EP UK Investments

South Humber Bank Energy Centre Project

Planning Inspectorate Reference: EN010107

South Marsh Road, Stallingborough, DN41 8BZ

The South Humber Bank Energy Centre Order

Document Reference: 5.6 Combined Heat and Power Assessment

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 - Regulation 5(2)(q)

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GLOSSARY

Abbreviation	Description
ACC	Air cooled condenser
BAT	Best Available Techniques
BEIS	Department for Business, Energy and Industrial Strategy
CBA	Cost-benefit assessment
CCGT	Combined Cycle Gas Turbine
CfD	Contracts for Difference
CHP	Combined Heat and Power
CHPQA	CHP Quality Assurance
CIBSE	Chartered Institution of Building Services Engineers
DCO	Development Consent Order: provides a consent for building and operating an NSIP
DFDS	Det Forenede Dampskibs-Selskab
DH	District Heating
DN	Diameter nominal
EA	Environment Agency
EfW	Energy from Waste: the combustion of waste material to provide electricity and/ or heat
EIA	Environmental Impact Assessment
EP	Environmental Permit
EPH	Energetický A Prumyslový Holding
EPUKI	EP UK Investments Ltd
EPWM	EP Waste Management Limited (the Applicant)
ES	Environmental Statement
GCV	Gross calorific value
HNIP	Heat Network Investment Project
ISO	International Organization for Standardization
LOR	Lindsey Oil Refinery
MW	Megawatt
MW_e	Megawatt electrical: the measure of power produced
MW_{th}	Megawatt thermal: the measure of heat produced
NCA	National Comprehensive Assessment
NCV	Net calorific value
NELC	North East Lincolnshire Council
NELLP	North East Lincolnshire Local Plan

NPS	National Policy Statement
NRSWA	New Roads and Street Works Act 1991
NSIP	Nationally Significant Infrastructure Project: for which a DCO is required
PA 2008	Planning Act 2008
PES	Primary Energy Savings
PINS	Planning Inspectorate
QI	Quality Index
RDF	Refuse derived fuel
RHI	Renewable Heat Incentive
RO	Renewables Obligation
SHBEC	South Humber Bank Energy Centre
SHBPS	South Humber Bank Power Station
SoS	Secretary of State

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SUMMARY

EP Waste Management (EPWM) is proposing to develop a waste-fired power plant, the South Humber Bank Energy Centre (SHBEC) ('the Proposed Development'), adjacent to the existing South Humber Bank Power Station (SHBPS). The Proposed Development will be a two-stream facility with an average nominal capacity of approximately 616,500 tonnes of refuse derived fuel (RDF) per annum at the design net calorific value (NCV) of 11 MJ/kg[1]. The purpose of this Combined Heat and Power Assessment is to assess the feasibility of supplying heat from the Proposed Development to local heat consumers.

In the base case scenario considered for this study, the Proposed Development will generate approximately 76.0 MW_e of electricity when operating in full condensing mode at the design ambient temperature. Power export to the National Grid will be approximately 68.3 MW_e after parasitic load is accounted for. The conceptual design for the Proposed Development allows heat export as either steam or hot water via extraction from the steam turbine. Sufficient space has been safeguarded for the installation of the required infrastructure to meet a range of potential heat export scenarios. These design considerations will be maintained during detailed design and procurement of the Proposed Development.

The Environment Agency (EA) Combined Heat and Power (CHP) Ready Guidance requires Best Available Techniques (BAT) to be demonstrated by maximising energy efficiency. Following screening of potential heat consumers, the preferred option was identified entailing the supply of a district heating (DH) network to light industrial and warehousing developments. Heat would be provided in the form of hot water, with the DFDS Immingham Terminal (5 km from the Proposed Development) used as an anchor load.

Through further development of a network heat demand profile, it was established that technically feasible opportunities exist to export an annual average heat load of up to 14.3 MW_{th} with, when accounting for consumer diversity and heat losses, a peak load of 37.7 MW_{th}. Average and peak loads are well within the CHP capabilities specified in the design concept for the Proposed Development.

While the quantity of heat demand identified is sufficient to achieve Primary Energy Savings (PES) in excess of the 10% technical feasibility threshold, it is not sufficient to be deemed 'Good Quality' in accordance with the CHP Quality Assurance (CHPQA) scheme. At the average heat load of the proposed heat, the PES was calculated to be 23.3% and the CHPQA Quality Index (QI) score was 64.3. A QI score of 105 is required at the design stage to be deemed 'Good Quality'. The onerous efficiency criteria set

[1] The average capacity would increase to up to 753,500 tonnes per annum with an RDF NCV of 9 MJ/kg.

out in the latest CHPQA guidance means that it is unlikely that any energy from waste plant will now reach 'Good Quality' status.

In accordance with Article 14 of the Energy Efficiency Directive, a cost-benefit assessment (CBA) of opportunities for CHP is required when applying for an Environmental Permit (EP). A CHP assessment is also required by the Overarching Energy National Policy Statement (EN-1). An assessment of the costs and revenues associated with the construction and operation of a potential heating network at the DFDS Immingham Terminal was undertaken, and the outcomes were entered into a CBA in accordance with the draft Article 14 guidance document issued by the EA. The results indicate that the nominal project internal rate of return and net present value (before financing and tax) over 33 years are negative. Therefore, the proposed heat network as modelled in the study is not considered an economically viable scheme. The economic feasibility of the scheme will be reassessed in the future when there is further certainty regarding heat loads and considering any subsidies that might be available at that time that support the export of heat.

The Proposed Development will be designed to be CHP-Ready to demonstrate BAT, meaning that it will be able to export heat in the future with minimum modification, by having steam capacity designed into the turbine bleed and space safeguarded to house CHP equipment. A CHP-Ready Assessment form has been completed and is provided in Appendix E of this report.

This approach to energy efficiency is considered the most appropriate in circumstances where there are not technically and economically viable opportunities for the supply of heat from the outset. EPWM recognises the benefits associated with maximising energy recovery from the thermal treatment of waste, through the implementation of CHP. As part of its duties under the Environmental Permit, EPWM will continue to explore commercial opportunities to export heat from the Proposed Development and periodically update its position.

1.0 INTRODUCTION

1.1 Overview

1.1.1 This ‘Combined Heat and Power Assessment’ document (Document Ref. 5.6) has been prepared on behalf of EP Waste Management Limited (‘EPWM’ or the ‘Applicant’). It forms part of the application (the 'Application') for a Development Consent Order (a 'DCO'), that has been submitted to the Secretary of State (the ‘SoS’) for Business, Energy and Industrial Strategy, under section 37 of ‘The Planning Act 2008’ (the ‘PA 2008’).

1.1.2 EPWM is seeking development consent for the construction, operation and maintenance of an energy from waste (‘EfW’) power station with a gross electrical output of up to 95 megawatts (MW) including an electrical connection, a new site access, and other associated development (together ‘the Proposed Development’) on land at South Humber Bank Power Station (‘SHBPS’), South Marsh Road, near Stallingborough in North East Lincolnshire (‘the Site’).

1.1.3 A DCO is required for the Proposed Development as it falls within the definition and thresholds for a 'Nationally Significant Infrastructure Project' (a 'NSIP') under sections 14 and 15(2) of the PA 2008.

1.1.4 The DCO, if made by the SoS, would be known as the ‘South Humber Bank Energy Centre Order' (‘the Order').

1.1.5 Full planning permission (‘the Planning Permission’) was granted by North East Lincolnshire Council (‘NELC’) for an EfW power station with a gross electrical output of up to 49.9 MW and associated development (‘the Consented Development’) on land at SHBPS (‘the Consented Development Site’) under the Town and Country Planning Act 1990 on 12 April 2019. Since the Planning Permission was granted, the Applicant has assessed potential opportunities to improve the efficiency of the EfW power station, notably in relation to its electrical output. As a consequence, the Proposed Development would have a higher electrical output (up to 95 MW) than the Consented Development, although it would have the same maximum building dimensions and fuel throughput (up to 753,500 tonnes per annum (tpa)).

1.2 The Applicant

1.2.1 The Applicant is a subsidiary of EP UK Investments Limited (‘EPUKI’). EPUKI owns and operates a number of other power stations in the UK. These include SHBPS and Langage (Devon) Combined Cycle Gas Turbine (‘CCGT’) power stations, Lynemouth (Northumberland) biomass-fired power station, and power generation assets in Northern Ireland. EPUKI also owns sites with consent for new power stations in Norfolk (King’s Lynn ‘B’ CCGT) and North Yorkshire (Eggborough CCGT).

1.2.2 EPUKI is a subsidiary of Energetický A Prumyslový Holding ('EPH'). EPH owns and operates energy generation assets in the Czech Republic, Slovak Republic, Germany, Italy, Hungary, Poland, Ireland, and the United Kingdom.

1.3 The Proposed Development Site

1.3.1 The Proposed Development Site (the 'Site' or the 'Order limits') is located within the boundary of the SHBPS site, east of the existing SHBPS, along with part of the carriageway within South Marsh Road. The principal access to the site is off South Marsh Road.

1.3.2 The Site is located on the South Humber Bank between the towns of Immingham and Grimsby; both over 3 km from the Site. The surrounding area is characterised by industrial uses dispersed between areas of agricultural land with the nearest main settlements being the villages of Stallingborough, Healing and Great Coates. The Site lies within the parish of Stallingborough although Stallingborough village lies over 2 km away.

1.3.3 The Site lies within the administrative area of NELC, a unitary authority. The Site is owned by EP SHB Limited, a subsidiary of EPUKI, and is therefore under the control of the Applicant, with the exception of the highway land on South Marsh Road required for the new Site access.

1.3.4 The existing SHBPS was constructed in two phases between 1997 and 1999 and consists of two CCGT units fired by natural gas, with a combined gross electrical capacity of approximately 1,400 MW. It is operated by EP SHB Limited.

1.3.5 The Site is around 23 hectares ('ha') in area and is generally flat, and typically stands at around 2.0 m Above Ordnance Datum (mAOD).

1.3.6 The land surrounding the Site immediately to the south, west and north-west is in agricultural use with a large polymer manufacturing site, Synthomer, and a waste management facility, NEWLINCS, both located to the north of the Site and also accessed from South Marsh Road. The estuary of the River Humber lies around 175 m to the east of the Site.

1.3.7 Access to the South Humber Bank is via the A180 trunk road and the A1173. The Barton railway line runs north-west to south-east between Barton-on-Humber and Cleethorpes circa 2.5 km to the south-west of the Site and a freight railway line runs north-west to south-east circa 300 m (at the closest point) to the Site.

1.3.8 A more detailed description of the Site is provided at Chapter 3: Description of the Proposed Development Site in the Environmental Statement ('ES') Volume I (Document Ref. 6.2).

1.4 The Proposed Development

1.4.1 The main components of the Proposed Development are summarised below:

- Work No. 1— an electricity generating station located on land at SHBPS, fuelled by refuse derived fuel ('RDF') with a gross electrical output of up to 95 MW at ISO conditions;
- Work No. 1A— two emissions stacks and associated emissions monitoring systems;
- Work No. 1B— administration block, including control room, workshops, stores and welfare facilities;

- Work No. 2— comprising electrical, gas, water, telecommunication, steam and other utility connections for the generating station (Work No. 1);
- Work No. 3— landscaping and biodiversity works;
- Work No. 4— a new site access on to South Marsh Road and works to an existing access on to South Marsh Road; and
- Work No. 5— temporary construction and laydown areas.

1.4.2 Various types of ancillary development further required in connection with and subsidiary to the above works are detailed in Schedule 1 of the DCO. A more detailed description of the Proposed Development is provided at Schedule 1 'Authorised Development' of the Draft DCO and Chapter 4: The Proposed Development in the ES Volume I (Document Ref. 6.2) and the areas within which each of the main components of the Proposed Development are to be built is shown by the coloured and hatched areas on the Works Plans (Document Ref. 4.3).

1.5 Relationship with the Consented Development

1.5.1 The Proposed Development comprises the works contained in the Consented Development, along with additional works not forming part of the Consented Development (‘the Additional Works’). The Additional Works are set out below along with an explanation of their purpose.

- a larger air-cooled condenser (ACC), with an additional row of fans and heat exchangers – this will allow a higher mass flow of steam to be sent to the steam turbine whilst maintaining the exhaust pressure and thereby increasing the amount of power generated;
- a greater installed cooling capacity for the generator – additional heat exchangers will be installed to the closed-circuit cooling water system to allow the generator to operate at an increased load and generate more power;
- an increased transformer capacity – depending on the adopted grid connection arrangement the capacity will be increased through an additional generator transformer operating in parallel with the Consented Development’s proposed generator transformer or a single larger generator transformer. Both arrangements would allow generation up to 95 MW; and
- ancillary works – the above works will require additional ancillary works and operations, such as new cabling or pipes, and commissioning to ensure that the apparatus has been correctly installed and will operate safely and as intended.

1.5.2 The likely construction scenario is for work on the Consented Development (pursuant to the Planning Permission) to commence in Quarter 2 (‘Q2’) of 2020 and to continue for around three years. Following grant of a DCO for the Proposed Development (approximately halfway through the three-year construction programme), the Applicant would initiate powers to continue development under the Order instead of the Planning Permission. The Order includes appropriate powers and notification requirements for the ‘switchover’ between consents, to provide clarity for the relevant planning authority regarding the development authorised and the applicable conditions, requirements, and other obligations. Once the Order has been implemented the additional works would be constructed and the Proposed Development would be built out in full. The Proposed Development would commence operation in 2023.

1.5.3 Alternative construction scenarios, involving construction entirely pursuant to the Order, are also possible. Accordingly, three representative scenarios are described within Chapter 5: Construction Programme and Management in the ES Volume I (Document Ref. 6.2) and assessed in the Environmental Impact Assessment ('EIA').

1.6 The Purpose and Structure of this Document

1.6.1 The purpose of this Combined Heat and Power Assessment is to assess the feasibility of supplying heat from the Proposed Development to local heat consumers.

1.6.2 The principal objectives of this study are as follows.

1. Prepare a Combined Heat and Power (CHP) Study in accordance with the requirements of the Environment Agency (EA) CHP-Ready Guidance, the Overarching National Policy Statement for Energy (EN-1) and other legislative and policy requirements (section 2.0).
2. Provide a technical description of the Proposed Development and heat export infrastructure (section 3.0).
3. Identify heat export opportunities local to the Proposed Development and assess feasibility for construction of a district heating (DH) network (section 4.0).
4. Calculate heat demand and profiles focusing on viable CHP opportunities, accounting for consumer diversity and seasonal variation (section 4.8).
5. Carry out an economic appraisal of the preferred indicative solution in accordance with the requirements of the EA's guidance on cost-benefit assessment (CBA) for combustion installations (section 5.0).
6. Calculate relevant energy efficiency measures to demonstrate legislative compliance (section 6.0).
7. Produce a CHP-Ready Assessment as required under the EA CHP-Ready guidance, including a clear statement on best available technique (BAT), CHP envelope and the CHP-Ready Assessment form (section 7.0).

2.0 LEGISLATIVE AND POLICY REQUIREMENTS

2.1 Legislative and policy requirements

2.1.1 In February 2013, the EA produced a guidance note titled 'CHP Ready Guidance for Combustion and Energy from Waste Power Plants'. This guidance applies to the following facilities, which are regulated under the Environmental Permitting (England and Wales) Regulations 2016:

- new combustion power plants (referred to as power plants) with a gross rated thermal input of 50 MW or more; and
- new energy from waste (EfW) plants with a throughput of more than 3 tonnes per hour of non-hazardous waste or 10 tonnes per day of hazardous waste.

2.1.2 The Proposed Development will be an EfW facility with a throughput of more than 3 tonnes per hour and will have a gross rated thermal input of more than 50 MW. Therefore, the requirements of the CHP-Ready guidance will apply.

2.1.3 The EA requires developers to demonstrate BAT for a number of criteria, including energy efficiency. One of the principal ways of improving energy efficiency is through the use of CHP, for which three BAT tests exist. The first involves considering and identifying opportunities for the immediate use of heat off-site. Where this is not technically or economically possible, the second test involves ensuring that the plant is built to be CHP-Ready. The third test involves carrying out periodic reviews to determine whether the situation has changed and there are opportunities for heat use off site.

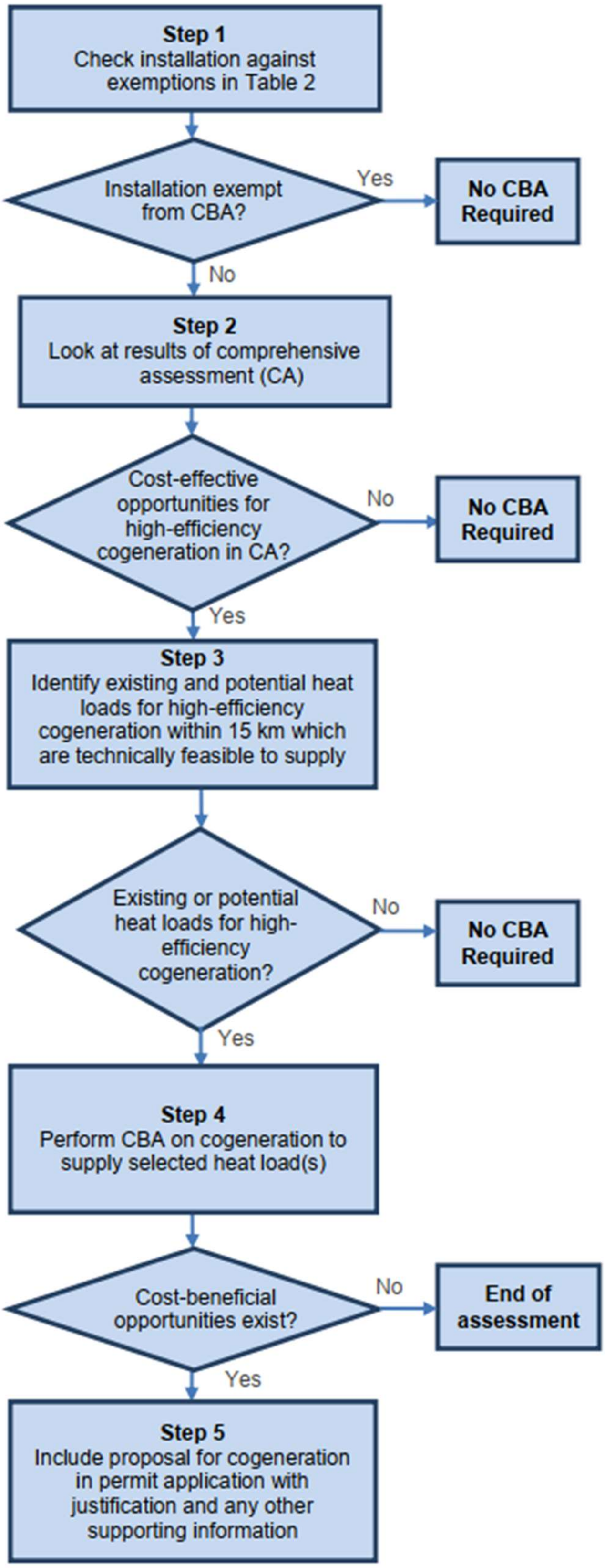
2.2 Energy Efficiency Directive

2.2.1 From 21st March 2015, operators of certain types of combustion installations are required to carry out a CBA of opportunities for CHP when applying for an Environmental Permit (EP). This is a requirement under Article 14 of the Energy Efficiency Directive. As a new electricity generation installation with a total aggregated net thermal input of more than 20 MW, the proposed development will be classified as an installation type 14.5(a).

2.2.2 In April 2015, the EA issued draft guidance on completing the CBA, entitled '*Draft guidance on completing cost-benefit assessments for installations under Article 14 of the Energy Efficiency Directive*'[2]. The methodology shown in Figure 1 describes the process that must be followed for type 14.5(a) and 14.5(b) installations.

[2] Draft guidance on completing cost-benefit assessments for installations under Article 14 of the Energy Efficiency Directive, V9.0 April 2015

Figure 1: CBA methodology for type 14.5(a) and 14.5(b) installations



Notes on Step 2
The comprehensive assessment is a country-wide assessment of the potential for the application of high-efficiency cogeneration and efficient district heating and cooling (see Annex VIII of the Energy Efficiency Directive). Until the results of this are available, omit Step 2 and proceed to Step 3.

Notes on Step 3

Potential heat loads are those where planning consent and investment have been publically announced, but the heat load is not yet in existence, or where the comprehensive assessment identifies clear perspectives, i.e. measures, policies or strategies that the heat load will come to existence. See Annex IX Part II of the Energy Efficiency Directive for more detail.

In order to determine whether a heat load is **technically feasible to supply**, see the guidelines in the section below.

Where the total heat load identified will not be sufficient for high-efficiency cogeneration (i.e. to achieve a minimum of 10% primary energy savings), installations covered by the Industrial Emissions Directive must still consider all possible cogeneration opportunities.

Notes on Step 5
Other supporting information could include evidence of discussions with operators of the identified heat load(s) proposed to be supplied.

2.3 North East Lincolnshire Local Plan

2.3.1 The North East Lincolnshire Council (NELC) sets out its vision and strategy for development in the North East Lincolnshire Local Plan (NELLP). The strategy aims for NELC to contribute significantly to the Humber's 'Energy Estuary' status.

2.3.2 In a broad sense, the NELLP sets out a goal to deliver 8,800 new jobs by 2032 with significant focus on the following economic sectors:

- ports and logistics;
- chemicals;
- food processing;
- renewable energy; and
- visitor economy, services and retail.

2.3.3 Specifically, the NELLP includes district heating for homes and businesses in its goals for new renewable and low carbon infrastructure. The NELLP has earmarked areas within reach of the SHBEC for significant residential development. These include sites in Healing (approximately 3 km from the Proposed Development), Immingham and Grimsby (approximately 5 km) and Laceby (approximately 7.5 km).

2.3.4 The strategy was formally adopted on 22nd March 2018.

2.4 Overarching National Policy Statement for Energy (EN-1)

2.4.1 Paragraph 4.6.2 of the Overarching National Policy Statement for Energy (EN-1) identifies that supplying steam direct to industrial customers or using lower grade heat, such as in district heating networks, can reduce the amount of fuel otherwise needed to generate the same amount of heat and power separately.

2.4.2 EN-1 confirms (paragraph 4.6.6) that under guidelines issued by DECC (then DTI) in 2006[3], any application to develop a thermal generating station under Section 36 of the Electricity Act 1989 must either include CHP or contain evidence that the possibilities for CHP have been fully explored.

2.4.3 EN-1 then states (paragraph 4.6.7) that in developing proposals for new thermal generating stations, developers should consider the opportunities for CHP from the very earliest point and it should be adopted as a criterion when considering locations for a project. With regards to viability, EN-1 (paragraph 4.6.5) states that to be economically viable as a CHP plant, a generating station needs to be located close to industrial or domestic customers with heat demands.

[3] Guidance on background information to accompany notifications under Section 14(1) of the Energy Act 1976 and applications under Section 36 of the Electricity Act 1989.

2.4.4 EN-1 (Paragraph 4.6.8) highlights that if the proposal is for thermal generation without CHP the applicant should:

- explain why CHP is not economically or practically feasible for example if there is a more energy efficient means of satisfying a nearby domestic heat demand;
- provide details of any potential future heat requirements in the area that the station could meet; and
- detail the provisions in the proposed scheme for ensuring any potential heat demand in the future can be exploited.

2.4.5 Regarding future requirements EN-1 (paragraph 4.6.12) also references that the Infrastructure Planning Commission (now the Planning Inspectorate) may be aware of potential developments which could utilise heat from the plant in the future and which is due to be built within a timeframe that would make the supply of heat cost-effective.

3.0 TECHNOLOGY AND HEAT NETWORK DESCRIPTION

3.1 Site selection

3.1.1 The Proposed Development Site is described in section 1.3. A provisional site layout is provided in Appendix A. The Site is located at approximate National Grid Reference TA 23064 13443.

3.1.2 The Proposed Development's process plant and buildings are located on the Main Development Area, an area of approximately 7 ha which is currently predominantly used for access between the SHBPS and its cooling water pumping station via the existing access road. Underground cooling water pipes and buried cables also run through the site.

3.2 The Proposed Development

3.2.1 A technical description of the Proposed Development and heat supply system is provided in the following sections. The main activities associated with the Proposed Development will be the combustion of incoming waste to raise steam and the generation of electricity in a steam turbine/ generator.

3.2.2 The Proposed Development will be a two-stream facility with the nominal capacity to process on average of 616,500 tonnes per annum of refuse derived fuel (RDF) at the design net calorific value (NCV) of 11 MJ/kg[4].

3.2.3 The Proposed Development will consist of the following key components:

- fuel (RDF) reception hall;
- fuel storage bunker;
- water, auxiliary fuel, and air supply systems;
- boilers;
- steam-turbine-generator;
- air cooled condenser (ACC);
- facilities for the treatment of exhaust gases;
- stacks; and
- systems for controlling combustion operations, recording and monitoring conditions.

3.2.4 For each line, RDF will be combusted on a reciprocating grate to ensure continuous mixing of the fuel and hence promote good combustion. The heat released by the combustion of the fuel is recovered in a water tube boiler, which is integral to the furnace and will produce high pressure superheated steam. It is envisaged that the steam from the boiler will feed a steam-turbine

[4] The average capacity would increase to up to 753,500 tonnes per annum with an RDF NCV of 9 MJ/kg.

generator to generate electricity. Exhaust steam would then be cooled using an air cooled condenser.

3.2.5 An average annual RDF processing availability of 89.6% over the Proposed Development's service life has been assumed for the purpose of this assessment. Details of the input RDF parameters and throughput are provided Table 1 below.

Table 1: Input waste design parameters and throughput

Parameter	Units	Value
Design net calorific value (NCV)	MJ/kg	11.0
Design gross calorific value (GCV)	MJ/kg	12.8
Waste throughput (RDF NCV of 11 MJ/kg)	tonnes/hour	78.5
Annual waste throughput (RDF NCV of 11 MJ/kg)	tonnes/year	616,500

3.2.6 The Proposed Development will generate approximately 76.0 MW_e of electricity in full condensing mode at the design ambient temperature of 10°C[5]. The Proposed Development will have a parasitic load of approximately 7.7 MW_e. Therefore, the export capacity of the Proposed Development will be approximately 68.3 MW_e at the assumed average ambient temperature.

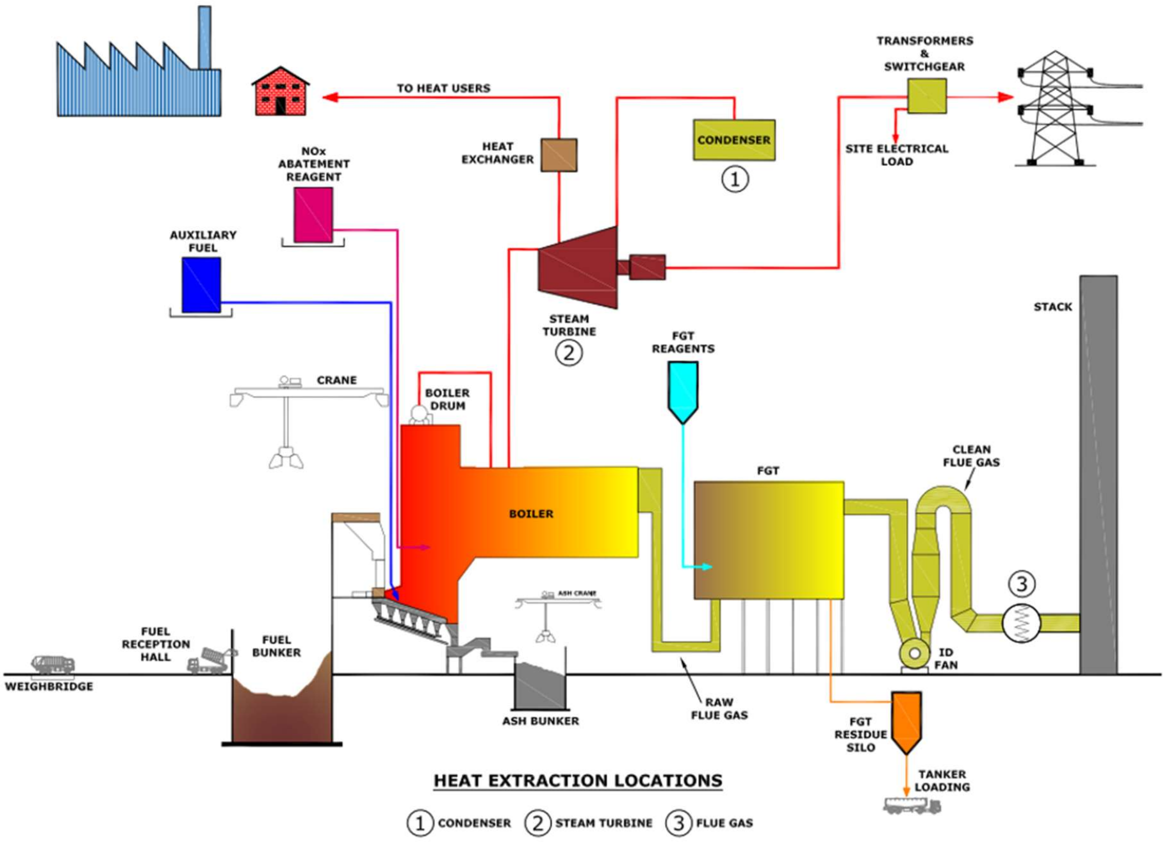
3.2.7 The conceptual design of the Proposed Development allows heat export as either steam or hot water, most likely via extraction from the steam turbine as discussed in section 3.3 below. Sufficient space has been safeguarded for the installation of the required infrastructure to meet a range of potential heat export scenarios, including those considered in this study. These design considerations will be maintained during detailed design and procurement of the Proposed Development.

3.3 Heat supply system

3.3.1 Heat is typically supplied from an energy recovery process in the form of steam or hot water, depending on the grade of heat required by the end consumer(s). The most commonly considered options for recovering heat in waste fired facilities are shown in Figure 2 and discussed below.

[5] Also assumed to be the average annual temperature.

Figure 2: Heat extraction locations



1. **Heat recovery from the air-cooled condenser**

   On an energy from waste plant wet steam emerges from a steam turbine typically at around 40°C. This energy can be recovered in the form of low grade hot water from the condenser depending on the type of cooling implemented.

   At the Proposed Development an ACC will be used to condense the steam turbine exhaust. In an ACC steam is condensed by transferring the heat in the steam into the air flow, which is rejected to atmosphere. An ACC generates a similar temperature condensate to mechanical draught or hybrid cooling towers. However, cooling this condensate further by extracting heat for use in a heat network results in a lower feedwater temperature. To compensate for the reduced feedwater temperature additional steam is extracted from the steam turbine to a condensate or feedwater heater. This additional steam extraction reduces the power generation from the plant.

2. **Heat extraction from the steam-turbine**

   Steam extracted from the steam turbine can be used to generate hot water for a DH network, which typically operates with a flow temperature of 90 to 120°C and return water temperature of 50 to 80°C. Steam is preferably extracted from the turbine at low pressure to maximise the power generated from the steam. Extraction steam is passed through condensing heat exchanger(s), with condensate recovered back into the feedwater system.

Hot water is pumped to heat consumers for consumption before being returned to the primary heat exchangers where it is reheated.

This source of heat offers the most flexible design for a heat network. However, the size of the heat load needs to be clearly defined to allow the steam bleeds and associated pipework to be adequately sized. Increasing the capacity of the bleeds once the turbine has been installed can be difficult.

3. **Heat extraction from the flue gas**

   The temperature of flue gas exiting the flue gas treatment plant is typically around 140°C and contains water in vapour form. This can be cooled further using a flue gas condenser to recover the latent heat from the moisture. This heat can be used to produce hot water for DH in the range 90 to 120°C.

   Condensing of the flue gas can be achieved in a wet scrubber. However, the scrubber temperature is typically no more than 80°C, which restricts the hot water temperature available for the consumer. Additionally, condensing water vapour from the flue gas reduces the flue gas volume and hence increases the concentration of non-condensable pollutants within it. The lower volume of cooler gas containing higher concentration of some pollutants would also be of lower thermal buoyancy and so is likely require a different stack height to effect adequate dispersion. The additional cooling of the flue gas would also result in the frequent production of a visible water vapour plume from the stack. The water condensed from the flue gas needs to be treated and then discharged under a controlled consent.

3.3.2 For the Proposed Development, heat extraction from the steam-turbine is likely to offer the most favourable solution for the following reasons.

1. Extraction of steam from the steam-turbine offers the most flexibility for varying heat quality and capacity to supply variable demands or new future demands. This is particularly relevant for facilities intended to supply DH networks with a mix of consumers.
2. The heat requirements of most of the identified consumers (as described in section 4.0) are suited to the temperatures attainable from the turbine with minimal power loss due to exporting energy to the heat circuit.
3. The use of a flue gas condenser would generate a visible water vapour plume which would be present for significant periods of the year and would also require a higher stack to facilitate adequate dispersion of the flue gas.

4.0 HEAT DEMAND INVESTIGATION

4.1.1 A review of the potential heat demand within a 15 km radius of the Proposed Development has been undertaken to assess potential known or consented future developments that may require heat and to identify any existing major heat consumers. This enabled the initial design of proposed heat network options to be developed. Potential heat consumers have been identified using a review of publicly available datasets on fuel use in the region, heat mapping tools and visual inspection of satellite imagery, as discussed in the following sections.

4.1.2 The viability of connecting potential identified heat users to a DH network has been considered based on maximising carbon savings and delivering the highest PES, while optimising pipe routes to minimise heat losses. Larger heat consumers and those closer to the Proposed Development have been prioritised ahead of other consumers on the basis they are more likely to yield an economically viable solution.

4.2 Wider heat export opportunities

The National Comprehensive Assessment

4.2.1 'National Comprehensive Assessment of the Potential for Combined Heat and Power and District Heating and Cooling in the UK'[6], dated 16th December 2015, was published by Ricardo AEA Limited on behalf of the Department of Energy and Climate Change (now part of the Department for Business, Energy and Industrial Strategy). The report was produced to fulfil the requirement (under Directive 2012/27/EU on energy efficiency) on all EU Member States to undertake a National Comprehensive Assessment (NCA) to establish the technical and socially cost-effective potential for high-efficiency cogeneration. The report also sets out information pertaining to heat policy development in the UK.

4.2.2 Section 3 of the report presents the results of the NCA. The Proposed Development falls within the Yorkshire and The Humber region of the assessment. Aggregated 2012 heat consumption and equivalent figures projected to 2025, split by sector, are presented in Table 2 below.

Table 2: Heat consumption in Yorkshire and The Humber

Sector	2012 consumption (TWh/annum)	2025 consumption (TWh/annum)
Industry (including agriculture)	25	24
Commercial services	2	1
Public sector	3	2
Residential	26	23
Total	**56**	**50**

6 National Comprehensive Assessment of the Potential for Combined Heat and Power and District Heating and Cooling in the UK, Ricardo AEA, December 2015

4.2.3 Evidently there is a downward trend in heating consumption anticipated in subsequent years. The energy projections take account of climate change policies where funding has been agreed and where decisions on policy design are sufficiently advanced to allow robust estimates of policy impacts to be made, including measures such as building regulations.

4.2.4 Similarly, current and projected space cooling consumption data is reported as follows. Given the paucity of available data on energy consumption for cooling, these figures are estimates based on consumption indicators, building types and floor areas; consequently, they should be considered as indicative.

Table 3: Cooling consumption in Yorkshire and The Humber

Sector	2012 consumption (TWh/annum)	2025 consumption (TWh/annum)
Industry (including agriculture)	1	1
Commercial services	1	1
Public sector	1	0
Total[7]	**3**	**3**

4.2.5 Due to the low resolution of the data, the results of the NCA can be considered as an overview only. Heat demand from the industrial sector is above the national average and demand from residential consumers is in line with the national average. Cooling demand is low across all sectors. A DH network serving a number of industrial heat consumers may therefore be a favourable solution in the area under consideration.

4.2.6 Higher resolution heat demand data is ascertained from heat mapping, as explained in the following section.

4.3 UK CHP Development Map

4.3.1 Potential heat loads have been identified using a review of publicly available datasets on the Department for Business, Energy and Industrial Strategy (BEIS) UK CHP Development Map[8]. This allows the heat demand in the area local to the Proposed Development to be determined. The tool geographically represents the heat demand across various sectors within England and helps to identify locations where implementation of heat networks is likely to be most economic.

4.3.2 Table 4 shows the annual heat demand, in MWh, for all sectors and building types within 15 km of the Proposed Development, limited to the South Humber Bank. The north bank of the Humber, towards Sunk Island, is not considered due to the prohibitive costs of a long-distance crossing of the estuary.

[7] We assume that the apparent discrepancy in the figures is due to rounding errors. We do not have access to the underlying data to verify this.

[8] http://chptools.decc.gov.uk/developmentmap/

Table 4: Heat demand within 15 km of the Proposed Development

Sector	Heat demand (MWh/annum)	Heat demand (%)
Communications and Transport	1,603	0.1%
Commercial Offices	6,845	0.3%
Domestic	1,645,863	62.9%
Education	26,752	1.0%
Government Buildings	4,040	0.2%
Hotels	7,413	0.3%
Large Industrial	683,556	26.1%
Health	3,169	0.1%
Other	126,835	4.9%
Small Industrial	79,798	3.1%
Retail	11,758	0.5%
Sport and Leisure	17,044	0.7%
Warehouses	1,909	0.1%
District Heating	0[9]	0.0%
Total	**2,616,585**	**100.0%**

4.3.3 With the exception of public buildings, the heat map is produced entirely without access to the meter readings or energy bills of individual premises. Therefore, results should be taken as estimates only.

4.3.4 The area surrounding the Proposed Development comprises heat demand predominantly from the industrial sector. This differs from the typical distribution observed throughout the UK due to the high proportion of industrial estates, distribution centres and manufacturing facilities located near the Site.

4.3.5 In most cases, existing domestic buildings are unsuitable for inclusion in a DH network due to the prohibitive costs of replacing existing heating infrastructure and connecting multiple smaller heat consumers to a network. However, new housing developments could represent a viable option and are discussed further in section 4.6.

4.4 Large heat consumers

4.4.1 Five large heat consumers were identified within 15 km of the Proposed Development, limited to the South Humber Bank, using the BEIS UK CHP Development Map tool.

[9] There is a large DH network near Immingham with a heat demand of 13,290,083 MWh/annum, however this network provides steam to the Lindsey Oil Refinery only. As discussed in section 4.4, it is not considered possible to connect to this network, so it has been omitted to present a more representative dataset.

Table 5: Large heat consumers

Sector	Heat demand (MWh/annum)	Distance from Proposed Development (km)	Postcode
Lindsey Oil Refinery	13,290,083	8	DN40 3LW
Tronox Stallingborough Plant	433,556	2	DN40 2PR
DFDS Immingham Terminal	131,584	5	DN40 2LZ
Synthomer	124,966	0[10]	DN41 8DB
Novartis Pharmaceuticals	74,074	2.5	DN31 2SR
Total	**14,054,237**	**n/a**	**n/a**

4.4.2 Details of the heat consumers listed in Table 5 above are provided in the sections below. These include the outcomes of discussions had with Tronox and Synthomer, the two consumers located closest to the Proposed Development.

Lindsey Oil Refinery

4.4.3 The Lindsey Oil Refinery (LOR), owned by Total S.A., accounts for most of the DH demand in the search area. This demand is met by the adjacent gas-fired Immingham CHP plant, which provides power and steam for fractionating processes. Should LOR require additional steam, a connection from the Proposed Development would not be feasible as the sites are 8 km apart and routing steam supply and condensate return pipelines over this distance is likely to present some major challenges. As such, LOR has been discounted and is not considered further.

Tronox Stallingborough Plant

4.4.4 The Tronox Stallingborough Plant (Tronox) is a titanium dioxide production facility located circa 2 km north west of the Proposed Development. EPWM has been approached by Tronox to discuss the potential for supplying heat to their process. Tronox is currently provided with steam by an existing CHP plant which, according to initial communications, is due to reach the end of its service life in the short to medium term. Therefore, a connection to the Proposed Development network may be an option.

4.4.5 However, the nature of the heat extraction (medium pressure steam, see explanation in section 4.4.9), combined with the distance of the site from the Proposed Development, means that a connection to Tronox is technically challenging. Furthermore, because of the way the Tronox' process is configured, it would not be possible for the steam condensate to be returned

[10] The Synthomer site is located adjacent to the SHBEC site.

to the Proposed Development. This would require a significant increase in size of the demineralization plant and result in increased raw water usage.

4.4.6 For these reasons, heat supply to Tronox has not been reviewed further in this report.

DFDS Immingham Terminal

4.4.7 The Det Forenede Dampskibs-Selskab (DFDS) Immingham Terminal occupies over 700,000 m² of terminal land split into two distinct terminals: Dockside and Riverside. Given that the terminal is used for warehousing, storage and cargo handling, a hot water supply to meet space heating requirements may present a viable configuration. Further details on a district heating network supplying hot water to the DFDS Immingham Terminal are provided in section 4.8.

Synthomer

4.4.8 Due to its proximity to the Proposed Development, steam supply to Synthomer, a polymer manufacturer, was considered. Initial discussions between EPWM and Synthomer indicated that the polymer manufacturing process is currently served via two onsite (gas-fired) steam generators, supplemented with hot water supplied from the adjacent Integrated Waste Management Facility. Synthomer has advised that it may be interested in steam supply at a minimum of 11 bar(a) if there is a benefit relative to its existing cost base. Analysis of demand data provided by Synthomer indicates that its site consumes approximately 8,500 MWh of steam per annum, equating to around 1 MW_{th} on an instantaneous basis, assuming substantially continuous operation. According to Synthomer, peak demands of around 2.5 MW_{th} are possible.

4.4.9 Delivering steam at 11 bar(a) would not align with the preferred turbine bleed pressure in the non-CHP case. Turbine bleed pressures are selected to optimise the efficiency of the steam cycle. Extracting steam from the turbine at higher pressure to meet Synthomer’s requirements would result in increased lost electrical export. The steam price would therefore need to be higher to offset increased capital costs of export infrastructure (for medium pressure steam), increased lost electrical export and make-up of demineralised water (since condensate cannot be recovered in the current configuration). On this basis, a steam supply to Synthomer is not considered to be economically feasible and as such this option is not considered further in this report.

Novartis Pharmaceuticals

4.4.10 Novartis Pharmaceuticals is also provided with steam from an on-site CHP plant constructed in 1992. As the CHP plant is now assumed to be towards the end of its useful service life (assuming no repowering works have been undertaken), a connection to the Proposed Development network may be an option. However, in September 2018 the Swiss company announced its plans to exit its Grimsby manufacturing site by the end of 2020. While there is a possibility that the facilities will be acquired and continue operations under a new ownership, it is understood that nothing has materialised to date. For this reason, this option is not considered further in this report.

4.5 Visual assessment

4.5.1 Broad assumptions were made regarding the estimated heat demand from existing potential heat consumers. Heat demands have been calculated based on benchmark figures from the Chartered Institution of Building Services Engineers (CIBSE) Guide F (Energy Efficiency in Buildings)[11]. This document provides good practice benchmark figures based on energy performance of existing buildings. In the CIBSE Guide, loads are expressed in terms of kWh per square metre of floor space per year of fossil fuel use (natural gas is typically assumed). Based on estimates of floor areas and an assessment of the development type, it is possible to estimate annual energy usage. Converting natural gas use to actual heat loads (which can be provided by a hot water distribution system) requires an assumption of gas-fired boiler efficiency; an efficiency of 85% is assumed, based on industry norms.

4.5.2 A list of potential heat consumers identified within 15 km of the Proposed Development, applying engineering judgment to screen out unfavourable routes, is provided in Appendix B.

4.6 Prospective Developments

4.6.1 According to planning information made available by NELC, a housing development consisting of 224 dwellings is to be constructed in north-west Grimsby. The development is located 4 km from the Proposed Development and is near Grimsby Leisure Centre and the South Humberside Industrial Estate. The planning application (planning reference DM/0766/16/FUL) was approved in November 2017.

4.6.2 In December 2017, an outline planning application was submitted for 152 dwellings in Laceby, south-west of Grimsby. The site is around 7.5 km from the Proposed Development and the application (planning reference DM/1133/17/OUT) was approved in August 2019.

4.6.3 Community heating in the UK has been difficult to implement historically due to the existence of an extensive natural gas network and a regulated energy supply market which allows customers the freedom to change suppliers to obtain preferential commercial terms. Recent moves to introduce regulatory controls on the supply of energy from DH may increase the operational costs for supplying residential consumers. The high cost of infrastructure is also a barrier to community heating, with a notable lack of domestic pipe suppliers. Developers of private residential properties are sometimes reluctant to utilise community heating as it often increases development costs. Furthermore, new developments will be constructed to the latest high energy efficiency requirements, meaning they will have a lower heat demand.

4.6.4 Community heating can be successful in circumstances where:

[11] CIBSE Guide F: Energy Efficiency in Buildings

1. new-build housing developments are aligned with low carbon heat sources in terms of timing and proximity;
2. developments offer heat demand density, for example apartment blocks;
3. there is a high level of Local Authority/ housing association properties; and
4. additional (non-residential) consumers are also connected to the network to improve network diversity and offset seasonality issues.

4.6.5 Given the above considerations, connections to both the above prospective developments are unlikely, as the developments will not offer sufficient heat demand density to provide an economic rate of return. In addition, connection to either development is likely to require two rail crossings, which would increase the investment costs and would require consent from Network Rail.

4.7 Heat consumer screening

4.7.1 The design of any heat network is the critical component in defining the technical and financial viability of a DH scheme. As part of the heat consumer screening, the various potential network options and heat supply considerations that feed into the financial modelling have been reviewed based on the estimated heat demands and physical constraints.

- Physical constraints imposed by local infrastructure and topology have a substantial impact on which consumers can viably be connected.
  - The nearby railway, shown in Appendix C, presents a technical constraint on potential network routes.
  - The Humber estuary to the east of the Proposed Development is also a significant obstruction to potential network routes. Given the lack of existing crossings and distance of the crossing required, potential consumers on the north bank of the Humber are not considered further.
  - Trenching in road crossings will require traffic management and permission from the highway authority.
- Routes through private land have not been considered due to the potential for high easement costs and ransom strip risk.
- Connections to large heat consumers and prospective developments which were assessed as not feasible in section 4.4 and 4.6 have been screened out.
- The Proposed Development has been discussed with the EA, including reference to the provision of combined heat and power.

4.7.2 Taking these factors into account, a preferred network option has been identified and presented in section 4.8. EPWM is committed to continuing to appraise heat export infrastructure as part of the Proposed Development, and to providing updates with relevant stakeholders as progress is made.

4.8 Preferred network option

4.8.1 The preferred option entails supplying hot water to light industrial and warehousing developments, with the DFDS Terminal at Immingham Dock (5 km from the Proposed Development) as an anchor load.

4.8.2 A number of warehousing and storage facilities which may benefit from hot water are located at Immingham Dock. As shown from the indicative pipe route provided in Appendix C, there is a relatively direct route to the dock along Laporte Road, which involves one rail crossing. It is noted that implementing a rail crossing will require detailed engineering assessment and require consent from Network Rail, which falls outside the scope of this study.

4.8.3 Industrial areas off Kiln Lane in Stallingborough, which includes the Kiln Lane Trading Estate, consist of light industrial and warehousing facilities. This area is along the proposed route to Immingham Dock. The area may be significantly extended due to the adjacent Stallingborough Enterprise Zone, so there is the possibility of expanding the DH network in future to accommodate new developments.

4.8.4 EPWM is committed to maximising the benefits associated with developing the Proposed Development as CHP. Should heat export to consumers identified within the preferred network option not materialise, EPWM intends to engage with other businesses to assess technical and economic feasibility of connections.

4.8.5 An economic assessment of the preferred DH network solution is presented in section 5.0.

Heat network profile

4.8.6 Generic heat demand profiles were developed to model the seasonal and diurnal variation in heat demand for the consumers identified by integrating the estimated annual heat demands (in MWh). This allowed the annual average and peak heat demands (in MW_{th}) to be calculated. A combined heat demand profile for the preferred heat network was then derived from the sum of the individual heat load profiles of the selected consumers.

4.8.7 The heat profile for the DFDS Immingham network, shown in Figure 3, includes heat demand from the industrial developments in the area. The heat network profile illustrates the variation in heat demand during a typical day in different seasons, accounting for network heat losses and demand diversity (see section 4.8.12).

Figure 3: Projected heat network profile showing daily and seasonal variation

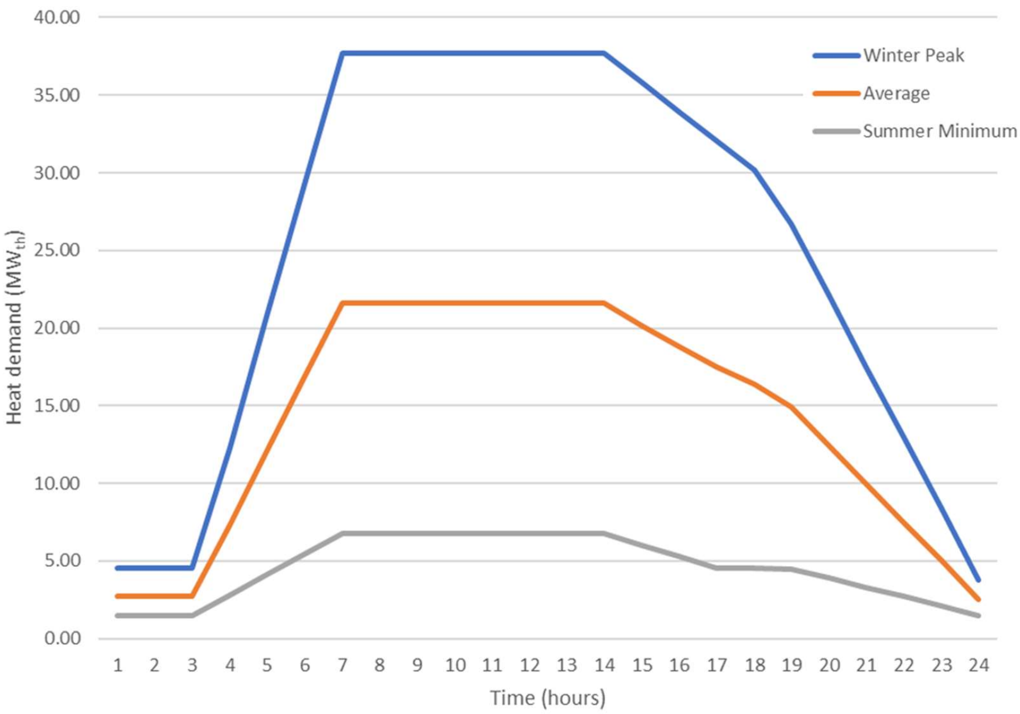


Table 6: Preferred DH network parameters

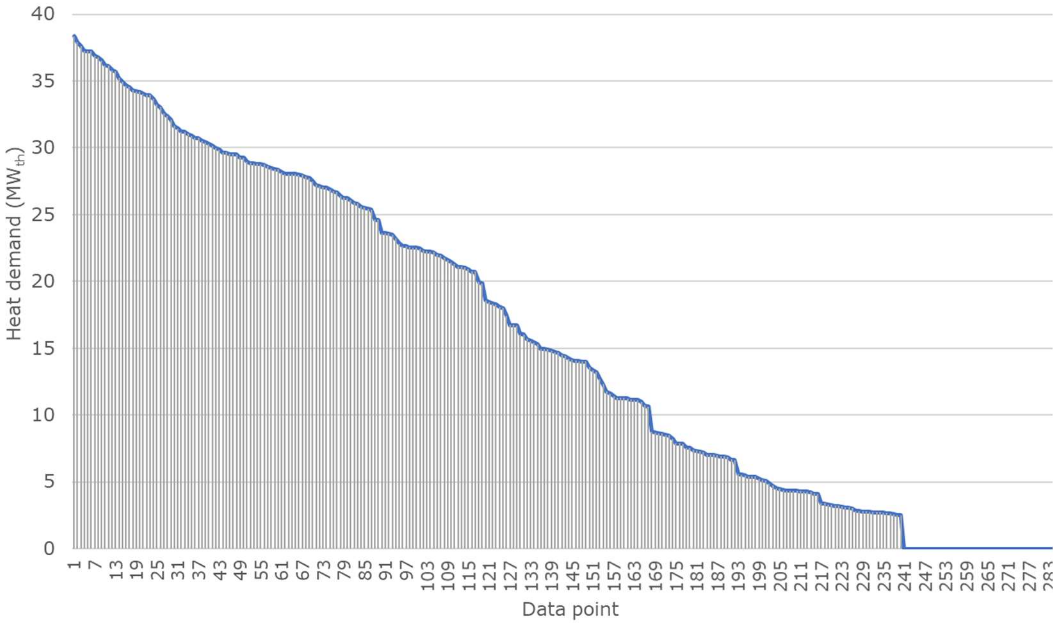
Consumers connected	Estimated heat demand	Estimated average heat demand	Estimated peak heat demand
DFDS, Immingham Dock Warehouses (see those in bold in Appendix B)	159,360 MWh/ annum	14.3 MW_{th}	37.7 MW

Heat load duration curve

4.8.8 The heat load duration curve presented in Figure 4 displays the instantaneous heat demand for the proposed DH network, arranged in order of decreasing magnitude, across the year.

4.8.9 Since detailed heat demand data is not available at this stage, the heat load duration curve has been developed based on instantaneous heat demand at each hour of a day in each month, producing a total of 288 data points (24 hours/day x 12 months/year).

Figure 4: Heat load duration curve



4.8.10 The estimated diversified peak demand of the proposed DH heat network is 37.7 MW_{th}, which the Proposed Development will be capable of meeting. The peak loads of the DFDS Terminal solution are expected to be well within the CHP capabilities specified in the Proposed Development's design concept.

4.8.11 Since projected peak loads are not likely to exceed the maximum heat export capacity, peak lopping[12] plant will not be required. Further, heat accumulators can be used to manage peak heat demand by storing excess heat generated during off-peak periods for supply at times of peak heat demand (reducing the total installed capacity of plant required). This approach decouples heat production from heat demand, improving the operational flexibility of a CHP plant. Heat accumulators are typically large water tanks; as heat is absorbed the temperature rises and as heat is extracted the temperature decreases. The feasibility of including a heat accumulator will be explored when there is more certainty over heat loads. A back-up system would also be required during periods of plant downtime (as described in section 4.8.19).

Demand diversity

4.8.12 Significant daily and seasonal variation in heat demand is typical for heat networks serving different types of consumers. Increasing the number and type of consumers connected to a DH network diversifies heat demand and helps to reduce the impact of the peak demand of any individual consumer, since it is less likely that peak demands will coincide. In calculating the diversified heat demand, we have assumed a diversity factor of 0.8, in

[12] 'Peak lopping' would be the use of an additional heat generation source in conjunction with the Facility to deliver enough heat to meet the peak demand that could not be met by the Facility.

accordance with CIBSE AM12[13], which is considered best industry practice for mixed use networks.

Heat network design

4.8.13 Heat distribution between the Proposed Development and offsite heat consumers would likely use buried pipework. Pre-insulated steel pipes are used to supply pressurised hot water to the customer, and to return cooler water. Where pipes are small, two pipes may be integrated within a single insulated sleeve. For larger heat demands, large bore pipes are installed as a single insulated run. Pipe technology is well proven and can provide a heat distribution system with a 30 year plus design life. Additional pipe work can be retrofitted, and it is reasonably straightforward to add branches to serve new developments.

4.8.14 Newly built EfW facilities are typically situated away from population centres. However, modern heat-insulated piping technology enables hot water to be transferred large distances without significant losses. Where the topography creates challenges, heat exchangers and additional pumping systems can be installed to create pressure breaks, enabling the network to be extended.

4.8.15 Heat delivery arriving at a consumer's premises usually terminates using a secondary heat exchanger. The heat exchanger is typically arranged to supply heat to a tertiary heating circuit upstream of any boiler plant. The water in the tertiary circuit is boosted to the temperature required to satisfy the heating needs of the building.

4.8.16 Water is pumped continuously around the system. Pumps are operated with 100% standby capacity to maintain heat in the event of a pump fault. Pumps are likely to utilise variable speed drives to minimise energy usage.

4.8.17 The following design criteria relate to a typical hot water network utilising conventional heat extraction (as detailed in section 3.3) and have been used to size the heat transmission pipe diameters. Flow and return temperatures have been selected to align with operating temperatures for the existing heating systems. However, during the detailed design stage and once secondary side heating systems are better understood, the network temperatures will be optimised with a view to reduce heat losses.

Table 7: Supply requirements

Parameter	Value
Water supply temperature to consumer	100°C
Water return temperature from consumer	70°C
Distance between flow and return pipes	150 mm
Soil temperature	10°C
Depth of soil covering	600 mm

[13] CIBSE AM12 Combined Heat and Power for Buildings, 2013

4.8.18 Using the above design criteria and accounting for the estimated heat demand for the preferred network, the primary hot water transmission pipe size has been calculated as DN400. This is an indicative figure and will be subject to heat demand verification and subsequent network design.

Back-up heat source

4.8.19 The Proposed Development is estimated to operate on average for 7,849 hours per year over its service lifetime. During periods of routine maintenance or unplanned outages the plant will not be operating. However, the heat consumers may still require heat. There is therefore a need, somewhere within the heat distribution system, to provide a back-up source of heat to meet the needs of the heat consumers. It is anticipated that the back-up heat source, if required, will be in operation for an average of up to 911 hours per year. In reality, planned maintenance outages of EfW facilities are typically scheduled during the summer period, when heat demand is low, and the number of hours the back-up heat source is required may be lower.

4.8.20 It is assumed that until its closure, the SHBPS, also owned by EPUKI, can act as a back-up heat source for the Proposed Development. Should this not be possible, standby plant in the form of back-up boilers can be used. The standby plant will likely (subject to detailed design) comprise two 15 MW_{th} and one 10 MW_{th} diesel or gas-fired hot water heaters (boilers) with separate dedicated stacks. Back-up boilers are typically designed to ensure that the peak heat export capacity can be met but also provide sufficient turndown to supply smaller summer loads with reasonable efficiency. It would be preferential to locate the back-up boilers closer to consumers to minimise heat losses when running on fossil fuel.

4.8.21 Subject to detailed heat demand modelling, opportunities for installing heat accumulators will be considered to lessen reliance on the back-up plant by storing excess heat generated during off peak periods for use during times of peak heat demand.

Additional heat sources

4.8.22 To maximise the benefits associated with developing a heat network, a review of heat sources in the area surrounding the Proposed Development has been undertaken. Additional heat sources could be used to increase the capacity of the heat network and the associated benefits.

4.8.23 According to the heat mapping and master planning in North East Lincolnshire report, there are six heat sources within the vicinity of the Proposed Development, with a further heat source in development.

1. The South Humber Bank Power Station, a 1,400 MW_e combined cycle gas turbine (CCGT) power station located on the same site as the Proposed Development and owned by EPUKI.
2. Immingham CHP, a 1,180 MW_e gas-fired CHP installation, located approximately 7.4 km to the north-west of the Proposed Development. The

CHP installation supplies energy to the adjacent Lindsey Oil Refinery, the Phillips 66 Humber Refinery and the National Grid.

3. A 16 MW_e gas-fired CHP installation, located approximately 1.8 km to the north-west of the Proposed Development. It supplies energy to the adjacent Tronox plant.
4. The Integrated Waste Management Facility, a 3.5 MW_e EfW plant with CHP, is located approximately 0.3 km to the north-west of the Proposed Development. The CHP installation supplies energy to the adjacent Synthomer plant.
5. A 46 MW_e gas-fired CHP installation is located approximately 1.1 km to the south east of the Proposed Development. The CHP installation supplies energy to the adjacent Technical Absorbents plant.
6. An 8 MW_e gas-fired CHP installation is located approximately 2.4 km to the south east of the Proposed Development. The CHP installation supplies energy to the adjacent Novartis Pharmaceuticals facility.
7. Great Coates Energy, an 18 MW_e planned (ref. DM/0329/18/FUL) EfW plant to be located approximately 1.1 km to the south east of the Proposed Development. If constructed, the EfW plant could supply energy to local industry.

4.8.24 Given the stated electrical capacities, the quantity of surplus heat (if any) available from the CHP installations may make a connection viable, particularly to those which are located close to the Proposed Development. On this basis, inclusion of additional heat sources is considered feasible subject to further technical assessment and consultation with the operators.

Indicative pipe route

4.8.25 A layout of the preferred DH network is provided in Appendix C. The routing is indicative; a detailed engineering assessment would be required to determine the optimum route, which is not appropriate for this initial study.

4.8.26 The predominant engineering issue associated with the supply of heat by hot water relates to the installation of the heat supply pipeline. The pipeline required to supply hot water is likely to be a pair of large diameter pipes which must be installed in a trench approximately 1.4 m wide. Determining a feasible route for such a pipeline is complex as outlined below.

4.8.27 Existing buried services may obstruct the most direct route to end consumers. Infrastructure crossings, such as a railway and bridge crossings, can be technically challenging and expensive. The supply and return pipelines would need to be routed along public highways with inevitable issues of traffic management and avoiding other buried services. These issues have a direct bearing on the cost and installation time.

4.8.28 To install heat supply infrastructure, such as pre-insulated DH pipes, in the public highway, the developer would need to comply with the requirements of the New Roads and Street Works Act 1991 (NRSWA). This lays out the legal obligations that apply to both statutory and non-statutory undertakers wishing to install apparatus in the public highway.

4.8.29 The provisions of the NRSWA do not apply to works carried out in private land. As a non-statutory undertaker, the developer would be required to negotiate the route of any pipeline with relevant land owners, allowing for access for construction and future maintenance. This will inevitably involve legal negotiations over the structure of any wayleaves or easements, as well as protective provisions for the operators of existing utilities and infrastructure potentially affected by any pipeline.

5.0 ECONOMIC ASSESSMENT

5.1 Fiscal Support

5.1.1 The following fiscal incentives are available to energy generation projects and impact the feasibility of delivering a district heating network.

1. **Capacity Market for electricity supplied by the Proposed Development**

   Under the Capacity Market, subsidies are paid to electricity generators (and large electricity consumers who can offer demand-side response) to ensure long-term energy security for Great Britain. Capacity Agreements are awarded in a competitive auction and new plants (such as the Proposed Development) are eligible for contracts lasting up to 15 years.

   Based on the scheme's eligibility criteria, the Proposed Development will be eligible for Capacity Market support. However, since Capacity Market support is based on electrical generation capacity (which would reduce when operating in CHP mode), these payments will act to disincentivise heat export and have therefore not been included in the economic assessment.

2. **Renewable Heat Incentive**

   The Renewable Heat Incentive (RHI) was created by the Government to promote the deployment of heat generated from renewable sources. However, no funding announcements have been published for the RHI post March 2021. Therefore, it is unlikely the Proposed Development will receive incentives under the RHI. In addition, to be eligible, the plant in question must not receive any other support or subsidy from public funds including any support received under the Capacity Market. Therefore, if the Proposed Development qualifies for support under the Capacity Market mechanism, it will not be eligible for the RHI.

3. **Contracts for Difference**

   Contracts for Difference (CfD) has replaced the Renewables Obligation (RO) as the mechanism by which the Government supports low carbon power generation. CfD de-risks investing in low carbon generation projects by guaranteeing a fixed price (the Strike Price) for electricity over a 15 year period. In the second CfD allocation round (executed on 11th September 2017) no funding was allocated for EfW plants, with or without CHP, on the basis that these are now considered established technologies. The third allocation round[14] was executed in September 2019 with contracts awarded to eligible less established technologies only[15]. On this basis, the Proposed Development would not receive support under the CfD mechanism.

[14] https://www.gov.uk/government/collections/contracts-for-difference-cfd-third-allocation-round

[15] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/832924/Contracts_for_Difference_CfD_Allocation_Round_3_Results.pdf

4. **Heat Network Investment Project funding**

   The Heat Network Investment Project (HNIP) aims to deliver carbon savings and create a self-sustaining heat network market through the provision of subsidies, in the form of grants and loans, for heat network projects. £320 million has been made available to fund the HNIP between 2019 and 2022. Following a pilot scheme, which ran from October 2016 to March 2017, BEIS has confirmed that funding will be available for both public and private sector applicants, and that there will be no constraints on scheme size.

   The HNIP may be a source of funding that would improve the economic viability of the heat network. The level of funding that the Proposed Development could achieve under this program would depend on the final size of the network and commercial arrangements.

5. **Heat Networks Delivery Unit**

   Relatively modest grant funding, to assist local authorities in heat network project development, is also available through the Heat Networks Delivery Unit, although this could not be received by the Proposed Development directly and would not serve to support project delivery.

5.2 Technical Feasibility

5.2.1 Step 3 of the CBA methodology (see section 2.2) requires identification of existing and proposed heat loads which are technically feasible to supply, as carried out in section 4.0 of this study. The draft Article 14 guidance states that the following factors should be accounted for when determining the technical feasibility of a scheme, pertaining to a type 14.5(a) installation.

1. **The compatibility of the heat source(s) and load(s) in terms of temperature and load profiles**

   The preferred DH network solution is intended to supply heat, in the form of hot water, to warehouses and storage facilities at Immingham Dock. On this basis, it will be possible to reduce system operating temperatures and heat losses in line with best industry practice.

   The nature of anticipated end users indicates that a DH supply temperature of circa 100°C will be sufficient to meet the requirements, which is considered possible based on the conceptual design. The heat source and loads are therefore considered compatible, with heat export facilitated through steam extraction from the turbine.

   As the analysis was undertaken using generic consumer heat profiles, consumer requirements (in terms of hot water temperature and load profiles) will need to be verified prior to the implementation of a heat network.

2. **Whether thermal stores or other techniques can be used to match heat source(s) and load(s) which will otherwise have incompatible load profiles**

   A thermal store (i.e. heat accumulator) or back-up heat source (as detailed in sections 4.8.11 and 4.8.19 respectively) will likely be included in the DH network to ensure continuity of supply. The thermal store will take precedence over any peak lopping plant to ensure that low carbon energy provision is prioritised. The specific arrangement will be selected when there is more certainty over heat loads.

3. **Whether there is enough demand for heat to allow high-efficiency cogeneration**

   High-efficiency cogeneration is cogeneration which achieves at least 10% savings in primary energy usage compared to the separate generation of heat and power. PES are calculated in the following section.

5.3 Primary Energy Savings

5.3.1 In order to be considered high-efficiency cogeneration, the scheme must achieve at least 10% savings in primary energy usage compared to the separate generation of heat and power. PES have been calculated in accordance with Directive 2012/27/EU Annex II part (b), using the following assumptions.

1. Annual throughput of 616,500 tonnes based on a fuel NCV of 11 MJ/kg.
2. Z ratio of 6.5.
3. Parasitic load of 7.7 MW_e.
4. Efficiency reference values for the separate production of heat and electricity have been taken as 80% and 25% respectively as defined in Annexes 1 and 2 of Commission Delegated Regulation (EU) 2015/2402[16].

5.3.2 When operating in fully condensing mode (i.e. without heat export) the Proposed Development will achieve a PES of 21.1%. This is in excess of the technical feasibility threshold defined in the draft Article 14 guidance. With the inclusion of heat export at an average of 14.3 MW_{th}, as anticipated for the proposed heat network, PES would be approximately 23.3%. On this basis, the Proposed Development will qualify as a high efficiency cogeneration operation when operating in CHP mode.

5.4 Cost-Benefit Assessment

5.4.1 A CBA has been carried out on the selected heat load, in accordance with section 3 of the draft Article 14 guidance. The CBA uses an MS Excel template, 'Environment Agency Article 14 CBA Template.xlsx' provided by the EA, with inputs updated to correspond with the specifics of this CHP assessment in order to appraise the economic feasibility of implementing the proposed heat network. The CBA model takes into account:

1. revenue streams (heat sales);
2. the costs streams for the heat supply infrastructure (construction and operational, including back up plant); and

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[16] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015R2402&from=EN

3. lost electricity sales revenue, over the lifetime of the scheme (electricity sales).

5.4.2 The following assumptions have been made.

1. The heat export infrastructure required to export heat from the Proposed Development to Immingham Docks is estimated to have a capital cost of approximately £11 million, split over a three year construction programme.
2. The heat station will cost approximately £2.6 million, split over a two year construction programme.
3. Back-up boilers will be provided to meet the diversified peak heat demand, at a cost of approximately £4 million.
4. Operational costs have been estimated based on similar sized projects.
5. Heat sales revenue will be £12/MWh, index linked for inflation.
6. Electricity sales revenue will be £52/MWh, index linked for inflation.
7. Standby boiler fuel costs will be £40/MWh, index linked for inflation.
8. Standby boiler(s) will supply heat during periods of unavailability of the Proposed Development (assumed to be approximately 13% of the year on average).

5.4.3 The results of the CBA indicate that both the nominal project internal rate of return and net present value (before financing and tax) over 33 years are negative. As a result, the returns based on heat sales revenue alone are unattractive. As currently modelled, the proposed heat network does not yield an economically viable scheme without financial support. Model inputs and key outputs are provided in Appendix D.

5.4.4 The economic feasibility of the scheme will be reassessed in the future when there is more certainty over heat loads and in light of any developments to the subsidy landscape.

6.0 ENERGY EFFICIENCY MEASURES

6.1 Heat and power export

6.1.1 The Z ratio, which is the ratio of reduction in power export for a given increase in heat export, can be used to calculate the effect of variations in heat export on the electrical output of the facility. A value of 6.5 was obtained following the approach set out in CHPQA Guidance Note 28[17], assuming steam extraction at a pressure of 2.0 bar(a), which is considered sufficient to meet the requirements of the heat consumers that comprise the DH network discussed in section 4.8. Heat and power export has been modelled across three load cases and the results are presented in Table 8.

Table 8: Heat and power export

Load case	Heat export	Gross power generated	Net power export	Z ratio
1. No heat export	-	76.0 MW_e	68.3 MW_e	n/a
2. DH network average heat load	14.3 MW_{th}	73.8 MW_e	66.1 MW_e	6.50
3. DH network peak heat load	37.7 MW_{th}	70.2 MW_e	62.5 MW_e	6.50

6.1.2 For the heat consumers identified in sections 4.8, load case 2, corresponding to an average heat export of 14.3 MW_{th}, will result in a net power export of 66.1 MW_e. Power export would decrease to 62.5 MW_e during periods of peak export.

6.2 CHPQA Quality Index

6.2.1 CHPQA is an energy efficiency best practice programme initiative by the UK Government. CHPQA aims to monitor, assess and improve the quality of CHP in the UK. In order to prove that a plant is a ‘Good Quality’ CHP plant, a QI of at least 105 must be achieved at the design, specification, tendering and approval stages. Under normal operating conditions (i.e. when the scheme is operational) the QI threshold drops to 100. The QI for CHP schemes is a function of their heat efficiency and power efficiency according to the following formula:

$$QI = X\eta_{power} + Y\eta_{heat}$$

where: η_{power} = power efficiency; and

η_{heat} = heat efficiency.

[17] CHPQA Guidance Note 28, 2007

6.2.2 The power efficiency within the formula is calculated using the gross electrical output and is based on the gross calorific value of the input fuel. The heat efficiency is also based on the gross calorific value of the input fuel. The coefficients X and Y are defined by CHPQA based on the total gross electrical capacity of the scheme and the fuel/ technology type used.

6.2.3 In December 2018, the Government released a revised CHPQA Standard Issue 7. The document sets out revisions to the design and implementation of the CHPQA scheme. These revisions are intended to ensure schemes which receive Government support are supplying significant quantities of heat and delivering intended energy savings. The following X and Y coefficients apply to the Proposed Development:

- X value = 220; and
- Y value = 120.

6.2.4 The QI and efficiency values have been calculated in accordance with CHPQA methodology for various load cases and the results are presented in Table 9. A gross calorific value of 12.8 MJ/kg was assumed for the RDF processed in the Proposed Development.

Table 9: QI and efficiency calculations

Load case	Gross power efficiency	Heat efficiency	Overall efficiency	CHPQA QI
1. No heat export	27.2%	0.0%	27.2%	59.9
2. DH network average heat load	26.4%	5.1%	31.5%	64.3
3. DH network peak heat load	25.1%	13.5%	38.6%	71.5

6.2.5 The results indicate that the Proposed Development will not achieve a QI score in excess of the ‘Good Quality’ CHP threshold (QI of 105 at the design stage) for none of the load cases considered in the assessment. This is due to the highly onerous efficiency criteria set out in the latest CHPQA guidance, most notably the underpinning requirement to achieve an overall efficiency (NCV basis) of at least 70.

6.2.6 For reference, assuming the same Z ratio as set out in the preceding section, an average heat export of 133 MW_{th} would be required for a heat network to achieve Good Quality status. Clearly the design proposed for heat recovery, based on the local heat demand, is not capable of supplying a sufficient quantity of heat at the design heat conditions.

7.0 EA CHP-READY GUIDANCE

7.1.1 The EA has published detailed guidance on CHP Assessments as part of the Environmental Permitting regime.

7.1.2 The EA requires EP applications to demonstrate BAT for a number of criteria, including energy efficiency. One of the principal ways of improving energy efficiency is through the use of CHP. The EA therefore requires developers to satisfy three BAT tests in relation to CHP. The first involves considering and identifying opportunities for the use of heat off-site, as demonstrated in this CHP study. Where this is not technically or economically possible and there are no immediate opportunities, the second test involves ensuring that the plant is built to be CHP-Ready. The third test involves carrying out periodic reviews to determine whether the situation has changed and there are opportunities for heat use off site.

7.1.3 Since constructing the Proposed Development as a CHP plant is not economically feasible (see section 5.0) the SHBEC will be constructed as CHP-Ready. A CHP-Ready Assessment has been carried out to demonstrate that the proposed development is designed to be ready, with minimum modification, to supply heat in the future. The completed CHP-Ready Assessment form is provided in Appendix E.

7.2 CHP envelope

7.2.1 The 'CHP envelope' as outlined under requirement 2 of the CHP-Ready Guidance, which identifies the potential operational range of a new plant where it could be technically feasible to operate electrical power generation with heat generation, is provided in Figure 5.

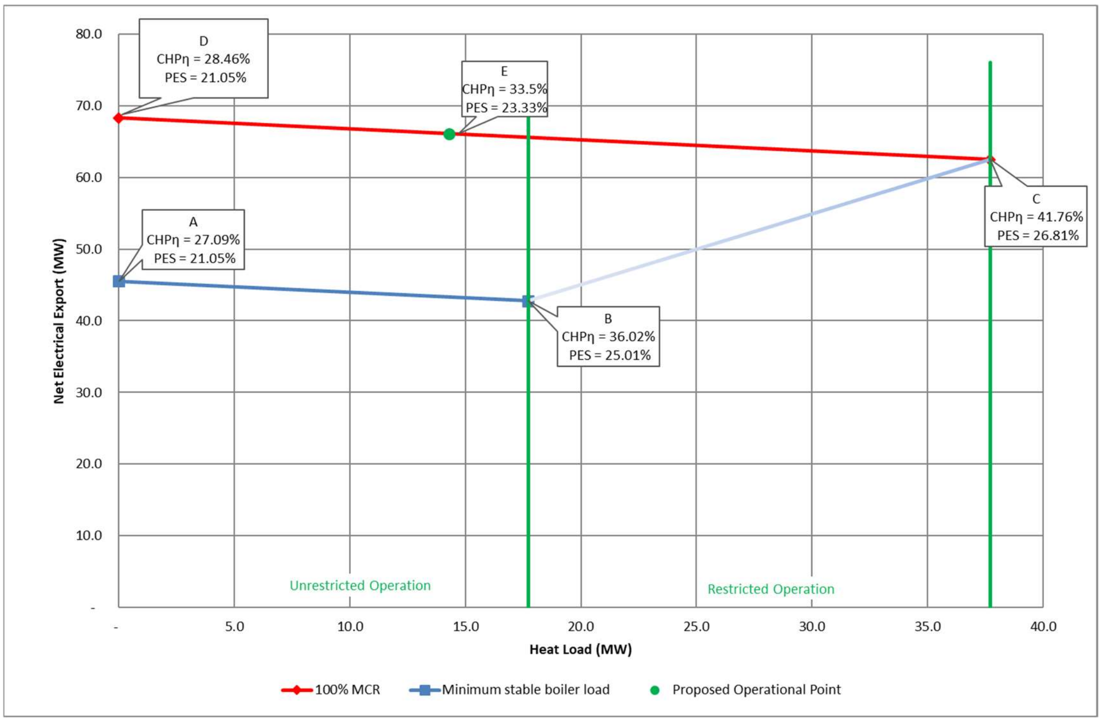
7.2.2 The points defining the CHP envelope are as follows.

- A: minimum stable load (with no heat extraction).
- B: minimum stable load (with maximum heat extraction).
- Line A to B: minimum electrical power output for any given heat load (corresponds to the minimum stable plant load).
- C: 100% load (with maximum heat extraction).
- D: 100% load (with no heat extraction).
- Line D to C: maximum electrical power output for any given heat load (corresponds to 100% plant load).
- E: proposed operational point of the plant, based on the proposed heat network.
- Unrestricted operation: if a selected heat load is located in this region, the plant will have the ability to operate at any load between minimum stable plant load and 100% plant load whilst maintaining the selected heat load.
- Restricted operation: if a selected heat load is located in this region, the plant will not have the ability to operate over its full operational range without a reduction in heat load.

7.2.3 In this context, the CHP efficiency (ηCHP) is defined as:

ηCHP = (Net heat output + Net power output) / (Thermal input)

Figure 5: Graphical representation of CHP envelope for proposed heat network



7.2.4 The proposed operational point (point E) represents the annual average heat demand that would be exported by the Proposed Development to support the proposed DH network. It considers the heat losses and pressure drop in the pipe network and therefore corresponds to the annual average heat demand predicted at the Site boundary. The operational range for the Proposed Development will ultimately be subject to the required hot water flow temperature and final steam turbine selection, which are subject to detailed design.

8.0 CONCLUSIONS

8.1 Technical solution

8.1.1 The Proposed Development will generate approximately 76.0 MW_e of electricity in full condensing mode at the design ambient temperature of 10°C. The Proposed Development will have a parasitic load of approximately 7.7 MW_e. Therefore, the export capacity will be approximately 68.3 MW_e.

8.1.2 The conceptual design for the Proposed Development allows heat export as either steam or hot water via extraction from the steam turbine. Sufficient space has been safeguarded for the installation of the required infrastructure to meet a range of potential heat export scenarios. These design considerations will be maintained during detailed design and procurement of the Proposed Development.

8.2 Heat demand investigation

8.2.1 A review of the potential heat demand within a 15 km radius of the Proposed Development has been undertaken in accordance with the requirements set out in the EA's CHP Ready Guidance.

8.2.2 Heat demand is predominantly from the domestic (63%) and large industrial (26%) sectors along the South Humber Bank. There is minimal heat demand along the north bank of the Humber Estuary and construction of heating infrastructure across the estuary would be prohibitively expensive. Therefore, this area was not considered in detail in this report.

8.2.3 While domestic demand was the highest identified across all sectors, in most cases existing domestic buildings are unsuitable for inclusion in a DH network due to the prohibitive costs of replacing existing heating infrastructure and connecting multiple smaller heat consumers to a network. The North East Lincolnshire Local Plan has earmarked areas within reach (i.e. 3 to 7.5 km) of the SHBEC for significant residential development. The timeline of this development is not known. However, a development with sufficient heat demand density may be a suitable anchor load in the future.

8.2.4 The large industrial demand identified is substantially contained within the area closely surrounding (approximately 5 km) the Site and the Immingham Docks area. It is likely that these sites will require steam, which may be challenging as steam networks are limited in length, require precise consumer conditions to be met and some consumers already have on-site CHP installations for such requirements. Steam consumers often require high supply pressures, which would have a significant impact on electricity generation capacity at the Proposed Development. Should the Proposed Development be able to supply heat aligned with requirements, consumers would need to be willing to contribute to the cost of upgrading existing heating systems to accept heat from a network, and to accept the resulting operational interruptions, which may present major barriers.

8.2.5 Five large heat consumers were identified within 15 km of the Proposed Development, all of which are industrial or commercial. The distances of these consumers from the Proposed Development are detailed in section 4.4.

- The largest consumer is an existing DH network providing steam to the Lindsey Oil Refinery. It is unlikely to be economically viable to supply steam to this network, due to its distance from the Proposed Development (8 km) and the fact that heat supply infrastructure is already established.
- The second largest consumer, Tronox, is a titanium dioxide production facility located circa 2 km north west of the Proposed Development. The Tronox option was screened out of the assessment due to the technical challenges it would entail to export medium pressure steam at the distance required and the impossibility for the steam condensate to be returned to the Proposed Development.
- Synthomer, a polymer manufacturer facility located adjacent to the Site, was considered due to its proximity to the Proposed Development. Further analysis of its process requirements, it was concluded that a steam supply to Synthomer would not be economically feasible and as such this option has been screened out of the study.
- A potential option involving steam export to Novartis Pharmaceuticals was also excluded given the uncertainties around its future operations (in 2018 Novartis announced its plans to exit its Grimsby manufacturing site by the end of 2020).
- The remaining large consumer is the DFDS Terminal at Immingham Docks, which consists of warehouses and storage facilities. The solution would consist of a hot water network for space heating at warehouses and storage facilities at Immingham Docks, with the DFDS Terminal as an anchor load.

8.2.6 Following the exclusion of the domestic developments and the above considerations on large industrial/commercial consumers, the DFDS Immingham Terminal was identified as the preferred technically viable heat supply solution.

8.3 Preferred network option

8.3.1 A heat demand profile has been developed to model the seasonal and diurnal variation of the preferred DH network option, i.e. export to DFDS Terminal at Immingham Docks. Accounting for network heat losses and diversity, the heat demand for the DFDS Terminal is projected as approximately 160,000 MWh/year, equating to an average and peak demand of 14.3 MW_{th} and 37.7 MW_{th} respectively.

8.3.2 The heat demand profile indicates that base loads can be met by the Proposed Development independently, except for periods of downtime of the Proposed Development when a back-up system will be required. When providing the average base load to the user (14.3 MW_{th}), the Proposed Development average electrical export would decrease from 68.3 MW_e to approximately 66.1 MW_e. The peak loads of the DFDS Terminal solution are well within the CHP capabilities specified in the Proposed Development’s design concept.

8.3.3 The most likely solution for implementing a DH network would be transferring heat in the steam extracted from the turbine to a closed hot water circuit via a series of condensing heat exchangers. The hot water would be supplied to the consumers through a pre-insulated buried pipeline, before being returned to the plant for reheating. This technology is well proven and highly efficient.

8.3.4 Detailed techno-economic modelling would be undertaken at the detailed design stage as and when there is more certainty over consumer heat demands.

8.4 Economic assessment

8.4.1 The costs and revenues associated with the construction and operation of the potential DH network with DFDS Terminal have been assessed and inputted into the cost-benefit assessment (CBA) template provided by the EA. The CBA takes account of heat supply system capital and operating costs, heat sales revenue and lost electricity revenue as a result of diverting energy to the heat network.

8.4.2 The results of the CBA indicate that the estimated circa £18.3 million capital investment will not be offset by heat sales revenue alone. The nominal project internal rate of return and net present value (before financing and tax) over 33 years (comprising 3 year build and 30 year operational life) are negative. It is therefore considered that the potential heat network to DFDS Terminal does not currently yield an economically viable scheme without financial support.

8.4.3 Given that the current Renewable Heat Incentive (RHI) scheme is due to end in March 2021, it is unlikely that the Proposed Development will qualify for support under the scheme. It may be possible to secure funding under the Heat Network Investment Project (HNIP) to improve the economic case. It is anticipated that grants and loans will be made available to both public and private sector applicants. The economic feasibility of a potential DH scheme will be reassessed in the future should there be more certainty over heat loads and in light of any developments to the subsidy landscape.

8.5 Energy efficiency measures

8.5.1 In order to qualify as technically feasible under the draft guidance to Article 14 of the Energy Efficiency Directive, the heat demand must be sufficient to achieve high efficiency cogeneration, equivalent to at least 10% savings in primary energy usage compared to the separate generation of heat and power. When operating in fully condensing mode (i.e. without heat export) the Proposed Development will achieve a primary energy saving (PES) of 21.1 %, which is in excess of the technical feasibility threshold defined in the draft Article 14 guidance. The proposed heat network will result in PES of 23.3 % which is in excess of the technical feasibility threshold and would therefore be technically feasible to supply.

8.5.2 To be considered ‘Good Quality’ CHP under the Combined Heat and Power Quality Assurance (CHPQA) scheme, the quantity of heat exported to a heat network must be sufficient to achieve a Quality Index (QI) of at least 105 at the design stage, reducing to 100 at the operational stage. The QI score which could be achieved by the proposed heat network would be 64.3 and 71.5 at average and peak demand respectively. On this basis, the heat network would not qualify as Good Quality CHP. It is noted that the efficiency criteria set out in the latest CHPQA guidance means that it is unlikely that any energy from waste plant will now achieve ‘Good Quality’ status.

8.5.3 The actual energy efficiency performance of the scheme will be dependent on the design of the Proposed Development and the nature of any DH network.

8.6 CHP-Ready assessment

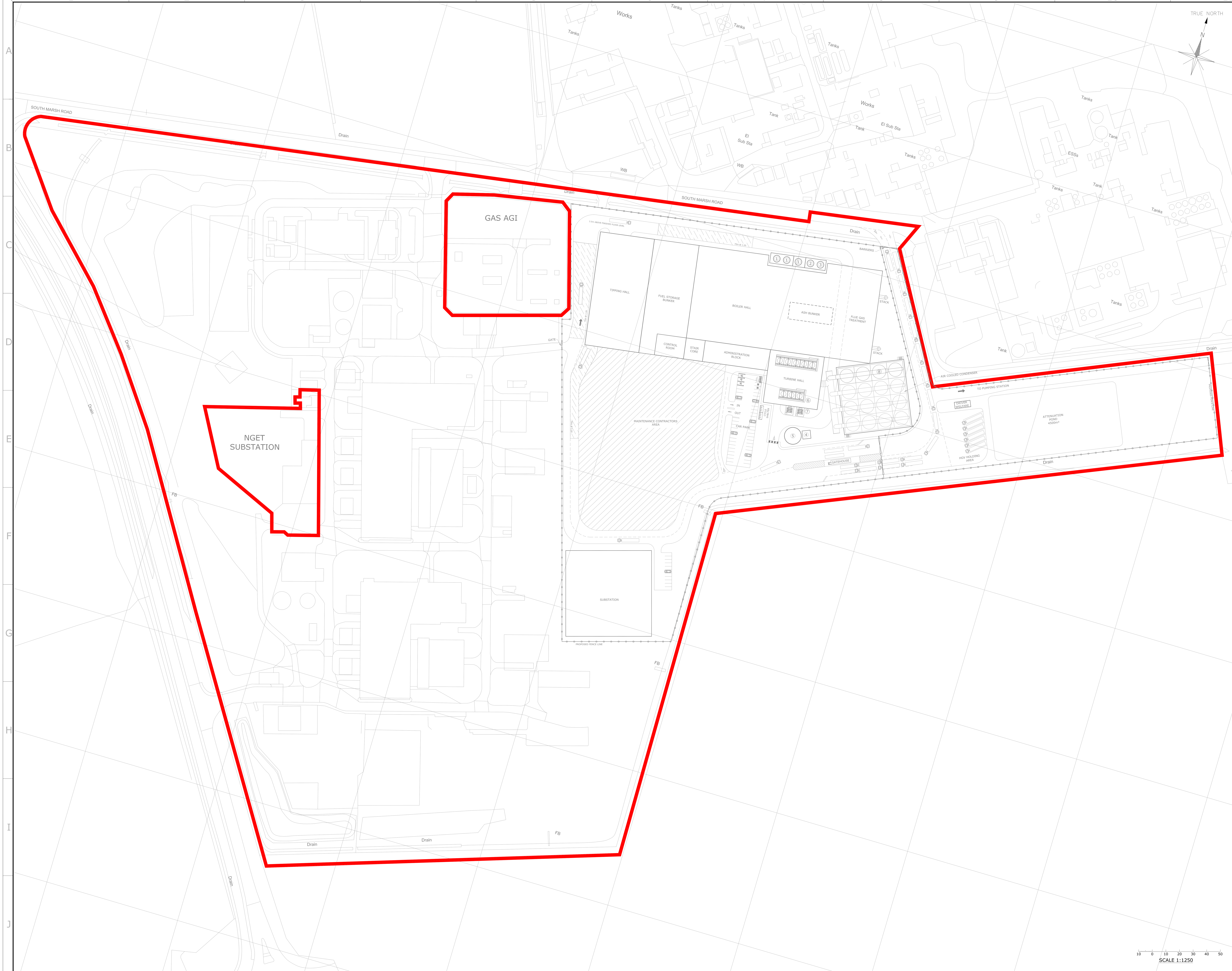
8.6.1 A CHP-Ready assessment was carried out as part of this study and the completed CHP-Ready assessment form is provided in Appendix E. As the economic case for the proposed heat network is not economically viable, constructing the Proposed Development as CHP-Ready is considered to represent BAT.

8.6.2 As CHP-Ready, the Proposed Development will be designed to be ready, with minimum modification, to supply heat in the future. Given the uncertainty of future heat loads, the initial electrical efficiency of a CHP-Ready facility (before any opportunities for the supply of heat are realised) should be no less than that of the equivalent non-CHP-Ready facility. The Proposed Development will include steam capacity designed into the turbine bleeds to facilitate heat export in the future, and safeguarded space to house CHP equipment as shown in the Provisional Site Layout drawing in Appendix A.

8.6.3 To satisfy the third BAT test on an ongoing basis, EPUKI is committed to carrying out periodic reviews of opportunities for the supply of heat to realise CHP.

APPENDICES

Appendix A - Provisional Site Layout



FOR PLANNING EXAMINATION PURPOSES ONLY

NOTE

1. ITEMS COLOURED RED COMPRISE THE 'ADDITIONAL WORKS'

LEGEND

1. REAGENT SILOS
2. AMMONIA TANK
3. FUEL OIL TANK
4. FIRE WATER PUMP HOUSE
5. FIRE WATER TANK
6. ADDITIONAL CLOSED CIRCUIT COOLING WATER FIN FAN COOLERS
7. ADDITIONAL TRANSFORMER CAPACITY
8. AIR COOLED CONDENSER EXTENSION

KEY

THE ORDER LIMITS

FENCELINE

GATES

NOTE

Infrastructure Planning
(Applications: Prescribed Forms and Procedure)
Regulations 2009 - Regulation 5(2)(o)

REV.	DETAILS OF REVISION	DRAWN	CHKD	APR	DATE
1.0	FOR APPROVAL	AO	RO		31.03.20

FICHTNER
CONSULTING ENGINEERS LIMITED

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Stockport, Cheshire, SK4 1LW, UK
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Website: www.fichtner.co.uk

CLIENT: EP WASTE MANAGEMENT LTD

SITE: SOUTH HUMBER BANK

PROJECT: SOUTH HUMBER BANK ENERGY CENTRE

TITLE: SOUTH HUMBER BANK ENERGY CENTRE ORDER INDICATIVE GENERATING STATION PLAN

DRAWING STATUS:	FOR APPROVAL		
DRAWN BY:	AO	DATE:	31.03.20
CHECKED BY:	RO	DATE:	31.03.20
APPROVED BY:		DATE:	
FILENAME:	S2522-0610-0004 R1.0 DTW Indicative Generating Station Plan, Section and Elevations		
OFFICE OF ISSUE:	STOCKPORT		
SHEET SIZE:	A1	SCALE:	1:1250

DRAWING No.: S2522-0610-0004 Sheet 1 Of 21

REVISION: 1.0

Appendix B - Potential Existing Heat Consumers

Potential existing heat consumers identified through visual assessment.

*Sites shown in **bold** are part of the DFDS Immingham Terminal, the preferred network option discussed in section 4.8. The approximate location of these sites is indicated by a red mark in the drawing provided in Appendix C.*

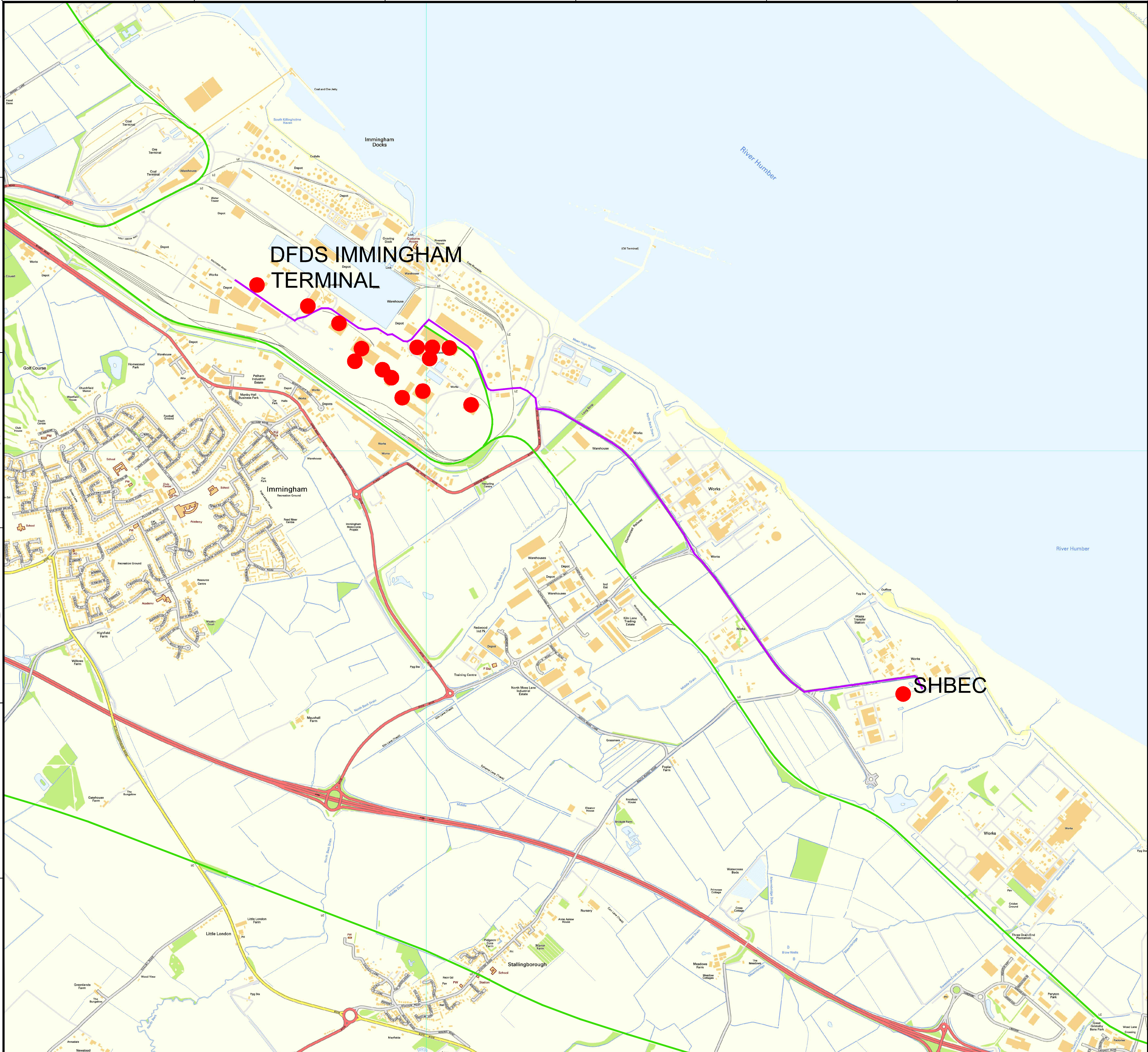
Site	Description	Postcode	Estimated heat demand (MWh/year)
Immingham Dock	**Warehouse**	**DN40 2NT**	**772**
Immingham Dock	**Warehouse**	**DN40 2NT**	**466**
Immingham Dock	**Warehouse**	**DN40 2NT**	**916**
Immingham Dock	**Warehouse**	**DN40 2NT**	**919**
Immingham Dock	**Warehouse**	**DN40 2NT**	**1,647**
Immingham Dock	**Warehouse**	**DN40 2NT**	**618**
Immingham Dock	**Warehouse**	**DN40 2NT**	**405**
Immingham Dock	**Warehouse**	**DN40 2NT**	**969**
Immingham Dock	**Warehouse**	**DN40 2NT**	**686**
Immingham Dock	**Warehouse**	**DN40 2NT**	**366**
Immingham Dock	**Warehouse**	**DN40 2NT**	**566**
Immingham Dock	**Warehouse**	**DN40 2NT**	**905**
Immingham Dock	**Warehouse**	**DN40 2NT**	**507**
Immingham Dock	**Warehouse**	**DN40 2NT**	**3,547**
Kiln Lane Trading Estate	Light Industry	DN41 8DY	155
Kiln Lane Trading Estate	Light Industry	DN41 8DY	155
Kiln Lane Trading Estate	Light Industry	DN41 8DY	155
Kiln Lane Trading Estate	Light Industry	DN41 8DY	155
Global Shipping Warehousing & Storage Ltd	Warehouse	DN41 8DY	1,531
BCA Automotive	Warehouse, car storage	DN41 8DY	546
Bring Cargo Ltd	Warehouse	DN41 8DD	615
Tereos UK & Ireland	Warehouse, food storage	DN41 8DD	517
Hodson & Kauss	Light Industry, metal fabrication	DN41 8DN	506
Ambassador Sea Foods	Warehouse, cold storage	DN41 8DN	48
Lindum Packaging	Light Industry, packaging	DN41 8DN	79
Khromatec Ltd	Light industry, bookbinder	DN41 8DN	55
Unknown	Light industry	DN41 8DN	69
Exceed Logistics Ltd	Warehouse	DN41 8DG	59
Unknown	Warehouse	DN41 8DG	252
World Cargo Logistics Ltd	Warehouse	DN41 8DW	248
LV Shipping Ltd	Warehouse	DN41 8DS	149
Shand Engineering Ltd	Light industry	DN41 8DL	55
E Handcock Ltd	Warehouse	DN41 8DL	403
Bis Ohare	Light Industry	DN41 8DU	218

Site	Description	Postcode	Estimated heat demand (MWh/year)
Clayden Engineering Ltd	Light Industry	DN41 8DU	72
Dowson Transport	Warehouse, logistics	DN41 8DT	545
Unknown	Warehouse	DN41 8DT	1,274
Handtrans	Warehouse, logistics	DN41 8DN	354
East Trans	Warehouse, logistics	DN41 8FD	1,550
JHS Fish Products	Warehouse, cold storage	DN41 8FD	206
Unknown	Warehouse	DN41 8FD	528
DFDS Logistics	Warehouse	DN41 8FD	1,024
Brooksby Projects	Light Industry	DN41 8FD	25
2 Sisters Food Group	Food storage warehouse	DN37 9TS	1,105
Morrisons Manufacturing	Food production	DN37 9TS	169
Ultimate Packaging	Packaging manufacturer	DN37 9TS	414
Sharp Iris	Graphic design office	DN37 9TT	86
TNT Special Services Grimsby	Warehouse and logistics	DN37 9TJ	109
Europarc Innovation Centre	Offices, mixed use	DN37 9TT	99
Humber Seafood Institute	Offices	DN37 9TZ	102
ENGIE Fabricom	Offices	DN37 9TZ	40
Worldpay	Offices	DN37 9TZ	40
Unknown	Offices	DN37 9TZ	40
Yara UK	Offices	DN37 9TZ	40
Northcoast Seafoods	Offices	DN37 9TZ	40
Albert Darnell Ltd	Seafood wholesaler	DN37 9TU	604
Haith's	Pet shop	DN37 9TU	515
ERIKS	Warehouse and logistics	DN37 9TL	133
Achtis Group	Light industry	DN37 9TL	76
Auto Trail V R	Caravan dealer	DN37 9TU	2,754
Daniels Group	Food processing	DN37 9TW	332
Morrisons Manufacturing International Seafoods	Seafood processing	DN37 9TW	442
Bakkavor Mariner	Food processing	DN37 9SY	262
Five Star Fish	Seafood wholesaler	DN37 9SY	1607
Havelok	Fish processing	DN37 9SZ	144
Hammond & Taylor Superlift Ltd	Light industry	DN37 9PH	47
Seachill	Fish processing	DN37 9TG	394
Ocean Bounty	Fish processing	DN37 9TG	49
Tri-Pack Plastics Ltd	Plastics manufacturer	DN31 2TB	197
Speedy Depot	Hire equipment supplier	DN31 2TB	66
Unknown	Warehouse (previously Sentura)	DN31 2TB	339
Flocktons	Tank fabricator	DN31 2TB	86
APT Marine Engineering Ltd	Light Industry	DN31 2TB	111

Site	Description	Postcode	Estimated heat demand (MWh/year)
UK Trailer Parts Ltd	Auto parts store	DN31 2TB	97
Link House	Industrial estate (light industry)	DN31 2TB	55
Pyewipe Place	Industrial estate (light industry)	DN31 2TB	91
Driving Test Centre	Office	DN31 2TB	30
Scania Grimsby	Truck dealership	DN31 2TA	160
Space People	Self storage warehouse	DN31 2TA	334
BJB Lift Trucks	Hire equipment supplier	DN31 2TB	58
Unknown	Light Industry	DN31 2TB	44
Motor Parts Direct	Auto parts store	DN31 2TB	28
Bush Tyres	Auto parts store	DN31 2TB	33
Sports Direct	Distribution Centre	DN31 2TB	388
Enterprise	Car rentals	DN31 2TN	126
3Q Industrial Supplies	Industrial equipment supplier	DN31 2TN	18
ADT Flexibles	Flexible hose manufacturer	DN31 2TN	51
Signs Express Ltd	Sign shop	DN31 2TN	29
NELCCG	Office	DN37 9ST	141
Europa Park	Business park (warehouses)	DN37 9ST	824
Premier Inn	Hotel	DN31 2UT	464
Brewers Fayre	Pub/restaurant	DN31 2UT	1,974
Cherry Tree Business Park	Retail	DN31 2TX	349
City Plumbing Supplies	Retail	DN31 2TX	48
Kloeckner Metals	Metals wholesale	DN31 2TX	397
Normac Commercials	Auto parts store	DN31 2TG	39
Thompson Commercials	Auto parts store	DN31 2TG	59
Bluesky Solutions	Packaging supplies	DN31 2TG	178
Peter Hogarth & Sons Ltd	Wholesaler	DN31 2UR	155
Express Industrial and Welding Supplies	Wholesaler	DN31 2UR	19
Environmental Expressions	Recycling facility	DN31 2TG	249
Fastnet Fish	Seafood wholesaler	DN31 2TG	242
Cromwell Tools	Tool shop	DN31 2TG	208
Cawoods	Fishmonger	DN31 2TG	271
6 Estate Road 1	Light industry park	DN31 2TG	180
Bennetts	Timber merchant	DN31 2TG	174
Marshall Paint & Body	Auto repair	DN31 2TG	131
Omega Business Park	Light industry park	DN31 2TG	492
DFDS	Warehouse	DN31 2TG	727

Site	Description	Postcode	Estimated heat demand (MWh/year)
Imperial Commercials	Commercial vehicle dealer	DN31 2TG	124
Truck Links	Van rental	DN31 2TG	63
BCA Fleet Solutions	British Car Auctions warehouse	DN31 2TG	523
Ice Fresh Seafood	Seafood wholesaler	DN31 2TG	727
Icelandic Seachill	Seafood processing	DN31 2TG	1,066
ACS&T Logistics	Warehouse and storage	DN31 2TG	1,095
Westside Industrial Estate	Light industry park	DN31 2TG	304
PPS East	Packaging supplies	DN31 2TG	359
Brianplant Humberside Ltd	Plant hire shop	DN31 2TG	63
BT	Warehouse	DN31 2TG	257
Estate Rd 8	Light industry park	DN31 2TG	729
Chapmans	Fishcake production	DN31 2TP	1,437
Blackrow	Light industry	DN31 2TP	580

Appendix C - Indicative Pipe Route



ALL INFORMATION ON THIS DRAWING IS INDICATIVE ONLY, AND MAY BE SUBJECT TO FURTHER DESIGN DEVELOPMENT.

DO NOT SCALE

NOTES:

- DISTRICT HEATING PIPE ROUTE
- RAILWAY LINE
- POTENTIAL HEAT USERS

REV.	DETAILS OF REVISION	DRAWN	CHKD	DATE
R1	PRELIMINARY	DTW	RO	06.04.20

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Website: www.fichtner.co.uk

CLIENT:
EP WASTE MANAGEMENT LTD

SITE:
SOUTH HUMBER BANK

PROJECT:
SOUTH HUMBER BANK ENERGY CENTRE

TITLE:
POTENTIAL HEAT USERS

DRAWING STATUS:	PRELIMINARY	
DRAWN BY:	DTW	DATE: 14.08.18
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Appendix D - Cost-Benefit Assessment Inputs and Key Outputs

INPUTS

Version Jan 2015

Scenario Choice (dropdown box)

Scenario Choice (dropdown box)	1	Power generator (Heat Source) same fuel amount

Technical solution features

Heat carrying medium (hot water, steam or other) (dropdown box)	Hot water
Total length of supply pipework (kms)	7
Peak heat demand from Heat User(s) (MWth)	37.72
Annual quantity of heat supplied from the Heat Source(s) to Heat User(s) (MWh)	*Lines 49 & 79*

Key

2	Participant to define
2	Regulatory prescribed
2	Calculated
2	Prescribed - but possibility to change if make a case

DCF Model Parameters

Discount rate (pre-tax pre-financing) (%) - 17% suggested rate	17%
Project lifespan (yrs)	30
Exceptional shorter lifespan (yrs)	0

Cost and revenue streams

Construction costs and build up of operating costs and revenues during construction phase

		% operating costs and revenues during construction phase	Heat Supply Infrastructure - used in Scenarios 1, 2, 3 and 5	Heat Station - used in Scenarios 1, 2 and 3	Standby boilers (only if needed for Scenarios 1, 2 and 3)	Industrial CHP - used in Scenario 4 *
Project asset lifespan (yrs)			30	30	30	20
Exceptional reason for shorter lifespan of Heat Supply Infrastructure, Standby Boiler and/ or Heat Station (yrs)						
Construction length before system operational and at steady state (yrs)	3					
Number of years to build			3	3	3	0
		% (ONLY IF APPLICABLE)	£m	£m	£m	£m
Year 1 costs (£m) and build up of operating costs and revenues (%)		0%	6	1.3	2	
Year 2 costs (£m) and build up of operating costs and revenues (%)		0%	4	1.3	2	
Year 3 costs (£m) and build up of operating costs and revenues (%)		50%	2	0	0	
Year 4 costs (£m) and build up of operating costs and revenues (%)						
Year 5 costs (£m) and build up of operating costs and revenues (%)						

Non-power related operations

OPEX for full steady state Heat Supply Infrastructure on price basis of first year of operations (partial or steady state) (£m)	0.2
OPEX for full steady state Heat Station on price basis of first year of operations (partial or steady state) (£m)	0.1
OPEX for full steady state Standby Boilers on price basis of first year of operations (partial or steady state) (£m)	0.1
OPEX for full steady state Industrial CHP on price basis of first year of operations (partial or steady state) (£m) *	
Additional equivalent OPEX to pay for a major Industrial CHP overall spread over the life of the asset (£m) on price basis of first year of operations (partial or steady state) (£m) *	
Other 1 - Participant to define (£m)	
Other 2 - Participant to define (£m)	
Total non-power related operations	**0.4**
Annual inflation for all non-power related OPEX from first year of operations (full or partial) (%)	2.0%

Unit Energy Prices, Energy Balance, Fuel Related Operational costs and Revenue Stream

	Scenario used	1 Power generator (Heat Source) same fuel amount	2 Power generator (Heat Source) same electrical output	3 Industrial installation (Heat Source) - use waste heat	4 Industrial installation (Heat Source) - CHP set to thermal input	5 District heating (Heat User)
Heat sale price (£/ MWh) at first year of operations (partial or full)	12.00	12.00	50.00	50.00		
Annual quantity of heat supplied from the Heat Source(s) to Heat User(s) at steady state (MWh)	160,000	160,000	1,000,000	250,000		
Equivalent heat sales if first year of operations is steady state (£ m)	1.9					
Heat sale price inflation from first year of operations (full or partial) (% per year)	3.0%	3.0%	3.0%	3.0%		
Percentage of heat supplied by Standby Boiler (if relevant)	13%	13%	20%	20%		
'Lost' electricity sale price (£/ MWh) at first year of operations	52.30	52.30				
Z-ratio (commonly in the range 3.5 - 8.5)	6.50	6.50				
Power generation lost at steady state (MWh)	21,415	21,415				
Equivalent 'lost' revenue from power generation if first year of operations is steady state (£ m)	1.12					
Electricity sale price inflation from first year of operations (full or partial) (% per year)	2.0%	2.0%				
Industrial CHP electricity sale price (£/ MWh) at first year of operations (full or partial)	0.00				110.00	
Industrial CHP electrical generation in steady state (MWh)	0				* 285,714	
Equivalent revenue from power generation if first year of operations is steady state (£ m)	0.00					
Industrial CHP electricity price inflation from first year of operations (full or partial) (% per year)	0.0%				2.0%	
Fuel price for larger power generator/ CHP at first year of operations (full or partial) (£ / MWh)	0.00		40.00		40.00	
Z-ratio (commonly in the range 3.5 - 8.5)	0		3.50			
Power efficiency in cogeneration mode (%)	0		30%			
Additional fuel required per year for larger power generator / CHP in steady state (MWh)	0		761,905		* 300,000	
Equivalent additional fuel costs if first year of operations is steady state (£ m)	0.00					
Fuel price inflation from first year of operations (full or partial) (% per year)	0.0%		3.0%		5.0%	
Fuel price for Standby Boiler at first year of operations (£ / MWh)	40.00	40.00	40.00	40.00		
Boiler efficiency of Standby Boiler (%)	80%	80%	80%	80%		
Additional fuel required per year for Standby Boiler in steady state (MWh)	26,000	26,000	250,000	62,500		
Equivalent additional fuel costs if first year of operations is steady state (£m)	1.04					
Fuel price inflation for Standby Boiler from first year of operations (full or partial) (% per year)	2.00%	2.0%	3.0%	3.0%		
Heat purchase price (£/ MWh) at first year of operations (partial or full)	0.00					35.00
Annual quantity of heat supplied from the Heat Source(s) to Heat User(s) at steady state (MWh)	0					200,000
Equivalent cost of heat purchased if first year of operations is steady state (£ m)	0.0					
Heat purchase price inflation from first year of operations (full or partial) (% per year)	0.0%					3.0%
Fuel price (£ / MWh) at first year of operations (partial or full)	0.00					40.00
Boiler efficiency of district heating plant	0%					80%
Fuel avoided per year in steady state (MWh)	0					250,000
Equivalent fuel savings if first year of operations is steady state (£m)	0.0					
Fuel price inflation from first year of operations (full or partial) (% per year)	0.0%					4.0%
Fiscal benefits (£m) in first year of operations assuming it is at steady state **	0.00	0.00	2.50		2.50	
Fiscal benefits inflation rate from first year of opeations (full or partial) (%) **	1.0%	1.0%	1.0%		1.0%	

* In the case of Industrial CHP a separate model template is available for typical indicative CAPEX, non-power related OPEX, additional equivalent OPEX to pay for a major overall, MWh of electricity generated in the steady state and the additional fuel required.

** Operator only needs to enter a value for fiscal benefits (£m) and the annual fiscal benefit inflation rate (%) if the NPV without fiscal benefits is negative at the specified discount rate

OUTPUTS

Nominal Project IRR (before financing and tax) over 33 years	#NUM!
Nominal NPV (before financing and tax) (£m) over 33 years	-16.79

	Scenarios 1	2	3	4	5	Totals	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
Project phase																			
Construction phase flag							1	1	1	0	0	0	0	0	0	0	0	0	0
Percent of full operations over project life							0%	0%	50%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Percent of full operations over exceptional shortened asset life							0%	0%	50%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Relevant percent of full operations figures							0%	0%	50%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Inflator rates for different costs/ revenues																			
Heat sale price inflator	√	√	√				0.00	0.00	1.00	1.03	1.06	1.09	1.13	1.16	1.19	1.23	1.27	1.30	1.34
'Lost' electricity sale price inflator	√						0.00	0.00	1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22
Industrial CHP electricity sale price inflator				√			0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fuel price inflator (power generator/ CHP)		√		√			0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fuel price inflator for Standby Boiler (if needed)	√	√	√				0.00	0.00	1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22
Heat purchase price inflator					√		0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fuel purchase price inflator (district heating)					√		0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Non-power operating cost inflator	√	√	√	√	√		0.00	0.00	1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22
Fiscal benefits inflator	√	√		√			0.00	0.00	1.00	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10

CASHFLOW (£M)

	1	2	3	4	5	Totals	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
Revenues and cost savings																			
Heat sales	√	√	√			**95.05**	0.00	0.00	0.96	1.98	2.04	2.10	2.16	2.23	2.29	2.36	2.43	2.51	2.58
Industrial CHP electricity sales				√		**0.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fuel savings district heating					√	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fiscal benefits (if needed)	√	√		√		**0.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total revenue						**95.05**	**0.00**	**0.00**	**0.96**	**1.98**	**2.04**	**2.10**	**2.16**	**2.23**	**2.29**	**2.36**	**2.43**	**2.51**	**2.58**
Construction costs																			
Heat Supply Infrastructure	√	√	√		√	**-12.00**	-6.00	-4.00	-2.00										
Heat Station	√	√	√			**-2.60**	-1.30	-1.30	0.00										
Standby Boiler that may be needed	√	√	√			**-4.00**	-2.00	-2.00	0.00										
CHP construction cost scenario				√		**0.00**	0.00	0.00	0.00										
Total construction costs						**-18.60**	-9.30	-7.30	-2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sale of plant if exceptional reason						**0.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Operations costs																			
Non-power operations costs	√	√	√	√	√	**-16.75**	0.00	0.00	-0.20	-0.41	-0.42	-0.42	-0.43	-0.44	-0.45	-0.46	-0.47	-0.48	-0.49
Additional fuel costs for installation		√		√		**0.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Additional fuel costs for Standby Boiler if needed		√	√			**-43.55**	0.00	0.00	-0.52	-1.06	-1.08	-1.10	-1.13	-1.15	-1.17	-1.19	-1.22	-1.24	-1.27
'Lost' electicity sales from power generation	√					**-46.91**	0.00	0.00	-0.56	-1.14	-1.17	-1.19	-1.21	-1.24	-1.26	-1.29	-1.31	-1.34	-1.37
Cost of heat purchased					√	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total operations costs							0.00	0.00	-1.28	-2.61	-2.66	-2.72	-2.77	-2.83	-2.88	-2.94	-3.00	-3.06	-3.12
Cashflow before taxation and financing						**-30.77**	**-9.30**	**-7.30**	**-2.32**	**-0.63**	**-0.63**	**-0.62**	**-0.61**	**-0.60**	**-0.59**	**-0.58**	**-0.57**	**-0.55**	**-0.54**

PROJECT RETURNS

	Nominal Project IRR (before financing and tax) over 33 years	**#NUM!**
17.0%	Nominal NPV (before financing and tax) (£m) over 33 years	**-16.79**

ASSET VALUES (£M)

	1	2	3	4	5	Totals	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
Asset value over Project Asset Lifespan																			
Opening balance							0.00	9.30	16.60	18.60	17.98	17.36	16.74	16.12	15.50	14.88	14.26	13.64	13.02
Additions	√	√	√		√	**18.60**	9.30	7.30	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Depreciation (straight line)	√	√	√		√	**-18.60**	0.00	0.00	0.00	-0.62	-0.62	-0.62	-0.62	-0.62	-0.62	-0.62	-0.62	-0.62	-0.62
Closing balance							**9.30**	**16.60**	**18.60**	**17.98**	**17.36**	**16.74**	**16.12**	**15.50**	**14.88**	**14.26**	**13.64**	**13.02**	**12.40**

Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30	Year 31	Year 32	Year 33	Year 34	Year 35
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	0%	0%
0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	0%	0%
1.38	1.43	1.47	1.51	1.56	1.60	1.65	1.70	1.75	1.81	1.86	1.92	1.97	2.03	2.09	2.16	2.22	2.29	2.36	2.43	0.00	0.00
1.24	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46	1.49	1.52	1.55	1.58	1.61	1.64	1.67	1.71	1.74	1.78	1.81	0.00	0.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00
1.24	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46	1.49	1.52	1.55	1.58	1.61	1.64	1.67	1.71	1.74	1.78	1.81	0.00	0.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00
1.24	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.46	1.49	1.52	1.55	1.58	1.61	1.64	1.67	1.71	1.74	1.78	1.81	0.00	0.00
1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.20	1.21	1.22	1.23	1.24	1.26	1.27	1.28	1.30	1.31	1.32	1.33	1.35	0.00	0.00
2.66	2.74	2.82	2.90	2.99	3.08	3.17	3.27	3.37	3.47	3.57	3.68	3.79	3.90	4.02	4.14	4.26	4.39	4.52	4.66	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.66	**2.74**	**2.82**	**2.90**	**2.99**	**3.08**	**3.17**	**3.27**	**3.37**	**3.47**	**3.57**	**3.68**	**3.79**	**3.90**	**4.02**	**4.14**	**4.26**	**4.39**	**4.52**	**4.66**	**0.00**	**0.00**
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-0.50	-0.51	-0.52	-0.53	-0.54	-0.55	-0.56	-0.57	-0.58	-0.59	-0.61	-0.62	-0.63	-0.64	-0.66	-0.67	-0.68	-0.70	-0.71	-0.72	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-1.29	-1.32	-1.35	-1.37	-1.40	-1.43	-1.46	-1.49	-1.52	-1.55	-1.58	-1.61	-1.64	-1.67	-1.71	-1.74	-1.78	-1.81	-1.85	-1.88	0.00	0.00
-1.39	-1.42	-1.45	-1.48	-1.51	-1.54	-1.57	-1.60	-1.63	-1.66	-1.70	-1.73	-1.77	-1.80	-1.84	-1.87	-1.91	-1.95	-1.99	-2.03	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-3.18	-3.25	-3.31	-3.38	-3.45	-3.51	-3.58	-3.66	-3.73	-3.80	-3.88	-3.96	-4.04	-4.12	-4.20	-4.28	-4.37	-4.46	-4.55	-4.64	0.00	0.00
-0.53	**-0.51**	**-0.49**	**-0.47**	**-0.45**	**-0.43**	**-0.41**	**-0.39**	**-0.36**	**-0.34**	**-0.31**	**-0.28**	**-0.25**	**-0.21**	**-0.18**	**-0.14**	**-0.10**	**-0.06**	**-0.02**	**0.02**	**0.00**	**0.00**
12.40	11.78	11.16	10.54	9.92	9.30	8.68	8.06	7.44	6.82	6.20	5.58	4.96	4.34	3.72	3.10	2.48	1.86	1.24	0.62	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-0.62	-0.62	-0.62	-0.62	-0.62	-0.62	-0.62	-0.62	-0.62	-0.62	-0.62	-0.62	-0.62	-0.62	-0.62	-0.62	-0.62	-0.62	-0.62	-0.62	0.00	0.00
11.78	**11.16**	**10.54**	**9.92**	**9.30**	**8.68**	**8.06**	**7.44**	**6.82**	**6.20**	**5.58**	**4.96**	**4.34**	**3.72**	**3.10**	**2.48**	**1.86**	**1.24**	**0.62**	**0.00**	**0.00**	**0.00**

Appendix E - CHP-Ready Assessment Form

CHP-Ready assessment template

This is a Word version of Appendix A of our CHP Ready guidance for combustion and energy from waste power plants for you to use as a template

February 2013

You can use this template to carry out a CHP-Ready assessment if you are making an environmental permit application for a new combustion or energy from waste power plant. This is a copy of the CHP-R Assessment Form in Appendix A of the CHP Ready Guidance and we recommend you read the guidance before completing it.

We would normally expect you to discuss CHP-Readiness as part of the pre-application process for your permit, and so if you have any queries about completing this template, please speak to the local Environment Agency Officer allocated to your pre-application.

#	Description	Units	Notes / Instructions
Requirement 1: Plant, Plant location and Potential heat loads			
1.1	**Plant name**		South Humber Bank Energy Centre (SHBEC), 'the Proposed Development'.
1.2	**Plant description**		The proposed development is designed to process approximately 1,900 tonnes per day of mixed refuse derived fuel with an NCV of 11 MJ/kg. SHBEC will be a two-stream facility using a reciprocating grate and conventional boiler, using the Rankine steam cycle to generate power via a turbine/generator. SHBEC will include fuel reception and storage areas, incineration grate and boilers, water, fuel and air supply systems, a flue gas treatment system, on-site facilities for treatment and storage of residues and waste water, stack, devices and systems for controlling incineration operations, education/visitor centre and staff facilities. The facility will have a design thermal input from fuel of approximately 240 MWth. The steam turbine will generate 76 MWe with approximately 68.3 MWe to be exported. Subject to detailed design the turbine will be selected to allow 38 MWth to be exported to local consumers.

1.3	**Plant location (Postcode / Grid Ref)**		The site comprises approximately 23 hectares of land located on South Humber Bank Power Station (SHBPS) land in North East Lincolnshire at approximate National Grid Reference TA 23064 13443. The Proposed Development’s process plant and buildings are located on the Main Development Area, an area of approximately 7 hectares which is currently predominantly used for access between the SHBPS and its cooling water pumping station via the existing access road. Underground cooling water pipes and buried cables also run through the site.
1.4	**Factors influencing selection of plant location**		The SHBEC site is in the area between Grimsby and Immingham, which hosts a number of industrial facilities. Immingham Docks are located within 5km of the site. The site is bounded to the north-east by the Humber. Railway lines are also present near the south-west boundary of the site. Currently, land is used for access to the power station's pumping station. The land also contains underground cooling water pipes and other buried services. The location was selected primarily as a result of the following factors: 1. The developers own the South Humber Bank Power Station, the land on which SHBEC will be constructed. 2. It avoids those areas most protected by policy e.g. greenbelt. 3. It is capable of providing enough space to minimise local adverse environmental impact. 4. Its location enables the required waste management and energy supply capacity to be provided in an advantageous position.
1.5	**Operation of plant**		
a)	Proposed operational plant load	%	100
b)	Thermal input at proposed operational plant load	MW	240.01
c)	Net electrical output at proposed operational plant load	MW	68.31
d)	Net electrical efficiency at proposed operational plant load	%	28.46 %

e)	Maximum plant load	%	100
f)	Thermal input at maximum plant load	MW	240.01
g)	Net electrical output at maximum plant load	MW	68.31
h)	Net electrical efficiency at maximum plant load	%	28.46 %
i)	minimum stable plant load	%	70.00 %
j)	Thermal input at minimum stable plant load	MW	168.01
k)	Net electrical output at minimum stable plant load	MW	45.51
l)	Net electrical efficiency at minimum stable plant load	%	27.09 %
1.6	**Identified potential heat loads**		
			Heat consumer identification has focused on industrial and commercial users, as the benefits of providing heat to large premises is generally more financially viable than supplier to multiple smaller consumers. After accounting for network heat losses and consumer diversity, a total average and peak heat demand of 14.3 MWth and 37.7 MWth respectively has been identified within a 15km radius of the site. Neighbouring polymer and pigment manufacturing facilities have been approached to discuss the potential supply of heat from SHBEC.] Full details of heat consumer identification and screening can be seen in Section 5 of the CHP Study.
1.7	**Selected heat load(s)**		
a)	Category (e.g. industrial / district heating)		District heating
b)	Maximum heat load extraction required	MW	Total average and peak heat demand have been estimated at 14.3 MWth and 37.7 MWth respectively.
1.8	**Export and return requirements of heat load**		
a)	Description of heat load extraction		Network to supply hot water at typical district heating temperatures (approximately 100°C) via turbine steam extraction(s) at approximately 2 bar(a).
b)	Description of heat load profile		Variable heat load, owing to mixed use of consumers. A heat load profile can be found in Section 5 of the CHP Study. The consumer heat load and profile is subject to verification.

c)	Export pressure	bar a	10
d)	Export temperature	°C	100
e)	Export flow	t/h	1080
f)	Return pressure	bar a	3
g)	Return temperature	°C	70
h)	Return flow	t/h	1080
Requirement 2: Identification of CHP Envelope			
2.0	**Comparative efficiency of a standalone boiler for supplying the heat load**	% LHV	80% - updated in accordance with the CHPQA Stakeholder Engagement Document, April 2016, Table 1
2.1	Heat extraction at 100% plant load		
a)	Maximum heat load extraction at 100% plant load	MW	37.72
b)	Maximum heat extraction export flow at 100% plant load	t/h	• 1080 (Assuming steam extraction at 2 bar(a) and heat exchanger delta T of 10°C)
c)	CHP mode net electrical output at 100% plant load	MW	62.51
d)	CHP mode net electrical efficiency at 100% plant load	%	26.04%
e)	CHP mode net CHP efficiency at 100% plant load	%	41.76%
f)	Reduction in primary energy usage for CHP mode at 100% plant load	%	26.81%
2.2	**Heat extraction at minimum stable plant load**		
a)	Maximum heat load extraction at minimum stable plant load	MW	17.73
b)	Maximum heat extraction export flow at minimum stable plant load	t/h	508 (Assuming steam extraction at 2 bar(a) and heat exchanger delta T of 10°C)
c)	CHP mode net electrical output at minimum stable plant load	MW	42.78
d)	CHP mode net electrical efficiency at minimum stable plant load	%	25.46%

e)	CHP mode net CHP efficiency at minimum stable plant load	%	36.02%
f)	Reduction in primary energy usage for CHP mode at minimum stable plant load	%	25.01%
2.3	**Can the plant supply the selected identified potential heat load (i.e.is the identified potential heat load within the 'CHP envelope')?**		Yes, but not deemed 'Good Quality' CHP as per the CHP Study
Requirement 3: Operation of the Plant with the Selected Identified Heat Load			
3.1	**Proposed operation of plant with CHP**		
a)	CHP mode net electrical output at proposed operational plant load	MW	66.11
b)	CHP mode net electrical efficiency at proposed operational plant load	%	27.55%
c)	CHP mode net CHP efficiency at proposed operational plant load	%	33.50%
d)	Reduction in net electrical output for CHP mode at proposed operational plant load	MW	2.20
e)	Reduction in net electrical efficiency for CHP mode at proposed operational plant load	%	0.92%
f)	Reduction in primary energy usage for CHP mode at proposed operational plant load	%	23.33%
g)	Z ratio		6.50
Requirement 4: Technical provisions and space requirements			
4.1	**Description of likely suitable extraction points**		Steam for the district heating network could be supplied via controlled steam flow extraction from a medium/low pressure bleed on the turbine at approximately 2 bar(a) or from heat from the live steam flow. Further details are provided in the CHP Study.
4.2	**Description of potential options which could be incorporated in the plant, should a CHP opportunity be realised outside the 'CHP envelope'**		The CHP opportunity lies within the CHP envelope.

4.3	**Description of how the future costs and burdens associated with supplying the identified heat load / potential CHP opportunity have been minimised through the implementation of an appropriate CHP-R design**		If the scheme were to be realised, space will be allocated for CHP equipment near the turbine hall. The turbine will be designed to maximise electrical efficiency while allowing for the option of heat export to be implemented in future. This aligns with EA CHP-R Guidance, which states that the electrical efficiency of a CHP-R plant (before any CHP opportunities are realised) should be no less than that of the equivalent non-CHP-R plant.
4.4	**Provision of site layout of the plant, indicating available space which could be made available for CHP-R**		Site layout drawing can be found in the CHP Study. The heat network will include steam extraction pipework, control and shut-off valves, heat exchangers, district heating circulation pumps, district heating supply and return pipework, condensate return pipework, C&I/electrical connections, expansion tank (for pressurisation of district heating pipe network) and heat metering. It is envisaged that the adjacent power station could be used as a back-up heat source. Should this not be possible, back-up boilers will be located on site, or closer to consumers if possible.
Requirement 5: Integration of CHP and carbon capture			
5.1	**Is the plant required to be CCR?**		No
5.2	**Export and return requirements identified for carbon capture**		
	100% plant load		
a)	Heat load extraction for carbon capture at 100% plant load	MW	N/A
b)	Description of heat export (e.g. steam / hot water)		N/A
c)	Export pressure	bar a	N/A
d)	Export temperature	°C	N/A
e)	Export flow	t/h	N/A
f)	Return pressure	bar a	N/A
g)	Return temperature	°C	N/A
h)	Return flow	t/h	N/A
i)	Likely suitable extraction points		N/A
	Minimum stable plant load		
j)	Heat load extraction for carbon capture at minimum stable plant load	MW	N/A

k)	Description of heat export (e.g. steam / hot water)		N/A
l)	Export pressure	bar a	N/A
m)	Export temperature	°C	N/A
n)	Export flow	t/h	N/A
o)	Return pressure	bar a	N/A
p)	Return temperature	°C	N/A
q)	Return flow	t/h	N/A
r)	Likely suitable extraction points		N/A
5.3	**Operation of plant with carbon capture (without CHP)**		
a)	Maximum plant load with carbon capture	%	N/A
b)	Carbon capture mode thermal input at maximum plant load	MW	N/A
c)	Carbon capture mode net electrical output at maximum plant load	MW	N/A
d)	Carbon capture mode net electrical efficiency at maximum plant load	%	N/A
e)	Minimum stable plant load with CCS	%	N/A
f)	Carbon capture mode CCS thermal input at minimum stable plant load	MW	N/A
g)	Carbon capture mode net electrical output at minimum stable plant load	MW	N/A
h)	Carbon capture mode net electrical efficiency at minimum stable plant load	%	N/A
5.4	**Heat extraction for CHP at 100% plant load with carbon capture**		
a)	Maximum heat load extraction at 100% plant load with carbon capture [H]	MW	N/A
b)	Maximum heat extraction export flow at 100% plant load with carbon capture	t/h	N/A
c)	Carbon capture and CHP mode net electrical output at 100% plant load	MW	N/A
d)	Carbon capture and CHP mode net electrical efficiency at 100% plant load	%	N/A
e)	Carbon capture and CHP mode net CHP efficiency at 100% plant load	%	N/A
f)	Reduction in primary energy usage for carbon capture and CHP mode at 100% plant load	%	N/A
5.5	**Heat extraction at minimum stable plant load with carbon capture**		
a)	Maximum heat load extraction at minimum stable plant load with carbon capture	MW	N/A

b)	Maximum heat extraction export flow at minimum stable plant load with carbon capture	t/h	N/A
c)	Carbon capture and CHP mode net electrical output at minimum stable plant load	MW	N/A
d)	Carbon capture and CHP mode net electrical efficiency at minimum stable plant load	%	N/A
e)	Carbon capture and CHP mode net CHP efficiency at minimum stable plant load	%	N/A
f)	reduction in primary energy usage for carbon capture and CHP mode at minimum stable plant load	%	N/A
5.6	**Can the plant with carbon capture supply the selected identified potential heat load (i.e. is the identified potential heat load within the 'CHP and carbon capture envelope')?**		N/A
5.7	**Description of potential options which could be incorporated in the plant for useful integration of any realised CHP system and carbon capture system**		N/A
Requirement 6: Economics of CHP-R			
6.1	**Economic assessment of CHP-R**		A Cost Benefit Assessment (CBA) has been carried out. The results of the CBA indicate that both the nominal project IRR and NPV are negative. We therefore consider that the proposed heat network for SHBEC does not currently yield an economically viable scheme. Further details are provided in the CHP Study.
BAT assessment			
	Is the new plant a CHP plant at the outset (i.e. are there economically viable CHP opportunities at the outset)?		No
	If not, is the new plant a CHP-R plant at the outset?		Yes
	Once the new plant is CHP-R, is it BAT?		Yes