The Keadby Next Generation Power Station Project

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The Keadby Next Generation Power Station Development Consent Order [year]

Land at, and in the vicinity of, the existing Keadby Power Station (Trentside, Keadby, Scunthorpe DN17 3EF)

Carbon Capture Readiness Statement

The Planning Act 2008

The Infrastructure Planning (Environmental Information Assessment) Regulations 2017

Applicant: Keadby Next Generation Limited

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Document History

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Glossary

Abbreviation	Description
ALARP	As Low As Reasonably Practicable
APFP	Applications: Prescribed Forms and Procedure
CCGT	Combined Cycle Gas Turbine
CCP	Carbon capture plant
CCR	Carbon Capture Readiness
CCUS	Carbon Capture, Usage and Storage
COMAH	Control of Major Accident Hazards
DCO	Development Consent Order
DESNZ	Department for Energy Security and Net Zero
EA	Environment Agency
EIA	Environmental Impact Assessment
ES	Environmental Statement
FEED	Front End Engineering Design
HSE	Health and Safety Executive
IED	Industrial Emissions Directive
LCP	Large Combustion Plants Directive
NGET	National Grid Electricity Transmission
NLC	North Lincolnshire Council
NPS	National Policy Statements
NSIP	Nationally Significant Infrastructure Project
PPE	Personal Protective Equipment
SoS	Secretary of State

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Executive Summary

1. Keadby Next Generation Limited (the 'Applicant') is seeking development consent for the construction, operation and maintenance of a new high efficiency Combined Cycle Gas Turbine (CCGT) Generating Station ('the Proposed Development'). The Proposed Development is a new gas fired electricity generating station of up to 910 megawatts (MW) electrical output and will be designed to run on 100% hydrogen and able to run on 100% natural gas or a blend of natural gas and hydrogen. The Proposed Development would therefore be able to make a significant contribution toward the UK reaching its Net Zero greenhouse gas emissions target by 2050.

2. The purpose of this document is to demonstrate that it is technically feasible to incorporate carbon capture technology within the Proposed Development and therefore that it is Carbon Capture Ready in accordance with the Carbon Capture Readiness (CCR) (Electricity Generating Stations) Regulations 2013. The Proposed Development will be designed to run on 100% hydrogen and able to run on 100% natural gas or a blend of natural gas and hydrogen and includes the capability to connect to third party hydrogen supply infrastructure. As such, it would be the intention of the Applicant to reduce carbon dioxide (CO_2) emissions by using hydrogen as a fuel thereby negating the need for carbon capture. However, to meet current guidance, a CCR Statement has been prepared to demonstrate that suitable space remains available at the Site and that CCS is technically and economically feasible to be retrofitted to the Proposed Development, in the eventuality that Carbon Capture and Storage (CCS) equipment is required.

3. This document has been produced in accordance with the requirements of the Department of Energy and Climate Change (DECC) November 2009 guidance 'Carbon Capture Readiness (CCR) – A Guidance Note'.

4. Following a technical feasibility assessment of Carbon Capture and Storage (CCS) technology, the likely sizing and utility demand has been established. The assessment concludes that there is sufficient space for the CCS technology within the Site. It is also concluded that CCS is technically and economically feasible for the Proposed Development.

5. The Government has recently consulted on Decarbonisation Readiness guidance which would replace the current CCR guidance. In anticipation of this forthcoming change, this document also sets out the Applicant's assessment of Hydrogen Readiness.

1. Introduction

1.1. Overview

1.1.1 This Carbon Capture Readiness ('CCR') Statement (**Application Document Ref 5.9**) has been prepared by Arup together with Keadby Next Generation Limited ('the Applicant') which is a wholly owned subsidiary of SSE plc. It forms part of the application for a Development Consent Order (DCO) ('the Application'), that has been submitted to the Secretary of State for Energy Security and Net Zero under Section 37 of 'The Planning Act 2008' ('the 2008 Act').

1.1.2 The Applicant is seeking development consent for the construction, operation and maintenance of a new combined cycle gas turbine ('CCGT') electricity generating station on land at, and in the vicinity of, the existing Keadby Power Station, Trentside, Keadby, Scunthorpe DN17 3EF ('the Site').

1.1.3 The Keadby Next Generation Power Station ('the Proposed Development') is a new electricity generating station with a capacity of up to 910MW electrical output. The CCGT electricity generating station will be designed to run on 100% hydrogen and able to run on 100% natural gas or a blend of natural gas and hydrogen and will be located on land to the west of Keadby 1 and Keadby 2 Power Stations. The Proposed Development includes connections for cooling water, electricity, hydrogen and natural gas, and construction laydown areas and other associated development. It is described in full in **Environmental Statement (ES) Volume I Chapter 4**: The Proposed Development, of the (**Application Document Ref 6.2**).

1.1.4 The Proposed Development falls within the definition of a 'Nationally Significant Infrastructure Project' (NSIP) under Section 14(1)(a) and Sections 15(1) and (2) of the 2008 Act, as it is an onshore generating station in England that would have a generating capacity greater than 50MW electrical output (50MWe). As such, a DCO application is required to authorise the Proposed Development in accordance with Section 31 of the 2008 Act.

1.1.5 The DCO, if made by the Secretary of State (SoS), would be known as 'The Keadby Next Generation Power Station Order' ('the Order').

1.2. The Applicant

1.2.1 The Applicant is a subsidiary of the FTSE-listed SSE plc, one of the UK's largest and broadest-based energy companies, and the country's leading developer of renewable energy. Over the last 20 years, the SSE Group has invested over £20 billion to deliver industry-leading offshore wind, onshore wind, CCGT, energy from waste, biomass, battery energy storage, energy networks and gas storage projects. Related SSE companies own and operate the adjacent Keadby 1 and 2 Power Stations and have the benefit of the DCO for Keadby 3 CCS Power Station (herein referred to as the 'Keadby CCS Power Station').

1.2.2 The Proposed Development is being developed with Equinor, one of the country's leading energy providers, supplying natural gas, oil and electricity. Equinor is developing multiple low-carbon hydrogen and carbon capture projects in the Humber, working towards transforming the UK's most carbon intensive industrial cluster into a net zero region.

1.2.3 SSE Renewables Limited operates Keadby Windfarm, which lies to the north and south of the Site and generates renewable electricity from 34 turbines, with a total installed generation capacity of 68MW.

1.2.4 SSE plc has set out a clear commitment to investment in low carbon power infrastructure, working with government and other stakeholders to create a Net Zero power system by 2040. This includes investment in flexible sources of electricity generation and storage for times of low renewable output which will complement other renewable generating sources, either using low carbon fuels and/ or capturing and storing carbon emissions.

1.2.5 The design of the Proposed Development demonstrates this commitment, and the Proposed Development will be built with a clear route to decarbonisation, consistent with SSE's Net Zero Acceleration Programme Plus and net zero transition plan which committed to the development and progression of new low carbon flexible power including hydrogen-fuelled generation.

1.3. The Proposed Development

1.3.1 The Proposed Development would comprise a high efficiency gas fired power station with an electrical output capacity of up to 910MWe and associated buildings, structures and plant and other associated development defined in the Schedule 1 of the **Draft DCO** (**Application Document Ref 3.1**) as Work Nos. 1-11 and shown on the **Works Plans** (**Application Document Ref 2.3**).

1.3.2 The Proposed Development will include:

- a new-build CCGT electricity generating station fuelled by hydrogen and/or natural gas with a power output of up to 910MW (**Work No. 1**) including:
  - a CCGT plant;
  - cooling infrastructure;
  - natural gas and hydrogen blending equipment (for the Applicant's infrastructure);
  - supporting facilities including administration and control buildings, workshops, storage buildings, effluent treatment facilities, fire water storage tank(s), demineralised water treatment plant including storage tank(s), and permanent laydown areas for operation and maintenance activities;
- a hydrogen supply pipeline, including a gas compound for the hydrogen supplier's apparatus and a hydrogen gas compound for the Applicant's apparatus (**Work No. 2**);
- a natural gas supply pipeline including a compound for the natural gas supplier's apparatus and a natural gas compound for the Applicant's apparatus (**Work No. 3**);
- electrical connection works for the export and import of electricity to and from the generating station to the existing 400kV National Grid Electricity Transmission (NGET) substation located adjacent to the Keadby Power Station site, including works within the substation (which would be undertaken by NGET) (**Work No. 4**);
- water supply connection works to provide cooling and make-up water to the generating station, including intake structures and an underground and/or overground water supply pipeline running between the generating station and the Stainforth and Keadby Canal (**Work No. 5**);
- connections to and use of an existing outfall and associated pipework for the discharge of used cooling water, surface water and treated effluent to the River Trent (**Work No. 6**);
- public water connection pipeline from a new connection on Chapel Lane to provide potable water to the generating station (**Work No. 7**);
- new permanent access to the generating station (**Work No. 8**), comprising:
  - maintenance and improvement of an existing private access road from the A18, including replacement of a private bridge (Mabey Bridge) (**Work No. 8A**);

  - installation of layby and gatehouse with barriers, enclosures, drainage and lighting north of the A18 junction (**Work No. 8B**) and associated utilities connections (**Work No. 8C**); and
  - emergency access route comprising the maintenance and improvement of an existing private track running between the generating station and Chapel Lane and including new private bridge crossing (**Work No. 8D**).

- temporary construction and laydown areas (**Work No. 9A**);
- maintenance and improvement of the existing access routes running between the A18 and construction laydown areas (**Work No. 9B**); and between Skew Bridge adjacent to the A18 and a temporary construction laydown area associated with Mabey Bridge replacement (**Work No. 9C**);
- retention, maintenance and improvement and subsequent removal of existing temporary haul route from the Waterborne Offloading Facility (**Work No. 9D**) and the inspection and repair of the existing wharf, and temporary placement of mobile cranes including the temporary oversailing of crane arms (**Work No. 9E**); and
- landscaping and biodiversity enhancement measures (**Work No. 10**);
- an allocation of land to meet the requirements of the Carbon Capture Readiness (Electricity Generating Stations) Regulations 2013 (**Work No. 11**).

1.3.3 The Applicant will be responsible for the construction, operation (including maintenance) and eventual decommissioning of the Proposed Development including the on-site connections to electricity, cooling water, natural gas and hydrogen supplies.

1.3.4 The Proposed Development will be capable of operating 24 hours per day, 7 days per week with programmed offline periods for maintenance.

1.3.5 The route for the hydrogen supply pipeline to the Proposed Development has not yet been confirmed. The supply pipeline is not included in the Proposed Development and will be progressed by a third party under a separate consent. In line with Government policy, it is recognised that developments such as the Proposed Development are needed to stimulate investment in the development of hydrogen production and supply infrastructure.

1.3.6 Further detail on the components of the Proposed Development are provided in **ES Volume I Chapter 4:** The Proposed Development

(**Application Document Ref**. **6.2**). The areas within which each numbered Work (component) of the Proposed Development are to be built are defined by the coloured and hatched areas on the **Works Plans** (**Application Document Ref. 2.3**).

1.4. The Proposed Development Site

1.4.1 The Site (which equates to the 'Order Limits') is located within and adjacent to the boundary of the existing Keadby Power Station site near Scunthorpe, Lincolnshire and lies within the administrative boundary of North Lincolnshire Council (NLC) ('the Site). The Keadby Power Station site currently encompasses the operational Keadby 1 and Keadby 2 Power Stations. The location of the Site, which is approximately centred on national grid reference (NGR) 481961, 412101 is shown on the **Site Location Plan (Application Document Ref. 2.1)**.

1.4.2 The Site encompasses an area of approximately 77.1 hectares (ha), of which approximately 26.7 ha of land is proposed for construction laydown.

1.4.3 The proposal includes multiple land uses with the different areas described in turn below and shown on **ES Volume III Figure 3.3** Indicative Parts of the Site Plan (**Application Document Ref. 6.4**) and the **Works Plans** (**Application Document Ref. 2.3**). These terms have been used to describe land use zones within the Site. Distances to environmental receptors reported within the ES Report are measured relative to the areas illustrated on **ES Volume III Figure 3.3:** Indicative Parts of the site Plan (**Application Document Ref. 6.4**).

1.4.4 The Site is divided into the following areas of permanent and temporary land use (the proposed use is described in more detail in **ES Volume I Chapter 3**: Site and Surrounding Area (**Application Document Ref 6.2.3**)):

- Main Site;
- Ancillary Facilities;
- Water Connections;
- Electricity Connections;
- Waterborne Transport Off-loading Area;
- Construction Laydown Areas;
- Access routes (emergency, permanent and construction);
- Connections to Keadby 1 and Keadby 2 power stations; and
- Additional areas for landscaping and biodiversity provision.

1.5. The DCO Process

1.5.1 The Proposed Development falls within the definition of a NSIP under Section 14(1)(a) and 15(2) of the 2008 Act as a 'generating station exceeding 50 MW'.

1.5.2 As a NSIP project, the Applicant is required to seek a DCO to construct and operate the generating station, under Section 31 of the 2008 Act. Section 37 of the 2008 Act also governs the form, content and accompanying documents that are required as part of a DCO application. The requirements are implemented through the Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 (as amended) ('APFP Regulations') which state that an application must be accompanied by an ES, where a development is considered to be 'EIA development' under the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (the EIA Regulations) (as amended).

1.5.3 An application for development consent for the Proposed Development has been submitted to the Planning Inspectorate (PINS) acting on behalf of the SoS. Subject to the application being accepted, PINS will then examine it and make a recommendation to the SoS, who will then decide whether to grant a DCO. The acceptance, examination, recommendation and decision stages are subject to fixed timescales and the decision is therefore anticipated to fall in 2026.

1.5.4 A DCO, if granted, has the effect of providing deemed planning permission for a development, in addition to a number of other consents and authorisations where specified within the Order.

1.6. The Purpose and Structure of this Document

1.6.1 The purpose of this document is to comply with Section 4.7.10 of the 'Overarching National Policy Statement for Energy (EN-1)' (DESNZ, 2023a), which requires developers promoting thermal generating stations to demonstrate CCR.

1.6.2 As the output capacity of the Proposed Development is greater than 300MWe, the generating station falls under the provisions of the Carbon Capture Readiness (Electricity Generating Stations) Regulations 2013 (the 'CCR Regulations'), which transposed Article 36 of Directive on Industrial Emissions (Integrated Pollution Prevention and Control) (Directive 2010/75/EU) ('the Industrial Emissions Directive' (IED)) into UK legislation.

1.6.3 The CCR Regulations provide that no DCO (in England and Wales) may be made in relation to a combustion plant with a capacity at or over 300MWe, unless the relevant authority has determined (on the basis of an assessment carried out by an applicant) whether it is technically and economically feasible to retrofit the equipment necessary to capture the carbon dioxide (CO_2) that would otherwise be emitted from the plant, and to transport and store such CO_2 from the site.

1.6.4 The Applicant must therefore demonstrate that the Proposed Development is CCR compliant under the regulatory requirements for an application for DCO.

1.6.5 The Proposed Development has been specifically designed, at the outset, to be able to operate on hydrogen as well as natural gas or a blend of the two and includes facilities to connect to third party hydrogen supply infrastructure. As such, it would be the intention of the project to decarbonise by using hydrogen as a fuel thereby negating the need for carbon capture. However, to meet current guidance, a CCR Statement has been prepared to demonstrate that suitable space remains available at the site for the purposes of CCR, in the eventuality that Carbon Capture and Storage (CCS) equipment is required.

1.6.6 This CCR Statement has been prepared in accordance with the Department of Energy and Climate Change (DECC) 2009 CCR Guidance (DECC, 2009) (see Section 2.3) to confirm that the specific requirements under the CCR Regulations have been met, noting that the basis of CCR demonstration is for retrofit to a generating station . The document also outlines the responsibilities and consenting route for any anticipated third party carbon dioxide gathering network.

1.6.7 The Government has recently consulted on Decarbonisation Readiness guidance which would replace the current CCR guidance. In anticipation of this forthcoming change, this document also sets out the Applicant's assessment of Hydrogen Readiness.

1.6.8 This report provides the Applicant's evidence submitted in demonstration of CCR, and is structured as follows:

- Section 2 outlines policy context relating to CCR, summarises the guidance on the information required as part of a DCO application to demonstrate CCR, and describes the assessment methodology used;
- Section 3 provides a description of the Proposed Development and outlines the responsibilities and consenting status of the anticipated third party hydrogen supply network.
- Section 4 outlines the technical assessment of Carbon Capture, Usage and Storage (CCUS);

- Section 5 outlines the economic assessment of CCUS;
- Section 6 outlines the health and safety considerations of a carbon capture plant (CCP);
- Section 7 presents the conclusions of the CCR assessment;
- Section 8 provides a list of references;
- Appendix A illustrates the CCR space allocation within the Site; and
- Appendix B sets out the assessment of Hydrogen Readiness.

2. Policy Context and Assessment Methodology

2.1. Carbon Capture Readiness (Electricity Generating Stations) Regulations 2013

2.1.1 The CCR Regulations came into force on 25 November 2013 and set out the current requirements of the assessment. These regulations were made in transposition of Article 36 of the EU Industrial Emissions Directive (see box below).

EU Directives
Some types of EU legislation, such as Directives, are indirectly applicable, meaning domestic legislation is required by EU member states to become law. In the UK this was often achieved via Statutory Instruments rather than passing primary legislation. The UK government has made the EU Withdrawal Act 2018 which maintains established environmental principles and ensures that existing EU environmental law will continue to have effect in UK law. The European Union (EU) published the Directive on the Geological Storage of Carbon Dioxide (Directive 2009/31/EC) ("the Directive") in the Official Journal of the European Union on 5 June 2009, with the Directive coming into force on 25 June 2009. Article 21 of the Directive requires that necessary measures are taken to allow access to transport networks and storage sites for geological storage of produced and captured CO2. Article 33 of the Directive requires an amendment to Directive 2001/80/EC (commonly known as the Large Combustion Plants Directive ("LCP")), via Article 9a, such that operators of all combustion plants with an electrical output of 300 MW or more (and for which the construction / operating license was granted after the date of the Directive) are required to carry out a study to assess: • Whether suitable storage sites for CO_2 are available; • Whether transport facilities to transport CO_2 are technically and economically feasible; and • Whether it is technically and economically feasible to retrofit for the capture of CO_2 emitted from the power station;

- This may be known as a 'CCR Feasibility Study', to be determined by the competent authority.

The Industrial Emissions Directive ("IED", Directive 2010/75/EU) entered into force in January 2011 and was to be transposed into national legislation by Member States by January 2013. The IED brought together seven existing directives, including the LCP. Article 36 of the IED replicates the requirements of Article 9a of Directive 2001/80/EC (LCP) and the above requirement for a CCR Feasibility Study

2.1.2 The CCR Regulations provide that no order for development consent (in England and Wales) may be made in relation to a combustion plant with a capacity at or over 300 MWe unless the relevant authority has determined (on the basis of an assessment carried out by the applicant) whether it is technically and economically feasible to retrofit the equipment necessary to capture the CO_2 that would otherwise be emitted from the plant, and to transport such CO_2 from the site to an appropriate long term geological store.

2.1.3 The CCR Regulations summarise the need for a CCR Feasibility Study and state (at Regulation 2(1)) that a: "CCR Assessment, in relation to a combustion plant, means an assessment as to whether the CCR Conditions are met in relation to that plant." In terms of the 'CCR Conditions', CCR Regulation 2(2) states that:

"for the purposes of these Regulations, the CCR Conditions are met in relation to a combustion plant, if, in respect of all of its expected emissions of CO2 –

a) suitable storage sites are available;

b) it is technically and economically feasible to retrofit the plant with the equipment necessary to capture that CO2; and

c) it is technically and economically feasible to transport such captured CO2 to the storage sites".

2.1.4 CCR Regulation 3(3) states that:

"If the Secretary of State –

a) determines that the CCR Conditions are met in relation to a combustion plant; and

b) decides to make a relevant consent order in respect of that plant, the Secretary of State must include a requirement in the relevant consent order that suitable space is set aside for the equipment necessary to *capture and compress all of the CO2 that would otherwise be emitted from the plant."*

2.1.5 In October 2024, DESNZ published its response to a consultation for expanding and updating the carbon capture readiness requirements (further details are outlined in Section 2.5). The scope of the current 'carbon capture readiness' requirements is to be expanded to become Decarbonisation Readiness requirements and enforced through the Environmental Permitting (Electricity Generating Stations) (Amendment) Regulations 2024. Although the current CCR requirements are still in force, the proposed Decarbonisation Readiness guidance is to come into effect in March 2026 and will replace the CCR requirements at that time. Under the proposed guidance, decarbonisation through hydrogen is recognised as an alternative route to carbon capture storage. The Proposed Development is seeking to follow the hydrogen route to decarbonisation.

2.2. National Policy Statements

2.2.1 The National Policy Statements (NPS) for energy infrastructure form the policy framework for applications for new generating stations of greater than 50 MW capacity in England and Wales. The NPS of most relevance to the Proposed Development (and this CCR Statement) are the 'Overarching National Policy Statement on Energy (EN-1)' (DESNZ, 2023a) and the 'National Policy Statement for Natural gas Electricity Generating Infrastructure (EN-2)' (DESNZ, 2023b). The NPS EN-2 is designed for facilities fired on natural gas, however in Section 1.6.3 it is recognised that the guidance may also be important and relevant to hydrogen gas-fired electricity generating infrastructure.

2.2.2 Under Section 104(3) of the Planning Act 2008, DCO applications for NSIP are required to be determined by the SoS in accordance with policy set out in the relevant NPS. As stated in NPS EN-1:

"To ensure that no foreseeable barriers exist to retrofitting CCS equipment on combustion generating stations, all applications for new combustion plants which are of generating capacity at or over 300MW and of a type covered by The Carbon Capture Readiness (Electricity Generating Stations) Regulations 2013141 should demonstrate that the plant is "Carbon Capture Ready" (CCR) before consent may be given."

2.2.3 In this regard, NPS EN-1 in Section 4.9.29 also states that:

"In order to assure the Secretary of State that a proposed development is CCR, applicants must demonstrate that their proposal complies with guidance issued by the Secretary of State in November 2009 or any successor to it."

2.2.4 The 2009 guidance referred to above is discussed in the Section 2.3 below.

2.2.5 In NPS EN-1, hydrogen is recognised as an alternative to natural gas for electricity generation. Section 3.3.49 states:

"Low carbon hydrogen could be capable of replicating the role of natural gas in the electricity system, including providing both firm, flexible capacity in the future and a decarbonisation route for unabated combustion power plants. The British Energy Security Strategy sets out our ambition for up to 10GW of low carbon hydrogen production capacity by 2030, subject to affordability and value for money, at least half of which will come from electrolytic hydrogen, working with industry to develop a strong and enduring UK hydrogen economy."

2.2.6 National Policy Statement for Energy for Natural Gas Electricity Generating Infrastructure (EN-2) (DESNZ, 2023b) (adopted January 2024) in Section 2.4.1 states:

"Natural gas generating stations have large land footprints and will therefore only be deliverable where the applicant is able to acquire a suitably-sized site. The site will also need to be big enough to conform to government policy on CCR, Decarbonisation Readiness (DR) and CCS, set out in Section 4.9 of EN-1."

2.2.7 DESNZ published revised drafts of some of the energy NPS (including EN-1 but not EN-2) for consultation in late April 2025. Paragraph 2.4.10 of Draft NPS EN-1 (DESNZ, 2025) states "*From February 2026, new gas plants will need to be built 'decarbonisation ready', demonstrating they are compatible with carbon capture, utilisation and storage or able to convert to hydrogen powered generation.*"

2.3. CCR Guidance

2.3.1 DECC published guidance on CCR in November 2009 entitled 'Carbon Capture Readiness (CCR) – A Guidance Note for Section 36 Electricity Act 1989 consent applications' (DECC, 2009). Though the Proposed Development intends to decarbonise through the use of hydrogen rather than CCS, the Proposed Development is still required to demonstrate accordance with the guidance, in the event that space is required for CCS plant and equipment. The guidance states that applicants are required to:

- demonstrate that sufficient space is available on or near the site to accommodate carbon capture equipment in the future;
- undertake an assessment into the technical feasibility of retrofitting CCP equipment;
- propose a suitable area of deep geological storage offshore for the storage of captured CO_2;
- undertake an assessment into the technical feasibility of transporting the captured $CO_2$to the proposed storage area;
- assess the likelihood that it will be economically feasible within the power station's lifetime to link it to a full CCUS chain, including retrofitting of capture equipment, transport and storage; and
- if necessary, apply for and obtain Hazardous Substance Consent (HSC) when applying for consent.

2.4. Assessment Methodology

2.4.1 This CCR report has been prepared to fulfil the requirements of the DECC November 2009 guidance as set out below:

- Allocation of Space for CCP Equipment: An assessment of appropriate space set aside to accommodate future carbon capture equipment is provided in Section 4.1 of this report. The space allocated for the CCP has been calculated to demonstrate compliance with the minimum footprint in the DECC guidance. CCR land is identified as Work No. 11 on the **Works Plans** (**Application Document Ref. 2.3**).
- Technical Assessment of Feasibility of CCP Retrofit: Annex C of the DECC guidance provides a detailed advisory checklist of the information to be included in a CCR Feasibility Study report on the technical assessment of the feasibility of retrofitting CCP equipment for a new natural gas combined cycle power station using post-combustion carbon capture. It is noted that a specific checklist for the technology intended for the Proposed Development is not provided by the DECC guidance, however, for the purposes of this CCR Statement, Section 4.2 of this report deals with the technical response to the requirements of Annex C, as being of most relevance to the Proposed Development.
- **Identification of Suitable Areas for Storage of Captured CO_2:** In accordance with the DECC guidance, at least two fields or aquifers with an appropriate CO_2 storage capacity, which have been listed in either the 'valid' or 'realistic' categories in the 2006 study of UK Storage Capacity (BGS, 2006) (which is provided in Annex D of the DECC

Guidance), should be proposed as suitable CO_2 storage locations for the Proposed Development. Such sites are identified in Section 4.3 of this report.

- **Technical Feasibility of Transport of Captured CO_2:** The DECC guidance states that the feasibility of any proposed site for a new combustion station will be influenced by the availability of transport routes to the proposed storage area. The technical feasibility of transporting the captured CO_2 to the storage area proposed for the Proposed Development is assessed in Section 4.4 of this report.
- **Economic Assessment of the Feasibility of CCUS:** The DECC guidance states that the main aim of the economic assessment is to provide an indication of the future likelihood of a retrofit of CCP equipment, CO_2 transport and storage of CO_2 being economically feasible at some stage during the proposed combustion plant's operational lifetime. This is discussed in Section 5 of this report.
- **Health and Safety Analysis:** An analysis of health and safety issues associated with the CCP, including consideration of whether a Hazardous Substances Consent may be required for the Proposed Development, is provided in Section 6 of this report.

3. Description of the Proposed Development

3.1. Location

3.1.1 The Site comprises land within and adjacent to the boundary of the existing Keadby Power Station site near Scunthorpe, Lincolnshire.

3.1.2 The Main Site, on which the CCGT Generating Station is proposed, is located approximately 4.1km to the west of the town of Scunthorpe.

3.2. Plant Description

3.2.1 The Proposed Development comprises a CCGT generating station designed to run on 100% hydrogen and able to run on 100% natural gas or a blend of natural gas and hydrogen.

3.2.2 This CCR Statement addresses the generating station and its readiness to address its own CO_2 emissions. The current CCR guidance (DECC, 2009) is based upon unabated plant capacity and therefore the largest gas turbine unit currently commercially available (H Class at c. 590-595 MW) has been assumed as the basis for approximate values for the various plant requirements.

3.2.3 The generating station is anticipated to operate dispatchably over its 25 year design lifetime.

3.2.4 The Proposed Development will be designed to operate for up to 25 years, after which ongoing operation and market conditions will be reviewed. If it is not appropriate to continue operating after that time, the generating station will be decommissioned.

3.3. Carbon Capture and Storage Technology

3.3.1 The current Emissions Performance Standard (EPS) set by the UK Government for new electricity generating stations is 450 gCO2/kWh (Energy Act 2013, Part 2, Chapter 8). This EPS is proposed by UK Government to be maintained for consented plants until 2045.

3.3.2 There are three carbon capture technologies available, namely:

- pre-combustion carbon capture;
- post-combustion carbon capture; and
- oxy-combustion carbon capture.

3.3.3 This CCR Statement has focused on the use of post-combustion carbon capture, as this was the chosen technology included as part of the Keadby 3 CCS Power Station that was consented on the Site previously. No further discussion is presented in this report on the alternative technologies given that decision was evaluated and made to develop the Keadby 3 concept previously, based on the same H Class CCGT concept in the same location.

3.3.4 The feasibility of CCUS for the Proposed Development has therefore been assessed on the basis of the best currently available post-combustion carbon capture technology which, for carbon capture from combustion flue gases, would use an amine-based solution as the absorption medium. For the purposes of concept design, Monoethanolamine (MEA) will be used as the base case. This is a non-proprietary and widely available solvent.

3.3.5 The conceptual design in this report has been based upon the post-combustion modelling developed using industry standard software and heat cycle data developed as part of the Keadby 3 CCS Power Station pre-FEED (Front End Engineering Design), together with CCGT design data from the adjacent operational Keadby 2 Power Station. In common with studies for other generating stations, a design target of 95% CO_2 capture efficiency has been used as the basis for the concept design.

3.3.6 This assessment has been developed for a single carbon capture train processing the mass flow rate of flue gas from the largest gas turbine unit currently commercially available.

3.3.7 The sizing and utility demand of the main CCP equipment required has been established using process modelling and experience from other design projects. The land allocated for CCR is defined by Work No. 11 on the **Works Plans** (**Application Document Ref 2.3**) (reproduced in Appendix A).

3.4. Carbon Dioxide Gathering Network

3.4.1 It is recognised that the CCR Guidance states that an applicant may not assume, at the CCR stage, that they will be able to outsource onshore CO_2 transport and storage arrangements (such as to a cluster network). Whilst this is noted, the Applicant considers that the greater certainty over the Government's Track 1 and Track 2 Cluster sequencing programme and the commitment from Government to supporting the establishment of CCUS in industrial clusters demonstrates that such links are justified within this Application.

3.4.2 The Humber Carbon Capture Pipeline is being developed by bp and its partners to connect industrial emitters in Humberside with the Track 1 expansion plans for Endurance saline aquifer. In addition, Harbour Energy have been granted development consent for the Viking CCS pipeline proposed to connect Immingham with the Viking depleted gas fields. Both carbon capture networks remain under development and could potentially connect to the Proposed Development in the future.

3.4.3 The Applicant continues to engage with the developers of both potential carbon capture networks regarding potential future connections to Keadby Power Station.

4. Technical Assessment

4.1. Space

4.1.1 An indicative layout of the Main Site has been developed, based on engineering studies conducted.

4.1.2 The CCP area calculation incorporates all the major equipment items described in the following subsection (Section 4.2) with appropriate areas for ductwork, piping, access and maintenance available.

4.1.3 Appendix A shows the space allocated on site for CCR purposes (Work No. 11, reproduced from the **Works Plans** (**Application Document Ref. 2.3**)).

Footprint Comparison

4.1.4 The 2009 CCR Guidance (DECC, 2009) provides an indicative CCR space requirement based on a 500 MW (net) power plant. For a CCGT power plant with post-combustion carbon capture, the indicative CCR space requirement was initially provided at 3.75 ha for 500 MW, which equates to 75 m^2 /MW.

4.1.5 However, following the publication of the CCR Guidance, the indicative CCR space requirement was reviewed by Imperial College, London (Imperial College, 2010). The Imperial College review concluded that the footprint estimates presented in the 2009 CCR Guidance were overly conservative and recommended the reduction of the indicative CCR space requirement for a CCGT power plant with post-combustion capture by 36%. Therefore, the corrected indicative CCR space requirement is 2.4 ha for 500 MW. This equates to 48 m^2 /MW.

4.1.6 In addition, the review by Imperial College further detailed additional scope for a reduction in the indicative CCR space requirement by 50% to 1.875 ha (including the reduction of 36%) considering technology advances and layout optimisation. This equates to 37.5 m^2 /MW. However, the paper also states that such a reduction can only be justified following a detailed engineering design rather than only a linear scaling of this value.

4.1.7 For the purposes of this CCR Statement, a 'worst-case' concept design and footprint area calculation has been estimated using the following sources of information:

- initial engineering studies developed as part of the Pre-FEED for the Proposed Development;

- DECC CCR Guidance (DECC, 2009); and
- Imperial College Paper on CCP Footprint Review (Imperial College, 2010).

4.1.8 On this basis, the indicative 'worst-case' total footprint has been estimated. A conservative design margin is applied to allow for ductwork, piping, access and maintenance, and to allow for the potential challenges of installing and maintaining a 'First of a Kind' plant (for which technology maturation and design optimisation may not be as advanced as for an 'Nth of a Kind' project).

4.1.9 An estimated CCR area of 43,800m^2 (4.38 ha) (50 m^2/MW) was calculated for the proposed Keadby 3 CCS Power Station development on the same Site as the Proposed Development. This figure is above the specific area target of 48 m^2/MW (without technology/ layout optimisation) and therefore indicates that the minimum required area has been allocated.

4.1.10 In addition, the land allocated for CCR is within the western part of the Main Site (Work No. 11 on the **Works Plans** (**Application Document Ref. 2.3**)) and is 5.8 ha in area, further exceeding the 4.38 ha calculated to be required.

4.2. Indicative Process Description

Introduction

4.2.1 The Proposed Development has been assessed based on a nominal unabated gross capacity of 910 MWe for the proposed generating station, against the criteria presented in Annex C of the DECC CCR guidance note (DECC, 2009).

Design, Planning Permissions and Approvals

4.2.2 The feasibility of CCUS for the Proposed Development has been assessed on the basis of the best currently available technology, which for post-combustion carbon capture from flue gases, is captured using amine-based absorption. The area reserved for CCR within the Site is shown in Appendix A.

Plant Location

4.2.3 It is anticipated that the exit point for the captured CO_2 from the Proposed Development would be located in the north part of the Main Site.

4.2.4 Further information on the transport and storage of captured CO_2 off-site is provided in Sections 4.3 and 4.4.

Space Requirements

4.2.5 The footprint discussed in Section 4.1 allows space for the following:

- CO2 capture equipment, including flue gas pre-treatment, and CO2 drying and compression;
- routing flue gas duct to the CO2 capture equipment;
- any extensions or additions to the balance of plant on the CCGT where necessary to cater for the additional requirements of the capture equipment;
- maintenance and operational vehicle movement;
- space for storage and handling of amines and handling of CO2, including space for infrastructure to transport CO2 to the plant boundary; and
- major plant deliveries and access around the Site.

Flue Gas Path and Pressure

4.2.6 The flue gas exiting the CCGT would be routed to the CCP via a diverter damper (or other suitable technique) during normal operation. During start-up, shutdown and fault conditions, the CCP damper would close and a similar damper on the HRSG stack would open.

4.2.7 The indicative design for the CCP accounts for any backpressure in the flue gas flow path by inclusion of a booster fan/ blower to compensate for the pressure drop through the CCP (primarily in the absorbers, direct contact cooler and dampers) which would be of the order of 50-90 mbar, depending on the design .

4.2.8 Based on the gas turbine flue gas flowrate of approx. 1,050 kg/s with a nominal pressure rise of 70 mbar, a booster fan with a power rating of approximately 10 MWe would be required. It would be imperative that in the event of a booster fan trip the HRSG damper opens sufficiently quickly to prevent a build-up in back-pressure in the HRSG ductwork and GT exhaust. This would be achieved by passive and active protection within the damper mechanism and other measures if deemed necessary, to be confirmed during design.

Flue Gas Cooling

4.2.9 The absorption process would require a flue gas cooler to lower the flue gas temperature to an acceptable temperature to enhance the CO_2 chemical absorption and to minimise amine degradation (using MEA as the base case as described in Section 3.3). The flue gas would be routed to a direct contact cooler (DCC), which would quench the flue gas to an acceptable temperature for absorption. A small slipstream of the circulating cooling water would be routed through the DCC water filter to remove particulate build-up. A portion of this particulate free stream would be returned to the DCC; the other portion would be directed to a wastewater treatment plant. Cool, saturated, flue gas from the DCC would be extracted through the booster fan as outlined above.

Carbon Dioxide Absorber

4.2.10 The cooled flue gas from the DCC would be fed to the bottom of the counter current absorber where CO_2 in the flue gas would be absorbed by the solvent. Flue gas would enter near the bottom of the absorber and flow upward through packed beds. CO_2 would react chemically with the solvent and be absorbed into the bulk solution. Rich solvent would leave the bottom of the absorber and be transferred to the stripper by the rich solvent pump.

4.2.11 Stripped flue gas, trace amounts of vaporised amine-based solution and other impurities travel would through a chimney tray and enter the next packed bed, known as the water wash section of the column, where water would be used to recover vaporised amine, trace degradation constituents and water. A wash water circulating pump would circulate the wash water between the absorber and wash water cooler.

4.2.12 The flue gas would then pass through a further chimney tray and into another packed bed, where, if required, a dilute acid solution would flow against the flue gas to provide a final stage of trace constituents' removal. This stage is therefore referred to as the acid wash. Similar to the water wash section, a pump would be employed to circulate the solution. In addition, a purge stream would be present for removal of impurities such as ammonia and amines.

4.2.13 Airborne emissions would be controlled to comply with any emission levels associated with the use of Best Available Techniques (BAT) as set out in the Environmental Permit that would be required for the operation of the carbon capture plant.

4.2.14 Treated flue gas would be vented to the atmosphere via the stack on top of the absorber at a temperature to be determined. The temperature of the flue gas leaving the acid wash section would be approximately 40-45 °C. If required on the basis of air dispersion modelling, the flue gas may be heated to c. 60-65°C by using low pressure steam condensate at c. 100-110 °C.

Carbon Dioxide Desorber (Stripper)

4.2.15 Rich solvent would leave the bottom of the absorber and be routed to the rich/ lean amine heat exchanger system, which would likely feature multiple parallel plate and frame units. This heat exchanger would increase the efficiency of the process by heating the rich amine to >100 °C using the heat in the lean amine stream from the stripper. The pre-heated rich amine would enter the stripper below the wash section of the column through a liquid distributor and flow down through the packed beds counter-current to the vapour from the reboiler system, releasing (‘desorbing’ or ‘stripping’) the absorbed CO_2. The lean amine from the bottom of the stripper would thence be pumped to the rich/ lean heat exchanger system, where it would be cooled against the rich amine from the absorber train. There may be scope for further heat optimisation within the desorption system, which would be evaluated during design.

4.2.16 The significant heat requirement for the desorption process, effected within the reboiler system, would be provided from the steam turbine within the CCGT; at a suitably low pressure to maximise the utilisation of steam within the power plant whilst providing adequate control of stripper column temperature. The quantity of steam required would depend on the solvent employed and the extent of heat optimisation within the CCP. For the proposed MEA solvent, it is anticipated that a ‘specific reboiler duty’ of c. 3.5-4.0 GJ/tonne of CO_2 removed would be required.

4.2.17 To remove impurities from the amine system, c. 10% of the cooled amine would be routed to the amine filter package. This would remove suspended solids and high molecular weight amine degradation products.

Stripper Overhead Condenser

4.2.18 The overhead vapour from the stripper at ~100-105 °C and 1.5-2 bar(a) would be cooled to ~25-30 °C in the overhead condenser, condensing some of the water content. The two-phase flow would enter the separation drum (separating the product gas which would be routed to the CO_2 compression/ conditioning units).

Amine Reclaimer

4.2.19 The amine-based solution would degrade in the presence of oxygen, nitrogen oxides, high temperatures, and corrosion products, leading to the formation and accumulation of undesirable compounds such as heat stable salts. A purification stage known as a thermal reclaimer would therefore be necessary to prevent accumulation of these compounds. The concept design assumes the thermal reclaimer is a kettle-type reboiler. There would be a feed of steam, water and sodium hydroxide to feed the reactions and processes required to recover part of the degraded solvent.

The thermal reclaimer would be expected to operate on an intermittent basis when the content of degradation products exceeds a predefined value.

Carbon Dioxide Compressor

4.2.20 The wet CO_2 from the stripper reflux drum would be routed to an intercooled CO_2 compressor. The captured CO_2 would be compressed and conditioned to meet the delivery pressure and specification required for the CO_2 export pipeline.

Dehydration and Deoxygenation Units

4.2.21 A dehydration package would be required to reduce the water content in the CO_2stream to export specification level, to ensure condensation in the CO_2 pipeline does not occur.

4.2.22 The technology would likely be an adsorbent based system, with the specific vendor to be selected during detailed design. The system would feature various vessels and a regeneration system to remove water from the adsorbent media.

4.2.23 A deoxygenation unit is also required to meet export requirements. This may take the form of a catalytic technique (CATOX), where the CO2 stream passes through a vessel containing a platinum or palladium based catalyst with an injection of hydrogen. The H2 reacts with the oxygen molecules to produce water which is then removed in the dehydration unit. The reaction also takes place at a moderately elevated temperature. To avoid the need for additional steam supply or other 'new' sources of energy, it is anticipated that the heat of compression will be utilised. This will be confirmed during detailed design.

4.2.24 The requirement or otherwise for further species removal such as ammonia and NOx prior to or post carbon capture would be assessed during detailed design based on expected maximum levels present in the flue gas. This would be used to determine BAT for emissions control from the plant.

Cooling System

4.2.25 An amine-based CCP process would have a significant cooling duty, which is estimated at c. 350-400 MWth. The CCP would be proposed to use hybrid cooling towers to address main cooling demands within the CCP process which comprise:

- flue gas DCC cooler;
- lean solution to absorber cooler;

- stripper overhead cooler; and
- CO2 compression intercoolers.

4.2.26 Space has been allocated for the cooling towers that would be needed to meet the cooling demand of both the CCGT and CCP. The CCGT condenser heat duty would correspondingly decrease due to low pressure steam offtake, such that the overall site cooling duty would increase by c. 30-50% compared with CCGT operation alone. The precise level would again depend on the final design configuration and solvent selection. There may also be scope to partially utilise air coolers for certain CCP cooling duties. This would reduce cooling water flowrate and hence abstraction and discharge but would increase site footprint.

Water Treatment

Raw Water

4.2.27 The Proposed Development would require a raw water abstraction of approximately 800 t/h if carbon capture was installed for the Proposed Development (which is already allowed for in the canal water abstraction licence that was obtained for Keadby 3 CCS Power Station and will be used for the Proposed Development). This is for the combined CCGT and CCP and at reference ambient temperature of 10°C and will vary with ambient temperature and humidity. This water will make up for evaporative losses within the hybrid cooling towers as well as the small losses in of the amine/ water solution loop caused by amine degradation or carry over.

Demineralised Water

4.2.28 Demineralised water will be required for supply to the CCGT steam cycle and would also be required for the CCP. During normal operation the CCP may not require demineralised make-up as the processes would be a net producer of water. This would be confirmed during detailed design.

Wastewater

4.2.29 The design of the CCP would include appropriate surface water drainage systems including oil interceptors as necessary, consistent with the surface water drainage systems for the wider power station. Space provision for site drainage e.g. surface water and process water drains has been included in the space allocation for the CCP.

4.2.30 The cooling of the flue gas would result in partial condensation of water vapour within the DCC. This water may contain ammonia if selective catalytic reduction (SCR) NOx removal unit is installed within the CCGT. The technology employed to remove ammonia would be confirmed during design. Air stripping and membrane separation would be possible technologies. The remaining treated water would be utilised within the CCP processes as required with excess likely discharged with the cooling tower blowdown effluent.

4.2.31 Within the CCP absorption and desorption systems, two potential waste streams would be present. These are the absorber acid wash bleed and reclaimer waste. It is envisaged that both would be safely transferred to tankers and treated offsite by specialist waste contractor(s).

4.2.32 The estimated effluent and waste flowrates are identified below in **Table 1**.

Table 1: Indicative Wastewater Output

Wastewater Stream	Approx. Flowrate / Quantities
Hybrid Cooling Tower blowdown	200 t/h
DCC effluent	100 t/h (possible/likely to be discharged with cooling tower blowdown flow)
Acid wash bleed	200-300 kg/h to tanker.
Reclaimer waste	Intermittent, c. 1000 tonnes per year to tanker.

4.2.33 The amine solvent make-up rate would depend on various factors (see paragraph 4.2.19 above). Operational profile, flue gas constituents' concentrations, stripper temperatures, reclaiming campaigns and metallurgical considerations would all influence the mass balance of solvent and degradation products. For MEA, it is anticipated a range of 0.5-1.5 kg solvent make-up per tonne of CO_2 captured would be required.

Electrical

4.2.34 In addition to the utilities described previously, the CCP would require the following utilities.

- electrical power distribution system; and
- fire protection and monitoring system.

4.2.35 The total power requirement of the CCGT and CCP combined would be expected to total approximately 70 MW. Further detail of individual users is presented in **Table 2**.

Table 2: CCGT and CCP Electrical Power Consumption

Area/ Equipment Items	Estimated Consumption (MW)
CO_2 compressor	25

Area/ Equipment Items	Estimated Consumption (MW)
Booster fan	10
Cooling water pumps	10
Water and solvent pumps	5
Hybrid cooling tower fans	5
CCP miscellaneous	5
CCGT power train and balance of plant	10 (excluding cooling tower fans and pumps)
Total	**70**

4.2.36 It is currently proposed that the electrical demand of the CCP would be taken directly from the output of the generating station, reducing the export capacity to National Grid accordingly.

Pipework

4.2.37 Space provision for plant pipe racks has been included in the CCR space allocation.

Control and Instrumentation

4.2.38 The control and instrumentation system for the CCP would be anticipated to be incorporated into the distributed control system of the Proposed Development, i.e. the control room. However, space would be available in the CCR space allocation for standalone control equipment should this be required.

Plant Infrastructure

4.2.39 It is anticipated that major plant may be delivered by road; additionally, an existing Waterborne Transport Offloading Area is available and an additional Abnormal Indivisible Load (AIL) route that could accommodate the largest components of a CCP has been consented under the Town and Country Planning Act 1990 (North Lincolnshire Council application no. PA/2023/1915). There are not considered to be any access constraints that could impede any future construction activities.

4.2.40 The final provisions for plant infrastructure would be detailed in the design of the CCP.

4.3. Identification of Suitable Offshore Area for Carbon Dioxide Storage

4.3.1 The maximum theoretical volume of CO_2 that could be anticipated to be captured during the lifetime of the Proposed Development (if it was to operate using 100% natural gas) is 50.7 million tonnes (assuming approximately 265-270 tCO_2/hour from the plant units, a maximum of 8,000 operating hours per year and a 25-year design lifetime).

4.3.2 The UK's major potential sites for the long-term geological storage of CO_2 are offshore depleted hydrocarbon (oil and gas) fields and offshore saline water-bearing reservoir rocks/ aquifers.

4.3.3 Oil and gas fields and saline aquifers are regarded as prime potential sites for CO_2 storage for the following reasons:

- they have a proven seal which has retained buoyant fluids, in many cases for millions of years.
- often a large body of knowledge and data regarding their geological and engineering characteristics has been acquired during the exploration and production phases of oil and gas development.

4.3.4 As shown in **Plate 1** most of the UK's large offshore oil fields are mainly in the Northern and Central North Sea Basin. The UK's offshore gas fields occur mainly in two areas: the Southern North Sea (SNS) Basin and the East Irish Sea Basin. The DECC CCR guidance (DECC, 2009) suggests that the simplest and most appropriate means of demonstrating there are 'no known barriers' to CO_2 storage is by delineating on a map a suitable storage area in either the North Sea or Irish Sea (Morecambe Bay). Within this delineated area, applicants are advised to identify at least two fields or aquifers, with an appropriate CO_2 storage capacity, which have been listed in either the 'valid' or 'realistic' categories in the DTI's 2006 study of UK Storage Capacity (BGS, 2006), which is provided in Annex D of the CCR Guidance.

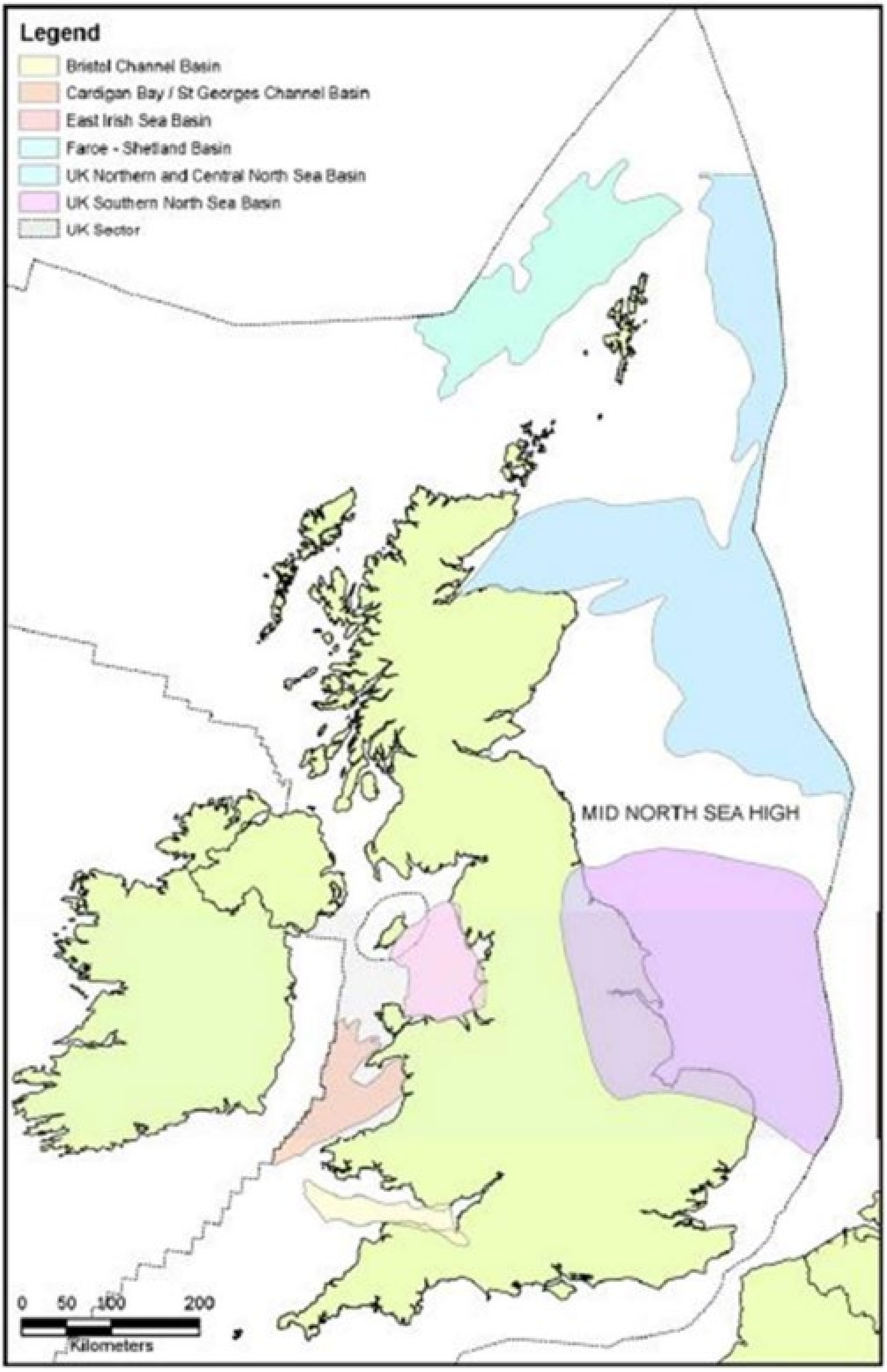


Plate 1: Major Sedimentary Basins of the UK Continental Shelf (BGS, 2006)

4.3.5 The Proposed Development is located in Keadby, North Lincolnshire and therefore the nearest hydrocarbon fields and saline aquifers are located in the SNS Basin. The Viking CCS pipeline that has been consented by third party is proposed to connect to depleted gas fields in this basin.

4.3.6 The CO_2 storage location proposed to be connected to by the Humber Carbon Capture Pipeline (via the Northern Endurance Partnership (NEP)) is the Endurance saline aquifer within the Bunter Sandstone Formation in the SNS basin (formally identified as 5/42 – refer to Figure 2). The estimated total storage capacity of this storage location is approximately 2,700 million tonnes based on the examination as part of the Field Development Report for the White Rose CCS project (DECC, 2016).

4.3.7 Based on the total potential CO_2 storage requirements of the Proposed Development (up to 50.7 million tonnes), the Proposed Development would use approximately 2.0% of the overall capacity of the Endurance saline aquifer. However, any connection to Endurance would form part of the Track 1 expansion project to develop additional saline aquifers for geological storage of CO_2 adjacent to the initial proposed aquifer. The storage capacity of the expanded Endurance site would therefore be much larger than that of the initial reservoir.

4.3.8 The location of the Endurance saline aquifer is illustrated in **Plate 2**.

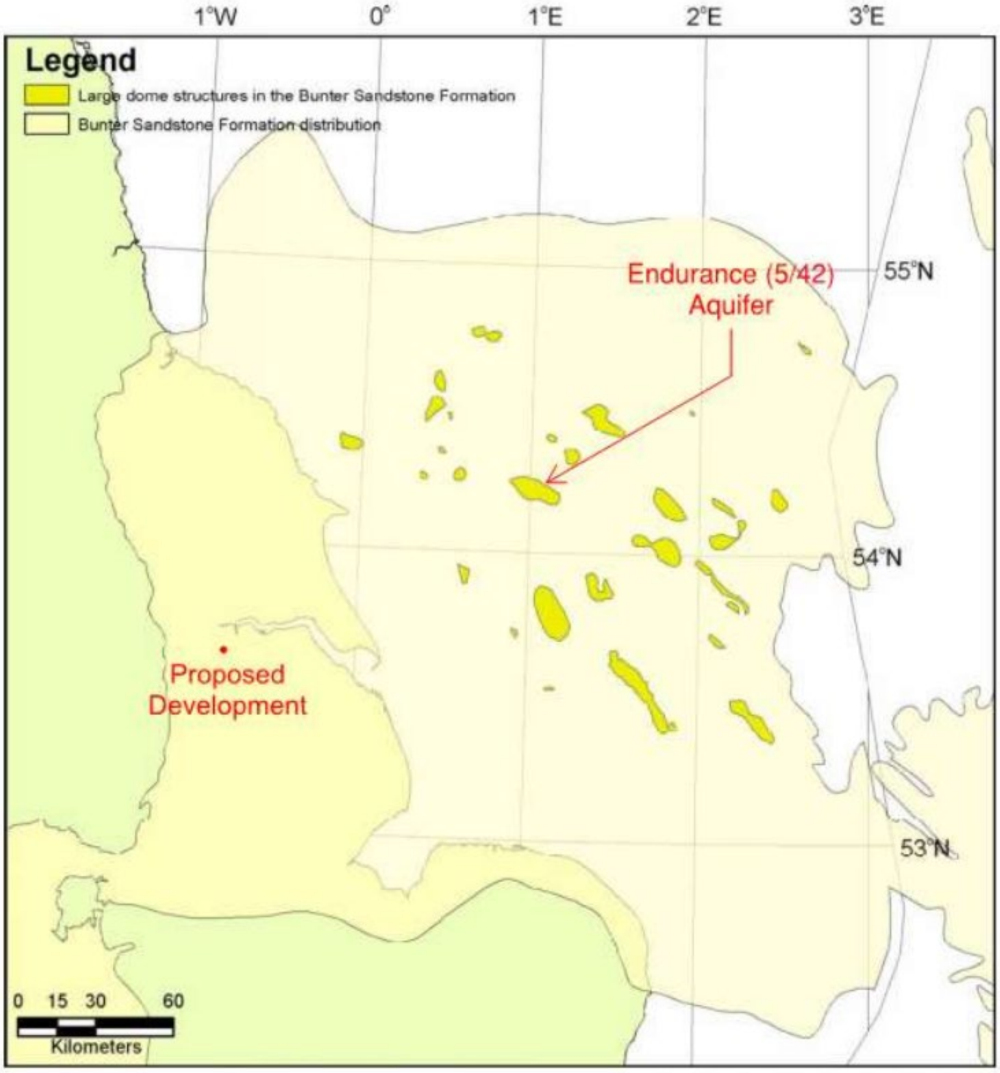


Plate 2: Map of storage sites within the Bunter Sandstone Formation with the location of the Endurance Aquifer (BGS, 2006)

4.3.9 In accordance with the CCR Guidance, the Bunter Sandstone Formation aquifer above is identified as having great potential as a CO_2 storage location in the DTI report (BGS, 2006).

4.3.10 Under the CCR Guidance, the storage assessment should be reviewed on an ongoing basis as part of the two-yearly Status Reports, with a view to incorporating developments in the design for the CCP. The Proposed Development could become an early user of the expanded Endurance store.

4.4. Assessment of the Technical Feasibility of Carbon Dioxide Transport

Overall Route

4.4.1 There are various options available for transporting CO_2 from point of capture to final geological storage, including onshore and offshore transportation by pipeline, and offshore transportation by pipeline or shipping.

4.4.2 The CO_2 captured from the Proposed Development would be transported to the storage site via onshore and offshore pipeline, and separate consents for the routing, construction and operation of the onshore and offshore pipelines are being progressed by third parties, notably NEP and Harbour Energy.

Predominantly Onshore Transport Prior to Transition

4.4.3 Developing networks where clusters of industrial emitters including power stations or other heavy industry adopting CCUS could use the same pipeline infrastructure is the most cost-effective solution for CCUS deployment compared to each installation building its own separate pipeline.

4.4.4 Which carbon capture pipeline network becomes available to the Proposed Development will depend on Government decisions on Track 1 expansion and Track 2 and wider deployment plans for Humberside.

4.4.5 Work No. 11 (**Works Plans, Application Document Ref. 2.3**) would provide sufficient space for the third party CO_2 pipeline operator to build a CO_2 AGI for the Proposed Development's connection

Predominantly Offshore Transport

4.4.6 The offshore pipeline would be developed by third party operator (for example NEP or Harbour Energy) and various proposals are being developed and consented to reuse existing and/ or install new pipelines for the transport of captured CO_2 to permanent storage reservoirs.

4.4.7 It is therefore considered that a feasible route exists to remove the captured CO_2 from the Proposed Development to the storage site identified, if required.

5. Economic Assessment

5.1. Overview

5.1.1 The CCR Regulations require the developer to assess the likelihood that it will be economically feasible to link any proposed power station to a full chain CCUS within the lifetime of the power station, considering the retrofit of capture equipment, CO_2 transport and storage. This Proposed Development is an alternative design to the Keadby 3 CCS Power Station. This alternative design is for a power station to be fired on hydrogen. In order to enable Financial Investment Decisions to be made in a timely manner, permission for both Site options are required, which will enable SSE to pivot to whichever decarbonisation pathway (hydrogen or CCS) becomes technically and commercially viable at the Site first.

5.1.2 The DCO for the CCGT with carbon capture technology (Keadby 3 CCS Power Station) has already been granted, and through that process the Applicant demonstrated that it is economically feasible to link any proposed power station to a full chain CCUS within the lifetime of the power station i.e. from the beginning of operations in that case.

5.1.3 Currently the Government support to CCS deployment covers the operational support to two Track 1 clusters plus in principle support to two Track 2 clusters. Power station emitters looking to connect to a cluster would negotiate a Dispatchable Power Agreement (DPA). The Net Zero Teesside CCGT project has reached agreement on a DPA and that sets out the fiscal mechanism and price support for low carbon power generated by that power station; it is envisaged a similar DPA would be agreed for the Proposed Development if carbon capture was required to be fitted.

6. Health and Safety Assessment

6.1. Pipeline

6.1.1 If carbon capture technology is required, the CO_2 would need to be transported offsite to a dedicated storage facility. In this event it would be likely that the onshore and offshore CO_2 transport from the Site would be in a 'dense phase', i.e. at a pressure greater than 73.9 bar.

6.1.2 CO_2 pipelines are not currently widely deployed in the UK and only some pipeline design codes include CO_2 as a relevant fluid within their scope. European Standards implemented in the UK as British Normative Standards (BS EN series) and supported by published documents (such as the British Standards PD series) provide a sound basis for the design of pipelines.

6.1.3 The DECC CCR Guidance states that, until the health and safety requirements of pipelines conveying dense phase CO_2 have been considered in more depth, such pipelines should be considered as conveying 'dangerous fluids' under the Pipeline Safety Regulations 1996 (PSR) (HSE, 1996) and 'dangerous substances' under the Control of Major Accident Hazards Regulations 2015 (COMAH).

6.1.4 The 'Comparison of risks from CO_2 and natural gas pipelines' (Health and Safety Executive (HSE), 2009) concluded that a loss of containment event from a dense or supercritical phase CO_2 pipeline presents a similar level of risk to a release from a high-pressure natural gas pipeline. As such, designers of CO_2 pipelines should consider applying a similar fluid hazard categorisation (chosen from an established pipeline design code) to that applied to high pressure natural gas pipelines.

6.1.5 Any such pipeline would therefore be considered to be a Major Accident Hazard Pipeline (MAHP). The CO_2 networks being developed by third parties have routed and consented their proposed pipelines on this basis.

6.2. On-Site

6.2.1 If carbon capture technology is installed, dense phase CO_2 would be present in pipework on-site once it has been compressed beyond its critical point prior to transport. Whilst CO_2 is not currently classified as hazardous, HSE recognise that an accidental release of large quantities of CO_2 (particularly in dense-phase) could result in a major accident.

6.2.2 It is not anticipated that bulk storage of dense or gaseous phase CO_2

would be required for the Proposed Development even if carbon capture technology is required to be installed. The only ‘stored’ CO_2 at the Site would therefore be the inventory in the CCP and on-site pipework. This would be envisaged to be less than ten tonnes.

6.2.3 It is envisaged that the CCP plant would require consent under the Planning (Hazardous Substances Consent) 2015 Regulations regime and may trigger the need for lower tier COMAH licensing, based on the inventory of amines and other substances stored on Site. This will be determined at the design stage.

6.2.4 The amine solvent would be stored in sufficient quantities for make-up with strategic reserve, and an additional solvent storage tank may be present for the purpose of ‘dispatchability’, i.e. to allow capture of CO_2 produced during start-up before the CO_2 desorber is fully operational. The total inventory would be established during design.

6.2.5 A Health and Safety Plan covering the works, commissioning and operation of the CCP would be prepared by the Applicant. For design and construction, a competent and adequately resourced Construction (Design and Management) (CDM) Coordinator and Principal Contractor would be appointed. The Applicant would monitor that its own staff, its designers and contractors follow the Approved Code of Practice (ACoP) laid down by the CDM Regulations 2015.

6.2.6 Written procedures clearly describing responsibilities, actions and communication channels would be available for operational personnel dealing with emergencies. Procedures would be externally audited, and contingency plans written in preparation for any unexpected complications.

6.2.7 The Proposed Development is using ‘safety in design’ principles to take into consideration safety issues and risks within the ongoing design, to reduce risks from the installation, as a whole, to as low as reasonably practicable (ALARP). As part of the layout evolution, the following safety in design mitigation hierarchy has been adopted:

- eliminate a hazard; in preference to
- control the hazard; in preference to
- provide personal protective equipment (PPE).

6.2.8 Design mitigation at the current concept design stage includes consideration of potential gas releases and includes (but is not limited to):

- careful equipment and material selection;

- siting of high-pressure gas equipment considering areas of potential exposure and prevailing wind direction;
- incorporation of gas leak detection systems; and
- consideration of venting or flaring arrangements.

6.2.9 If the design of a CCP is required, further consideration would continue, potentially including additional dispersion modelling to confirm whether design mitigation is considered ALARP for the installation as a whole (i.e. future site users and general public). Further detailed evaluation and quantitative risk assessment would continue throughout the design stage.

7. CCR Conclusion and Review

7.1.1 The intention of the Proposed Development in regard to decarbonising is to remove direct CO_2 emissions by using hydrogen as a fuel thereby negating the need for carbon capture. However, to meet current guidance, a CCR assessment is still required and this document demonstrates that suitable space remains available at the Site and that CCS is technically and economically feasible to be retrofitted to the Proposed Development, in the eventuality that Carbon Capture and Storage (CCS) equipment is required.

7.1.2 As it is the intention to deliver low carbon energy through the combustion of hydrogen, and to demonstrate Decarbonisation Readiness by meeting the Hydrogen Conversion Readiness tests which are in development, it is considered that there will be no need to undertake regular reviews of CCR status in the future beyond the date of implementation of the Decarbonisation Readiness requirements in March 2026.

8. References

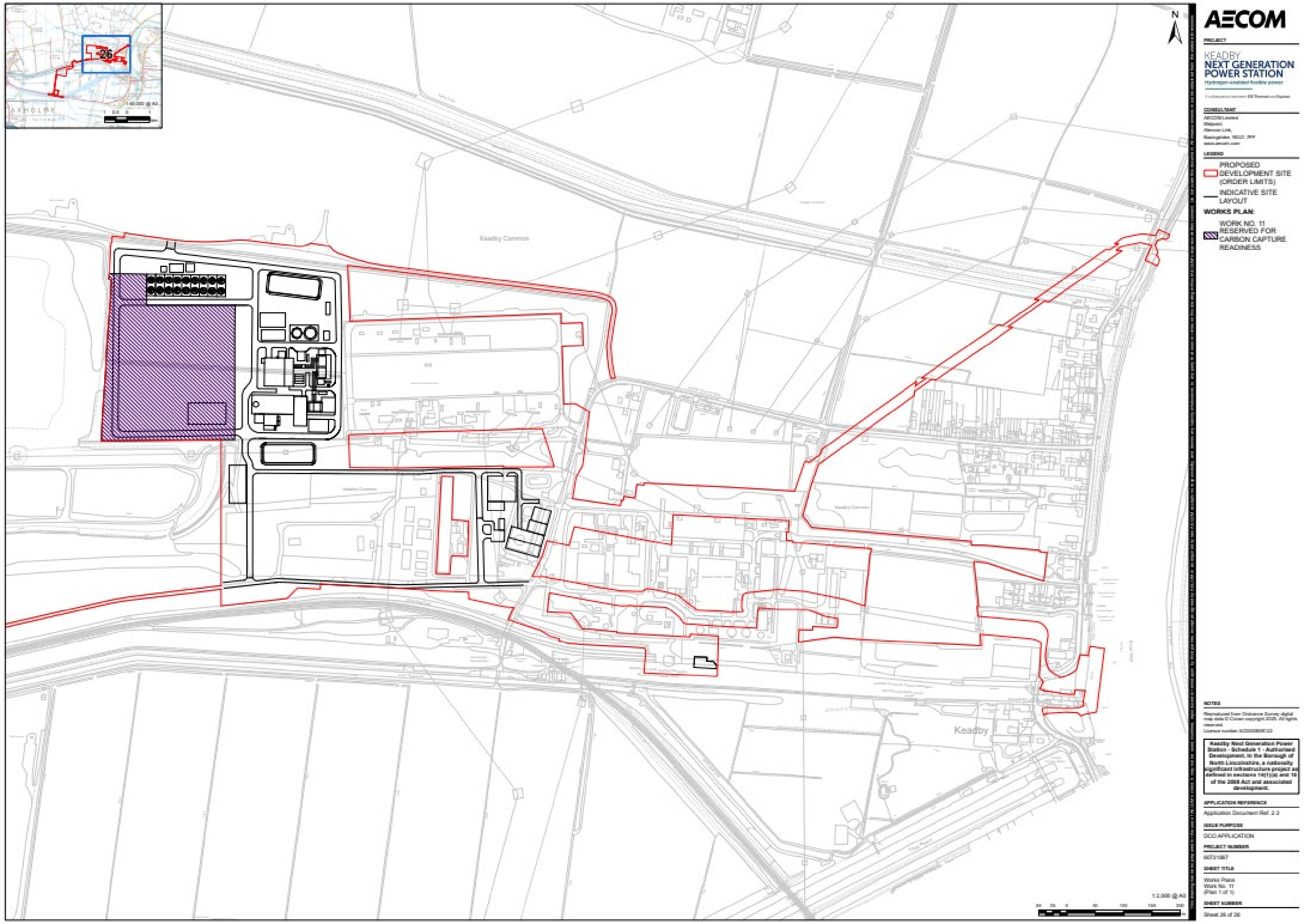
- British Geological Survey (BGS), 2006, Industrial Carbon Dioxide Emissions and Carbon Dioxide Storage Potential in the UK (DTI/Pub URN 06/2027), prepared for the UK Department of Trade and Industry, now the Department of Business Enterprise and Regulatory Reform.)
- Department of Energy & Climate Change (DECC), 2009, '*Carbon Capture Readiness (CCR) – A guidance note for Section 36 Electricity Act 1989 consent application'*. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/43609/Carbon_capture_readiness_-_guidance.pdf [Last Accessed 27.08.25]
- Department for Energy Security & Net Zero (DESNZ), 2022a, '*Decarbonisation Readiness: Consultation on updates to the 2009 Carbon Capture Readiness requirements'.* Available at: https://assets.publishing.service.gov.uk/media/640efb5ad3bf7f02f4c7682c/decarbonisation_readiness_consultation.pdf [Last Accessed 27.08.25]
Department for Energy Security & Net Zero (DESNZ), 2023a, *'Overarching National Policy Statement for Energy (EN-1)*'. Available at: https://assets.publishing.service.gov.uk/media/65bbfbdc709fe1000f637052/overarching-nps-for-energy-en1.pdf [Last Accessed 27.08.25]
- Department for Energy Security & Net Zero (DESNZ), 2023b, '*National Policy Statement for Natural gas Electricity Generating Infrastructure (EN-2)'.* Available at: https://www.gov.uk/government/publications/national-policy-statement-for-natural-gas-electricity-generating-infrastructure-en-2 [Last Accessed 27.08.25]
- Department for Energy Security & Net Zero (DESNZ), 2025. *''Draft Overarching National Policy Statement for Energy (EN-1)'.* Available at: EN-1 Overarching National Policy Statement for Energy [Last Accessed 27.08.25]
- Department for Energy Security & Net Zero (DESNZ), Welsh Government & Department for Business, Energy & Industrial Strategy (BEIS), 2021, *'Decarbonisation readiness: call for evidence on the expansion of the 2009 Carbon Capture Readiness requirements'*. Available at: https://www.gov.uk/government/calls-for-evidence/decarbonisation-readiness-call-for-evidence-on-the-expansion-of-the-2009-carbon-capture-readiness-requirements [Last Accessed 27.08.25]
- Environment Agency (EA), 2025, 'Hydrogen decarbonisation readiness route. Available at:

https://consult.environment-agency.gov.uk/environment-and-business/decarbonisation-readiness-dr-guidance/supporting_documents/section%205%20hydrogen%20decarbonisation%20readiness%20route.docx [Last Accessed 27.08.25]

- Health and Safety Executive (HSE) (2009) Comparison of risks from carbon dioxide and natural gas pipelines. Available online: https://webarchive.nationalarchives.gov.uk/ukgwa/20241206191306/https://www.hse.gov.uk/research/rrhtm/rr749.htm [Last Accessed 27.08.25]

Appendices

Appendix A: CCR Space Allocation (Work No. 11)


N
AECOM
PROJECT
KEADBY
NEXT GENERATION
POWER STATION
CONSULTANT
LEGEND
PROPOSED DEVELOPMENT SITE (ORDER LIMITS)
INDICATIVE SITE LAYOUT
WORKS PLAN:
WORK NO. 11 RESERVED FOR CARBON CAPTURE READINESS
NOTES
Keadby Next Generation Power Station - Schedule 1 - Authorised Development. In the Borough of North Lincolnshire, a nationally significant infrastructure project as defined in sections 14(1)(a) and 15 of the 2008 Act and associated development.
APPLICATION REFERENCE
Application Document Ref. 2.3
ISSUE PURPOSE
DCO APPLICATION
PROJECT NUMBER
SHEET TITLE
Works Plans
Work No. 11
(Plan 1 of 1)
SHEET NUMBER
Sheet 26 of 26
Keadby
26

Appendix B: Hydrogen Readiness

9. Hydrogen Readiness

9.1. Introduction

9.1.1 In July 2021, the UK Government and Welsh Government published a joint call for evidence (DESNZ, Welsh Government & BEIS, 2021) seeking initial views on updating the 2009 Carbon Capture Readiness (CCR) requirements to ensure all new build combustion power plants have a viable route to decarbonisation. Low carbon hydrogen is recognised as a critical component of the UK strategy to deliver energy security and contribute to the National Net Zero Targets (DESNZ, 2022a).

9.1.2 The outcome of the consultation determined that the CCR Regulations will be expanded and updated to Decarbonisation Readiness (DR). In addition the requirements will be moving from the planning consent process to the Environmental Permitting process. The new requirements, called 'decarbonisation readiness', will amend the Environmental Permitting (England and Wales) Regulations 2016 to the Environmental Permitting (Electricity Generating Stations) (Amendment) Regulations 2024. This is expected to come into force in February 2026.

9.1.3 The alternative route to decarbonisation to carbon capture that will be introduced as a result of these changes is through conversion to hydrogen.

9.1.4 The Environment Agency has released a consultation on proposed guidance outlining the requirements of the Hydrogen Decarbonisation Readiness Route (EA, 2025). In the proposed guidance it states the following four tests must be addressed for a development to be considered decarbonisation ready through hydrogen conversion:

- that sufficient space is available on or near the site to accommodate the proposed hydrogen conversion equipment
- that it is technically feasible to convert the combustion power plant to hydrogen firing and detail what modifications will be required
- that there is a suitable plan for hydrogen fuel access
- that the plan is economically feasible.

9.1.5 Applicants must be able to demonstrate that there are reasonable grounds to believe that all of the criteria can be met during the lifetime of the plant.

9.2. Assessment

Sufficient Space

9.2.1 Applicants must be able to demonstrate that there are reasonable grounds to believe that all of the criteria can be met during the lifetime of the plant.

9.2.2 The design and layout of the Proposed Development includes space and provision for any infrastructure required to enable the generating station to operate on hydrogen fuel.

9.2.3 In particular, space has been allocated and reserved for the installation of a hydrogen Above Ground Installation (AGI) to receive hydrogen fuel from a supply network, as well as space for blending of hydrogen and for any necessary supporting infrastructure to enable hydrogen-firing to be optimised.

9.2.4 The Applicant has also considered hazard consultation zones and safety implications for any hydrogen fuel reception at the Site to ensure that the hydrogen infrastructure can be developed and operated while still complying with the necessary COMAH and Hazardous Substances Consent requirements.

Technical Feasibility

9.2.5 The Applicant has worked with technology providers to demonstrate that a 100% hydrogen-fired CCGT can be delivered, installed and operated once a secure and stable supply of hydrogen fuel can be obtained. This includes design and optimisation of burners which can be undertaken when necessary to optimise combustion once the hydrogen fuel is commercially available.

Access to Hydrogen Fuel

9.2.6 The third test of Hydrogen Readiness requires applicants to consider the commercial availability of hydrogen as a fuel.

9.2.7 The Applicant has been working with third party hydrogen producers and suppliers as well as developing its own hydrogen production and storage infrastructure in order to help develop the commercial deployment of hydrogen fuel both nationally and in proximity to the Proposed Development. The Applicant retains close links with East Coast Hydrogen and Project Union both of which aim to develop a hydrogen supply network and infrastructure to enable industry and power generation sites to switch from natural gas to hydrogen. Indeed, the development of this project in part will help stimulate the required investment in hydrogen production, storage and supply infrastructure, since it will be a significant potential offtaker designed for that purpose. The Applicant engages regularly with the UK Government on the development of the supportive policy frameworks which will be required to establish hydrogen production, transport and storage, including bilaterally as a developer of infrastructure and through industry working groups.

9.2.8 Any such switch will need Government pricing support through the Hydrogen to Power business model.

9.2.9 There are therefore reasonable grounds to consider that it will be possible to ensure access to a sufficient supply of hydrogen for use in the Proposed Development.

Economic Assessment

9.2.10 As discussed above, any CCGT switching to hydrogen fuel will need a combination of support through a Capacity Market agreement or Availability Payment as part of a Hydrogen to Power business model (H2PBM) contract, and one of:

- Price support to enable hydrogen-fired plant to displace natural gas fired plant in the electricity market, as part of a H2PBM contract; or
- A high and stable carbon price which will incentivise the dispatch of low carbon electricity generation plant, such as hydrogen to power, relative to higher carbon alternatives such as natural gas fired plant.

9.2.11 SSE engages regularly with the UK Government Department for Energy Security and Net Zero (DESNZ) on policy development on the Capacity Market and the development of the H2PBM, including through DESNZ's Hydrogen to Power Industry Working Group.

9.3. Conclusion

9.3.1 Based on the assessment presented above, it is concluded that the Proposed Development meets the Hydrogen Readiness tests and is therefore considered to be Hydrogen Ready.