Fosse Green Energy

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Fosse Green Energy

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9.12 Solar Technology Technical Guide (Clean)

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Regulation 8(1)(k)

Infrastructure Planning (Examination Procedure) Rules 2010

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Development Consent Order 202[ ]

9.12 Solar Technology Technical Guide

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1. Introduction

1.1.1 An application (the Application) was made to the Secretary of State for Energy Security and Net Zero for a Development Consent Order (DCO) under section 37 of the Planning Act 2008 (PA 2008) for Fosse Green Energy (the Proposed Development). The Application was submitted by Fosse Green Energy Limited (the Applicant) on 18 July 2025 and was accepted for examination on 15 August 2025. The examination into the Application commenced on 6 January 2026.

1.1.2 The Proposed Development will comprise the construction, operation (including maintenance) and decommissioning of a ground-mounted solar photovoltaic (PV) electricity generating station with battery storage, onsite substation and associated infrastructure to generate and export/import electricity.

1.1.3 The associated infrastructure includes, but is not limited to, access provision, underground cabling, areas of landscaping and biodiversity enhancement, and a 400 kilovolt (kV) underground grid connection cable circuit (approximately 10 kilometre (km)), connecting to an existing section of the National Electricity Transmission System (NETS) at a proposed National Grid substation near Navenby.

1.2 Purpose of this Technical Guide

1.2.1 This Solar Technology Technical Guide (Technical Guide) sets out the Applicant's response to the Examining Authority's First Written Questions, published on 16 January 2026 **[PD-011]**, that relate to solar technology. The Written Questions addressed are set out in Table 1-1 below with a signpost to where the detail is contained in this Technical Guide.

Table 1-1 Signpost for Written Questions

Written Question	Technical Guide Signpost
GC 1.01 Although the applicant explained what notifications it had received from NESO during ISH1, in response to one of the ExA's questions, it would nevertheless assist the ExA and potentially other interested parties, if the applicant would provide an explanation of what the timescales for the offers confirmed under Gates 1 and 2 might mean for the delivery for the proposed development.	Section 11.2
GC 1.02 - Conversion of generated direct current (DC) electricity to exportable (AC) electricity	Section 8

Conversion of generated direct current (DC) electricity to exportable (AC) electricity Provide a worked calculation or calculations, using any non-technical language as necessary, demonstrating the losses of electrical power involved in converting DC electricity generated by the proposed solar panel arrays to AC electricity capable of being exported to the national transmission system (NTS). The calculation(s) should demonstrate any power losses at each of the following stages: a) converting generated electricity from DC to AC via inverters; b) stepping up the voltage of the generated electricity to a level cable of being exported to the NTS; and c) charging and discharging the proposed battery energy storage system (BESS).	
GC 1.03 - Generating output for the proposed development and relationship with the secured grid connection limit Generating output for the proposed development and relationship with the secured grid connection limit Provide the predicted electricity generating output, expressed in megawatt hours (MWh) for the proposed development for every hour in a typical calendar year (365 days/8,760 hours duration). In answering this question the applicant should also provide for a calendar year predictions for: a) the total number of hours in a year when the proposed development would be expected to generate electricity in excess of the secured grid limit of 240 megawatts (MW) (paragraph 2.1.2 in the Grid Connection Statement [APP-200]); and b) the total number of hours in a year when the proposed development would be expected to generate electricity at levels below the secured grid connection limit, for each of the following percentage bands: 0 to 9; 10 to 19; 20 to 29; 30 to 39; 40 to 49; 50 to 59; 60 to 69; 70 to 79; 80 to 89; and 90 to 99%.	Section 8
GC 1.04 - Justification for the proposed solar array overplanting ratio of 1.6 In paragraph 7.5.2 of the Statement of Need [APP-184] it is stated that an overplanting ratio of 1.6 has been applied to the design for the proposed solar array areas, resulting in a maximum installed capacity of 385MW DC* (for the fixed south facing solar panel option). Provide the justification for needing to apply an overplanting planting	Section 5

ratio of 1.6 to the scaling for the proposed solar arrays, given a grid connection offer of 240MW has been secured (paragraph 2.1.2 in [APP-200]).

** Note that the DC capacity of 385MW in this question is now 381MW following the Change Request [AS-103]*

GC 1.05 - Comparison between the proposed development and other utility scale solar farms For each solar farm that is the subject of a made DCO or is currently at the application stage (accepted and is in pre-examination, in examination, in reporting or being determined) identify: a) The gross land area b) The net area for the solar arrays c) The overplanting ratio d) The net area identified for biodiversity net gain (BNG) provision e) The confirmed/anticipated generating capacity in MW for the solar arrays f) The confirmed/anticipated generating output in MWh or the secured transmission system or district network connection limit if the anticipated generating output has not been publicly stated g) Whether a BESS has been consented/proposed and the capacity of any consented BESS. **The Examining Authority has not requested that the response to this written question is included in this Technical Guide but it has been included nonetheless for completeness.*	Section 10

GC 1.06 - Solar panel performance degradation In paragraph 6.4.67 of Chapter 6 (Climate Change) of the Environmental Statement (ES) [APP-031] an explanation for the expected degradation rate for the solar panels (modules) to be installed as part of the proposed development is given, namely 2% for year one of the proposed development and then 0.45% for each year between year 2 and year 30. It being envisaged that the originally installed modules would be replaced from year 31 onwards. a) For a solar module with a generating capacity of 670 watts (the illustrative design referred to in paragraph 3.3.6 of Chapter 3 of the ES [APP-028]) provide a worked calculation for the performance degradation for the solar module for each year of its anticipated 30 year life, assuming 2% degradation in year one and 0.45% degradation in each of the subsequent years through to year 30. b) Explain what accounts for a 2% reduction in panel performance in year one relative to a 0.45% reduction in performance in subsequent years. Clarify whether with the assumed panel replacement from year 31 onwards it would be correct to apply a performance degradation factor of 0.45% for year 31 and all subsequent years or whether a higher factor should be applied to year 31 and then 0.45% in all subsequent years.	Part a – Section 5.2 Part b – Section 11
GC 1.07 - Justification for the scale of the proposed BESS The grid connection offer for the proposed development would allow for the export or import of up to 240MW. Paragraph 3.3.33 of Chapter 3 of the ES [APP-028] states that the proposed BESS would have a capacity of up to 480 MWh. Explain the justification for the proposed BESS having a capacity that would be twice the grid connection limit that has been secured. In answering this this question, the applicant should: a) Identify typically how long it would take to fully charge and fully discharge the proposed BESS b) Comment on whether the generating station (solar arrays) element of the proposed development would or would not be financially viable without a BESS. c) If the answer to part b) of this question is no, identify the minimum capacity for a BESS that would be needed	Section 11.4

to render the generating station element of the proposed development viable. d) Comment on whether the BESS of the scale proposed within the submitted application would or would not accord with the principles for associated development set out in paragraph 5 of the 'Guidance on associated development applications for major infrastructure projects' (Department for Communities and Local Government, April 2013). e) In terms of the operational revenue expected to be earned by the proposed development identify the proportion (percentage) arising from: the generation of electricity on-site, inclusive of any of that electricity that would be stored in the BESS prior to it being exported to the national transmission system; and the importation and exportation of electricity generated by a generating station other than that forming part of the proposed development.	
GC 1.08 - Generating output for the proposed BESS relative to the proposed solar arrays In paragraph 6.4.76 of Chapter 6 of the ES (Climate Change) [APP-031] it is stated *"Should the BESS be charged from the Proposed Development, and discharged back into the grid once each day, at a typical round-trip efficiency of 85% and an overall lifetime degradation rate of 80% (accounting for replacements), it will be able to supply 7,985 GWh to the electricity grid over its 60-year operational lifetime. As the lifetime generation figure of the BESS is significantly less than that of the Proposed Development, it is reasonable to assume that the battery will only store and discharge energy generated by the Proposed Development."* In paragraph 6.4.67 of [APP-031] it is stated that the proposed solar arrays would have *"…a total energy generation figure of 19,438,499 MWh over the assessed 60-year Proposed Development lifetime".* The ExA notes that the generation output figures for the solar arrays and the BESS have been quoted using different units, respectively megawatt hours (MWh) and gigawatt hours (GWh). If the anticipated generating output for the BESS is converted to MWh (7,985,000 MWh), and 7,985,000 MWh would be around 41% of the anticipated generating output for the proposed solar arrays, is it correct to say that the generation output for the BESS would be significantly less than the projected output for the proposed solar arrays. Would the capacity of the proposed BESS, as proposed associated development,	Section 11.5

"… be proportionate to the nature and scale of the principal development" (paragraph 5(iv) in Guidance on associated development applications for major infrastructure projects April 2013)?	
GC 1.09 - Operational safety of BESS Multiple interested parties have raised concerns about the operational safety of the proposed BESS, particularly with regard to the potential for thermal runaway to cause fires. Worldwide identify instances of BESS having caught fire, advising on where those incidents have occurred and giving the reason(s) for those incidents.	Section 11.6
GC 1.22 - Comparison between the generating outputs between the proposed development and the United Kingdom What contribution would the proposed development make to the predicted demand for electricity in the United Kingdom firstly at the point it would become fully operational (assuming full build out to accommodate the secured grid connection limit of 240MW) and secondly in 2050? In answering this questions any quoting of generating outputs should ensure that the same unit is used (MWh, GWh or Terawatt hours) for both the proposed development and the United Kingdom.	Section 9

1.2.2 This Technical Guide also provides a response to the Action Points from Issue Specific Hearing 1 **[EV2-014]**, held on 6 January 2026, for those action points that have not been replaced by Written Questions. Table 1-2 provides a signpost to where these actions have been addressed in this Technical Guide.

Table 1-2 Signpost for Hearing Actions from ISH 1

Hearing Action	Technical Guide Signpost
With respect to the land-take for the proposed solar arrays, identify the land area (in hectares and acres) and number of solar modules required for modules rated at 500 watts, 670 watts (candidate design), and higher rated modules in the range of 700-800 watts.	Section 2
Clarification about the estimated maximum power output (dc) for the Proposed Development with the installation of fixed south-facing and single axis tracker modules having regard to the numbers referred to in Table 3-1 in ES Chapter 3 The Proposed Development [APP-028]; and those in paragraphs 7.3.4 and 7.3.5 in Statement of Need	Section 4

(Rev 1) [APP-184]; and paragraph 6.4.31 ES Chapter 6 Climate Change [APP-031].	
Clarification about the overplanting ratio for the Proposed Development for fixed south-facing and single axis tracker modules.	Replaced with Written Question G1.04 Section 5
Clarification about the area of land proposed for occupation by solar arrays (by fixed south facing and single axis tracker modules) and whether the figures quoted would relate to the whole of field, or just those parts of fields covered by the proposed solar arrays.	Section 6
With respect to the efficiency of solar modules, clarify what the level: has historically been; is currently; and what it might be going forward for different types of module technologies.	Section 3
What contribution the Proposed Development would make to the predicted energy demand in the United Kingdom when it became fully operational in 2032/2033 and for 2050.	Replaced with Written Question GC 1.22 Section 9
Clarify the figures quoted in the Environmental Statement for the lifetime generating outputs of the proposed solar arrays and BESS (respectively 7,985GWh for the BESS and 19,500,000 MWh hours in paragraphs and 6.4.76 and 6.4.67 in ES Chapter 6 Climate Change [APP-031] so that they are stated in the same units. Address whether it can be assumed that the BESS would only store and discharge electricity generated by the Proposed Development, as set out in the Environmental Statement, and the output from the BESS would be significantly less than from the solar arrays.	Replaced with Written Question GC 1.06 Sections 7 and 11.5
Provide estimates for: a. how many days each year the output from the proposed solar arrays would exceed the capacity of the grid connection; and b. what proportion of electricity generated by the solar arrays would be “clipped” (i.e. exceed that which can be transmitted via the grid connection).	Replaced with Written Question GC 1.03 Section 8

1.2.3 In addition, this Technical Guide also provides a response to Action Point 2 from Issue Specific Hearing 3 **[EV5-002]**, held on 11 and 12 March 2026.

Table 1-3 Signpost for Hearing Actions from ISH 3

Hearing Action	Technical Guide Signpost
Submit an updated version of the **Solar Technology Technical Guide [REP2-033]**: Explaining the logistics of how the battery energy storge system is managed, including the most efficient way to utilise battery storage, noting seasonal variation, weather variation, and how that relates to when there may or may not be much solar in the electricity system.	Section 12
Explaining the difference between Nominal Operating Cell Temperature (NOCT) and Standard Test Conditions (STC) in lay persons' terms and explain the overplanting ratio differences between NOCT and STC.	Section 5.3
Amend the entry in Table 10-1 for the Little Crow solar farm to refer to that development having a grid connection capacity limit of 99.9MW (AC).	See Table 10-1

2. The Impact of Module Capacity on Development Footprint

2.1.1 The Applicant has been asked to provide a summary of *"how the footprint of the Proposed Development might look using different capacity modules, for example 550W and 750W, compared with the default 670W modules used for the DCO application. The ExA expectation is that less land will be required if the modules are a higher capacity. The Note will need to also explain why flexibility is needed at this stage on module capacity, and how module sizing and inter row spacing plays into these assumptions."*

2.1.2 The table below shows the dimensions and power output of two modules with the same efficiency that are available on the market currently. As can be seen in the table when two modules have the same efficiency the power output is directly proportional to the surface area of the module. Smaller sized modules have a lower maximum output, and larger sized modules have a higher maximum output. Therefore, if a lower power output module is used in place of a higher power output module, (assuming they have the same efficiency), the Proposed Development would comprise a larger number of smaller modules as opposed to a smaller number of larger modules to achieve the proposed DC capacity. However, the total area of modules in each composition would be the same

Table 2-1 Example module dimensions and power outputs

	465W Module	725W Module	Difference when using 725Wp
Surface Dimensions	1762 x 1134	2384 x 1303	725W modules are larger
Efficiency	23.3%	23.3%	None
Surface Area per module	2.00	3.11	~1 m^2 per module
W/m^2	465 / 2 = 232.5	725 / 3.11 = 233.1	Only 0.25% difference in W/m^2 between the two modules
Number of modules required for 100kWp	215	138	77 fewer modules using 725W modules. Almost identical total panel surface area between the two layouts

2.1.3 In other words, as the output power (Wp) of a PV module decreases, the surface area of each module also decreases, and the land area required for each module also decreases. However, this does not mean that the proposed Development would take up less land area in total, because a greater number of modules would be required to meet the proposed DC capacity of the scheme.

2.1.4 In summary, for schemes comprising modules of the same efficiency but different rated power outputs, the overall land take of the scheme will stay largely unchanged.

2.1.5 Flexibility is crucial in the detailed design stage to maximise the specific yield of the system and to allow for the system to be optimised to the technology and module types available at the time of construction.

2.1.6 Specific yield describes how much energy the solar farm produces relative to its installed capacity e.g. how many MWh are expected to be generated per year per MWp (DC) installed.

2.1.7 However, the module layout can be optimised to maximise the specific yield for a given land take. This can be achieved by increasing the row spacing and the module pitch, even if this means fewer modules can be installed within the agreed land take. This reduces row-to-row shading effects, improving system performance and the specific yield. Optimising a scheme layout allows the greatest quantity of energy to be generated from the suitable land available to the scheme, thereby maximising the decarbonisation, energy security and affordability benefits brought forward by the scheme.

2.1.8 This is the primary reason why the secured parameter for the scheme is the total land take of the corresponding Work Number (Work Number 1 as set out in Schedule 1 of the **Draft DCO [REP1-007]**) rather than a specific module number or DC capacity. The numbers provided within the Application were provided for sufficient project definition to enable environmental impact assessment to be undertaken.

2.1.9 Either of the modules shown in the table above would be compliant with the development parameters for the scheme, as set out in the **Proposed Development Parameters [REP1-029]**.

3. Module Efficiency Trends

3.1.1 This section of the Technical Guide provides an overview of Solar PV module efficiency trends relevant to the planned development of a ground mounted solar farm of approximately 454.5 Hectares (approximately 1,100 acres) being the area of Work Number 1 in the **Works Plans [AS-105]**). It is important to note that this section specifically discusses module efficiency, not cell efficiency.

3.1.2 Solar modules are made up of a collection of connected solar cells. Each individual cell has an efficiency rating, which describes how effectively it converts sunlight into electrical energy under standard test conditions. In contrast, module efficiency describes how the entire module performs, accounting for losses such as resistance in the interconnections and the layout of the individual cells across the surface area of each module (some area is taken up by the module frame, spaces between cells and cell busbars). The analysis in this section focuses on monocrystalline modules (current industry standard), with consideration of thin film modules[1] and also emerging perovskite silicon tandem modules.

3.1.3 Polycrystalline modules are not commonly used because they are outperformed by monocrystalline modules, therefore they have not been considered in this analysis.

3.1.4 The aim of this section is to support technology selection for an installation targeted around 2030, ensuring that the project maximises energy output whilst maintaining long term affordability for consumers.

3.1.5 Although solar PV exhibits lower conversion efficiency than many other electricity generating technologies used in the UK, this should not be viewed as a disadvantage. Solar energy benefits from an abundant, predictable, renewable low carbon and free energy source with no marginal carbon emissions, no long-term waste and minimal mechanical complexity. These characteristics underpin its suitability for large scale deployment despite lower conversion efficiencies.

3.1.6 Monocrystalline modules continue to dominate global PV technology. Efficiency improvements have been steady, historically rising by roughly 0.3-0.4% per year. Commercial module efficiencies today typically fall in the range of 21-23% for mainstream monocrystalline modules, with advanced architectures achieving slightly higher values in the range of 24-25%. [REF-1]

3.1.7 Recent market examples illustrate this trend, for example, a module released in 2020 offered around 21.3% efficiency, while a 2023 model from another manufacturer reached 23%. These incremental improvements reflect the broader industry trajectory. [REF-3]

3.1.8 The Applicant anticipates that, by 2030, silicon modules may achieve efficiencies in the region of 25-27%, representing a linear continuation of

[1] Thin film modules are lightweight and flexible. They use a thin layer of semiconductor in place of silicon wafers used in traditional modules.

efficiency gains recently realised. However, the Applicant cannot assume that expected gains will materialise in time to considered for use as part of the Proposed Development. Therefore, the Applicant has designed the Proposed Development using the best currently available technology on the market. Future gains are expected to be incremental rather than via any large transformative leap, therefore the Applicant does not expect there to be any land within Work Number 1 'left over' after optimisations at the detailed design stage, even if module efficiencies increase according to the expectations referenced.

3.1.9 Thin film modules currently achieve 17-19% efficiency [REF 1], with projections suggesting values of 22-24% by 2030. However, thin film modules require more land area for the same installed capacity due to lower efficiency.

3.1.10 Perovskite silicon tandem modules are an emerging technology with significant long-term potential. Laboratory cells have already exceeded 30% efficiency [REF 2], and early commercial module efficiencies may reach the high 20% range by the end of the decade. However, these technologies are currently still in early pilot production. Although modules in the 24-25% efficiency range are now available, they typically carry a significant price premium. A small efficiency gain of 1-2% can result in disproportionately higher module cost, without delivering a corresponding reduction in Levelized Cost of Energy[2] (LCOE) [REF 3]. In addition to this potential cost increase the availability of the highest output panels can be limited as production capacity of these modules cannot be guaranteed by the Applicant to be widely available at the time of construction and therefore, has based the Proposed Development on modules that will be available at the time of construction.

3.1.11 This means that the highest efficiency modules do not necessarily produce the lowest-cost energy and over-specifying efficiency can reduce the project's ability to deliver affordable energy.

3.1.12 Mainstream monocrystalline modules with efficiencies in the 22-23% range, rather than the absolute highest efficiency modules, are currently considered to be the most cost-effective choice of module for large-scale schemes. These modules balance the aim of maximising generation versus the land take required; balancing these two factors is key in developing projects to deliver land-efficient and affordable energy to the grid.

3.1.13 Although higher efficiency modules allow a facility to install fewer modules for a given capacity, the total land coverage of a solar farm does not necessarily reduce. This is due to:

a. Shading and row spacing i.e. tighter spacing increases shading losses whereas greater row spacing reduces installed capacity but can improve overall yield.

b. Bifacial modules are expected to remain standard through 2030 and can increase rear side gains (dependent on ground reflectivity and shading

[2] "Levelised Cost of Energy (LCOE) is an important metric allowing all forms of generation to be compared with each other on a consistent basis. LCOE is calculated using a discounting methodology and is a measure of the lifetime unit cost of generation from an asset, including capital and operating costs. In-life capital and operating expenses, for example the re-powering of sites to manage anticipated degradation, are also anticipated.

conditions). This increases the yield that the system can achieve, but since wider spacing may be required to prevent self-shading, the land coverage may increase rather than reduce.

c. System layout can impact annual MWh output as much as small differences in module efficiency. Increasing efficiency does not proportionally reduce the area required for racking, inverters, access tracks, or maintenance corridors.

3.1.14 Long term energy yield is influenced by both initial module efficiency and degradation rates. Monocrystalline modules typically degrade at around 0.45 per year after an initial Light Induced Degradation of around 2% in the first year. Thin film modules may have lower degradation rates which partially offset their lower efficiency rate.

3.1.15 The PV market is characterised by rapid technological evolution and therefore module dimensions, efficiency, degradation rates, and availability may all change significantly between now and 2030.

3.1.16 Monocrystalline modules are expected to remain the most reliable and cost-effective option for utility scale solar farms through 2030, with expected efficiencies in the 25-28% range. While higher efficiency modules exist, their cost premium means they do not necessarily offer the lower LCOE.

3.1.17 System design, degradation rates, and site optimisation are equally important in determining the total energy yield of a scheme. Given the pace of PV technology development, maintaining flexibility in module selection is essential since it will ensure the project can respond to market conditions and strike the best balance between cost, performance and reliability at the point in time when the project comes forward.

3.1.18 The range of land area required for each MW of output provided as guidance increased from 2-4 acres per MW (0.8 – 1.6 ha per MW) installed (National Policy Statement for Renewable Energy Infrastructure (EN-3) (NPS EN-3) (2023), Para 2.10.17) to 4 - 5.6 acres per MW (1.6 – 2.26 ha per MW) (NPS EN-3 (2025), Para 2.10.9). The indicative design provided at Examination for the Proposed Development utilises 2.95 acres per MW (1.19 ha per MW) for the solar development areas (Works Number 1 of the **Works Plans [AS-105]**), based on the maximum footprint allowed in the Application. When calculating this the DC capacity has been used, in line with the methodology used and agreed by the ExA and SoS in previous solar NSIPs. The Applicant has compared the Scheme against other solar NSIPs consented or pending determination and confirms that they all fall within the suggested guideline range of 2-4 acres/MW. Other SAT projects that have been examined (Mallard Pass Solar Farm, Cottam Solar Farm, and West Burton Solar Farm) range between 2.5 and 2.9 acres/MW. The Applicant has also reviewed Byers Gill Solar and Tillbridge Solar which are also SAT configuration. Insufficient information exists in the application documents to accurately determine the land use ratio but based on the Works No 1 for solar PV for Byers Gill covering 1032 acres and an 180MWac grid offer (assuming it is overplanted by 1.3) gives a ratio of 4.4 acres/MW. Tillbridge Solar Works No 1 for solar PV covers a developable area of 1,827 acres and has a connection offer of 500MWac (assuming 1.3 overplanting ratio), giving a ratio of 2.8 acres/MW. The land use efficiency therefore aligns with the guideline in the NPSs.

4. Peak Capacity for Fixed South Facing (FSF) and Single Axis Tracker (SAT) layouts

4.1.1 The applicant has been asked to provide clarification on the estimated maximum power output (dc) for the Proposed Development. The scheme has been based on the DC capacities being 381MWdc for the Fixed South Facing (FSF) layout and 317MWdc for the Single Axis Trackers (SAT). Typically, the FSF can have a greater capacity per hectare than the SAT, but SAT typically has a greater yield (MWh) per MW installed. It should be noted that neither of these values are secured as part of the application; the parameter secured is the 454.8 hectares (1123 acres) of solar development area secured by the **Works Plans [AS-105]**. The capacity used for the assessment is based on a realistic scheme that can be developed within the **Proposed Development Parameters [REP1-029]** using currently available equipment. Should the Proposed Development be consented, the detailed design would use technology available at the time of design/construction but the area of work number 1 and development parameters would still form the basis of the implemented design.

5. Overplanting Ratio of Proposed Development

5.1.1 This section provides information on the overplanting ratio of the proposed development. At the end of this section, clarification relating to the role of the BESS is also provided.

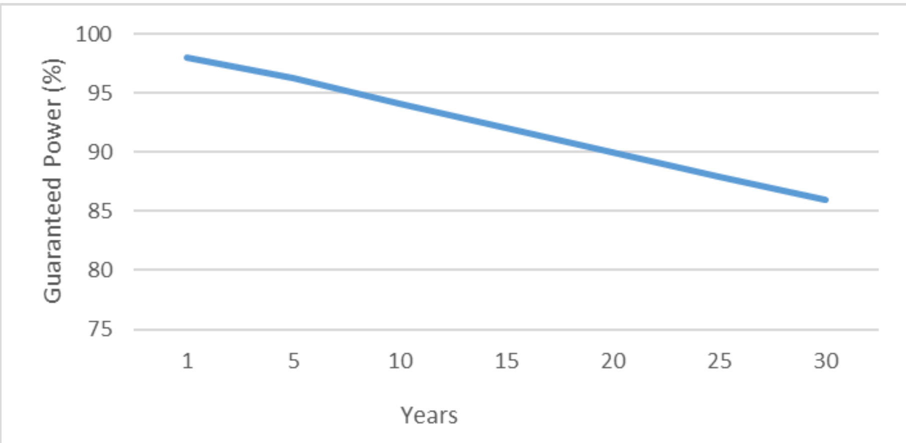
5.1.2 The overplanting ratio of the scheme for the FSF is 1.59 and for SAT is 1.32. It should be noted that these are the values used in the assessment of the scheme and are not secured by the DCO within the application. Once detailed design is undertaken, the overplanting ratio could change should it be shown to result in a more optimal option for the development.

5.1.3 The following section covering overplanting has been prepared, firstly to provide a typical degradation graph of a solar module and to provide some more context relating to the overplanting of the solar PV array areas for the Proposed Development. This section has been based on an FSF scheme with an initial overplanting ratio of 1.59 and includes the effects of degradation over time.

5.2 Module Degradation

5.2.1 Solar module degradation is higher in the first year (~2%) due to Light-Inducted Degradation (LID), which is caused by a module's first exposure to sunlight after being manufactured. Each year after this, the modules can be expected to degrade at a rate of approximately 0.45% per year per the module datasheet used for the indicative layouts, assuming an appropriate and consistent maintenance regime over the module's operating life (assumed to be 30 years). These assumptions result in a module power output after 30 years of approximately 87% of the original rated power output. Once modules are replaced in year 31, they will undergo the same 1-2% LID in year 31 followed by 0.45%/year for the remainder of their lifetime.

Plate 5-1: Typical solar module degradation curve



5.3 Overplanting

5.3.1 The output of PV modules is impacted by two key factors, the solar irradiance and cell temperature. Modules have two output ratings depicted on their datasheets, Standard Test Conditions (STC) and Nominal Operating Cell Temperature (NOCT).

5.3.2 STC output rating is used to allow for fair comparison across different PV modules, by using set values of irradiance and temperature when testing panel performance. The STC output rating as defined by IEC 61215, is an output at an irradiance of 1000W/m^2 and a cell temperature of 25°C. However, these values represent ideal laboratory conditions of peak sunshine and without any cloud cover, which is not representative of typical operating conditions experience in real solar installations in the UK.

5.3.3 To give a more realistic estimation of a panel's performance, the output rating is used. Unlike the STC, NOCT conditions consider that panels are usually much hotter and rarely receive perfect irradiance. NOCT output rating is the output assuming an ambient air temperature of 20°C, which equates to a cell temperature of around 45°C, almost double that of the cell temperature used in STC. The output rating is also derived using a lower irradiance value of 800W/m^2 and accounts for the likely occurrence of a light breeze by considering a wind speed of 1m/s.

5.3.4 In summary, the STC output rating is used for comparing different panels on an equal basis, whereas the NOCT output rating gives a more accurate estimation of energy production in real-life conditions.

5.3.5 The table below illustrates the difference between these rating conditions. For a module that measures 670Wp at STC, the output at NOCT will be ~502Wp. Real life conditions vary day-to-day; the NOCT operating conditions are an indication of typical performance and can therefore be exceeded on sunny days in the UK. Given the location of the Proposed Development and using available weather data for the simulation, the number of hours where the designed solar farm will experience irradiance exceeding the NOCT rating (800W/m^2) is 150 hours per year. This is based on the average irradiation over the hour being higher than 800W/m^2.

Table 5-1 Module Testing Parameters

	Standard Test Conditions	Nominal Operating Cell Temperature
Irradiance	1000 W/m^2	800 W/m^2
Cell Temperature	25°C	43°C
Air Mass	1.5	N/A
Windspeed	N/A	1 m/s

5.3.6 The table below shows the DC capacity and effective overplanting ratio (i.e. estimated peak generation capacity taking into account the effects of module degradation) from year 1 to 30 at both STC and NOCT conditions assuming a 2% LID and 0.45%/year degradation after year 1. For example, the End of Year 1 Effective Overplanting at STC is 1.56, i.e. 98% of the nameplate overplanting ratio of 1.59.

Table 5-2 Effective Overplanting ratio by year

End of year	Effective DC Capacity at STC (MWp)	Effective DC Capacity at NOTC (MWp)	Effective Overplanting at STC	Effective Overplanting at NOCT
Y1	373.55	279.89	1.56	1.17
Y2	371.87	278.63	1.55	1.16
Y3	370.20	277.37	1.54	1.16
Y4	368.53	276.12	1.54	1.15
Y5	366.87	274.88	1.53	1.15
Y6	365.22	273.64	1.52	1.14
Y7	363.58	272.41	1.51	1.14
Y8	361.94	271.19	1.51	1.13
Y9	360.31	269.97	1.50	1.12
Y10	358.69	268.75	1.49	1.12
Y11	357.08	267.54	1.49	1.11
Y12	355.47	266.34	1.48	1.11
Y13	353.87	265.14	1.47	1.10
Y14	352.28	263.95	1.47	1.10
Y15	350.70	262.76	1.46	1.09
Y16	349.12	261.58	1.45	1.09
Y17	347.55	260.40	1.45	1.09
Y18	345.98	259.23	1.44	1.08
Y19	344.43	258.06	1.44	1.08
Y20	342.88	256.90	1.43	1.07
Y21	341.33	255.74	1.42	1.07
Y22	339.80	254.59	1.42	1.06
Y23	338.27	253.45	1.41	1.06
Y24	336.75	252.31	1.40	1.05
Y25	335.23	251.17	1.40	1.05
Y26	333.72	250.04	1.39	1.04
Y27	332.22	248.92	1.38	1.04
Y28	330.72	247.80	1.38	1.03

Y29	329.24	246.68	1.37	1.03
Y30	327.75	245.57	1.37	1.02

5.3.7 As can be seen in the above table, the STC output rating results in output rating results in higher overplanting ratios than the NOCT output rating. This is because for the STC output rating, the DC rating is based on idealised conditions rather than real-world operating temperature and irradiance, meaning the power output predicted for the STC output rating is higher than that of the more realistic NOCT output rating values. Since the purpose of overplanting is to ensure that generating levels are maintained in the real world, it is NOTC output rating that is used to derive the level of overplanting required. After 30 years the effective overplanting ratio of the scheme based on NOCT values is just over the grid connection capacity of 240MW. One aim of the level of initial overplanting is to ensure that the scheme is capable of producing its rated grid connection output of 240MW at peak levels of irradiance throughout the 30-year expected lifespan of the modules. Table 5-2 also shows why the scheme has built in a module replacement as part of the DCO consent to enable the Proposed Development to deliver up to 240MW of power over its full 60-year consent period.

5.3.8 Figure 7.3 of the Statement of Need **[APP-184]** shows that an overplanted scheme exports more energy to the grid each year than a Unitary scheme, being one in which the capacity of modules (measured in MW(dc)) matches the export capacity of that scheme (measured in MW(ac)). Figure 7.3 of the Statement of Need **[APP-184]** shows that outside times of peak irradiance, the overplanted scheme will export more energy than the unitary scheme. However, at times of peak irradiance, some of the energy generated by the overplanted scheme will be lost because it cannot be exported through the grid connection (unless diverted to on-site storage for later export to the market when needed).

5.3.9 Overplanting up to the ratios anticipated at the Proposed Development are commercially rational and a solar development developed with the indicative overplanting ratio would perform to the modelled yield and connection capacity detailed above.

5.3.10 Solar schemes can come forwards as standalone schemes, or as schemes which are co-located with Battery Energy Storage Systems (BESS). On overplanted schemes, BESS can be used to store clipped energy (being energy generated in excess of the grid connection capacity) for later export to the grid. Any co-located BESS simply provides yet further benefit over and above the solar development in isolation.

5.3.11 The overplanting ratio does not account for losses through the solar stations, 33kV cable network, the substation transformers and the 400kV cable, these losses would be accounted for within the detailed design. Meaning that the installed capacity of solar modules would be determined to account for losses on the system, resulting in the grid connection capacity of the Proposed Development being achieved even after such losses have been considered.

5.3.12 By bringing forward a scheme which allows for overplanting and retains flexibility at delivery the Applicant is able to deliver a scheme which will generate a substantial quantity of low carbon generation from the land and grid connection available to the scheme to support the government in its aims to deliver a low-carbon, secure and affordable electricity system on the way to Net Zero by 2050. The levels of overplanting proposed have been fully assessed in the ES in line with the parameters assessed (i.e., the Rochdale envelope approach as explained in **Chapter 5 Environmental Impact Assessment Methodology** of the ES **[APP-030]**). If the Proposed Development was to come forward without overplanting, although it would still deliver substantial benefits to the Government's aims, the quantity of those benefits would not be as substantial as those arising from an overplanted scheme.

6. Clarification of Land Cover

6.1.1 The Applicant has been asked to clarify the area of land which is to be occupied by solar arrays. The areas shown on the **Works Plans [AS-105]** are larger than required during operation for a few areas, primarily to provide flexibility for the detailed design and construction activities. As shown below in Table 6-1, the area required for each work number will vary during construction and operation depending on the works required.

6.1.2 The following paragraphs summarise each work number and outline why flexibility is required and the area that will be required for construction and operation of the asset. This has been based on engineering judgement and may not reflect the as-delivered scheme following detailed design; however, it should provide a reasonable indication of the land areas likely required for each stage of the project. It should also be noted that any of the individual works detailed by the Work Numbers cannot be installed outside of the areas shown on the **Works Plans [AS-105],** since the areas on the **Works Plans [AS-105]** are a secured document within the application.

6.1.3 **Work Number 1:** Solar Generating Area covers 454.5ha and will take up the same amount of land during construction and operation. However, not all of this area will be solar modules. The Ground Coverage Ratio describes the front-to-back length of solar modules vs the distance between the front of each row required to limit shading (row pitch). For example, the ground coverage ratios in both **Figure 3-2A Indicative Fixed South Facing Layout [AS-022]** and **Figure 3-2B Indicative Single Axis Tracker Layout [AS-023]** are approximately 0.48, meaning that approximately half of the land area in Work Number 1 will be covered by modules, and half will not.

6.1.4 **Work Number 2:** AC BESS Compound will take up the same amount of land during construction and operation. This is shown on the **Works Plans [AS-105]**.

6.1.5 **Work Number 3:** Decentralised BESS work areas cover all the solar area except for Flood Zones, to allow for flexibility in locating BESS units during detailed design. During operation the area taken up by decentralised BESS would total ~8 ha.

6.1.6 **Work Number 4:** Main Substation will take up the same amount of land during construction and operation. This is shown on the **Works Plans [AS-105]**.

6.1.7 **Work Number 5A:** HV Cable Route has a larger land take than required for operation due to flexibility sought to not limit the detailed design stage. As the detailed design has not been completed and exact ground conditions are not known, the Applicant has highlighted an area larger than required for operation to allow flexibility in cable routing. The "during construction" area includes a working width suitable for the installation of the cables (temporary haul road, cable trench, topsoil and separate subsoil storage areas and temporary storage and construction compounds etc). The cable route areas required for operation have been calculated by assuming a reasonable route and typical wayleave width between the Main Substation and the Navenby Substation.

6.1.8 **Work Number 5B:** HV Connection Works are shown on the **Works Plans [AS-105]**. These works will take up the same amount of land during construction and operation. However, because National Grid will be building the new Navenby Substation, and details of the exact location of the connection bay have yet to be provided, the Applicant has included the whole area of the Substation in Work Number 5B. When the exact location of the bay that the Proposed Development will connect into is known, the area of Work Number 5B will likely reduce. The applicant only intends to develop the area required for its works in the National Grid substation, but at this time flexibility has been sought such that the scheme is able to deliver its connection, wherever the connection bay is located. At this stage the construction and operation areas cannot be reduced conclusively within this estimate.

6.1.9 **Work Number 6:** Interconnecting Cables require a larger land take than required for operation due to flexibility sought to not unduly constrain the Proposed Development at detailed design stage and given currently unknown exact ground conditions. Therefore, the Applicant has highlighted an area larger than required for operation to allow flexibility in cable routing. The cable route areas required for operation have been calculated by assuming a reasonable route and working widths between the Solar Generating Areas and the Main Substation. This area has been measured as the area required that is not already covered by Work Numbers 1,2,3 and 4 on the **Works Plans [AS-105]**.

6.1.10 **Work Number 7:** Temporary Construction Compounds will take up the same amount of land during construction as detailed in the application area and is what is shown on the **Works Plans [AS-105]**. During operation these will no longer be required and would be removed and back filled with solar development. The area of Work Number 7 is therefore also included in Work Number 1).

6.1.11 **Work Number 8A:** Works to Facilitate Access will take up the same amount of land during construction and operation. This is shown on the **Works Plans [AS-105]**. The works during operation would likely just be to maintain the visibility splays to a safe distance to allow for egress from the operational access.

6.1.12 **Work Number 8B:** Ancillary Works to Facilitate Access will take up the same amount of land during construction as that shown on the **Works Plans [AS-105]**. During operation this area will no longer be required as it will only be used during construction for traffic management.

6.1.13 **Work Number 9:** Landscaping, Biodiversity, and Ancillary Works encompasses areas not captured by other Work Numbers in addition to the solar areas. For construction this area has been assumed to be the same as during operation however the planting schedules and locations will be confirmed at the detailed design stage. Once in operation, the area required has been calculated to include the 10m buffer surrounding all solar areas, along with 64ha of permanent grassland, 181 ha of managed arable land, and 1.8ha for the proposed community orchard.

6.1.14 To capture a realistic estimate for the final size of the scheme during operation, Work Number areas have been sized to avoid overlapping, and therefore avoid double counting land area, where possible.

Table 6-1 Work Number Land-Take

Work Area	Shown On Works Plan [AS-105]		Construction		Operation	
	Area (acre)	**Area (ha)**	**Area (acre)**	**Area (ha)**	**Area (acre)**	**Area (ha)**
No. 1: Solar Generating Areas	1123.1	454.5	1123.1	454.5	1123.1	454.5
No. 2: AC BESS Compound	9.2	3.7	9.2	3.7	9.2	3.7
No. 3: Decentralised BESS	1065.2	431.1	19.8	8.0	19.8	8.0
No. 4: Main Substation	3.8	1.5	3.8	1.5	3.8	1.5
No. 5A: HV Cable Route	949.9	384.4	134.1	54.3	67.1	27.1
No. 5B: HV Connection Works	76.5	30.9	76.5	30.9	76.5	30.9
No. 6: Interconnecting Cables	1744.0	705.8	66.1	26.7	33.0	13.4
No. 7: Temporary Construction Compounds	14.7	6.0	14.7	6.0	0.0	0.0
No. 8A: Works to Facilitate access	21.9	8.9	21.9	8.9	21.9	8.9
No. 8B: Ancillary Works to Facilitate Access	32.7	13.2	32.7	13.2	0.0	0.0
No. 9: Landscaping, Biodiversity, and Ancillary Works	2541.2	1028.4	905.8	366.5	905.8	366.5
Totals	**7582.3**	**3068.4**	**2407.6**	**974.3**	**2260.1**	**914.6**

7. Clarification of Environmental Statement Figures

7.1.1 The solar arrays within the Proposed Development have a total installed capacity of 381 MWp for the FSF configuration, and their lifetime electrical generation is estimated to be 19,439,499 MWh, which equates to 19,439 GWh. This figure is based on anticipated yield and takes account both of ongoing module degradation and a repowering of all PV modules in year 30, as discussed in para 6.4.67 of **Chapter 6 Climate Change** of the ES **[REP1-017]**.

7.1.2 The Battery Energy Storage System (BESS) is an integral part of the Proposed Development and has an installed storage capacity of 480 MWh. As described in para 6.4.76 of **Chapter 6 Climate Change** of the ES **[REP1-017]** it is assumed that the BESS:

a. Only stores electricity generated by the Proposed Development;

b. Is charged and discharged once daily, storing power to be used as fast response dispatchable electricity for grid balancing purposes;

c. Has a round-trip efficiency of 85% and a capacity that degrades by 20% over the 20-year lifetime of each battery module.

7.1.3 On this basis, the BESS can be assumed to store and supply to the grid a total of 7,952,328 MWh of electricity, which equates to 7,952 GWh during the assessed life time of the project.

7.1.4 Since the BESS is assumed to only store electricity generated by the Proposed Development, it is important to note that the 19,439 GWh of electricity estimated to be generated by the solar arrays is inclusive of the 7,952 GWh stored and supplied by the BESS; these figures cannot be added together.

7.1.5 Regarding the installed capacities of the solar arrays and the BESS and the units in which these are expressed, the solar array has a total installed generation capacity of 381 MWdc, and a total lifetime electricity generation of 19,439 GWh as described in para 6.4.67 of Chapter 6 Climate Change of the ES. The BESS, in contrast, has a total installed storage capacity of 480 MWh and, when used as described in para 6.4.76 of Chapter 6 Climate Change of the ES, can store and supply 7,954 GWh of electricity into the grid.

7.1.6 The relative capacities of the solar array and the BESS can also be expressed as follows: the centralised BESS, with total storage capacity of 480 MWh, could in theory store the electricity generated by the solar array with its total generating capacity of 240 MWac operating at maximum output for c. 2 hours. The distributed BESS with a total storage capacity of 480MWh could in theory store the energy generated from the 381MWdc solar arrays operating at maximum output for c. 1.25 hours

7.1.7 As described above, the climate change chapter has only considered energy stored from the solar arrays as part of the climate change assessment, however, the BESS could be used for wider support of National Grid services to ensure that the security of supply and overall resilience of the energy system is maintained.

8. Output Estimation of Proposed Development

8.1.1 The Applicant was asked to provide an estimate of how many hours the solar generation would exceed the grid connection. Table 8-1 shows how many hours of the year during year 1 of operation during which the Proposed Development will generate at each percentage range of its grid connection capacity assuming a FSF orientation with an installed capacity of 381 MWp. It should be noted that these values include all hours of the year and hence the number of hours of 0% generation includes all dark hours including nighttime.

Table 8-1 Hours/year at each power level

Range	Lower (%)	Higher (%)	Lower (MW)	Higher (MW)	Hours of the year
0%	0%	0%	0	0	4642
0-10%	0.01%	10%	0.0	23.9	1011
10-20%	10%	20%	23.9	47.9	663
20-30%	20%	30%	47.9	71.8	441
30-40%	30%	40%	71.8	95.8	421
40-50%	40%	50%	95.8	119.7	298
50-60%	50%	60%	119.7	143.7	284
60-70%	60%	70%	143.7	167.6	225
70-80%	70%	80%	167.6	191.6	170
80-90%	80%	90%	191.6	215.5	145
90-100%	90%	100%	215.5	239.5	460

8.1.2 The above table shows that for approximately 5% of the year (~460 hours) the Proposed Development would be producing above 90% of its rated output. The yield simulation performed to gather the above information estimated a clipping loss of approximately 1.6% in year 1 (as modules degrade over time, this clipping loss will decrease). This clipping occurs at the Solar Stations on the DC side of the inverters rather than on the AC side of the equipment between the Solar Stations and the National Grid point of connection where the maximum output was 239.46MWac.

8.1.3 The above estimate is based on what is known as a P50 yield assessment, which is the yield that equates to an equal chance (50% probability) that any year will produce a higher, or lower, yield than this value.

8.1.4 To design a solar development like this you first design from the grid connection capacity back to the solar farm accounting for losses along the way. In effect this means that the Proposed Development can always deliver the grid connection capacity and any losses through cabling, transformers and inverters are accounted for before the power output at the grid connection is reduced or curtailed.

8.1.5 Power losses on the AC electrical side are almost always highest when delivering the maximum capacity e.g. 240MW so that the losses based on maximum output of the grid connection can be calculated. The Examining Authority has requested a worked calculation using non-technical language which is in the following paragraphs.

8.1.6 To design a scheme such as the Proposed Development, you start from knowing that the grid connection is 240MW and the onsite substation is ~7km away from the grid connection point. First you calculate the power loss in this cabling. Power loss in the cabling is usually very small, typically less than 1%, (it is likely that for the Proposed Development he HV cable losses would be less than 0.1%, but this would be confirmed in more detail during the detailed design of the Proposed Development) when the cable is delivering the maximum output of the grid connection, this loss is primarily in relation to resistive losses in the form of heat dissipation. This means that it can be determined that the Proposed Development will need to have transformers capable of delivering 240MW + 1%, so the transformers would be rated above ~242.4MW (the transformers are usually rated higher than this as it is typical to run transformers at ~80% of their nameplate capacity). These transformers are then designed to run efficiently at this rated output of 242.4MW. Transformers typically have losses of around 2%, partially through the production of heat in the copper windings and partially through core losses, from two processes, called hysteresis losses and eddy current losses. This then means that it can be determined that the input power of the transformer needs to be 242.4MW+ 2% which is 247.2 MW. These steps are then repeated through the distribution network to the Solar Stations (1% Cable losses and 2% transformer losses at the solar stations). This then provides the inverter capacity that needs to be installed at the Solar Stations to deliver the grid connection capacity, which in this case is 255MW.

8.1.7 The above worked calculation is only considering the active power of the Proposed Development. However, the design also needs to accommodate the reactive power requirements of the grid connection, which is outside of the scope of a non-technical summary of losses.

8.1.8 These losses are typical of any electrical infrastructure and are not exclusive to a development like this, any generation or demand scheme accounts for these losses through the design of the system. As noted above these losses are calculated when operating at peak power output. As shown in table 8-1, most of the time the Proposed Development will operate at lower power output than rated output, meaning although the peak operating loss is ~6% the cumulative yield loss for the Proposed Development is lower than this when you consider that much of this energy is delivered at a lower power output and therefore has a lower loss fraction in a given period.

8.1.9 This calculation would be replicated for the Centralised BESS (Distributed BESS share the same inverters and therefore do not need to have an additional calculation). Lastly there is a control mechanism in place to ensure the grid connection is not breached particularly when there are multiple generation sources behind the connection point. This control system is typical of many solar schemes particularly where there is colocation of two or more types of generation.

8.1.10 DC to AC losses in inverters are very low, typically inverters are around 98% efficient when running at rated power and slightly lower when running below rated power (under low irradiance conditions). This is one of the reasons to oversize the PV arrays (Overplant) as it allows the inverters to be used at their most efficient more frequently.

8.1.11 The round-trip efficiency of a typical BESS system is currently around 85% but improving all the time. The Proposed Development will not be permitted to export more power than the grid connection agreement and the design will deliver an engineered control to adhere to this requirement across the whole Proposed Development, including at times when the solar and the BESS are both exporting power.

9. The Contribution of the Proposed Development Towards Meeting the UK Energy Demands

9.1.1 The path toward achieving net zero requires the uptake of electrification in the UK to increase, leading to substantial growth in energy demand. The energy requirement of datacentres to support the growth in AI will further produce a noticeable increase in demand over the next 25 years. These datacentres are part of the government's key strategic plan for growth of the UK economy.

9.1.2 The Government expects electricity demand could more than double by 2050 as large parts of transport, heating and industry decarbonise by switching from fossil fuels to low carbon electricity (Overarching National Policy Statement for Energy (EN-1) (2025), Para 3.3.3).

9.1.3 NESO publish Future Energy Scenarios (FES). These annual publications explore strategic, credible choices to propel GB on the route to decarbonisation. They are an important point of view, which contribute to an objective assessment of the scale of future GB energy needs and where that energy might come from, to build pathways through which net zero could be reached.

9.1.4 FES (2025) [REF 5] presents one counterfactual pathway that does not meet net zero in 2050 alongside three pathways that do.

9.1.5 NESO reported that [REF 5, Key Statistics]:

a. Annual electricity demand in 2024 was 290TWh;

b. In 2030, electricity demand in net-zero consistent scenarios could range from 335TWh to 345TWh;

c. In 2040, electricity demand in net-zero consistent scenarios could range from 564TWh to 617TWh; and

d. In 2050, electricity demand in net-zero consistent scenarios could range from 705TWh to 797TWh.

9.1.6 To realise the required carbon savings from displacing fossil fuels from transport, heat and industry, it is imperative that new sources of electricity are low carbon.

9.1.7 Further, to ensure that there is a sufficient supply of low-carbon energy to provide comfort to consumers to switch away from fossil fuels, new supplies must come forward with urgency. Indeed, the Government stated in their Clean Power 2030 Action Plan that to meet expected growth in electricity demand over the 2030s and 40s, projects needed for 2030 must be prioritised and a robust pipeline beyond 2030 maintained [REF 6].

9.1.8 The indicative yield assessment of the Proposed Development is 345,607MWh in year 1 (345.6 GWh, or 0.346 TWh). Therefore, the Proposed Development would expect to contribute approximately 0.1% of total electricity demand in 2030 (assuming this as the commissioning date), reducing to 0.04% by 2050 due to an expected increase in demand and solar module degradation.

9.1.9 There is an intrinsic link between the availability of low-carbon sources of electricity and the rate at which consumers will move away from established but volatile and carbon intensive fossil fuels, towards electricity.

9.1.10 This analysis highlights the scale of new low-carbon generation that will be required over the next 25 years to meet future levels of electricity demand required to meet Net Zero.

10. Comparison between the proposed development and other utility scale solar farms

10.1.1 Included below in Table 10-1 is a summary of other solar NSIPs and information about each development where available at the time of writing. Cells left blank denote where information could not be found for that development. The overplanting ratio was calculated the DC capacity (if known) / TEC Capacity. This may result in values that do not match what was installed on site if details have changed since the information has been published.

10.1.2 *Information followed by an asterisk is an assumption based on publicly available information and may not accurately reflect the development.

Table 10-1 Summary of Solar NSIPs

Planning Inspectorate Case Reference	Project name	Applicant name	Connection Capacity MW AC	MW solar DC Capacity	Total Area (Ha)	Solar Area (Ha)	Overplanting Ratio (DC/AC ratio)	BNG Area (Ha)	The confirmed/ anticipated generating output in MWh *(homes supplied, no output given)*	BESS (Y/N)	BESS Capacity (MW/duration)
EN010085	Cleve Hill Solar Park	Cleve Hill Solar Park Ltd	Phase 1 350MW	373	491.2	176.3	1.07	50.1Ha of functional habitat management land		Y	
EN010101	Little Crow Solar Park	INRG SOLAR (Little Crow) Ltd	99.9	150-200	225	153.4	1..5 - 2	59.862		Y	90MW*
EN010106	Sunnica Energy Farm	Sunnica Ltd	500	627	981	621	1.25	292	643,400 MWh in the first year.	Y	Not stated
EN010118	Longfield Solar Farm	Longfield Solar Energy Farm Limited	500	371	453	275	0.74	55.8ha of functional habitat management land		Y	
EN010122	Oaklands Farm Solar Park	Oaklands Farm Solar Limited	162.3	138	191	135	0.85	Not stated		Y	37.5MW*
EN010123	Heckington Fen Solar Park	Ecotricity (Heck Fen Solar) Limited	400	500	542	417.07	1.25	194		N	
EN010127	Mallard Pass Solar Project	Mallard Pass Solar Farm Limited	240	350	852	420	1.46	395		N	
EN010131	Gate Burton Energy Park	Gate Burton Energy Park Ltd	500		824	474		Not Listed		Y	
EN010132	West Burton Solar Project	West Burton Solar Project Limited	480					513.7	583,000 MWh/year	Y	
EN010133	Cottam Solar Project	Cottam Solar Project Limited	600	871	1451.2 3	879.39	1.45	16.5Ha - BNG areas only	578,160 MWh/year	Y	
EN010135	Stonestreet Green Solar	EPL 001 Limited	100	165	192		1.65		*42,000 homes*	Y	
EN010139	Byers Gill Solar	RWE Renewables UK Solar and Storage Limited	180	180	490		1.00		*70,000 homes*	Y	180*
EN010140	Helios Renewable Energy Project	Enso Green Holdings D Limited	190	250	475	392.87	1.32		*>50 OR 44,800 homes*	Y	
EN010141	East Park Energy	BSSL Cambsbed 1 Limited	500	400	769		0.80		176,550MWh/year	Y	100
EN010142	Tillbridge Solar Project	Tillbridge Solar Limited	500	800	1400	900	1.60	500		Y	500*
EN010143	East Yorkshire Solar Farm	East Yorkshire Solar Farm Limited	400	480.8	1276.5	966.4	1.20	107.9	549,760 MWh/yr	Y	

EN010147	Botley West Solar Farm	Photovolt Development Partners (PVDP) on behalf of SolarFive Ltd	840	840	1,418	843	1.00	461	*330,000 homes*		
EN010149	Springwell Solar Farm	Springwell Energy Farm Limited	800	800	1280		1.00		*180,000 homes*	Y	not listed
EN010151	Beacon Fen Energy Park	Beacon Fen Energy Park Limited	600	536	757.6	529.2	1.34			Y	600*
EN010152	Fenwick Solar Farm	Fenwick Solar Project Limited	237.5	237.5	509	407	1.00			Y	31.7
EN010153	Frodsham Solar	Frodsham Solar Ltd	200	147	314	290	0.74	80		Y	100*
EN010155	Dean Moor Solar Farm	FVS Dean Moor Limited	150		276.5			615 units		Y	100MW
EN010157	Peartree Hill Solar Farm	RWE Renewables UK Solar and Storage Limited	320		891			1636.34 area habitat biodiversity units		Y	
EN010158	Rosefield Solar Farm	Rosefield Energyfarm Limited	335		675	280		95 ha creation of grassland	*57,000 homes*	Y	
EN010159	One Earth Solar Farm	One Earth Solar Farm	740	1036	1414	945	1.40			Y	740MW/2 hours
EN010162	Great North Road Solar and Biodiversity Park	Elements Green Trent Limited	800		1765	1025		78 ha creation of habitat		Y	Up to 800MW/no duration listed
EN010163	Steeple Renewables Project	Steeple Solar Farm Limited	600		888	467		10% gain		Y	150MW
EN010168	Lime Down Solar Project	Lime Down Solar Park Limited	500		1237	749.3		171.07 ha created		Y	1000MWh
EN010170	Green Hill Solar Farm	Green Hill Solar Farm Limited	500		1200	550		281.6 ha created		Y	500MW, MWh not confirmed
EN0110013	The Droves Solar Farm	The Droves Solar Farm Limited	500		825					Y	500MW

11. Responses to the Examining Authority's First Written Questions

11.1.1 The Examining Authority issued its first Written Questions on 16 January 2026 **[PD-011]** and requested the Applicant to include their answers to several questions in this Technical Guide. This section provides the Applicant's responses to the questions identified in Table 1-1 of this Technical Guide.

11.2 Question GC 1.01 - Provide an explanation of what the timescales for the offers confirmed under Gates 1 and 2 might mean for the delivery for the proposed development

11.2.1 The Applicant has confirmed within the **Applicant's Written Summaries of Oral Submissions for Issue Specific Hearing 1 [REP1-046]** that the solar component of the Proposed Development has secured a Gate 2 Phase 2 prioritisation (i.e. between 2031 and 2035 inclusive) and that the BESS component of the Proposed Development has secured a Gate 1 prioritisation, which means its connection date has not yet been confirmed and is currently indicative. The Applicant awaits confirmation from NESO of its confirmed connection date for the solar (expected to be issued no later than the end of Q3 2026), and NESO's indicative connection date for the BESS (expected to be issued later in 2026).

11.2.2 The Applicant does not consider that there is any reasonable basis to revise the timescales for the delivery of the Proposed Development from those currently stated.

11.2.3 If a Gate 2 connection agreement is not received for the BESS, the Applicant has confirmed at GC.1.08(d) that solar development is commercially rational on a standalone basis. Further, the Applicant's **Statement of Need [APP-184]** confirms that standalone solar is also beneficial to the government's aims, and is technically achievable.

11.2.4 Thus, the Applicant contends that the Proposed Development is entirely justified even if a BESS does not come forward.

11.3 Question GC 1.06 Part b – Solar panel performance degradation

11.3.1 The 2% degradation in Year 1 is the result of Light Induced Degradation (LID). This is a common degradation faced by solar modules when they are first exposed to light. After this initial LID, the module degrades much more slowly at 0.45%/year. LID is the initial damage that occurs within the crystal lattice of the solar cell as it is first exposed to light, after Year 1 the degradation totals 2% - Part LID and part normal degradation. In subsequent years, the LID reduces and just the residual degradation of ~0.45% remains. These values are the ones warrantied by the module suppliers. Typically the industry sees the LID in Year 1 and slightly less degradation for ~10years and slightly higher over the next 15-20 years with the overall warrantied output being correct after ~30 years (previously this was typically 20 or 25 years periods but as solar has improved and more data has been available to manufacturers of real world performance the warrantied periods are extending and warrantied degradation levels year to year has reduced).

11.3.2 Assuming panel replacement in Year 31, there would be an initial 2% LID for the first year with 0.45% thereafter. This would match the Year 1-30 degradation chart provided in Plate 5-1. Again, this could improve with newer technology after another 30 years of solar module development and continued improvements in construction, maintenance and monitoring of modules.

11.4 Question GC 1.07 - Justification for the scale of the proposed BESS

11.4.1 The Applicant considers that this question may reflect a mis-understanding. The 480MWh value refers to the storage capacity and not he power output capability of the BESS. The BESS proposed for the Proposed Development is capable of exporting power up to the grid connection agreement of 240MW and if it was a full discharge cycle at the rated power then the energy delivered to the grid would be 480MWh. This is what is known as a 2 hour BESS. If it was discharging at half power then the discharging could last for 4 hours (480MWh/120MW).

11.4.2 The BESS could be charged or discharged in 2 hours if running at maximum power.

11.4.3 There are DCO scale solar farms proposed and consented without BESS but the functionality and efficiency of the infrastructure is improved by the use of a BESS.

11.4.4 The following addresses each point of para 5 of the Guidance on associated development applications for major infrastructure projects' (Department for Communities and Local Government, April 2013):

a. Direct relationship: The BESS will store energy generated at the Proposed Development if it is not needed at the time of its generation and will export it when it is needed. This supports the operation of the Proposed Development by increasing its effectiveness (timing its generation to when there is demand); reducing the potential for electricity generated to be wasted (i.e. the energy is stored and used later instead). This assists in maximising the level of carbon free MWh sent to the grid and enhances the significant benefits that the Proposed Development will already deliver. The BESS will also be capable of delivering system services which are procured by the National Energy System Operator (NESO) to ensure that supply and demand on the grid are kept in balance and which are increasingly needed to support the stability and operability of the GB energy system. These services also support the operation of the Proposed Development by increasing the security reliability and flexibility of the system to which it connects.

b. Subordinacy: It is the generation of renewable energy which is fundamental to achieving Net Zero, and the Proposed Development aims to meet the need for new generation on the grid by developing the principal, solar generation, component of the Proposed Development. A standalone BESS development would not on its own generate low-carbon electricity. Therefore, the associated development is subordinate to the principal development within the context of Proposed Development's stated benefits. Further, generation from the solar panels would be prioritised for dispatch to the grid ahead of energy stored in the BESS and the BESS is therefore also subordinate in an operational sense.

c. Cross subsidisation: Investing in unsubsidised solar is economically rational on a stand-alone basis and requires no cross-subsidisation financially to justify the cost of the principal development. For example, NPS EN-3 Para 2.10.13: "Solar farms are one of the most established renewable electricity technologies in the UK and the cheapest form of electricity generation". However, the provision of a BESS enhances the benefits that the principal development brings forward and is not only necessary as a source of additional revenue for the applicant, in order to cross-subsidise the cost of the principal development.

d. Proportionality: The power capacity of the associated development matches the grid export capacity available to it. The power generated by the main solar development over the course of a day can regularly exceed the energy storage capacity of the associated development. This can occur at all times of the year, however is more likely to happen in months with higher solar irradiation (especially March to October). The associated development may therefore regularly be fully utilised by the main solar development and is therefore not disproportionate to it.

e. Operational revenue is the output of operational actions and market prices. Market price fluctuates with supply and demand. It is therefore not possible to assess in any meaningful way, what actions will be carried out 'on average' by the BESS (i.e. storing generation from the solar panels, or storing generation from the grid) or indeed what revenue would be secured from carrying out each of those different actions. When, how often and at what times different actions would occur will depend on many factors including national demand, the weather and the composition of the future GB generation fleet. However, the provision of a BESS enhances the benefits that the principal development brings forward.

11.5 Question GC 1.08 - Generating output for the proposed BESS relative to the proposed solar arrays

11.5.1 Paragraphs 6.4.74 to 6.4.78 of **Chapter 6 Climate Change** of the **ES [REP1-017]** set out the potential carbon savings derived from a hypothetical scenario of one charging cycle per day. However, Paragraph 6.4.78 highlights that this illustrates a conservative scenario. Further the BESS decarbonisation benefits are not considered in the overall quantitative carbon assessment. As detailed in response to GC.1.07, it is not possible to meaningfully predict a lifetime energy storage operational scenario in a meaningful way, therefore an illustrative example has been presented only to demonstrate the scale of potential savings.

11.5.2 However, in general, the BESS will support the operation of the co-located solar array by storing generation when it is not needed and exporting it to the grid when it is needed, and by providing a grid balancing function using electricity from the Proposed Development or from the wider grid if that grid balancing function could not be achieved when required using only electricity from the Proposed Development. It is not correct that the generation output of the BESS would be significantly less than the projected output for the proposed solar arrays; the analysis in **Chapter 6 Climate Change** of the **ES [REP1-017]** is only an illustrative example of the potential scale of carbon benefits from the BESS in the scenario described. Both foreseen uses of the BESS will provide a low-carbon alternative to existing marginal, short term forms of current energy generation in the UK which predominantly come from fossil fuels, as is stated in **Chapter 6 Climate Change** of the **ES [REP1-017]**.

11.5.3 BESS store electricity when it is in abundant supply and is therefore at a lower price due to economic principles of supply and demand. BESS discharge electricity when it is needed. The need for electricity drives prices higher due to the same economic principles.

11.5.4 When electricity is in abundant supply and prices are low, carbon-intensive generation switches off so as not to incur a loss. Renewable generation may continue to generate without loss because the variable (i.e. per MWh) component of a renewable generator's cost is very low while a carbon intensive generator must purchase fuel for each MWh it generates.

11.5.5 Therefore, when electricity is in abundant supply, the carbon content of the electricity system is low. Conversely, when electricity is in high demand, fossil fuel generators will turn on to meet that demand and the carbon content of the electricity system will rise. By dispatching low-carbon electricity stored in a BESS into periods of higher demand, the BESS displaces higher-carbon electricity from the grid.

11.5.6 Therefore, BESS will not tend to store electricity which has a high carbon content such as that generated by GB's carbon-emitting thermal power stations, and this analysis illustrates that BESS will store electrical energy when supplies are abundant and have a low-carbon content. That electricity will then be exported back to the grid when it is needed. The stored energy may have been generated from a co-located renewable scheme or imported from the grid. Regardless of the location and source of this energy, the Proposed Development will still have a beneficial impact in line with UK's Net Zero goals. Based on this, it is the Applicant's position that there is no need to amend the text within **Chapter 6 Climate Change** of the **ES [REP1-017]** as the conclusion and scale of benefits set out in paragraphs 6.4.74 to 6.4.78

would not be affected by the BESS having a higher generation output or mix of energy sources between the grid and the Proposed Development.

11.5.7 The Applicant has provided its analysis of the BESS against the tests for associated development in relation to paragraph 5(i)-(iv) in Guidance on associated development applications for major infrastructure projects April 2013 in answer to GC.1.07 above.

11.6 Question GC 1.09 - Operational safety of BESS

11.6.1 The Applicant has undertaken a variety of assessments to address any potential areas of risk from the BESS – for example, **Appendix 14-G: Unplanned Emissions Assessment** of the **ES [APP-176]** provides an assessment of the potential consequences of unplanned emissions to air from the Proposed Development BESS, and **Chapter 9: Water Environment** of the **ES [REP1-021]** includes an assessment of the potential for impact on groundwater or surface water from firewater runoff in the event of a BESS fire.

11.6.2 The Proposed Development includes embedded design mitigation and protection measures to reduce fire/explosion risk, during the operation of the BESS, as detailed in the **Framework Battery Safety Management Plan** (BSMP) **[REP1-041]**. These measures include, for example, an automatic cooling system which will be integrated into the BESS to stop or reduce the risk of a cell from overheating and failing and triggering a chain reaction in neighbouring cells (thermal runaway).

11.6.3 Under Requirement 7 of the **Draft DCO [REP1-007]** a detailed BSMP must be submitted to Lincolnshire County Council (LCC) for approval which must prescribe measures to facilitate safety during construction, operation and decommissioning of the BESS. This detailed BSMP must be substantially in accordance with the framework BSMP and LCC must consult with Lincolnshire Fire and Rescue Services and the Environment Agency before approving the BSMP.

11.6.4 Refer to Appendix A: Worldwide BESS Fire and Failure Incidents.

12. Battery storage management

12.1.1 At Issue Specific Hearing 3, the Examining Authority requested the Applicant include a section in this Solar Technology Technical Guide to explain the logistics of how the battery storage element is managed, including the most efficient way to utilise battery storage, noting seasonal variation, weather variation, and how that relates to when there may or may not be much solar in the electricity system.

12.1.2 The Examining Authority also asked the Applicant to explain aspects of 'leakage' of charge from a BESS during periods of operational standby.

12.2 Battery storage management

12.2.1 Storage assets (BESS) support the operation of renewable technologies in all seasons of the year by balancing supply to meet demand. This means, storing energy when it is needed less (including when generation is abundant) and releasing it when it is needed more.

12.2.2 The BESS proposed as part of the Proposed Development will support the operation of the Solar PV panels.

12.2.3 That support can take many forms and may look different at different times . How the Proposed Development (i.e. the solar and the BESS in combination) would operate at any one time would depend on a number of factors including but not limited to: national demand, the weather, and the technical composition of the UK energy system (i.e. share of capacity of renewable and other generation technologies).

12.2.4 At times when the solar array does not need operational support from the BESS, the BESS may support the national supply and demand balance by importing directly from the grid rather than from the co-located solar.

12.2.5 A co-located BESS with import and export grid connection capacity can operate as follows during its operational life:

a. Importing from the co-located solar facility when local solar generation is high but national generation is higher than national demand

b. Exporting to the grid when co-located solar generation is low but national demand is higher than national generation

c. Importing from the grid when national demand is low but national generation is high

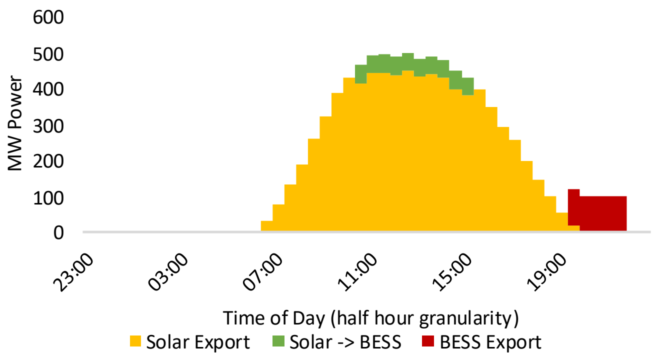
d. Exporting to the grid when national generation is low but national demand is high; and

e. Importing or exporting under a grid balancing contract instruction from NESO.

12.2.6 The Applicant provides the following illustrative examples to show how the BESS might be used at different times of the year. However, the Applicant notes that BESS respond to the market signals (price) arising from an imbalance in supply (increasingly related to when the wind or the sun are strong) and demand (when consumers actually use energy e.g. when they make a cup of tea, cook dinner, or increasingly, use electricity to heat their homes or charge their cars). Accordingly, the following examples should be interpreted as being illustrative and not seen as 'hard and fast' proposed modes of operation.

12.2.7 During the summer, when solar generation at the Proposed Development is high, the BESS may store some of that energy, e.g. from the middle of the day, so that it can be released in the evening when solar output is lower.

Plate 12-1: BESS imports solar during the day and exports in the evening



12.2.8 The yellow area in Plate 12-1 represents output from a solar scheme. The green area represents energy which is diverted to the battery. The red area represents energy which is released from the battery to the grid. Market needs would influence the shape of the green and red areas, however the storage capacity of the BESS (measured as maximum instantaneous power (MW) and energy capacity (MWh)) would determine the maximum size of the green and red areas.

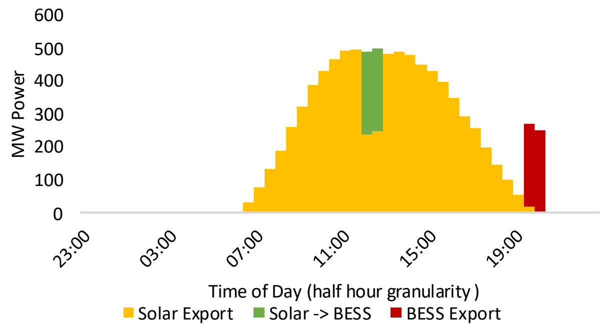
12.2.9 Plate 12-2 shows an alternative example, where both the import from solar to BESS and the export from BESS to grid, are at a higher power (MW) but last for a shorter duration (hours). However, the size of the green and red areas in both figures are the same.

12.2.10 Both of these operations could occur in any season of the year, although the quantity of energy generated by the panels and therefore available to be stored in the BESS is likely to be greater in the summer than the winter.

12.2.11 During the winter when winds can be stronger and less predictable, the timing of daily peak solar irradiation (and therefore generation) generally remains constant around the middle of the day. Even at times when solar generation may not be to the full capacity of the grid connection, storing energy generated by the solar panels in the BESS, means that that energy may be exported later when demand is higher.

12.2.12 Exporting stored low-carbon energy at times of higher demand, goes towards displacing carbon emitting generation from the grid at those times. However, the way the GB electricity market works means that the export would have to be priced competitively versus available alternatives. Therefore, by releasing stored solar to meet demand, BESS can reduce the carbon content of the grid, and help to reduce price spikes at times of high demand.

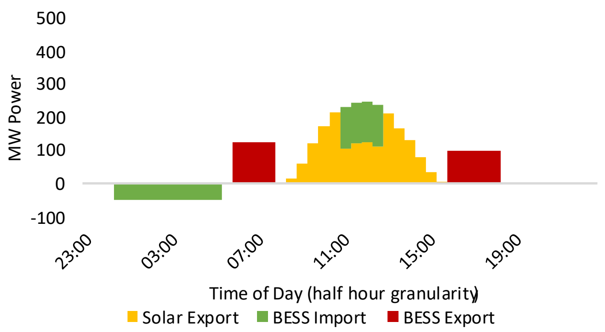
Plate 12-2: BESS imports solar during the day and exports in the evening (alternative example)



12.2.13 Exporting stored low-carbon energy at times of higher demand, goes towards displacing carbon emitting generation from the grid at those times. However, the way the GB electricity market works means that the export would have to be priced competitively versus available alternatives. Therefore, by releasing stored solar to meet demand, BESS can reduce the carbon content of the grid, and help to reduce price spikes at times of high demand.

12.2.14 At times when the solar array does not need operational support from the BESS, the BESS may import directly from the grid rather than from the co-located solar. Plate 12-3 shows how such an operation may occur without impacting on the ability of the BESS to support the solar.

Plate 12-3: BESS imports grid and solar generation and exports twice in the day



12.2.15 In this example, the BESS imports energy from the grid overnight (for example if wind generation is high) and exports it in the morning to meet morning demand, without overlapping with increasing solar generation from the co-located solar panels as the sun rises. The BESS is therefore available to store energy generated by the solar panels during the day, and export it to the grid in the evening, to meet demand when solar generation is lower (or zero).

12.2.16 Such two-cycle operation could occur in any season of the year.

12.3 Battery charge leakage

12.3.1 The proposed BESS is suited to short duration electricity storage operation.

12.3.2 Short Duration Storage (SDS) systems typically have storage durations of four hours or lower, and are more suited to addressing short duration balancing needs.

12.3.3 This means that the BESS will likely charge and discharge on a relatively frequent cycle (indicatively, subject to prevailing conditions, from once or twice each week to once or twice each day). The energy stored in a BESS will not be likely to be stored within it for long.

12.3.4 Over the hours-to-days period in which energy will 'sit' in the BESS, leakage of that energy will be very small.

12.3.5 Two academic studies listed following show that daily losses from a BESS would be 0.05% - 0.3% (or 0.5 – 3kWh per day for a 1,000kWh system).

a. Feehally, T., Forsyth, A., Todd, R., Liu, S., & Noyanbayev, N. K. (2018). Efficiency Analysis of a High Power Gridconnected Battery Energy Storage System. Paper presented at IET International Conference on Power Electronics, Machines and Drives (PEMD). Available at: https://pure.manchester.ac.uk/ws/portalfiles/portal/74265359/Green_access_efficiency_paper.pdf

b. The Faraday Institution. (2023). Market and Technology Assessment of Grid-Scale Energy Storage required to Deliver Net Zero and the Implications for Battery Research in the UK. Available at: https://www.faraday.ac.uk/wp-content/uploads/2023/09/20230908_Rho_Motion_Faraday_Institution_UK_BESS_Report_Final.pdf

13. References

REF 1 Solar Magazine (2022) Thin-film solar panels.

Available at Solar Magazine

REF 2 Marino J (2026) Researchers make revolutionary breakthrough that could transform solar panels: 'Greater flexibility'. The Cool Down.

Available at The Cool Down

REF 3 Peters IM, Rodriguez Gallegos CD, Sofia SE, Buonassisi T (2019) The Value of Efficiency in Photovoltaics. Joule, Volume 3, Issue 11.

Available at The Value of Efficiency in PV

REF 4 UK Government (2024) Clean Power 2030 Action Plan.

Available at Clean Power 2030 Action Plan (UK Government)

REF 5 National Energy System Operator (2025) Future Energy Scenarios 2025 V.5: Pathways to Net Zero.

Available at Future Energy Scenarios (NESO)

Appendix A Worldwide BESS Fire and Failure Incidents

Response to ExA's Request for information on Historical BESS Fires

The ExA raised concerns in Question GC.1.09 of The Examining Authority's first written questions and request for information (ExQ1) **[PD-011]** about the operational safety of the proposed BESS, particularly with regard to the potential for thermal runaway to cause fires. The ExA requests that the Applicant identify instances of BESS having caught fire worldwide, advising on where those incidents have occurred and giving the reason(s) for those incidents

The Applicant is aware that safety standards differ widely country-to-country and therefore considers the safety history of BESS in the UK to be most relevant to the Proposed Development. Nevertheless, both UK and worldwide BESS fires are discussed here.

The Renewable Energy Database[1] managed by Department for Energy Security and Net Zero (DESNZ) logs the energy generation and storage facilities in the UK. It shows that as of end of Oct 2025 (the latest data set available at the time of writing):

- There are 136 BESS facilities currently operational in the UK.
- The total capacity of the operational BESS in the UK is currently 3,269MW (3.3GW). This is 13 times more capacity than the BESS proposed as part of the Proposed Development.
- The operational BESS facilities range from having begun operation in 2006 up to the present day, with most sites becoming operational in the last few years. It shows 92 BESS facilities (68% of the currently operational BESS facilities) were constructed before any BESS safety standards were introduced in the UK.

From these 136 BESS facilities, there have been 3 BESS fires in the UK to date. These are discussed below.

One of these 3 fires (Statera's 300 MW battery energy storage site at East Tilbury in Thurrock, Essex) occurred during construction rather than operation and has not yet released a safety report, and therefore it is not possible to comment on the cause of the fire. Firefighters managed the fire over 24 hours, and a water curtain was used to prevent propagation.

The 2 operational BESS fires in the UK comprise:

[1] Renewable Energy Planning Database: quarterly extract - GOV.UK

Orsted's Carnegie Road BESS, Liverpool in September 2020. This was a 20MW BESS scheme in Liverpool, well reported for its planning failures because it was installed without the knowledge of the local fire and rescue service (LFRS) and in a relatively urban location close to sensitive receptors, with inadequate safety controls. This BESS experienced an explosion which led to the container door being found 6m away and debris spreading 22m from the container. The post fire safety report identified it did not have adequate explosion prevention measures or fire suppression systems, and it used an air cooled pouch cell BESS system which presents a high fire risk. The LFRS and National Fire Chiefs Council (NFCC) concluded that this technology is not appropriate for the UK. An automatic fire suppression system was fitted but failed to actuate, allowing the fire to develop.

Cirencester Hybrid Solar Farm in March 2025. The 23 MW solar and 10 MW of BESS entered operation in 2022 using an air cooled pouch cell BESS system, which as noted above, is no longer acceptable technology to NFCC and the LFRS. At the time, air-cooled battery containers were widely used, before liquid-cooled designs became common, and have a lower cooling efficiency and uneven heat dissipation which can create thermal hotspots within the container, increasing the risk of thermal events. The container spacing was less than 3m (the minimum spacing now allowed by NFCC guidelines), which enabled the fire to spread to a second container. The overall fire event lasted 7 hours.

Critically, both the Carnegie Road BESS and Cirencester Hybrid Solar Farm BESS were built prior to the NFCC 2022 safety guidelines[2] and NFPA 855 (2023)[3]. They were therefore both non-compliant with NFPA 855 and UL 9540 fire standards. In other words, the detection system, overall design, and safety controls would not meet current safety standards enforced by the NFCC and LFRS. Lessons learnt from the Carnegie Road BESS fire led to the development of the 2022 NFCC 'Grid Scale Battery Energy Storage System planning – Guidance for FRS'[2].

The Applicant notes that 92 of the 136 currently operational BESS facilities in the UK were constructed prior to the NFCC safety guidelines being published in November 2022 (or indeed any UK safety guidelines in the UK on BESS safety), and therefore further fires at these other sites cannot be ruled out, which may affect the public's perception of BESS safety.

The Proposed Development has taken into account and complies with the NFCC 2022 safety guidelines, NFPA 855, and UL 9540A, and is therefore designed to a higher standard than the Carnegie Road BESS and Cirencester Hybrid Solar Farm BESS. The **Draft Development Consent Order [REP1-007]** secures this via Requirement 7, which states that Work No. 2 or Work No. 3 (which comprise the centralised and distributed BESS) must not commence until a Battery Safety Management Plan (BSMP) has been submitted to and approved by the relevant planning authority. It states that the BSMP must be substantially in accordance with the Framework BSMP, and the relevant planning authority must consult with Lincolnshire Fire and Rescue and the Environment Agency before determining an application for approval of the battery safety management plan. By virtue of

[2] https://nfcc.org.uk/wp-content/uploads/2023/10/Grid-Scale-Battery-Energy-Storage-System-planning-Guidance-for-FRS.pdf
[3] https://www.nfpa.org/codes-and-standards/nfpa-855-standard-development/855

Requirement 7 of Schedule 2 to the **draft DCO [REP1-007]**, the BSMP must be implemented as approved. This document ensures the Proposed Development BESS incorporates multi-layers of safety through battery management systems that are incorporated into each battery, rack, and container. The battery cells are remotely monitored 24/7 so if a cell start to fail or generate gases, it is shut down and disconnected from the rest of the system and the ventilation system initiates. This is monitored by an off-site control room who are monitoring 24/7 changes across every cell. The system also allows advance warning to the LFRS of any issues and overheating which have the potential to cause a fire.

In terms of the ExA's question regarding worldwide fires, there have been other BESS fires outside the UK. The Applicant considers these to be less relevant due to the safety standards being lower than the UK in some countries, other than the lessons learnt from these fires has raised the general safety standard in the industry and led to the development of the aforementioned safety standards.

According to StorageWiki (a wiki-style hub for energy storage research at the Electric Power Research Institute (EPRI[4])) there was 8 reported BESS failures in 2024 worldwide (2025 data not available yet)and 107 BESS fires worldwide since EPRI records began in 2011. The EPRI reports that the failure/fire rate dropped by 98% for operational BESS over the 7 year period from 2018 to 2024 as the lessons learned from early failures were incorporated into the latest designs and best practices. Modern BESS solutions incorporate smoke, temperature and gas detection systems, fire suppression systems and explosion prevention systems. It has become standard practice for BESS manufacturers to test their systems to UL9540A, and as a result newly built BESSs pose significantly lower risks of fire or explosion.

In conclusion, there have been 2 BESS fires associated with operational BESS facilities in the UK to date. Both facilities were designed and built prior to UK safety guidelines for BESS, and therefore neither facility met current NFCC safety guidelines. These fires would not have occurred if the principles and commitments in the Framework BSMP for the Proposed Development had been applied.

[4] BESS Failure Incident Database - EPRI Storage Wiki. https://storagewiki.epri.com/index.php/BESS_Failure_Incident_Database