APPENDIX D:
SUPPORTING CARBON CAPTURE READINESS (CCR) ASSESSMENT / INFORMATION

This Appendix provides the supporting CCR assessment and information to fulfil the relevant CCR requirements. This Appendix is presented as a stand-alone CCR Assessment.

Intended for

Spalding Energy Company Limited

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SPALDING ENERGY PROJECT

CARBON CAPTURE READINESS ASSESSMENT

Variation Application under Section 36C of the Electricity Act 1989

RAMBOLL

SPALDING ENERGY PROJECT

CARBON CAPTURE READINESS ASSESSMENT
Variation Application under Section 36C of the Electricity Act 1989

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CONTENTS

LIST OF ABBREVIATIONS

ACC	Air Cooled Condenser
AGI	Above Ground Installation
AGP	Advanced Gas Path
AONB	Area of Outstanding Natural Beauty
BAT	Best Available Techniques
BEIS	Department for Business, Energy and Industrial Strategy
BoP	Balance of Plant
BPEO	Best Practicable Environmental Option
CCGT	Combined Cycle Gas Turbine
CCR	Carbon Dioxide Capture Readiness
CCS	Carbon Dioxide Capture and Storage
CIA	Cumulative Impact Assessment
CO_2	Carbon Dioxide
DCS	Distributed Control System
DECC	Department of Energy and Climate Change
DTI	Department for Trade and Industry
EIA	Environmental Impact Assessment
EU ETS	European Union Emissions Trading Scheme
FES CT	(National Grid) Future Energy Scenario Consumer Transformation
FES LtW	(National Grid) Future Energy Scenario Leading the Way
FES SP	(National Grid) Future Energy Scenario Steady Progression
FES ST	(National Grid) Future Energy Scenario System Transformation
FES ST Gas CCS	(National Grid) Future Energy Scenario System Transformation Gas CCS
IED	Industrial Emissions Directive
LCP	Large Combustion Plant
LCPD	Large Combustion Plant Directive
MEA	MonoEthanolAmine
NNR	National Nature Reserve
OCGT	Open Cycle Gas Turbine
Ramboll	Ramboll UK Limited
SAC	Special Area of Conservation
SAM	Scheduled Ancient Monument
SECL	Spalding Energy Company Limited
SEE	Spalding Energy Expansion
SEP	Spalding Energy Project
SNS	South North Sea
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
SUDS	Sustainable Drainage System

1. OVERVIEW

1.1 The Spalding Energy Project

1.1.1 The Spalding Energy Project (SEP) is a combined cycle gas turbine (CCGT) generating station, located on West Marsh Road, in Spalding, Lincolnshire. SEP is located to the north of the newly constructed Spalding Energy Expansion (SEE) Open Cycle Gas Turbine (OCGT) generating station.

1.1.2 On 15 November 2000, the original consent was granted for SEP under Section 36 of the 1989 Electricity Act[1]. The original consent was accompanied by a direction that planning permission be deemed to be granted under Section 90 of the 1990 Town and Country Planning Act[2]. Together, these (the original consent and the direction that planning permission be deemed to be granted) comprise the existing consent for SEP. Appendix A provides further background information on the consenting history of SEP.

1.1.3 At Paragraph 2, the existing consent for SEP provides that: "*the Development shall be about 800 MW capacity*". Subsequently, in May 2001, the Department for Trade and Industry (DTI) (the predecessor to the Department of Energy and Climate Change (DECC), now the Department for Business, Energy and Industrial Strategy (BEIS)) confirmed that the tolerance provided by Paragraph 2 of the existing consent for SEP allowed for an electricity generation output of 840 MW capacity.

1.1.4 The existing consent for SEP was originally granted to InterGen. On 13 May 2002, InterGen transferred the benefit of the existing consent for SEP to Spalding Energy Company Limited (SECL) (a wholly owned subsidiary of InterGen).

1.2 The Proposed Development

1.2.1 The Proposed Development relates to the way in which SEP is authorised to operate.

1.2.2 In early 2019, SECL undertook an Advanced Gas Path (AGP) upgrade to SEP. The AGP upgrade to SEP comprised a number of changes to the existing gas turbines and associated systems, and improved both the environmental performance and electricity market competitiveness of SEP. Amongst the improvements, the AGP upgrade to SEP will allow for an increase in the maximum electricity generation output to up to 950 MW capacity. This is above the current permitted electricity generation output of about 800 MW.

1.2.3 Therefore, as enabled by the AGP upgrade to SEP, the Proposed Development comprises the increase in the maximum electricity generation output of SEP to up to 950 MW.

1.3 The Variation Application and the Purpose of this (Appendix) Report

The Variation Application

1.3.1 SECL is submitting a variation application under Section 36C of the 1989 Electricity Act (the variation application) to the Secretary of State for Business, Energy and Industrial Strategy (Secretary of State), via BEIS, which primarily seeks to amend increase in the permitted electricity generation output of SEP to up to 950 MW capacity.

1.3.2 The variation application also seeks a direction to amend various conditions subject to which the planning permission was deemed to be granted under Section 90(2ZA) of the 1990 Town and Country Planning Act. The amendments are: to reflect the fact that the construction of SEP is complete; to allow for certain further changes to the conditions, or matters controlled by those conditions, to be agreed with the local planning authority; and, to reflect other changes in circumstances since 2000 (when the existing consent was granted).

[1] The Electricity Act 1989. Available at: https://www.legislation.gov.uk/ukpga/1989/29/contents
[2] The Town and Country Planning Act 1990. Available at: https://www.legislation.gov.uk/ukpga/1990/8/contents

1.3.3 The 2013 Carbon Dioxide (CO_2) Capture Readiness (CCR) Regulations[3] apply to certain variation applications. Specifically, Regulation 6(1) of the 2013 CCR Regulations provides that: "*The appropriate authority must not –*

(a) vary a section 36 consent in respect of a combustion plant with a rated electrical output of less than 300 megawatts in such a way as to enable the plant to have a rated electrical output of 300 megawatts of more; or

(b) vary a relevant section 36 consent in such a way as to enable a combustion plant to increase its rated electrical output,

unless the appropriate authority has determined whether the CCR conditions are met in relation to the combustion plant, as constructed or extended in accordance with the section 36 consent as so varied ('the modified plant')".

1.3.4 Regarding the interpretation of Regulation 6(1)(b) of the 2013 CCR Regulations, Regulation 2(1) of the 2013 CCR Regulations provides that: a "'*relevant section 36 consent' means a section 36 consent — (a) for the construction of a combustion plant with a rated electrical output of 300 megawatts or more* […]".

1.3.5 In association, Regulation 6(2) of the 2013 CCR Regulations provides that: "*The appropriate authority's determination under* [Regulation 6(1)] *must be made on the basis of –*

(a) a CCR assessment of the modified plant prepared by the person who applied for the section 36 consent to be varied; and

(b) any other available information, particularly concerning the protection of the environment and human health".

1.3.6 Regarding the interpretation of Regulation 6(2) of the 2013 CCR Regulations, Regulation 2(1) of the 2013 CCR Regulations provides that: a "'*CCR assessment', in relation to a combustion plant, means an assessment as to whether the CCR conditions are met in relation to that plant*".

1.3.7 Regulation 2(2) of the 2013 CCR Regulations provides that: "*For the purposes of these Regulations, the CCR conditions are met in relation to a combustion plant, if, in respect of all of its expected emissions of CO_2 —*

(a) suitable storage sites are available;

(b) it is technically and economically feasible to retrofit the plant with the equipment necessary to capture that CO_2; and

(c) *it is technically and economically feasible to transport such captured CO_2 to the storage sites referred to in sub-paragraph (a)*".

1.3.8 The variation application will, under Regulation 6(1)(b) of the 2013 CCR Regulations, request that the appropriate authority vary a relevant section 36 consent in such a way as to enable a combustion plant (with a rated electrical output of 300 MW or more) to increase its rated electrical output. Therefore, the appropriate authority is required to determine whether the CCR conditions are met.

1.3.9 In October 2020, SECL submitted a CCR Screening Assessment[4] to BEIS which:

(a) Under Regulation 6(2)(a) of the 2013 CCR Regulations, presented the initial results of the CCR Assessment for the variation application; and,

(b) Under Regulation 6(2)(b) of the 2013 CCR Regulations, presented other available information on the protection of the environment and human health relevant to the variation application.

1.3.10 The CCR Screening Assessment also, under Regulation 6(1)(b), requested clarification on whether the Secretary of State for BEIS, as the appropriate authority, could vary the existing consent for SEP (i.e. could vary a relevant section 36 consent) in respect of the

[3] The Carbon Capture Readiness (Electricity Generating Stations) Regulations 2013. Available at: https://www.legislation.gov.uk/uksi/2013/2696/made
[4] 'Spalding Energy Project: Carbon Capture Readiness Screening Assessment' (Ramboll, 15 October 2020)

Proposed Development to allow an increase in the permitted electricity generation output of SEP to up to 950 MW (i.e. in such a way as to enable a combustion plant (with a rated electrical output of 300 MW or more) to increase it rated electrical output) should he determine that the CCR conditions are not met. In recognition of previous UK precedence where CCR conditions were not applied / the CCR conditions are not met, the request for clarification was made with regard to the Proposed Development improving both the environmental performance and electricity market competitiveness of SEP by, in particular, allowing for an improvement (increase) in the electrical generation efficiency, thus also reducing the specific CO_2 emissions associated with electricity generation.

1.3.11 Subsequently, on 23 December 2020, BEIS confirmed, via e-mail[5], that the: "'*in principle' position is that, in the particular circumstances where a section 36 consent issued under the Electricity Act had been granted before the* [2009 CCR Guidance[6]] *was issued, the Secretary of State would be able to grant a consent for a variation of that section 36 consent in a situation where the development that is the subject of the application has not met the Carbon Capture Readiness conditions*". BEIS further confirmed that they: "*did not see, on the basis the section 36 consent for the Spalding Energy* [Project] *was granted in 2000, that the* [2009 CCR Guidance] *would apply to any application to vary the consent*".

The Purpose of this (Appendix) Report

1.3.12 This is a CCR Assessment which:

(a) Under Regulation 6(2)(a) of the 2013 CCR Regulations, presents the results of the CCR Assessment for the variation application; and,

(b) Under Regulation 6(2)(b) of the 2013 CCR Regulations, presents other available information on the protection of the environment and human health relevant to the variation application.

1.3.13 Ramboll UK Limited (Ramboll) has been appointed by SECL to prepare this CCR Assessment.

[5] 'RE: InterGen – Spalding S36C' (Welford, K (Energy Development and Resilience) [e-mail], 23 December 2020).
[6] 'Carbon Capture Readiness (CCR): A Guidance Note for Section 36 Electricity Act 1989 Consent Applications' (URN 09D/810) (Department of Energy and Climate Change, November 2009). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/43609/Carbon_capture_readiness_-_guidance.pdf

2. RELEVANT CONTEXT

2.1 Introduction

2.1.1 This Section considers the relevant context regarding the variation application and CCR Assessments set by European Union Directives, implementing UK legislation / regulations and associated UK Government guidance.

2.2 European Union Directives

2.2.1 Article 33 of the 2009 CO_2 Capture and Storage (CCS) Directive[7] inserted Article 9a into the 2001 Large Combustion Plant Directive[8] (LCPD) to provide, from 25 June 2009[9], that:

"*(1) Member States shall ensure that operators of all combustion plants with a rated electrical output of 300 megawatts or more for which the original construction licence or, in the absence of such a procedure, the original operating licence is granted after entry into force of* [the 2009 CCS Directive[10]] *have assessed whether the following conditions are met:*

- *suitable storage sites are available;*
- *transport facilities are technically and economically feasible; and,*
- *it is technically and economically feasible to retrofit for CO_2 capture*".

(2) If the conditions in paragraph 1 are met, the competent authority shall ensure that suitable space on the installation site for the equipment necessary to capture and compress CO_2 is set aside. The competent authority shall determine whether the conditions are met on the basis of the assessment referred to in paragraph 1 and other available information, particularly concerning the protection of the environment and human health".

2.2.2 Subsequently, Article 36 of the 2010 Industrial Emissions Directive[11] (IED) replaced these provisions from 7 January 2013.

European Union Directives and the Variation Application

2.2.3 On 15 November 2000, the existing consent (i.e. the original construction licence) was grated for SEP. Similarly, on 24 August 2001, the original Environmental Permit (i.e. the original operational licence), was granted for SEP. Therefore, the existing consent (i.e. the original construction licence and the original operation licence) was granted prior to the entry into force of the 2009 CCS Directive.

2.2.4 As such, the variation application is not subject to the 2009 CCS Directive or the 2010 IED (and their associated provisions), and a CCR Assessment is not required under the 2009 CCS Directive / 2010 IED.

2.3 Implementing UK Legislation / Regulations

2.3.1 The 2013 CCR Regulations apply to certain variation applications under Section 36C of the 1989 Electricity Act.

2.3.2 Specifically, Regulation 6(1) of the 2013 CCR Regulations provides that: "*The appropriate authority must not –*

(a) vary a section 36 consent in respect of a combustion plant with a rated electrical output of less than 300 megawatts in such a way as to enable the plant to have a rated electrical output of 300 megawatts of more; or

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[7] Directive 2009/31/EC on the geological storage of carbon dioxide. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0031&from=EN

[8] Directive 2001/80/EC on the limitation of certain pollutants into the air from large combustion plants. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32001L0080&from=EN

[9] The 2009 CCS Directive (at Article 40) provides that: "*This Directive shall enter into force on the 20th day following its publication in the Official Journal of the European Union*". The Directive was published on 5 June 2009. Therefore, the 2009 CCS Directive entered into force on 25 June 2009.

[10] See previous footnote.

[11] Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control). Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32001L0080&from=EN

(b) vary a relevant section 36 consent in such a way as to enable a combustion plant to increase its rated electrical output,

unless the appropriate authority has determined whether the CCR conditions are met in relation to the combustion plant, as constructed or extended in accordance with the section 36 consent as so varied ('the modified plant')".

2.3.3 Regarding the interpretation of Regulation 6(1)(b) of the 2013 CCR Regulations, Regulation 2(1) of the 2013 CCR Regulations provides that: a "'*relevant section 36 consent' means a section 36 consent — (a) for the construction of a combustion plant with a rated electrical output of 300 megawatts more* […]".

2.3.4 In association, Regulation 6(2) of the 2013 CCR Regulations provides that: "*The appropriate authority's determination under* [Regulation 6(1)] *must be made on the basis of –*

(a) a CCR assessment of the modified plant prepared by the person who applied for the section 36 consent to be varied; and

(b) any other available information, particularly concerning the protection of the environment and human health".

2.3.5 Regarding the interpretation of Regulation 6(2) of the 2013 CCR Regulations, Regulation 2(1) of the 2013 CCR Regulations provides that: a "'*CCR assessment', in relation to a combustion plant, means an assessment as to whether the CCR conditions are met in relation to that plant*".

2.3.6 Regulation 2(2) of the 2013 CCR Regulations provides that: "*For the purposes of these Regulations, the CCR conditions are met in relation to a combustion plant, if, in respect of all of its expected emissions of CO_2 —*

(a) suitable storage sites are available;

(b) it is technically and economically feasible to retrofit the plant with the equipment necessary to capture that CO_2; and

(c) it is technically and economically feasible to transport such captured CO_2 to the storage sites referred to in sub-paragraph (a)".

2.3.7 Subsequently, Regulation 6(3) of the 2013 CCR Regulations provides that: "*If the appropriate authority —*

(a) determines that the CCR conditions are met in relation to a combustion plant; and

(b) decides to —

(i) vary a section 36 consent in respect of that plant in the way described in paragraph (1)(a); or

(ii) (ii) vary a relevant section 36 consent in respect of that plant in the way described in paragraph (1)(b),

it must ensure that the section 36 consent (as varied) includes a condition that suitable space is set aside for the equipment necessary to capture and compress all of the CO_2 that would otherwise be emitted from the plant".

Implementing UK Legislation / Regulations and the Variation Application

2.3.8 The variation application will, under Regulation 6(1)(b) of the 2013 CCR Regulations, request that the appropriate authority vary a relevant section 36 consent in such a way as to enable a combustion plant (with a rated electrical output of more than 300 MW or more) to increase its rated electrical output. Therefore, the appropriate authority is required to determine whether the CCR conditions are met.

2.3.9 As such, the variation application is subject to the 2013 CCR Regulations provisions, and, under Regulation 6(2) of the 2013 CCR Regulations, a CCR Assessment (and any other available information (in particular on the protection of the environment and human health)) is required.

2.3.10 However, regarding the 2013 CCR Regulations provisions (and of particular relevance to this document), it is understood that a CCR Assessment is only required to determine whether the CCR conditions are met, not that the CCR conditions are met. Therefore, it is also understood that the Secretary of State for BEIS, as the appropriate authority, can vary a relevant section 36 consent in such a way as to enable a combustion plant (with a rated electrical output of 300 MW or more) to increase its rated electrical output should he determine that the CCR conditions are not met.

2.3.11 In this regard, in October 2020, SECL submitted a CCR Screening Assessment to BEIS. Subsequently, on 23 December 2020, BEIS confirmed, via e-mail, that the: "'*in principle' position is that, in the particular circumstances where a section 36 consent issued under the Electricity Act had been granted before the* [2009 CCR Guidance] *was issued, the Secretary of State would be able to grant a consent for a variation of that section 36 consent in a situation where the development that is the subject of the application has not met the Carbon Capture Readiness conditions*".

2.4 UK Government Guidance

2.4.1 Page 4 of the 2009 CCR Guidance states that: "*This guidance applies to applicants:*

- *who submitted before 23 April 2009 an application for Section 36 consent for a <u>new</u> power station of the type described above*[12] *but on which a decision has not yet been taken by the Secretary of State; and*
- *submitting after 23 April 2009 an application for Section 36 consent for a <u>new</u> power station of the type described above*[13]" (emphasis added).

2.4.2 In addition, paragraph 1 (page 7) of the 2009 CCR Guidance states that: "*CCR should be assessed during the consenting process for the construction and operation of <u>new</u> power stations under Section 36 and that no power station at or over 300 MWe and of a type covered by the* [2001] *LCPD would be consented unless it could demonstrate it would be CCR*" (emphasis added). Similarly, paragraph 2 (page 7) of the 2009 CCR Guidance states that: "*This guidance implements both Article 33 of the* [2009 CCS] *Directive and the Government's further requirement that if a proposed power station is <u>subject to the</u> [2009 CCS] <u>Directive requirement</u>, it will only be granted development consent if it is assessed positively against the Article 33* [of the 2009 CCS Directive] *criteria*" (emphasis added).

UK Government Guidance and the Variation Application

2.4.3 Regarding page 4 and paragraph 1 / paragraph 2 (page 7) of the 2009 CCR Guidance, the variation application is not for a new generating station. Similarly, regarding paragraph 1 / paragraph 2 (page 7) of the 2009 CCR Guidance, the variation application is not subject to the 2009 CCS Directive (or the 2010 IED) (and it associated provisions).

2.4.4 As such, the variation application is not subject to the 2009 CCR Guidance (and its associated provisions), and a CCR Assessment is not required under the 2009 CCR Guidance.

2.4.5 In this regard, in October 2020, SECL submitted a CCR Screening Assessment to BEIS. Subsequently, on 23 December 2020, BEIS confirmed, via e-mail, that they: "*did not see, on the basis the section 36 consent for the Spalding Energy* [Project] *was granted in 2000, that the* [2009 CCR Guidance] *would apply to any application to vary the consent*".

2.4.6 Notwithstanding, within this document, the basis for the appraisals / assessment is taken from the 2009 CCR Guidance, as this is considered to provide a recognised framework and methodology to be adopted for a CCR Assessment.

[12] With regards to "*of the type described above*", page 4 of the 2009 CCR Guidance states that: "*The CCR requirements (and therefore this guidance) apply to applications for power stations with an electrical generating capacity at or over 300 MW and of a type covered by the* [2001 LCPD]". The associated footnote explains that: "*energy from waste plants are not covered by the* [2001] *LCPD*".
[13] See previous footnote.

3. THE EXISTING SPALDING ENERGY PROJECT / THE PROPOSED DEVELOPMENT

3.1 Introduction

3.1.1 This Section provides a description and comparison of the existing SEP and the Proposed Development.

3.2 The Existing Spalding Energy Project

3.2.1 SEP is a CCGT generating station, located on West Marsh Road, in Spalding, Lincolnshire.

3.2.2 At Paragraph 2, the existing consent for SEP provides that: *"the Development shall be about 800 MW capacity and comprise:*

(a) two gas turbines and heat recovery steam generators;

(b) one steam turbine;

(c) one bank of air cooled condensers;

(d) ancillary plant and equipment; and,

(e) the necessary buildings (including administration buildings) and civil engineering works".

3.2.3 Subsequently, in May 2001, the DTI confirmed that the tolerance provided by Paragraph 2 of the existing consent for SEP allowed for an electricity generation output of 840 MW capacity.

3.2.4 SEP burns natural gas, which is supplied to the site via a connection into the National Grid Gas Transmission System Feeder 7 Pipeline. Natural gas is the primary fuel, and no back-up fuel is required.

3.2.5 During operation, SEP burns the natural gas in the combustion chamber of the gas turbines from where the resulting hot gases expand and generate sufficient power to drive the air compressor sections and gas turbine generators to produce electrical power. The hot exhaust gases still contain recoverable energy and are used in heat recovery steam generators (HRSGs) to generate steam which is expanded in common steam turbine plant to drive the common steam turbine generator to produce additional electrical power. The steam exhausting the steam turbine plant is passed to an air-cooled condenser (ACC) where it is condensed. The resulting condensate is returned to the HRSGs to continue the steam cycle. Subsequently, the flue gases are discharged from the HRSGs via dedicated 78 m high stacks. Overall, the energy demand and heat used is typical of a CCGT generating station.

3.2.6 The gas turbine generators and common steam turbine generator produce electrical power at approximately 19 kV which is stepped up to 400 kV through the three main transformers, and the electricity generated is dispatched to the National Grid Electricity Transmission System.

3.2.7 The use of a combined gas and steam cycle configuration increases the overall fuel efficiency of the generating station compared to an open (gas) cycle configuration, where the hot exhaust gases are directly discharged.

3.2.8 At Paragraph 4(2), the existing consent for SEP provides that: *"the construction or the Development shall only take place within the boundary of the Site"*. Figure 1 ('Plan DWD 2544/2/G') presents the original application site plan referred to in the existing consent for SEP (which identifies the area of land (i.e. "*the Site*"), shown as the area outlined black, within which SEP was authorised to be constructed and is authorised to be operated).

3.2.9 SEP is located to the north of the newly constructed SEE OCGT generating station.

3.3 The Proposed Development

3.3.1 The Proposed Development relates to the way in which SEP is authorised to operate.

3.3.2 In early 2019, SECL undertook an AGP upgrade to SEP. The AGP upgrade to SEP comprised a number of changes to the existing gas turbines and associated systems, including:

- An upgrade of the gas turbine combustion system;
- The replacement of some gas turbine components (e.g. gas turbine blades) with the latest proven designs;
- The modification of some Balance of Plant (BoP) components;
- An upgrade of the main generator transformer cooling system; and,
- An upgrade of some Distributed Control System (DCS) components with the latest digital software platforms.

3.3.3 Providing the rationale for development, the AGP upgrade to SEP improved both the environmental performance and electricity market competitiveness of SEP by:

- Allowing for an increase in the maximum electricity generation output to up to 950 MW capacity (this is above the current permitted electricity generation output of about 800 MW);
- Allowing for an improvement (increase) in the electrical generation efficiency (thus also reducing the specific CO_2 emissions associated with electricity generation);
- Increasing the overall flexibility (by reducing the start-up times and increasing the operational load range); and,
- Extending the availability (by extending the maintenance intervals).

3.3.4 However, the AGP upgrade to SEP resulted in no external changes to any building / equipment / stack dimensions, elevations, footprints or locations. As such the AGP upgrade to SEP does not affect the design, size or shape of the existing SEP and does not amount to an 'extension' of the existing SEP as defined in Section 36(9)[14] of the 1989 Electricity Act.

3.3.5 Therefore, as enabled by the AGP upgrade to SEP, the Proposed Development comprises the increase in the maximum electricity generation output of SEP to up to 950 MW.

3.3.6 The Proposed Development is wholly contained within the existing SEP.

[14] Section 36(9) provides that: *"In this Part "extension", in relation to a generating station, includes the use by the person operating the station of any land or area of waters (wherever situated) for a purpose directly related to the generation of electricity by that station and "extend" shall be construed accordingly"*.

4. CCR ASSESSMENT

4.1 Introduction

4.1.1 This Section presents the results of the CCR Assessment for the variation application.

4.2 Methodology

4.2.1 Based on Regulation 2(2) of the 2013 CCR Regulations, the methodology adopted for the CCR Assessment comprises:

Step 1: Setting out the CCR Assessment basis, in terms of: the assumed CO_2 capture process; the estimated CO_2 capture and storage requirements; and, the Required CCR Space Allocations;

Step 2: An appraisal of potential CO_2 storage areas / sites;

Step 3: An appraisal of the technical retrofitting of CO_2 capture equipment requirements;

Step 4: An appraisal of the technical CO_2 transport requirements; and, subsequently,

Step 5: An economic assessment (considering the retrofitting of CO_2 capture equipment and CO_2 transport requirements).

4.3 Step 1: CCR Assessment Basis

4.3.1 This sub-Section sets out the CCR Assessment basis, in terms of: the assumed CO_2 capture process; the estimated CO_2 capture and storage requirements; and, the Required CCR Space Allocations.

Assumed CO_2 Capture Process

4.3.1 At the time of writing (January 2021), a number of CO_2 capture processes / technologies exist, and it is highly probably that this number will increase. However, this document focuses on currently available CO_2 capture processes / technologies rather than speculating on future developments and, therefore, is based on the assumption of the best currently available CO_2 capture process / technology for CCGT units (which are existing at the time of CO_2 capture installation), which is post-combustion CO_2 capture via chemical absorption.

4.3.2 Post-combustion CO_2 capture via chemical absorption (using monoethanolamine (MEA)) comprises: a CO_2 capture section (including: flue gas cooling; and, CO_2 absorption); a CO_2 handling section (including: CO_2 stripping / desorption; and, CO_2 compression and discharge); and, a cooling system.

4.3.3 This assumed CO_2 capture process may be regarded as commercially available, but has not yet been commercially proven and deployed / retrofitted for large-scale combustion plant applications. However, it is the opinion of Ramboll that no technical barriers exist to extending existing experience to a scale appropriate for a CCGT generating station.

Estimated CO_2 Capture and Storage Requirements

CO_2 Capture Efficiency

4.3.4 Within the 2013 CCR Regulations, reference to:

- (at Regulation 6(3)) "*all of the CO_2*"; and,
- (at Regulation 2(2)) "*all of its expected emissions of CO_2*"

indicates that a CCR Assessment should consider all of the expected CO_2 emissions (and similarly the highest possible CO_2 capture efficiency), rather than just a certain percentage (i.e. a 50%) of the expected CO_2 emissions.

4.3.5 Therefore, within this document, "*all of the CO_2*" and "*all of its expected emissions of CO_2*" is assumed to be all of the CO_2 emissions which can be captured in line with Best Available Techniques (BAT). This is considered to be in line with the 2009 CCR Guidance which (at paragraph 11) requires that: "*applicants should explain what percentage of these CO_2 emissions they consider will be captured by their proposed capture technology, in keeping with the principles of best practice*".

Estimated CO_2 Capture and Storage Requirements

4.3.6 Preliminary thermodynamic modelling of the CCGT units without CO_2 capture was undertaken using Thermoflow, Version 29. Based on preliminary thermodynamic modelling, Table 4-1 presents the estimated CO_2 capture and storage requirements.

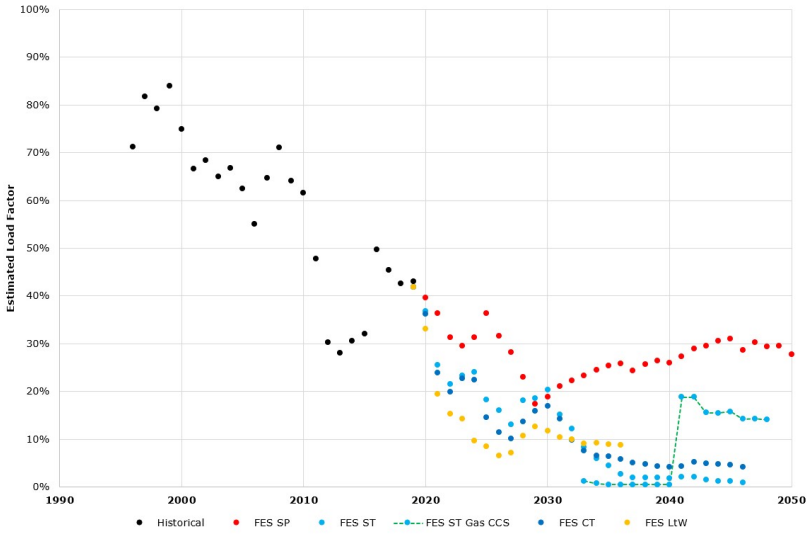
Table 4-1: ESTIMATED CO_2 CAPTURE AND STORAGE REQUIREMENTS

		Estimated Requirements
CO_2 Generated	kg/s	97.6
	t/hr	351.2
CO_2 Capture Process Requirement (Assuming 90% CO_2 Capture)	t/hr	316.1
	t/day	7,585.9
Annual CO_2 Storage Requirement (Assuming a 28% Load Factor)	Mt/yr	0.8
Total CO_2 Storage Requirement (Assuming a Total of 20 Years of CO_2 Capture)	Mt	15.5

Regarding the Annual CO_2 Storage Requirement / Annual Load Factors

4.3.7 Within Table 4-1, the annual CO_2 storage requirement assumes a 28% load factor. Insert 4-1 indicates that this assumed load factor is considered to be appropriate when compared with historical / current CCGT load factors[15] (shown as black •) together with the highest projected CCGT load factors[16] (shown as red •). Furthermore, a 28% load factor is also considered to be in line with InterGen's internal market forecasts / models.

Insert 4-1: CONSIDERATION OF ANNUAL LOAD FACTORS



4.3.8 However, Insert 4-1 indicates this assumed load factor may be considered to be optimistic when compared with other projected CCGT load factors. Indeed, Insert 4-1 indicates that other projected CCGT load factors[17] will average between 10 to 12% between 2020 and

[15] 'Digest of UK Energy Statistics (DUKES) 2010' (Department for Business, Energy and Industrial Strategy, 30 July 2020). Available at: https://www.gov.uk/government/statistics/digest-of-uk-energy-statistics-dukes-2020

[16] Based on National Grid's '2020 Future Energy Scenarios' Steady Progression ('FES SP') Scenario (shown as red •, which is the slowest credible decarbonisation scenario) (National Grid, July 2020). National Grid's '2020 Future Energy Scenarios' available at: https://www.nationalgrideso.com/future-energy/future-energy-scenarios/fes-2020-documents

[17] Based on National Grid's '2020 Future Energy Scenarios' System Transformation ('FES ST') Scenario (shown as light blue •, where consumers are less likely to change their behaviour), Consumer Transformation ('FES CT') Scenario (shown as dark blue •, where consumers are more likely to change their behaviour), and Leading the Way ('FES LtW') Scenario (shown as orange •, which is the fastest credible decarbonisation scenario) (National Grid, 2020).

2050, and will drop to less than 10% by 2035 and to 0% by 2050 (i.e. no unabated gas capacity).

4.3.9 The economic assessment considers the impact of varying the load factor.

4.3.10 Here, it is also worth noting that, at the time of writing (January 2021), SEP has already been in commercial operation for approximately 16 years and is based on 'F-Class' technology (with more efficient 'H-Class' technology now available). As such, it may be lower in the merit order thus reducing the projected load factor further.

4.3.11 In addition, it is also worth noting that, Insert 4-1 indicates that the projected gas CCS load factor[18] will average 8% between 2020 and 2050, and will drop to 0% by 2050.

Regarding the Total CO_2 Storage Requirement / Years of CO_2 Capture

4.3.12 Within Table 4-1, the total CO_2 storage requirement assumes a total of 20 years of CO_2 capture. This is considered to be appropriate as this takes the overall economic (operational) lifetime to 2050, and could include a 15 year initial time period covered by either a Capacity Market contract or a Contract for Difference.

4.3.13 The economic assessment considers the impact of varying the economic (operational) lifetime.

Required CCR Space Allocations

4.3.14 Table 4-2 provides a summary of the Required CCR Space Allocations for SEP based on CCGT units with post-combustion CO_2 capture as defined by:

- The Original Allocation, set via Table 1 ('Approximate minimum land footprint for some types of CO_2 capture plant') of the 2009 CCR Guidance, as 3.75 ha for 500 MW (net) (or 75 m^2/MW);
- The Corrected Allocation, set via Table A1 ('Approximate minimum land footprint for some types of CO_2 capture plant with correction for CCGT with post-combustion capture') of the 2010 Imperial College Review[19], as 2.4 ha for 500 MW (net) (or 48 m^2/MW); and,
- The Reduced Allocation, set via the 2010 Imperial College Review, as 1.875 ha for 500 MW (net) (or 37.5 m^2/MW).

Table 4-2: REQUIRED CCR SPACE ALLOCATIONS FOR SEP (FOR A 950 MW CCGT GENERATING STATION)

	Required CCR Space Allocation	
	ha	***m^2/MW***
Original Allocation	7.13	75
Corrected Allocation	4.56	48
Reduced Allocation	3.56	37.5

4.3.15 Figure 2 presents an overview of the available space on the existing SEP / Proposed Development site. Based on Figure 2, it can be seen that the application site boundary (i.e. Redline Boundary) covers a total area of approximately 12.78 ha and within this:

- The CCGT generating station covers an area of approximately 3.46 ha;
- The offsite Gas Reception Facility covers an area of approximately 1.15 ha;
- The National Grid Electrical Substation and export pylon covers an area of approximately 1.79 ha;

[18] Based on National Grid's '2020 Future Energy Scenarios' System Transformation ('FES ST Gas CCS') Scenario (shown as light blue • with green dotted line, where consumers are less likely to change their behaviour, but is the only scenario which includes gas CCS capacity (i.e. abated gas capacity) for electricity generation).

[19] 'Assessment of the Validity of 'Approximate Minimum Land Footprint for some types of CO_2 Capture Plant' (Imperial College London, October 2010). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/47932/553-imperial-college-review-ccr-guidance.pdf

- The landscaping and Sustainable Drainage System (SUDS) pond covers an area of approximately 2.56 ha; and,
- West Marsh Road covers an area of approximately 0.67 ha.

4.3.16 Therefore, there is 3.15 ha of 'available' space on the site. However, this 'available' space is not located in an isolated location and much is used for internal access roads.

4.3.17 As such, based on a comparison of the Required CCR Space Allocations against this available space on the site, none of the Required CCR Space Allocations are met.

4.3.18 In addition, it is noted that, as the existing consent (i.e. the original construction / operation licence) was granted prior to the entry into force of the 2009 CCS Directive, the existing consent contains no CCR condition which requires sufficient space to be retained on the site.

4.4 Step 2: Appraisal of Potential CO_2 Storage Areas / Sites

4.4.1 The basis for this appraisal is taken from the 2009 CCR Guidance, in particular paragraphs 32 – 42 on the demonstration that there are suitable deep geological off-shore CO_2 storage areas / sites.

4.4.2 From Table 4-1, the estimated total CO_2 storage requirement is 16.6 Mt.

4.4.3 Noting the previous CCR Feasibility Studies undertaken for the SEE CCGT generating station[20,21,22], the South North Sea (SNS) can be identified as a suitable deep geological off-shore CO_2 storage area, and the Pickerill and West Sole gas fields can be identified as potential CO_2 storage sites within that area. Both the Pickerill and West Sole gas fields are listed as "realistic" in the 2006 CO_2 Storage Potential Report[23]. Table 4-3 provides an estimate of the total CO_2 which could be stored in the Pickerill and West Sole gas fields.

Table 4-3: TOTAL CO_2 WHICH COULD BE STORED IN THE PICKERILL AND WEST SOLE GAS FIELDS

		Pickerill	***West Sole***
CO_2 Storage Capacity	Mt	37.0	143.0
SEP CO_2 Storage Requirement (Assuming 20 Years of CO_2 Capture)	Mt	15.5	15.5
Other Potential Users[24] CO_2 Storage Requirement	Mt	0.0	78.0
% CO_2 Storage Capacity Used	%	41.9	65.4
Remaining CO_2 Storage Capacity	Mt	21.5	49.5

4.5 Step 3: Appraisal of the Technical Retrofitting of CO_2 Capture Equipment Requirements

4.5.1 The basis for this appraisal is taken from the 2009 CCR Guidance, in particular paragraphs 20 – 31 on the technical feasibility of retrofitting CO_2 capture equipment to the generating station.

4.5.2 Noting the requirements of Annex C ('Environment Agency Verification of CCS Readiness New Natural Gas Combined Cycle Power Station using Post-Combustion Solvent

[20] 'Spalding Energy Expansion: Carbon Capture Readiness Feasibility Study' (Parsons Brinckerhoff (Ref PBP/INT/SH/000003), March 2009).
[21] 'Spalding Energy Expansion: Carbon Capture Readiness Feasibility Study' (Parsons Brinckerhoff, January 2010).
[22] 'Spalding Energy Expansion: Revised Carbon Capture Readiness Feasibility Study' (Ramboll (Ref 371455-1 (Rev 3), 14 April 2015).
[23] 'Industrial Carbon Dioxide Emissions and Carbon Dioxide Storage Potential in the UK' (Commercial Report CR/06/185N) (British Geological Society, June 2006). Available at: http://nora.nerc.ac.uk/id/eprint/4837/1/CR06185N.pdf
[24] Regarding the use of the West Sole gas field, it is noted on the GOV.UK website ('Energy Infrastructure Development Applications: Carbon Capture Readiness Decisions') that this CO_2 storage site has one other potential user. The other potential user is the SEE CCGT generating station, with an estimated CO_2 storage requirement of 78.0 Mt. The GOV.UK website is available at: https://www.gov.uk/government/collections/energy-infrastructure-development-applications-carbon-capture-readiness-decisions

Scrubbing') of the 2009 CCR Guidance, Table 4-4 provides the appraisal of the technical retrofitting of CO_2 capture equipment.

Table 4-4: APPRAISAL OF THE TECHNICAL RETROFITTING OF CO_2 CAPTURE EQUIPMENT

Requirement of Annex C	***Appraisal***
C1: Design, Planning Permissions and Approvals	*The specific requirement is that a pre-feasibility level conceptual study should be provided, which includes technical feasibility of retrofitting CO_2 capture equipment information alongside preliminary CO_2 capture equipment layouts.* This CCR Assessment has considered (at Section 4.3) the Required CCR Space Allocations and whether there is suitable space on the existing SEP / Proposed Development site. Based on a comparison of the Required CCR Allocations against the available space on the existing SEP / Proposed Development site (where none of the Required CCR Space Allocations are met), it is considered that there are barriers to demonstrating the technical feasibility of retrofitting for CO_2 capture equipment (and regarding this specific requirement, associated barriers to providing the preliminary CO_2 capture equipment layouts).
C2: Power Plant Location	*The specific requirement is that the appraisal / assessment on technical CO_2 transport requirements should be provided, which includes the details of any flue gas terminal point from the generating station and any CO_2 terminal point from the CO_2 capture equipment / site.* This CCR Assessment has considered (at Section 4.3) the Required CCR Space Allocations and whether there is suitable space on the existing SEP / Proposed Development site. Based on a comparison of the Required CCR Allocations against the available space on the existing SEP / Proposed Development site (where none of the Required CCR Space Allocations are met), it is considered that there are barriers to demonstrating the technical feasibility of retrofitting for CO_2 capture equipment (and regarding this specific requirement, associated barriers to providing the details of the flue gas terminal point from SEP and the CO_2 terminal point from the CO_2 capture equipment / site).
C3: Space Requirements	*The specific requirement is that the pre-feasibility level study should describe how space allocations were determined and how they would be met. The space allocations would be required for:* *(a) Steam turbine system additions and modifications;* *(b) Balance of plant system additions, extensions and modifications;* *(c) Flue gas ducting from the generating station to the CO_2 capture equipment;* *(d) CO_2 capture equipment;* *(e) Chemical storage and handling, CO_2 handling, and CO_2 transport to the CO_2 capture equipment / site boundary; and,* *(f) Additional vehicle movements.* This CCR Assessment has considered (at Section 4.3) the Required CCR Space Allocations and whether there is suitable space on the existing SEP / Proposed Development site. Based on a comparison of the Required CCR Allocations against the available space on the existing SEP / Proposed Development site (where none of the Required CCR Space Allocations are met), it is considered that there are barriers to demonstrating the technical feasibility of retrofitting for CO_2 capture equipment (and regarding this specific requirement, associated barriers to describing the space allocations).
C4: Gas Turbine Operation with Increased Exhaust Pressure	*The specific requirement notes that increased back pressure on the gas turbine (including upstream ducting and HRSG) would be imposed by the CO_2 capture process, and that the pre-feasibility level study should describe the expected pressure drop for current commercial CO_2 capture equipment, together with either:* *(a) Details of any effects on gas turbine performance and a manufacturer's confirmation that the gas turbine can accommodate this; or,* *(b) Details of a booster fan specification, including any space allocations / provisions.* This CCR Assessment has considered (at Section 4.3) the Required CCR Space Allocations and whether there is suitable space on the existing SEP / Proposed Development site. Based on a comparison of the Required CCR Allocations against the available space on the existing SEP / Proposed Development site (where none of the Required CCR Space Allocations are met), it is considered that there are barriers to demonstrating the technical feasibility of retrofitting for CO_2 capture equipment (and regarding this specific requirement, associated barriers to providing the preliminary CO_2 capture equipment layouts (which would include any booster fan space allocations / provisions).

Requirement of Annex C	***Appraisal***
C5: Flue Gas System	*The specific requirement notes that space will be required for any flue gas pre-treatment and for flue gas ducting from the generating station to the CO_2 capture equipment, and that the pre-feasibility level study should describe the required flue gas system modifications, including any space allocations / provisions.* This CCR Assessment has considered (at Section 4.3) the Required CCR Space Allocations and whether there is suitable space on the existing SEP / Proposed Development site. Based on a comparison of the Required CCR Allocations against the available space on the existing SEP / Proposed Development site (where none of the Required CCR Space Allocations are met), it is considered that there are barriers to demonstrating the technical feasibility of retrofitting for CO_2 capture equipment (and regarding this specific requirement, associated barriers to providing the preliminary CO_2 capture equipment layouts (which would include any flue gas system space allocations / provisions)).
C6: Steam Cycle	*The specific requirement is that the pre-feasibility level study should demonstrate that the steam cycle could be operated with CO_2 capture processes using solvent systems with a range of steam requirements and should estimate the steam extraction energy penalty, including any space allocations / provisions.* This CCR Assessment has considered (at Section 4.3) the Required CCR Space Allocations and whether there is suitable space on the existing SEP / Proposed Development site. Based on a comparison of the Required CCR Allocations against the available space on the existing SEP / Proposed Development site (where none of the Required CCR Space Allocations are met), it is considered that there are barriers to demonstrating the technical feasibility of retrofitting for CO_2 capture equipment (and regarding this specific requirement, associated barriers to providing the preliminary CO_2 capture equipment layouts (which would include the steam cycle space allocations / provisions)).
C7: Cooling System	*The specific requirement notes that additional cooling will be required for the CO_2 capture process, and that the pre-feasibility level study should describe the expected requirements, including any space allocations / provisions.* This CCR Assessment has considered (at Section 4.3) the Required CCR Space Allocations and whether there is suitable space on the existing SEP / Proposed Development site. Based on a comparison of the Required CCR Allocations against the available space on the existing SEP / Proposed Development site (where none of the Required CCR Space Allocations are met), it is considered that there are barriers to demonstrating the technical feasibility of retrofitting for CO_2 capture equipment (and regarding this specific requirement, associated barriers to providing the preliminary CO_2 capture equipment layouts (which would include the additional cooling system space allocations / provisions)).
C8: Compressed Air System	*The specific requirement notes that additional compressed air (process and instrument / service air) may be required for the CO_2 capture process, and that the pre-feasibility level study should describe the expected requirements, including any space allocations / provisions.* This CCR Assessment has considered (at Section 4.3) the Required CCR Space Allocations and whether there is suitable space on the existing SEP / Proposed Development site. Based on a comparison of the Required CCR Allocations against the available space on the existing SEP / Proposed Development site (where none of the Required CCR Space Allocations are met), it is considered that there are barriers to demonstrating the technical feasibility of retrofitting for CO_2 capture equipment (and regarding this specific requirement, associated barriers to providing the preliminary CO_2 capture equipment layouts (which would include the additional compressed air system space allocations / provisions)).
C9: Raw Water Pre-Treatment	*The specific requirement notes that additional raw water pre-treatment may be required for the CO_2 capture process, and that the pre-feasibility level study should describe the expected requirements, including any space allocations / provisions.* This CCR Assessment has considered (at Section 4.3) the Required CCR Space Allocations and whether there is suitable space on the existing SEP / Proposed Development site. Based on a comparison of the Required CCR Allocations against the available space on the existing SEP / Proposed Development site (where none of the Required CCR Space Allocations are met), it is considered that there are barriers to demonstrating the technical feasibility of retrofitting for CO_2 capture equipment (and regarding this specific requirement, associated barriers to providing the preliminary CO_2 capture equipment layouts (which would include the additional raw water pre-treatment space allocations / provisions)).
C10: Demineralisation / Desalination	*The specific requirement notes that additional pure water may be required for the CO_2 capture process, and that the pre-feasibility level study should describe the expected requirements, including any space allocations / provisions.* This CCR Assessment has considered (at Section 4.3) the Required CCR Space Allocations and whether there is suitable space on the existing SEP / Proposed Development site. Based on a comparison of the Required CCR Allocations against the available space on the existing SEP / Proposed Development site (where none of the Required CCR Space Allocations are met), it is considered that there are barriers to demonstrating the technical feasibility of retrofitting for CO_2 capture equipment (and regarding this specific requirement, associated barriers to providing the preliminary CO_2 capture equipment layouts (which would include the additional demineralisation / desalination space allocations / provisions)).

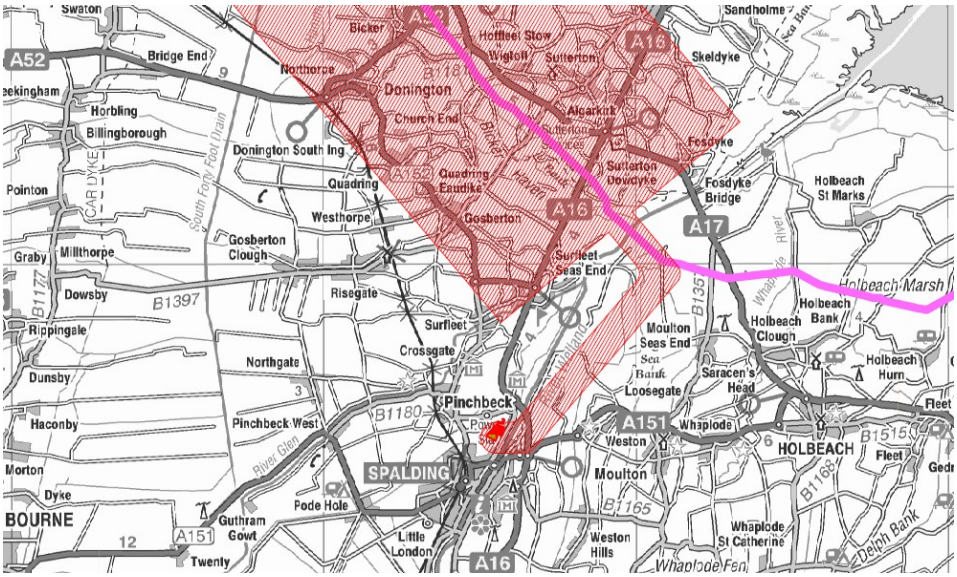
Requirement of Annex C	***Appraisal***
C11: Waste-Water Treatment	*The specific requirement notes that additional waste-water treatment may be required for additional effluents generated by the CO_2 capture process, and that the pre-feasibility level study should describe the expected requirements, including any space allocations / provisions.* This CCR Assessment has considered (at Section 4.3) the Required CCR Space Allocations and whether there is suitable space on the existing SEP / Proposed Development site. Based on a comparison of the Required CCR Allocations against the available space on the existing SEP / Proposed Development site (where none of the Required CCR Space Allocations are met), it is considered that there are barriers to demonstrating the technical feasibility of retrofitting for CO_2 capture equipment (and regarding this specific requirement, associated barriers to providing the preliminary CO_2 capture equipment layouts (which would include the additional waste-water treatment space allocations / provisions)).
C12: Electrical	*The specific requirement notes that additional electrical loads may be introduced by the CO_2 capture process, and that the pre-feasibility level study should describe the expected requirements, including any space allocations / provisions.* This CCR Assessment has considered (at Section 4.3) the Required CCR Space Allocations and whether there is suitable space on the existing SEP / Proposed Development site. Based on a comparison of the Required CCR Allocations against the available space on the existing SEP / Proposed Development site (where none of the Required CCR Space Allocations are met), it is considered that there are barriers to demonstrating the technical feasibility of retrofitting for CO_2 capture equipment (and regarding this specific requirement, associated barriers to providing the preliminary CO_2 capture equipment layouts (which would include the additional electrical load space allocations / provisions)).
C13: Plant Pipe Racks	*The specific requirement notes that additional plant pipe racks would be required for the CO_2 capture process, and that the pre-feasibility level study should describe the expected requirements, including any space allocations / provisions.* This CCR Assessment has considered (at Section 4.3) the Required CCR Space Allocations and whether there is suitable space on the existing SEP / Proposed Development site. Based on a comparison of the Required CCR Allocations against the available space on the existing SEP / Proposed Development site (where none of the Required CCR Space Allocations are met), it is considered that there are barriers to demonstrating the technical feasibility of retrofitting for CO_2 capture equipment (and regarding this specific requirement, associated barriers to providing the preliminary CO_2 capture equipment layouts (which would include the additional plant pipe racks space allocations / provisions)).
C14: Control and Instrumentation	*The specific requirement notes that additional control and instrumentation may be required for the CO_2 capture equipment, and that the pre-feasibility level study should describe the expected requirements, including any space allocations / provisions.* This CCR Assessment has considered (at Section 4.3) the Required CCR Space Allocations and whether there is suitable space on the existing SEP / Proposed Development site. Based on a comparison of the Required CCR Allocations against the available space on the existing SEP / Proposed Development site (where none of the Required CCR Space Allocations are met), it is considered that there are barriers to demonstrating the technical feasibility of retrofitting for CO_2 capture equipment (and regarding this specific requirement, associated barriers to providing the preliminary CO_2 capture equipment layouts (which would include the additional control and instrumentation space allocations / provisions)).
C15: Plant Infrastructure	*The specific requirement notes that additional access / space would be required in appropriate zones for the CO_2 capture equipment, and that the pre-feasibility level study should describe the expected requirements, including any access / space allocations / provisions.* This CCR Assessment has considered (at Section 4.3) the Required CCR Space Allocations and whether there is suitable space on the existing SEP / Proposed Development site. Based on a comparison of the Required CCR Allocations against the available space on the existing SEP / Proposed Development site (where none of the Required CCR Space Allocations are met), it is considered that there are barriers to demonstrating the technical feasibility of retrofitting for CO_2 capture equipment (and regarding this specific requirement, associated barriers to providing the preliminary CO_2 capture equipment layouts (which would include the additional access / space allocations / provisions)).

4.6 Step 4: Appraisal of the Technical CO_2 Transport Requirements

4.6.1 The basis for this appraisal is taken from the 2009 CCR Guidance, in particular paragraphs 43 – 61 on the demonstration that is it technically feasible for CO_2 transport from the generating station site (with CO_2 capture) to the proposed CO_2 storage area.

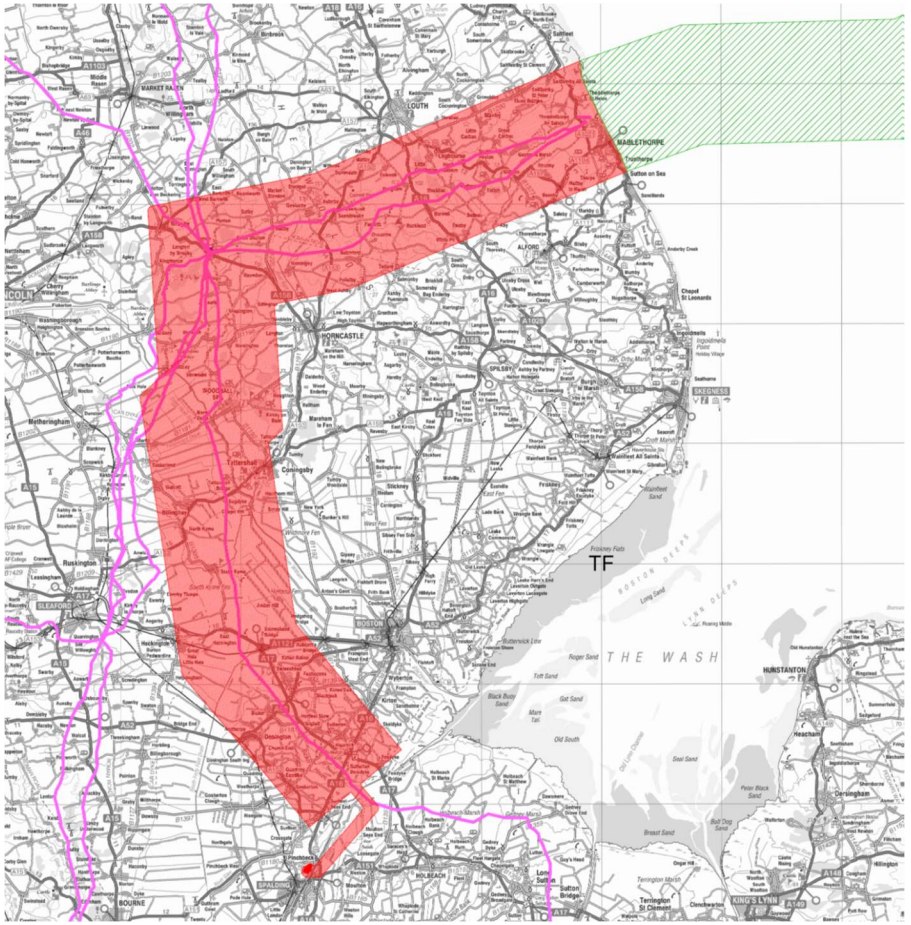
4.6.2 Noting the previous CCR Feasibility Studies undertaken for the SEE CCGT generating station, for the on-shore CO_2 transport, Insert 4-2 identifies for the first 10 km surrounding the SEP site, a 1 km wide CO_2 transport corridor and Insert 4-3 identifies, after the first 10 km surrounding the SEP site, a 10 km wide CO_2 transport corridor.

Insert 4-2: FOR THE ON-SHORE CO_2 TRANSPORT / FOR THE FIRST 10 KM SURROUNDING THE SEP SITE, A 1 KM WIDE CO_2 TRANSPORT CORRIDOR[25]



[25] Based on Figure 2A ('On-Shore CO_2 Pipeline Indicative Route (First 10 km') from 'Spalding Energy Expansion: Revised Carbon Capture Readiness Feasibility Study' (Ramboll (Ref 371455-1 (Rev 3), 14 April 2015).

Insert 4-3: FOR THE ON-SHORE CO_2 TRANSPORT / AFTER THE FIRST 10 KM SURROUNDING THE SEP SITE, A 10 KM WIDE CO_2 TRANSPORT CORRIDOR[26]



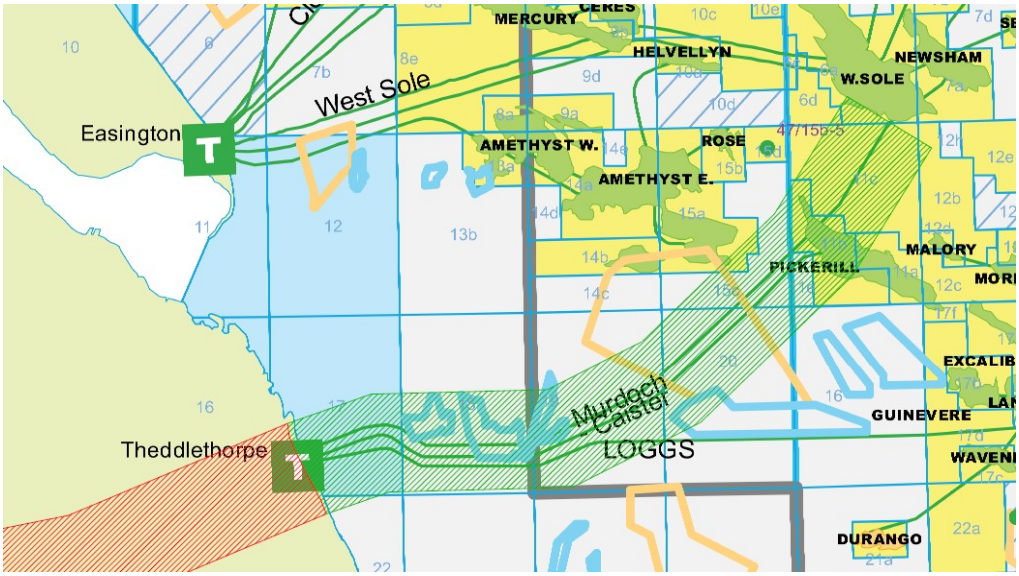
[26] Based on Figure 2B ('On-shore CO_2 Pipeline Indicative Route') from 'Spalding Energy Expansion: Revised Carbon Capture Readiness Feasibility Study' (Ramboll (Ref 371455-1 (Rev 3), 14 April 2015).

4.6.3 In summary, the proposed on-shore CO_2 transport corridors consider:

- The presence of the existing National Grid Gas Transmission System underground high-pressure natural gas pipelines; and,
- The location and presence of designated sites, such as Special Areas of Conservation (SAC), Special Protection Areas (SPA), Ramsar Sites, Sites of Special Scientific Interest (SSSI), National Nature Reserves (NNR), Areas of Outstanding Natural Beauty (AONB), Scheduled Ancient Monuments (SAM) and Designated Gardens and Parks.

4.6.4 Also noting the previous CCR Feasibility Studies undertaken for the SEE CCGT generating station, for the off-shore CO_2 transport, Insert 4-4 identifies a 10 km wide CO_2 transport corridor (and also identifies the locations of off-shore CO_2 storage area / sites).

Insert 4-4: FOR THE OFF-SHORE CO_2 TRANSPORT, A 10 KM WIDE CO_2 TRANSPORT CORRIDOR (AND THE LOCATIONS OF THE OFF-SHORE CO_2 STORAGE AREAS)[27]



4.6.5 In summary, the proposed off-shore CO_2 transport corridor considers:

- A proposed on-shore to off-shore transition point;
- The presence of any existing pipelines (e.g. those associated with the proposed gas / oil fields); and,
- The location and presence of designated sites.

4.6.6 In terms of safety, it is noted that:

- It is likely that on-shore CO_2 transport will be in a 'dense' state (in the order of 70 to 100 bar), and that off-shore CO_2 transport will be in a 'supercritical fluid' state;
- As per the 2009 CCR Guidance, any CO_2 transport pipelines should be considered to be conveying 'dangerous fluids' under the 1996 Pipeline Safety Regulations[28] / 'dangerous substances' under the 2015 Control of Major Accident Hazards Regulations[29], and should be considered to be Major Accident Hazard Pipelines; and therefore,

[27] Based on Figure 3 ('Off-shore CO_2 Pipeline Indicative Route') from 'Spalding Energy Expansion: Revised Carbon Capture Readiness Feasibility Study' (Ramboll (Ref 371455-1 (Rev 3), 14 April 2015).
[28] The Pipeline Safety Regulations 1996. Available at: https://www.legislation.gov.uk/uksi/1996/825/contents/made
[29] The Control of Major Accident Hazard Regulations 2015. Available at: https://www.legislation.gov.uk/uksi/2015/483/contents/made

- During the further development and detailed design of any CO_2 transport pipelines, consideration should be given to the requirements for:
  - Emergency equipment, such as shut-down valves;
  - Emergency procedures (including arrangements and organisation); and,
  - The necessary Major Accident Hazards Prevention documentation.

4.6.7 In terms of environmental impact management / mitigation, it is noted that:

- There are very few areas on the coastline of England (or the rest of the UK) which are free of designated sites; but,
- The presence of a designated site does not forbid development, but requires that development is controlled to avoid / reduce potential environmental impacts with the importance of the development weighted against the potential environmental impacts; and,
- The potential environmental impacts can be managed / mitigated as far as practicable by the use of advanced drilling methods / trenchless construction methods (such as Horizontal Directional Drilling); and overall,
- At the time of any eventual CO_2 transport pipeline installation, the most appropriate on-shore to off-shore transition point would be selected on the basis of the prevailing environmental conditions (including designated sites) and technical constraints.

4.7 Step 5: Economic Assessment

4.7.1 Appendix B provides the economic assessment (considering the retrofitting of CO_2 capture equipment and CO_2 transport requirements).

4.7.2 Based on Appendix B, it is noted that for an economic assessment varying the carbon price:

- The Calculated (Central) Break-Even Carbon Price (where the levelised cost of electricity for the 'Base Scenario' equals the levelised cost of electricity for the 'Retrofitted Scenario') is £225/t CO_2, however:
  - The BEIS Central projections reach this in around 2049 (24 years after the assumed first year of construction of CO_2 capture equipment, with 1 year left of the projected economic (operational) lifetime);
  - The BEIS Low projections do not reach this within the projected economic (operational) lifetime; and,
  - The BEIS High projections reach this in around 2039 (14 years after the assumed first year of construction of CO_2 capture equipment, with 11 years left of the projected economic (operational) lifetime);
- The Calculated (Low) Break-Even Carbon Price is £202/t CO_2, however:
  - The BEIS Central projections reach this in around 2046 (21 years after the assumed first year of construction of CO_2 capture equipment, with 4 year left of the projected economic (operational) lifetime);
  - The BEIS Low projections do not reach this within the projected economic (operational) lifetime; and,
  - The BEIS High projections reach this in around 2037 (12 years after the assumed first year of construction of CO_2 capture equipment, with 13 years left of the projected economic (operational) lifetime);
- The Calculated (High) Break-Even Carbon Price is £248/t CO_2, however:
  - The BEIS Central projections do not reach this within the projected economic (operational) lifetime;
  - The BEIS Low projections do not reach this within the projected economic (operational) lifetime; and,

  - The BEIS High projections reach this in around 2041 (16 years after the assumed first year of construction of CO_2 capture equipment, with 9 years left of the projected economic (operational) lifetime);

- However, as the calculation assumes the carbon price to be constant throughout the economic life / operating period, this would not be economically viable and, therefore, it is considered that there are barriers to demonstrating economic feasibility.

4.7.3 Furthermore, based on Appendix B, it is also noted that for both an economic assessment varying the carbon price with additional sensitivity analysis varying the load factor and an economic assessment varying the economic lifetime, there are also barriers to demonstrating economic feasibility.

4.8 CCR Assessment Conclusions

4.8.1 Based on the appraisals and assessments above, it is concluded that:

- Regarding potential CO_2 storage areas / sites, it is considered that there are no major barriers to demonstrating potential CO_2 storage sites are available;
- Regarding the technical retrofitting of CO_2 capture equipment requirements, it is considered that there are barriers to demonstrating technical feasibility of retrofitting for CO_2 capture equipment (as there are barriers to demonstrating available space on the existing SEP / Proposed Development site);
- Regarding the technical CO_2 transport requirements, it is considered that there are no major barriers to demonstrating the technical feasibility for CO_2 transport; and,
- Regarding the economic assessment, it is considered that there are barriers to demonstrating economic feasibility.

5. CONSIDERATION OF OTHER AVAILABLE INFORMATION

5.1 Introduction

5.1.1 This Section presents the consideration of other available information on the protection of the environment and human health relevant to the proposed variation application. This Section also considers previous European Union and UK precedence on the consideration of CCR and the CCR conditions.

5.1.2 With reference to the October 2020 CCR Screening Assessment, and associated December 2020 BEIS response, this Section also presents consideration of the UK Government's commitment to meeting its legal obligations in respect of the '2050 Net Zero' target[30].

5.2 The Protection of the Environment and Human Health

Environmental Assessment

5.2.1 With regards to the relevant environmental assessment requirements, the 2017 Environmental Impact Assessment (EIA) Regulations[31] apply to variation applications.

5.2.2 In particular, Regulation 10(1) of the 2017 EIA Regulations provides that: *"A person (the "developer") who intends to make an application for a section 36 or 37 consent, or a section 36 variation, for development may request the relevant authority to make a screening decision"*. Further regulations (within the 2017 EIA Regulations) provide the required content of a request for a screening decision (i.e. the required content of an EIA Screening Report).

5.2.3 Accordingly, in April 2020, SECL submitted an EIA Screening Report[32] to the Secretary of State for BEIS, via BEIS. The EIA Screening Report supported SECL's request that the Secretary of State for BEIS adopt a screening decision (i.e. an EIA Screening Opinion) to the effect that the Proposed Development is not EIA Development. The EIA Screening Report did not consider the construction or operation of any CO_2 capture equipment.

5.2.4 Subsequently, on 26 June 2020, the Secretary of State for BEIS adopted an EIA Screening Opinion that the Proposed Development is not EIA Development, noting that: "*the proposed development* […] *would not result in any materially new of materially different environmental impacts from those already assessed from the original development"*.

Best Available Techniques

5.2.5 With regards to BAT, the principles of the BAT Conclusions for Large Combustion Plants[33] (LCP) (at BAT 12 and BAT 40) are that:

- BAT is to increase / maximise electrical (and energy) efficiency; and,
- BAT is to prevent and / or reduce emissions, including CO_2 emissions.

5.2.6 As noted previously to provide the rationale for development, the AGP upgrade to SEP improved both the environmental performance and electricity market competitiveness of SEP by, in particular, allowing for an improvement (increase) in the electrical generation efficiency, thus also reducing the specific CO_2 emissions associated with electricity generation.

5.2.7 Table 5-1 presents the indicative improvement (increase) in electrical generation efficiency and the indicative reduction in specific CO_2 emissions. It should be noted that the Table is provided for indicative purposes only, although it is considered to be in line with a typical AGP upgrade to a similar CCGT generating station.

[30] The '2050 Net Zero' target, set via the 2019 amendment to the 2008 Climate Change Act, requires a 100% reduction of all greenhouse gas emissions compared with 1990 levels. The original 2008 Climate Change Act required an 80% reduction of all greenhouse gas emissions compared with 1990 levels. Amended 2008 Climate Change Act available at: https://www.legislation.gov.uk/ukpga/2008/27/contents

[31] The Electricity Works (Environmental Impact Assessment) (England and Wales) Regulations 2017. Available at: https://www.legislation.gov.uk/uksi/2017/580/contents/made

[32] 'Spalding Energy Project: Environmental Impact Assessment Screening Report' (Ramboll, 22 April 2020)

[33] Commissioning Implementing Decision 2017/1442 establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU, for large combustion plants. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017D1442&from=EN

Table 5-1: INDICATIVE IMPROVEMENT (INCREASE) IN ELECTRICAL GENERATION EFFICENCY AND INDICATIVE REDUCTION IN SPECIFIC CO_2 EMISSIONS

	Electrical Generation Efficiency (%)	***Specific CO_2 Emissions (gCO_2/kWh)***
Without Supplementary Firing		
Pre-AGP Upgrade to SEP	55.4	368.3
Post-AGP Upgrade to SEP	56.2	362.8
Incremental Electrical Generation Efficiency / Reduction in Specific CO_2 Emissions	69.1	-5.5
With Supplementary Firing		
Pre-AGP Upgrade to SEP	53.9	378.0
Post-AGP Upgrade to SEP	54.9	371.4
Incremental Electrical Generation Efficiency / Reduction in Specific CO_2 Emissions	68.0	-6.6

5.2.8 Therefore, should it be the case that the Secretary of State cannot vary the existing consent for SEP should he determine that the CCR conditions are not met (as there are barriers to demonstrating technical feasibility of retrofitting for CO_2 capture equipment and barriers to demonstrating economic feasibility), the principles of the BAT Conclusions for LCP would not be achieved.

5.3 Previous European Union Precedence: 2009 CCS Directive Implementation

5.3.1 Article 27 of the 2009 CCS Directive requires that, every three years, Member States submit individual implementation reports. Subsequently, the Commission publishes summary implementation reports. At the time of writing (January 2021), the Commission has published three summary implementation reports, comprising:

- 1st Implementation Report[34] (February 2014), based on Member States individual implementation reports between July 2011 and April 2013;
- 2nd Implementation Report[35] (February 2017), based on Member States individual implementation reports between May 2013 and April 2016; and,
- 3rd Implementation Report[36] (October 2019), based on Member States individual implementation reports between May 2016 and April 2019.

5.3.2 Regarding situations where there was consideration of CCR, but the CCR conditions were not met, it is noted that:

- (At Section 3.3) the 2nd Implementation Report states that: *"Assessments were carried out in Belgium (one), the Czech Republic (one), Germany (five), Romania (six), Poland (ten), Slovenia (one) and Spain (five). Assessments found that CCS is not economically feasible. Some further difficulties were found for some of the plants – no suitable storage sites in Belgium and Estonia or technical incompatibility with the flexible operation of a plant. However, even if the assessments were not positive, many [but not all] of the permitted power plants are setting aside land for the equipment to remove and compress CO_2 and are designed in such a way that CCS can be connected later on without major layout modifications* […]" (emphasis added); and,

[34] 'Report from the Commission to the European Parliament and the Council – on the implementation of Directive 2009/31/EC on the geological storage of carbon dioxide' (COM(2014) 99 Final). Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014DC0099&from=EN

[35] 'Report from the Commission to the European Parliament and the Council – on the implementation of Directive 2009/31/EC on the geological storage of carbon dioxide' (COM(2017) 37 Final). Available at: http://data.consilium.europa.eu/doc/document/ST-5908-2017-INIT/en/pdf

[36] 'Report from the Commission to the European Parliament and the Council – on the implementation of Directive 2009/31/EC on the geological storage of carbon dioxide' (COM(2019) 566 Final). Available at: https://ec.europa.eu/clima/sites/clima/files/strategies/progress/docs/com_2019_566_en.pdf

- (At Section 2.3) the 3rd Implementation Report states that: *"Assessments were carried out in Estonia (one), France (one), Germany (six), Romania (six) and Poland (eight). The assessments find that CCS is not economically feasible. Some further difficulties were found for some of the plants – in Estonia geological conditions are considered unfavourable, while in Germany plants do now have access to suitable storage sites. Despite the low feasibility level in the assessments, most* [but, again, not all] *of the power plants (e.g. in Poland, Estonia and Germany) are setting aside land for the installation of CO_2 capture equipment"* (emphasis added).

Previous European Union Precedence and the Variation Application

5.3.3 Based on these Implementation Reports, this would indicate that, previous European Union precedence includes successful applications for new generating stations (i.e. where the original consent (i.e. original construction / operation licence) is granted after the entry into force of the 2009 CCS Directive) where the CCR conditions are not met.

5.3.4 Previous European Union precedence does not include reference to similar variation applications for existing generating stations (i.e. where the existing original consent was granted prior to the entry into force of the 2009 CCS Directive). This is considered to be because such variation applications are not subject to the 2009 CCS Directive (and its associated provisions).

5.4 Previous UK Precedence: Consents under Section 36 and Section 36C of the 1989 Electricity Act

5.4.1 Appendix C provides details of the previous UK (predominately England and Wales) consideration of CCR and the CCR conditions based on consents under Section 36 and Section 36C of the 1989 Electricity Act (and under Section 37 of the 2008 Planning Act). Based on Appendix C, it is noted that there are a number of specific consents / situations where either:

- There was consideration of CCR, but CCR conditions were not applied / the CCR conditions were not met (as Seal Sands / Thor CoGeneration below);
- There was consideration of CCR, but the CCR conditions were not updated (as Barking / Drakelow below); and / or,
- The consent is considered pertinent (as Keadby II / King's Lynn below).

5.4.2 Regarding these specific consents / situations, it is noted that:

- ***Seal Sands / Thor CoGeneration***

  Both the Seal Sands consent and Thor CoGeneration consent were granted prior to the entry into force of the 2009 CCS Directive. However, both consents were granted at a time when there was consideration of CCR during the consent determination and, where applicable, inclusion of preliminary CCR conditions within consents granted for CCGT generating stations. During both consent determinations, it was noted that there was insufficient space on the sites, and therefore there was no inclusion of CCR conditions within the consents.

  This is comparable to the variation application where, based on a high-level appraisal comparison of the Required CCR Space Allocations against this available space on the site, none of the Required CCR Space Allocations are met.

- ***Barking / Drakelow***

  Both the Barking original consent and Drakelow original consent were granted prior to the entry into force of the 2009 CCS Directive, and have since been subject to variation applications. During both variation determinations, it was noted that as the variation applications were not seeking to increase the generating capacity there was no need for inclusion / updated of CCR conditions.

- ***Keadby II / King's Lynn B***

  Both the Keadby II original consent and King's Lynn B original consent were granted prior to the entry into force of the 2009 CCS Directive, and have since been

subject to variation applications. During both variation determinations, it was noted that as the variation applications were seeking to increase the generating capacity, there was inclusion of CCR conditions.

However, these are not considered comparable to the variation application as the generating stations were not constructed at the time of their respective variation applications.

5.5 UK Government's Commitments: '2050 Net Zero' Target

5.5.1 In October 2020, SECL submitted a CCR Screening Assessment to BEIS. Subsequently, on 23 December 2020, BEIS noted, via e-mail, that: "*the* [UK] *Government's commitment to meeting its legal obligations in respect of Net Zero means that policy on the requirement for the abatement of carbon and other greenhouse gas emissions may change in the future and may impact upon the Spalding* [Energy] *Project*".

5.5.2 Indeed, in this regard, it is noted that:

- The Committee on Climate Change's proposed Sixth Carbon Budget[37] ('The UK Path to Net Zero') states that: "*Following on from the 2024 coal phase out, gas-fired power without CCS should be phased out by 2035"*; and, also,
- The UK Government's latest Energy White Paper[38] ('Powering our Net Zero Future') states that:
  - "*We will consult on steps to ensure that new thermal plants can convert to low-carbon alternatives*"; noting that,
  - "*Since 2009, our Carbon Capture and Readiness requirements have ensured that planning consent is only granted to thermal plants for which it will be technically and economically feasible to retrofit* [CO_2 Capture, Usage and / or Storage] *CCUS*"; but that,
  - "*The* [CCR] *requirements do not reflect recent technological advances, including alternative options for decarbonising gas plants, such as conversion to firing clean hydrogen. Therefore, we intend to consult in early 2021 over proposals to update the requirements to reflect recent technological advances*".

5.5.3 Therefore, whilst this document has demonstrated that the CCR conditions are not met (as there are barriers to demonstrating technical feasibility of the retrofitting for CO_2 capture equipment and barriers to demonstrating economic feasibility), this does not preclude a demonstration that an alternative decarbonisation option would be technically and economically feasible.

5.5.4 However, as the alternative decarbonisation options (and associated conditions to be met) are not known / set at the time of writing this document (January 2021), such a demonstration cannot be provided.

[37] The Committee on Climate Change's proposed Sixth Carbon Budget ('The UK Path to Net Zero') (published 9 December 2020). Available at: https://www.theccc.org.uk/publication/sixth-carbon-budget/

[38] UK Government's Energy White Paper 'Powering our Net Zero Future' (published 14 December 2020). Available at: https://www.gov.uk/government/publications/energy-white-paper-powering-our-net-zero-future

6. CONCLUSIONS

6.1 Overview

6.1.1 SEP is a CCGT generating station, located on West Marsh Road, in Spalding, Lincolnshire. SEP is located to the north of the newly constructed SEE OCGT generating station.

6.1.2 At Paragraph 2, the existing consent for SEP provides that: "*the Development shall be about 800 MW capacity*". Subsequently, in May 2001, the DTI confirmed that the tolerance provided by Paragraph 2 of the existing consent for SEP allowed for an electricity generation output of 840 MW capacity.

6.1.3 The Proposed Development relates to the way in which SEP is authorised to operate. In particular, as enabled by the AGP upgrade to SEP, the Proposed Development comprises the increase in the maximum electricity generation output of SEP to up to 950 MW.

6.1.4 As such, SECL is submitting the variation application which primarily seeks to amend increase in the permitted electricity generation output of SEP to up to 950 MW capacity.

6.1.5 The variation application also seeks a direction to amend various conditions subject to which the planning permission was deemed to be granted under Section 90(2ZA) of the 1990 Town and Country Planning Act. The amendments are: to reflect the fact that the construction of SEP is complete; to allow for certain further changes to the conditions, or matters controlled by those conditions, to be agreed with the local planning authority; and, to reflect other changes in circumstances since 2000 (when the existing consent was granted).

6.1.6 The 2013 CCR Regulations apply to certain variation applications. Specifically, Regulation 6(1) of the 2013 CCR Regulations provides that: "*The appropriate authority must not –*

(a) […]

(b) vary a relevant section 36 consent in such a way as to enable a combustion plant to increase its rated electrical output,

unless the appropriate authority has determined whether the CCR conditions are met in relation to the combustion plant, as constructed or extended in accordance with the section 36 consent as so varied ('the modified plant')".

6.1.7 Regarding the interpretation of Regulation 6(1)(b) of the 2013 CCR Regulations, Regulation 2(1) of the 2013 CCR Regulations provides that: a "'*relevant section 36 consent' means a section 36 consent — (a) for the construction of a combustion plant with a rated electrical output of 300 megawatts or more* […]".

6.1.8 In association, Regulation 6(2) of the 2013 CCR Regulations provides that: "*The appropriate authority's determination under* [Regulation 6(1)] *must be made on the basis of –*

(a) a CCR assessment of the modified plant prepared by the person who applied for the section 36 consent to be varied; and

(b) any other available information, particularly concerning the protection of the environment and human health".

6.1.9 Regarding the interpretation of Regulation 6(2) of the 2013 CCR Regulations, Regulation 2(1) of the 2013 CCR Regulations provides that: a "'*CCR assessment', in relation to a combustion plant, means an assessment as to whether the CCR conditions are met in relation to that plant*".

6.1.10 Regulation 2(2) of the 2013 CCR Regulations provides that: "*For the purposes of these Regulations, the CCR conditions are met in relation to a combustion plant, if, in respect of all of its expected emissions of CO_2 —*

(a) suitable storage sites are available;

(b) it is technically and economically feasible to retrofit the plant with the equipment necessary to capture that CO_2; and

(c) it is technically and economically feasible to transport such captured CO_2 to the storage sites referred to in sub-paragraph (a)".

6.1.11 The variation application will, under Regulation 6(1)(b) of the 2013 CCR Regulations, request that the appropriate authority vary a relevant section 36 consent in such a way as to enable a combustion plant (with a rated electrical output of 300 MW or more) to increase its rated electrical output. Therefore, the appropriate authority is required to determine whether the CCR conditions are met.

6.1.12 In October 2020, SECL submitted a CCR Screening Assessment to BEIS which:

(a) Under Regulation 6(2)(a) of the 2013 CCR Regulations, presented the initial results of the CCR Assessment for the variation application; and,

(b) Under Regulation 6(2)(b) of the 2013 CCR Regulations, presented other available information on the protection of the environment and human health relevant to the variation application.

6.1.13 The CCR Screening Assessment also, under Regulation 6(1)(b), requested clarification on whether the Secretary of State for BEIS, as the appropriate authority, could vary the existing consent for SEP (i.e. could vary a relevant section 36 consent) in respect of the Proposed Development to allow an increase in the permitted electricity generation output of SEP to up to 950 MW (i.e. in such a way as to enable a combustion plant (with a rated electrical output of 300 MW or more) to increase it rated electrical output) should he determine that the CCR conditions are not met. In recognition of previous UK precedence where CCR conditions were not applied / the CCR conditions are not met, the request for clarification was made with regard to the Proposed Development improving both the environmental performance and electricity market competitiveness of SEP by, in particular, allowing for an improvement (increase) in the electrical generation efficiency, thus also reducing the specific CO_2 emissions associated with electricity generation.

6.1.14 Subsequently, on 23 December 2020, BEIS confirmed, via e-mail, that the: "'*in principle' position is that, in the particular circumstances where a section 36 consent issued under the Electricity Act had been granted before the* [2009 CCR Guidance] *was issued, the Secretary of State would be able to grant a consent for a variation of that section 36 consent in a situation where the development that is the subject of the application has not met the Carbon Capture Readiness conditions*". BEIS further confirmed that they: "*did not see, on the basis the section 36 consent for the Spalding Energy* [Project] *was granted in 2000, that the* [2009 CCR Guidance] *would apply to any application to vary the consent*".

6.2 Conclusions

6.2.1 This is a CCR Assessment which has:

(a) Under Regulation 6(2)(a) of the 2013 CCR Regulations, presented the results of the CCR Assessment for the variation application; and,

(b) Under Regulation 6(2)(b) of the 2013 CCR Regulations, presented other available information on the protection of the environment and human health relevant to the variation application.

6.2.2 Concerning the results of the CCR Assessment, it is concluded that:

- Regarding potential CO_2 storage areas / sites, it is considered that there are no major barriers to demonstrating potential CO_2 storage sites are available;
- Regarding the technical retrofitting of CO_2 capture equipment requirements, it is considered that there are barriers to demonstrating technical feasibility of retrofitting for CO_2 capture equipment (as there are barriers to demonstrating available space on the existing SEP / Proposed Development site);
- Regarding the technical CO_2 transport requirements, it is considered that there are no major barriers to demonstrating the technical feasibility for CO_2 transport; and,
- Regarding the economic assessment, it is considered that there are barriers to demonstrating economic feasibility.

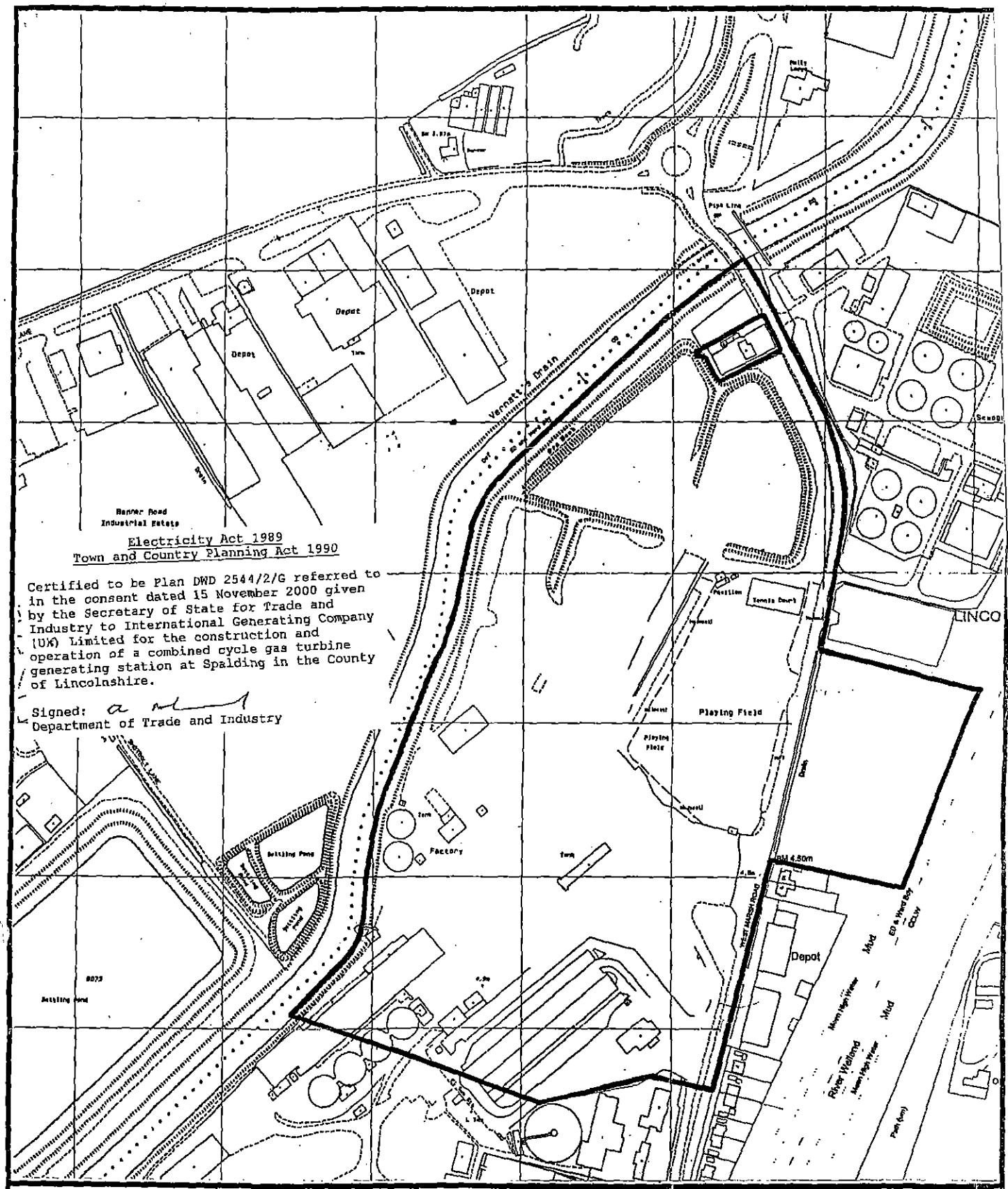
6.2.3 Concerning the other available information, it is noted that:

- Regarding the protection of the environment and human health, it is considered that:
  - The Proposed Development is not EIA Development, and "*the proposed development* […] *would not result in any materially new of materially different environmental impacts from those already assessed from the original development"*; and,
  - Should it be the case that the Secretary of State cannot vary the existing consent for SEP should he determine that the CCR conditions are not met, the principles of the BAT Conclusions for LCP would not be achieved;
- Regarding previous European Union precedence, this includes successful applications for new generating stations (i.e. where the original consent (i.e. original construction / operation licence) is granted after the entry into force of the 2009 CCS Directive) where the CCR conditions are not met;
- Regarding previous UK precedence, this includes (in particular) specific consents / situations where there was consideration of CCR, but CCR conditions were not applied / the CCR conditions were not met; and,
- Regarding the UK Government's commitments in respect of the '2050 Net Zero' target, whilst this document has demonstrated that the CCR conditions are not met (as there are barriers to demonstrating technical feasibility of the retrofitting for CO_2 capture equipment and barriers to demonstrating economic feasibility), this does not preclude a demonstration that an alternative decarbonisation option would be technically and economically feasible.

FIGURES

The following Figures are provided:

- Figure 1 ('Plan DWD 2544/2/G'): Original Application Site Plan referred to in the Existing Consent for SEP.
- Figure 2: Overview of Available Space on the Existing SEP / Proposed Development Site.



Electricity Act 1989
Town and Country Planning Act 1990

Certified to be Plan DWD 2544/2/G referred to in the consent dated 15 November 2000 given by the Secretary of State for Trade and Industry to International Generating Company (UK) Limited for the construction and operation of a combined cycle gas turbine generating station at Spalding in the County of Lincolnshire.

Signed: a
Department of Trade and Industry

Dalton Warner Davis

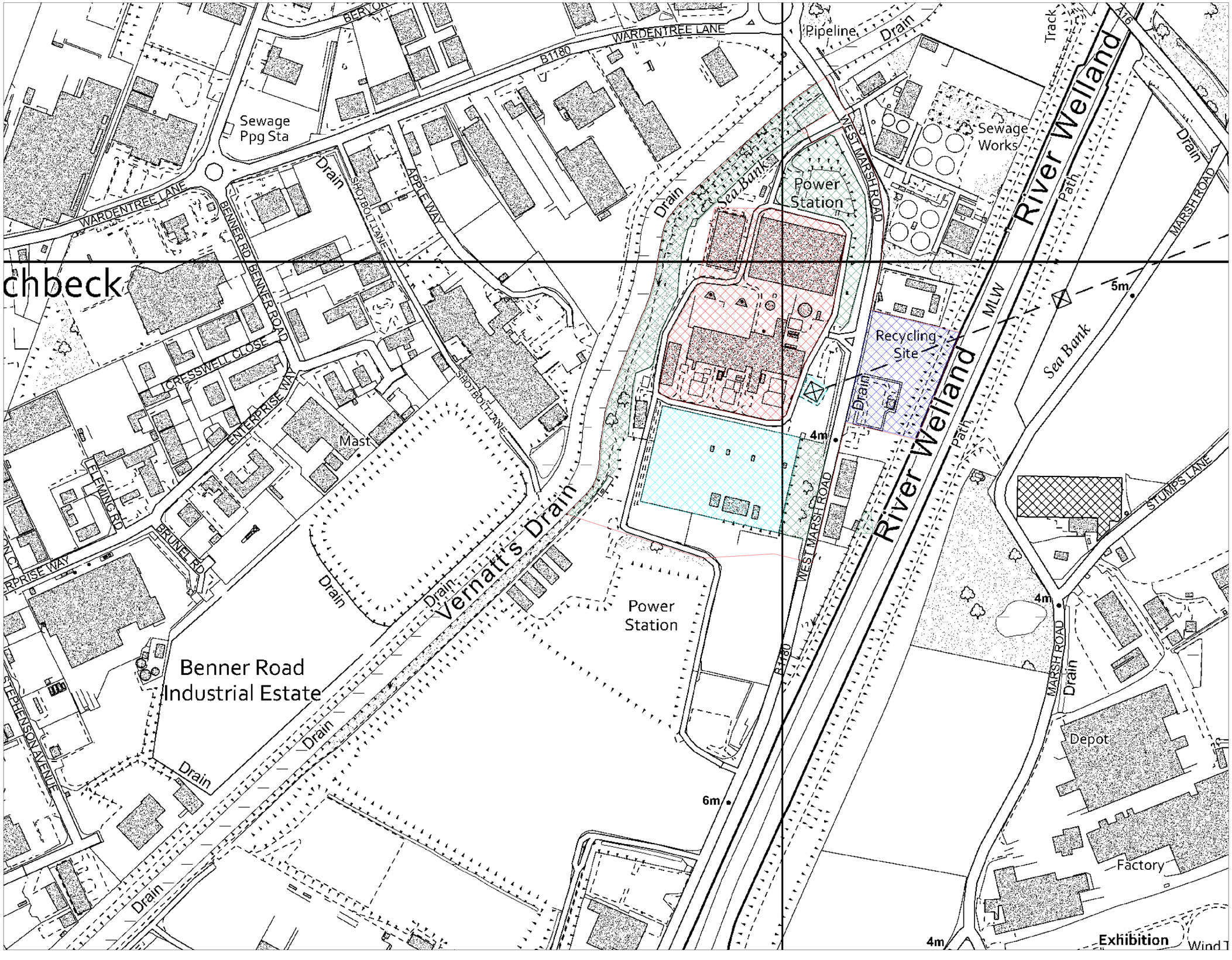
Chartered Surveyors
Commercial Property & Town Planning Consultants
19/20 Garlick Hill, London. EC4V 2AH.
Telephone : 0171 489 0213
Facsimile : 0171 248 4743

TITLE SPALDING ENERGY PROJECT - INTERNATIONAL GENERATING CO (UK) LTD : APPLICATION PLAN DWD 2544/2/G

ADDRESS WEST MARSH ROAD, SPALDING, LINCOLNSHIRE

SCALE 1 : 2,500

DATE 20.08.96



Notes

- CCGT GENERATING STATION AREA
- GAS RECEIVING FACILITY AND OFFSITE AREA
- ELECTRICAL SUBSTATION AND EXPORT PYLON
- LANDSCAPING AND SUDS POND

NOTES:

- SECTION 36 CONSENT BOUNDARY TAKEN FROM 'PLAN DWD 2544/2/G'

Rev	Description	Date	By / Chk	App
P01	FOR INFORMATION	05/10/20	ML / EA	EA

INTERGEN

SPALDING PROJECTS

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FIGURE 2
OVERVIEW OF
AVAILABLE SPACE ON THE SEP:
PROPOSED DEVELOPMENT SITE

Scale:	Date:	Drawn:	Checked:
1:4000 / A3	05/10/2020	ML	EA

Drawing No.: 1620002349-024A-001 Rev: P01

APPENDIX A:
CONSENTING HISTORY OF THE SPALDING ENERGY PROJECT

CONSENTING HISTORY OF THE SPALDING ENERGY PROJECT

A.1 Introduction

This Appendix provides further background information on the consenting history of the existing Spalding Energy Project (SEP).

A.2 The Existing Spalding Energy Project

In August 1996, InterGen submitted an application for SEP under Section 36 of the 1989 Electricity Act. In addition, the application sought a direction that planning permission be deemed to be granted under Section 90 of the 1990 Town and Country Planning Act.

Within the application, the basic elements of SEP comprised:

(a) Two gas turbine generators and two heat recovery steam generators (HRSGs), including associated stacks;

(b) One steam turbine generator;

(c) Condensing plant, and a water-based mechanical-draft cooling tower system with drift eliminators and plume abatement;

(d) Ancillary plant and equipment; and,

(e) Necessary buildings.

In terms of the environmental assessments / studies, the application was accompanied by the August 1996 Environmental Statement comprising:

- Non-Technical Summary[39];
- Environmental Statement Volume 1: Main Report[40]; and,
- Environmental Statement Volume 2: Technical Annexes[41].

Following submission of the application, the overall project (covering SEP and its associated components) was subject to further design and refinement. At the time, the associated components comprised:

(a) An Above Ground Installation (AGI) and 7.4 km underground gas pipeline, for a natural gas supply to the site connecting into the National Grid Gas Transmission System ((formerly Transco) Feeder 7 Pipeline;

(b) An electrical substation and a 5.8 km overhead electricity line, for the electricity dispatch to the National Grid Electricity Transmission System; and,

(c) A 27.0 km underground water pipeline, for a water supply for the cooling tower system connecting into the Trent-Witham-Ancholme system.

To cover the updates from the further design and refinement process, in December 1996, the application was supplemented by the December 1996 Cumulative Impact Assessment[42] (CIA).

The December 1996 CIA presented the results of the cumulative impact assessment for the construction and operation of the overall project beyond the individual impact assessments for the construction and operation of the individual components.

Subsequently, following a review and assessment of water resources issues relating to SEP and the use of a water-based cooling tower system, the Environment Agency and SECL resolved that the best practicable environmental option (BPEO) for the Spalding location was an air-cooled system.

Other than the cooling system, the land take and basic elements of SEP remained unchanged.

[39] 'Spalding Energy Project: Environmental Statement – Non-Technical Summary' (Environmental Resources Management, 19 August 1996).
[40] 'Spalding Energy Project: Environmental Statement Volume 1 – Main Report' (Environmental Resources Management, 16 August 1996).
[41] 'Spalding Energy Project: Environmental Statement Volume 2 – Technical Annexes' (Environmental Resources Management, 16 August 1996).
[42] 'Spalding Energy Project: Assessment of Cumulative Impacts' (Environmental Resources Management, 4 December 1996).

To cover the change in cooling system, in March 1997, the application was further supplemented by the March 1997 Environmental Statement Supplementary Note[43] (ESSN).

The March 1997 ESSN presented the results of the review of the implications on the results and conclusions of the previous impact assessment for a change in cooling system and, where necessary, presented updated impact assessments and additional measures for the construction and operation of an air-cooled system.

On 15 November 2000, the original consent was granted for SEP under Section 36 of the 1989 Electricity Act. The original consent was accompanied by a direction that planning permission be deemed to be granted under Section 90 of the 1990 Town and Country Planning Act. Together, these (the original consent and the direction that planning permission be deemed to be granted) comprise the existing consent for SEP.

The existing consent for SEP was originally granted to InterGen. On 13 May 2002, InterGen transferred the benefit of the existing consent for SEP to Spalding Energy Company Limited (SECL) (a wholly owned subsidiary of InterGen).

A.3 Associated Authorisation: The Gas Connection

SEP burns natural gas, which is supplied to the site via a connection into the National Grid Gas Transmission System Feeder 7 Pipeline. Natural gas is the primary fuel and no back-up fuel is required. The connection comprises:

(a) An AGI and ancillary development near Wragg Marsh; and,

(b) A 7.4 km underground gas pipeline from the AGI to the site.

On 25 March 1997, planning permission (Ref: H22/0056/97) was granted under the 1990 Town and Country Planning Act for the AGI and ancillary development near Wragg Marsh. On 11 February 2002, a planning permission renewal (Ref: H22/0019/02) was granted under the 1990 Town and Country Planning Act for the AGI and ancillary development near Wragg Marsh.

On 15 December 2000, consent was granted under Section 1 of the 1962 Pipelines Act for the 7.4 km underground gas pipeline from the AGI to the site. The consent was originally granted to InterGen. Subsequently, on 14 May 2001, InterGen transferred the benefit of the consent to SECL.

In terms of environmental assessments / studies, the applications for the planning permission and the consent were supported by 'Spalding Energy Project Gas Pipeline: Environmental Statement' (Penspen Environmental, dated September 1996).

A.4 Associated Authorisation: The Electrical Connection

The electricity generated is dispatched to the National Grid Electricity Transmission System. The connection comprises:

(a) A connection into the National Grid Spalding North Substation adjacent to the south of the site; and,

(b) A 5.8 km overhead electricity line.

On 11 October 2001, consent was granted under Section 37 of the 1989 Electricity Act for the electrical substation and the 5.8 km overhead electricity line. The consent was granted to National Grid.

In terms of environmental assessments / studies, the application for the consent was supported by 'Spalding Energy Project Proposed 400 kV Overhead Transmission Line: Environmental Statement' (National Grid, September 1996).

A.5 Associated Authorisation: Environmental Permit

During operation, activities on the site are undertaken in accordance with an Environmental Permit.

SECL already holds an Environmental Permit for SEP (EPR/BK0701IW). On 24 August 2001, the original Environmental Permit was granted for SEP. In May 2020, the latest version (V005) was issued under the 2016 Environmental Permitting (England and Wales) Regulations.

[43] 'Spalding Energy Project: Environmental Statement – Supplementary Note' (Environmental Resources Management, 11 March 1997).

APPENDIX B:
ECONOMIC ASSESSMENT

ECONOMIC ASSESSMENT

B.1 Introduction

This Appendix provides the economic assessment (considering the retrofitting of CO_2 capture equipment and CO_2 transport requirements). The basis for this economic assessment is taken from the 2009 CCR Guidance, in particular paragraphs 62 – 69, and the methodology adopted is consistent with other CCR Assessments for new CCGT generating stations.

B.2 Methodology

The methodology adopted for the economic assessment comprises:

Step 1: Use of the economic model to calculate the levelised cost of electricity (not including the effects of taxation, expressed in p/kWh) for the 'Base Scenario' (i.e. a CCGT generating station without the retrofitting of CO_2 capture equipment (and associated CO_2 transport / storage)) assuming that allowances (under the EU Emissions Trading Scheme (EU ETS) / UK Carbon Floor Price) must be purchased for 100% of the residual CO_2 emissions (with the calculations based on constant fuel (gas) prices and carbon prices);

Step 2: Use of the economic model to calculate the levelised cost of electricity (not including the effects of taxation, expressed in p/kWh) for the 'Retrofitted Scenario' (i.e. a CCGT generating station with the retrofitting of CO_2 capture equipment (and associated CO_2 transport / storage)) assuming that allowances (under the EU ETS / UK Carbon Floor Price) must be purchased for 100% of the residual CO_2 emissions (with the calculations based on constant fuel (gas) prices and carbon prices);

Step 3: Economic feasibility assessment by varying the carbon prices to identify the break-even carbon price (where the levelised cost of electricity for the 'Base Scenario' equals the levelised cost of electricity for the 'Retrofitted Scenario'), including a sensitivity analysis considering capital costs and fuel (gas) prices, and a further sensitivity analysis varying the load factor; and,

Step 4: A further economic feasibility assessment by varying the economic lifetime to identify the break-even economic life, including a sensitivity analysis considering capital costs and BEIS projections[44] for fuel (gas) prices and carbon prices, and a further sensitivity analysis varying the load factor.

B.3 Scenarios Considered

For the economic assessment, Table B.1 sets out the scenarios considered.

TABLE B.1: SCENARIOS CONSIDERED

Scenario	***Description***
'Base Scenario':	A CCGT generating station without the retrofitting of CO_2 capture equipment (and associated CO_2 transport / storage)).
'Retrofitted Scenario':	A CCGT generating station with the retrofitting of CO_2 capture equipment (and associated CO_2 transport / storage)). Furthermore, the 'Retrofitted Scenario' assumes that: • The CCGT generating station will be the first to the retrofitted with CO_2 capture equipment (and associated CO_2 transport / storage) (this means that construction costs will be relatively high because of lack of experience); • The on-shore and off-shore CO_2 transport and off-shore CO_2 storage infrastructure will be new assets (again, this means that construction costs will be relatively high because of lack of experience); and, • Sizing will be for the CCGT generating station only; and, • The CO_2 capture equipment (and associated CO_2 transport / storage) will be dedicated assets.

[44] Based on the Data Tables for 'Green Book Supplementary Guidance: Valuation of Energy Use and Greenhouse Gas Emissions for Appraisal' (Department for Business, Energy and Industrial Strategy, updated 19 March 2020). Data Tables available at:
https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

B.4 Assumptions / Estimations

The 2009 CCR Guidance notes, at paragraph 68, that any economic assessment should consider a wide range of parameters. Table B.2 sets out the main parameters considered, and the associated assumptions / estimations.

TABLE B.2: MAIN PARAMETERS CONSIDERED, AND THE ASSOCIATED ASSUMPTIONS / ESTIMATIONS

Parameter	***Unit***	***'Base Scenario'***	***'Retrofitted Scenario'***
First Year of Construction of CO_2 Capture Equipment	-	N / A	2025
First Year of Operation of CO_2 Capture Equipment	-	N / A	2030
Economic Life of CO_2 Capture Equipment	-	N / A	20[45]
(Projected) Last Year of Operation	-	2050[46]	2050
Nominal Discount Rate (Hurdle Rate)	%	7.5%	9%
Fuel (Gas) Price[47]	p/therm	63	
Levelised Cost of Electricity	-	As Calculated	
Carbon Allocations	-	None (Full Purchase)	
Net Output	%	939	814[48]
Net Efficiency (based on the Lower Heating Value)		55	48
(Reamining) Lifetime Load Factor	%	28	28
CO_2 Emitted	t/hr	351	35

In addition to the above, this initial economic assessment has also considered estimated costs of the permitting, construction and operation of: CO_2 capture equipment; on-shore and off-shore CO_2 transport; and, off-shore CO_2 storage. Within this economic assessment, these estimated costs are based on the most recent data / studies available, and it is noted that these estimated costs are expected to reduce over time, bearing in mind the likely future developments.

B.5 Economic Assessment: Varying the Carbon Price

Insert B.1 plots the levelised cost of electricity against carbon price for both the 'Base Scenario' and the 'Retrofitted Scenario'. The lifetime cost of electricity is shown on the y-axis and the carbon price is shown on the x-axis. For each of the scenarios considered, the economic model has the capability to vary parameters as part of a sensitivity analysis, and Table B.3 describes the varied parameters for the sensitivity analysis.

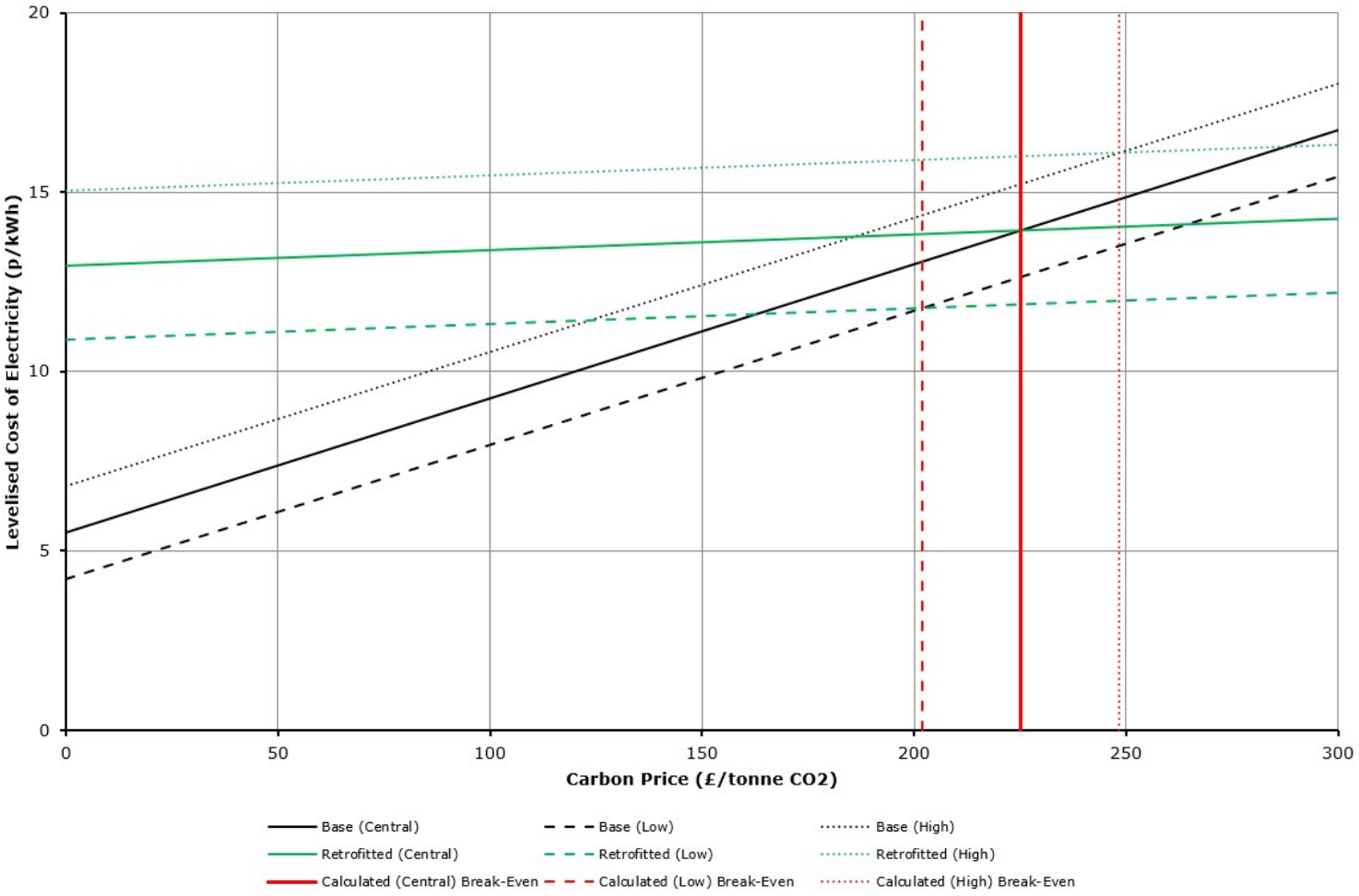
TABLE B.3: VARIED PARAMETERS FOR THE SENSITIVITY ANALYSIS

	Capital Costs	***Fuel (Gas Price)***
	The Capital Costs have been stressed with a ±10% uncertainty range.	The Fuel (Gas) Prices have been stressed with a ±30% uncertainty range to reflect the volatility and uncertainty in the future / longer-term gas markets.
Low	-10%	-30%
'Central'	As Table B.2 (Main Parameters Considered, and associated Assumptions / Estimations)	
High	+10%	+30%

The solid lines represent the central case for each Scenario and the dotted lines represent the cumulative effects of the factors decreasing the levelised cost of electricity (low capital cost, low fuel (gas) price), and of the factors increasing the levelised cost of electricity (high capital cost, high fuel (gas) price).

[45] 20 years is considered to be appropriate as this takes the overall economic (operational) lifetime to 2050, and could include a 15 year initial time period covered by either a Contract for Difference or Capacity Market contract.
[46] SEP was commissioned in 2004. This projected last year of operation would allow for a circa 45 year economic lifetime.
[47] Based on BEIS projections for fuel (gas prices). This fuel (gas) price is quoted for the 'Central Case' from 2030 to 2100.
[48] Includes the 'lost' output due to the CO_2 capture process steam extraction and the auxiliary power for the CO_2 capture equipment.

INSERT B.1: LEVELISED COST OF ELECTRICITY AGAINST CARBON PRICE



Insert B.1 shows that for carbon prices between £0/t CO_2 to £300/t CO_2:

- For the 'Base (Central) Scenario', the levelised cost of electricity ranges between 5.5 p/kWh and 16.7 p/kWh;
- For the 'Retrofitted (Central) Scenario':
  - The levelised cost of electricity ranges between 13.0 p/kWh and 14.3 p/kWh; and,
  - The Calculated (Central) Break-Even Carbon Price (where the levelised cost of electricity for the 'Base (Central) Scenario' equals the levelised cost of electricity for the 'Retrofitted (Central) Scenario') is £225/t CO_2.

Based on the sensitivity analysis and varied parameters (capital costs and fuel (gas) prices), Insert B.1 shows the cumulative effects of the factors decreasing the levelised cost of electricity (low capital cost, low fuel (gas) price), and of the factors increasing the levelised cost of electricity (high capital cost, high fuel (gas) price). Accordingly, Table B.4 provides the results of the sensitivity analysis, with the levelised cost of electricity quoted for carbon prices between £0/t CO_2 to £300/t CO_2.

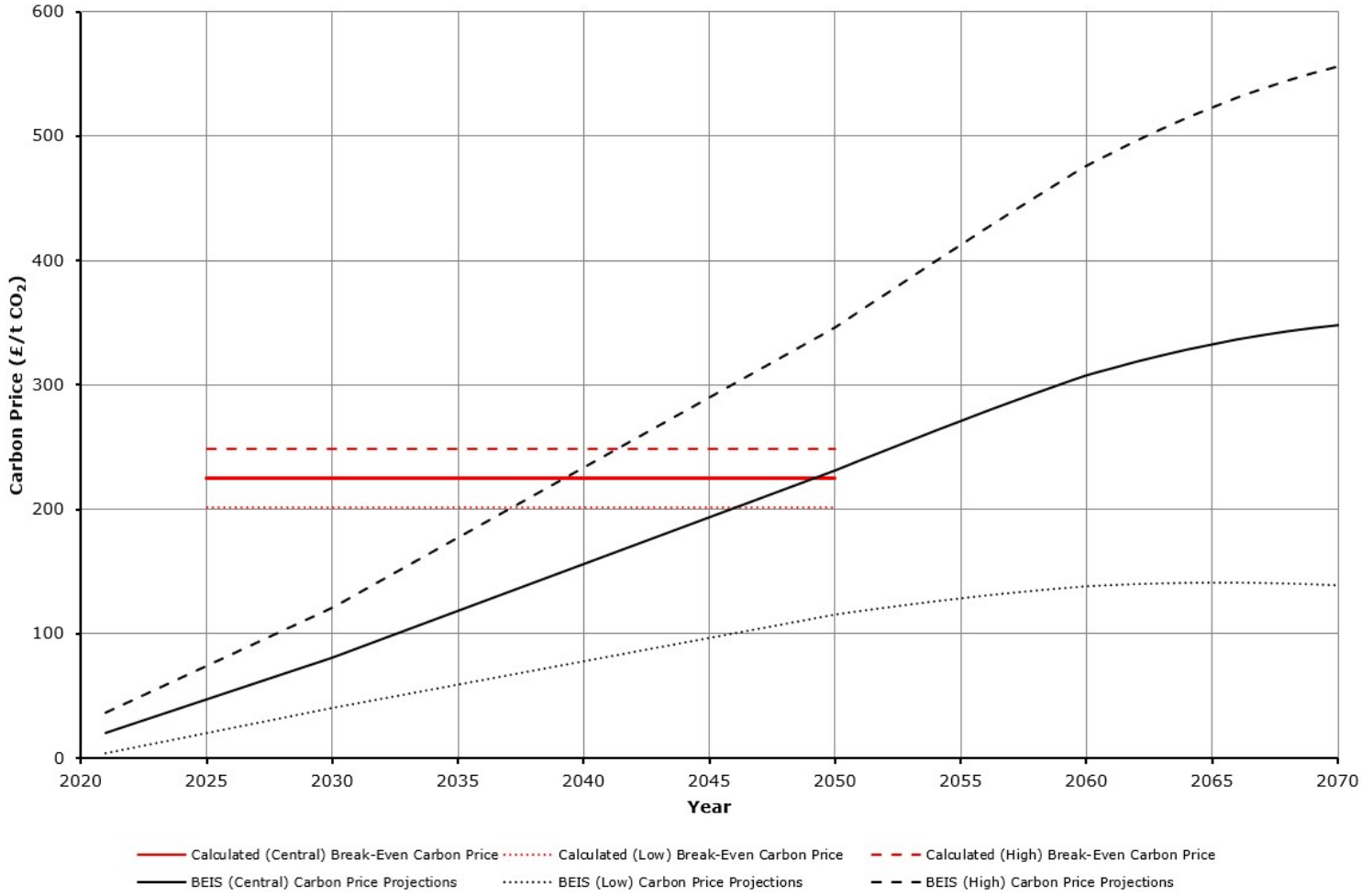
TABLE B.4: RESULTS OF THE SENSITIVITY ANALYSIS

	'Base Scenario'	***'Retrofitted Scenario'***	
	Levelised Cost of Electricity (p/kWh)	***Levelised Cost of Electricity (p/kWh)***	***Break-Even Carbon Price (£/t CO_2)***
Low	4.2 – 15.4	10.9 – 12.2	202
'Central'	5.5 – 16.7	13.0 – 14.3	225
	As Insert B.1 (Lifetime Cost of Electricity Against Carbon Prices)		
High	6.8 – 18.0	15.0 – 16.3	248

Therefore, with regards to the break-even carbon price (where the levelised cost of electricity for the 'Base Scenario' equals the levelised cost of electricity for the 'Retrofitted Scenario') the Calculated Break-Even Carbon Price varies between £202/t CO_2 and £248/t CO_2. However, it should be emphasised that the calculation assumes the carbon price to be constant throughout the economic life / operating period.

Insert B.2 compares the BEIS carbon price projections with the Calculated Break-Even Carbon Prices.

INSERT B.2: COMPARISON OF BEIS PROJECTIONS FOR CARBON PRICES WITH CALCULATED BREAK-EVEN CARBON PRICES



With regards to the Calculated (Central) Break-Even Carbon Price, Insert B.2 shows that the BEIS Central projections reach this in around 2049. This is 24 years after the assumed first year of construction of CO_2 capture equipment, with 1 year left of the projected economic lifetime.

However, as the calculation assumes the carbon price to be constant throughout the economic life / operating period, this would not be economically viable and, therefore, it is considered that there are barriers to demonstrating economic feasibility.

Furthermore, also with regards to the Calculated (Central) Break-Even Carbon Price, Insert B.2 shows that:

- The BEIS Low projections do not reach this within the projected economic lifetime; and,
- The BEIS High projections reach this in around 2039, 14 years after the assumed first year of construction of CO_2 capture equipment, with 11 years left of the projected economic lifetime.

With regards to the Calculated (Low) Break-Even Carbon Price, Insert B.2 also shows that:

- The BEIS Central projections reach this in around 2046, 21 years after the assumed first year of construction of the CO_2 capture equipment, with 4 years left of the projected economic lifetime;
- The BEIS Low projections do not reach this within the projected economic lifetime; and,
- The BEIS High projections reach this in around 2037, 12 years after the assumed first year of construction of the CO_2 capture equipment, with 13 years left of the projected economic lifetime.

Again, as the calculations assume the carbon price to be constant throughout the economic life / operating period, this would not be economically viable and, therefore, it is considered that there are barriers to demonstrating economic feasibility.

With regards to the Calculated (High) Break-Even Carbon Price, Insert B.2 also shows that:

- The BEIS Central projections do not reach this within the projected economic lifetime;
- The BEIS Low projections do not reach this within the projected economic lifetime; and,
- The BEIS High projections reach this in around 2041, 16 years after the assumed first year of construction of the CO_2 capture equipment, with 9 years left of the projected economic lifetime.

Again, as the calculations assume the carbon price to be constant throughout the economic life / operating period, this would not be economically viable and, therefore, it is considered that there are barriers to demonstrating economic feasibility.

B.6 Economic Assessment: Varying the Carbon Price with Additional Sensitivity Analysis Varying the Load Factor

The economic assessment assumes a 28% load factor. This assumed load factor will have an impact on the lifetime cost of electricity.

Therefore, for this economic assessment, the additional sensitivity analysis varying the load factor, noting the projected CCGT and gas CCS load factors[49], comprises:

- A 40% High Load Factor, which will decrease the levelised cost of electricity, (which is considered optimistic and is not currently projected); and,
- A 10% Low Load Factor, which will further increase the levelised cost of electricity.

For each of the load factors considered, Table B.5 provides the results of the additional sensitivity analysis varying the load factor. Within Table B.5, the levelised cost of electricity is quoted for carbon prices between £0/t CO_2 to £300/t CO_2.

[49] 'Future Energy Scenarios' (National Grid, July 2020). Available at: https://www.nationalgrideso.com/future-energy/future-energy-scenarios/fes-2020-documents

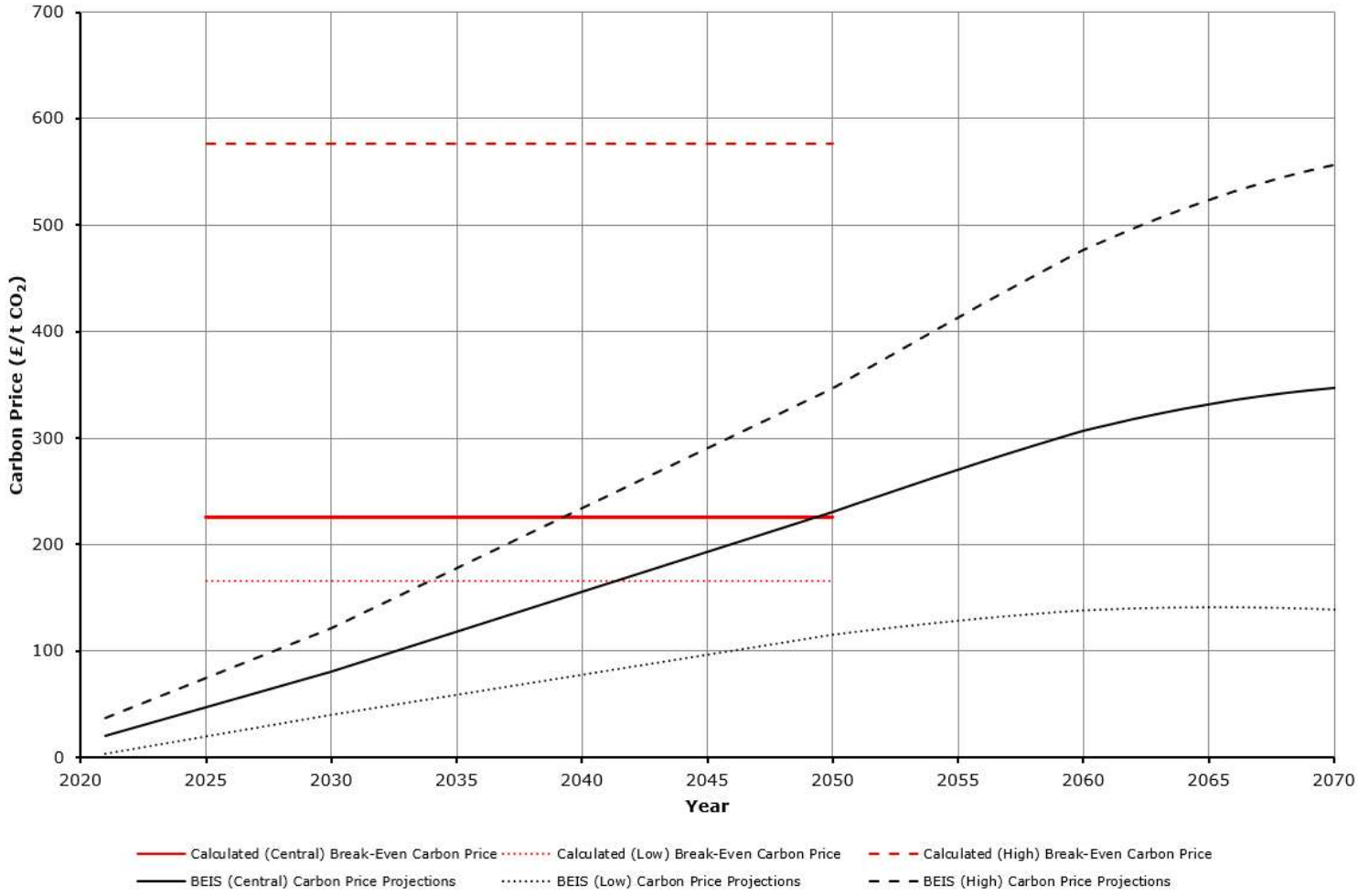
TABLE B.5: RESULTS OF THE ADDITIONAL SENSITIVITY ANALYSIS VARYING THE LOAD FACTOR

	'Base Scenario'	***'Retrofitted Scenario'***	
	Levelised Cost of Electricity (p/kWh)	***Levelised Cost of Electricity (p/kWh)***	***Break-Even Carbon Price (£/t CO_2)***
High LF	5.3 – 16.5	10.8 – 12.1	166
'Central'	5.5 – 16.7	13.0 – 14.3	225
	As Insert B.1 (Lifetime Cost of Electricity Against Carbon Prices)		
Low LF	6.8 – 18.1	25.9 – 27.2	577

Therefore, with regards to the break-even carbon price (where the levelised cost of electricity for the 'Base Scenario' equals the levelised cost of electricity for the 'Retrofitted Scenario') the Calculated Break-Even Carbon Price varies between £166/t CO_2 and £577/t CO_2. However, again, it should be emphasised that the calculation assumes the carbon price to be constant throughout the economic life / operating period.

Insert B.3 compares the BEIS carbon price projects with the Calculated Break-Even Carbon Prices.

INSERT B.3: COMPARISON OF BEIS PROJECTIONS FOR CARBON PRICES WITH CALCULATED BREAK-EVEN CARBON PRICES



With regards to the Calculated (Low) Break-Even Carbon Price (at a 40% (High) Load Factor), Insert B.3 shows that:

- The BEIS Central projections reach this in around 2042, 17 years after the assumed first year of construction of the CO_2 capture equipment, with 8 years left of the projected economic lifetime;
- The BEIS Low projections do not reach this within the projected economic lifetime; and,
- The BEIS High projections reach this in around 2034, 9 years after the assumed first year of construction of the CO_2 capture equipment, with 16 years left of the projected economic lifetime.

As the calculations assume the carbon price to be constant throughout the economic life / operating period, this would not be economically viable and, therefore, it is considered that there may be barriers to meeting the economic requirements.

With regards to the Calculated (High) Break-Even Carbon Price (at a 10% (Low) Load Factor), Insert B.3 also shows that:

- The BEIS Central projections do not reach this within the projected economic lifetime;
- The BEIS Low projections do not reach this within the projected economic lifetime; and,
- The BEIS High projections do not reach this within the projected economic lifetime.

B.7 Economic Assessment: Varying the Economic Lifetime

B.7.1 Varying the Economic Lifetime: Without Sensitivity Analysis Varying the Load Factor

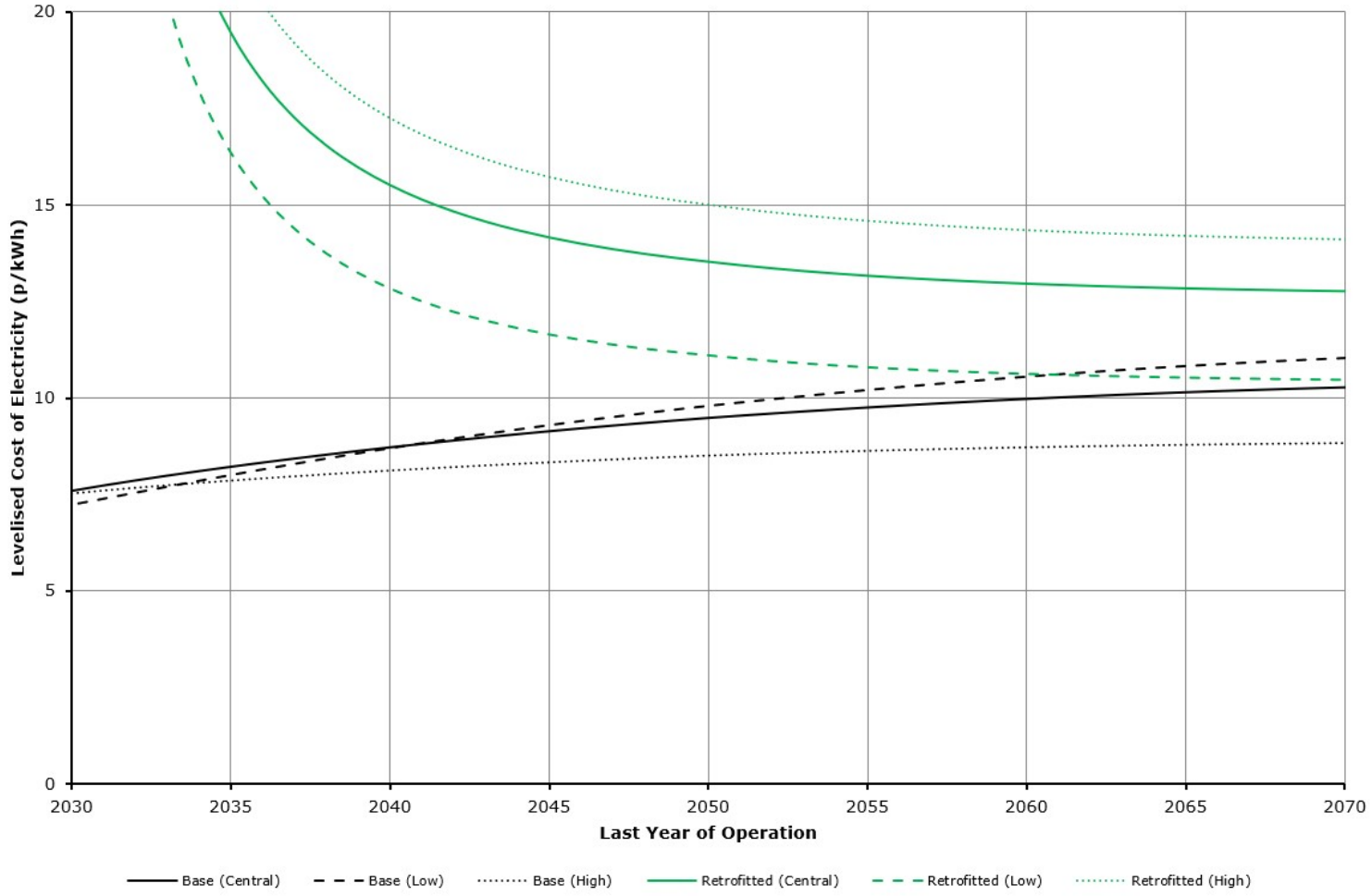
Insert B.4 plots the levelised cost of electricity against the economic lifetime for both the 'Base Scenario' and the 'Retrofitted Scenario'. The lifetime cost of electricity is shown on the y-axis and the economic lifetime (as last year of operation) is shown on the x-axis. For each of the scenarios considered, the economic model has the capability to vary parameters as part of a sensitivity analysis, and Table B.6 describes the varied parameters for the sensitivity analysis.

TABLE B.6: VARIED PARAMETERS FOR THE SENSITIVITY ANALYSIS

	Capital Costs	***Fuel (Gas) Price***	***Carbon Price***
	The Capital Costs have been stressed with a ±10% uncertainty range.	The Fuel (Gas) Prices have been stressed within the BEIS projections range.	The Carbon Prices have been stressed within the BEIS projections range.
Low	-10%	As BEIS Low Projections for Corresponding Year	As BEIS High Projections for Corresponding Year
'Central'	As Table B.2 (Main Parameters Considered, and associated Assumptions / Estimations)	As BEIS Central Projections for Corresponding Year	As BEIS Central Projections for Corresponding Year
High	+10%	As BEIS High Projections for Corresponding Year	As BEIS Low Projections for Corresponding Year

The solid lines represent the central case for each Scenario and the dotted lines represent the cumulative effects of the factors decreasing the levelised cost of electricity for the 'Retrofitted Scenario' (low capital cost, low fuel (gas) price, high carbon price), and of the factors increasing the levelised cost of electricity for the 'Retrofitted Scenario' (high capital cost, high fuel (gas) price, low carbon price).

INSERT B.4: LEVELISED COST OF ELECTRICITY AGAINST ECONOMIC LIFE



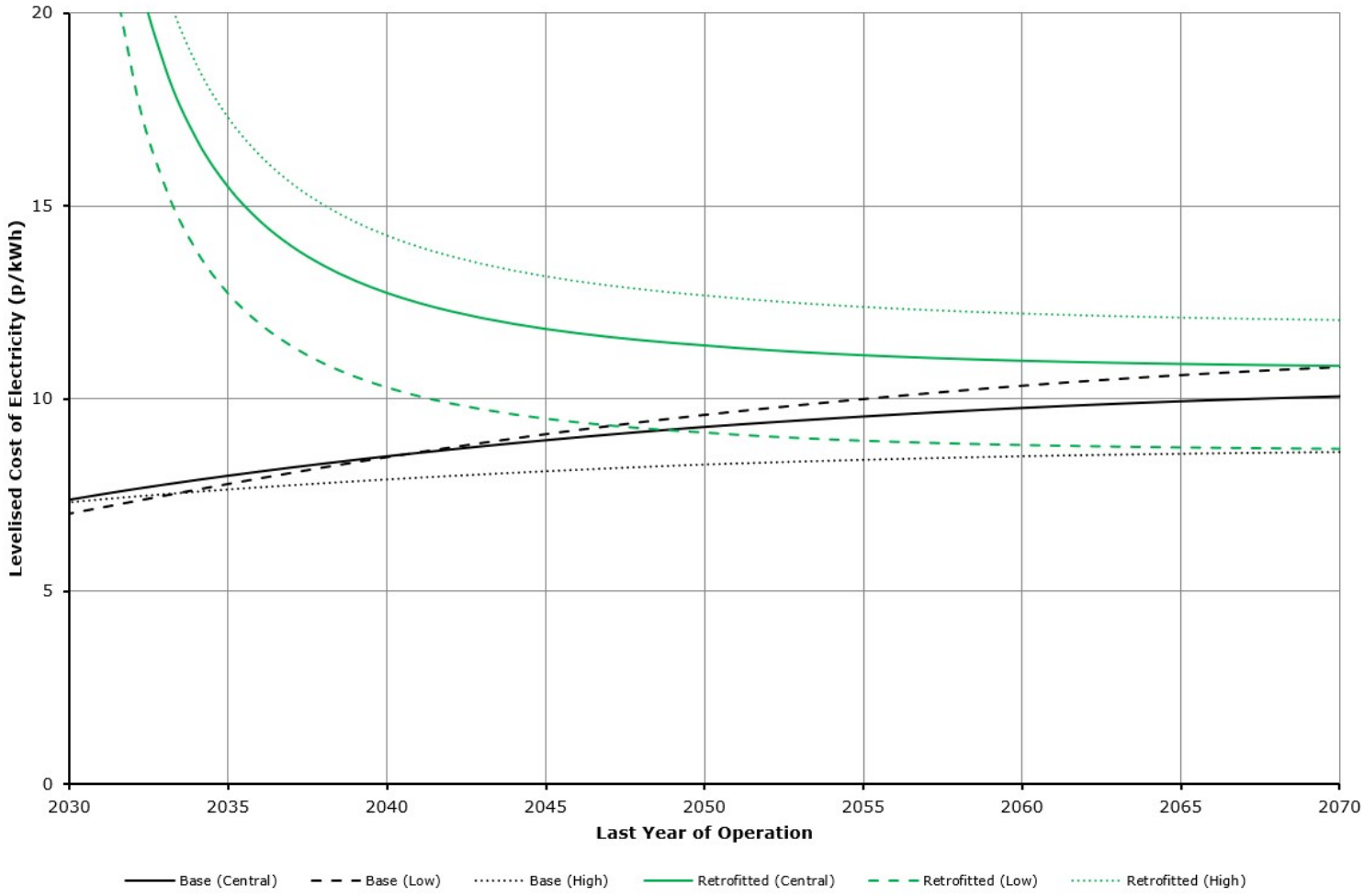
Insert B.4 shows that the 'Central' case breakeven last year of operation is beyond 2070 (i.e. after the (projected) last year of operation). This would not be economically viable and, therefore, it is considered that there are barriers to demonstrating economic feasibility.

Based on the sensitivity analysis and varied parameters (capital costs, fuel (gas) prices and carbon prices), Insert B.4 shows the cumulative effects of the factors decreasing the levelised cost of electricity for the 'Retrofitted Scenario' (low capital cost, low fuel (gas) price, high carbon price). Even here, Insert B.4 shows that the 'Low' case breakeven last year of operation is beyond 2060 (i.e. also after the (projected) last year of operation). Again, this would not be economically viable and, even against factors decreasing the levelised cost of electricity for the 'Retrofitted Scenario', it is considered that there are barriers to demonstrating economic feasibility.

Varying the Economic Lifetime: With Sensitivity Analysis Varying the Load Factor

Noting that the 40% load factor reduces the break-even price to £166/t CO_2, Insert B.5 plots the levelised cost of electricity against the economic lifetime for both the 'Base Scenario' and the 'Retrofitted Scenario' for a 40% load factor. For each of the scenarios considered, the economic model varied the same parameters as the previous sensitivity analysis.

INSERT B.4: LEVELISED COST OF ELECTRICITY AGAINST ECONOMIC LIFE (40% LOAD FACTOR)



Insert B.5 shows that the 'Central' case breakeven last year of operation is still beyond 2070 (i.e. after the (projected) last year of operation). As before, this would not be economically viable and, therefore, it is considered that there are barriers to demonstrating economic feasibility.

APPENDIX C:
PREVIOUS UK CONSIDERATION OF CCR AND THE CCR CONDITIONS

PREVIOUS UK CONSIDERATION OF CCR AND THE CCR CONDITIONS

C.1 Introduction

This Appendix provides details of previous (predominately England and Wales) consideration of CCR and the CCR conditions based on consents granted after August 2007[50] under Section 36 and Section 36C of the 1989 Electricity Act (and under Section 37 of the 2008 Planning Act)[51,52].

C.2 Previous Precedence of the Consideration of CCR and the CCR Conditions

Table C.1 presents details of the previous (predominately England and Wales) consideration of CCR and the CCR conditions. Within Table C.1, *specific situations are shown in red, italic text* where either:

- There was consideration of CCR, but CCR conditions were not applied / the CCR conditions were not met;
- There was consideration of CCR, but the CCR conditions were not updated; and / or,
- The consent is considered pertinent.

[50] August 2007 was when letters accompanying consents began to include a summary of the 'Secretary of State's Decision on Carbon Capture' (or (in later letters accompanying consents) the 'Secretary of State's Decision on Carbon Capture Readiness (CCR)').
[51] Information taken from 'BEIS Energy Infrastructure: Recent Decisions on Applications'. Available at: https://itportal.beis.gov.uk/EIP/pages/recent.htm
[52] Information also taken from 'Energy Infrastructure Development Applications: Decisions'. Available at: https://www.gov.uk/government/collections/energy-infrastructure-development-applications-decisions

Table C.1: PREVIOUS UK CONSIDERATION OF CCR AND THE CCR CONDITIONS

Date	*Generating Station*[53]	1989 Electricity Act	2008 Planning Act	2009 CCS Directive	2013 CCR Regulations	2009 CCR Guidance	Consideration of CCR	CCR Assessment	CCR Conditions	CCR Conditions Met	*Additional Comments / Notes*
11/02/1992	*Barking*	✓	-	-	-	-	×	-	-	-	
10/09/1993	*Keadby II*	✓	-	-	-	-	×	-	-	-	
17/08/2007	Severn Power 800 MW CCGT	✓	-	-	-	-	✓	-	✓	-	
16/10/2007	*Drakelow* *1220 MW CCGT*	✓	-	-	-	-	✓	-	✓	-	
30/10/2007	West Burton B 1270 MW CCGT	✓	-	-	-	-	✓	-	✓	-	
20/11/2007	Prenergy Power 350 MW Biomass	✓	-	-	-	-	×	-	×	-	At the time, consideration of CCR was only made with regards to CCGT generating stations.
19/12/2007	Barking Increase, to 1000 MW	✓	-	-	-	-	✓	-	✓	-	Via the addition of a 470 MW CCGT
30/07/2008	Carrington 860 MW CCGT	✓	-	-	-	-	✓	-	✓	-	Replaced the previous 360 MW CCGT
28/08/2008	*Thor CoGeneration* *1020 MW CCGT-CHP*	✓	-	-	-	-	✓	-	×	-	Within the letter accompanying the consent it was stated that: • (at paragraph 7.2) "*The current position is that, where appropriate, a condition requiring the proposal to have enough land for future carbon capture technology forms part of the section 36 consent* […]. [The associated guidance] *makes clear that such a condition is not necessarily appropriate for fossil fuel power stations that offer combined heat and power (CHP). This is because CHP plant is usually sited adjacent to industrial users of close by to domestic heat users. That can make it more difficult for a developer to identify and retain space on site to accommodate future carbon capture plant*". • (at paragraph 7.3) "*Officials from the Department visited the site* […] *and discussed the availability of additional land for CCR* […]. *The landowner informed officials that the land surrounding the proposed Development has either already been allocated for other industrial development or is to form part of a nature reserve offered as compensation for the loss of other ecological habitat of the area. Officials are of the view that insufficient land is available on the site of the proposed Development to accommodate both CCR and the plant, equipment and service corridor for CHP. The Secretary of State* […] *has decided not to include a section 36 condition requiring sufficient space to be retained on site to allow for the fitting in the future of carbon capture plant*" (emphasis added).

[53] Table covers all listed generating stations at or over 300 MW, and of a type covered by the 2001 LCPD.

Date	***Generating Station***[53]	**1989 Electricity Act**	**2008 Planning Act**	**2009 CCS Directive**	**2013 CCR Regulations**	**2009 CCR Guidance**	**Consideration of CCR**	**CCR Assessment**	**CCR Conditions**	**CCR Conditions Met**	***Additional Comments / Notes***
05/02/2009	Hatfield 900 MW CCGT / IGCC	✓	-	-	-	-	✓	-	✓	-	
05/02/2009	*King's Lynn B* *1020 MW CCGT*	✓	-	-	-	-	✓	-	✓	-	
05/02/2009	Pembroke 2000 MW CCGT	✓	-	-	-	-	✓	-	✓	-	
22/04/2009	*Seal Sands* *800 MW CCGT-CHP*	✓	-	-	-	-	✓	-	×	-	Within the letter accompanying the Consent: • (at paragraph 6.2) "*As with other recent decisions to consent to new power stations, the Secretary of State has considered whether it would be appropriate to include in any section 36 he may grant, a condition that the necessary space is available at the site so as to allow for the future installation of any carbon capture plant ('the CCR condition')*". • (at paragraph 6.3) "*In this case, the Department as discussed the availability of additional land for CCR purposes with the Company. After visiting the site and talking to the Company, it is clear to the Department that the land surrounding the proposed Development has already been allocated for other industrial development or is to form part of a compensation package for the loss of other ecological habitat in the area. The Secretary of State is of the view that unusually in this case, insufficient land is available on the site of the proposed Development to accommodate both CCR and the plant, equipment and service corridor for CHP*" (emphasis added). • (at paragraph 6.4) "*The Secretary of State has therefore decided on this occasion not to include a section 36 condition requiring sufficient space to be retained on site to allow for the fitting in the future of carbon capture plant*. […]" (emphasis added).
01/04/2010	Trafford Power 1520 MW CCGT	✓	-	✓	-	✓	✓	✓	✓	✓	
11/11/2010	Spalding Energy Expansion 900 MW CCGT	✓	-	✓	-	✓	✓	✓	✓	✓	
25/01/2011	Damhead Creek 2 1000 MW CCGT	✓	-	✓	-	✓	✓	✓	✓	✓	
23/02/2011	Abernedd 870 MW CCGT	✓	-	✓	-	✓	✓	✓	✓	✓	
04/03/2011	Willington C 2000 MW CCGT / 400 MW OCGT	✓	-	✓	-	✓	✓	✓	✓	✓	
04/08/2011	Gateway Energy Centre 900 MW CCGT	✓	-	✓	-	✓	✓	✓	✓	✓	

Date	***Generating Station***[53]	**1989 Electricity Act**	**2008 Planning Act**	**2009 CCS Directive**	**2013 CCR Regulations**	**2009 CCR Guidance**	**Consideration of CCR**	**CCR Assessment**	**CCR Conditions**	**CCR Conditions Met**	***Additional Comments / Notes***
31/10/2011	Thorpe Marsh 1500 MW CCGT	✓	-	✓	-	✓	✓	✓	✓	✓	
28/07/2014	Damhead Creek 2 Increase, to a 1200 MW CCGT	✓ (S36C)	-	✓	✓	✓	✓	✓	✓	✓	
11/09/2014	North Killingholme Power Project 470 MW CCGT / IGCC	-	✓	✓	✓	✓	✓	✓	✓	✓	
23/10/2014	South Hook 500 MW CCGT-CHP	-	✓	✓	✓	✓	✓	✓	✓	✓	
18/11/2014	Gateway Energy Centre Increase, to a 1250 MW CCGT	✓ (S36C)	-	✓	✓	✓	✓	✓	As Before		The variation could be considered to be for a new generating station (i.e. is not for a constructed / existing generating station), and therefore could also be considered to be subject to the 2009 CCR Guidance.
19/11/2014	Trafford Power Increase / Variation, to an 1800 MW CCGT / 260 MW OCGT	✓ (S36C)	-	✓	✓	✓	✓	✓	As Before		The variation could be considered to be for a new generating station (i.e. is not for a constructed / existing generating station), and therefore could also be considered to be subject to the 2009 CCR Guidance.
10/03/2015	Knottingley Power Project 1500 MW CCGT	-	✓	✓	✓	✓	✓	✓	✓	✓	
16/09/2015	Sutton Bridge B 1800 MW CCGT	✓	-	✓	✓	✓	✓	✓	✓	✓	
23/10/2015	Damhead Creek 2 Increase, to an 1800 MW CCGT	✓ (S36C)	-	✓	✓	✓	✓	✓	As Before		The variation could be considered to be for a new generating station (i.e. is not for a constructed / existing generating station), and therefore could also be considered to be subject to the 2009 CCR Guidance.
30/10/2015	Spalding Energy Expansion Variation, to a (945 MW) CCGT / OCGT	✓ (S36C)	-	✓	×	✓	✓	✓	As Before		The variation was not for an increase in permitted electricity generation output as the original 2010 consent was for "about 900 MW" with "a tolerance of up to 5% is permitted", and therefore would not be subject to the 2013 CCR Regulations. The variation could be considered to be for a new generating station (i.e. is not for a constructed / existing generating station), and therefore could also be considered to be subject to the 2009 CCR Guidance.

Date	***Generating Station[53]***	**1989 Electricity Act**	**2008 Planning Act**	**2009 CCS Directive**	**2013 CCR Regulations**	**2009 CCR Guidance**	**Consideration of CCR**	**CCR Assessment**	**CCR Conditions**	**CCR Conditions Met**	***Additional Comments / Notes***
06/07/2016	*Drakelow* *Variation, to extend 'Time Limits'*	✓ (S36C)	-	×	×	✓	✓	×	As Before	-	The original consent (i.e. original construction licence) was granted prior to the entry into force of the 2009 CCR Directive (was granted in October 2007). The variation was not for an increase in permitted electricity generation output, and therefore would not be subject to the 2013 CCR Regulations. The variation could be considered to be for a new generating station (i.e. is not for a constructed / existing generating station), and therefore could also be considered to be subject to the 2009 CCR Guidance. Within the letter accompanying the Consent: • (at paragraph 5.1) "*The Secretary of State notes that the original section 36 consent was issued in 2007 before the adoption of the* [2009 CCR Guidance] *and the* [2013 CCR Regulations]. *There is therefore no provision made in the original section 36 consent for CCS. She further notes that neither the* [2009 CCR Guidance] *not the* [2013 CCR Regulations] *require compliance in the case of a variation where there is no increase in capacity*". • (at paragraph 5.2) "*The Secretary of State has considered whether the proposed variation would be subject to the* [2009 CCR Guidance] *and the* [2013 CCR Regulations]*, and has determined that as the Applicant is not seeking a change in the generating capacity of the Development through the variation application, there is no requirement to apply either the* [2009 CCR Guidance] *or the* [2013 CCR Regulations]". However, it is noted that the original consent contains the Initial CCR Space Condition (at Condition 3(2): *"The layout of the Development shall be such so as to permit the installation of such plant as may reasonably be required to achieve the prevention of discharge of carbon and its compounds to the atmosphere"*).
12/07/2016	Damhead Creek 2 Variation, to a CCGT / OCGT	✓ (S36C)	-	✓	×	✓	✓	✓	As Before		The variation was not for an increase in permitted electricity generation output, and therefore would not be subject to the 2013 CCR Regulations. The variation could be considered to be for a new generating station (i.e. is not for a constructed / existing generating station), and therefore could also be considered to be subject to the 2009 CCR Guidance.
03/08/2016	Gateway Energy Centre Variation, to a CCGT / OCGT	✓ (S36C)	-	✓	×	✓	✓	✓	As Before		The variation was not for an increase in permitted electricity generation output, and therefore would not be subject to the 2013 CCR Regulations. The variation could be considered to be for a new generating station (i.e. is not for a constructed / existing generating station), and therefore could also be considered to be subject to the 2009 CCR Guidance.
19/10/2016	Trafford Power Decrease / Variation, to a 1931 MW CCGT	✓ (S36C)	-	✓	×	✓	✓	×	As Before		The variation was not for an increase in permitted electricity generation output, and therefore would not be subject to the 2013 CCR Regulations. The variation could be considered to be for a new generating station (i.e. is not for a constructed / existing generating station), and therefore could also be considered to be subject to the 2009 CCR Guidance.
01/11/2016	Thorpe Marsh Increase, to a 1575 MW CCGT	✓ (S36C)	-	✓	✓	✓	✓	×	As Before		The variation could be considered to be for a new generating station (i.e. is not for a constructed / existing generating station), and therefore could also be considered to be subject to the 2009 CCR Guidance.

Date	***Generating Station[53]***	**1989 Electricity Act**	**2008 Planning Act**	**2009 CCS Directive**	**2013 CCR Regulations**	**2009 CCR Guidance**	**Consideration of CCR**	**CCR Assessment**	**CCR Conditions**	**CCR Conditions Met**	***Additional Comments / Notes***
03/11/2016	*Keadby II* *Increase, to an 820 MW CCGT*	✓ (S36C)	-	×	✓	✓	✓	✓	✓	✓	The original consent (i.e. original construction licence) was granted prior to the entry into force of the 2009 CCR Directive (was granted in September 1993). The variation could be considered to be for a new generating station (i.e. is not for a constructed / existing generating station), and therefore could also be considered to be subject to the 2009 CCR Guidance. Within the letter accompanying the Consent: • (at paragraph 61) "*The Secretary of State notes that an assessment of CCR did not form part of the assessment process in relation to the consideration of the decision to grant the original consent as this preceded the introduction of guidance on CCR. However, the Secretary of State has considered the variation in light of the* [2009 CCR Guidance] *which sets out the factors that need to be considered in making an assessment about CCR*". The Conditions were updated to include the Standard CCR Conditions.
27/01/2017	*Barking* *Variation, to a CCGT / OCGT*	✓ (S36C)	-	×	×	×	✓	×	×	×	The original consent (i.e. original construction licence) was granted prior to the entry into force of the 2009 CCR Directive (was granted in February 1992). The variation was not for an increase in permitted electricity generation output, and therefore would not be subject to the 2013 CCR Regulations The variation was not considered to be for a new generating station (i.e. was for a constructed / existing generating station), and therefore was not considered to be subject to the 2009 CCR Guidance. Within the letter accompanying the Consent: • (at paragraph 31) "*The Secretary of State notes that an assessment of CCR did not form part of the assessment process in relation to the consideration of the decision to grant the original consent as this preceded the introduction of both the* [2013 CCR Regulations] *and* [the 2009 CCR Guidance]. *However, the Secretary of State has considered the variation application in the light of both the CCR Regulations and the CCR Guidance*". • (at paragraph 32) "*The* [2013] *CCR Regulations only require consideration of whether the CCR conditions are met where variations under section 36C of the Electricity Act 1989 would amount to an increase in the electrical capacity of the development is proposed. As no increase in capacity is proposed in respect of the Development in the variation application, then consideration of carbon capture readiness is not required in this case*".
21/12/2017	*Keadby II* *Increase, to a 910 MW CCGT*	✓ (S36C)	-	×	✓	✓	✓	✓	✓	✓	The original consent (i.e. original construction licence) was granted prior to the entry into force of the 2009 CCR Directive (was granted in September 1993). The variation could be considered to be for a new generating station (i.e. is not for a constructed / existing generating station), and therefore could also be considered to be subject to the 2009 CCR Guidance.

Date	***Generating Station[53]***	**1989 Electricity Act**	**2008 Planning Act**	**2009 CCS Directive**	**2013 CCR Regulations**	**2009 CCR Guidance**	**Consideration of CCR**	**CCR Assessment**	**CCR Conditions**	**CCR Conditions Met**	***Additional Comments / Notes***
12/01/2018	*Drakelow* *Variation, to amend 'Development'*	✓ (S36C)	-	×	×	✓	✓	×	As Before	-	The original consent (i.e. original construction licence) was granted prior to the entry into force of the 2009 CCR Directive (was granted in October 2007). The variation was not for an increase in permitted electricity generation output, and therefore would not be subject to the 2013 CCR Regulations. The variation could be considered to be for a new generating station (i.e. is not for a constructed / existing generating station), and therefore could also be considered to be subject to the 2009 CCR Guidance. Within the letter accompanying the Consent: • (paragraph 6.1) "*The Secretary of State notes that the original consent was issued in 2007 before the adoption of the* [2009 CCR Guidance] *and the* [2013 CCR Regulations]. *There is therefore no provision made for CCR in compliance with* [2009 CCR Guidance] *or* [the 2013 CCR Regulations] *in the original consent. He further notes that neither the* [2009 CCR Guidance] *or* [the 2013 CCR Regulations] *require compliance in the case of a variation to an existing section 36 consent where there is no increase in capacity*". • (paragraph 6.2) "*The Secretary of State has considered whether the proposed variation would be subject to the* [2009 CCR Guidance] *and the* [2013 CCR Regulations], *and has determined that as the Applicant is not seeking an increase in the generating capacity of the Development through the variation application, there is no requirement to apply either the* [2009 CCR Guidance] *or the* [2013 CCR Regulations]". However, it is noted that the original consent contains the Initial CCR Space Condition (at Condition 3(2): *"The layout of the Development shall be such so as to permit the installation of such plant as may reasonably be required to achieve the prevention of discharge of carbon and its compounds to the atmosphere"*).
31/01/2018	Spalding Energy Expansion Variation, to a CCGT / OCGT / BESS	✓ (S36C)	-	✓	×	✓	✓	×	As Before		The variation was not for an increase in permitted electricity generation output, and therefore would not be subject to the 2013 CCR Regulations. The variation could be considered to be for a new generating station (i.e. is not for a constructed / existing generating station), and therefore could also be considered to be subject to the 2009 CCR Guidance. Within the letter accompanying the consent: • (at paragraph 8.3) "*The Secretary of State has considered whether the proposed variation would be subject to the* [2009 CCR Guidance] *and the* [2013 CCR Regulations], *and has determined that, as the Company is not seeking an increase in the generating capacity of the Development through the variation application, there is no requirement to apply either the* [2009 CCR Guidance] *or the* [2013 CCR Regulations]*".*
20/09/2018	Eggborough 2500 MW CCGT	-	✓	✓	✓	✓	✓	✓	✓	✓	

Date	***Generating Station[53]***	**1989 Electricity Act**	**2008 Planning Act**	**2009 CCS Directive**	**2013 CCR Regulations**	**2009 CCR Guidance**	**Consideration of CCR**	**CCR Assessment**	**CCR Conditions**	**CCR Conditions Met**	***Additional Comments / Notes***
10/12/2018	*King's Lynn B* *Increase, to a 1700 MW CCGT*	✓ (S36C)	-	×	✓	✓	✓	✓	As Before, but updated to include the Standard CCR Conditions		The original consent (i.e. original construction licence) was granted prior to the entry into force of the 2009 CCR Directive (was granted in February 2009). The variation could be considered to be for a new generating station (i.e. is not for a constructed / existing generating station), and therefore could also be considered to be subject to the 2009 CCR Guidance. Within the letter accompanying the consent: • (at paragraph 6.6) "*The decision on the original section 36 application identified land for carbon capture and export, and a condition was included to ensure that the necessary space remains available at the site to allow for the future installation of a carbon capture plant*". The Conditions were updated to include the Standard CCR Conditions.
01/03/2019	*Keadby II* *Variation, to make Minor Amendments*	✓ (S36C)	-	×	×	✓	✓	×	As Before		The original consent (i.e. original construction licence) was granted prior to the entry into force of the 2009 CCR Directive (was granted in September 1993). The variation was not for an increase in permitted electricity generation output, and therefore would not be subject to the 2013 CCR Regulations. The variation could be considered to be for a new generating station (i.e. is not for a constructed / existing generating station), and therefore could also be considered to be subject to the 2009 CCR Guidance. Within the letter accompanying the consent: • (at paragraph 7.1) "*The Secretary of State notes that the previous Variation Application (resulting in the 2017 variation) included a Carbon Capture Readiness ('CCR') report demonstrating that Keadby II would be carbon capture ready and that sufficient land has been set aside for any future carbon capture plant*". • (at paragraph 7.2) "*The Secretary of State is satisfied that the Application has no implications in terms of the ability for Keadby II to be CCR ready and therefore the CCR Report remains valid*".
05/04/2019	Tees 1520 MW CCGT	-	✓	✓	✓	✓	✓	✓	✓	✓	-
04/10/2019	Drax Re-Power 3800 MW CCGT / OCGT	-	✓	✓	✓	✓	✓	✓	✓	✓	-

Date	***Generating Station[53]***	**1989 Electricity Act**	**2008 Planning Act**	**2009 CCS Directive**	**2013 CCR Regulations**	**2009 CCR Guidance**	**Consideration of CCR**	**CCR Assessment**	**CCR Conditions**	**CCR Conditions Met**	***Additional Comments / Notes***
11/11/2020	Gateway Energy Centre Variation, to a CCGT / OCGT / BESS	✓ (S36C)	-	✓	×	✓	✓	✓	As Before, but updated to allow for separate Development Options		The variation was not for an increase in permitted electricity generation output, and therefore would not be subject to the 2013 CCR Regulations. The variation could be considered to be for a new generating station (i.e. is not for a constructed / existing generating station), and therefore could also be considered to be subject to the 2009 CCR Guidance. Within the letter accompanying the consent: • (at paragraph 9.2) "*The Secretary of State has considered whether the proposed variation to the section 36 consent would have any impact on the previous conclusions in relation to CCR for the Development. The Application proposes that an alternative and smaller area of land be safeguarded for carbon capture equipment under Development Option (ii), compared to the original area of land associated with Development Option (ii).* […]" • (at paragraph 9.3) "*The Secretary of State notes that the Environment Agency has confirmed that sufficient space is available to house the necessary carbon capture and storage infrastructure and that there are no foreseeable barriers to the* […] *retrofit for either* [Development] *Option (i) the 1250 MWe power station; or* [Development] *Option (ii), the 630 MWe power station".*