CONTENTS

TABLES

4.0 THE PROPOSED DEVELOPMENT

4.1 Introduction

4.1.1 The Proposed Development comprises the construction, operation (including maintenance) and eventual decommissioning of a low carbon Combined Cycle Gas Turbine (CCGT) with a gross electrical generating capacity of up to 910MW to be located on land in the vicinity of the Keadby Power Stations (the existing Keadby 1 Power Station and Keadby 2 Power Station, which is under construction) near Scunthorpe in North Lincolnshire (the Proposed Development Site).

4.1.2 The low carbon CCGT generating station will be fuelled by natural gas and requires electricity and cooling water connections. It will be designed to operate with a post-combustion carbon capture plant (CCP) installed and will generally be operated as a dispatchable low carbon generating station. A schematic of the Proposed Development is shown in **Plate 4.1**.

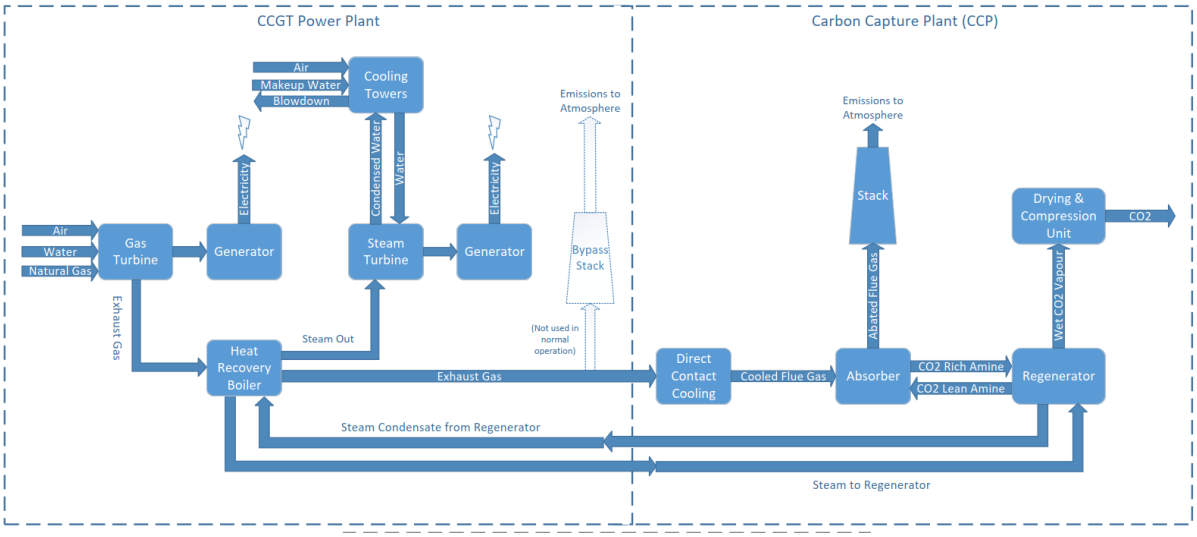

Plate 4.1: The Proposed Development

4.1.3 The Proposed Development has been sited to be able to connect into the emerging proposals for the Humber Low Carbon Pipeline being developed by National Grid Carbon (NGC) to connect carbon emitters in the region and transport the captured carbon dioxide onshore to Easington. The proposals form part of the Zero Carbon Humber (ZCH) Partnership as shown on **Plate 4.2.** The onward transport of carbon dioxide to an off-site geological store is to be developed by the Northern Endurance Partnership (NEP). The Endurance geological storage facility will be operated under a licence from the Oil and Gas Authority (OGA) and regulated by the OGA under a storage permit.

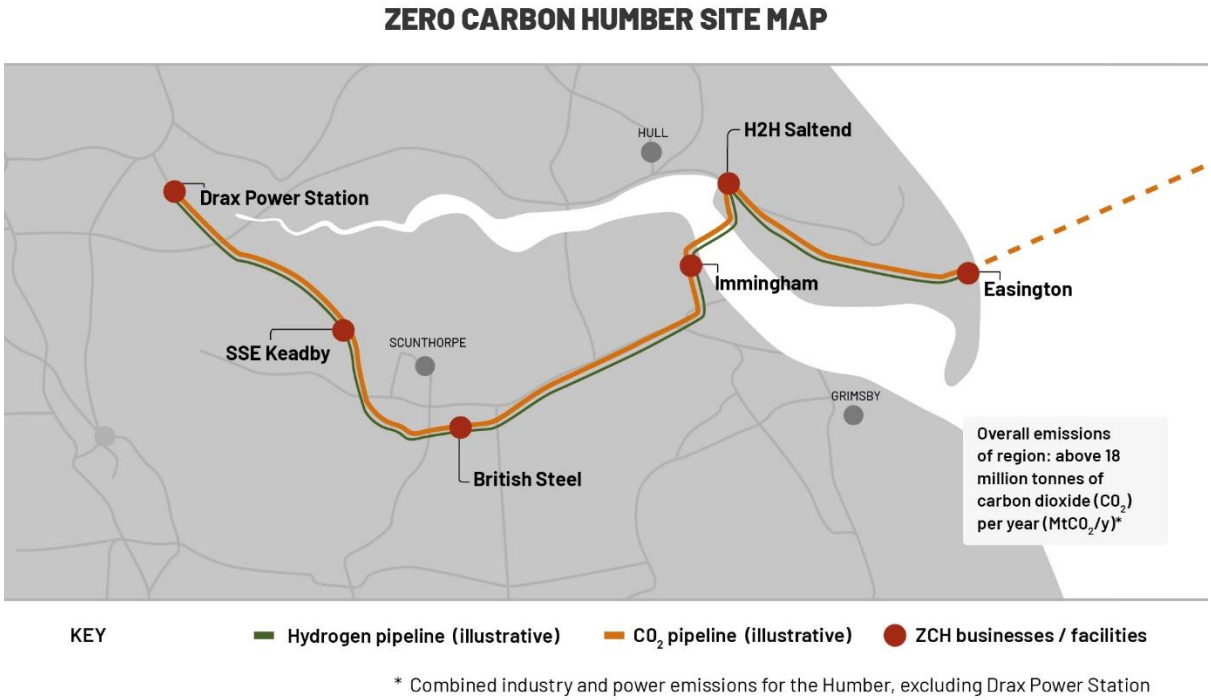

Plate 4.2: Zero Carbon Humber Partnership Proposals

4.1.4 The Applicant would not build the CCGT without the CCP, as the Applicant is fully committed to building a generating station which has a clear route to decarbonisation. Further information is provided in **Chapter 1: Introduction** and **Chapter 2:** Assessment Methodology (ES Volume I – **Application Document Ref. 6.2**). An indication of the likely approach to development of this third party infrastructure is described in Section 4.3.

4.1.5 The Applicant has progressed concept design work on the preferred low carbon option having initially also considered an alternative low carbon technology pathway using hydrogen firing as reported in the Environmental Impact Assessment (EIA) Scoping Report (**Appendix 1A**, ES Volume II – **Application Document Ref. 6.3**). Further information on the alternatives considered and reasons for selection of the preferred option is presented in **Chapter 6**: Consideration of Alternatives (ES Volume I - **Application Document Ref. 6.2**).

4.1.6 The National Infrastructure Plan (NIP) (HM Treasury, 2014) sets out a vision for the development of infrastructure within the UK and in doing so, reinforces the Government's commitment to investing in infrastructure and improving its quality and performance. In relation to the UK Energy System, the NIP states that strategic investment in gas and low carbon electricity generation is vital in order to replace ageing energy infrastructure, maintain secure energy supplies and meet legally binding environmental targets.

4.1.7 Given the inherent intermittency of the primary forms of renewable energy (onshore wind, offshore wind and solar photovoltaics), other sources of generation are required in order to complement renewables whilst maintaining security of supply. This is acknowledged by the NIP which reports that 'New

gas plant is also needed as a vital backup for less flexible renewable generation and to ensure that the system can meet peak electricity demand' (NIP, 2014). More recently, the National Infrastructure Commission (NIC) has highlighted the role of flexible generation as playing a vital role alongside a 'highly renewable power system' (NIC, 2020).

4.1.8 The Energy White Paper – Powering our Net Zero Future' (EWP) (HM Government, 2020), presented to Parliament in December 2020 has at its core the commitment to achieve Net Zero and tackle climate change. The EWP seeks to put in place a strategy for the wider energy system that transforms energy, supports a green recovery and creates a fair deal for consumers, confirming the Government's support for carbon capture, usage and storage (CCUS) (drawing upon the resource provided by the North Sea). The EWP constitutes government policy, and also sets out a timescale for updating the Energy National Policy Statements.

4.2 Proposed Development

4.2.1 The Proposed Development includes the following elements (references to 'Work No.' are to the corresponding Work Numbers in Schedule 1 of the draft DCO (**Application Document Ref. 2.1** – and the location of each Work No. within the Proposed Development Site is shown on the Works Plans (**Application Document Ref. 4.3**):

- a new build carbon capture enabled electricity generating station fuelled by natural gas and with a gross electricity generating capacity of up to 910MW ('the Low Carbon Gas Power Station' - **Work No. 1**) comprising:
  - a CCGT plant (**Work No. 1A**);
  - cooling infrastructure (**Work No. 1B**);
  - a CCP (**Work No. 1C**);
  - natural gas receiving facility (**Work No. 1D**);
  - supporting facilities including administration and control buildings, workshops, stores, raw water storage tank(s), demineralised water treatment plant including storage tanks and permanent laydown areas for operation and maintenance activities (**Work No. 1E**);
- a high pressure gas pipeline to supply the CCGT including a gas compound for National Grid Gas's (NGG) apparatus (**Work No. 2A**) and a gas compound for the Applicant's apparatus (**Work No. 2B**) (**Gas Connection Corridor**);
- electrical power export lines from the Low Carbon Gas Power 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. 3A – Electrical Connection Area to National Grid 400kV Substation**); and up to 132 kilovolt underground electrical cables to the Low Carbon Gas Power Station from the existing Northern Powergrid Substation located at Chapel Lane, including works within the substation, for the supply of electricity at up

to 132kV to the Proposed PCC Site (**Work No. 3B - Potential Electrical Connection to Northern Powergrid Substation**);

- water supply connections works (**Water Connection Corridor**) to provide cooling and make-up water to the Low Carbon Gas Power Station, comprising either:
  - intake structures and an underground and/ or overground water supply pipeline running between Work No. 1E and the Stainforth and Keadby Canal (**Work No. 4A – Canal Water Abstraction Option**); or
  - in the event that the canal abstraction option is not available, works to the existing Keadby 1 Power Station cooling water supply pipelines running between Work No. 1E and existing intake structures within the River Trent (**Work No. 4B – River Water Abstraction Option**);
- use of an existing outfall and associated pipework for the discharge of return cooling water and treated wastewater to the River Trent (**Work No. 5 - Water Discharge Corridor**);
- towns water connection pipeline from existing water supply within the Keadby 1 Power Station to provide potable water to Work No. 1 (**Work No. 6**);
- above ground carbon dioxide compression and export infrastructure comprising an above ground installation (AGI) for the undertaker's apparatus including deoxygenation, dehydration, staged compression facilities, outlet metering and electrical connection (**Work No. 7A**) and an AGI for NGC apparatus (**Work No. 7B**);
- new permanent access to the Low Carbon Gas Power Station (**Work No. 8**), comprising:
  - maintenance and improvement of an existing private access road from the A18, including replacement of private bridge (Mabey Bridge) and improvement of the existing junction with the A18 (**Work No. 8A**);
  - installation of layby and gatehouse with barriers, enclosures, drainage and lighting north of the A18 junction (**Work No. 8B**); and
  - emergency access route comprising the maintenance and improvement of an existing private track running between the Low Carbon Gas Power Station and Chapel Lane, Keadby and including new private bridge crossing, (**Work No. 8C – Emergency Vehicle Access Road**);
- temporary construction and laydown areas (**Work No. 9A** - Construction Laydown Areas); and the maintenance and improvement of the existing paved haulage routes running between the construction laydown areas including the skew bridge (**Work No. 9B**); and a temporary construction laydown area associated with Mabey Bridge replacement (**Work No. 9C**);
- retention, construction and subsequent removal of existing temporary haulage route (**Work No. 10A – Additional Abnormal Indivisible Load Route**) and the inspection and repair of the existing jetty, and temporary placement of mobile cranes including the temporary oversailing of crane arms (**Work No. 10B – Waterborne Transport Offloading Area**); and

- Landscaping, planting and biodiversity enhancement measures (**Work No. 11A**); and security fencing and boundary treatment (**Work No. 11B**).

4.2.2 To the extent that it does not form part of any of the above works, further associated development within the meaning of the 2008 Act is proposed and has been assessed within the ES comprising:

- surface water drainage systems, including works to existing drainage systems;
- electrical, gas, potable water supply, foul water drainage and telecommunications infrastructure connections and works, and works to alter the position of such services and utilities connections;
- hard standings and hard landscaping;
- soft landscaping, including bunds and embankments;
- external lighting, including lighting columns;
- gatehouses and weighbridges;
- closed circuit television cameras and columns and other security measures;
- site establishment and preparation works, including site clearance, earthworks and excavations; temporary construction access; alteration of services and utilities; and works for the protection of buildings and land;
- temporary construction laydown areas and contractor facilities, including materials and plant storage and laydown areas; generators; concrete batching facilities; vehicle and cycle parking facilities; pedestrian and cycle routes and facilities; offices and staff welfare facilities; security fencing and gates; external lighting; roadways and haul routes; wheel wash facilities; and signage;
- vehicle parking and cycle storage facilities;
- accesses, roads and pedestrian and cycle routes; and
- temporary works associated with the maintenance of the authorised development.

4.2.3 Each part of the Proposed Development is described in further detail below. The maximum (and where relevant minimum) dimensions of each component are detailed in Section 4.3 of this chapter.

4.2.4 The Low Carbon Gas Power Station including the associated CCP facilities are referred to as the 'Proposed PCC Site' in this ES. Further details of the Proposed Development are set out in Section 4.3. The areas of the Proposed Development Site described above are shown in **Figure 3.3** and an indicative Site Layout Plan is included as **Figure 4.1** (ES Volume III - **Application Document Ref. 6.4**).

4.2.5 The Proposed Development is a 'first of a kind' for this type of power station infrastructure project and would represent one of the UK's first power stations with carbon capture and storage (CCS) technology. Consequently, at this

consenting stage of the project, a number of the design aspects and features of the Proposed Development cannot be confirmed until the detailed design of the Proposed Development has been completed. For example, the building sizes may vary, depending on the Engineering, Procurement and Construction (EPC) contractor selected and their specific configuration and selection of plant and equipment. It is also important that the consent retains some flexibility to allow for changing economic conditions and the advancement of CCGT and CCP technology in the period between preparing the Application and starting construction.

4.2.6 In order to ensure a robust assessment of the likely significance of the environmental effects of the Proposed Development, the EIA has been undertaken adopting the principles of the 'Rochdale Envelope' approach, where appropriate in accordance with the Planning Inspectorate's Advice Note 9: The Rochdale Envelope (PINS, 2018). This involves assessing the maximum (or where relevant, minimum) parameters for the elements where flexibility needs to be retained (such as the building dimensions or operational modes for example). Where this approach has been applied to the specific aspects of the EIA, this is confirmed within the relevant chapters of this ES.

4.2.7 Justification for the need to retain flexibility in certain parameters is outlined in this chapter and also in **Chapter 6:** Consideration of Alternatives (ES Volume I – **Application Document Ref. 6.2**). As such, this ES presents a reasonable worst-case assessment of the potential impacts of the Proposed Development at its current stage of design.

4.2.8 Construction of the Proposed Development is described in **Chapter 5**: Construction Programme and Management (ES Volume I - **Application Document Ref. 6.2**). At this stage in the project development, a detailed construction programme is not available as this is normally determined by the EPC contractor(s) which has/ have not yet been appointed; however, an indicative construction programme is presented within **Chapter 5**: Construction Programme and Management (ES Volume I – **Application Document Ref. 6.2**) on which the potential environmental effects of the Proposed Development have been assessed.

4.2.9 Construction of the Proposed Development could (subject to the necessary consents being granted and an investment decision being made) start as early as Quarter 4 2022. Assuming an approximate three and a half year construction programme followed by a period of commissioning, the Proposed Development is unlikely to commence commercial operation before 2026 with timescales for commercial operation linked to the development of the Humber Low Carbon Pipeline (HLCP) proposals by NGC into which the Proposed Development will connect.

4.2.10 The Applicant is collaborating with NGC and other partners as part of the ZCH Partnership and NGC has confirmed their intentions to route the HLCP through the Keadby Power Station site. At the time of submission of this Application, NGC has confirmed to PINS that routing and siting feasibility and relevant surveys for the HLCP are being progressed and it is anticipated that non-

statutory consultation for the HLCP DCO application will be completed in Q3 2021, with EIA scoping planned for Q4 2021 after non-statutory consultation. The HLCP DCO application is expected to be submitted to the Planning Inspectorate in Q3 2022. On this basis, determination of that DCO application is therefore anticipated in 2024/ 2025 after which, construction could commence. Permitting in relation to the NEP carbon dioxide storage proposals is noted by NGC to be being progressed in parallel, with offshore survey work planned in 2021 to support assessments and the permit application for the Endurance site. The ongoing work is considered by NGC to be sufficiently advanced to provide confidence of a full chain scheme. Further information on the proposed operation is provided in Section 4.4.

4.2.11 It is envisaged that the power generation and carbon capture elements of the Proposed Development will have a design life of circa 25 years. At the end of the design life, these elements would be assessed for ongoing viability and only if no longer viable, be decommissioned as outlined in Section 4.5 below. It is therefore anticipated that, at the earliest, decommissioning of the Proposed Development would be expected to commence at some point after 2051. This ES has assumed that the Proposed Development could operate for longer than a 25 year design life, and in relevant chapters has considered and assessed the potential for operational impacts/ effects to continue beyond this timeframe. If the operating life were to be extended, the Proposed Development would be upgraded in line with the legislative requirements at that time.

4.2.12 A combined heat and power (CHP) Assessment has been prepared to accompany the Application (**Application Document Ref. No. 5.7**). This considers the feasibility of installing CHP and concludes that:

- the Proposed Development meets the best available techniques (BAT) tests outlined in the CHP-Readiness (CHP-R) Guidance;
- there is a potential to supply up to 95MWth and 46MWth of waste heat for local district heating at full load and part load respectively, recognising that steam and heat from the generating station is to be utilised in the CCP where feasible and also that the plant is expected to operate primarily in dispatchable mode (intermittently) rather than baseload (all the time);
- there are a number of theoretical identified heat users within a 15km radius of the Proposed Development Site and although there are large heat loads related to domestic, small industrial and education within the study area, none of these offer economically viable opportunities for a heat network; and
- CHP is therefore not proposed to be installed from the outset, but the Proposed Development will be CHP-R with the inclusion of connection flanges at suitable locations to export waste heat in the future should this become viable.

4.2.13 This is considered to be BAT for plant such as the Proposed Development.

4.2.14 The electrical, steam, steam condensate and water circuits between the power generation and capture plant will be integrated as far as is reasonably practicable in order to reduce energy use. For example, steam will be extracted

from the HRSG for use in the capture plant and, once used, condensed and returned to the HRSG for re-use.

4.3 Components of the Proposed Development

4.3.1 This section provides further detail on the components of the Proposed Development within the Proposed Development Site. A full detailed description of the different areas of the Proposed Development Site is detailed provided within **Chapter 3**: The Site and Surrounding Area (ES Volume I - **Application Document Ref. 6.2**) and these are illustrated on the accompanying **Figure 3.3**: Areas of the Site Described in ES (ES Volume III - **Application Document Ref. 6.4**).

The Proposed PCC Site

4.3.2 The Low Carbon Gas Power Station will comprise a single high efficiency CCGT unit and associated CCP to be developed on the Proposed PCC Site shown on **Figure 3.3** in ES Volume III (**Application Document Ref. 6.4**).

4.3.3 Given the first of a kind nature of the Proposed Development (refer to paragraph 4.2.5), the design assessed in this ES is based on a range of the most likely CCGT equipment to be used and most likely licensor designs for the CCP; this means that there may be a range of electrical output of the Low Carbon Gas Power Station depending on the technology selected; at this stage in project design therefore, the largest unit currently commercially available has been selected as the conservative basis for assessments, unless otherwise stated.

4.3.4 The maximum electrical power generation will be seasonally dependent; for example, the power station is anticipated to generate maximum electricity in the winter when air density is at its highest. The operation of the CCP systems will reduce the amount of electricity that can be exported from the Proposed Development to the UK transmission system.

4.3.5 In abated mode, when the CCP is in operation, the net output could reduce depending on whether the Electrical Connection to the 132kV Northern Powergrid Substation (**Work No. 3B**) is used to supply low voltage electricity – accordingly the range of carbon-abated electrical export is likely to be in the range of around 750 MWe to 840 MWe.

4.3.6 As described in Section 4.4, there may be some occasions when the CCGT operates in unabated mode (without carbon capture) when power output increases, ranging from around 840 MWe to over 870 MWe. Since power outputs increase with cooler ambient temperatures, the maximum outputs for any chosen configuration can periodically be higher than this. The power output is ultimately limited by the Grid Connection which is rated at 910 MWe.

4.3.7 The Proposed PCC Site is illustrated on **Figure 4.1**: Indicative Layout Proposed PCC Site (ES Volume III - **Application Document Ref. 6.4**) and comprises an integrated power generation and carbon capture train encompassing:

- a gas turbine;

- a heat recovery steam generator (HRSG);
- a steam turbine;
- gas and steam turbine buildings;
- gas turbine air intake filters;
- selective catalytic reduction (SCR) equipment for the removal of nitrogen oxides (NO_x) from the flue gas;
- CCP comprising a direct contact cooler (DCC) and associated pumps, one or two absorber column(s) for carbon capture and solvent regenerator/ carbon dioxide stripper enabling re-concentration of the solvent and separation of captured carbon dioxide;
- carbon dioxide treatment plant, including low/ medium pressure compression and metering equipment;
- cooling infrastructure, comprising hybrid cooling cells and associated pipework, plant and buildings;
- natural gas reception facility including National Grid and Applicant AGI, gas conditioning, let down and metering equipment and instrumentation and electrical building;
- stack(s) for the discharge of treated flue gas from the absorber column(s) plus a stack to discharge emissions to air from the HRSG if required;
- a continuous emissions monitoring system (CEMS);
- transformers (for the import and export of electricity); and
- facilities required in connection with the above including: an auxiliary boiler, an emergency diesel generator, and associated diesel storage tanks; water treatment plant; wastewater treatment plant; ancillary equipment (including air compressors, pumps, chemical storage, above ground demineralised and fire water storage tanks and associated infrastructure).

4.3.8 The Proposed PCC Site will also include:

- a gatehouse, security building and staff parking;
- permanent plant laydown area for operation and maintenance activities;
- administration, control and stores buildings; and
- a surface water drainage system comprising pond(s) and/ or a tank or similar.

4.3.9 The administration/ control building(s) would contain the main reception, offices, control room, electrical equipment and staff welfare facilities.

4.3.10 Stores building(s) would be required for operation and maintenance activities and storage of materials.

4.3.11 There would be provision for several car parking spaces and cycle storage on-site for operational use. Additional car parking spaces would be provided to support outages, if required.

4.3.12 Each of the main components of the Proposed PCC Site is described below.

Power Generation and Associate Stack

4.3.13 Natural gas that has been conditioned to the required temperature and pressure in the Natural Gas Connection (**Work No. 2**) will be combusted in the CCGT (**Work No. 1A**). The gas turbine selected will be provided with dry low NO_x (DLN) burners to minimise the formation of NO_x.

4.3.14 Following combustion in the gas turbine, the hot product gases expand across the blades of the turbine causing it to rotate and drive an electrical generator. The gas turbine exhaust gases are passed through the HRSG to recover the useful heat in order to produce steam (at various pressures) which is used to generate further power via a separate steam turbine, and for heating of process streams within the CCP.

4.3.15 The flue gases will then be further treated with SCR to further remove NO_x to the required emissions limits and to reduce the NOx levels entering the absorber. The SCR will be supplied with urea or aqueous ammonia feedstock to treat the flue gas NO_x which will be converted into nitrogen and water vapour in the flue gas.

4.3.16 During normal (abated) operation, the flue gases will enter the integrated CCP. However, during outages of the CCP, it will be possible to discharge exhaust gases through a dedicated stack above the HRSG building, which will be fitted with CEMS instrumentation.

4.3.17 Spent steam exhausting from the steam turbine will be cooled and condensed with the condensate returned to the steam-water cycle of the HRSG for continued re-use. Water used within this steam/ water cycle will be treated to minimise the build-up of residual dissolved solids in pipework arising from the continuous evaporation and condensing of water within the cycle. To further manage this, it will be necessary to purge a small amount of the recirculating water (known as 'boiler blowdown') intermittently. Boiler blowdown water removed from the cycle will be replaced with fresh demineralised water.

4.3.18 The condensation of steam exiting the steam turbine will be achieved using wet/ dry (hybrid) cooling towers (**Work No. 1B**) which are specifically designed to minimise the formation of visible plumes, although some may occur dependent on the ambient weather conditions.

4.3.19 An emergency diesel generator is required in order to provide a short-term source of electricity, in the event of a simultaneous loss of power generation and external power supply, to provide power for emergency and safety critical equipment until external power can be re-established.

Selective Catalytic Reduction

4.3.20 Combustion of natural gas is highly efficient and, due to the nature of the fuel, the combustion gases from a typical CCGT plant contain negligible amounts of sulphur dioxide (SO_2) and particulate matter. In addition, the optimisation of combustion within a gas turbine is well understood, such that the emissions of NO_x and carbon monoxide (CO) are carefully controlled by design and typically through the implementation of primary control measures such as burner design and staged combustion.

4.3.21 In August 2017, revised Best Available Techniques (BAT) Conclusions for Large Combustion Plants were published, which set out the Achievable Emission Levels (AEL) for combustion plant, including new CCGT. These AEL may not be consistently achievable in high efficiency CCGT plant when only using primary control measures (such as use of DLN burners). In addition, NO_x concentrations in the flue gases entering the CCP need to be minimised to prevent the degradation of solvent within the CCP and in order to optimise the carbon dioxide capture efficiency.

4.3.22 SCR is therefore proposed to control NO_x levels entering the carbon capture system. SCR is a secondary abatement technique typically involving either the injection of ammonia or urea into the flue gas to react with any NO_x present in the presence of a catalyst. The SCR equipment will be installed adjacent to the HRSG, as is common practice within the power industry.

4.3.23 The level of NO_x removal required is the subject of ongoing technical studies regarding the capture plant and emission limits that will be required to be met from the generating station and will be partially dependent upon the sensitivity of the carbon capture solvent to NO_x. These studies will seek to optimise the operation of the plant in order to maximise efficiency and minimise emissions and waste.

4.3.24 The Air Quality assessment of NO_x emissions (**Chapter 8**: Air Quality (ES Volume I, **Application Document Ref. 6.2**)) has assumed NO_x emissions at the BAT-associated emission levels (BAT-AEL), set out in the BAT Reference Document (BREF) for Large Combustion Plants (European Commission, 2017), since as a minimum it is expected that these emission levels must be met.

4.3.25 In a conventional CCGT plant, the flue gas from the SCR is released to atmosphere from the HRSG exhaust stack. However, in the Proposed Development, the flue gas from the HRSG post-SCR will be directed into the CCP for the removal of carbon dioxide from the gas stream. However, there will still be an HRSG stack for use at times when the CCP is not operational and the plant is operating without carbon capture. These occurrences are expected to be infrequent.

Carbon Capture Plant and Associated Stack(s)

4.3.26 The CCGT unit will be served by a dedicated and fully integrated CCP (**Work No. 1C**) as shown in **Diagram 4.1** and will include:

- flue gas pre-treatment, including cooling/ scrubbing;
- flue gas blower;
- carbon dioxide absorption column(s) (absorber) and associated stack(s);
- carbon dioxide removal column (stripper/ regenerator); and
- ancillary equipment (including heat exchangers, air compressors, pumps, chemical storage, water treatment plant and associated inter-connecting pipework).

4.3.27 The CCP will be designed to be capable of capturing over 90% of the carbon dioxide emitted from the generating station, with an average capture rate of around 90%. At full load, this could equate to a capture of just over two million tonnes of CO_2 per year, dependent upon the turbine equipment chosen and the dispatch load factor of the power plant.

4.3.28 Prior to their introduction into the absorber column, the flue gases from the generating station will be cooled to the optimal carbon capture plant design temperature (approximately 35°C) by using a DCC that quenches the hot flue gases with a fine water spray in a column using indirect cooling by the hybrid cooling towers. Cooled water is returned to the DCC in a closed loop cycle.

4.3.29 Once cooled, the flue gases from the generating station will be introduced to one or two absorber column(s). In the column(s), the flue gases will be passed through a solvent that will remove the carbon dioxide from the gas stream. The solvent to be used is the subject of ongoing technical studies but is assumed to be an aqueous solution of amines. The alkaline nature of the solvent will mean that it will selectively absorb acidic gases such as carbon dioxide.

4.3.30 Even with the use of SCR technology, it will not be possible to entirely remove NO_x or other impurities from the flue gases from the generating station which include the residual oxygen from combustion. Therefore, some ongoing degradation of the solvent is to be expected, mainly managed by solvent reclaiming.

4.3.31 The reclaiming process concentrates the residual impurities which will be purged from the process. The capture solvent loop will normally be operated in a neutral balance of water i.e. without continuous make-up consumption or effluent production (other than the reclaimer sludge mentioned above). However, provision will be made for an occasional purge of liquid if excess condensation and therefore accumulation occurs in the process.

4.3.32 A flue gas washing unit will be located within the absorber column(s) to remove entrained solvent and potentially ammonia from the flue gases. The carbon dioxide lean flue gases (treated flue gas) will then be treated to remove entrained mist droplets.

4.3.33 A flue gas heater may be required in the absorber column(s). Waste heat from the steam condensate stream will be used to increase thermal buoyancy of the treated, washed flue gas, before release from the top of the absorber column(s) via dedicated stack(s) for dispersion to the atmosphere.

4.3.34 Carbon dioxide rich solvent from the absorber(s) will pass from the bottom of the absorber column(s) to a stripper column for regeneration. The stripper column uses heat (steam) to release the carbon dioxide from the solvent. The hot carbon dioxide lean solvent then leaves the stripper column and is recirculated via a heat exchanger, back to the top of the absorber column(s).

4.3.35 The carbon dioxide gas exiting the top of the stripper column will be passed through a condenser to remove water and solvent vapours. The carbon dioxide stream will then pass to the carbon dioxide conditioning/ compressor unit.

Carbon Dioxide Conditioning and Medium Pressure Compressor Unit

4.3.36 The gaseous carbon dioxide stream from the CCP will be saturated with water and will contain traces of oxygen which will need to be reduced in a gas conditioning facility to achieve a specification agreed with NGC prior to export to the Humber Low Carbon Pipeline and gathering network.

4.3.37 The conditioning equipment/ processes are the subject of ongoing technical studies and discussions with NGC; however, it is envisaged that the captured carbon dioxide stream will be cooled and partly compressed before the trace oxygen and water are removed. Following treatment, the carbon dioxide stream will be compressed to pipeline pressure for export, measured in a metering station and transferred into the Humber Low Carbon Pipeline.

Carbon Dioxide Export Pipeline

4.3.38 The Proposed PCC Site has been sited to connect into the carbon dioxide gathering network including an export pipeline that is being designed and will be operated by NGC as part of the ZCH Partnership. It is expected that the HLCP will extend into the Keadby Power Station site to facilitate a connection from the Proposed Development. The Applicant continues to engage with NGC in relation to routing and the parties are collaborating to identify options for pipeline routes, taking into consideration technical and environmental opportunities and constraints. **Chapter 19**: Cumulative and Combined Effects (ES Volume I – **Application Document Ref. 6.2**) provides further information on the assessment of cumulative impacts and effects of the carbon dioxide export pipeline.

4.3.39 The development of the carbon dioxide export pipeline is being progressed under a separate DCO application by NGC and is not included in the DCO Order Limits for the Proposed Development. Rather, the Proposed Development includes necessary equipment to enable connection into this infrastructure (**Work No. 7B**).

4.3.40 Adjacent to the CCP, the conditioned and dehydrated carbon dioxide produced from the CCP would be compressed to a pressure (to be agreed with NGC) and after metering, discharged into the carbon dioxide gathering network. Power will be supplied to the compressor from the Proposed Development. No on-site storage of compressed carbon dioxide will be required.

4.3.41 The offshore transport and storage elements will be separately consented as part of the NEP and also do not form part of the Proposed Development – including the offshore section of the carbon dioxide export pipeline, the carbon dioxide store itself and the associated carbon dioxide injection wells and offshore infrastructure (see Section 4.6).

Other Connections

Natural Gas (Fuel) Connection and Treatment Infrastructure

4.3.42 Natural gas will be used as the fuel for the operation of the CCGT. Subject to agreement with NGG, natural gas will be supplied via a tie-in to the high pressure gas transmission network on-Site. It is currently anticipated that a minimum off-take connection will be constructed, and natural gas will be transferred via a below ground pipeline corridor within the Proposed PCC Site from a new AGI **Work No. 2A**) and gas receiving area (**Work No. 2B**), where the gas would be metered and conditioned to that required for the Proposed Development.

Electricity Connections

4.3.43 The existing electrical infrastructure in the area comprises 132 kilovolt (kV) and 400 kV overhead lines as well as underground cables that serve existing substations.

4.3.44 In order to export electricity from the Proposed Development, engagement is ongoing with NGET to identify the preferred connection option including any upgrades to existing switchgear or other existing equipment that may be required. The Proposed Development will require a direct connection to the 400kV system and will connect to the existing National Grid 400kV Substation directly to the east of the Proposed PCC Site. The connection between the Proposed Development and existing 400kV substation would comprise 400kV electrical cables which would be installed either above ground or below ground, or a combination of both (**Work No. 3A**) and is referred to as the 'Electrical Connection Area to National Grid 400kV Substation' (as shown on **Figure 3.3** (ES Volume III – **Application Document Ref. 6.4**)).

4.3.45 NGET will be responsible for the relevant connection works. No new overhead lines are proposed as part of the works required for the Proposed Development.

4.3.46 The Proposed Development could utilise a connection into the existing Northern Powergrid Substation to provide an auxiliary power supply to the Proposed Development (**Work No. 3B**). For this reason, two potential connection routes are included within the Proposed Development Site as described in **Chapter 3**: The Site and Surrounding Area (ES Volume I - **Application Document Ref. 6.2**) and shown on **Figure 3.3** (ES Volume III - **Application Document Ref. 6.4**). Each of these options is assessed in this ES.

Cooling Water and Wastewater Connection Works

4.3.47 The Proposed PCC Site will require a source of cooling water for heat rejection purposes. Process water will also be required in order to provide make-up to the steam/ water cycle of the Proposed PCC Site. There will also be a requirement for water for domestic and sanitary use.

4.3.48 Technical assessments are ongoing in order to identify preferred cooling options for the Proposed Development and at this stage, two water sources are under consideration; the Stainforth and Keadby Canal or the River Trent (refer to the Water Connection Corridor - **Figure 3.3** in ES Volume III - **Application Document Ref. 6.4**).

4.3.49 The preferred cooling method, for reasons of operational functionality and performance, is hybrid cooling of both the CCGT and CCP using water abstracted from the Stainforth and Keadby Canal (**Work No. 4A** - Canal Water Abstraction Option). Should this option be selected, an intake structure would be constructed within the canal with equipment to comply with the Eels (England and Wales) Regulations 2009 (HMSO, 2009) ('the Eels Regulations') which may comprise 2mm eel screens, baffles and fish return system (similar to that approved by the Environment Agency and that has been constructed for Keadby 2 Power Station) together with intake pipework, a wet well pumping station and chlorination plant. A pipeline would be constructed from this inlet into the Proposed PCC Site initially broadly following the route consented for Keadby 2 Power Station.

4.3.50 Treatment of the raw abstracted water would be undertaken in a water treatment plant located on the Proposed PCC Site to provide the necessary quality for use as make-up water in the hybrid cooling towers. Water would be treated to remove dissolved solids present and provide demineralised make-up water to the steam/ water cycle.

4.3.51 In the event that the preferred abstraction of water from the canal is not feasible, an alternative option would be to utilise the existing Keadby 1 Power Station cooling water abstraction infrastructure from the River Trent for the Proposed Development (**Work No. 4B** - River Water Abstraction Option). Keadby 1 Power Station would not run at the same time as the Proposed Development, so they would not require cooling water at the same time. It is anticipated that this infrastructure is in a suitable condition for re-use with some refurbishment and additions (e.g. new pumps), although the existing River Trent water intake would be subject to modification (either involving a new gravity or pumped intake system) to address silt issues and to comply with the Eels Regulations including accommodating new 2mm eel screens. In either case, the screen wash water and associated screenings/ fish would be returned to the River Trent and any captured grit either disposed of to landfill or returned to the River (for example during ebb tides), subject to further assessment. To further mitigate issues with sedimentation, particularly during plant outage periods, silt curtains and automatic scouring systems are also proposed. The existing water pipeline would be extended away from the river across the Keadby Power Station site by approximately 1km into the Proposed PCC Site.

4.3.52 The Applicant is proposing to re-use existing assets and pipework for Keadby 1 Power Station for the discharge of treated effluent to the River Trent. A Water Discharge Corridor (**Work No. 5**) is included in the Proposed Development Site comprising the easement of the existing cooling water corridor north-east from Keadby 1 Power Station connecting with the River Trent. Interconnecting pipework would extend from Proposed PCC Site to connect to this infrastructure.

4.3.53 A number of potential sources of wastewater may arise from the Proposed Development including (but not limited to):

- neutralised effluent streams from the demineralisation plant;
- blowdown from the Proposed PCC Site (CCP and CCGT);
- treated effluent from the CCP;
- uncontaminated surface water;
- surface water incident on process areas, that may be contaminated with oils or amines;
- river water treatment wastewater, including brine where relevant (the River Water Abstraction option is selected); or
- canal water wastewater.

4.3.54 Effluent discharges would be treated and would be regulated by the Environment Agency through the Environmental Permit required for the operation of the Proposed Development. Surface water will be appropriately segregated, treated and attenuated prior to discharge. The preferred option is to discharge to a drain managed by the IDB. An alternative discharge route is also proposed, should this be required, via the existing Keadby 1 Power Station cooling water culvert and outfall. Specific details regarding control of discharges are set out in **Chapter 12**: Water Environment and Flood Risk (ES Volume I - **Application Document Ref. 6.2**) and in the conceptual drainage strategy in Section 5 of **Appendix 12A**: Flood Risk Assessment (ES Volume II – **Application Document Ref. 6.3**).

4.3.55 As part of refurbishment and/ or replacement and maintenance works within the Water Discharge Corridor, various works may be required including upgraded or replacement sections of pipework. Information on construction methods is provided in **Chapter 5**: Construction Programme and Management (ES Volume I – **Application Document Ref. 6.2**).

Domestic and Sanitary Effluent

4.3.56 Foul drainage from permanent welfare facilities would be directed to the local sewerage system, subject to agreement with the local sewerage undertaker. The existing foul sewer connection within the Keadby Site would be utilised if it is found to be fit for purpose for life of development. If this is not the case, a package treatment plant will be used which will discharge into the cooling water outfall.

Towns Water Connection

4.3.57 A new towns water connection will be required including works to the existing towns water pipelines within the Keadby Power Station site and connections to fire and raw water storage tanks (**Work No. 6**).

Chemical Storage

4.3.58 A number of chemicals will be required to be transported to, stored and used on the Proposed PCC Site. The Proposed PCC Site will therefore contain chemical storage facilities including road tanker unloading area (refer to **Figure 4.1** in ES Volume III – **Application Document Ref. 6.4**).

4.3.59 Where any substance could pose a risk to the environment through its uncontrolled release (e.g. surface water drains), the substance will be stored within appropriate containment facilities including impermeable concrete surfaces and appropriately designed and sized bunds.

4.3.60 The inventory of materials to be stored on the Proposed PCC Site will be developed through the detailed design. However, where storage of hazardous materials, individually or in-combination exceeds the relevant thresholds, separate permissions will be sought from the Health and Safety Executive (HSE) and local planning authority as appropriate for their storage, under the Planning (Hazardous Substances) Regulations 2015 (HMSO, 2015a) and Control of Major Accident Hazards Regulations 2015 (COMAH) (HMSO, 2015b) regimes. All chemical storage will be regulated by the Environment Agency through an Environmental Permit that will be required for the operation of the Proposed Development.

Heavy Goods Vehicle Movements

4.3.61 Heavy Goods Vehicle (HGV) will use the A18 to access the Proposed Development Site. Operational traffic movements are detailed within the Transport Assessment (TA) (**Appendix 10A**, ES Volume II - **Application Document Ref. 6.3**). In summary it is anticipated that during the operational phase of the Proposed Development, total HGV movements at the Proposed PCC Site will be around 10 in and 10 out per day. These figures include movements associated with delivery of consumables and removal of waste products.

4.3.62 The air quality, noise and transport assessments (**Chapters 8, 9** and **10** respectively in ES Volume I - **Application Document Ref. 6.2**) consider the worst-case traffic profile relevant to that topic, which are associated with construction – a detailed assessment of the operational phase of the Proposed Development is not considered necessary as the vehicle numbers generated would be considerably lower than the screening threshold for a more detailed assessment (e.g. >200 vehicles per day).

4.3.63 Construction traffic movements are described in **Chapter 5**: Construction Programme and Management (ES Volume I - **Application Document Ref. 6.2**).

Landscaping and Biodiversity

4.3.64 The Proposed Development would include provision of landscaping, planting and biodiversity enhancement works as defined in the draft DCO (**Application Document Ref. 2.1**) as **Work No. 11A** and shown on the Works Plans (**Application Document Ref. 4.3**).

4.3.65 A Landscaping and Biodiversity Management and Enhancement Plan (**Application Document Ref. No. 5.10**) has been prepared to accompany the Application. This document sets out the principles of habitat creation, management and enhancement and of landscape design that will be adopted in the detailed design process and the areas of the Proposed Development Site allocated for this purpose, as well as the existing areas of planting to be retained, protected and managed. Implementation of the proposed measures would be secured by a Requirement of the draft DCO (**Application Document Ref. 2.1**).

Security Fencing and Gates

4.3.66 Security systems would be provided in respect of the Proposed PCC Site. This would include paladin (or similar) fencing, intruder alarms and may include turnstiles (or similar) for the Proposed PCC Site to manage people access.

4.3.67 Close circuit television (CCTV) and other security measures are anticipated to be required for security purposes at the Proposed Development Site.

Design Parameters

4.3.68 The design of the Proposed Development is not yet finalised and will not be completed until the detailed design phase. However, the final design will be within the parameters assessed within this ES and presented in the draft DCO (**Application Document Ref. 2.1**). The evolution of the Proposed Development to date is outlined in **Chapter 6**: Consideration of Alternatives (ES Volume I - **Application Document Ref. 6.2**).

4.3.69 Table 4.1 sets out the maximum dimensions for the main components of the Proposed Development which have been used as the basis for the various technical assessments. Although design work is ongoing, maximum and minimum parameters have been devised to enable the EIA to progress in the absence of the final design information and to enable the compilation of a robust assessment, based on a reasonable and appropriate worst-case option.

4.3.70 Existing natural ground levels at the Proposed PCC Site are approximately 0m to 1mAOD on the northern part of Keadby Common (referred to in this ES as the 'Main Site') where the CCGT and CCP are proposed. Part of this area is currently in use for soil storage during construction of the Keadby 2 Power Station. In the southern part of the Proposed PCC Site ground levels are typically 1m - 2mAOD.

4.3.71 It has been assumed for the purposes of the Proposed Development that ground elevations post site clearance will initially be restored to natural levels

once construction of Keadby 2 Power Station is complete. Proposed ground elevations post-site clearance and final finished floor levels have been informed by flood risk assessment modelling presented in **Appendix 12A**: Flood Risk Assessment (ES Volume II – **Application Document Ref. 6.3**).

4.3.72 Table 4.1 sets out the parameters that have been assessed within this ES for the Proposed Development. Maximum heights of buildings and other structures are given in mAOD. For buildings and structures within the Proposed PCC Site, these parameters take into account the expected minimum finished floor design level of +2.6mAOD for CCGT/ CCP infrastructure within the Proposed PCC Site including the administration/ control building that would provide a safe place of refuge in a breach event.

4.3.73 An accompanying indicative layout drawing is presented as **Figure 4.1** (ES Volume III - **Application Document Ref. 6.4**). Elevations drawings are presented for the Proposed PCC Site in the **Application Document Ref. 4.7**; for the Gas Connection in **Application Document Ref. 4.11**; and for the carbon dioxide AGI in **Application Document Ref. 4.12)**.

Table 4.1: Maximum Design Parameters (including limits of deviation)

Component	Length (m)	Width (m)	Height (m) above ground level (AGL)	Height (m AOD)*
Minimum design level (final ground height) within 'Main Site' for CCGT/ CCP infrastructure (Work 1A/ 1C) and administration/ control buildings (Work 1E)	2.6m AOD			
Gas Turbine Hall (Work 1A)	22	50	32	34.6
Steam Turbine Hall (Work 1A)	50	40	35	37.6
HRSG Building (Work 1A)	28	50	56	58.6
HRSG Stack (Work 1A)	Up to 8.0m diameter		85	87.6
Carbon Dioxide stripper (Work 1C)	Up to 15.0m diameter		53	55.6
Single Absorber (Work 1C)	16	43	99	101.6
Absorber Stack (Work 1C)	Up to 6.7m diameter		105	107.6

Component	Length (m)	Width (m)	Height (m) above ground level (AGL)	Height (m AOD)*
A18 Gatehouse (Work 8B)	6	7	6	7.5

4.3.74 Further flood resilience measures are proposed for critical operational infrastructure associated with the CCGT (defined in paragraph 6.3.11 of **Appendix 12A**: Flood Risk Assessment (ES Volume II – **Application Document Ref. 6.3**) that provide a level of resilience of no less than 3.6m AOD and up to 4.4m AOD.

4.3.75 The exact positions of the CCGT and absorber stack(s) cannot be fixed until the detailed design stage as they will depend on the final technical configuration and plant optimisation. The height of the stacks above ground will also depend on the final finished ground level. Consideration has been given to both a single large absorber (presented in Table 4.1 above) and the option of a smaller twin absorber configuration with two stacks up to 76m high in determining worst-case assessments.

4.3.76 For the purposes of the assessment, the CCP absorber units have been assessed at alternative locations within Work No. 1C (**Application Document Ref. 4.3**) of the Proposed PCC Site, with different building orientations as applicable, in order to determine the worst-case impacts at different receptors. The results in **Chapter 8**: Air Quality (ES Volume I - **Application Document Ref. 6.2**) represent the worst-case from any of the modelled layouts.

4.3.77 Similarly, for noise and vibration, in order to ensure that the impact assessment presented is robust and conservative, a number of plant configurations have been assessed in order to determine a worst-case. **Chapter 9**: Noise and Vibration (ES Volume I - **Application Document Ref. 6.2**) describes this further.

4.3.78 In assessing effects on landscape and visual amenity and setting effects on built heritage receptors, the assessment is based upon the largest possible dimensions for the Proposed Development, and a worst-case stack height of up to 105m AGL (107.5m AOD), as these are considered most likely to result in significant effects and represent the worst- case scenario. The maximum dimensions are based upon the widest building footprint and tallest potential height as detailed in Table 4.1. **Chapter 14**: Landscape and Visual Amenity and **Chapter 15**: Cultural Heritage (ES Volume I - **Application Document Ref. 6.2**) describe this further.

4.3.79 As outlined in **Chapter 2**: Assessment Methodology (ES Volume I - **Application Document Ref. 6.2**) in order to determine whether the potential future removal of Keadby 1 Power Station structures would provide a worst-case, this additional scenario (Scenario 2) has also been considered in the assessment of landscape and visual amenity and built heritage aspects in

Chapter 14: Landscape and Visual Amenity and **Chapter 15**: Cultural Heritage (ES Volume I - **Application Document Ref. 6.2**).

4.4 Proposed Development Operation

Operational Modes

4.4.1 The Low Carbon Gas Power Station is designed to be able to operate in either baseload or in a flexible (dispatchable) mode in the future.

4.4.2 Baseload mode power refers to power generation that generally runs continuously throughout the year and whereby the CCGT plant is operated at stable power output levels. Dispatchable mode generation refers to highly flexible operation when the Low Carbon Gas Power Station will be on demand and dispatched according to market conditions and needs, generally to provide electricity when intermittent renewable technologies cannot meet demand.

4.4.3 A CCGT power station capable of running in both baseload and dispatchable modes is:

- able to provide robust utility scale power throughout the year;
- responsive to seasonal demand fluctuation;
- responsive to daily demand fluctuation (flexible power);
- able to address renewables intermittency (in particular wind and solar) by replacing the electricity supplied by renewables at time of low renewable generation capacity; and
- able to adapt to a changing market in the future (i.e. an increase in renewables capacity).

4.4.4 It is anticipated that on commissioning, the Proposed Development will initially operate in baseload mode i.e. generation that generally runs continuously throughout the year so that the plant is operated at stable power output levels. Continuous and stable carbon dioxide production and export is preferred during this period to minimise changes to injection rates into the offshore underground storage reservoir. Operating in baseload mode could involve up to 20 start-up/ shutdown cycles per year.

4.4.5 After a period of baseload operation, and after carbon dioxide levels within the Humber Low Carbon Pipeline and gathering network have grown and stabilised, there is the opportunity for the Low Carbon Gas Power Station plant to be able to operate in dispatchable mode, i.e. being able to export power into the day-ahead market to match the anticipated intermittency of renewable power in the future power market. Operating in dispatchable mode could, in principle, involve up to 200 start-up/ shutdown cycles per year or more. However, operations in baseload mode are considered the worst-case in terms of environmental impacts based on mass emission rates of pollutants and have therefore been assessed in the ES, as set out in **Chapter 8**: Air Quality (ES Volume I – **Application Document Ref. 6.2**).

4.4.6 In the event of CCP outages, for example, it could be necessary to operate the Proposed Development for a short period of time in unabated mode, with exhaust gases from the CCGT being routed via the HRSG stack. These occurrences are expected to be infrequent.

4.4.7 The combustion emissions (NO_x and CO, including ammonia (NH_3) from the SCR) associated with operating in abated or unabated mode would be subject to the same emission limit values and therefore the associated release rates would be comparable. The unabated emissions from the CCGT plant only would be released at a higher temperature (approximately 75ºC compared with circa 60ºC for the carbon capture process) and therefore have improved thermal buoyancy, and consequentially dispersion, resulting in a level of impact that is no worse than for the carbon capture mode of operation. The HRSG stack is only expected to be used infrequently would be sized appropriately to ensure that this is the case.

Hours of Operation

4.4.8 The facility will be designed to operate 24 hours per day, 7 days per week with programmed offline periods for maintenance.

Staff

4.4.9 Operation of the Proposed Development is anticipated to create up to circa full-time 50 operational roles.

4.4.10 Plant operative staff will typically work on a two 12-hour shift pattern, with the first shift between 07:00 - 19:00 and the second between 19:00 - 07:00.

4.4.11 Administrative staff will typically work an office-hour pattern of 08:30 – 18:00.

4.4.12 Temporary and contractor employees associated with maintenance activities would also be employed, as required.

Process Inputs

4.4.13 The Proposed Development will use various raw materials during operation. Except for natural gas and water, these will predominantly be delivered to the Proposed Development by road tanker. Storage capacity at the Proposed Development Site has been designed to reflect the process requirements and delivery capability.

4.4.14 Materials including chemicals to be stored and used within the Proposed PCC Site will be subject to control via the Environmental Permit, COMAH Licence (if applicable) and other necessary consents required, and are anticipated to include the following process chemicals:

- solvent that will remove the carbon dioxide from the gas stream in the CCP. The solvent to be used is the subject of ongoing technical studies but is assumed to be an aqueous solution of amines. The CCP includes

equipment for reclaiming used solvent within the process, but make-up will be required;

- sodium hydroxide and sulphuric acid for pH control and treatment within the CCP;
- power plant treatment chemicals (oxygen scavenger, SCR reagent (ammonia or urea) and phosphate);
- capture plant treatment chemicals (sodium hydroxide, sulphuric acid and triethylene glycol – insulating gas for HV electrical systems);
- water treatment plant chemicals (biocides, antiscalants, sulphuric acid, sodium hydroxide, phosphoric acid, polyelectrolyte, molasses);
- hydrogen for generator cooling and deoxygenation of product carbon dioxide stream; and
- cooling tower chemicals (biocides, bio dispersants, corrosion inhibitors).

4.4.15 Other chemicals required for routine cleaning, maintenance and emergency firefighting uses include:

- distillate fuel;
- nitrogen (natural gas system and other equipment purge);
- cleaning chemicals;
- acetylene (metal cutting);
- inert fire-fighting gases;
- lubricating oils; and
- carbon dioxide for purging of electrical generators for maintenance purposes.

4.4.16 In order to reduce the risks of contamination to processes and surface water, all liquid chemicals stored on site will be kept in bunded controlled areas with a volume of 110% of storage capacity and be appropriately segregated.

Maintenance

4.4.17 The objective of plant maintenance is to ensure the Proposed PCC Site including utility connections operates safely and reliably. Inspection and maintenance activities have informed the Proposed PCC Site footprint and layout. Areas for permanent laydown and turnaround areas for maintenance are included in the Proposed Development Site as shown on **Figure 3.3** (ES Volume III – **Application Document Ref. 6.4**).

4.4.18 Routine maintenance will be planned and scheduled via the maintenance management system with major overhauls occurring approximately once every two to five years depending on the nature of plant operations in that period. These maintenance activities will require additional contractors to work on-site.

The contractors will access the Proposed Development Site via the main entrance off the A18.

4.4.19 The maintenance strategy to be adopted will use established methods such as Risk Based Inspection (RBI) and Reliability Centred Maintenance (RCM) to support the required facility availability. Therefore, to support the maintenance strategy for the Proposed PCC Site facilities, each major equipment item will be provided with appropriate access and overhaul laydown areas and the internal road layout for the Proposed PCC Site will be designed to enable free movement for cranes and heavy lifting equipment.

4.4.20 It is anticipated that an integrated Operations and Maintenance (O&M) team will have responsibility for daily operations, including troubleshooting and effecting minor repairs on the Proposed PCC Site. Major and specialist O&M interventions (turnarounds, CCGT scheduled maintenance and turbine overhauls, etc) are likely to be outsourced and major equipment items serviced by original equipment manufacturers (OEM).

4.4.21 If required, pipeline inspection plans will be prepared and Pipeline Inspection Gauge ('pig') launching and receiving facilities for intelligent 'pigging' operations will be considered.

4.4.22 It is intended that major maintenance activities be harmonised around the longest or most constrained outages. For example, it is likely that planned maintenance of the Proposed Development will be scheduled to not coincide with planned maintenance of Keadby 2 Power Station.

Hazard Prevention and Emergency Planning

4.4.23 The Applicant aims to protect human health by safely and responsibly managing activities on site. A Health and Safety Plan covering the works, commissioning and operation of the Proposed Development will be prepared by the Applicant. For design and construction, a competent and adequately resourced Construction (Design and Management) (CDM) Coordinator and Principal Contractor will be appointed. The Applicant will ensure that its own staff, its designers and contractors follow the Approved Code of Practice (ACoP) laid down by the CDM Regulations 2015.

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

4.4.25 The inventory of materials to be stored on the Proposed PCC Site will be finalised through the detailed design. However, where storage of hazardous materials, individually or in-combination exceeds the relevant thresholds, separate permissions will be sought from the HSE and local planning authority for their storage, under the COMAH and Hazardous Substance Consent regimes respectively. The project is currently working on the basis that lower tier COMAH will apply to the Site operations as a minimum, but this will only be confirmed during detailed design once all chemicals required have been

identified along with the quantities which exist within the Proposed Development site. All chemical storage will be regulated by the Environment Agency through an environmental permit that will be required for the operation of the Proposed Development.

4.4.26 As set out in **Chapter 18**: Major Accidents and Disasters in ES Volume I (**Application Document Ref. 6.2**), carbon dioxide is not harmful to human health at low concentrations, it is not flammable, and it will not support combustion. As the concentration of carbon dioxide in air rises, the hazardous effects on people and the environment increase. However, compared with other materials conveyed via major pipelines in the UK, such as natural gas and ethylene, the risks of harm (e.g. of asphyxiation or freeze burns) is relatively low. The key risk relates to its toxicity at elevated concentrations and potential to act as an asphyxiant gas in low lying locations or confined spaces should it displace air from these locations due to its density being higher than that of air. High pressure (dense phase) carbon dioxide adds additional risks, but the carbon dioxide captured, compressed and piped from Proposed PCC Site will not be dense phase.

4.4.27 Guidance and best practice information for carbon capture technology and transport via pipeline is available from the HSE. Carbon dioxide is not currently defined as a dangerous substance under the COMAH Regulations 2015 and the status of the Proposed Development relating to the COMAH Regulations 2015 has not yet been confirmed. Guidance and best practice information for CCP is however, available from the HSE. The HSE does not currently provide Land Use Planning (LUP) advice for carbon dioxide capture, although for LUP purposes, HSE uses Dangerous Toxic Load (DTL) to describe a substance's airborne concentration and duration of exposure which would produce a particular level of toxicity in the general population. This advice has been considered in designing the Proposed Development including safety distances from high pressure carbon dioxide equipment on the Proposed PCC Site.

4.4.28 The HSE is a statutory consultee for all Nationally Significant Infrastructure Projects (NSIP), such as the Proposed Development therefore consultation with the HSE has been undertaken and will be ongoing through the detailed design process.

4.4.29 The Proposed Development is using 'safety in design' principles to take into consideration safety issues and risks and to enable 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).

4.4.30 Design mitigation at the current concept design stage includes consideration of potential carbon dioxide releases and includes, (but is not limited to):

- careful equipment and material selection;
- siting of higher pressure carbon dioxide equipment considering areas of potential exposure and prevailing wind direction;
- incorporation of gas leak detection systems; and
- consideration of venting arrangements.

4.4.31 As the design of the Proposed Development progresses, preliminary Quantitative Risk Assessment (QRA) is being carried out to identify the Major Accident Hazards – Worst-Case Scenarios associated with aspects of the design, the systems and operation of the proposed facility as known at the Pre-FEED stage. The objective of the preliminary QRA is to identify any critical drawbacks and/or regulatory non-compliance and provide any appropriate recommendations to be resolved in the next stage of design. Further detailed evaluation will continue throughout the FEED stage when the Proposed Development is further refined.

4.4.32 The Pipeline Safety Regulations 1996 do not consider an on-shore high pressure carbon dioxide pipeline as a Major Accident Hazard Pipeline (MAHP). However, given the volume of carbon dioxide to be exported, the Humber Low Carbon Pipeline to be constructed by NGC is expected to be designed, installed and operated as if it were a MAHP, and the high-pressure carbon dioxide were to be classified as a 'dangerous fluid'. A Major Accident Prevention Document (MAPD) is likely to be produced by the operator of the Humber Low Carbon pipeline during the design process and the HSE will be consulted. Relevant British Standards Institution (BSI) publications including Document PD 8010: Code of practice for Pipelines – Part 1: Steel pipelines on land (BSI, 2015) will provide the basis for design.

4.4.33 **Chapter 18**: Major Accidents and Disasters (ES Volume I – **Application Document Ref. 6.2**) provides an assessment of effects of the Proposed Development on the environment arising from the vulnerability of the Proposed Development to risks of relevant major accidents or disasters, including measures envisaged to prevent or mitigate the any likely significant adverse effects and details of preparedness for and response to emergencies.

Routine and Emergency Access / Egress

4.4.34 Permanent access to the Proposed Development Site during operation would be via the existing road access road from the A18 which passes via the existing North Pilfrey Bridge over the Stainforth and Keadby Canal and the Scunthorpe to Doncaster passenger rail line (refer to **Figure 3.3** (ES Volume III - **Application Document Ref. 6.4**)). Vehicles would access the Proposed Development Site from the A18, via this existing access road/ Bonnyhale Road/ existing private access roads and a new main access road to be constructed into the Proposed PCC Site (**Work No. 8A**).

4.4.35 A new security gatehouse and parking would be provided at the entrance to the Proposed Development Site, set back from the A18 (refer to **Chapter 3**: The Site and Surrounding Area in ES Volume I – **Application Document Ref. 6.2**)

and **Application Document Ref. 4.14**. The Proposed PCC site includes a main car park, including muster point (upwind of the CCP) in the event of emergency, a manned gatehouse and a control building which would be designed as a place of safety in the event of emergency.

4.4.36 Four emergency access/ egress points have been provided within the Proposed Development Site:

- a northern emergency access route (both pedestrian and vehicular) comprising the maintenance and improvement of an existing private track running between the Low Carbon Gas Power Station and Chapel Lane, including new private bridge, (**Work No. 8B** – Emergency Vehicle Access Road). The emergency access will be gated, and under normal operation this gate will be closed and unmanned;
- a western emergency exit (pedestrian only). This is located south-west of the CCP and therefore in an emergency scenario, upwind of a potential release;
- an eastern emergency exit (pedestrian only). This is located adjacent to the northern perimeter fence and existing 400kV National Grid Substation; and
- the southerly route main access (described in paragraph 4.4.34 above) – (pedestrian and two-lane vehicular). This main access to the Proposed Development Site that would also be available for emergency purposes.

4.4.37 The location of these access points is illustrated on **Figure 4.1** (ES Volume III (**Application Document Ref. 6.4**)).

External Lighting

4.4.38 An Indicative Lighting Strategy is included in the Application (**Application Document Ref. 5.11**). Before any lighting is installed, a detailed lighting scheme will be submitted to the local planning authority for approval. The external lighting scheme will be designed in accordance with relevant standards, including the Guidance Notes for the Reduction of Obtrusive Light (2020) published by the Institute of Lighting Engineers and/ or Chartered Institution Building Services Engineers (CIBSE) requirements, as appropriate.

4.4.39 The external lighting scheme will be designed to provide safe working conditions in all relevant areas of the Proposed Development Site whilst reducing light pollution and the visual impact on the local environment. This is likely to be achieved using luminaires that eliminate the upward escape of light.

Environmental Management

4.4.40 The Proposed Development will comply with the Environmental Permitting (England and Wales) Regulations 2016 (as amended) under its Environmental Permit so that any impacts of emissions to air, soil, surface and groundwater, to the environment and human health will be minimised and avoided where possible.

4.4.41 The Proposed Development Site will be operated in line with appropriate standards and the operator will implement and maintain an Environment Management System (EMS) which will be certified to International Standards Organisation (ISO) 14001. The EMS will outline requirements and procedures required to ensure that the Proposed Development is operating to the appropriate standard.

4.4.42 Sampling and analysis of pollutants will be undertaken where required including monitoring of exhaust emissions levels using CEMS, prior to discharge from the stacks, in accordance with the Environmental Permit.

4.5 Decommissioning

4.5.1 The power generation and carbon capture elements of the Proposed Development have a design life of circa 25 years. At the end of their design life, it is expected that these elements of the Proposed Development may have some residual life remaining and the operational life may be extended. If the operating life were to be extended, the Proposed Development would be upgraded in line with the legislative requirements at that time. On this basis, decommissioning activities are currently anticipated to commence after 2051.

4.5.2 At the end of its operating life, it is anticipated that all above-ground equipment associated with the parts of the Proposed Development to be decommissioned will be decommissioned and removed from the Proposed Development Site. Prior to removing the relevant plant and equipment, all residues and operating chemicals will be cleaned out from the plant and disposed of in an appropriate manner.

4.5.3 The bulk of the relevant plant and equipment will have some limited residual value as scrap or recyclable materials, and the demolition contractor will be encouraged to use materials that could be recycled.

4.5.4 Prohibited materials such as asbestos, polychlorinated biphenyls (PCB), ozone depleting substances and carcinogenic materials will not be allowed within the design of the Proposed Development. Other materials recognised to pose a risk to health, but which are not prohibited, will be subject to a detailed risk assessment.

4.5.5 Prevention of contamination is a specific requirement of the Environmental Permit for the operation of the Proposed Development and therefore it is being designed such that it will not create any new areas of ground contamination or pathways to receptors as a result of construction or operation. Once the relevant plant and equipment have been removed to ground level, it is expected that the hardstanding and sealed concrete areas will be left in place. Any areas of the Proposed Development which are to be decommissioned that are below ground level will be backfilled to ground level to leave a levelled area.

4.5.6 A Decommissioning Plan (including Decommissioning Environmental Management Plan (DEMP)) will be produced within the period specified in the relevant legislation in force at the time of cessation of operations and agreed with the Environment Agency as part of the Environmental Permit and site

surrender process. The DEMP will consider in detail all potential environmental risks and contain guidance on how risks can be removed, mitigated or managed. This will include details of how surface water drainage should be managed during decommissioning and demolition.

4.5.7 The Decommissioning Plan will include an outline programme of works. It is anticipated that it would take up to a year to decommission the Proposed PCC Site, with demolition following thereafter, i.e. taking approximately two years to complete.

4.5.8 During decommissioning and demolition there will be a requirement for the provision of office accommodation and welfare facilities.

4.5.9 Any demolition contractor would have a legal obligation to consider decommissioning and demolition under the CDM Regulations 2015, or the equivalent prevailing legislation at that time.

4.5.10 Decommissioning activities will be conducted in accordance with the appropriate guidance and legislation at the time of the Proposed Development's closure. All decommissioning activities will be undertaken in accordance with the waste hierarchy. Materials and waste produced during decommissioning and demolition will be stored in segregated areas to maximise reuse and recycling. All materials that cannot be reused or recycled will be removed from the Proposed Development Site and transferred to suitably permitted waste recovery/disposal facilities. It is anticipated that a large proportion of the materials resulting from demolition will be recycled and a record will be kept in order to demonstrate that the maximum level of recycling and reuse has been achieved.

4.5.11 Upon completion of the decommissioning programme, including any remediation works that might be required, the Environment Agency will be invited to witness a post-decommissioning inspection by site staff. All records from the decommissioning process will be made available for inspection by the Environment Agency and other relevant statutory bodies, in accordance with the Environmental Permit requirements.

4.5.12 In the light of the control measures set out above that would form part of the proposed DEMP, decommissioning is not anticipated to present any significant environmental effects beyond those assessed for the construction phase of the Proposed Development and are not assessed separately in this ES.

4.6 Elements of the Proposed Development Consented under a Deemed Marine Licence

4.6.1 In England, the Marine and Coastal Access Act (2009) (MCAA) provides that a Marine Licence (ML) is required for certain 'licensable activities' within the UK Marine Area (Section 42, MCAA). These activities include deposits, removals and construction/'alteration' works (Section 66, MCAA) which are below Mean High Water Springs (MHWS).

4.6.2 Whether issued via a 'standalone' Marine Licence Application (MLA) or a licence 'deemed' within the body of the DCO i.e. a Deemed Marine Licence (DML), the MMO is the body responsible for issuing, revoking and enforcing a ML other than where a licence is 'deemed' within the body of a DCO (a DML), in which case the Secretary of State has the power to grant it.

4.6.3 It is the Applicant's intention to secure a marine licence via a DML for any necessary works relating to the River Water Abstraction Option (**Work No. 4B**), (should the preferred Canal Water Abstraction (**Work No. 4A**) not be feasible) and the minor works which may be required at the outfall structure (**Work No. 5**).

4.6.4 In line with the recommendations of Advice Note Eleven (PINS, 2017) detailed discussions have been undertaken with the MMO regarding the scope, content and detail of the DML. A draft DML is provided with the application with the Draft DCO (**Document Ref. 2.1**).

4.7 References

British Standards Institute (2015) *Document PD 8010: Code of practice for Pipelines – Part 1: Steel pipelines on land.*

Commission Implementing Decision (EU) 2017/1442 of 31st July 2017, establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for large combustion plants' (2017). Official Journal L212 p. 1. [Accessed 01 March 2021]. Available online: https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1503383091262&uri=CELEX:32017D1442

Department of Energy and Climate Change (2009) *Carbon Capture Readiness – A Guidance Note for Section 36 Electricity Act Consent Applications.* Available online: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/43609/Carbon_capture_readiness_-_guidance.pdf

European Commission (2017) *Best available techniques Reference document for Large Combustion Plants*. [Accessed 01 March 2021]. Available online: https://eippcb.jrc.ec.europa.eu/sites/default/files/2019-11/JRC_107769_LCPBref_2017.pdf

HM Treasury (2014) *National Infrastructure Plan*. Available online: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/381884/2902895_NationalInfrastructurePlan2014_acc.pdf

Secretary of State for Business, Energy and Industrial Strategy (2020). *The Energy White Paper - Powering our Net Zero Future*. Available online: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/945899/201216_BEIS_EWP_Command_Paper_Accessible.pdf

Institute of Lighting Professionals (2020). *Guidance Notes for the Reduction of Obtrusive Light*. Available online: https://www.e-lindsey.gov.uk/media/7382/ILP-Light-Nuisance-Guidance/pdf/ilp-guidance-note-1-for-the-reduction-of-obtrusive-light-2020.pdf?m=637165179566500000

National Infrastructure Commission (2020). *Net Zero - Opportunities for the Power Sector*. Available online: https://nic.org.uk/app/uploads/Net-Zero-6-March-2020.pdf.

The Construction (Design and Management) Regulations 2015 (SI 2015 No.51). London: The Stationery Office. Available online: https://www.legislation.gov.uk/uksi/2015/51/contents/made

The Control of Major Accident Hazards Regulations 2015 (SI 2015 No.483). London: The Stationery Office. Available online: https://www.legislation.gov.uk/uksi/2015/483/contents/made

The Eels (England and Wales) Regulations 2009. (SI 2009 No. 3344). London: The Stationery Office. Available online: https://www.legislation.gov.uk/uksi/2009/3344/made

The Environmental Permitting (England and Wales) Regulations 2016 (SI 2016 No. 1154). London: The Stationery Office. Available online: https://www.legislation.gov.uk/uksi/2016/1154/contents/made

The Marine and Coastal Access Act 2009 (c. 23). London: The Stationery Office. Available online: https://www.legislation.gov.uk/ukpga/2009/23/contents

The Marine Licensing (Exempted Activities) Order 2011 (SI 2011 No.409). London: The Stationery Office. Available online: https://www.legislation.gov.uk/uksi/2011/409/contents/made

The Pipeline Safety Regulations 1996 (SI 1996 No.825). London: The Stationery Office. Available online: https://www.legislation.gov.uk/uksi/1996/825/contents/made

The Planning (Hazardous Substances) Regulations 2015. (SI 2015 No. 627). London: The Stationery Office. Available online: https://www.legislation.gov.uk/uksi/2015/627/contents/made

Planning Inspectorate (2018) Advice Note Nine: Rochdale Envelope, Version 3, July 2018. Available online: https://infrastructure.planninginspectorate.gov.uk/legislation-and-advice/advice-notes/

Planning Inspectorate (2017) Advice Note Eleven: Working with public bodies in the infrastructure planning process, Version 4, November 2017. Available online: https://infrastructure.planninginspectorate.gov.uk/legislation-and-advice/advice-notes/