

WHITE ROSE CARBON CAPTURE AND  
STORAGE: COMBINED HEAT AND  
POWER ASSESSMENT

*Capture Power Ltd*

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*[Draft]*



# **White Rose Carbon Capture and Storage: Combined Heat and Power Assessment**

**287072A / 12.1**

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**LIST OF ABBREVIATIONS**

ASU	Air separation unit
BAT	Best available techniques
CCS	Carbon capture and storage
CHP	Combined heat and power
CHP-R	Combined heat and power ready
CO <sub>2</sub>	Carbon dioxide
CPL	Capture Power Ltd
DCO	Development Consent Order
DECC	Department of Energy and Climate Change
DTI	Department of Trade and Industry
EA	Environment Agency
EED	Energy Efficiency Directive
EMS	Environmental Management System
GPU	Gas processing unit
IED	Industrial Emissions Directive
IP	Intermediate pressure
IPPC	Integrated pollution prevention and control
km	kilometre
kW	kilowatt
kWh	kilowatt-hour
LP	Low pressure
m <sup>2</sup>	square metre
MW	megawatt
MWe	megawatt electrical
MWth	megawatt thermal
NEEAP	National Energy Efficiency Action Plan
NER 300	New Entrant Reserve
NGCL	National Grid Carbon Ltd
NPS	National Policy Statement
NSIP	Nationally significant infrastructure project
PA 2008	Planning Act 2008
TWh	terawatt-hour





## EXECUTIVE SUMMARY

This Combined Heat and Power (CHP) Assessment has been prepared by Parsons Brinckerhoff Ltd on behalf of Capture Power Ltd (CPL) in order to support an application for consent (DCO) to construct and operate a new 426 MWe (gross) power station (the White Rose Carbon Capture and Storage Project). The Project will have the capacity to provide electricity to up to 630 000 households whilst capturing approximately two million tonnes of carbon dioxide (CO<sub>2</sub>) per year arising from the combustion process.

CHP is the generation of electrical power and usable heat in a single process. This is also known as co-generation. CHP is a well proven technique for reducing primary energy consumption, thereby reducing the total carbon emissions that would result from the generation of electrical power and heat separately.

The CHP Assessment has been undertaken in line with the requirements of the '*Overarching National Policy Statement for Energy EN-1*' and the '*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*'. The approach to the CHP Assessment and the preparation of this document has also been undertaken with due regard paid to the relevant provisions of the '*CHP Ready Guidance for Combustion and Energy from Waste Power Plants*'.

A study area of up to 15 km from the Project was considered (CHP Search Area).

Consultation has been undertaken with organisations identified, in guidance, as being able to assist in locating potential CHP opportunities. Given the dispersed, sparsely populated, nature of the land within the CHP Search Area, this CHP Assessment has placed great importance on seeking the views of such organisations in identifying potential heat / steam off takers.

Parsons Brinckerhoff has also examined the UK CHP Development Map which is the latest version of the map, originally developed as a tool aimed at assisting power station developers considering the opportunities for supplying heat and development of CHP.

At present, no feasible CHP opportunities (considering both technical and economic feasibility) have been identified in the vicinity of the Project. However CPL is committed to maintaining on-going consultation with local planning authorities and other relevant stakeholders (including local business) to identify any future potential CHP opportunities at the earliest stage.

Throughout the operating life of the Project, and at least every two years, CPL will carry out a comprehensive review of opportunities for the supply of heat for the realisation of CHP.

In order to realise potential future CHP opportunities, the Project will include technical provisions that will mean that it is designed to be CHP-ready.

Subject to the identification of a suitable (i.e. technically and economically feasible) off taker, the technical provisions will enable the Project to export heat / steam of up to approximately 27 MWth without impact to its operational range.

Above 27 MWth, the operating range of the Project would be restricted however it will be capable of exporting heat / steam up to approximately 75 MWth.

At full load operation, with maximum heat / steam extraction, the Project will be capable of delivery a reduction in primary energy usage of approximately 5 per cent.

The appropriate provisions (such as the reservation of space) will be secured by way of a requirement in the DCO. It is considered that this is an appropriate solution given the current uncertainty (and thus absence of economic feasibility) surrounding the identified and future CHP opportunities.



SECTION 1

**INTRODUCTION**



## **1 INTRODUCTION**

### **1.1 Overview**

1.1.1 This Combined Heat and Power (CHP) Assessment has been prepared by Parsons Brinckerhoff Ltd on behalf of Capture Power Ltd (CPL).

1.1.2 CPL plans to construct and operate a new 426 MWe (gross) power station (the Project) with the capacity to provide electricity to up to 630 000 households whilst capturing approximately two million tonnes of carbon dioxide (CO<sub>2</sub>) per year arising from the combustion process. The Project will support the development of a CO<sub>2</sub> transport pipeline (a separate project developed by National Grid Carbon Ltd (NGCL)) that is anticipated to also be used by other industries and power stations in the Yorkshire and Humber area to transport their CO<sub>2</sub> emissions for permanent storage in geological formations beneath the North Sea.

### **1.2 Application for a Development Consent Order**

1.2.1 In England and Wales, an onshore electricity generating station is considered to be a Nationally Significant Infrastructure Project (NSIP) if the electrical power generating capacity is more than 50 MW. As the electrical power generating capacity of the Project will exceed this threshold, it will be a NSIP.

1.2.2 Under Section 31 of the Planning Act 2008 (PA 2008), a development consent order (DCO) is required to authorise the construction and operation of a NSIP.

1.2.3 A DCO may only be granted pursuant to an application under Section 37 of the Planning Act 2008. To inform decisions upon such applications, the PA 2008 required the development and implementation of new national policy regarding NSIPs which is set out in National Policy Statements (NPS). Those NPS that are relevant to the Project, and this CHP Assessment, are:

- a The Overarching National Policy Statement for Energy (NPS EN-1); and,
- b The National Policy Statement for Fossil Fuel Electricity Generating Infrastructure (NPS EN-2).

1.2.4 NPS EN-1 states (at paragraph 4.6.6) that:

*“Under Guidelines issued by DECC (then DTI) in 2006 [the CHP Guidance<sup>1</sup>], 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 to inform... consideration of the application. This should be through an audit trail of dialogue between the applicant and prospective customers. The same principle applies to any thermal power station which is the subject of an application for development consent under the Planning Act 2008. The [Secretary of State] should have regard to DECC’s Guidance, or any successor to it, when considering the CHP aspects of applications for thermal generating stations.”*

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<sup>1</sup> 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 (December 2006)

**1.3 Purpose and Structure of this Document**

1.3.1 In line with the requirements of NPS EN-1 and the CHP Guidance, this CHP Assessment has been prepared to support the application for a DCO to authorise the Project.

1.3.2 This document comprises:

**Section 1** – A brief introduction;

**Section 2** – The context and methodology of the CHP Assessment;

**Section 3** – A description of the Project;

**Section 4** – A discussion of the potential opportunities for the implementation of CHP; and

**Section 5** – Summary and conclusions of the CHP Assessment.

1.3.3 Additional supporting information is provided in the Appendices to this document, which comprise:

**Appendix A** – Summary of Consultation Responses; and

**Appendix B** – Output from consultation of the UK CHP Development Map<sup>2</sup>.

1.3.4 The approach to the CHP Assessment and the preparation of this document has also been undertaken with due regard paid to the relevant provisions of the '*CHP Ready Guidance for Combustion and Energy from Waste Power Plants*' (Environment Agency, 2013) (CHP-Ready Guidance).

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<sup>2</sup> <http://chp.decc.gov.uk/developmentmap/>

SECTION 2

**CHP CONTEXT AND ASSESSMENT  
METHODOLOGY**





## **2 CHP CONTEXT AND ASSESSMENT METHODOLOGY**

### **2.1 Introduction**

2.1.1 CHP is the generation of electrical power and usable heat in a single process. This is also known as co-generation. CHP is a well proven technique for reducing primary energy consumption<sup>3</sup>, thereby reducing the total carbon emissions that would result from the generation of electrical power and heat separately.

### **2.2 European Policy**

#### Industrial Emissions Directive

2.2.1 Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control) (IED) recast seven directives related to industrial emissions into a single legislative instrument to improve the permitting, compliance and enforcement regimes adopted by Member States.

2.2.2 With regard to this CHP Assessment, this includes Directive 2008/1/EC of 15 January 2008 concerning integrated pollution prevention and control, which represented a codified version of Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control (the Integrated Pollution Prevention and Control (IPPC) Directive).

2.2.3 The IPPC Directive introduced the concept of the application and implementation of best available techniques (BAT) in respect of industrial installations and required the development and exchange of information at Community level as to what constituted BAT. Under this provision, the EU IPPC Bureau published the '*Integrated Pollution Prevention and Control Reference Document on Best Available Techniques for Large Combustion Plants*' (July 2006) (LCP BREF).

2.2.4 The IED makes provisions for the continuation of the requirements and principles of the IPPC Directive with full compliance required by 1 January 2016. The IED includes a requirement for "*reference documents for best available techniques ... [are to] be drawn up, reviewed and, where necessary, updated...*"

2.2.5 The LCP BREF is currently under review and the first draft of this review was published in June 2013. It is currently expected that the updated LCP BREF will be finalised during 2015.

2.2.6 The IED is implemented in the UK by the Environmental Permitting (England and Wales) Regulations 2010, as amended (the EP Regulations).

#### Energy Efficiency Directive

2.2.7 Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency (the Energy Efficiency Directive, EED) establishes a common framework of measures for the promotion of energy efficiency within the EU in order to ensure the achievement of the target of a 20 per cent reduction in primary energy consumption by 2020 (compared to current projections for that date) and to pave the way for further energy efficiency improvements in the future.

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<sup>3</sup> '*Primary energy consumption*' is defined as the gross inland consumption of the energy transformation sector and energy industries

- 2.2.8 Article 24(2) of the EED requires that Member States publish a National Energy Efficiency Action Plan every three years from April 2014 that covers significant energy efficiency improvement measures and expected and / or achieved energy savings taking into account national circumstances that may affect primary energy consumption.

*National Energy Efficiency Action Plan*

- 2.2.9 In April 2014, DECC published the 'UK National Energy Efficiency Action Plan' (NEEAP). The NEEAP states that the UK target for final energy savings is 324 TWh and that, through a suite of 19 policy measures, "*the total quantifiable savings equivalent to 476 TWh have been identified...*"

- 2.2.10 Section 4.1 of the NEEAP states:

*"Industrial energy consumption is projected to fall by 12% over the next two decades due to opportunities in [CHP] and process, energy and material efficiency."*

- 2.2.11 Further discussion of CHP is provided in Section 5, which states:

*"The most energy-efficient way to use any fuel is to convert it into power and heat simultaneously. Provided there is a demand for both, cogeneration (or [CHP] as it is known in the UK) can deliver energy and carbon savings of up to 30% by reducing energy lost as waste heat, compared to separate power and heat generation from the same fuel. Most UK CHP capacity is industrial, supplying process steam. A smaller, but expanding, proportion of heat supplied by CHP is in the form of 'Low Temperature Hot Water' for space and water heating.*

*Whilst many heat intensive industries are already close to maximising their energy efficiency, evidence shows that a range of cost-effective opportunities remain available. The UK's policies are designed to realise this potential, including energy efficiency, switching to lower carbon fuels, industrial carbon capture and storage (CCS) and CHP. As shown below, the Government, in conjunction with the Devolved Administrations, is taking a range of steps to address the barriers facing growth in renewable and natural gas CHP capacity, and to encourage the development of heating and cooling networks."*

## **2.3 National Policy**

### National Policy Statements

- 2.3.1 Section 4.6 of NPS EN-1 provides the details for the consideration of CHP as relevant to an application for a DCO for a thermal generating station.

- 2.3.2 Paragraph 4.6.1 states:

*"A CHP Station may either supply steam direct to the customers or capture waste heat for low-pressure steam, hot water or space heating purposes after it has been used to drive electricity generating turbines. The heat can also be used to drive absorption chillers, thereby providing cooling."*

- 2.3.3 Furthermore, in terms of thermal generating stations and their potential to incorporate CHP, NPS EN-1 states (at paragraph 4.6.2) that:

*“In conventional thermal generating stations, the heat that is raised to drive electricity generation is subsequently emitted to the environment as waste. Supplying steam direct to industrial customers or using lower grade heat...can reduce the amount of fuel otherwise needed to generate the same amount of heat and power separately. CHP is technically feasible for all types of thermal generating stations, including nuclear, energy from waste and biomass, although the majority of CHP plants in the UK are fuelled by gas.”*

And (at 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.”*

And (at paragraph 4.6.8) that:

*“Utilisation of waste heat that displaces conventional heat generation from fossil fuel sources is to be encouraged where, as will often be the case, it is more efficient than the alternative electricity / heat generation mix. To encourage proper consideration of CHP, substantial additional positive weight should therefore be given by the [Secretary of State] to applications incorporating CHP.”*

#### CHP Guidance

2.3.4 The CHP Guidance “...is aimed at providing more information on how power station developers should give full consideration of opportunities to develop [CHP].”

2.3.5 Paragraph 8 of the CHP Guidance states:

*“Government believes it is highly preferable, from a climate change and fuel efficiency perspective, for the waste heat from large power stations to be put to beneficial use where possible. It expects developers to explore opportunities to use CHP fully, including community heating, when developing proposals for new power stations.”*

2.3.6 Paragraph 9 continues:

*“In line with these broader objectives, [DECC] expects developers to submit information... which demonstrates that they have seriously explored opportunities for CHP, including community heating, in developing their proposals...”*

## **2.4 Interactions with the Environmental Permit**

### CHP-Ready Guidance

2.4.1 The Environment Agency (EA) published the CHP-Ready Guidance in 2013 to apply to:

- a “Applicants / operators for new plants such that they can:
  - i Provide sufficient information to the Environment Agency in an application for an Environmental Permit to demonstrate BAT for a new plant which uses CHP at the outset or is designed to be [CHP-ready (CHP-R)];
  - ii In the case of a CHP-R plant, show that the new plant is designed to be ready, with minimum modification, to supply heat in the future;

- iii *In the case of a CHP-R plant, make adequate technical provisions such that the new plant is ready, with minimum modification, to supply heat in the future; and,*
- iv *Carry out periodic reviews of opportunities for the supply of heat.*
- b *The Environment Agency when assessing an application for an Environmental Permit for a new plant which uses CHP at the outset or is designed to be CHP-R.”*

#### Environmental Permitting

##### *Best Available Techniques*

- 2.4.2 The Project will be regulated by, and be required to operate in accordance with an Environmental Permit, issued under the EP Regulations. The application procedure for obtaining a Permit requires the applicant / operator (CPL) to demonstrate that BAT has been applied throughout the Project.
- 2.4.3 The commencement of the LCP BREF review activated a Technical Working Group (TWG) and was followed by a request to the TWG for establishing a ‘wish list’ for the provisions to be included in the updated LCP BREF.
- 2.4.4 In May 2011, the ‘*Summary of the UK wish list LCP BREF review*’ (May 2011) (UK Wish List) was published that summarised the UK position for existing and new large combustion plant, including emerging techniques.
- 2.4.5 Recent guidance from the EA has indicated that the current reference point for its interpretation and position regarding BAT, as relevant to an application for an Environmental Permit for a large combustion plant, is the UK Wish List.

##### *Energy Efficiency*

- 2.4.6 Within the UK Wish List, the BAT position for different types of generation is defined as a combination of emissions levels and achievable energy efficiency.
- 2.4.7 Whilst the UK Wish List does not specifically consider plant built as CCS from the outset (such as this Project), it is stated in Section 4.1.1 (‘thermal efficiency’) that:  
  
*“CHP is BAT for new build plant and CHP-ready, on a site specific basis, where there are no immediate opportunities for CHP.”*

##### *Consideration of CHP under the EP Regulations*

- 2.4.8 Whilst discussion of the CHP-Ready Guidance is included within this document, it is noted that this will form part of the basis for determination, by the EA, of the application for an Environmental Permit. It is therefore considered that the relevant discussions within this document should be read in light of paragraph 4.10.3 of NPS EN-1 which states:  
  
*“The [Secretary of State] should work on the assumption that the relevant pollution control regime and other environmental regulatory regimes, including those on land drainage, water abstraction and biodiversity, will be properly applied and enforced by the relevant regulator. It should act to complement but not seek to duplicate them.”*

2.4.9 Therefore, this document does not seek (nor is it required) to address all of the requirements of the CHP-Ready Guidance. CPL acknowledges that the CHP Assessment may require further development as part of its application for an Environmental Permit using the most up to date information available at that time. The specific requirements of any development of the CHP Assessment will be discussed with the EA as part of the discussions to be held prior to the preparation and submission of the application for an Environmental Permit.

## **2.5 CHP Assessment Methodology**

2.5.1 This section outlines the requirements of the assessment of potential opportunities for the implementation of CHP (either at the outset or at a later stage) which are defined by the relevant provisions of the range of guidance available in relation to CHP (as identified / discussed above).

2.5.2 These requirements have formed the scope of this CHP Assessment.

### National Policy Statements

2.5.3 NPS EN-1, at paragraph 4.6.6, states that:

*“Under [the CHP Guidance], 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 to inform the [Secretary of State]’s consideration of the application. This should be through an audit trail of dialogue between the applicant and prospective customers. The same principle applies to any thermal power station which is the subject of an application for development consent under the Planning Act 2008.”*

2.5.4 Paragraph 4.6.7 notes the importance of liaison with potential heat / steam off takers (customers) when considering the scope for implementation of CHP:

*“... applicants should not only consult those potential customers they have identified themselves but also bodies such as the Homes and Communities Agency (HCA), Local Enterprise Partnerships (LEPs) and Local Authorities and obtain their advice on opportunities for CHP.”*

2.5.5 Where no immediate opportunities for the implementation of CHP are identified, NPS EN-1, at paragraph 4.6.8, states that:

*“If the proposal is for thermal generation without CHP, the applicant should:*

- a 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;*
- b Provide details of any potential future heat requirements in the area that the station could meet; and*
- c Detail the provisions in the proposed scheme for ensuring any potential heat demand in the future can be exploited.”*

2.5.6 The implementation of CHP may require additional space than that required for a non-CHP generating station. NPS EN-1 recognises this fact, for instances where there are no immediate CHP opportunities, in paragraph 4.6.9:

*“The material provided by applicants should therefore explain how the development can [...] be ready to provide CHP in the future [...] or set out any constraints (for example space restrictions) which would prevent this.”*

#### CHP Guidance

- 2.5.7 In terms of the exploration of CHP opportunities to be included in the CHP Assessment, the CHP Guidance requires (at paragraph 16<sup>4</sup>) that developers, should in their application:
- a *“Demonstrate that they have properly consulted the results of the UK heat mapping exercise...;”*
  - b *Demonstrate that they have explored a number of potential heat markets, either singly or in combination; and*
  - c *Demonstrate that they have contacted [identified] organisations that can assist developers in identifying potential CHP customers...”*
- 2.5.8 The CHP Guidance provides details for the organisations referred to in Paragraph 2.5.5 (c) (above) in Annex B to that document.
- 2.5.9 To show that CHP opportunities have been actively explored, the CHP Guidance requires (as per paragraphs 11 and 12) that developers must include within their CHP Assessments:
- a *“An explanation of their choice of location, including the potential viability of the site for CHP;”*
  - b *A report on the exploration carried out to identify and consider the economic feasibility of local heat opportunities and how to maximise the benefits from CHP;*
  - c *The results of that exploration; and*
  - d *A list of organisations contacted.”*
- 2.5.10 If a proposal is for generation without CHP (at the outset):
- a *“The basis for the developer’s conclusion that it is not economically feasible to exploit existing regional heat markets;”*
  - b *A description of potential future heat requirements in the area; and*
  - c *The provisions in the proposed scheme for exploiting any potential heat demand in the future.”*

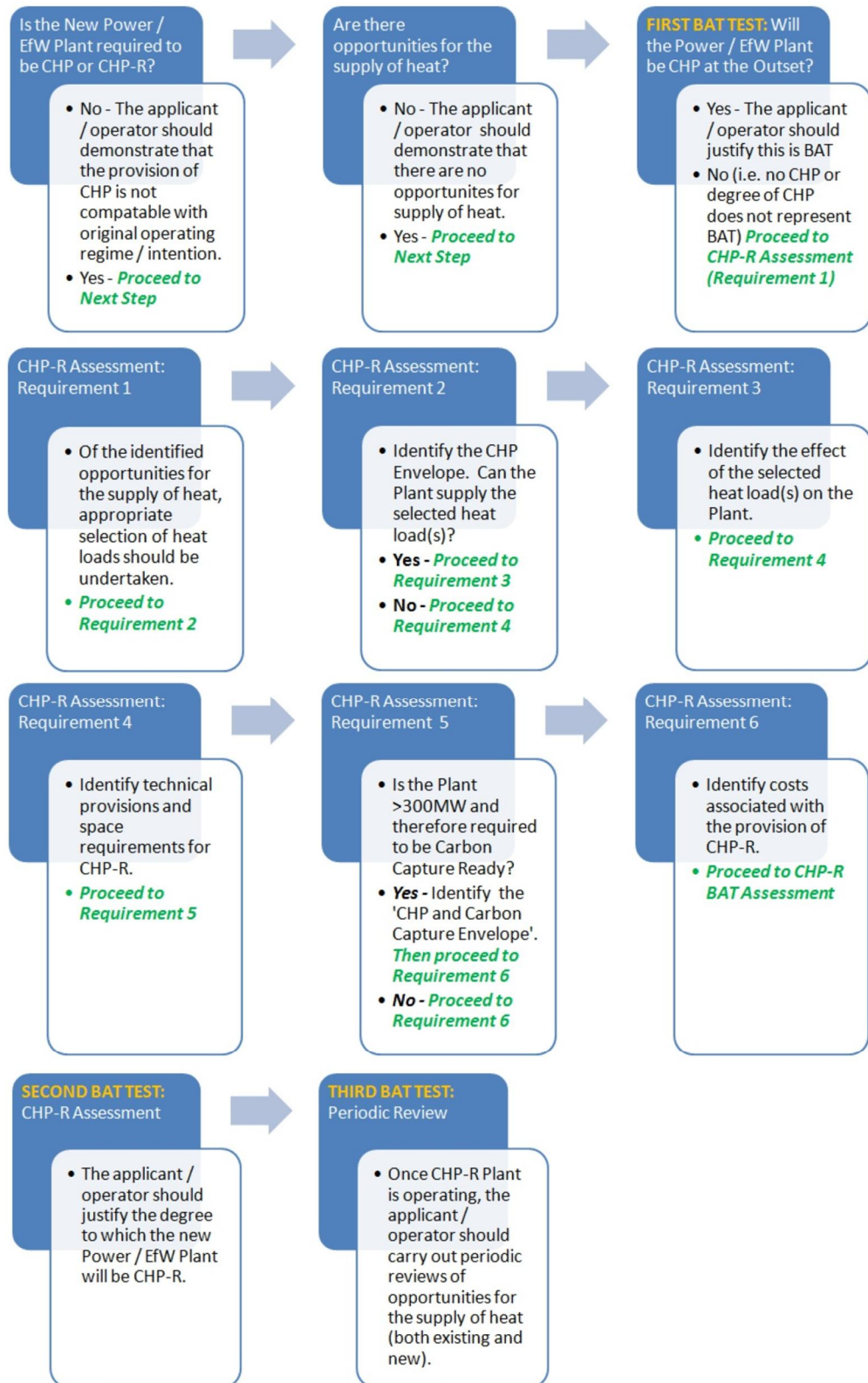
#### CHP-Ready Guidance

- 2.5.11 The CHP-Ready Guidance introduces three tests, associated with the use of CHP, that are required in order to determine whether the proposals for a combustion plant (such as the Project) can be considered to represent BAT, which will be a key consideration during the determination of the application for an Environmental Permit.
- 2.5.12 The CHP-Ready Guidance provides a useful illustration of the BAT assessment process for CHP and CHP-R, which is reproduced as Insert 1, below.

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<sup>4</sup> *The requirements of paragraph 16 of the CHP Guidance refer to Regional Spatial Strategies which have since been abolished by the relevant provisions of the Localism Act 2011; the relevant requirement has therefore not been considered as part of the CHP Assessment.*

**Insert 1: BAT Assessment Process**



**2.6 CHP Assessment Requirement Checklist**

- 2.6.1 The various guidance and requirements outlined in Section 2.5 (above) infer a range of requirements for developers for inclusion within a CHP Assessment. These requirements have been fulfilled for the Project.
- 2.6.2 Table 1 below, lists each of these requirements, together with references to where the relevant information is presented within this document.



**Table 1: CHP Assessment Requirements Checklist**

<b>Guidance Document</b>	<b>Evidence / Information Required</b>	<b>Location in this CHP Assessment</b>
National Policy Statements	Consultation with identified organisations / bodies	Section 4.2
	Identification as to whether CHP is economically or practically feasible from the outset	Section 4.5
	Explanation as to why CHP is not economically or practically feasible from the outset (if applicable)	Section 4.5
	Details of any potential future heat requirements in the area that the station could meet	Section 4.6
	Detail the provisions in the proposed scheme for ensuring any potential heat demand in the future can be exploited	Section 4.8
	Explanation of how the development can be ready to provide CHP in the future or set out any constraints which would prevent this (if applicable)	Sections 4.8 and 4.9
CHP Guidance	Demonstrate proper consultation of the results of the UK heat mapping exercise	Section 4.3
	Demonstrate exploration of a number of potential heat markets, either singly or in combination	Sections 4.2, 4.4 and 4.5
	Demonstrate contact with identified organisations that can assist developers in identifying potential CHP customers	Section 4.2
	Explanation of the choice of project location, including the potential viability of the site for CHP	Section 3.4
	Report on the exploration carried out to identify and consider the economic feasibility of local heat opportunities and how to maximise the benefits from CHP	Section 4
	The results of the exploration carried out	Section 4.4 and 4.5
	A list of organisations contacted	Section 4.2
	The basis for the developer's conclusion that it is not economically feasible to exploit existing regional heat markets (if applicable)	Section 4.5
	A description of potential future heat requirements in the area	Section 4.6
	The provisions in the proposed scheme for exploiting any potential heat demand in the future	Section 4.8

Guidance Document	Evidence / Information Required	Location in this CHP Assessment
CHP-Ready Guidance *	Will the plant be CHP at the outset?	(FIRST BAT TEST) Section 4.5
	Identification of opportunities for the supply of heat	(Requirement 1) Sections 4.2, 4.3, 4.4 and 4.6
	Identification of the CHP Envelope	(Requirement 2) Section 4.6
	The effect of selected heat load	(Requirement 3) N / A
	Identify technical provisions and space requirements for CHP-R	(Requirement 4) Section 4.8
	Identify costs associated with CHP-R	(Requirement 6) N / A
	BAT Assessment	(SECOND BAT TEST) N / A
	Periodic review	(THIRD BAT TEST) Section 4.8

*\* Please refer to Paragraph 2.4.9; the approach to the CHP Assessment and the preparation of this document has been undertaken with due regard paid to the CHP-Ready Guidance however this document does not seek (nor is it required) to address all of the requirements of the CHP-Ready Guidance.*

SECTION 3

**WHITE ROSE CCS PROJECT**



### **3 WHITE ROSE CCS PROJECT**

#### **3.1 Capture Power Ltd<sup>5</sup>**

3.1.1 CPL will be responsible for the development, implementation and operation of the proposed White Rose CCS Project.

3.1.2 CPL has been formed by three companies:

- a Alstom;
- b Drax; and
- c BOC.

3.1.3 Alstom has extensive experience in the world of power generation, power transmission and rail infrastructure. One quarter of the world's power station fleet utilises Alstom technology.

3.1.4 Drax is the owner of Drax Power Station, which, current average output levels, meets some 7 per cent of the electricity needs for the UK. For a number of years a proportion of renewable and sustainable biomass fuel has been blended with coal (co-firing). Drax Power Station is the largest co-firing facility in the world; the current co-firing capacity is approximately 12.5 per cent of total generation output.

3.1.5 Alstom will be responsible for construction and Drax for the operation and maintenance of the Project, including the CO<sub>2</sub> capture facilities.

3.1.6 BOC is the UK's largest industrial, medical and special gases provider with experience and capabilities in all three currently viable CCS technologies.

3.1.7 BOC will be responsible for the construction, operation and maintenance of the air separation unit (ASU) that will supply pure oxygen for the combustion process within the boiler system of the Project.

#### **3.2 The Project**

3.2.1 The Project, although at a commercial scale, will serve to demonstrate oxyfuel technology which allows the capture of CO<sub>2</sub> from power plant exhaust gases. The anticipated capture efficiency of the Project will be approximately 90 per cent of the CO<sub>2</sub> produced by the combustion process.

3.2.2 The proposed technology involves combustion of fuel in a boiler in a mixture of oxygen and re-circulated flue gas (largely CO<sub>2</sub> and water). The process eliminates the high volume of nitrogen that comes with the air during conventional combustion. This, in turn, considerably reduces the oxides of nitrogen content of the resulting CO<sub>2</sub>-rich flue gas, which readily enables the achievement of the required purity levels for transportation and storage.

3.2.3 The oxygen for the combustion process is produced in an ASU, which separates oxygen and nitrogen from air.

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<sup>5</sup> Information taken from <http://www.whiteroseccs.co.uk/>

- 3.2.4 Following treatment in the proposed air quality control system equipment, the flue gas will be passed to a direct contact cooler in order to condense the water vapour for subsequent removal from the gas stream.
- 3.2.5 The final CO<sub>2</sub> processing takes place in a gas processing unit (GPU) where the CO<sub>2</sub> is further purified and compressed to transportation / storage specification for onwards transmission and storage.
- 3.2.6 The Project will operate under supercritical steam conditions and broadly consist of:
- a A dual air / oxygen fired pulverised coal boiler;
  - b A steam turbine-generator unit; and
  - c The CO<sub>2</sub> capture system.
- 3.2.7 The Project will be designed to burn coal, and coal / biomass blends, from the existing Drax Power Station coal yard. Deliveries to the yard will, generally, be via the existing rail arrangements for Drax Power Station.

#### Air Separation Unit

- 3.2.8 Due to the large quantity of high-purity oxygen typically required in Oxyfuel combustion, cryogenic air separation is currently the preferred option for oxygen production and will be used for the Project. Distillation at cryogenic (i.e. very low) temperature will be used to separate air into its constituent parts (principally nitrogen and oxygen). The oxygen stream from the ASU will be introduced into the boiler system for the combustion of fuel.

#### Steam / Water (Rankine) Cycle

- 3.2.9 The boiler system is required to generate high pressure (supercritical) steam that will be used to drive the steam turbine. The steam turbine will be a single-shaft, tandem compound, 3000 revolutions per minute (rpm), single reheat condensing turbine.
- 3.2.10 High pressure steam will expand over the blades of the steam turbine in order to rotate the turbine and drive an electrical generator. The residual heat within the spent steam will be rejected via a condenser system and the resultant condensate will be returned to the HRSG for re-use.
- 3.2.11 The turbo-generator will be a two pole three phase synchronous one with hydrogen gas cooling of all internal components, except the stator winding and its connections, which will be cooled by water.

#### Cooling

- 3.2.12 The cooling duty for the condenser system will be provided using a water-based cooling system that will consist of mechanical draft, low plume, cooling towers.
- 3.2.13 The heat rejected by the condenser steam is passed to, and thus heats, the cold cooling water. The system operates by circulating water between the condenser and the cooling tower arrangement. The water (at elevated temperature) leaving the condenser is passed through the cooling towers where the heat is rejected to atmosphere through evaporation. The cold water exiting the tower system will be returned to the condenser.

- 3.2.14 This evaporation and continuous recirculation results in a concentrating of the dissolved solids present in the cooling water that could impact on the operating efficiency of the condenser and cooling systems through fouling / scaling of the heat transfer interfaces. In order to maintain the correct chemical control of the system, it is necessary to purge continuously the cooling water and replace this water, and that lost by evaporation, with make-up taken from a raw water source.
- 3.2.15 Make-up water will be taken from the River Ouse using the existing Drax Power Station abstraction and pre-treatment facilities. The purge will be discharged, via the existing waste water terminal point, under the conditions of the existing Environmental Permit for Drax Power Station.

#### Gas Processing Unit

- 3.2.16 The purpose of the GPU is to condense and purify the rich flue gas and to provide a CO<sub>2</sub> product that meets the specification required, by NGCL, for its subsequent transmission and storage.
- 3.2.17 The GPU will remove the water vapour from the flue gases, and then process the CO<sub>2</sub>-rich gas stream. Purified CO<sub>2</sub> will be delivered to the CO<sub>2</sub> pipeline header of the CCS cluster in the Humber region.

#### Environmental Management

- 3.2.18 It is anticipated that CPL will include the Project within the existing environmental management system (EMS) for Drax. The EMS will be an integral part of the overall management system for the Project.
- 3.2.19 The EMS will define the policies, management principles, organisational structure, responsibilities, standards / procedures, process controls and resources that are in place to manage environmental protection (and improvement, where practicable) across all aspects of the Project.
- 3.2.20 The EMS will place particular importance on:
- a Reducing risks to the environment to a level that is as low as reasonably practicable, using BAT;
  - b Integrating EMS responsibilities within line management;
  - c A commitment to personnel environmental awareness and competence;
  - d The on-going monitoring and review of environmental performance; and
  - e A commitment to working to achieve continuous improvement in environmental performance.
- 3.2.21 The EMS will therefore include provisions regarding the potential for implementation of CHP and the maximising of future opportunities that could be served by the Project.

### **3.3 Application Site Location / Description**

- 3.3.1 The Project is to be located at (and to the north of) the site of the existing Drax Power Station, approximately 6 km south east of Selby, which has been in operation since 1974.

- 3.3.2 The Project site will be located entirely within the administrative boundary of Selby District Council and is within the Yorkshire and Humber region of England.
- 3.3.3 The nearest residential settlements to the Project site are the villages of:
- a Barlow (approximately 1 km west);
  - b Long Drax (approximately 2 km east);
  - c Drax (approximately 2 km south east); and
  - d Camblesforth (approximately 2.5 km west / south west)
- 3.3.4 There are also several scattered properties in the vicinity of the Project site.
- 3.3.5 The land surrounding the Project site is predominantly used for agriculture, with the exception of the existing Drax Power Station. A number of small patches of planted woodland exist within and around the Project site boundary.
- 3.3.6 Larger settlements / towns in the vicinity of the Project site are:
- a Selby (approximately 6 km to the north west); and
  - b Goole (approximately 8 km to the south east).
- 3.3.7 The site is well-served by the local motorway and road network, with the M62 and M18 approximately 6 km to the south, and the A63 and A19 Trunk roads to the north and west. The A645 and A1041 to the south connect to a limited network of minor local roads. Access to the existing Drax Power Station is directly from the A645.
- 3.3.8 The River Ouse follows a southeasterly route c.1 km to the north east of the Project site. The Trans Pennine Trail and National Cycle Network route 65 follow the northern bank of the River Ouse, on the opposite side of the River to the Project site.

### **3.4 Selection of Site Location**

#### CCS Commercialisation Competition

- 3.4.1 The UK CCS Commercialisation competition makes available £1 billion capital funding, together with additional operational funding through the UK Electricity Market Reforms, to support the design, construction and operation of the UK's first commercial-scale CCS projects.
- 3.4.2 The Project is one of two CCS schemes supported under the Competition, with around £100 million of the funding intended to support the detailed planning and engineering.

#### New Entrants Reserve

- 3.4.3 New Entrants Reserve (NER 300) is a European funding programme managed by the European Commission, European Investment Bank and member states to support the development of CCS and innovative renewable energy technologies.
- 3.4.4 In July 2014, the European Commission announced a €300 million (around £240 million) grant for the Project. The funding comes from the NER 300 programme.



Key Considerations and Project Drivers

- 3.4.5 Government intention for successful participants in the CCS Commercialisation competition is to:
- a Generate learning that will help to drive down the costs of CCS;
  - b Test and build familiarity with the CCS specific regulatory framework;
  - c Encourage industry to develop suitable CCS business models; and
  - d Contribute to the development of early infrastructure for CO<sub>2</sub> transport and storage.
- 3.4.6 DECC believes that the only feasible way to reduce CO<sub>2</sub> emissions and maintain fossil fuels in the electricity mix is to develop CCS. Fossil fuels will continue to form an important part of the mix because they allow a balance between the intermittency of renewable sources and the inflexibility of nuclear power.
- 3.4.7 In addition to this, the NER 300 'call for proposals' was specifically related to:
- "...financing of commercial demonstration projects that aim at the environmentally safe capture and geological storage of CO<sub>2</sub>, as well as demonstration projects of innovative renewable energy technologies under the scheme for greenhouse gas emission allowance trading within the Community, established by Directive 2003/87/EC"*
- 3.4.8 Whilst there are a range of factors that can influence the site selection of a new fossil fuelled thermal generating station (such as the Project), including the potential for the provision of CHP, the Project is being promoted, by CPL, to demonstrate oxyfuel technology which allows the capture of CO<sub>2</sub> from power plant exhaust gases at a commercial scale.
- Justification for Site Selection
- 3.4.9 The site selection for the Project has had the principal focus of being able to readily deliver a commercial scale CCS demonstration scheme.
- 3.4.10 In terms of a suitable location for demonstrating the oxyfuel technology for CCS the selected Project site has the following key benefits:
- a Proximity to the proposed NGCL pipeline;
  - b Existing power transmission infrastructure;
  - c Existing coal and biofuel import infrastructure;
  - d Good road / rail access; and
  - e Existing ancillary infrastructure (e.g. for cooling water supply and discharge).
- 3.4.11 NPS EN-2 (at paragraph 2.2.1) states: "*it is for energy companies to decide what applications to bring forward and the Government does not seek to direct applicants to particular sites for fossil fuel generating stations.*"
- 3.4.12 Paragraph 2.2.1 of NPS EN-2 states:
- "The specific criteria considered by applicants, and the weight they give to them, will vary from project to project. The choices which energy companies make in selecting*

*sites reflect their assessment of the risk that the [Secretary of State], following the general points set out in Section 4.1 of EN-1, will not grant consent in any given case.”*

- 3.4.13 Notwithstanding the above, CPL recognises the benefits to be gained from the implementation of CHP and has explored the potential for CHP opportunities in the surrounding area.
- 3.4.14 Section 4.1 of NPS EN-1 outlines:  
  
*“...certain general policies in accordance with which applications relating to energy infrastructure are to be decided that do not relate only to the need for new energy infrastructure [...] or to particular physical impacts of its construction or operation...”*
- 3.4.15 Of these policies, paragraph 4.1.3 summarises how the Secretary of State should take into account the *“...potential benefits including [the Project] contribution to meeting the need for energy infrastructure, [...] and any long-term or wider benefits.”*
- 3.4.16 It is considered that the successful demonstration of CCS at a commercial scale will play an extremely important role in the development and / or implementation of CCS technology across the electricity industry (and other CO<sub>2</sub>-intensive industries). The long-term benefits of the Project are noted in Paragraph 3.4.5 (above), helping the UK maintain its energy security whilst meeting emissions obligations and assisting Government objectives and policy in the move to a low-carbon economy.

SECTION 4

**CHP OPPORTUNITIES**



## **4 CHP OPPORTUNITIES**

### **4.1 Introduction**

4.1.1 NPS EN-1 states (at paragraph 4.6.5) 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. The distance will vary according to the size of the generating station and the nature of the heat demand, but is likely to mean within a distance of up to 15 km.”*

4.1.2 Accordingly, CHP opportunities (i.e. the above noted “*industrial or domestic customers with heat demands*”) are likely to be related to the following heat recipients within a distance of 15 km from the Project:

- a Chemical Plants, Refineries and Factories (including those for paper, board mills, sugar refining, pharmaceutical, food processing, pet food processing, breweries);
- b Refrigeration stores;
- c Offices (for heating or cooling);
- d Leisure facilities and sports halls (including swimming pools);
- e Glass houses for horticulture;
- f Fish farming, such as trout or eels; and,
- g District heating (including homes).

4.1.3 In general, CHP is more attractive in cases when the heat load is large and constant throughout the year. This is typically the case with chemical plants, refineries and factories which depend upon continuous processes and use large amounts of heat (usually supplied as steam).

4.1.4 CHP is less attractive in cases where the heat load is seasonal or intermittent. This is typically the case for district heating in countries (such as the UK) which have a relatively short winter heating season (compared to Scandinavian or Eastern European countries). As such, there is a general absence of significant district heating schemes in the UK and where they are developed, district heating schemes have generally been associated with new-build publicly funded and often high-rise housing where the heat loads can be readily combined and the heat distribution piping is compact. Furthermore, it is recognised<sup>6</sup> that there are limited (and not economically viable) opportunities to provide CHP to domestic users other than part of district heating schemes.

### **4.2 Consultation to identify CHP Opportunities**

4.2.1 In accordance with NPS EN-1 and the CHP Guidance, consultation has been undertaken with organisations identified as being able to assist in locating potential CHP opportunities. Given the dispersed, sparsely populated, nature of the land within the CHP Search Area, this CHP Assessment has placed great importance on seeking the views of such organisations in identifying potential heat / steam off takers.

4.2.2 The results of the consultation are presented in Appendix A.

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<sup>6</sup> “*The Potential and Costs of District Heating Networks*”, Pöyry and Faber Maunsell, April 2009.

- 4.2.3 The following provides a summary of the consultation and potential CHP opportunities identified:
- a 14 consultees were contacted;
  - b 12 consultees did not provide a response;
  - c 1 consultee (Confederation of Paper Industries) provided a response which stated that there were no CHP opportunities relevant to their work; and,
  - d 1 consultee (Energy Saving Trust) provided a response which stated that they were able to supply information regarding typical heat and overall energy demand profiles though no specific CHP opportunities were identified.

4.2.4 The results from the consultation indicate that, at this time, there are limited specific CHP opportunities and limited CHP interest.

### **4.3 UK CHP Development Map**

4.3.1 The CHP Guidance recommended that CHP Assessments examine the information available on the Online Industrial Heat Map.

4.3.2 Since the publication of the CHP Guidance, the Online Industrial Heat Map has been replaced with the UK CHP Development Map<sup>7</sup>, which is:

*“The latest version of the map, originally developed as a tool aimed at assisting power station developers considering the opportunities for supplying heat and development of [CHP] as required under planning policy.”*

4.3.3 Further to this, the latest version is also to:

*“Be used by both small and large organisations to help identify the locations where the supply of CHP heat would have the greatest potential, and therefore the largest positive environmental impact.”*

4.3.4 The results of the examination of the UK CHP Development Map, covering a search area of 15 km radius (centred upon the Project site) (the “CHP Search Area”), are presented in Appendix B.

4.3.5 The breakdown of the UK CHP Development Map Sector totals within the CHP Search Area showed that the largest heat loads were related to:

- a Domestic;
- b Small Scale Industrial; and
- c Large Industrial.

4.3.6 These heat loads are examined further in this sub-Section.

#### Domestic

4.3.7 The results from the UK CHP Development Map show that the Domestic Heat Load within the CHP Search Area is 425 161 kW (425 MW, 76.8 per cent of the total heat load in the CHP Search Area).

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<sup>7</sup> Available at: <http://chp.decc.gov.uk/developmentmap/>

- 4.3.8 The River Ouse represents a natural barrier to the supply of heat / steam to the north of the River, at this time. Such a supply would require the installation of supply / return pipes on, or underneath, the River which carries both technical and, potentially, environmental constraints.
- 4.3.9 Based on further investigation, the UK CHP Development Map shows that the Domestic Heat Load within the CHP Search Area located to the south of the River Ouse is 307 272 kW (307 MW, 55.5 per cent of the total heat load in the CHP Search Area).
- 4.3.10 The Domestic Heat Loads, south of the River Ouse, are spread intermittently throughout the study area as may be expected of agricultural or sparsely-populated land that is in the vicinity of the Project site.
- 4.3.11 The towns of Selby and Goole represent 'more concentrated' potential Domestic Heat Loads of approximately 53 MW and 60 MW, respectively.

#### Small Industrial

- 4.3.12 The results from the UK CHP Development Map show that the Small Scale Industrial Heat Load within the CHP Search Area is 42 903 kW (43 MW, 7.8 per cent of the total heat load in the CHP Search Area). However, this is split between the north and south sides of the River Ouse.
- 4.3.13 Based on further investigation, the UK CHP Development Map shows that the Small Industrial Heat Load within the CHP Search Area located to the south of the River Ouse is 30 284 kW (30 MW, 5.5 per cent of the total heat load in the CHP Search Area).
- 4.3.14 Of this 30 MW, the UK CHP Development Map indicates that c.1.5 to 6 MW (spread over 2 km<sup>2</sup>) is located to the west of Goole and c.1 to 5 MW (over 1 km<sup>2</sup>) located within Selby. Further investigation shows that these Small Industrial Heat Loads (with reference to the respective 'Lower Layer Super Output Area'<sup>8</sup>) are:

a	East Riding of Yorkshire 040D (Goole)	2237 kW
b	Selby 005F (Selby)	1783 kW

- 4.3.15 A Small Industrial Heat Load of c.1 to 5 MW (over 1 km<sup>2</sup>) is also identified, on the Development Map, to the west of Barlow however the area is remote and it is unclear as to the 'industry' that this is related to.
- 4.3.16 It is therefore considered that CHP provisions within the Project could potentially serve a total Small Industrial Heat Load of c.4 MW.

#### Large Industrial

- 4.3.17 The results from the UK CHP Development Map show that the Large Industrial Heat Loads within the CHP Search Area are 40 019 kW (40 MW, 7.2 per cent of the total heat load).

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<sup>8</sup> Lower Layer Super Output Areas are used by the Office of National Statistics as a geographical boundary for the collection and publication of small area statistics, each representing approximately 1500 residents and 650 households

4.3.18 Details of the Large Industrial Heat Loads, which have been obtained from the UK CHP Development Map, are shown in Table 2.

**Table 2: Identified Large Industrial Heat Loads**

Name	Total Heat Load (kW)	Heat Load already provided by CHP (kW)	Remaining Heat Load (kW)
Harworth Power Ltd	15339	15339	0
Rigid Paper Ltd	11109	10542	567
Hazlewood Grocery Ltd and Greencore Grocery	7342	79	7263
Tate & Lyle Industries Ltd	6229	6229	0
<b>Total</b>	<b>40 019</b>	<b>32 189</b>	<b>7830</b>

4.3.19 Of the four Large Industrial Heat Loads identified, two are fully served by existing CHP arrangements.

4.3.20 Of the remaining two, Hazlewood Grocery Ltd and Greencore Grocery is located north of the River Ouse, which is affected by the constraints highlighted in Paragraph 4.3.8.

4.3.21 Rigid Paper Ltd is almost completely served by existing CHP arrangements (with a remainder of 0.5 MW). For the purposes of this document, given the location of Rigid Paper Ltd, this small heat requirement has, hereafter, been included in the Small Industrial Heat Load identified for Selby (total 2350 kW).

4.3.22 It is therefore considered that there are currently no Large Industrial Heat Loads that could be served by CHP provisions within the Project.

#### **4.4 Summary of Potential CHP Opportunities**

##### UK CHP Development Map

4.4.1 Consultation of the UK CHP Development Map has identified:

- a A total Domestic Heat Load of approximately 307 MW, and more realistic Domestic Heat Load of approximately 113 MW;
- b A total Small Scale Industrial Heat Load of approximately 30 MW, and more realistic Small Scale Industrial Heat Load of approximately 4.5 MW; and
- c A total Large Industrial Heat Load of approximately 40 MW, with an actual Large Industrial Heat Load of approximately 7 MW and no actual realistic Large Industrial Heat Loads.

##### Consultation

4.4.2 No specific CHP opportunities were identified during the consultation process that has formed part of this CHP Assessment.



- 4.4.3 A search of the local planning registers has indicated:
- a Selby District Council:
    - i 10 'major applications' in the postcode area YO8 (Selby); and
    - ii 5 'major applications' in the postcode area DN14 (Goole).
  - b East Riding of Yorkshire Council:
    - i No 'major applications'.
- 4.4.4 In postcode area YO8:
- a Three of the ten applications were refused / withdrawn;
  - b Four of the seven permitted applications are north of the River Ouse;
  - c Two of the three south of the River Ouse were for Selby College; and
  - d The final application was for Selby War Memorial Hospital.
- 4.4.5 The permitted applications south of the River Ouse are dated 2004 (2 no.) and 2008 (1 no.). As such, it is reasonable to assume that the potential heat requirements are included within the results of the UK CHP Development Map and do not represent 'new opportunities'.
- 4.4.6 In postcode area DN14:
- a All of the applications are located on Selby Road, Eggborough (c.11 km south west of the Project);
  - b One of the five application was refused;
  - c One of the applications is listed as 'disposed of';
  - d Two of the three permitted applications are for small residential developments; and
  - e The final application is for a warehouse, bagging plant and associated works.
- 4.4.7 As above, the dates of the permitted applications (2007 and earlier) are such that it is reasonable to consider that the potential heat requirements are included in the results of the UK CHP Development Map and do not represent 'new opportunities'.
- Summary
- 4.4.8 There is a range of potential CHP opportunities in the CHP Search Area. In addition, it may also be that future CHP opportunities could be identified (or forthcoming) in the event that the Project is consented and moves towards the detailed design stage.
- 4.5 Feasibility of CHP implementation from the outset**
- 4.5.1 The above section identify that the 'sectors' that offer the best opportunities for the implementation of CHP are:
- a Domestic Heat Loads; and
  - b Small Industrial Heat Loads.
- 4.5.2 Each of these sectors is considered in turn.

#### Domestic Heat Loads

4.5.3 NPS EN-1 states (at paragraph 4.6.5) in terms of “district heating networks” that:

*“A 2009 Report for DECC<sup>9</sup> on district heating networks concluded that ... the provision of CHP is most likely to be cost-effective and practical where it is included as part of the initial design and is part of a mixed-use development. For example, retrofitting a district heating network to an existing housing estate may not be efficient.”*

4.5.4 As the Domestic Heat Loads identified from the UK CHP Development Map are not considered to be representative of a ‘new’ heat load, the cost and practical benefits of including it as part of any initial design cannot be realised. Indeed, the results from the UK CHP Development Map indicate that the Domestic Heat Load is characterised by disparate, smaller settlements in the area. In addition, it is also understood that there are no proposals for large-scale residential settlements in the area.

4.5.5 Therefore, subject to the discussions in Section 4.8 of this document, it is unlikely that implementing CHP for the existing Domestic Heat Load would be economically viable at this time.

#### Small Industrial Heat Loads

4.5.6 Based on the discussions above, it is considered that the provision of heat / steam to Small Industrial Heat Loads has the greatest technical potential to allow the Project to implement CHP from the outset.

4.5.7 However, the identified Small Industrial Heat Loads for Selby and Goole are small (2.2 MW and 2.4 MW, respectively). The provision of CHP for both Loads is not aided by the fact they are separated by approximately 14 km and are in opposite directions from the Project site.

4.5.8 Therefore, in order to serve both Loads, separate systems of CHP pipework will be required. This means that to determine the feasibility of implementing CHP from the outset it is necessary to consider supplying heat / steam to each identified Load separately.

4.5.9 The capital cost of providing supply and return pipework to / from either Selby or Goole could, based on figures published by DECC<sup>10</sup>, range from £5 million to £11 million. The final cost is dependent upon a range of factors including:

- a Ground conditions;
- b Other buried services;
- c Number of bends (i.e. the route); and
- d Construction / assembly methods.

4.5.10 Given the uncertainty with regards to the factors relevant to the cost of implementation of CHP (including those in Paragraph 4.5.9), the high end capital cost is assumed for the purposes of this analysis.

<sup>9</sup> “The Potential and Costs of District Heating Networks”, Pöyry and Faber Maunsell, April 2009.

<sup>10</sup> <http://chp.decc.gov.uk/cms/cost-of-district-heating/>

- 4.5.11 Assuming that a constant supply of heat / steam is required by either location, the total energy (heat) provided would be approximately 19 270 to 21 030 MWh per annum.
- 4.5.12 If a standalone boiler is considered for the provision of the above heat, assuming a 90 per cent efficient boiler fired on natural gas, the required energy would be approximately 21 410 to 23 360 MWh per annum.
- 4.5.13 At current gas prices for non-domestic customers (2.2p / kWh<sup>11</sup>) the total energy costs for a standalone boiler would be approximately £627 000 to £684 000 per annum.
- 4.5.14 An indicative, high level, analysis is presented in Table 3 of the discounted costs over an assumed equipment lifetime / contract period of 10 years.

**Table 3: Indicative NPV Cost Analysis for CHP Implementation**

CHP 'Supply Year'	CPL Discount Factor *	Capital Cost of CHP (£ 000's , divided over 10 years)	Capital Cost of CHP Net Present Value (£ 000's)	Off taker Discount Factor **	Estimated Fuel Cost (£ 000's)	Estimated Fuel Cost Net Present Value (£ 000's)
1	0.92	1 100	1012	0.95	627	596
2	0.85	1 100	931	0.90	627	566
3	0.78	1 100	857	0.86	627	538
4	0.72	1 100	788	0.81	627	511
5	0.66	1 100	725	0.77	627	485
6	0.61	1 100	667	0.74	627	461
7	0.56	1 100	614	0.70	627	438
8	0.51	1 100	565	0.66	627	416
9	0.47	1 100	519	0.63	627	395
10	0.43	1 100	478	0.60	627	376
<b>TOTAL</b>		<b>11 000</b>	<b>7 155</b>		<b>6 270</b>	<b>4 783</b>

\* Discount Rate of 8 per cent assumed for CPL

\*\* Discount Rate of 5 per cent assumed for 'Off taker'

- 4.5.15 The high-level analysis presented in Table 3 highlights that, for the identified Small Industrial Heat Load at Selby, that the NPV of the 'fuel' costs to service the Load is approximately two thirds of the NPV of the capital cost of the CHP system itself.
- 4.5.16 It is also noted that the above only considers capital cost of the supply / return pipework only and does not include:
- a Additional equipment required to facilitate CHP, such as:
    - i Auxiliary / stand-by boilers; and
    - ii Metering / interface systems.
  - b The operating costs for the CHP system.

<sup>11</sup> One therm = 0.029 MWh

- 4.5.17 Inclusion of such factors would further increase the 'cost of CHP implementation'.
- 4.5.18 In order to be economically feasible, the costs of CHP implementation must, at least, be capable of being met by payments from the potential off taker over the lifetime of the contract / equipment.
- 4.5.19 Based on the above analysis, the identified Small Industrial Heat Load at Selby (and similar comments can be made to the Load at Goole) would actually need to pay significantly more for heat / steam from the Project than for purchasing natural gas from a gas supplier.
- 4.5.20 It is therefore considered that, at this time, it is not economically feasible to implement CHP for the provision of heat / steam to either Selby or Goole.
- 4.5.21 It is acknowledged that there are a number of unknowns and simplifications in the above analysis however, addressing these unknowns and seeking to review the potential for the implementation of CHP is discussed in Section 4.8 of this document.

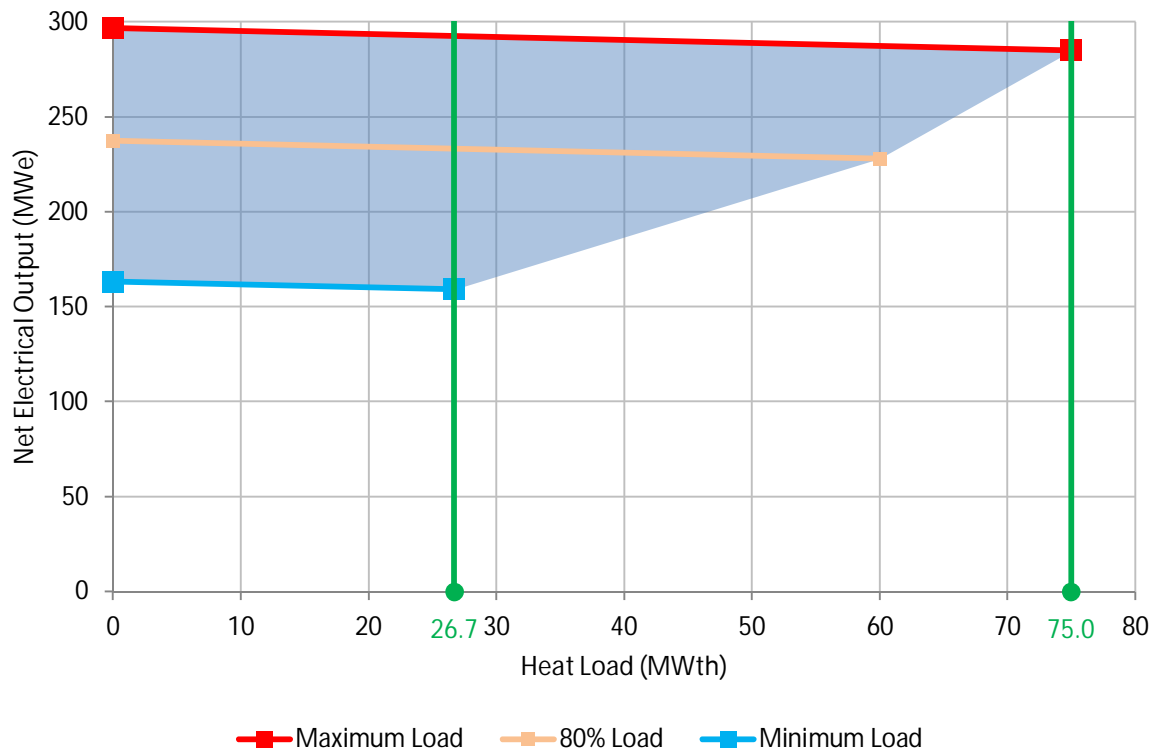
#### **4.6 Future Heat Requirements**

- 4.6.1 The analysis and discussion presented above is based on known existing potential heat loads identified within the CHP Search Area.
- 4.6.2 The Project will be capable of providing heat / steam (i.e. it will be technically feasible) to off-site users, should suitable off takers be identified in the future (e.g. from new developments over the lifetime of the Project).
- 4.6.3 To allow any identified and additional future CHP opportunities to be realised, the design (and final build) of the Project will incorporate a number of appropriate provisions which will allow for the future implementation of CHP. The details of these are discussed in Section 4.7 of this document.

##### Potential CHP Envelope

- 4.6.4 As per Paragraph 2.5.3, NPS EN-1, if the Project does not include implementation of CHP from the outset, requires information regarding the potential future heat requirements in the area that the Project could meet.
- 4.6.5 The CHP-Ready Guidance states that "*...consideration needs to be given to the ability of the new plant to meet future heat loads within its likely operational profile. This consideration allows for the identification of a 'CHP Envelope'.*"
- 4.6.6 The heat and power envelope for the Project is presented as Insert 2.

Insert 2: Indicative CHP Envelope for the Project



- 4.6.7 From Insert 2, it can be seen that:
- a The Project could export heat / steam of up to approximately 27 MWth without impact to its operational range (i.e. the electrical generation of the Project can be anywhere between 100 per cent load and the Minimum Stable Load [MSL] whilst supplying heat / steam up to 27 MWth);
  - b The maximum heat / steam that could be provided by the Project will be approximately 75 MWth; and
  - c The provision of heat / steam greater than approximately 27 MWth will impact upon the operational range of the Project (i.e. as the heat / steam extraction increases so does the lower bound of the operating range for power generation).
- 4.6.8 The CHP-Ready Guidance seeks to implement CHP with the aim of 'primary energy reduction' in accordance with the relevant provisions of the EED. The primary energy reduction can be calculated using the formula provided at Item 2.1 (f) of Appendix A to the CHP-Ready Guidance.
- 4.6.9 For this calculation, the parameters presented in Table 4 have been modelled for the Project at 100 per cent electrical load with the maximum potential heat / steam extraction. The calculated achievable reduction in primary energy usage at this operating point will be 5 per cent.

**Table 4: Calculation of Primary Energy Reduction (at ‘full load’)**

Parameter		Unit	Modelled Value	Calculated Value
Thermal Input (coal / biomass)	$H_i$	MWth (LHV)	907.3	
Reference Electrical Output	$Ref E$	MWe (net)	296.6	
Reference Electrical Efficiency	$Ref E\eta$	%	32.7	
Heat Load Extraction (heat / steam)	$H$	MWth (net)	75.0	
CHP Heat Efficiency	$CHP H\eta$	%		8.3
CHP Electrical Output	$E$	MWe (net)	285.0	
CHP Electrical Efficiency	$CHP E\eta$	%		31.4
CHP Mode CHP Efficiency (net)	$CHP\eta$	%		39.7
Reference Heat Efficiency	$Ref H\eta$	%	90 *	
<b>PRIMARY ENERGY REDUCTION (%)</b>				<b>5.0</b>

\* Taken from Item 2.0 of Appendix A to the CHP-Ready Guidance

#### 4.7 Provisions for realising future CHP Opportunities

4.7.1 In order to realise potential future CHP opportunities, the Project will include technical provisions that will mean that it is designed to be CHP-R.

4.7.2 These provisions, principally, relate to:

- a Suitable steam extraction points within the design of the steam / water cycle; and
- b The reservation of space on-site sufficient to accommodate additional equipment that could potentially be required to facilitate the successful implementation of CHP.

##### Steam Extraction

4.7.3 Whilst the specific steam extraction points will be selected based on the specific heat / steam requirements of any future off taker, this section provides a summary of the potential extraction points currently considered most suitable for a ‘typical’ off taker.

4.7.4 Although occasionally required at high pressure, process steam is usually required at intermediate pressure (IP) or low pressure (LP). For the purposes of this CHP Assessment, export of either IP or LP process steam is considered as follows<sup>12</sup>:

<sup>12</sup> The export IP and LP steam conditions considered are typical steam conditions, and may be varied in the future. However, this would not significantly affect the results and conclusions of this CHP Assessment.

- a IP steam could be exported at a pressure between 2.9 to 22 bar a; and,
  - b LP steam could be exported at a pressure of 1.4 bar a.
- 4.7.5 However, it is noted that the exact extraction pressure (and likewise the location) will depend on the demand pressure and the pressure drop in the steam distribution system<sup>13</sup>.
- 4.7.6 In terms of likely technical provisions to be CHP-R (for IP steam), a flanged tap-off point could be provided. To avoid a flanged tap-off point connection, it might be preferred to identify a section of pipe which can be readily replaced with a forged branch piece, welded into the section at the time of conversion.
- 4.7.7 LP steam could be taken from:
- a The LP system of the heat recovery steam generator;
  - b The IP turbine exit; and / or
  - c A modified IP / LP crossover pipe.
- 4.7.8 All of these would require a control valve in the LP steam turbine inlet line to maintain steam pressure.

#### Space Requirements

- 4.7.9 Although a means of providing standby / back-up steam is usually provided at the site of the CHP off taker, a stand-by boiler could be included at the Project site to provide a back-up heat / steam supply when the Project is not in operation (or operating at a load below which is can provide sufficient heat / steam).
- 4.7.10 The standby arrangements would be subject to discussion and agreement with the off taker, and likely secured by the terms of a supply contract between the off taker and CPL.
- 4.7.11 For district heating systems, it is likely that two heat exchangers would be installed at the Project site utilising steam at IP and LP from suitable points of the steam turbine.
- 4.7.12 In addition, and the expansion tank may be required in order to compensate for expansion in the overall district heating circuit. Pumps for the pressurising of, and circulation within, the district heating system will likely be installed in order to maintain the recirculating water pressure and consequently avoid cavitation on the highest point of the circuit.
- 4.7.13 The final arrangements will be incorporated into the detail design of the CHP system (i.e. when the CHP opportunity is realised), at such a time when the exact heat loads (and their nature and associated conditions) have been identified. As such, the overall space requirements could vary significantly dependent upon the nature of any future off taker.
- 4.7.14 As a worst case, it is considered that district heating would require the greatest amount of space within the Project site (estimated at approximately XX ha for a 75 MWth system, being the maximum heat load that the Project could provide). This area will be reserved as part of the proposals for the Project (as shown in Figure 1).

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<sup>13</sup> For a given heat load, the electrical power output and hence CHP efficiency will reduce as the steam delivery pressure is increased.

#### **4.8 Further Considerations**

- 4.8.1 The results from the consultation undertaken as part of this CHP Assessment indicate that, at this time, whilst there is a range of potential CHP opportunities in the vicinity of the Project, there is limited feasibility due to the small scale and / or dispersed nature of potential heat loads in the CHP Search Area.
- 4.8.2 Furthermore, regarding both identified and future CHP opportunities, it is possible that the surety that the Project will come forward, that a DCO would provide, may be required before a CHP heat recipient will show serious interest in fully exploring the opportunities.
- 4.8.3 Therefore, at this time, there are no identified feasible CHP opportunities (considering both technical and economic feasibility) in the vicinity of the Project and it is considered that the Project will be constructed to be CHP-R.
- 4.8.4 In order to maximise the potential for any identified and additional future CHP opportunities to be realised, thus making the most of the Project CHP-readiness, CPL will:
- a Engage in on-going consultation with local businesses and industries and other interested parties in an attempt to identify any additional CHP opportunities at the earliest stage;
  - b Regularly review the environmental performance of the Project through the policies defined in the EMS, which will include consideration of potential energy efficiency improvements;
  - c Monitor the estimated heat loads in the CHP Search Area and amend the CHP Assessment appropriately as discussions progress with any identified CHP heat recipients up to the point that the design of the Project is finalised;
  - d In conjunction with Selby District Council, inform potential CHP heat recipients of the potential for a heat supply and offer to hold informal discussions with them if they have interest;
  - e Undertake further / updated assessment of the potential CHP opportunities during its application for an Environmental Permit;
  - f Ultimately ensure that the Project is designed and built with the appropriate provisions which will allow for the future implementation of CHP (i.e. is built to be CHP-R); and
  - g Throughout the operating life of the Project, and at least every two years, carry out a comprehensive review of opportunities for the supply of heat for the realisation of CHP at the Project. The review will consider:
    - i New heat loads being built in the vicinity of the Project; and / or
    - ii Relevant changes in policy and financial incentives which may affect / improve the economic viability of a heat distribution network served by the Project.
- CPL will report the results of each review to the EA and Selby District Council.
- 4.8.5 The appropriate provisions (such as the reservation of space) will be secured by way of a requirement in the DCO. It is considered that this is an appropriate solution given the current uncertainty (and thus absence of economic feasibility) surrounding the identified and future CHP opportunities.



SECTION 5

**CONCLUSIONS**



## **5 CONCLUSIONS**

### **5.1 CHP Assessment**

5.1.1 This CHP Assessment has been undertaken in full accordance with the relevant provisions of:

- a NPS EN-1; and
- b The CHP Guidance.

5.1.2 The CHP Assessment has also been undertaken with due regard paid to the relevant provisions of the CHP-Ready Guidance.

5.1.3 This Section presents a summary of the results of the Assessment.

### **5.2 Existing / Identified CHP Opportunities**

5.2.1 Consultation of the UK CHP Development Map has identified:

- a A total Domestic Heat Load of approximately 307 MW, and more realistic Domestic Heat Load of approximately 113 MW;
- b A total Small Scale Industrial Heat Load of approximately 30 MW, and more realistic Small Scale Industrial Heat Load of approximately 4.5 MW; and
- c A total Large Industrial Heat Load of approximately 40 MW, with an actual Large Industrial Heat Load of approximately 7 MW and no actual realistic Large Industrial Heat Loads.

5.2.2 No specific CHP opportunities were identified during the consultation process that has formed part of this CHP Assessment.

5.2.3 The results from the UK CHP Development Map indicate that the Domestic Heat Load is characterised by disparate, smaller settlements in the vicinity of the Project and it is also understood that there are no local proposals for large-scale residential settlements. Therefore, it is unlikely that implementing CHP for the existing Domestic Heat Load would be economically viable at this time.

5.2.4 The identified Small Industrial Heat Loads for Selby and Goole are small (2.2 MW and 2.4 MW, respectively). In order to serve both Loads, separate systems of CHP pipework will be required and therefore the feasibility of supplying each Load has to be considered separately.

5.2.5 In order to be economically feasible, the costs of CHP implementation must, at least, be capable of being met by payments from the potential off taker over the lifetime of the contract / equipment. However, initial estimates suggest that the costs of receiving heat / steam from the Project could be 50 per cent more than for the equivalent supply of natural gas.

5.2.6 It is therefore considered that, at this time, it is not economically feasible to implement CHP for the provision of heat / steam to either Selby or Goole.

### 5.3 Future Potential for CHP

#### Technical Provisions

- 5.3.1 There are no identified feasible CHP opportunities (considering both technical and economic feasibility) in the vicinity of the Project.
- 5.3.2 In order to realise potential future CHP opportunities, the Project will include technical provisions that will mean that it is designed to be CHP-R.
- 5.3.3 These provisions, principally, relate to:
- a The inclusion of suitable steam extraction points within the design; and
  - b The reservation of space on-site to accommodate CHP equipment.
- 5.3.4 Subject to the identification of a suitable (i.e. technically and economically feasible) off taker, the technical provisions will enable the Project to export heat / steam of up to approximately 27 MWth without impact to its operational range.
- 5.3.5 Above 27 MWth, the operating range of the Project would be restricted however it will be capable of exporting heat / steam up to approximately 75 MWth.
- 5.3.6 At full load operation, with maximum heat / steam extraction, the Project will be capable of delivery a reduction in primary energy usage of approximately 5 per cent.

#### Monitoring of Potential CHP Opportunities

- 5.3.7 Throughout the operating life of the Project, and at least every two years, CPL will carry out a comprehensive review of opportunities for the supply of heat for the realisation of CHP at the Project. The review will consider<sup>14</sup>:
- a New heat loads being built in the vicinity of the Project; and / or
  - b Relevant changes in policy and financial incentives which may affect / improve the economic viability of a heat distribution network served by the Project.
- 5.3.8 CPL will report the results of each review to the Environment Agency and Selby District Council.
- 5.3.9 The appropriate provisions (such as the reservation of space) will be secured by way of a requirement in the DCO. It is considered that this is an appropriate solution given the current uncertainty (and thus absence of economic feasibility) surrounding the identified and future CHP opportunities.

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<sup>14</sup> A full list of the methods by which CPL will seek to maximise the potential for the implementation of CHP is presented in Section 4.8 of this document.

APPENDIX A

**CONSULTATION RESPONSES**



Organisation	Reference to NPS / Guidance	Response	Potential Heat Load Recipient
Department of Energy and Climate Change	CHP Guidance	N / A	
CHP Policy: Renewables and Low Carbon Energy Team	CHP Guidance	N / A	
Quality Assurance for Combined Heat and Power (CHPQA)	CHP Guidance	N / A	
Combined Heat and Power Association	CHP Guidance (optional)	N / A	
The Energy Saving Trust	CHP Guidance (optional)	<p><i>"We do have information that can assist with this including:</i></p> <ul style="list-style-type: none"> <li><i>• Type of building and use (industrial, school, hospital, restaurant etc.)</i></li> <li><i>• Size of building in m<sup>2</sup></i></li> <li><i>• Typical heat and overall energy demand profiles for these types and sizes of buildings</i></li> <li><i>• Overall energy and heat demand in the areas concerned"</i></li> </ul>	
The Carbon Trust	CHP Guidance (optional)	N / A	
NHS Trust Development Authority		N / A	
Confederation of Paper Industries Ltd		<i>"...paper mills are relatively large users of heat and steam. However, none of the fifty UK paper mills are within 15km of the proposed White Rose project site."</i>	
HM Prison Service: Property Services Group		N / A	
North East, Yorkshire and the Humber: Homes and Communities Agency	NPS EN-1	N / A	
York, North Yorkshire & East Riding Local Enterprise Partnership	NPS EN-1	N / A	
Selby District Council	NPS EN-1	N / A	
North Yorkshire County Council	NPS EN-1	N / A	
Hazlewood Grocery Ltd & Greencore Grocery		N / A	✓





APPENDIX B

**UK CHP DEVELOPMENT MAP**



Using the 'Radius Search' Option and the approximate centre of the Operational Area; the following results are obtained for a CHP Search Area of 15 km radius from the approximate centre.

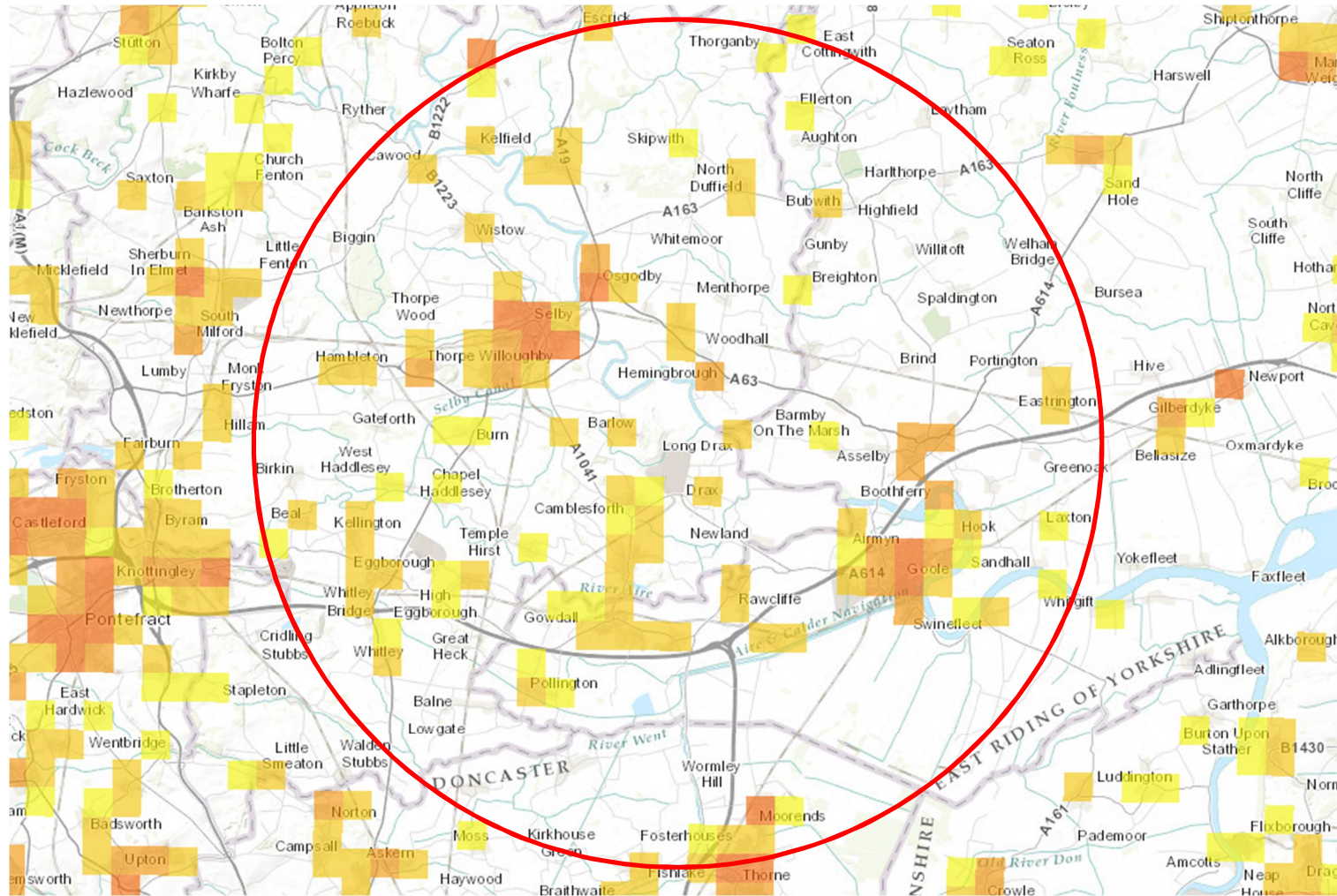
A breakdown of the UK CHP Development Map Sector Totals within the CHP Search Area is provided in the Table below.

**CHP Search Results**

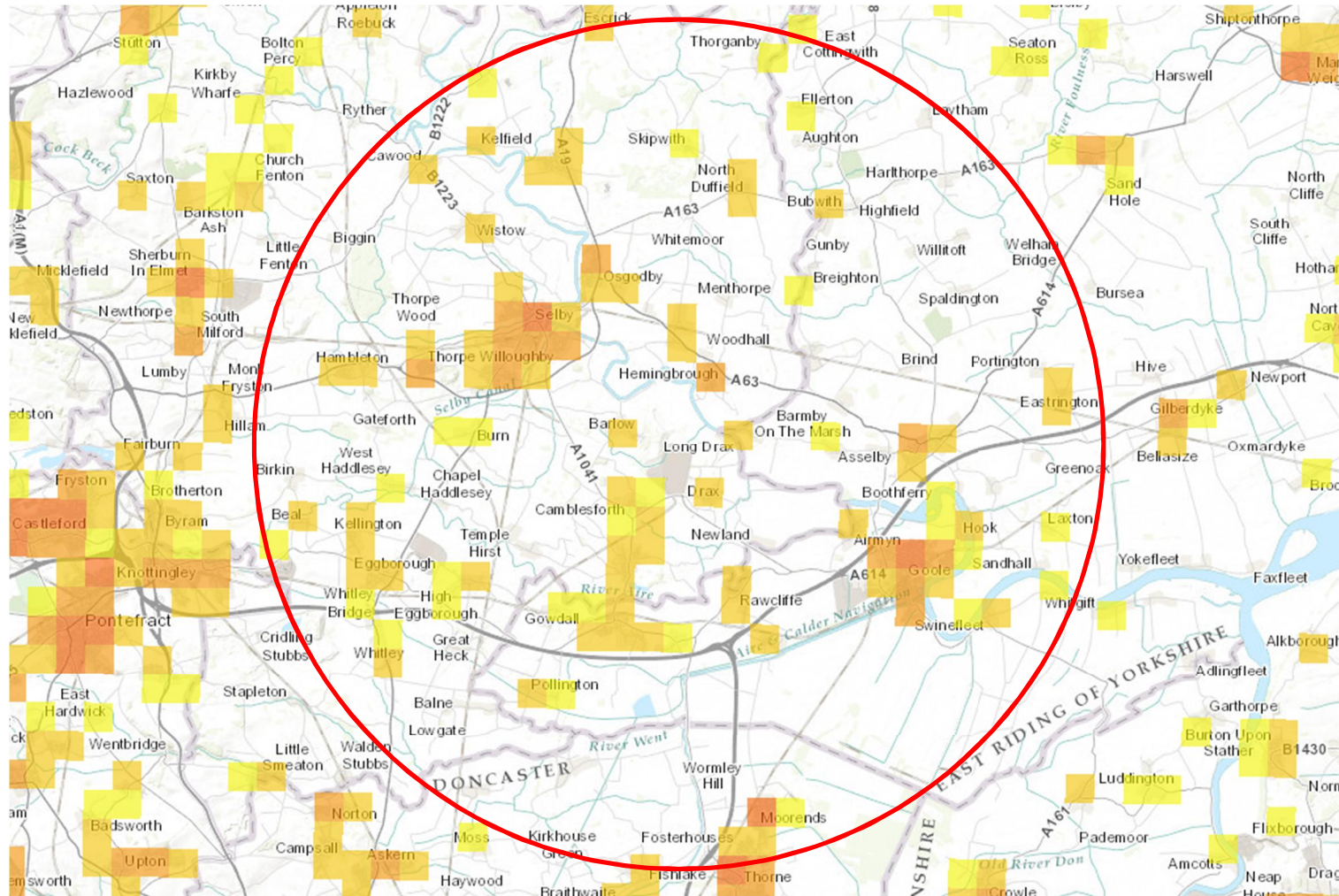
<b>Sector Name</b>	<b>Share</b>	<b>Potential Total Heat Load (kW)</b>
<b>TOTAL</b>	<b>100%</b>	<b>533,707</b>
Domestic	76.78%	425,161
Small Industrial	7.75%	42,903
Large Industrial	7.23%	40,019
Warehouses	2.62%	14,523
Education	1.1%	6,110
Retail	1.05%	5,810
Hotels	0.84%	4,625
Commercial Offices	0.77%	4,266
Other	0.66%	3,649
Government Buildings	0.58%	3,223
Sport and Leisure	0.39%	2,172
Health	0.18%	1,003
Communications and Transport	0.04%	241

The following inserts are taken from the UK CHP Development Map for each highlighted sector.

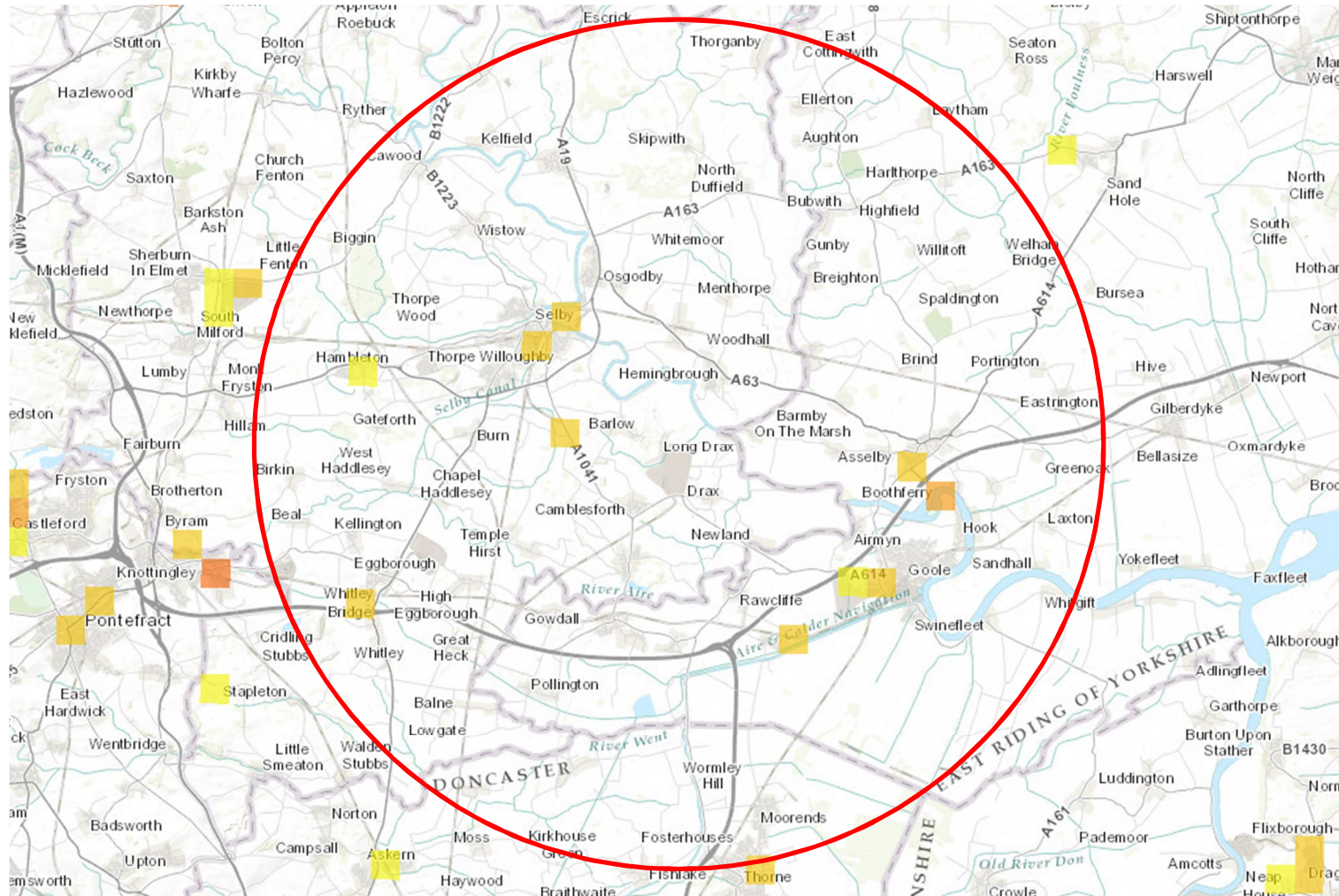
**Total Heat Load**



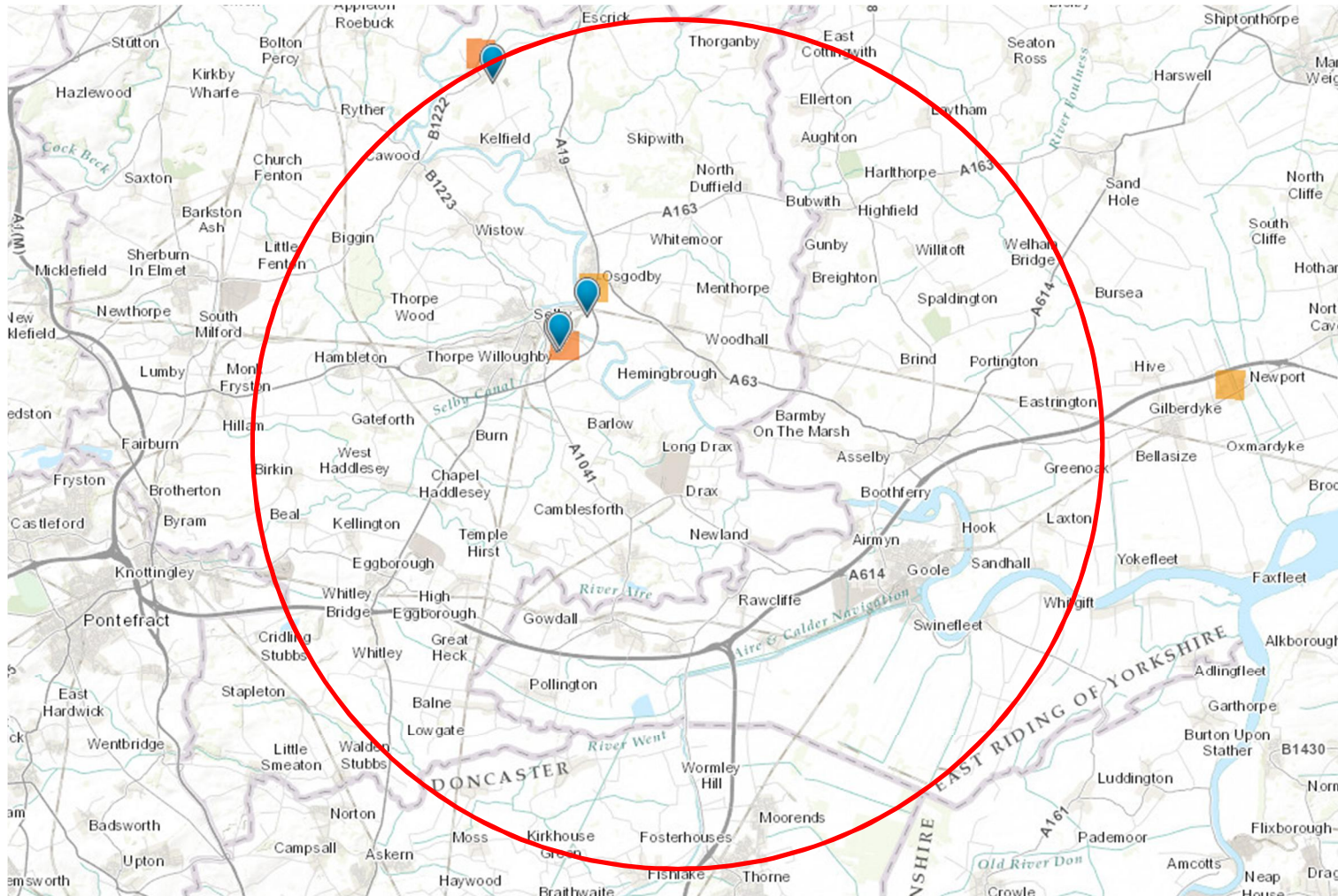
**Domestic**



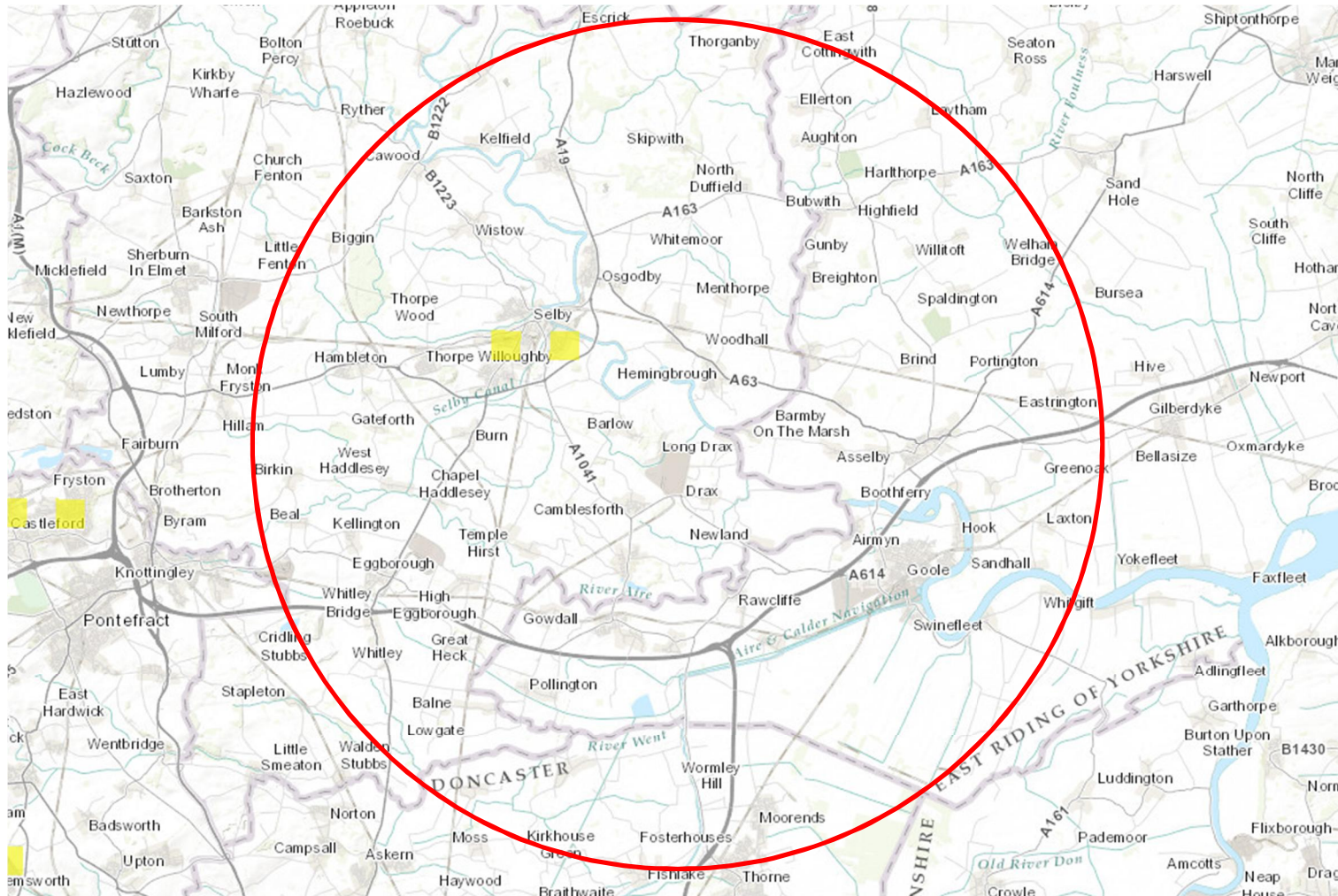
**Small Industrial**



**Large Industrial**

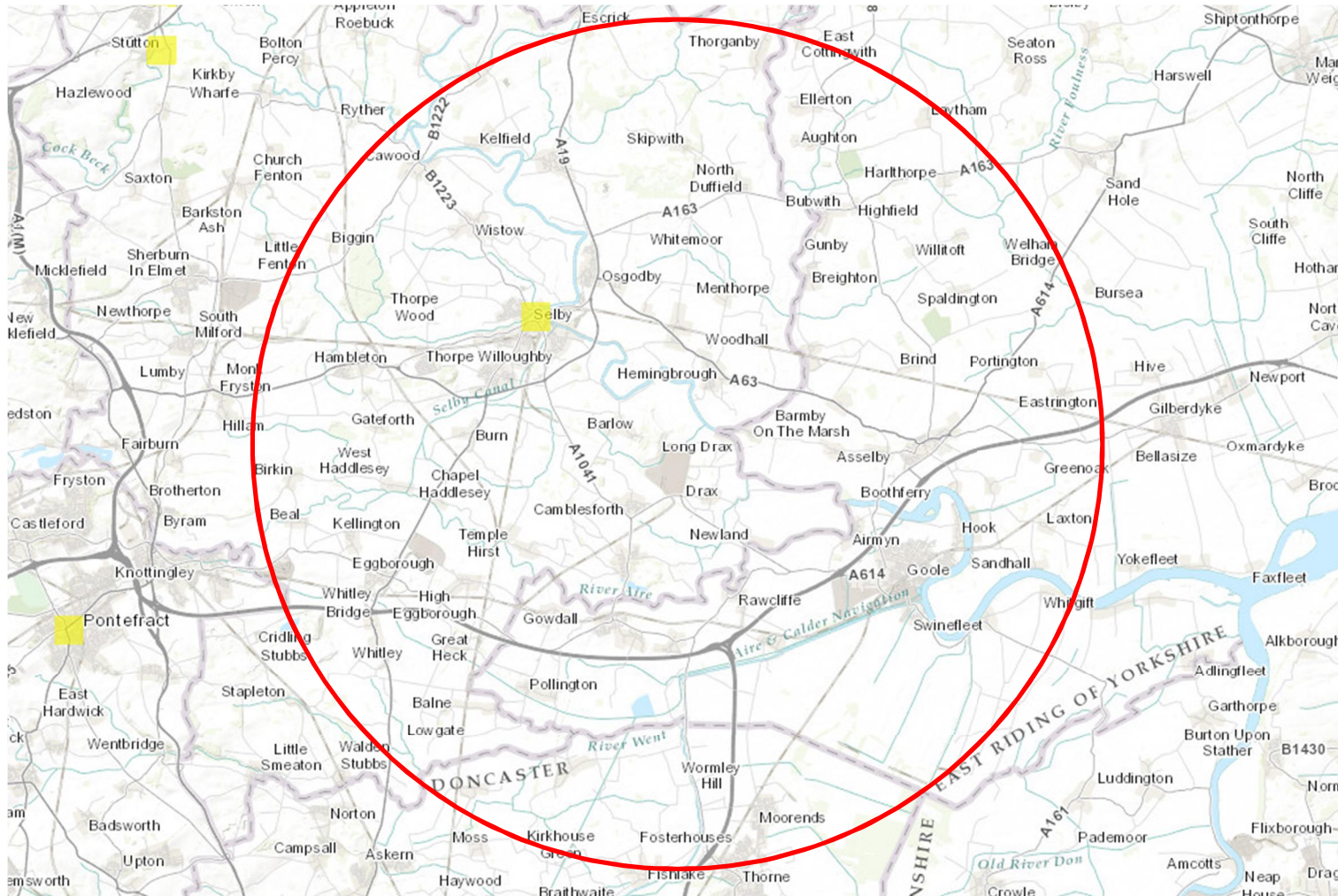


**Education**





**Commercial Offices**



**Government Buildings**

