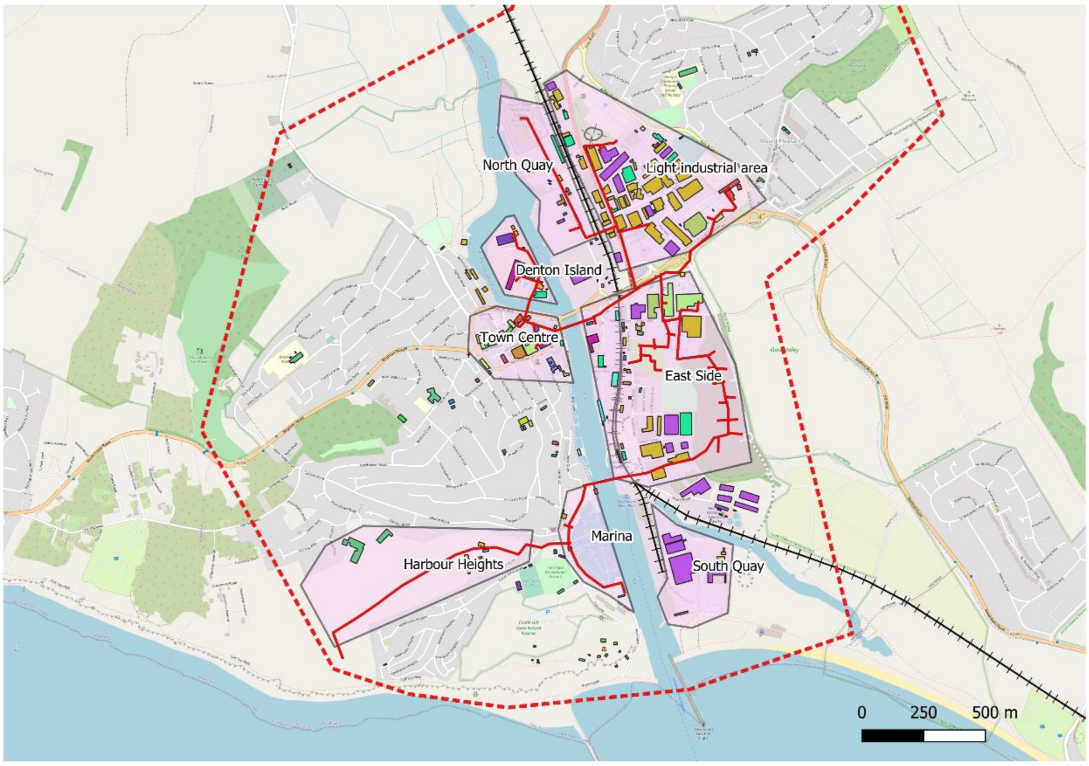


Figure 13: Identified Opportunity Areas

Areas of new development

There are a number of housing projects under construction or soon to be under construction after receiving planning permission. Currently, the Old Parker Pen site is being developed with 145 homes. The nearby open areas of waste land in the Eastside district will contain 190 new homes and Reprodux House, covering 600m^2 will comprise of 80 homes. Also, nearby on Transit Road, there is due to be a development consisting of 41 homes and an 81-bed hotel.

To the west across the river, there are plans for the development of Newhaven Marina which has permission for up to 380 homes and additional commercial space. Even further to the west, planning permission for up to 700 homes has been granted to an area known as Harbour Heights.

There are other developments that have been given the go-ahead namely the Town Centre Redevelopment Site, the Railway Quay Development Site and the new waste and recycling depot which is located in the industrial estate.

Utilities infrastructure review

Gas

Reviewing publicly available gas infrastructure record for Newhaven it is apparent that a reasonable proportion of the town centre and industrial areas have no gas connection.

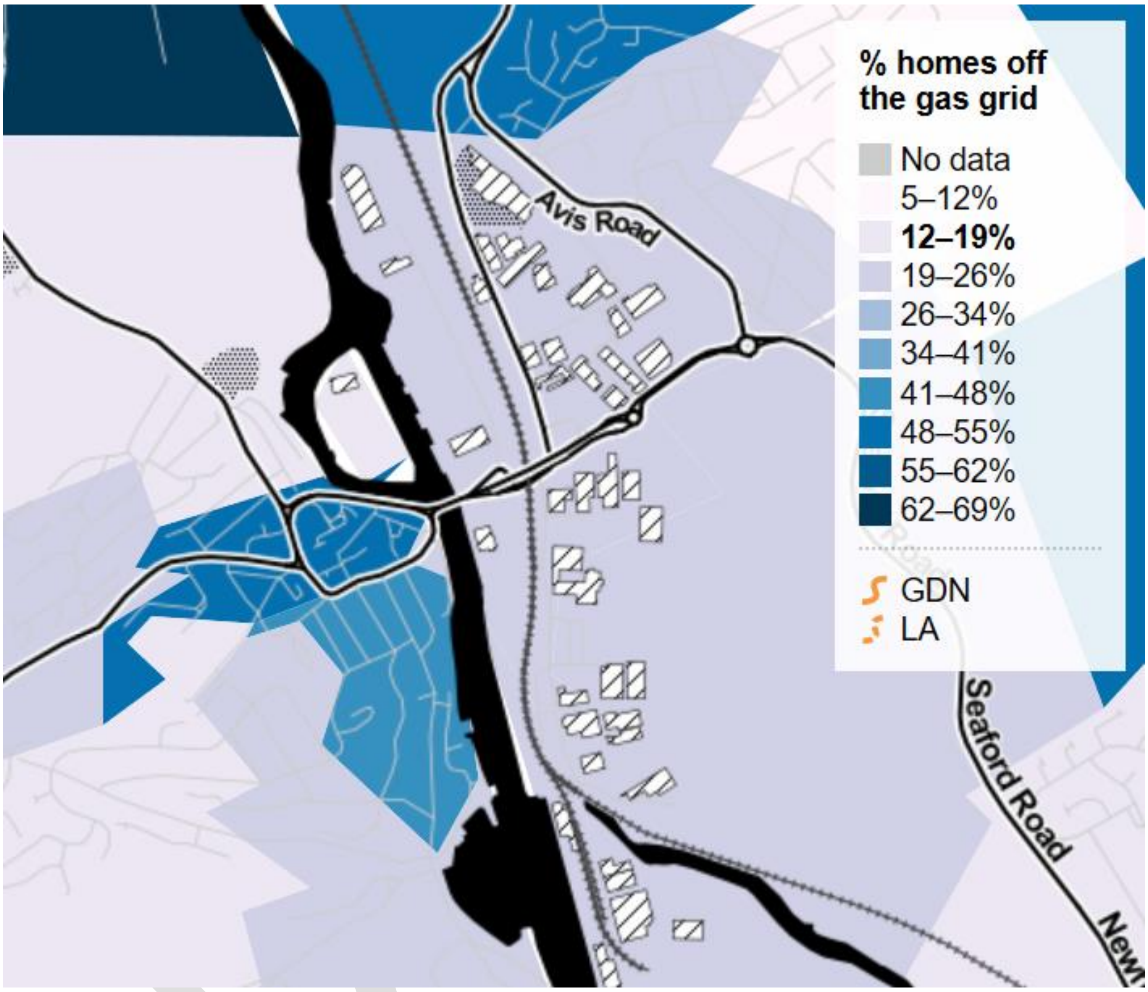


Figure 14: Proportion of off-gas-grid homes[1]

Figure 14 demonstrates that a large proportion of the town centre (approximately 40%) on the West bank is not connected to the gas grid. It is assumed that properties in this area are electrically heated, likely by storage or direct systems.

Reviewing non-domestic properties in Figure 15, a large number of these on the East bank also only appear to have electricity only connections.

[1] https://www.nongasmap.org.uk/

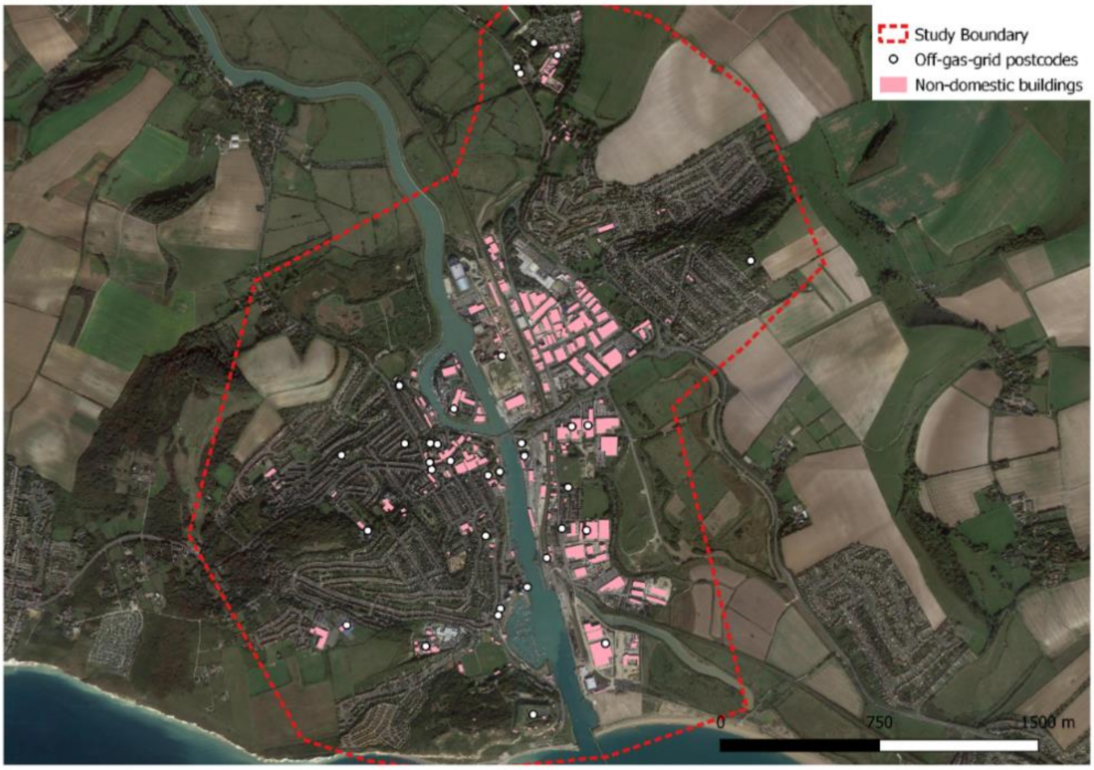


Figure 15: Off-gas-grid postcodes

It has also been confirmed to us that there is no natural gas supply to the Veolia Energy from Waste facility. Start up and heating top up (intermittent maintaining a minimum operating temperature) of this facility is undertaken on heavy fuel oil.

It also appears from site visits that at least one tarmac plant in the adjacent north Quay area operates from Heavy Fuel oil (Figure 16), with the second still awaiting connection to the utilities and also currently relying on the use of Fuel oils for electricity and bulk heating.

Figure 16: Oil and bitumen tanks outside the Tarmac process plant

A review of utility infrastructure maps (Figure 17) and engagement with the port harbour authority indicates that the gas systems either side of the harbour are sperate, with no gas infrastructure crossing beneath the commercial waterway. Instead, the west bank and east bank are serviced from separate gas systems fed from the wider network.

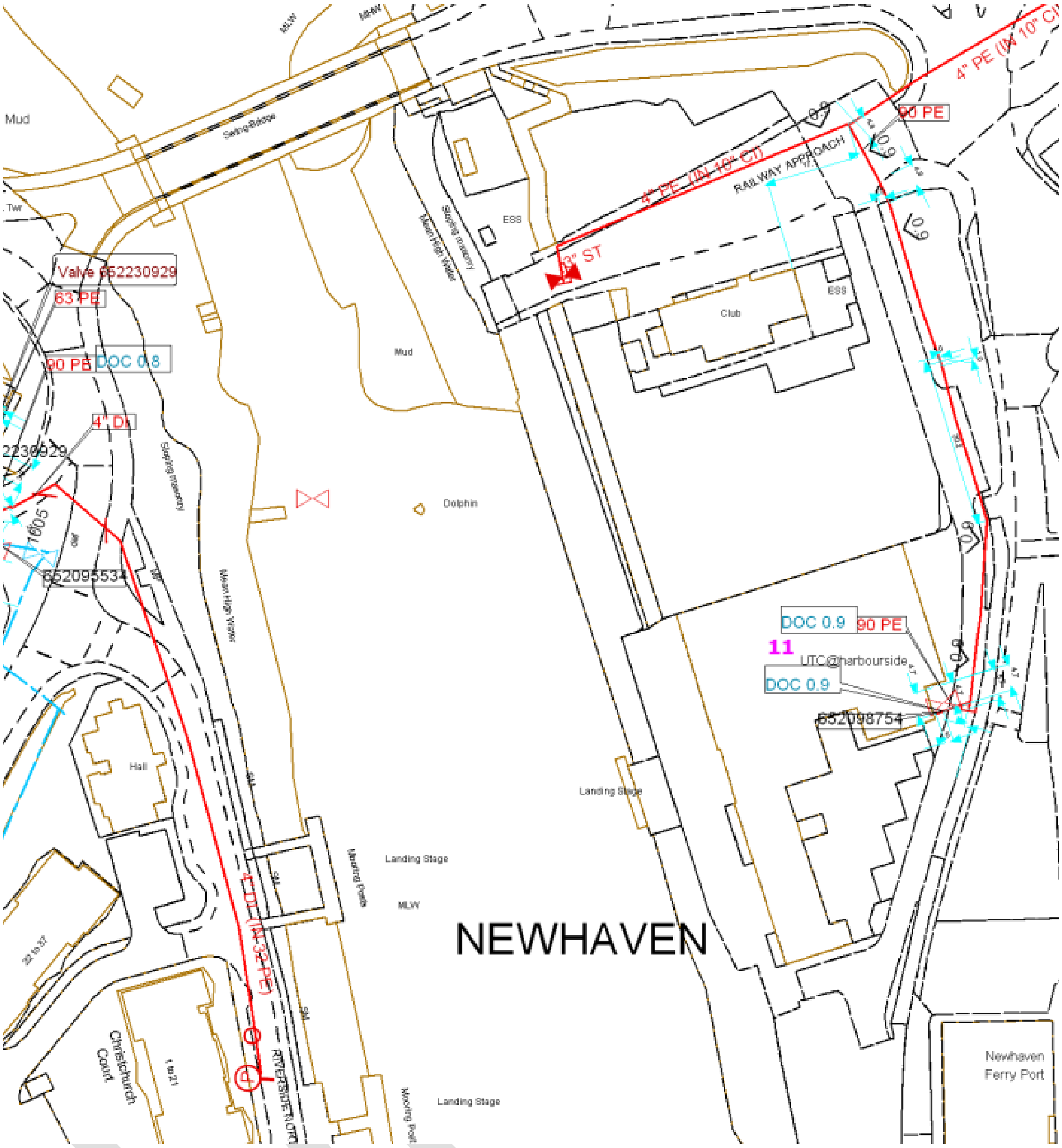


Figure 17: Extract from SGN's utility plans demonstrate a gas network system separated by the geographical barrier of the River Ouse

Unlike many areas in the UK it appears that gas infrastructure is not widespread throughout Newhaven, and this will likely have an impact on the study taken forward in Work Package 2, with electrical or oil based systems being the Counterfactual alternative in several situations.

Electricity

Figure 18: Ramboll's previous route plan and the locations of UKPN substations

National Grid has a 132kV pylon terminating into a bulk supply point, BSP, to the East of the River Ouse, near the intersection between the A26 and A259. Within this UKPN compound the supply is transformed down to 33kV. The power is taken underground, across a small slip road leading to the A259, to the Newhaven 33/11kV primary substation (Figure 19) where a series of transformers reduce the voltage prior to onward distribution to the local area.

Figure 19: National grid to UKPN bulk supply point where 132kV is transformed down to 33kV on the left. Newhaven Primary substation on the right where 33kV is transformed to 11kV for onward distribution

The North Quay, where the Veolia EfW plant is located, is serviced by the DNO. One is able to identify a number of substations from North Quay road. According to the UKPN asset map (Figure 18), there are 8 no. substations, including one to the Newhaven EfW plant to provide standby power; this is understood to be a 33/11kV 3MVA connection. It is thus known that there are 11kV as well as 33kV cables in this area.

Figure 20: Some of the various transformers along the North Quay Road

The EfW plant has a connection to both Newhaven and Peacehaven at 33kV into which it feeds approximately 16MVA. The cabling from Peacehaven can be seen on 2 overhead power lines as it comes in from the West of the River Ouse, just to the North of the EfW plant. It drops down, converting to subterranean armoured cabling before traversing the river (Figure 21). The crossing takes place beyond the commercial navigable zone of the harbour, between two diamond-shaped signs on either side which informs leisure sailors to the dangers of anchoring. It is worth noting, the stated voltage on these signs appear inaccurate.

Figure 21: Images of the underground cables traversing the river

Down at the East Quay (Figure 22), between Seaford Bay and the River Ouse there is an industrial site where CTEC's medical EfW plant is located. Following conversations with the Port Authority, we understand that due to access restrictions, there is no public electricity network. The Newhaven Port Authority informed us that it has its own 11kV private wire network consisting of a couple of rings which traverse the site for energy consumers to tap into and purchase at an agreed rate; it is maintained by UKPN. The network consists of 11 no. transformers and receives 2 two feeds from UKPN. CTEC are intermittently supplying 40 kVA across three phases into this service but are not currently receiving any payment for the export. As CTEC upgrades its facility it will be exporting more energy into the network; a long-term contract has already been agreed with the Port Authority who will purchase the exported energy at a commercial rate. It is believed that there are no further upgrades required to the network to achieve this.

Figure 22: A view across to the East Quay

Water

Although the water utilities are not usually covered in these studies, for Newhaven there is relevance with regards to district heating. With regards to utility assets crossing the harbour, stakeholder engagement with the harbour authority has identified a historic submerged water main traversing close to the swing Bridge structure. The area of the harbour channel is protected from anchoring by vessels using the channel.

This does represent a utility asset crossing the harbour area, which is approximately analogous to a water-based heat main. However, the port authority also indicated within their engagement that there have been two replacement attempts of this main owing to its age, utilising directional drilling or similar techniques by Southern Water. To the harbour authority's knowledges both attempts failed on drilling technicalities, and the water main has not been replaced to date.

This therefore indicates the ground risk assumed when taking forward such works and is a useful information point for the future deployment of a district heating network.

Opportunities and Energy assets

Within Newhaven, there are a number of opportunities to facilitate the deployment or energy networks.

Energy from waste – Veolia

Two Energy from Waste plants have been identified within Newhaven.

The major facility on North Quay is operated by Veolia and comprises 2 boiler lines. From engagement with Veolia staff it is understood each boiler consumes approximately 28 tonnes of waste an hour, and produces 1042 tonnes of steam at 400 C. The steam operates a single electrical turbine generating up to 18 MW of power. With an onsite electrical consumption of 2 MW this allows the exporting off site of approximately 16 MW of electrical power. A process steam bleed off point exists and is used within the EfW plant for process loads. The existing turbine is fitted with steam extraction points for future District heating deployment.

From our analysis of electrical loads, we understand the electrical supply from the EfW plant exceeds the demand of the whole of Newhaven, therefore, the majority of this is exported from the town.

It is understood that the contract for running and operating facility has a duration of 30 years and expires around 2033.

Energy from Waste is recognised as a potential key asset for District heating systems, and in the longer term as a potential low zero carbon source of electricity and heat. Currently there are carbon emissions linked from such facilities owing to fossil carbon within the waste stream they process. Typically, traditional EfW plants are designed around a calorific fuel content of waste feedstock. Usually, this is assumed to be a mixed refuse and is therefore lower than the calorific content of some pure materials within a waste stream. For example, plastics often have a higher calorific content than the design point of a EfW plant, therefore burning plastic within such a facility is generally not beneficial, taking it out of its normal operation range. This provides a natural incentive for the removal or such material from the waste stream.

Nonetheless, current UK waste streams contain a Biogenic (i.e .short term carbon cycle) and fossil carbon element. The fossil element is typically assumed to range from 25-75% of the waste fraction, with 50% often taken as a balance point for make-up. This makes EfW plant currently a net carbon fuel source for energy.

The long-term solution to decarbonise EfW plants is to decarbonise waste streams, which is part of the circular economy challenge. Once fossil content is stripped out of waste, often the remaining waste fraction continues to have a calorific content within the design range of a facility. With no carbon in the waste stream there is then no carbon associated with the energy from this, providing a long-term route to zero carbon for these facilities.

With regards to the economics of facilities, revenues are typically derived from:

- A waste Gate Fee
- Electricity revenue sales
- Sales (where feasible) of final byproducts e.g. metals, Bottom ash
- Heat (where feasible)
- Other incentives – for example historically ROCS, though this scheme is closed for new plant

Heat is not currently sold from this facility. Electricity wholesale prices can be seasonally low through the summer and inter-seasonal period owing to greater deployment of renewable electrical systems and have become increasingly volatile for similar reasons. This presents a pressure on future electrical revenues.

Therefore, heat sales, if they can be facilitated, represent additional revenue and for a given facility may either assist in profitability or in the long run allow for lower gate fees in comparison to facilities without a heat connection.

Furthermore, the overall efficiency of electricity only EfW plants is limited by thermodynamic laws to low levels (circa 20-30%). Higher levels may only be achieved by utilising heat as well as electricity (it should be noted doing so does reduce electrical production from a facility). Higher efficiency facilities, such as those typically found in Scandinavia typically serve metropolitan areas and logically have lower carbon emission per unit of heat produced even where there is a fossil content of the waste stream owing to the higher proportion of energy captured from the waste.

A critical question therefore exists regarding the future intent of the Newhaven facility. In a low carbon future, it is possible to envisage the Energy from Waste facility being a key energy asset, with incentives to make the greatest use of all by-products (heat, electricity etc). Electricity may be distributed long distances with relative ease via the national grid system. Heat typically requires water (or potentially steam) for distribution which is likely to only ever be local owing to the energy penalty of long-distance distribution.

Similarly, increasing pressure is being brought to bear on local authorities to decarbonise its vehicle fleet. One of the hardest vehicle types to decarbonise is the waste collection fleet, which is one of the least efficient HGV types owing to a large proportion of operation being stop/start street collection, as well as requiring the haulage of large weights. Currently waste from the region is bought to the Newhaven facility. There is a strategic consideration as to how this activity fits into the waste authority's decarbonisation strategy leading to a statutory 2050 Net Zero Carbon target, and whether a lower carbon alternative is required.

Both these factors are likely in the long term exert some pressure on relocation of a future facility to a major metropolitan area, to reduce strategic vehicle journey's and allow a widespread deployment of potentially valuable low carbon waste heat. This decision is foreseeable in the medium-term future when the contract for the Newhaven facility comes to a commercial close and will require a decision from the regional waste and political authorities.

Whichever decision is made will likely have a large impact on the use of it as part of a wider heat source within the Newhaven area.

Energy from waste - CTEC

Separate from the large-scale plant, Newhaven is also home to an innovative smaller scale medical waste energy from waste gasification facility. Medical waste is an example of a current and future waste stream which is always likely to require some form of Thermal treatment owing to its hazardous nature. The removal of the fossil content of this stream (e.g. medical plastics) remains a part of the wider circular economy challenge, however once again assuming this is achieved this represents a future low carbon energy pathway.

Two online meetings were held with CTEC and the information gained has already been partially outlined earlier in the report under the existing infrastructure review. Essentially, they have been successfully exporting 40kVA across three phases onto the Port Authority's private wire network free of charge. With the forthcoming installation of new EfW plants, the export is going to increase. The Covid-19 outbreak has slowed the rollout of the new plant, but it is nonetheless due to be installed and brought onstream later in the year and early new year. The plan is for 2 no. EfW plants, each capable of producing 300kW electrical power to feed into the local network or community. CITEC inform us this figure may be able to be increased up to 1MW for four-hour intervals using biogas, and potentially some form of energy storage.

CTEC have been in contact with Morisons building contractors to offer their waste heat to the new housing developments. Plans are underway for the inclusion of a district heating scheme; the water pipework will follow the new port access bridge thereby clearing two geographic obstacles, the creek and the railway line before continuing along the new port access road to the development. Heat substations will be proposed to be used to distribute heat to the dwellings.

Newhaven Sewage Treatment Works

On the corner of Fort Road and Fort Rise, there appears to be a sewage treatment centre with a power supply and generator back up.

Sewage treatment works provide the potential for another heat source. The outfall from a sewage treatment works is typically clean, but also at elevated temperatures (in comparison to ambient water) as a result of the discharge of warm water through the sewage system.

An added attribute is this water is unlikely to be adversely saline, potentially simplifying some of the material selection for heat extraction equipment. It appears that the outfall may discharge to the Mill Creek, which itself discharges to the sea via a culvert beneath the harbour.

The key challenge in making use of this facility is the comparatively low density of heat density in the immediate vicinity.

Figure 23- The footprint of a 35x20m EfW plant is marked out alongside the sewage treatment works. This would benefit from the EfW plant's electrical supply and already has a grid connection in place for backup. The generators could be decommissioned.

Marine Source

Newhaven is located on the South Coast of England. As such the river Ouse and harbour provide a potential source of low-grade heat for extraction by heat pump systems.

Heat pumps are refrigeration systems that use electricity to transfer heat from a source (in this case the river or sea) to a sink, potentially a heat network.

Heat pump efficiency is dependent on the temperature difference between source and sink, and the closer these are the more efficient the system is. As the River or Sea is typically at a higher temperature than ambient air in Winter this typically offers an efficiency improvement over the most often cited alternative, Air Source Heat pumps.

The marine environment also results in additional complications for machinery and pipework as it is corrosive by nature. Additionally, marine organisms (e.g. filter feeders such as muscles) can colonise sea water extraction pipework, as well as extraction points needing protection from silting up or clogging from debris, or damage from shipping.

It should be noted that Air base heat exchangers for heat pumps are also at risk from similar corrosive effects where these are located by the sea, and usually require a coating treatment or similar to prevent excessive corrosion.

Marine source systems may well be feasible in Newhaven therefore are proposed to be investigated as part of Work Package 2 as both a source of heating supply and as a backup system.

Review of past work and conclusions

From the energy mapping exercise, opportunity areas can be identified up and are shown in Figure 24. Overall, our neat mapping results are in agreement with and broadly validate the previously identified loads and opportunity areas in the Ramboll masterplan study.

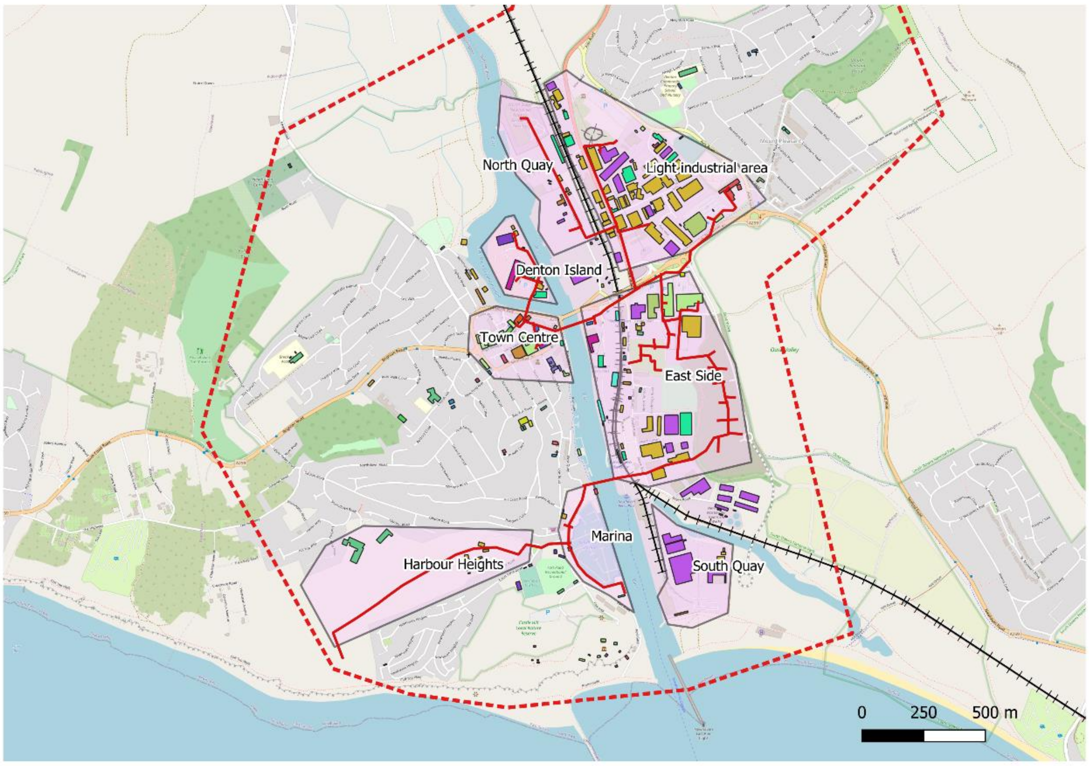


Figure 24: Identified opportunity areas

The current study was done without using the National Heat Map, which has now been decommissioned. Informal enquiries made at the beginning of this study have shown that some previously identified loads obtained from the national heat map are not suitable for districting namely. In particular, the Sainsbury's superstore (BN9 0AG) does not have a 'wet' heating system which makes it unsuitable for a district energy connection unless a significant investment is made (in excess of £80k). Similarly, analysis of display energy certificates records indicates that Sussex Down College (BN9 9BN, Denton Island) and Newhaven library are supplied with grid electricity which could make them unsuitable for connection. This is corroborated by the relatively high number of postcodes which are off the gas grid (Figure 14 and Figure 15).

It has been identified that previously estimated electrical loads appear too optimistic for the Newhaven area, with an updated assessment of electrical supply given for the whole of Newhaven based on publicly available information.

City wide network Consideration

The routing suggested in the previous masterplan study aimed to propose options which could lead to potential town-wide network with some suggestions of local networks such as suggested the Marina development area. It is suggested that local solutions using water source heat pumps should be assessed as credible low carbon counterfactuals. This is particularly relevant given the significant challenges and costs to overcome for crossing natural and built barriers such as the river Ouse, the train tracks, roads A259 and B2109. A high-level assessment of the unsuitability of crossing River Ouse to supply the West bank of Newhaven from EfW heat is given in the scenarios below.

Last, we note some potentially interesting loads were omitted such as the Seahaven academy (within a reasonable distance of the branch serving the Harbour Heights development), and Denton Community Primary School (**Error! Reference source not found.**). However, we believe these loads would be better served with their own networks and heat sources (e.g. Ground source heat pumps or biomass cogeneration)

Counterfactual - Business as usual

As is noted in the Gas utility review, not all areas of Newhaven are apparently well served with gas infrastructure. As a result some large industrial facilities appear to be running on heavy fuel oil and certain areas of the town appear to be heated with alternative systems assumed to be electricity.

The town also has a low heat density with some localised buildings with a cooling load, and is exporting more electricity than it consumes in the immediate area from the Energy from Waste facility. As a result, the counterfactual is proposed for work package 2 is proposed to be stand alone, marinized electrically powered Air Source Heat Pump. Some alternative Marine or water source solutions are also being investigated in the scenarios below, though this is not proposed to form the counterfactual in Work Package 2.

Scenarios

The following scenarios are proposed to be further investigated as part of Work Package 2.

Scenario 1a: Veolia EfW plant serving North Quay

The major initial scenario focuses on the energy from waste facility in the North of the town. It is noted that the contractual life of this asset is limited, though the physical life may be extended. It has also been flagged that the asset represent a potentially a major future source of low carbon heat and electricity, and strategic consideration is required from the council as to how and where this will be deployed in the future.

Assuming this remains with Newhaven, the initial focus will be on facilitating low carbon industrial heat and electrical process loads to initiate as system, as the town and outlying towns have limited heat density therefore demand to make use of the waste heat provided.

The North quay is geographically constraint by the edge of the developed area, the railway, the River Ouse and the A259 coast road, all of which require additional investment for any infrastructure crossing.

Within the landholding are two Asphalt plants. These have substantial heat demands and are both currently operating on Fuel oil or heavy fuel oil, a disproportionately polluting fuel.

The initial proposal focuses on the business case for heat infrastructure from the waste facility to decarbonise these industrial operations as an anchor load.

It is recommended that Local Enterprise is then used to attract other high energy consuming industries to this area, ideally initially to the North Quay, where deployment of infrastructure will be easier to make best use of the energy available.

Scenario 1A: Electrical considerations

As already mentioned earlier in this report, there is an existing 33kV and 11kV DNO owned and operated network running along the North Quay road.

The Veolia EfW plant already exports excess energy in the order of 16 MW into the 33kV networks running to Newhaven and Peacehaven. It is certainly possible to add a private wire network along the North Quay road but there are anticipated to be additional costs associated with this given that the road is of particularly heavy duty construction, made from reinforced concrete. This makes it harder to create. Pricing books (e.g. SPONS) suggests a cost of £69.53/m when $185mm^2$ 11kV cable is laid in a trench or duct. An EDF document on the OFGEM website suggests a cost in the order of £91/m in a highway footpath. The date of publication of this document is unknown so caution should be used with this number.

If one was to assume that the outward leg from the EfW plant to the far end of North Quay road was approximately 850 m, then by adding a return leg and using the cost provided by EDF with a 20% uplift for contingency and a further 20% for a more difficult dig, it might be fair to assume the install cost for the cable alone without any deviations to substations back from the road would be in the order of £216.5k. If numerous substations were included, one might expect to pay in the region of £40,000 per substation and any subsequent costs to connect to the consumer's main LV panel and civils works including underground ducting, concrete bases and a GRP enclosure.

There is also the cost of any upgrades required and substations or switchgear needed at the Veolia plant. If Veolia was hypothetically able to sell all its electricity at 10p/kWh through a series of private wires, this will generate a revenue stream of £14 million a year. But as the demand does not exist, this would be pro-rated and extra supply sold back at a lower rate to the DNO. The rate at which excess power is sold to the grid is commercially sensitive information and unknown, but for the purpose of this report it is assumed to be 4.5p/kWh. The delta would therefore be the difference, 5.5 p/kWh sold to any private wire consumer. Assuming an installation cost of £650,000 a revenue stream of £54,166 a year would be needed to breakeven over a 12 year period, coinciding with the EfW plant's 2033 licence for renewal. This equates to only 0.7% of the available annual energy generated by the EfW plant. In other words, 985MWh per year needs to be sold into a private wire to breakeven; anything above that that will likely result in a profit excluding some low maintenance costs. The current demand in the area is still to be confirmed, but having had conversations with FM Conway, assuming they run at their maximum demand of 700kVA for 9 hours a day, 260 days a year, this alone would equate to 1,638MWh per year making this a viable proposition.

Alternative commercial solutions may also exist utilising the existing electrical network via a 'sleeving' type commercial arrangement. Although lower capital cost it is likely to result in lower revenues and savings for the EfW plant and industrial users, as some form of access charges will need to be paid to use this equipment.

Both this and a private wire network will be explored in this area as an initial scenario.

Scenario 1b: Rolling out to light industrial estate across railway

Assuming a business case may be developed for the existing facility, and further business may be attracted to the local industrial area with sufficient process energy consumption to facilitate it, a logical extension to Scenario 1 is the crossing of the railway to provide supply to the adjacent industrial area.

To date it remains unclear what provision exists for services to cross the railway line separating the Veolia plant from the light industrial zone. Private property runs between North Quay road and the railway which places legal hurdles for permission to access and subsequent wayleaves before any underground directional drilling can be undertaken. The earlier Ramboll report refers to direction drilling at a cost of £250k to traverse the lines (Update Note: Estimations in WP2 for this cost were closer to £500k, which was used in the CAPEX for this scenario); but through conversations with Newhaven Port Authority it was discovered that historically Network Rail has refused the Port's attempts to extend its private wire using this method.

In the event Network Rail were to overturn their historical objections to directional drilling, possibly by using one of their own approved contractors, the easiest way would appear to be to the North East of the Veolia plant near the pedestrian level crossing. The nearby land is undeveloped and looks to be used as a car park. Access is good on both sides of the line and would provide a direct route to the light industrial zone.

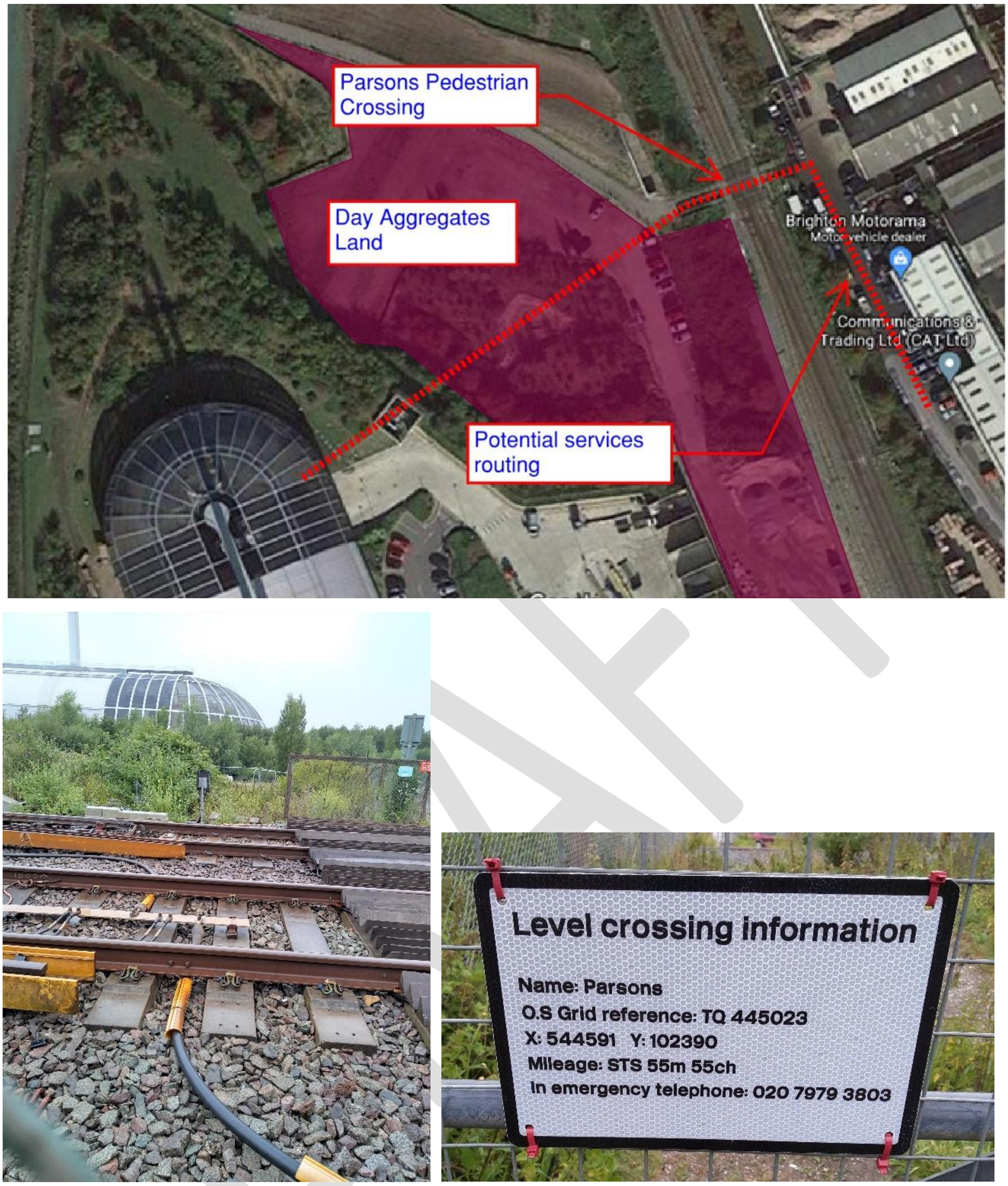


Figure 25: Potential route across Parsons level crossing from the North Quay to the light industrial zone

The favoured option of a subterranean crossing of the railway line involves a large capital outlay which will adversely affect the return on investment.

However, the railway represents an easier geographical feature to cross in comparison to the harbour and may in time open up other domestic areas of the town to a wider network. No demand lies to the north of the plant, and lower heat loads lie to the south, with the complicated road structure of the A259 at this location adding some complexity to routing.

This may represent some form of 'Phase 2' of this system and is currently believed to be the most feasible route for building out to a wider town network, therefore will be investigated as part of WP2. It will however require sufficient revenue to justify the additional investment of the railway crossing.

Scenario 1B: Electrical considerations

An alternative route for crossing the railway from an electrical perspective would be to route cable underground to the end of the North Quay road, ascend the piers of the A259 flyover and cross above the railway line; this would need agreement from the highway authority. The disadvantage of pursuing this route is the cost of taking cabling all the way south to the bridge and then making it turn back to serve the loads to the North. It will be expensive to carry out the civil works, the cables may need to be larger to offset the volt drop as a result of the distance or more cables and circuits will be used to support smaller pockets of demand which will add to cost. The energy requirement needs to be sufficient to warrant these costs.

As discussed earlier in the report, Veolia are already exporting their electricity, so the payback comes from the delta between the price achieved when selling to end consumers versus the price achieved when selling into the grid. It is assumed the price advantage would be in the order of 5.5p/kWh. Only if there is sufficient demand from the light industrial area would it make this crossing a viable proposal, or if the crossing costs were considered holistically with sufficient sales of hot water.

Scenario 2: CTEC shipping heat to Eastside

CTEC have liaised with the main housing development contractor on the East side, Morisons, to discuss the provision of power and heat to the new sites. It is understood that the contractor has been receptive to the initiative and will be integrating the district heating network into the various schemes.

On this basis scenario 2 will investigate shipping heat to the Eastside area for use in new developments, making use of the new port access bridge (see Figure 26) which is understood to have some infrastructure transfer facilities built into it. This will resolve geographical access issues regarding access over the railway and the Mill Creek. It may also in time be a route for public electrical infrastructure access to this area of land in the other direction.

It would be proposed that this network is specified and future proofed to be compatible with any residential network arising from scenario 1B, which would allow in time interconnection of a system North South through Newhaven were this to be viable at a future date.

This scenario is proposed to be taken forward as part of Work Package 2.

Figure 26: Route and distance of a possible route from CTEC to the Eastside housing estate

Scenario 2: Electrical considerations

A long-term commercial agreement has been reached between the Port Authority and CTEC to provide an electrical power supply at a competitive tariff. Although the exact figure is unknown, it is unlikely that there will be a large advantage in exporting electricity to individual households in Eastside because of the extra infrastructure required and the administrative burden of chasing payments. Employing an IDNO or facilities management company could be a way of avoiding the administrative heavy lifting, but there would be a statutory requirement on the energy provider to operate within tolerances and continuity of operation as set out by the Electricity Safety, Quality and Continuity, ESQC Regulations 2002. Fines could be levied upon the supplier for downtime during planned maintenance or a fault which means having adequate backup systems in place, be it a temporary generator or connection to the DNO. Injecting directly into the Port Authority's ring avoids a number of these problems as it will only be used to displace energy use within a system already connected to the grid. Only if the cables and infrastructure of the Port's network are running at full capacity in the future, would there be a dependency for a feed from CTEC, but the onus of continuity of supply would still lie with the Port Authority.

Given that electrical demand is available on the doorstep without penalties for reduced supply, assuming the agreed contract is solely based upon electrical input, it would be bold to take on the extra responsibilities, CAPEX and OPEX with the uplift in risk. Furthermore, even if the supply to the housing estate was cheaper than the general market for the residential consumer, the consumer would be unable to pick from an alternative shipper. With the advent of smart meters, in future people are going to be increasingly receiving their power with dynamic costs to reflect market availability within the network. Indeed, Octopus Energy recently offered negative pricing to consumers of 5p/kWh during certain periods of the day. It is unclear how this could be passed on through a private wire system.

Based on a 1.2km feed to a substation located in the centre of the Eastside development and using the higher figure of £91/m for an HV cable installation from earlier in the report, a radial feed would be around £109k. Add to that a substation at £40k, the price would come to around £150k. This cost is a worst case and does not consider the cost advantage of sharing a trench with a district heating pipe. Ryefield panels would still be required to split the power which is then to be taken off with individual cables and meters to each dwelling. With a continuous supply of 600kWh, according to the Schneider Electrical Installation Guide, this would serve up to an equivalent of 217 apartment dwellings, thus likely to cover the 190 Eastside homes. Given that the demand profile will vary with time and yet the supply will be continuously rated at 600kVA, the residual supply will still need to be put either exported to the Port's network or to the grid, perhaps near Eastside.

As the price per unit offered by the Port Authority's purchasing agreement was not disclosed, it is not possible to work out a payback period with a high level of confidence. However, for academic purposes only if it were assumed that power was sold to households at 10p/kWh net of OPEX, if 60% of the supply was consumed, because the remaining 40% is exported to the grid due to householders being at work or asleep then the income from the householders would be £315k a year with £94.6k from the grid (based on 40% export at 4.5p/kWh). This equates to a revenue stream of circa £410k/yr.

If power is sold to the Port Authority at 8p/kWh, CTEC could expect a revenue stream of £420k. This demonstrates using the above assumptions that CTEC's existing approach is the most profitable.

A public grid connection from Eastside across the bridge would be useful in providing resilience and an alternative supply route to CTEC in the future, as well as opening up potential development opportunities in the adjacent harbour area.

The business case could potentially be marginally improved by bringing other developments within the fold of this private wire network so that 100% of CTEC's supply is consumed even during the lowest demand period at night. Higher periods of demand could be met by the DNO which is paralleled to the network. But given the differential between the gain of selling into the retail market versus selling directly to the Port, it is unlikely to be an attractive proposition and would come with a long payback period.

A private wire network is not proposed to be investigated further as part of Scenario 2 under work package 2.

Scenario 3 Harbour Heights and the Mariner- New CTEC Plant on the West side

Harbour Heights is a proposed housing development for 700 dwellings on the West side of the River Ouse to the North and North West of Newhaven Fort and sits behind aspirational housing built in the 1980's.

CTEC's modus operandi is to use smaller EfW plants for waste destruction as they believe they can retain greater control of emissions. Their preferred modular system comes in a 35x20m footprint and produces 300kW_e and 2.3MW_{th}. CTEC are looking at the possibility of constructing an EfW plant on the West side with a view to providing power and hot water to local development, which could include Harbour Heights and the Mariner. As the EfW plant consumes 500kg of waste per hour, it would only necessitate a single HGV delivery each day to keep the plant fully operational and would therefore likely have a limited impact to the overall traffic in the vicinity.

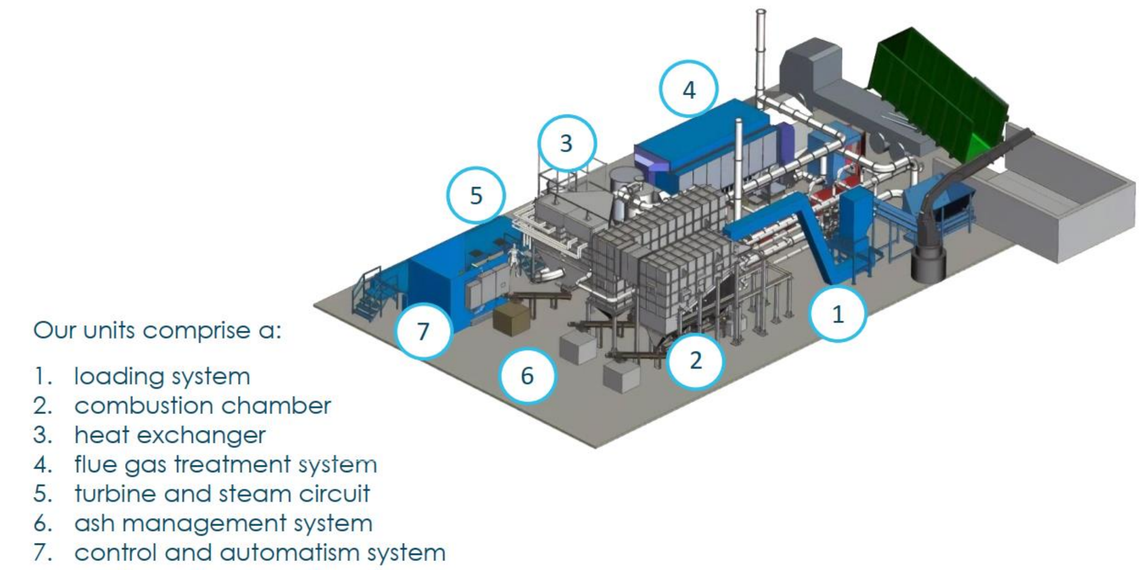


Figure 27- A modular EfW plant

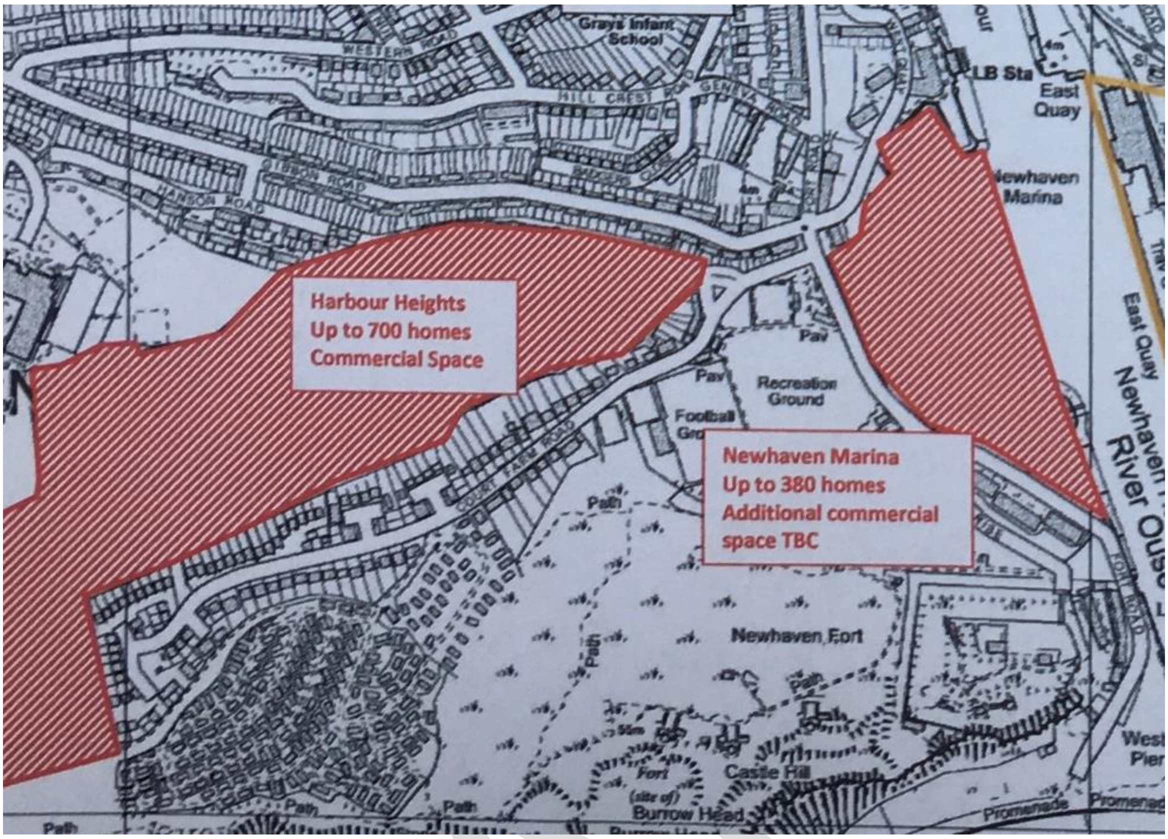


Figure 28- Proposed development sites on the west side of the River Ouse

Figure 29: A potential location for a CTEC system – the Quarry Road Industrial estate

A very similar narrative exists for the marina as for the Harbour Heights scenario, namely that should a suitable location for an additional EfW plant be found, then hot water and electricity could service its energy needs.

As a preliminary position we would propose an energy centre on the nearby Quarry Road Industrial estate, which is located separate from residential areas, but between the developments. This would be investigated further in Work Package 2.

An alternative to the EfW plant would be to provide a power supply to marine source heat pumps located at the Marina.

Scenario 3: Electrical considerations

As per scenario 2 with CTEC's ability to feed into the residential market, the opportunities and challenges would share a number of commonalities. But first a suitable site would need to be found. Despite the relatively small 35x20m footprint, a 50,000sq ft commercial building is required. Wherever this location may be, for a private wire electrical system one or two 11kV feeds would need to run to Harbour Heights and the Mariner probably in a radial configuration to serve one or more substations which will fully support in the region of 100 homes. Given that there are approximately 700 homes planned, the shortfall in power would necessitate a paralleled connection to the DNO. A facilities management company or IDNO would maintain the network as well as possibly manage the associated administration. It is not possible at this stage to offer any indication of cost or payback as the key components for such a calculation, namely location and length of cable run are missing.

The EfW plant could only provide enough power to serve in the region of 100 homes, so a paralleled connection would be the most likely. This would make the development's electrical supply private, thus depriving householders from choosing their shipper from the open market.

It is possible as in any of the other scenarios, that where a public supply exists locally, electricity could be injected straight in as long as capacity exists within the infrastructure. There will be an associated monetary benefit to the energy supplier as a result, probably around 4.5p/kWh.

Both approaches will be investigated further as part of Work Package 2.

West area pre-assessment

Scenario 1c: The whole West side of Newhaven from Veolia

Initial expectations that the River Ouse would provide a barrier to services, effectively dividing the town into two, were confirmed following a number of utility asset searches. With the large marine vessels operating in the river, utilities are at risk from the requirement of regular dredging. Furthermore, the marine traffic necessitates a swing bridge, making incorporation of utility services unachievable. The only known active utility crossing is an old water main owned by the water authority located just to the south of the swing bridge. The Port Authority have indicated there had been two attempts to replace it with directional drilling, but neither occasion was successful.

The only likely viable crossing option is at the North edge of Veolia's land where the 33kV cables from the EfW plant cross in the direction of Peacehaven. This crossing is North and outside of the main navigable zone and is marked by a couple of diamond signs on either side to warn leisure traffic to the hazards below.

Whilst there are no urban obstacles of note, land ownership will need to be considered as the cables and/or pipework are brought along the river's edge in a southerly direction. The infrastructure will stretch 1km before approaching the nearest building just across from Denton Island.

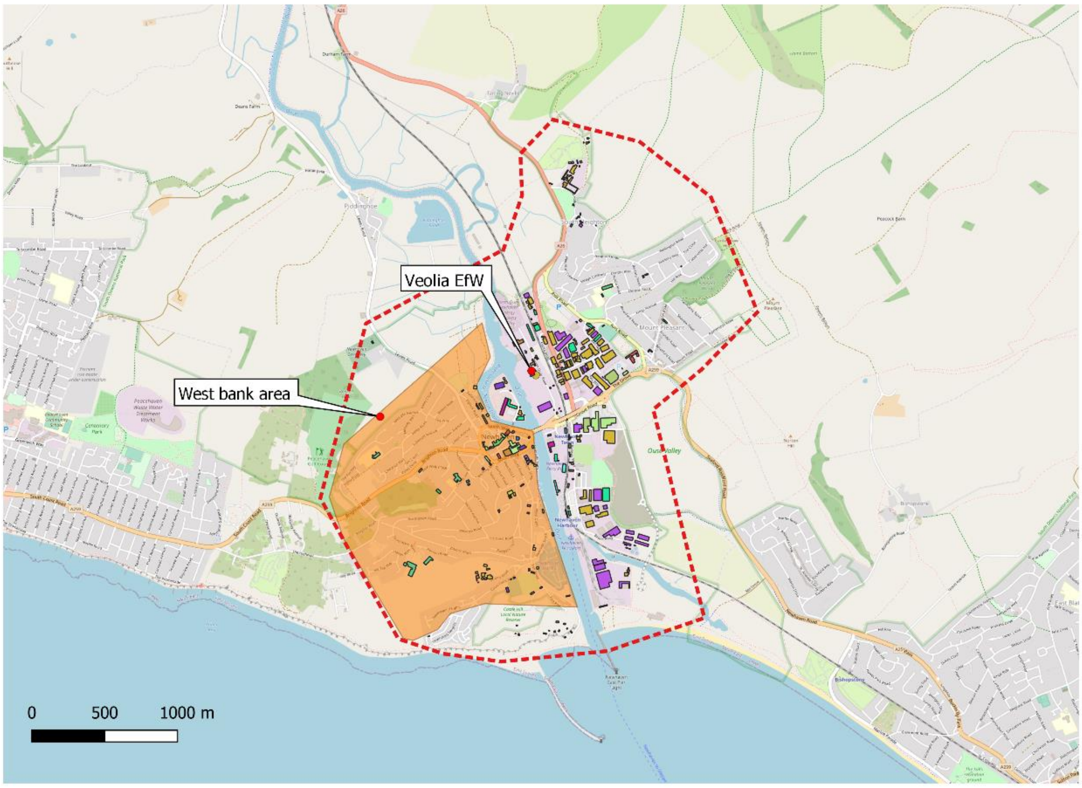


Figure 30: West side of River House (displaying non-domestic buildings)

Please note the following economic analysis has been updated from Work Package 1 in work package 2 to align with heat price assumptions and additional capital information utilised in the later analysis.

Based on LSOA subnational gas statistics the total estimated demand for the area West of the River Ouse is 34.77 GWh. This assumes a boiler efficiency of 85%. Using a conservative heat sale price of 11p/kWh the annual revenue, assuming a 90% update would be £3.44m.

Using Ordnance Survey data for the road network (total length 25.7km) the West area would normally require at the very least 15,000 m of transmission and distribution network which, using a cost of £1,500/m amounts to a CAPEX of £22.50m. Also note that the linear heat density in this case is 2.32 MWh/m which is well below 4MWh/m typically required for a successful heat network scheme[2].

The number of connections would be of the order of 4850 (using AddressBase® data), giving an additional CAPEX figure of £7.27m (£1,500 per connection). A provision of £2m is assumed for the crossing of River House. The total CAPEX for this scenario is £31.77m. This excludes any energy centre CAPEX for peaking and backup plants and thermal storage. The minimum annual OPEX would be £120k.

Using the above figures, a 15-year NPV at 4.5% discount rate is -£596k and the IRR is 4.26%.

---

[2] https://www.districtheatingscotland.com/wp-content/uploads/2017/10/Module-5-Infrastructure.pdf

From this initial calculation it may be seen that connecting the west side of Newhaven is likely to be a significant undertaking, with the economics likely to be marginal even after very high uptake. In discussions with the client at the conclusion of Work Package 1 it was agreed that this would not be taken forward as a detailed scenario in work package 2.

Scenario 1c: Electrical considerations

The electrical load for residential housing is typically small and follows a time dependent profile; the Schneider Electrical Installation Guide suggests allowing 6kVA per apartment dwelling as an average which is diversified down as more and more apartments are connected to a limit of 46%. It should be noted these values assume an alternative heating method to electrical night storage. For the purposes of this report, it is assumed the demand between a typical apartment dwelling and a regular house are similar since the activities undertaken in either premises will be of a similar nature. Given that a typical 3 core 185mm^2 11kV aluminium cable in a ring formation would provide in the region of 8MVA, one could expect a maximum of 2,900 homes. These homes would need to be rewired with a new incoming cable to take advantage of a private wire network and in so doing, considerable disruption would be caused to the area as the necessary infrastructure is installed. Furthermore, some residents may refuse to partake as they would lose the ability to choose the electrical shipper. From an economic point of view, it could be hard to compete against the DNO who already has assets in place and where the uplift in revenue is only 5.5p/kWh for exported electricity.

The green credentials of such a proposal are less obvious given the embodied carbon of materials and the construction work required to turn this scenario into a reality. The energy is anyway pumped into the grid and extracted from the grid meaning that other than some incidental losses, common to any network, public or private, there would be little benefit.

On this basis, a Private wire option in the West Area will not be investigated as part of Work Package 2.

Work Package 1 – Conclusions

Both EfW plants suffer from geographical constraints namely the river and railway lines. Whilst these are not insurmountable problems, solutions come with large costs and make the business case for investment less attractive. In particular, the business case for crossing the river with Infrastructure seems to be a historical and is likely to be a current financial and engineering challenge.

A critical strategic question exists about the strategic future of the large-scale energy from waste plant. This currently exports substantially more electricity from Newhaven than is used within the town area, and has a large heat availability, but limited local heating demand. There is a risk that future economic and environmental pressures may align for a large fraction of its input to be diverted to other major metropolitan areas where it may be utilised with a uplift in system efficiency, as well as reduction in haulage requirements.

The smaller scale CTEC plants appear initially better matched so some of the development proposals in Newhaven, as well as allowing modular deployment either side of the river avoiding an infrastructure crossing.

Anthesis are in broad agreement with the previous study (undertaken by Ramboll) regarding heat load densities, however we believe electrical loads are misaligned with the historic consumption data of Newhaven. Additionally, we believe a river crossing presents a great challenge to the network proposed in the previous report, particularly given its proposed location in the navigation channel, and with a small quantum of load connected on the east bank.

On this basis it was proposed to take the following scenarios forward in the Work Package 2 stage:

- Counterfactual – a Marinised individual electrically powered Air Source Heat Pump per property
- Scenario 1a – Supply of industrial areas on the North Quay with high grade heat and electricity by Private wire from the Veolia Energy from Waste facility
- Scenario 1b – Extension of heat network 1a to industrial areas of Newhaven across the railway line (and potentially onward to residential zones)
- Scenario 2 – A self-contained network from the CTEC plant on East Quay providing heat to development in the Eastside area of Newhaven via the port access road and bridge
- Scenario 3 - A self-contained network from a new CTEC plant on the west bank providing heat to development at Harbour Heights and the Marina. This will include investigation of marine source heat pumps as an alternative heat energy source

A further scenario, scenario 1c investigates connecting the entire West Bank of Newhaven to the Veolia Energy from waste facility. Early indications are that the revenue generated from this heat demand may struggle to justify financing a river crossing for heat. Other comparable infrastructure (e.g. gas) does not cross the harbour, which may be for similar financial reasons. In discussions with the client at the conclusion of work package 1 it was decided that neither this, nor a private wire electricity equivalent will not be taken forward in Work Package 2.

Qualitative assessment of LZC solutions

The town of Newhaven already has two Energy from Waste facilities with the potential for additional units or facilities to open within the town. As Previously discussed, these may be considered effectively low carbon Combined Heat and Power plant, with further decarbonisation possible as the waste stream itself is decarbonised.

Waste heat sources from the sea and potentially the sewage works were also identified during the Work Package 1 stages.

As a part of work package 2 a full range of energy systems has been qualitatively assessed for use within the potential energy centres, with commentary provided on their applicability for each of the proposed scenarios to be feasibility tested in the following table.

Table 2: Qualitative assessment of LZC sources at Newhaven

Heating Source	Qualitative Commentary	Modelled
Fossil Fuel (Gas or Oil) Boilers	As noted in the utility infrastructure review parts of Newhaven do not have access to the national gas network. As a result, certain facilities are understood to run on oil based systems. Therefore, both Gas and Oil boilers are considered in this section as fossil fuel boilers. Fossil fuel boilers inevitably lead to Carbon dioxide emissions, with greater emission from oil systems. As the intent is for Newhaven to have a decarbonised heat supply these have been discounted within workpackage 2, with alternative systems proposed to achieve this objective. This includes as a counterfactual, with heat pumps selected for the new build housing proposed. However, there may some validity in retaining existing system for a period of time as backup or potentially peaking plant dependant on the economics of replacing these, which will be discussed later in this report.	Not Included
Gas fired Combined Heat and Power (CHP)	The Energy from Waste facilities identified in work package 1 are effectively low carbon forms of Combined Heat and Power plant. These effectively displace a gas equivalent, particularly considering the lower penetration of gas infrastructure across Newhaven town. Therefore, separate gas fired CHP systems have not formed part of the next stage of modelling at this location	Not Included

Biomass boiler	Biomass boilers are often less well suited to urban areas, owing to concerns regarding the transportation of fuel and the quality of flue gas emissions. However, in Newhaven these factors may be considered to be able to be mitigated. Transportation, particularly to the harbour area is generally high quality, with Heavy Good vehicle access to the harbourside, as well as other modal operations possible. For example, there is quayside space which may allow for the importation of wood fuel by sea, as well as a harbourside railhead, which may allow the transportation of bulk wood fuel even by rail, should either of these options be economically viable. Furthermore any new Biomass plant at scale would likely be anticipated to meet the Medium Plant Combustion Directive requirements on emissions, and be co-located on industrial sites where they may be able to be incorporated within an existing Environmental permit systems (e.g. The Industrial Emissions Directive) . An Air Quality Management area does exist in Newhaven, associated with the town centre gyratory. This is outside the proposed energy centre locations for each of the scenarios. Furthermore, Biomass is one of the few low carbon opportunities to raise high grade heat in the form of steam, as may be necessary in Scenario 1. It therefore provides a useful low carbon peaking or backup opportunity in these specific circumstances. Therefore, Biomass is included within the study as a potential alternative backup and peaking plant within the scenarios	Included – Future out scenarios
Water Source Heat Pump	Water source heat pumps require a water-based heat source. Newhaven is adjacent to the sea, on an estuary with a river body passing through the town, There is also a local sewage works. As a result, there is access to ambient temperature water sources in the vicinity of the scenarios. These offer the potential of improving the efficiency of heat pump scenarios. They also likely negate the additional expense of a Ground source system in this location, as there is ready access to extensive water bodies at ground level. Water source heat pumps have the potential to meet a proportion of the heating needs for District heating, though this is restricted to scenario's 2 and 3, as higher grade heat sources are likely to be required in scenario 1, which heat pumps are not technically able to achieve.	Included – Future build out scenarios 2 and 3

Air Source Heat Pump	An alternative to a water source system is an air source system. The large thermal loads and higher operating temperatures of district heating would still favour specialist refrigeration systems such as Ammonia based heat pumps. It is preferable not to circulate this refrigerant within large radiator circuits to minimise the refrigerant charge quantity owing to safety considerations. For this reason, it is assumed a water-based heat absorption circuit would be utilised with large V bank type radiators. Consideration of the treatment of these will be required owing to the proximity of the sea. A suitable defrost cycle will also be required to prevent the freezing up of coils in winter conditions. Air source solutions suffer from lower performance at lower ambient air conditions i.e. in winter, therefore electricity consumption would increase. The size of the heat absorption equipment is at this scale is likely to be large. Logistical requirements limit radiator sizing to modules large enough for road freight, these then also need dispersing at appropriate intervals to prevent air recirculating through adjacent heat exchanger equipment and continually cooling instead of mixing with ambient. Noise from the fans distributing the air requires planning and design consideration. Local microclimate effects may also result from large scale air cooling that may require further investigation. Heat pumps are limited in the temperature grade they can produce, with efficiency falling the further the source temperature is from the heating supply temperature. As such, it is not believed heat pumps will be suitable within Scenario 1, however these may be considered within Scenarios 2 and 3. Additionally, considering the restricted access for gas systems with certain parts of Newhaven, and the decarbonisation of the national electrical grid, small individual mass manufactured air source heat pumps will be considered at the counterfactual heat source within new build properties in scenarios 2 and 3.	Included – future build out scenarios – see commentary

Solar Thermal/ Photovoltaic Thermal	Solar Thermal technology is able to produce heat efficiently from the sun at higher grades over the summer months. A greater quantity of energy may be extracted across the year from lower temperature operation, However, 80C flow temperatures are entirely feasible in direct summer sunshine. Within Newhaven these would reduce the base summer heating demand. Solar thermal can convert very high levels of sum energy into heat e.g. circa 90%, compared to a conversion efficiency of 10-15% for PV of sunlight into electricity. When considering the COP of heat pumps this may be a 30-45% overall heat conversion ratio. A large thermal store at the energy centre as well as large thermal inertia within any network may assist in managing any short variations in energy captured. Any solar thermal system cannot be relied on to deliver peak heating loads nor winter baseload but can trim energy required to operate a system. There may even be scope to use a proportion of combined photovoltaic solar thermal systems (making electricity as well as heat) up to the summer base thermal load, though this technology is currently only commercially available from limited suppliers. The key restriction at Newhaven would be the conflict of these systems with the EfW plants, also seeking a sink for their waste heat in the summer months of operation. Additionally, these systems require a large land surface area for installation at any large scale capacity, and opportunities for this are limited at the Energy Centre locations under consideration in these scenarios. As a result, these systems have not been taken forward further within Work package 2.	Not – Included – future build out scenarios

Quantitative assessment of Back up LZC heat sources

Each of the proposed scenarios makes use of Energy from Waste as a low carbon heat source to supply a wider network. At each location additional plant is required to meet heat peak loads and as a redundant heat source in the event of planned and unplanned downtime from the EfW facility. The requirement for this study is to identify Low carbon options for such plant. From the qualitative assessment it may be observed that Biomass and heat pumps are the proposed LZC backup heat sources for each scenario. Within scenario 1, only biomass can raise heat at an equivalent grade as the EfW plant, for use as steam within industrial facilities, therefore this is the only technically viable alternative from the list of items considered. It is recommended that having the backup heating/system resilience on the demand side, rather than the supply side, is investigated, and the option of not installing biomass boilers/heat pumps considered for value engineering. This is because the heat load is significant and having backup equipment to provide this will involve large capital investment for equipment with minimal use, that potentially may not meet the needs of the heat demand. Thus, if the current heating systems on the demand side are maintained to be used as a backup heating when necessary, this capital expenditure may be avoided.

For scenarios 2 and 3 there is the potential for heat pumps to be utilised in place of Biomass. These have been qualitatively assessed in the following Techno economic manner to determine their viability as a backup and redundant heat source for scenarios 2 and 3.

Table 3: Techno-economic parameters for the ASHP and biomass boiler options for scenarios 2 and 3

Option	Fuel	Efficiency	Price	Heat Cost	Maintenance Cost	CAPEX (Installed Costs)
Biomass Boilers	Biomass	82%	£40/MWh (£140/ton, 3.5MWh/ton)	£48.8 / MWh	£12.5/kW	£356k
Air Source Heat Pump	Electricity	300%	£120 / MWh of electricity	£40 / MWh	£12/kW	£470k

Table 4: Opex Comparison of back-up options for scenarios 2 and 3

	Scenario 2	**Scenario 3**
Back-up Heat Production MWh	73 MWh	137 MWh
Annual OPEX Biomass (including maintenance)	£11,062	£21,685
Annual OPEX ASHP (including maintenance)	£26,920	£29,480

From the above nominal parameters (

Table 4 and Table 3), the fuel costs contributions of the OPEX for the biomass boiler and ASHP are similar and it is not possible, due to the uncertainty in the input parameters (efficiencies, calorific values, maintenance cost) to conclude on the superiority of one of the two solution over the other; initial simulations in EnergyPro show that each alternative produces the same amount of backup heat. However, it is known that the heat pump CAPEX is £114k in excess of that of the biomass boiler, which makes the biomass boiler solution more economical and this option was therefore favoured and taken to the techno-economic stage.

Any alternative heat pump option utilising the Ground or Marine energy sources is likely to have an even higher capital requirement, further worsening the financial case. For this reason these alternative heat pump options will not be considered further through Work Package 2.

In addition, the carbon content of the biomass heat is currently lower and also lower when considering future extrapolated grid decarbonisation.

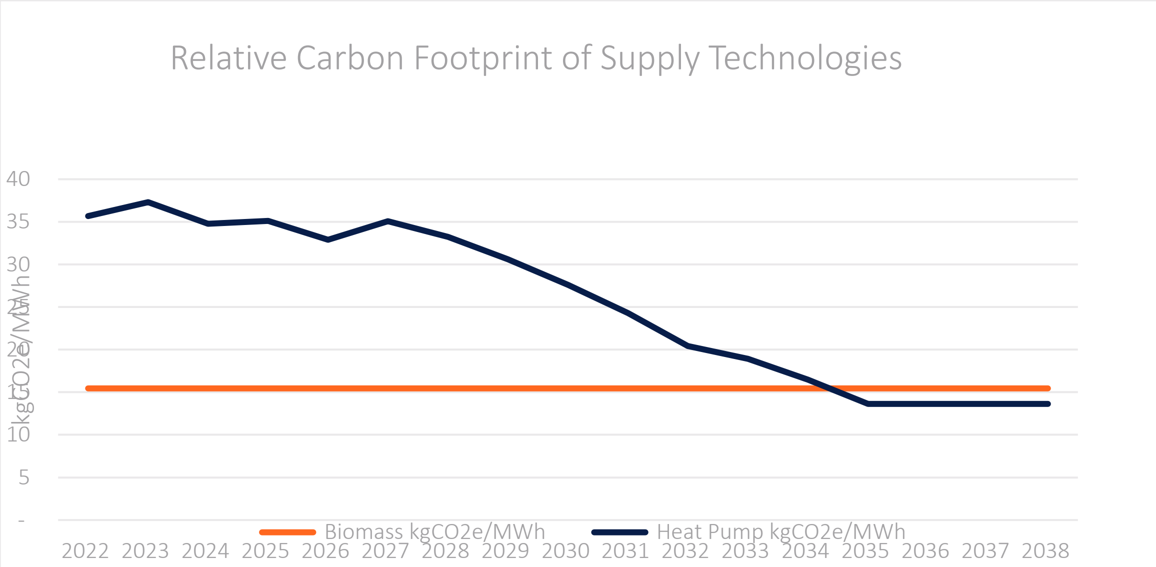


Figure 31:15 years projections of carbon factor which is the economic life of the boiler – Biomass factor is DEFRA 2020 Woodchip, Heat Pump is Green Book 2019 Domestic Consumption Based Factors divided by COP3.

The ASHP carbon content may become comparable in 15 years (Figure 31) which is the economic life of the biomass boiler. Therefore, an alternative technological approach may be to design systems to operate at lower temperatures, install Biomass initially and replace with a heat pump at the equipment's end of life should the economical or carbon case for this solution be appropriate.

Another advantage of a biomass boiler over the ASHP is the absence of electrical network constraints which might affect the ASHP especially in an environment with a multiplicity of competing loads.

Given the very low amount of heat required as backup in scenarios 2 and 3 it might be economically justifiable to install a high efficiency gas or oil boiler for backup or peak lopping, though this would then not be a zero-carbon solution. This may be particularly preferable as Biomass boilers tend to be better suited to constant operation for longer time durations and are not as flexible as conventional fossil fuelled technologies. Components such as mechanical items (e.g. feed screws, blowers) and the refectory lining of the boiler are likely to have a higher failure rate under intermittent infrequent operation increasing the maintenance cost of the system. This option is therefore recommended to be investigated further in later studies for example as part of a detailed sensitivity analysis.

Scenario Assessments – Energy Centre and Plant RIBA stage 2 cost estimates

To address the needs of this feasibility study exercise Anthesis have prepared outline RIBA stage 2 mechanical and electrical designs as the basis for costing under each scenario.

Anthesis employs chartered energy engineers, mechanical and electrical engineers who have informed this output. Anthesis are not dedicated specialist in other professional fields, e.g. process engineering, architects, fire engineers, refrigeration engineering or structural engineering, however the nature of the RIBA stage 2 exercise requires assumptions that impacts on these and potentially other specialist fields.

For this reason, the following design should be viewed as an outline at feasibility stage and not a complete detailed design, neither should any element of it be utilised for construction purposes. It is recommended that the design is further developed at the next stage, e.g. RIBA stage 3 in consultation with at least the following (but not exclusively limited to) professional advisers. These may in turn recommend the engagement of other specialist depending on design risk mitigation and management over the course of design development:

- Industrial Architect
- Structural engineer
- Fire Engineer
- Specialist Refrigeration Engineers, with experience working with and risk assessing industrial refrigeration systems (e.g. Ammonia based)
- Building service engineers, including Mechanical and Electrical disciplines
- Electrical Power Systems Engineer (HV network, generation integration, distribution etc)
- Dynamic Hydraulic modeller
- Control engineer
- Quantity Surveyor

Anthesis's strategy has not extended to the Carbon Dioxide equivalent of Refrigerants utilised in the Heat pumps. Historic refrigerants have had very high (sometimes in excess of 3000) global warming potential, with leakage a common occurrence. As a result, measurable quantities of industrial refrigerant gas in the atmosphere now make a meaningful contribution to climate change. Refrigerant regulation (F-gas) has been amended recently to reflect this and is leading to a large change in equipment design and refrigerant selection. This makes it difficult for Anthesis to quantify the carbon impact of future refrigerant equipment.

Additionally, some new or alternative refrigerants have additional risk in usage in comparison to historic refrigerants, for example:

- Increased flammability
- Explosive risk
- Toxicity, in a natural state, or upon combustion

For clarity, Anthesis have not conducted any specialist risk assessments at this feasibility stage that may arise from the selection of certain refrigeration systems (e.g. fire risk, Explosion risk, Ammonia usage), as they are the domain of other professionals and require further design detail than is available at this stage.

Please note that Biomass systems and stores represents a separate fire risk and has other Health And safety Implications (e.g. dust risks, carbon monoxide poisoning) that must also be accounted for in future design. Again, for clarity Anthesis has not conducted these at this stage.

Finally, scenario 1 assume the utilisation of high temperature, high pressure steam from an existing industrial facility serving another facility. Steam heating systems do exist outside of an industrial context, however these are generally being phased out for water based systems, owing to additional risks from using this heat medium. As detailed below, it may be necessary to use this medium in Scenario 1,however the reader should be aware that steam systems have additional risks, for example steam explosion, high temperature burns etc that require mitigation and risk management over Low Temperature Hot Water systems, as usually found in modern district heating. Again for clarity Anthesis has not conducted any risk assessment related to these risks at this initial stage, particularly as they are ultimately likely to be linked to the overall risk management strategy of similar systems at the industrial sites described under scenario 1, for which we have limited information.

Scenario 1 – Detailed proposal

The following table details the approach for scenario 1, which is broken into two phases, A and B.

Table 5: Feasibility Approach to Scenario 1

Proposal	Summary
Energy centre location	Adjacent to Newhaven EfW, preferentially with access to dock and rail system (where feasible) to facilitate bulk fuel handling.
Energy Centre Primary Plant assumptions	Steam supply from EfW, to feed industrial loads. This requirement is driven by the heat demands of adjacent asphalt plants, which maintain molten bitumen at 200°C. Biomass Steam boiler as backup/redundancy. Low Temperature Hot Water generation from steam via plate/shell & tube heat exchanger within plant room for Phase 1B. Biomass LTHW boilers for redundancy/backup
Future low carbon transition	Dependant on decarbonisation of waste stream. Sustainable sourced biomass is general considered a low carbon fuel, however this may require some embodied emissions within this fuel top be offset in some manner
Private Wire Opportunities	Private wire supply to industrial facilities in North Quay proposed
Network type	Phase 1A is proposed to be an above ground industrial steam network for supplying heat to North Quay. This will likely require significant input from a process engineer familiar with steam systems, the operations of the waste and Asphalt plants. Phase 1B is proposed to be a below ground LTHW network supplying industrial loads across the nearby railway.
Network Parameters	Steam network – to be determined by Process engineer – assumed for this study – live steam circa 200C as required by process. LTHW network assumed to be a 4th generation system, with flow temperatures <100C, preferentially variable to <70C with 40 C returns targeted to protect for future expansion
Significant network obstructions	River Ouse, Network Rail mainline, A259 coastal road
Phasing	Phase 1A forms the catalyst for a new network, Phase 1B to follow when financial viability allows
Counterfactual	Industrial heat sources as installed (electrical and fuel oil based) Building service systems as installed across the industrial estate on Phase 1B.

Plant Room

The following details the assumed plant room layout for Scenario 1. Please note, this encompasses the plant estimations for Phase 1A and B. For Scenario 1b, the division between the scenarios and transfer of heat between the two circuits is proposed to be via a shell and tube or plate heat exchanger. The liquid circuit in Phase 1B is heated by the steam from the circuit in Phase 1A. A shell and tube heat exchanger has been drafted, though at detail design stage, a plate heat exchanger option is also recommended to be investigated. The plantrooms include space allocation for all critical services including circulation pump skid arrangement, plantroom ventilation and electrical distribution boards and control panels. The bleed-in steam connection and flow & return pipework to the energy centre is proposed to cross the road into the energy centre via an underground trench. The heating plant in Phase 1A supplies the steam directly to the network, with the high temperature condensate liquid returning for potential use locally within the energy centre. In Phase 1B, the hot water is stored in 160,000L of thermal stores before distribution to the network. Separate 600kW biomass boiler systems acts as resilience for each of the 2 phases.

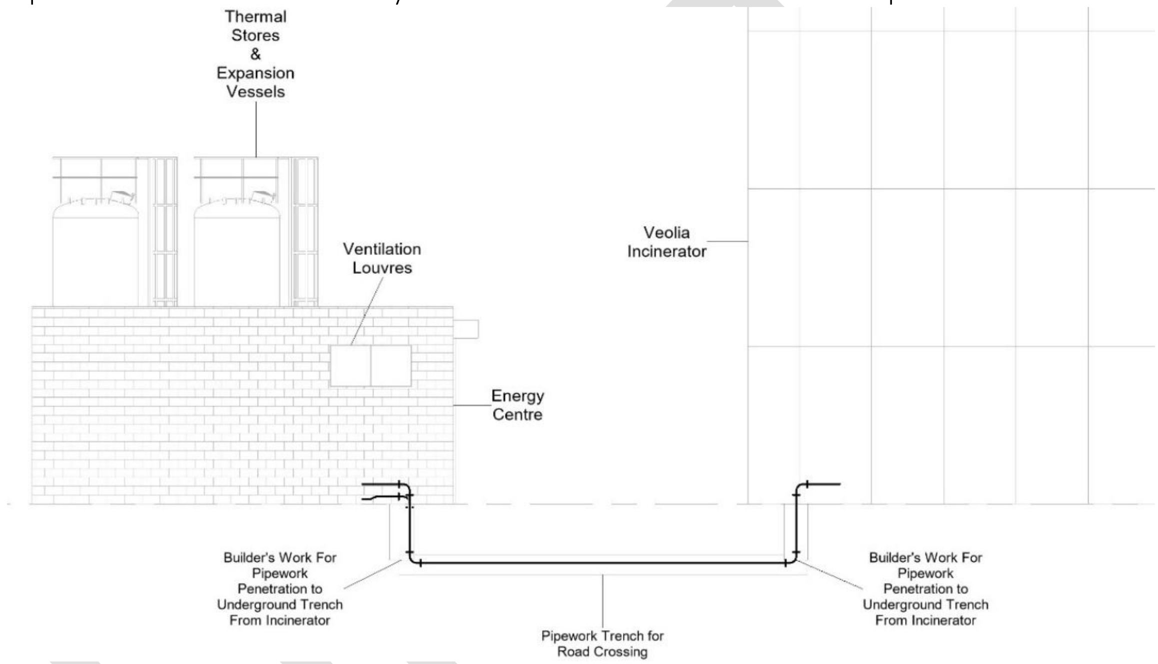


Figure 32 - Steam Pipework Road-Crossing Trench

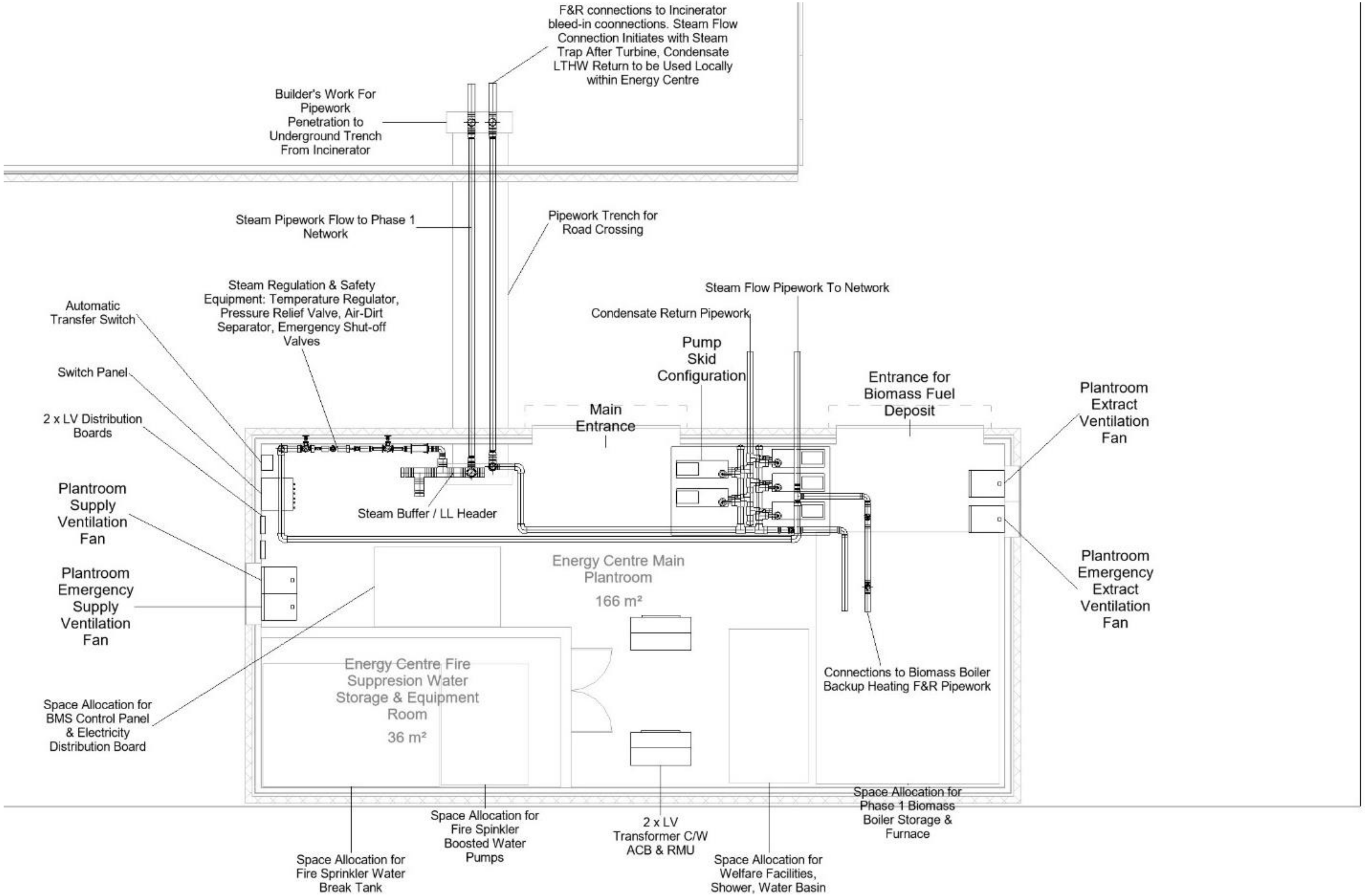


Figure 33: Scenario 1A plantroom layout

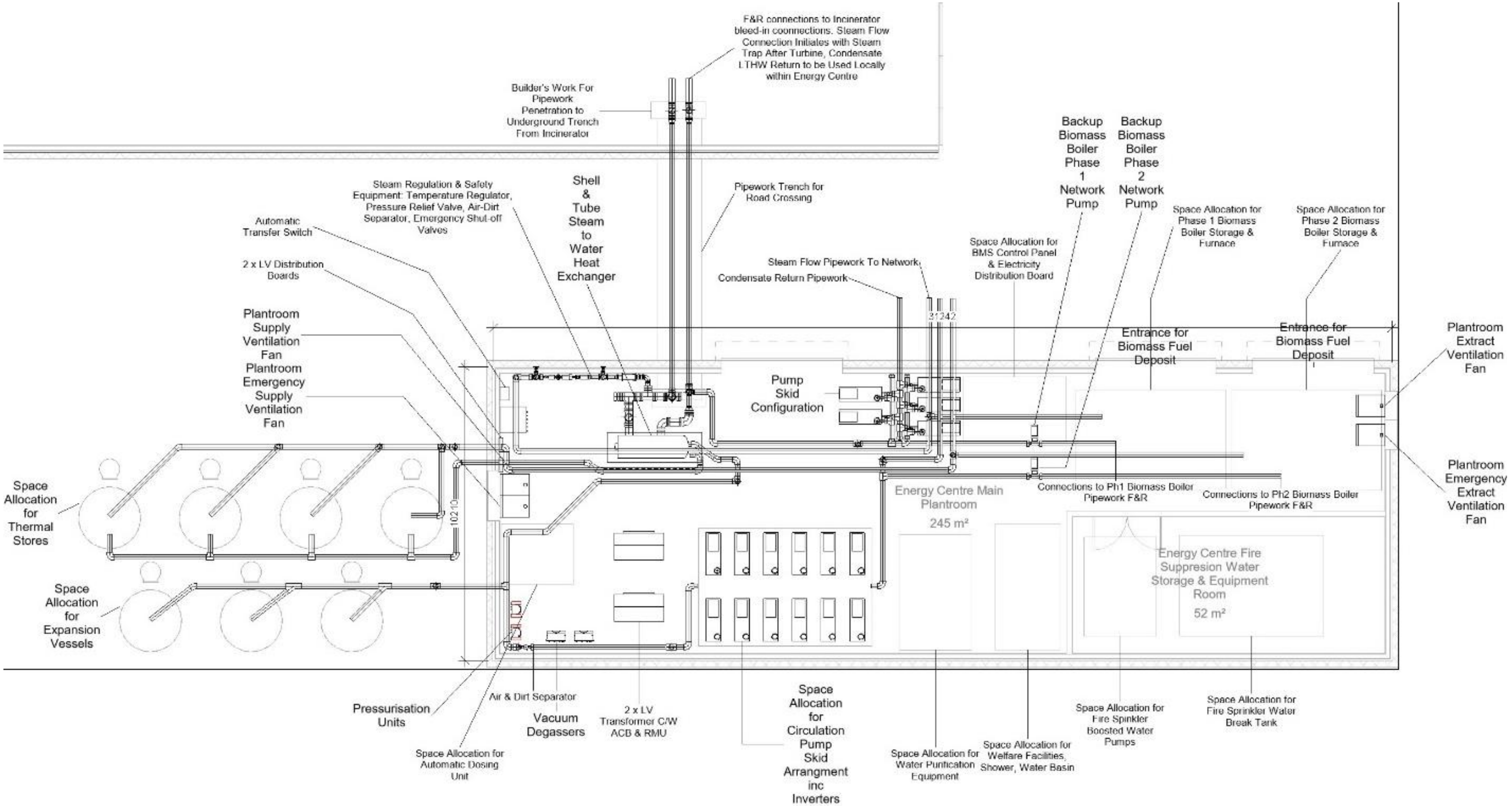


Figure 34: Scenario 1B plantroom layout

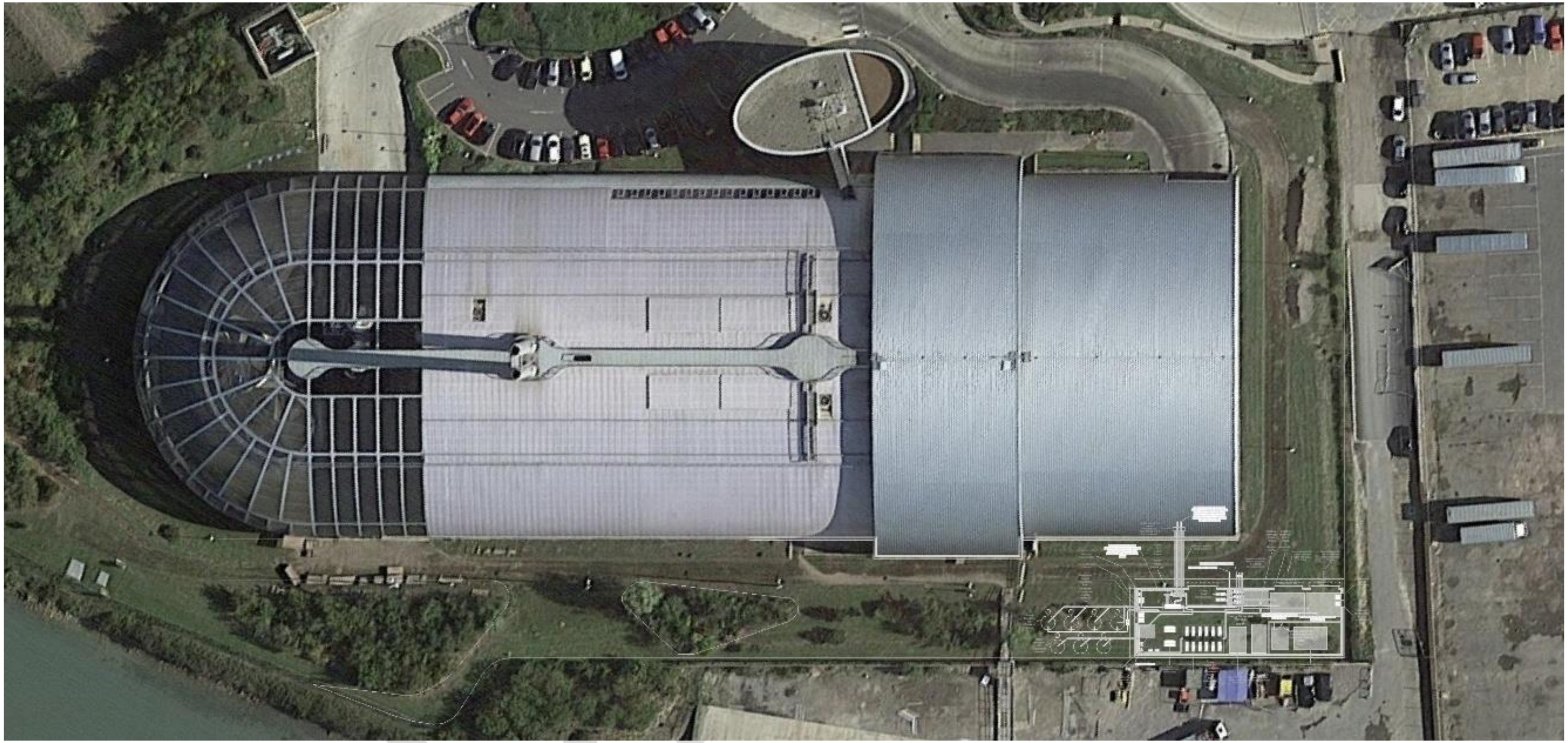


Figure 35: Scenario 1 plantroom in relation to surrounding buildings

Network Routing

The following details the Network routing for Phase 1A and 1B. Please note that Phase 1A is assumed to be above ground Steam pipework with Phase 1B below ground LTHW network.

Figure 36: Scenario 1 network routing

Electrical Implications Scenario 1A

Scenario 1A takes electrical power generated at 11kV from the Veolia EfW plant and uses it to drive the district heat network through its backup boilers, pumps and all necessary support equipment in the adjacent purpose-built plantroom. The scheme requires an 11 kV switch positioned in the EfW plant building and an underground cable routed to a 300 kVA transformer located in the new plantroom. A second transformer provides back up from UKPN during maintenance periods.

There are two further private wire options as part of scenario 1.

Option one involves taking an additional radial feed from the EfW plant to FM Conway. We know through stakeholder engagement that FM Conway used two generators to power their production process whilst they waited for an electrical service from UKPN; they were consuming between 650 and 700 kVA. To model this option, an allowance was made for an 11kV switch from the EfW plant, subsurface cabling routed to a small purpose built substation on the FM Conway boundary which would house a 1000 kVA transformer, a means of isolation, an air circuit breaker, an automatic changeover switch to serve as a resiliency feature during downtimes when power is to be imported from UKPN and an allowance to connect into their existing main LV panel. The subsurface cabling was costed at a premium due to the extra difficulty in dealing with the reinforced concrete road.

Option two involves forming a ring circuit from the EfW plant to pick up FM Conway and the Tarmac facility across the road. The cost is a little under double the price of option one. Being a ring, there is a cable that feeds out and one that returns to the EfW plant. This equates to double the cable length and two HV switches in the EfW plant plant. Furthermore, in order to make a successful ring, HV ring main units need to be incorporated at each site. Tarmac has been estimated to have a lower load with corresponding lower rated components but wired in a similar arrangement to FM Conway. The transformer is rated at 300 kVA, the air circuit breaker and automatic transfer switch housed in the purpose-built enclosure are all lower capacity. The construction of a ring circuit provides additional resiliency to the downstream connected sites. If a cable were to get damaged, the power could be rerouted around the other cable. This would cause only a short interruption to the power supply. It may be cheaper to put in a radial solution like in option one which would necessitate a single HV switch and single length of cable to travel to the two substations.

The makeup of the load at the FM Conway plant is unknown, only that in aggregate the maximum demand is between 650 and 700 kVA. A large portion of that that is thought to provide electrical energy to heaters within the six bitumen tanks to maintain the temperature between 170 and 180 Celsius. These are electrically heated but could be switched to a steam arrangement at a cost, including connectors and pipework, of approximately £110,000 each or £660,000 collectively for new tanks, a worse case scenario. There may be a small uplift to increase the diameter of the steam pipework and any supporting equipment. A small proportion of the power is assumed to drive motor loads, small power and lighting across the site. Since this is unlikely to be a large load, if the bitumen tanks were to be instead fed by steam the case for a private wire network becomes less viable.

Assuming the bitumen tanks remain electrically heated it has been calculated that a £220,000 private wire investment to FM Conway could be recovered within 1.3 years, representing a 75.6% rate of return. To arrive at this figure, the electricity sale price was calculated at 8.05p/kWh, there is a peak demand of 650kW for 8 hours a day, 5 days a week and that all the remaining time is considered to be off peak with a 500kW load to power the bitumen tanks. Integration with the industrial process is not part of this commission, so a Process Engineer would need to be engaged to verify this figure and the assumptions used in obtaining it. Using the BEIS 2020 non-domestic energy prices, the calculations have been rerun using the extreme cases of the 10% and 90% decile industrial electric sales figures. Because the business case is so compelling, altering these figures has little impact on the result.

Should the bitumen tanks be switched from electric heating to steam, there would be a relief on the private wire cost due to the lower rated equipment. It is estimated the cost would be around £166k. The simple payback period would become 12.4 years, representing an 8.1% rate of return on investment. To arrive at this figure, the electricity sale price was again calculated at 8.05p/kWh, there is a peak demand of 150kW for 8 hours a day, 5 days a week and that all the remaining time is considered to be off peak with a notional 10kW load to power perimeter security lighting and various other undefined loads. Re-running the calculations using the extreme electrical prices, simple payback can fall as low as 9.7 years and may make a slightly more persuasive case for investment.

Electrical Implications Scenario 1B

Scenario 1B base case closely follows scenario 1A in that there is a supply from both Veolia and a backup from UKPN serving the district heat network through its backup boilers, pumps and all necessary support equipment. Supply transformers are similarly sized for both scenarios but account has been taken in the uplift of additional equipment to support a heating network to the light industrial zone and costed to suit.

As an additional option, a 2000kVA substation has been modelled in the light industrial zone. An 11kV switch in the EfW plant provides a radial feed to an 800m long subsurface cable. The substation is self-contained in a purpose-built housing and comes with 12 outgoing ways, each of which can feed multiple business units. The cost of the land to site the substation has not been considered nor have the circuits from the substation to the business units. It is assumed that the tenants will pay for the trenching and installing of cable to make the connection to benefit from the lower electrical charges. Typically, a long cable would be taken from the substation and new consumers would pay to create a joint onto the cable. The tenant would also need to fund the cost of a change over switch in their demise to allow for an alternative supply from UKPN during maintenance periods. For a 100A three phase switch this will likely be in the region of £800 to supply and install.

The business case appears very promising. Assuming the district heat network is installed, the uplift to cross the railway line with cabling would be £30k for the horizontal drill and a further £15k for the preparation works. Add to that £266k for the supply and installation of a 2MVA substation described above, it would come to a grand total of £311k.

With a business to business sale price anticipated to bring in a revenue stream 4.7p/kWh above that offered by the gird, a total of 6.639 GWh needs to be consumed to recoup the investment. Selling 1.3278 GWh a year would see the initial investment returned within 5 years. A transformer of this size could in theory handle 17.52 GWh annually and would only need to run at just 7.58% of its potential continuous throughput. Although the overall demand of the light industrial zone is unknown, it can be reasonably assumed that with 12 utility transformers covering the area, demand for a cheaper service could prove popular and that the return on investment could be quick.

Therefore if sufficient thermal load can be aggregated to facilitate the railway crossing from, industrial tenants, it is recommended that a private wire electrical solution continues to be investigated as an additional revenue stream for the facility, making use of the economics of scale to cross the railway and install electrical infrastructure alongside the heat network.

Commentary

The intent with Scenario 1 is to initiate district heating from the large Municipal EfW plant with the supply of industrial process heat load to adjacent high-grade heat users. Please note that Anthesis are not process engineers, and this solution requires interrogation and likely adjustment by such professionals to tailor a solution that meets both the process needs of the EfW facility, as well as the manufacturing requirements of the adjacent asphalt plants.

As the Asphalt plants operate at above 100 C additional risks arise from using water as a heat transfer medium, for example the risk of steam explosions. Heat is required for a number of purposes within the asphalt facility, primarily to maintain bitumen in its liquid form at circa 200C. Additional loads may include drying aggregate whilst in storage, and prior to manufacture, as well as heating during the production of asphalt. This last operation is currently undertaken using an 18MW burner operated on fuel oil, representing a substantive heat load. Understanding if and how this process may be facilitated with alternative heat sources e.g. steam is likely to be key to understanding the economics of this scenario. This detailed process engineering aspect is beyond the remit of this study.

This high-grade heat requirement has driven the assumption of a Steam system within the north Quay area to serve the industrial loads. As this is an industrial zone, it has been assumed this system is routed above ground to minimise cost and facilitate maintenance.

The aspiration would be to attract additional high-grade heat users to the quayside in the future to make use of the Low Carbon heat available at this location.

For the second stage (Phase 1B) it has been assumed that heat at <100C is required to displace thermal loads within adjacent industrial estate across from the railway. Therefore, this stage assumes that LTHW is generated from steam within the scenario 1 plant room as distributed to the industrial area. The aim would be to maintain consistent operation parameters for the LTHW network with Scenarios 2 and 3 (i.e. temperature, pressure etc), to allow future integration across the Newhaven area in the event that this becomes economically viable. The buildings in Phase 1B are existing structures, therefore have an associated risk of requiring higher flow temperatures and returning heat at higher return temperatures than the ideal for efficient heat distribution. It is assumed that these would in time be retrofitted with low temperature heat emitters to facilitate increased network efficiency and bring these in alignment with the lower operating temperatures likely achievable in Scenario 2 and 3 from the outset.

Both systems are proposed to have redundancy and/or backup from biomass boilers and spatial allowance has been made for these within the plantrooms. It would be anticipated that the EfW plant would close down for 1-2 weeks per annum for planned maintenance, assumed within the summer months on top of any unplanned downtime. The biomass facilities are proposed to stand in during these occasions and maintain a heat supply for end users.

Scenario 2 – Detailed proposal

The following table details the approach for scenario 2.

Table 6: Feasibility Approach for Scenario 2

Proposal	Summary
Energy centre location	Adjacent to existing CTEC plant within Newhaven, preferentially with access to dock and rail system (where feasible) to facilitate bulk fuel handling. Note the existing EfW represents a 3rd party hosting of energy production plant.
Energy Centre Primary Plant assumptions	Low Temperature Hot Water generation from CTEC plant. Biomass LTHW boilers for redundancy/backup and to assit with any peak loads
Future low carbon transition	Dependant on decarbonisation of waste stream. Sustainable sourced biomass is general considered a low carbon fuel, however this may require some embodied emissions within this fuel to be offset in some manner
Private Wire Opportunities	Private wire supply to the existing Private Wire Harbour electrical supply system proposed
Network type	Below Ground Low Temperature Hot Water system
Network Parameters	LTHW network assumed to be a 4th generation system, with flow temperatures <100C, preferentially variable to <70C with 40 C returns targeted to protect for future expansion
Significant network obstructions	Mill Creek, Network Rail mainline, A259 coastal road
Phasing	Any network phasing to match development phasing within the area, as the proposed system only serves new build assets
Counterfactual	Individual marinized air source heat pumps within each housing's demise.

Plant Room

The following details the assumed plant room layout for Scenario 2. Please note, this assumes that the CTEC facility continues operation and is maintained within the adjacent industrial building. The CTEC heat recovery pipework runs from the CTEC turbine to a plate heat exchanger within the energy centre via builder's work. The LTHW is then stored in 440,000L of thermal storage before distribution to the network. A 600kW biomass boiler is connected to provide resilience.

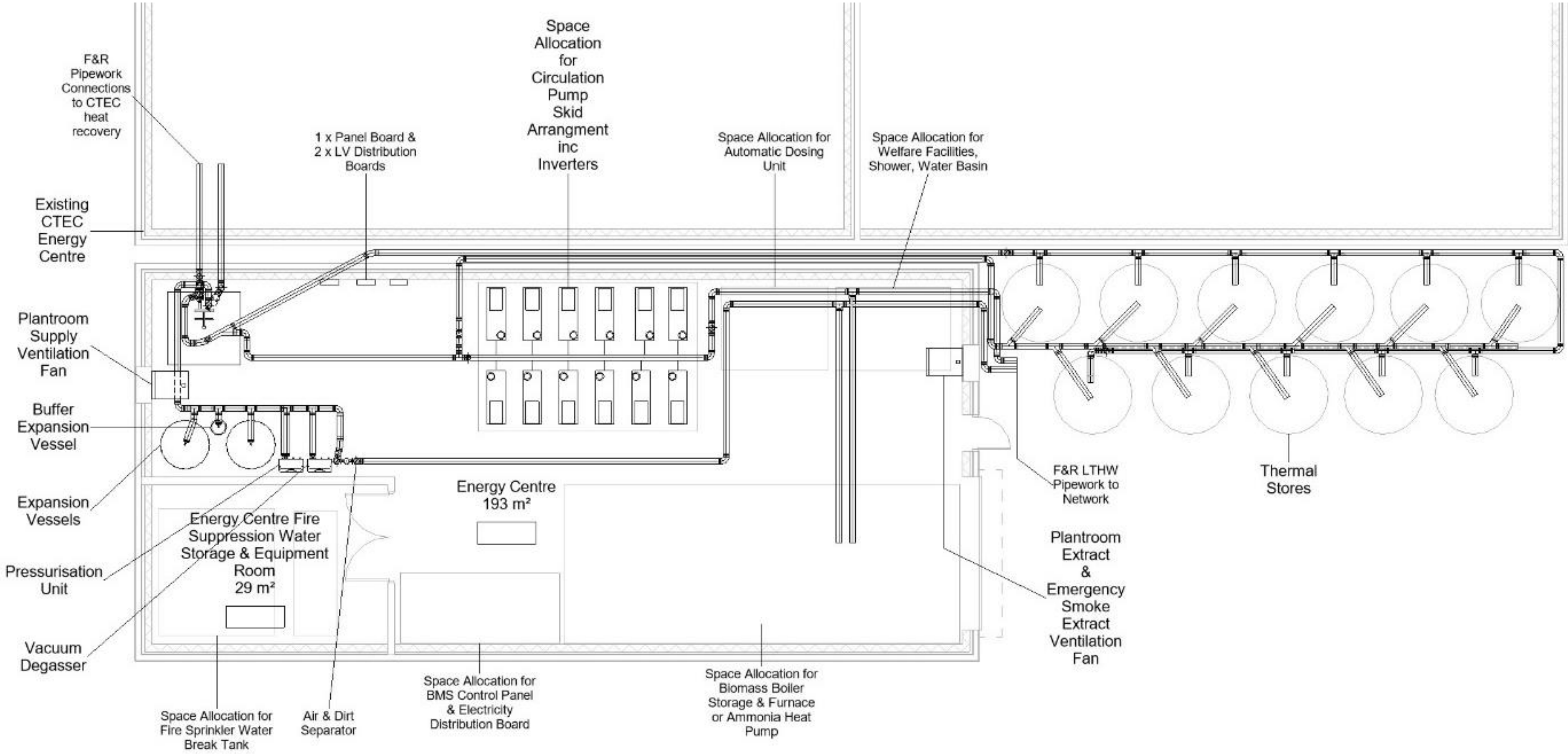


Figure 37: Scenario 2 plantroom layout

Figure 38: Scenario 2 plantroom in relation to surrounding buildings

Network Routing

The following details the Network routing for Scenario 2.

Figure 39: Scenario 2 network routing

Electrical Implications

As mentioned elsewhere in the report, electricity is already being exported to the local harbour private wire network by CTEC tariff free on an experimental basis. CTEC have carried out a cost benefit analysis for the inclusion of a second plant on their existing site which has shown a demonstrable business case to proceed. Agreement has been reached with the Port Authority to sell electricity into their private wire network at an undisclosed rate with investigations ongoing into selling the hot water to new local developments. Since the electrical infrastructure is already in place barring a possibility for some small upgrade costs to export onto the private wire, the costs are likely to be negligible in proportion to the scheme and are covered by CTEC's own existing business appraisal therefore have been negated.

The electrical infrastructure costs to introduce new switchgear and a purpose-built plant room have been considered in the techno economic model. This electrical equipment will, as in the other scenarios, drive the backup boilers, pumps and all necessary district heat support equipment. The prescription of a cost would assume it is free to just dump excess heat in a counterfactual exercise, but this view is incorrect since a cost needs attributing to heat removal whether it be by pumping river water, pumping through a radiator or some other method. This serendipitously increases the favourability of the DHN business case. In conclusion, the cost of the electrical provision to drive this scenario is low and is unlikely to have a bearing on the overall economics.

Counterfactual Electrical Considerations

The counterfactual requires one large heat pump to the hotel and an individual heat pump to each household. For each household, the electrical cost runs into the low hundreds to cover the installation of a miniature circuit breaker, cabling, containment and local isolator. There will be no upgrade to household incoming utility fuses. Whilst there are no further implications on individual dwellings, by disregarding the district heat network and a gas main, the local network electrical supply will need bolstering to account for the increased aggregate demand and will have a bearing on the infrastructure. Based on an 11kW thermal heat pump, it is believed household electrical demand will rise by almost 4kW. Across the 456 homes, this will add over 1.6MW demand to the network and will necessitate additional substations. The uplift in cost for these two substations would be in the order of £150k. The hotel too will require an extra supply; this is estimated to cost around £85k. These costs do not include for any further upgrades arising from additional demand for electric vehicle charging, which do not form part of this study, but may also drive an increase in even more electrical infrastructure deployment at additional cost.

Commentary

The intent with Scenario 2 is to make use of the existing CTEC medical waste plant within the Newhaven harbour area. This is a novel technology using Pyrolysis to produce thermal energy from medical waste, which in turn is used to produce electricity in a steam turbine. Currently electricity generated by the system is sold to the harbour private wire network at a commercial rate. It is not thought that the public electricity network extends to this area of the docks, therefore sales to this system are not possible. In part this arises from the difficulty in accessing this dock area, which is separated from Newhaven by the railway system and the Mill Creek.

A new access road and bridge to this part of the harbour provides an opportunity for alternative access routes to the plant, both for fuel delivery but also infrastructure deployment. It is proposed that this is used to access areas of New build development proposed on the East side with a 4th Generation type District heating system using LTHW. This is likely to be able to be operated at temperatures lower than 70C flow assuming that all new build developments are constructed with emitters operating below 55C and instantaneous Domestic Hot Water system, e.g. Heat Interface Units. However it is recommended that the system is made compatible with that of Scenario 1, with the ability to operate at temperatures up to 90C intermittently, to retain the ability to serve existing buildings in the area, as well as protect in the future a link up across town and the A259 to the system in Scenario 1.

The cost uplift for district heating pipework may be offset by the additional cost of installing whatever alternative Green Infrastructure would be required to facilitate development, for example a reinforced electrical network (to facilitate heating and vehicle charging) or in place of a piped gas network.

Preferentially the system would be run by a professional industrial operator, for Example, CTEC itself to facilitate high levels of service, availability, and efficiency.

Scenario 3 – Detailed proposal

The following table details the approach for scenario 3.

Table 7: Feasibility Approach for Scenario 3

Proposal	Summary
Energy centre location	A new energy centre would be required encompassing an additional CTEC unit, with backup thermal generation and electrical equipment to facilitate exporting electrical energy to the surrounding local area. Note the existing facility represents a 3rd party hosting of energy production plant.
Energy Centre Primary Plant assumptions	Low Temperature Hot Water generation from CTEC plant. Biomass LTHW boilers for redundancy/backup and to assist with any peak loads
Future low carbon transition	Dependant on decarbonisation of waste stream. Sustainable sourced biomass is general considered a low carbon fuel, however this may require some embodied emissions within this fuel to be offset in some manner
Private Wire Opportunities	Not proposed, Private wire sales would be to the local District Network Operator.
Network type	Below Ground Low Temperature Hot Water system
Network Parameters	LTHW network assumed to be a 4th generation system, with flow temperatures <100C, preferentially variable to <70C with 40 C returns targeted to protect for future expansion
Significant network obstructions	River Ouse
Phasing	Any network phasing to match development phasing within the area, as the proposed system only serves new build assets
Counterfactual	Individual marinized air source heat pumps within each housing's demise. Communal Air Source Heat Pumps serving apartments in the Mariner area

Plant Room

The following details the assumed plant room layout for Scenario 3. It is noted that this is likely to require the potential acquisition and demolition of existing structures within the industrial area. Spatial allocation has been given to the proposed CTEC plant adjacent; this has been included in-line with the published CTEC plantroom estimates. Whilst spatial allocation has been included within the site planning analysis, the CTEC construction in its whole has not been included as part of the costing exercise, as it is considered a separate entity undertaken by CTEC. The CTEC heat recovery pipework runs from the CTEC turbine to a plate heat exchanger within the energy centre via builder's work. The LTHW is then stored in 440,000L of thermal storage before distribution to the network. 2 No. 600kW (1,200kW total) biomass boilers are connected to provide resilience. A new electrical substation is drafted as part of the energy centre.

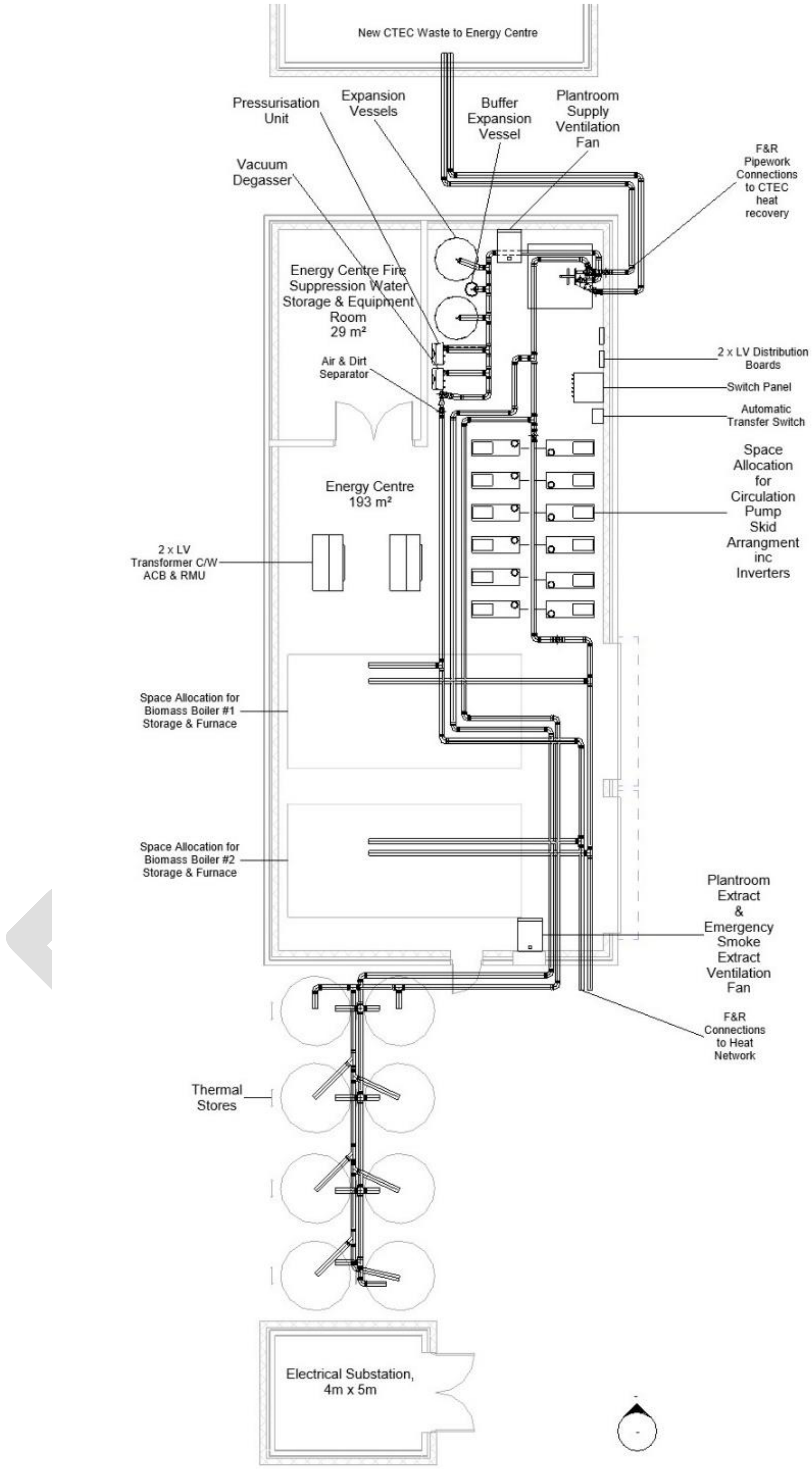


Figure 40: Scenario 3 plantroom layout

Figure 41: Scenario 3 plantroom in relation to surrounding buildings

Network Routing

The following details the Network routing for Scenario 3.

Figure 42: Scenario 3 network routing

Electrical Implications

CTEC's modular plant electrical outputs are modest at 300kVA. This scenario deals with a single plant to the West of the River Ouse and is planned to serve the Marina and Harbour Heights with hot water. For the purpose of this exercise it is assumed to be located in the Quarry Road Industrial Estate. Given the long cable runs in excess of 700m, a number of detrimental factors come to the fore when distributing at low voltage. Beyond 500m it becomes difficult to provide power with adequate protection and within suitable tolerances; one would be better advised to convert to HV. Taking the Marina in isolation, the capital cost of transforming to HV and subsequently transforming down again after 700m would be in the order of £232k. There is then the cost of distributing out to the different apartment blocks and synchronising with the grid. Due to licensing restrictions, it is not possible to sell the energy directly to domestic consumers so it would have to be operated and maintained by an Independent Distribution Network Operator, IDNO.

Industry practice suggests a maximum demand of 3kW for a non-electrically heated apartment. This implies a maximum 100 apartments could be connected to a 300kW source, but in reality, because of the grid connection to assist with the changing demand profile throughout the day, the full development could be connected. It would be beneficial to consume as much "cheap" energy from the EfW plant where possible so that only the bare minimum is returned to the grid at a lower sale price.

Based on a mixture of 2 and 3 bedroom apartments, figures from the Government regulator OFGEM would suggest an annual demand of 0.846GWh which is not enough to consume the 2.5GWh generated. It thus means there is a large component that would be exported back to the grid at a lower rate.

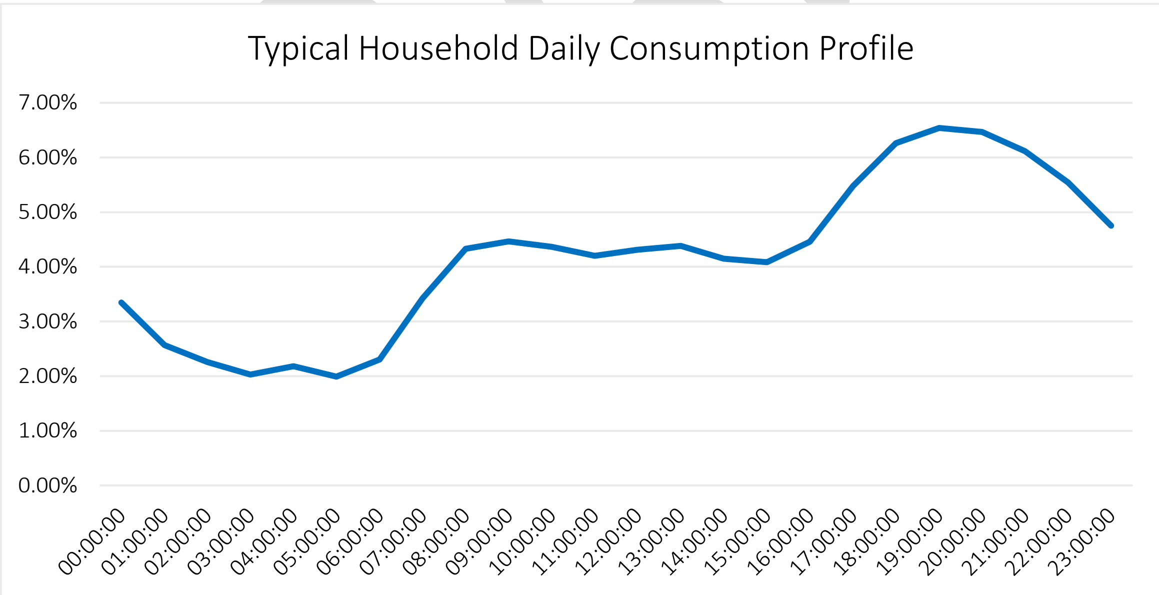


Figure 43: Typical daily demand profile as a function of time for a typical British family home

Energy shipper, OVO, provides results on its website showing load consumption data averaged between 250 typical British homes in 2012. Using this dataset and applying it to the Marina, it was observed that all apartments could be serviced but 1.65GWh would be exported to the grid at a lower rate. When summed, the difference in revenue from full sales to the grid and selling a portion at 9p/kWh to the IDNO comes in at circa £64.5k making a simple payback in the order of 15.9 years. Considering ongoing maintenance costs are to be added, this is unlikely to be an attractive proposition. Whilst there are more homes to sell energy to at harbour heights, it is believed the business case will not be hugely different. Furthermore, because of the lower housing density and distances involved, there would be a need for additional substations to counteract the long LV cable runs discussed earlier; this only serves to elevate the initial cost of investment.

There is a counter argument which suggests the payback could be accelerated if the IDNO chose to increase their margin by not passing on any price advantages to the end users. Additionally, because the private wire will extend into all apartment blocks, the scope of UKPN's network could be reduced pushing the savings elsewhere in the wider business case, probably to the property developers.

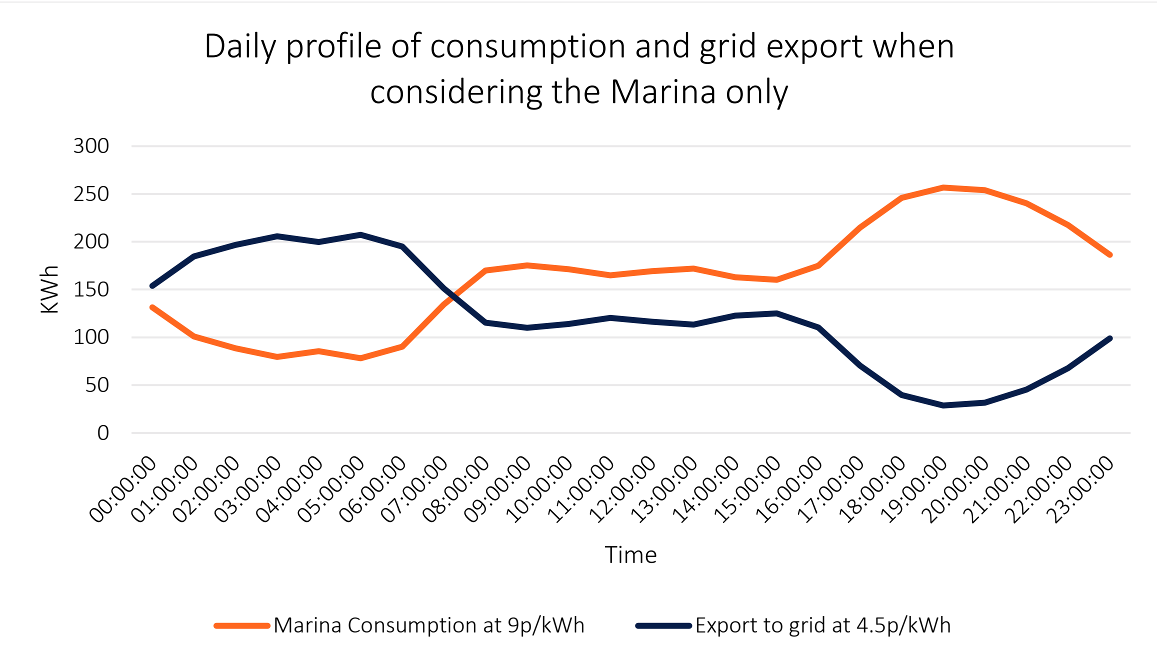


Figure 44: Predicted power consumption by domestic apartments at the Marina and exports back to the grid over a typical day

Provision for a 300kVA substation has been allowed for within the TEM model to facilitate the import and export of power to the grid directly from the EfW plant. Exporting power to homes via an IDNO is thought an unlikely investment prospect. There is already an active transformer on the industrial estate, but its spare capacity has not been determined. Should there be capacity which can be used in lieu of constructing a new £59k substation, the business case for an EfW plant would become more favourable.

Counterfactual Electrical Considerations

Part of the counterfactual scenario relies on landlord heat pumps in the individual apartment blocks. The connection cost for a utility supply will depend on its distance from the existing infrastructure, the spare capacity of that infrastructure and whether upgrades are required. In order to establish this, a study would need to be carried out by UKPN. For this exercise it assumed that there is capacity in the network and the uplift in cost is solely for providing additional power to support the heat pumps. It is estimated a cost of £478k would be incurred for the three 1000kVA transformers and associated equipment.

The counterfactual for Harbour Heights relies on individual households using a spare way in their consumer unit to supply their own heat pump. The cost runs into the low hundreds and there will be no upgrade to household incoming utility fuses. Whilst there are no further implications on individual dwellings, by disregarding the district heat network and a gas main, the electrical supply will need bolstering to account for the increased aggregate demand and will have a bearing on the infrastructure. As previously discussed, the capacity of the local DNO's network is unknown, but assuming availability, there will be either the need to increase transformer size or transformer quantity. Increasing transformer size would generally be the cheaper option as it avoids equipment duplication but UKPN have in the past been keen to standardise transformer sizes. In the instance of a transformer failure, standard sizes ensure replacements are shelf-ready allowing substitutions to be rapidly implemented. OFGEM encourages rapid rectification to outages using penalties as a disincentive to a tardy response. It is thus that DNOs like UKPN often restrict maximum transformer size to 1000kVA. Running with this constraint and using a figure of 9.99KVA per dwelling with electric heating in lieu of 5.5kVA per dwelling without, over 700 dwellings one would expect a further three 1000kVA substations costing in the region of £225k. Again, these assumptions do not include for any other foreseeable additional demand, for example arising from vehicle charging arising within these properties, which may require additional electrical infrastructure at additional cost.

Commentary

Scenario 3 represents a full new build deployment of a district heating system on the West bank of Newhaven to serve two potential major areas of redevelopment, Harbour heights and the mariner. Harbour heights in particular is a development on open land that will require the deployment of new energy infrastructure in all development scenarios. This offers the opportunity for a district heating network to displace a piped gas network or potentially offset additional reinforcement of the electrical network that may be required for heating or vehicle charging.

This would be combined with connection to proposed development of residential apartments at the nearby Mariner.

CTEC have indicated that given the right economic circumstances they may wish to deploy a second medical EfW plant within Newhaven. Considering the interconnection of the two schemes a logical deployment of an energy centre would be at the nearby Quarry Industrial estate, approximately midway between the developments. As CTEC represents an industrial enterprise this would not require deploying industrial systems in other residential areas and would likely simplify planning applications.

This facility would require a full build out as no element of it currently exists, including any local electrical upgrades required for exporting the electrical energy produced. This therefore represents the largest energy centre (as a new build element) across the 3 scenarios, which may require the procurement of land and clearance of existing facilities to facilitate.

Techno Economic Model

Anthesis have constructed a FAST compliant Techno Economic Model (TEM) to further investigate the scenarios proposed as part of WP1 over 40, 30 and 25 year lifetimes.

Business As usual

Business as usual has been modelled against each of the current (where existing) or alternative (where new build is proposed) pathways to a District energy approach.

Under Scenario 1, the FM Conway industrial facilities that form Phase 1a are known to utilise heavy fuel oil for asphalt production, therefore this has been assumed as the Business as usual approach. Properties in the adjacent industrial estate which are within Phase 1b are assumed to receive thermal energy supplies via the gas network, therefore business as usual is assumed to be these systems allowing for typical conversion efficiencies and fuel costs for existing buildings of this usage type.

For Scenarios 2 and 3, as these are new build properties the Counterfactual is assumed as described under Work package 1, i.e. marinise Air Source Heat Pumps, on the basis that future connections to the national gas grid infrastructure will be limited for new build properties.

CAPEX

Capital costs have been estimated from a range of sources, including quotations from suppliers and cost databases. Notional percentages have been included for items such as design, construction and programme management to estimate the costs of these additional professional services. Where required, preliminaries, overheads and profits have been added to quotations to amend these to construction costs from single equipment quotes. CAPEX has been corrected for Region, the current price of copper (where relevant) and accounting for construction inflation, where historic data is used. Full breakdowns are available in Appendix .

Pipe network costs from energy centres were estimated using the hydraulic models (further details in Appendix D) which provided estimated pipe sizing, accounting for hard and soft dig areas, or above ground distribution (where feasible)

For the Counterfactual cost estimates for the installation of heat pumps in new build were sourced from Currie and Brown's 2019 report to the Climate Change Committee, allowing for larger radiators, thermal storage and allocated according to property type (e.g. small house, flat etc). Apartment buildings as found for example in the mariner proposal were assumed to be communal heat pump systems, whilst individual houses had their own individual heat pump integrated on a per property basis. Allowance was made for minor electrical capital costs per property where heat pumps were installed, additional electrical switchgear and equipment for centralised communal systems and the additional electrical infrastructure expected over and above a level anticipated where gas fired heating is prevalent.

OPEX

Operational energy consumption was estimated using scenario models built within EnergyPRO software. These include constant thermal loads (e.g. Hot water) and variable temperature dependant loads (e.g .space heating), which are tailored to represent occupation or operational hours or

Operational costs of energy centres and their heat networks were estimated from government sources and Anthesis's historic industrial experience for some systems where public data is lacking.

Plant maintenance costs for both the municipal and CTEC Energy from Waste were not included within these models, as they are considered to form part of the existing business case for these facilities excluding the sale of heat, as this is how both existing facilities are operated.

Within the counterfactuals allowance was made for an annual inspection and planned maintenance of thermal stores and heat pumps, based on a manufacturers quote.

REPEX

The economic lifetime of components has been estimated in general from referenceable sources, for example CIBSE Guide M appendices. At the defined end of life of the equipment and additional capital sum equivalent to the initial sum is allowed for in that year to account for the replacement of the equipment. This is consistent across the scenarios tested and the counterfactuals

Scenario Results: IRR and NPV

Scenario 1

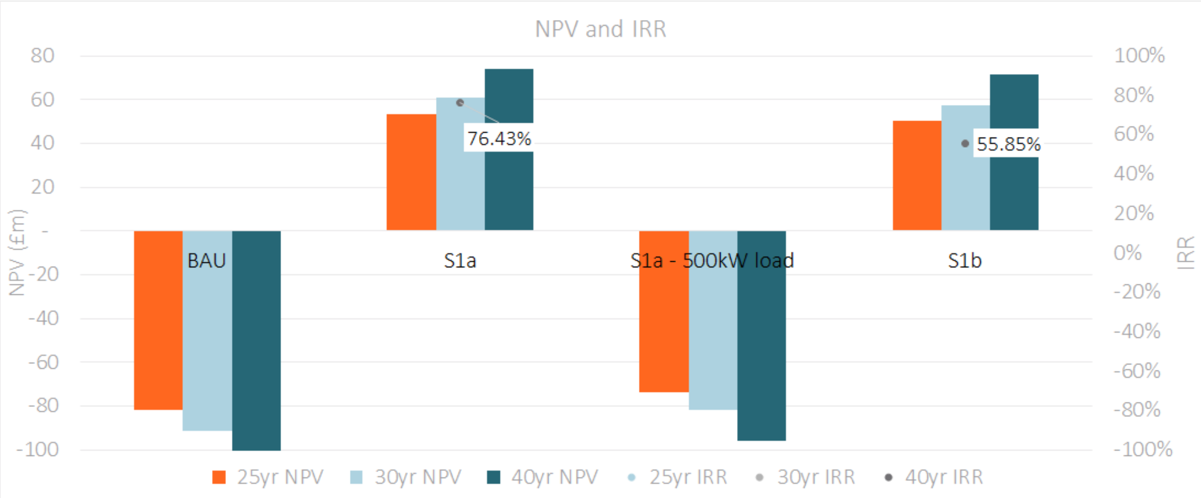


Figure 45: NPV and IRR for Scenario 1 phases 1a and1b

Table 8: NPV comparison against Counterfactuals in scenario 1

Financial Metrics	BAU	S1a	S1a - 500kW load	S1b
25yr NPV (£)	(81,845,346)	53,496,429	(73,966,983)	50,521,476
30yr NPV (£)	(91,623,114)	60,719,126	(81,847,232)	57,552,737
40yr NPV (£)	(109,521,967)	74,097,887	(95,868,080)	71,332,985
25yr IRR	#N/A	76.43%	#N/A	55.85%
30yr IRR	#N/A	76.43%	#N/A	55.85%
40yr IRR	#N/A	76.43%	#N/A	55.85%

Scenario one's results are presented in Figure 46 and table 8. All the scenarios modelled were an improvement on Business As usual. To understand the relationship between bulk heat supply to the FM Conway plant this was modelled with an upper and lower heat bound. The upper bound (S1a) assumes that the heat for the asphalt process currently produced by a large 18MW oil burner may be substituted by high temperature steam from the EfW plant. Please note, there are significant technical assumptions for both process plants with regards to this type of integration, which have not been explored by Anthesis as they lie outside of our areas of engineering expertise. However, from purely an energy perspective there are no obvious barriers to thermal transfer of this quantity of energy from one facility to the other by the use of steam or an equivalent medium. Additionally, bitumen warming of 500 kW is assumed which may also be met from this source. Additional drying loads for aggregate storage at this facility have been excluded as this additional opportunity is not the current business practice. Therefore, it would likely improve the business case, but not be comparable to existing operations.

What this scenario indicates is should it be technically feasible from a process perspective to supply heat from the municipal EfW plant to the asphalt plant there appears to be a significant business case opportunity to explore, with a high level of NPV and IRR in comparison to business as usual. It should be noted that this also removes an estimated 500 kW electrical load from the existing plant, changing the business case for a Private Wire connection from the facility as previously discussed.

The IRR for a private wire appears similar to the steam system, however the quantum of revenue for the steam system to the EfW plant is much larger as it takes on meeting part of the heating load currently provided for by burning oil. Therefore, it is likely that the steam transfer (if technically feasible, and fully costed) would be more attractive to both operators than private wire, as well as substantially reducing the case for a Private wire connection.

To test a lower bound, in the event that the larger burner could not be superseded by a steam supply a second scenario 1a was run with only 500 kW of thermal load, representing the 'keep warm' demand of the bitumen tanks. This is labelled S1a – 500 kW load. As may be observed this results in a substantial impact in the business case with better NPV to business as usual, but with a long term negative NPV. This suggests that in the event steam cannot be used as part of the asphalt production process a much closer review would be required of the merits of steam over a Private wire. The private wire electricity revenues were estimated at £220k pa, with a steam equivalent of £283k pa. The Steam system is expected to have a larger capital investment requirement; therefore, the comparative merits of each approach would need closer inspection to determine the economically most attractive route for investment.

Scenario 1b represents further sales of industrial heat to facilities across the railway from the EfW plant. This has a positive IRR and NPV, however it may be seen these are lower than Scenario 1a (including heat offsetting the burner). Therefore, this extension is worsening the business case for heat supply in comparison to direct bulk heat sales to FM Conway, although this may increase financial resilience by generating revenues from multiple additional consumers at this location.

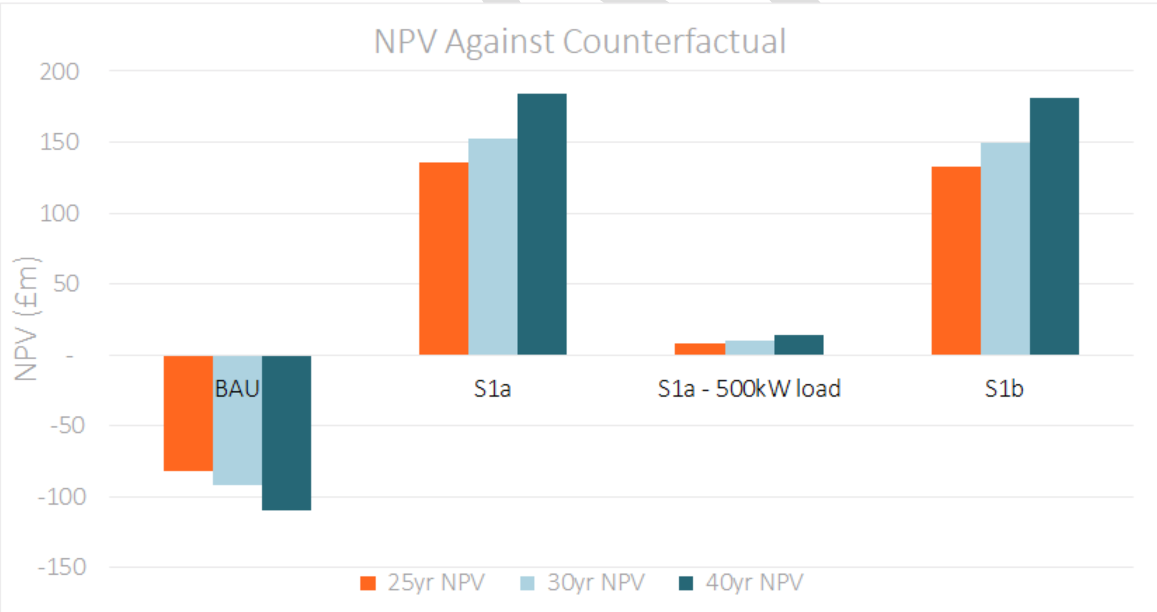


Figure 46: Graph of NPV Against the counterfactual for Scenario 1

Table 9: Table of NPV Against the counterfactual for Scenario 1

Value Against Counterfactual	BAU NPV (No comparison)	S1a	S1a - 500kW load	S1b
25yr NPV (£)	(81,845,346)	135,341,775	7,878,363	132,366,822
30yr NPV (£)	(91,623,114)	152,342,241	9,775,883	149,175,851
40yr NPV (£)	(109,521,967)	183,619,854	13,653,888	180,854,953

When the NPV for Scenario 1 is compared against the counterfactuals, the positive business case for all scenarios is easier to observe. All iterations have a positive value, even the low load 500 kW proposals in the long run. The NPV of this scenario is dragged down by the continual purchase of oil for the large burner previously discussed in this section. The transfer of large quantities of process heat to supersede this heat demand continues to be the major opportunity under scenario 1.

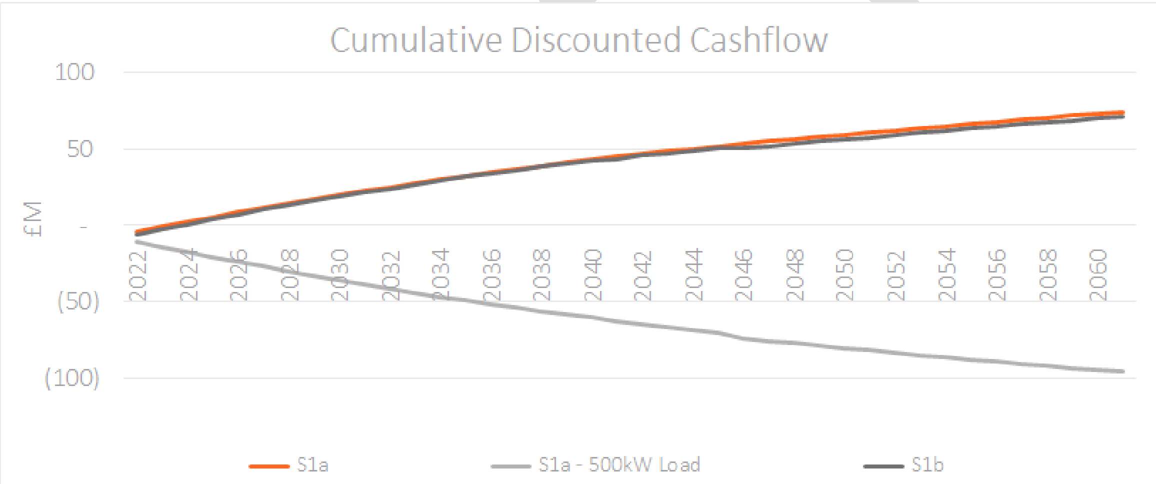


Figure 47: Cumulative Discounted cashflow for Scenario 1

Reviewing the Break even point in cashflow, Phase 1a and 1b of scenario 1 have the opportunity to payback within the order of 3 years, which is in the order of magnitude of a conventional business case. Please note scenario 1a and 1b's cashflows are quite similar leading to some overlaying of lines on the graph in Figure 48 This is less likely to occur in reality with scenario 1b, as it assumes all parties sign up and connect within the industrial site at the onset of the project, which is unlikely to be commercially achievable. However as it is likely this result is biased by the single large consumption opportunity from FM Conway, this is much more likely to be the case in Scenario 1a, as it only requires the direct agreement of two commercial parties.

Scenarios 2 and 3

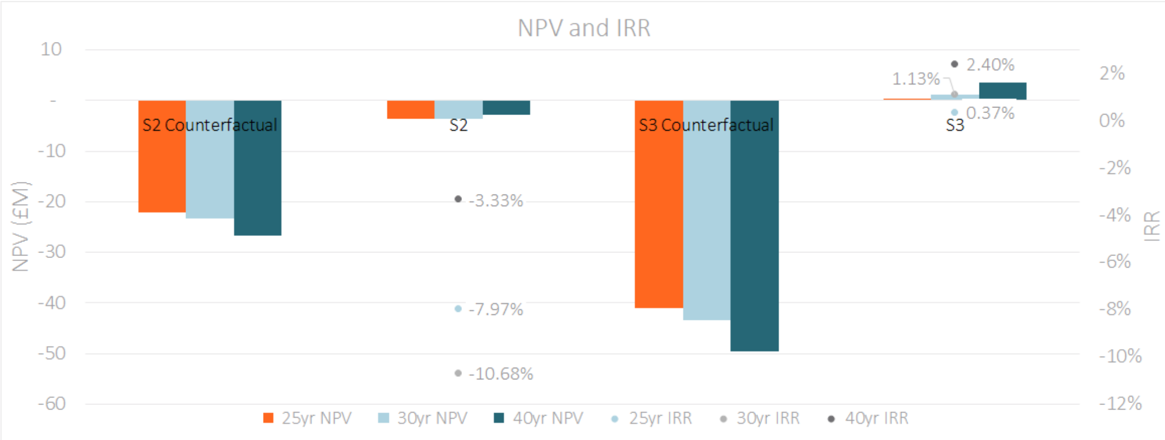


Figure 48: Graph of NPV and IRR for Scenario's 2 and 3

Table 10: Table of NPV for scenarios 2 and 3

Summary Stats	S2 Counterfactual	S2	S3 Counterfactual	S3
25yr NPV (£)	(22,209,638)	(3,685,533)	(41,038,419)	333,846
30yr NPV (£)	(23,294,278)	(3,712,766)	(43,379,800)	1,169,126
40yr NPV (£)	(26,683,314)	(2,800,850)	(49,673,633)	3,569,547
25yr IRR	-	-7.97%	-	0.37%
30yr IRR	-	-10.68%	-	1.13%
40yr IRR	-	-3.33%	-	2.40%

Figure 48 and Table 10 details the financial performance of Scenario's 2 and 3 against their counterfactuals. As may be seen, the counterfactuals have a poor business case, as they represent an initial capital investment followed by continual outgoing energy and operational costs to run the system. No revenue streams are available and RHI has been assumed not to be obtained given the potential timeframes of the new development.

By comparison, both scenario 2 and 3 have improved business cases in comparison to the counterfactual. Scenario 2 is still a negative NPV, but is a substantial improvement on the counterfactual. Scenario 3 represents a positive NPV and IRR across the 3 timeframes. The key differential appears to be the quantum of heat sales. Broadly speaking scenario 2 and 3 are the same modular EfW facility, however Scenario 3 has substantially higher heat sales to both the Mariner and Harbour heights. It is believed this is a key difference in the business case, and highlights the requirement to maximise heat sales for a given investment in order to optimise the business case for these systems.

for the initial investment, therefore grant funding, a developer contribution or connection charges to properties are likely to improve this case, by reducing the initial capital investment sum required.

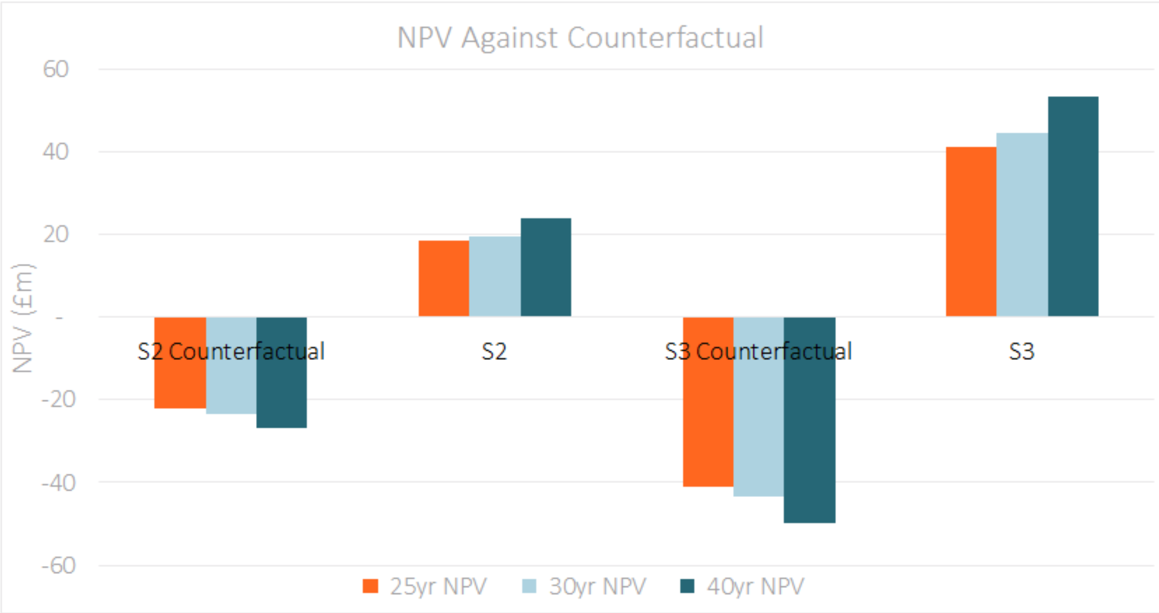


Figure 49: NPV against Counterfactuals for Scenarios 2 and 3

When compared directly against the counterfactual the NPVs for both scenarios are more obviously positive, though neither are as attractive as the process heat opportunity identified in scenario 1.

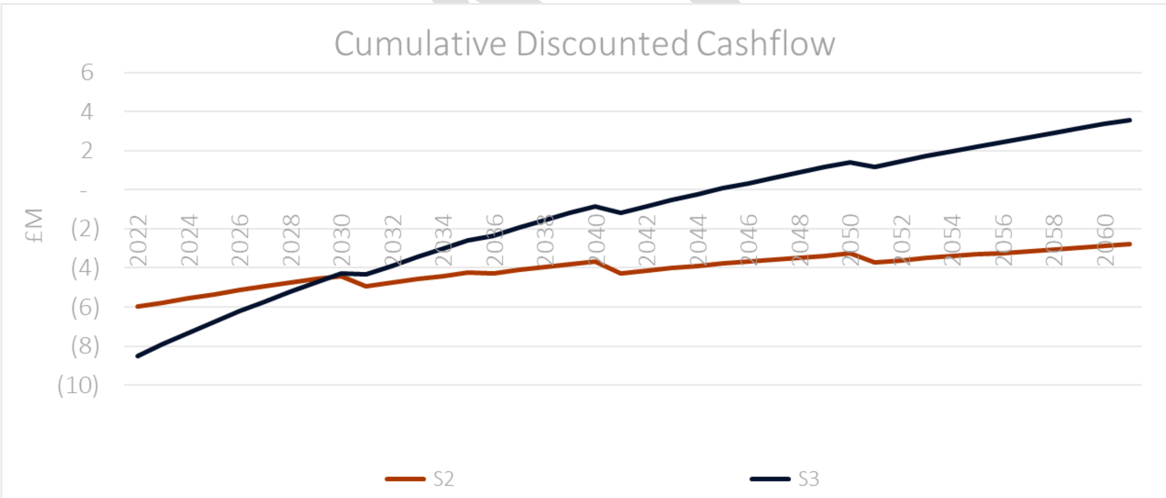


Figure 50: Cumulative Discounted cashflow for scenarios 2 and 3

The cumulative cashflow for Scenario 3 breaks even after 24 years of operation, however Scenario 2 does not break even after the 40 years reviewed. Both scenarios do indicate a positive cashflow and after the initial investment produce a year on year excess.

Levelised Cost of Heat

The levelised cost of heat (LCOH) is a useful metric to review as it can highlight the relative costs of heat sources and where revenue is valuable to a heat supplier. Conventional fossil-based heat sources have a positive heat cost as fuel has to be purchased at the rate of heat production to provide the heat. Where alternative heat sources have a lower heat price relative to these sources, then they potentially offer value which can result in a profit to the provider or a discount to the user, commercially often a mixture of both. Where a levelised cost of heat is negative it indicates that any increase of heat from these systems increases revenue to the operator. For example with Combined heat and power systems (such as the Energy from Waste Plants), now there is a pure payment for any use of heat in comparison to just a margin upon the cost to produce heat from the plant.

In these LCOH analysis we have excluded the conventional business model of the Energy from Waste operators. This is based upon two revenue streams, a price for the removal and management of waste (also known as a gate fee) and revenue from electrical generation. In an integrated business case these would likely further reduce the levelised cost of heat relative to other sources, as with Energy from Waste plant operators are paid to consume the fuel provided, they do not pay for this energy source. However, for our analysis we are just considering the lost electricity sales that arise as a result of the thermodynamic link between heat take off and reduced energy availability for electricity production. This provides a 'worse case' viewpoint for each system.

Table 11: Levilised cost of heat under each scenario £MWh (Negative numbers in brackets)

Summary Stats	BAU	S1a	S1a - 500kW load	S1b	S2 Counterfactual	S2	S3 Counterfactual	S3
LCOH	80	(54)	70	(46)	296	31	256	(18)

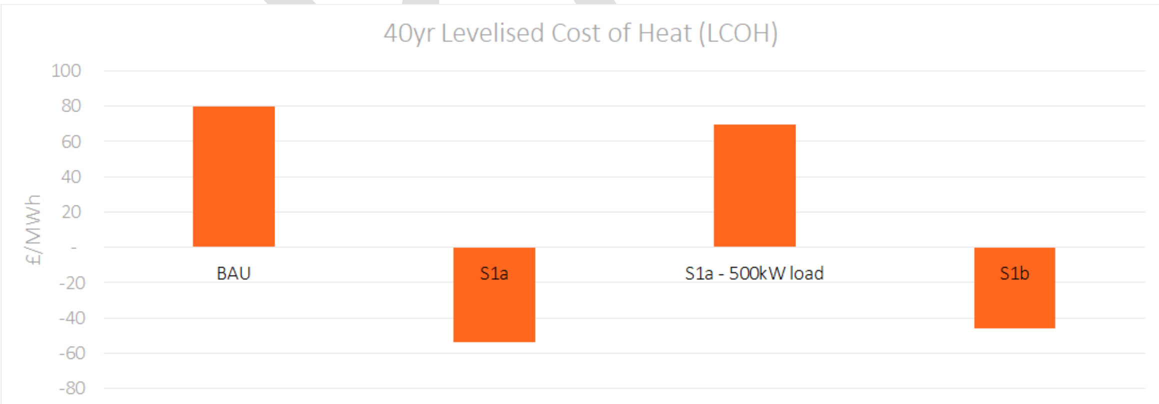


Figure 51: Levelised Cost of Heat for Scenario 1

In scenario 1, assuming the heat sold has an equivalent value to heat generated from oil source, there is a negative levelised heat price, indicating the opportunity of a strong revenue stream for the plant operator and availability of a potential discount on heat supply to the end user. The only exception is the low load 500 kW option, though this still indicates a better price than business as usual.

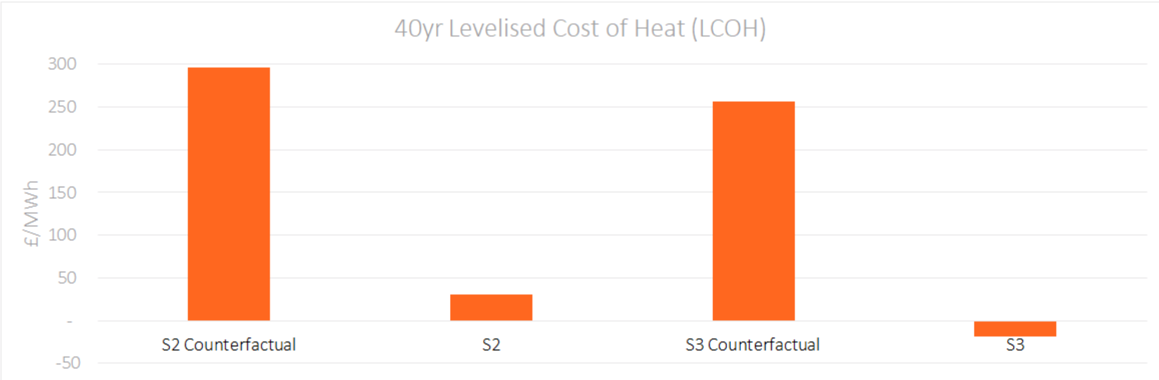


Figure 52: Levelised Cost of Heat for Scenarios 2 and 3

Under scenario's 2 the levelized cost of heat is not negative, however it moves to this in scenario 3, from what is effectively very similar heat plant. The key difference between the two scenarios appears to be the volume of heat sales, with the higher quantity in Scenario 3 driving more value in comparison to scenario 2. Both scenarios have lower levelised cost of heat than the counterfactuals using heat pumps, therefore represent better value than these alternatives. This is in part driven by the much higher unit price of residential electricity, circa 17p kWh as a fuel source.

The differences between Scenario 2 and Scenario 3 also indicate how a given heat plant matches a heat load. There is an 'optimum' amount of heat to extract from a system. Below this, more revenue may be realised from increased heat usage. Above it, increasing amounts of alternative heat sources, or potentially additional capital payment is required to service a given heat load. Scenario 3 appears to be closer to the optimum load profile for a CTEC unit, than Scenario 2, ignoring other real world constraints.

This also indicates how a large Municipal Energy from Waste facility, such as that at Newhaven may not be optimised to the surrounding heat urban heat load and the network required to service it. This may have negative impacts on the 'optimum' utilisation of heat and heat price from the system, in comparison to the same facility in a dense urban environment or meeting a large process load demand.

Sensitivity Analysis

Funding Gap

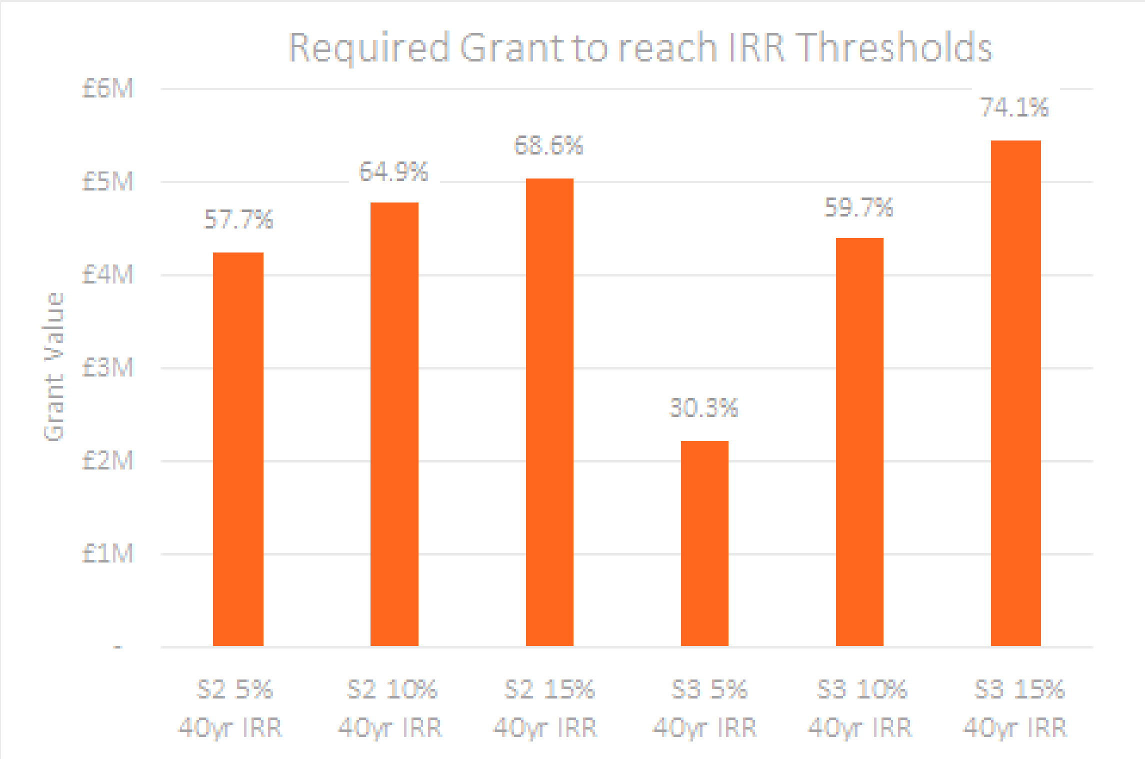


Figure 53: Grant analysis in scenarios 2 and 3 to achieve IRR rates

The analysis in Figure 54 indicates the required level of Grant funding to achieve a five, ten or fifteen percentage IRR in a 40-year timeframe.

Scenario 1 has not been considered as there appears to be a business case without grant funding support.

As the business case appears to be better in scenario 3, a lower grant funding level is required to initially improve the IRR. Higher levels of funding are required, comparable to scenario 2 are required for the ten and fifteen year scenarios.

Sensitivities - HNIP sensitivity

Monte Carlo analysis uses pseudo random numbers to vary all input parameters to a maximum of +/- 10% in variation, with CAPEX +/- 30%. This gives a distribution of output IRR and NPV's under a large number of scenarios. By reviewing the statistical occurrence of these values the level of risk associated with the project can be better understood. Ten thousand model runs for each scenario were undertaken in the following analysis.

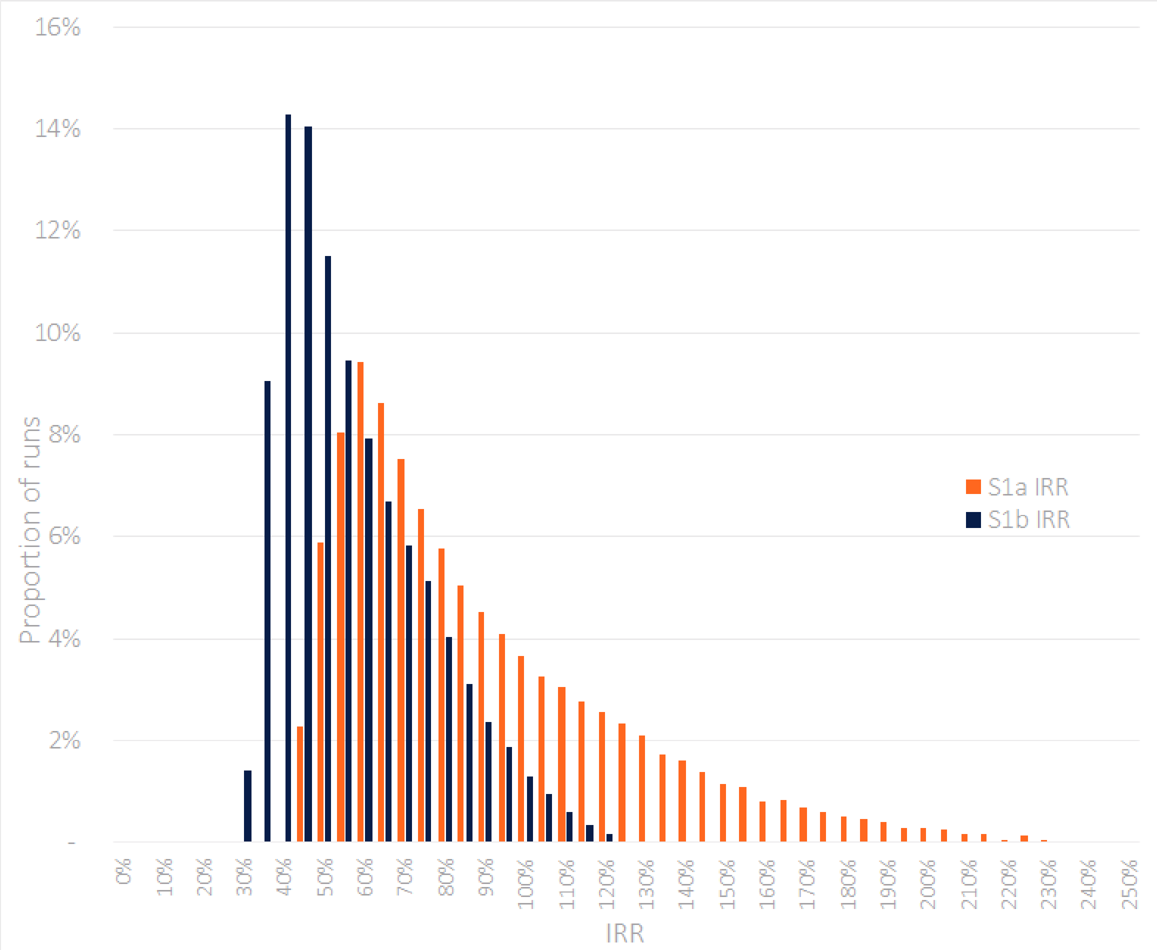


Figure 54: Distribution of IRR for full set of Monte-Carlo Analysis Runs under Scenario 1

The distribution of IRR for Scenario 1 (both 1a and 1b) is positive with a long positive tail but a sharp drop at the low end. This sharp drop in a positive IRR shows that with all the tested parameters, the project under these assumptions tends to have a positive IRR.

The mean values of the project are:

- S1a: Mean NPV: £ 74,055,987
- S1a: Mean IRR: 89.38%
- S1b: Mean NPV: £ 66,063,165
- S1b: Mean IRR: 55.68%

For S1a these values show a moderate positive skew of 0.78 against the presented scenario suggesting that the project may perform above expectations. This is higher than the Scenario 1b which has a moderate positive skew of 0.61. These positive skews suggest that the projects are likely to perform better than modelled if all prices and costs stay within the limits of the sensitivity analysis. However, stakeholder engagement is essential due to the assumptions that all available loads will connect to the network and purchase heat at the prices presented.

Risk can be highlighted by considering the mean NPV of the worst 5% of cases.

- S1a: Mean Risk NPV: £64,023,811 Mean Risk IRR: 44.97%
- S1b: Mean Risk NPV: £55,711,436 Mean Risk IRR: 30.73%

This indicates there is a good prospect for a positive outcome for both scenarios given the range of assumptions taken, with Scenario 1a less risky than the extension of the network investigated in scenario 1b

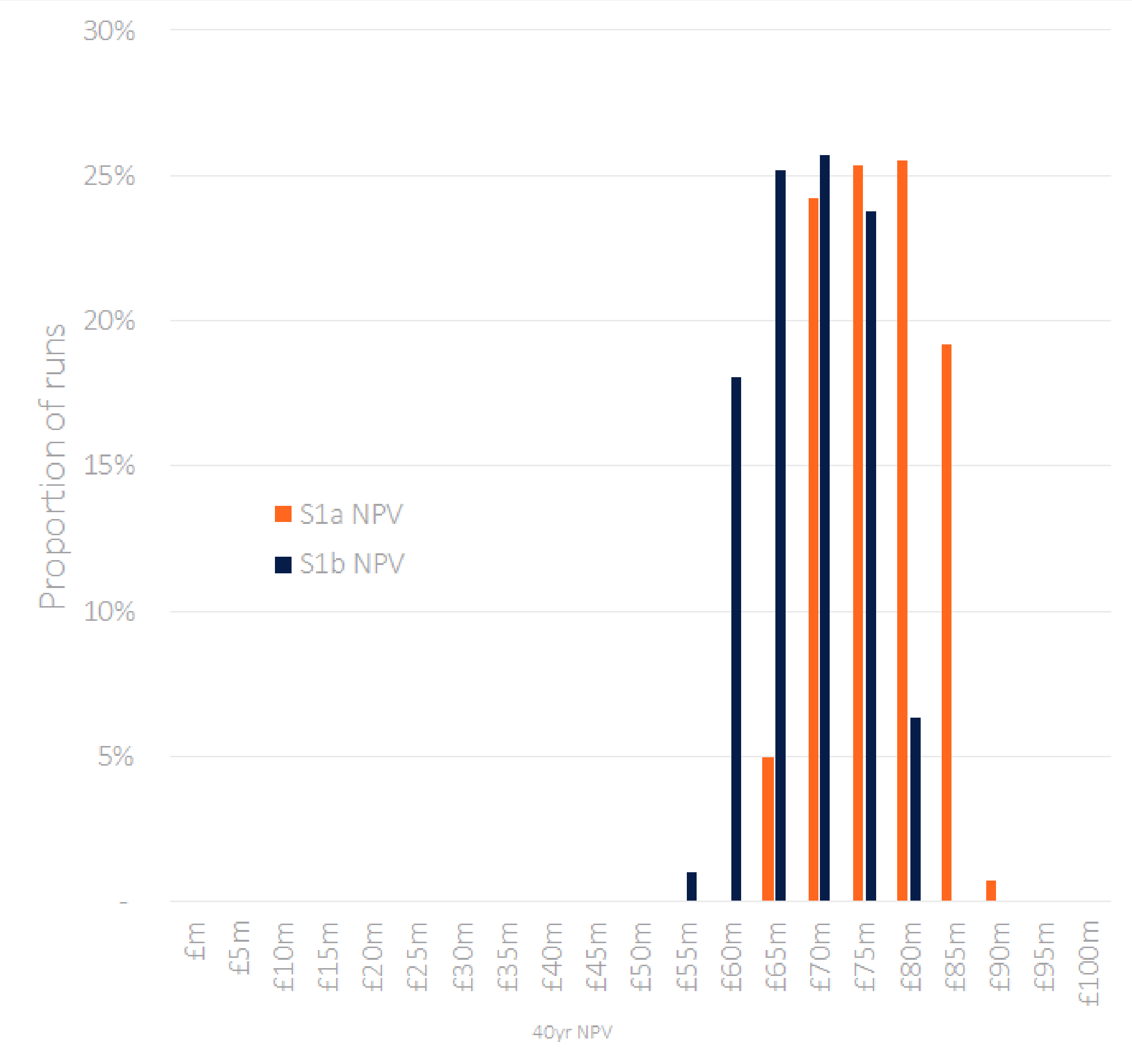


Figure 55: Distribution of NPV for full set of Monte-Carlo Analysis Runs

Reviewing Scenario 1 the 40yr NPV is positive in all cases with the value of S1a being slightly higher than the NPV of S1b.

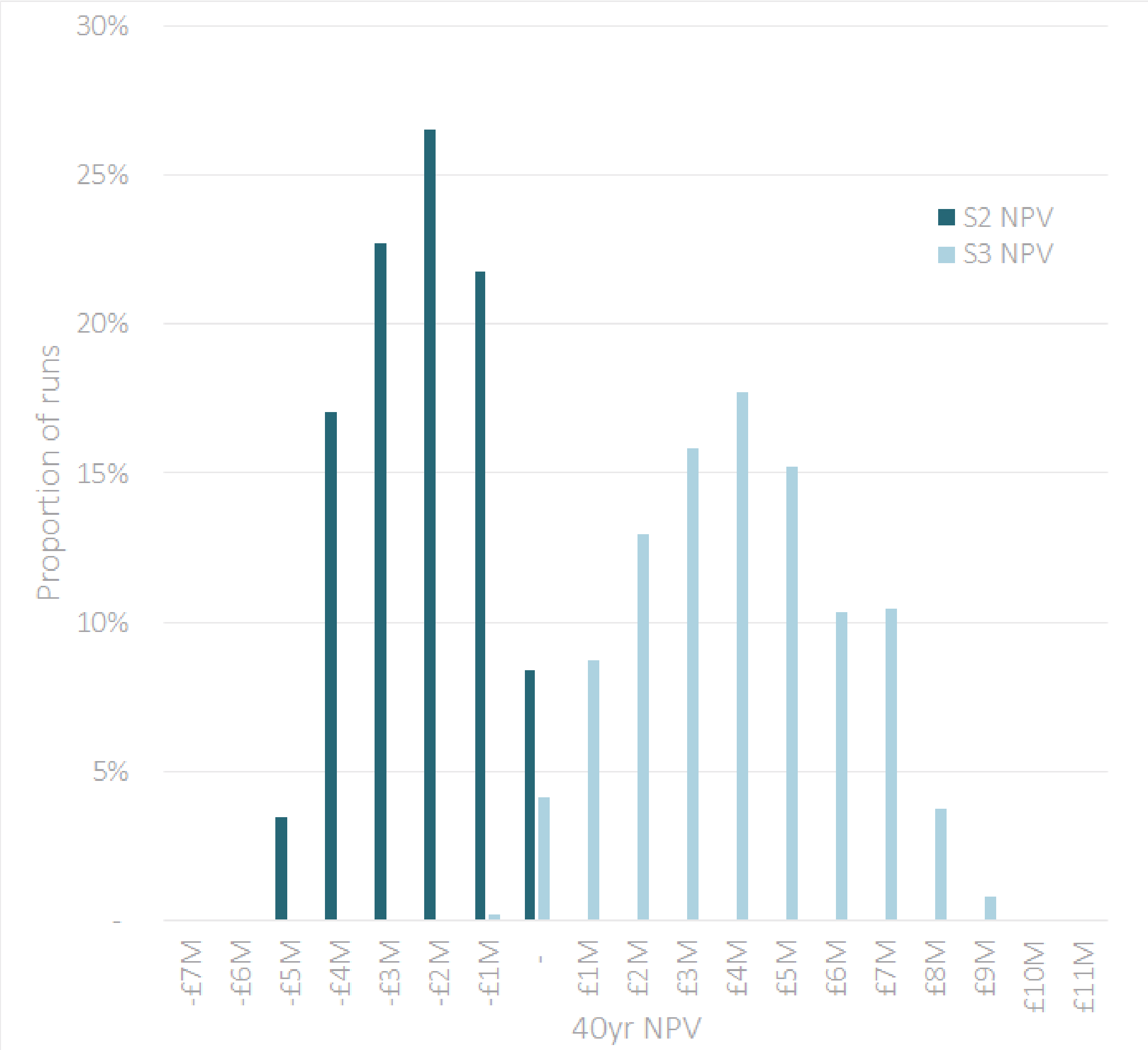


Figure 56: Distribution of NPV for full set of Monte-Carlo Analysis Runs for Scenarios 2 and 3

After 10,000 Monte Carlo runs, for S2 the parameters show that in 99.96% of cases, the project has a negative 40yr NPV. This may still be better than the counterfactual with heat pumps, but is also an indication of how lower heat sales and lower network density can negatively impact broadly the same plant deployed in Scenario 2 and 3.

In S3, 95.69% of the runs return a positive 40yr NPV. Highlighting the greater sturdiness of the business case if the assumptions used are correct.

For S2 these values show a slight positive skew of 0.16 against the presented scenario and 0.29 for S3. This is a small skew which only suggests that the projects may perform above expectations in only a smaller number of cases.

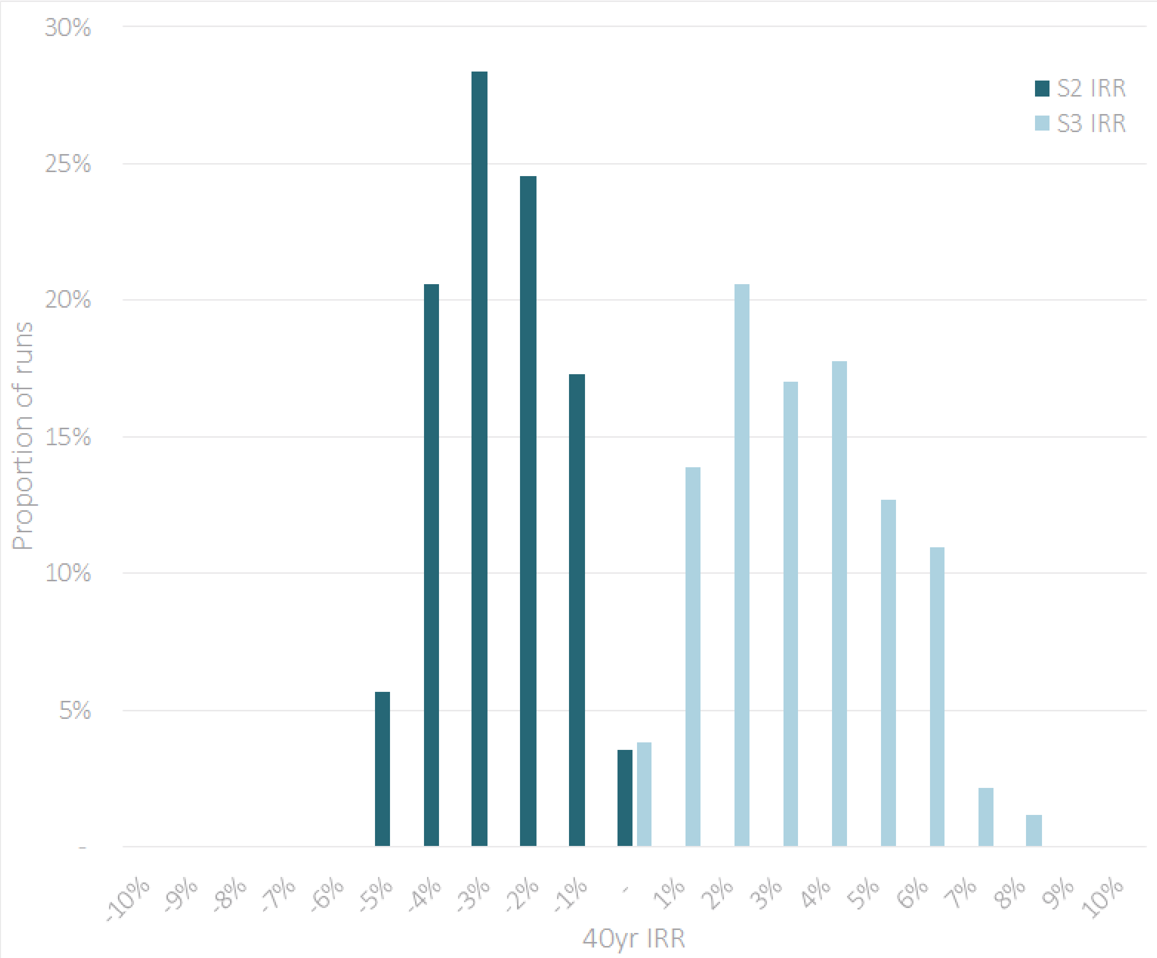


Figure 57: Distribution of IRR for full set of Monte-Carlo Analysis Runs for Scenarios 2 and 3

Similar trends may be observed in the IRR distribution of Scenarios 2 and 3. Scenario 3 is more likely to have a positive IRR for this given set of assumptions, with a lower chance of the project having a negative IRR. Scenario 2 conversely is likely to have a negative IRR, irrespective of changes in input parameters. This may still be better than the counterfactual scenario with heat pumps, but also indicates that this scenario is more likely to need some form of financial support if additional heat sales or other financial contributions cannot be realised. In summary:

- S2 has a mean NPV of -£ 2,785,428
- S3 has a mean NPV of £ 3,512,898
- S2 has a mean IRR of -3.14%
- S3 has a mean IRR of 2.79%

Once again, reviewing the averages in the lowest 5% of projects, to assist in determining the risk level of scenarios 2 and 3 results in the following

  - S2: Mean Risk NPV: -£5,115,515 Mean Risk IRR: -5.3%
  - S3: Mean Risk NPV: -£374,620 Mean Risk IRR: -0.2%

Here it may be seen that there is a risk of negative NPV and IRR in both scenarios, in particular Scenario 2. This still may be better than the counterfactual, however it is likely that more care and further detailed investigation and risk control is required under scenarios 2 and 3 to confirm a straightforward business case.

Environmental

CO_2 savings - against Counterfactual

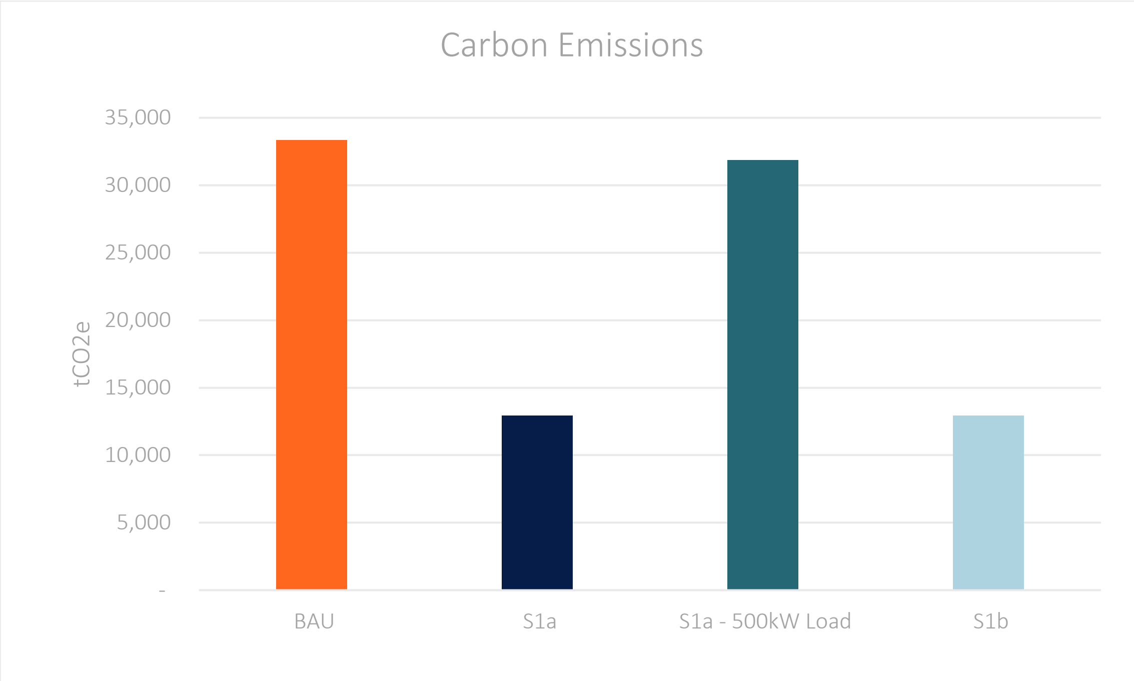


Figure 58: Carbon Emissions under Scenario 1

It is assumed that the emissions from Energy from Waste plants are present in all scenarios as a result of their normal business activities.

As a result the annual CO_2 emissions reductions for Scenario 1 are significant. In part these arise from the complete and direct elimination of oil firing for the asphalt plant because of diverting the heat currently wasted from the Energy from Waste plant. Any additional connection from the industrial estate under phase 1b also represents the elimination of a gas boiler equivalent at this location, leading to further environmental benefits.

Some benefit is also derived from even the low load (5oo kW) FM Conway connection, though it is clear that the major benefit arises from substituting process heat requirements over the bitumen tank storage warming facility.

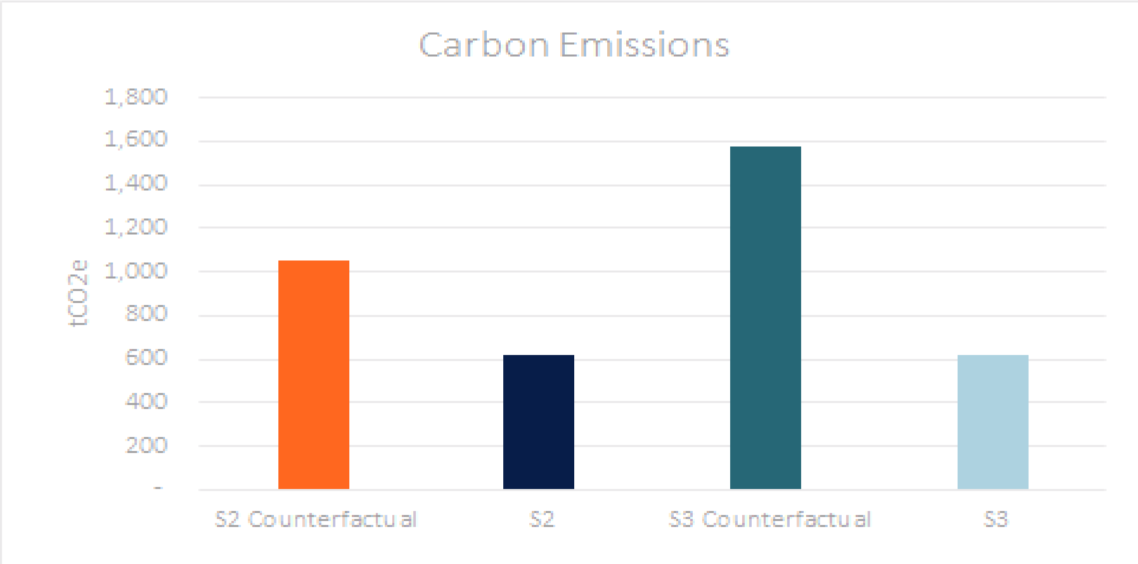


Figure 59: Carbon emissions for scenarios 2 and 3

The annual CO_2 emissions for S2 and S3 also show major reductions because the existing emissions of the plant occur irrespective of heat take off. Note as these are very similar the lines are almost identically overlayed in figure 61, and hard to distinguish from each other. However in this scenario the carbon emissions of the counterfactual are also going to change over time with the anticipated ongoing decarbonisation of the national grid.

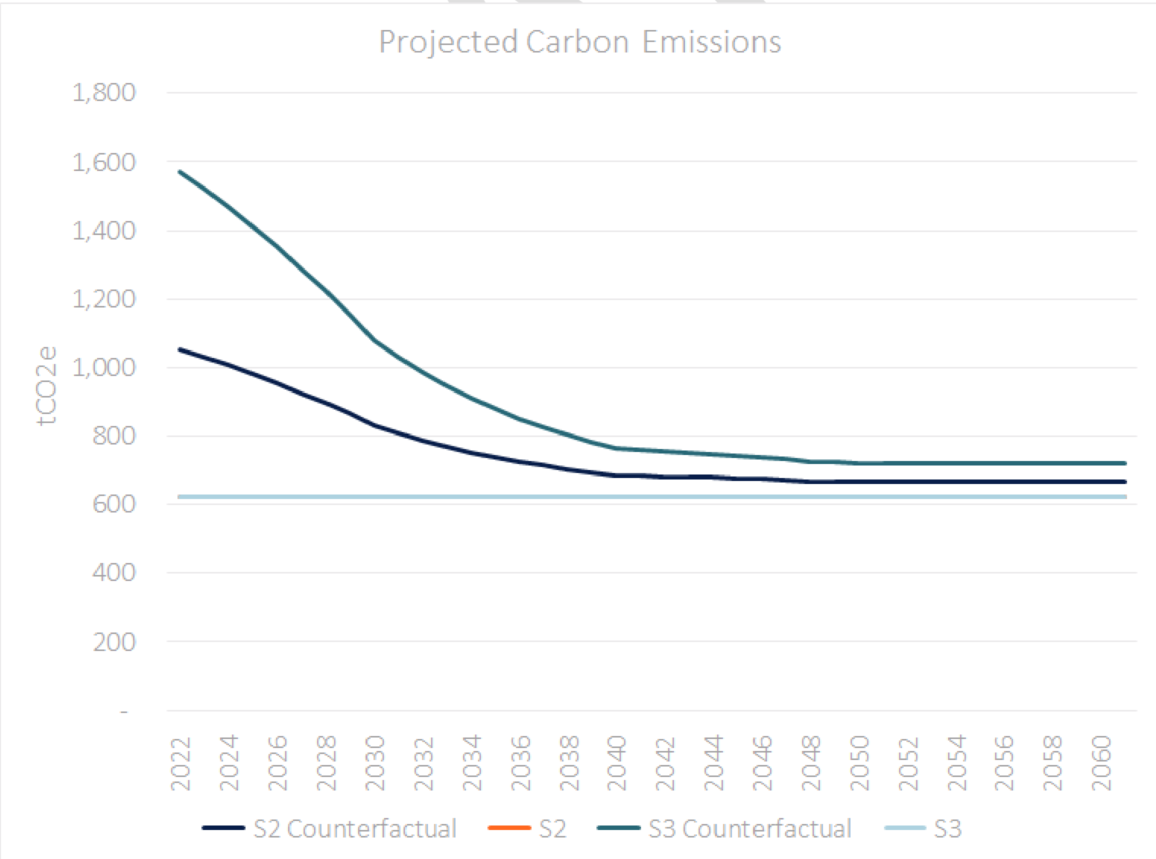


Figure 60: Scenario 2 and 3, changes to carbon emissions over time

This snapshot of Carbon emissions in year 1 of the project shows a large difference in CO_2 emissions. However, the graph below shows that as the grid decarbonises, the total emissions of the counterfactuals tend towards the heat network scenarios. The carbon savings diminish with time in line with grid decarbonisation, assuming the carbon emissions of the EfW plant remain constant in the same timeframes. This is unlikely to be the case, however the carbon content of energy from waste is a much more complicated assessment, as it depended on the waste content, the embodied carbon of this and alternative disposal options (and as a consequence their emissions). As 'waste' decarbonises through industrial efficiency improvements, lower energy carbon factors and a focus on the 'circular economy' there is a consummate reduction in the carbon emissions from energy reclamation. However estimating this for a given waste stream over a lifetime is difficult, particularly with the specialist waste disposed of by CTEC. This will likely require a dedicated analysis for each of the energy from waste plants of current waste make up, with a forecast of its change over time, the fossil and non-fossil components of this, and the fraction attributed to both electrical and heat generation from the respective plant.

A smaller component of the carbon emissions is the fraction from Biomass back-up and peaking plant. These are very low, but are positive to reflect the emissions arising from harvesting and transporting the wood fuel. Newhaven has multiple transport options for wood fuel importing (road, rail, sea) therefore may be able to reduce these marginally through its procurement choices. Ultimately these emissions will also decrease as wood production processes decarbonise, however the operators may wish to offset emissions from the outset through the installation of alternative zero carbon energy sources, for example PV on the facility roof areas. These opportunities would be best explored at later project and study phases.

As S2 and S3 ultimately only have slight variances in back-up fuel utility, the carbon emissions are almost identical when viewed for the combined system.

NO_x and SO_x emissions

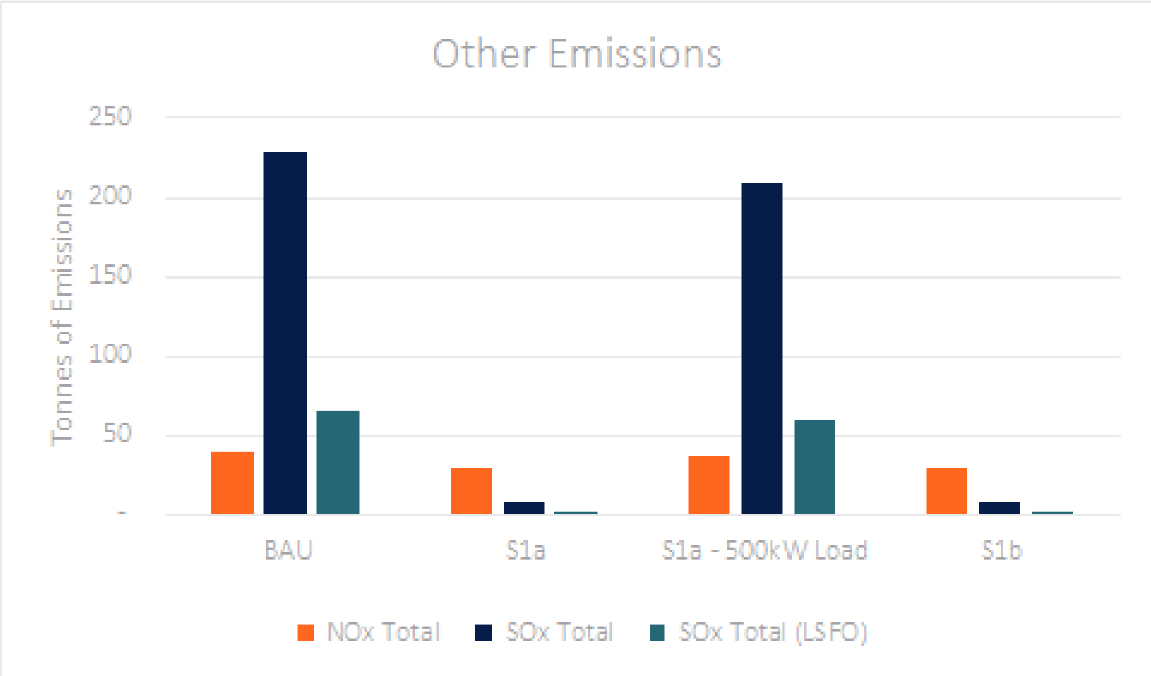


Figure 61: Reductions in Nitrous and Sulphur Oxides in Scenario 1

As with carbon, a large offsetting of oil consumption through process heat substitution has a large impact on Nitrous Oxides and Sulphur Oxides emissions, both of which have direct impacts on air quality. This impact is largely dependent on the grade of oils used, the chemical composition of these (High or low Sulphur fuel) and exhaust treatments on site. The FM Conway facility is modern, and likely to be directly regulated with regards of its emissions, limiting the existing impact to environment to regulatory requirements. However the transfer of substantial heating loads to a process steam supply, were this to be technically feasible would directly eliminate the use of oil, resulting in direct savings in local NO_x and SO_x emissions, which are estimated in These are direct 'local' emissions and so have an immediate and direct local benefit where reductions are delivered.

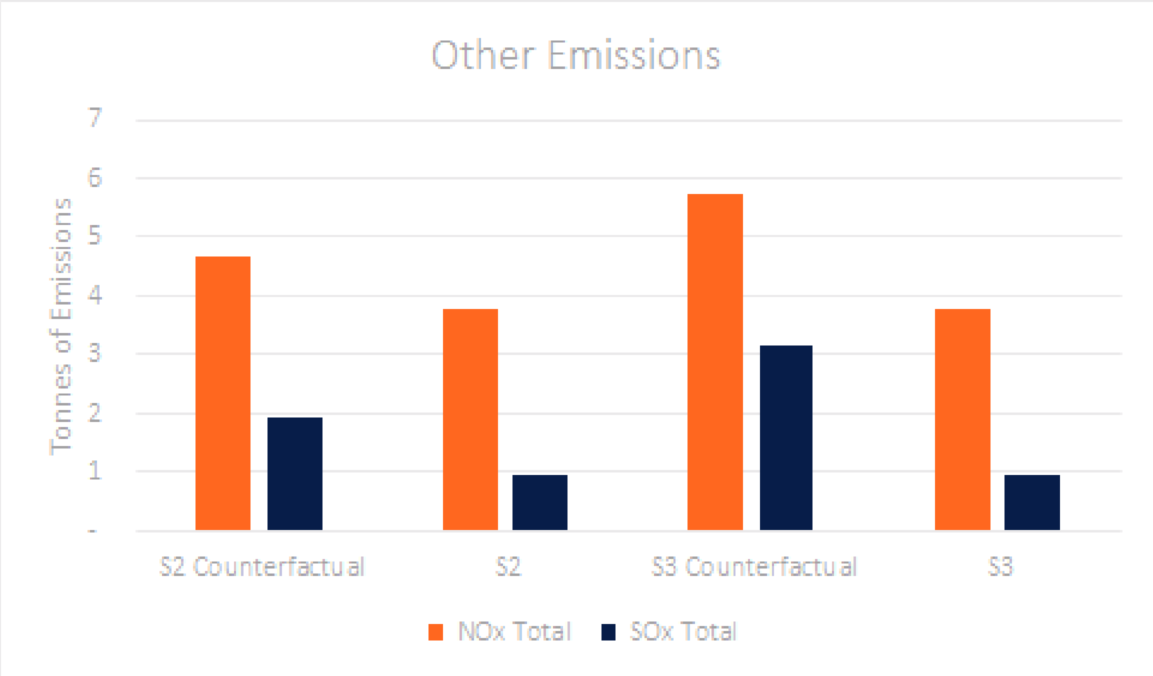


Figure 62: Emissions of NOx and SOx for each scenario

In Scenario 2 and 3 the SO_x and NO_x emissions that are offset are far lower, as no fuel oil consumption is offset and the plats are regulated to modern standards. The reductions that do occur are on the displacement of emissions of these pollutants nationally via avoided consumption form the electrical grid. These are distributed at a national level due to the decreased demand for electricity compared with running heat pumps in the counterfactual. As a result this is an important but less locally significant reduction in emissions.

Work Package 2 Conclusion

Scenario 1

The UK has a statutory commitment under the climate change act to decarbonise the UK by 2050. Both heat and waste form key parts of this commitment, with the contribution of heat demand often underestimated by the general public.

As discussed within the work package 1 conclusions, a key consideration for local and regional government is the future location and use of municipal waste plant. The municipal (Veolia) Energy from Waste facility at Newhaven can be expected to enter negotiations within 15 years for an extension of its concession. Any extension beyond 17 years (and 30 year concessions are not infrequent in this industry) will take the life of the facility beyond 2050 and this statutory commitment.

Prior to this it is recommended that this extension by regional government is reviewed in the round with the decarbonisation strategy for the area. Potentially the availability of low carbon heat from waste, as well as reductions in road-based freight transportation may provide an alternative strategic direction for future local requirements. This may be offset by the embodied carbon considerations of the existing plant, and the condition and economic life remaining in the facility.

The outcome of this review will likely determine the long-term viability of waste heat use from this facility within Newhaven. As discussed within the report, the longer-term deployment of a large scale heat network within Newhaven suffers economically from a low heat density, itself arising from the low density of development in the area. This is not to say that this is uneconomic, however it is foreseeable that alternative networks in denser urban environments would likely have a better financial viability, and these will likely compete for bulk large scale sources of low carbon heat, such as is found from municipal Energy from Waste facilities.

In addition to this, the low density of heat consumption makes it hard to justify large scale infrastructure to cross the commercial harbour, which appears already to be the case for other existing infrastructure providers. This further complicates any future roll out of district heating to the wider area.

If it is considered likely that the existing EfW plant in Newhaven will be retained to 2050 and potentially beyond, there appears to be a strategic case for the use of heat from the facility to offset industrial heat requirements. The clear caveat required at this stage, is that this has not been reviewed from a process engineering perspective as appropriate for manufacturing facilities of this nature. There has also been limited information supplied by the parties involved, therefore a large number of technical assumptions have been made at feasibility stage.

From a basic energy perspective, the Municipal Energy from Waste raises heat in a medium at a higher temperature than that required in the adjacent facility.

The adjacent facility has clear needs for high grade heat at temperatures above that normally utilised in modern district heating networks.

There is no fundamental thermodynamic barrier for the transfer of heat from one to the other, however in doing so it will be important not to adversely compromise the running of either facilities.

From the Veolia plant perspective, heat take off at these temperatures is likely to require modifications to existing steam plant, and the distribution of steam at high temperatures from the facility. This may well not have been planned at its inception, particularly considering the higher temperatures required, and therefore will require thorough interrogation before proceeding. It will likely effect the electrical generating capacity of the plant, and this will need to be compensated for in any commercial model taken forward.

For the asphalt plant operator's perspective, the heat supply must be able to meet the needs of the manufacturing facility. From this study the critical aspect of this appears to be substituting the large oil-fired burners currently understood to be used in the asphalt production. We are not in a position to determine the technical viability of this, however our commercial model brackets two extremes, substituting a large quantum of heat from this burner, or a much lower (500 kW) quantity of heat assumed for keeping stored Bitumen molten.

As may be seen in the results, there is a large potential for an attractive business and environmental case to exist should heat towards the higher quantum be provided from the EfW plant. Capital costs for deployment may be reduced by above ground heat transfer via steam pipes, further enhancing this. As there is a second asphalt plant in the vicinity there may be an opportunity to deploy the same solution twice to improve commercial terms. Any further heat usage, e.g. to keep aggregate dry in storage would also likely improve the business case further.

The provision of heat also determines the business case for the installation of a Private Wire supply to this facility. If heat is provided directly, this supresses electrical load and reduces the revenue from a private wire investment once the currently electrically warmed bitumen stores are heated from alternative sources. As a result, this is a lees appealing business case. If there is no heat supply to the asphalt plant, then potentially a private wire connection is a viable infrastructure investment.

This would appear the initial strategic case for starting a form of heat network within Newhaven. We have explored a phase 1b extension of this network using conventional District heating LTHW systems to the adjacent industrial areas, however with current heat loads this appears to depress the business case of phase 1a.

We would therefore recommend that should the Municipal Energy from Waste facility remain at this location through to 2050, local and regional government should seek to draw further industrial heat users to the area, to seek to make best use of the low carbon heating energy from the facility. This in turn may become the genesis for a wider heat network saving other properties (e.g. residential areas) of the town.

Scenarios 2 and 3

Scenarios 2 and 3 demonstrate some of the key principles discussed under scenario 1. The CTEC energy from waste facilities investigated appear better matched to some of the smaller scale heat loads present within Newhaven. This allows the potential deployment of separate systems either side of the harbour, avoiding the expense of a major infrastructure crossing. Scenario 3 then appears to be the more economically attractive proposition from a heat sales perspective, owing to the potentially larger volume of heat sales to be made from the plant. With the proposed central location of the energy plant, and higher density development in the form of flats, a plant of similar size to the existing appears to have a better business case for heat sales.

There is still a business case for scenario 2, however greater care is required developing the detail of this and the infrastructure deployment is larger (in distance), increasing the proportional CAPEX investment with a lower potential for heat sales. As a result, the NPV and IRR of this proposal is less favourable, being marginally negative with the assumptions made.

These economic assessments exclude consideration of the other revenue streams at the Energy from Waste facilities, as these are part of the current operational business model, however a full integration of this with a heat system may enhance financial benefits for heat. For example, if existing operational staff are paid for under the existing business arrangements, but may be deployed to operate a future heat network this would decrease the operation costs of the network in comparison to investigating the network as a a 'standalone' business entity. These potential benefits have not been investigated at the feasibility stage; it is recommended that they are at any future design development

There is still a business and environmental case for both these scenarios, as they both perform better than the Counterfactual scenarios utilising heat pumps. The risk remains that the legal and contractual complexity of developing alternative large green infrastructure, in comparison to the existing defined routes for increasing conventional infrastructure (e.g. gas or electricity networks) outweighs the potential financial benefits by any investor.

The environmental benefits in carbon and local air quality are clear in every scenario, as utilising waste heat from any of these facilities has very limited net local environmental impact above their existing emissions. Each heat connection therefore represents the elimination of an equivalent combustion process or increase in electrical demand. This is particularly impactful where non-gas fuels are in use, for example oil systems.

We are mindful however that scenario 2 and 3 are dependent on the commercial appetite of CTEC, the existing facility operator, for heat offtake. Scenario 3 may be a better business opportunity but is conditional on speculative future development and a busines decision to locate a new plant separate from the existing one. Scenario 2 may therefore represent a lower business risk, as a plant is already located and operational, therefore an investment decision is dependent on the commitment and commercial case of the first connection.

In either case it is recommended that system parameters are adopted favouring lower flow temperatures and retaining compatibility with a potential wider network interconnecting the opportunity areas identified should they initially develop as separate entities.

Next Steps

A clear business opportunity exists around heat offtake for the municipal Energy from Waste facility. This is dependent on the quantum of heat that may be extracted from the existing facility at high grade (i.e. high temperature) and the energy this can displace within the asphalt plants. Preferentially a technical solution would be found to displace the main 18 MW oil fired burner understood to be currently used within the Asphalt process with heat from EfW plant, assumed in this exercise to be steam. This would deliver the highest carbon and environmental savings within the schemes identified, as well as having the opportunity for financial benefits to the parties involved.

To understand this in greater detail it is recommended that this proposal developed up in detail, with a design and costings with input from process engineers familiar both with Municipal Energy from Waste systems, and the Asphalt production process. The parameters of such as system take it outside the normal range of most modern district heating solutions and may therefore lie outside the norms of standards HNDU Detailed Design development work, this will also require consideration if this is taken forward.

The business payback may lie within the contractual timeframes of the existing concession, however the long term role of such as system would be aided with guidance on the long term strategic fit of this facility within the region's wider decarbonisation pathway.

It is also recommended that further design development takes place with CTEC regarding the opportunities to develop the existing plant, or a new facility with heat offtake supplying new residential development at Eastside, The mariner or Harbourside. The specific of these scenarios are likely to depend on the timing of new development, and the quantum of new housing and heat sales available for connection under each scenario. However, should sufficient heat sales be available, there is again a potential business case, and definite environmental benefits for the deployment of district heating systems in these locations.

HNDU Appendix A

HNDU Appendix B

HNDU Appendix C

Appendix D Hydraulic Analysis

General / Approach

A preliminary Hydraulic modelling was conducted to identify likely pipe sizes along the route for Scenarios 1 to 3. The network length was estimated base on approximate distances taken from QGIS3 software.

This network was sized and modelled in dedicated hydraulic modelling software assuming the following parameters.

Table 12 Hydraulic analysis – network parameters

Parameter	Typical building (with HIU)	Marina & Harbour Heights (PHX)	East Side & South Quay (PHX)
Flow Temperature	70°C	75°C	75°C
Return Temperature	40°C	45°C	45°C
Pressure	250 Pa/m	300 Pa/m	300 Pa/m
Velocity Limits	< 50 mm nominal diameter – 1.5 m/s >50mm nominal diameter – 2.5 m/s	< 50 mm nominal diameter – 1.5 m/s >50mm nominal diameter – 2.5 m/s	< 50 mm nominal diameter – 1.5 m/s >50mm nominal diameter – 2.5 m/s
Loads	Estimated Peak – dominated by residential DHW	Estimated Peak – single plate heat exchanger load	Estimated Peak – single plate heat exchanger load
Minimum Index Pressure (Dynamic)	0.3bar	10.3 bar	11.5 bar
Pump Location	N/A	New CTEC	Existing CTEC

The modelling software estimates pipe sizing based on 1st principles at a steady state. Please note, no topology survey has been available for the modelling work and there may be elevation changes throughout the town. There is no topological survey currently available, therefore the potential impacts on static pressure, including assessments of installation at differing depths have not been investigated in this model. It has not therefore been possible to estimate the impacts of this within the system and therefore confirm pressure rating design criteria for equipment. This check must be undertaken at future design stages.

Large networks are proposed, some operating at high temperatures (above 90°C), therefore there are increased risks with the hydraulic system, for example:

- Risk of local steam explosion from uncontrolled pressure release
- Water hammer or Surge

These have not been assessed in detail at this early stage.

Scenario 1A&1B – North Quay & Light Industrial area

Scenario 1A

At this stage under the Scenario 1A, it was proposed that two significant consumers: FM Conway and Tarmac could be interested in the opportunity of buying heat from a heat network. The total load for the FM Conway (infrastructure company) was determined as replacement for 18MW oil fired (duel fuel) burner with the outgoing steam delivered at 200°C and 2.7bar. Additional 0.5MW was added for other equipment on this site. There is no confirmed load for the Tarmac company, however for the purpose of the pipework sizing it was estimated to be 25% of the FM Conway load. The steam pipework was sized base on the velocity method. As a general rule, a velocity of 25 to 40 m/s is used when saturated steam is the medium. The 40m/s should be considered as a maximum limit, as above this noise and erosion will take a place particularly if the steam is wet.

Parameters	
Inlet pressure	2.7 bar g
Steam Temperature	200°C
Specific Enthalpy of Steam (hg)	2791.5 kJ/kg
Steam flowrate - FM Conway	23,858 kg/h
Steam flowrate – Tarmac	5,965 kg/h
Maximum velocity	40 m/s

The North Quay area have a few more stakeholder which could be connected to the heat network. However, at this stage processes used by stakeholder are unknown, therefore the smaller load connections were excluded from this network pipe sizing model.

Scenario 1B – Light industrial area

An initial network route was proposed as per Figure 63: Scenario 1 network routing from the existing EfW plant to the identified points of connection to serve the light industrial area of the phase 1B. The peak load for the light industrial area was calculated by a degree-day analysis from non-domestic MSOA level gas demand data using a total heat demand of 8,215 MWh, a balancing temperature of 15.5C and a weather dependent fraction of the demand of 60% excluding the May-September. The peak was established to be 2.5MW for the whole area. There is no peak loads data available for each individual connection at this stage, therefore the network main pipe size was calculated base on the total of 2.5MW load and delta T=30°C and pressure drop not exceeded 300Pa/m. Using the above information, the pipe size was calculated as 125mm. In addition to the main run, there were smaller connections indicated on the Figure 36. These connections were assumed to be 100mm for the purpose of the CAPEX calculation.

Table 13 Heat network sizing for the light industrial area

Network	Pipe size	Length [m]
Main run	DN125	1852 m
Small branches	DN100	1776 m

Scenario 2 – East Side & South Quay

An initial network route was proposed as per *Figure 64: Scenario 2 network routing* from the existing CTEC Plant to the identified points of connection to serve the new build areas of the East Side & South Quay. A pressure loss allowance of 80kPa has been allowed for in the analysis for building connections.

The peak load for DHW generation was calculated as a 38kW for the house and 36kW for the hotel room. The total DHW load was diversified following The Danish standard DS 439 calculation method. The heating load was calculated as 6.2kW per house and 2.1 per hotel room with overall diversity factor of 0.76. The factor used, is a combination of maximum heating load during the DHW peak load of 0.95 and the diversity factor for group of similar buildings of 0.8 (CIBSE A Table 5.13).

Table 14 indicates the peak loads used within the hydraulic model.

Table 14 Hydraulic load – peak load assumptions for Scenario 2

Development	No. of homes	Heating load	DHW Load	DHW Diversity	Total Htg + DHW
Transit Road	41	6.2	38	0.121	381
Transit Road Hotel	81 rooms	2.1	36	0.093	400
Reprodux House	80	6.2	38	0.094	660
Eastside 1	85	6.2	38	0.092	695
Eastside 2	85	6.2	38	0.092	695
East Side 3 - 20 houses connection	20	6.2	38	0.167	221
Parker Pen 1	70	6.2	38	0.098	590
Parker Pen 2	75	6.2	38	0.096	625

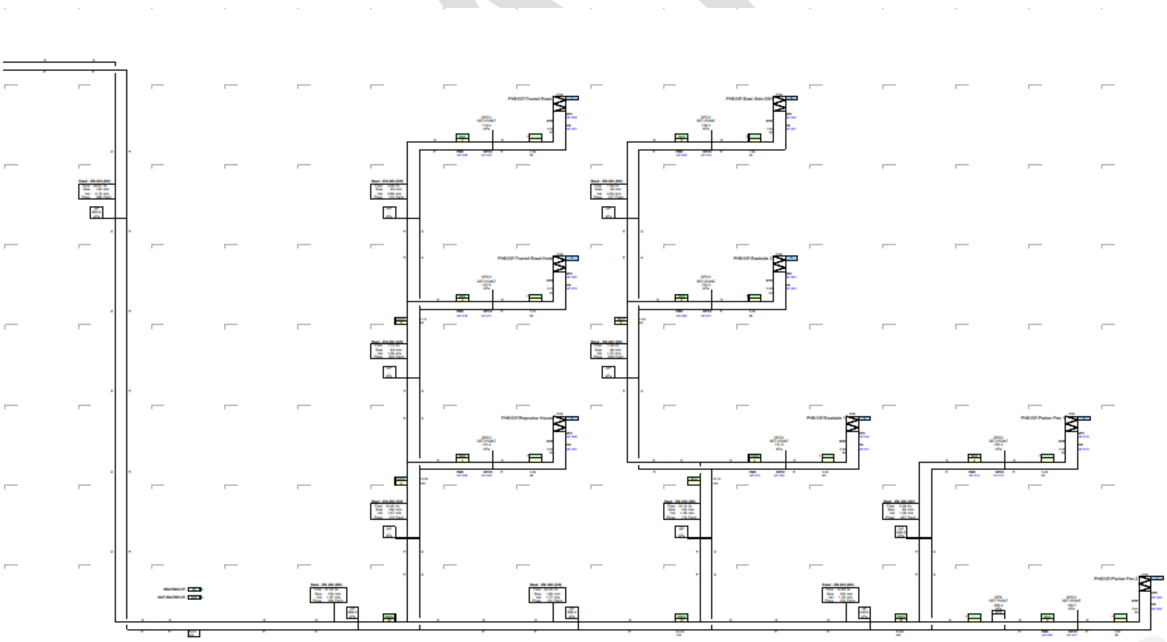


Figure 65 Heat network connection schematic for East Side & South Quay

Scenario 3- Harbour Heights & Marina

Newhaven Marina

The new residential development, referred to as Newhaven Marina was arranged into 12 buildings to estimate the pipework sizes for this area which is proposed to be connected to the new CTEC Plant. The typical building model consisted 32 apartments from which 90% was assumed to be 2 bedrooms and 10% - 3-bedrooms, giving in total 384 apartments. Each of the apartment was modelled with the Heat Interface Unit with DHW peak load of 36kW and average heating load of 2.74kW (based on 40W/m² heat losses). The DHW load was diversified following The Danish standard DS 439 calculation method. The Danish standard DS 439 calculation method has been approved in BS 8558/BSEN 806-3 stating “the designer is free to use a nationally approved detailed calculation method for pipe sizing”. Furthermore, CIBSE AM12:2013 states: “Experience from continental schemes indicates BS 6700 (BSI, 2009a) factors are too conservative and Danish standard DS 439 2009 (Dansk Standard, 2009) diversity factors are recommended for sizing supplies to multiple dwellings.” The heating load was diversified with the factor of 0.76. The factor used, is a combination of maximum heating load during the DHW peak load of 0.95 and the diversity factor for group of similar buildings of 0.8 (CIBSE A Table 5.13).

Base on the parameters described as above the peak load at each of the 12 buildings was 226 kW at 160kPa pressure drop. This figure was used to determine the network pipe sizes for the scenario 3.

Harbour Heights

It is proposed that the future development of 700 homes referred as Harbour Heights will be supplied by the new CTEC plant. To estimate the network pipe sizes the development was split into 10 areas with 70 houses each. The model includes 80% of detached homes and 20% terraced homes. Each of the house was modelled with the Heat Interface Unit with DHW peak load of 38kW and average heating load of 6.2kW (based on 45W/m² heat losses). The DHW load was diversified following The Danish standard DS 439 calculation method. The heating load was diversified with the factor of 0.76. The factor used, is a combination of maximum heating load during the DHW peak load of 0.95 and the diversity factor for group of similar buildings of 0.8 (CIBSE A Table 5.13).

Base on the parameters described as above the peak load at the area was 634 kW at 263kPa pressure drop. This figure was used to determine the network pipe sizes for the scenario 3.

The table below indicates the peak loads used within the hydraulic model.

Table 15 Hydraulic load – peak load assumptions for Scenario 3

No.	Terminal type	Ref.			Details			Peak output (W)	Temps (degC)		Flow rate (l/s)
		Pref	Level	No.	Make	Model	Type		Flow (degC)	Return (degC)	
1	PLATE HEAT EXCHANGER	PHE	GF	Area 1				634000	75	45	5.138
2	PLATE HEAT EXCHANGER	PHE	GF	Area 2				634000	75	45	5.138
3	PLATE HEAT EXCHANGER	PHE	GF	Area 3				634000	75	45	5.138
4	PLATE HEAT EXCHANGER	PHE	GF	Area 4				634000	75	45	5.138
5	PLATE HEAT EXCHANGER	PHE	GF	Area 5				634000	75	45	5.138
6	PLATE HEAT EXCHANGER	PHE	GF	Area 6				634000	75	45	5.138
7	PLATE HEAT EXCHANGER	PHE	GF	Area 7				634000	75	45	5.138
8	PLATE HEAT EXCHANGER	PHE	GF	Area 8				634000	75	45	5.138
9	PLATE HEAT EXCHANGER	PHE	GF	Area 9				634000	75	45	5.138
10	PLATE HEAT EXCHANGER	PHE	GF	Area 10				634000	75	45	5.138
11	PLATE HEAT EXCHANGER	PHE	GF	Block 1				226000	75	45	1.831
12	PLATE HEAT EXCHANGER	PHE	GF	Block 2				226000	75	45	1.831
13	PLATE HEAT EXCHANGER	PHE	GF	Block 3				226000	75	45	1.831
14	PLATE HEAT EXCHANGER	PHE	GF	Block 4				226000	75	45	1.831
15	PLATE HEAT EXCHANGER	PHE	GF	Block 5				226000	75	45	1.831
16	PLATE HEAT EXCHANGER	PHE	GF	Block 6				226000	75	45	1.831
17	PLATE HEAT EXCHANGER	PHE	GF	Block 7				226000	75	45	1.831
18	PLATE HEAT EXCHANGER	PHE	GF	Block 8				226000	75	45	1.831
19	PLATE HEAT EXCHANGER	PHE	GF	Block 9				226000	75	45	1.831
20	PLATE HEAT EXCHANGER	PHE	GF	Block 10				226000	75	45	1.831
21	PLATE HEAT EXCHANGER	PHE	GF	Block 11				226000	75	45	1.831
22	PLATE HEAT EXCHANGER	PHE	GF	Block 12				226000	75	45	1.831

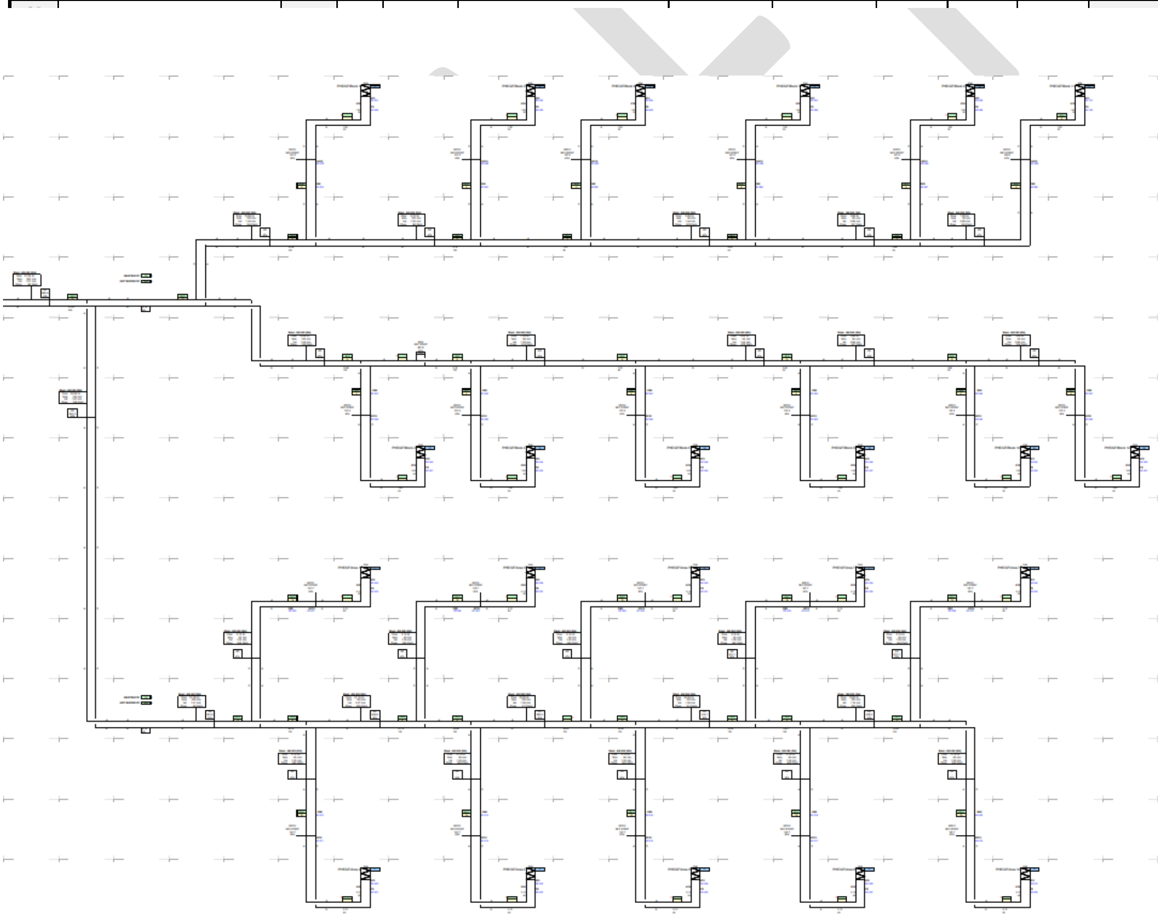


Figure 66 Heat network connection schematic for Harbour Heights and Newhaven Marina.

Key findings and summary

- The hydraulic model (and pipe sizing) is most sensitive to temperature differential. Lower return temperatures allow the use of smaller diameter network pipes, with lower capital cost and lower thermal losses, as a greater quantum of thermal energy is delivered per unit of water. Similarly, failing to achieve the specified return temperature results in capacity restrictions which prevent the distribution network from delivering the required peak load.
- Varying the allowable pressure drop at peak load, did not result in substantial differences in pipe sizing.

The current hydraulic analysis does not consider dynamic hydraulic effects and is not suitable for detail design at this stage. It has been used at this stage to estimate pipe sizing, which has then formed the basis for the risk assessment and capital cost estimate in this study.

Appendix E CP1 checklist

Appendix F GIS outputs

Appendix G Risk Analysis

Appendix H Technical assumptions

Appendix I CAPEX Summary

Summary Costs	S1a	S1b	S2	S3	S2 Counter-factual	S3 Counter-factual
A) Gas fuelled combined heat and power (CHP) Units	-	-	-	-	-	-
B) Biomass heat only system	251,547	511,776	258,480	498,706	-	-
C) Heat pumps (HP)	-	-	-	-	4,624,296	7,712,958
D) Other heat supply technologies not covered above	254,753	396,943	114,165	109,697	-	-
E&F) Back-up boilers	-	-	-	-	-	-
G) Energy Centre items, or refurbishment of existing plant areas, as applicable	522,652	745,175	529,497	525,294	9,624	253,656
H) Thermal storage	-	236,752	652,168	473,504	1,984,885	3,560,522
I) Utility connections	86,202	86,202	-	-	190,271	379,233
J) Electrical export by Private Wire or export to grid	-	-	-	22,991	-	-
K) Heating Network	3,803,640	4,160,717	2,586,085	4,423,018	-	-
L) Cost of connections at heat user locations	-	-	-	-	-	-

Summary Costs	S1a	S1b	S2	S3	S2 Counter-factual	S3 Counter-factual
M) Engineering, Procurement and Project Management (excluding hardware, civils and direct construction labour).	1,418,948	1,739,855	1,218,918	1,776,600	2,028,238	3,456,983
N) Any other Design & Build or Engineering, Procurement and Construction Costs (other costs to be given in section O below).	726,790	906,395	615,215	909,277	1,045,139	1,826,132
O) Other non-Design/Build or Engineer/Procure /Construct Project Costs	301,797	375,115	255,205	372,848	420,824	731,588
Total Cost	7,366,329	9,158,931	6,229,732	9,111,936	10,303,277	17,921,073

Appendix J

Newhaven Town Centre Gas Network

SGN Your gas. Our network.

Contact Us

Mapping Enquiries: All areas

General Enquiries: All areas

Date Requested: 20/05/2020
Job Reference: 18430459
Site Location: 544677 101543
Requested by:
Mr Jamie Cara-Southey
Your Scheme/Reference:
Newhaven district heating network

This plan shows the location of those pipes owned by Scotia Gas Networks (SGN) by virtue of being a licensed Gas Transporter (GT). Gas pipes owned by other GTs or third parties may also be present in this area but are not shown on this plan. Information with regard to such pipes should be obtained from the relevant owners. No warranties are given with regard to the accuracy of the information shown on this plan. Service pipes, valves, siphons, sub-connections etc. are not shown but their presence should be anticipated. You should be aware that a small percentage of our pipes/assets may be undergoing review and will temporarily be highlighted in yellow. If your proposed works are close to one of these pipes, you should contact the SGN Safety Admin Team on 0800 912 1722 for advice. No liability of any kind whatsoever is accepted by SGN or its agents, servants or sub-contractors for any error or omission contained herein. Safe digging practices, in accordance with HS (G)47, must be used to verify and establish the actual position of mains, pipes, services and other apparatus on site before any mechanical plant is used. It is your responsibility to ensure that plant location information is provided to all persons (whether direct labour or sub-contractors) working for you on or near gas apparatus. Information included on this plan should not be referred to beyond a period of 28 days from the date of issue.

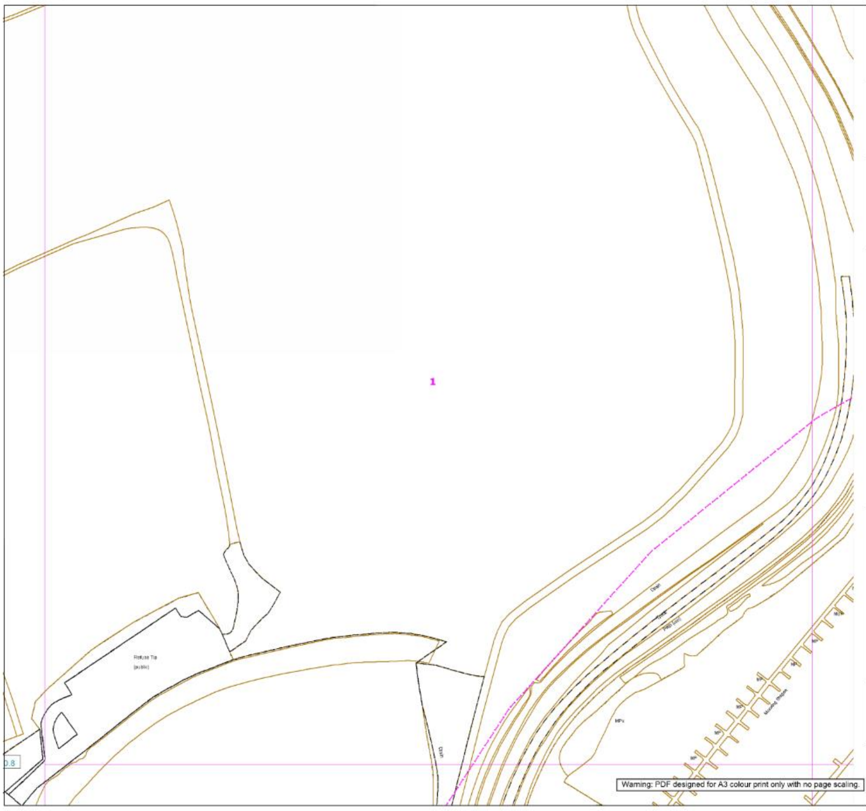
Report damage immediately – KEEP EVERYONE AWAY FROM THE AREA
0800 111 999

Low Pressure Mains
Medium Pressure Mains
Intermediate Pressure Mains
High Pressure Mains
LAs
GTs
SSSIs

Some Examples Of Plant Items
Valve Syphon Depth of Cover Diameter Change Material Change

Digsite: Line: Area:

Linesearch beforeUdig



SGN Your gas. Our network.

Contact Us

Mapping Enquiries: All areas

General Enquiries: All areas

Date Requested: 20/05/2020
Job Reference: 18430459
Site Location: 544677 101543
Requested by:
Mr Jamie Cara-Southey
Your Scheme/Reference:
Newhaven district heating network network
Exact Scales:
1:1000 Area or Circle dig site
1:1000 Line dig site

This plan shows the location of those pipes owned by Scotia Gas Networks (SGN) by virtue of being a licensed Gas Transporter (GT). Gas pipes owned by other GTs or third parties may also be present in this area but are not shown on this plan. Information with regard to such pipes should be obtained from the relevant owners. No warranties are given with regard to the accuracy of the information shown on this plan. Service pipes, valves, siphons, sub-connections etc. are not shown but their presence should be anticipated. You should be aware that a small percentage of our pipes/assets may be undergoing review and will temporarily be highlighted in yellow. If your proposed works are close to one of these pipes, you should contact the SGN Safety Admin Team on 0800 912 1722 for advice. No liability of any kind whatsoever is accepted by SGN or its agents, servants or sub-contractors for any error or omission contained herein. Safe digging practices, in accordance with HS (G)47, must be used to verify and establish the actual position of mains, pipes, services and other apparatus on site before any mechanical plant is used. It is your responsibility to ensure that plant location information is provided to all persons (whether direct labour or sub-contractors) working for you on or near gas apparatus. Information included on this plan should not be referred to beyond a period of 28 days from the date of issue.

Report damage immediately – KEEP EVERYONE AWAY FROM THE AREA
0800 111 999

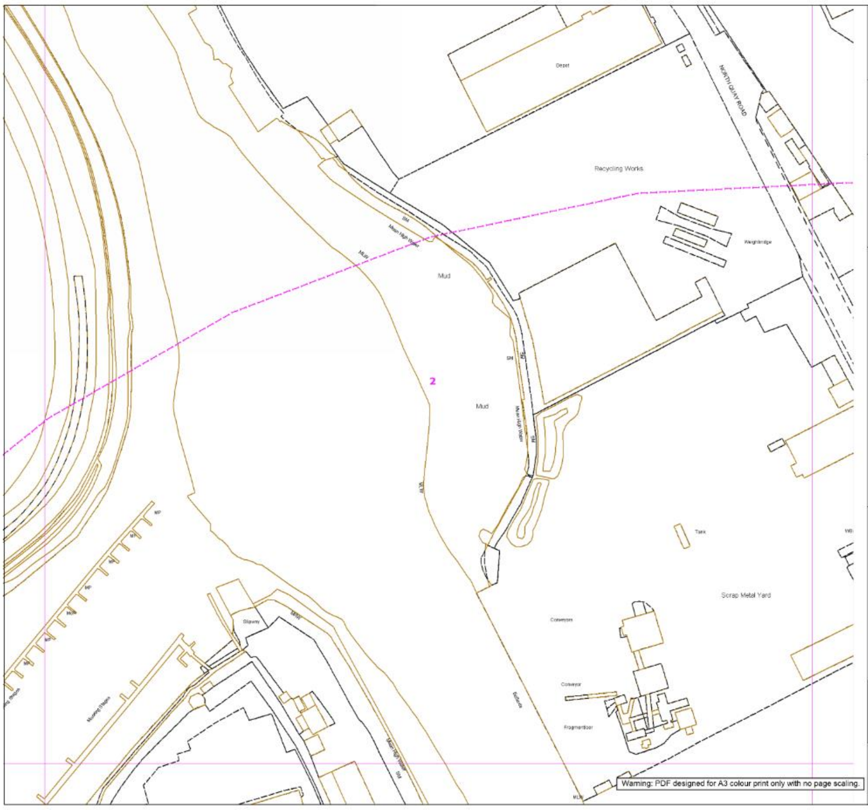
Low Pressure Mains
Medium Pressure Mains
Intermediate Pressure Mains
High Pressure Mains
LAs
GTs
SSSIs

Some Examples Of Plant Items
Valve Syphon Depth of Cover Diameter Change Material Change

Digsite: Line: Area:

Linesearch beforeUdig

This plan is reproduced from or based on the OS map by Scotia Gas Networks plc, with the sanction of the controller of HM Stationery Office. Crown Copyright Reserved. Southern Gas – 100044373 and Scotland Gas – 100044366.



Contact Us
Mapping Enquiries: All areas
General Enquiries: All areas

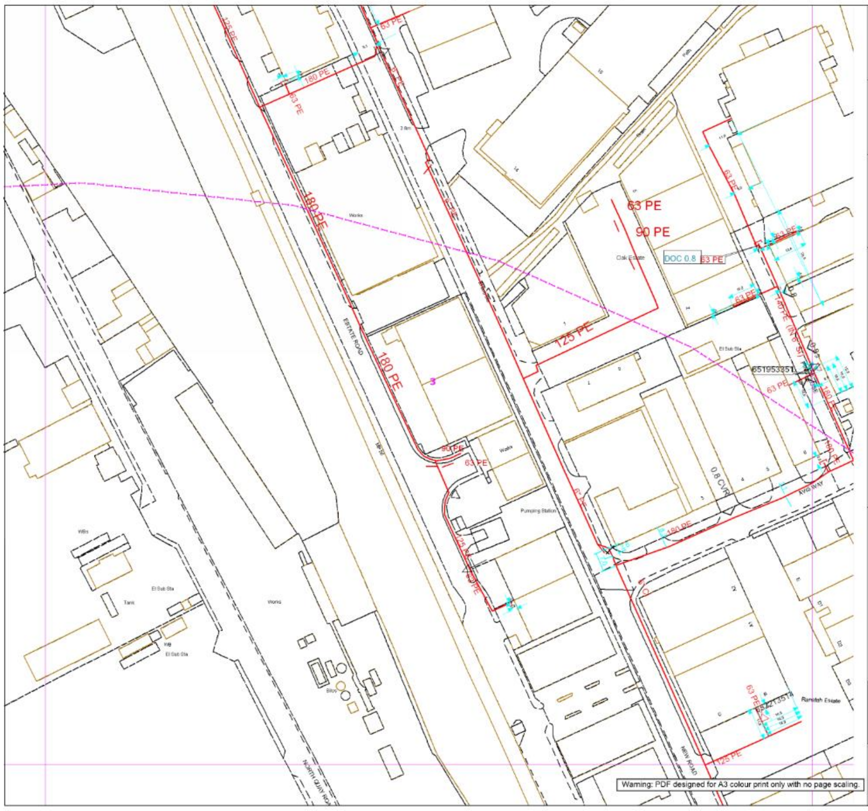
Date Requested: 20/05/2020
Job Reference: 18430459
Site Location: 544677 101543
Requested by:
Mr Jamie Cara-Southey
Your Scheme/Reference:
Newhaven district heating network network network
Exact Scales:
1:1000 Area or Circle dig site
1:1000 Line dig site

This plan shows the location of those pipes owned by Scotia Gas Networks (SGN) by virtue of being a licensed Gas Transporter (GT). Gas pipes owned by other GTs or third parties may also be present in this area but are not shown on this plan. Information with regard to such pipes should be obtained from the relevant owners. No warranties are given with regard to the accuracy of the information shown on this plan. Service pipes, valves, siphons, sub-connections etc. are not shown but their presence should be anticipated. You should be aware that a small percentage of our pipes/assets may be undergoing review and will temporarily be highlighted in yellow. If your proposed works are close to one of these pipes, you should contact the SGN Safety Admin Team on 0800 912 1722 for advice. No liability of any kind whatsoever is accepted by SGN or its agents, servants or sub-contractors for any error or omission contained herein. Safe digging practices, in accordance with HS (G)47, must be used to verify and establish the actual position of mains, pipes, services and other apparatus on site before any mechanical plant is used. It is your responsibility to ensure that plant location information is provided to all persons (whether direct labour or sub-contractors) working for you on or near gas apparatus. Information included on this plan should not be referred to beyond a period of 28 days from the date of issue.

Report damage immediately – KEEP EVERYONE AWAY FROM THE AREA 0800 111 999

Low Pressure Mains
Medium Pressure Mains
Intermediate Pressure Mains
High Pressure Mains
LAs
GTs SSSIs
Some Examples Of Plant Items
Valve Syphon Depth of Cover Diameter Change Material Change
Digsite: Line: Area:

Linesearch beforeUdig



Contact Us
Mapping Enquiries: All areas
General Enquiries: All areas

Date Requested: 20/05/2020
Job Reference: 18430459
Site Location: 544677 101543
Requested by:
Mr Jamie Cara-Southey
Your Scheme/Reference:
Newhaven district heating network network network network
Exact Scales:
1:1000 Area or Circle dig site
1:1000 Line dig site

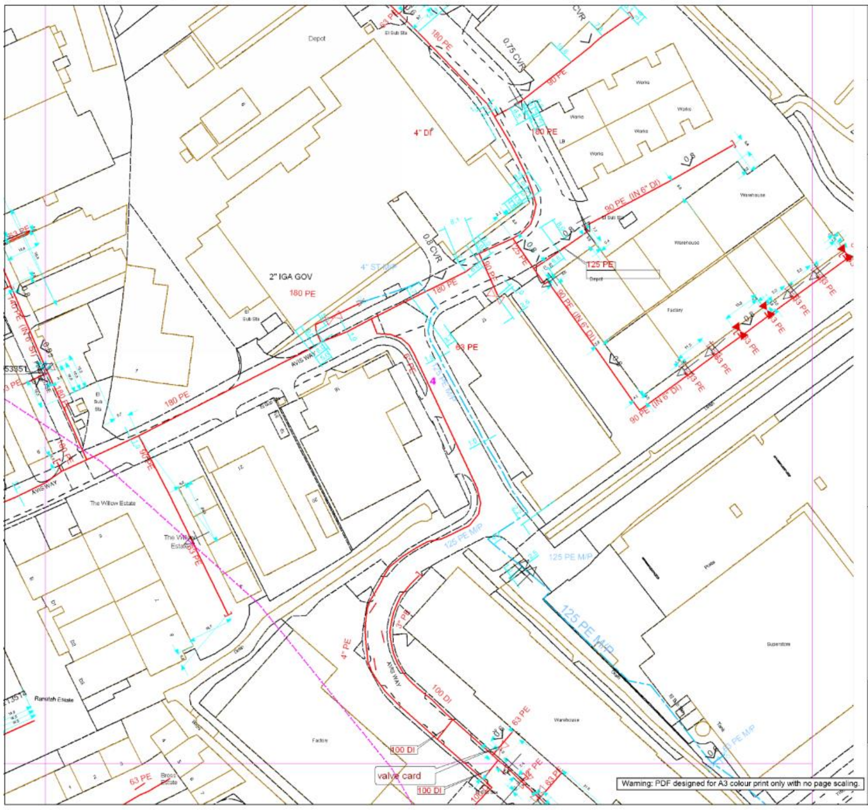
This plan shows the location of those pipes owned by Scotia Gas Networks (SGN) by virtue of being a licensed Gas Transporter (GT). Gas pipes owned by other GTs or third parties may also be present in this area but are not shown on this plan. Information with regard to such pipes should be obtained from the relevant owners. No warranties are given with regard to the accuracy of the information shown on this plan. Service pipes, valves, siphons, sub-connections etc. are not shown but their presence should be anticipated. You should be aware that a small percentage of our pipes/assets may be undergoing review and will temporarily be highlighted in yellow. If your proposed works are close to one of these pipes, you should contact the SGN Safety Admin Team on 0800 912 1722 for advice. No liability of any kind whatsoever is accepted by SGN or its agents, servants or sub-contractors for any error or omission contained herein. Safe digging practices, in accordance with HS (G)47, must be used to verify and establish the actual position of mains, pipes, services and other apparatus on site before any mechanical plant is used. It is your responsibility to ensure that plant location information is provided to all persons (whether direct labour or sub-contractors) working for you on or near gas apparatus. Information included on this plan should not be referred to beyond a period of 28 days from the date of issue.

Report damage immediately – KEEP EVERYONE AWAY FROM THE AREA 0800 111 999

Low Pressure Mains
Medium Pressure Mains
Intermediate Pressure Mains
High Pressure Mains
LAs
GTs SSSIs
Some Examples Of Plant Items
Valve Syphon Depth of Cover Diameter Change Material Change
Digsite: Line: Area:

Linesearch beforeUdig

This plan is reproduced from or based on the OS map by Scotia Gas Networks plc, with the sanction of the controller of HM Stationery Office. Crown Copyright Reserved. Southern Gas – 100044373 and Scotland Gas – 100044366.



Contact Us
Mapping Enquiries: All areas
General Enquiries: All areas

Date Requested: 20/05/2020
Job Reference: 18430459
Site Location: 544677 101543
Requested by:
Mr Jamie Cara-Southey
Your Scheme/Reference:
Newhaven district heating network network network network network
Exact Scales:
1:1000 Area or Circle dig site
1:1000 Line dig site

This plan shows the location of those pipes owned by Scotia Gas Networks (SGN) by virtue of being a licensed Gas Transporter (GT). Gas pipes owned by other GTs or third parties may also be present in this area but are not shown on this plan. Information with regard to such pipes should be obtained from the relevant owners. No warranties are given with regard to the accuracy of the information shown on this plan. Service pipes, valves, siphons, sub-connections etc. are not shown but their presence should be anticipated. You should be aware that a small percentage of our pipes/assets may be undergoing review and will temporarily be highlighted in yellow. If your proposed works are close to one of these pipes, you should contact the SGN Safety Admin Team on 0800 912 1722 for advice. No liability of any kind whatsoever is accepted by SGN or its agents, servants or sub-contractors for any error or omission contained herein. Safe digging practices, in accordance with HS (G)47, must be used to verify and establish the actual position of mains, pipes, services and other apparatus on site before any mechanical plant is used. It is your responsibility to ensure that plant location information is provided to all persons (whether direct labour or sub-contractors) working for you on or near gas apparatus. Information included on this plan should not be referred to beyond a period of 28 days from the date of issue.

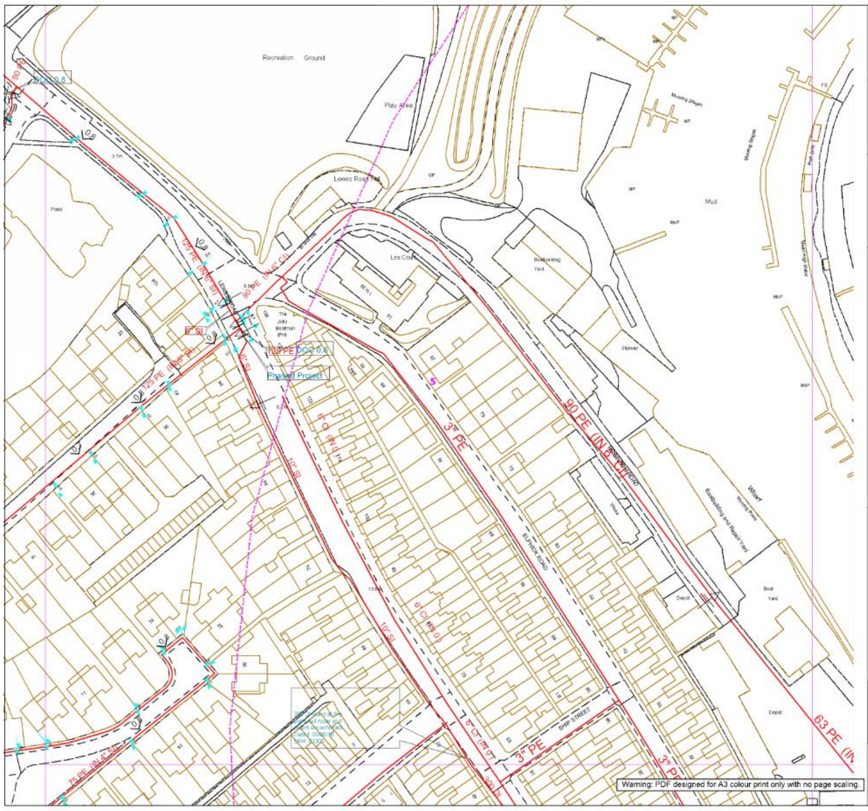
Report damage immediately – KEEP EVERYONE AWAY FROM THE AREA
0800 111 999

Low Pressure Mains
Medium Pressure Mains
Intermediate Pressure Mains
High Pressure Mains
LAs
GTs
SSSIs

Some Examples Of Plant Items
Valve Syphon Depth of Cover Diameter Change Material Change

Digsite: Line: Area:

Linesearch beforeUdig



Contact Us
Mapping Enquiries: All areas
General Enquiries: All areas

Date Requested: 20/05/2020
Job Reference: 18430459
Site Location: 544677 101543
Requested by:
Mr Jamie Cara-Southey
Your Scheme/Reference:
Newhaven district heating network network network network network
Exact Scales:
1:1000 Area or Circle dig site
1:1000 Line dig site

This plan shows the location of those pipes owned by Scotia Gas Networks (SGN) by virtue of being a licensed Gas Transporter (GT). Gas pipes owned by other GTs or third parties may also be present in this area but are not shown on this plan. Information with regard to such pipes should be obtained from the relevant owners. No warranties are given with regard to the accuracy of the information shown on this plan. Service pipes, valves, siphons, sub-connections etc. are not shown but their presence should be anticipated. You should be aware that a small percentage of our pipes/assets may be undergoing review and will temporarily be highlighted in yellow. If your proposed works are close to one of these pipes, you should contact the SGN Safety Admin Team on 0800 912 1722 for advice. No liability of any kind whatsoever is accepted by SGN or its agents, servants or sub-contractors for any error or omission contained herein. Safe digging practices, in accordance with HS (G)47, must be used to verify and establish the actual position of mains, pipes, services and other apparatus on site before any mechanical plant is used. It is your responsibility to ensure that plant location information is provided to all persons (whether direct labour or sub-contractors) working for you on or near gas apparatus. Information included on this plan should not be referred to beyond a period of 28 days from the date of issue.

Report damage immediately – KEEP EVERYONE AWAY FROM THE AREA
0800 111 999

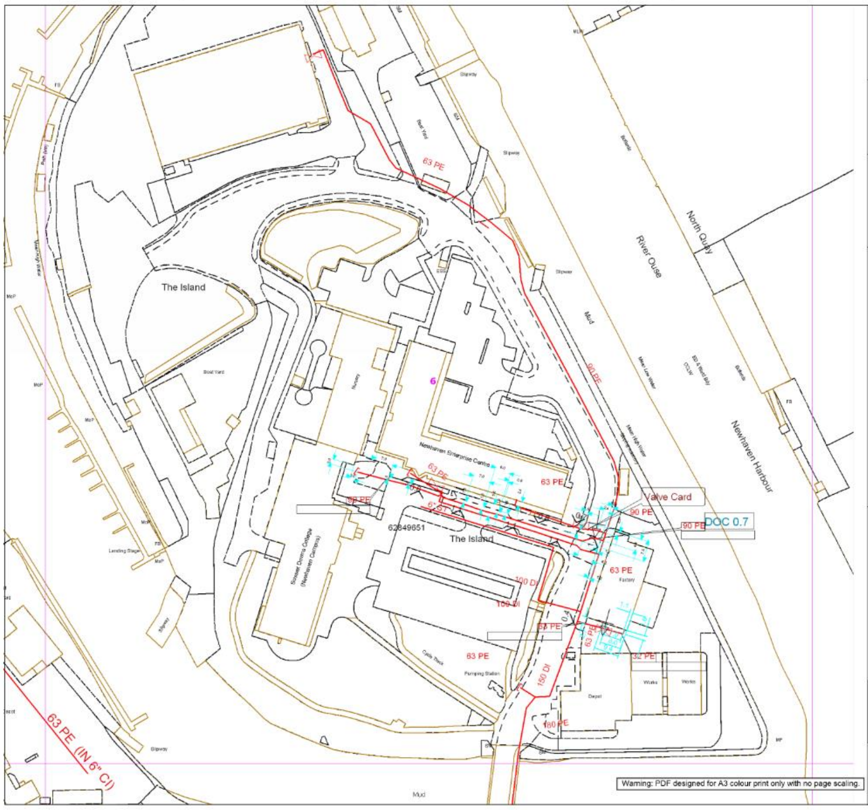
Low Pressure Mains
Medium Pressure Mains
Intermediate Pressure Mains
High Pressure Mains
LAs
GTs
SSSIs

Some Examples Of Plant Items
Valve Syphon Depth of Cover Diameter Change Material Change

Digsite: Line: Area:

Linesearch beforeUdig

This plan is reproduced from or based on the OS map by Scotia Gas Networks plc, with the sanction of the controller of HM Stationery Office. Crown Copyright Reserved. Southern Gas – 100044373 and Scotland Gas – 100044366.



SGN
Your gas. Our network.

Contact Us
Mapping Enquiries: All areas
General Enquiries: All areas

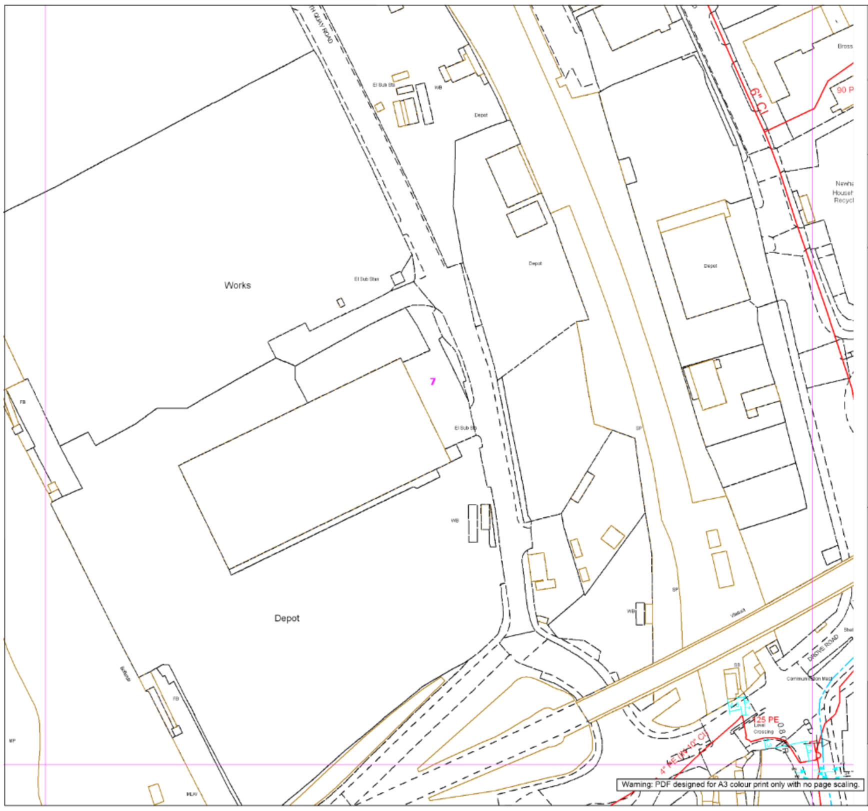
Date Requested: 20/05/2020
Job Reference: 18430459
Site Location: 544677 101543
Requested by:
Mr Jamie Cara-Southey
Your Scheme/Reference:
Newhaven district heating network network network network network
Exact Scales:
1:1000 Area or Circle dig site
1:1000 Line dig site

This plan shows the location of those pipes owned by Scotia Gas Networks (SGN) by virtue of being a licensed Gas Transporter (GT). Gas pipes owned by other GTs or third parties may also be present in this area but are not shown on this plan. Information with regard to such pipes should be obtained from the relevant owners. No warranties are given with regard to the accuracy of the information shown on this plan. Service pipes, valves, siphons, sub-connections etc. are not shown but their presence should be anticipated. You should be aware that a small percentage of our pipes/assets may be undergoing review and will temporarily be highlighted in yellow. If your proposed works are close to one of these pipes, you should contact the SGN Safety Admin Team on 0800 912 1722 for advice. No liability of any kind whatsoever is accepted by SGN or its agents, servants or sub-contractors for any error or omission contained herein. Safe digging practices, in accordance with HS (G)47, must be used to verify and establish the actual position of mains, pipes, services and other apparatus on site before any mechanical plant is used. It is your responsibility to ensure that plant location information is provided to all persons (whether direct labour or sub-contractors) working for you on or near gas apparatus. Information included on this plan should not be referred to beyond a period of 28 days from the date of issue.

Report damage immediately – KEEP EVERYONE AWAY FROM THE AREA
0800 111 999

Low Pressure Mains
Medium Pressure Mains
Intermediate Pressure Mains
High Pressure Mains
LAs
GTs
SSSIs
Some Examples Of Plant Items
Valve Syphon Depth of Cover Diameter Change Material Change
Digsite: Line: Area:

Linesearch before U dig



SGN
Your gas. Our network.

Contact Us
Mapping Enquiries: All areas
General Enquiries: All areas

Date Requested: 20/05/2020
Job Reference: 18430459
Site Location: 544677 101543
Requested by:
Mr Jamie Cara-Southey
Your Scheme/Reference:
Newhaven district heating network network network network network
Exact Scales:
1:1000 Area or Circle dig site
1:1000 Line dig site

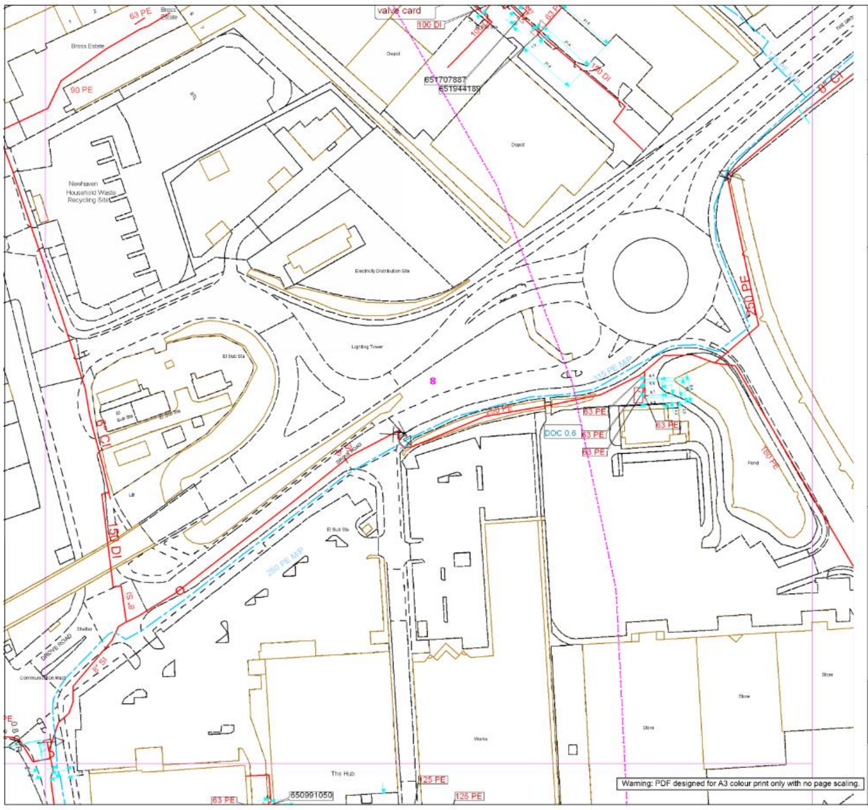
This plan shows the location of those pipes owned by Scotia Gas Networks (SGN) by virtue of being a licensed Gas Transporter (GT). Gas pipes owned by other GTs or third parties may also be present in this area but are not shown on this plan. Information with regard to such pipes should be obtained from the relevant owners. No warranties are given with regard to the accuracy of the information shown on this plan. Service pipes, valves, siphons, sub-connections etc. are not shown but their presence should be anticipated. You should be aware that a small percentage of our pipes/assets may be undergoing review and will temporarily be highlighted in yellow. If your proposed works are close to one of these pipes, you should contact the SGN Safety Admin Team on 0800 912 1722 for advice. No liability of any kind whatsoever is accepted by SGN or its agents, servants or sub-contractors for any error or omission contained herein. Safe digging practices, in accordance with HS (G)47, must be used to verify and establish the actual position of mains, pipes, services and other apparatus on site before any mechanical plant is used. It is your responsibility to ensure that plant location information is provided to all persons (whether direct labour or sub-contractors) working for you on or near gas apparatus. Information included on this plan should not be referred to beyond a period of 28 days from the date of issue.

Report damage immediately – KEEP EVERYONE AWAY FROM THE AREA
0800 111 999

Low Pressure Mains
Medium Pressure Mains
Intermediate Pressure Mains
High Pressure Mains
LAs
GTs
SSSIs
Some Examples Of Plant Items
Valve Syphon Depth of Cover Diameter Change Material Change
Digsite: Line: Area:

Linesearch before U dig

This plan is reproduced from or based on the OS map by Scotia Gas Networks plc, with the sanction of the controller of HM Stationery Office. Crown Copyright Reserved. Southern Gas – 100044373 and Scotland Gas – 100044366.



SGN
Your gas. Our network.

Contact Us

Mapping Enquiries: All areas

General Enquiries: All areas

Date Requested: 20/05/2020
Job Reference: 18430459
Site Location: 544677 101543
Requested by:
Mr Jamie Cara-Southey
Your Scheme/Reference:
Newhaven district heating network network network network network
Exact Scales:
1:1000 Area or Circle dig site
1:1000 Line dig site

This plan shows the location of those pipes owned by Scotia Gas Networks (SGN) by virtue of being a licensed Gas Transporter (GT). Gas pipes owned by other GTs or third parties may also be present in this area but are not shown on this plan. Information with regard to such pipes should be obtained from the relevant owners. No warranties are given with regard to the accuracy of the information shown on this plan. Service pipes, valves, siphons, sub-connections etc. are not shown but their presence should be anticipated. You should be aware that a small percentage of our pipes/assets may be undergoing review and will temporarily be highlighted in yellow. If your proposed works are close to one of these pipes, you should contact the SGN Safety Admin Team on 0800 912 1722 for advice. No liability of any kind whatsoever is accepted by SGN or its agents, servants or sub-contractors for any error or omission contained herein. Safe digging practices, in accordance with HS (G)47, must be used to verify and establish the actual position of mains, pipes, services and other apparatus on site before any mechanical plant is used. It is your responsibility to ensure that plant location information is provided to all persons (whether direct labour or sub-contractors) working for you on or near gas apparatus. Information included on this plan should not be referred to beyond a period of 28 days from the date of issue.

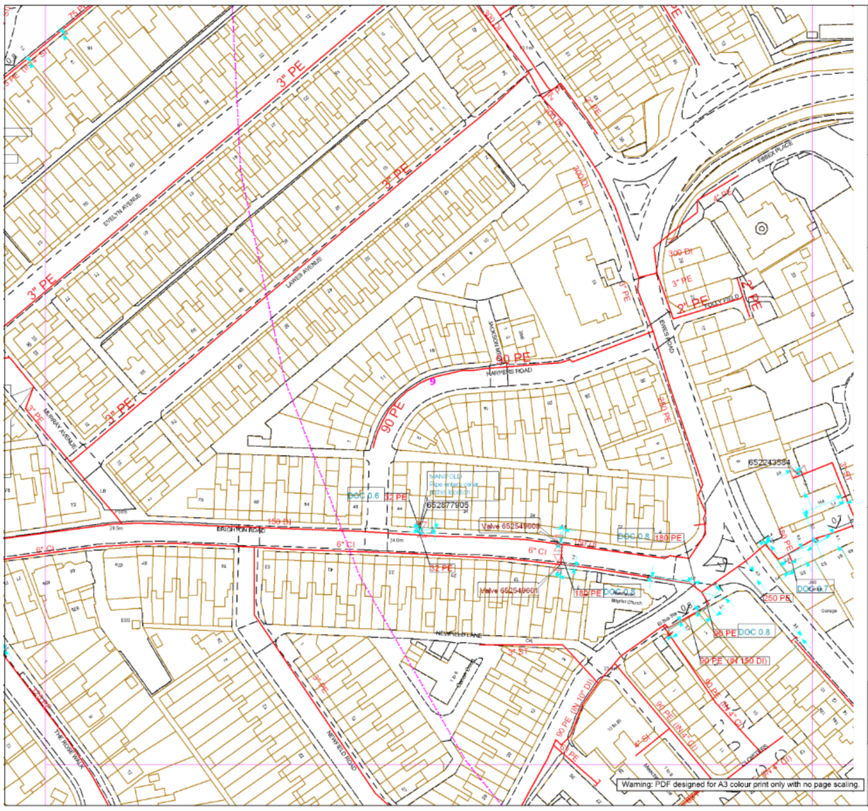
Report damage immediately – KEEP EVERYONE AWAY FROM THE AREA 0800 111 999

Low Pressure Mains
Medium Pressure Mains
Intermediate Pressure Mains
High Pressure Mains
LAs
GTs
SSSIs

Some Examples Of Plant Items
Valve · Syphon · Depth of Cover · Diameter Change · Material Change

Digsite: Line: · Area:

Linesearch beforeUdig



SGN
Your gas. Our network.

Contact Us

Mapping Enquiries: All areas

General Enquiries: All areas

Date Requested: 20/05/2020
Job Reference: 18430459
Site Location: 544677 101543
Requested by:
Mr Jamie Cara-Southey
Your Scheme/Reference:
Newhaven district heating network network network network network
Exact Scales:
1:1000 Area or Circle dig site
1:1000 Line dig site

This plan shows the location of those pipes owned by Scotia Gas Networks (SGN) by virtue of being a licensed Gas Transporter (GT). Gas pipes owned by other GTs or third parties may also be present in this area but are not shown on this plan. Information with regard to such pipes should be obtained from the relevant owners. No warranties are given with regard to the accuracy of the information shown on this plan. Service pipes, valves, siphons, sub-connections etc. are not shown but their presence should be anticipated. You should be aware that a small percentage of our pipes/assets may be undergoing review and will temporarily be highlighted in yellow. If your proposed works are close to one of these pipes, you should contact the SGN Safety Admin Team on 0800 912 1722 for advice. No liability of any kind whatsoever is accepted by SGN or its agents, servants or sub-contractors for any error or omission contained herein. Safe digging practices, in accordance with HS (G)47, must be used to verify and establish the actual position of mains, pipes, services and other apparatus on site before any mechanical plant is used. It is your responsibility to ensure that plant location information is provided to all persons (whether direct labour or sub-contractors) working for you on or near gas apparatus. Information included on this plan should not be referred to beyond a period of 28 days from the date of issue.

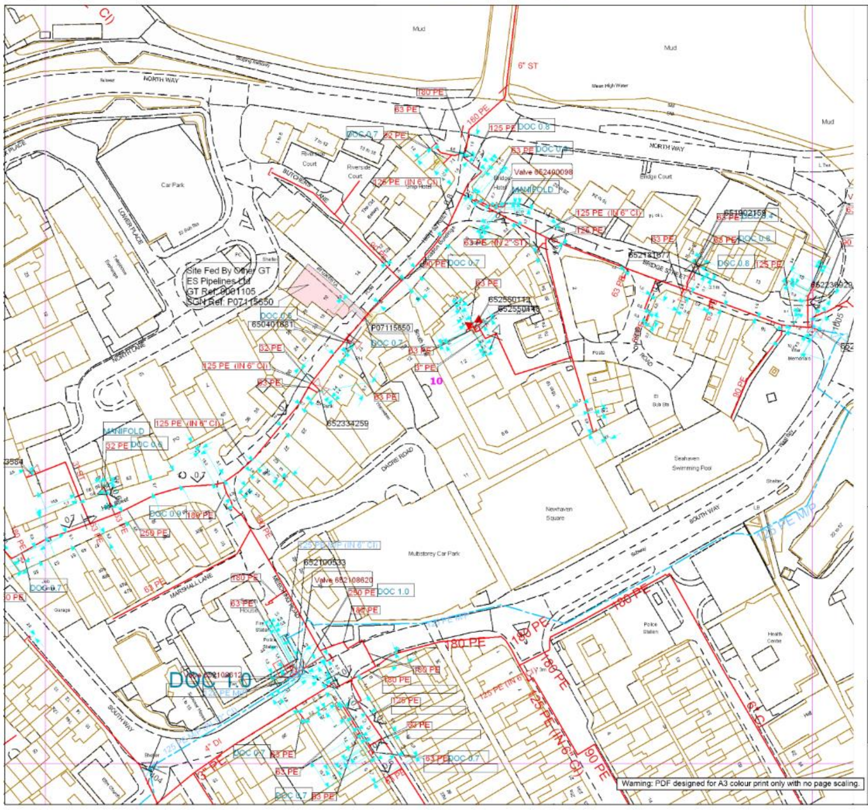
Report damage immediately – KEEP EVERYONE AWAY FROM THE AREA 0800 111 999

Low Pressure Mains
Medium Pressure Mains
Intermediate Pressure Mains
High Pressure Mains
LAs
GTs
SSSIs

Some Examples Of Plant Items
Valve · Syphon · Depth of Cover · Diameter Change · Material Change

Digsite: Line: · Area:

Linesearch beforeUdig



SGN
Your gas. Our network.

Contact Us
Mapping Enquiries: All areas
General Enquiries: All areas

Date Requested: 20/05/2020
Job Reference: 18430459
Site Location: 544677 101543
Requested by:
Mr Jamie Cara-Southey
Your Scheme/Reference:
Newhaven district heating network network network network network
Exact Scales:
1:1000 Area or Circle dig site
1:1000 Line dig site

This plan shows the location of those pipes owned by Scotia Gas Networks (SGN) by virtue of being a licensed Gas Transporter (GT). Gas pipes owned by other GTs or third parties may also be present in this area but are not shown on this plan. Information with regard to such pipes should be obtained from the relevant owners. No warranties are given with regard to the accuracy of the information shown on this plan. Service pipes, valves, siphons, sub-connections etc. are not shown but their presence should be anticipated. You should be aware that a small percentage of our pipes/assets may be undergoing review and will temporarily be highlighted in yellow. If your proposed works are close to one of these pipes, you should contact the SGN Safety Admin Team on 0800 912 1722 for advice. No liability of any kind whatsoever is accepted by SGN or its agents, servants or sub-contractors for any error or omission contained herein. Safe digging practices, in accordance with HS (G)47, must be used to verify and establish the actual position of mains, pipes, services and other apparatus on site before any mechanical plant is used. It is your responsibility to ensure that plant location information is provided to all persons (whether direct labour or sub-contractors) working for you on or near gas apparatus. Information included on this plan should not be referred to beyond a period of 28 days from the date of issue.

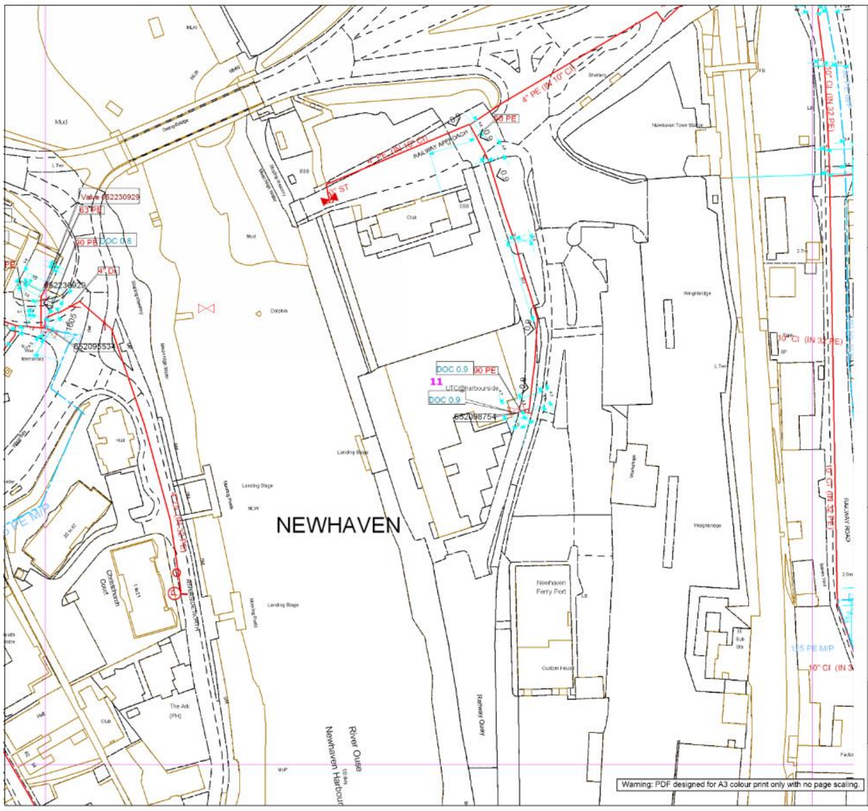
Report damage immediately – KEEP EVERYONE AWAY FROM THE AREA 0800 111 999

Low Pressure Mains
Medium Pressure Mains
Intermediate Pressure Mains
High Pressure Mains
LAs
GTs
SSSIs

Some Examples Of Plant Items
Valve Syphon Depth of Cover Diameter Change Material Change

Digsite: Line: Area:

Linesearch before U dig



SGN
Your gas. Our network.

Contact Us
Mapping Enquiries: All areas
General Enquiries: All areas

Date Requested: 20/05/2020
Job Reference: 18430459
Site Location: 544677 101543
Requested by:
Mr Jamie Cara-Southey
Your Scheme/Reference:
Newhaven district heating network network network network network
Exact Scales:
1:1000 Area or Circle dig site
1:1000 Line dig site

This plan shows the location of those pipes owned by Scotia Gas Networks (SGN) by virtue of being a licensed Gas Transporter (GT). Gas pipes owned by other GTs or third parties may also be present in this area but are not shown on this plan. Information with regard to such pipes should be obtained from the relevant owners. No warranties are given with regard to the accuracy of the information shown on this plan. Service pipes, valves, siphons, sub-connections etc. are not shown but their presence should be anticipated. You should be aware that a small percentage of our pipes/assets may be undergoing review and will temporarily be highlighted in yellow. If your proposed works are close to one of these pipes, you should contact the SGN Safety Admin Team on 0800 912 1722 for advice. No liability of any kind whatsoever is accepted by SGN or its agents, servants or sub-contractors for any error or omission contained herein. Safe digging practices, in accordance with HS (G)47, must be used to verify and establish the actual position of mains, pipes, services and other apparatus on site before any mechanical plant is used. It is your responsibility to ensure that plant location information is provided to all persons (whether direct labour or sub-contractors) working for you on or near gas apparatus. Information included on this plan should not be referred to beyond a period of 28 days from the date of issue.

Report damage immediately – KEEP EVERYONE AWAY FROM THE AREA 0800 111 999

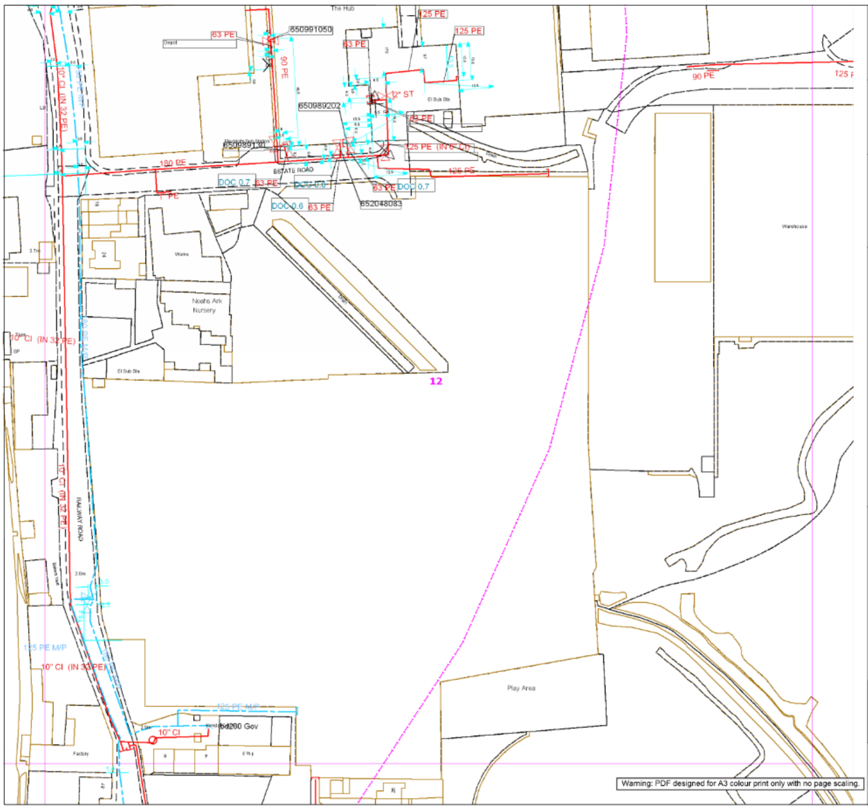
Low Pressure Mains
Medium Pressure Mains
Intermediate Pressure Mains
High Pressure Mains
LAs
GTs
SSSIs

Some Examples Of Plant Items
Valve Syphon Depth of Cover Diameter Change Material Change

Digsite: Line: Area:

Linesearch before U dig

This plan is reproduced from or based on the OS map by Scotia Gas Networks plc, with the sanction of the controller of HM Stationery Office. Crown Copyright Reserved. Southern Gas – 100044373 and Scotland Gas – 100044366.



Contact Us

Mapping Enquiries: All areas

General Enquiries: All areas

Date Requested: 20/05/2020
Job Reference: 18430459
Site Location: 544677 101543
Requested by:
Mr Jamie Cara-Southey
Your Scheme/Reference:
Newhaven district heating network network network network network
Exact Scales:
1:1000 Area or Circle dig site
1:1000 Line dig site

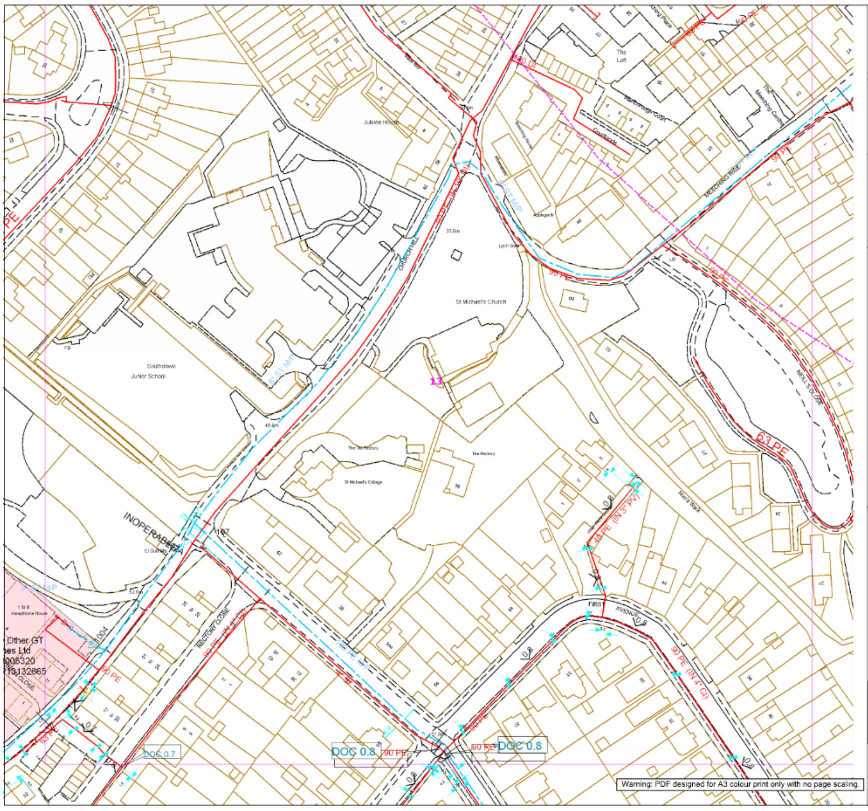
This plan shows the location of those pipes owned by Scotia Gas Networks (SGN) by virtue of being a licensed Gas Transporter (GT). Gas pipes owned by other GTs or third parties may also be present in this area but are not shown on this plan. Information with regard to such pipes should be obtained from the relevant owners. No warranties are given with regard to the accuracy of the information shown on this plan. Service pipes, valves, siphons, sub-connections etc. are not shown but their presence should be anticipated. You should be aware that a small percentage of our pipes/assets may be undergoing review and will temporarily be highlighted in yellow. If your proposed works are close to one of these pipes, you should contact the SGN Safety Admin Team on 0800 912 1722 for advice. No liability of any kind whatsoever is accepted by SGN or its agents, servants or sub-contractors for any error or omission contained herein. Safe digging practices, in accordance with HS (G)47, must be used to verify and establish the actual position of mains, pipes, services and other apparatus on site before any mechanical plant is used. It is your responsibility to ensure that plant location information is provided to all persons (whether direct labour or sub-contractors) working for you on or near gas apparatus. Information included on this plan should not be referred to beyond a period of 28 days from the date of issue.

Report damage immediately – KEEP EVERYONE AWAY FROM THE AREA 0800 111 999

Low Pressure Mains
Medium Pressure Mains
Intermediate Pressure Mains
High Pressure Mains
LAs
GTs
SSSIs

Some Examples Of Plant Items
Valve Syphon Depth of Cover Diameter Change Material Change

Digsite: Line: Area:



Contact Us

Mapping Enquiries: All areas

General Enquiries: All areas

Date Requested: 20/05/2020
Job Reference: 18430459
Site Location: 544677 101543
Requested by:
Mr Jamie Cara-Southey
Your Scheme/Reference:
Newhaven district heating network network network network network
Exact Scales:
1:1000 Area or Circle dig site
1:1000 Line dig site

This plan shows the location of those pipes owned by Scotia Gas Networks (SGN) by virtue of being a licensed Gas Transporter (GT). Gas pipes owned by other GTs or third parties may also be present in this area but are not shown on this plan. Information with regard to such pipes should be obtained from the relevant owners. No warranties are given with regard to the accuracy of the information shown on this plan. Service pipes, valves, siphons, sub-connections etc. are not shown but their presence should be anticipated. You should be aware that a small percentage of our pipes/assets may be undergoing review and will temporarily be highlighted in yellow. If your proposed works are close to one of these pipes, you should contact the SGN Safety Admin Team on 0800 912 1722 for advice. No liability of any kind whatsoever is accepted by SGN or its agents, servants or sub-contractors for any error or omission contained herein. Safe digging practices, in accordance with HS (G)47, must be used to verify and establish the actual position of mains, pipes, services and other apparatus on site before any mechanical plant is used. It is your responsibility to ensure that plant location information is provided to all persons (whether direct labour or sub-contractors) working for you on or near gas apparatus. Information included on this plan should not be referred to beyond a period of 28 days from the date of issue.

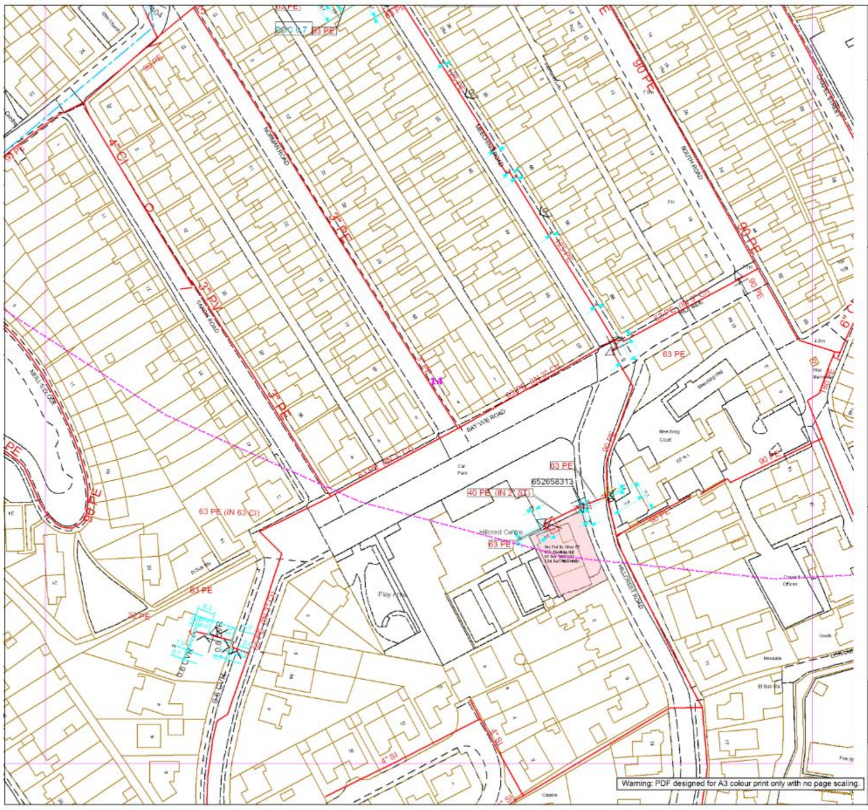
Report damage immediately – KEEP EVERYONE AWAY FROM THE AREA 0800 111 999

Low Pressure Mains
Medium Pressure Mains
Intermediate Pressure Mains
High Pressure Mains
LAs
GTs
SSSIs

Some Examples Of Plant Items
Valve Syphon Depth of Cover Diameter Change Material Change

Digsite: Line: Area:

This plan is reproduced from or based on the OS map by Scotia Gas Networks plc, with the sanction of the controller of HM Stationery Office. Crown Copyright Reserved. Southern Gas – 100044373 and Scotland Gas – 100044366.



Contact Us
Mapping Enquiries: All areas
General Enquiries: All areas

Date Requested: 20/05/2020
Job Reference: 18430459
Site Location: 544677 101543
Requested by:
Mr Jamie Cara-Southey
Your Scheme/Reference:
Newhaven district heating network network network network network
Exact Scales:
1:1000 Area or Circle dig site
1:1000 Line dig site

This plan shows the location of those pipes owned by Scotia Gas Networks (SGN) by virtue of being a licensed Gas Transporter (GT). Gas pipes owned by other GTs or third parties may also be present in this area but are not shown on this plan. Information with regard to such pipes should be obtained from the relevant owners. No warranties are given with regard to the accuracy of the information shown on this plan. Service pipes, valves, siphons, sub-connections etc. are not shown but their presence should be anticipated. You should be aware that a small percentage of our pipes/assets may be undergoing review and will temporarily be highlighted in yellow. If your proposed works are close to one of these pipes, you should contact the SGN Safety Admin Team on 0800 912 1722 for advice. No liability of any kind whatsoever is accepted by SGN or its agents, servants or sub-contractors for any error or omission contained herein. Safe digging practices, in accordance with HS (G)47, must be used to verify and establish the actual position of mains, pipes, services and other apparatus on site before any mechanical plant is used. It is your responsibility to ensure that plant location information is provided to all persons (whether direct labour or sub-contractors) working for you on or near gas apparatus. Information included on this plan should not be referred to beyond a period of 28 days from the date of issue.

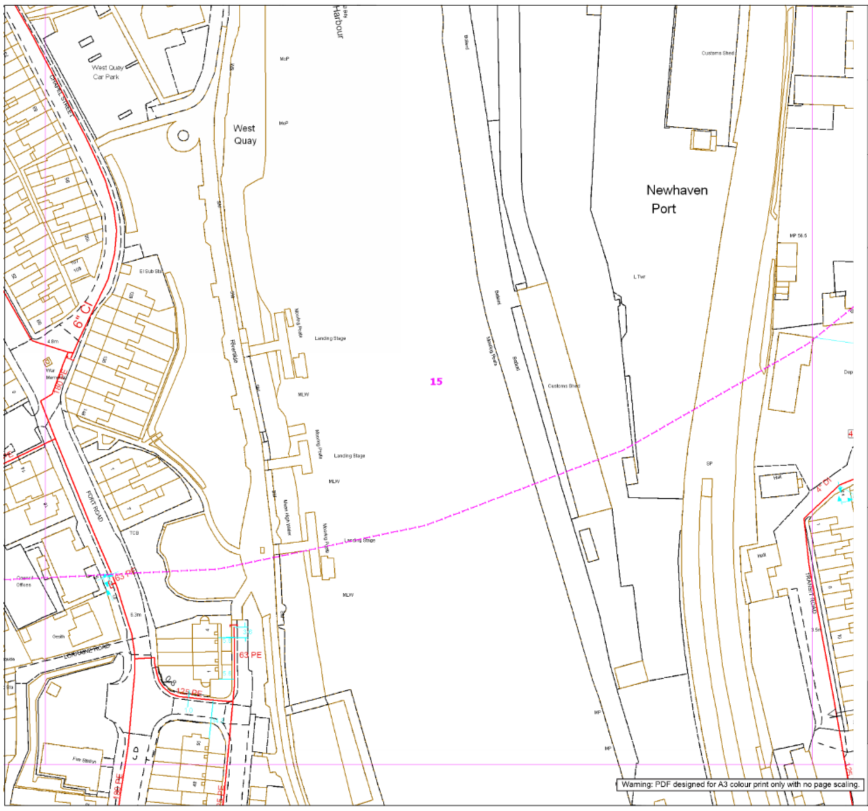
Report damage immediately – KEEP EVERYONE AWAY FROM THE AREA 0800 111 999

Low Pressure Mains
Medium Pressure Mains
Intermediate Pressure Mains
High Pressure Mains
LAs
GTs
SSSIs

Some Examples Of Plant Items
Valve Syphon Depth of Cover Diameter Change Material Change

Digsite: Line: Area:

Linesearch beforeUdig



Contact Us
Mapping Enquiries: All areas
General Enquiries: All areas

Date Requested: 20/05/2020
Job Reference: 18430459
Site Location: 544677 101543
Requested by:
Mr Jamie Cara-Southey
Your Scheme/Reference:
Newhaven district heating network network network network network
Exact Scales:
1:1000 Area or Circle dig site
1:1000 Line dig site

This plan shows the location of those pipes owned by Scotia Gas Networks (SGN) by virtue of being a licensed Gas Transporter (GT). Gas pipes owned by other GTs or third parties may also be present in this area but are not shown on this plan. Information with regard to such pipes should be obtained from the relevant owners. No warranties are given with regard to the accuracy of the information shown on this plan. Service pipes, valves, siphons, sub-connections etc. are not shown but their presence should be anticipated. You should be aware that a small percentage of our pipes/assets may be undergoing review and will temporarily be highlighted in yellow. If your proposed works are close to one of these pipes, you should contact the SGN Safety Admin Team on 0800 912 1722 for advice. No liability of any kind whatsoever is accepted by SGN or its agents, servants or sub-contractors for any error or omission contained herein. Safe digging practices, in accordance with HS (G)47, must be used to verify and establish the actual position of mains, pipes, services and other apparatus on site before any mechanical plant is used. It is your responsibility to ensure that plant location information is provided to all persons (whether direct labour or sub-contractors) working for you on or near gas apparatus. Information included on this plan should not be referred to beyond a period of 28 days from the date of issue.

Report damage immediately – KEEP EVERYONE AWAY FROM THE AREA 0800 111 999

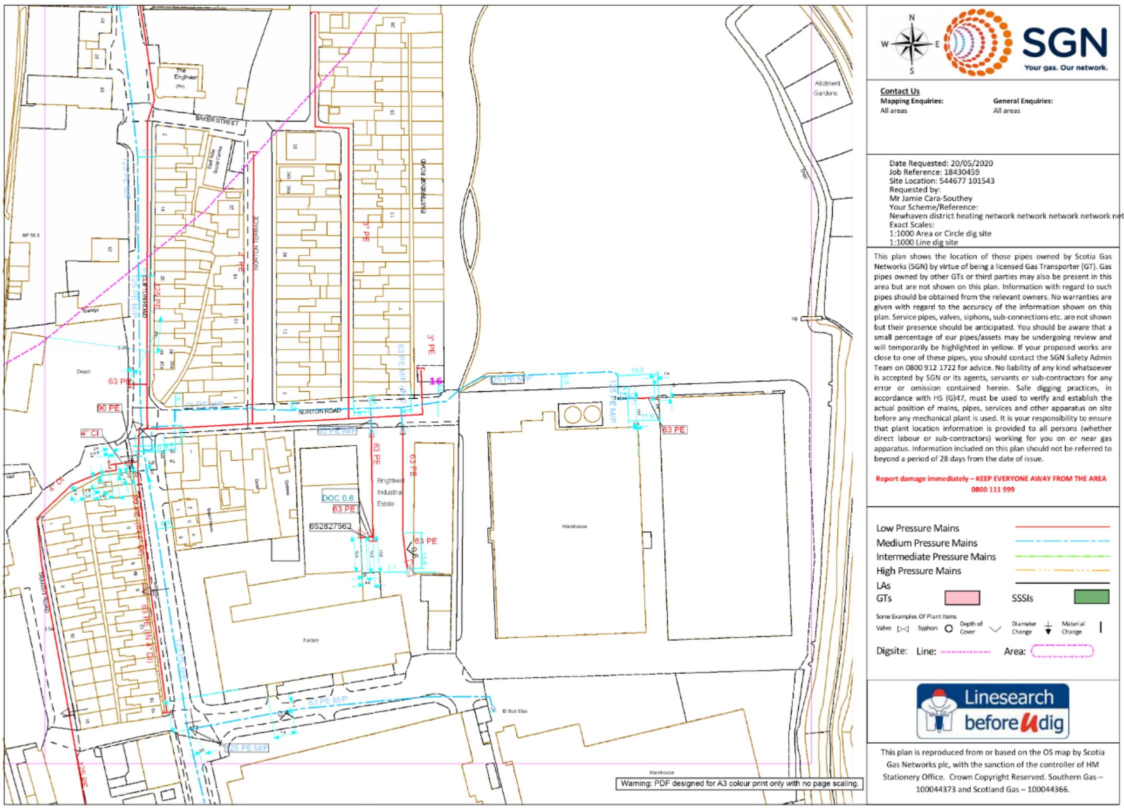
Low Pressure Mains
Medium Pressure Mains
Intermediate Pressure Mains
High Pressure Mains
LAs
GTs
SSSIs

Some Examples Of Plant Items
Valve Syphon Depth of Cover Diameter Change Material Change

Digsite: Line: Area:

Linesearch beforeUdig

This plan is reproduced from or based on the OS map by Scotia Gas Networks plc, with the sanction of the controller of HM Stationery Office. Crown Copyright Reserved. Southern Gas – 100044373 and Scotland Gas – 100044366.


SGN
Your gas. Our network.
Contact Us
Mapping Enquiries:
All areas
General Enquiries:
All areas
Date Requested: 20/05/2020
Job Reference: 18430459
Site Location: 544677 101543
Requested by:
Mr Jamie Cara-Southey
Your Scheme/Reference:
Newhaven district heating network network network network network
Exact Scales:
1:1000 Area or Circle dig site
1:1000 Line dig site
This plan shows the location of those pipes owned by Scotia Gas Networks (SGN) by virtue of being a licensed Gas Transporter (GT). Gas pipes owned by other GTs or third parties may also be present in this area but are not shown on this plan. Information with regard to such pipes should be obtained from the relevant owners. No warranties are given with regard to the accuracy of the information shown on this plan. Service pipes, valves, siphons, sub-connections etc. are not shown but their presence should be anticipated. You should be aware that a small percentage of our pipes/assets may be undergoing review and will temporarily be highlighted in yellow. If your proposed works are close to one of these pipes, you should contact the SGN Safety Admin Team on 0800 912 1722 for advice. No liability of any kind whatsoever is accepted by SGN or its agents, servants or sub-contractors for any error or omission contained herein. Safe digging practices, in accordance with HS (G)47, must be used to verify and establish the actual position of mains, pipes, services and other apparatus on site before any mechanical plant is used. It is your responsibility to ensure that plant location information is provided to all persons (whether direct labour or sub-contractors) working for you on or near gas apparatus. Information included on this plan should not be referred to beyond a period of 28 days from the date of issue.
Report damage immediately – KEEP EVERYONE AWAY FROM THE AREA
0800 111 999
Low Pressure Mains
Medium Pressure Mains
Intermediate Pressure Mains
High Pressure Mains
LAs
GTs
SSSIs
Some Examples Of Plant Items
Valve
Syphon
Depth of Cover
Diameter Change
Material Change
Digsite:
Line:
Area:
Linesearch beforeUdig
This plan is reproduced from or based on the OS map by Scotia Gas Networks plc, with the sanction of the controller of HM Stationery Office. Crown Copyright Reserved. Southern Gas – 100044373 and Scotland Gas – 100044366.
Warning: PDF designed for A3 colour print only with no page scaling.
BAKER STREET
NORTON ROAD
Warehouse
Factory
Brightwell Industrial Estate
DOC 0.6
63 PE
90 PE
4" CI
652827562
Allotment Gardens
Depot
El Sub Sta