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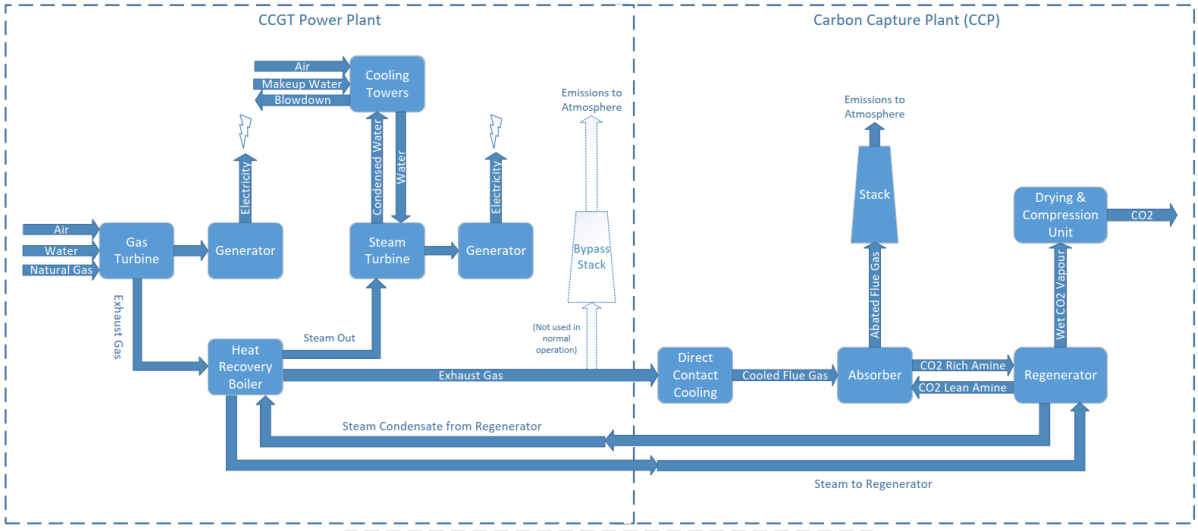
4.0 THE PROPOSED DEVELOPMENT

4.1 Introduction

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

4.1.2 The low carbon CCGT generating station (the Proposed Development) will require natural gas (as a fuel source), electricity and cooling water connections and will be designed to operate with post-combustion carbon capture and compression plant (CCP) installed such that the plant can 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 Zero Carbon Humber (ZCH) Partnership carbon dioxide (CO_2) pipeline being developed to connect carbon emitters in the region and transport the captured carbon to an off-site geological store for end usage and sequestration to be developed by the Northern Endurance Partnership.. The Applicant would not build or operate 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 (PEI Report Volume I). An indication of the likely approach to development of this third party infrastructure is described in **Section 4.4**.

4.1.4 The Applicant is progressing concept design work on the preferred low carbon option using a CCGT plant fired on natural gas, with post-combustion CCP; having initially considered an alternative low carbon technology pathway using hydrogen firing as reported on in the Environmental Impact Assessment (EIA) Scoping Report (**Appendix 1A**, PEI Report Volume II). Further information on the alternatives considered and

reasons for selection of the preferred option is presented in **Chapter 6**: Consideration of Alternatives (PEI Report Volume I).

4.1.5 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.

4.1.6 Given the inherent intermittency of the primary forms of renewable energy (on-shore wind, off-shore 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).

4.2 Project Elements

4.2.1 The Proposed Development would comprise a low carbon gas fired power station with a gross electrical output capacity of up to 910MWe and associated buildings, structures and plant, including:

- a carbon capture enabled electricity generating station including a CCGT plant with integrated cooling infrastructure and CCP, including compression equipment and associated utilities, various pipework, water treatment plant, wastewater treatment, firefighting equipment, emergency diesel generator, control room, workshops, stores and gatehouse and a permanent laydown and turnaround area for maintenance;
- chemical storage facilities, other minor infrastructure and auxiliaries/ services, and natural gas receiving facility (all located in the **Proposed Power and Carbon Capture (PCC) Site**);
- natural gas pipeline from the existing National Grid Gas high pressure (HP) gas pipeline within the Proposed Development Site to supply the Proposed PCC Site, including an above ground installation (AGI) for both National Grid Gas's apparatus and the Applicant's (**Gas Connection Corridor**);
- electrical connection works to and from the existing National Grid 400kV Substation (**Electrical Connection Area to National Grid 400kV Substation)** for export of power;
- Electrical connection from the existing Northern Powergrid 132kV Substation (**Potential Electrical Connection to Northern Powergrid 132kV Substation**) for supply of power to the Proposed PCC Site during start-up of plant and equipment);
- Water Connection Corridors including:
  - a water intake within the Stainforth and Keadby Canal, which could be utilised for cooling water and make-up water subject to ongoing engagement with the

Canal and Rivers Trust and Environment Agency (**Canal Water Abstraction Option)**;

- in the event that water from the Stainforth and Keadby Canal is not available or there is insufficient capacity for provision of water for the Proposed Development, an intake to provide cooling and make-up water from the River Trent (**River Water Abstraction Option**);
- disposal of used cooling water to the River Trent (**Water Discharge Corridor**);
- towns water connection pipeline from existing water supply within the Keadby Power Station for potable water;

- AGI for connection to third party CO_2 export infrastructure including compression facilities;
- permanent access to the Proposed Development Site from A18 and means of permanent emergency access via Chapel Lane, including improvement works to existing routes;
- a new surface water drainage system comprising pond(s) and/ or a tank or similar, including a new surface discharge connection to a drainage channel;
- associated development including:
  - temporary construction and laydown area including weighbridges, contractor facilities/ cabins and parking;
  - temporary retention, improvement and use of an existing Waterborne Transport Offloading Area and Additional Abnormal Indivisible Load (AIL) Route;
  - site preparation including earthworks;
  - pipeline and cable connections between part of the Proposed Development Site;
  - landscaping and biodiversity enhancement areas, internal access roads, roadways and footpaths;
  - gatehouses, security and fencing; and
  - lighting.

4.2.2 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 3.2** and an indicative Site Layout Plan is included as **Figure 4.1** (PEI Report Volume III).

4.2.3 Construction of the Proposed Development is described in **Chapter 5**: Construction Programme and Management (PEI Report Volume I). At this stage a detailed construction programme is not available as this is normally determined by the Engineering Procurement and Construction (EPC) contractor who has not yet been appointed; however, an indicative programme is presented within **Chapter 5:** Construction Programme and Management on which the potential environmental effects of the Proposed Development have been assessed.

4.2.4 Construction of the Proposed Development could (subject to the necessary consents being granted and an investment decision being made) start as early as Quarter 3/4 2022. Construction activities are expected to be completed within three years, followed by commissioning.

4.2.5 The Applicant is working closely with National Grid Ventures and other partners as part of the ZCH Partnership. It is understood from discussions with ZCH Partnership that the CO_2 pipeline design development is currently at the pre-feasibility stage, with options for routing of the ZCH Partnership CO_2 transport pipeline currently being evaluated, having confirmed that it will be routed into the Keadby Power Station site en route to an outfall location on the east coast, with the final route being determined to connect as many major emitters as feasible to do so.

4.2.6 It is understood that front end engineering design (Pre FEED) of the preferred pipeline route is likely to commence in 2021 with a programme for DCO submission shortly after this. It has therefore been assumed that the CO_2 pipeline could be constructed in parallel with the Proposed Development, which would allow commercial operation to commence at the earliest in late 2025. Further information on the proposed operation is provided in **Section 4.4**.

4.2.7 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, if appropriate, be decommissioned as outlined in **Section 4.5** below. It is anticipated that decommissioning of the power generation and carbon capture elements will most likely commence at some point after 2050.

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 description of the different areas of the Proposed Development Site is detailed within **Chapter 3:** The Site and Surrounding Area (PEI Report Volume I) and these are illustrated on the accompanying **Figure 3.2**: Areas of the Site Described in PEI Report (PEI Report Volume III).

The Proposed PCC Site

4.3.2 The Proposed PCC Site will be a natural gas fired powered power station with carbon capture. It will comprise a single CCGT unit with a gross electrical output capacity of 910MWe. The maximum power generation will be seasonally dependent; for example, the power station is anticipated to generate maximum power in the winter when air density is at its highest and the CCGT can produce maximum power. The operation of the carbon capture and compression systems will reduce the amount of electricity that can be exported from the Proposed Development to the UK transmission system.

4.3.3 The Proposed PCC Site is illustrated on **Figure 4.1**: Indicative Layout Proposed PCC Site (PEI Report Volume III) and comprises an integrated power generation and carbon capture train encompassing:

- a combined cycle gas turbine plant, comprising: a gas turbine, generator and auxiliaries enclosed within a building, with associated air inlet; a heat recovery steam generator (HRSG), continuous emissions monitoring system (CEMS) and auxiliaries and instrumentation enclosed within a building, with associated stack; a steam turbine, generator and condenser and auxiliaries/ transformers enclosed within a building; transformers (for the import and export of electricity); selective

catalytic reduction (SCR) equipment for the removal of nitrogen oxides (NO_x) from the flue gas;

- combined cycle gas turbine plant cooling infrastructure, comprising hybrid cooling cells and associated pipework, plant and buildings;
- CO_2 capture plant comprising: a direct contact cooler (DCC) and associated pumps for carbon capture; an absorber column, with wash plant, CEMS and associated stack(s); CO_2 treatment plant and associated electrical and instrumentation building; flue gas pre-treatment, including cooling/ scrubbing and flue gas blower;
- natural gas reception facility including National Grid and Applicant AGI, gas conditioning, let down and metering equipment and instrumentation and electrical building;
- facilities required in connection with the above including: an emergency diesel generator and 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);
- above ground CO_2 export infrastructure including CO_2 compression and metering equipment and a National Grid CO_2 AGI to facilitate the export of pressurised CO_2 to the HLC network by others.

4.3.4 The electrical, steam and water circuits within the 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.

4.3.5 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 new surface water drainage system comprising pond(s) and/ or a tank or similar.

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

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

4.3.8 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.

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

Power Generation and Associated Stack

4.3.10 Natural gas that has been conditioned to the required temperature and pressure will be combusted in the CCGT. The gas turbine selected will be provided with dry low NOx (DLN) burners to minimise the formation of NOx.

4.3.11 Following combustion, the hot product gases enter the gas turbine where they will 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) to generate further power via a separate steam turbine, and for heating of process streams within the CCP.

4.3.12 The flue gases will then be further treated with SCR to further remove NOx to the required emissions limits. The SCR will be supplied with aqueous ammonia feedstock to treat the flue gas NOx which will be converted into nitrogen and water vapour in the flue gas.

4.3.13 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.

4.3.14 Spent steam from the steam turbine will be cooled and condensed with the condensate returned to the HRSG for reuse. 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. It will be necessary to purge a small amount of the recirculating water ('boiler blowdown') intermittently for this purpose. Boiler blowdown water removed from the cycle will be replaced with fresh demineralised water.

4.3.15 The condensation of steam exiting the steam turbine will be achieved using wet/ dry (hybrid) cooling towers which are specifically designed to minimise the formation of visible plumes, although some may occur dependent on the ambient weather conditions.

4.3.16 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

4.3.17 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 NOx 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.

4.3.18 In July 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 using primary control measures (such as use of DLN burners) alone.

4.3.19 NOx concentrations in the flue gases also need to be minimised to prevent the degradation of solvent within the CCP in order to optimise the CO_2 capture efficiency.

4.3.20 SCR is therefore proposed to control NOx 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 NOx 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.

4.3.21 The level of NOx 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 NOx. These studies will seek to optimise the operation of a plant in order to maximise efficiency and minimise emissions and waste.

4.3.22 In a conventional CCGT plant, the treated flue gas from the SCR is released from a stack. However, in the Proposed Development, the flue gas post-SCR will be directed into the CCP for the removal of CO_2 from the gas stream.

Carbon Capture Plant and Associated Stack(s)

4.3.23 The CCP will be designed to be capable of capturing over 90% of the CO_2 emitted from the generating station, with an average capture rate of around 90% (subject to completion of studies and commercial agreement). 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 running hours of the plant.

4.3.24 Prior to their introduction into the absorber column, the flue gases from the generating station will be cooled to the required design temperature (approximately 35°C) by using a direct contact cooler 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 direct contact cooler in a closed loop cycle.

4.3.25 Once cooled, the flue gases from the generating station will be introduced to one or more absorber column(s). In the column(s), the flue gases will be passed through a solvent that will remove the CO_2 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 CO_2.

4.3.26 Even with the use of SCR technology, it will not be possible to entirely remove NOx 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.

4.3.27 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.

4.3.28 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 CO_2 lean flue gases (treated flue gas) will then be treated to remove entrained mist droplets.

4.3.29 Provision will be made for a future flue gas heater in the absorber column (requirement to be confirmed by dispersion modelling). If the heater is required, 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.

4.3.30 CO_2 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 CO_2 from the solvent. The hot CO_2 lean solvent then leaves the stripper column and is recirculated, likely via a heat exchanger, back to the top of the absorber column(s).

4.3.31 The CO_2 gas exiting the top of the stripper column will be passed through a condenser to remove water and solvent vapours. The CO_2 stream will then pass to the CO_2 conditioning/ compressor unit.

CO_2 Conditioning and Compression

4.3.32 The gaseous CO_2 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 prior to export to the ZCH Partnership CO_2 pipeline and gathering network.

4.3.33 The conditioning equipment/ processes are the subject of ongoing technical studies and discussions with National Grid; however, it is envisaged that the captured CO_2 stream will be cooled and partly compressed before the trace oxygen and water are removed. Following treatment, the CO_2 stream will be compressed to pipeline pressure for export, measured in a metering station and transferred into the ZCH Partnership pipeline network (by third parties).

Natural Gas (Fuel) Connection and Treatment Infrastructure

4.3.34 Natural gas will be used as the fuel for the operation of the CCGT. Subject to agreement with National Gas Grid (NGG), natural gas will be supplied via a tie-in to the HP 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 National Grid AGI and gas receiving area, where the gas would be metered and conditioned to that required for the Proposed Development.

Electricity Connections

4.3.35 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.

4.3.36 In order to export electricity from the Proposed Development, engagement is ongoing with National Grid to identify the preferred connection option including any upgrades to existing switchgear or other existing equipment that may be required. It is anticipated that the Proposed Development will require a direct connection to the 400kV system and is therefore likely to 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 and is referred to as the **'Electrical Connection Area to National Grid 400kV Substation**' (as shown on **Figure 3.2**, PEI Report Volume III).

4.3.37 The Proposed Development could utilise a connection into the existing 132kV Northern Powergrid Substation to provide an auxiliary power supply to the Proposed Development. For this reason, two potential connection routes are included within the Proposed Development Site as described in **Chapter 3**: The Site and Surrounding Area (PEI Report Volume I) and shown on **Figure 3.2** (PEI Report Volume III). Each of these options is assessed in this PEI Report.

Cooling Water and Wastewater Connection Works

4.3.38 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.

4.3.39 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 3.2** in PEI Report Volume III).

4.3.40 The preferred cooling method is hybrid cooling of both the CCGT and CCP using water abstracted from the Stainforth and Keadby Canal (**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 which may comprise screens, baffles and fish return system (similar to that approved by the Environment Agency and currently being constructed for Keadby 2 Power Station). A pipeline would be constructed from this inlet into the Proposed PCC Site broadly following the route consented for Keadby 2 Power Station.

4.3.41 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.

4.3.42 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 (**River Water Abstraction Option**). 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 significant modification (either involving a new gravity or pumped intake system) to address silt issues and to comply

with the Eels (England and Wales) Regulations 2009. 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. The existing pipeline would be extended by approximately 1km into the Proposed PCC Site.

4.3.43 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** 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 the Proposed PCC Site to connect to this infrastructure.

4.3.44 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);
- river water treatment wastewater, including brine where relevant (if hybrid cooling options selected); or
- canal water wastewater.

4.3.45 Discharges would be treated and would be regulated by the Environment Agency through the Environmental Permit required for the operation of the Proposed Development. Specific details regarding control of discharges are set out in **Chapter 12**: Flood Risk and Water Resources.

4.3.46 As part of refurbishment and/ or replacement works within the Water Discharge Corridor, various ancillary works may be required.

4.3.47 Discharge of domestic/ sanitary effluent would be to the local sewerage system, subject to agreement with the local sewerage undertaker.

Land associated with Keadby 2 Power Station and Keadby 1 Power Station

4.3.48 The Proposed Development is currently subject to ongoing design studies and at this stage, a number of connections to the Proposed Development from the operational Keadby 1 Power Station and the Keadby 2 Power Station (currently under construction) remain under consideration.

4.4 CO_2 Compression Station and Export Pipeline

4.4.1 The Proposed PCC Site has been sited to connect into a CO_2 gathering network including a CO_2 export pipeline that will be designed and operated by other parties in the ZCH Partnership. Various routing options are available to connect the Proposed PCC Site into the necessary CO_2 export infrastructure. Discussions with ZCH Partnership are ongoing in respect of the required pipeline connections and parties are working closely to identify options for pipeline routes, taking into consideration technical and environmental opportunities and constraints. **Chapter 19**: Cumulative

and Combined Effects (PEI Report Volume I) provides further information on the likely effects of the CO_2 export pipeline.

4.4.2 The development of the CO_2 export pipeline will be progressed under separate consent and is not included in the indicative DCO order limits for the Proposed Development Site. Rather, the Proposed Development includes necessary equipment to enable connection into this infrastructure.

4.4.3 Adjacent to the CCP, the conditioned and dehydrated CO_2 product from the CCP would be compressed to a pressure (to be agreed with National Grid) and after metering and discharged into the CO_2 Gathering Network. Power will be supplied from wider electrical supply for the Proposed Development Site.

4.4.4 It is not considered that any on-site storage of compressed CO_2 will be required.

4.5 Chemical Storage

4.5.1 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.

4.5.2 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.

4.5.3 The inventory of materials to be stored on the Proposed PCC Site will be developed through the design process. However, where storage of hazardous materials, individually or in-combination exceeds the relevant thresholds, separate permissions will need to 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 and Control of Major Accident Hazards Regulations 2015 (COMAH) regimes. All chemical storage will be regulated by the Environment Agency through an environmental permit that will be required for the operation of the PCC Site.

4.6 Design Parameters

4.6.1 The design of the Proposed Development is following an iterative process, based on preliminary environmental assessments and consultation with statutory and non-statutory consultees. The design of the Proposed Development may change as the EIA process progresses. However, the design parameters defined within the DCO will be retained in order to allow construction of the Proposed Development to progress from Q3 2022. The evolution of the Proposed Development to date is outlined in **Chapter 6:** Consideration of Alternatives.

4.6.2 A number of the design aspects and features of the Proposed Development cannot be confirmed until the tendering process for the design and construction 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 market

conditions and the advancement of CCGT and CCP technology in the period between preparing the Application and starting construction,

4.6.3 In order to ensure a robust assessment of the likely significance of the environmental effects of the Proposed Development, the EIA is being undertaken adopting the principles of the 'Rochdale Envelope' approach, where appropriate, to assess the potential environmental effects of different options under consideration and parameters of the Proposed Development that cannot yet be fixed. These include aspects such as:

- the specific locations of emission points within the Proposed PCC Site;
- the massing of structures and buildings to allow flexibility in selection of preferred technology; and
- and the final stack locations and heights.

4.6.4 Wherever an element of flexibility is maintained, each environmental discipline has considered which scenario represents a worst-case scenario for potential environmental effects and that scenario has been assessed in the associated topic specific chapters (**Chapter 6-19**) and reported in the PEI Report.

4.6.5 Feasibility work will continue to further refine the options prior to submission of the DCO application, where possible. As such, this PEI Report represents a reasonable worst-case assessment of the potential impacts of the Proposed Development at its current stage of design.

4.6.6 Table 4.1 sets out the maximum dimensions for the main components of the Proposed PCC Site which have been used as the basis for the various technical assessments. Although design work is ongoing, maximum parameters have been devised to enable the EIA to progress in the absence of the final design information and to enable robust impact assessment based on a reasonable and appropriate worst-case option. An accompanying indicative layout drawing is presented as **Figure 4.1** (PEI Report Volume III).

4.6.7 Natural ground levels at the Proposed PCC Site are approximately 0m to 1m AOD on the northern part of Keadby Common where the CCGT and CCP plant are proposed. Part of this area is currently in use for used 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 - 2m AOD.

4.6.8 It has been assumed for the purposes of the Proposed Development that ground elevations post site clearance will 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 are the subject of ongoing studies and will be confirmed in the EIA to accompany the DCO Application.

Table 4.1: Maximum Design Parameters at PEI Report Stage

Component	Length (m)	Width (m)	Height (m) above ground level (AGL)	Height (m AOD)*
Gas Turbine Hall	22	50	32	34
HRSG Building	28	50	56	58
Steam Turbine Hall	50	40	35	37
Steam Turbine Auxiliaries Building	50	10	13	15
Absorber	13	40	99	101
Stack(s)			85m (HRSG) 105m (Absorber)	87 107

* based on an indicative ground level of 2m AOD

4.6.9 Further information on maximum design parameters and limits of deviation will be provided in the draft DCO and described in the final ES.

4.6.10 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. For the purposes of the assessment, the CCGT and CCP units have been assessed at alternative locations within 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 (PEI Report Volume I) represent the worst-case from any of the modelled layouts.

4.6.11 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 (PEI Report Volume I) describes this further.

4.6.12 In assessing effects on landscape and visual amenity 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, as these are considered most likely to result in significant effects and represent the worst- case scenario. The maximum stack height will be fixed at the DCO submission stage. 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 (PEI Report Volume I) describes this further.

4.7 Proposed Development Operation

Operational Modes

4.7.1 It is anticipated that on commissioning, the Proposed Development will 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, for several years. Continuous

and stable CO_2 production and export is preferred during this period to minimise changes to injection rates into the CO_2 collection system of the ZCH Partnership network. Operating in baseload mode could involve up to 20 start-up/ shutdown cycles per year.

4.7.2 After a period of baseload operation, it is expected that the CCGT plant will operate in dispatchable mode, i.e. being able to export power to match the anticipated intermittency of renewable power in the future power market. Operating in dispatchable mode could involve up to 100 start-up/ shutdown cycles per year.

4.7.3 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.

Hours of Operation

4.7.4 The Proposed Development will be expected to operate flexibly during its lifetime with hours of operation driven by the dynamics of the energy market. The facility will be designed to operate 24 hours per day, 7 days per week with programmed offline periods for maintenance.

Staff

4.7.5 Operation of the Proposed Development is anticipated to create up to circa 50 operational roles. Temporary and contractor employees associated with maintenance activities would also be employed, as required.

4.7.6 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.

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

Process Inputs

4.7.8 The Proposed Development will use various raw materials during operation. Except for natural gas and water, these will 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.

4.7.9 Materials including chemicals to be used will be subject to control via the Environmental Permit, COMAH Licence (if applicable) and other necessary consents required, and are anticipated to include:

- solvent that will remove the CO_2 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 CPP;
- 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);
- cooling tower chemicals (biocides, bio dispersants, corrosion inhibitors);
- distillate fuel;
- nitrogen (natural gas system and other equipment purge);
- cleaning chemicals;
- acetylene (metal cutting);
- inert fire-fighting gases;
- lubricating oils;
- hydrogen for generator cooling and deoxygenation of product CO_2 stream; and
- carbon dioxide for purging of electrical generators for maintenance purposes.

Maintenance

4.7.10 The objective of plant maintenance is to ensure the Proposed PCC Site including utility connections operates safely and reliably.

4.7.11 Routine maintenance will be planned and scheduled via the maintenance management system with major overhauls occurring approximately once every two years. These maintenance activities will require additional contractors to work on-site. The contractors will access the Proposed Development Site via the main entrance.

4.7.12 Inspection and maintenance activities are one of a number of key criteria for determining the Proposed PCC Site footprint and layout. 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 have appropriate access and overhaul laydown areas and the internal road layout for the Proposed PCC Site will enable free movement for cranes and heavy lifting equipment.

4.7.13 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 O&M interventions (turnarounds, turbine overhauls, etc) are likely to be outsourced and major equipment items serviced by original equipment manufacturers (OEM).

4.7.14 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 and planned maintenance of the CO_2 compressors will be aligned with shutdowns of the CO_2 emitter facilities.

Hazard Prevention and Emergency Planning

4.7.15 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.

4.7.16 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.

4.7.17 Depending on the volumes of hazardous materials stored on Site, a Hazardous Substances Consent and if necessary, a COMAH licence will be obtained. This will introduce additional hazard prevention and emergency planning procedures.

4.7.18 CO_2 is not harmful to human health at low concentrations, it is not flammable and will not support combustion. As the concentration of CO_2 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 potential to act as an asphyxiant gas at low lying locations should it displace air from these locations due to its density being higher than that of air.

4.7.19 CO_2 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 practise information for CCP is however, available from the HSE. The HSE does not currently provide Land Use Planning (LUP) advice for CO_2 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 CO_2 equipment on the Proposed PCC Site.

4.7.20 The HSE is a statutory consultee for all Nationally Significant Infrastructure Projects (NSIPs), such as the Proposed Development, therefore consultation with the HSE will be ongoing throughout the design and planning process.

4.7.21 The Proposed Development is using 'safety in design' principles to take into consideration safety issues and risks and to ensure that the ongoing design reduces 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).

4.7.22 Design mitigation at the current concept design stage includes consideration of potential CO_2 releases and includes, (but is not limited to)

- careful equipment and material selection;
- siting of high pressure CO_2 equipment considering areas of potential exposure and prevailing wind direction;
- incorporation of gas leak detection systems; and
- consideration of venting arrangements.

4.7.23 As the design of the Proposed Development progresses, prior to the DCO Application, further consideration will 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 will continue throughout the FEED stage when the Proposed Development is further defined.

4.7.24 The Pipeline Safety Regulations 1996 do not consider an on-shore high pressure CO_2 pipeline as a Major Accident Hazard Pipeline (MAHP). However, given the volume of CO_2 to be exported, the CO_2 pipeline to be constructed by ZCH Partnership will be designed, installed and operated as if it were a MAHP, and the high-pressure CO_2 were to be classified as a 'dangerous fluid'. A Major Accident Prevention Document (MAPD) will be produced during the design process and the HSE will be consulted.

4.7.25 **Chapter 18:** Major Accidents and Disasters provides a preliminary 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

4.7.26 Access to the Proposed Development Site during operation would be via the existing access road from the A18 which passes via the existing Pilfrey Bridge over the Stainforth and Keadby Canal and the Scunthorpe to Doncaster passenger rail line (refer to **Figure 3.2** in PEI Report Volume III). 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.

4.7.27 A gatehouse and parking may be provided at the entrance to the Proposed Development Site, off the A18. Alternatively, this would be provided within the Proposed PCC Site. The Proposed PCC site includes a main car park, including muster point (upwind of CCP) in the event of emergency, manned gate house and control building which shall be designed as a place of safety in the event of emergency.

4.7.28 A total of four potential emergency access points have been identified for the Proposed Development Site at this stage:

- a northern emergency exit (both pedestrian and single track vehicular). A new crossing will be installed across the existing unnamed drain to allow for emergency

vehicle access (single track, circa 3.5m wide) and will connect with the existing service road for Keadby Wind Farm. 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 4.8.21 above) – (pedestrian and two lane vehicular). This main access to the Proposed Development Site that would also be available for emergency purposes.

4.7.29 The location of these access points is illustrated on **Figure 4.1** in PEI Report Volume III.

External Lighting

4.7.30 Prior to the commissioning of the Proposed Development, a detailed lighting scheme will be submitted for approval. This will be based on the Lighting Strategy to be prepared to accompany the DCO application. The external lighting scheme will be designed in accordance with relevant standards, such as 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.

4.7.31 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

4.7.32 The Proposed Development will comply with the 2010 Industrial Emissions Directive (IED) (Directive 2010/75/EU) 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.

4.7.33 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.

4.7.34 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.

Heavy Goods Vehicle Movements

4.7.35 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**, PEI Report, Volume II). 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.

4.7.36 The air quality, noise and transport assessments (**Chapters 8, 9** and **10** respectively in PEI Report, Volume I) consider the worst-case traffic profile relevant to that topic.

4.7.37 Construction traffic movements are described in **Chapter 5**: Construction Programme and Management (PEI Report, Volume I).

4.8 Decommissioning

4.8.1 The Proposed Development is expected to operate for up to 25 years. At the end of operation, it is expected that the Proposed Development will have some residual life remaining and an investment decision would then be made based on the market conditions prevailing at that time. 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 2057.

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

4.8.3 The bulk of the 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.

4.8.4 Prohibited materials such as asbestos, polychlorinated biphenyls (PCBs), 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.

4.8.5 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 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 that are below ground level will be backfilled to ground level to leave a levelled area.

4.8.6 A Decommissioning Plan (including Decommissioning Environmental Management Plan (DEMP)) will be produced and agreed with the Environment Agency as part of the Environmental Permitting 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 on the Proposed PCC Site during decommissioning and demolition.

4.8.7 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.

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

4.8.9 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.

4.8.10 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 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.

4.8.11 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.

4.8.12 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 PEI Report.

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

4.9.1 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).

4.9.2 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.

4.9.3 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 (comprising intake refurbishment and/ or replacement), pending a condition assessment of the existing intake infrastructure, should works be required below Mean High Water Springs (MHWS) in the River Trent. Consideration will also be given to works relating to the Canal Water Abstraction Option where such works within the Stainforth and Keadby Canal require consideration as part of the DML.

4.10 References

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.

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The Construction (Design and Management) Regulations 2015 (SI 2015/51). London: The Stationery Office

The Control of Major Accident Hazards Regulations 2015 (SI 2015/483). London: The Stationery Office.

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HM Treasury (2014) *National Infrastructure Plan 2014. HM Government, London.*

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