Longfield Solar Farm

Environmental Statement [PINS Ref: EN010118]

Volume 1

Chapter 3: Alternatives and Design Evolution

Document Reference: EN010118/APP/6.1

Revision Number: 1.0

February 2022

Longfield Solar Energy Farm Ltd

APFP Regulation 5(2)(a)

Planning Act 2008

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

Quality information

Prepared by	Checked by	Verified by	Approved by
JS / PD	PD	PD	NT

Prepared for:

Longfield Solar Energy Farm Ltd

Prepared by:

AECOM Limited
Midpoint, Alencon Link
Basingstoke
Hampshire RG21 7PP
United Kingdom

T: +44(0)1256 310200
aecom.com

Table of Contents

Tables

3 Alternatives and Design Evolution

3.1 Introduction

3.1.1 This chapter of the Environmental Statement (ES) describes the consideration of alternatives and the iterative process of design evolution in relation to the Scheme. A description of the Scheme is presented in ***Chapter 2: The Scheme*** of the ES [**EN010118/APP/6.1**]. Further information on the alternatives and design evolution of the Scheme is presented in the Design Statement [**EN010118/APP/7.3**], which explains how the Scheme is appropriate for and been influenced by the site and its setting, and the design principles and concepts that have been applied to the Scheme.

Legislation and Planning Policy

3.1.2 Schedule 4, paragraph (2) of the Environmental Impact Assessment (EIA) Regulations requires the following information to be presented in the ES: "*A description of the reasonable alternatives (for example in terms of development design, technology, location, size and scale) studied by the developer, which are relevant to the proposed project and its specific characteristics, and an indication of the main reasons for selecting the chosen option, including a comparison of the environmental effects*".

3.1.3 National Policy Statement (NPS) EN-1 (Ref 3-1) paragraph 4.4.1 states that "*as in any planning case, the relevance or otherwise to the decision-making process of the existence (or alleged existence) of alternatives to a proposed development is in the first instance a matter of law, detailed guidance on which falls outside the scope of this NPS*". The NPS confirms that from a policy perspective there is no general requirement to consider alternatives or to establish whether a development represents the best option. This is reinforced by Paragraph 4.2.11 of the Draft NPS EN-1 (Ref 3-2).

3.1.4 The NPS and Draft NPS do, however, highlight that in addition to the requirement under the EIA Regulations set out above and referred to in the first bullet of paragraph 4.4.2 of NPS EN-1, which require applicants to include information in the ES on the reasonable alternatives studied, there are other specific legislative requirements and policy circumstances which may require the consideration of alternatives.

3.1.5 These include a requirement under the Habitats Directive, as transposed into UK law by the Conservation of Habitats and Species Regulations 2017, and also in relation to avoiding significant harm to biodiversity and geological conservation interests, flood risk, and development within nationally designated landscapes set out in sections 5.3, 5.7 and 5.9 of NPS EN-1. Paragraph 4.4.3 of NPS EN-1 states "*where there is a policy or legal requirement to consider alternatives the applicant should describe the alternatives considered in compliance with these requirements*".

3.1.6 Taking into consideration the policy and legal requirements as well as the iterative approach to the design to date, the following alternatives have been considered for the Scheme and are discussed in this chapter:

a. Alternative sites;

b. Alternative technologies;

c. Alternative layouts;

d. Alternative cable route corridors and points of connection to the National Grid; and

e. Alternative layouts for the Bulls Lodge Substation.

3.1.7 The 'no development' scenario as an alternative to the Scheme has not been considered. This is because 'no development' is not considered to be a reasonable alternative to the Scheme as it would not deliver the proposed additional electricity generation capacity. It is also covered in each technical chapter of the ES where appropriate as a 'future baseline' scenario, which presents the expected baseline conditions during construction, operation, and decommissioning, should the Scheme not come forward. The assessments have been presented relative to this future baseline to demonstrate the effect of the Scheme.

3.2 Need for the Scheme

3.2.1 The Scheme's objective is to generate low-carbon electricity for an operational period of circa 40 years, to meet the UK's growing need for low-carbon electricity.

3.2.2 Longfield Solar Energy Farm Limited (hereafter will be referred to as the 'Applicant') has a grid connection agreement in place for a 500MW capacity connection to the National Electricity Transmission System at Bulls Lodge Substation within the south west of the Order limits. The Scheme aims to maximise the renewable energy generation onsite by making full use of the available grid capacity and contributing to a net zero economy.

3.2.3 The inclusion of the Battery Energy Storage System (BESS) provides a means of further enhancing the utility of the power generated by the Scheme by providing energy balancing capability and other services to support the operation of the National Electricity Transmission System. It can store surplus renewable energy and release it to the grid at times of lower generation.

3.2.4 The Government, through the Climate Change Act 2008, made the UK the first country in the world to set legally binding carbon budgets, aiming to cut emissions (versus 1990 baselines) by 34% by 2020 and at least 80% by 2050. This is to be achieved *"through investment in energy efficiency and clean energy technologies such as renewables, nuclear and carbon capture and storage"*.

3.2.5 In October 2018, following the adoption by the UN Framework Convention on Climate Change of the Paris Agreement, the Intergovernmental Panel on Climate Change ('IPCC') published a 'Special Report on the impacts of global warming of 1.5°C above pre-industrial levels' (Ref 3-5). This report concludes that human-induced warming had already reached approximately 1ºC above preindustrial levels, and that without a significant and rapid decline in emissions across all sectors, global warming is not likely to be contained, and therefore more urgent international action is required.

3.2.6 In response, in May 2019, the Government's independent expert Climate Change Committee published 'Net-Zero: The UK's contribution to stopping global warming' (0). This report recommended that the UK Government extend the ambition of the Climate Change Act 2008 and that *"The UK should set and vigorously pursue an ambitious target to reduce greenhouse gas emissions (GHGs) to 'Net-Zero' by 2050, ending the UK's contribution to global warming within 30 years"*.

3.2.7 In June 2019, the Government announced the laying of a statutory instrument in Parliament, which amended the Climate Change Act 2008, in order to implement the Climate Change Committee's recommendation into law, and the UK became the first major economy to pass laws to end its contribution to global warming by 2050. The Climate Change Act 2008 was consequently amended to commit to 100% reduction in emissions by 2050 (amending the previous 80% target).

3.2.8 In June 2020, the Climate Change Committee made recommendations for the Department for Business, Energy and Industrial Strategy (BEIS) to "*deliver plans to decarbonise the power system to reach an emissions intensity of 50 gCO_2/kWh by 2030, with at least 40 GW of offshore wind and a role for onshore wind and large-scale solar power, with a clear timetable of regular auctions*".

3.2.9 Because electricity can be generated from low-carbon sources, the decarbonisation of non-electric sectors (transport, heat, industrial process, etc.) will cause a significant increase in electricity demand. This means that the capacity of electricity generation in the UK must grow to meet that demand. Emerging energy vectors, such as hydrogen electrolysis and large-scale electricity storage, are earmarked to enable the decarbonisation of traditionally hard-to-reach sectors, such as chemical processing and freight transport. The need for a significant growth in new low carbon generation assets, including well-proven renewable technologies such as wind and solar, is therefore clear.

3.2.10 Not only will new assets be required to meet additional anticipated demand, but they will also be needed to replace existing generation capacity, which is due to close over the next decade, either because of environmental regulation or technological lifetime limits.

3.2.11 A diverse renewable generation fleet (i.e., consisting of many different technologies) in the UK will play an important role in the resilience of the UK's electricity system from an adequacy and system operation perspective; diversity improves the resilience of low-carbon supplies against the uncertainty of when they will be generated.

3.2.12 The Statement of Need accompanying the DCO Application (hereafter will be referred to as the 'Application) sets out a detailed compelling case as to why the Scheme is urgently required at the location and scale proposed.

3.3 Alternative Sites

3.3.1 The selection of the Scheme's location has followed a systematic step-by-step process. This process and confirmation of its suitability when considered against potential alternative sites is set out below.

3.3.2 In order to determine the location of a potential solar farm site, there needs to be an available grid connection, and, if possible, a landowner agreeable to their land being used for the development; in the case of delivering a viable solar NSIP, a single contiguous land parcel (or sites in close proximity to one another) exceeding 300 ha was sought by the Applicant. A 'smaller development' as an alternative to the Scheme has not been considered further, as NPS EN-1 at paragraph 4.4.3 states that the decision maker: *"…should be guided in considering alternative proposals by whether there is a realistic prospect of the alternative delivering the same infrastructure capacity (including energy security and climate change benefits) in the same timescale as the proposed development"*. A smaller scheme would not deliver the same generation capacity or energy security and climate change benefit as the Scheme, and as such would not represent a reasonable alternative. A Statement of Need is submitted with the Application which addresses the need for the Scheme at the size it is.

3.3.3 In order to be deliverable and suitable, a solar farm site also requires good irradiance and site topography, as well as relatively few key environmental and social constraints. The length of the grid connection is also critical, to minimise environmental and social impacts and deliver an economically viable scheme.

Grid Connection

3.3.4 The proximity to, and the availability of capacity on the National Grid network is key to the feasibility of solar farm and battery storage projects.

3.3.5 Therefore, the point of connection of the Scheme to the National Grid was a key criterion, with a target 5km radius from existing National Grid infrastructure. Beyond this distance the environmental and social effects are likely to increase, more land and possibly compulsory acquisition may be required, and the Scheme potentially becomes less financially viable.

3.3.6 The 400kV overhead line that stretches from Braintree Substation to the Rayleigh Substation located to the east of Basildon, was initially identified as having capacity of up to 500MW to allow a connection from a potential solar farm. This was therefore considered as the starting point for further local assessment, and a variety of constraints were mapped and used to exclude unsuitable areas and identify potential alternative sites.

Environmental Feasibility

3.3.7 An initial feasibility check was carried out for a study area within 5km of the the Braintree to Rayleigh overhead line to identify the presence/absence of key environmental and social constraints. The search was used to identify contiguous potential developable areas of around or greater than 300ha with the ability to accommodate a NSIP solar scheme, which were not overly constrained by environmental and social aspects. Smaller, multiple sites were not considered further as they would not deliver the same generation capacity or energy security and climate change benefit and are more challenging to deliver without generating additional environmental and social impacts and increased construction costs.

3.3.8 The following elements were checked to ensure they are not within the Order limits or, where they are within the Order limits, that a sufficient buffer from the

Scheme infrastructure can be achieved to avoid or minimise significant environmental and social effects:

a. Ecological elements – Special Areas of Conservation (SACs), Special Protection Areas (SPAs), Sites of Special Scientific Interest (SSSI's), Ramsar Sites, National Nature Reserves, Local Nature Reserves, Local Wildlife Sites, Site of Importance for Nature Conservation (SINCs) and Ancient Woodland. These are all outside the Longfield site with the exception of ancient woodland, which needed further investigation to avoid significant environmental effects;

b. Heritage elements – Conservation Areas, Listed Buildings, Scheduled Monuments, Registered Parks and Gardens and Registered Battlefields. None of these constraints are located within the Order limits;

c. Landscape elements – National Parks, Areas of Outstanding Natural Beauty (AONB), Country Parks, Special Landscape Areas. None of these constraints are located within the Order limits;

d. Proximity to Dwellings. There are no dwellings within the Order limits and sufficient land within the Order limits to allow an adequate setback of Scheme infrastructure;

e. Land designated for other uses in the Councils Local Plan, for example open space and employment land. The Order limits is not designated for other uses in the local plan;

f. Areas of high flood risk - Flood Risk Zones 2 and 3. A small area of Flood Zone 2 and 3 is located within the Order limits which can be adequately avoided through the Scheme design;

g. Green Belt. The Order limits is not within Green Belt land; and

h. Best and Most Versatile (BMV) agricultural land (Grade 1, Grade 2 and Grade 3a Agricultural Land Classification (ALC)). BMV land has been avoided as far as practical in the Order limits and Grade 1 land in particular has been avoided.

Site Selection

3.3.9 Following the high-level appraisal of the land within the 5km study area around the Braintree to Rayleigh overhead line, discrete areas of land were identified that were considered potentially suitable to accommodate a proposed solar farm. A desk-based assessment was then undertaken to refine the search by applying further search criteria at a local level, including:

a. Topography – the site needs to be flat or gently south facing slopes;

b. Field Shape and Pattern – fields need to be large and of regular shape;

c. Landowners – ideally a small number of willing landowners;

d. Environmental – not overlooked by communities or overly constrained by environmental features that the Scheme could become unviable or unable to achieve the target renewable energy generation;

e. Residential Amenity – avoiding close proximity to settlements, where possible;

f. Public Rights of Way – seek to either minimise effects upon receptors using PRoW or seek opportunities to provide connectivity; and

g. Access – ease of access for construction and decommissioning stages to be considered.

3.3.10 Having regard to the above environmental constraints and criteria, the land at the Longfield site (part of which is now the Order limits) was identified as being suitable for a solar farm development. Upon speaking to the landowner and reaching agreement that there was ample capacity within their landholding to accommodate a solar farm, the Longfield site was taken forward for further assessment.

3.3.11 **Table 3-1** presents a summary of the site selection appraisal for the Longfield site.

Table 3-1: Site Selection Appraisal of the Longfield site (including the Order limits)

Constraint	*Longfield site (including the Order limits)*
Point of Connection	The 400 kV overhead line runs through the Longfield site and has sufficient capacity for 500MW, with a Point of Connection initially identified either directly within the Solar Farm Site or to the South West of the Solar Farm Site at Bulls Lodge.
Topography	The majority of the Longfield site is south facing with some gently sloping areas or generally flat, with a small area of north facing slopes in the north of the Longfield site.
Field Shape	The majority of the Longfield site is formed of large regular fields, suitable for solar development.
Number of Landowners	A single landowner (for the Solar Farm Site).
Landscape and Visual	The Longfield site is not located within any landscape designations. There are various woodland blocks located adjacent to the Longfield site which provide containment and screening to views in and out of the Longfield site.
Residential Amenity	The closest settlement to the Longfield site is Terling, located approximately 550m east. There are some residential properties and isolated farmsteads located close to the Longfield site.
Heritage	The Longfield site is located 120m to the west of Terling Place Registered Park and Gardens. Terling Conservation Area is located within 800m of the Longfield site. There are a number of Listed Buildings near to the Longfield site which will need to be considered.
Ecology	There are no ecological designations within the Longfield site although several national and local designations including various Ancient Woodland blocks, the River Ter SSSI, and a number of Local Wildlife Sites are in close proximity. In addition, there are various non designated woodland blocks and ponds within or adjacent to the Longfield site.
Flood Risk	Lies largely in Flood Risk Zone 1 with small areas of Flood Risk Zones 2 and 3 in the north.
Public Rights of Way (PRoW)	Several PRoW cross the Longfield site although these are fragmented and lacking connectivity in places.

Transport and Access	The Longfield site is located to the north of the A12 carriageway with good connection routes locally.
Agricultural Land Classification	Whilst the high-level mapping undertaken in 1982 classified the Longfield site, and much of the county of Essex as Grade 2 or 3, the landowner advised, from decades of experience of yields from the land, that the fields within the Longfield site were likely to be of lower quality. An Agricultural Land Classification (ALC) survey subsequently identified some Grade 2 and 3a land, along with a greater proportion of Grades 3b and 4.

3.3.12 The Longfield site is situated within the optimal 5km of the Bulls Lodge Substation and provides a developable area with the ability to accommodate a large-scale solar scheme. It was deemed a suitable option to move forwards with designing a scheme and looking at an Environmental Impact Assessment (EIA) with a view to preparing an application for a DCO.

3.4 Alternative Layouts

Introduction

3.4.1 Prior to arriving at the proposed Order limits, there were several stages of design evolution, during which the original area of the Longfield site was refined. That process of design evolution has been informed by ongoing environmental assessments, engineering and design considerations, as well as engagement with stakeholders. At the EIA Scoping stage, the area under consideration (The Scoping Boundary, shown in Figure 3-1) comprised an area of 582 ha to ensure that the maximum potential area for the Scheme was considered. The same area was considered at the non-statutory consultation stage, and then refined ahead of the statutory consultation and preparation of the Preliminary Environmental Information (PEI) Report, through technical surveys, site visits and assessments, design development and having regard to feedback coming out of the non-statutory consultation. The area under consideration in the PEI Report comprised a reduced area of 474 ha (the PEI Boundary).

3.4.2 The surveys undertaken that influenced the reduction from the Scoping Boundary to the PEI Boundary were:

a. Agricultural Land Classification;

b. Landscape and Visual;

c. Cultural Heritage; and

d. Ecology.

3.4.3 Capacity was also a consideration as the Applicant's aim is to make efficient use of the land area in terms of generating the largest annual yield Megawatt hours (MWh) for the available developable area, once due consideration is given to environmental and social constraints.

3.4.4 Following publication of the PEI Report and completion of statutory consultation, the PEI Boundary was further refined to the area now proposed as the Order limits, being an area of 453 ha that is illustrated in Figure 1-2 [**EN010118/APP/6.3**] and described in ***Chapter 2: The Scheme***

[**EN010118/APP/6.1**]. Further details on the progression of the Order limits and design are provided below.

Progression of the Order limits and Scheme Design

3.4.5 The layout of the Scheme has evolved iteratively taking into consideration environmental effects, the environmental policy objectives and Scheme functionality, and feedback from stakeholders and public consultation.

3.4.6 The purpose of this section is to describe the alternative layouts considered for the Scheme to date. The Design Statement submitted with the Application further explains the design evolution of the Scheme. **Table 3-2** summarises the main design layout iterations considered for the Scheme. The following figures illustrate the changes in terms of land area:

Figure 3-1	EIA Scoping Boundary
Figure 3-2	PEI Report Site Boundary
Figure 3-3	Statutory Consultation Boundary
Figure 1-2	Order limits

Table 3-2: Main Design Iterations for the Site

Stage	*Proposed Site/Layout*	*Consultation and Surveys which influenced the proposed layout at this stage*	*Design evolution*
Scoping Boundary (Figure 3-1, 16 October 2020)	The site comprised a single parcel of land separated by several areas of woodland approximately 582ha in size. A preliminary layout was not illustrated in the Scoping Report.	This was a preliminary site boundary prior to extensive consultation with relevant stakeholders and therefore was not influenced by external parties.	The Scoping Boundary was defined with limited data from desk based and preliminary environmental surveys and was adopted with a view to including in the Scoping Report any land that could ultimately be within the Order limits. The intention was that the area would be further refined following surveys, environmental assessment, and consultation. No layout was illustrated in the Scoping Report.
Non-Statutory Consultation Layout (November / December 2020)	The area consulted upon was the Scoping Boundary.	Landowner discussions	The Non-Statutory Consultation Layout was a preliminary layout showing the key features of the Scheme, developed with the feedback from the EIA scoping process and ongoing landowner discussions. This layout showed three options for the siting of a National Grid Electricity Transmission (NGET) substation: one in the north of the Order limits located to the east of Fuller Street; one option directly to the north of Toppinghoehall Wood, in the southern part of the Order limits; and the final option shown as the connection to the existing Bulls Lodge Substation to the west of the Order limits.
PEI Boundary and Layout (Figure 3-2, March 2021)	The PEI Boundary comprised a single parcel of land separated by several areas of woodland approximately 459ha in size with a potential developable area for solar PV and battery of 293ha (referred to as the Solar Farm Site). This is a reduction in size from the Scoping Boundary.	Landowner discussions Non-statutory consultation feedback Agricultural Land Classification Surveys Geophysical Surveys Environmental Surveys including landscape and visual, ecology, heritage,	Following initial Agricultural Land Classification surveys and a geophysical investigation, the PEI Boundary was revised to remove a discrete parcel of land located to the south of Toppinghoehall Wood, immediately to the north of the A12. This land was identified as being Best and Most Versatile (BMV) land in entirety, and also as containing below ground archaeological assets. The northern part of the PEI Boundary between Sandy Wood and Fuller Street was excluded. The removal of this part of the PEI Boundary was facilitated by National Grid's decision not to progress the northern grid connection option presented at non-statutory consultation, and in response to feedback from stakeholders as part of the Landscape and Visual Impact Assessment.

Stage	Proposed Site/Layout	Consultation and Surveys which influenced the proposed layout at this stage	Design evolution
		noise, transport, and other topics forming the PEI Report. National Grid feedback regarding use of Bulls Lodge substation as Point of Connection.	Land north of the River Ter has been excluded from the Order limits to preserve the River Ter Valley character. Land to the south of Ringers Farm was proposed as set-aside and this was excluded from the Order limits after discussions with the landowner. This land also formed parcels of Grade 2, 3a and 3b agricultural land, so their removal resulted in further areas of BMV land being removed from the Order limits. Proposals to access the Scheme from local roads were removed in favour of a single site access location off Waltham Road due to the identification of Protected Lanes, and the desire to minimise disruption on the existing road network during the construction phase. The larger built elements of the solar farm, such as the Longfield Substation and BESS were carefully located in an area of existing screening provided by large woodland blocks. As a result of the strategic environmental design process the Scheme incorporated the following design principles: - Provision of generous buffers and offsets from existing landscape features such as ponds, hedgerows, woodland and Public Rights of Way. - New grassland and wildflower mixes were proposed under the panels to enhance the range of fauna, enhancing biodiversity and providing resource for pollinators. - The Scheme embedded new green infrastructure as a core design element, improving ecological and recreational

Stage	Proposed Site/Layout	Consultation and Surveys which influenced the proposed layout at this stage	Design evolution
			connectivity across the Order limits. This includes a new north/south green route, and new permissive paths. - Extensive and substantial tree, hedgerow and woodland planting, to increase connectivity. - The proposal for lower PV Tables in sensitive areas such as close to residential properties or heritage assets. A strategic environmental design was developed for the PEI Report to respond to the environmental opportunities and constraints of the site and non-statutory consultation feedback, particularly in relation to scale, proximity to existing residential areas, visual impact, and ecological and heritage assets. This identified developable areas for solar PV, battery storage and suitable locations for associated infrastructure as well as environmental mitigation. The proposed developable area for Solar PV was 293ha (the Solar Farm Site), with substantial areas identified as habitat, access, vegetation connectivity and associated infrastructure.
Statutory Consultation Layout (Figure 3-3, May 2021)	The area consulted upon was the PEI Boundary.	Feedback from stakeholders received during the preparation of the PEI Report	This was broadly the same as the layout shown in the PEI Report. Following further site investigation, additional areas of screening were shown across the site at statutory consultation, with the BESS and Longfield substation adjusted from the Non-Statutory Consultation Layout to fit between new proposed screening to the east and west. Significant areas of planting were proposed to mitigate the impact on local sensitive receptors following completion of the studies to inform the PEI Report and feedback from stakeholders during this process. Perimeter deer fencing areas were optimised to reduce run length whilst not further infringing on buffers to environmental sensitivities. More detail was developed on the access arrangements which was included in the consultation material (outside the PEI Report), including

Stage	*Proposed Site/Layout*	*Consultation and Surveys which influenced the proposed layout at this stage*	*Design evolution*
			ensuring all junctions allowed full HGV access to the site. Multiple new secondary tracks with HGV-capable turning areas were added to the layout included at statutory consultation to ensure all Potential Development Areas (PDAs as illustrated on The Works Plans [**EN010118/APP/2.2**]) had acceptable track access from the spine road; these new tracks, as well as the spine road, were re-aligned to make the site easier and quicker to navigate without sacrificing generation capacity.
Order limits and Application Layout (Figure 1-2, January 2022)	The Order limits comprises a single parcel of land separated by several areas of woodland approximately 453ha in size with a developable area of 275.26ha (referred to as the Solar Farm Site). This is a reduction in size from the PEI Boundary.	Landowner discussions Statutory consultation feedback and ongoing engagement with consultees/stakeholders	Following statutory consultation, several changes were made to the Statutory Consultation Layout, including: ▪ The removal from the Order limits of further fields and parts of fields that were formed of BMV land, including a section of the Order limits to the west of Toppinghoehall Wood (Grade 3a), and two fields to the north east of Ringers Farm (Grade 3a and 3b) PDA 24 and 25, which were also removed to protect the setting of the listed building at Ringers Farm; ▪ Further areas of agricultural land were retained within the Order limits but proposed development was removed from the layout of the Scheme, including a parcel of land to the north of White House Farm (Grade 3b), a field to the north of Little Weathers (Grade 3b), sections of land to the east of White Oak Cottages (Grade 3b), land to the north and east of Noakes Barn (Grade 3b), and land to the east of Buftons (Grade 3a). ▪ Dividing areas with different panel heights into separate PDAs following responses with concern for impacts on landscapes from visibility. ▪ Changes to secondary track turning heads for more efficient space usage. ▪ Changes to PDA 11 secondary track to mitigate the impact on an existing visibility splay. ▪ Widening of the spine road to 6m to enable access for abnormal loads required during construction phase.

Stage	Proposed Site/Layout	Consultation and Surveys which influenced the proposed layout at this stage	Design evolution
			▪ Undergrounding of existing overhead line to the east of Stocks Farm. ▪ Detail was added on the Bulls Lodge Substation Extension following confirmation of location and cabling. ▪ Increase in the buffer distance for Scheme infrastructure from existing grid pylons to 15 m. ▪ Amendments to proposed landscaping across the site following a review of PEI impacts with local councils. ▪ Offsets from properties were reviewed and adjusted through design development to respond to the existing character of views from residential properties. With reference to the Design Principles and Works Plans the Scheme design has been carefully sited where it would appear in views experienced by residents to avoid or minimise adverse effects ▪ 50m buffer added to Stocks Cottage, and greater buffers applied around other residential properties including at Noakes Barn, Leylands, Little Weathers, White House Farm, White Oaks, Buftons, and Ringers Farm. ▪ Cable route option refined to achieve preferable stakeholder and environmental results. ▪ 12m buffer added to the Grid Connection Route and BESS. ▪ Areas of Advanced Mitigation Planting have been agreed with the landowners and will be implemented prior to the grant of consent. ▪ Refinement of the Order limits to include the Bulls Lodge Substation Extension and associated access requirements, temporary construction compounds, and parking areas. ▪ Amendments to the SuDS design ▪ Inclusion of road verges and highways land for minor road widening.

Alternative Substation Locations

3.4.7 At EIA Scoping stage the preferred and expected position of a NGET substation extension at Bulls Lodge Substation was presented, with the option of a new substation in what was at that time the northern part of the Scoping Boundary to the immediate south of Hookley Wood and near Brickhouse Wood, or within the central part of the Scoping Boundary adjacent to Porters Wood / Toppinghoehall Wood. These three options are illustrated on **Figure 2-6** and were subject to feedback from stakeholders and National Grid, and technical and environmental feasibility work.

3.4.8 The location at Porters Wood / Toppinghoehall Wood was practical for the Applicant but would have led to significant impacts on the landscape and views from close range Public Rights of Way, Holts Lane and properties adjacent to Waltham Road. From an ecological perspective, Porters Wood Local Wildlife Site (LWS) and Toppinghoehall Wood LWS (both Ancient Woodland) are located immediately to the north and south of this option, with ponds located to the north and south in Porters and Toppinghoehall Wood and east with potential for great crested newts. This location was discounted primarily due to the expected significant visual effects in consultation with National Grid, as well as some ecological considerations and a greater proportion of BMV land (Grade 2).

3.4.9 The location south of Hookley Wood near Brickhouse Wood was remote from the Solar Farm Site and would have needed more cabling and potentially an internal haul road to enable construction traffic to construct it. It was expected to lead to localised changes to fields and character, being located in a part of the landscape where the character is of smaller historic villages and in an elevated position within the landscape. It would have been subject to views from close range Public Rights of Way, Braintree Road and the wider landscape. It was therefore discounted due to a combination of technical challenges, cost, environmental effects, greater land take of BMV land (Grade 3a), and feedback from National Grid on the practicality of delivering a substation at this location.

3.4.10 The chosen location at Bulls Lodge Substation requires additional cabling in the form of the Grid Connection Route but has an existing access via Generals Lane. Its association with the existing Bulls Lodge Substation would retain the existing landscape character. There were expected to be some views from Public Rights of Way, road networks and properties, but it would be seen in the existing context of the Bulls Lodge Substation and overhead lines. Background noise is currently influenced by the existing Bulls Lodge Substation, the railway line, and A12 carriageway, which lie to the south of the Order limits.

3.4.11 This option is located in a Minerals Consultation Area, which applies to the Bull Lodge Quarry, however no obvious potentially contaminative sites including current or historical landfill sites, have been identified for this option. This option was preferred by National Grid due to its relative simplicity and National Grid's statutory duty to aim to deliver the most economical and efficient solution for its consumers whilst taking into account its statutory environmental obligations. It was therefore selected as the option to take

forward in the Application, due to a combination of technical, cost, and environmental considerations.

3.4.12 The specific location of the Bulls Lodge Substation Extension, to the west of the existing Bulls Lodge National Grid Substation was selected because this part of the Order limits is situated furthest from residential receptors such as Brickhouse Farm, is already partly screened by the existing woodland at The Grove, and has existing access along Generals Lane.

Alternative Cable Route Corridors

3.4.13 Following a decision to proceed with the Bulls Lodge Substation Extension, an optioneering process was undertaken to identify a suitable cable route for the Scheme to connect the Solar Farm Site and Bulls Lodge Substation Extension.

3.4.14 As described in ***Chapter 2: The Scheme***, the Longfield Substation will convert electricity generated, imported and stored by the Scheme to 400kV for onward transmission to the National Grid via the Grid Connection Cables and the Bulls Lodge Substation Extension.

3.4.15 **Table 3-3** presents the evaluation criteria and factors for consideration applied to determining suitable cable routes and determining the most suitable route to include in the Application.

Table 3-3: Cable route corridor considerations

Criteria	*Considerations / Criteria*
Technical and engineering requirements	Optimising routing so the cable can be laid in a straight line or in shallow curves so that the cable can be pulled through the ducting efficiently. Space for jointing bays and pits. Working area for cable trenching. Areas of working (e.g. pits and construction compounds) for road, rail and river/watercourse crossings. Boring, micro-tunnelling or moling requirements – impacts on hydrology and watercourses and needing to adhere to the Environment Agency's specific guidance on watercourse crossings.
Planning and environmental constraints	Proximity to residential property. Avoidance of national ecological designations. Avoidance of national cultural heritage designations. Proximity to local ecological designations and sensitive ecological receptors. Proximity to public rights of way. Flood risk. Sensitivity of watercourse crossings. Avoidance/minimising impacts and sterilisation of minerals extraction areas and areas consented for working of minerals
Land use and ownership constraints	Affecting a minimum number of landowners. Following field edges in order to minimise possible disturbance for the landowner when farming or using land for other purposes.

Criteria	Considerations / Criteria
	Where possible reducing interaction on rail network or strategic road infrastructure, utilities and other infrastructure.

3.4.16 A total of 8 routes were identified by the technical design team as requiring further consideration: 6 routes and 2 additional minor variations. These all broadly followed a similar corridor, between the Solar Farm Site travelling in a south-westerly direction to the Bulls Lodge Substation Extension.

3.4.17 A key consideration for all routes was minimising ecological and hydrological disturbance, and land use; aiming to minimise the disturbance to the Minerals Safeguarding Area within which Hanson has permission to extract minerals.

3.4.18 Options for open trenching, moling, micro tunnelling and horizontal directional drilling (HDD) were explored for the watercourse crossings, with a technical preference for open trenching where possible, but a solution chosen to use HDD underground techniques was eventually agreed upon following further ecological survey work.

3.4.19 For the type of cable two alternatives were considered; a single-circuit 400kV cable and a double-circuit 400kV cable. A single circuit cable was chosen to minimise the amount of below ground intrusion and because it offers a more economical solution.

3.4.20 The Grid Connection Route is discussed further in ***Chapter 2: The Scheme***, i.e. the Grid Connection Route to the existing Bulls Lodge Substation.

Alternative Habitat Management Options

3.4.21 An alternative design option for the Scheme would have been to provide a minimum landscape design, and only seek to mitigate significant adverse visual impacts and to achieve a Biodiversity Net Gain (BNG) of around 10%. In developing the proposals for the Scheme, the Applicant identified opportunities to provide significant areas of landscape and biodiversity enhancements in order to maximise BNG. These were discussed and agreed with relevant statutory stakeholders such as Natural England and the Host Authorities. It also formed part of the Statutory Consultation, seeking feedback from the local community and other stakeholders on options for delivering habitat management and biodiversity enhancement.

3.4.22 The proposals to include significant areas of biodiversity enhancements and additional landscape elements were already well defined at the statutory consultation stage. This is described and illustrated in the Outline Landscape and Ecological Management Plan (OLEMP) [**EN010118/APP/7.13**] and within the Design Statement [**EN010118/APP/7.3**] and will be secured through the DCO Requirements.

3.4.23 Given the availability of land and potential for betterment, it was not considered appropriate to only seek to mitigate significant visual effects and achieve the minimum policy expectations. The Outline Landscape and Ecological Management Plan (OLEMP) illustrates the extensive planting and habitat enhancement proposals, and the Biodiversity Net Gain Report

[**EN010118/APP/6.5**] demonstrates that the Scheme will achieve 79% net gain for biodiversity.

3.5 Alternative Technologies

3.5.1 As described in ***Chapter 2: The Scheme***, the parameters of the Application will maintain some degree of design flexibility under the Rochdale Envelope to allow the latest technology to be utilised at the time of construction. Notwithstanding this, several technological design options have been considered and preferred options taken forward taking into consideration environmental effects and the Scheme's objectives and need for optimal functionality.

3.5.2 As described in Schedule 1 of the DCO [**EN010118/APP/3.1**], and ***Chapter 2: The Scheme***, the design elements have been placed within discrete Work Numbers. These are:

a) Work No. 1: Solar Photovoltaic Generating Station up to 275.26ha, known as 'The Solar Farm Site' for ease of refence throughout this ES;

b) Work No 2: Battery Energy Storage System (BESS) up to 5.2ha

c) Work No 3: Longfield Substation: up to 1.66ha;

d) Work No 4: Grid Connection Route including access tracks (Work No 4A) and temporary construction laydown areas (Work No. 4B): up to 22.90ha;

e) Work No. 5: Bulls Lodge Substation Extension including electricity switching station (Work No. 5A up to 4.62ha) and temporary overhead line alterations (Work No. 5B up to 3.72);

f) Work No 6: works (up to 370.09ha) including

- electrical cables including electrical cables connecting to Work No. 1 to Work No. 3;
- fencing, gates, boundary treatment and other means of enclosure;
- works for the provision of security and monitoring measures such as CCTV columns, lighting columns and lighting, cameras, weather stations, communication infrastructure, and perimeter fencing;
- landscaping and biodiversity mitigation and enhancement measures including planting;
- improvement, maintenance and use of existing private tracks; and
- laying down of internal access tracks, ramps, means of access, footpaths, permissive paths, cycle routes and roads, including the laying and construction of drainage infrastructure, signage and information boards;
- temporary footpath diversions;
- earthworks;
- SuDs Ponds, runoff outfalls, general drainage and irrigation infrastructure and improvements or extensions to existing drainage and irrigation systems;

- up to 10 secondary temporary construction compounds, both within the permanent work area and outside the permanent work area;
- works to divert and underground existing electrical overhead lines.

g) Work No 7: Temporary construction and decommissioning compounds (Work No. 7A, up to 6.9ha), secondary temporary construction compounds within the Solar Farm Site (part of Work No. 6), and temporary construction laydown for the Bulls Lodge Substation Extension (Work No. 7B, up to 7.21ha);

h) Work No 8: Ancillary Buildings, being office, warehouse and plant storage building: up to 0.61ha;

i) Work No. 9: Works to facilitate site access to the Solar Farm Site and the Bulls Lodge Substation Extension up to 5.11ha; and

j) Work No. 10: Habitat Management Areas: a minimum of 55.8ha.

3.5.3 There are many alternative types of technology available for consideration when designing a Solar Farm, and technology is constantly evolving and changing such that it is expected that other alternatives may become available during the Application process. Therefore, there is a need for flexibility and this ES takes a 'Rochdale Envelope' approach to the assessment, as set out in *Chapter 2: The Scheme*. Each chapter in the ES assesses the 'worst case' scenario for their environmental topic.

3.5.4 The text below sets out the design elements and alternatives considered throughout the design process relative to Work Numbers 1 and 2, which are the Solar Farm Site and BESS. There were few substantial technological alternatives considered for Work Numbers 3-10, other than the potential for an overhead line instead of a buried Grid Connection Route and minor iterations of the design for the Bulls Lodge Substation Extension. Works Numbers 4 and 5 on the Grid Connection Route and Bulls Lodge Substation Extension are also discussed in Section 3.4 above.

Solar Farm Site

3.5.5 The Solar Farm Site comprises elements such as PV modules and tables and the Balance of Solar System (BoSS) including Solar Stations, inverters, and transformers. To maintain flexibility in the assessment and within the Application, both string inverters and central inverters have been considered within the ES to allow for changes in technology and efficiencies.

Table 3-4: Solar Farm Site

Design element	*Configuration*	*Alternative Considered*
PV panels	Mono- or bifacial panels	The application allows for use of single (mono) facing or bifacial panels, with the latter being typically slightly more transparent and with the ability to absorb sunlight on the underside of the panel. It was not considered that this option would affect the EIA.
	Colour of panels	Dark blue, grey, or black in colour. It was not considered that this option would affect the EIA.
PV Table	South-facing	East to west orientated panels were considered and included as an option at the EIA Scoping stage. This

		was discounted due to a combination of economic factors, the lower biodiversity benefits that can be achieved under the denser panel configuration, and the higher traffic numbers that would be needed to deliver the additional panels. A south facing orientation was therefore selected as the preferred option with lower environmental impacts.
	Fixed slope	Alternative angle options considered include single- and dual-axis trackers which are capable of optimisation by following the sun's movements; these can be overall less efficient due to the increased space requirements per table, as well as being less economically viable in the UK and typically being higher than fixed panels. It was considered that a fixed slope orientation would maximise the renewable energy generation without leading to greater environmental impacts.
	Height	The EIA Scoping Report allowed for panels up to 3.6m height above ground level. A range of panel heights and angles was considered but feedback from Heritage and Landscape assessments influenced the final decision to install PV Tables of up to 3m in height.
Solar Stations	Central and strong inverters	Central and string inverters were considered, as well as more complex options which combine inverter, transformer, and switchgear functions. The DCO application is retaining the flexibility to consider both options prior to construction of the Scheme due to anticipated technical advances.

Battery Energy Storage System (BESS)

3.5.6 Battery storage is a rapidly evolving technology and improvements to factors such as cost, efficiency, duration, and safety are expected between the time of submission and construction. The Application therefore seeks to keep the technological possibilities open so far as reasonable.

Table 3-5: Battery Energy Storage System

Design Element	*Configuration*	*Comment*
Type of battery storage technology: DC coupling (decentralised) or AC coupling (centralised)	Centralised BESS	The installation of a centralised AC-coupled BESS has been selected due to the consideration that a single location for the BESS allows for structural planting to provide landscape and visual screening and enhancement measures, avoiding the introduction of large units throughout the Order limits (decentralised) which would be more unsightly and more difficult to screen.
Heights for battery storage	4.5m height	The height of the battery storage facility was originally proposed to be up to 9m to allow for the double stacking of the container units. This has been reduced to 4.5m to minimise the visual impact of the containers and still allow for the height of a standardised battery storage container, which most technologies use, with some headroom to accommodate all potential technology providers. This height also retains flexibility to enable the containers to be mounted on some form of raised structure or foundations to

	enable cables to enter from the underside. Heating and cooling infrastructure could also be installed on the top of the containers if necessary.

Grid Connection

3.5.7 The preliminary design and Scoping Report allowed for an overhead line connection to the chosen substation location as an alternative to a buried cable. This would have been economically beneficial compared with a buried cable and easier to maintain but was considered likely to introduce new significant effects on landscape, visual amenity, and heritage, which could have been avoided by burying the cable. A decision was therefore made to opt for an underground cable connection.

3.5.8 In terms of considering the precise location for the required NGET substation infrastructure, two locations for a new, separate NGET air insulated switchgear substation to the east and north east of the existing NGET Bulls Lodge Substation were considered. Both locations would, however, have been wholly on land within the Minerals Consultation Area and likely to have increased visual impact. The use of gas insulated switchgear presented the possibility to extend the existing Bulls Lodge substation instead of building a separate new substation and required a much smaller footprint. It therefore minimises the land requirement within the Minerals Consultation Area and any potential visual impact. Accordingly, the decision was taken to use gas insulated switchgear to extend the existing substation as proposed in the application.

3.6 References

Ref 3-1 Department of Energy and Climate Change (DECC), (2011) National Policy Statement for Energy (EN-1),

Ref 3-2 Department of Energy and Climate Change (DECC), (2021) Draft National Policy Statement for Energy (EN-1)

Ref 3-3 DECC (2011) National Policy Statement for Electricity Networks Infrastructure (EN-5),

Ref 3-4 Ministry of Housing, Communities and Local Government (MHCLG) (2019) National Planning Policy Framework,

Ref 3-5 Intergovernmental Panel on Climate Change (October 2018) ‘Special Report on the impacts of global warming of 1.5°C above pre-industrial levels’

Ref 3-6 Committee on Climate Change (May 2019) Net-Zero: The UK’s contribution to stopping global warming’

Ref 3-6 Her Majesty’s Stationary Office (HMSO) (2017) The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017.