

Keadby Next Generation Power Station

Environmental Permit Application

Main Supporting Document

The Environmental Permitting (England and Wales) Regulations 2016

Operator: Keadby Next Generation Limited

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GLOSSARY

Abbreviation	Description
AEP	Annual Exceedance Probability
AGI	Above Ground Installation
AGST	Above Ground Storage Tank
AQS	Air Quality Standard
BAT	Best Available Techniques
BAT-AEL	BAT-Achievable Emission Levels
BAT-AEEL	BAT-Associated Energy Efficiency Levels
BATc	Best Available Technique Conclusions
BRef	BAT Reference Document
CBA	Cost Benefit Analysis
CCGT	Combined Cycle Gas Turbine
CCS	Carbon Capture and Storage
CEMS	Continuous Emissions Monitoring System
CHP	Combined Heat and Power
CO	Carbon monoxide
CO ₂	Carbon dioxide
CoC	Cycles of Concentration
CRT	Canal and River Trust
DAA	Directly Associated Activities
DCO	Development Consent Order
DCS	Distributed Control System
DLN	Dry Low NOx
EA	Environment Agency
EAL	Environmental Assessment Levels
EIA	Environmental Impact Assessment
ELV	Emission Limit Value
EMS	Environmental Management System

Abbreviation	Description
ESRS	Electricity System Restoration Standard
ES	Environmental Statement
GET	Guidance on Emerging Techniques
GHG	Green House Gas
GT	Gas Turbine
HRSG	Heat Recovery Steam Generation
HMI	Human Machine Interface
IBC	Intermediate Bulk Containers
IDB	Internal Drainage Board
KGL	Keadby Generation Limited
KNG	Keadby Next Generation
KNGPS	Keadby Next Generation Power Station
LCP	Large Combustion Plant
MCP	Medium Combustion Plant
MCPD	Medium Combustion Plant Directive
MWe	megawatts electrical
MWth	megawatts thermal
MSUL	Minimum start-up load
MSDL	Minimum shut-down load
NETS	National Electricity Transmission system (NETS)
NLC	North Lincolnshire Council
NOx	Oxides of Nitrogen
NSR	Noise Sensitive Receptor
NGTS	National Gas Transmission System
OEM	Original Equipment Manufacturer
O&M	Operations and Maintenance
PC	Process Contribution
PEC	Predicted Environmental Concentration
PIG	Pipeline Inspection Gauge
RBI	Risk Based Inspection
RCM	Reliability Centred Maintenance
SCADA	Supervisory Control and Data Acquisition
SCR	Selective Catalytic Reduction
SIS	Safety Instrumented System
SPZ	Source Protection Zones
ST	Steam Turbine
TDS	Total Dissolved Solids
WTP	Water Treatment Plant

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1. Non-technical Summary

This document presents the supporting information for a Bespoke Environmental Permit application under the Environmental Permitting (England and Wales) Regulations 2016 (as amended) ('the EP Regulations'), submitted on behalf of Keadby Next Generation Limited ('KNG', part of the FTSE-listed SSE plc) to operate the proposed Keadby Next Generation Power Station ('KNGPS' or the 'Proposed Installation'), to be located on land adjacent to the existing Keadby Power Station site near Scunthorpe in North Lincolnshire. The existing Keadby Power Station site comprises two operational power stations, referred to as Keadby 1 and Keadby 2, which are operated by Keadby Generation Limited ('KGL', also part of the FTSE-listed SSE plc) under Environmental Permit EPR/YP3133LL.

The Proposed Installation is an alternative to the already permitted Keadby 3 Carbon Capture and Storage (CCS) Power Station, the operation of which has been included in the existing Keadby Power Station Environmental Permit (EPR/YP3133LL/V013) and would be located on the same plot of land.

The Proposed Installation consists of a combined cycle gas turbine (CCGT) electricity generating station designed to run on 100% hydrogen and capable of operating on 100% natural gas from the start of operations. When hydrogen becomes available and operation with hydrogen firing is commercially viable, the Proposed Installation will be upgraded to operate on a blend of natural gas and hydrogen or 100% hydrogen, dependent on availability. Unlike combustion of conventional fuels, combustion of hydrogen produces no direct emissions of carbon dioxide (CO₂) and therefore, it is a credible avenue for low-carbon combustion processes.

As the existing Keadby Power Station is operated by KGL and the Proposed Installation would be operated by a different SSE entity (i.e. KNG), a separate new Permit application is being made. Permitting both the Keadby 3 and the Proposed Installation in this way will enable SSE to make Financial Investment Decisions in a timely manner and to pivot to whichever decarbonisation pathway (hydrogen or CCS) becomes technically and commercially viable at the Site first. As such, only one option (KNGPS or Keadby 3 CCS Power Station) will ever progress to the construction and operational stages, and the redundant Environmental Permit would be surrendered, or partially transferred, as applicable.

The Proposed Installation's location in relation to the existing Keadby Power Station Environmental Permit and the Proposed Installation Site Boundary are provided in Figures 1 and 2 (Appendix A).

This Environmental Permit application is made in connection with the application for a Development Consent Order (DCO) that has been submitted to the Planning Inspectorate for the Proposed Installation. The Environmental Statement (ES) for the DCO application is provided in Appendix B.

The Site for the Proposed Installation is to the west of the existing Keadby Power Station Installation Boundary, on land that has until recently been used for arable

production. Should the Proposed Installation be constructed, this area of the Keadby Power Station Installation would require a partial transfer to KNG.

An assessment of the current site conditions has been undertaken for the Installation Boundary, and the application Site Condition Report is provided in Appendix C.

As the Proposed Installation is a 'first of a kind' for this type of power station infrastructure project and would represent one of the UK's first hydrogen-fired power stations, certain design aspects and features cannot be confirmed until the detailed design stage has been completed. The design of the Proposed Installation therefore, incorporates a necessary degree of flexibility, to allow for design amendments in line with detailed design progression as well as changing economic conditions and the advancement of hydrogen fired CCGT technology in the period between submitting the Permit application and starting construction.

The Proposed Installation will have a capacity of up to 910 megawatts electrical output (MWe), for export onto the UK National Electricity Transmission System (NETS). As previously stated, Proposed Installation will be capable of operating using 100% natural gas from the start of operation, as hydrogen firing may not be feasible, however it will be designed to run on 100% hydrogen from the start. The time required to upgrade the Proposed Installation to hydrogen firing would be minimised as a result of embedding key design requirements in the Proposed Installation within the baseline design. It is therefore considered that the Proposed Installation will ensure the earliest possible decarbonisation of the electricity system.

It is recognised that after 28th February 2026, the Decarbonisation Readiness requirements will be implemented through the EP Regulations, however at this time the Carbon Capture Readiness (Electricity Generating Stations) Regulations 2013 (the 'CCR Regulations') are still in place. The intention of the Proposed Installation in regard to decarbonising is to remove direct CO₂ emissions by using hydrogen as a fuel thereby negating the need for carbon capture. However, to support the DCO application a CCR Report was produced to demonstrate that there is suitable space for CCS and that it is technically and economically viable. In addition, the report provides a review of the four tests proposed by the EA in their draft guidance for Hydrogen Decarbonisation Readiness for the Proposed Installation. This report is provided in Appendix D.

The Proposed Installation will generate electricity from the combustion of hydrogen or natural gas within a CCGT, using hot gas from the combustion process to drive the gas turbine (GT), and steam generated from the heat of the hot gas, in the heat recovery steam generator (HRSG), which is used to drive the steam turbine (ST). If required to ensure that the required Best Available Techniques Associated Emission Levels (BAT-AELs) are achieved for oxides of nitrogen (NO_x), the exhaust gas will then pass through a Selective Catalytic Reduction (SCR) system to reduce concentrations of NO_x in the resulting flue gas.

The design and operation of the Proposed Installation is intended to meet the indicative requirements of BAT as defined for Large Combustion Plant (LCP), as summarised in this document and described in full in Appendix E1.

Cooling for the Proposed Installation will be achieved through the use of hybrid (wet-dry) cooling towers, with freshwater make-up to the towers (and to the HRSG boiler and other minor uses) obtained from the Stainforth and Keadby Canal. The use of freshwater hybrid cooling for the Proposed Installation was determined as BAT for the Keadby 3 Proposed Installation, through an assessment process which considered a number of options and the site-specific technical considerations for generational output, parasitic load and water resource impacts, amongst others. The assessment has been updated for the Proposed Installation and concluded that there would be no change to the outcome of the Keadby 3 assessment, and therefore the proposed cooling technique of freshwater hybrid cooling is still considered to be BAT for the Proposed Installation. The updated assessment is provided in Appendix E2.

The Proposed Installation will be Combined Heat and Power (CHP) ready, with sufficient space allocated for future retrofit of a heat offtake within its footprint, should that be required, although it is not considered to be viable for CHP opportunities at the outset of commercial operation. A CHP Assessment is provided in Appendix F.

Emissions from the CCGT will be exhausted through an 85m above ground level (AGL) high stack, serving the HRSG exhaust. Emissions will meet the emission limits for LCP under the Industrial Emissions Directive (IED), the LCP BAT Reference document (LCP BRef) and BAT Conclusions for natural gas fired operation and the Environment Agency's (EA's) Guidance on Emerging Techniques (GET) Emission Limit Values (ELVs) for hydrogen firing.

The stack height and emission concentrations required to minimise impacts on air quality receptors from the main pollutants to an acceptable level have been determined through an Air Quality Impact Assessment, undertaken in accordance with the EA's Risk Assessment guidance. The assessment includes dispersion modelling of maximum emission parameters and existing air quality baseline conditions (including modelling of Keadby 2 emissions), to determine the worst-case predicted environmental concentrations for comparison with air quality standards. The impact assessment is presented in Appendix G.

Discharge of effluent from the Proposed Installation will include blow-down from steam and cooling water systems, to maintain operational performance. Other minor and intermittent water discharges will be combined with the process effluent, such as rainwater run-off collected in potentially contaminated areas (such as bunds) that has been tested to ensure it is safe for discharge and discharge from the demineralisation plant, and will be discharged into the existing Keadby 1 discharge infrastructure, via a dedicated compliance point for the Proposed Installation (Emission Point W1), and ultimately to the River Trent. Although no specific impact assessment has been carried out for the discharge to Emission Point W1, it is considered that the assessments carried out for Keadby 3 represent a worst-case assessment for the Proposed Installation, and therefore these assessments have been provided in Appendix H.

Uncontaminated surface water will be contained within two attenuation ponds prior to discharge to the Internal Drainage Board (IDB) at greenfield run-off rates via Emission Points W2 and W3.

A Noise Impact Assessment using the EA's Noise and Vibration Management guidance methodology has been carried out to assess the impacts of noise on identified Noise Sensitive Receptors (NSR). The assessment concluded that with appropriate mitigation measures, predicted noise emissions arising from the Proposed Installation would not exceed the background sound level ($L_{A90,T}$). As noted in BS4142, where the rating level does not exceed background sound levels, this is an indication of the specific sound source having a low impact. By reference to the EA permit guidance, the level of noise impact results in "no noise, or barely audible or detectable noise". The Noise Impact Assessment is provided in Appendix I.

Wastes from the Proposed Installation are expected to be minimal and will be appropriately disposed of via licensed 3rd party waste contractors.

The Proposed Installation will be operated in line with the wider SSE ISO14001:2015 accredited Environmental Management System (EMS), which includes operating procedures to manage the various aspects of the operation of the plant, including, but not limited to; emissions monitoring, accident management, waste minimisation and management, and infrastructure maintenance.

2. Introduction

2.1 Proposed Operation

This Main Supporting Document supports an application submitted by Keadby Next Generation Limited ('KNG') (a wholly owned subsidiary of SSE plc) for an Environmental Permit to operate the proposed Keadby Next Generation Power Station ('KNGPS' or the 'Proposed Installation'). This application is made under the Environmental Permitting (England and Wales) Regulations 2016 (as amended) ('the EP Regulations') and is submitted in parallel with an application by KNG for a Development Consent Order (DCO) for the Proposed Installation to the Planning Inspectorate, under The Planning Act 2008.

The Proposed Installation is to be located on land adjacent to the existing Keadby Power Station site, near Scunthorpe in North Lincolnshire. The existing Keadby Power Station site comprises two operational power stations, referred to as Keadby 1 and Keadby 2, which are operated by Keadby Generation Limited ('KGL', also part of the FTSE-listed SSE plc) under Environmental Permit EPR/YP3133LL.

The Proposed Installation consists of a combined cycle gas turbine (CCGT) electricity generating station designed to run on 100% hydrogen and capable of operating on 100% natural gas from the start of operations. When hydrogen becomes available and operation with hydrogen firing is commercially viable, the Proposed Installation will be upgraded to operate on a blend of natural gas and hydrogen or 100% hydrogen, dependent on its availability. Unlike combustion of conventional fuels, combustion of hydrogen produces no direct emissions of carbon dioxide (CO₂) and therefore, it is a credible avenue for low-carbon combustion processes.

The Proposed Installation is an alternative to the already permitted Keadby 3 Carbon Capture and Storage (CCS) Power Station, the operation of which has been included in the existing Keadby Power Station Environmental Permit (EPR/YP3133LL/V013) and would be located on the same plot of land.

As the existing Keadby Power Station is operated by KGL and the Proposed Installation would be operated by a different SSE entity (i.e. KNG), a separate new Permit application is being made. Permitting both the Keadby 3 and the Proposed Installation in this way will enable SSE to make Financial Investment Decisions in a timely manner and to pivot to whichever decarbonisation pathway (hydrogen or CCS) becomes technically and commercially viable at the Site first. As such, only one option (KNGPS or Keadby 3 CCS Power Station) will ever progress to the construction and operational stages, and the redundant Environmental Permit would be surrendered, or partially transferred, as applicable.

The Proposed Installation's location in relation to the existing Keadby Power Station Environmental Permit and the Proposed Installation Site Boundary are provided in Figures 1 and 2 (Appendix A).

The Environment Agency (EA) is a statutory consultee to the DCO application and must provide assurance to the Planning Inspectorate that the Proposed Installation would be granted an Environmental Permit to operate, in order that the Examining Authority gain confidence that there is no impediment to the granting of Development Consent. A copy of the Environmental Statement (ES) supporting the application for a DCO is included in Appendix B of this document.

It is recognised that this Environmental Permit application is being made before detailed design of the Proposed Installation has been completed; and therefore, further information may need to be provided to the EA following completion of detailed design, in order to reflect design changes that may have occurred after this application has been submitted. As such, where possible, conservative or worst-case assumptions have been used in this application.

2.2 Background

The Keadby Power Station site encompasses the operational Keadby 1 and Keadby 2 Power Stations, both owned and under the control of KGL and regulated by the EA under the permit EPR/YP3133LL. The Keadby Power Station site is located approximately 5 km to the west of the town of Scunthorpe, Lincolnshire and falls within the administrative area of North Lincolnshire Council (NLC). The village of Keadby is the nearest settlement, approximately 500 m to the southeast.

A variation to the Keadby Power Station Permit was submitted in July 2021 for the addition of the Keadby 3 CCS Power Station. This variation was granted by the EA in November 2024.

Hydrogen firing was considered as an alternative low carbon technology pathway at the Environmental Impact Assessment (EIA) Scoping stage of the Keadby 3 CCS DCO application. However, this option was not taken forward because at that time the Zero Carbon Humber Cluster CO₂ pipeline had progressed further than the hydrogen supply option, and the timescale for supply of hydrogen to the Site was uncertain. Whilst some uncertainty remains in the development timelines of the infrastructure required to operate CCS enabled and hydrogen-fired power stations, KNG considers that the most effective and quickest way to decarbonise electricity generation is to construct power stations which are enabled to decarbonise by the most viable means, technically and economically, and therefore requires an Environmental Permit to enable the option of constructing and operating a hydrogen-fired CCGT on the Keadby CCS Power Station site as an alternative to the permitted Keadby 3 CCS Power Station.

The Proposed Installation is being progressed in parallel with the development of hydrogen fuel infrastructure for the following reasons:

- It is anticipated that security of electricity supply will be a key national topic, especially from the early 2030s, and the Proposed Installation will contribute to this objective – to this end, the Proposed Installation requires to complete early project development activities in the mid-2020s such that delivery can be completed by the early 2030s.

- If the Proposed Installation has taken a Final Investment Decision in the late 2020s and is in operation by the early 2030s, the Proposed Installation will provide an additional driver to accelerate and provide certainty to hydrogen production, storage and transport infrastructure projects in the Humber, due to being a hydrogen-enabled large scale offtaker and potential customer.
- The Proposed Installation will ensure the earliest possible decarbonisation of the electricity system, by ensuring that the technology is hydrogen-enabled, and switchover from natural gas to hydrogen can occur with minimal outage time as soon as the fuel is available, rather than awaiting fuel availability to commence development.

The Site for the Proposed Installation comprises approximately 22.5 hectares (ha) of land to the west of the existing Keadby Power Station Installation Site, within the area known as Keadby Common, formerly used for arable production although historically included parts of a former coal-fired power station.

Should the Proposed Installation be constructed, the land associated with the Keadby 3 CCS Power Station would need to be transferred from the Keadby Power Station EPR/YP3133LL Environmental Permit to KNG and the conditions associated with the Keadby 3 CCS Power Station removed.

The Proposed Installation Site Boundary is shown in Figure 2 (Appendix A).

2.3 Listed Activities

The Proposed Installation will comprise a single high efficiency CCGT unit with a nominal power export capacity of up to 910 MWe (approximately 1,460 MWth). The Proposed Installation will be designed to run on 100% hydrogen and capable of operating on 100% natural gas from the start of operations. When hydrogen becomes available and operation with H₂-firing is commercially viable, the Proposed Installation will be upgraded to operate on a blend of natural gas and hydrogen or 100% hydrogen, dependent on its availability.

The main activity of burning of any fuel in an appliance with a rated thermal input of 50 MW or more is a listed Section 1.1 Part A(1)(a) activity under the EP Regulations. In addition to the main activity, there will be a number of directly associated activities (DAA) required to support the main activity.

The activities to be carried out at the Proposed Installation are detailed in Table 1.

Table 1: Schedule 1 Listed Activities

Activity Ref	Activity listed in Schedule 1 of the EP Regulations	Description of Specified Activity	Limits of Specified Activity
AR1	Section 1.1 Part A(1)(a): Burning of any fuel in an appliance with a rated thermal	Operation of a Combined Cycle Gas Turbine for the generation of electricity (gross	The operation of a hydrogen/ natural gas fired power station from receipt of fuels as specified in Table S2.1 to discharge of

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Activity Ref	Activity listed in Schedule 1 of the EP Regulations	Description of Specified Activity	Limits of Specified Activity
	input of 50 MW or more.	output capacity of up to 910 MW). A diesel fired generator (4.1 MWth) for emergency shut-down protection of the CCGT unit. One diesel fuelled fire pump.	exhaust gases and the generation of electricity for export. Including the operation of selective catalytic reduction abatement plant.
AR2	Directly associated activity	Oil storage	From receipt of raw materials to handling, on-site storage and handling for use.
AR3	Directly Associated activity	Surface water drainage	Handling and storage of site drainage until discharge to the site surface water system. Including surface water storage in attenuation ponds.
AR4	Directly Associated activity	Water treatment	From receipt of raw materials to dispatch of treated effluent and process waters to final discharge.
AR6	Directly Associated activity	Hybrid cooling system – Indirect cooling water system used to cool exhaust steam and components of the generating plant.	From intake of water into the system from the Stainforth and Keadby canal, to compliance point W1 and the Keadby 1 discharge into the River Trent.
AR7	Directly Associated activity	Raw materials handling and storage – receipt, storage and handling of water treatment chemicals, ammonia, fuel and lubricating oils, turbine cleaning chemicals and all other raw materials.	From receipt of raw materials to their point of use.

Due to the early development of the Proposed Installation, as previously outlined, it is currently anticipated that the required hydrogen supply chain may not be available at the start of operation. As such, the Proposed Installation will be capable of operating using 100% natural gas from the start of operations. Three key parameters would need to be met for the Proposed installation to be upgraded to hydrogen firing:

- Hydrogen firing is technically feasible;
- There is sufficient supply of hydrogen to site; and
- The upgrade to hydrogen firing is economically viable.

Decarbonisation Readiness

After 28th February 2026 the Decarbonisation Readiness requirements will be implemented through the EP Regulations, however at this time the Carbon Capture Readiness (Electricity Generating Stations) Regulations 2013 (the 'CCR Regulations') are still in place. The intention of the Proposed Installation in regard to decarbonising is to remove direct CO₂ emissions by using hydrogen as a fuel thereby negating the need for carbon capture.

To support the DCO application a CCR Report was produced to demonstrate that there is suitable space for CCS and that it is technically and economically viable. In addition, the report provides a review of the four tests proposed by the EA in their draft guidance for Hydrogen Decarbonisation Readiness for the Proposed Installation. This report is provided in Appendix D.

2.4 Environmental Setting

The Site for the Proposed Installation comprises approximately 22.5 hectares (ha) of land to the west of the existing Keadby Power Station Installation Site, within the area known as Keadby Common. The relevant part of Keadby Common was historically associated with a former coal-fired power station that was demolished in the 1990s. The area was then used for arable production until 2017/ 2018. It has recently been used as laydown for Keadby 2 construction.

Various types of power infrastructure have been developed near the Proposed Installation in recent years, including overhead electricity transmission and distribution infrastructure and the Keadby Windfarm to the north which became operational in 2014. Additional wind turbines and electricity transmission and distribution infrastructure is present over the wider surrounding area, including an overhead electricity transmission line, associated with the existing National Grid 400 kV Substation to the east of the Proposed Installation.

Beyond the existing Keadby Power Station Site to the east of the Proposed Installation, the immediate land use is mostly arable farming. To the west of the Proposed

Installation is the Ash Tip associated with the former operation of the coal-fired power station.

Keadby Common has a drainage ditch on each boundary (four drains in total), and a drain crosses the common between a field to the north and the southern area.

Further built development is proposed to the south of the substation for administration/ control room/ warehouse buildings and car parking areas, although this is not included in the Installation Boundary. The approximate central point of the main operational area of the Proposed Installation is NGR 482020, 412030.

Residential and canal/river related uses are found in the nearby villages of Keadby and Gunness. The nearest settlement is the village of Keadby which is located approximately 1 km east from the Proposed Installation Site at its closest point.

Other settlements nearby include: Crowle (3.6 km) and Ealand (2.2 km) to the west; Althorpe (1.7 km) to the south-east and Gunness (1.8 km) to the east on the eastern bank of the River Trent. Closer to the Site are a small number of individual residential properties.

3. Application Site Condition Report

The Proposed Installation is to be developed on land covering an area of approximately 22.5 ha located within an area called Keadby Common (although this is not defined as Common Land), within the wider Keadby Power Station land and Installation Site Boundary owned by KGL.

The relevant part of Keadby Common was historically associated with a former coal-fired power station that was demolished in the 1990s. The area was then used for arable production until 2017/ 2018. It has recently been used as laydown for Keadby 2 construction.

As the site for the Proposed Installation lies within the existing Installation Boundary of the Keadby Power Station there would need to be a partial transfer of the Permit land to KNG for the construction of the Proposed Installation to take place.

An assessment of the current site conditions has been undertaken for the Installation Boundary and the application Site Condition Report is provided in Appendix C, which includes a Stage 1 – 3 Hazardous Substances Assessment.

The environmental sensitivity of the Proposed Installation site is considered to be as follows:

- Groundwater - Low to very high sensitivity

The underlying Mercia Mudstone Formation - Mudstone bedrock deposit is classified as Secondary Aquifer - B. The underlying superficial deposits consist of Secondary Aquifer - A (Alluvium/ Warp). The sensitivity of the underlying deposits is therefore classified as varying from low to very high.

- Surface water - Moderate sensitivity

The River Trent is located approximately 1 km to the east of the Proposed Installation Site. The Sheffield and South Yorkshire Navigation/ Stainforth and Keadby Canal is situated approximately 0.3 km to the south. The Three Rivers is approximately 0.5 km to the south and there are two drains (the North and South Soak Drain) following the canal.

- Land use – Low sensitivity

The Proposed Installation is surrounded by industrial and agricultural land and no significant land uses have been identified.

4. Operating Techniques

4.1 Technical Standards

The Proposed Installation will operate in accordance with the conditions of the Environmental Permit and also applicable EA Sector Guidance:

- EPR 1.01: How to Comply with your Environmental Permit, Additional Guidance for: Combustion Activities¹;
- Best Available Techniques (BAT) Reference Document for Large Combustion Plants² (LCP BRef);
- BAT Conclusions for Large Combustion Plants³ (LCP BATc);
- Environment Agency's Guidance on Emerging Techniques Hydrogen combustion: comply with emission limit values⁴
- Electricity Supply Industry – Industrial Emissions Directive (IED) Compliance Protocol for Utility Boilers and Gas Turbines (LCP BREF Update 2022)⁵.

The United Kingdom (UK) is no longer a member of the European Union (EU). Most EU legislation as it applied to the UK on 31st December 2020 is now a part of UK domestic legislation, under the control of the UK's Parliaments and Assemblies as a form of domestic legislation known as 'retained EU legislation'. This is set out in Sections 2 and 3 of the European Union (Withdrawal) Act 2018. Section 4 of the European Union (Withdrawal) Act 2018 ensures that most remaining EU rights and obligations, including directly effective rights within EU treaties, continue to be recognised and available in domestic law after exit.

The new CCGT plant for the combustion of fuel to generate power will be covered as a Section 1.1(A1)(a) - Burning any fuel in an appliance with a rated thermal input of 50 or more megawatts.

If firing on 100% natural gas, the Proposed Installation will be compliant with the IED, Large Combustion Plant (LCP) BRef and the associated LCP BAT Conclusions

¹ How to comply with your environmental permit, Additional guidance for: Combustion Activities (EPR 1.01), EA, March 2009

² Best Available Techniques (BAT), Reference Document for Large Combustion Plants Industrial Emissions Directive 2010/75/EU of the European Parliament and of the Council, July 2017. Available at: [Large Combustion Plants | EU-BRITE](#)

³ Commission Implementing Decision Establishing Best Available Techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for Large Combustion Plants, European IPPC Bureau, November 2021. Available at: [Large Combustion Plants | EU-BRITE](#)

⁴ [Hydrogen combustion: comply with emission limit values - GOV.UK](#)

⁵ Joint Environmental Programme, JEP22EMB01: Electricity Supply Industry – IED Compliance Protocol for Utility Boilers and Gas Turbines (LCP BREF Update 2022)

(BATc); and a summary of compliance against the current BATc is provided in Appendix E1.

As an emerging technique, the BRef and accompanying BATc do not address combustion plant firing on hydrogen, and therefore the EA have produced specific guidance for deriving appropriate emission limits for hydrogen firing, Hydrogen combustion: comply with emission limit values (Hydrogen Guidance on Emerging Techniques (GET)) for plant that is covered within the scope of Chapter III of the IED (LCP plant).

The guidance sets out what emission limits the EA expect hydrogen firing plant to be able to meet, until there is enough uptake of these technologies to understand what is achievable for air pollutant emissions. When appropriate, specific hydrogen BAT documents and associated emission levels (AELs) will be developed for the permitting process in the legislation.

The Proposed Installation will be operated in accordance with a management system that is compliant with the EA's guidance - 'Develop a management system: Environmental Permits'⁶.

4.2 Process Description

Proposed Installation Overview

The CCGT unit will include a gas turbine (GT), a heat recovery steam generator (HRSG) and a steam turbine (ST).

Natural gas to fire the GT will be supplied with gas imported from the National Gas Transmission (NGTS) System via a new above ground installation (AGI) on the Proposed Installation's Site.

Subject to agreement with the hydrogen supplier, hydrogen will be supplied via a pipeline and will be imported onto Site from a new hydrogen AGI and hydrogen receiving area.

The heat from the GT exhaust gas will be recovered in the HRSG to generate steam in the boiler, which will then drive the ST to maximise power generation. Power generated from the GT and ST will be exported to National Grid's National Electricity Transmission System (NETS).

If required to ensure that the required oxides of nitrogen (NO_x) emission limits are achieved from the LCP, the exhaust gas from the HRSG will be passed through a Selective Catalytic Reduction (SCR) abatement system located within the HRSG for

⁶ Develop a management system: Environmental Permits, EA, Published: February 2016, Last Updated on: 14th January 2019, accessed at <https://www.gov.uk/guidance/develop-a-management-system-environmental-permits> on 19th August 2019

optimal temperature conditions. The exhaust gas will then be discharged to atmosphere from a stack located adjacent to the HRSG building.

The extent of the Proposed Installation is shown in Figure 2 and the indicative Proposed Installation layout is illustrated in Figure 3 (Appendix A) and comprises:

- A GT and associated generator, located within a GT building;
- An HRSG;
- A ST and associated generator located within a ST building;
- GT air intake louvres, filters and ductwork;
- SCR equipment for the removal of NO_x from the flue gas, consisting of a catalyst chamber, associated pipework, fans and ammonia storage vessels (if required);
- A stack for the discharge of exhaust gas from the HRSG;
- A continuous emissions monitoring system (CEMS);
- Cooling infrastructure, comprising hybrid cooling cells and associated pipework, plant and buildings;
- Natural gas reception facility including NGTS minimum off-take connection and KNG AGI, gas conditioning, pressure and temperature control, fiscal metering equipment;
- Hydrogen gas reception facility including the hydrogen suppliers minimum off-take connection and KNG AGI, gas conditioning, let down and metering equipment and instrumentation and electrical building;
- Natural gas and hydrogen blending equipment;
- Electrical power export lines from the generating station to the existing 400kV NETS Substation located adjacent to the Keadby Power Station site;
- Transformers (for the import and export of electricity); and
- Facilities required in connection with the above including: an electrical auxiliary boiler, an emergency diesel generator, and associated diesel storage tanks; administration and control buildings, workshops, stores, raw water storage tank(s), demineralised water treatment plant including storage tanks and permanent laydown areas for operation and maintenance activities.

The administration/ control building(s) will contain the main reception, offices, control room, electrical equipment and staff welfare facilities. Stores building(s) will also be required for operation and maintenance activities and storage of materials.

A process flow diagram for the Proposed Installation is provided in Figure 4 (Appendix A).

Gas Reception and Conditioning

The Proposed Installation will be designed to run on 100% natural gas from the start of operation, as hydrogen firing may not be feasible, however it will be designed to operate on 100% hydrogen from the start. The time required to upgrade the Proposed Installation to hydrogen firing would be minimised as a result of embedding key design requirements in the Proposed Installation within the baseline design.

Subject to agreement with the hydrogen supplier, hydrogen will be supplied via a pipeline to a new hydrogen AGI and hydrogen receiving area within the Installation Boundary, where the hydrogen gas would be metered and conditioned to the requirements of the CCGT. Hydrogen conditioning will include mechanical and coalescing filters, pressure reduction equipment and fiscal flow measurement. There will be no storage of hydrogen within the Proposed Installation.

Subject to agreement with NGTS, natural gas will be supplied to a new minimum off-take area within the Installation Boundary, where the gas would be metered and conditioned to the requirements of the CCGT.

When firing on natural gas, gas from the NGTS will enter the Site at high pressure and will pass through mechanical and coalescing filters, be let-down to the required pressure and metered. The gas handling unit within the Proposed Installation ('gas receiving area') will provide electric pre-heating to counter the Joule-Thomson effect from pressure reduction, and heating of the gas to optimise efficiency of the CCGT. There will be no storage of natural gas on site.

A key design requirement for upgrading the Proposed Installation to hydrogen firing is a blending skid. The blending skid would manage the mixing of natural gas and hydrogen. The blending skid will consist of the following equipment:

- Blending ratio control system – to ensure desired blend ratio is monitored and maintained;
- Gas flow meter(s) – to measure and control the flowrates of natural gas and hydrogen to ensure that the desired blend ratio is achieved;
- Control valve(s) – to maintain desired blend ratio;
- Mixer pipework with back-flow protection; and
- Monitoring instrumentation – to measure parameters such as temperature, pressure, composition, flowrate and Wobbe index.

CCGT Power Generation Plant

The CCGT plant within the Proposed Installation will comprise one high efficiency (H/J class) GT unit, which in combination with the ST will have a nominal generation

capacity of up to 910 MWe (approximately 1,460 MWth). Given the first-of-a-kind nature of the Proposed Installation, the design detailed in this Permit application is based on a range of the most likely CCGT equipment to be used; this means that there may be a range of electrical output depending on the technology selected; at this stage in project design therefore, the largest unit currently commercially available has been selected as the conservative basis for assessments, unless otherwise stated.

The Proposed Installation will be designed to operate on 100% hydrogen. Space has been allocated and reserved for the installation of a hydrogen AGI to receive hydrogen fuel from a supply network, as well as space for necessary infrastructure required for blending of hydrogen and natural gas. The time required to upgrade the Proposed Installation from natural gas to H₂-firing would be minimised as a result of embedding key design requirements in the Proposed Installation within the baseline design. The HRSG shall be capable of generating steam from flue gases arising from combustion of natural gas and blends up to 100% hydrogen without modification.

Prior to entering the GT combustion system, the fuel gas will pass through a fuel gas heater, which increases the efficiency of the CCGT by reducing fuel required to reach turbine firing temperatures. Pre-heating of fuel gas will be undertaken using recovered heat from the water-steam cycle (note that flue gas is not used for pre-heating of fuel gas).

Within the GT, the heated gaseous fuel will be mixed and combusted with ambient air from the compressor outlet. Air from the compressor outlet is >450°C and therefore there is no requirement for additional pre-heating. The fuel-air mixture combustion results in high temperature combustion gases that expand across the blades of the turbine producing mechanical energy used to drive a generator to produce electricity.

The GT system will have equipment to reliably monitor the fuel flow rate, temperature, pressure and shaft speeds of the system, with the control system being temperature and power based in order to ensure safe and efficient operation. The control system will include emergency fuel shut off systems.

The hot exhaust gases from the GT will then be passed through an HRSG to produce high-pressure, medium-pressure and low-pressure steam, which would otherwise be lost through the exhaust stack, (i.e. in an open cycle gas turbine). The resulting steam is used to drive a ST, also connected to a generator; thereby maximising electricity generation from the fuel being combusted.

The control systems of the ST will monitor and regulate its operation, ensuring optimal performance. These control systems will monitor the steam flowrates, temperature, and pressure of the system. Furthermore, the ST will be fitted with safety mechanisms such as emergency stop steam safety valves, steam bypasses to condenser, overspeed protections, and vibration monitoring systems.

The steam exhausting from the ST will be condensed with the condensate returned to the steam-water cycle of the HRSG for continued reuse. Water used within this steam/ water cycle will need to be treated to be of extremely high purity to regulate the build-up of residual dissolved solids arising from the continuous evaporation and condensing

of water within the cycle. Water used within this steam/ water cycle will be dosed to control pH. To further manage this, it will be necessary to intermittently purge a small amount of the boiler water (known as 'blowdown') to the cooling tower basin. Any blowdown removed from the cycle will need to be made up with fresh demineralised water.

The condensation of steam exiting the ST will be achieved using a separate circuit of cooling water that will be recirculated through hybrid cooling towers.

The water/ steam control systems of the ST will monitor and regulate its operation, ensuring optimal performance. These control systems will monitor the steam flowrates, temperature, and pressure of the system. Furthermore, the steam turbine will be fitted with safety mechanisms such as emergency stop systems, steam isolation, overspeed protections, and vibration monitoring systems to protect against operational hazards.

The LCP BRef requires new CCGT plants combusting natural gas and having a thermal input of > 600 MWth to have net electrical efficiency levels in the range of 57 - 60.5%. The combination of the high-efficiency GT and the HRSG/ ST is anticipated to be capable of achieving electrical efficiency levels of >61% when firing on natural gas and hydrogen (anticipated to be >62.5% on natural gas and >61.5% on hydrogen depending on final combustion system design), thereby achieving or exceeding the efficiency envelope quoted within the LCP BRef.

The plant is also designed to be CHP-Ready; however, CHP is not proposed to be installed from the outset of commercial operation. The potential for using the CCGT plant as a CHP plant will be assessed periodically, as per regulatory requirements. A CHP assessment has been undertaken for the Proposed Installation and is provided in Appendix F.

Exhaust Gas Treatment

Combustion of natural gas and hydrogen is highly efficient with regards to 100% oxidation at high loads, and due to the nature of the fuels, the combustion gases from a typical CCGT plant contain negligible amounts of sulphur dioxide (SO₂) and particulate matter. Abatement of these species is therefore not considered to be necessary.

The optimisation of natural gas combustion within a GT is well understood, such that the emissions are carefully controlled by design and typically through the implementation of primary control measures such as Dry Low NOx burners (DLN) with staged combustion in some designs.

At this stage of the design, it is assumed that additional (secondary) abatement of NOx may be required to achieve the required Emission Limit Values (ELVs). When firing on natural gas, the LCP BRef includes a requirement for NOx emission from new CCGT plant to be at a BAT-AEL daily average of 40 mg/Nm³ and a BAT-AEL annual average of 30 mg/Nm³ (with the energy efficiency correction factor applied). Some high efficiency CCGT vendors have indicated that the required BAT-AELs can be achieved by means of primary abatement measures such as DLN burners alone, however this will not be confirmed until the CCGT vendor is selected.

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The selection of high efficiency CCGT plant for the LCP has been subject to a BAT assessment (Appendix E1).

As an emerging technology, there are no BAT-AELs for hydrogen-fired CCGTs included within the LCP BRef or BATc. The combustion of 100% hydrogen in a GT will result in a reduction in the flue gas volume (normalised conditions, 15% O₂) compared with natural gas by approximately 27%. This is due to the fundamental combustion chemistry of the respective fuels and inherent gas turbine design characteristics with respect to high excess air. This means that the concentration of pollutants in the flue gas when the CCGT is fired on hydrogen will be higher than when fired on natural gas, such that the BAT-AEL for natural gas firing would not be achievable in hydrogen fired plant.

The EA has developed Guidance on Emerging Technologies (GET): Oxides of Nitrogen ELV for Combustion of Hydrogen Combustion: comply with emission limit values⁷, where an ELV of 68.5 mg/Nm³ for 100% hydrogen firing is proposed, which is a factor of 1.37 higher than the IED ELV of 50 mg/Nm³ on 100% natural gas. This will result in an identical mass release rates of NO_x between the two fuels based on the IED ELV.

If the CCGT cannot meet the required ELVs for natural gas and/ or hydrogen firing by primary techniques alone, the GT exhaust gas will be treated using SCR based on ammonia (NH₃) injection, to reduce the NO_x emissions of the exhaust gas to meet the required ELVs.

SCR is a secondary abatement technique typically involving the injection of NH₃ into the exhaust gas to react with any NO_x present in the presence of a catalyst to produce nitrogen and water. If required, the SCR system would be located within the HRSG, at the optimum catalyst temperature zone (c. 300-400°C).

The SCR system will comprise:

- SCR housing as an integral part of the HRSG;
- SCR catalyst;
- NH₃ injection system;
- NH₃ flow control unit (skid based); and
- Instrumentation and control.

The required amount of NH₃ will be pumped via the feed control valve to the vaporiser where it will be mixed with a slipstream of flue gas. The vaporised NH₃ will then be injected into the main flue gas, upstream of the SCR catalyst via the NH₃ injection grid,

⁷ [Hydrogen combustion: comply with emission limit values - GOV.UK](#)

which will ensure homogeneous mixing. Any unreacted ammonia in the SCR will remain within the exhaust gas (NH₃ slip) from the HRSG.

The flue gas NO_x concentration at the outlet of the SCR will be analysed and a Proportional Integral Derivative (PID) control loop and Feed Forward logic will modulate the NH₃ feed control valve, regulating the NH₃ flow against the required level of NO_x reduction in the flue gas leaving the SCR to ensure that the required NO_x ELV is achieved, and that NH₃ slip is minimised.

It is anticipated that the NH₃ slip from the SCR will be in compliance with the required LCP BAT-AEL of < 3 - 10 mg/Nm³ as a yearly average, or average over the sampling period (noting that the lower end of the range is applicable to SCR, with the upper end applicable to Selective Non-Catalytic Reduction (SNCR)).

Opportunities for the re-use of catalysts from the SCR unit will be investigated and wherever possible utilised, however at this stage, when it is not known whether SCR will be required, this cannot be confirmed. Any opportunity for re-use of the catalyst would include the consideration of suitable waste preparation for re-use, where specific quality criteria are requested, in line with LCP BAT 16.

The use of primary measures for the control of NO_x is preferable and therefore if attainment of the BAT-AELs and ELVs can be achieved without the need for SCR, this would not be installed; or if SCR is not required at lower loads, the injection will be stopped. If SCR was not required this would result in energy savings for the Proposed Installation, remove the requirement for catalyst (and therefore the associated waste) and NH₃ use and consequently mean that NH₃ emissions would not occur from the CCGT.

Emissions of carbon monoxide (CO) will only occur during natural gas or hydrogen/natural gas blend firing. CO emissions will be controlled through primary combustion controls, with no requirement for secondary abatement.

Exhaust gases will be released from the HRSG stack, Emission Point A1, with a stack height of 85 m above ground level.

Operational Modes of the Installation

There is the opportunity for the Proposed Installation to be able to operate in baseload (i.e. generation that generally runs continuously throughout the year) or dispatchable mode (i.e. being able to export power into the day-ahead market to match the anticipated intermittency of renewable power in the future power market). The Proposed Installation is designed to be able to operate in either baseload or in a dispatchable mode. A CCGT power station capable of running in both baseload and dispatchable modes is:

- Able to provide robust utility scale power throughout the year;
- Responsive to seasonal demand fluctuation;
- Responsive to daily demand fluctuation (flexible power);

- Able to address renewables intermittency (in particular wind and solar) by replacing the electricity supplied by renewables at time of low renewable generation capacity; and
- Able to adapt to a changing market in the future (i.e. an increase in renewables capacity).

Operating in baseload mode could involve up to 20 start-up/ shutdown cycles per year. Operating in dispatchable mode could, in principle, involve up to 200 start-up/ shutdown cycles per year or more. However, operations in baseload mode have been considered the worst case in terms of environmental impacts based on mass emission rates of pollutants. Therefore, where relevant, baseload operations have been used as a conservative estimation of operations, even where this is not considered the most likely mode of operation.

The start-up and shut-down process will be optimised during plant commissioning. The general overriding principles will be to minimise the period during which the GT and HRSG are considered to be in start-up or shut-down modes and to reach stable generation without undue delay. However, the desire to minimise start-up time and fuel consumption must be balanced by due consideration of component and material design properties; with process safety and asset integrity aspects being the highest priority.

Minimum start-up and shut-down loads (MSUL/ MSDL) will be defined following commissioning.

Differences Between Hydrogen Firing and Natural Gas Firing

Natural gas firing and hydrogen firing result in changes in chemical and thermodynamic nature of the fuel gas and the flue gas that need to be considered when converting the CCGT from natural gas to hydrogen. This includes:

- Hydrogen has a lower energy density per volume than natural gas, and therefore when blended, the overall calorific value of the gas mixture decreases on a volumetric basis as hydrogen concentration increases.
- Hydrogen ignites at a lower energy threshold, much lower than that of natural gas, which poses the risk of unintended/ premature ignition.
- Hydrogen burns with a flame speed approximately seven times faster than methane (the primary compound in natural gas) which will affect combustion behaviour in the GT.
- At typical ambient conditions hydrogen can burn in concentrations of air ranging from approximately 4 - 75%, compared to 5 - 15% for natural gas.
- Hydrogen has a higher combustion temperature under stoichiometric conditions, which can lead to increased NO_x emissions.

- Hydrogen poses the risk of embrittlement in metals commonly used in natural gas infrastructure. Materials, equipment, and subcomponents will require evaluation and potential replacement in order to handle hydrogen safely.
- Hydrogen is a significantly smaller molecule compared to methane (the primary component of natural gas). This increases the chance of leakage; common causes include, mechanical damage, seal/ gasket failure, improper welding of joints, and material degradation.
- At hydrogen combustion ratios the flame brightness decreases which may impair the operator's ability to visibly identify them.
- Hydrogen leaks fire and gas detection: For hydrogen firing systems ultraviolet detection may be more appropriate as opposed to infra-red fire detection used for natural gas.

To take account of these differences, configuration of the plant during the detailed design stage will minimise the extent of modification required once the plant is operational with the intent for the plant to be hydrogen ready by its Commercial Operation date. This will require pipe and valve sizing, equipment metallurgy selection, instrumentation selection, and oversizing the SCR system to handle any additional NOx produced when firing with hydrogen fuel.

Such modifications may include:

- Fuel nozzles and combustion assemblies: To prevent flashback, modified burner designs will be developed which provide greater fuel-air mixing and momentum, enabling the flames to be sufficiently detached downstream.
- Flame Arrestors: Flame Arrestors may be installed to prevent the flame from travelling back into the fuel supply.
- Control System(s): The control system will be modified to account for the new fuel conditions and to manage the blending composition. Furthermore, modifications to the flame detection system may be required to incorporate appropriate detection for hydrogen flames.
- Combustion System: The air and purge flows within the combustion system may have to be modified for stability and emissions control.
- Enhanced air ventilation: As hydrogen is a lighter molecule than natural gas, GT enclosure air ventilation will be enhanced to prevent accumulation of hydrogen – especially in enclosed areas.
- Introduction of hydrogen zoning: Distinct zones can be established on the plant based on their hydrogen risk levels.
- UK Explosive rating of equipment: equipment may undergo hazardous zoning re-evaluation when hydrogen is introduced. It is strongly recommended that this

is carried out during detailed design in order to mitigate the potential costs of future upgrades.

Cooling System

A cooling system will be required to condense the steam in the ST condenser and to cool auxiliary CCGT functions (e.g. bearing lube oil, generator coolant). The cooling load associated with the CCGT plant will be of the order 410 – 445 MWth, comprising a main condenser cooling duty of 400 - 430 MWth and an additional auxiliary load of the order of 10 - 15 MWth.

A BAT for Cooling assessment has been undertaken to determine and demonstrate which of the available cooling option represents BAT for the Proposed Installation and is provided in Appendix E2. The BAT assessment, summarised here, has considered a range of cooling options, and operating parameters including:

- Cooling water sources, utilising either:
 - the Stainforth and Keadby Canal (preferred source, and in addition to the abstraction for Keadby 2 hybrid cooling system); or
 - the River Trent, which is saline as a result of tidal influence (as used for Keadby 1, once-through cooling).
- Consideration of the design reference case, under summer, winter and minimum flow operations, as well as two potential cooling water temperature rises and maximum temperatures at discharge outfall; and
- Consideration of the overall cooling duty of each option, net power generation, water consumption, water source and necessary treatment, parasitic energy load from pumps, and fans, and capital costs for equipment, pipework and intake and outfall upgrades.

The options for the cooling configuration for the Proposed Installation were ranked according to the overall energy efficiency, water consumption, specific cooling cost (lifetime costs per MWth cooling duty) and capex.

The BAT assessment concludes that the use of hybrid cooling towers, with make-up water sourced from the Stainforth and Keadby Canal, represents BAT for the Proposed Installation. This option is considered to represent BAT in terms of consideration of the overall efficiency of the plant, potential for impacts resulting from abstraction and discharge of make-up cooling water, visual impacts of footprint and building massing and visible plumes, and costs. This option also provides for greater integration and flexibility within the cooling system for the Proposed Installation as a whole, representing indicative BAT.

The Keadby 2 Power Station is cooled by cooling water from the Stainforth and Keadby Canal via an abstraction licence by the Canals and River Trust (CRT) (MD/028/0083/014). In 2023 a variation to the Keadby 2 abstraction licence was

granted for the already permitted Keadby 3 CCS Power Station for additional cooling water abstraction from the Stainforth and Keadby Canal. As the Proposed Installation will be an alternative to the Keadby 3 CCS Power Station (as detailed in the Main Supporting Document) it is anticipated that the abstraction licence would be transferred to KNGPS to provide cooling water.

The water abstraction requirement from the KNGPS cooling tower is expected to be approximately 19.6 mega litres per day (ML/day), and the abstraction limit is 27.4 ML/day taken from the Stainforth and Keadby Canal.

The hybrid cooling towers are expected to comprise a bank of up to 16 cooling cells, and the majority of water abstracted from the canal will be supplied directly to cooling towers without pre-treatment.

Treatment of the recirculating cooling water will be carried out through direct dosing of acid, hardness stabiliser and biocide. The cooling tower system requires a balance of abstraction and discharge to match the losses through evaporative cooling, whilst maintaining dissolved solids at an acceptable level. The system is therefore designed for a specific number of Cycles of Concentration (CoC), with combined optimisation of water abstraction quantity and chemical dosing. Values for CoC of 3 - 5 are typical for systems using freshwater.

The cooling towers are specifically designed to minimise the formation of visible plumes, although some may occur dependent on the ambient weather conditions. An assessment of the visible plumes associated with the proposed hybrid cooling towers is included in Annex E of the Air Quality Impact Assessment provided in Appendix G.

Process Control System

The operation of the Proposed Installation will be highly automated to ensure optimal operation, safety, and efficiency during operation on the full range of fuel gas composition.

There will be a central control room to serve as the hub for monitoring and controlling all plant operations. It will be equipped with Human-Machine Interface (HMI) systems, where operators can view real-time data, trends, and alarms.

A Distributed Control System (DCS) will manage the operation of the GT, ST, HRSG, and Balance of Plant systems providing monitoring and control. The DCS shall facilitate real-time process control, data acquisition, and system integration. The design philosophy of the DCS will be to provide the maximum possible level of automation for all systems installed and the plant will, in general, operate automatically under operator supervision during normal operation.

Semi-automatic sequences and manually requested actions will also be available via the DCS when required, for instance operator intervention may be required to maintain minimum utility flows by the opening of equipment by-passes or shutting down unnecessary equipment (e.g. cooler fans, circulation pumps). Generally, plant operations will be carried out from the operator desk in the control room. The DCS

allows items, systems and the entire plant to be started, operated and stopped in a safe manner.

The DCS will display and record the plant operating parameters required for best practice process control and minimisation of environmental impacts. For example, the cooling tower blow-down system will provide information to the operators covering flow, temperature, pH, residual chlorine etc. This information will be available on-line to the operator via the plant operating screens as instantaneous values, with historical data available via trend screens.

The DCS will also include CEMS information. CEMS at site will comprise monitoring of parameters applicable to the Proposed Installation and will include exhaust gas concentrations of NO_x and CO (and NH₃ if SCR is installed) and moisture content. This information will also be available for offline analysis by operators and site engineering.

The plant operational data will allow the plant processes and maintenance procedures to be reviewed and optimised. The data available via the DCS will also allow reporting of plant performance and environmental compliance.

Furthermore, the DCS will provide the operators with a series of alarms should an operating parameter approach, or exceed, its control set point value. These alarms will be displayed on the appropriate plant operating screen as well as a dedicated alarm screen for operator review and relevant action.

The DCS will use control logic and trips to prevent an undesirable situation from occurring or continuing. For example, discharge of cooling tower blow-down would be prevented if any of the monitored parameters exceeded permitted levels.

Supervisory Control and Data Acquisition (SCADA) systems are employed for high-level supervision and data analysis. SCADA collects data from various plant components, providing a comprehensive overview of plant performance and enabling predictive maintenance and operation.

Safety Instrumented System (SIS) – The SIS will provide automated protection against hazardous conditions. It includes emergency shutdown systems and fire and gas detection systems to ensure the safety of personnel and equipment.

Alarm Management – An alarm management system prioritises and categorises alarms, helping operators respond effectively to critical issues. It reduces alarm fatigue and enhances situational awareness, improving overall plant safety and reliability.

4.3 Ancillary Equipment and Structures

To support the operation of the CCGT and the cooling system, a number of ancillary operations are required, described below.

Electricity Connections

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.

In order to export electricity from the Proposed Installation, a direct connection to the 400kV system will be required to connect to the existing National Grid 400kV Substation situated to the east of the Proposed Installation. The connection would comprise 400kV electrical cables which would be installed primarily below ground but some sections may be above ground.

Water Supply

As detailed previously, water will be abstracted from the Stainforth and Keadby Canal for cooling for the CCGT. An intake structure would be constructed within the canal with equipment to comply with the Eels (England and Wales) Regulations 2009 (HMSO, 2009) ('the Eels Regulations') and also meet any relevant conditions defined in the Abstraction License.

A pipe would be constructed from the intake into the Proposed Installation. In addition, process water will also be required in order to provide make-up to the steam/ water cycle of the Proposed Installation and will also be sourced from the canal.

For process water applications, abstracted water from the canal will be directed to a Water Treatment Plant (WTP) where it will be processed to produce demineralised water suitable for the steam/ water cycle and other consumers of high purity water such as gas turbine wash-water. The treatment process will consist of the following stages:

- Initial screening – to remove large debris and particulates
- Coagulation & flocculation – to aggregate fine suspended particles
- Sedimentation – to remove the flocs
- Filtration – to remove any remaining particles

Further treatment steps may be required for the steam cycle make-up and closed water loops – depending on the composition of the water sourced from the canal. These additional treatment steps may include:

- Chemical treatment
- pH adjustment
- Corrosion inhibition and use of anti-scaling agents
- Reverse Osmosis
- Electro-deionisation

Discharge water from the WTP will be treated, if required, and passed to the cooling towers for discharge into the existing Keadby 1 discharge infrastructure, via a dedicated compliance point for the Proposed Installation (Emission Point W1), and ultimately to the River Trent.

There will also be a requirement for potable water for domestic and sanitary uses.

Auxiliary Boiler

An electrical auxiliary boiler will be required to provide heat/ steam during commissioning, start-up and during shutdown periods for warm-keeping.

Emergency Diesel Generator

UK Grid Code mandates power stations to have 72 hours of resilience under the Electricity System Restoration Standard (ESRS) after a loss of electricity supply. This is to ensure that critical infrastructure can be restored to service.

An emergency 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 essential and non-essential services (heating, ventilation and air conditioning (HVAC), telecoms, emergency lighting and plant control systems) for up to 72 hours until external power can be re-established.

Electrical power will be provided to the Proposed Installation via the hierarchy of:

- KNGPS;
- National Grid;
- KNGPS emergency diesel generator.

The emergency diesel generator is therefore the last resort in the event of a power loss and subsequently is very unlikely to ever be required for its intended purpose.

The capacity of the generator is expected to be relatively small, of the order of 4.1MWth input. Up to three days fuel storage will be provided.

In order to ensure that the emergency generator remains fit for purpose, it will undergo routine testing, likely to comprise less than one hour of operation per month, and therefore significantly <50 hours a year.

As the emergency back-up generator would only be used to provide power at the site during an emergency, it is excluded from the Specified Generator requirements of the EP Regulations and as it would operate for less than 500 hours per year it would also be exempt from the MCP ELVs.

The type of generator is yet to be confirmed, however it will comply with the EA's BAT Guidance for emergency engines on Installations. An indicative quantitative risk assessment of emissions to air from appropriate diesel generator plant has been carried out for the emergency diesel generator and is provided in the Air Quality

Impact Assessment (Appendix G).

Diesel would be stored locally to the emergency diesel generator in above ground storage tanks of approximately 40m³ total storage capacity, with appropriate secondary containment.

Other Combustion Plant

In addition to the above, a gas-fired building heater in the region of 1.2MW_{th} input may also be installed, to provide building heating. Alternatively, electrical building heating may be provided. If a gas-fired heater was used, as it would provide direct gas-fired heating it would be exempt from Medium Combustion Plant Directive (MCPD) controls and therefore would not need to be included in the Permit.

Compressed Air, Nitrogen and Hydrogen

Compressed and instrument air will be provided by an on-site air package for pneumatic tools, instrumentation and control systems.

Nitrogen will be provided by an onsite nitrogen generation package for the nitrogen purge system to enhance the safety and operational efficiency of the plant.

The nitrogen purge system will prevent the presence of explosive gas mixtures within the plant. The nitrogen purge system will utilise inert nitrogen gas to displace oxygen and other potentially reactive gases on start-up and shut-down, therefore, reducing the risk of unintended combustion or explosion. The nitrogen purge system will include the following equipment:

- Nitrogen storage tanks
- Pressure regulators
- Control Valves
- A network of distribution piping

Nitrogen purge will also be utilised to create a safe, inert atmosphere for maintenance activities.

The nitrogen purge system is particularly important during the transition to hydrogen firing, as hydrogen is highly flammable and has a wider explosive range compared to natural gas.

Hydrogen for the generator cooling loop will be stored in cylinders on Site.

4.4 Site Drainage

The operational areas of Proposed Installation will be fully surfaced with impermeable concrete.

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A suitable surface water drainage network and management system will be provided for the Proposed Installation, to segregate uncontaminated surface waters (i.e. surface water run-off) from those that could potentially be contaminated. The drainage network will provide appropriate interception, conveyance, treatment, and attenuation of surface water runoff.

The Proposed Installation will have two drainage systems;

- Surface water system; and
- Process/ blowdown effluents.

At this stage of the Proposed Installation design, only an Outline Drainage Strategy Report has been prepared as part of the ES (Appendix B (see Volume II, Appendix 12A, Annex 3)). A detailed drainage strategy and figure showing the site drainage will be developed in consultation with the EA and other stakeholders, including other statutory agencies during detailed design.

Surface Water Drainage

The proposed surface water drainage system will employ attenuation ponds and oil water separators, to attenuate surface water flows due to increases in the impermeable area as a result of the Proposed Installation.

The drains will direct water to two retention ponds which will be sized to enable greenfield runoff rates to be maintained to preserve the local drainage network capacity outside the Proposed Installation and not affect the Internal Drainage Board (IDB) controlled pumping to the River Trent.

There will be a northern and southern attenuation pond. For the northern pond the preferred option is to discharge surface water to a drain managed by the IDB (Emission Point W2). Drain 1 (Glew Drain, on the northern Proposed Installation boundary) is the preferred option, and is an IDB drain, however Drain 5 (on the eastern Proposed Installation Boundary and an SSE drain) could also be considered for discharge. Drain 5 drains into Drain 1 and therefore the point at which the drainage enters the IDB managed Drain 1 would remain the ultimate Emission Point.

The southern pond will discharge surface water to an SSE drain (Drain 2, which ultimately enters the River Trent) at Emission Point W3.

Where there is potential for contaminated surface water run-off, bunding will be provided so that these streams can be managed separately and therefore only uncontaminated surface water will go directly to the retention pond for discharge.

The opportunity to supply clean water from the attenuation ponds to the raw water tank will be investigated during detailed design in line with BAT 13.

Process/ blowdown Effluents

The key effluent stream generated by the Proposed Installation will be blow-down from the cooling tower circulation system, containing contaminants (such as those that are present in the abstracted canal water). There will also be blow-down from the CCGT steam/ water cycle, stack drain, condensate polishing (if applied) and effluent from the WTP.

These effluents will be discharged into the River Trent following treatment (pH correction) via a tie-in to the existing K1 and K2 cooling water discharge culvert via a compliance point to ensure that releases remain within the current K1 discharge specification (as described in Section 5.2). The compliance point will be referred to as Emission Point W1.

It is proposed that low level effluent streams including the boiler blowdown are returned to the cooling tower basin for dilution and reuse.

No chemical drainage will be present within the Proposed Installation and all effluent generated from maintenance activities which cannot be reused will be managed via containers for off-site treatment or disposal via a licenced third-party waste contractor. This will include heavily contaminated effluents, such as ammoniated water from the condensate polishing plant.

Potentially Contaminated Effluents

Surface water in process areas that may be contaminated with oils and chemicals, such as surface water collected in bunds, will be tested to check for contamination before being either collected for suitable off-site disposal or directed to the cooling tower basin for neutralisation, dilution and reuse.

Following treatment (pH correction), the effluents will be discharged into the River Trent via tie-in to the existing K1 and K2 cooling water discharge culvert via the compliance point (Emission Point W1).

Areas where chemicals are handled will comprise concrete hardstanding of watertight construction and be kerbed/ bunded to ensure that spillages and/ or leaks in those areas are contained, manually cleaned up and removed for treatment off-site. Containment bunds would be provided around all chemical storage and would be designed and constructed according to the requirements of CIRIA C736⁸, API 650 and relevant Eurocodes. Road tanker unloading areas will have the kerbed/ bunded areas sized to hold the full inventory of the tanker, in line with the CIRIA guidance in the event of a full loss of containment

⁸ The SuDS Manual, CIRIA C753, CIRIA, 2015

4.5 Management Systems

The Proposed Installation will be operated in line with appropriate standards and the operator will implement the accredited SSE (ISO) 14001:2015 Environment Management System (EMS). The Certificate for the EMS is provided in Appendix J.

The EMS outlines the requirements and procedures required to ensure that the Proposed Installation is operating to the appropriate standards. It has been developed to enable compliance with Environmental Permits and other legislative requirements for the protection of the environment and human health and is in line with both the EA's Guidance and the requirements of LCP BAT1.

The EMS details measures that are in place to ensure resilience to climate change.

The EMS and procedures will be available for inspection at the Proposed Installation and will be applicable to all staff, contractors and visitors to the Installation.

4.6 General Maintenance

Routine maintenance will be planned and scheduled via a maintenance management system with major overhauls occurring approximately once every two to five years depending on the nature of plant operations in that period.

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 Installation facilities, each major equipment item will be provided with appropriate access and overhaul laydown areas and the internal road layout for the Site will be designed to enable free movement for cranes and heavy lifting equipment.

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 Installation. Major and specialist O&M interventions (turnarounds, CCGT scheduled maintenance and turbine overhauls, etc.) are likely to be outsourced and major equipment items serviced by original equipment manufacturers (OEM).

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

Maintenance routines will follow a cycle as outages are required after a set number of GT operating hours or start-ups (whichever comes earliest). Routine and major maintenance will be undertaken periodically according to a defined maintenance programme and manufacturer recommendations. Periodically the GT will be taken off-line and washed with a high concentration detergent solution.

4.7 Raw Materials

The use of hazardous materials within the CCGT will be eliminated by design where possible, and minimised where it is not practical to eliminate.

The main raw material for the power plant will be the hydrogen or natural gas, which will fuel the CCGT. It is anticipated that the CCGT plant will use approximately 1,380 – 1,420 MWth (LHV) of natural gas sourced from the NTS per hour at maximum load. The thermal input for natural gas and hydrogen are expected to be broadly similar, and therefore it is anticipated that for 100% hydrogen firing, the Proposed Installation will use in the region of 1,380 – 1,420 MWth (LHV) of hydrogen. Blends of natural gas and hydrogen may be slightly less.

Neither fuel hydrogen nor natural gas will be stored on site prior to use as a fuel.

Bulk storage of chemicals in AGSTs will include NH₃ for use in the SCR plant (if required), diesel for the emergency generator and fire water pump and various other chemicals for use in the WTP (such as sulphuric acid, sodium hydroxide, biocides and anti-scalants). Cooling tower chemicals will include biocides, sulphuric acid, hardness stabiliser and corrosion inhibitors.

Suitable chemical storage facilities will be provided, including a road tanker unloading area with appropriate secondary containment (such as a Class 1 forecourt separator sized to capture full discharge from a single failed cell of a road tanker (up to 7,600L maximum)).

Other raw materials for use at the Proposed Installation will be stored in appropriate containers, within suitable spill protection including bunds, on banded pallets, on drip trays, in specifically designed cabinets and cupboards or other appropriate storage units and areas. Additional hazardous materials will be supplied, stored and used in containers of 1m³ or less. A Stage 1 – 3 Hazardous Substances Assessment has been carried out and is presented in Annex A of the Site Condition Report (Appendix C).

Table 2 summarises the raw materials to be used by the Proposed Installation. Safety Data Sheets are provided in Annex B of the Site Condition Report (Appendix C).

Table 2: Raw Materials to be used at the Proposed Installation

Material	Purpose	Estimated Maximum Storage Quantity	Indicative Annual Consumption
24.5% wt Ammonia (aqueous)	SCR plant (if required)	2 x 50m ³ storage tanks	3,000m ³
15% wt Ammonia (aqueous)	Water-steam cycle dosing	1m ³ IBC	25m ³

Material	Purpose	Estimated Maximum Storage Quantity	Indicative Annual Consumption
96% wt Sulphuric acid	Cooling tower pH control	15m ³ storage tank	270m ³
Hardness stabiliser	Cooling tower	2×1m ³ IBC	24m ³
12.5% Sodium hypochlorite	Cooling tower biocidal control	2×1m ³ IBC	44m ³
Diesel	Emergency Diesel Generator Storage	40m ³	15m ³
Water treatment chemicals (biocides, anti-scalant, oxygen scavenger etc.)	Water Treatment Plant dosing; demineralised water plant ion exchange regeneration; closed-circuit cooling water circulation	1-2m ³	30m ³
38% Hydrogen sulphate	Condensate polishing plant	10m ³	30m ³
50% Sodium hydroxide	Condensate polishing plant	10m ³	30m ³
Lubricating oils	Turbine oil for the GT and ST, hydraulic oil for valves	7m ³	7m ³
Nitrogen	Start-up and shut down purge.	10 bottles 10m ³ each	230 bottles 10m ³ each
Hydrogen	For generator cooling	100m ³	12,500m ³
Oxygen	Water-steam cycle dosing	2 bottles 10m ³ each	50 bottles 10m ³ each

In addition to the above listed materials, small quantities of laboratory reagents, lubricants, catalysts and filters will be used and stored on Site within appropriate containers.

Secondary containment will be provided to all storage containers, including AGSTs and IBCs, in line with the appropriate legislation and regulatory guidance. In general, all bunds and bunded pallets shall be constructed and sized in line with CIRIA 736.

Secondary containment, in the form of kerbed areas connected to the appropriate drainage system, will be provided in areas where there is risk of spills occurring, such as unloading areas for road tankers delivering fuel or chemicals to the plant, so as to contain any spill events.

Furthermore, controls such as emergency isolation valves will be put in place to minimise the risk of discharges off-site from any spillages entering the Site's surface water drainage system.

It is typical practice to include a breather vent on storage tanks to allow for vapour maintenance/ displacement during tank filling, fire exposure relieving rate from the tank and/ or nitrogen purging when unloading road tankers or cleaning lines. Due to the potential odour emissions associated with the storage of NH₃ (if SCR is required), the tank will be kept under a small positive pressure, with a relief valve and a carbon filter. This is in line with the NH₃ tank that was installed on the Keadby 2 plant.

The Proposed Installation will use a significant quantity of water, primarily as cooling tower make-up and steam-system make-up. Based on the current conceptual design, it is anticipated that the water demand will be 340 - 830 t/hr, across the ambient range (500 – 600t/hr during normal operation between 10 - 15°C) mainly raw water abstraction from the Stainforth and Keadby canal, used in addition to water demand for making up losses in cooling water due to evaporation/ drift and blow-down and demineralised water make-up to the boiler feed (boiler blow-down). It should be noted that as a recirculating system, most of the cooling water (95 - 99%) will be recirculated within the system, dependent on the CoC required in the final technology selection, determined during detailed design.

A new town's water connection will be required from the Yorkshire Water main situated along Chapel Lane for the Proposed Installation.

4.8 Waste

Small quantities of operational waste will be generated from the operation and maintenance of the proposed CCGT plant, in addition to minor amounts of dry mixed recyclables and general domestic waste.

The GT will periodically be taken off-line and washed with a high concentration detergent solution, in accordance with OEM's recommendation. This activity is expected to be infrequent and will be undertaken as a planned maintenance activity. The effluent from this cleaning activity will be collected in a sump or in IBCs and disposed of off-site via a licensed waste contractor.

The HRSG may periodically be subject to chemical cleaning and passivation producing waste with low pH, high in suspended solids and also Total Dissolved Solids (TDS) in the form of iron corrosion products. This activity is expected to be infrequent (may only occur once during initial commissioning) and part of planned maintenance activities. The effluent from this cleaning activity will be collected in IBCs and disposed of off-site via a licensed waste contractor. This waste stream is anticipated to be in the region of 20 tonnes per wash event.

All waste generated on Site will be managed in line with the waste hierarchy and disposed of by licenced waste contractors where necessary.

Wastes generated by the Proposed Installation are listed in Table 3.

Table 3: Wastes Generated by the Proposed Installation

Material	Purpose	Estimated Maximum Storage Quantity	Indicative Annual Generation	Disposal Route
General mixed wastes	From administration buildings etc.	2 tonne	60 tonne	Segregated for recycling and landfill by licensed 3 rd party waste contractor
Waste oil	Turbine lube oil exchange and overhaul	50m ³ per major overhaul	50m ³ per major overhaul	Recycled/ recovered for fuel by licensed 3 rd party waste contractor
Oily water	Oil separators	1 tonne	10 tonnes	Recycled/ recovered for fuel by licensed 3 rd party waste contractor
GT Cleaning effluent	Periodic cleaning	20 tonnes	20 tonnes	Disposal by licensed 3 rd party waste contractor
Regen waste	From the WTP	5 tonnes	350	Disposal by licensed 3 rd party waste contractor
Ammoniated water	Condensate polishing plant	10 tonnes	1,000	Disposal by licensed 3 rd party waste contractor
Filters	GT air filters	<1 tonne	5 tonnes	Disposal by licensed 3 rd party waste contractor
Ion exchange resins	From WTP plant	No storage, disposed of when generated	10 tonnes every 7 – 10 years	Disposal by licensed 3 rd party waste contractor

4.9 Energy Use

A 910 MW CCGT would use approximately 1,380 – 1,430 MWth (LHV) of natural gas sourced from the NTS per hour at maximum load. The range stated is dependent on the final GT technology selected and ambient conditions where fuel consumption correlates with GT and CCGT output.

The thermal input for natural gas and hydrogen would be the same, and therefore for 100% hydrogen firing, the Proposed Installation will use 1,380 – 1,430 MWth (LHV) of hydrogen.

The internal electricity parasitic load of the Proposed Installation when the site is operational is estimated to be around 15 - 17 MWe.

A Sankey diagram of the Energy Inputs and Outputs of the Proposed Installation is shown in Figure 5 (Appendix A).

Some diesel will be used to carry out regular testing of the emergency generator, as well as a diesel fire pump, if required.

4.10 Energy Efficiency

The Proposed Installation will comprise a new generation high efficiency CCGT (H/J Class). The efficiency of the proposed CCGT plant will be greater than 61%, and when firing on natural gas is anticipated to be 62.5%, in line with the Keadby 2 CCGT. When firing on hydrogen the efficiency is anticipated to be >61.5% (depending on final combustion system design). This therefore complies with the BAT-Associated Energy Efficiency Levels (BAT-AEEL)⁹ of 57 - 60.5% for net electrical efficiency (%) for new CCGT units having a thermal output of > 600 MWth.

General measures to maximise energy efficiency across the Proposed Installation include:

- The plant components will be sized appropriately for the design capacity of the plant, so that each element is operating optimally and efficiently.
- Use of high efficiency motors and to minimise parasitic load;
- The effective insulation of hot surfaces;
- Regular planned maintenance in order to maximise the efficiency of the equipment and plant, with performance monitoring and audits to optimise the maintenance schedule.

CHP Readiness

As an electricity generating installation, a cost-benefit analysis (CBA) which assesses the cost and benefits of providing for the operation of the Proposed Installation as a

⁹ Best Available Techniques (BAT) Reference Document for Large Combustion Plants, Joint Research Centre, July 2017

high-efficiency cogeneration installation is required, in compliance with Schedule 24 of the EP Regulations. A CHP Assessment has been prepared to support the application (Appendix F). This considers the feasibility of installing CHP and concludes that:

- There is a potential to supply up to 368 MWth of waste heat for heat off-takers at full load and 147 MWth at part load;
- There are suitable heat users of applicable scale to the heat available within a search area up to 15 km from the Proposed Installation; and
- None of the heat loads identified, which relate to domestic, small industrial and education, offer economically viable opportunities for a heat network.

For these reasons the Proposed Installation is not considered to be viable for CHP opportunities at the outset of commercial operation as there is no current heat demand within the technically feasible radius that is considered economically viable.

However, the plant will be designed to be CHP-Ready with the inclusion of connection flanges at suitable locations to export waste heat in the future should this become viable.

5. Emissions to Air, Water and Land

5.1 Point Source Emissions to Air

There will be one main Emission Point (A1) to air associated with the Proposed Installation's CCGT emissions. The emissions when firing on natural gas or hydrogen will comprise emissions of NO_x and, as discussed in Section 4.2 due to the potential requirement of an SCR unit, ammonia (NH₃).

When firing on natural gas only, there will also be an emission of CO, however there is no CO emission when firing on hydrogen. The use of natural gas and/ or hydrogen means that emissions of sulphur dioxide (SO₂) and particulates from the CCGT plant will be negligible as the sulphur and particulate content of these fuels is very low. Therefore, emissions of SO₂ and particulates have been discounted from consideration.

Emissions of Oxides of Nitrogen

Emissions of NO_x from the CCGT plant will be controlled by primary means and the use of DLN burners, operated and controlled through an automated process control system in accordance with BAT.

Secondary abatement in the form of SCR may also be applied, if required to meet the BAT-AELs associated with gas-firing and the ELV associated with hydrogen firing, if these cannot be met by primary means alone.

For plants with a net electrical efficiency (EE) greater than 55%, a correction factor may be applied to the higher end of the natural gas BAT-AEL range (yearly average of 10–30mg/Nm³ and daily average of 15–40 mg/Nm³), as detailed in the LCP BAT Conclusions. The efficiency of the CCGT plant will be >61%, and therefore it is considered appropriate to apply the efficiency uplift to the natural gas NO_x BAT-AEL for this mode of operation.

The EA's Hydrogen GET provides a monthly ELV of 68.5 mg/Nm³ for 100% hydrogen firing, which is a factor of 1.37 higher than the IED monthly ELV of 50 mg/Nm³ for natural gas firing. This will result in an identical mass release rate of NO_x between the two fuels based on the monthly IED ELV.

The GET for Hydrogen Combustion does not detail the application of an efficiency factor for hydrogen firing, due to the use of the higher IED BAT ELV to derive the hydrogen BAT-AELs.

Emissions of Ammonia

If required to meet the required NO_x ELVs, SCR abatement will be installed. As detailed previously, SCR abatement can result in 'NH₃ slip', where the incomplete reaction of NH₃ in the SCR plant leads to a release of NH₃ into the atmosphere. The LCP BAT conclusions state that the BAT-AEL for emissions of NH₃ to air from the use of SCR and/ or SNCR is < 3–10 mg/Nm³ as a yearly average or average over the

sampling period. The lower end of the range can be achieved when using SCR and assumed to be an appropriate ELV to apply for the Proposed Installation for the purpose of assessment.

Emissions of Carbon Monoxide

Emissions of CO from the CCGT when firing on natural gas will also be controlled by primary means and will be balanced against the requirement to minimise NO_x, as this has a greater potential for air quality impacts. Whilst it is recognised that the BATc detail an indicative yearly average of 5–30 mg/Nm³ for new CCGT plant, due to the potential dispatchable operation of the Proposed Installation, and therefore a reduction in steady state operation over a baseload CCGT, it may not be possible for the CCGT to meet this indicative level as an annual average.

Emissions of CO have been assumed to be at the monthly IED ELV of 100mg/Nm³, for the purpose of the Air Quality Impact Assessment carried out for the Proposed Installation, given that there are no annual average Air Quality Standards (AQS) or Environmental Assessment Levels (EALs) for CO.

The data provided in Table 4 represents the emission parameters for the Proposed Installation. An Air Quality Impact Assessment has been carried based on these parameters (Appendix G) and a summary of the results is provided in Section 7. The assessed locations of the Emission Points to air are shown in Figure 6 (Appendix A).

Table 4: Proposed Emission Parameters for the Proposed Installation (Emission Point A1)

Parameter		HRSG Stack (Emission Point A1)	
		100% Hydrogen Firing	100% Natural Gas Firing
Stack height (m above finished ground level)		85	
Assessed stack locations (OS Grid reference)		482064, 411945	
Average efflux velocity (m/s)		19.7	19.1
Volumetric flow at stack exit parameters (Am ³ /s)		1,091	1,058
Volumetric flow (Nm ³ /s) ¹		860	1,176
Average stack exit conditions	Temp (°C)	75.0	75.0
	O ₂ (% dry)	13.8	11.5
	Moisture (%)	16.0	10.1
Approx. internal flue diameter (m)		8.4	
Assumed maximum operating hours / year for assessment purposes		8,760	
Oxides of nitrogen (NO _x) ELV mg/Nm ³ (annual average)		68.5 ²	34 ³
Oxides of nitrogen (NO _x) emission rate (g/s) (annual average)		58.9	40.1

Parameter	HRSG Stack (Emission Point A1)	
	100% Hydrogen Firing	100% Natural Gas Firing
Oxides of nitrogen (NO _x) ELV mg/Nm ³ (daily average)	-	45.4 ³
Oxides of nitrogen (NO _x) emission rate (g/s) (daily average)	-	53.4
Carbon monoxide (CO) ELV mg/Nm ³	-	100
Carbon monoxide (CO) emission rate (g/s)	-	117.6
Ammonia (NH ₃) ELV mg/Nm ³	3.0	3.0
Ammonia (NH ₃) emission rate (g/s)	2.6	3.5

¹ Concentration normalised to reference conditions: 273K, 101.3kPa, dry, 15%v/v oxygen
² Based on the IED monthly ELV of 50mg/Nm³
³ For plants with a net electrical efficiency (EE) greater than 55%, a correction factor may be applied to the higher end of the BAT-AEL range, e.g. for the annual average AEL - 30 mg/m³ x 61 / 55.

Additional Release Points to Air

In addition to the CCGT, there will be one further Emission Point to air for the emergency diesel generator (Emission Point A2). This source is very small in comparison with the CCGT and falls within the scope of the MCPD.

In order to ensure that the emergency generator remains fit for purpose, it will undergo routine testing, likely to comprise less than one hour of operation per month, and therefore significantly <50 hours a year.

As the emergency back-up generator would only be used to provide power at the site during an emergency, it is excluded from the Specified Generator requirements of the EP Regulations and as it would operate for less than 500 hours per year it would also be exempt from the MCP ELVs.

An indicative quantitative risk assessment of emissions to air from the diesel generator has been carried out and is provided in the Air Quality Impact Assessment (Appendix G).

Visible Plumes

There is potential for visible plumes to occur from the HRSG stack, during natural gas and hydrogen firing. Due to the increased moisture content of the stack gas when firing on hydrogen, the potential for visible plumes to occur during hydrogen firing is increased. The potential for visible plumes to occur for both fuel types has been assessed and is included in Appendix G, Annex E. The assessment predicted that for natural gas firing visible plumes may be present for up to 47% of the time, with the average plume length being up to 147m. For hydrogen firing visible plumes may be present for up to 87% of the time, with the average plume length being up to 207m.

The proposed cooling technology is hybrid cooling towers, which are plume abated to reduce the potential for visible plumes to form. However, an assessment of the Keadby Next Generation Power Station Project

potential for visible plumes to form has been carried out (Appendix G, Annex E) and indicates that a short visible plume may be present for up to 26% of the time once the Proposed Installation becomes operational, only two of the five years of meteorological data used in the assessment resulted in plumes greater than 1m.

5.2 Point Source Emissions to Water

The key sources of waste waters generated at the Proposed Installation will originate from:

- Clean surface water run-off from non-process areas of the Proposed Installation;
- Blow-down from the hybrid cooling towers;
- Blow-down from the HRSG steam/ water cycle;
- Demin plant effluent streams, including condensate polishing plant;
- Rejected effluent stream from the raw water treatment plant; and
- Surface water run-off from potentially contaminated plant areas (containing oil/ chemical spills).

Clean Surface Water

Clean surface water run-off will not require any treatment, however appropriate attenuation will be provided on-site and it is intended that this will be discharged into the IDB network via Emission Points W2 and W3.

The final location of W2 is still to be decided, however the preferred option is to discharge surface water from the northern attenuation pond to a drain managed by the IDB. Drain 5 (on the eastern Proposed Installation Boundary and an SSE drain) could also be considered for discharge however, Drain 5 drains into Drain 1 and therefore the point at which the drainage enters the IDB managed Drain 1 would remain the ultimate Emission Point from the Proposed Installation.

The location of W2 is shown in Figure 6 (Appendix A).

The southern attenuation pond will discharge surface water to an SSE drain (Drain 2, which ultimately enters the River Trent) at Emission Point W3.

The location of W3 is shown in Figure 6 (Appendix A).

Blow-down Waters

Blow-down waters from the CCGT steam/ water cycle and hybrid cooling towers are likely to contain total dissolved solids, with some suspended solids plus trace chemical and organics resulting from water treatment chemical addition. The composition of the

cooling tower blow-down will be limited by the number of CoC that the water undergoes.

It is proposed that blow-down will either be used for cooling water make-up or be discharged via a dedicated compliance point (W1) connection to the existing infrastructure used by K1 Power Station to the River Trent. It is anticipated that under normal operation the blowdown water will remain within acceptable limits for discharge without further treatment; the quality of the blow-down water will be confirmed via regular monitoring.

Demin Plant Regeneration

The effluent from the WTP and possible steam condensate polishing plant will be treated prior to discharge to the W1 compliance point. The effluent would contain trace contaminants and suspended solids removed during raw-water treatment.

Firewater

All structures within the Proposed Installation will be provided with adequate firewater containment. In the event of a fire, firewater would be collected in the surface water drainage system, which would be closed (via isolation valves) to prevent contaminated water being released from the attenuation ponds to the receiving waters.

A fire water drainage strategy will be developed to ensure that, should an incident occur, contaminated firewater would not be discharged via the surface water drainage system or process water system. Whilst such systems may be used for containment of firewater, any retained firewater on site would be analysed for composition and, if appropriate, tankered off-site for disposal, in line with existing SSE procedures and in accordance with waste management legislation. Penstocks will be provided to isolate any spills or firewater in the surface water drainage system and prevent its discharge to the environment.

Surface Water Run-off from Potentially Contaminated Areas

Due to the nature of the Proposed Installation, it is possible that, in some areas, a range of different diffuse pollutant types may be present in surface water runoff. All hazardous substances will be stored within bunded areas or internally within buildings with sealed drainage. The Proposed Installation will employ appropriate procedures, which will be used to contain and clean-up the release before it reaches the drainage system. Spill kits will be present at various locations on site to ensure prompt clean-up in case of a spill.

The risk for contamination to occur will therefore be mitigated by providing suitable bunding and containment measures and ensuring their maintenance.

Surface water run-off from these areas will be collected and sampled to determine whether they are suitable for release, or whether off-site disposal is required. If suitable for release, they will be discharge to the cooling tower blow down basin which will allow treatment (pH correction). The effluent will then be discharged to the River Trent via a tie-in to the existing Keadby 1 and Keadby 2 cooling water discharge culvert via a

compliance point (Emission Point W1) to ensure that the releases remain within the current K1 discharge specification. The location of W1 is shown in Figure 6 (Appendix A).

The proposed emissions for release to W1 from the Proposed Installation are provided in Table 5, which have been derived from the canal raw water intake parameters and the anticipated CoC for the cooling water release.

Ammonia is present due to dosing into the boiler feedwater for the purposes of minimising corrosion internally within the steam/ water systems. Concentrations in the W1 effluent are anticipated to be <5mg/l.

Table 5: Proposed Emissions for the Proposed Installation (Emission Point W1)

Emission Point ref. & Location	Parameter	Unit	Value
W1 on site plan Figure 6 (compliance point to Keadby 1 River Trent discharge)	Release rate	m ³ / second	0.1
	Chloride	µg/l	630,000
	Copper		36
	Fluoride		48
	Iron		1,440
	Ammonia	mg/l	5*
* Note that for Keadby 3, the concentration of ammonia assessed in the discharge was 13.2mg/l			

Discharges from the Proposed Installation, as detailed in Table 5, are in-line with the discharges that were assessed through a H1 screening assessment and CORMIX Water Modelling Assessment submitted in response to a Not Duly Made notification from the Environment Agency (EA) for Keadby 3 in June 2022. The assessment demonstrated that there were no exceedances of the EQS values except for copper.

In March 2024, SSE provided further information on the impacts of copper emissions from Keadby 2 and Keadby 3, in response to a Schedule 5 notice issued for Keadby 3. A revised assessment was carried out for copper on the basis that the original assessment had used a maximum outlier result from 2015, which was not representative of average canal water samples taken during 2023. The revised assessment resulted in the impacts of copper being screened from requiring further assessment.

As the Proposed Installation is an alternative to Keadby 3, and the discharges from the Proposed Installation will be in-line with, or potentially lower than those assessed for Keadby 3 (due to there not being a carbon capture plant with a Direct Contact Cooler leading to ammonia emissions and due to reduced cooling water requirements), it is therefore considered that the assessments already carried out demonstrate that there would be no adverse impacts as a result of emissions to water from the Proposed Installation. The relevant Keadby 3 assessments have been provided in Appendix H.

As part of the Keadby 3 Environmental Permit variation, the thermal discharge of cooling water to the River Trent was assessed. At this time, it was envisaged that the Keadby 1 Power Station would have ceased operation by the time Keadby 3 commenced operation, and therefore the modelling was carried out for Keadby 2 and Keadby 3 only.

The EA's existing thermal standards specify that a temperature uplift above 2°C, should not occupy more than 25% of the cross section of an estuary for more than 5% of the time.

The modelling carried out for Keadby 3 showed that the maximum predicted extents of 2°C above the ambient water temperature only occurred for only 1.2m, representing <1% of the total channel width, with the plume predicted to attached to the left riverbank (looking downstream) in a confined small area. The thermal effects are expected to be localised and an excess temperature of 2.0°C is achieved in a range of 5m to 15m.

It was therefore concluded that the Keadby 3 discharge would have a very limited impact on the water quality in the River Trent, given that the plumes are rapidly diluted.

It is now envisaged that Keadby 1 Power Station will remain operational, and therefore the impacts of the thermal discharge of the Proposed Installation need to be considered in conjunction with those from Keadby 1 and Keadby 2.

In January 2024, a Thermal Modelling assessment for Keadby 1 Power Station was submitted in support of an Environmental Permit variation. The assessment considered an abnormal operational scenario, where one of the Keadby 1 cooling water pumps was out of service, resulting in the volume of cooling water that was being abstracted being reduced and consequently the differential temperature at the point of discharge increased. The discharge from Keadby 1 was modelled as 12m³/s, with two alternative temperature scenarios: $\Delta T +10\text{ }^{\circ}\text{C}$ and $\Delta T +5\text{ }^{\circ}\text{C}$. The assessment also included the contribution of Keadby 2 cooling waters (at 0.11m³/s, which is <1% of the Keadby 1 volume assessed).

The January 2024 modelling showed the thermal plume to be strongly buoyant and predicted to mostly lie on the surface until it has lost heat when it then mixes down. The analysis presented in the report indicated that most scenarios modelled occupy only a small fraction of the river cross section above 2°C (3 – 13%). The only exception to this was at low water slack when the cross section in excess of 2°C reaches up to 19%, though still less than the 25% criteria. It should also be noted that the period of low water slack is only approximately 20 min every 12 hrs, i.e. 2.8% of the time, less than the EA 5% criteria.

Although this latest model scenario only considered the impacts of Keadby 1 and Keadby 2 thermal discharges, it is considered that the very small addition of cooling water from the Proposed Installation (again <1% of the volume of the Keadby 1 discharge) would impact the results of the January 2024 modelling, especially considering that when Keadby 2 and 3 modelled together showed maximum predicted extents of 2°C above the ambient water temperature of <1% of the total channel width. The January 2024 modelling is provided in Appendix H.

5.3 Point Source Emissions to Sewer

Discharges to sewer from the Proposed Installation are only expected to include domestic sewage from the Proposed Installation's offices and other welfare facilities, which will be directed to the local sewerage system, subject to agreement with the local sewerage undertaker. If this is not the case, a package treatment plant will be used which will discharge into the cooling water outfall at compliance point W1.

5.4 Emissions to Land

All areas of the Proposed Installation, with the exception of landscaped areas, will be covered in hardstanding. There will be no soakaways on the site. Consequently, no direct emissions to land will occur as a result of the operation of the Proposed Installation.

5.5 Fugitive Emissions

Fugitive Emissions to Air

There are a number of fugitive emission sources to air associated with the Proposed Installation, mainly relating to steam emissions from safety valves, boiler blowdown tank vent(s), and AGST breather vents.

If SCR is required, the ammonia storage tank will be pressurised with a carbon filter on the relief valve vent, in order to reduce emissions and prevent the potential for odour in the event of a relief valve lift event.

Fugitive Emissions to Water

The Proposed Installation's drainage concept and measures to protect surface waters from fugitive emissions are described in Section 4.4, including the management of surface water, oily effluent and condensate polishing plant effluent. There are no other potential sources of fugitive emissions to surface water.

Fugitive Emissions to Land

The Proposed Installation's drainage concept and measures to protect land and groundwater from fugitive emissions are described in Section 4.4, including the management of surface water, oily effluent and condensate polishing plant effluent. There are no other potential sources of fugitive emissions to land and groundwater.

5.6 Odour

The natural gas and hydrogen supplied to the Site will be unodourised and therefore there is no potential for odour nuisance to occur from these sources. As stated above, if SCR is required, the ammonia storage tank will have a carbon filter on the tank relief

valve, in order to reduce emissions and prevent the potential for odour. It is therefore considered that there is unlikely to be any issues associated with odour from the Site.

5.7 Noise

The Proposed Installation will include several key plant and equipment which could lead to noise emissions without appropriate mitigation. A Noise Impact Assessment of the potential noise impacts has been completed and is provided in Appendix I.

Analysis of the noise source contributions from each modelled plant item/ building in the indicative concept layouts for the Proposed Installation indicates that there are a range of noise sources contributing to the predicted levels at Noise Sensitive Receptors (NSRs), whilst the exact noise contribution from each building or plant item at each NSR is dependent upon the source and NSR position.

The assessment has assumed that potential sound of a tonal, impulsive or intermittent nature (according to BS4142: 2014) will be designed out of the Proposed Installation during the detailed design phase through the selection of appropriate plant, building cladding, louvres and silencers/ attenuators as necessary.

The Noise Impact Assessment concludes that additional attenuation of specific plant or buildings would be needed to achieve the defined noise criteria, and therefore further assessment will be undertaken during the detailed design stage; these are likely to include, but may not be limited to, the:

- HRSG building;
- All pumps; and
- Hybrid cooling towers.

It is proposed that confirmation of the specific mitigation measures to be applied is provided to the EA upon completion of the final detailed design, prior to commencement of operation of the Proposed Installation, and to demonstrate compliance with the requirements of the EP Regulations.

In addition, other potential mitigation measures and general principals may include, but not be limited to the following, depending upon potential benefits achieved from such measures:

- Reducing the breakout noise from plant through use of enhanced enclosures, or potentially containing them within a building;
- Reducing air inlet noise emissions by addition of further in-line attenuation;
- Reducing stack outlet noise emissions by addition of silencers or sound proofing panels;
- Reducing cooling plant fan noise emissions by screening, re-sizing, fitting low noise fans or attenuation;

- Use of screening or bunding to shield receptors from noise sources; or
- Orientation of plant within the Site to provide screening of low-level noise sources by other buildings and structures, or orientating fans and the air inlets away from sensitive receptors.

6. Monitoring

6.1 Infrastructure

An infrastructure monitoring plan will be implemented at the Proposed Installation, so as to protect the soil and groundwater beneath the Site.

Regular inspection of all Site infrastructure associated with bulk storage of chemicals, oils and diesel will be undertaken. The routine infrastructure audits are likely to comprise identification of issues relating principally to:

- Minor leaks;
- Standing water in bunded areas; and
- Storage tank bunds.

6.2 Emissions to Air

As detailed in Section 5.2, there are two new Emission Points to air associated with the Proposed Installation, comprising:

- A1 – HRSG main stack (up to 85m above ground level); and
- A2 – Emergency diesel generator.

The new combustion plant will be maintained to ensure optimum thermal and electrical efficiency and minimise emissions generation.

Sample locations will be compliant with the requirements of the EA's Monitoring Stack Emissions: Measurement Locations¹⁰.

The list of the emission points at the Proposed Installation and the proposed monitoring to be carried out is shown in Table 6.

¹⁰ Available at [Monitoring stack emissions: measurement locations - GOV.UK](https://www.gov.uk/guidance/monitoring-stack-emissions-measurement-locations)

Table 6: Proposed Emissions and Monitoring

Release Point	Parameter	Source	Proposed Emission Limit ¹	Reference Period	Monitoring Frequency	Monitoring Standard
Emission Limits Associated with Gas-firing						
A1	Oxides of Nitrogen (NO and NO ₂ expressed as NO ₂)	HRSG Stack	45 ² mg/Nm ³	Daily mean of validated hourly averages	Continuous	MCERTS BS EN 14181
			34 ² mg/Nm ³	Yearly mean	Continuous	MCERTS BS EN 14181
			50	Monthly mean of validated hourly averages	Continuous	MCERTS BS EN 14181
			100	95% of validated hourly averages within a calendar year	Continuous	MCERTS BS EN 14181
	Carbon Monoxide (CO)		110 mg/m ³	Daily mean of validated hourly averages	Continuous	MCERTS BS EN 14181
			100 mg/m ³	Yearly mean of validated hourly averages	Continuous	MCERTS BS EN 14181
			100 mg/m ³	Monthly mean of validated hourly averages	Continuous	MCERTS BS EN 14181
			200 mg/m ³	95% of validated hourly averages within a calendar year	Continuous	MCERTS BS EN 14181

Release Point	Parameter	Source	Proposed Emission Limit ¹	Reference Period	Monitoring Frequency	Monitoring Standard
	Sulphur dioxide		-	-	At least every 6 months	Concentration by calculation, as agreed in writing with the Environment Agency
	Sulphur trioxide		-	Daily average or average over the sampling period	Yearly	As agreed in writing with the EA
	Ammonia (NH ₃)		3.0	Yearly mean	Continuous	MCERTS BS EN 14181
	Oxygen		-	-	Continuous as appropriate to reference period	MCERTS BS EN 14181
	Water vapour		-	-		MCERTS BS EN 14181
	Stack gas temperature		-	-		Traceable to national standards
	Stack gas pressure		-	-		Traceable to national standards
	Carbon dioxide		-	-		BS EN 14181
	Stack gas volume flow		-	-		BS EN 16911-2
Emission Limits Associated with 100% Hydrogen-firing						

Release Point	Parameter	Source	Proposed Emission Limit ¹	Reference Period	Monitoring Frequency	Monitoring Standard
A1	Oxides of Nitrogen (NO and NO ₂ expressed as NO ₂)	HRSG Stack	75.4 mg/Nm ³ ³	Daily mean of validated hourly averages	Continuous	BS EN 14181
			68.5 mg/Nm ³	Monthly mean	Continuous	BS EN 14181
			137 mg/Nm ³ ⁴	95% of validated hourly averages within a calendar year	Continuous	BS EN 14181
	Ammonia (NH ₃)		3.0	Yearly mean	Continuous	BS EN 14181
	Oxygen		-	-	Continuous as appropriate to reference period	BS EN 14181
	Water vapour		-	-		BS EN 14181
	Stack gas temperature		-	-		Traceable to national standards
	Stack gas pressure		-	-		Traceable to national standards
Stack gas volume flow	-	-		BS EN 16911-2		
Other Emission Points						
A2	Oxides of Nitrogen (NO and NO ₂ expressed as NO ₂)	Emergency generator 4.1MWth	No limit	Periodic	First monitoring measurements shall be carried out within four months of the issue date of the permit or of the date	BS EN 14792
	Carbon monoxide		No limit	Periodic		MCERTS BS EN 15058

Release Point	Parameter	Source	Proposed Emission Limit ¹	Reference Period	Monitoring Frequency	Monitoring Standard
					when the MCP is first put into operation, whichever is later. Then after 500 hours operation and no less frequent than every 5 years.	
¹ The limits do not apply during periods of shut down or start up. ² For plants with a net electrical efficiency (EE) greater than 55%, a correction factor may be applied to the higher end of the BAT-AEL range, corresponding to upper end of the BAT-AEL mg/m ³ x EE / 55. ³ No validated daily average value exceeds 110% of the relevant ELV in line with the EA GET. ⁴ 95% of validated hourly average values over the year do not exceed 200% of the relevant ELV.						

6.3 Emissions to Water

Measures will be taken to ensure accidental emissions such as fuel/ chemical spillages and firewater are not released from Emissions Points W1, W2 and W3, likely to include isolation valves such as penstocks, or source control measures such as booms or absorbent systems.

The key emissions to water will include the discharge of HRSG blowdown, cooling water blowdown, the reject stream from the WTP and the discharge of surface water run-off from potentially contaminated areas, which will be discharged to the Keadby 1 outfall to the River Trent via a compliance point W1.

The discharge at compliance point W1 will be subject to continuous monitoring for volumetric flow and discharge temperature. Daily spot sampling and testing will be conducted for residual chlorine and pH, and no visible oils or greases, as shown in Table 7.

Trace contaminants (cadmium, mercury) that may be present in water treatment chemicals such as sodium hydroxide, will be controlled through specification and routine testing of raw materials.

Clean surface water run-off will be contained within the attenuation ponds prior to discharge to the IDB network, subject to the outcome of discussions with the EA and the IDB. This would be released via Emission Points W2 and W3 and would be subject to daily monitoring for oil and grease only.

Table 7: Proposed Emission Parameters for the Proposed Installation (Emission Points W1, W2 and W3)

Emission Point ref. & Location	Source	Parameter	Limit	Reference period	Monitoring Frequency	Monitoring Standard or Method
W1 on site plan Figure 6 (compliance point in Keadby 1 River Trent discharge)	HRSG and cooling water blowdown, WTP effluent and surface water from potentially contaminated areas	Daily maximum flow rate	83.5 l/s	Average of 24-hour period	Daily	MCERTS
		pH	6 – 9	24-hour period	Continuous	BS 6068-2.50
		Absolute discharge temperature	35°C	Maximum based on hourly averages	Continuous	Calibrated resistance thermometer device (RTD) UKAS approved
		Oil and grease	No visible emission	-	Daily	Visual inspection
		Residual chlorine	0.2mg/l Cl ₂	-	-	-
		Conductivity	5000µS/cm	-	-	-
		Cadmium	-	-	-	Note 1
		Mercury	-	-	-	Note 2
W2 on site plan Figure 6 emission to drain	Northern attenuation pond – uncontaminated surface water	Oil and grease	No visible emission	Average 24-hour period	Daily	Visual inspection
W3 on site plan Figure 6 emission to drain	Southern attenuation pond – uncontaminated surface water	Oil and grease	No visible emission	Average 24-hour period	Daily	Visual inspection
Note 1. The discharge of mercury from the processes shall be controlled by limiting the concentration of mercury or its compounds in the raw materials as: 46% sodium hydroxide < 500 µg/kg 98% sulphuric acid < 1000 µg/kg water treatment chemicals < 400 µg/kg						

Emission Point ref. & Location	Source	Parameter	Limit	Reference period	Monitoring Frequency	Monitoring Standard or Method
<p>Note 2. The discharge of cadmium from the processes shall be controlled by limiting the concentration of cadmium or its compounds in the raw materials as: - 46% sodium hydroxide < 500 µg/kg 98% sulphuric acid < 1000 µg/kg water treatment chemicals < 400 µg/kg</p>						

The Proposed Installation will be controlled and managed via a central DCS for all operations. The DCS at the plant will provide the site operator with alarms should an operating parameter approach or exceed its set-point/ control value.

The DCS will continuously monitor various parameters of the process water, and will use interlocks and trips where appropriate, based on environmental risk, to prevent water of unacceptable quality from being discharged into surface water.

6.4 Emissions to Sewer

There are no process emissions to sewer from the Proposed Installation and therefore no monitoring of foul water discharges will be required.

7. Environmental Risk Assessment (Impact Assessment)

7.1 Introduction

This section discusses the potential impact on sensitive receptors and the surrounding area and shows how the emissions from the Proposed Installation have been assessed and minimised.

Guidance contained in the EA guidance – ‘Risk assessments for your environmental permit’¹¹, has been used to scope and assess the emissions from the Site.

Where necessary baseline impact assessments and dispersion modelling has been completed to ensure that any predicted significant effects on sensitive receptors can be avoided/ mitigated.

The results of the baseline impact assessments are reported in the Air Quality Impact Assessment, Water Impact Assessment and the Noise Impact Assessment, provided in Appendices G, H and I respectively.

7.2 Site Location and Sensitive Receptors

Human Receptors

The nearest large settlement is the village of Keadby which is located approximately 1 km east from the Proposed Installation at its closest point.

Other settlements nearby include: Crowle (3.6 km) and Ealand (2.2 km) to the west; Althorpe (1.7 km) to the south-east and Gunness (1.8 km) to the east on the eastern bank of the River Trent. Closer to the Proposed Installation are a small number of individual residential properties, including Holly House 300 m to the north-east and Vazon Bridge House and the Scunthorpe Sea Cadets approximately 350 m to the south.

The receptors are selected to be representative of residential dwellings and recreational areas around the Proposed Installation and are shown in Table 8.

Table 8: Human Receptor Locations

Receptor ID	Receptor Description	Distance and Direction from Proposed Installation
R1	Holly House	780 m northeast
R2	1 Trent Side	1.2 km southeast
R3	North Pilfrey Farm	990 m south-west

¹¹ Risk Assessments for Your Environmental Permit, DEFRA and EA, Published on: 1st February 2016, Last updated on: 10th January 2019, accessed at: <https://www.gov.uk/guidance/risk-assessments-for-your-environmental-permit> Keadby Next Generation Power Station Project

Receptor ID	Receptor Description	Distance and Direction from Proposed Installation
R4	Keadby Grange	800 m south
R5	Pharon-Ville - Guinness	1.8 km east
R6	Boskeydyke Farm	2.0 km north-east
R7	Grange Cottage	2.5 km north-east
R8	Pilfrey Farm	2.1 km south-west
R9	Thorne Village ¹	12.2 km west
R10	Vazon Bridge House ²	455 m south
R11	North Moor Farm	740 m north-west
R12	Trent Road	1 km east

¹ Included due to previous request from the Local Council for consideration due to high local NO₂ concentrations

² Taken to also be representative of the Scunthorpe Sea Cadets receptor.

Sensitive Environmental Habitats

EA guidance requires that the effects of stack emissions on designated ecological sites be assessed where they fall within set distances of the source, up to 10 km for European designated sites and up to 2 km for nationally designated sites. For 'large emitters' the distance considered for European sites should be extended to 15 km.

Statutory designated sites have been identified through a desk study of the Defra Magic mapping¹² website, which identifies Sites of Special Scientific Interest (SSSIs), RAMSAR sites, Special Protection Areas (SPAs) and Special Areas for Conservation (SACs). The statutory designated sites are listed below in Table 9.

Table 9: Statutory Designated Ecological Receptor Locations

Receptor I.D.	Ecology Site	Designation	Distance and direction from Proposed Installation
E1	Humber Estuary	Ramsar, SAC, SSSI	1.3 km east
E2	Humber Estuary	SSSI	1.4 km east
E3	Humber Estuary	SSSI	1.5 km east
E4	Humber Estuary	SSSI	1.6 km east
E5	Humber Estuary	SSSI	1.8 km east
E6	Crowle Borrow Pits	SSSI	2.9 km west
E7	Hatfield Chase Ditch	SSSI	3.3 km southwest
E8	Eastoft Meadow	SSSI	3.6 km northwest
E9	Belshaw	SSSI	7.7 km southwest

¹² Defra Magic mapping accessed at <http://magic.defra.gov.uk/MagicMap.aspx> on 03/02/2017

Receptor I.D.	Ecology Site	Designation	Distance and direction from Proposed Installation
E10	Thorne Moor	SAC, SPA and SSSI	6.3 km northwest
E11	Epworth Turbary	SSSI	9.8 km southwest
E12	Risby Warren	SSSI	9.1 km east
E13	Hatfield Moor	SAC, SPA and SSSI	10.4 km west
E14	Messingham Heath	SSSI	9.9 km southeast
E15	Tuetoes Hills	SSSI	10.4 km south
E16	Haxey Turbary	SSSI	11.9 km southwest
E17	Rush Furlong	SSSI	11.9 km south
E18	Hewson's Field	SSSI	12.7 km south
E19	Messingham Sand Quarry	SSSI	12.0 km southeast
E20	Manton and Twigmoor	SSSI	12.2 km southeast
E21	Scotton and Laughton Forest Ponds	SSSI	12.4 km south
E22	Broughton Far Wood	SSSI	13.6 km east
E23	Broughton Alder Wood	SSSI	13.9 km east
E24	Scotton Beck Field	SSSI	13.9 km south-east
E25	Scotton Common	SSSI	14.1 km south
E26	Laughton Common	SSSI	14.7 km south
E32	Humber Estuary (at Blacktoft Sands)	Ramsar, SAC, SPA and SSSI	10.3 km north-east

In addition, non-statutory designated receptors have also been identified, including Local Wildlife Sites (LWSs); these are listed below in Table 10.

Table 10: Non - Statutory Designated Ecological Receptor Locations

Receptor I.D.	Ecology Site	Designation	Distance and direction from Proposed Installation
E27	Stainforth and Keadby Canal Corridor	LWS	330 m south
E28	Keadby Wetland	LWS	695 m east
E29	Keadby Wet Grassland	LWS	710 m east
E30	Three Rivers	LWS	1.1 km southeast
E31	Ash Tip	N/A	Adjacent to west

In addition, there are two further SSSIs within 15 km of the Proposed Installation (Conesby Quarry and Manton Stone Quarry), which are designated due to their geological features. It is therefore considered that these sites will not be affected by emissions from the Proposed Installation, as the Critical Levels and Critical Loads assigned to such sites are for the protection of vegetation and ecosystems only, and therefore they have been screened from further assessment.

Three LWSs (Keadby Boundary Drain, South Soak Drain and Keadby Warping Drain) have not been included in the assessment as the relevant habitats are aquatic, and therefore not considered to be sensitive to air quality impacts from nitrogen. Guidance from the Chartered Institute of Ecology and Environmental Management¹³ states that *“Freshwater systems are generally phosphorus-limited....while the presence of nitrogen is not irrelevant, in most freshwater systems it is more important to control phosphorus inputs than nitrogen inputs. This is why phosphate discharge limits are often introduced on wastewater treatment works in order to protect freshwater habitats, but why nitrogen limits are rarely introduced to achieve the same objective. Phosphorus does not typically deposit from the atmosphere.”*

Geology

Artificial Ground is widespread across the Proposed Installation site. Although not mapped at the Site, Made Ground is expected across the Proposed Installation Site given the historical site use, up to a depth of 2 m. The Made Ground across the Site is made up of Artificial deposits on the natural ground's surface.

Below the Made Ground deposits lie deposits of clay and silt with subsequent layers with potential presence of silt, sand, peat and basal gravel, having a thickness of between 12 and 17 m. These layers together comprise the Superficial Deposits at the Site.

The Bedrock deposits across the Site comprise Mercia Mudstone Group, consisting of predominantly red, less commonly green-grey, mudstones and subordinate siltstones with thick halite-bearing units in some basinal areas. Thin beds of gypsum/ anhydrite widespread; sandstones are also present.

Hydrology

There are numerous surface water features located within the Proposed Installation and wider study area. The River Trent (tidal river) (Humber Upper) flows in a north-south direction to the east of the Site. The River Torne flows 20 m south of the A18 junction.

¹³ Chartered Institute of Ecology and Environmental Management (CIEEM) (2021). Advisory Note: Ecological Assessment of Air Quality Impacts.

Sheffield and South Yorkshire Navigation/ Stainforth and Keadby Canal runs along the southern boundary of the Site and crosses the northern section of the A18 access road flowing in a west-east direction.

Nine active surface water abstractions have been identified within 250 m of the Proposed Installation and it is located within a nitrate vulnerable zone – surface water.

The EA 'Flood map for planning' indicates that the entire Proposed Installation Site and surrounding environs is within the EA's indicative Flood Zone 3 that is defined as land assessed as having a 1 in 100 or greater annual probability of river flooding (> 1% Annual Exceedance Probability or AEP), or a 1 in 200 or greater annual probability of flooding from the sea (> 0.5% AEP) in any year.

Land north of the canal benefits from flood defences (embankments) along the River Trent. Based on the information provided by the EA, it has been determined that during the existing scenario the Proposed Installation site is at a 'low' risk of flooding from tidal sources with the defences in place or resulting from overtopping of the defences during events that exceed a 0.5% AEP (1 in 200 chance) of flooding.

Hydrogeology

The superficial geology (Alluvium/ Warp) is classified as a Secondary A aquifer. These are permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.

The bedrock geology (Mercia Mudstone Formation) is classified as a Secondary B aquifer. These are predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. These are generally the water-bearing parts of the former non-aquifers.

EA Groundwater Maps show that the Proposed Installation falls outside any Groundwater Source Protection Zones (SPZ). There are no SPZ within 1 km of the Proposed Installation.

The Proposed Installation is also identified to be located in an area with the groundwater vulnerability classified as medium-high. These are high priority groundwater resources that have limited natural protection. These areas are likely to be characterised by generally high leaching soils. This results in a medium-high overall pollution risk to groundwater from surface activities.

The Proposed Installation is indicated to be outside any surface water Safeguard Zones for Drinking Water.

There are no licenced groundwater abstraction recorded within the Proposed Installation site and none within 1km. A historical abstraction license on Site is listed and was licensed to Siemens Energy Ltd for dewatering (MD/028/0093/040) the license was for three abstraction points, two of which were located within the Site and expired in March 2022 and a third point 24m to the east which expired in March 2024.

Based on local authority consultation carried out, there are no records of private water abstractions within a 1 km radius of the Proposed Installation.

Groundwater levels within the historical borehole records reviewed indicate generally shallow groundwater levels within the superficial geology of between 0.9m - 3.0m below ground level (bgl). Occasionally, deeper groundwater strikes were recorded between 5.4 m - 6.9 m bgl. There is insufficient information to conclude at this stage whether these levels are representative of true groundwater levels across the wider area. The EA do not hold any groundwater level monitoring data within a 1 km radius from the Proposed Installation Site Boundary.

Pathways for Pollution

In order for a pollution risk to occur, there has to be a source - pathway - receptor (S-P-R) linkage.

Pathways to sensitive receptors primarily include, but are not limited to, the following:

- Chemicals and fuel (diesel) required for the operation of the Proposed Installation could be accidentally released and leach into the ground and be washed into surface water or groundwater through the underlying soils.
- Chemicals required for the operation of the Proposed Installation could be accidentally released and discharged into surface water via the compliance point at W2.
- Combustion gases from the CCGT plant will be dispersed in the air to sensitive receptors.

In order to prevent and minimise the risk of pollution, the Proposed Installation will be designed and managed to isolate or reduce the effectiveness of these pathways, preventing contaminants from migrating off site other than through properly managed abatement systems.

The detailed description provided in Section 4 of this supporting document demonstrates how BAT have been applied to prevent pollution from the Proposed Installation.

7.3 Impact Assessment

The following sections provide an assessment of the impact of releases from the Proposed Installation, so as to underpin and justify the measures that will be put in place for their control and that will adequately protect the environment.

The risk assessment approach has been based on the following four sequential stages:

- Identify risks from the activity;
- Assess the risks and check that they are acceptable;
- Justify appropriate measures to control the risks, if necessary; and

- Present the assessment as detailed in the EA's Guidance 'Risk assessments for your environmental permit'¹⁴.

Activities with the potential to impact on the surrounding environment have been identified in line with guidance provided by the EA, and include the following assessments:

- Amenity and accidents;
- Emissions to air;
- Emissions to surface water;
- Global warming potential;
- Emissions to groundwater.

7.4 Amenity and Accidents

A qualitative risk assessment has been undertaken for the Proposed Installation and is included in Appendix J of this document.

A short description of the key potential risks from the Proposed Installation is provided in the following subsections.

Odour

Given the CCGT plant will use natural gas and/ or hydrogen as a fuel, it is expected that odour from the proposed CCGT operations will not be a significant issue.

Storage of ammonia for the SCR plant, may have the potential to generate odour. In order to minimise the potential for odour to occur, carbon filters will be present on the breather vents.

Noise and Vibration

Measures to be included in the design and operation of the Proposed Installation for the management and control of noise and vibration are discussed in Appendix I. These measures have been scoped and developed in consultation with the Local Authority during the DCO processes and include a baseline noise assessment.

Specific measures to be applied to the Proposed Installation for mitigating noise emissions from site will be confirmed during the detailed design phase, and be provided to the EA for approval prior to commencement of operations.

¹⁴ Risk assessments for your environmental permit, DEFRA and EA, published on: 1st February 2016, last updated on: 10th January 2019, available at: <https://www.gov.uk/guidance/risk-assessments-for-your-environmental-permit>, accessed on: 21st August 2019

Fugitive Emissions

Based on the various controls placed on the site plant and equipment, it is expected that fugitive emissions from the site, particularly process emissions to air and water will be negligible.

Visible Plumes

Visible plume modelling undertaken for the Proposed Installation demonstrates that there is an increased potential for visible plumes to occur during hydrogen firing, compared to natural gas firing. The assessment predicted that for natural gas firing visible plumes may be present for up to 47% of the time, with the average plume length being up to 147m. For hydrogen firing visible plumes may be present for up to 87% of the time, with the average plume length being up to 207m.

There is limited potential for visible plumes from the cooling towers.

The Air Quality Impact Assessment (Appendix G, Annex E) includes a plume visibility assessment to support the conclusion that only small plumes will be generated.

Accidents

A Major Accident and Disasters assessment has been carried out for the ES (Appendix B (see Volume I, Chapter 19)), which details the main hazards for the site and identifies appropriate precautionary actions, to prevent or mitigate potentially significant risks associated.

For the management of day-to-day accidents, an Accident Management Plan (AMP) will be in place for the Proposed Installation including all associated equipment.

A number of environmental protection measures will be implemented on site via the EMS to prevent and control spill events, including but not limited to:

- Plans to deal with accidental pollution and any necessary equipment (e.g. spill kits) will be held on site and all site personnel will be trained in their use. The EMS will incorporate details on how to appropriately deal with accidental spillages to ensure they are not released into any surface water system.
- Implementation of containment measures, including bunding or double-skinned tanks for fuels and oils. All chemicals will be stored in accordance with their COSHH guidelines.
- Incorporation of interceptors into the drainage system to prevent spilled fuel entering the surface water drainage system or local water bodies.
- In case of a fire, the firewater will be contained on site and will subsequently be disposed off-site if contaminated.

In line with the requirements of LCP BRef and BATc, a management plan will be in place as part of the EMS in order to reduce emissions to air and/ or to water during other than normal operating conditions (OTNOC) that includes the following elements:

- set-up and implementation of a specific preventive maintenance plan for these relevant systems;
- review and recording of emissions caused by OTNOC and associated circumstances and implementation of corrective actions if necessary;
- periodic assessment of the overall emissions during OTNOC (e.g. frequency of events, duration, emissions quantification/estimation) and implementation of corrective actions if necessary.

As such, the appropriate design of the systems including low-load design concepts for reducing the minimum start-up and shutdown loads for stable generation in GTs considered relevant in causing OTNOC that may have an impact on emissions to air, water and/ or soil will be implemented on site.

Flood Risk Assessment

The EA's 'Flood Map for Planning'¹⁵ identifies areas subject to fluvial/ tidal flood risk. The River Trent is considered tidal from the Humber Estuary to Keadby Bridge, just upstream of the Proposed Installation Site. The EA's flood maps illustrate that the entire Site and surrounding environs (other than a small, slightly elevated area between Keadby Common in the east, Keadby Boundary Drain in the west, and the canal to the south, and around Crowle) is within the EA's indicative Flood Zone 3. Flood Zone 3 is land assessed as having >1% Annual Exceedance Probability (AEP) (1 in 100 or greater annual chance) of river flooding, or a >0.5% AEP (1 in 200 or greater annual chance) of flooding from the sea. These definitions do not take account of flood defences.

The River Trent is tidal and tidal food risk (flooding from the sea) is the dominant source of flooding. There are however EA maintained flood defences (embankments) along the River Trent.

The following mitigation measures were considered to protect the Proposed Installation within the Site in accordance with the legislative and regulatory authority requirements:

- The Proposed Installation will be raised above the modelled breach flood level for the 0.5% AEP plus climate change tidal event;
- Critical operational infrastructure will be further raised, at least by 1m above the development platform;
- A suitable surface water drainage network and management system will be provided for the Proposed Installation that will provide appropriate interception, conveyance, treatment, and attenuation of surface water runoff. It is anticipated that surface water discharge from the Site will be restricted to

¹⁵ Check the long term flood risk for an area in England, EA, 2020, available online at: <https://flood-warning-information.service.gov.uk/long-term-flood-risk/postcode>

the existing greenfield runoff rate or if this cannot be accommodated by the IDB, at the agricultural runoff/ alternative rate agreed with the IDB.

- It is anticipated that as far as reasonably practicable surface water runoff will be conveyed through drainage ditches and filter drains before attenuation in a basin. Locations with higher pollution potential will be independently bunded and spills treated outside of the surface water system. Where necessary, additional oil separators or sediment capture will also be incorporated into the system.
- Preparation of a Flood Emergency Response Plan, and Emergency access and egress.

A copy of the flood risk assessment undertaken for the site is included in the ES (Appendix B (see Volume II, Appendix 12A)).

7.5 Emissions to Air

An air dispersion modelling exercise has been undertaken to assess the impact on local air quality as a result of the anticipated emissions identified in Table 4 and the Air Quality Impact Assessment is included in Appendix G. The key findings of the Air Quality Impact Assessment are summarised here.

Appropriate Stack Heights

The stack height for the HRSG stack has been optimised by the modelling with consideration given to minimising the ground-level air quality impacts, and the visual impacts of taller stacks. A stack height assessment is provided in the Air Quality Impact Assessment (Appendix G, Annex B).

Dispersion modelling undertaken determined the optimum stack height was 85 m, through comparison of the maximum impacts at human health and ecological receptors. An evaluation of the release height for the HRSG stack has shown that a release height of 85 m is capable of mitigating the short-term and long-term impacts of emissions to an acceptable level, with regard to existing air quality and ambient air quality standards at human health receptors.

Assessment Methodology

The Proposed Installation will be designed such that combustion plant emissions to air comply with the emission requirements specified in the BATc (i.e. BAT-AELs) and GET for hydrogen combustion.

The assessment has considered two potential operational scenarios, to enable the flexible operation of the Proposed Installation, depending on the fuel source available to the Site when operation commences:

- Proposed Installation operating on 100% hydrogen firing:
- Proposed Installation operating on 100% natural gas

There is also potential for the Proposed Installation to operate on a blend of natural gas and hydrogen, however it is considered that the two scenarios assessed represents the full range of potential impacts that could occur from the Proposed Installation, as impacts associated with any interim operation on blends of natural gas and hydrogen would fall within this range.

Detailed dispersion modelling has been used to calculate the concentration of pollutants at identified sensitive receptors and these have been compared with National Air Quality Strategy objectives, and Critical Levels and Critical Loads for ecosystems, with consideration for the baseline air quality and ecological deposition rates, in accordance with EA methodology.

The assessment has considered the impact of the operational process emissions on local air quality under normal operating conditions, with the CCGT operational for 8,760 hours per year, as this represents the worst case for annual average impacts.

The dispersion modelling assessment has considered the effects from combustion emissions of NO_x, CO and NH₃. A number of other conservative assumptions have been made in combination, including:

- Emissions from the Keadby 2 Power Station and the Proposed Installation operating concurrently, given that the background concentrations do not include the operation of the Keadby 2 Power Station which only became commercially operational in March 2023;
- Modelling of maximum ground-level impacts at a range of release heights for the Proposed Installation's stack (between 75 m and 100 m AOD), in order to evaluate the effect of increasing the release height on dispersion;
- The use of the worst-case year of 5 years of meteorological data modelled;
- The use of maximum building sizes within the concept design; and
- Reporting of impacts at the location of maximum impact, and also at identified human health and sensitive ecological receptors.

Detailed Dispersion Modelling Results

The maximum annual mean NO₂ predicted concentration that occurs anywhere within the study area as a result of the Proposed Installation occurs during the 100% hydrogen firing scenario, and results in a predicted Process Contribution (PC) of 1.8 µg/m³, which represents 4.6% of the AQS objective.

The annual mean NO₂ Predicted Environmental Concentration (PEC) is 9.2 µg/m³ and represents 22.9% of the AQS objective and therefore is well below the second stage of screening criteria 70%. NO₂ emissions from the Proposed Installation are therefore not predicted to lead to a risk of the annual mean Air Quality Standard (AQS) objective being exceeded anywhere within the vicinity of the Site.

The maximum predicted hourly mean NO₂ concentration (as the 99.79th percentile of hourly averages) that occurs anywhere as a result of the Proposed Installation occurs

as a result of the 100% hydrogen firing scenario, and results in a PC of $36.6\mu\text{g}/\text{m}^3$. This occurs approximately 500m to the northeast of the Proposed Installation. This represents 18.3% of the hourly mean NO_2 AQS objective of $200\mu\text{g}/\text{m}^3$ and therefore is over the first stage screening criteria of 10% for short term impacts. The PC represents 19.8% of the short term AQS minus twice the long-term background concentration and therefore is below the second stage screening criteria of 20%. The Proposed Installation is therefore not predicted to lead to a risk of the hourly mean NO_2 AQS objective being exceeded.

Carbon monoxide emissions are only released if the Proposed Installation is fired on natural gas. If required to operate on 100% natural gas, the maximum hourly and 8-hour running mean PCs that occur anywhere as a result of the Proposed Installation are well below the first screening criteria of 10% of the relevant AQS objective and therefore can be considered to be insignificant at all receptor locations.

The maximum annual and hourly average PCs of NH_3 occur when firing on 100% natural gas, due to the higher mass release rate of NH_3 that results from this mode of operation. The predicted PCs that occur anywhere as a result of the Proposed Installation represent less than 1% of the relevant EALs and therefore can be considered to be insignificant at all receptor locations. In addition, when added to the background concentrations in the study area, the PEC remains less than 1% of the relevant EAL for both averaging periods.

The assessment results show that the predicted annual average and daily average NO_x impacts are below the criteria for insignificance at the majority of the ecological receptors assessed for the operating scenario that resulted in the highest impacts at receptors (100% hydrogen firing).

PCs of more than 1% of the annual average Critical Load (CL) for NO_x occur at the adjacent Humber Estuary SAC, SSSI and Ramsar, Keadby Wetland LWS, Keadby Wet grassland and Three Rivers LWSs, however in combination with the Keadby 2 modified background concentrations, all sites are well below 70% of the critical level threshold for insignificance, therefore no exceedances of the annual CL are predicted.

The daily CL is below the 10% screening threshold for insignificance at all the statutory designated sites except for the Humber Estuary. In combination with the Keadby 2 modified background concentration at the Humber Estuary, the impacts are 34% of the daily CL and therefore indicate that no exceedance of the daily CL is predicted as a result of the operational Proposed Installation.

The assessment results show that the predicted annual average NH_3 impacts at all the ecological receptors for the worst case operating scenario (100% Natural Gas firing) are below the criteria for insignificance (<1% of the CL) for all but two habitat receptors and therefore can be considered insignificant. When combined with the Keadby 2 modified background concentrations, the impacts at the Humber Estuary SSSI, SAC and Ramsar and the Keadby Wetland LWS are both less than 70% of the CL and therefore can be considered to be insignificant.

Deposition impacts have also been assessed, and the full results are presented in Air Assessment in Appendix G. Both the nutrient nitrogen and acid depositional impacts are insignificant (< 1%) of the relevant critical loads at the majority of ecological sites.

7.6 Emissions to Water

There will not be any direct discharges to the ground/ groundwater from the Proposed Installation.

A summary of the emissions from the Proposed Installation to surface water via Emission Point W1 is provided in Section 5.2, including details of potential process effluent discharges and controls which will be applied to them. Wastewater treatment will be required for process effluents prior to discharge to the environment.

Discharges from the Proposed Installation are in-line with the discharges that were assessed through a H1 screening assessment and CORMIX Water Modelling Assessment submitted in response to a Not Duly Made notification from the EA for Keadby 3. The assessment demonstrated that there were no exceedances of the EQS values except for copper.

In March 2024, SSE provided further information on the impacts of copper emissions from Keadby 2 and Keadby 3, in response to a Schedule 5 notice issued for Keadby 3. A revised assessment was carried out for copper on the basis that the original assessment had used a maximum outlier result from 2015, which was not representative of average canal water samples taken during 2023. The revised assessment resulted in the impacts of copper being screened from requiring further assessment.

As part of the Keadby 3 Environmental Permit variation, the thermal discharge of cooling water to the River Trent was assessed. At this time, it was envisaged that the Keadby 1 Power Station would have ceased operation by the time Keadby 3 commenced operation, and therefore the modelling was carried out for Keadby 2 and Keadby 3 only.

The EA's existing thermal standards specify that a temperature uplift above 2°C, should not occupy more than 25% of the cross section of an estuary for more than 5% of the time.

The modelling carried out for Keadby 3 showed that the maximum predicted extents of 2°C above the ambient water temperature only occurred for only 1.2m, representing <1% of the total channel width, with the plume predicted to attached to the left riverbank (looking downstream) in a confined small area. The thermal effects are expected to be localised and an excess temperature of 2.0°C is achieved in a range of 5m to 15m.

It was therefore concluded that the Keadby 3 discharge would have a very limited impact on the water quality in the River Trent, given that the plumes are rapidly diluted.

It is now envisaged that Keadby 1 Power Station will remain operational, and therefore the impacts of the thermal discharge of the Proposed Installation need to be considered in conjunction with those from Keadby 1 and Keadby 2.

In January 2024, a Thermal Modelling assessment for Keadby 1 Power Station was submitted in support of an Environmental Permit variation. The assessment considered an abnormal operational scenario, where one of the Keadby 1 cooling water pumps was out of service, resulting in the volume of cooling water that was being abstracted being reduced and consequently the differential temperature at the point of discharge increased. The discharge from Keadby 1 was modelled as 12m³/s, with two alternative temperature scenarios: $\Delta T +10\text{ }^{\circ}\text{C}$ and $\Delta T +5\text{ }^{\circ}\text{C}$. The assessment also included the contribution of Keadby 2 cooling waters (at 0.11m³/s, which is <1% of the Keadby 1 volume assessed).

The January 2024 modelling showed the thermal plume to be strongly buoyant and predicted to mostly lie on the surface until it has lost heat when it then mixes down. The analysis presented in the report indicated that most scenarios modelled occupy only a small fraction of the river cross section above 2°C (3 – 13%). The only exception to this was at low water slack when the cross section in excess of 2°C reaches up to 19%, though still less than the 25% criteria. It should also be noted that the period of low water slack is only approximately 20 min every 12 hrs, i.e. 2.8% of the time, less than the EA 5% criteria.

Although this latest model scenario only considered the impacts of Keadby 1 and Keadby 2 thermal discharges, it is considered that the very small addition of cooling water from the Proposed Installation (again <1% of the volume of the Keadby 1 discharge) would impact the results of the January 2024 modelling, especially considering that when Keadby 2 and 3 modelled together showed maximum predicted extents of 2°C above the ambient water temperature of <1% of the total channel width. The January 2024 modelling is provided in Appendix H.

As the Proposed Installation is an alternative to Keadby 3, and the discharges from the Proposed Installation will be in-line with, or potentially lower than those assessed for Keadby 3 (due to there not being a carbon capture plant with a Direct Contact Cooler leading to ammonia emissions and due to reduced cooling water requirements), it is therefore considered that the assessments already carried out demonstrate that there would be no adverse impacts as a result of emissions to water from the Proposed Installation. The relevant Keadby 3 assessments have been provided in Appendix H.

All discharges to W2 from the Proposed Installation will be continuously monitored to ensure compliance with the Environmental Permit. It is therefore considered that the impact of the discharges to surface water from the Proposed Installation will be insignificant.

The Site does not propose to discharge any contaminated effluent into the foul sewer and the site does not have a Trade Effluent Discharge consent.

On this basis it is considered that the risk of impact to water from treated process water, blow-down from cooling tower, HRSG and auxiliary boiler and uncontaminated surface water run-off from the Proposed Installation will be very low.

7.7 Noise Emissions

Noise emissions from the operational Proposed Installation have been assessed, as described in Appendix I.

An environmental sound survey was undertaken to capture the site's prevailing conditions and set noise thresholds at the closest sensitive receptors in line with BS 7445-1:2003 *Description and measurement of environmental noise - Guide to quantities and procedures* and BS 4142:2014+A1:2019 *Methods for rating and assessing industrial and commercial sound*.

To assess the noise impacts from operation of the Proposed Installation, a three-dimensional noise model was constructed using SoundPlan 9.1 software to assess the noise sources with the potential to cause adverse impacts. The assessment was undertaken following EA Guidance – Noise and vibration management: environmental permits and other best practice guidance.

With no mitigation, the noise model predicted that the level of noise impact results in “significant noise” at the identified receptors, with an increase in the excess of rating level over background sound level ($L_{Ar,Tr} - L_{A90,T}$), dB of +15db at the worst effected noise sensitive receptor.

When mitigation measures, including selection of equipment with lowest practicable noise emission; design of building envelopes with appropriate sound insulation performance; provision of acoustic louvres for the building openings which face the closest receptors; and acoustic enclosures are taken into account, the excess of rating level over background sound level ($L_{Ar,Tr} - L_{A90,T}$), dB is reduced to 0db at the worst effected noise sensitive receptor and therefore shows that the impacts from the Proposed Installation will be low.

Operational plant is not expected to result in vibrational emissions and impacts from vibration are expected to be insignificant. Noise impacts on ecological receptors are considered to be insignificant as a result of the distance to receptors and the applied mitigation discussed.

7.8 Global Warming Potential (GWP)

A Greenhouse Gas (GHG) assessment has been carried out as part of the DCO application (Appendix B, Chapter 18 Climate Change). The assessment carried out looks at the GHG emissions of seven operational scenarios, depending on the availability of hydrogen. The scenarios assessed are based on assumed average operating hours of 3,500 hours per year for the first 15 years of operation (assuming operation commences in 2031), and averaging 1,500 hours per year thereafter until 2055. This stepped operating hours forecast is considered to represent a reasonable worst case, reflecting the expected reduction in dispatchable plant use over time. However, in reality, the Proposed Installation is expected to operate below this level for many of the years of operation.

- Scenario A – Hydrogen Full Lifetime: 25 years of operation with 100% hydrogen.

- Scenario B – Early Full Decarbonisation: 2 years of operation with 100% natural gas, followed by 23 years of 100% hydrogen.
- Scenario C – Full Decarbonisation by 2035: 5 years of operation with 100% natural gas, followed by 20 years with 100% hydrogen.
- Scenario D – Blending Ramp-up: 3 years of operation with 100% natural gas, followed by 2 years of 20% hydrogen, then 10 years with 50% hydrogen, and 10 years with 100% hydrogen.
- Scenario E – Late Full Decarbonisation: 15 years of operation with 100% natural gas, followed by 10 years with 100% hydrogen.
- Scenario F – Late Partial Decarbonisation: 15 years of operation with 100% natural gas, followed by 10 years with 50% hydrogen
- Scenario G – Natural Gas Full Lifetime: 25 years of operation with 100% natural gas

A summary of the results of the Scope 1 CO₂ emissions from the GHG assessment is provided in Table 11. The GHG calculations have been developed to present the worst-case scenario for each use of fuel option. Therefore, the calculations have used the emissions intensity of hydrogen reported in the Low Carbon Hydrogen Standard as an assumption for the GHG emissions associated with hydrogen fuel. This standard requires hydrogen producers to meet a maximum GHG emissions intensity of 20g CO₂e/MJLHV of hydrogen produced. However, it should be noted that this is considered to be an extremely conservative assumption for the carbon intensity of hydrogen for the whole lifetime emissions.

Table 11: Lifetime Scope 1 Summary of the GHG Assessment

Scenario	Estimated Emissions (tCO ₂ e)
Scenario A – Hydrogen Full Lifetime	3,041
Scenario B – Early Full Decarbonisation	2,033,413
Scenario C – Full Decarbonisation by 2035	5,078,972
Scenario D – Blending Ramp-up	12,817,300
Scenario E – Late Full Decarbonisation	15,230,832
Scenario F – Late Partial Decarbonisation	18,605,910
Scenario G – Natural Gas Full Lifetime	19,581,630

The release of GHG emissions from the emergency diesel generator has been calculated in Table 12 based on guidance presented in the EA guidance – ‘Assess the impact of air emissions on global warming’^[1].

Table 12: Diesel Generator Energy Consumption

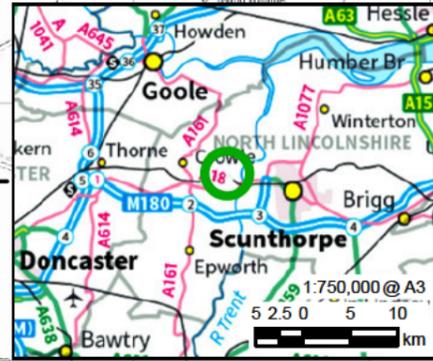
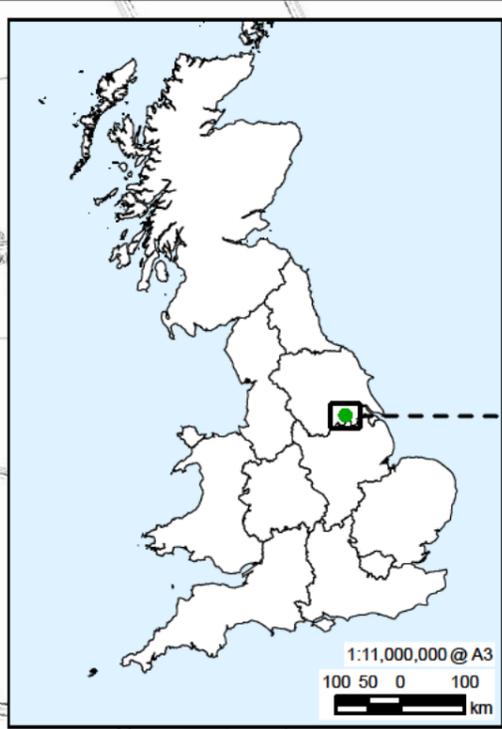
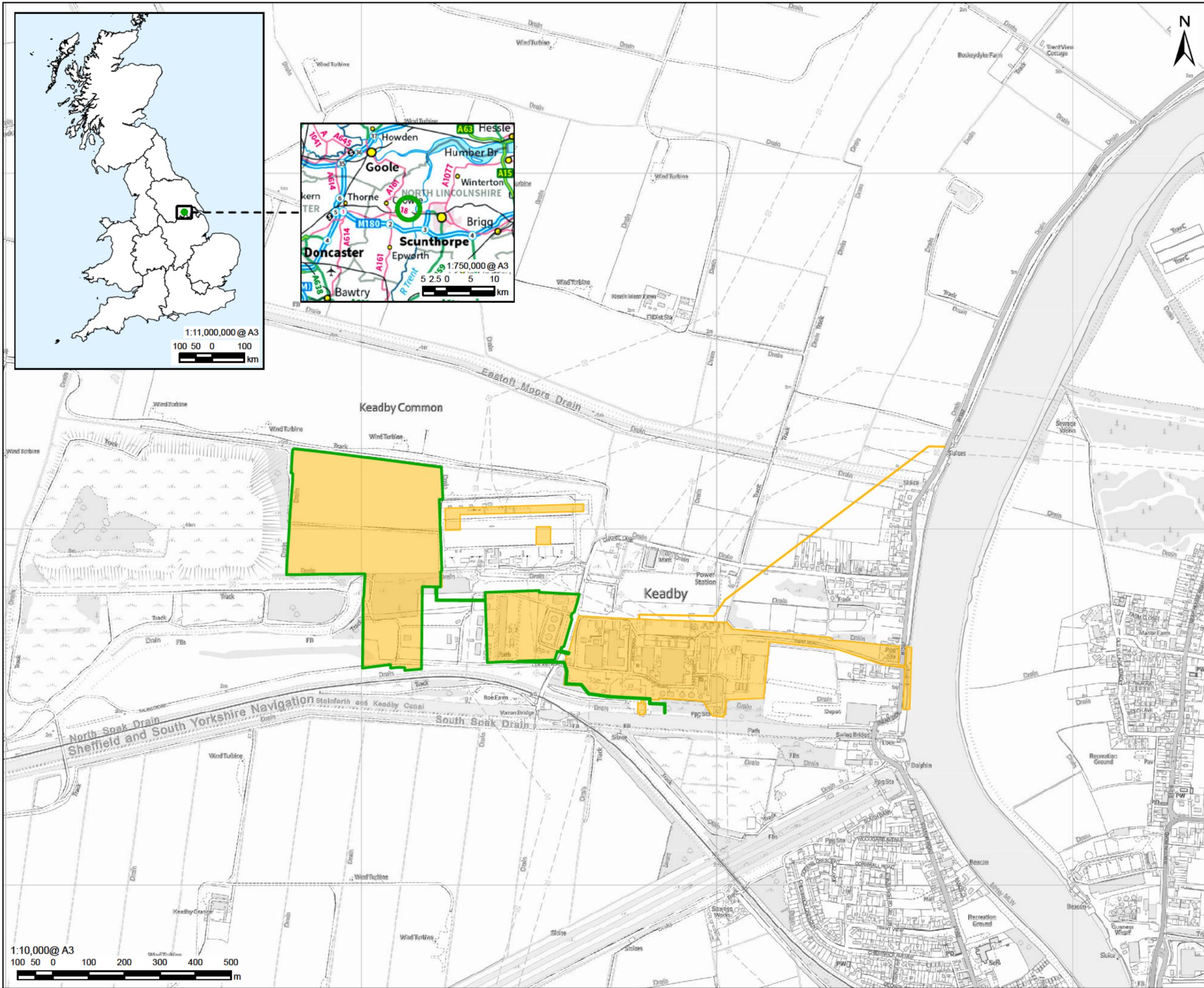
Energy Source	Energy Consumption Primary		
	At Primary Source	CO ₂ Emission Factor	Annual CO ₂ Emissions (tonnes)
Diesel ¹ (emergency generators, diesel fire pump)	15,000 litres	2.63 kg/CO ₂ e/litre	40
Notes: ¹ On the basis of the assumption that the emergency generator and the fire pump will be operated for up to 50 hours per year.			

7.9 Site Closure

It is envisaged that the Proposed Installation will be designed to operate for at least 25 years. At this stage, it is expected that after this time the Proposed Installation will have some residual life remaining, and an investment decision would then be made based on an assessment of the technical feasibility and the market conditions prevailing at that time.

A plan for appropriate decommissioning and closure of the Proposed Installation at the end of its operating life will be developed. The plan will ensure that the site is returned to the baseline condition, as outlined in this application.

APPENDIX A: FIGURES



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LEGEND

- ▭ Keadby Next Generation Power Station Installation Boundary
- ▭ Existing Keadby Power Station Installation Boundary

NOTES

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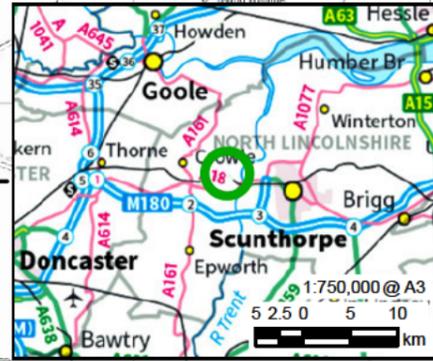
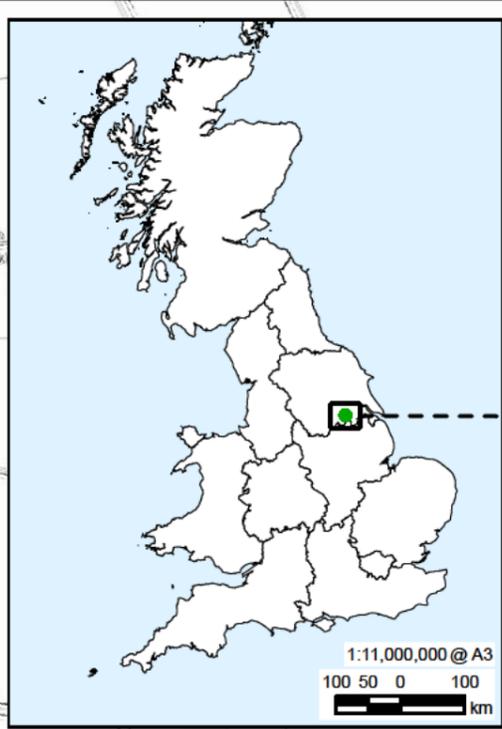
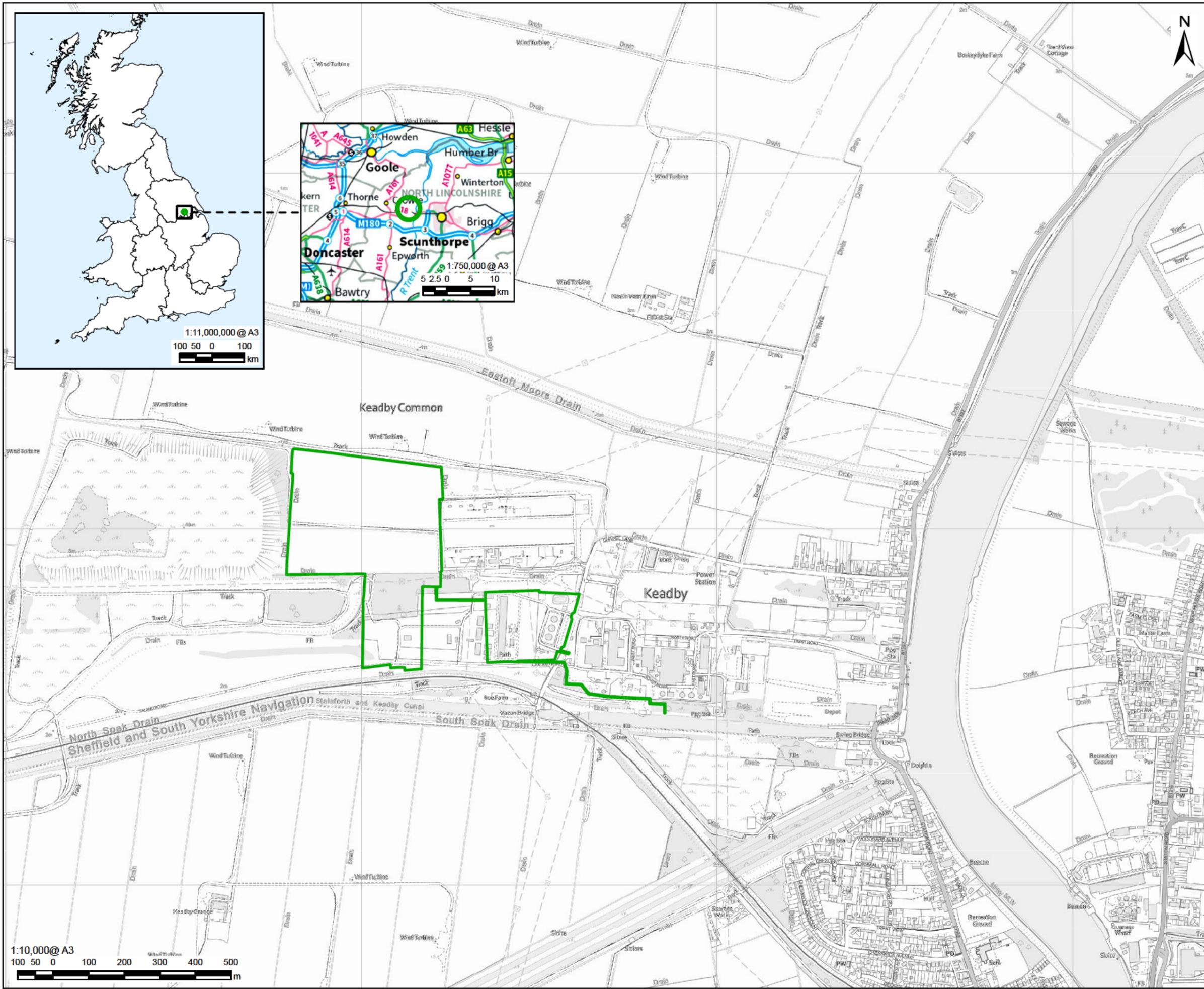
FIGURE TITLE

Installation Location Plan

FIGURE NUMBER

Figure 1

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LEGEND

-  Keadby Next Generation Power Station Installation Boundary

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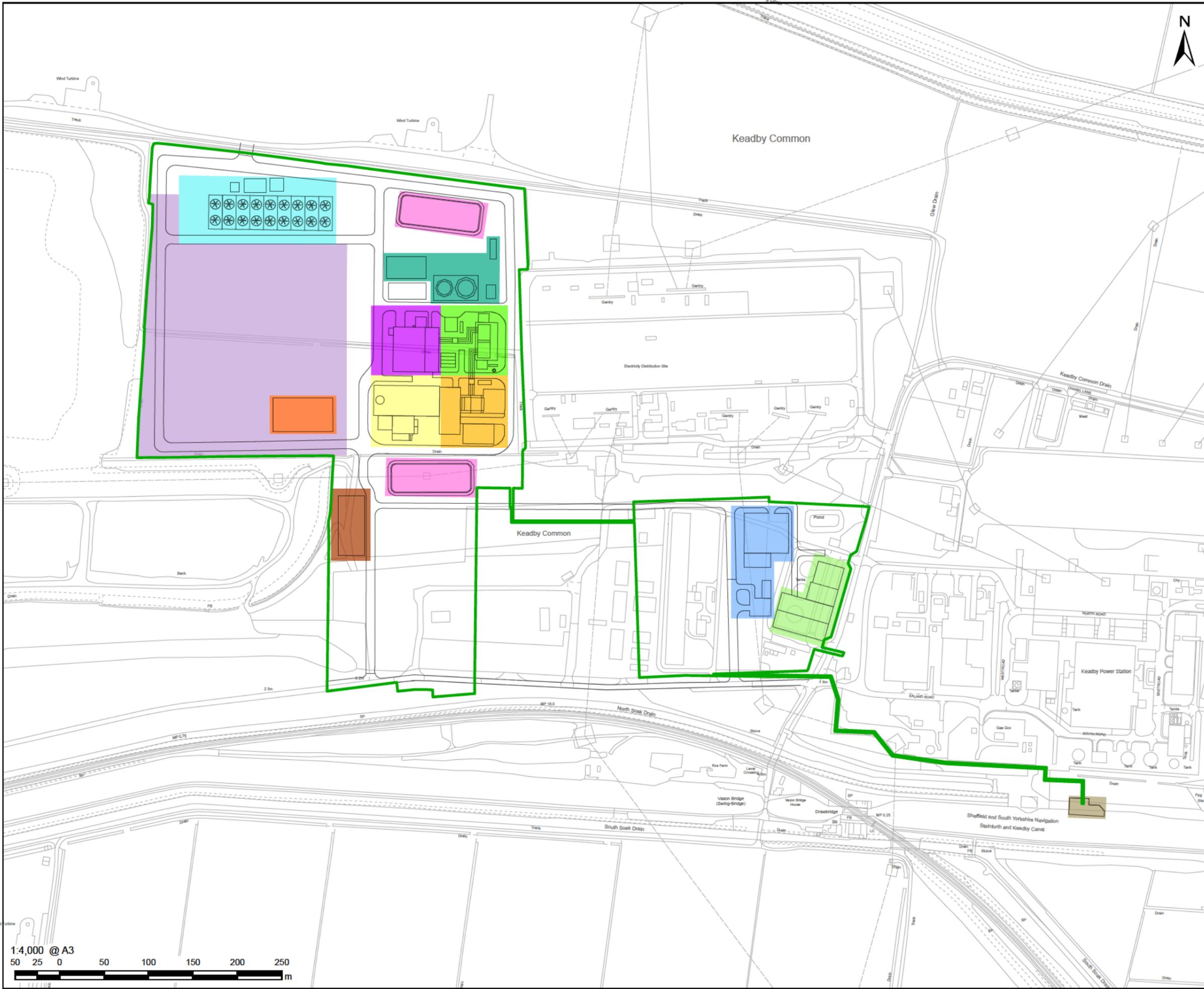
FIGURE TITLE

Installation Boundary

FIGURE NUMBER

Figure 2

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LEGEND

- KEADBY NEXT GENERATION POWER STATION INSTALLATION BOUNDARY
- INDICATIVE SITE LAYOUT
- INDICATIVE PARTS OF THE SITE:**
- ABSTRACTION PUMP
- ADMIN CONTROL ROOM AND STORES BUILDING
- ATTENUATION POND
- CARBON CAPTURE READINESS RESERVE
- COOLING TOWERS
- GAS TURBINE AND AUXILIARIES
- GATE HOUSE
- GATEHOUSE SECURITY AND PARKING
- HRSG AND AUXILIARIES
- HYDROGEN AGI
- NATURAL GAS AGI
- POWER ISLAND ELECTRICAL EQUIPMENT
- RAW WATER TREATMENT
- STEAM TURBINE AND AUXILIARIES

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FIGURE TITLE

Indicative Layout of Main Site and Ancillary Facilities

FIGURE NUMBER

Figure 3

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Figure 4 - Power Generation Process

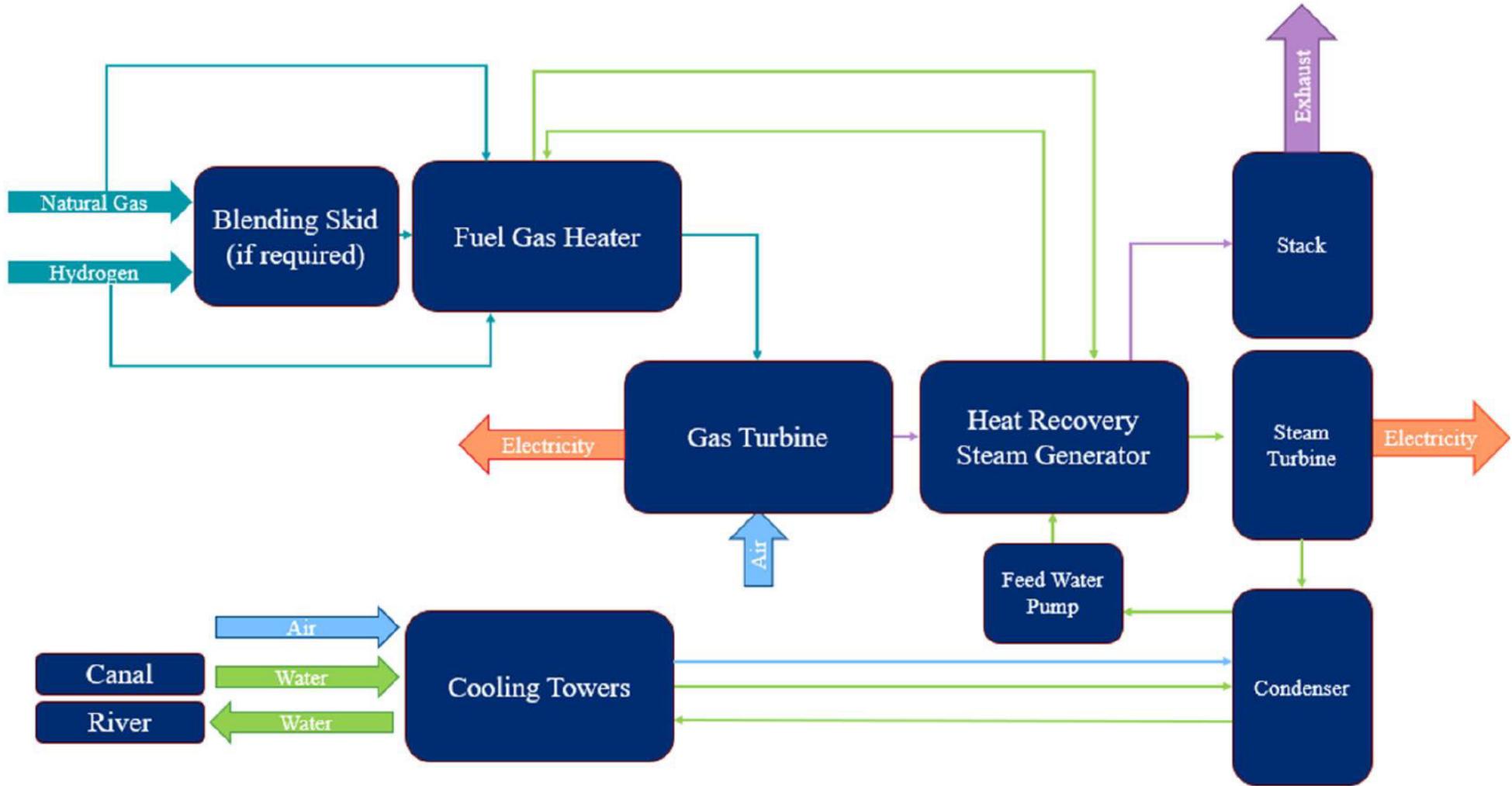
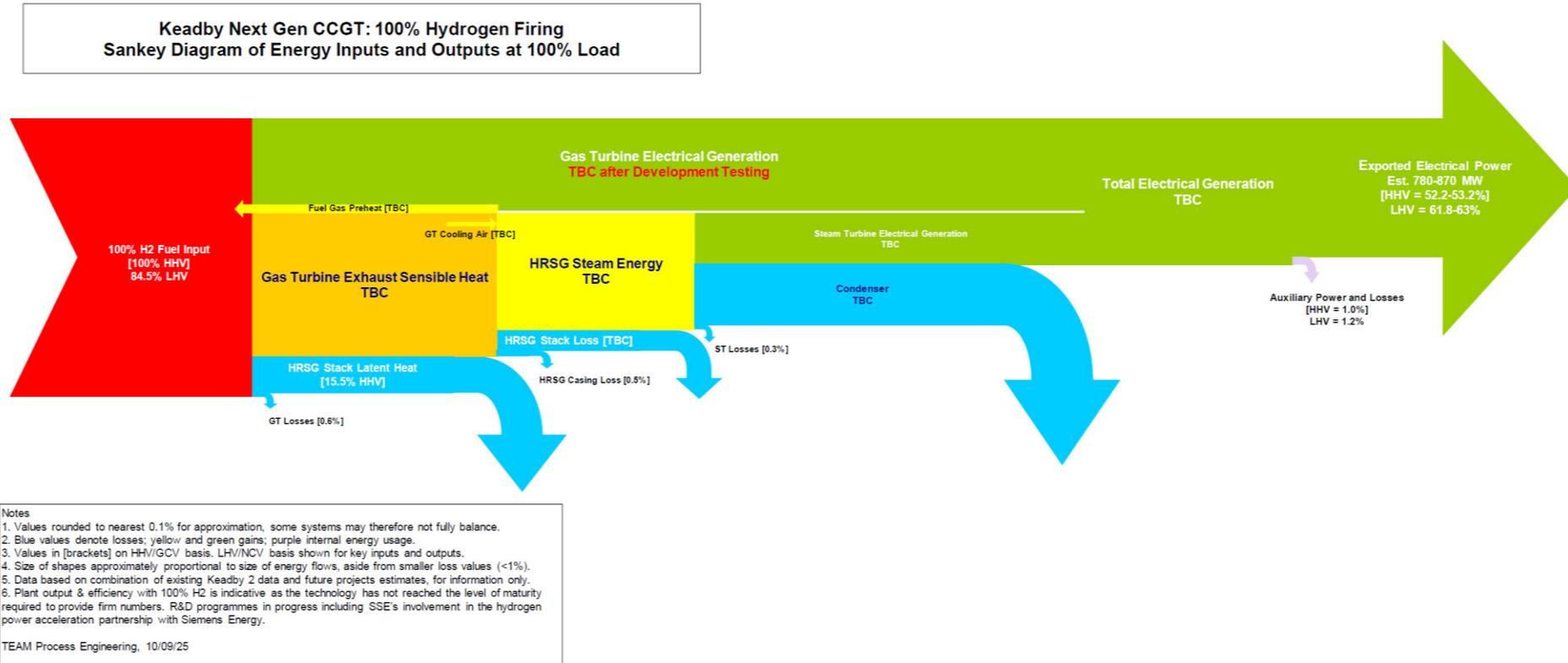
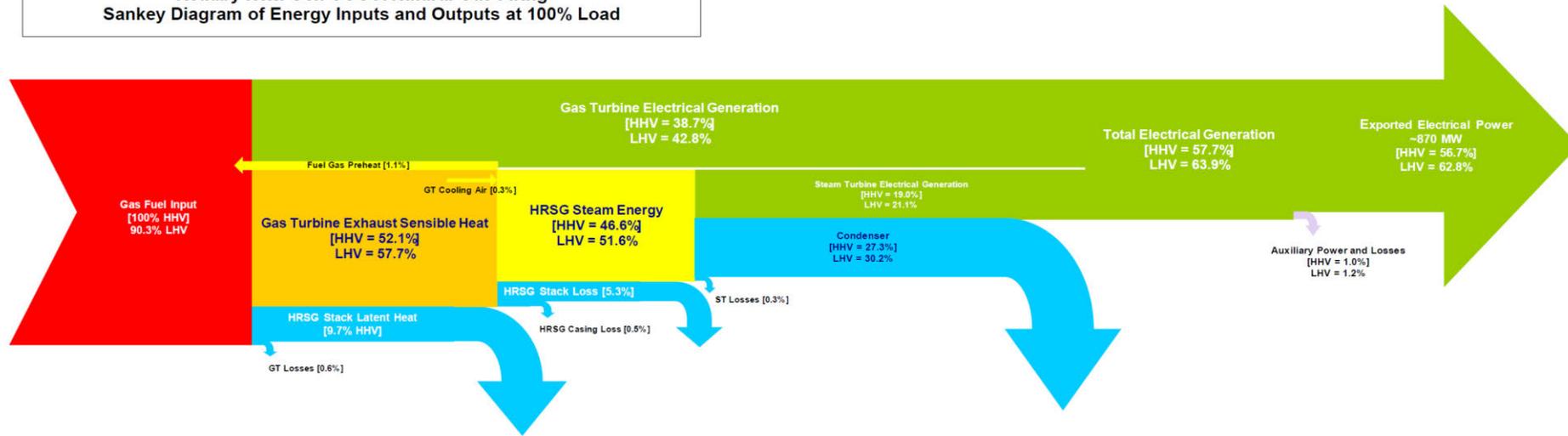


Figure 5: Sankey Diagrams



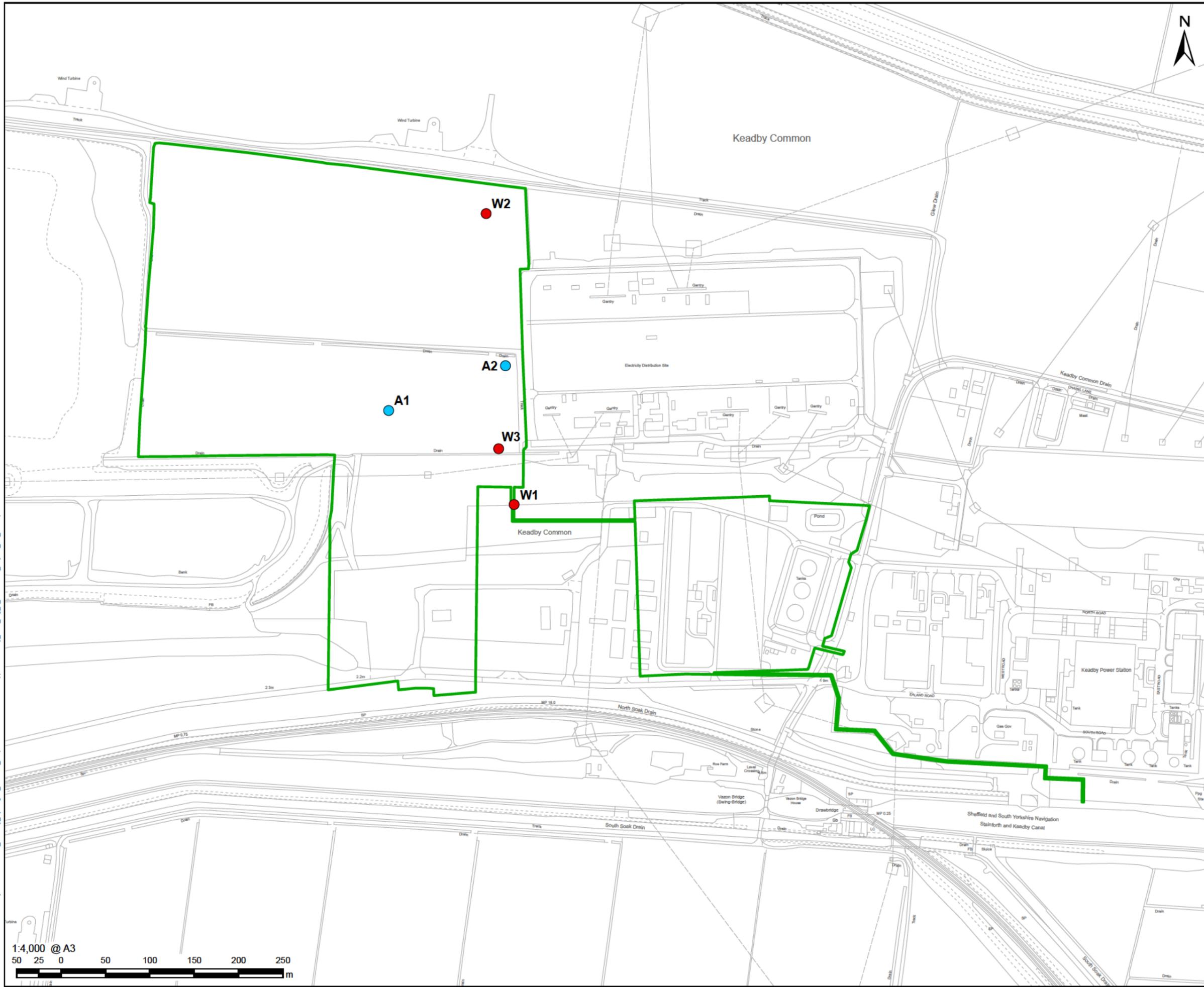
Keadby Next Gen CCGT: Natural Gas Firing
 Sankey Diagram of Energy Inputs and Outputs at 100% Load



Notes

1. Values rounded to nearest 0.1% for approximation, some systems may therefore not fully balance.
2. Blue values denote losses; yellow and green gains; purple internal energy usage.
3. Values in [brackets] on HHV/GCV basis. LHV/NCV basis shown for key inputs and outputs.
4. Size of shapes approximately proportional to size of energy flows, aside from smaller loss values (<1%).
5. Data based on combination of existing Keadby 2 data and future projects estimates, for information only.

TEAM Process Engineering, 05/09/25



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LEGEND

- ▭ Keadby Next Generation Power Station Installation Boundary
- Water Emission Point
- Air Emission Point

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FIGURE TITLE

Emission Point Locations

FIGURE NUMBER

Figure 4

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APPENDIX B: ENVIRONMENTAL STATEMENT

See accompanying Appendix B folder

APPENDIX C: SITE CONDITION REPORT

See accompanying Appendix C folder

APPENDIX D: CARBON CAPTURE READINESS ASSESSMENT

See accompanying Appendix D report

APPENDIX E: BAT ASSESSMENTS

E1 – LCP BAT ASSESSMENT

E2 – COOLING BAT ASSESSMENT

See accompanying Appendix E1 and E2 reports

APPENDIX F: COMBINED HEAT AND POWER ASSESSMENT

See accompanying Appendix F report

APPENDIX G: AIR QUALITY ASSESSMENT

See accompanying Appendix G folder

APPENDIX H: KEADBY 3 WATER IMPACT ASSESSMENTS

See accompanying Appendix H folder

APPENDIX I: NOISE IMPACT ASSESSMENT

See accompanying Appendix I folder

APPENDIX J - ISO 14001 EMS CERTIFICATION

Certificate of Registration



This is to certify that the Environmental Management System of:

SSE Plc

Inveralmond House, 200 Dunkeld Road, Perth, PH1 3AQ

applicable to:

The generation of electricity and supply of heat, Gas storage. The development, operation and maintenance of an electricity distribution network. The administration activities associated with the design, delivery, maintenance and optimisation of energy services for homes and businesses in the UK and Ireland, including; electricity and gas services, supply of green energy, energy and infrastructure upgrades and smart meter and boiler installations. The design, delivery, adoption, maintenance and optimisation of energy infrastructure, including; electricity, gas and heat networks, smart buildings, electric vehicle infrastructure, digital solutions, and distributed generation and storage. The development and operation of an electricity transmission network including the Provision of hard and soft FM services

has been assessed and registered by NQA against the provisions of:

ISO 14001:2015

This registration is subject to the company maintaining an environmental management system, to the above standard, which will be monitored by NQA



0015

Managing Director

Certificate No.	189966
ISO Approval Date:	16 October 2006
Reissued:	19 May 2025
Valid Until:	24 June 2027
EAC Code:	25, 26, 35



Appendix to Certificate Number 189966

Generation of Electricity

Includes Facilities Located at:

SSE Plc, Inveralmond House, 200 Dunkeld Road, Perth, PH1 2AQ

SSE Thermal a trading name of SSE Plc, Great Island Power Station Campile, New Ross County Wexford Y34 KC62

SSE Thermal a trading name of SSE plc, Keadby Generation Limited, Keadby Power Station Trentside, Keadby DN17 3EF

Scottish Hydro Electric Power Distribution plc, Lerwick Power Station Gremista Shetland ZE1 0PS

SSE Thermal a trading name of SSE plc, Medway Power Limited, Medway Power Station Isle of Grain, ME3 0AG

SSE Thermal a trading name of SSE plc, Peterhead Power Station Boddam Peterhead, AB42 3BZ
Renewables Operations, Inveralmond House 200 Dunkeld Road Perth, PH1 3AQ

SSE Thermal a trading name of SSE plc, Tarbert Power Station Tarbert County Kerry, V31 YX52

SSEPG (Operations) Limited - Embedded Generation UK, Chickerell Power Station, Off Radipole Lane Chickerell, DT4 9RP

SSE Generation Ireland Rhode Generating Station Coolcor, Rhode, County Offaly, R35 NW84

SSE Generation Ireland Ltd Tawnaghmore Generating Station, Killala Mayo, F26 EK25

Embedded Generation UK Burghfield Power Station Cottage Lane, Pigewood Reading Berkshire, RG30 3UW

The Generation and Supply of Heat

Includes Facilities Located at:

Slough Power Station 342 Edinburgh Avenue Slough Berkshire, SL1 4TU

Gas Storage

Includes Facilities Located at:

SSE Hornsea Ltd, Gas Storage Business Aldbrough Gas Storage Garton Road HU11 4QB

SSE Hornsea Ltd, Gas Storage Business, Atwick as Storage Facility Skipsea Road Driffield YO25 8ER



ISO Approval Date:	16 October 2006
Reissued:	19 May 2025
Valid Until:	24 June 2027



Appendix to Certificate Number: 189966

The Development and Operation of an Electricity Transmission Network

Includes Facilities Located at:

Scottish Hydro Electric Transmission, Inveralmond House 200 Dunkeld Road Perth PH1 3AQ

The development, operation and maintenance of an electricity distribution network

Includes Facilities Located at:

Distribution, Inveralmond House 200 Dunkeld Road Perth PH1 3AQ

The administration activities associated with the design, delivery, maintenance and optimisation of energy services for homes and businesses in the UK and Ireland, including; electricity and gas services, supply of green energy, energy and infrastructure upgrades and smart meter and boiler installations

Includes Facilities Located at:

SSE Energy Customer Solutions, SSE Airtricity Energy Services Red Oak South County Business Park Dublin D18 W688

SSE Energy Customer Solutions SSE Business Energy 1 Forbury Place, Reading RG31 3JH

The design, delivery, adoption, maintenance and optimisation of energy infrastructure, including; electricity, gas and heat networks, electric vehicle infrastructure, digital solutions, and distributed generation

Includes Facilities Located at:

SSE Utility Solutions Ltd t/a SSE Enterprise Utilities 1 Forbury Place 43 Forbury Road Reading RG1 3JH

Provision of hard and soft FM services

Includes Facilities Located at:

SSE, Facilities Management, Inveralmond House, 200 Dunkeld Road, Perth, PH1 3AQ



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16 October 2006

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APPENDIX K – QUANTITATIVE RISK ASSESSMENT

APPENDIX L: LIST OF RELEVANT PERSONS

Keadby Next Generation Limited

Company number: 15866301

Registered Office Address: One Forbury Place, 43 Forbury Road, Reading, England, RG1 3JH

Date Incorporated: 30 July 2024

Details of Relevant Persons (Active only)

Name (Last name, First name)	Designation	Date of Birth	Appointed on
Colin Charles Swan	Secretary		30 July 2024
Kelly De Azevedo Dent	Director		4 November 2025
Martin Beattie	Director		30 July 2024
John Johnson	Director		30 July 2024
Mandy Mackay	Director		30 July 2024
Finlay Alexander McCutcheon	Director		30 July 2024
Adrian Marc James Rudd	Director		30 July 2024
Zahida Zakir	Director		30 July 2024