Contents

6. CONSIDERATION OF ALTERNATIVES AND DESIGN EVOLUTION

6.1. Background

6.1.1. This chapter of the Environmental Statement (ES) sets out the alternatives that have been considered during the evolution of the Proposed Development, design process and design evolution to date, notably since publication of the PEI Report**.**

6.1.2. The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (the 'EIA Regulations') (HMSO, 2017) state that an ES should contain *'A description of the reasonable alternatives (for example in terms of development design, technology, location, size and scale) studied by the applicant, which are relevant to the proposed development and its specific characteristics, and an indication of the main reasons for the option chosen, taking into account the effects of the development on the environment.'* (Regulation 14(2)(d)). This chapter recognises and fulfils this requirement in respect of the Proposed Development.

6.1.3. On the matter of alternatives, National Policy Statement (NPS) EN-1 (DESNZ, 2024) paragraph 4.3.9 states that "*This NPS does not contain any general requirement to consider alternatives or to establish whether the proposed project represents the best option from a policy perspective*." Paragraph 4.3.15 goes on to state that "*Applicants are obliged to include in their ES, information about the reasonable alternatives they have studied. This should include an indication of the main reasons for the applicant's choice, taking into account the environmental, social and economic effects and including, where relevant, technical and commercial feasibility*." These paragraphs are not amended in the revised draft NPS EN-1 published for consultation in April 2025 (DESNZ, 2025).

6.1.4. In this context, the consideration of alternatives and design evolution has been undertaken with the aim of developing a high-efficiency dispatchable power station to meet the identified national need for such facilities, while avoiding and/ or reducing adverse environmental effects (following the mitigation hierarchy of avoid, reduce and, if possible, remedy) and whilst also maximising its wider benefits, maintaining operational efficiency and cost-effectiveness, and considering other relevant matters, such as available land and planning policy.

6.1.5. The basic design of the Proposed Development is continuing to be developed in parallel to the Application and is informed by the Applicant's knowledge of combined cycle gas turbine power stations (CCGTs), including through experience of developing projects that have gained consent (and/or become operational), and engagement with the supply chain. The design of the cooling

water supply source, electrical connection point and the location of construction laydown have evolved from the Keadby 3 CCS Power Station DCO ('Keadby CCS Power Station') granted in December 2022. The design evolved through further engineering design work, engagement with stakeholders and with reference to additional surveys and technical studies that have been completed. Detailed design work will proceed after Final Investment Decision (FID), which is forecast in 2027, although any changes that result from the detailed design work will remain within the design parameters that will be set by the **Draft DCO** (**Application Document Ref. 3.1**).

6.2. The Need for the Proposed Development

6.2.1. The need for the Proposed Development is set out in **ES Volume I Chapter 7:** Legislative Context and Planning Policy (**Application Document Ref. 6.2.7**) and is in accordance with NPS EN-1, EN-2 and EN-4, the Marine Policy Statement, the East inshore and East Offshore Marine Plan, the Energy White Paper – Powering our Net Zero Future' (EWP) (HM Government, 2020), and the Clean Growth Strategy (Department for Energy Security and Net Zero and Department for Business, Energy & Industrial Strategy, 2017). The alternative 'do-nothing' scenario is described in Section 6.7, including the reasons for the Applicant proceeding with the Proposed Development.

6.3. Alternative Sites

6.3.1. Land at Keadby Power Station is ideally suited to the development of a low carbon power station because of its location in the Humber cluster where the development of industrial decarbonisation infrastructure is well progressed.

6.3.2. The Proposed Development Site ('the Site' as shown on **ES Volume III Figures 3.1:** Proposed Development Site and **3.2:** Aerial Photo of the Proposed Development Site (**Application Document Ref. 6.4**)) within the Keadby Power Station site has been selected by the Applicant for the Proposed Development, as opposed to other potentially available sites for the following reasons:

- the Site is suitably located to connect to the developing hydrogen supply network, which includes National Grid's Project Union (a national hydrogen transmission network for the UK, connecting hydrogen production and storage to hydrogen consumers) and Northern Gas Networks' proposed local hydrogen transmission network (East Coast Hydrogen project);
- the Site has excellent links to existing infrastructure including electrical grid and gas (specifically the National Grid electricity and natural gas transmission networks); water (given proximity to both the Stainforth and Keadby Canal and River Trent) and transport (A18 and M180 as well as waterborne options);

- the Site is located largely within the boundary of the existing Keadby Power Station site (and associated land within the ownership or control of the Applicant);
- the Main Site is a brownfield site, which is considered more appropriate to redevelop for large scale power generation than an alternative greenfield site, and has no existing major structures requiring demolition, treatment and removal;
- the location of the Main Site minimises interference with the Landscape and Creative Conservation Plan for Keadby 2 Power Station and specifically, the Habitat Management Areas secured via Conditions 31-34 inclusive of the Section 36 consent for Keadby 2 Power Station;
- the Main Site provides sufficient space to accommodate the required scale of a single high efficiency CCGT unit, without encroaching on the exclusion areas for the Keadby Wind Farm turbines to the north, the former Keadby Ash Tip to the west and the existing overhead lines to the south and east; and
- the Main Site is located in close proximity to the existing Keadby 1 and Keadby 2 Power Stations, providing opportunities for synergies and efficiencies for the Proposed Development, such as shared use of the existing cooling water discharge infrastructure and existing access routes.

6.3.3. During the early stage of the Proposed Development, the Applicant considered potential sites in the Humber region for a new CCGT project, reviewing a number of factors: environmental impact (including those topics considered in the EIA), electrical grid connection, cooling water availability, natural gas supply, proximity to future hydrogen supply, access constraints and land and space constraints. The electrical grid connection was a key differentiator favouring development on the Keadby Power Station site, as well as the other advantages summarised above.

6.4. Alternative Technologies and Fuels

6.4.1. The UK Government has developed a policy and investment framework to support low carbon technologies. At the time of the Keadby CCS Power Station DCO application in June 2021, the most mature low carbon technology for large scale dispatchable power generation was considered by the Applicant to be a post-combustion carbon capture plant. However, there have since been delays with the development of the CO_2 transport and storage network required to export captured CO_2 from Keadby CCS Power Station to storage under the North Sea. The continued development of hydrogen fired CCGT technology, growing policy support for the UK hydrogen economy and the progress of hydrogen production, storage and transport proposals in the Humber region, mean the Applicant now considers hydrogen firing to be an equally mature

technology option. Consent for the Proposed Development is therefore sought as an alternative to Keadby CCS Power Station. This is to provide the Applicant with flexibility to make a decision regarding the decarbonisation pathway for the next power station at the Keadby site once a clearer understanding of the availability of infrastructure critical to decarbonisation is known. This is likely to be driven by government policy, a factor which is outside the control of the Applicant.

6.4.2. The final decision has not yet been made on the choice of vendor for the generating station and this decision will not be made until a later stage of the project development. Therefore, the design of the Proposed Development at this stage incorporates a degree of flexibility in the dimensions and configurations of buildings and structures to allow for the future selection of the preferred technology and contractor. In order to provide a robust assessment of the likely significant environmental effects of the Proposed Development, the EIA has been undertaken adopting the principles of the 'Rochdale Envelope' approach (Advice Note 9, PINS, 2025) where appropriate. This involves assessing the maximum (or where relevant, minimum) parameters for the elements where flexibility needs to be retained (emissions performance, building dimensions or operational modes for example). As such, this ES represents a reasonable worst-case assessment of the potential impacts of the Proposed Development at its current stage of design.

6.4.3. Other alternative technologies for large scale dispatchable power generation could include:

- a CCGT power station solely consented to operate on natural gas, with Carbon Capture Readiness (CCR) land – this would be similar to Keadby CCS Power Station, but built in advance of the CO_2 transport and storage network being consented;
- a CCGT power station solely consented to operate on natural gas without CCR land – this would not comply with The Carbon Capture Readiness (Electricity Generating Stations) Regulations 2013 and would not comprise low carbon technology so has been ruled out; or
- a natural gas fired Open Cycle Gas Turbine (OCGT) power station – a CCGT is considered the best use of the land space and available grid connection capacity so this alternative has also been ruled out.

6.5. Alternative Design Options and Design Evolution

6.5.1. As part of the ongoing design process, consideration has been given to a range of design options. Decisions taken regarding the concept design of the Proposed Development have, where relevant and possible, been informed by environmental appraisal and assessment work and by consultation with stakeholders.

6.5.2. A number of aspects of design have been settled. These are outlined below:

- a single CCGT unit would be installed on the Main Site, north of the existing overhead power lines, whilst some ancillary plant, buildings and facilities may need to be located south of the Main Site, to the east and west of the Keadby 2 Power Station cooling towers;
- hydrogen production, storage and supply infrastructure is currently being developed by SSE, Equinor and others. The CCGT would be designed to run on 100% hydrogen, however it is anticipated that the required hydrogen supply infrastructure may not be available at the start of operation, in which case the Proposed Development would also need to be able to operate using natural gas and blends of natural gas and hydrogen.
- the Applicant will work collaboratively with the hydrogen and natural gas suppliers to facilitate installation and operation of a hydrogen above ground installation (AGI) and a natural gas AGI and ensure they are in a suitable location to align with the pipeline connection points;
- hybrid cooling will be used for the cooling of the CCGT, rather than once-through cooling or air cooled condensers. A cooling technology BAT assessment including consideration of overall cooling duty, water consumption, water source and treatment, parasitic energy load and capital costs will accompany the Environmental Permit Application, providing further justification for the selected option;
- water for cooling will be abstracted from the Stainforth and Keadby Canal – the option to abstract cooling water from the River Trent (which was included in the Keadby CCS Power Station DCO and EIA Scoping Report for the Proposed Development) has now been discounted by the Applicant on the basis of technical and environmental considerations (the river water abstraction option would require works in the tidal river, and the river water would require more treatment to remove sediment meaning that a larger volume would need to be abstracted to provide the required volume of treated water for cooling);
- the water abstraction infrastructure along the Stainforth and Keadby Canal has been positioned immediately to the east of the existing Keadby 2 Power Station canal water abstraction infrastructure so as to avoid the North Soak Drain siphon pipes immediately to the west. This is in accordance with the discussions undertaken with the Environment Agency following the Keadby CCS Power Station DCO. As part of the Keadby CCS Power Station Project, a variation to the Canal and River Trust's licence to abstract water from the Stainforth and Keadby Canal was approved by the EA and as the Proposed Development is an alternative to the Keadby CCS Power Station project, it is considered that the abstraction licence could be utilised for the

Proposed Development. The Applicant is continuing to engage with the Canal and River Trust in regards to the abstraction);

- the electrical connection for the Proposed Development will be to the 400kV National Grid substation adjacent to the Main Site – the option for an electricity supply connection from the 132kV Northern Powergrid substation on Chapel Lane (which was included in the Keadby CCS Power Station DCO and EIA Scoping Report for the Proposed Development) has now been discounted as it is not required for the Proposed Development;
- the main construction and operational access to the Site will be to the south of Keadby Common, with access via North Pilfrey bridge from the A18:
  - the selection of the A18 for the construction access was based on its accepted use for Keadby 2 Power Station construction (and accepted proposed use for Keadby CCS Power Station) and the benefits for local villages including Keadby and Althorpe of avoiding HGV traffic entering the village. Alternatives such as routing all construction traffic via Ealand and Bonnyhale Road were also discounted for these reasons; and
  - the selection of the A18 for the operational access was based on its suitability along with the findings of statutory public consultation for Keadby CCS Power Station DCO since the reduction in traffic in the villages was a benefit valued by respondents.

6.5.3. The replacement of Mabey Bridge considered two options during the initial feasibility work. The selection of the preferred option (a composite weathering steel beam deck with integral piled foundation) over the alternative option (a precast prestressed beam deck integral with the piled abutment) has been informed by environmental considerations. The preferred option was selected as it enables piling to take place behind the existing bankseats avoiding the need for them to be removed, therefore minimising impacts on Hatfield Waste Drain. This option also enables a higher soffit level to be maintained which provides increased conveyance along Hatfield Drain and subsequently minimises flood risk.

6.5.4. A number of options remain under consideration for certain aspects of the Proposed Development, so options have been included and assessed within this ES including:

- the final stack height may change but would remain within the maximum design parameters of the Rochdale Envelope assessed (refer to Table 4.1 in **ES Volume I Chapter 4**: The Proposed Development (**Application Document Ref. 6.2**));

- the final treatment and disposal option for sanitary and domestic effluent, which may either be conveyed to the existing foul sewer, subject to the agreement of the sewerage undertaker, or if this option is not feasible for the lifetime of the Proposed Development, treated in a package treatment plant and discharged via the Water Discharge Corridor to the River Trent;
- the need or otherwise for certain buildings and/ or enclosures;
- the preferred surface water drainage strategy and discharge point; and
- the preferred route of the electrical connection cable from the CCGT into the existing 400kV National Grid Substation has not yet been fixed so two options are retained in the Application allowing for connection into either the west side or the east side of the substation (preferred connection location within the existing substation to be determined in discussion with National Grid).

6.5.5. The Rochdale Envelope approach has been applied to address these options and each has been evaluated in terms of environmental effects, constructability and land ownership. The approach taken has been described within each topic specific chapter (**ES Volume I Chapters 8-20** of **Application Document Ref. 6.2**).

6.5.6. The design and definition of the Proposed Development has continued to evolve since the publication of the PEI Report for statutory consultation, partly in response to consultation responses, and also due to ongoing refinement of the design and Site boundary with reference to ongoing discussions with technology providers and manufacturers. The main design refinements are summarised in Table 6.1.

Table 6.1: Summary of design refinements since publication of the PEI Report

Topic	Information reported in the PEI Report	Information now reported in the ES and draft DCO	Reason for change
Maximum design parameters reported in Rochdale Envelope	HRSG Building: 28m length, 69m width, 56m height above ground level (AGL), 59.0m height above ordnance datum (AOD). Stack: Up to 8.5m diameter. Cooling towers: 123m length, 38m width and 25m AOD height.	HRSG Building: 33m length, 74m width, 58m height AGL, 61.0m AOD. Stack: Up to 9m external diameter (8.4m internal diameter). Cooling towers: 170m length, 38m width, 28m AOD height.	Refined during design development and in consultation with technology manufacturers. Cooling towers dimension has evolved to enable the towers to be orientated in either a paired line or a single line – as the dimensions for the latter are greater they have been adopted as the worst-case.
Electrical connection route	Electrical connection route from the Main Site directly into the existing 400kV substation from the west.	An alternative connection route has been designed to enable connection from the Main Site to the 400kV substation from the east via an underground cable along Chapel Lane. Both options are to be retained until final connection agreement is confirmed.	Input from engagement with National Grid necessitating flexibility to be retained as to where the power station will connect into the substation.

Topic	Information reported in the PEI Report	Information now reported in the ES and draft DCO	Reason for change
Construction staff numbers	Peak construction staff estimated to be 1,300.	Peak construction staff estimated to be 1,050.	The initial figures were based on Keadby CCS. Based on a review of the construction workforce used on Keadby 2 Power Station (considered to be more similar in scale to the Proposed Development) and refinement of the calculations for the volume of material required in the land raising, the figures have been reduced.
Site boundary	Site boundary presented in PEI Report covered an area of 70.9 hectares (ha) .	Site boundary has been adjusted to reflect design evolution and covers an area of 77.1ha . The Site boundary refinements are: 1. Inclusion of additional land around the junction of the access road with the A18.	The reason for each Site boundary change is: 1. To allow for utility connections to the proposed A18 gatehouse. 2. To accommodate the proposed replacement bridge which is

Topic	Information reported in the PEI Report	Information now reported in the ES and draft DCO	Reason for change
		2. A marginal increase in the width of the Site boundary around Mabey Bridge. 3. An increase to area allowed for the natural gas connection to the National Grid Gas natural gas supply network. 4. Inclusion of land to the south-east of the 400kV Substation. 5. Inclusion of wider area in the Stainforth and Keadby Canal. 6. Inclusion of land to the south of Railway Wharf. 7. Minor refinements to remove small areas of third party land.	marginally wider than the existing. 3. To facilitate the most direct natural gas connection route within the Site. 4. To allow for an alternative electrical connection route into the eastern side of the 400kV Substation. 5. To ensure there is a sufficient temporary working area in the Canal to install the temporary cofferdam. 6. To enable land access to an existing anchor point for vessels using the Waterborne Transport Offloading Area (Railway Wharf).

Topic	Information reported in the PEI Report	Information now reported in the ES and draft DCO	Reason for change
			7. Areas are no longer considered to be required.
Cumulative impacts	The longlist and shortlist of committed developments was presented in the PEI Report with a high level cumulative assessment	The committed developments have been updated and a more detailed assessment of cumulative impacts is presented within the ES.	Refined to reflect the latest known status of other proposed developments within the zone of influence and to provide a robust cumulative impact assessment.

6.6. Alternative Layouts and Temporary Construction Laydown Areas

6.6.1. During the early stages of the design evolution for the Proposed Development, an alternative layout was considered using the Ancillary Facilities and Construction Laydown areas immediately to the south of the Main Site for the CCGT (see **ES Volume III Figure 3.3:** Indicative Parts of the Site Plan (**Application Document Ref. 6.4**)). However, as this area is smaller than the Main Site, using this plot for the Proposed Development would also potentially require part of the former Keadby Ash Tip to the west (which has become an established semi-natural habitat) to be developed. This plot is also allocated as Carbon Capture Readiness (CCR) land for Keadby 2 Power Station. The Main Site was therefore selected as the preferred location to develop as a priority at this time.

6.6.2. A long list of potential laydown land parcels (both within the Applicant's control and third party land) were subject to desk based appraisal during the preparation of the Keadby CCS Power Station DCO application. It was concluded at that time that in order to achieve the necessary laydown area requirements, whilst mitigating significant environmental effects (e.g. avoiding land of high value for biodiversity and known archaeological features), third party land in close proximity to the Main Site that would be suitable for temporary laydown would be required. The conclusions have been reviewed for the Proposed Development and remain valid, as the contracting strategy for the Proposed Development is currently in development and may require construction space for several Engineering, Procurement and Construction (EPC) contractors. The areas included within the Site for laydown (see **ES Volume III Figure 3.3:** Indicative Parts of the Site Plan (**Application Document Ref. 6.4**)) are:

- An unused parcel of land adjacent to the Mabey Bridge replacement;
- An area to the south of the existing access road within agricultural land;
- An area to the north of the existing access road and south of the Stainforth and Keadby Canal on land owned by the SSE and including land which has recently been used for temporary laydown for Keadby 2 Power Station construction;
- Land within and adjacent to the Main Site including land recently used as temporary laydown for Keadby 2 Power Station construction; and
- Land within the Main Site.

6.6.3. These areas are described in **ES Volume I Chapter 3**: The Site and Surrounding Areas (**Application Document Ref. 6.2**) and have been assessed

in the relevant topic specific chapters of this ES (**ES Volume I Chapters 8-20** (**Application Document Ref. 6.2**).

6.7. The Do-Nothing Alternative

6.7.1. It is considered that a 'do nothing' scenario is not appropriate given the established national need for new low carbon dispatchable energy generation to meet the UK's Net Zero targets (refer to **ES Volume I Chapter 7**: Legislative Context and Planning Policy Framework (**Application Document Ref. 6.2**).

6.7.2. A 'do nothing' alternative would mean that a first of a kind hydrogen-fired power station would not be developed, meaning that dispatchable low carbon generating plant would not be available to support the increased deployment of renewables onto the UK transmission system.

6.7.3. Another key disadvantage of a 'do nothing' scenario would be the lack of additional investment in the local economy since the Proposed Development would not be developed.

6.7.4. For these reasons the 'do nothing' scenario is not considered appropriate, although it has been assessed as part of the baseline conditions in the EIA presented in the topic specific chapters of this ES (**ES Volume I Chapters 8-20** (**Application Document Ref. 6.2**).

6.8. Conclusions

6.8.1. The Site was identified as being the most suitable for the following key reasons:

- suitable location to connect to the developing hydrogen supply network;
- excellent links to existing infrastructure including electrical grid, gas, water and transport;
- the Site is largely within the Applicant's control;
- absence of major structures requiring demolition, treatment and removal on the Main Site, which comprises brownfield land rather than greenfield;
- location of the Main Site minimises interference with Landscape and Creative Conservation Plan for Keadby 2 Power Station;
- sufficient space is available within the Main Site to accommodate the power generation equipment, without encroaching on the exclusion areas for the Keadby Wind Farm turbines to the north, the former Keadby Ash Tip to the west and the existing overhead lines to the south and east; and
- proximity to the existing Keadby 1 and Keadby 2 Power Stations providing opportunities for synergies and efficiencies, such as shared use of the existing cooling water discharge infrastructure and existing access routes.

6.8.2. The form and approach to the Proposed Development has been identified as above, taking into account potential environmental effects, alongside other factors such as technical and commercial feasibility.

6.9. References

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