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6.0 NEED, ALTERNATIVES AND DESIGN EVOLUTION

6.1 Introduction

6.1.1 This chapter of the Preliminary Environmental Information (PEI) Report sets out a summary of the need case for the Proposed Development, and the alternatives that have been considered during the evolution of the design process as presented in Chapter 4: Proposed Development (PEI Report, Volume I) up to statutory consultation.

6.1.2 The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (the 'EIA Regulations') state that an Environmental Statement (ES) (and, in following its structure, a PEI Report) should contain "*A description of the reasonable alternatives (for example in terms of development design, technology, location, size and scale) studied by the developer, which are relevant to the proposed project and its specific characteristics, and an indication of the main reasons for selecting the chosen, option, including a comparison of the environmental effects"* (Regulation 14(2)(e)). This chapter recognises and fulfils this requirement in respect of the Proposed Development.

6.1.3 Under the EIA Regulations there is no requirement to assess the alternatives, only a requirement to provide information regarding the alternatives that have been considered.

6.1.4 On the matter of alternatives, National Policy Statement (NPS) EN-1 (DECC, 2011) paragraph 4.4.1 states that "*This NPS does not contain any general requirement to consider alternatives or to establish whether the proposed project represents the best option''.* Paragraph 4.4.2 goes on to state "*However, applicants are obliged to include in their ES, as a matter of fact, information about the main 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"*.

6.1.5 Similarly, paragraph 4.2.15 of draft revised EN-1 (refer to Chapter 7: Legislative Context and Planning Policy of this PEI Report (PEI Report, Volume I)) (Department for Energy Security and Net Zero (DESNZ, 2023)) states 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'*.

6.1.6 Paragraphs 4.2.18-4.2.28 of the draft revised NPS go on to set out the various considerations that the Secretary of State (SoS) should take into account in considering alternatives.

6.1.7 In this context, the consideration of alternatives and design evolution has been undertaken with the aim of avoiding and/or reducing adverse environmental effects (following the mitigation hierarchy of avoid, reduce and, if possible, remedy), while maintaining operational efficiency and cost-effectiveness, considering other relevant

matters such as available land and planning policy, and taking into account the alternatives considerations that apply under the Water Environment (Water Framework Directive (WFD)) (England and Wales) Regulations 2017 (2000/60/EC) (HM Government, 2017), the Conservation of Habitats and Species Regulations 2017 (Habitats Regulations) (HM Government, 2017), common law and compulsory acquisition regimes.

6.1.8 The design of the Proposed Development is at a sufficiently advanced stage to allow meaningful consultation. The design remains preliminary and will continue to evolve up to the point of the DCO Application submission in response to consultation feedback and with reference to any ongoing surveys and technical studies. Detailed design work will proceed once the project moves into the '*Front End Engineering Design*' (FEED) stage which is due to commence in 2024. The detailed FEED work will remain within the design parameters set out in the DCO Application and as assessed within the ES.

6.2 The Need for the Proposed Development

6.2.1 As outlined in Chapter 4: Proposed Development (PEI Report, Volume I), the Proposed Development comprises the construction, operation (including maintenance), and decommissioning of an approximately 1.2 GWth LHV (Phase 1, 600-megawatt thermal (MWth) LHV and Phase 2, 600 MWth LHV) Carbon, Capture and Storage (CCS) enabled Hydrogen Production Facility ('the Production Facility') located in the Teesside industrial cluster area. This includes hydrogen (H_2) distribution pipelines to supply H_2 to various offtakers on Teesside and within the surrounding area.

6.2.2 bp is aiming to be a net zero company by 2050 or sooner. In support of this, bp is determined to advance the H_2 industry across the UK, Europe, Australia and US. H_2 is set to provide a low carbon energy for activities and processes that are difficult to electrify – especially in industry: iron, steel and chemicals for high-temperature processes. It can also help to decarbonise long-distance transportation in marine, aviation and heavy-duty road transport.

6.2.3 'Blue hydrogen', or 'CCS-enabled hydrogen', is H_2 that is extracted from natural gas, but the vast majority of CO_2 produced during this process is captured and stored permanently. Blue hydrogen, integrated with carbon capture and storage, can provide the scale and reliability needed by industrial processes. It can play an essential role in decarbonising industries that are hard to electrify – for example cement and steel making, which depend on fuels that can create intense heat, and heavy transport, which need fuels capable of powering vehicles with heavy loads.

6.2.4 Low carbon H_2 can be used to decarbonise a range of carbon intensive sectors including industry (as a low carbon fuel and feedstock), power and steam generation, mobility and transport (heavy duty fleets, buses, rail, aviation and marine) and grid blending. H2Teesside H_2 demand will come from multiple end users, including to support fuel switching from natural gas to H_2 within process heat, steam raising and power generation applications, therefore reducing CO_2 emissions from these industries.

6.2.5 The Proposed Development would deliver low carbon H_2 production at scale, coupled with CCS. It is well placed to support large-scale industrial decarbonisation, being located in one of the UK's major industrial clusters, with the potential to supply H_2 to a number of industrial users/offtakers, while linking into the NEP infrastructure for the transportation and storage of the CO_2 generated during the H_2 production process.

6.2.6 Further information on the need for the Proposed Development will be provided in the Planning Statement which will be submitted in support of the DCO Application.

6.3 The Do Nothing Alternative

6.3.1 The 'Do Nothing' alternative would mean that the Proposed Development would not be developed, meaning that it would not produce nor distribute any low carbon H_2. There would not be opportunity for offtakers within the Teesside region to transition to this low-carbon alternative, generated at the Production Facility.

6.3.2 In addition, Carbon Capture and Storage (CCS) is recognised in Government policy as being essential to achieving the UK Government's commitments to achieving net-zero emissions by 2050. In particular, H_2 is identified as critical to the decarbonisation of industries that are hard to electrify. The Proposed Development is well placed to support large-scale industrial decarbonisation, as it is located in one of the UK's major industrial clusters, with the potential to supply H_2 to a number of industrial users/offtakers and linking into the Northern Endurance Partnership (NEP) infrastructure for the transportation and storage of the CO_2 generated during the H_2 production process.

6.3.3 If the Proposed Development was not progressed, then the opportunity that it presents in helping to achieve those targets would not exist.

6.3.4 For these reasons, the 'Do Nothing' alternative scenario is not considered appropriate. This scenario has implicitly been assessed as it represents the baseline conditions in the EIA.

6.4 Alternative Technologies

6.4.1 No alternatives to H_2 production have been considered given the need for the Proposed Development as outlined above. The consideration of alternative technologies has focused only on the means of delivering a H_2 production facility.

6.4.2 Blue hydrogen has been selected for H_2 production as it uses proven and widely used technology for H_2 production, combined with proven carbon capture technologies (thereby delivering low carbon H_2). The technology is readily available and can be deployed at a large scale to meet Government ambitions, such as those outlined in the UK Hydrogen Strategy (HM Government, 2021).

6.4.3 Different syngas technologies have been evaluated to identify the preferred option for delivering this CCS enabled blue H_2 production facility. Two potential technology options are being considered at this stage, as part of the Proposed Development. These are referred to as Case A (which involves ATR based reforming) and Case B (which utilises a proprietary Low Carbon Hydrogen technology). Only one of these

technologies will be selected, based on factors such as capacity, scalability, cost, technology readiness level, energy efficiency, associated emissions, safety considerations and capture rate. A summary of the key differences between Case A and Case B is provided in Chapter 4: Proposed Development (PEI Report, Volume I). Partial oxidation was also evaluated but is no longer considered a preferred option.

6.4.4 It is anticipated that one of these technologies will be selected as the EIA progresses and the justification for this will be clearly outlined in the ES.

6.4.5 These technologies would be combined with chemical solvents for carbon capture and the following technologies for H_2 purification:

- physical solvents;
- chemical solvents;
- cryogenics separation; and
- pressure swing adsorption.

6.5 Alternative Sites

6.5.1 Within Teesside, a number of sites were considered by the Applicant for the Production Facility. The analysis of potential sites focussed on identifying a site that supports the development of a viable blue H_2 project that facilitates industrial connectivity and the path to decarbonisation.

6.5.2 Various factors influenced the site selection process. The criteria that were considered as part of the site selection process include:

- process safety considerations;
- proximity to the east coast and NEP infrastructure, to enable high pressure CO_2 export to be quickly directed offshore, specifically to the Endurance storage facility;
- size – ensuring there is sufficient space for the Proposed Development, that it is safe to construction, and it has expansion potential;
- utilising brownfield land where possible;
- distance from residential areas (with remoteness from residential receptors being preferable);
- proximity to industrial offtakers that could connect into the H_2 network;
- proximity to necessary connections including a gas network, electricity transmission network, water supply and wastewater management options;
- minimising environmental/social effects or risks; and
- discussions with landowners.

6.5.3 The EIA Scoping Report presented within Appendix 1A (PEI Report, Volume III) provides details of two Main Site options, namely Main Site A (the Foundry) and Main Site B (RBT). Both site options provide proximity to existing and potential future users

of low carbon H_2 and access to the off-shore Endurance carbon store via NEP's nearby proposed infrastructure. Both locations (the Foundry and RBT) were considered sufficiently remote from any safety sensitive receptors, thereby minimising process safety risks. In addition, both Main Site options could be easily connected to the required infrastructure (including natural gas, water and electrical).

6.5.4 In June 2023, the Applicant decided to progress with Main Site A. Main Site A is directly adjacent to the NEP onshore facilities, thereby simplifying the connection corridor routing.

6.5.5 Main Site A is also large enough to allow for the potential expansion of the H2Teesside project, as well as possible co-location other proposed bp projects in Teesside (such as HyGreen, a green H_2 project which is proposed to be located adjacent to the Proposed Development Site), allowing synergies between the projects to be explored.

6.5.6 Main Site A also offers greater opportunity to manage process safety risk; its size means that potential process safety impacts on adjacent sites can be minimised.

6.5.7 As identified in the EIA Scoping Report included at Appendix 1A (PEI Report, Volume III), the environmental baseline conditions for both Main Site options are very similar. They are located in proximity to each other and as such, are in similar proximity to sensitive receptors; although, Main Site B is slightly closer to the River Tees and Teesmouth National Nature Reserve (NNR). Main Site A is slightly closer to the nearest residential receptor (Marsh House Farm), but both Main Sites are generally remote from residential receptors. Marsh House Farm is located approximately 1.3 km and 2.2 km to the east of Main Sites A and B respectively. Both Main Sites have similar industrial histories, and similar topographies.

6.6 Alternative Layouts within the Main Site

6.6.1 Alternative development layouts within the Main Site are being evaluated. Options will continue to be refined as the DCO Application progresses, including (but not limited to):

- the layout of the Proposed Development including the configuration of the structures and buildings within the Main Site; and
- the design of the Proposed Development, e.g. the solution chosen in terms of O_2 and N_2 supply (whether sourced locally or requiring an Air Separation Unit (ASU)).

6.6.2 The location and layout of proposed infrastructure within the Main Site has considered relevant development plans (outlined in Chapter 7: Legislation and Planning Policy (PEI Report, Volume I), ground conditions and proximity to sensitive receptors. At this stage, design and assessment work is still ongoing to determine the most appropriate layout for the Main Site. Some of the factors that are being considered during this process are:

- consideration of space available for the plant and construction laydown;
- process safety;

- proximity to the NEP infrastructure on the adjacent NZT site, thereby minimising the length of the high-pressure CO_2 export connection;
- distance from residential areas/population/sensitive ecological receptors;
- access to water supply;
- access to the proposed NZT effluent outfall to Tees Bay or the existing Bran Sands Wastewater Treatment Works (WwTW) outfall to Dabholm Gut ; and
- construction access including jetties that could be used for the delivery of Abnormal Indivisible Loads (AILs).

6.7 Connection Corridor Routing

6.7.1 At this stage, some options remain under consideration for the routing of the Connection Corridors required for the Proposed Development, as shown on Figures 4-2 to 4-8 (PEI Report, Volume II).

6.7.2 Options will be refined as the DCO Application progresses, including (but not limited to):

- the options and refinement of routes carried forward for connection to the natural gas, 'other gases' (O_2 and N_2) and electricity supply networks within the proposed connection corridors;
- the options and refinement of routes for the H_2 pipeline within the proposed Hydrogen Pipeline Corridor; and
- the options and refinement of routes for the water connection within the proposed Water Connections Corridor.

6.7.3 Various options have been considered for the routing of the Hydrogen Pipeline Corridor. Since the preparation of the EIA Scoping Report, the route options have been refined, informed by engineering feasibility work, the outcome of environmental studies and consultation with statutory consultees such as Natural England and the Environment Agency (EA). This includes the removal of a route option to the western extent of the Proposed Development Site. Only one route option is now being considered for the crossing of Greatham Creek, as shown by Figure 4-4: Hydrogen Pipeline Corridor (PEI Report, Volume II). Ultimately, a single route option to each offtaker will be selected.

6.7.4 The optionality in the routing of the Hydrogen Pipeline Corridor still includes several options for the crossing of the River Tees, as shown by Figure 4-4: Hydrogen Pipeline Corridor (PEI Report, Volume II). The choice of routing in this location depends upon the construction methodology selected (e.g. Horizontal Directional Drilling (HDD) or micro-tunnelling, as only trenchless methods are being considered for this particular crossing); further detail regarding this is provided in Section 6.8.

6.7.5 The options being considered in respect to the water management are outlined in Chapter 4: Proposed Development (PEI Report, Volume I). In summary:

- Raw water (for process and sanitary uses) will be supplied via the existing Northumbrian Water Limited (NWL) raw water supply to the Teesworks site, which is an existing licensed abstraction from the River Tees.
- Two options are under consideration in terms of process effluent management. The first option is based on Minimalised Liquid Discharge (MLD) from the Effluent Treatment Plant. In this scenario, treated wastewater from the Effluent Treatment Plant will be reused as makeup water in the Proposed Development's Water Treatment Plant. A low volume liquid waste stream containing salts and nutrients would be taken offsite for further treatment. The second option is an alternative to MLD and requires discharge of process effluent to the NZT project outfall at Tees Bay.
- Clean surface water runoff would be discharged to the Tees Estuary via Dabholm Gut or Tees Bay. The following options are being considered:
  - direct feed to Dabholm Gut (with any new pipework and outfall to be consented under a subsequent planning application);
  - discharge via the existing Brans Sands discharge pipeline (but not requiring treatment at Brans Sands WwTW as this is surface water runoff); or
  - discharge via the NZT outfall.

6.7.6 Final routings for all connections will take into consideration the location of sensitive environmental receptors including but not limited to statutory designated sites (such as Ramsar sites, Special Protection Areas (SPAs) and Sites of Special Scientific Interest (SSSIs)) within the area. Where possible, the selected route will seek to avoid environmentally sensitive areas and utilise existing established pipeline routes, and/or the least intrusive construction methodologies (e.g., trenchless methods, as opposed to open-cut trench). The final routings will be outlined in the ES.

6.8 Connection Corridor Construction Methodologies

6.8.1 The proposed construction methodologies for each of the connection corridors are outlined in Chapter 4: Proposed Development (PEI Report, Volume I). In summary, various options are being considered, including trenchless crossings (such as HDD), below ground open trench (buried), the installation of new or existing above ground support structures, and the repurposing and reuse of existing pipelines (where possible). This is subject to ongoing design work, discussions with landowners and statutory consultees, and is being informed by environmental sensitive receptors and constraints and surveys.

6.8.2 Since the preparation of the EIA Scoping Report, the construction methodologies for the Hydrogen Pipeline Corridor have been refined, informed by engineering feasibility work, the outcome of environmental studies and consultation with statutory consultees such as Natural England and the EA. This includes the decision to utilise trenchless methods for the crossing of the River Tees and Greatham Creek; no other methodologies are being considered in these locations.

6.8.3 The final construction methodologies selected will take into consideration the location of sensitive environmental receptors within the area. Where possible, existing established pipeline routes will be utilised, and/or the least intrusive construction methodologies (i.e. trenchless methods, as opposed to open-cut trench). The final design will be outlined in the ES.

6.9 Conclusions

6.9.1 As outlined at Section 6.4, no alternatives to H_2 production have been considered given the need for the Proposed Development. Blue hydrogen production has been selected as it uses proven, widely used and readily available technology that can be deployed at a large scale to deliver low carbon H_2 in line with Government ambitions.

6.9.2 Different syngas technologies have been evaluated; two options are being considered at this stage, referred to as Case A and Case B. Only one of these technologies will be selected, based on factors such as capacity, scalability, cost, technology readiness level, energy efficiency, associated emissions, safety considerations and capture rate.

6.9.3 As outlined at Section 6.5, the site selection process concluded that the Foundry Main Site is the most appropriate for the Production Facility, given its location on brownfield land suitable for redevelopment, its proximity to a number of existing industrial offtakers and to the proposed NEP infrastructure, and its remoteness from residential receptors. It is also sufficiently large to minimise process safety risks and to allow for potential synergies with other projects (such as HyGreen) to be explored.

6.9.4 As outlined in Sections 6.6 - 6.8, the layout of the Proposed Development (including the routeing of the connection corridors), and the proposed construction methodologies, are being developed taking into account the potential environmental effects, alongside other factors such as technical and commercial feasibility. The design of the Production Facility and the associated connection corridor routes and construction methodologies will continue to be refined following consultation, with the final Rochdale Envelope design being reported in the ES to be submitted as part of the DCO Application.

6.9.5 The ES will include a full summary of the alternatives considered throughout the design process, including the reasons for any changes.

6.10 References

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