SUNNICA ENERGY FARM

EN010106

Volume 8

8.8 Applicant's Response to the First Written Questions – Appendices A - M

Planning Act 2008

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

11 November 2022
Version 00

Planning Act 2008

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

Sunnica Energy Farm

Development Consent Order 202[x]

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Appendices

Appendix A Settlement design iteration

1 Introduction

1.1.1 This document describes how landscape and visual effects have been an integral part of the design of the Scheme, and how that design has evolved to address landscape and visual effects identified through the Landscape and Visual Impact Assessment (LVIA) process, the final result of which is set out in the LVIA in Chapter 10 of the Environmental Statement **[APP-042]**. It does not introduce new evidence, but makes reference to existing Application documents

1.1.2 The design of the Scheme has involved the contribution of a wide range of technical specialists. Landscape architects responsible for carrying out the LVIA have strongly influenced the design by leading on the development of the design vision and principles and the development of landscape masterplans which embedded mitigation into the Scheme.

Design evolution

1.1.3 As described in the Design and Access Statement (DAS) **[APP-264]** and the LVIA [**APP-042**, section 10.7], the design of the Scheme has been an iterative process, which commenced in 2015 at the initial feasibility stage. It has been guided by the "*criteria for good design*" set out in the Overarching National Policy Statement for Energy EN-1 (NPS), published landscape character assessments and fieldwork analysis. Some detail is provided in the DAS and LVIA (section 10.7) regarding how the Scheme design conforms with these criteria. In particular, this includes siting of the solar panels relative to existing landscape patterns, landform and vegetation, through:

- careful siting of the Scheme in the landscape by the structures being offset from settlement edges, existing vegetation, including hedgerows and "pine lines", public rights of way and road networks;
- conserving field patterns, ecology and historical features (including below ground archaeology) across the Order limits, including pine lines; and
- creating new green infrastructure within the Order limits which integrates with networks across the study area and includes new permissive routes to provide linkages between Freckenham and Isleham and Red Lodge and Worlington.

Non statutory consultation design

1.1.4 Early consultation was held with the community in the summer of 2019 through a series of public exhibitions. The extent of the Scheme as presented at this non-statutory consultation design stage is shown in Figure 3-5 of the DAS **[APP-264]**.

1.1.5 At this early stage, little detail was available on the likely layout of the solar panel arrays and other infrastructure. Concern was raised, particularly through Parish Councils and the Say No to Sunnica action group, regarding the scale of the proposed energy farm and its proximity to existing settlements. As a consequence, the most substantial changes to the extent, layout and design of the Scheme were made in the period following this non-statutory consultation. Whilst the design has considered the landscape as a whole, this technical note focuses on the design iterations relating in particular to settlements to explain further how these specific concerns have been considered and addressed.

Statutory consultation design

1.1.6 As described in the DAS **[APP-264]** (Section 3.5), the design presented at the statutory consultation stage was illustrated on a draft strategic environmental masterplan, taking into consideration feedback from the non-statutory consultation. The design principles which influenced the masterplanning process included the following aspects in relation to settlements:

- consideration of scaling of the Sites to minimise impacts on views and the setting of settlements by providing offsets and buffer zones and using the existing landform; and
- the development of new green infrastructure within the Sites and creation of permissive routes to provide linkages across the Sites and between settlements.

1.1.7 The draft strategic environmental masterplan (Figures 3-7 and 3-8 of the DAS) **[APP-264]** shows how the design evolved to apply these principles.

2 Settlement specific design iteration

2.1.1 This section explains how the design of the Scheme has developed to address specific landscape or visual effects or concerns raised through consultation for each of the principal settlements within or in proximity to the Scheme.

2.1.2 Extracts of Figure 3-5 from the non-statutory consultation design are provided in this report to illustrate how the design of the Scheme has changed in relation to the Landscape Masterplan Figure 10-14A [**APP-209**]. The Local Landscape Character Areas (LLCA) referred to below are defined within Appendix 10E **[APP-104]** and shown on Figure 10-10 **[APP-200]**.

Burwell

2.1.3 Burwell (LLCA 38) is a large village on the edge of the Fens[1]. Cable Route B would be located in the landscape to the north and west of the village. The Burwell National Grid substation extension (if Option 2 continues to be retained) would be located adjacent, to the west of the village.

2.1.4 As described in Chapter 4: Alternatives and Design Evolution [**APP-036**], an optioneering process was undertaken to identify both the cable route and the location for the substation extension. The potential for landscape and visual effects fed into the optioneering process. The outcomes of this process were designed-in mitigation to avoid and minimise landscape and visual effects.

Cable route B connection to the Burwell National Grid Substation

2.1.5 Three options were considered against constraints, which included landscape and visual considerations. Specifically, this included proximity to residential properties, public rights of way and ecological and heritage designations. Cable routes 2 and 3 would be in particularly close proximity to residential receptors. Based on these considerations, cable route 1 was considered to be the preferred alignment from a

[1] Appendix 10E Local Landscape Character Areas (LLCAs) **[APP-104]**

planning and environmental perspective. Cable route 1 was therefore selected as the preferred cable route corridor.

Chippenham

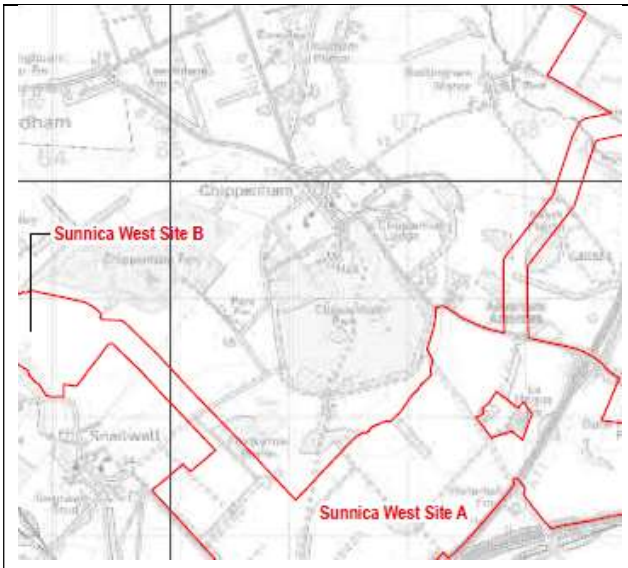
2.1.6 Chippenham (LLCA 23A) is a small, linear settlement adjacent and to the north of the Chippenham Park Registered Park and Garden (RPG)[2]. Trees and woodland around the village provide enclosure. The settlement of Chippenham is approximately 1km north of Sunnica West Site A.

2.1.7 Figure 1 shows the design evolution of the Scheme in relation to Chippenham and Chippenham Park. As explained in paragraph 3.6.7 of the DAS, a design decision was made between statutory consultation and submission of the Application to omit parcels W13, W14 and W16 adjacent to Chippenham Park in response to feedback received from stakeholders, including local planning authorities. This moved the northern boundary of Sunnica West Site A approximately 600m further south and avoided encircling La Hogue Farm. As noted in paragraph 10.6.309 of the LVIA [**APP-042**], the ZTV shows no visibility of the Scheme across Chippenham or Chippenham Park. This is confirmed by VP30 from Chippenham High Street, illustrated in Figure 10.54A and 10.54B [**APP-227**]. This figure shows that intervening vegetation and buildings screen views of the land within the Order limits from within Chippenham. Similarly, for VP31 in Figure 10.55A [**APP-227**] and VP32 within Chippenham Park shown in Figure 10.98A to 10.98C [**APP-228**], vegetation and the tall boundary wall would screen views of the Scheme. Updated ZTVs were submitted at Deadline 1 [**REP1-008 to REP1-013**].

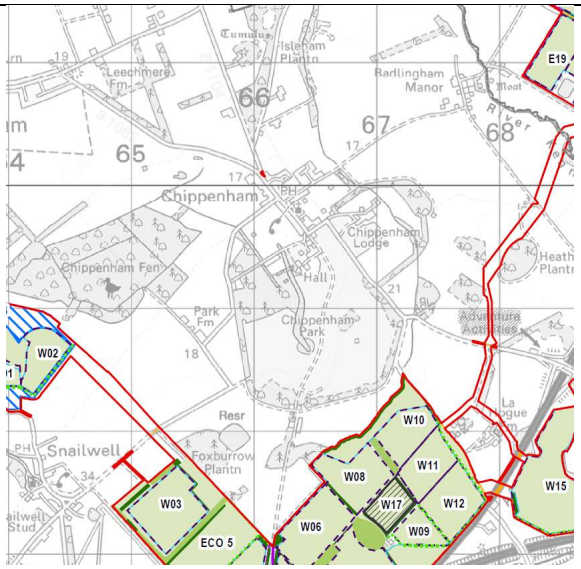
2.1.8 Effects on LLCA 23A are assessed as neutral in construction, operation and decommissioning [**APP-106**]. For visual receptors, significant effects are predicted for people using public right of way 49/7 represented by viewpoint 29 in construction relating to the cable route between Sunnica East Site B and Sunnica West Site A. However, effects on people's views related to viewpoints 30 and 31 and viewpoint 29 in year 1 and year 15 of operation and decommissioning will be not significant [**APP-107**].

[2] Appendix 10E LLCAs [APP-104]

Figure 1 Chippenham design evolution



Extract from DAS Figure 3-5 showing the non-statutory consultation boundary



Extract from Landscape Masterplan Figure 10-14A

Freckenham

2.1.9 Freckenham (LLCA 12), is a small, nucleated village with some vegetated enclosures, set within a rural setting of undulating farmland to the south of the River Lark[3]. Freckenham is approximately 0.6km south of the boundary of Sunnica East Site A at its closest point, though approximately 1.2km from the nearest solar panels (within parcel E05).

2.1.10 Figure 2 below shows the design evolution of the Scheme in relation to Freckenham, including substantial scaling back of the proposals to the northern and eastern edges of the village and provision of landscape offsets to reduce impacts on the setting and views of the Scheme from the village.

2.1.11 The boundaries of the Scheme have been moved approximately 1km away from Freckenham in response to concerns raised through consultation regarding the potential for the physical coalescence of settlements. This change retains the open character to the south of Beck Road, between Isleham and Freckenham by preserving the existing field patterns and introducing extensive areas of habitat which will be laid out in Parcels Eco 1 and Eco 2, which will comprise areas of proposed native grassland[4].

2.1.12 The Scheme design has conserved field boundaries and vegetation patterns by offsetting solar panels from the field edges to retain views across the landscape. It has responded positively to the Freckenham Neighbourhood Plan Landscape Character Assessment guidance *"by using and extending the existing woodland*

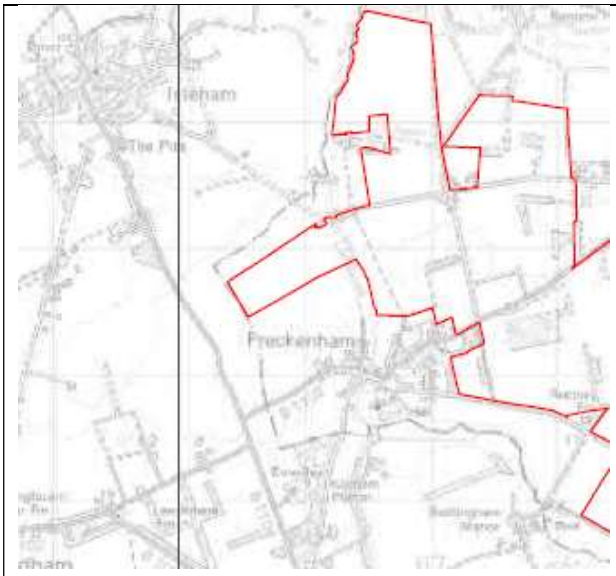
[3] Appendix 10E LLCAs [APP-104]
[4] As described in the Schedule of Environmental Mitigation [APP-257] (ID 36) and Appendix 10I Landscape and Ecology Management Plan (OLEMP) [APP-108] paragraph 1.7.6c

structure to help assimilate and provide screening, arrays contained in land parcels surrounded by belts of woodland would, over time, become well assimilated"[5].

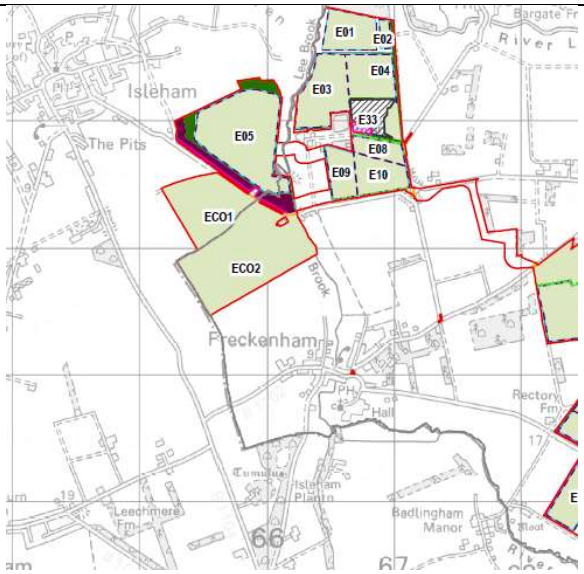
2.1.13 New permissive routes shown on Figure 10-14b [**APP-210**], adjacent to Beck Road will enable off-road public access for recreation across the landscape[6] between Freckenham and Isleham. These permissive routes will link with Bridleway W-257/002/X and Mortimer Lane, which lead north from Freckenham and are shown on Figure 10-4 [**APP-194**].

2.1.14 The LVIA concludes that effects on LLCA 12 would be not significant in construction, operation and decommissioning [**APP-106**]. With reference to viewpoints 8 and 9, no significant visual effects have been identified relating to Freckenham in construction, operation or decommissioning [**APP-107**].

Figure 2 Freckenham design evolution



Extract from DAS Figure 3-5 showing the non-statutory consultation boundary



Extract from Landscape Masterplan Figure 10-14A

Isleham

2.1.15 Isleham (LLCA 10) is a nucleated village in a rural setting on the edge of the Fens, to the south of the River Lark[7]. Isleham is approximately 0.5km to the north-west of the closest part of Sunnica East Site A (Parcel E05).

2.1.16 Figure 3 shows the design evolution of the Scheme in relation to Isleham. The Scheme boundary was extended closer to the village between the non-statutory consultation in 2019 and submission of the Application when land to the east was

[5] As described in the LVIA (paragraph 10.74d) [APP-042]
[6] As described in the OLEMP (paragraph 1.7.6f) [APP-108]
[7] Appendix 10E LLCAs [APP-104]

omitted. The Alternatives Chapter (Chapter 4) **[APP-036]** explains the changes as follows:

1. *"Further reduction in land occurred in the eastern area of Sunnica East to remove sites proposed for extensions to Worlington Quarry following discussions with the mineral operator regarding the programme for mineral extraction and thus impact on its mineral operations.*
    1.a.1 *Land for Solar PV in the western area of Sunnica East was removed as a result of landowner discussions. Land was retained to accommodate a cable route crossing linking Sunnica East Site A and Sunnica East Site B. Additional land was included to the north west of Sunnica East (now Sunnica East A) within the land holding already within the proposed DCO Site. These changes were to accommodate environmental mitigation areas particularly for stone curlew and deliver electricity generation capacity." Solar panel arrays have been introduced in Parcel E05, which lies to the east of Sheldrick's Road. This parcel was chosen because the land here is within in the lower lying land defined by the valley of Lee Brook, which flows north to meet the River Lark. It is approximately 5m lower than Isleham, which is located on an island of higher ground above the Fens. This higher ground falls gently towards Sheldrick's Road, reducing visibility of the closest parts of Parcel E05 from the edge of the village. This is illustrated in Section 1, presented in Figure 8 of the OLEMP [**APP-108**]. Woodland and hedgerows are proposed along the western edge of this parcel and will be effective in screening views when this vegetation has established.*

2.1.17 As with the mitigation design for Freckenham described above, the solar panel arrays have been sited away from Isleham to avoid the Scheme resulting in the physical coalescence of settlements. This assists in retaining the open character to the south of Beck Road, between Isleham and Freckenham, including the enhancement of the character and quality of the landscape through the introduction of ECO1 and ECO2, which are areas of proposed native grassland.

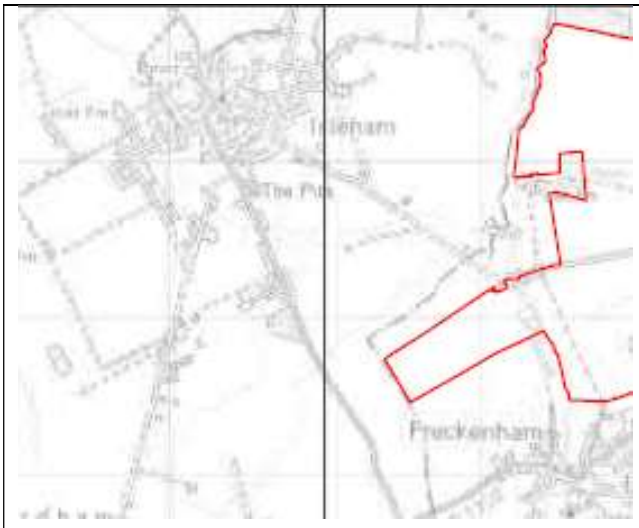
2.1.18 Solar panels in parcel E05 have been offset from Beck Road via a landscape buffer of native grassland and woodland as illustrated in Section 2, presented in Figure 9 of the OLEMP [**APP-108**]. This reduces the proximity of the panels to road users and retains views along the road corridor of churches in Isleham and Freckenham to retain the perception of travelling through the landscape that separates the settlements[8]. The proposed woodland planting, which has also been set back from the road, will provide a more vegetated setting to the southern part of the village, reflecting the pattern of woodland to the south of Isleham, adjacent to the B1104 (Station Road).

2.1.19 As described in the OLEMP [**APP-108**] (paragraph 1.7.6f), new permissive routes between Freckenham and Isleham, adjacent to Beck Road will enhance public access for recreation across the landscape, avoiding high speed (60mph), narrow roads without pavements.

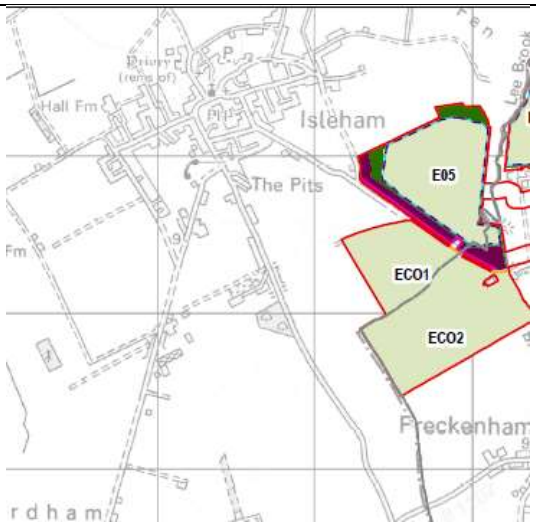
[8] As described in the LVIA (paragraph 10.8.331) [APP-042], the OLEMP (paragraph 1.7.7e) [**APP-108**] and as shown on the Landscape Masterplan [**APP-209**]

2.1.20 The LVIA concludes that effects on LLCA 10 would be not significant in construction, operation and decommissioning [**APP-106**]. Effects on visual receptors associated with viewpoints 3, 4, 4a and 6 however would be significant in construction and year 1 of operation, before planting carried out as mitigation will have established. By year 15 of operation, whilst some effects on views would remain, these would be not significant [**APP-107**]

Figure 3 Isleham design evolution



Extract from DAS Figure 3-5 showing the non-statutory consultation boundary



Extract from Landscape Masterplan Figure 10-14A

Kennett

2.1.21 Kennett (LLCA 25) is a dispersed settlement adjacent to the gentle river valley of the River Kennett[9]. It is located approximately 1.5km east of Sunnica West Site A at its closest point.

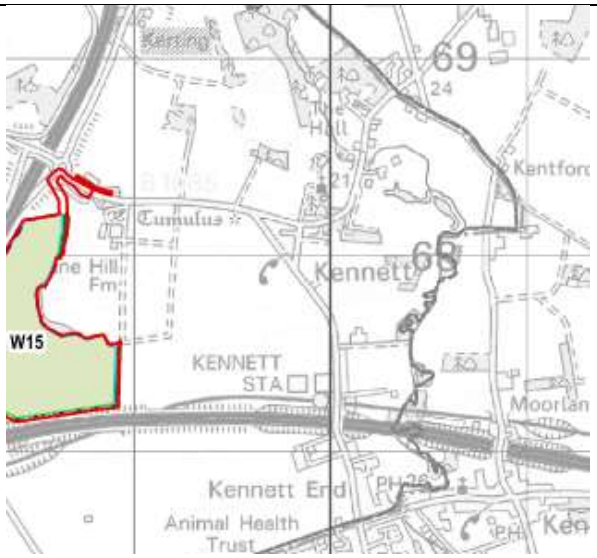
2.1.22 Figure 4 shows the design evolution of the Scheme in relation to Kennett. This includes refinement of the siting of the Scheme boundary to the south-west of Kennett, to the west of the watercourse. The solar panels within W15 have been pulled back beyond the watercourse, retaining the riverside trees and riparian vegetation [10]. New woodland is proposed on the eastern edge of Parcel W15. This existing vegetation and proposed planting will screen and soften views from Kennett, as described in paragraph 10.7.7h of Chapter 10 of the Environmental Statement [**APP-042**] and enhance local vegetation patterns.

2.1.23 Appendix 10G [**APP-106**] concludes that there will be significant effects relating to LLCA 25 as a consequence of the construction, operation or decommissioning of the Scheme. With respect to views, significant effects are predicted for residents of Kennett (VP36) in construction, but during operation and decommissioning effects would be not significant [**APP-107**].

[9] Appendix 10E LLCAs [APP-104]
[10] As described in the LVIA (paragraph 10.7.7h) [APP-042]

Figure 4 Kennett design evolution

Extract from DAS Figure 3-5 showing the non-statutory consultation boundary



Extract from Landscape Masterplan Figure 10-14A

Red Lodge

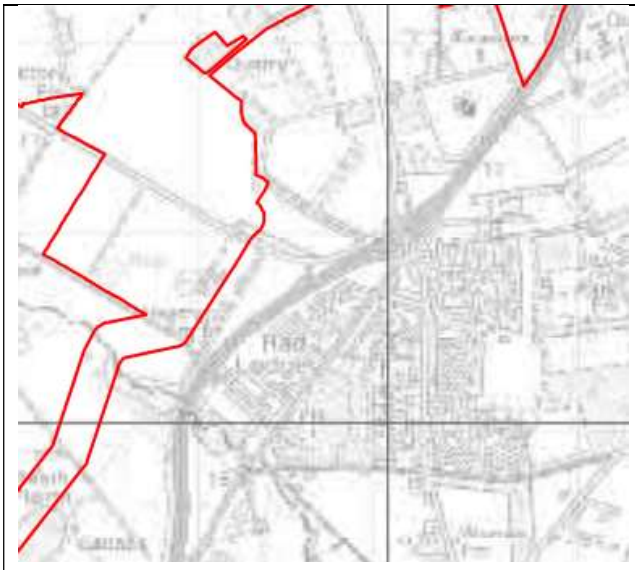
2.1.24 Red Lodge (LLCA 15) is a nucleated settlement with large areas of recent housing along the eastern side of the busy A11 trunk road. It is located approximately 0.4km to the east of Sunnica East Site B at its closest point.

2.1.25 Figure 5 shows the design evolution of the Scheme in relation to Red Lodge, including scaling back the Scheme boundary to the west, moving it further away from Red Lodge. Solar panel arrays to the west of Red Lodge have been located within the existing pattern of smaller field parcels to reflect the existing landscape pattern and retain the intervening hedgerows and pine lines. New woodland is proposed around the perimeter of the parcels to screen views from Bridge End Road and local PRoW and to reduce the perception of the Scheme from Badlingham, as described in paragraph 10.7.51 of Chapter 10 of the Environmental Statement [**APP-042**].

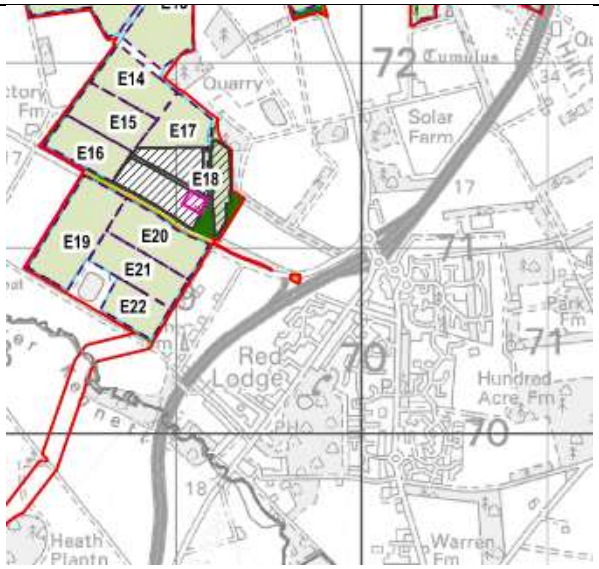
2.1.26 As described in the OLEMP [**APP-108**] (paragraph 1.7.6f), a new permissive route adjacent to Elms Road and around the perimeter of E19 and E22 to link with existing routes between Red Lodge and U6006, will enable enhanced public access for recreation across the landscape.

2.1.27 The LVIA concludes that effects on the character of Red Lodge will be neutral [**APP-106**]. No significant effects are predicted with respect to views of residents of Red Lodge, represented by viewpoints 27 and 28 [**APP-107**].

Figure 5 Red Lodge design evolution



Extract from DAS Figure 3-5 showing the non-statutory consultation boundary



Extract from Landscape Masterplan Figure 10-14A

Snailwell

2.1.28 Snailwell (LLCA 21) is a small, nucleated settlement with some vegetated enclosures, set within undulating farmland to the north of the A14[11]. It is located between Sunnica West Site B, which is approximately 0.5km to the north and Sunnica East Site A, which is approximately 0.4km to the southwest. A gap of approximately 1.1km will be retained between the two sites, with the landscape pattern and character preserved between.

2.1.29 Figure 6 shows the design evolution of the Scheme in relation to Snailwell. Whilst the Scheme boundary has not changed substantially, further design refinements have been introduced to enhance its integration with the landscape.

2.1.30 To the south-east of the village, solar panels within Sunnica West Site A will be sited between existing woodland blocks where the ground falls away to the south. Proposed woodland to the south of Snailwell on the northern edge of Parcel W03 will further aid in screening this part of the Scheme, and proposed native grassland/wetland and retained woodland adjacent to the River Snail to the north of the village will reinforce the existing vegetation pattern.

2.1.31 By keeping development away from Chippenham Road, the perception of the Scheme will be limited in journeys between settlements to the north.

2.1.32 To the north of the village, solar panels within Sunnica West Site B have been sited in small parts of parcels W01 and W02 away from the River Snail and Snailwell Road. This is to conserve the landscape features of woodland and the river and reduce the visibility of the Scheme from local roads. New native wet grassland is proposed across these parcels as a positive response to the

[11] Appendix 10E LLCAs [APP-104]

adjacent Chippenham Fen National Nature Reserve and to preserve below ground archaeology[12].

2.1.33 The LVIA has concluded that there would be significant intra-project effects on the character of Snailwell (LLCA 21) during construction, but that the effects of operation and decommissioning would be not significant [**APP-106**]. Significant intra-project visual effects have also been identified in construction, but visual effects during operation and decommissioning are also predicted to be not significant [**APP-107**].

Figure 6 Snailwell design evolution

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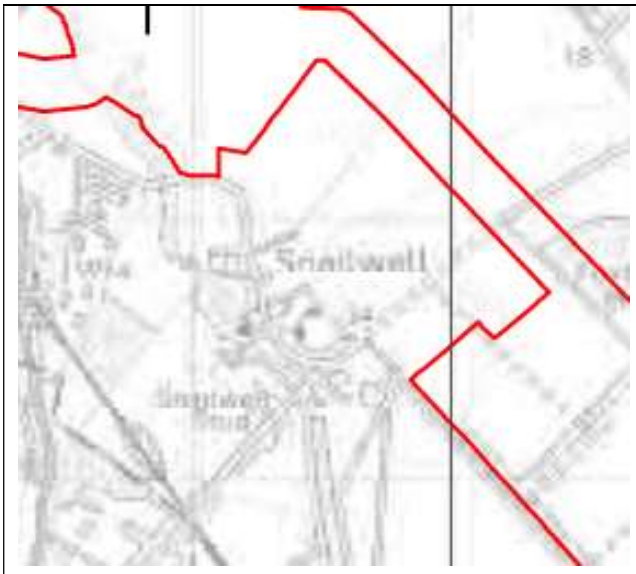
<td> 
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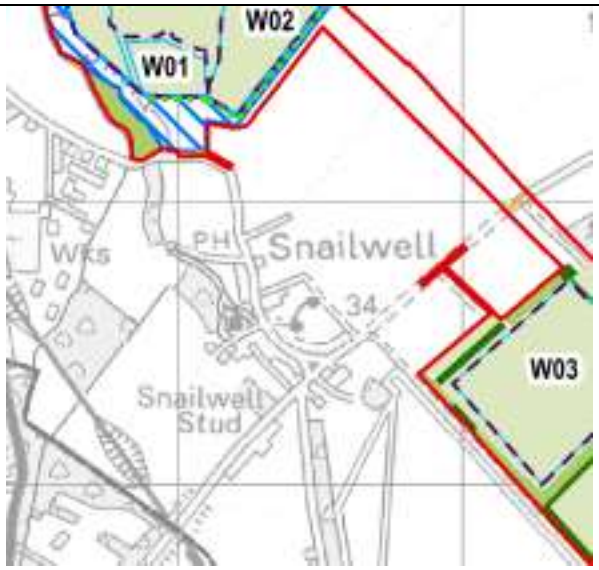
<td> 
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<td>Extract from DAS Figure 3-5 showing the non-statutory consultation boundary</td>
<td>Extract from Landscape Masterplan Figure 10-14A</td>
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West Row

2.1.34 West Row (within LLCA 5) is a small, dispersed rural settlement lying to the north of the River Lark within the settled fen edge landscape. It is located approximately 0.7km to the north-east of the closest part of Sunnica East Site A.

2.1.35 As noted in paragraph 10.6.314 of chapter 10 of the Environmental Statement [**APP-042**] in relation to VP2 by Jude's Ferry, the riverside vegetation and rising landform screens views of the fields across the eastern part of the Sunnica East Site A, but the upper parts of Lee Farm are visible.

2.1.36 Figure 7 shows the design evolution of the Scheme in relation to West Row. A substantial belt of woodland is proposed along the eastern edge of Parcel E02 and E04, which will further screen views from West Row and the River Lark.

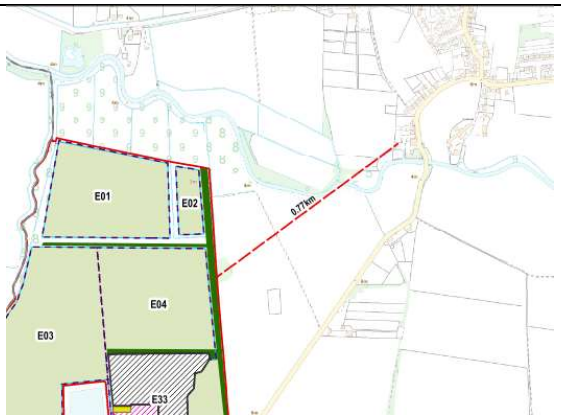
2.1.37 The LVIA concludes that effects on LLCA 5 will be neutral in the construction, operation and decommissioning phases [**APP-106**]. People walking along the River Lark and visiting Jude's Ferry are predicted to experience significant effects

[12] As described in the OLEMP (paragraph 1.7.9a) [APP-108]

during construction, but effects in operation and decommissioning are considered to be not significant [**APP-107**].

Figure 7 West Row design evolution

Extract from DAS Figure 3-5 showing the non-statutory consultation boundary



Extract from Landscape Masterplan Figure 10-14B

Worlington

2.1.38 Worlington (LLCA 8) is a small village to the south of the River Lark, within a rural and recreational landscape setting[13]. Sunnica East Site B borders the southern and eastern edges of Worlington, though the nearest fields with solar panel arrays are approximately 0.5km to the south of the village within parcel E12, and 0.3km south of properties on Freckenham Road.

2.1.39 Figure 8 shows the design evolution of the Scheme in relation to Worlington. The main changes were to introduce substantial ecological mitigation areas to the south west of the village and to remove the area directly south of the village from the Order limits. This effectively creates two parts to Sunnica East Site B, reducing its overall scale and impacts on the landscape setting of the village. The part of the Scheme previously proposed to the west of Parcel E12 has also been omitted to avoid a sense of coalescence with Freckenham and impacts on views on the journey between these settlements along the B1102 Freckenham Road.

2.1.40 Native chalk grassland in parcel ECO3 to the south of Worlington, has been incorporated to create a substantial offset from Freckenham Road and residents in the village to reduce the perception of the solar panels and proximity to residents.

2.1.41 The southern boundary of ECO3, which adjoins the proposed solar panels in Parcel E12, will be planted with hedgerows and woodland is proposed along the northern boundary of parcel E24. This planting will screen the panels and reduce the perception of the Scheme when travelling along Worlington Road.

[13] Appendix 10E LLCAs [APP-104]

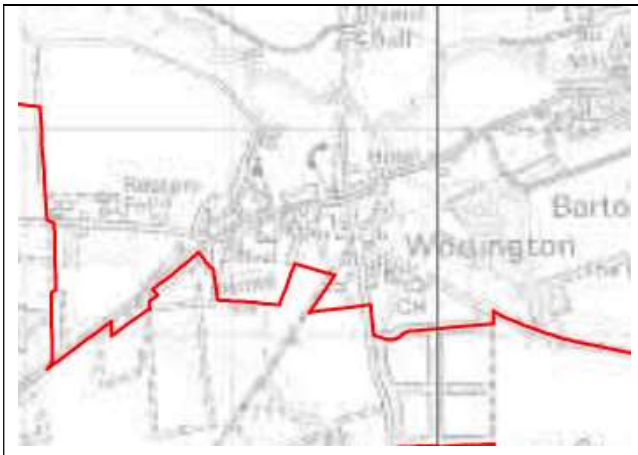
2.1.42 To the southeast of Worlington, solar panel arrays in parcels E26 and E27 have been located in small scale fields beyond dense existing boundary vegetation to retain the landscape pattern and screen the panels in views from the village. Adjacent to these, proposed hedgerow and woodland planting along Golf Links Road will reduce the perception of the Scheme in relation to Worlington.

2.1.43 The U6006 Badlingham Lane County Wildlife Site (CWS) will be retained..

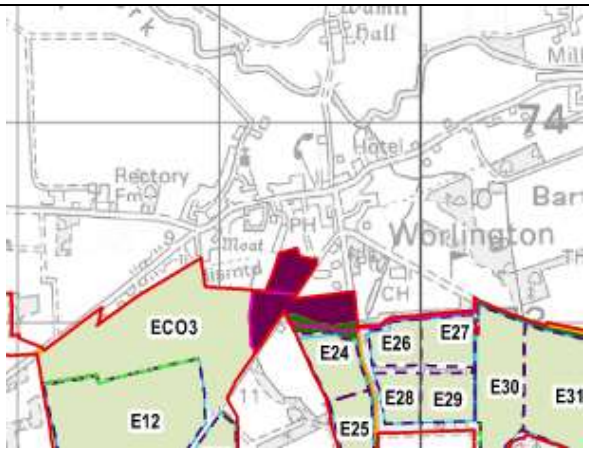
2.1.44 As described in paragraph 1.7.6f of the OLEMP [**APP-108**], a new permissive route to the south of Worlington, along U6006 and between U6006 and E24 and across E26 to E27 to connect with Golf Links Road will increase public access opportunities for recreation across the landscape and respond positively to published Green Infrastructure strategies.

2.1.45 No significant effects have been identified with respect to LLCA 8, which relates to the settlement of Worlington, in construction, operation or decommissioning [**APP-106**]. Impacts on views of the Scheme relating to viewpoints 14, 14A and 23A in construction would result in significant effects [**APP-107**]. These would largely reduce to not significant in year 1 of operation, apart from views south from Queens Hill (VP23A) to the east of the village, where effects would remain significant. All effects by year 15 of operation and in decommissioning would be not significant.

Figure 8 Worlington design evolution



Extract from DAS Figure 3-5 showing the non-statutory consultation boundary



Extract from Landscape Masterplan Figure 10-14B

3 Summary

3.1.1 The evolution of the Scheme from its inception to the outline design is outlined in the DAS [**APP-264**]. Landscape architects have strongly influenced the design, informed by emerging findings from the LVIA and guided by the criteria for good design outlined in the relevant National Policy Statements. In summary, the following design changes have been made to refine and improve the Scheme to minimise its impact on settlements and their landscape setting and people's use and views across the landscape:

- Scaling back the area of land required for the Scheme - this has been reduced by 189ha since the Scheme's inception to address the concerns of scale and as a result of landowner discussions.
- The landscape and ecological design proposed has been refined to provide over 30% of the area of the Sites as green infrastructure, utilising existing landscape and ecological features and habitats and providing mitigation for landscape and visual impacts and impacts on ecological species of the Scheme.
- The design of the proposed green infrastructure has been refined to reduce the visual impact of the Scheme in relation to nearby settlements by providing screening, offsets and buffer zones.
- The inclusion and subsequent refinement of proposed permissive routes to provide linkages across the Sites and between settlements away from busy roads.
- Careful siting of the solar panel arrays and other infrastructure in relation to landscape character, landform and vegetation. Particular consideration has been given to the relationship with settlements, including the siting of the solar panels to avoid the Scheme resulting in physical coalescence. Substantial offsets from Freckenham, Isleham and Worlington have been integrated into the design. Offsets from local roads have also been included, such as to the west of Beck Road and Freckenham Road, to retain views along the road corridor of the churches in Isleham and Freckenham and a perception of travelling through the landscape that separates the settlements.

Appendix B Sunnica Energy Farm: Battery Energy Storage System

Document Purpose

1. The purpose of this document is to provide further information in respect of the proposed Battery Energy Storage System ("BESS") associated with the Sunnica Energy farm proposals, and to answer relevant parts of the Examining Authority's First Written Questions namely:

Q1.0.9. Connection to the national grid

In paragraph 4.1.4 of the Grid Connection Statement [APP-265] you say that the connection to the national grid will be an import and export connection.

- Why does the BESS require charging from external sources

Q1.0.10. Transfer of energy to the national grid

Our understanding is that a battery energy storage system (BESS) is needed to control the transfer of energy to the national grid because of the fluctuating quantities of energy generated by the solar panels: the BESS is thus necessary development associated with the NSIP which is the solar energy generating panels.

Paragraph 3.4.23 of the Scheme Description [APP-035] says that "T*he BESS is designed to provide peak generation and grid balancing services to the electricity grid by allowing excess electricity generated either from the solar PV panels, or imported from the electricity grid, to be stored in batteries and dispatched when required*."

Please explain:

i. Under what circumstances and why it would be necessary to allow electricity imported from the national grid to be stored in the Sunnica BESS; and
ii. How and why this is necessary to the operation of the NSIP, ie the solar panels generating the electricity, and thus fulfils the requirements of associated development.

2. This paper (a) outlines the requirements for associated development set out in guidance, (b) explains how this applies to BESS at Sunnica, including the import connection, and (c) then specifically turns to the ExA's questions.

3. As explained at ISH1, the BESS is associated development because its purpose is to store energy from the solar farm and thus to increase the benefit of the solar farm authorised as "Work No 1" in the dDCO [AS-293, revised at Deadline 2]. The BESS is not standalone development; it will only be constructed in association with Work No 1. Since the production of energy from the solar farm depends on sunlight, it is necessarily intermittent and its output is not dependent on the level of grid demand. The BESS can address that by storing energy when it is produced and exporting it to the grid when it is needed.

Planning Guidance

4. *Planning Act 2008: Guidance on associated development applications for major infrastructure projects* ("GADA") provides guidance on Associated Development for Nationally Significant Infrastructure Projects (NSIPs).

5. Paragraph 3 of GADA states *"Associated development is defined in the Planning Act as development which is associated with the principal development ... Associated development can include development in England."*

6. GADA sets out associated development principles which the Secretary of State will take into account in making a decision on a proposed project. These are (summarised):

    A. Associated development requires a direct relationship between associated development and the principal development. Associated development should therefore either:
        - Support the construction or operation of the principal development, or
        - Help address its impacts.

    B. Associated development should not be an aim in itself but should be subordinate to the principal development.

    C. Development should not be treated as associated development if it is only necessary as a source of additional revenue for the applicant, in order to cross-subsidise the cost of the principal development. This does not mean that the applicant cannot cross-subsidise.

    D. Associated development should be proportionate to the nature and scale of the principal development. However, associated infrastructure development that is on a larger scale than is necessary to serve the principal development shall not be excluded if that associated infrastructure provides capacity that is likely to be required for another proposed major infrastructure project.
        - In such a case, each application will have to be assessed on its own merits, including for example whether a future application is proposed to be made by the same or related developer as the current application, the degree of physical proximity of the proposed application to the current application, and the time period in which a future application is proposed to be submitted.

    E. Associated development is expected in most cases to be brought forward alongside the relevant type of principal development or of a kind that is usually necessary to support a particular type of project.

BESS, including its import connection, as associated development.

7. In this section, each of the requirements A to E in the GADA section above are examined to demonstrate that BESS are associated in a planning sense with principal solar developments.

A. A direct relationship between associated development and the principal development

8. The BESS supports the operation of the principal solar generation development by ensuring that energy which is generated but not immediately required is not wasted, but instead is stored to be released when it is needed. This creates the direct relationship identified in the GADA.

9. Further, the BESS helps to address the impacts of the solar generation, namely its intermittency and dependence on environmental, rather than grid demand, factors. Each of these points is addressed further below.

<u>Supporting the operation of the solar farm</u>

10. As to the first purpose, one of the acknowledged weaknesses with solar generation is that generating stations cannot control either when the sun shines, or when the power produced is needed. There will often be a temporal disconnect between supply and demand. In the UK this is a particularly pronounced problem, because the UK occupies a relatively short span of longitude. Energy generation from solar farms will thus generally occur consistently across the UK, peaking at the same times and falling at the same times. These periods will often not coincide with the peak demand for electricity in the grid.

11. In order to progress the UK's decarbonisation, make the best and most efficient use of the energy generated by solar farms (including Sunnica), keep costs as low as possible for consumers, and ensure a reliable electricity system, it is therefore important that there is a measure which can store energy generated by the solar PV panels for later use to support the operation of the solar farm.

<u>Addressing the impacts of the solar farm</u>

12. The effect of increasing the amount of utility scale solar generation in the grid is that the amount of energy generation which is dependent on environmental factors will increase. The purpose of developing renewable sources is to displace carbon-intensive, but "dispatchable", generation from the grid. Gas fired power stations can

be operated to provide power to the grid when it is most needed and also provide essential ancillary services to the grid – for example frequency response, system inertia, short term operating reserves and Balancing Mechanism participation. Renewable sources (such as wind and solar) do not provide those services to the same extent as dispatchable fossil-fuelled generation currently do, but those same ancillary services are critical in systems with large shares of renewable generation capacity. Although displacing carbon intensive generation is a key benefit of the solar scheme, a reduction in critical ancillary services provided by those displaced generators is a key impact which must be addressed.

13. The BESS development at Sunnica will help address that impact. The Appendix to this paper provides examples of the displacement described above in two important ancillary services - those of system inertia and frequency response. In summary, the analysis shows that:
    - As renewable generation sources grow in capacity, output from fossil fuelled sources reduces.
    - Reducing fossil-fuel output drives a need either for more services (for example system inertia), and/or for new providers of existing services (for example frequency response services).
    - BESS can provide both the new services needed, and participate in the existing services when fossil fuelled stations are no longer able.

14. More information on power system operation and the ancillary services which are essential for smooth system operation can be found in Statement of Need [APP-260] Sections 7.2 and 7.3, and further information on the capabilities and suitability of BESS to meet the UK's electricity system operation needs can be found in the Statement of Need, Section 10.4.

15. A BESS which can draw energy from the grid helps protect against impacts of the scheme displacing fossil fuelled generation by providing ancillary services. BESS deliver ancillary services by either injecting power into the grid (to increase frequency and increase energy supply) or drawing power from the grid (to reduce frequency and increase energy demand). When the solar scheme is generating, storing that power in the BESS (rather than exporting it to the grid) has the same effect on the national electricity system as increasing energy demand. However, at times when the solar scheme is not generating power it is necessary for the BESS to import electricity from the grid to provide the services needed. If the BESS is limited to charging only with energy generated by the scheme's solar panels, the BESS cannot provide these important ancillary services .

16. An impact of the rollout of low-carbon generation, including large-scale solar and Sunnica Energy Farm, is the closure of fossil-fuelled dispatchable generators such as CCGTs, OCGTs, Gas Reciprocating Engines and Diesel Gensets which currently provide essential system services to the safe and reliable operation of the National Electricity Transmission System. Accordingly, the association of a BESS development with the solar development at Sunnica Energy Farm meets the test of "help[ing] to address its impacts."

17. However, this role of the BESS needs to be understood in the context of the direct relationship with the solar farm. Because the grid connection point at Sunnica is shared between the solar generation development and the associated BESS development, the operation of the BESS is dependent on the operation of the solar development.
    - At times when solar generation is high, the solar development will be using a significant proportion of the available grid export capacity. The level at which the BESS can export power at such times will therefore be small and the BESS will therefore largely be available only to import power from the solar development if that power is not immediately needed.
    - Conversely at times when solar generation is low, the level at which the BESS can export power will be high, and the level at which the BESS can import power will also be high. At such times this is likely to be the import of external power rather than the import of power generated by the solar development. At times of low solar generation, therefore, the BESS will be able to export any energy it has previously stored, or provide ancillary services.

18. Therefore the operation of the BESS is dependent on the operation of the solar generation capacity with which it is associated.

B. The import connection to the BESS at Sunnica Energy Farm is subordinate to the principal (solar) development

19. The aim of the project is to generate renewable energy. The BESS does not do that – rather, it facilitates the more efficient use of the power generated by the solar panels, and the import connection to the BESS provides ancillary services which are necessary to deal with the impacts on the grid of the main development.

C. The BESS (and its import connection) is not necessary as a source of additional revenue for the applicant

20. Chapter 9 of the Statement of Need demonstrates that solar is economically efficient in GB. Solar is already the cheapest form of generation in the UK and over 1GW of unsubsidised solar has been deployed since the end of the feed in tariff regime. The Sunnica scheme is expected to be delivered for a total project cost which is consistent with the estimates provided in Chapter 9 of the Statement of Need. Publicly available information, including BEIS' own Cost of Generation estimates, indicate that Solar is economically rational on a standalone basis and the BESS is not required for cross-subsidisation of the solar facility.

D. The proposed associated development at Sunnica Energy Farm is proportionate to the nature and scale of the principal development.

21. The import connection is one component of the BESS, and the BESS is itself proportionate to the nature and scale of the principal development.

22. As outlined above, introducing a BESS component is proportionate in **nature** to the principal development, as it (a) helps make more efficient use of the energy generated by the solar panels and (b) the import connection specifically provides necessary ancillary services which the solar panels displace.

23. It is also the case that the BESS proposed here, including its import connection, is proportionate in **scale** to the principal development. There are various ways in which proportionality can be considered:

(1) Power: the BESS shares the same import/export power capacity as the solar farm - I.e. its 500MW connection is no larger than the principal development.
(2) Energy: as explained at ISH1, the energy stored in the BESS (expressed in MWh) will depend on the number of hours it is intended to store. Whilst most systems are currently configured for up to 2 hours, it is possible that up to 4 hours will be used in the future. The table below demonstrates that for 6 months of the year, more energy is predicted to be generated from the solar farm than would be stored in the BESS, confirming that the scale is proportionate to the principal development.
2.

Month	Average monthly electricity production (MWh/ month)	Average daily electricity production (MWh/ day)	Average daily solar PV energy production available to charge a 500MW power rated BESS (500MWh)
January	15577	502	1.0
February	25756	920	1.8
March	53849	1737	3.5
April	78569	2619	5.2
May	85874	2770	5.5
June	87408	2914	5.8
July	88032	2840	5.7
August	75741	2443	4.9
September	62448	2082	4.2
October	37863	1221	2.4
November	19323	644	1.3
December	12921	404	0.8
Yearly total	**643361**	**1763**	**4**

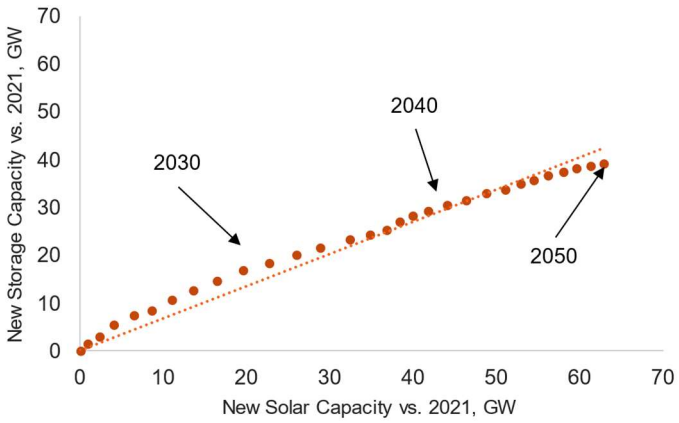
To explain the data shown in the table further, the first column shows the average monthly electricity production from the solar PV panels measured in MWh/month. The second column shows the resulting average daily electricity production in MWh/day. The third column shows the ratio of the average daily electricity production from the solar PV panels to the energy capacity of a 500MW / 500 MWh BESS. The third column therefore demonstrates that during 6 months of the year (between April and September) the solar PV panels would generate enough energy to charge the BESS for more than 4 hours equivalent energy capacity for the BESS.

During 2 months of the year (March and October) the solar PV panels would generate enough electricity to charge the BESS for between 2 to 3 hours equivalent energy capacity for the BESS. During the remaining 4 months of the year the average daily electricity production from the solar PV panels would generate average less than 2 hours equivalent energy capacity for the BESS. It also shows that overall average daily production equates to a four hour duration charge for a 500 MW power rated BESS system.

(3) Physical scale: the DCO parameters restrict the overall scale of the BESS. The areas identified for BESS amount to c. 31Ha of a scheme area which exceeds 1000Ha, c. 3% of the land required for the scheme. In reality only a small proportion of this 31Ha will contain batteries due to the need for separation between containers etc: see the Outline Battery Fire Safety Management Plan (updated and submitted at Deadline 2).

(4) The scale of storage capacity required as the amount of solar on the grid increases:

a. National Grid's Future Energy Scenarios ("FES") indicates that as renewable generation capacity increases to 2050, that flexible storage capacity is expected to increase with it. The figure below shows that the FES foresees that the installed capacity of flexible generation (GW) is needed in approximately 2:3 measure compared with new solar generation capacity (i.e. storage capacity is projected to need to increase by 2MW for every 3MW of new solar generation capacity), to support additional renewable generation onto the grid, but that in the years until 2030, the ratio of new storage capacity to new solar capacity is projected to be much closer to 1:1.



b. Accordingly when considering whether the BESS mitigates for the impacts of the principal development in proportion to those impacts in terms of the displacement of dispatchable fossil fuel generating stations, the evidence suggests that the power of the BESS should correspond with the power of the installed solar.

E. The associated development will be brought forward alongside the principal development.

24. Sunnica proposes to construct the BESS facility in parallel with the principal development such that operation of both aspects can commence in parallel once construction is complete. The BESS would not be constructed without the solar farm, and as such is evidently subordinate to it. A restriction to this effect in the DCO would be acceptable to the Applicant.

Responses to questions

25. Against that background, the responses to the questions are as follows.

Q1.0.9 Why does BESS require charging from an external source?

26. The BESS could be operated solely to charge from the solar farm. However, such an operation would be less efficient than that which is proposed and fail to realise the full benefits of the BESS. The ability of the BESS to import from the grid does not have any bearing on the environmental effects of the proposal, and it does not alter any of the parameters for the BESS which are being examined.

27. As explained above, there are significant benefits from importing power, which serve to mitigate the effects of new solar development displacing fossil fuel generation from the grid. The BESS will provide system ancillary services which are essential to support the smooth functioning of the grid. The BESS will also help National Grid balance supply and demand by participating in the Balancing Markets. The need for assets to participate in both of these functions is necessary to address the impacts of increasing renewable energy sources which displace carbon intensive means of generation that have traditionally met this requirement. The need is expected to grow as a result of the further rollout of renewable energy sources onto the GB electricity system. In order for the BESS to fulfil both of these functions, the BESS will at times import power from the principal solar development. It will also need to be able to import power from the grid as well as export power to the grid to provide these services.

28. Sunnica Energy Farm holds a Bilateral Connection Agreement with National Grid ESO for 500MW of import power, and 500MW of export power. The principal solar development has been designed to optimise both land use and grid connection capacity, by developing as efficient as possible a scheme. The development of the BESS with the solar farm, and its ability to import power from the grid, further optimises the use of land and maximises the contribution of renewable energy sources to the grid. The British Energy Security Strategy (April 2022) recognised the benefits of co-located storage with solar "to maximise the efficiency of land use".

Q1.0.10(i) Under what circumstances would it be necessary to allow imported electricity to be stored in the Sunnica BESS

29. The BESS will import and store energy from the grid where that service is required, essentially when the supply to the grid from other sources is greater than the demand. Specifically, in the provision of Ancillary Services, the BESS will import power from the grid when the grid's system frequency is higher than it should be. In the provision of services to balance supply and demand, the BESS will import power when more electricity is supplied onto the grid than the grid demands at that point in time.

30. At times when solar generation is high, the BESS will import power from the solar development if that power is not immediately needed in the grid. Conversely at times when solar generation is low, the BESS will be able to provide ancillary services by exporting any energy it has previously stored, or by importing energy from the grid.

Q1.0.10(ii) how and why is this necessary to the operation of the NSIP…and thus fulfils the requirements of associated development

31. The BESS is associated development whether or not it is used to import power from the grid. It supports the operation of the solar farm by storing renewable energy when it is not needed on the grid. By all measures it is proportionate in its scale and nature to the generating station proposed. This conclusion that the BESS is AD is unaffected by its ability to import power, particularly since that ability raises no different effects of the scheme as a whole.

32. The import capacity of the BESS further addresses the impacts of the principal development by providing the services described above which would otherwise be provided fossil fuel generating stations.

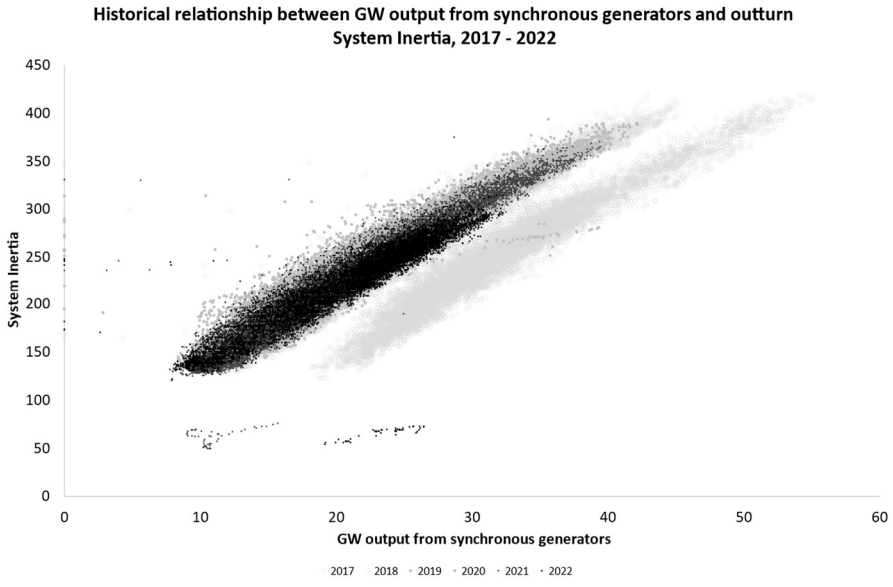
Appendix – Development of ancillary services as a result of increased generation from renewable sources

33. National Grid's 2017 System Needs and Product Strategy ("SnaPS") which is submitted as an annex to this paper **[ExQ Ref 1.0.09 Appendix B, Annex A – System Needs and Product Strategy]** explains how the changing nature of the grid and the power generators connected to it, leads to a requirement for different ancillary services (needed by NGESO to manage operation of the electricity system), and different providers of existing ancillary services. From that document we highlight two examples - the relationship between **system inertia** and **frequency response**.

34. In brief, system inertia determines how quickly frequency will change when there is a change in the balance of generation and demand – the greater the inertia, the slower the change in frequency; the lower the inertia, the higher the rate of change of frequency. Some generators have protective relays in place to disconnect or 'trip' them if there is too high a rate of change of frequency. So, the rate of change of frequency must be kept below those thresholds [SNaPS p.8].

35. **System inertia** comes from the rotational energy stored in synchronous machines such as coal, nuclear, gas or hydro power plants. These synchronous generators provide inertia because of the spinning masses of metal they connect to the grid, keeping system frequency locked close to its statutory target of 50Hz. As levels of wind, solar and interconnection between national electricity markets continue to increase, system inertia is expected to decrease. [SNaPS, p8]. Therefore an increase in products which manage low inertia is needed.

36. The figure below shows the relationship between MW output from synchronous (i.e. inertia-providing) generators and system inertia over the financial years 2017 to 2022 (to end September). The lighter dots are the older years; the darker dots are more recent years. The figure demonstrates that:
    - As less inertia-providing assets are connected to the grid, system inertia decreases. This is shown by the shape of the loci shown, covering bands from low left to high right on the graph.
    - In recent years, less inertia-providing units have been connected to the grid, therefore inertia has been lower in recent years than it was in previous years. This is shown by the darker loci being left, and below, the lighter loci.



37. **Frequency response** is an automatic change in generation or demand to counteract changes in system frequency [SNaPS p. 11]. It is required to balance

system frequency in real time. The need is greatest when system inertia is lowest. National Grid procures response in two ways - Firm Frequency Response (FFR) (products procured up to a month ahead of time) and Mandatory Frequency Response (accessed closer to real time).

38. National Grid need response that acts faster than the products that were used in 2017 and also need flexibility closer to real time [SNaPS, p11]. A response product is required to replace existing frequency products which should ensure access to the faster-acting services that are needed and also allow closer to real time procurement of the flexibility that is needed [SNaPS, p14].

39. In October 2017, approximately half of the capacity submitted to NGESO's Firm Frequency Response (FFR) tender event was from thermal (carbon intensive) assets. In NGESO's most recent market tender event, 94% of submitted capacity was from storage assets.

40. Because ancillary service provision needs to transition away from fossil-fuelled assets, and because of NGESO's needs described above, NGESO have modernised the services they require by developing a suite of "Dynamic" products (Dynamic Regulation, Dynamic Moderation and Dynamic Containment) which are currently replacing Frequency Response products . Almost all of the assets which participate in the Dynamic products are BESS, and as a further transition away from fossil-fuelled asset occurs, more services will be needed from BESS, implying that a greater capacity of BESS will be required to participate in such ancillary markets.

41. The SNaPS document demonstrates that as renewables come online and displace fossil fuels as a contributor to the grid, system inertia is reducing. Accordingly, a way must be found to provide synthetic inertia or otherwise manage frequency response. If this impact is not addressed, there is a risk that power system quality (See Statement of Need Section 7.2) will reduce, in effect lowering the reliability and stability of the national electricity system. A less reliable and stable national electricity system may experience a growing frequency and wider geographic propagation of faults; brown outs or (worse) black outs. Managing the quality parameters of a less stable system will incur higher system operational costs, which are ultimately recovered from consumers.

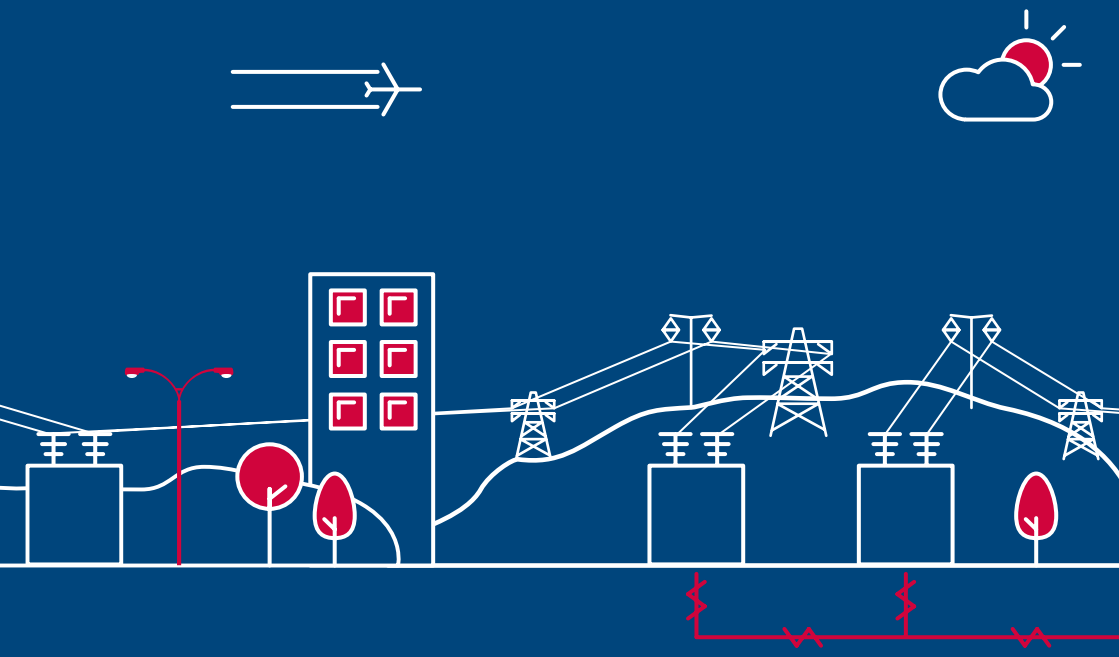
42. Other Ancillary Services which will follow the route away from fossil assets to RES and storage include – for example – Short Term Operating Reserve (STOR). STOR currently remains dominated by carbon-intensive generation (CCGT, OCGT, Gas Reciprocating Engines and Diesel Gensets). A transition away from carbon-intensive generation will increase the requirement for storage capacity to connect to the NETS in order to manage its safe and secure operation. BESS are a critical current and future provider of all ancillary services (as shown in the Statement of Need, Table 10-1).

Annex A – National Grid System Needs and Product Strategy (June 2017)

nationalgrid

System Needs and Product Strategy

UK electricity transmission



June 2017

How to use this interactive document

To help you find the information you need quickly and easily we have published *System Needs and Product Strategy* as an interactive document.

Home
This will take you to the contents page. You can click on the titles to navigate to a section.

Arrows
Click on the arrows to move backwards or forwards a page.

Hyperlinks
Hyperlinks are highlighted in bold throughout the report. You can click on them to access further information.

Foreword

As the UK transitions to a low carbon economy, it brings changes to the way we operate the electricity system.

We are moving away from a historical reliance on large thermal power generation and there is now a greater diversity of supply and flexible demand than ever before.

The System Operator (SO) has an important role to play in facilitating the transition to a smart, flexible energy system. We are changing to meet the evolving needs of the energy market, while consistently delivering improvements in consumer value. System operation will continue to become ever more sophisticated and complex. We are identifying robust, cost-effective and innovative solutions that will support a secure, low carbon future as economically and efficiently as possible.

We are working with industry to deliver the right solutions at the right time; improving transparency of our needs and developing solutions to maximise the use of all available assets (network, generation and demand) for the benefit of the end consumer.

Our aim is to create balancing services markets that meet our changing system needs and in which all technology types can compete on a level playing field. To achieve this we will provide market information that plainly sets out our needs and simplify balancing services to create transparent markets.

This document is intended to give more information on our future system needs and to consult on how we can best facilitate the evolution of future balancing services markets. As developments occur, we will use our new Future of Balancing Services web page to provide additional information and updates as we progress with our thinking over the coming months.

We will also be working closely with our colleagues in the Distribution Networks to understand how best to facilitate a whole system approach to managing the network, ensuring parties at all levels of the system have the appropriate access and routes to market. As always, we are keen to understand your views and feedback either through the consultation questions within the document or more generally about this publication. Please contact us using the Future of Balancing Services email address: **box.futureofbalancingservices@nationalgrid.com**

Cathy McClay
Head of Commercial, Electricity

Contents

Executive summary

A flexible system that makes the best use of all available resources will enable the System Operator to meet its customers' needs in an economic and efficient way, particularly in a future smarter energy world. To do this, we intend to create balancing services that allow new and existing providers to participate.

You told us:

- balancing services are not accessible to all potential providers
- balancing services are complicated, they are unclear and not future-proof
- investors need to know our plans so they can make informed decisions of their own.

We are committed to responding to this feedback by creating balancing services that are simple, transparent and deliver value to the end consumer.

To make this happen we are:

- improving the information we share to make it easier for industry to see and meet our future system needs
- consulting on and simplifying our balancing services. We want to remove the barriers you have highlighted so the system makes better use of all resources.

System Needs and Product Strategy

This document *System Needs and Product Strategy* is the first step toward improving the information that we share. It has been published on our new Future of Balancing Services webpage. We will use this page to share the latest information about our needs and balancing services developments.
www2.nationalgrid.com/futureofbalancingservices/

In chapter one, we provide an overview of our **System Needs** over the next five years. We discuss how these needs are evolving (and increasing in certain timeframes). We also discuss the improvements required to balancing services to meet these needs.

On **Product Strategy**, we are asking for your engagement and ideas to simplify and evolve balancing services and the products that we use to address these system needs. This consultation should help us understand industry thinking about improvements that could be made to our various services and markets. Responses are invited using the survey on our webpage by 18 July 2017.

We will also be looking at the structure of our contracts, reviewing our testing and compliance requirements and trialling new procurement methods.

We will be engaging with industry over the next few months and publishing our post-consultation recommendations for a balancing services product strategy at the end of September 2017. At that time we will also have a detailed plan showing milestones for how our proposed strategy will be implemented.

Introduction

National Grid is the electricity System Operator for Great Britain. We are responsible for operating the GB high-voltage electricity transmission network in a safe, secure, reliable and cost-efficient manner.

Residual balancer

As the SO, we are the residual system balancer; this means we must ensure the balance between supply and demand is maintained continuously. We do this by refining the generation output and demand delivered by the wholesale market.

System needs

We must also ensure that the system is operated within a number of defined limits and that likely system events can be managed; in this document we describe these as 'system needs'. We do this by accessing flexible generation close to real time in the Balancing Mechanism (BM) and by contracting for balancing services ahead of time where we are confident those needs will exist in real time.

Changing energy mix

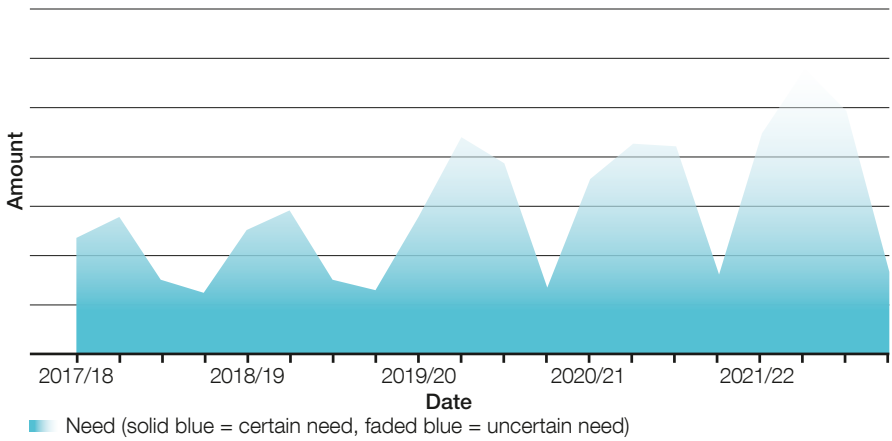
Less synchronous generation on the transmission system and an increase in intermittent generation embedded within the distribution network has led to system needs becoming less predictable and more volatile. A reduction in generation available in the BM able to offer the flexibility that is needed to address the increasing volatility means we are taking more actions as the residual balancer for operability reasons.

Need for change

The approach of accessing flexibility in the BM and contracting for firm needs in balancing services has been fit for purpose in the past. It has delivered on our objectives of a safe, secure, reliable and cost-efficient system; however, the changing energy mix and the increasing requirement for cost-effective flexibility (either in the BM or otherwise) means that the current approach must be reviewed.

Figure 0.1 demonstrates the general trend for system needs over the next five years using illustrative data, with the increasing transparency aiming to show how our requirements become less certain at the extremes. In general, system needs are increasing, most notably at the extremes. The volatility of the extremes is also increasing. Currently we access the flexibility required to manage the extremes and volatility, near real time, in the BM (mandatory services and BM availability). More certain or 'firm' needs are procured further ahead of time in tendered balancing services markets. These firm needs remain relatively stable across the five-year timeframe. As the energy mix changes, the availability of flexibility in the BM is reducing or is becoming increasingly costly to access. Therefore routes to market must be created for all providers to offer flexibility across the SO's range of requirements.

Figure 0.1
Illustration of balancing services trend



Our ambition is to work with industry to design and create a transparent, technology-neutral set of products that allow access to the flexibility that is increasingly required. ***System Needs and Product Strategy*** is the first deliverable of this ambition. It is divided into two distinct parts, the system needs and the product strategy consultation.

The System needs chapter provides:

- a summary of five key future system needs. These have been broadly written in the order they are required from real time.
  - Inertia and Rate of Change of Frequency (RoCoF)
  - Response
  - Reserve
  - Reactive Power/Voltage Support
  - Black Start
- a summary of how these needs are currently met and any potential improvements that could be made
- where appropriate, a forecast of how the needs change in the one to five year timeframe. It should be noted that any future improvements to balancing services will impact these forecasts.

Future requirement modelling

Throughout the System needs chapter we refer to data from our future requirement forecast model. This model uses a half hourly forecast of generation and demand using the methodology developed in *SOF 2016*. To display the requirements, we have chosen the **Consumer Power** scenario from the *FES 2016* as it most closely reflects the issues and trends that we currently experience.

To demonstrate the range of possible requirements, we present the data using the 50th percentile and 97.5th percentile values. The 50th percentile can be thought of as a medium or normal likelihood and the 97.5th percentile represents the high or extreme likelihood. A range is used due to the number of variables including demand, generation and weather.

Future product and service designs are subject to consultation. The forecasts included in this document are therefore modelled using today's products and service assumptions. We will update any forecasts as the products are developed.

Introduction

The Product strategy consultation chapter provides:

- details of the engagement programme and the steps we will take to review the way we procure balancing services
- a number of alternative approaches and options for the future
- consultation questions to gather industry feedback to begin the design process
- a timeline for the consultation, design and implementation of changes.

Future of balancing services

We will continue to use the Future of Balancing Services webpage to provide further updates and details as and when the product strategy develops. **www2.nationalgrid.com/futureofbalancingservices/**

If you would like to know more about our current balancing services please visit: **www2.nationalgrid.com/uk/services/balancing-services/**

If you would like to know more about our operability requirements from a technical perspective please visit: **www.nationalgrid.com/SOF**

Chapter one

System needs

System inertia and Rate of Change of Frequency

System inertia comes from the rotational energy stored in synchronous machines such as coal, nuclear, gas or hydro power plants.

Inertia determines how quickly frequency will change when there is an imbalance between generation and demand; the greater the inertia, the slower the change in frequency. As levels of wind, solar and interconnection continue to increase, system inertia is expected to decrease.

Inertia stabilises frequency and reduces the Rate of Change of Frequency (RoCoF). While faster acting frequency response helps to manage a higher RoCoF, some inertia is still required to hold frequency for long enough to allow even the fastest frequency response to be triggered[1].

System inertia and Rate of Change of Frequency summary

- Inertia stabilises frequency and reduces the Rate of Change of Frequency (RoCoF).
- System inertia is expected to decrease as the energy mix changes.
- RoCoF must be managed to avoid generation protection relays tripping.
- Reducing the largest credible loss will reduce maximum potential RoCoF following a loss. This is currently the most efficient solution.
- Increasing the levels of inertia on the system is less effective than reducing the largest credible loss, therefore we will not create a specific inertia product.
- Desensitising RoCoF relays will allow the system to operate at lower levels of inertia.
- Inertia is linked to managing frequency. Its value will be assessed as part of a new frequency response product to be designed and implemented by March 2018.

How do we manage inertia and RoCoF today and where do we see issues going forward?

The lower the level of inertia on the system, the higher the RoCoF will be in the event of a generation or demand loss. Some distributed generators have protection relays in place which will disconnect or 'trip' them from the system if a high RoCoF is detected[2]. In a worst case scenario, uncontrolled disconnection of large quantities of generation could lead to partial system shut down. This means at times of low inertia (which are coincident with times of low transmission demand) we must take more actions to keep the potential RoCoF below the trigger points of these relays.

[1] More details on the difference between inertia and faster frequency response can be found in chapter 3 of the *SOF 2016* www.nationalgrid.com/SOF

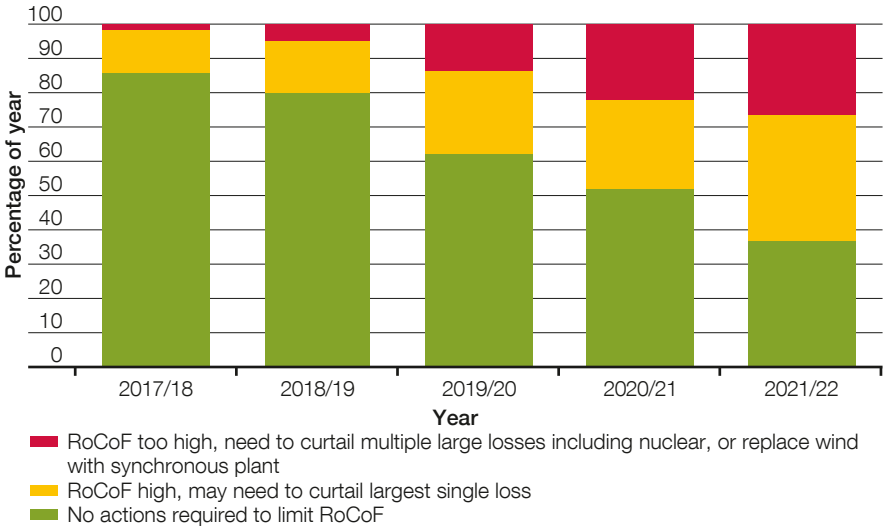
[2] RoCoF protection relays are in place to avoid damage to generator or network assets in case part of the distribution network is disconnected, however the settings are widely accepted to be too sensitive for the GB system.

Currently the most economic and efficient option to limit RoCoF is to limit the largest credible loss[3]. We do this by trading or by taking BM actions to reduce the level of the generation or demand that comprises the largest loss. This could be reducing the output of one generator (or multiple generators running at the same level) and increasing output elsewhere. Alternatively this could be reducing demand or export on an interconnector and reducing generation output to balance. Reducing the potential largest single loss on the system reduces the RoCoF on the system that would occur in the event of that loss. This therefore ensures that the system RoCoF is below the trigger points of the generation protection relays. In the future, as levels of wind, solar and interconnectors increase, system inertia will decrease further and reducing the largest loss to ensure RoCoF is below relay settings levels may not always be economic or possible.

Our inertia and RoCoF strategy

Figure 1.1 below shows the percentage of time that we might be required to take actions to reduce RoCoF. This is based on our half hourly requirements model using the **Consumer Power** scenario[4]. For the majority of time, RoCoF can be managed by reducing the largest single loss (shown in yellow); however, in the future, it may be increasingly necessary to take action to bring on additional synchronous generation to increase system inertia (in red) or to find an alternative solution.

Figure 1.1
*Five-year RoCoF trajectory (**Consumer Power**)*



[3] Chapter 5 of the Security and Quality of Supply Standards (NETS SQSS) defines the secured credible fault outages. http://www2.nationalgrid.com/uk/industry-information/electricity-codes/sqss/the-sqss/ The largest loss is the largest total demand or generation at risk from a single credible fault.

[4] For further details on requirement forecasts please refer to the Future requirement modelling section in the Introduction, page 5.

System needs

Taking specific action to increase system inertia is less economic than reducing the largest loss. Increasing the level of inertia on the system would reduce RoCoF, however, this option is less efficient than reducing the largest loss. Adding 3 GW of synchronous generation to increase inertia will have approximately the same effect on RoCoF as reducing the largest loss by 100 MW[5]. We therefore do not intend to manage RoCoF in this way and would not advocate a specific inertia market.

Desensitising RoCoF relays will allow operation of the system at lower levels of inertia. Distributed generators are undergoing a programme[6] to desensitise their RoCoF relays. This will enable system operation at lower inertia levels. This programme was initially expected to be implemented by August 2016, but has been delayed because more distributed generators are using these devices than was expected. A new target date for the completion of this work has not been set, but is likely to be several years away.

It may be possible to take the value of inertia into account in a new frequency response product. Since inertia is intrinsically linked to managing system frequency, it is appropriate to assess the value of inertia in the design of the frequency response product. Faster-acting frequency response helps to arrest a faster RoCoF, however, some inertia will still be required to hold frequency for long enough to allow even a very fast response to trigger. It may similarly be possible to value inertia in a future voltage market design. This concept will be explored as part of our product strategy work.

Synchronous compensators (including generators with a synchronous compensator mode) and similar devices can provide operational benefits such as inertia and voltage control without generating active power.
We are a partner in Project Phoenix which is a collaborative Network Innovation Competition funded project led by Scottish Power Energy Networks. The project will design, deploy and demonstrate the benefits of a new hybrid synchronous compensator. The commercial arrangements for synchronous compensator operation will also be explored further as part of our product strategy work.

[5] This is based on the contribution to system inertia of approximately six 500 MW synchronous generators, each with an inertia constant of 6.26s. More information is available in section 3.5.3 of the *System Operability Framework* www.nationalgrid.com/SOF.

[6] Ofgem RoCoF relays modification proposal: https://www.ofgem.gov.uk/sites/default/files/docs/2014/07/gc0035_authority_decision_0.pdf

Frequency response

Part of our role is to maintain a stable system frequency. Frequency response is an automatic change in generation or demand to counteract changes in system frequency.

The amount of response needed is directly influenced by system inertia and the size of the largest generation or demand loss. The need is greatest when system inertia is low as frequency moves faster when inertia is lower.

- 'Dynamic' response is used to continuously follow and control minor deviations in frequency due to small imbalances in generation and demand.
- 'Static' response activates when a fixed frequency limit is breached. It is used, in conjunction with dynamic response, to contain a large frequency event such as generator or demand trips.

Frequency response summary

- Response is required to balance system frequency in real time.
- Response needs are increasing and the need is highest when the system inertia is low.
- We buy a firm volume of response through Firm Frequency Response (FFR) ahead of time. This volume is expected to be stable.
- The remaining, increasing and more volatile volume is accessed through Mandatory Frequency Response (MFR) in the BM closer to real time. This is currently economic and offers flexibility.
- Faster-acting response can reduce the overall volume of response needed.
- The flexibility offered by MFR is required for the volatility of the need, however providers are reducing.
- Changes to response products are required which provide a route to market for fast-acting response and the flexibility that we need closer to real time.
- This will be designed using industry consultation and implemented by the end of March 2018.

How do we manage frequency response today and where do we see issues going forward?

We need response that acts faster than the products that we use today and we need flexibility closer to real time.

- The need is highest when system inertia is low. With lower inertia on the system, the frequency moves more quickly. This means we need faster-acting response.
- The certainty of the need is also less because of variable factors such as transmission demands and output from wind and solar. This means we need a market structure that allows procurement and access to flexibility closer to real time as needs become more certain.

The alternative would be to procure greater volumes of the existing response products. While this would have the same effect in the short term, it is unlikely to be a sustainable or economic approach.

System needs

We procure response in two ways; the Firm Frequency Response (FFR) product and the Mandatory Frequency Response (MFR) market. FFR offers providers contracts from up to one month ahead. We use this to contract for volumes of response that are firm and where contracting is more economic than the alternative. The alternative is MFR, which is response accessed through flexible generation available in the BM closer to real time.

The FFR products and the MFR market do not provide a specific route to market for response faster than a ten-second (primary) initiation speed. In 2016, we ran a trial tender for sub-second Enhanced Frequency Response (EFR). Rather than a second tender, we believe faster response should be incorporated into the wider response products. Faster response, with controlled delivery, that can be sustained for longer is the most valuable.

The FFR products' structure and tendering process do not allow for the close to real time variability of the response needs. The MFR market does offer this, however the availability of the generation providing this flexibility in the BM is reducing.

Figures 1.2 and 1.3 show the response needs in a high and a medium requirements scenario[7]. The charts show the Primary response needs (i.e. required to manage low frequency) and the High frequency response needs across the next five years. We have displayed Primary response as a positive value on the chart axis, representing the increase in MW delivered and High frequency response as a negative value representing the decrease in MW delivered.

To demonstrate the effect sub-second response could have on the overall requirement, the upper line assumes 200MW of sub-second response and the dotted line demonstrates the effect an additional 300MW of sub-second response would have on the overall requirement (300MW is used as an illustrative example and should not be interpreted as an indication of our future requirements for sub-second response). The blue line on Figures 1.2 and 1.3 shows the average amount that we currently contract for each month in FFR if economic. The average has been used to illustrate the FFR requirement as the actual amounts change monthly dependent on forecasts of transmission demand and inertia. More detailed information can be found in the FFR market report[8].

[7] For further details on requirement forecasts please refer to the Future requirement modelling section in the Introduction, page 5.

[8] FFR Market reports: http://www2.nationalgrid.com/UK/Services/Balancing-services/Frequency-response/Firm-Frequency-Response/Firm-Frequency-Response-Information/

Figure 1.2
*Primary and High response requirement (97.5th Percentile **Consumer Power**)*

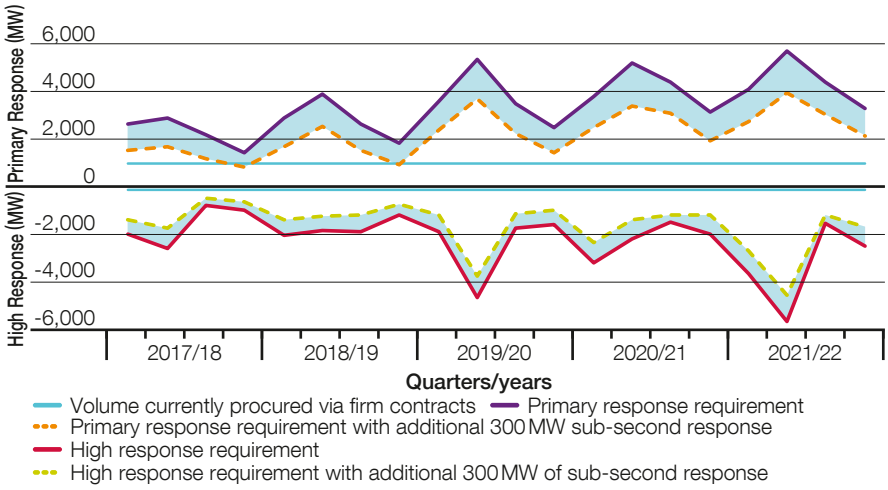
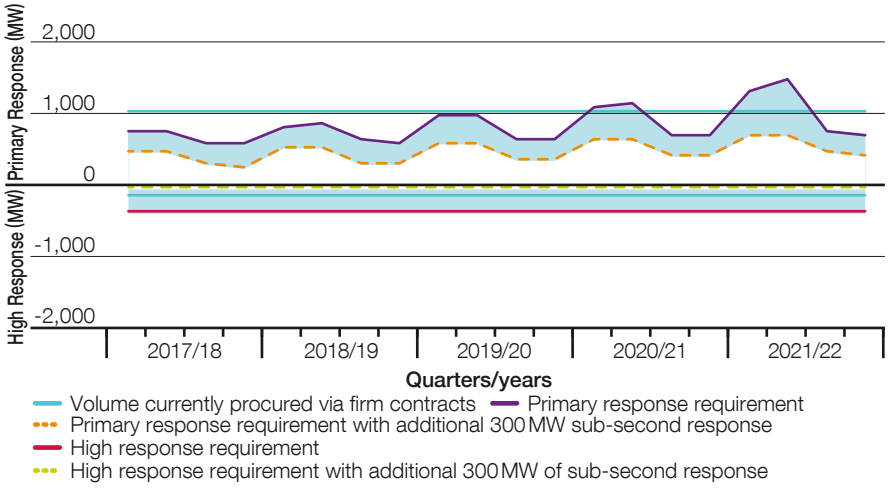


Figure 1.3
*Primary and High response requirement (50th Percentile **Consumer Power**)*



System needs

Our frequency response strategy

A response product is required to replace the existing FFR and EFR products. This should ensure access to the faster-acting response that is needed and increase transparency of how this is valued against existing response provision. The development of this will also allow us to explore closer to real time procurement of the flexibility that is needed. This could be achieved either through procurement closer to real time or procurement ahead of time with options for refinement closer to real time. The consultation questions within this document and further engagement with industry will be used to design and implement an improved frequency response product by March 2018[9].

In parallel to our product strategy work, we will also consider the outputs of the Enhanced Frequency Control Capability (EFCC) project[10], for which we successfully received Network Innovation Competition funding in 2014.

The project is exploring more advanced methods of triggering frequency response in sub-second timescales, coordinated via a wide area monitoring and control solution. This should allow a route to market for more providers.

The *Future Energy Scenarios 2016*[11] show that it is feasible that interconnector capacity could almost triple by 2022. Interconnectors are able to alter their input and output almost instantaneously. To prevent this from impacting system frequency, we currently impose ramping limitations through bilateral connection agreements. With unconstrained ramp rates, the amount of response needed could further increase. Our strategy for response must take account of this and we will continue to engage on this topic.

[9] The implementation of this new product will not change the response definitions for MFR.

[10] http://www.nationalgridconnecting.com/The_balance_of_power/

[11] The *Future Energy Scenarios 2016*: http://fes.nationalgrid.com

Reserve

Reserve is needed to ensure imbalances that arise from forecasting errors or unexpected losses on the system can be managed.

Reserve is manually instructed after automatic frequency response services have delivered. Reserve can be either upward (an increase in generation/decrease in demand) or downward (a decrease in generation/increase in demand). Reserve is also used to describe the actions that we take to ensure that sufficient upward and downward flexibility is available. We use a mix of balancing services products, the BM and trading to ensure that we have access to reserve in the necessary timescales.

Reserve summary

- Reserve is required to correct imbalances arising from forecast errors and the unexpected loss of generation or demand. It is manually instructed and slower acting than frequency response.
- The reserve required to correct for forecast errors and losses is relatively certain ahead of time. This is procured through tendered reserve products where economic. This firm need remains stable over the next five years.
- The actions that we take to ensure additional upward and downward flexibility are less certain and only become clear closer to real time. This variable need becomes more volatile and increases as response requirements increase.
- Access to flexible plant that provides reserve in the BM is limited at times of low transmission demand.
- New reserve products must be developed that ensure:
  - sufficient flexibility is available close to real time
  - market access for both BM and non BM providers
  - compatibility with pan-European reserve services.
- We will consult with the industry to develop and implement this new product. The ambition is to complete this by 2018/19 depending on industry feedback.

How do we manage reserve today and where do we see issues going forward?

Firm volumes which are required for managing demand forecasting errors and large losses are procured via regular tenders ahead of time (e.g. Short Term Operating Reserve (STOR) and Demand Turn-Up (DTU)). In addition, variable volumes are required for upward and downward flexibility. These are satisfied closer to real time by part-loaded plant operating in the energy market, instructions in the BM, or trading. There is now less certainty as to how these variable requirements will be satisfied closer to real time as the levels of wind and solar generation have increased.

System needs

An increasing proportion of the potential reserve providers that are available in the BM are needed to meet frequency response requirements. Providers of frequency response cannot use the same capacity for reserve while continuing to provide response. The number of potential reserve providers in the BM is therefore reducing. At times of low transmission demands there are fewer providers available in the BM.

Figure 1.4 shows the firm needs for upwards and downward reserve over the next five years based on the 50th percentile[12] from the requirements forecast. Figure 1.5 shows the range of variable volumes that we require using the 97.5th and the 50th percentile of the requirements forecast. The 97.5th percentile requirement is large but infrequent. We would therefore not procure this as a firm need ahead of time. However, we must ensure we have capability to manage the more variable extremes.

Downward reserve

Our firm downward reserve need in this scenario is stable between 1 and 2 GW (Figure 1.4). Our variable need for this year is between 3 and 5 GW, however we expect this to increase over the next five years (Figure 1.5). Currently both our firm and variable downward requirements are mostly accessed through the BM or trading, however this availability is reducing, particularly at times of low transmission demand. To increase the options available to us, we have therefore recently tendered for demand turn-up and also issued an expressions of interest for other downward reserve options such as the ability to reduce minimum generation output[13].

Upward reserve

The firm upward reserve requirement is stable and remains between 2 and 3 GW (Figure 1.4). The firm requirement we will procure in STOR will remain at 2.3 GW if economic (shown by orange line in Figure 1.4) and any real-time deficit can be accessed in the BM. This however offers limited transparency and will be decreasingly effective as potential reserve providers are less available in the BM. The variable upward reserve required for flexibility increase over the next five years as response requirements increase.

[12] For further details on requirement forecasts please refer to the Future requirement modelling section in the Introduction, page 5.

[13] http://www2.nationalgrid.com/uk/services/balancing-services/Reserve-services/Footroom/Footroom-servies/

Figure 1.4
*Upward and downward firm reserve requirement (50th Percentile **Consumer Power**)*

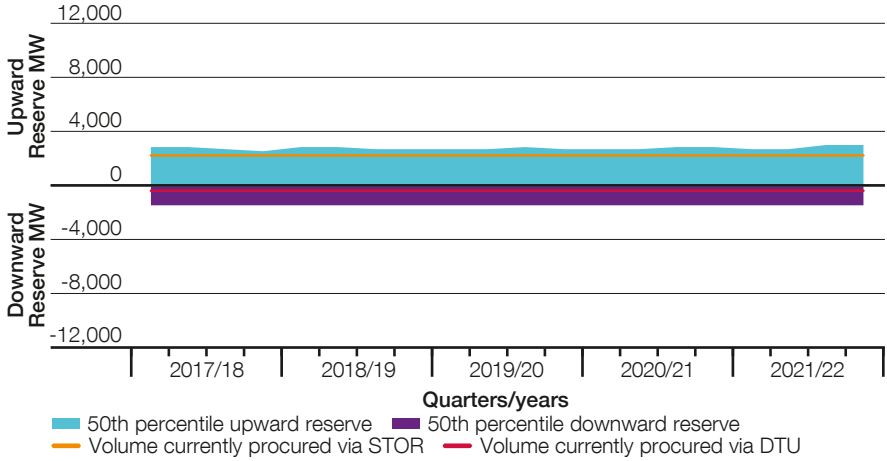
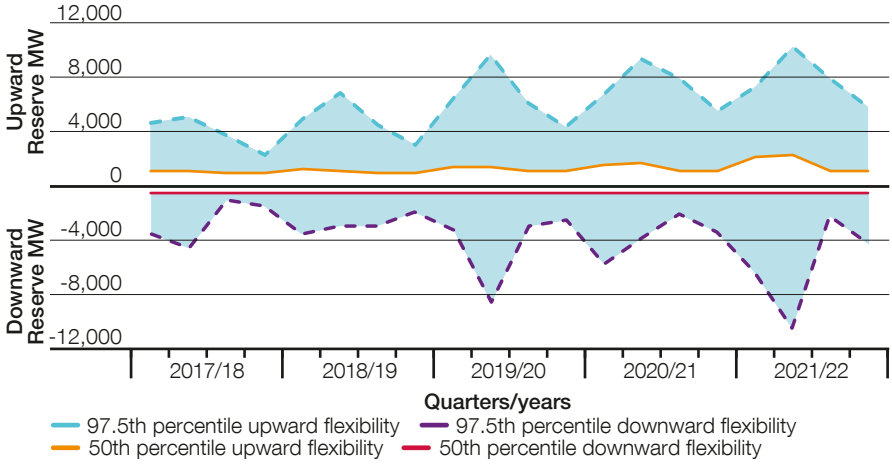


Figure 1.5
*Range of upward and downward flexibility required (**Consumer Power**)*



System needs

Our reserve strategy

Currently there are a number of different balancing services products for reserve that have overlapping timescales of delivery and differing technical requirements and characteristics. These multiple products inhibit transparency of the total market opportunity. We will be rationalising and simplifying these services through our product strategy work, considering both upward and downward reserve services. Our ambition is to consult with the industry to develop and implement a new reserve product in 2018/19.

In improving the products, we must take account of European developments in this area. Project TERRE will introduce the first standardised pan-European reserve service, RR (Replacement Reserve), going live in 2019. Future standardised reserve services must also be factored into our market design, such as mFRR (manual Frequency Restoration Reserve), due to go live in 2021.

From Quarter3 2018, the trading arrangements across interconnectors to Europe will change. Currently, the interconnectors are a cost-effective and reliable tool for managing a number of system needs including reserve. New cross-border trading arrangements will make trading available up to one hour ahead, as opposed to three hours ahead today. This will increase uncertainty in our generation and demand because interconnector flows could change closer to real time. We are investigating the impact of this and it must also be considered in any new product design.

Reactive power

Reactive power (measured in Mvar) is used to control voltage. Generation, demand and network equipment (such as transformers, overhead lines and cables) can either generate or absorb reactive power. These contributions need to be kept in balance to keep the voltage at the right level. Voltage is a local property of the system so requirements vary from one region to another.

Reactive power summary

- The generation or absorption of reactive power is used to control voltage which must be maintained within prescribed limits.
- More reactive power absorption is needed to prevent high voltages at time of low transmission demands and there are specific locational sensitivities.
- The need is addressed by using network-based assets (reactors and capacitors) and by accessing the mandatory reactive market in the BM.
- The existing mandatory reactive market does not properly value the reactive power capability.
- The existing mandatory reactive market is not accessible to Distributed Energy Resources.
- A new reactive market will be designed and implemented by the end of 2018/19. We will use industry engagement and the findings of the Power Potential project.

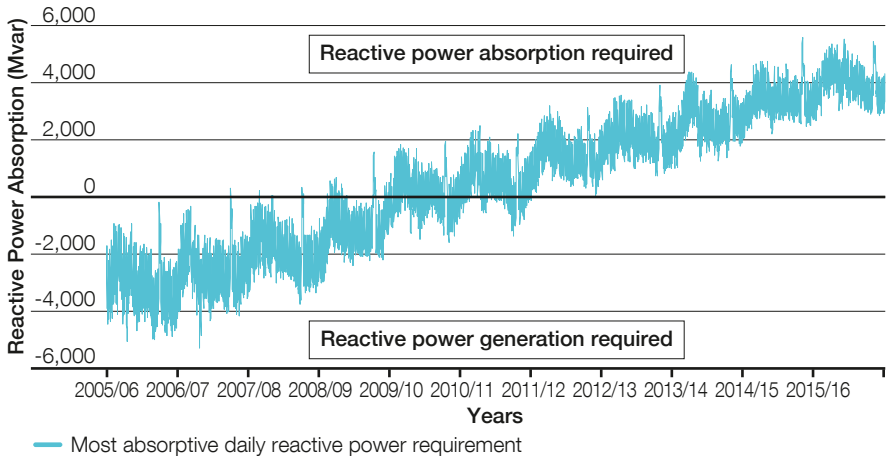
How do we manage reactive power today and where do we see issues going forward?

When transmission demand is low, electricity networks tend to generate reactive power. This means that the voltage will increase unless additional reactive power absorption is available. When transmission demand is high, networks will tend to absorb reactive power. In this case, voltage decreases unless additional reactive power generation is made available.

Figure 1.6 shows that the need has moved from the generation of reactive power to the absorption of reactive power. This trend is driven by low transmission demands and increased reactive power contribution from distribution networks. We expect the need for absorption to continue to grow.

System needs

Figure 1.6
Reactive power requirement



We currently manage reactive power using network assets such as reactors and capacitors, and mandatory provision of reactive power from generators in the BM.

Most of our voltage control challenges occur in the summer when demand on the transmission system is low and fewer flexible generators are running. The locational nature of reactive power means that we may have to instruct synchronous generation to start up where we need extra reactive power absorption and therefore must instruct some generation to stop generating to keep the system balanced.

At times when additional reactive support is required, we issue instructions for active power to access the mandatory reactive range provided by BM participants. Mandatory reactive power is paid at a value of £2.386/Mvarh (summer 2016) £2.565/Mvarh (winter 2016/17). The mandatory price calculation is based on a legacy methodology that reflected the cost at the time to synchronous generation of providing reactive power. This price does not represent the full cost of providing or procuring mandatory reactive power. The cost of instructing generation to run so that we can access the mandatory reactive service needs to be included to give a better indication of the value.

Our reactive power strategy

We must reassess the commercial valuation of reactive power and consider locational sensitivities. This must be supported by clearer signals of need and appropriate routes to market for potential providers. We also need to access reactive power from generation when at low or no active power output.

Presently, there are a number of technical barriers to Distributed Energy Resources being able to provide reactive power to the transmission system. The Power Potential project (formerly known as TDI 2.0[14]) seeks to investigate how to access reactive power from distributed providers. The project will trial enhanced coordination with UK Power Networks to ensure reactive power can be delivered to the transmission system and correctly valued.

Synchronous compensators, as described in the inertia chapter, could offer multiple operational benefits without generating active power.[15] Project Phoenix will explore synchronous compensators as an approach to meeting requirements for both inertia and voltage control.

We must create a market that values reactive power in a transparent manner and aim to do this by the end of 2018/19. This design will begin following consultation and will use the results of Power Potential and Project Pheonix.

[14] More information on Power Potential (formerly TDI 2.0) is available on Ofgem's website: https://www.ofgem.gov.uk/network-regulation-riio-model/network-innovation/electricity-network-innovation-competition/national-grid-electricity-transmission

[15] More information on Project Phoenix is available on Ofgem's website: https://www.ofgem.gov.uk/network-regulation-riio-model/network-innovation/electricity-network-innovation-competition/scottish-power-transmission-limited

System needs

Black start

Black start is required to enable the restoration of the electricity network if the transmission system or a large section of the system shuts down. In this very unlikely event, it is important that we are able to restore power in a timely manner.

Black start summary

- Black start is the service used to restore the system in the unlikely event of a partial or total shut down.
- The total number of black start services required is expected to remain the same.
- The availability of existing providers is expected to reduce as thermal generation moves away from base load output.
- There are opportunities for new providers to enter contracts to deliver black start services from 2018.
- There are opportunities for new alternative technology providers, however they must meet a set of technical requirements.
- We are reviewing our black start strategy to better suit future generation backgrounds and consider alternative approaches to system restoration.
- Our longer-term strategy is to investigate Distributed Energy Resources, aid the introduction of a formal restoration standard and procure services through tenders where appropriate.

How do we manage black start today and where do we see issues going forward?

To restore power, we need generation capable of starting up without external power supplies, energising the transmission system and supporting the reconnection of demand. We ensure there are enough generators which have this capability by entering into black start contracts.

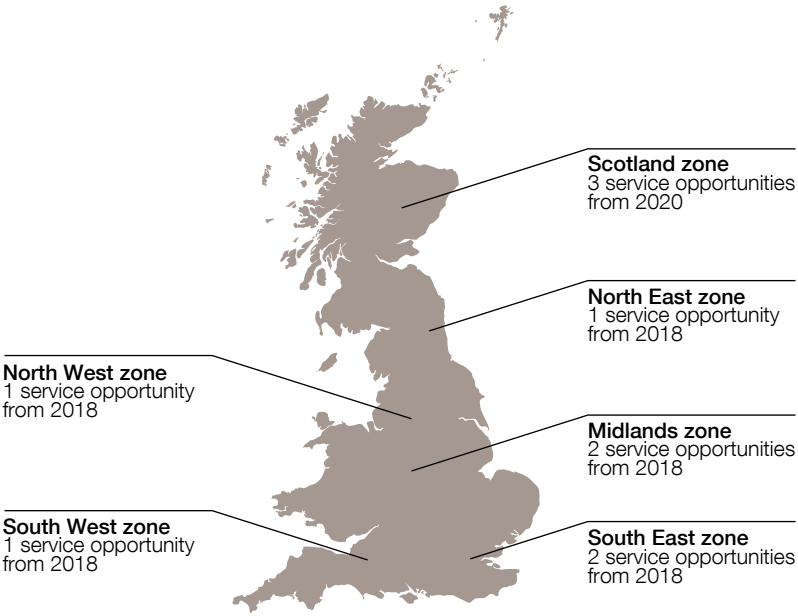
The requirement for black start services is not increasing. However, the availability of some of our existing providers is expected to reduce as thermal generation moves away from base load output. This change means that opportunities are becoming available for new providers on a more regular basis. Contracts are assessed both on their technical capability[16], contribution to restoration, locational requirements and economics.

[16] http://www2.nationalgrid.com/uk/services/balancing-services/system-security/black-start/

Our current strategy is to divide the system into six zones and then procure up to three services in each zone. While not all services would be required in the event of a system restoration, a higher number of services allows for more restoration options and gives greater resilience to failures or unavailability at any given time. Not all power stations will be capable of meeting the technical requirements for black start and we must also strike a balance between the number of providers and the cost of procurement.

Figure 1.7 summarises the zones and where there are opportunities for new black start provision in future years. These dates are based on the length of existing contracts; once a contract expires, those services would be renegotiated or replaced by new providers. Zones do not have exact boundaries and can be flexed around the contracted services.

Figure 1.7
Map of black start service opportunities



This requirement is based on our current restoration strategy. This restoration strategy is under review and alternative restoration approaches taking into account the changing market conditions (e.g. significant levels of Distributed Energy Resources) are being considered for the future.

System needs

Our black start strategy

Our strategy over the next one to two years is to investigate how alternative transmission-connected generation can be used to support the restoration strategy. The following opportunities are under review.

- VSC (Voltage Source Converter) interconnectors have the potential to provide services.
- Intermittent generation is yet to be proven but may be able to play a role in restoration.
- Upgrades to thermal stations leading to a station being able to maintain black start capability for longer periods without having to run on a regular basis.
- Generation that is able to automatically island itself from the transmission system in the event of a disturbance (and remain operational). This small power island could then be used to support the restoration of the wider network.
- Small generation working in partnership with large generation rather than building new auxiliary generators.

Our longer-term strategy is to consider restoration standards, approaches and procurement methods.

- An initial step in this process is to publish the current black start restoration strategy and procurement methodology in summer 2017 which will improve the transparency of these aspects of the service.
- We will aid the development of a clear restoration standard or timeframe for restoration and adapt our restoration strategy to ensure the agreed standard is met.
- Investigation of alternative restoration approaches for example restoring the network via an initial spine or restoring demand more locally using distributed generation. Both approaches are very different to what we do today and technical considerations such as additional reactive power requirements, communication, control, network capability, role of a DNO and restoration modelling need to be considered in detail.
- Subject to sufficient market liquidity, which could be improved by our work to investigate alternative technologies and restoration approaches, a tender approach could be developed to procure Black Start.

Table 1.1
Summary of the system needs discussed in this document

System need	What is the need?	Why is the need changing?	Where is the need?	How will we address the need?	When will we address the need?
System inertia/ Rate of Change of Frequency (RoCoF)	■ Inertia is required to ensure the Rate of Change of Frequency is manageable. ■ The number of occasions that the SO must act to manage inertia or RoCoF are increasing.	■ Less generation on the system providing inertia means that frequency changes happen more quickly.	■ General system need; while there is variation in the RoCoF across the system we currently need to manage system-wide and do not currently resolve on a locational basis.	■ Programme to desensitise RoCoF relays. ■ Reduce largest loss below RoCoF relay trigger points when required.	■ Ambition is to improve response products by March 2018. ■ RoCoF relay programme began in 2016 for >5MW generation. Second phase currently being designed to address smaller generation.
Frequency response	■ Response needs become more volatile with greater extremes. ■ Increasing need for fast-acting sources of frequency response. ■ Tendered firm volumes remain fairly stable.	■ Less generation on the system providing inertia means that frequency changes happen more quickly.	■ General system need; no specific locational sensitivities.	■ New response product design which will include inertia and sub-second response. ■ Until launch, continue to contract for firm needs ahead of time in tendered markets and access close to real-time flexibility in BM through mandatory services.	■ Response product to be designed and launched by March 2018.
Reserve	■ Reserve needs become more volatile with greater extremes. ■ Increasing need for downward reserve when transmission demand is low. ■ Increasing need for close to real-time flexibility. ■ Tendered firm volumes remain stable.	■ Reserve needs increase due to uncertainty in weather-based generation and uncertainty of small-scale generation.	■ General system need; no specific locational sensitivities.	■ Standardise current reserve products to increase transparency of value. ■ New reserve product design to allow closer to real-time procurement of flexibility. ■ Flexibility accessed in BM through mandatory services.	■ Standardisation of current reserve products to be completed summer 2017. ■ New reserve product to be designed and launched in 18/19.

System needs

Table 1.1 continued
Summary of the system needs discussed in this document

System need	What is the need?	Why is the need changing?	Where is the need?	How will we address the need?	When will we address the need?
Voltage control	■ More reactive power absorption is needed to prevent high voltages when the network is lightly loaded. ■ The BM mandatory reactive market does not transparently signal the requirement as it relies on dispatching MW to access reactive support.	■ Less synchronised generation available to provide reactive power support. ■ Lower transmission demand means the network is lightly loaded which in turn generates reactive power.	■ Reactive power is a locational need. The current market structure does not support locational signals.	■ Design a reactive market which values the reactive power support required and provides location signals. ■ The Power Potential project will investigate routes to reactive market for Distributed Energy Resources.	■ Power Potential and market design to be completed 18/19.
Black Start	■ Requirement for new providers and better understanding of how alternative technologies can contribute to restoration. ■ Total requirement up to 18 services across 6 geographic zones.	■ Less synchronised generation available to provide Black Start. ■ Current restoration strategy suited to large synchronous generation.	■ Future contractual opportunities in all 6 geographic zones.	■ Publish more information with regard to our current restoration strategy. ■ Design a more transparent approach to black start procurement which enables greater competition.	■ Restoration strategy to be published summer 2017. ■ Contract opportunities available from April 2018.

If you would like to know more about our current balancing services please visit: **www2.nationalgrid.com/uk/services/balancing-services/**

If you would like to know more about our operability requirements from a technical perspective please visit: **www.nationalgrid.com/SOF**

Chapter two

Product strategy consultation

In order to address the limitations with the existing balancing services and better meet the challenges of the changing technology mix, we will simplify our product range.

The goal is to provide clear and consistent signals (aligned with the system needs) to support investment decisions, lower barriers to entry for new technologies and new business models, and deliver the most economic outcome for consumers. In line with this goal, we want to ensure that parties can optimise wherever possible the use of their assets by offering multiple services to multiple market participants including DNOs.

This work will initially be progressed through simplification of existing products and markets, but the intent is to trial more fundamental shifts in procurement such as day ahead markets and cleared price auctions to explore new approaches. We are also working with DNOs to understand their current and future service needs to ensure that any developments do not create barriers to future whole system approaches.

Finally, the intention is to future-proof our balancing services in order to provide stable and investable markets, which include and complement the forthcoming pan-European balancing products. We will be publishing our initial thoughts on whole system optimisation and the creation of new markets for constraint management in a separate paper in July. We welcome feedback on all aspects of our proposed approach. We have listed a number of consultation questions at the end of this section. Please respond to this consultation by 18 July 2017 using the survey on our **webpage**.

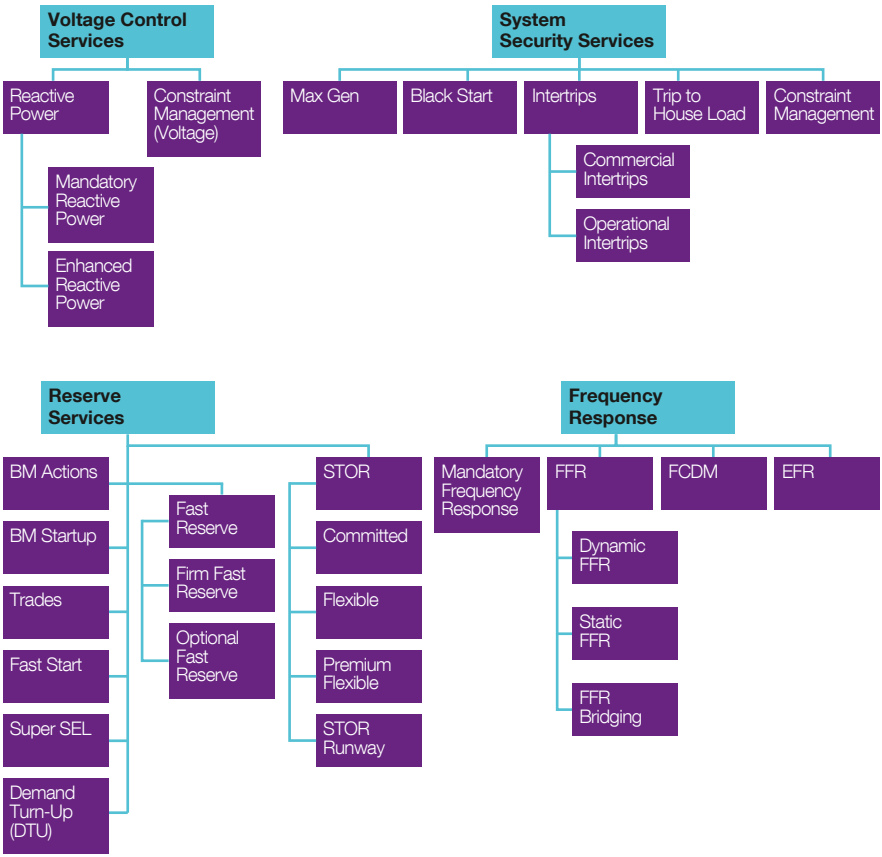
State of play of existing markets

In September 2016, we carried out a survey to understand the issues with the current balancing services markets, and identify the characteristics that parties would ideally want from these markets. We received over one hundred responses from individuals and providers, and from those responses a number of themes emerged.

Too many products

The existing service suite and the products within them have been built up over many years as our needs have gradually shifted. There are, however, now more than 20 different products that providers can choose from, each with different technical requirements and routes to market, as summarised in Figure 2.1.

Figure 2.1
Existing product suite

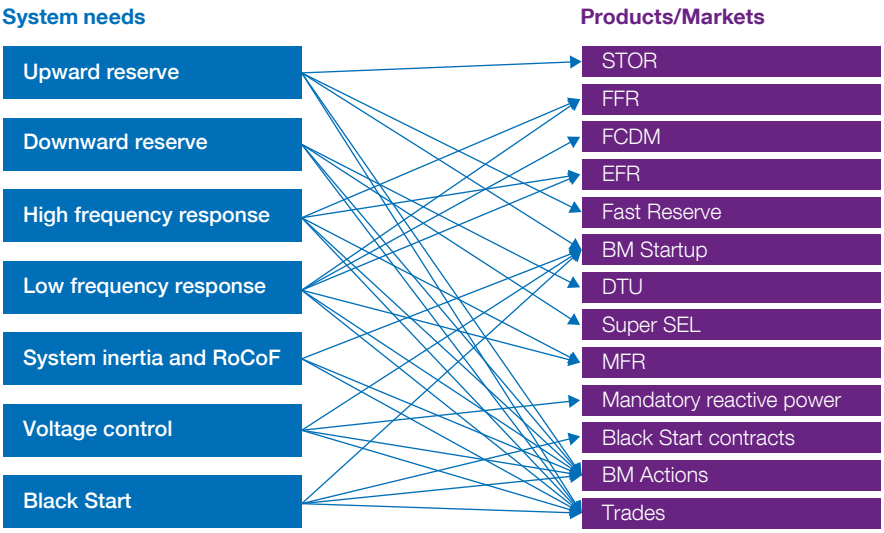


How we buy each product is different, but the purpose of each one is to ensure that we have the tools available to maintain the quality and security of the electricity supply at the lowest cost to consumers. This complexity creates a barrier to entry. This affects existing providers as well as new providers, new technologies and business models which may not fit into current product structures.

Product strategy consultation

Unclear requirements and interactions
The system issue that a particular market or product is attempting to address is often not clear to participants. In many cases the requirement is being driven by several system issues which interact, and this interaction is not communicated to the market in advance of assessment. Furthermore, requirements can change from tender to tender as a result of variations in some of the underlying system issues with little or no explanation to tendering parties. These issues together result in confusion over why certain tenders have been accepted and others have not, and also uncertainty over the stability and long-term sustainability of our markets. Figure 2.2 illustrates some of the overlaps and interactions between our needs and current suite of products.

Figure 2.2
Mapping of current markets and products to system needs



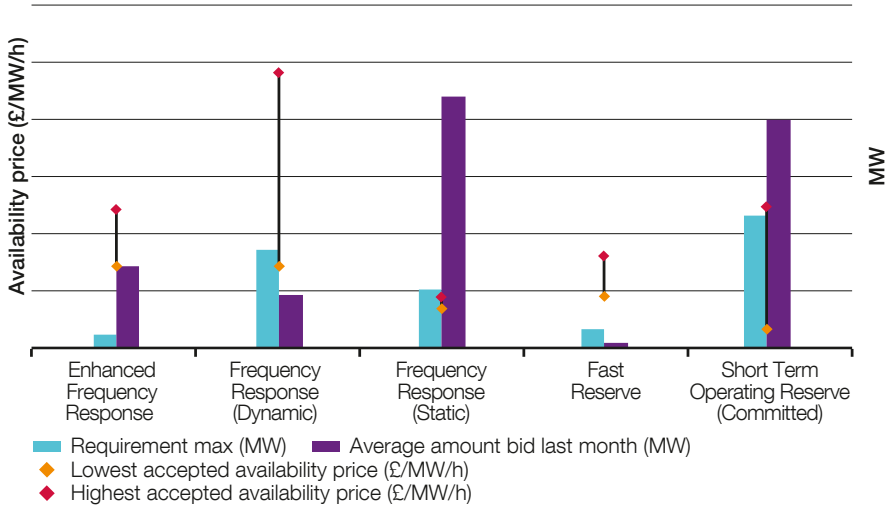
Unclear assessment criteria

Even within tendered markets such as FFR and STOR, there is little consistency in terms of offering standard products that are easily comparable by market participants post-assessment. In FFR, factors such as the length of contract period or how quickly an asset ramps up in response to a frequency deviation are left up to providers to specify, with no guidance as to how we attribute value to these parameters during assessment. Equally in STOR, the trade-off between utilisation price and availability price and our assumptions behind procurement decisions is not transparent. This creates uncertainty and inhibits competition in these markets.

Overlapping markets

When considering individual products, it becomes apparent that there is considerable overlap in terms of what each product is trying to achieve. A further consideration is the way that each one of these overlapping products is procured. Some are tendered, some are bilateral, but all are assessed and contracted for by separate processes. Looking at a snapshot of the products delivering the services in Figure 2.3, it can be seen that the products with a significant oversubscription are those with the lowest accepted availability price, whereas undersubscribed products have a higher accepted availability price.

Figure 2.3
Oversubscribed and undersubscribed markets



If the products are very similar in terms of technical requirement and capability, yet they are being procured and valued in isolation, then the markets may not be delivering the optimum economic outcome for the consumer.

Product strategy consultation

Simplify the existing products

We will address the issues outlined above through a three-stage programme of rationalisation, standardisation and improvement with significant engagement with providers.

Stage 1 – Rationalisation

A number of products are no longer required in their current form, or have been superseded by later products. We are therefore proposing a review to reduce the suite of products that we procure. Existing contracts for these products will still be honoured, but the potential to move to market-based alternatives will be offered where possible. This does not necessarily mean that the requirement behind the product has reduced, just that there is or will be an alternative route to market for those providing the product.

Stage 2 – Standardisation

Our existing markets (e.g. FFR, Fast Reserve and STOR) include a number of parameters which parties can vary when submitting tenders. In addition to the information on interactions and requirements provided in this document, we will also be looking to provide more definition around these tendered parameters through standardising the products within each service market. Approaches to this include fixing parameters such as:

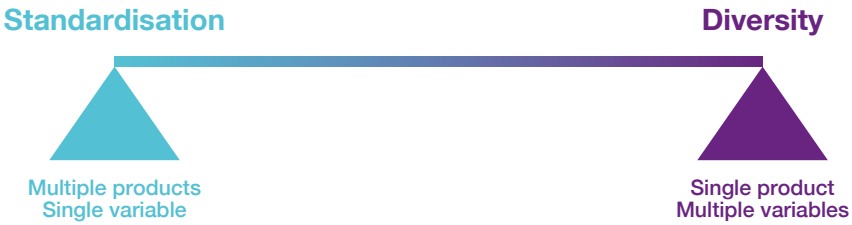
- daily availability windows, e.g. 24-hour, 24-hour triad avoidance, overnight, evening peak
- contract terms, e.g. 1 month, 6 months, 1 year, 2 years
- frequency response droop curve, e.g. minimum MW delivery at 0.2, 0.5 and 0.8Hz deviations
- speed of delivery of reserve energy, e.g. 2 minutes, 5 minutes, 10 minutes, 20 minutes.

We will also be reviewing our contract terms to ensure that they are fit for all technology types that could provide the service. We will continue to work with industry to understand the optimum way to standardise the existing markets through the change proposal governance process.

Stage 3 – Improvement: single product versus standardised products

We want to ensure that the products that we buy are fit for purpose now and in the future. We will therefore work with the industry to improve and develop our product suite beyond just standardising the existing market products. We will improve the products we buy to better meet both changes in the technical abilities of the assets providing the services, and changes in the commercial arrangements supporting the investment and operation of those assets. The proposed approach to this will be set out in our forthcoming product strategy report, which will be based on industry views provided through this consultation on the options outlined below.

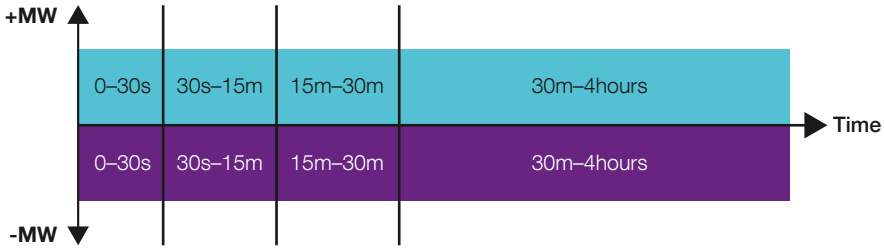
Figure 2.4
Spectrum of standardisation and diversity



In any market, there is a spectrum between how standardised the products being bought and sold are (Figure 2.4). For example, a stall selling fruit will have different product types ('apples', 'bananas', etc.), whereas a car showroom has a single product ('cars') but will also include diverse variables such as different ranges, model types, optional extras, financing and servicing packages. At this stage we are not advocating any one path, but rather setting out possible approaches and seeking feedback from industry as to which would best address the issues raised through the survey and provider groups.

Standardisation
Standardisation would involve reviewing the existing markets and changing the products within them to ensure that their parameters best fit our operational needs and the abilities of existing and new technologies. As with 'single product', this approach would also involve needing to accurately define the value functions of the various parameters, as this information would be crucial in defining what the standard products were. Figure 2.5 is an example covering response and reserve services. One potential effect of this approach would be to facilitate secondary trading of balancing products, and the importance of this is something we value feedback on.

Figure 2.5
Example of standardised products



Product strategy consultation

Where assets could not provide the full product there could be a penalty structure applied to the settlement, which could be based on the value function of the variable not met. For example, an asset providing 30s–15minute energy which was limited to responding in 35s would have a penalty based on the difference in value between 30s and 35s energy delivery.

Single product

Taking a single product route would involve combining the products within each market (e.g. for frequency response combining enhanced, primary, secondary, high, dynamic and static frequency response), thereby moving from multiple product with single tendered variables to single products with multiple tendered variables. The key to combining and simplifying those products would be to identify their individual technical and commercial parameters, and understand the relationships between them. In summary we would be moving from a number of precisely defined products to a smaller number of products which have a number of parameters.

Products could be grouped based on similar technical and operational characteristics; this would be based on a qualitative assessment of the technical requirements, the timescales involved, and the operational need that they are addressing. The following groupings were identified from the existing suite of products as having the potential to form deeper markets (Figure 2.6).

Figure 2.6
Possible product groupings under a diversification approach

Frequency Response Products
Enhanced Frequency Response (EFR)
Firm Frequency Response (dynamic)
Firm Frequency Response (static)
Firm Frequency Response (bridging)
Frequency Control by Demand Management
Mandatory Frequency Response

Voltage Control Products
Mandatory Reactive Power
Enhance Reactive Power
Constraint Management (Voltage)

Reserve Products
Fast Reserve
Demand Turn-Up
Short Term Operating Reserve
Short Term Operating Reserve Runway
Super SEL
Fast Start
BM Startup
BM Actions
Trades

System Security Products
Black Start
Max Gen
Intertrips
Trip to House Load
Constraint Management

Within each group, the value of the parameters of each product would need to be determined. These value functions, or exchange rates, would need defining along with the interactions between them and any caps/collars on amount required. These value functions would be built into an optimisation algorithm to assess providers' submissions from the market. This algorithm would deliver the least cost solution based on all the different submissions and associated parameters.

The table below shows an example of how providers may bid into a Frequency Response market:

Table 2.1
Illustrative single product FFR tender submissions (other variables could be included)

Parameter	Provider 1	Provider 2	Provider 3
Speed of response (s)	3	1	10
MW delivered (MW)	120	70	300
Duration (minutes)	12	2	30
Unit price (£/MW/h)	17	10	6
Availability (hours)	24	12	20

One key success factor would be that the value functions are clear and transparent to participants, and that the assessment process is clearly understood.

Standardisation versus single product

There needs to be continuous dialogue with the industry to design new products that are fit for purpose, meet the needs of providers and reward flexibility. We will also ensure that there is enough time for parties to become familiar with the new structure ahead of implementation.

Existing contracts for affected services will not be cancelled, and successful tenders as well as bilateral contracts will continue as agreed. Our intention throughout this process of change is to minimise disruption to existing providers as far as possible, and to test improvements made to the products before introducing further change.

Stage 3 – Improvement: long-term versus short-term contracts

A key design question in developing the future product strategy relates to industry's preference for short-term markets or longer-term contracts to drive investor confidence in developing new flexible assets.

Stakeholders have told us that short-term markets (e.g. day ahead) can provide confidence to investors as every day provides a new opportunity for revenues. This could also unlock more demand side capacity because office, consumption and manufacturing processes are more certain nearer to real time. It may also allow us to be more certain about our requirement, and therefore increase the volume that we buy through the market. On the other hand, some parties have outlined the need for longer-term contracts to provide the revenue streams to support investment. We believe that there may be merit in providing a long-term route to market in the current climate to instil confidence in balancing services' revenue streams, particularly if and while short-term markets are developing. We continue to welcome industry views on this design decision.

Product strategy consultation

Future vision and consultation

New procurement approaches

There is a question over whether the existing pay-as-bid tenders are the appropriate approach for procuring balancing services. Depending on the approach taken to improving the products, standardisation or a smaller number of products with more variables, there are different procurement methods which could be trialled. Pay-as-bid tenders are useful when there is a market with a small number of participants and where there are highly standardised products, however a pay-as-clear auction approach may incentivise bidding at marginal price and increase transparency of the pricing signal in a market with standard products. There are also auction designs which are well-suited to optimising across multiple tendered variables which could be trialled in the frequency response market towards the end of 2018. We would also like to test markets that are closer to real time (e.g. day ahead or week ahead) in 2018.

Wider markets

The current set up of the balancing mechanism (BM) does not currently provide a viable route to market for non-traditional business models such as demand aggregation, distributed generation and DSR providers, due to the high cost of participation and compliance. We fully support introducing wider access to the BM and will be working with the industry over the coming months to determine how this could be implemented, taking into account all of the initiatives already underway (e.g. Project TERRE solution).

We are also working to understand the implications of the various Distribution System Operator models that are currently being developed, and increasing coordination across the networks. We will be publishing our initial thoughts in this space in July.

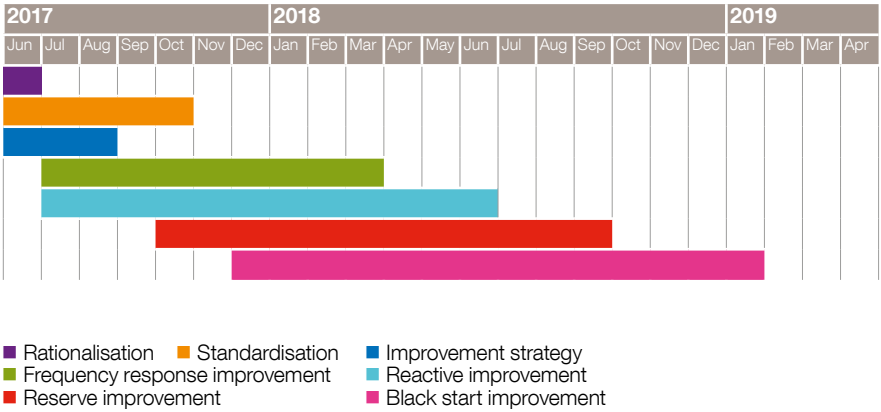
Other market design changes which we believe should be explored include regional market signals and any additional changes to the wholesale market identified as part of our ongoing engagement with market participants.

Timetable

The exact nature of the developments undertaken will depend on the industry feedback that we receive through this consultation and subsequent engagement.

We have set out a high level aspirational timetable for the work areas below. This will be complemented by continuing our programme of stakeholder engagement.

Figure 2.7
Timeline for key work areas



Product strategy consultation

Consultation questions
We welcome views on all aspects of our approach to simplifying balancing services markets to address the issues that have been raised by industry. We have listed some specific questions below to provide structure, but we would be interested to hear any feedback on the issues and pathways set out in this section. Please respond to this consultation by 18 July 2017 using the survey on our **webpage**.

Q1.
Do you agree with the summary of the issues identified around balancing services markets? If not, what additional concerns do you have?

Q2.
Do you agree with our approach to resolving the issues identified through simplification of the product suite? If not, what alternative approach should be taken?

Q3.
What are your views on the possible approaches to standardisation of the existing markets?

Q4.
What effect will fixing product parameters have on transparency and competition in the markets?

Q5.
What are the pros and cons of the two approaches to service improvement: single product and standardisation?

Q6.
Where do you see the optimum balance being between single product and standardisation?

Q7.
What are your views on the benefits and disadvantages of secondary trading in balancing services, and how do single product and standardisation affect secondary trading?

Q8.
How would the two approaches, single product or standardisation, affect the ability of providers to stack multiple services, and how important is this aspect when also considering short- and long-term contracts?

Q9.
What are the pros and cons of short- and long-term markets particularly in respect of existing and new-build assets?

Q10.
What do you consider to be the most appropriate route to support the delivery of new flexible capacity or capability?

Q11.
What are your views on the possibility of trialling different procurement approaches such as cleared price auctions and day-ahead markets?

Q12.
What other changes need to be made to other markets, such as the Balancing Mechanism, wholesale market and capacity market?

Q13.
What considerations should be made during this work to ensure that any future DSO developments (i.e. the procurement of balancing services by or from distribution networks) are coordinated?

Disclaimer

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Appendix C Review of impact of Sunnica energy farm on aquatic invertebrates

1 Introduction

1.1.1 Artificial horizontally polarising surfaces, the reflection-polarisation characteristics of which are similar to those of water, can attract water-leaving polarotactic insects posing a potential threat to these species. Examples of these surfaces include:

- roofs, windscreens and bonnets of cars and other vehicles;
- expanses of glass panes and panels on buildings including greenhouses;
- photovoltaic panels, e.g. on roofs or in solar farms;
- black plastic sheets used in agriculture and horticulture; and
- asphalt surface of newly laid roads.

1.1.2 The potential impacts of these surfaces on aquatic invertebrate fauna include:

- interfering with movements of aquatic invertebrates, attracting them away from their natural habitat;
- attracting insects in large numbers to lay eggs on these surfaces instead of ovipositing them on a water surface; and
- reducing the rate of colonisation of newly formed or recently managed waterbodies, e.g. ditches and ponds.

1.1.3 This technical note explores the potential impact of these horizontally polarising surfaces and solar panels in particular on aquatic insects. It begins by reviewing published information and the evidence of impacts on aquatic insects from shiny surfaces mistaken for waterbodies. The second part is the determination of which taxa of aquatic insects could be impacted. The third part considers what is known about the aquatic invertebrates of, Fenland Special Area of Conservation (SAC), Chippenham Fen Ramsar and Chippenham Fen and Snailwell Poor's Fen Site of Special Scientific Interest (SSSI) (collectively referred to as 'Chippenham Fen'), and the likelihood of these species being impacted by the proposed Sunnica Energy Farm.

2 Method

2.1.1 The impact that horizontally polarising surfaces may have on the aquatic invertebrates and in particular those present in the Chippenham Fen designated sites has been considered using a three-part method.

Part 1. A review of published information and the evidence of impacts on aquatic invertebrates from shiny surfaces mistaken for waterbodies

2.1.2 This review relied mainly on information which is freely available on the internet including such databases as the Freshwater Biological Association Library and Ephemeroptera Galactica.

Part 2. Scoping of aquatic invertebrate taxa, an assessment of predicted impact from horizontal polarising surfaces and key features of taxa likely to be impacted

2.1.3 A review was undertaken of information regarding the behaviour of the taxa of aquatic invertebrates and how this may be impacted by horizontal polarising surfaces, including the key features of taxa likely to be impacted, i.e. although theoretically possible, is it feasible that the taxa would be impacted by horizontal polarising surfaces?

2.1.4 To be taken forward for further consideration, it was considered that a taxon would need to be at risk of mistaking such surface for water, such that this would impact their life cycle and the maintenance of the species in local aquatic habitats. This approach therefore differentiates between an invertebrate mistaking a panel for water, landing on it, and then flying on, from an insect such as mayfly being at risk of laying its eggs on a horizontal polarising surface with a potentially significant impact on the population. In other taxa, the assessment is less straightforward, e.g. some damselflies lay their eggs on floating and, or submerged plants and may not be attracted by the panel surface ("Indeterminate" in Table 1). For certain taxa, e.g. beetles and true flies, it is impractical to provide an overview due to the large number of species and lack of autecological information about swarming, mating and egg-laying. Such taxa, have been scoped into this consideration on a precautionary basis.

Part 3. A review of the aquatic habitats and macroinvertebrates of Fenland SAC and Chippenham Fen Ramsar and Chippenham Fen and Snailwell Poor's Fen SSSI

2.1.5 Information was collated on the aquatic habitats present in Chippenham Fen and Snailwell Poor's Fenand those aquatic insects that have been recorded there that are in publicly available records e.g. *et al.* (1996*),* and the Fens Biodiversity Audit (Mossman *et al.,*(undated)) . (Chippenham Fen and Snailwell Poor's Fen were not surveyed as part of the Scheme biodiversity appraisal as the importance of the site was already established on the basis of surveys over the long term.) This information was then used to determine the likelihood of these species being impacted by the proposed Sunnica Energy Farm.

3 Results

3.1.1 The results are presented for the three parts of the investigation.

Part 1. A review of published information and the evidence of impacts on aquatic invertebrates from shiny surfaces mistaken for waterbodies

3.1.2 The aquatic invertebrates reported as being affected by such shiny surfaces are winged insects. Other aquatic invertebrates, e.g. molluscs, worms including leeches, flatworms and crustaceans are not able to be attracted to shiny surfaces. Those winged insect taxa that might be impacted by horizontal polarising surfaces are identified in **Table 1**. Other aquatic insect taxa have been scoped out of the review, e.g. those taxa laying their eggs in riparian vegetation.

3.1.3 A review of those textbooks providing overviews of aquatic and wetland habitats and the impacts upon them found that none of those searched mentioned aquatic insects being attracted to shiny surfaces including shallow lakes and ponds (e.g. Hejny *et al*. (1986) and Moss (1986)), rivers (e.g. Holmes and Raven (2014) and Calow & Petts, 1994) and fens (e.g. McBride *et al*. (2011)).

3.1.4 The pattern of reporting the impact of shiny surfaces on aquatic insects in the scientific literature is based on taking instances where aquatic insects have been observed in large numbers being attracted to shiny surfaces with a description and, or investigation of that instance. Examples of these are:

Vehicle bodywork and windscreens

3.1.5 Anecdotal information was found that aquatic insects such as mayflies have been recorded as being attracted to the shiny metalwork and laying eggs on cars.

Newly laid asphalt

3.1.6 Male and female mayflies have been observed swarming and mating above asphalt roads and performing the behavioural elements, e.g., egg laying flight, frequent surface-touching manoeuvres and dropping onto the surface and egg laying (Kriska *et al*., 1998). Kriska *et al*. (1998) have noted such behaviours above asphalt roads in the following mayfly species: *Ephemera danica* (Mull), *Ecdyonurus venosus* (Fabr.), *Epeorus silvicola* (Etn.), *Baetis rhodanmi* (Pict.), *Rhithrogena semicolorata* (Curt.) and *Haproleptoides confusa* (Hag.).

3.1.7 In addition to the attraction to surfaces mimicking a highly polarised water surface, an additional feature of roads is their conspicuous and elongated form, especially where there is no canopy, together with heat emanation which might enhance the attraction (Williams (2006).

Expanses of glass including greenhouses

3.1.8 Malik *et al.* (2008) describes the observation that *Hydropsyche pellucidula*, a net-spinning caddis-fly, swarms near sunset at the vertical glass surfaces of buildings standing on the bank of the River Danube in Budapest, Hungary. These aquatic insects emerge from the Danube and are lured to dark vertical panes of glass, where they swarm, land, copulate, and remain for hours. It was also shown that ovipositing *H. pellucidula* are attracted to highly and horizontally polarized light stimulating their ventral eye region and thus have positive polarotaxis. The attraction of these aquatic insects to vertical reflectors is surprising, because after their aerial swarming, they return to the horizontal surface of water bodies from which they had emerged and at which they lay their eggs.

Large expanses of black polythene sheeting

3.1.9 In north-eastern Switzerland in July 2006, azure damselfly *Coenagrion puella* and four-spotted chaser *Libellula quadrimaculata* were attracted away from waterbodies in numbers to a large strawberry field that was covered with shiny black plastic sheets between the rows of plants (Wildermuth, 2007). Both sexes exhibited typical elements of the species-specific reproduction behaviour including oviposition attempts. It was speculated that the damselflies lost time, energy and possibly also genetic material by their maladaptive habitat choices,

described as an ecological trap. In 2007 only few individuals of *C. puella* and no *L. quadrimaculata* were found on the same strawberry field. During sporadic checks of other fields with plastic sheets in the region no Odonata were observed, indicating that such surfaces only attract reproductively active individuals in numbers and only under special conditions, e.g., perhaps at high population densities (Wildermuth, 2007). It was concluded that the negative effects of black shiny surfaces on damselfly populations was probably negligible (Wildermuth, 2007).

Solar panels

3.1.10 Horvath *et al.* (2010) found that solar panels polarize reflected light almost completely (degree of polarization d ≈100%) and substantially exceeded typical polarization values for water (d ≈30–70%). Mayflies, stoneflies (Plecoptera), caddis-flies (Trichoptera), dolichopodid dipterans (Dolichopodidea), and tabanid flies (Tabanidae) were the most attracted to solar panels and exhibited oviposition behaviour above solar panels more often than above surfaces with lower degrees of polarization (including water).

Part 2. Scoping of aquatic macroinvertebrate taxa, an assessment of predicted impact from horizontal polarising surfaces and key features of taxa likely to be impacted

3.1.11 **Table 1** lists those aquatic macroinvertebrate taxa that require scoping in (or out) of the assessment process. For those taxa scoped in, information was collated that could be useful in mitigating against and such potential risks (**Tables 2** and **3**).

Table 1. Assessment of risk for aquatic macroinvertebrate taxa of potentially being impacted by solar panels

Taxon/species	Egg laying on horizontal polarising surfaces (Scoped as "In", "Indeterminate" or "Out")	Attraction to horizontal polarising surfaces (Scoped as "In", "Indeterminate" or "Out")	References
Ephemeroptera (Mayflies)			
Female goes underwater and eggs laid on substratum	Out	In	Eliot & Humpesch, 1983
Females rest on a stone above water and eggs are laid on the substratum under water	Out	In	Eliot & Humpesch, 1983
Female flies down to water surface and eggs are released in a single mass	In	In	Eliot & Humpesch, 1983

Taxon/species	Egg laying on horizontal polarising surfaces (Scoped as "In", "Indeterminate" or "Out")	Attraction to horizontal polarising surfaces (Scoped as "In", "Indeterminate" or "Out")	References
Female flies down to water surface and eggs are released in several batches	In	In	Eliot & Humpesch, 1983
Plecoptera (Stoneflies)	In - Eggs deposited on water surface: in larger species by running or swimming on surface where eggs fall apart and sink, and smaller species fly down and dip the egg mass into the water where it rapidly disintegrates.	In	Hynes, 1977
Odonata (Dragonflies and damselflies)			
Endophytic eggs	Out - Elongated in shape, eggs are laid into plant material. All damselflies and hawker dragonflies have scythe-like ovipositors and inject their eggs into plant stems or leaves, rotten wood or mud on or close to the surface of the water. Emerald damselflies and migrant hawkers inject their eggs into rush stems well above the water surface, while other hawkers lay into rotten wood or other debris just above the waterline.	Indeterminate - During egg-laying, male damselflies, chasers, skimmers and darters guard the females with which they have just mated, either by staying linked 'in tandem' or by flying in close attendance.	Corbett, 1962; McGeeney, 1986
Exophytic eggs	In - Eggs are round in shape, laid in a jelly-like substance and are deposited loosely into water, including some emerald dragonflies, chasers, skimmers and darters. They do this by repeatedly dipping the tips of their abdomens into water, each time releasing one or more	Indeterminate - During egg-laying, male damselflies, chasers, skimmers and darters guard the females with which they have just mated, either by staying linked 'in tandem' or by flying in close attendance.	Corbett, 1962; McGeeney, 1986

Taxon/species	Egg laying on horizontal polarising surfaces (Scoped as "In", "Indeterminate" or "Out")	Attraction to horizontal polarising surfaces (Scoped as "In", "Indeterminate" or "Out")	References
	eggs that settle below the surface. Some female damselflies submerge completely to lay their eggs, often using their still-attached partner to pull them up again afterwards. Coenagrion puella and Libellula quadrimacultata were observed trying to lay eggs on black plastic.		Wildermuth, 2007
Hemiptera (Water bugs)	Out – Eggs laid underwater inside plant tissues, singly on submerged plants, or in gelatinous masses attached to stones (Mellanby, 1963). *Notonecta maculata* attaches eggs to hard surfaces underwater (Macan, 1965).	In – Flights made by individuals to colonise new habitat	Mellanby, 1963; Macan, 1965
Trichoptera (Caddis-flies)			
Caddis-flies in general	Out - Eggs are laid most frequently underwater, attached to stones or plants either surrounded by a material which swells up into a jelly mass in contact with water, or in flat masses cemented together.	In – Flights made by individuals to colonise new habitat	Mellanby, 1963
Caseless caddis-flies	Out - The adult female lays eggs in a plate-like mass, usually on a submerged boulder	In	Edington and Hildrew, 1981
Coleoptera (Water Beetles)			
Riffle beetles (Elminthidae)	Out - Eggs are laid in moss or other plants or in crevices in stones.	Out	Holland, 1972
Diptera (Flies)			

Taxon/species	Egg laying on horizontal polarising surfaces (Scoped as "In", "Indeterminate" or "Out")	Attraction to horizontal polarising surfaces (Scoped as "In", "Indeterminate" or "Out")	References
- chironomids and other nematocerans (except tabanids)	In – Eggs laid singly or in rafts on water surface	In	Mellanby, 1963
- meniscus midges	In – Adults may be observed in flight near water and in suitable weather conditions some species may form lax swarms over or near water	In	Disney, 1975
- trickle midges	Out - Females avoid light and crawl under bryophytes or into cracks in rocks and eggs usually laid singly or in small clutches of 2-4, attached to the substratum by a slender film of mucus	Out	Mandaron, 1963; Popham, 1952
Neuroptera (Alder-flies)	Out - Females lay eggs on vegetation overhanging water	Out	Elliott, 2009; Mellanby, 1963
Collembola (Springtails)	Out – Springtails are wingless and unable to be attracted by shiny surfaces	Out - Springtails are wingless and unable be attracted by shiny surfaces	Mellanby, 1963
Lepidoptera (Crambidae: Acentropinae and (China-mark Moths) with aquatic larvae)	Out - Eggs laid on underside of water plants by bending the abdomen around the edge	In – Mating may occur at the water surface or on vertical surfaces. Females moves across patches of duckweed (*Lemna* species) for hours, stopping at some points and immersing their ovipositor into the water to attach from 2-5 eggs on the submerged part of a *Lemna* frond.	[redacted] Mariani, 2021

Part 3. A review of publicly available information on the aquatic habitats and macroinvertebrates of Fenland SAC, Chippenham Fen Ramsar and Chippenham Fen and Snailwell Poor's Fen SSSI

3.1.12 Chippenham Fen is a shallow basin located close to the start of the Chippenham River and is surrounded by higher land over chalk. The site is fed both by water emerging in some places from the chalk aquifer and from chalk streams. The aquatic habitats within the fen site are drainage ditches (dykes) which have been cut throughout (now used to enable management and to increase water levels in the fen during the summer) and several ponds, all taking water from the springs in the south to the Chippenham River, near the site's northern boundary (Plantlife, 2022). A rich diversity of fenland and aquatic plants can be found there, including the very rare Cambridge milk parsley (*Selinum carvifolia*), and the site is also known for its impressive invertebrate community.

3.1.13 Chippenham Fen Ramsar site within the Fenland SAC and is designated on the basis of three criteria:

Ramsar criterion 1. A spring-fed calcareous basin mire with a long history of management, which is partly reflected in the diversity of present-day vegetation.

Ramsar criterion 2. The invertebrate fauna is very rich, partly due to its transitional position between Fenland and Breckland. The species list is very long, including many rare and scarce invertebrates characteristic of ancient fenland sites in Britain.

Ramsar criterion 3. The site supports diverse vegetation types, rare and scarce plants. The site is the stronghold of Cambridge milk parsley Selinum carvifolia.

3.1.14 Chippenham Fen and Snailwell Poor's Fen SSSI is also a part of the Fenland SAC, the other two fens being Woodwalton Fen SSSI and Wicken Fen SSSI. The Fenland SAC is designated as such due to the qualifying habitats:

- calcareous fens with Great Fen-sedge (*Cladium mariscus*) and species of the Caricion davallianae (calcium-rich fen dominated by Great fen-sedge (saw sedge))
- *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*). (Purple moor-grass (*Molinia caeruleae*) meadows); and
- the qualifying species: Spined Loach (*Cobitis taenia*) and Great Crested Newt (*Triturus cristatus*).

3.1.15 As a fenland system, the SAC is not designated for any aquatic habitats or aquatic species including aquatic macroinvertebrates. The Fenland SAC comprises only 5% inland water bodies (Standing water, Running water) with the majority of the SAC being fenland (70%) with 20% broad-leaved deciduous woodland and 5% other arable land.

3.1.16 The SAC is nevertheless recognised for "its impressive invertebrate community" and "of particular importance are the rare fenland plants and invertebrates" (Natural England, 2019). Likewise for the Ramsar site: "The invertebrate fauna is very rich, partly due to its transitional position between Fenland and Breckland",

placing an emphasis on semi-aquatic and terrestrial species. Eleven of the 12 nationally important invertebrate species occurring on the site were insects, however, none of these is an aquatic insect or an insect with any stage of its life cycle linked to water. .

3.1.17 Shaw *et al*. (1996), referring specifically to the aquatic invertebrates in Chippenham Fen, sampled the aquatic habitats in the Fen in 1991 for a wide range of invertebrate groups and found that either there were very low numbers or very few species in many of these groups. Surveys continued annually from 1991 to 1995 but focussed on aquatic (water) beetles and molluscs with aquatic Hemiptera included in 1993 and 1994.

3.1.18 Shaw *et al*. (1996) found a mix of flowing and still water species with variation according to amount of flow being most clearly manifest in the water beetles. The molluscs "tend simply to be relatively poor in species, considering the water chemistry of the site" [hard, calcium rich water].

3.1.19 On the basis of the above relatively recent account, it is assumed that Natural England and JNCC (with respect to the Ramsar site) are not referring specifically to aquatic invertebrates in their recognition of Chippenham Fen for "its impressive invertebrate community" and "very rich invertebrate fauna" respectively, but, in the case of Natural England to Woodwalton Fen and, or Wicken Fen (Natural England, 2019).

3.1.20 There are some rare species of aquatic invertebrates found in the aquatic habitats of Chippenham Fen SSSI. Shaw *et al*. (1996) in their surveys of aquatic habitats for all aquatic invertebrates (1991), aquatic coleoptera and aquatic molluscs (1992, 1995) and aquatic Hemiptera (1993, 1994) recorded 18 nationally scarce species, 17 of which were beetles (not all are aquatic species). The eighteenth was the aquatic bug *Microvelia pygmaea*. The aquatic Hemiptera recorded, apart from *Microvelia pygmaea*, were almost all common or only slightly local (Shaw *et al.* 1996).

3.1.21 The 15 aquatic species are listed in **Table 2** along with a summary of habitat preferences to help inform an appraisal as to the likelihood of a given species being attracted to the solar panels, e.g. for egg laying.

Table 2. Nationally rare or otherwise notable aquatic macroinvertebrate species recorded from Chippenham Fen SSSI

Species	Shaw *et al.* (1996)	Habitat preference	Reference
Water-bug			
Microvelia pygmaea	-	Small bug living on the water surface found on floating pondweeds or wet sphagnum moss and in still or very slowly flowing water, usually where there is a thick growth of emergent vegetation such as reeds or sedges, or	

Species	Shaw *et al.* (1996)	Habitat preference	Reference
		where there is extensive growth of overhanging marginal vegetation	
Stoneflies			
Nemoura dubitans	-	A species of marshes, seepages and overgrown springs rather than streams, rivers or ponds	Colston *et al.* (1997)
Water beetles			
Agabus chalconatus	Recorded from main group of locations	Acid water, often shaded	Friday (1988)
Cercyon convexiusculus	A species of terrestrial areas of fen that had "wandered" into aquatic samples	Fen litter	Friday (1988)
Cercyon sternalis	A species of terrestrial areas of fen that had "wandered" into aquatic samples	Fen litter	Friday (1988)
Cercyon tristis	A species of terrestrial areas of fen that had "wandered" into aquatic samples	Bogs and fens	Friday (1988)
Graptodytes granularis	Well recorded in flowing water ditches in several locations	Swampy areas of ponds, fens, bogs	Friday (1988)
Haliplus laminatus	Recorded from main group of locations	Canals, rivers and silt ponds	Friday (1988)
Helophorus nanus	Only recorded from one location	Acid water and fens	Friday (1988)
Helophorus strigifrons	Only recorded from one location	Temporary waters with rushes and sedges	Friday (1988)
Hydraena testacea	Recorded from main group of locations	Stagnant water or muddy streams	Friday (1988)
Laccobius sinuatus	Recorded from main group of locations	Slow-flowing drains and new ponds	Friday (1988)
Noterus crassicornis	Well established, but only recorded from one location	The typical habitat is still or slow-moving water bodies with plenty of vegetation and detritus, fens,	Friday (1988)

Species	Shaw *et al.* (1996)	Habitat preference	Reference
		canals, drainage ditches, lake and pond margins etc., The life-cycle is oviposition on submerged leaves and stems in the spring.	
Rhantus grapii	Recorded from main group of locations	Ponds and fen drains	Friday (1988)
Scarodytes halensis	Well recorded in flowing water in several locations	Slow-flowing streams and silt ponds	Friday (1988)

4 Discussion and conclusions

4.1.1 Human-made objects (e.g. buildings with glass surfaces) can reflect horizontally polarized light so strongly that they appear to aquatic insects to be bodies of water. Insects that lay eggs in water are especially attracted to such structures because these insects use horizontal polarization of light off bodies of water to find egg-laying sites. Thus, these sources of polarized light can become ecological traps associated with reproductive failure and mortality in organisms that are attracted to them and by extension with rapid population declines or collapse.

Which invertebrate species may be impacted?

4.1.2 This review has not found any instances of invertebrates other than aquatic insect taxa being attracted to or in any other way impacted by solar panels and other horizontal polarising surfaces. Within those orders which comprise aquatic insects, there are relatively few that have been found to or be considered likely to be impacted by these surfaces (**Table 1**). Of these taxa, not all constituent families and species will be impacted. For example, in the mayflies, those species most at risk are those which lay their eggs on the water surface as opposed to those in which the female goes underwater and lays her eggs on substratum.

4.1.3 Conclusion: There are relatively few taxa of aquatic insects that might be susceptible to an impact from solar panels. These taxa should be the focus of attention.

What is the incidence of significant impacts of shiny surfaces on aquatic insects?

4.1.4 Whilst the effects of shiny surfaces on aquatic insects have been known about for 60 years (Fernando, 1958, 1959; Popham, 1964), e.g. shiny surfaces such as recently laid asphalt, glass panels and the bodywork of vehicles, the impact of such surfaces on the aquatic insects of waterbodies is not regarded as a significant form of light pollution, receiving no mention in such texts reviewing the impacts of human activity on aquatic and wetland systems. In a short review of the main impacts on the ecology and distribution mayflies, an impact from horizontal polarised surfaces is not mentioned (Elliott and Humpesch, 2010).

4.1.5 The review of those reports where shiny surfaces have impacted aquatic insects were described as one-off and unusual instances, i.e. there was no account of a species of aquatic insect regularly swarming over shiny surfaces. In some accounts investigations in the subsequent year failed to find a repetition of the behaviours.

4.1.6 An explanation of why reflection-polarisation light pollution is not recognised as a significant form of light pollution is likely to be due to the other factors that also influence or possibly trigger behaviour in aquatic insects in particular weather, e.g. wind strength and direction, and temperature (Brodskity, 1973; Savolainen, 1978). Additionally, the actual process of habitat selection may involve one or more of the insects' senses. Popham (1953), for example, showed that sight was important in corixids as flying adults orient themselves at a set angle to incident light and thus the reflection of light from a water surface is sufficient for them to home in on.

4.1.7 In a detailed study of polarised pattern of freshwater habitats via video polarimetry, Hovrath and Varju (1997) showed that the patterns of small water bodies are highly variable in different spectral ranges, according to ambient illumination. For example, under a clear sky, and in the visible range of the spectrum, calm water surfaces reflecting light from the sky are most strongly polarised in the blue range. However, under an overcast sky radiating diffuse white light, small pools are characterised by a high level of horizontal polarisation in most spectral ranges. These differences have consequences for water-seeking insects which rely on highly horizontally polarised light during habitat selection, and thus are not attracted by waterbodies that reflect vertically polarised light, or by horizontally polarised light with a low degree of polarisation (Williams, 2006).

4.1.8 Conclusions: The incidence of shiny surfaces impacting aquatic insects is only occasionally reported and typically as a one-off phenomenon. The occurrence of significant impacts of shiny surfaces on aquatic insects is dependent on the coincidence of a number of conditions needed to create the condition in which an insect would be attracted to a solar panel.

What is the impact of horizontal polarising surfaces on the colonisation process?

4.1.9 Following the steps proposed by Fernando (1958) in the pattern of aquatic insect colonisation, the first one, dispersal, is driven by conditions in the habitat currently occupied by the insect, e.g. drying out or lack of prey, with Step 2 being the location of new habitat and Step 3 selection of habitat. Step 1 is unaffected by artificial horizontal polarising surfaces and Step 2 depends on factors such as distance between current habitat and the surface and the ability to sense the surface. The information found regarding selection of such surfaces (Step 3) shows that these surfaces can attract insects to them with a view to colonisation either by colonisation by the adult itself or egg laying by the female to establish a new population. The latter may have been preceded by mating behaviour between the female and a male(s) attracted to the horizontal polarising surface.

4.1.10 The area of the shiny surface is likely to be another key factor, especially for aquatic insects of small water bodies such as ponds, dykes and wet fen areas. It is presumed that such species would not be attracted to large areas of shiny

surface as such habitats would be unsuitable for them. No accounts have been found of the aquatic insect fauna of small waterbodies around lakes and reservoirs becoming negatively impacted by the large water areas. The image presented to aquatic insects by a solar energy farm is more like a lake in terms of scale of waterbody, a habitat to which the aquatic fauna of the fens is much less likely to respond to than a smaller waterbody.

4.1.11 Conclusion: The colonisation process is relatively complex and is not as simple as an insect seeing a shiny surface and straightaway moving towards it.

What is the likely impact of the solar panels of the aquatic fauna of Fenland SAC, Chippenham Fen Ramsar and Chippenham Fen and Snailwell Poor's Fen SSSI?

Species associated with Chippenham Fen likely to be potentially at risk and relevant behaviour

4.1.12 A review of the aquatic habitats and aquatic insect fauna of Chippenham Fen and Snailwell Poor's Fen has shown that aquatic habitats form a relatively small proportion of the site and that the majority of aquatic insects occurring in the site that are of conservation significance are not aquatic and are very unlikely to be attracted to solar panels, e.g. moths, wasps and beetles of fen habitat.

4.1.13 On the basis of those taxa which could be at risk of being attracted to solar panels (Table 1), a taxon that would provide a good basis for assessing this impact is mayflies. Whilst there are no rare or otherwise notable mayflies in Chippenham Fen and Snailwell Fen, this taxon can be used on a precautionary and worst case basis being a group of species that exhibits swarming behaviour and flight, some species laying eggs on water surfaces. Mayflies have also been observed being attracted to solar panels and laying eggs on them.

4.1.14 Appendix 1 provides a review of data on the swarming of mayflies including heights swarms can climb to. On average this is 4.8 m, the maximum height being for sepia dun (*Leptophlebia marginata*) at 10 m.

4.1.15 An initial assessment has been undertaken to determine if there are factors that are likely to prevent aquatic insects reaching the solar panels, namely:

- barriers between Chippenham Fen and Snailwell Fen and the nearest solar panels; and
- the prevailing wind in relation to geography of the site.

Factors constraining the movement of aquatic insects between aquatic habitats and solar panels

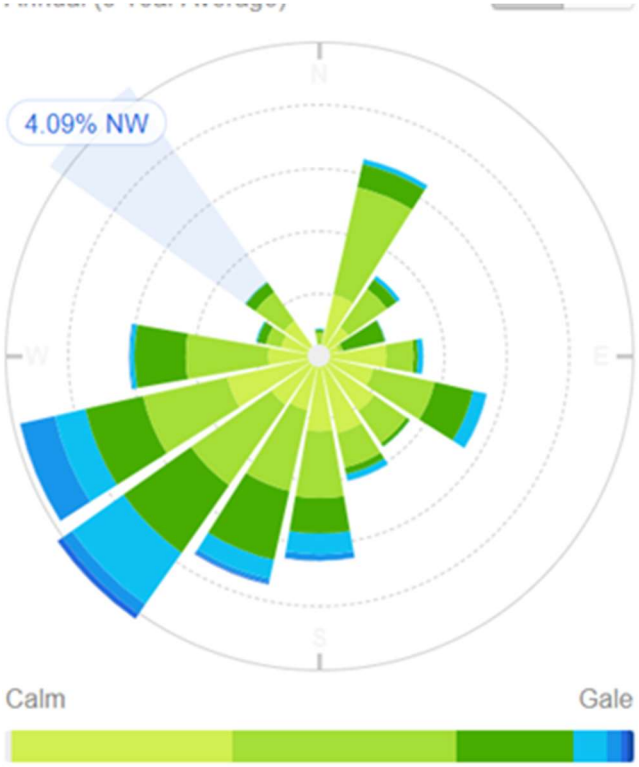
4.1.16 The distance between waterbodies and the solar panels and the height of obstructions to the view of insects, e.g. shrubs and trees, were measured from on-site height assessments and distances taken from maps. Figure 1 illustrates a cross-section between Chippenham Fen and Snailwell Poor's Fen and the solar panels in West Site B. The belt of trees around the nature reserve which has been allowed to develop delineating the boundary of the nature reserve and buffering the drift of pesticides and fertilisers into the reserve, creates a barrier

about 27 m in height. This much higher than a mayfly is likely to fly to, 10 m being an approximate maximum height with a flight distance of at least 300 m (Figure 1)

Figure 1. Cross-section from Chippenham Fen and Snailwell Poor's Fen to Sunnica West Site B (see also Appendix 2 for locations).

4.1.17 An initial assessment of prevailing winds indicates that the wind direction is such that insects emerging from aquatic habitats in the nature reserve are more likely to be blown away from the solar panels than towards them (Figure 2).

Figure 2. Wind rose (5 year average) for Cambridge.



4.1.18 Conclusion: Using an aquatic insect such as a mayfly, an examination of the constraints to such insects finding and reaching the solar panels in West Site B demonstrates that they would not be able to see the panels and that the prevailing wind is likely to be blow them away from West Site B.

4.1.19 The overall conclusion is that some aquatic insects are attracted to solar panels although this is an unusual event dependent on the coincidence of a number of suitable conditions to trigger off such behaviour. The likelihood of aquatic insects from a fenland habitat being attracted to large open areas of shiny surfaces is low given that such species will preferentially use smaller shiny surfaces. Only a small proportion of Chippenham Fen and Snailwell Poor's Fen is aquatic habitat and most of those aquatic insect species of conservation value known from the site do not use open water areas for any of their behaviours. For those common species such as mayfly that may be present in the nature reserve, the factors of barriers and prevailing wind, pose significant constraints, making such movement highly unlikely.

4.1.20 The impact of solar panels on aquatic insects would be Negligible.

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Ref 1-48 Schwind, R. 1995. Spectral regions in which aquatic insects see reflected polarized light. Journal of Comparative Physiology, A. 117, 439-448.

Ref 1-49 Shaw, S.C. and Wheeler, B.D. 1996. Chippenham Fen NNR botanical, invertebrate and hydrological monitoring 1991–1995. Appendix 2: Vegetation monitoring. English Nature Research Reports, No. 193.

Ref 1-50 Shaw, S.C., Wheeler, B.D., Kirby, P. and White, P. 1996. Chippenham Fen NNR botanical, invertebrate and hydrological monitoring 1991–1995. Final report. English Nature Research Reports, No. 191.

Ref 1-51 White, P, Townend, L & Butcher, DP (1996) Chippenham Fen NNR botanical, invertebrate and hydrological monitoring 1991–1995. Appendix 1: Hydrological assessment. English Nature Research Reports, No. 192.

Ref 1-52 Vondel, B.J. van 1998. Another case of water beetles landing on a red car roof. Latissimus, 10, 29.

Ref 1-53 White, P, Townend, L & Butcher, DP (1996) Chippenham Fen NNR botanical, invertebrate and hydrological monitoring 1991–1995. Appendix 1: Hydrological assessment. English Nature Research Reports, No. 192.

Ref 1-54 Wildermuth, H. 2007. Polarotaktische Realtionen von *Coenagrion puella* and *Libellula quadrimaculata* auf Erdbeerkulturen als ökologische Falle (Odonata: Coenagrionidae, Libellulidae). Libellula, 26, 143-150.

Ref 1-55 Williams, D.D. 2006. The biology of temporary waters. Oxford University Press, Oxford.

Ref 1-56 Kassas, M. (1951a). Studies in the ecology of Chippenham Fen. I. The fen water-table. I. Ecol. 39: 1-18.

Ref 1-57 Kassas, M. (1951b). Studies in the ecology of Chippenham Fen. II. Recent history of the fen, from evidence of historical records, vegetational analysis and tree-ring analysis. I. Ecol. 39: 19-32.

Ref 1-58 Kassas, M. (1952a). Studies in the ecology of Chippenham Fen III. The Forty Acre Wood. J. Ecol. 40: 50-61.

Ref 1-59 Kassas, M. (1952b). Studies in the ecology of Chippenham Fen. IV. Tree and bush colonisation in south Chippenham Fen. J. Ecol. 40: 62-73.

6 Appendix 1. Summary of swarming characteristics for mayflies (Ephemeroptera) of Britain

Taxa	Peak emergence period	Swarming height (m)	Swarm size (number of individuals)	Habitat for nymphs	Notes
Baetidae					
Baetis	April-early October (except species below)			Running water	
Beatis rhodani	March and October-November	1-5	Large	Running water	Over water but sometimes at a considerable distance from water
Baetis scambus	2-3 periods between February-November			Running water	
Baetis muticus		1-5	4-40	Running water	
Baetis vernus		1-5	Small	Running water	Over water but sometimes at a considerable distance from water
Centroptilum	April-October	1-4	40-100	Streams with moderate flow and close inshore in lakes	Very close to, or more often over, the edge of water
Cloeon				Ponds, ditches and small lakes; sometimes in very slow rivers	
Cloeon dipterum	April-early November or even later	1-2	4-100		Close to but generally not over water

Taxa	Peak emergence period	Swarming height (m)	Swarm size (number of individuals)	Habitat for nymphs	Notes
Cloeon simile	March-November	1-2	4-100		Close to but generally not over water
Procloeon	June-August	-	-	Slow moving water	-
Ceanidae					
Brachycercus	June-August	-	-	Silted edges of slow rivers or small lakes	-
Caenis	May-September	0.5-6	5-50	Slow rivers, streams and small ponds	Often at dawn or dusk at water's edge
Ephemeridae					
Ephemera	Late May-July	1-6	4-200 (but swarms may merge)	May swarm higher amongst trees	Sandy or muddy parts of rivers and lakes
Ephemerellidae					
Ephemerella					Fast running water
Ephemerella ignita	June-early September	1-4	4-20	Above or very close to water	
Ephemerella notata	Late May-early June	-	-		
Heptageniidae					
Ecdyonurus	April-October	1-5	3-15 but up to 60 or more	Above streams and along shoreline, sometimes verging	Running water and large lakes with stony bottoms
Heptagenia lateralis	May-September	1-4	2-50 or more	Near to but generally not over water	Running water and large lakes with stony bottoms

Taxa	Peak emergence period	Swarming height (m)	Swarm size (number of individuals)	Habitat for nymphs	Notes
Heptagenia sulphurea	May-July	1-4	3-6	Sometimes swarms form over tops of trees	Running water and large lakes with stony bottoms
Rhithrogena	March-April (*Rhitrogena germanica*); May-August (*Rhithrogena semicolorata*0	-	Small	Sometimes swarms form over tops of trees	Running water and large lakes with stony bottoms
Leptophlebiidae					
Haptophlebia	May-late August	-	Small		Slow parts and backwaters of streams and rivers
Leptophlebia					
Leptophlebia marginata	April-May	3-10	20-100	Near to, or up to 50 m from water. Swarms may appear to merge.	Lakes, ponds and slower parts of streams
Leptophlebia vespertina	May-end July		50-many hundreds	Often as low flat swarm but also in swarms of 3 m in diameter and up to 3 m high.	
Paraleptophlebia submarginata					Streams and rivers
Paraleptophlebia werneri	June-August	-	-		Streams and rivers
Potamanthidae					
Potamanthus	-	-	-		Sandy parts of rivers
Siphlonuridae					
Ameletus	June-July	-	-		Running water and

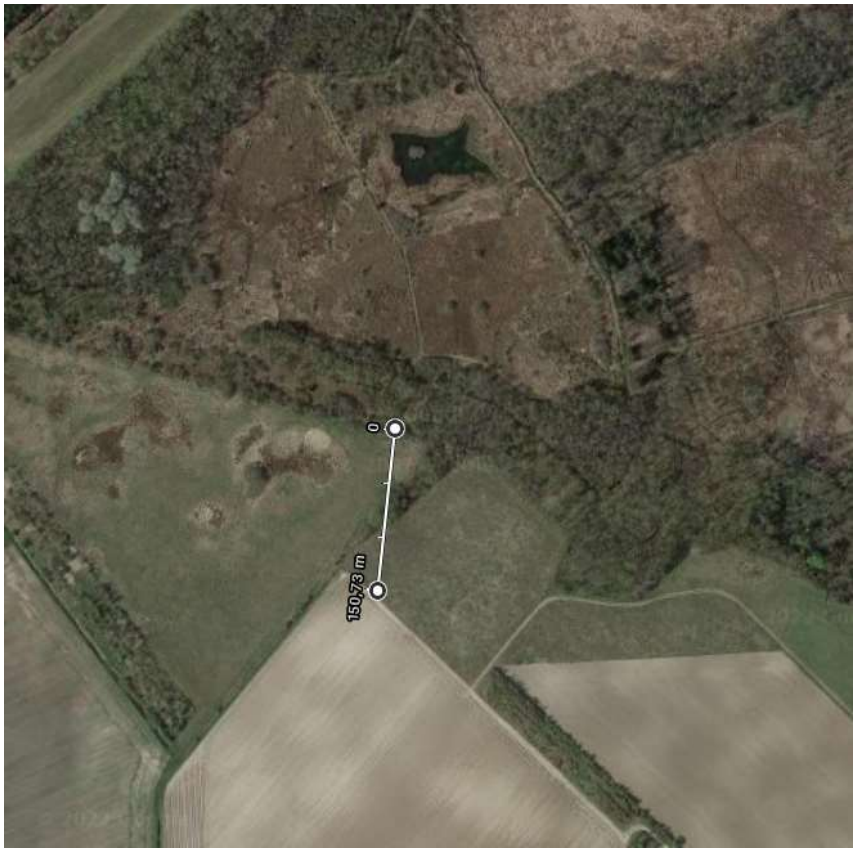
Taxa	Peak emergence period	Swarming height (m)	Swarm size (number of individuals)	Habitat for nymphs	Notes
					large lakes with stony bottoms in mountains
Siphlonurus	Late May-September	1-4	5-40	Usually swarm over water but sometimes near water	Drainage channels on hillsides or overflow channels of rivers

Sources: Elliott and Humpesch, 1983; Harker, 1989; Harris, 1956.

7 Appendix 2. Aerial photographs

***Aerial photograph 1**. Distance from the pond to the Chippenham Fen boundary (170m) Source:Google Maps.*

***Aerial photograph 2**. Extent of the Chippenham Fen woodland (60m). Source:Google Maps*



***Aerial photograph 3**. Distance from the Chippenham Fen boundary woodland to the Solar farm boundary fence (150m). Source:Google Maps.*

Appendix D Objections Schedule

Obj No.[i]	Name/ Organisation	IP/AP Ref No[ii]	RR Ref No[iii]	WR Ref No[iv]	Other Doc Ref No[v]	Interest[vi]	Nature of Interest	Permanent/ Temporary [vii]	Plot(s)	CA?[viii]	Status of objection
1	John James		RR-0018			Part 1	Freeholder	Permanent Rights - Access Rights	7-06, 7-07	Yes	Relevant Representation submitted
2	Dr Harry Sidebottom		RR-0203			Part 1, 2 and 3	Freeholder Occupier, Freeholder, Rights	Permanent Rights	16-04, 16-06, 16-08, 16-09, 16-10, 16-11, 16-12, 16-13	Yes	Relevant Representation submitted
3	Frances Sidebottom		RR-0218			Part 1	Freeholder	Permanent Rights	16-09, 16-12	Yes	Relevant Representation submitted
4	Lisa Sidebottom		RR-0222			Part 1, 2 and 3	Rights	Permanent Rights	16-04, 16-06	Yes (assumed to be Elisabeth Adrienne Sidebottom)	Relevant Representation submitted
5	Susan Chapman		RR-0287			Part 1, 2 and 3	Freeholder Occupier, Freeholder, Rights	Permanent Rights	18-09, 18-11, 18-12, 18-13, 18-14	Yes	Relevant Representation submitted
6	George Gibson		RR-0290			Part 1	Freeholder Occupier	Permanent Rights	16-18, 16-19, 16-20, 17-01, 17-02	Yes	Relevant Representation submitted
7	Louise Andreasen		RR-0417			Part 1	Occupier	Permanent Rights	8-02	Yes	Relevant Representation submitted
8	Elizabeth Mary Garget		RR-0568			Part 1	Freeholder Occupier, Freeholder	Permanent Rights	8-02, 8-03	Yes	Relevant Representation submitted
9	Claire Tilbrook		RR-0683			Part 1	Freeholder	Plots removed from Order limits	6-05, 6-06	No (plots to be removed)	Relevant Representation submitted
10	Mrs Heather Tilbrook		RR-0717			Part 1	Freeholder Occupier, Freeholder	Permanent Rights Permanent Acquisition	10-17, 10-19, 10-28, 10-33, 11-01, 11-02, 11-03, 11-04, 11-05, 11-06, 9-03, 9-04, 9-05, 9-06, 9-07	Yes	Relevant Representation submitted
11	Priscilla McDonagh		RR-0723			Part 1	Freeholder	Permanent Rights	7-06	Yes	Relevant Representation submitted
12	Hannah Murphy		RR-0780			Part 1	Occupier	Permanent Rights	9-02	Yes	Relevant Representation submitted
13	Huw Neal		RR-0870			Part 1	Freeholder Occupier, Freehold	Permanent Rights	19-08, 19-09, 19-10	Yes	Relevant Representation submitted
14	Ian Garget		RR-0871			Part 1, 2 and 3	Rights	Permanent Rights	8-02	Yes (assumed to be I K Garget)	Relevant Representation submitted
15	Joanna Reeks		RR-0881			Part 1	Freeholder	Permanent Rights Permanent Acquisition	10-02, 10-03, 10-05, 10-06, 10-07, 10-08, 10-09, 10-10, 10-11, 10-12, 10-17, 10-19, 10-28, 10-29, 10-33, 11-01, 11-02, 11-03, 11-04, 11-05, 11-06, 9-03, 9-04, 9-05, 9-06, 9-07	Yes	Relevant Representation submitted

Obj No.[i]	Name/ Organisation	IP/AP Ref No[ii]	RR Ref No[iii]	WR Ref No[iv]	Other Doc Ref No[v]	Interest[vi]	Nature of Interest	Permanent/ Temporary [vii]	Plot(s)	CA?[viii]	Status of objection
16	La Hogue Farm Foods		RR-0887			N/A	Not a registered Interest	N/A	N/A	No (although La Hogue Farm Foods are not an affected party, they are recognised as being affiliated with the La Hogue interests which are listed in the Book of Reference)	Relevant Representation submitted
17	Robert Palmer		RR-0922			Part 1	Freeholder Occupier	Permanent Rights	18-08	Yes (assumed to be Michael Robert Palmer)	Relevant Representation submitted
18	East Cambridgeshire District Council		RR-0998			Part 1, 2 and 3	Rights	Permanent Rights	18-16	Yes	Relevant Representation submitted
19	Graham Reeve		RR-1009			Part 1, 2 and 3	Freeholder, Tenant Occupier, Rights	Permanent Rights Permanent Acquisition	20-09, 20-10, 20-11, 20-12, 20-13, 20-14, 20-15, 20-17, 20-18, 20-20, 20-22, 20-23, 20-24, 20-26, 20-27, 20-28, 20-29	Yes	Relevant Representation submitted
20	Bryan Cave Leighton Paisner LLP on behalf of HPUT A Limited and HPUT B		RR-1017			Part 1	Freeholder	Permanent Rights	16-03, 16-04, 16-05, 16-06, 16-07	Yes	Relevant Representation submitted
21	Jane James		RR-1028			Part 1	Freeholder	Permanent Rights	7-06, 7-07	Yes (assumed to be Kathryn Jane James)	Relevant Representation submitted
22	Katherine Stewart		RR-1045			Part 1	Freeholder	Permanent Rights	21-01	Yes	Relevant Representation submitted
23	Lesley Haird		RR-1054			Part 1	Freeholder	Permanent Rights	10-02	Yes	Relevant Representation submitted
24	Nick Wright		RR-1102			N/A	Not a registered Interest	N/A	N/A	No (although Nick Wright is not listed as an affected party, they are recognised as being the director of A.G. Wright & Son (Farms) Limited which are listed in the Book of Reference)	Relevant Representation submitted

Obj No.[i]	Name/ Organisation	IP/AP Ref No[ii]	RR Ref No[iii]	WR Ref No[iv]	Other Doc Ref No[v]	Interest[vi]	Nature of Interest	Permanent/ Temporary [vii]	Plot(s)	CA?[viii]	Status of objection
25	Bidwells on behalf of B C Mitcham Farms Ltd		RR-1170			Part 1, 2 and 3	Rights	Permanent Rights	17-03, 18-01	Yes	Relevant Representation submitted
26	Cadent Gas Limited		RR-1176			Part 1, 2 and 3	Freeholder, Rights	Permanent Rights Permanent Acquisition	16-05, 16-07, 16-10, 16-11, 16-13, 17-03, 18-03, 18-04, 18-05, 18-06, 18-07, 18-08, 21-01, 21-02, 21-03, 5-03, 5-09, 5-12, 6-01, 6-02, 6-03, 6-04, 7-05	Yes	Relevant Representation submitted
27	Cambridgeshire County Council		RR-1178			Part 1, 2 and 3	Freeholder Occupier, Freeholder, Occupier, Rights	Permanent Rights Permanent Acquisition	10-02, 10-19, 10-24, 10-26, 11-02, 11-03, 11-04, 11-05, 11-06, 13-01, 14-05, 14-08, 15-02, 15-03, 15-07, 16-10, 16-11, 16-13, 16-15, 16-16, 16-17, 16-18, 18-02, 18-03, 18-04, 18-05, 18-06, 18-07, 18-11, 18-12, 18-15, 18-16, 18-18, 19-12, 19-13, 19-14, 20-01, 20-03, 20-12, 20-13, 20-15, 20-21, 22-01, 23-01, 8-06, 9-03, 9-04, 9-05, 9-07	Yes	Relevant Representation submitted
28	Environment Agency		RR-1208			Part 1, 2 and 3	Freeholder Occupier, Occupier, Rights	Permanent Rights Permanent Acquisition	12-02, 15-10, 15-12, 16-02, 16-03, 17-01, 17-02, 18-12, 18-14, 18-17, 20-02, 20-03, 3-07, 3-08, 8-03	Yes	Relevant Representation submitted
29	Bidwells on behalf of M R Mitcham		RR-1263			Part 1, 2 and 3	Freeholder Occupier, Freeholder, Rights	Permanent Rights	17-03, 18-01, 18-02, 18-16, 18-17, 18-18, 19-02, 19-03, 19-04	Yes	Relevant Representation submitted
30	Bidwells on behalf of Mitcham Contracts (Burwell) Ltd		RR-1275			Part 1	Freeholder	Permanent Rights	16-11, 16-13, 16-14	Yes	Relevant Representation submitted
31	Eversheds Sutherland (International) LLP on behalf of National Grid Electricity Transmission Plc		RR-1289			Part 1, 2 and 3	Freeholder Occupier, Freeholder, Rights	Permanent Rights Permanent Acquisition	20-08, 20-09, 20-10, 20-11, 20-12, 20-13, 20-14, 20-15, 20-17, 20-18, 20-20, 20-21, 20-22, 20-23, 20-24, 20-26, 20-27, 20-29, 20-30	Yes	Relevant Representation submitted
32	Eversheds Sutherland (International) LLP on behalf of National Grid Gas Plc		RR-1290			Part 1, 2 and 3	Rights	Permanent Rights Permanent Acquisition	16-04, 16-06, 16-09, 16-11, 16-12, 16-13, 16-14, 16-15, 16-16, 5-12, 6-01, 6-03, 7-03, 7-05, 7-06, 7-07	Yes	Relevant Representation submitted

Obj No.[i]	Name/ Organisation	IP/AP Ref No[ii]	RR Ref No[iii]	WR Ref No[iv]	Other Doc Ref No[v]	Interest[vi]	Nature of Interest	Permanent/ Temporary [vii]	Plot(s)	CA?[viii]	Status of objection
33	Addleshaw Goddard on behalf of Network Rail Infrastructure Limited		RR-1292			Part 1	Freeholder Occupier, Freeholder	Permanent Rights Permanent Acquisition	16-17, 16-19, 16-20, 17-01, 17-02, 3-01, 3-03, 3-11, 4-01, 4-05, 5-03	Yes	Relevant Representation submitted
34	Suffolk County Council		RR-1340			Part 1, 2 and 3	Freeholder Occupier, Freeholder, Occupier, Rights	Permanent Rights Permanent Acquisition	1-02, 1-03, 1-04, 21-01, 21-02, 21-03, 24-01, 3-06, 3-07, 3-08, 4-03, 4-04, 5-02, 5-03, 5-04, 5-08, 5-09, 5-10, 5-11, 6-02, 6-05, 6-07, 6-08, 7-06, 7-07, 8-02	Yes	Relevant Representation submitted
35	Turner		RR-1348			Part 1	Freeholder, Tenant Occupier	N/A	13-03, 13-04, 14-02, 14-03, 14-04, 14-07, 15-01, 15-08, 15-09, 15-10, 15-11, 9-02, 9-03, 9-04, 9-05	Yes (assumed to be Roger John Turner)	Relevant Representation submitted

i Obj No = objection number. All objections listed in this table should be given a unique number in sequence
ii Reference number assigned to each Interested Party (IP) and Affected Person (AP)
iii Reference number assigned to each Relevant Representation (RR) in the Examination library
iv Reference number assigned to each Written Representation (WR) in the Examination library
v Reference number assigned to any other document in the Examination library
vi This refers to parts 1 to 3 of the Book of Reference:
• Part 1, containing the names and addresses of the owners, lessees, tenants, and occupiers of, and others with an interest in, or power to sell and convey, or release, each parcel of Order land;
• Part 2, containing the names and addresses of any persons whose land is not directly affected under the Order, but who "would or might" be entitled to make a claim under section 10 of the Compulsory Purchase Act 1965, as a result of the Order being implemented, or Part 1 of the Land Compensation Act 1973, as a result of the use of the land once the Order has been implemented;
• Part 3, containing the names and addresses of any persons who are entitled to easements or other private rights over the Order land that may be extinguished, suspended or interfered with under the Order.
vii This column indicates whether the applicant is seeking compulsory acquisition or temporary possession of land/ rights
viii CA = compulsory acquisition. The answer is 'yes' if the land is in parts 1 or 3 of the Book of Reference and National Grid are seeking compulsory acquisition of land/ rights.

Appendix E Statutory Undertaker Representations Schedule (PA2008 S127)

Name/ Organisation	Nature of Undertaking	Plot(s)	PA2008 s127(3)(a) or (b)	PA2008 s127(6)(a) or (b)	PP/Agreement	Status of Representation / Evidence of Agreement
Environment Agency	Environment	12-02, 15-10, 15-12, 16-02, 16-03, 17-01, 17-02, 18-12, 18-14, 18-17, 20-02, 20-03, 3-07, 3-08, 8-03	N/A	N/A	PP	Negotiations are ongoing
National Grid Electricity Transmission plc	Electricity	20-08, 20-09, 20-10, 20-11, 20-12, 20-13, 20-14, 20-15, 20-17, 20-18, 20-20, 20-21, 20-22, 20-23, 20-24, 20-26, 20-27, 20-29, 20-30	Yes	Yes	PP/Agreement	Negotiations are ongoing
National Highways Limited	Highways	10-02, 10-04, 10-13, 10-14, 10-15, 10-16, 10-18, 10-19, 10-20, 10-22, 10-23, 10-24, 10-25, 10-26, 10-27, 10-30, 10-31, 10-32, 24-02, 6-09, 7-06, 7-09, 7-10	N/A	N/A	PP	PP agreed October 2022
Network Rail Limited	Rail	16-17, 16-19, 16-20, 17-01, 17-02, 3-01, 3-03, 3-11, 4-01, 4-05, 5-03	N/A	N/A	PP/Agreement	Negotiations are ongoing

Appendix F Statutory Undertaker Representations Schedule (PA2008 S138)

Name/ Organisation	Nature of Undertaking	Plot(s)	PA2008 s138	PP/Agreement	Status of Representation / Evidence of Agreement
Airwave Solutions Limited	Telecommunications	9-06	Yes	PP	No representation made
Anglian Water Services Limited	Water	1-01, 12-02, 13-02, 13-03, 14-03, 14-05, 14-08, 15-02, 15-07, 16-04, 16-05, 16-11, 16-13, 18-02, 18-04, 18-05, 18-11, 18-12, 18-17, 19-12, 19-13, 19-14, 20-15, 2-02, 21-02, 21-03, 5-02, 6-02	Yes	PP	PP agreed August 2021
BT Group plc	Telecommunications	10-02, 10-03, 10-04, 10-05, 1-01, 10-13, 10-14, 10-18, 10-19, 1-02, 10-25, 10-26, 10-27, 1-03, 10-30, 10-31, 1-04, 11-04, 16-04, 16-05, 16-06, 16-11, 16-13, 18-02, 18-11, 18-12, 18-16, 19-13, 19-14, 20-07, 20-13, 20-21, 20-28, 21-02, 3-02, 3-06, 3-07, 3-08, 3-09, 4-02, 4-03, 6-02, 9-04, 9-05	Yes	PP	Negotiations on PPs are ongoing
Cadent Gas Limited	Gas	16-05, 16-07, 16-10, 16-11, 16-13, 17-03, 18-03, 18-04, 18-05, 18-06, 18-07, 18-08, 21-01, 21-02, 21-03, 5-03, 5-09, 5-12, 6-01, 6-02, 6-03, 6-04, 7-05	Yes	PP	PP agreed October 2022
CityFibre Limited	Telecommunications	16-17	Yes	PP	CityFibre responded to say they don't believe their assets are affected on 15 February 2021. The Applicant has, in any event, included standard telecommunications protective provisions in the draft Sunnica DCO in Part 2 of Schedule 12.

Name/ Organisation	Nature of Undertaking	Plot(s)	PA2008 s138	PP/Agreement	Status of Representation / Evidence of Agreement
Eastern Power Networks plc	Electricity	10-05, 10-06, 1-01, 10-21, 10-22, 10-33, 1-07, 11-01, 11-04, 11-08, 12-02, 13-02, 16-14, 16-15, 16-16, 16-19, 17-03, 18-01, 18-02, 18-07, 18-11, 18-12, 18-16, 18-18, 19-01, 19-02, 19-03, 19-11, 19-13, 19-14, 19-15, 20-01, 20-02, 20-03, 20-04, 20-06, 20-08, 20-09, 20-10, 20-11, 20-12, 20-13, 20-14, 20-17, 20-18, 20-19, 20-20, 20-22, 20-23, 20-26, 20-27, 20-28, 20-29, 20-30, 3-06, 3-10, 4-01, 4-03, 4-05, 6-03, 6-06, 7-03, 7-08, 8-02, 8-03, 9-06	Yes	PP	PP agreed 9 June 2021
Environment Agency	Environment	12-02, 15-10, 15-12, 16-02, 16-03, 17-01, 17-02, 18-12, 18-14, 18-17, 20-02, 20-03, 3-07, 3-08, 8-03	Yes	PP	Negotiations are ongoing
GTC Pipelines Limited	Gas/Electricity/Water	7-06	Yes	PP	No representation made
Lightsource SPV 115 Limited	Electricity	18-16, 19-12, 20-08, 20-09, 20-10, 20-11, 20-13, 20-14, 20-15, 20-21	Yes	PP	Apparatus adopted by UKPN
National Grid Electricity Transmission plc	Electricity	20-08, 20-09, 20-10, 20-11, 20-12, 20-13, 20-14, 20-15, 20-17, 20-18, 20-20, 20-21, 20-22, 20-23, 20-24, 20-26, 20-27, 20-29, 20-30	Yes	PP/Agreement	Negotiations are ongoing
National Grid Gas plc	Gas	16-04, 16-06, 16-09, 16-11, 16-12, 16-13, 16-14, 16-15, 16-16, 5-12, 6-01, 6-03, 7-03, 7-05, 7-06, 7-07	Yes	PP	Negotiations are ongoing

Name/ Organisation	Nature of Undertaking	Plot(s)	PA2008 s138	PP/Agreement	Status of Representation / Evidence of Agreement
National Highways Limited	Highways	10-02, 10-04, 10-13, 10-14, 10-15, 10-16, 10-18, 10-19, 10-20, 10-22, 10-23, 10-24, 10-25, 10-26, 10-27, 10-30, 10-31, 10-32, 24-02, 6-09, 7-06, 7-09, 7-10	Yes	PP	PP agreed October 2022
Network Rail Limited	Rail	16-17, 16-19, 16-20, 17-01, 17-02, 3-01, 3-03, 3-11, 4-01, 4-05, 5-03	Yes	PP	Negotiations are ongoing
Openreach Limited	Telecommunications	10-02, 10-03, 10-04, 10-05, 1-01, 10-13, 10-14, 10-18, 10-19, 1-02, 10-25, 10-26, 10-27, 1-03, 10-30, 10-31, 1-04, 11-04, 16-04, 16-05, 16-06, 16-11, 16-13, 18-02, 18-11, 18-12, 18-16, 19-13, 19-14, 20-07, 20-13, 20-21, 20-28, 21-02, 3-02, 3-06, 3-07, 3-08, 3-09, 4-02, 4-03, 6-02, 9-04, 9-05	Yes	PP	Part of BT Group and negotiations are ongoing
South Staffordshire Water plc	Water	15-03, 15-05, 15-10, 15-12, 16-06	Yes	PP	Negotiations are ongoing
Swaffham Internal Drainage Board	Environment/Drainage	10-05, 10-06, 1-01, 15-07, 15-10, 15-12, 16-02, 16-04, 16-08, 16-15, 16-18, 17-01, 17-03, 18-01, 18-19, 19-01, 19-02, 19-04, 19-06, 19-08, 19-10, 19-13, 19-14, 20-06, 20-08, 20-09, 20-12, 20-13, 20-14, 20-15, 20-19, 20-21, 20-25, 20-28, 5-03	Yes	PP	PP agreed November 2022
UK Power Networks Limited	Electricity	20-08, 20-09, 20-10, 20-11, 20-13, 20-14, 20-15, 20-21	Yes	PP	PP agreed 9 June 2021

Appendix G Errata Report for Changes Application

1.1 Introduction

1.1.1 This errata report has been prepared to assist with reading the Applicant's Proposed Changes to the Application [AS-243].

1.1.2 This report involves clarifications made to Table 2-3 (pages 21 to 28) and Table 2-4 (pages 30-31) of Applicant's Proposed Changes to the Application [AS-243].

1.1.3 Alongside the clarifications provided in Table 1-1 below, the Applicant has also provided copies of the relevant tables from AS-243 with revisions included. These are provided in Table 1-2 (Table 2-3 of AS-243) and Table 1-3 (Table 2-4 of AS-243) of this report.

Table 1-1 Errata Report for the Changes Application

Page and paragraph/table reference	Clarification/Correction
Page 21, Table 2-3	Reference 2-3.1 should be added to the table.
Page 21, Table 2-3	Reference 2-3.2 should be added to the table.
Page 22, Table 2-3	The heading 'Land use (continued)' should be added to the table.
Page 22, Table 2-3	Reference 2-3.3 should be added to the table.
Page 22, Table 2-3	Reference 2-3.4 should be added to the table.
Page 22, Table 2-3	Reference 2-3.5 should be added to the table.
Page 22, Table 2-3	Reference 2-3.6 should be added to the table.
Page 22, Table 2-3	Reference 2-3.7 should be added to the table.
Page 23, Table 2-3	The heading 'Design (continued)' should be added to the table.
Page 23, Table 2-3	Reference 2-3.8 should be added to the table.
Page 23, Table 2-3	Reference 2-3.9 should be added to the table.
Page 23, Table 2-3	Reference 2-3.10 should be added to the table.
Page 23, Table 2-3	Reference 2-3.11 should be added to the table.
Page 24, Table 2-3	The heading 'Consultation (continued)' should be added to the table.
Page 24, Table 2-3	Reference 2-3.12 should be added to the table.
Page 24, Table 2-3	Reference 2-3.13 should be added to the table.
Page 24, Table 2-3	Reference 2-3.14 should be added to the table.
Page 24, Table 2-3	Reference 2-3.15 should be added to the table.
Page 24, Table 2-3	Reference 2-3.16 should be added to the table.

Page and paragraph/table reference	Clarification/Correction
Page 25, Table 2-3	The heading 'DCO Application (continued)' should be added to the table.
Page 25, Table 2-3	Reference 2-3.17 should be added to the table.
Page 25, Table 2-3	Reference 2-3.18 should be added to the table.
Page 25, Table 2-3	Reference 2-3.19 should be added to the table.
Page 25, Table 2-3	Reference 2-3.20 should be added to the table.
Page 25, Table 2-3	Reference 2-3.21 should be added to the table.
Page 25, Table 2-3	Reference 2-3.22 should be added to the table.
Page 26, Table 2-3	The heading 'Ecology (continued)' should be added to the table.
Page 26, Table 2-3	Reference 2-3.23 should be added to the table.
Page 26, Table 2-3	Reference 2-3.24 should be added to the table.
Page 26, Table 2-3	Reference 2-3.25 should be added to the table.
Page 26, Table 2-3	Reference 2-3.26 should be added to the table.
Page 27, Table 2-3	The heading 'Transport and access (continued)' should be added to the table.
Page 27, Table 2-3	Reference 2-3.27 should be added to the table.
Page 27, Table 2-3	Reference 2-3.28 should be added to the table.
Page 27, Table 2-3	Reference 2-3.29 should be added to the table.
Page 27, Table 2-3	Reference 2-3.30 should be added to the table.
Page 27, Table 2-3	Reference 2-3.31 should be added to the table.
Page 27, Table 2-3	Reference 2-3.32 should be added to the table.
Page 27, Table 2-3	Reference 2-3.33 should be added to the table.
Page 28, Table 2-3	Reference 2-3.34 should be added to the table.
Page 28, Table 2-3	Reference 2-3.35 should be added to the table.
Page 28, Paragraph 2.5.15	The final sentence should be deleted and the text should read as follows: "A response was received on 1 August 2022, requesting further information regarding Plate 7 of the Abnormal Indivisible Load (AIL) Tracking Report. A copy of the AIL Tracking Report is available to view in Appendix P. The Applicant provided a detailed plan for this location on 2 August 2022 and a further response is awaited."
Page 30, Table 2-4	Reference 2-4.1 should be added to the table.

Page and paragraph/table reference	Clarification/Correction
Page 30, Table 2-4	Reference 2-4.2 should be added to the table.
Page 30, Table 2-4	Reference 2-4.3 should be added to the table.
Page 30, Table 2-4	Reference 2-4.4 should be added to the table.
Page 31, Table 2-4	The heading 'Transport (continued)' should be added to the table.
Page 31, Table 2-4	Reference 2-4.5 should be added to the table.
Page 31, Table 2-4	Reference 2-4.6 should be added to the table.

Table 1-2 Amended Table 2-3 of AS-243

Summary of issue raised	Applicant's response
Location	
2-3.1 BT has an exchange potentially impacted by your proposals, known as Isleham UAX.	The Applicant acknowledges the location of this apparatus and notes that it is currently situated outside of the Order limits. It is therefore not considered to be affected by the proposed change application.
Land use	
2-3.2 Do National Grid plan on building on the Option 1 land? If they do, how will you connect to the Grid? Especially if Option 2 is no longer viable.	Within its Relevant Representation [RR-1289], National Grid Electricity Transmission (NGET) states that the land required for Option 1 is not available for the following reasons: "that the land requested by Sunnica for their substation to be provided pursuant to the DCO was larger than originally discussed between NGET and Sunnica; and in addition, NGET must meet requirements to provide other connections at the Burwell Main Substation site. To facilitate this, as Sunnica is aware, NGET is undertaking an extension of the substation. The land required for this will mean that the Option 1 connection is not possible. The correct reference for option 1 is Land Plots 20-16, 20-17, 20-18, 20-19, 20-20 as shown on the Land and Crown Plans [rev1] (AS003). This does not affect Sunnica's connection agreement with NGET at the Burwell 400kV substation and bays remain allocated for the connection." Option 2 remains technically feasible.
Land use (continued)	
2-3.3	The proposed Change 2 does not require that any land is added to the Order limits. The proposed

Summary of issue raised	Applicant's response
Will there be new land acquisition required as a result of the amended cable routes across the Scheme?	400kV cabling can be accommodated within the existing Order limits.
2-3.4 Change 1 cannot be said to be a deletion because rights underground through the land are still required.	The Applicant acknowledges that plots 20-16, 20-17, 20-18, 20-19 and 20-20 will remain within the Order limits as rights over this land will still be required to facilitate the connection to the Burwell National Grid Substation under both Option 2 and Option 3. However, the acquisition of rights is a lesser imposition than the acquisition of the land. The proposal is to alter the design by removing the transformer compound at this location due to changing the electrical configuration of the Scheme.
Design	
2-3.5 What would installing a shunt reactor at Sunnica East Site B involve?	A shunt reactor is a piece of equipment designed to compensate for reactive power. This is required as part of the grid code. Installing the shunt reactor will involve preparing the ground with foundations in the same way as the rest of the substation compound, delivering the piece of equipment to site and installing it alongside the rest of the equipment. When installed, shunt reactors are similar in size and appearance to electricity transformers, and will benefit from the same landscape screening as part of the Sunnica East Site B on-site substation. They will be within the overall parameters of the substation areas as provided for in Chapter 3 of the Environmental Statement **[EN010106/APP/6.1]** and in the Design and Access Statement **[EN010106/APP/7.3].**
2-3.6 What are the changes to the cable route?	The cable route itself remains unchanged. It will continue to follow the same route as that specified within the DCO submission documents (see Figure 1-1 of the Environmental Statement **[APP-129]**). The specifications for a 400kV cable and associated works are likely to require a smaller footprint than the 132kV cables that would be required under grid connection options 1 and 2. However, the consideration of this change in the Changes Report has assumed the maximum parameters from the 132kV cable route options.
Design (continued)	

Summary of issue raised	Applicant's response
2-3.7 Can you please provide detailed confirmation of the building/structure size now required across all the proposed sites?	The maximum footprint of each on-site substation is as described within the Applicant's DCO application This is: Sunnica East Site A: 85m by 55m footprint, 10m in height. Sunnica East Site B: 85m by 130m footprint, 10m in height. Sunnica West Site A: 85m by 130m footprint, 10m in height. Further information on the on-site substations is given in Chapter 3: Scheme description of the Environmental Statement **[EN010106/APP/6.1]**. The Applicant has provided further information on its proposed changes to the on-site substation arrangements within Chapter 6 of this document.
2-3.8 Insufficient information has been provided as to the layout of the BESS/substation areas.	The Applicant has provided illustrative layouts of the proposed 400kV Substations within this Report. Please see figures 5-1 to 5-6. In addition, in response to questions received during the consultation, the Applicant provided illustrative plans of the substation layouts at the public exhibition events and on its website. However, it is important to note that the Applicant is not requesting consent for the layout as shown on the illustrative figures and the environmental assessment in the Environmental Statement and the consideration of the changes in the Changes Report has been undertaken using the Rochdale Envelope based on the maximum parameters as outlined in Chapter 3 of the Environmental Statement and in the Design and Access Statement as provided in Appendix E and F of this Report, respectively.
2-3.9 What happens if Option 3 proves not to be feasible? Will there be other new options?	Option 2 is technically feasible. The Option 3 connection is approved in principle by NGET (pending formal written approval of the technical feasibility of Option 3 by NGET engineers).
Consultation	
2-3.10 Insufficient information has been presented as to the nature of the changes and their resultant impacts.	The Applicant considers the consultation document and content that it presented at the public exhibitions to be sufficient to comment on the proposed changes at a stage prior to the submission of a changes application to the Examining Authority. The Applicant has provided further detail within its changes application, including an appraisal of the likely environmental effects of each change. This appraisal can be viewed in chapters 3, 4 and 5 of this document.
2-3.11 The visualisations of the changes provided as part of the consultation were insufficient.	The Applicant considers the illustrations that it has provided sufficient to understand the scope of the proposed changes. In response to questions received during the consultation, the Applicant provided illustrative plans of the substation layouts at the public exhibition events and on its website. As

Summary of issue raised	Applicant's response
	the proposed substation changes would be within the maximum specified in the Applicant's DCO application as submitted, the Applicant considers the photomontages **[APP-215 to APP-232]** to still represent the visual impact of the proposed Scheme including the substation arrangements.
Consultation (continued)	
2-3.12 The public exhibitions were insufficient.	The Applicant believes that it has consulted appropriately given the scope of the non-statutory consultation on its proposed changes. Public exhibitions enable anyone with an interest in the proposals to attend and speak to members of the project team directly about the issues that are most important to them in particular. The Applicant organised the consultation events in response to comments made by the Examining Authority [PD-008]. The Applicant gave in excess of 7 days' notice for the two events, wrote to over 11,000 addresses to promote the events and submitted its invitation letter to the Examining Authority to allow interested parties to be notified. The consultation arrangements allowed for anyone to obtain a hard copy of the consultation document on request, collect a copy of the consultation document from a deposit point, and to contact the project team using the Freephone, Freepost or email. The consultation was not therefore only dependent upon the public exhibitions.
2-3.13 All interested parties should have received a consultation booklet.	The Applicant disagrees as the scope of this non-statutory consultation was limited. The Applicant did seek to promote the consultation to those who have registered as interested parties by submitting its consultation notice [AS-0234] (which included details of how to access the consultation document) for acceptance into the Examination. When this notice was published, anyone who has signed up for updates through the National Infrastructure Planning website would have received an email update. The Applicant also wrote to all persons and bodies notified of the acceptance of the application under Section 56 of the Planning Act 2008.
DCO Application	

Summary of issue raised	Applicant's response
2-3.14 The DCO application should never have been submitted to The Planning Inspectorate in November 2021 unless a signed contract was available with National Grid.	Sunnica has a signed Bilateral Connection Agreement with National Grid. National Grid has confirmed in their letter on 11 July 2022 to Sunnica that their representation regarding Option 1 'does not affect Sunnica's connection agreement with NGET at the Burwell 400kV substation and bays remain allocated for the connection'.
2-3.15 The changes represent a material change to the DCO.	The Applicant respectfully disagrees, and Chapter 2 of the changes report explains why it is considered that the changes are non-material.
2-3.16 If a modified application is submitted, we would expect all documents to be updated accordingly, including the EcIA, landscape plans, CEMP and LEMP.	As shown in chapters 3 to 5 of this report, there are no new or different significant effects as a result of the proposed changes. Therefore, the mitigation outlined within the current EcIA and the management plans remain valid as no new or additional mitigation is required. As such there is no intention to update the current suite of mitigation documents; apart from where identified in the relevant sections of this Report to ensure consistency across the suite of documents and in response to the procedural decisions of the ExA.
DCO Application (continued)	
2-3.17 Details of the proposed changes should not be subject to the Rochdale Envelope.	As outlined in Section 3.3 of the updated Chapter 3: Scheme Description (see Appendix E of this Report), Solar PV and BESS are rapidly evolving and as a result, the draft DCO **[EN010106/APP/3.1]** and supporting Works Plans **[EN010106/APP/2.2]** propose a degree of flexibility to allow the latest technology to be utilised at the time of construction. Given the flexibility applied for and in order to ensure a robust assessment of the likely significant environmental effects of the Scheme, the Environmental Impact Assessment (EIA) has been undertaken adopting the principles of the 'Rochdale Envelope' where appropriate, as described in the Planning Inspectorate's Advice Note 9. This involves assessing the maximum (and where relevant, minimum) parameters for the Scheme where flexibility needs to be retained. This is a standard approach to undertaking an EIA.
Construction	
2-3.18	The AIL's would require very minimal vegetation clearance. The locations where vegetation may require clearance have been assessed by an

Summary of issue raised	Applicant's response
There will be a requirement for significant removal of roadside vegetation which would create an environmental impact.	ecologist and assessed as not leading to significant adverse environmental effects.
2-3.19 How exactly will the construction methodology required differ (as stated) from the DCO application?	The construction methods are not anticipated to change; however, the timing of the works will be extended for the cable installation and the onsite substation works, which will increase from 30 to 50 weeks. Although this is an increase for these works it is still within the total 24-month construction programme.
Operations	
2-3.20 How will the proposed changes affect the import and export of energy to the grid by Sunnica?	In terms of the amount of energy that is imported or exported to and from the grid, nothing will change as a result of including Option 3.
Ecology	
2-3.21 Assurance is required in relation to Change 2 as to whether there could be an effect on hydrology from installing a 400kV cable, with potential implications for Chippenham Fen SSSI, County Wildlife Sites, peat soils and directional drilling under watercourses	As shown in Chapter 4 of this Report, the maximum parameters, e.g., depth, width, installation technique or duration, for the Cable Route, should Change 2 be taken forward would not change as a result of the proposed change to a 400kV cable. Therefore, no changes in the magnitude of the effects assessed for potential degradation and disturbance to Chippenham Fen SSSI, County Wildlife Sites, peat soils and water courses would arise and so the conclusions of the Environmental Statement would remain the same.
Ecology (continued)	
2-3.22 What will be the impact of Change 3 on levels of disturbance to birds, such as Stone Curlews, as a result of changed staff and vehicle movements, and changes to the timings or duration of works?	The proposed changes will not result in the need for additional staff or vehicle movements. In terms of noise, changes in noise as a result of Option 3 would result in an increase in noise from combined solar infrastructure plant and the substation and battery storage areas of no greater than 2 decibels (dB). This is not anticipated to alter the magnitude of impact / significance effect of the Scheme on biodiversity. The anticipated programme of the cable installation and the onsite substation works will increase from 30 to 50 weeks, which although an increase is still within the total 24-month construction programme. All restrictions related to the timing of works to avoid ecology impacts during construction will be retained and incorporated into the phasing plan developed by the principal contractor.
Landscape and visual amenity	

Summary of issue raised	Applicant's response
2-3.23 Further information is required to fully assess the visual impacts of the proposed changes on the landscape.	The consideration of the visual impacts of the changes are provided in chapters 3 to 5 of this Report. The assessment has concluded that there will be no new or different significant effects as a result of the proposed changes.
2-3.24 Option 3 has no material impact on the existing approved scheme and avoids further unsightly electrical equipment at Burwell.	Option 3 if taken forward would remove the requirement for a substation to be located in the vicinity of the existing National Grid Burwell Substation.
2-3.25 Would the revised substation arrangements have the same skyline, be more intrusive, or be bulkier?	The massing is larger with the 400kV transformer as is demonstrated in the figures provided within this report. However, as the proposed substation changes would be within the maximum parameters specified in the Applicant's DCO application, a worst case assessment has been undertaken within the Environmental Statement and no new or different significant effects are anticipated. The Applicant considers the photomontages **[APP-215 to APP-232]** to still represent the visual impact of the proposed Scheme including the revised substation arrangements.
Transport and access	
2-3.26 What impact will the changes have on highways?	The proposed changes will not impact on the proposed haulage routes; however, larger Abnormal Indivisible Load (AIL) vehicles will be required to transport the 400kV transformer to Sunnica West Site A, Sunnica East Site A and Sunnica East Site A, should Option 3 be taken forward. Therefore, a tracking exercise (swept path analysis) for AILs has been undertaken on the identified routes which has demonstrated that manoeuvres, including over/under-sail, can be accommodated within the highways boundary in all but one location – the Mildenhall Road/Ferry Lane T-junction. A minor update to the Order Limits has been made at this location to accommodate the over-sail of the trailer at the junction.
Transport and access (continued)	
2-3.27	The transformers and shunt reactor will be transported to site using AILs. All other equipment will be transported on standard size HGVs. The

Summary of issue raised	Applicant's response
The equipment in these drawings (on-site substations) seem to effectively increasing the size and doubling up on your largest components which will surely have an impact on rural roads.	transport assessment for Option 3 is presented in Chapter 5 of this Report.
Human health	
2-3.28 The introduction of further electrical equipment at the substations will increase the risk of fire.	It is not anticipated that Option 3 will increase the fire risk of the batteries. Adequate control measures and separation distances have been set out within the Outline Fire Safety Battery Management Plan **[APP-124]** and would equally apply to the new arrangements.
2-3.29 The revised cabling arrangements and increase in voltage (400kV rather than 132kV) will create electromagnetic field impacts which will be a health and safety risk.	The magnetic field is a function of the current flowing in the cables. The current flowing in the 400kV cables will be less than in the 132kV cables by about 30% (per cable) and therefore the magnetic field will be lower by approximately 30%.
2-3.30 A risk assessment should be included in the proposals.	The Applicant is following industry guidelines for the installation of cables and equipment in the design. Prior to construction all appropriate construction and operational risk will be assessed further.
Noise and vibration	
2-3.31 What are the operating noise differences at each of Sunnica West A and B and East A and B with the different equipment now proposed over Option 1?	Further information on the environmental assessment can be found in Chapter 5 of this Report. Changes in noise as a result of Option 3 would result in an increase in noise from combined solar infrastructure plant at receptors nearest the substation and battery storage areas (R5, R6, R8, R9, R10, R11) of no greater than 2 decibels (dB). This difference in noise is not perceptible to the average human ear and would result in absolute noise levels that are no worse than a low impact. Consequently, the new infrastructure associated with Option 3 would not result in additional significant noise effects.
2-3.32 The proposed substation arrangement changes may lead to noise pollution from wind tones in certain conditions.	Noise predictions are undertaken using ISO9613-2, which assumes downwind conditions with windspeeds up to 5 m/s. So unfavourable wind conditions are inherent in noise predictions. The new layout will not result in any material changes in noise impacts.
Compulsory acquisition	
2-3.33 How much of the Scheme requires compulsory purchase? Are there other areas	Where possible the Applicant is committed to securing voluntary property agreements but has sought compulsory acquisition powers to ensure that the Scheme can be delivered if this is not possible. The Applicant does not currently propose to make

Summary of issue raised	Applicant's response
that may need to change if the landowner is unwilling to let you use their land?	any other changes to the Scheme and in any event would note that the proposed changes do not arise from the land powers sought.
Other	
2-3.34 The changes to the substations and cabling will have a profound effect on the local community.	The environmental consideration of the changes in chapters 3 to 5 of this Report have concluded that there will be no materially new or materially different significant effects as a result of the proposed changes.
2-3.35 The DCO application should not have been submitted until a suitable agreement with NGET was in place.	Sunnica has been negotiating with National Grid since 2018 to secure the grid connection at Burwell. This includes many rounds of meeting and negotiations over the length of that time with increasing intensity towards the submission of the DCO. The Applicant was taken by surprise by the representation from NGET. Sunnica holds a contracted position with National Grid for a Bilateral Connection and NGET has confirmed in writing on 11 July 2022 that "This does not affect Sunnica's connection agreement with NGET at the Burwell 400kV substation and bays remain allocated for the connection."

Table 1-3 Amended Table 2-4 of AS-243

Summary of issue raised	Applicant's response
Consultation	
2-4.1 The plan showing the proposed change to the Order limits contained no reference points that would allow the location to be identified.	The Applicant provided details in the covering letter and text on the website confirming the location of the point where the oversailing has been identified and that the change to the Order limits is required.
2-4.2 It is inappropriate to consult during August when many people are away and are unable to meet.	The Applicant carried out this non-statutory consultation to provide local parish councils and other stakeholders with an opportunity to review the AIL Tracking Report prior to the submission of the changes application to the Examining Authority. Should the Examining Authority accept the application, the AIL report and wider documentation relating to the changes will be available for the parish council and other interested parties to comment on through the Examination process. This is not therefore the only opportunity for the parish council to comment on the AIL report.
Transport	
2-4.3	The Applicant considers that the level of detail is sufficient for the stage of the Scheme. However,

Summary of issue raised	Applicant's response
The Applicant has not commissioned detailed surveys to confirm the highway boundaries of the relevant junctions and links and thereby confirming that AILs (or other works) do not extend beyond the public highway except where already identified.	consultation will continue with the Local Highways Authority regarding their concerns with the use of OS mapping.
Transport (continued)	
2-4.4 The use of ordnance survey (OS) mapping for the swept analysis should be questioned.	The Applicant considers that the level of detail is sufficient for the stage of the Scheme. However, consultation will continue with the Local Highways Authority regarding their concerns with the use of OS mapping.
2-4.5 Not all of the hedgerows/trees identified for works have been assessed as part of the Preliminary Bat Roost Appraisal Report (figures 2.1-2.9, Appendix 8J - Report on Surveys for Bats, ES [APP-087]). It is therefore not possible to determine the level of impact of these works.	All affected trees have been assessed by a qualified ecologist. It is considered that all affected trees/hedgerows do not have any bat roost potential, apart from two trees on Weirs Drove. These two trees have low/moderate bat roost potential; however, no bat roosts were identified at the time of the previous. A re-survey for bats will be carried out prior to works being carried out. As required in Table 3-3 Biodiversity of the Framework Construction Environmental Management Plan **[App-123]**, the Contractor will updated species surveys, including bats, great crested newt, breeding birds, otter, water vole and badger, to re-confirm the status of protected species identified, to inform mitigation requirements and support protected species licence applications, if required by Natural England.
Other	
2-4.6 No terms have been proposed as to a license agreement for the land that will be oversailed. Therefore, the interested party resolves to withhold their position on the license agreement at this time.	The Applicant acknowledges this response and would be happy to commence formal negotiations for a licence if this is confirmed to be something the Charity would like to pursue.

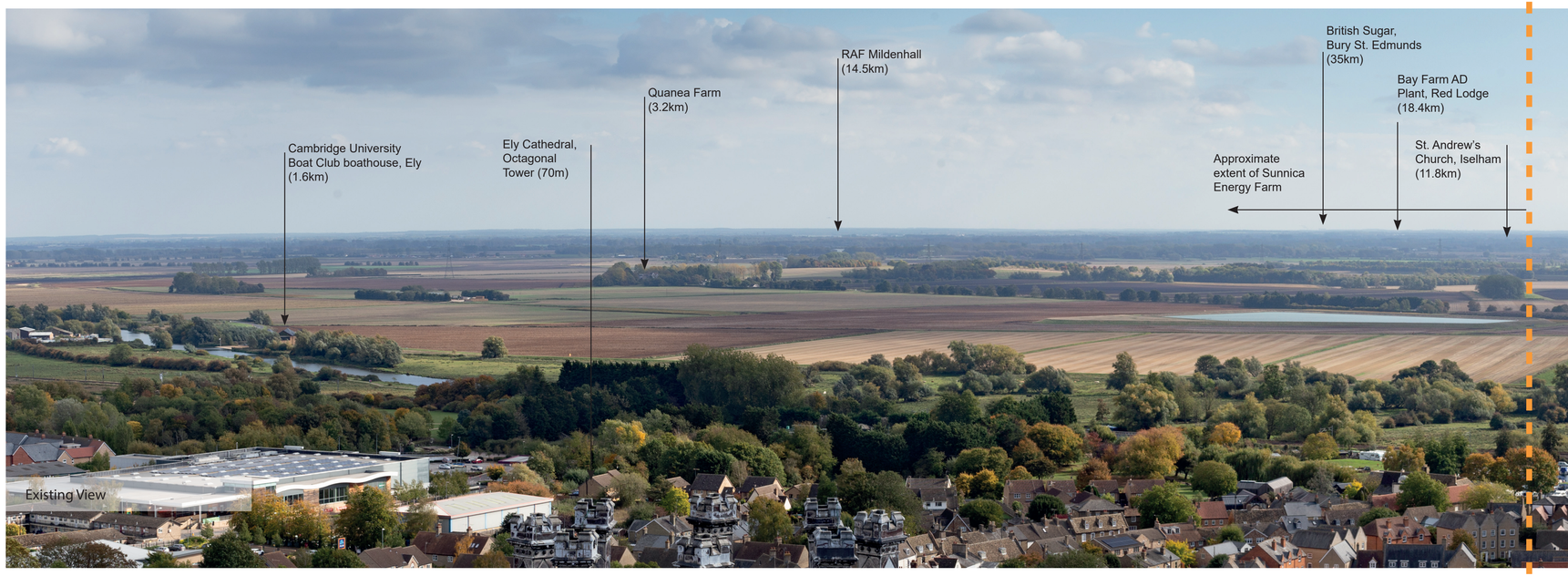
Appendix H Relationship of plans and other documents secured by the DCO

REQUIREMENT	PLAN OR OTHER DOCUMENT SECURED BY REQUIREMENT & SUMMARY DESCRIPTION	OUTLINE OR FRAMEWORK PLAN CITED	COMPLEMENTARY SUB-PLANS & PROCEDURES
Requirement 6 – Detailed design approval	6(1) Detailed design approval, requiring details of layout, scale, proposed FGL etc to be provided prior to commencement of authorised development. Details to accord with the **Design Principles** and the **Flood Risk Assessment**. The **Design Principles [APP-264]** set out design parameters for individual elements of the Scheme, in terms of (among other things) scale, layout, appearance and materials. The **Flood Risk Assessment [APP-095 – APP-098]** identifies potential forms of flooding, establishes the risk of flooding to the Scheme, determines the effects of the Scheme on flooding elsewhere, and suggests appropriate measures to mitigate flood risk.		
Requirement 7 – Fire safety management	7(2) **Battery Fire Safety Management Plan** prescribing measures to facilitate safety during construction, operation and decommissioning of Work No. 2.	Substantially in accordance with **Outline Battery Fire Safety Management Plan [APP-267]**.	
Requirement 8 – Landscape and ecology management plan	8(1) **Landscape and Ecology Management Plan** setting out details of how it will secure minimum 10% biodiversity net gain and how landscape and ecological measures will be managed and maintained.	Substantially in accordance with **Outline Landscape and Ecology Management Plan [APP-108]**.	
Requirement 9 – Implementation and maintenance of landscaping	All landscaping works must be carried out in accordance with **Landscape and Ecology Management Plan**.	Substantially in accordance with **Outline Landscape and Ecology Management Plan [APP-108]**.	
Requirement 10 – Stone curlew	10(1) Offsetting habitat provision for stone curlews in accordance with **offsetting habitat provision for stone curlews specification**. The **offsetting habitat provisions for stone curlews specification [APP-258]** provides details of the offsetting measures for stone curlew, for example that certain works may not commence until offsetting habitat provision for stone curlew has been provided.		
Requirement 11 – Fencing and other means of enclosure	11(1) Written details of all proposed temporary fences, walls or other means of enclosure, including those set out in **Construction Environmental Management Plan**.	Substantially in accordance with **Framework Construction Environmental Management Plan [APP-123]**.	
Requirement 12 – Surface and foul water drainage	12(1) Details of **surface water drainage strategy** and (if any) foul water drainage system.	Substantially in accordance with **drainage strategy [APP-098]**.	

	The **surface water drainage strategy** summarises existing drainage and outlines how surface water will be managed on the Scheme.		
Requirement 13 – Archaeology	13(1) **Written scheme of archaeological evaluation** (relating to Work No. 5).		
	13(2) **Detailed archaeological mitigation strategy**, which must include (among other things) an archaeological and historical background, the rationale, statement of significance and research objectives of the scheme, programme, the methodology for site investigations / excavations and assessment, and provision for dissemination of results of investigation programme.	In respect of Work No. 5 only, detailed archaeological mitigation strategy must take into account results of the written scheme of archaeological evaluation.	
Requirement 14 – Construction Environmental Management Plan	14(1) **Construction Environmental Management Plan** identifying design and mitigation measures to reduce potential adverse impacts during construction.	Substantially in accordance with **Framework Construction Environmental Management Plan [APP-123]**.	Construction Resource Management Plan, Soil Management Plan, Dust Management Plan, Water Management Plan, and Water Framework Directive Mitigation Strategy
	14(2) CEMP must include **Construction Resource Management Plan** that includes details of proposals to minimise the use of natural resources and unnecessary materials.	Substantially in accordance with **Framework Construction Environmental Management Plan [APP-123]**.	
Requirement 15 – Operational Environmental Management Plan	15(1) **Operational Environmental Management Plan** identifying design and mitigation measures to reduce potential adverse impacts during operation.	Substantially in accordance with **Framework Operational Environmental Management Plan [APP-126]**.	Landscape and Ecology Management Plan.
Requirement 16 – Construction Traffic Management Plan	16(1) **Construction Traffic Management Plan** setting out mitigation measures to manage construction traffic and staff vehicles during construction.	Substantially in accordance with **Framework Construction Traffic Management Plan [APP-118]**.	
Requirement 17 – Operational noise	17(1) Operational noise assessment containing details of how design has incorporated mitigation to ensure compliance with operational noise rating levels, as set out in the **Environmental Statement**. Chapter 11 (Noise and Vibration) of the **Environmental Statement [APP-043]** sets out operational noise rating levels.		
Requirement 18 – Ground conditions	18(1) **Written strategy** in relation to identification and remediation of any risks associated with contamination – must include geo-environmental investigations.		Strategies prepared under R18(1) and (2) must include: • **site investigation scheme** providing details of the detailed risk assessment to be carried out for
	18(2) If contamination not previously identified is found to be present, must prepare **remediation strategy** detailing how to deal with contamination.		

			receptors that may be affected by the Scheme; and • **verification plan** identifying data to be collected to demonstrate remediation measures have been completed and are effective.
Requirement 19 – Water Management Plan	19(1) **Water Management Plan** including details as to management of water use and discharge during construction, including surface water, drainage and water quality.		
Requirement 20 – Skills, Supply Chain and Employment	20(1) **Skills, Supply Chain and Employment Plan** identifying opportunities for individuals and businesses to access employment and supply chain opportunities associated with construction, operation and maintenance, and means for publicising such opportunities.	Substantially in accordance with **Outline Skills, Supply Chain and Employment Plan [APP-268]**.	
Requirement 21 – Permissive path	21(1) **Permissive path details** covering final routing, specification, and maintenance regime of each permissive path to be provided	Substantially in accordance with plans contained within the **Outline Landscape and Ecological Management Plan [APP-108]**.	
Requirement 22 – Decommissioning and restoration	22(1) **Decommissioning Environmental Management Plan** identifying design and mitigation measures to reduce potential adverse impacts during decommissioning.	Substantially in accordance with relevant part of **Framework Decommissioning Environmental Management Plan [APP-125]**.	Decommissioning Resource Management Plan, Decommissioning Traffic Management Plan, and Decommissioning Worker Travel Plan.
	22(3) Decommissioning Environmental Management Plan must include a **Resource Management Plan** setting out details of measures to minimise use of natural resources and unnecessary materials during decommissioning.	**Framework Decommissioning Environmental Management Plan [APP-125].**	

Appendix I SEF Ely Cathedral Figure



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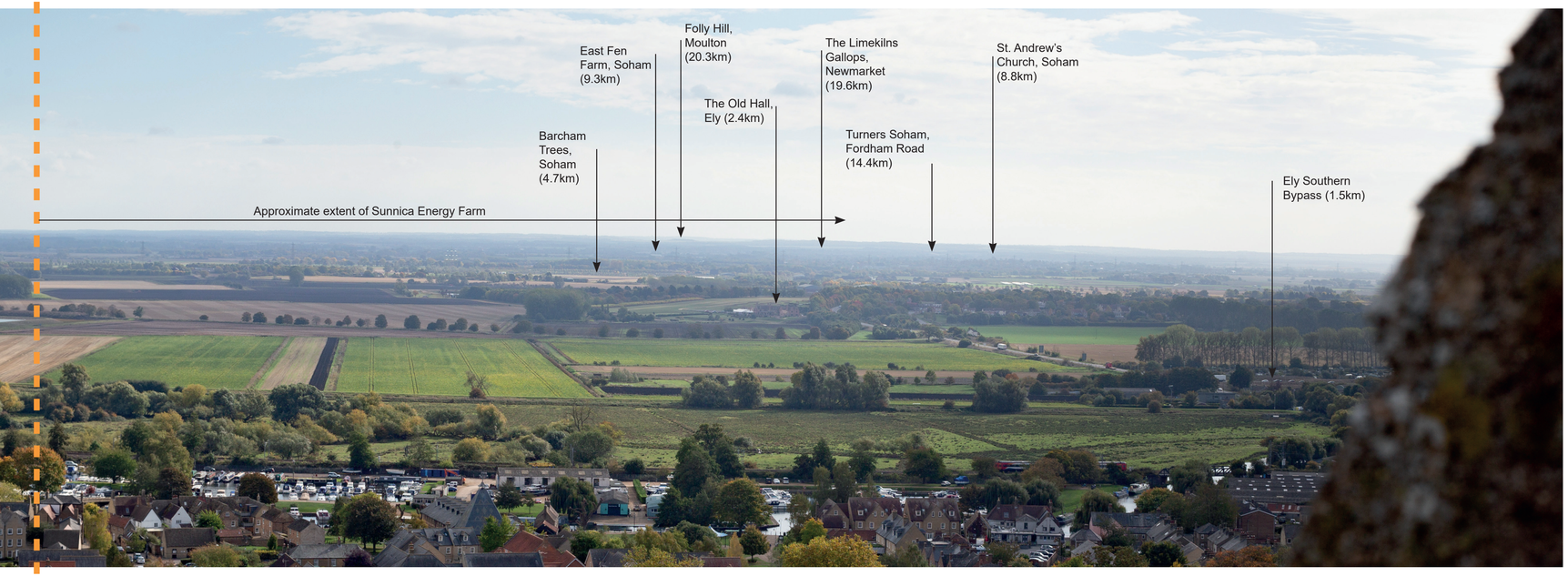
Visualisation Type:	1	Date / Time:	12/10/2022 11:33
Projection:	Cylindrical	Camera:	Canon EOS 6D
Enlargement Factor:	N/A	Lens:	Canon EF 50mm f/1.2L USM
Paper Size:	A1	Horizontal Field of View:	80°
Correct printed image size:	547 x 146mm	Direction of View:	South-east

Location:	E554051, N280276	Note:	Photographs captured by hand due to access constraints. Images to be viewed at a comfortable arm's length.
Eye level:	Approximately 95m AOD		
Height of Camera:	1.6m		
Distance to Site:	Approximately 13km		

Sunnica Energy Farm

Appendix I

View south-east from the West Tower of Ely Cathedral – Existing View


Folly Hill, Moulton (20.3km)
East Fen Farm, Soham (9.3km)
The Limekilns Gallops, Newmarket (19.6km)
St. Andrew's Church, Soham (8.8km)
The Old Hall, Ely (2.4km)
Barcham Trees, Soham (4.7km)
Turners Soham, Fordham Road (14.4km)
Ely Southern Bypass (1.5km)
Approximate extent of Sunnica Energy Farm

Appendix J LVIA and glint and glare

1 Introduction

1.1.1 This technical note clarifies the relationship between the separate Landscape and Visual Impact Assessment (LVIA) set out in Chapter 10 of the Environmental Statement [**APP-042**] and the Glint and Glare Assessment set out in Appendix 16A [**APP-121**]. The Glint and Glare Assessment, which is desk-based, specifically addresses the potential for impacts on people's views and visual amenity relating to the sun reflecting from solar panel surfaces. The LVIA considers the range of impacts that people might experience as a consequence of the construction, operation and decommissioning of the Scheme, of which glint and glare is one of several considerations in determining the magnitude, and is therefore broader in scope.

1.1.2 The approach to these separate assessments and the effects which they report are different, but related. They share a common baseline and some receptor groups are the same. Where the Glint and Glare Assessment has identified effects in Appendix 16A, which relate to visual receptors identified in the LVIA, these are cross-referenced in Chapter 10 and have informed the assessment of visual effects and underpin the conclusions for relevant receptors.

2 Receptors common to the LVIA and Glint and Glare Assessment

2.1.1 Most receptors who would potentially be affected by glint and glare effects are located in proximity to Sunnica East Site A and Sunnica East Site B.

Residents

2.1.2 As set out in section 8.9 of Chapter 16, for residential receptors, the key considerations to determine the impact significance are:

a. Whether a reflection is predicted to be experienced in practice

b. The duration of the predicted effects, relative to thresholds of:

i. 3 months per year; and

ii. 60 minutes per day.

2.1.3 Most residential visual receptors identified as being potentially affected by glint and glare effects are located on the southern and eastern edges of Isleham, to the west of Sunnica East Site A.

2.1.4 Those living along Station Road (B1104) to the south of the village are broadly associated with Viewpoint 6 in the LVIA. These receptors are predicted to experience moderate adverse effects in construction and year 1 of operation relating principally to activities and development in the middle ground of views to the east. These effects are considered significant. By year 15 of operation, when planting proposed along the western boundaries of Parcel E05 will have established, effects would have reduced to minor adverse, which is not significant. Effects in decommissioning would also be not significant.

2.1.5 Possible reflections towards these receptors are identified in the Glint and Glare Assessment (Receptors 175-179) in the opening year, limited to the morning. However, the Glint and Glare assessment concludes the following:

- *No significant impacts predicted prior to the implementation and establishment of mitigation measures.*
- *Predicted solar reflections will be mostly screened by existing and proposed vegetation. Partial views of the reflecting panels possible when vegetation not in leaf.*
- *No significant impacts predicted following the implementation and establishment of mitigation measures because reflections will be fully screened.*

2.1.6 The Glint and Glare Assessment concludes that no solar reflections are geometrically possible for people living on Croft Road (Receptor 187-190), whose properties face broadly south. By comparison, within the LVIA assessment as a whole residents on the eastern edge of Isleham represented by Viewpoint 4a are predicted to experience moderate adverse (significant) effects in year 1 of operation, reducing to minor adverse (not significant) by year 15 of operation.

2.1.7 People living on Festival Road, Kennedy Road and Houghtons Lane on the eastern side of Isleham (Receptors 195-199 and 207) are located between Viewpoint 03, Viewpoint 04 and Viewpoint 4a in the LVIA. The Glint and Glare Assessment concludes that predicted solar reflections will originate from solar panels that are over 1km from the dwellings and therefore no significant impacts are predicted.

2.1.8 Residents of Lee Farm, located north of Beck Road between Isleham and Worlington are associated with Viewpoint 12 in the LVIA and Receptor 173 in the Glint and Glare assessment. Due to their proximity to Sunnica East Site A, which would wrap around the farm complex, the LVIA predicts major adverse effects in construction and year 1 of operation, which are significant. By year 15 of operation these effects would have reduced to minor adverse, which is not significant, due to the establishment of planting on the boundaries of Parcels E03, E05 and E09. Effects of decommissioning would be moderate adverse, which is significant. By comparison, the Glint and Glare assessment concludes that, whilst solar reflections would be possible towards the receptor during the morning and evening before the establishment of mitigation, no significant impacts are predicted following the implementation and establishment of mitigation measures by year 15 of operation.

2.1.9 A further group of residents distributed along Bridge End Road to the west of the A11 and Red Lodge has been identified as potentially experiencing glint and glare effects (Receptors 34-36). Prior to the establishment of the mitigation measures, a moderate impact is predicted upon residents of three dwellings (receptors 34-36), which will remain until the proposed vegetation screening has established and the reflecting panels are obstructed from view. No visual effects on residents of Bridge End Road have been identified in the LVIA due to the density of vegetation on the boundaries of these properties. These receptors lie between Viewpoints 19 and 20 identified in the LVIA, which are representative of people travelling along roads and public rights of way from which there are more open views. The Glint and Glare Assessment has determined that there would be

possible reflections towards receptors 34-36 in the afternoon and concludes the following:

- *No significant impacts predicted prior to the implementation and establishment of mitigation measures.*
- *Predicted solar reflections will be mostly screened by existing and proposed vegetation. Partial views of the reflecting panels possible when vegetation not in leaf.*
- *No significant impacts predicted following the implementation and establishment of mitigation measures.*

Users of roads and public rights of way

2.1.10 The Glint and Glare assessment has identified potential effects on people using unclassified road U6006, which connects Elms Road in the south and Worlington in the north (Receptors 149-153). These receptors are represented by Viewpoints 15b and 16 in the LVIA, which concludes that there would be major adverse effects in construction, reducing to moderate adverse in year 1 of operation. These effects, which consider a range of factors including glint and glare, are significant. By summer of year 15 of operation, when existing deciduous vegetation would be in leaf and proposed planting would have established, these effects would reduce to minor adverse, which is not significant. This can be seen in the context that the glint and glare assessment has concluded that there would be possible reflections towards the receptor during the morning and afternoon, but that solar reflections will be significantly screened by existing vegetation and no significant impacts are predicted.

2.1.11 People travelling along Elms Road between Red Lodge in the east and Freckenham in the west have also been identified as potentially being affected by glint and glare effects in the morning. These receptors, which include equestrian users, are associated with Viewpoint 17 in the LVIA. Effects in operation in the LVIA assessment are predicted to be neutral. The Glint and Glare assessment concludes that predicted solar reflections will be mostly screened by existing vegetation and that whilst partial views of the reflecting panels may be possible, no significant impacts are predicted.

3 Summary

3.1.1 The Glint and Glare assessment presented in Appendix 16A of the Environmental Statement [**APP-121**] concludes that glint and glare effects are only geometrically possible when the sun would be in a specific point in the sky. It identifies the following principal groups of people who may experience solar reflections in operation. These receptors comprise:

- people living on the southern and eastern edges of Isleham in the west, in proximity to Sunnica East Site A.
- people living on Bridge End Road, west of Red Lodge.
- people travelling along Elms Road between Red Lodge and Freckenham.
- people travelling along unclassified road U6006, north of Elms Road.

3.1.2 With reference the views of residents, section 8.9.1 of Chapter 16 states that "*significant impacts are not predicted for 115 (out of 118) of the dwellings in accordance with the impact significance defined in Appendix D because the duration of effects is predicted to be less than 3 months per year and less than 60 minutes per day, or there are sufficient mitigating factors that will reduce the level of impact.*"

3.1.3 Prior to the establishment of the mitigation measures, a moderate glint and glare impact is predicted upon residents of three dwellings (receptors 34-36), which will remain until the proposed vegetation screening has established and the reflecting panels are obstructed from view.

3.1.4 In all cases the Glint and Glare Assessment concludes that, whilst some receptors might be affected by solar reflections at certain times of the day or year, no significant impacts are predicted following the establishment of mitigation measures at year 15 of operation. The LVIA includes cross references to the Glint and Glare Assessment where relevant and has taken into account the findings in drawing conclusions on the likely significant effects on a case-by-case basis where appropriate.

Appendix K Summary of intra-cumulative landscape and sequential visual effects

1 Introduction

1.1.1 This technical note has been prepared by the Applicant to inform the Examination on matters raised by host planning authorities on how landscape and visual effects, including intra-project effects between different aspects of the Scheme, relate at different scales. These authorities state that a project of the scale and nature proposed, will radically change the sense of place, the place attachment of the residents, and the recreational amenities of the affected villages and communities, over a long period of time. Rather than being perceived as a solar development occupying an area of land within a wider landscape, they are concerned that the Scheme has the potential to dominate and transform the local landscape, to alter it beyond recognition, and thus to create a new landscape altogether. This is not the conclusion of the Landscape and Visual Impact Assessment (LVIA) set out in Chapter 10 of the Environmental Statement (ES) **[APP-042]**, which has applied a hierarchical approach to the assessment of landscape effects, and has informed the design of the Scheme from the strategic scale masterplan to specific elements of the mitigation.

2 Approach within the LVIA

2.1.1 The LVIA summarised in Chapter 10 of the Environmental Statement (ES) **[APP-042]** and supported by associated appendices and figures provides a detailed assessment of the likely significant effects on the landscape and people's views of the landscape. It follows a structure which is consistent within the ES for other topics, addressing the effects of each Site within the Scheme in turn for the construction, operation and decommissioning phases.

2.1.2 The Guidelines for Landscape and Visual Impact Assessment, 3rd Edition (GLVIA3) states in paragraph 5.48 that "*the magnitude of landscape impacts should be assessed in terms of its size or scale, the geographical extent of the area influenced, and its duration and reversibility*".

2.1.3 Regarding geographical scale, it states in paragraph 5.50 that "*the geographical area over which the landscape effects will be felt must also be considered. This is distinct from the size or scale of the effect – there may for example be moderate loss of landscape elements over a large geographical area, or a major addition affecting a very localised area. The extent of the effects will vary widely depending on the nature of the proposal and there can be no hard and fast rules about what categories to use. In general effects may have an influence at the following scales, although this will vary according to the nature of the project and not all may be relevant on every occasion:*

- *at the site level, within the development site itself;*
- *at the level of the immediate setting of the site;*
- *at the scale of the landscape type or character area within which the proposal lies;*
- *on a larger scale, influencing several landscape types or character areas."*

2.1.4 This paper provides a broader narrative around the effects on the landscape character and the way it is experienced at various scales with reference to

documents within the Application. It concludes with a summary on the geographical scale of effects.

The process of landscape character assessment

2.1.5 The UK government defines landscape character assessment as "*the process of identifying and describing variation in character of the landscape*". It can be used to help to explain the unique combination of elements and features that make landscapes distinctive and show how the landscape is perceived, experienced and valued by people at any scale.

2.1.6 There is a long-established approach to landscape character assessment advocated by Natural England and most recently published in their document 'An Approach to Landscape Character Assessment' in 2014. Whilst most practitioners make reference to this general approach, there can be variations in the methodology adopted. Moreover, in some places existing landscape character assessments can be missing, dated or with gaps. GLVIA3 therefore advocates a thorough review of existing baseline information, supplemented with additional study where necessary.

Summary of the landscape character baseline

Historical development

2.1.7 The landscape within the DCO site and the study area for the LVIA is the product of centuries of human intervention. Whilst it includes some semi-natural features and characteristics, it cannot be described as a natural landscape. It is principally a landscape of intensive agricultural production, with other modern rural land uses, particularly the breeding and training of racehorses. Chippenham Fen, which comprises a mosaic of semi-natural habitats, and the registered landscape of Chippenham Park are isolated but notable exceptions in the west.

2.1.8 Chapter 7 of the Environmental Statement **[APP-039]** provides a summary of the historical background based on a desk-based assessment and updated Historic Environment Record (HER) data received from Suffolk County Council and Cambridgeshire County Council in 2020. It also makes reference to the Suffolk Historic Landscape Characterisation (HLC) project, which formed part of the wider East of England HLC project. The detail of these assessments is provided in Appendix 7C to 7E of the Environmental Statement **[APP-059** to **APP-061]**.

2.1.9 Farming practices changed radically in the post-World War II period as science and technology developed and demand from an increasing population grew. Mechanisation, the introduction of chemical herbicides, pesticides and fertilisers altered the requirements for field size and access and encouraged expansion to maximise productivity. This, together with price guarantees, saw significant increases in yield throughout the second half of the 20th century. This expansion and intensification led to large scale reduction in habitats and a consequential reduction in biodiversity, as reported in the *House of Commons Environmental Audit Committee Biodiversity in the UK: bloom or bust? report, 2021-2022*. Examples include the removal of hedgerows, which function as important networks of linear habitats. Evidence suggests that approximately half of hedgerows in the UK have been lost since the end of World War II. There are signs across the DCO site and wider landscape of hedgerow removal to facilitate

field amalgamation and access. Grassland, particularly rough pasture and furze (gorse), which is indicated as an extensive habitat in the early 20th century on OS maps, has now also been substantially depleted.

2.1.10 Some semi-natural features remain important to the character, particularly the distinctive "pine lines" of the Breckland in the east. The "Breaking New Ground" Heritage Lottery funded Landscape Partnership notes that these are a human intervention of the 19th century. They are considered a short-term fashion and were originally planted as windbreaks and now comprise grown out hedgerows.

Sunnica East Site A

2.1.11 Sunnica East Site A lies on the southern periphery of the Fens. The Ordnance Survey (OS) Six Inch map of 1888-1913 indicates an historical pattern of small strip fields around the edges of Isleham and extending north into the Fens. A comparison with modern OS maps and aerial photographs available online through the National Library of Scotland indicates that there has been some development around the edges of the settlement and amalgamation of fields to accommodate modern farming practices. Sunnica East Site A avoids these more intricate historical field patterns and is located in an area either side of Lee Brook, which the 1888-1913 OS indicates has largely retained its larger-scale field pattern. Key changes are the removal of the Cambridge to Mildenhall railway line across the southern part of the site and the expansion of Lee Farm and the introduction of large reservoirs.

Sunnica East Site B

2.1.12 This site lies on the southern edge of the Brecklands, which extend north across Suffolk into the southern part of Norfolk. Worlington, which lies to the north of the site, has seen some modest expansion since the 1888-1913 OS, particularly in the west. The field pattern around the village has largely been retained, with an increase in woodland cover to the south and east. Evidence of the railway line, which previously cut across the landscape to the south of the village, has mostly disappeared.

2.1.13 The most substantial change to the south of Worlington, within Sunnica East Site B, is the conversion of rough pasture and furze (gorse) to arable land and pig farming and the sub-division of fields with the introduction of further shelter belts, particularly to the east of U6006. The avenue of trees which lined the central section of this unclassified road, has now established as a more substantial belt of vegetation with a dense understorey. The area between the two parts of Sunnica East Site B, which is shown on the 1888-1913 OS as predominantly rough pasture and woodland plantation, is now a mixture of predominantly arable land and open cast mineral extraction and processing.

Sunnica West Site A

2.1.14 The field pattern within Sunnica West Site A is predominantly the same as shown on the 1888-1913 OS map. Key changes include the introduction of the Snailwell Gallops to the south-west of the site, which occupy land which was formerly RAF Snailwell. This airfield was built in 1940 and was operational until 1946. It comprised three grass runways and associated taxiways, hardstandings and buildings. Buildings can be seen within the avenue of trees extending south from

Chippenham Park on the 1949-1971 OS. Very little trace of the airfield is evident today, but the location of one of the runways extends across Parcel ECO5 within this site. The A14 and A11 trunk roads are also modern introductions. The A11 to the east of Sunnica West Site A largely follows an historic alignment, but the A14, which opened in the 1970's, cuts across former farmland. Further woodland planting is evident along some field boundaries, forming shelter belts.

Sunnica West Site B

2.1.15 A comparison between the 1888-1913 OS map and modern aerial photographs shows that there have been some minor changes to field boundaries within the Sunnica West Site B. The most substantial changes around the site include the Fordham Road industrial estate to the south of Snailwell Road and areas of plantation woodland along the River Snail and Fordham Road.

Existing landscape character assessments which have informed the LVIA

2.1.16 Paragraph 5.12 of GLVIA3, explains that "*Many parts of the UK are already covered by existing character assessments at different scales. There is a hierarchy of assessment, from broad-scale national or regional assessments, through to more detailed local authority assessments, to in some cases quite fine-grain local or community assessments*." Consequently, for a study area as broad as the Scheme, several sources of existing published information are available. These have been thoroughly reviewed and assessed in terms of the sensitivity to the Scheme and their relationship with one another to understand the effects of the Scheme at different scales.

2.1.17 At the National scale, Natural England has split the country into a series of 159 National Character Areas (NCA). These provide a broad assessment covering large swathes of landscape with broadly common characteristics.

2.1.18 The NCA presented in Figure 10-5 **[APP-195]** show that the DCO Site lies at a point of transition in the landscape where three NCAs converge. As such, it shares some characteristics between different areas and some characteristics are weaker than parts more central to these NCAs.

2.1.19 The majority of the Scheme is located within the northern part of NCA 87: East Anglian Chalk, which includes the higher ground around Newmarket and lower lying areas north of the A14. Sunnica East Site B lies on the southern periphery of NCA 85: The Brecks. A very small part of Sunnica East Site A falls within NCA 46: The Fens. These areas extend well beyond the study area for the LVIA, which has concluded that there would not be significant effects on the landscape at this scale during construction, operation or decommissioning. These areas are helpful in understanding the broader context and to inform the design response.

2.1.20 At the regional level, the East of England Landscape Framework has established broad landscape character types (LCT) at a consistent scale across the region. The areas defined by these types are large but also helpful in providing context. Significant, inter-project effects have been identified in relation to the Lowland Village Chalklands LCT during construction, but effects are predicted to be not significant in operation or decommissioning. Effects on all other LCTs defined at the regional scale are assessed as not significant in all phases.

2.1.21 Information from published landscape character assessments at the county level available is variable but relevant in understanding the likely effects at a scale appropriate to the Scheme. As set out in Appendix 10D of the Environmental Statement **[APP-103]**, the Suffolk Landscape Character Assessment, published in 2010, describes the landscape typologies (LT) of Suffolk and extends partly into Cambridgeshire. The Cambridgeshire Landscape Guidelines, published in 1991, remain the only published landscape character assessment for the county.

2.1.22 The Norfolk and Suffolk Brecks Landscape Character Assessment covers the north-eastern part of the study area including Sunnica East Site B.

2.1.23 At the local level, Freckenham Parish Council has prepared a Character and Sensitivity Appraisal to inform its emerging neighbourhood development plan. This study covers the settlement of Freckenham and the rural parts of the parish to the north and south.

Definition of Local Landscape Character Areas by the Applicant

2.1.24 Paragraph 5.13 of GLVIA3 states that "*existing assessments must be reviewed critically as their quality may vary, some may be dated and some may not be suited to the task in hand.*"

2.1.25 Review and analysis of the existing published landscape character assessments described above provided useful context and understanding of key characteristics of the area, generally at the broader scale. However, some of these assessments, particularly those defined at the county level, are dated. This means that there are differences in the approaches used to define LCTs and LCAs. In some areas, for example on the edges of Isleham and Red Lodge, there have also been changes in the landscape through new development or different land uses.

2.1.26 The Applicant undertook a landscape character assessment to provide an up-to-date baseline at a finer grain appropriate to consider the localised effects of the Scheme and inform its design. These 44 LLCA provide full coverage of the study area at a consistent scale. The extent and boundaries of these LLCA have been informed by published studies, further detailed desk study and fieldwork. They have been discussed with relevant local planning authorities and amended based on feedback received.

2.1.27 A table is provided at the end of Appendix 10E of the Environmental Assessment **[APP-104]**, which sets out the relationship between the LLCA defined by the Applicant and LCAs defined in published landscape character assessments.

3 Intra-project effects

3.1.1 Chapter 10 of the Environmental Statement **[APP-042]** sets out a separate assessment of the effects of the Scheme in relation to the following for construction, operation and decommissioning:

- Sunnica East Site A
- Sunnica East Site B
- Sunnica West Site A
- Sunnica West Site B

- Cable Route A
- Cable Route B
- Burwell National Grid substation extension, Option 1
- Burwell National Grid substation extension, Option 2

3.1.2 The assessment has been broken down in this way to provide granularity to the assessment of landscape and visual effects across the Scheme. This assists in understanding which elements of the Scheme are likely to result in effects locally. This information has also been used to inform the design response.

Intra-project landscape effects

3.1.3 A separate assessment has also been made of combined, intra-project landscape effects, which are the effects relating to each of the elements of the Scheme described above, considered together. This allows conclusions to be drawn on the consequent accumulation of potential effects of the Scheme on the wider landscape.

3.1.4 This approach has allowed distinctions to be made regarding the size, scale and geographical extent of impacts, in line with best practice set out in section 5 of GLVIA3. It has informed the design of the Scheme, including decisions regarding the siting and layout of development to avoid and minimise impacts and the integration of embedded mitigation measures.

Intra-project visual effects

3.1.5 Landscape officers of host planning authorities have expressed concerns that many residents will experience adverse visual and perceptual effects of various elements of the solar farm as part of their daily routines. Effects on people's views have been assessed with reference to visual receptor groups and associated representative viewpoints, in line with GLVIA3. Some people may be attributable to more than one visual receptor group, e.g. residents of settlements in proximity to the Scheme who also use the public right of way and local road networks. In line with best practice, these effects are assessed separately and then those individual assessments are considered on a cumulative basis for intra-project impacts as summarised in section 10.8 of Chapter 10 of the ES and also considered in Appendix 10H.

3.1.6 With respect to viewpoints, paragraph 6.21 of GLVIA3 states that these "*need to cover as wide a range of situations as is possible, reasonable and necessary to cover the likely significant effects*." Paragraph 6.22 adds that "*in addition to fixed views, the viewpoints should also, as far as possible, cover important sequential views along key routes and transport corridors. Viewpoints should cover both near and more distant views, though not so distant as to be meaningless, unless it is useful to demonstrate the influence of distance. And they should cover the full range of different types of people who may be affected.*" The selection of representative viewpoints used in the LVIA has followed this approach and has considered the likelihood of intra-project cumulative effects and sequential views.

3.1.7 In the case of views, there are some visual receptors, for example users of public rights of way and roads, who would experience sequential views of the Scheme along a route. These effects have been assessed separately for each part of the Scheme with reference to representative viewpoints and then those individual

assessments are considered on a cumulative basis for intra-project impacts as summarised in section 10.8 of Chapter 10 of the ES and also considered in Appendix 10H.

3.1.8 In addition, the combined intra-project effects of the Scheme on people's views of the landscape have also been considered in Chapter 10 of the Environmental Statement **[APP-042]**. Such effects would arise where different parts of the Scheme would be visible in the same view.

Construction

Intra-project landscape effects of construction

3.1.9 The majority of intra-project landscape effects in construction, relating to LCAs defined in published landscape character assessments, would be not significant.

3.1.10 Significant effects resulting from construction have been identified for LCT Lowland Village Chalklands, defined in the East of England Landscape Framework, and LCT Rolling Estate Chalklands, defined in the Suffolk Landscape Character Assessment. The areas defined by these two LCTs are broadly contiguous, with the boundaries of the LCT Rolling Estate Chalklands, being more refined than the regional level LCT Lowland Village Chalklands. These extensive areas, which extend well beyond the Order limits, encompass the majority of the Scheme, including Sunnica East Site A, a large part of Sunnica East Site B, Sunnica West Site A, Sunnica West Site B and Cable Route B.

3.1.11 The assessment of effects on LLCAs defined by the Applicant is consistent with this assessment of wider scale landscape effects, demonstrating that within these broader LCTs effects of construction would be more localised. Significant effects are predicted for LLCA 11 East Fen Chalklands, LLCA 13 Estate Sandland Mosaic and LLCA 24 Lowland Estate Chalkland.

Intra-project and sequential visual effects of construction

3.1.12 As set out in paragraph 10.8.161 of Chapter 10 of the Environmental Statement [**APP-042**], "*the impact to these receptors would be a greater amount of construction activity within views and therefore an increase in the magnitude of impact in comparison to the assessments of the individual Order limits areas*". These effects have been assessed with reference to representative viewpoints.

3.1.13 The combined intra-project effects of construction on visual receptors are summarised in section 10.8 of Chapter 10 of the ES and also considered in Appendix 10H. Table 10-15 identifies 14 visual receptor groups who would experience views of more than one part of the Scheme simultaneously or sequentially. Of these, ten visual receptor groups are predicted to experience significant intra-project cumulative visual effects during construction. These effects are temporary and short-term.

3.1.14 Table 10-28 of Chapter 10 of the ES sets out all visual receptor groups who would experience residual visual effects of construction. This includes the receptors referred to above, who would experience intra-project effects and those who would experience static and sequential views of the construction of specific parts of the Scheme.

3.1.15 The following provides a summary of visual receptor groups with sequential views of one part of the Scheme and which are represented by more than one viewpoint.

3.1.16 People using public right of way (PRoW) W-398/030/0, which is a footpath adjacent to the River Lark, are represented by viewpoints 1 and 2A. They would experience significant visual effects ranging from moderate to major adverse at these locations, relating to the construction of Sunnica East Site A. There would not be significant effects further east and west along the River where views are more substantially screened or filtered by existing vegetation.

3.1.17 People using PRoW, W-257/002/0 are represented by viewpoints 9, 9A and 11. This byway leads north from Freckenham along Mortimer Lane, becoming a bridleway which links with Beck Road approximately 1km north of the village. At the southern end, visual effects associated with the construction of Sunnica East Site A are predicted to be negligible. Further north, where views are more open, effects are predicted to be significant during construction, ranging from moderate to major adverse, representing the worst-case.

3.1.18 Recreational users, including equestrian users on U6006, would experience sequential views of Sunnica East Site B and are represented by viewpoints 15, 15A, 15B and 16. These viewpoints illustrate how views change along the route, between sections enclosed by dense trees and scrub and more open areas. Effects during construction close to Worlington in the north are assessed as minor adverse (not significant). However, users on a larger part of the route south from here would experience major adverse (significant) effects where construction activities would be visible in proximity, intermittently through gaps in vegetation. This includes views of the laying out of the substantial ecology areas south of the village.

3.1.19 People travelling along La Hogue Road, represented by viewpoints 32 and 33, would experience major adverse effects during construction, which are considered significant. These intra-project effects arise from the proximity and extent of construction activity visible in gaps in the roadside hedgerows related to Sunnica West Site A and Cable Route B.

3.1.20 Bridleway PRoW 204/5 connects Snailwell with the A1304 north east of Newmarket. Users of this PRoW are represented by three viewpoints. The majority of the route is separated from the DCO Site by dense vegetation adjacent to the PRoW. Viewpoint 39 is located within the avenue of trees south of Chippenham Park to the south of the A14 trunk road and viewpoint 40 is slightly further north on the bridge across the A14. Effects of construction relating principally to Sunnica West Site A are predicted to be minor adverse due to the abundance of existing vegetation along the route; these effects are not significant. Viewpoint 41 is located on higher ground close to Snailwell, beyond where the existing shelter belt to the south ends. Views across the landscape to the north east are more open and effects are predicted to be moderate adverse during construction along this short section, which is considered significant.

3.1.21 Users of the Devil's Ditch PRoW 191/10, which is a footpath, are represented by viewpoints 58 and 59. Negligible adverse effects are predicted, relating to the

construction of the Burwell National Grid Substation Extension options and Cable Route B in the distance. These effects are not considered significant.

Operation

Intra-project landscape effects of operation

3.1.22 Localised impacts are predicted across the DCO Site, comprising Sunnica East Site A, Sunnica East Site B, Sunnica West Site A, Sunnica West Site B and Burwell National Grid Substation Extension during year 1 of operation. These impacts would lead to significant effects at the DCO Site level which, with the exception of Sunnica West Site A, would remain at year 15 of operation. Significant effects are also predicted within LLCA 11 East Fen Chalklands, LLCA 13 Estate Sandland Mosaic and LLCA 24 Lowland Estate Chalkland defined by the Applicant in year 1 of operation. These effects would remain significant in year 15 of operation, apart from LLCA 11 East Fen Chalklands, which would reduce to not significant.

3.1.23 These localised landscape effects would contribute to intra-project landscape effects at the scale of LCAs defined in published landscape character assessments. Significant effects would be limited to LT Rolling Estate Chalklands defined in the Suffolk Landscape Character Assessment in year 1 and year 15 of operation. Vegetation, particularly on field boundaries, watercourses and settlement edges in this predominantly flat landscape would limit the scale of effects and changes within the majority of LT Rolling Estate Chalklands would not be perceptible. Significant effects are also predicted within the Rural 2 North and Rural 3 East LCAs defined in the Freckenham Neighbourhood Plan. Effects on all other published LCAs are not considered significant during year 1 and year 15 of operation.

Intra-project visual effects of operation

3.1.24 The combined intra-project effects of year 1 of operation on visual receptors are summarised in section 10.8 of chapter 10 of the ES. In many cases, views from roads and public rights of way of the Scheme would be oblique to the direction of travel and screened or filtered by existing vegetation. There are limited locations, for example between Freckenham and Isleham, where the landscape is more open and there may be more open views of structures while planting establishes. Table 10-21 shows that significant effects relating to receptor groups who would experience views of more than one part of the Scheme simultaneously or sequentially would be limited to motorists on Chippenham Road, represented by viewpoint 42. Effects on this receptor group would reduce to not significant by year 15 of operation.

3.1.25 Visual receptor groups with sequential views of only one part of the Scheme and who are represented by more than one viewpoint who would experience significant effects during operation are set out below.

3.1.26 Significant effects would remain for people using public right of way (PRoW) W-398/030/0, which is a footpath adjacent to the River Lark. However, these would be limited to the part of the route west of Lee Brook, represented by viewpoint 1. By year 15 of operation, effects on this receptor group would further reduce to not

significant due to the establishment of new planting and existing vegetation in leaf.

3.1.27 People using PRoW, W-257/002/0, represented by viewpoints 9, 9A and 11, would continue to experience significant adverse effects in year 1 of operation due to their proximity to Sunnica East Site A north of Freckenham, where some views towards the Scheme would remain. By year 15 of operation, these effects are predicted to reduce to not significant due principally to the establishment of planting proposed along the southern edge of E05.

3.1.28 Significant effects would also remain in year 1 of operation for recreational users including horse riders on U6006 with sequential views of Sunnica East Site B, represented by viewpoints 15, 15A, 15B and 16. By year 15 of operation these effects are predicted to reduce to not significant as existing vegetation would be in leaf and planting carried out as part of the Scheme would have established. The effectiveness of this mitigation is illustrated in Figure 10 of the Outline Landscape and Ecology Management Plan **[APP-108]** and the photomontage from viewpoint 15A in Figure 10.95 **[APP-225]**.

3.1.29 Effects on sequential views related to users of Bridleway PRoW 204/5 between Snailwell and the A1304 and users of the Devil's Ditch PRoW 191/10 would not be significant in operation. This is due the distance, limited extent of views and short section of the routes affected.

3.1.30 Intra-project visual effects relating to people travelling along La Hogue Road (VP32 and VP33) would be moderate adverse in year 1 of operation, which is considered significant. These effects would relate to the extent of solar panel arrays to the south of the road within parcels W10, W11 and W12. By year 15 of operation the proposed hedgerow planting would have established to screen the built elements of the Scheme, reducing effects to not significant.

Decommissioning

Intra-project landscape effects of decommissioning

3.1.31 The activities and therefore the impacts relating to decommissioning are similar to construction. Significant intra-project effects are predicted for LT Rolling Estate Chalklands. The localised nature of effects is reflected in the significant effects predicted at the DCO Site level, the Rural 2 North and Rural 3 East LCAs defined in the Freckenham Neighbourhood Plan and LLCA 11, 13 and 24 defined by the Applicant. These effects would be short term and temporary and limited in scale by the density of existing and proposed vegetation in the relatively flat landscape.

Intra-project visual effects of decommissioning

3.1.32 The majority of visual effects relating to decommissioning would be not significant, due to the maturity of proposed planting and management of existing vegetation to screen views. Significant intra-project effects would relate to people travelling along La Hogue Road, represented by viewpoints 32 and 33. From this route there would be views of activities to remove Sunnica West Site A and Cable Route B.

4 Mitigation

4.1.1 As set out in paragraph 10.7.1 of Chapter 10 of the Environmental Statement "*the LVIA has informed the iterative design process, via design principles which respond to the policy requirements, published landscape character assessments and field work analysis, in order to mitigate the likely adverse effects of the Scheme*." The landscape mitigation, which has been developed by applying the mitigation hierarchy, is embedded in the design. The first principle has therefore been to avoid effects (i.e. to reduce visual effects to zero) by, for example, changing the layout to move built elements away from sensitive visual receptors. The second stage is to minimise impacts identified above by, for example, introducing planting or offsets into the design.

4.1.2 The approach to the design of the Scheme has considered the potential impacts and opportunities first at the broad scale, to retain and reinforce the existing landscape pattern, its legibility and characteristics within a framework of green infrastructure. This multi-functional framework has been designed to provide a range of benefits, including to biodiversity and amenity. The character of this green infrastructure framework will respond to the character of the landscape, as set out in the vision and principles within the Outline Landscape and Ecology Management Plan **[APP-108]**. This includes specific design solutions for each Site, to reflect how the conditions and required functions are different across the Scheme.

4.1.3 Whilst it is inherent in the outline nature of the design that some detailed design matters are reserved, attention has been given to how specific elements relate to the existing landscape and address the effects of the Scheme. The Design and Access Statement (DAS) **[APP-264]** sets out design principles and parameters, which when read alongside the Environmental Masterplans in Figures 10-14a to 10-14f **[APP-209 to APP-214]** provide information on how specific mitigation will address specific effects.

4.1.4 With respect to visual mitigation, the introduction of new planting to screen built elements has been balanced, as far as practicable, against screening longer distance views which can, for example, contribute to people's sense of place and place attachment.

5 Summary

5.1.1 The landscape within the study area for the LVIA is the product of centuries of human influence. It is predominantly an intensive agricultural landscape, interspersed with small settlements and other land uses. The horse breeding and racing industry has exerted an influence on the character of the landscape, particularly in the south, where stables, gallops and studs associated with Newmarket are located.

5.1.2 The LVIA summarised in Chapter 10 of the Environmental Statement **[APP-042]** has assessed the potential impacts on the landscape at scales ranging from national to local, using evidence from published landscape character assessments and LLCA defined by the Applicant. It also includes a separate assessment of the impacts of each Site within the Scheme and an assessment of intra-project effects where relevant. This enables distinctions to be drawn

regarding the geographical scale of likely significant effects in line with best practice. The assessment identifies that significant intra-project residual effects of operation on the landscape would be focussed within the LT Rolling Estate Chalklands defined in the Suffolk Landscape Character Assessment.

5.1.3 The LVIA has concluded that there would be few locations where more than one part of the Scheme would be visible. However, there are some roads and public rights of way which either pass through or adjacent to the Sites where there would be sequential views of the Scheme. Representative viewpoints have been used within the assessment to illustrate the nature of views for different visual receptors and how the effects of the Scheme would differ along such routes. The management of existing vegetation and the establishment of proposed planting is predicted to reduce most visual effects to not significant by year 15 of operation. The only visual receptors predicted to experience significant residual effects in year 15 of operation are people visiting the Limekilns Gallops, including members of the Jockey Club and members of the public who informally view the horses between breaks in the roadside vegetation. These receptors are represented by Viewpoint 38.

5.1.4 In summary, it is acknowledged that there will be adverse residual landscape effects at the scale of the Rolling Estate Chalklands LT defined in the Suffolk Landscape Character Assessment. A finer grained assessment has determined that there would be variation in the extent of significant effects at the local level, focused within the Sites and some LLCAs defined by the Applicant. These effects would not be of such an extent that the Scheme would radically change the sense of place, the place attachment of the residents, and the recreational amenities of the affected villages and communities. The LVIA has not concluded that the Scheme would dominate and transform the local landscape to the extent that it would be altered beyond recognition. The mitigation proposed to address adverse effects of the Scheme is the product of an iterative process, informed by the LVIA over several years. Further planting would not further reduce the significance of the effects reported.

Appendix L Further clarification on LVIA methodology

1 Introduction

1.1.1 This technical note responds to concerns raised by host local planning authorities (LPA) in their Relevant Representations and in discussions on the proposed Statement of Common Ground (SoCG) between the Applicant and the LPAs regarding the methodology for the Landscape and Visual Impact Assessment (LVIA) in the Environmental Statement.

1.1.2 The note deals specifically with:

- How criteria for value, susceptibility and sensitivity were defined with reference to previous correspondence with LPAs.
- Addressing concerns raised by the LPAs that the methodology is geared towards making the effects look less severe, that the susceptibility criteria are not appropriate and that sensitivity and value criteria are formulaic.
- Further explanation on the scenarios assessed and why a year 5 assessment has not been carried out.

2 LVIA methodology

2.1.1 The methodology for the LVIA, which is set out in Appendix 10C [**APP-102**], has been developed with reference to industry standard published guidance. The general approach is in accordance with the Guidelines for Landscape and Visual Impact Assessment, 3rd Edition (GLVIA3), which superseded the 2nd Edition referred to in the Overarching National Policy Statement for Energy (EN-1).

2.1.2 GLVIA3 sets out a process for determining the landscape and visual baseline, the sensitivity of this baseline, the magnitude of impacts and the significance of resulting effects. The criteria for determining these aspects are not defined in GLVIA3. The guidance makes clear that they should be informed by an understanding of the baseline and the specific proposal and recorded on a verbal scale.

2.1.3 This approach has been applied to the definition of criteria in the LVIA. Paragraph 2.25 of GLVIA3 states that "*even with qualified and experienced professionals there can be differences in the judgements made. This may result from using different approaches or different criteria, or from variation in judgements based on the same approach and criteria. Ideally, and especially for complex projects, more than one person should be involved in the assessment to provide checks and balances, especially in identifying the likely significant effects.*" The LVIA for the Scheme was carried out by a team of landscape architects with extensive experience in assessing the effects of major projects and involved dialogue with host authorities on matters including the methodology and the criteria defined within it at various stages in preparation of the Application.

2.1.4 The methodology presented in the Scoping Report [**APP-051**] was updated following receipt of comments in the Scoping Opinion [**APP-052**] and presented in the Preliminary Environmental Information Report (PEIR). It was then further reviewed and updated in response to comments made by LPAs through consultation. In line with GLVIA3, professional judgement has been used in applying these criteria and this is explained in the narrative for each receptor. Further detail on this evolution of the methodology is provided below.

Study area

2.1.5 Paragraph 5.2 of GLVIA3 explains that "*the study area should include the site itself and the full extent of the wider landscape around it which the proposed development may influence in a significant manner*." Further advice is given regarding existing information, which can help inform the extent of the study area. It goes on to state that "*this will usually be based on the extent of Landscape Character Areas likely to be significantly affected either directly or indirectly. However, it may also be based on the extent of the area from which the development is potentially visible, defined as the Zone of Theoretical Visibility, or a combination of the two*."

2.1.6 The study area for the assessment of landscape and visual effects reported in Chapter 10 of the Environmental Statement [**APP-042**] has followed this approach and is considered suitable. It is based on a thorough analysis of the baseline and the Scheme, including:

- Published landscape character assessments [**APP-103**];
- Local Landscape Character Areas (LLCA) defined by the Applicant [**APP-104**]; and
- Zones of Theoretical Visibility (ZTV) [**APP-201** to **APP-206**].

2.1.7 Additional ZTVs have been prepared to illustrate the theoretical extent of visibility of horse riders [**REP1-018** to **REP1-022**]. These apply an eye height of 2.7m above ground level, which is defined in the government's Standards for Highways *CD 143 - Designing for walking, cycling and horse-riding*. In preparing these ZTVs it was noted that the models upon which the ZTVs presented in **APP-201** to **APP-206** were based on a previous iteration of the Scheme boundary, which included Parcels W13, W14 and W16. These ZTVs therefore suggested a greater extent of theoretical visibility than would be the case. They have been reproduced using the application Order limits, consistent with the ZTVs prepared for horse riders, allowing a direct comparison [**REP1-008** to **REP1-013**].

2.1.8 The ZTV has been refined as the design of the Scheme has developed in response to the assessment, from an initial area of search through to the final study area shown in the Application. The ZTVs presented in Figures 10-11e [**REP1-012**] and 10-11f [**REP1-013**] provide a useful visual aid to demonstrate how existing features in the landscape, such as woodland and buildings, limit the extent of effects in the predominantly flat or gently undulating landscape. Figure 10-11f [**REP1-013**] presents a ZTV of the Scheme with these barriers incorporated. It shows that, theoretical visibility is largely limited to the Sites (E.g. Sunnica East Site A) and their immediate landscape setting, including for horse riders. This indicated that there are few places where both Sunnica East and Sunnica West would theoretically be visible.

2.1.9 The study area and selection of landscape and visual receptors has been further refined through fieldwork to verify the extent of likely effects on the character of the landscape and views. This fieldwork demonstrated that hedgerows and narrow belts of vegetation, which are not modelled in the ZTVs, are effective in reducing the extent of views further, particularly around existing settlements, where the field pattern tends to be smaller. Existing hedgerows within and on the boundaries of the DCO Site are illustrated on the Environmental Masterplan to be

submitted at Deadline 3. An example of this is views north from the western edge of Freckenham, represented by viewpoint 13. The ZTV with barriers presented in Figure 10-11f **[REP1-013]** indicates theoretical visibility along Freckenham Road (B1102), but the magnitude of impact is assessed as neutral in year 1 of operation from this location, as illustrated by Figure 10-31a to 10-43b **[APP-216]**. This evolution of the study area is explained further in section 10.4 of Chapter 10: Landscape and Visual Amenity of the Environmental Statement [**APP-042**].

Visual receptors and viewpoint selection

2.1.10 The visual assessment is concerned with assessing the likely significant effects of the Scheme on people's views of the landscape. These people are referred to as the visual receptors of the Scheme.

2.1.11 As explained in paragraph 6.16 of GLVIA3, viewpoints are locations where there is potential for the proposal to actually be seen by different visual receptor groups.

2.1.12 Paragraph 6.18 of GLVIA3 states that "*the viewpoints to be used in an assessment of visual effects should be selected initially through discussions with the competent authority and other interested parties at the scoping stage. But selection should also be informed by the ZTV analysis, by fieldwork, and by desk research on access and recreation, including footpaths, bridleways and public access land, tourism including popular vantage points, and distribution of population*."

2.1.13 The selection of viewpoints has been refined in response to desk study, fieldwork and consultation with landscape officers of host authorities and is considered suitable for informing judgements on likely significant effects. Representative viewpoints are included within the LVIA to inform the assessment of effects on visual receptor groups. These representative viewpoints, which are presented on Figure 10-12 [**APP-207**], are distributed across the study area. These figures omitted to include some viewpoints identified in Appendix 10F [**APP-105**] and 10H [**APP-107**], which were assessed in the LVIA. They have been updated to include these viewpoints and were submitted at Deadline 1 [**REP1-014**]. Baseline photographs from each viewpoint are included in Figures 10-20a [**APP-215**] to 10-84b [**APP-219**]. In some cases, more than one viewpoint relates to the same visual receptor group, for example to illustrate how the extent of sequential views and likely effects change along a public right of way. Photomontages area provided for a selection of key viewpoints in Figures 10-90 [**APP-220**] to 10-102 [**APP-232**]. A detailed description of baseline views related to each representative viewpoint and visual receptor is set out in Appendix 10F [**APP-105**] with associated visual effects reported in Appendix 10H [**APP-107**].

Sensitivity criteria

2.1.14 As set out in GLVIA3, the sensitivity of landscape and visual receptors is the relationship between the value attached to the landscape or view and its susceptibility to change arising from the specific proposal. The criteria set out in Appendix 10C of the Environmental Statement [**APP-102**] for determining the sensitivity of landscape and visual receptors are well considered and impartial and have not been defined to make the effects of the Scheme look less severe. In applying these criteria, the Applicant has had in mind the reasonable worst-case

and applied reasoned professional judgement, evidenced in the narrative, based on experience of the assessment of similar schemes.

Sensitivity of landscape receptors

2.1.15 The study area does not include any designated landscapes. Paragraph 5.26 of GLVI3 states that "*the fact that an area of landscape is not designated either nationally or locally does not mean that it does not have any value*." Paragraph 5.28 goes on to state that "*in cases where there is no existing evidence to indicate landscape value, and where scoping discussions suggest that it is appropriate, value should be determined as part of the baseline study through new survey and analysis. This requires definition of the criteria and factors that are considered to confer value on a landscape or on its components.*"

2.1.16 Landscape value criteria established by the Applicant were initially set out in Table 10-1 of the Scoping Report [**APP-051**] based on the geographical scale at which the value of the landscape is recognised. This verbal scale was informed by the guidance presented in paragraph 3.27 of GLVIA3, which states that "*the words used will usually be specific for each criterion – for example the value of landscape receptors could be categorised as international, national, regional, local authority or local community*."

2.1.17 Landscape value criteria were further developed between publication of the PEIR in March 2019 and completion of the LVIA presented in Chapter 10 of the Application [**APP-042**]. This was in response to the publication of Technical Guidance Note (TGN) 02/21 by the Landscape Institute on Assessing landscape value outside national designations. TGN 02/21 provides a new framework, which in combination with Box 5.1 of GLVIA3, assisted in defining a new set of criteria which are refined to the qualities of the landscape within the study area. Comments were made by host LPAs at a meeting with the Applicant held on 25 February 2021, relating to the value attached to specific parts of the landscape within the study area. The geographical scale at which the value of the landscape is recognised was absorbed within these new criteria, for example with reference to conservation areas in LLCA 10: Isleham. These criteria are purposefully not formulaic and are rooted in an understanding of the landscape and are sufficiently broad to account for how it varies across of the study area.

2.1.18 The value of each landscape receptor has been defined with reference to the criteria in Tables 2-1 and 2-2 of Chapter 10. Reasoned justifications are provided in Appendix 10D – Published Landscape Character Extracts [**APP-103**] and Appendix 10E – Local Landscape Character Areas [**APP-104**].

2.1.19 The criteria which guided judgements on the susceptibility of landscape receptors to change were also changed between publication of the PEIR and submission of the Application. This was in response to further evaluation of the baseline and design parameters of the Scheme. Landscape officers of host LPAs provided detailed feedback on the criteria proposed in the PEIR at the meeting held on 25 February 2021. Concern was raised that these criteria needed to be more representative of the Scheme and the features and characteristics of the receiving landscape. There was also discussion regarding the verbal scale against which landscape susceptibility is recorded. In the PEIR, this was based on a three-point scale ranging from high to low. It was agreed that a very low category was

required, and a four-point scale was settled upon, with further differentiation to be provided between medium and low categories.

2.1.20 The criteria for landscape susceptibility were subsequently reviewed by the Applicant and revised taking account of this feedback. The criteria presented in Table 2-3 of Appendix 10C of the Environmental Statement [**APP-102**] make reference to features and characteristics of the landscape in the study area which are susceptible to the changes which would be brought about by the Scheme, such as patterns of landform and vegetation. They are sufficiently broad to account for variation across the study area. An example is the application of the criteria to LLCA 13: Estate Sandlands Mosiac, which makes reference to the very gently undulating topography, enclosure, a geometric pattern and characteristic pine lines as being particularly susceptible to the changes proposed. Care was taken to avoid conflating these criteria with magnitude of impact, which specifically address the scale, extent, duration and reversibility of such changes.

2.1.21 The criteria which have guided conclusions on landscape sensitivity, by combining judgements on landscape value and susceptibility, have also been refined by the Applicant between publication of the PEIR and the Environmental Statement. These changes, which addressed the changes to value and susceptibility criteria, were made to provide consistency with the changes made to landscape value and susceptibility criteria and to draw clearer distinctions between categories.

2.1.22 The assessment of landscape effects has been carried out at various scales. This has assisted in drawing distinctions between effects on the wider landscape and more localised effects. This approach helps to understand how the sensitivity of the landscape varies across the study area. For example, whilst a landscape character area or type defined at the regional or county level may have a high sensitivity to the Scheme, there may be smaller parts where value, susceptibility and sensitivity are lower. An example of this is Local Landscape Character Area (LLCA) 13: Estate Sandlands Mosaic, which lies within the Estate Sandlands landscape type defined in the Suffolk Landscape Character Assessment, which is assessed as high sensitivity. LLCA 13 is assessed as medium sensitivity because it is broadly representative of the wider area, but includes some elements including active quarries and a solar farm, which reduce its susceptibility to the Scheme.

Sensitivity of visual receptors

2.1.23 There was a similar evolution of criteria to guide the assessment the sensitivity of visual receptors between those presented in the Scoping Report, PEIR and the Environmental Statement. These changes were made following consultation with landscape officers of host LPAs. They were also informed by the extensive fieldwork and desk study carried out by the Applicant.

2.1.24 Criteria referred to in assessing the value attached to views were refined to reference specific aspects of the planning policy framework and landscape of the study area, for example by making reference to the character of views described in the East of England Landscape Framework. An example of this is the distinctive pine lines referred to in determining the value attached to views represented by viewpoint 10, which are referred to in the description of the LCT Lowland Village Chalklands. These criteria were recast on a verbal scale from

high to very low. Geographical scale, which was the basis of the scale presented in the PEIR, was absorbed within the definition of these criteria.

2.1.25 Further detail was also added to the criteria for guiding the assessment of the susceptibility of visual receptors to changes in their views as a result of the Scheme between publication of the PEIR and the Environmental Statement. This included, for example, recognising that people using promoted routes through the landscape are likely to be more susceptible, because views across the landscape may attract people to use such routes and contribute more to their experience of using the route.

2.1.26 The criteria referred to in determining the sensitivity of visual receptors were also refined to reflect the changes made to the criteria for the value attached to views and the susceptibility of visual receptors to change.

Assessment scenarios

2.1.27 The LVIA has assessed the likely significant effects of the Scheme during construction (winter), year 1 of operation (winter), year 15 of operation (summer) and decommissioning. These scenarios are common in LVIA.

2.1.28 Assessing the effects of construction, year 1 of operation and decommissioning in winter presents a worst-case scenario, when deciduous vegetation is likely to be less effective in screening or filtering views. It also takes into account the temporary nature of construction effects and the duration of operational effects.

2.1.29 The purpose of assessing the effects of the Scheme in the summer of year 15 of operation is to assess the effectiveness of proposed planting in mitigating adverse effects. As set out in the Outline Landscape and Ecology Management Plan (OLEMP) [**APP-108**], the majority of planting is proposed to be carried out with forestry transplants, which would measure approximately 40-80cm in height at the point of planting. It takes time for plants to establish in their final location and the rate of this establishment can vary depending on factors, such as the weather and infestations of non-native species. The OLEMP includes measures to mitigate such risks, for example through irrigation of trees and monitoring and controlling weeds. Chapter 10 of the Environmental Statement [**APP-042**] includes conservative assumptions based on these measures regarding the height at which plants are likely to grow per year. These assumptions are an average and it is likely that growth rate will vary from year to year, accelerating in later years as the root system and canopy of plants expands. By year 15 of operation, it is expected that proposed planting would have fully established and the canopy of woodland and hedgerows would have closed.

2.1.30 As set out in Table 10-2 of Chapter 10 of the Environmental Statement [**APP-042**], an interim assessment of landscape and visual effects has not been undertaken. It is considered that the assessment of effects at year 1 of operation provides a more conservative assessment of the worst-case and the assessment of effects at year 15 is a more reliable measure of the adequacy of proposed mitigation. This is set in the context of the proposed 40-year life of the Scheme, such that there would be a further 25 years of establishment of proposed planting before decommissioning commenced.

2.1.31 It is possible to provide some estimates on how tall proposed planting could be by year 5 of operation, based on the assumptions set out in paragraph 10.3.11 of Chapter 10 of the Environmental Statement [**APP-042**]. Assuming that the growth rate of 20cm per year stated in 10.3.11 (d) was applied to hedgerows and woodland planted with forestry transplants of 40 to 80cm, by year 5 of operation, these may on average have grown to approximately 1.4m to 1.8m. At this height, proposed vegetation would begin to provide an effective visual screen, based on average eye height of 1.5 to 1.7m above ground level (GLVIA3, paragraph 6.11). This does not take consideration of the proximity of the receptor or the elevation of the viewing place relative to the Scheme, which may affect the extent of views.

2.1.32 To illustrate these assumptions, year 5 photomontages have been prepared for viewpoints the following viewpoints and issued to the LPAs, and appended to this technical note:

Viewpoint 5: View south-east from Beck Road (Sunnica East Site A)

Viewpoint 15A: View south from U6006 (Sunnica East Site B)

Viewpoint 32: View south-west from La Hogue Road (Sunnica West Site A)

Viewpoint 46: View north from Fordham Road (Sunnica West Site B).

2.1.33 These show that even by year 5 of operation, the new planting will begin to screen and filter views of the Scheme

Appendix M Proposed Year 5 Visualisations

60° 55° 50° 45° 40° 35° 30° 25° 20° 15° 10° 5° 0°

AECOM Imagine it. Delivered.

Visualisation Type:	4
Projection:	Cylindrical
Enlargement Factor:	96%
Paper Size:	A1
Correct printed image size:	547 x 146mm

Date / Time:	17/07/2020 07:46
Camera:	Canon EOS 5D Mark III
Lens:	Canon EF50mm f/1.8 STM
Horizontal Field of View:	120°
Direction of View:	south-east

Location:	E565275 N273847
Eye level:	10.1m AOD
Height of Camera:	1.6m
Distance to Site:	185m

Note:
Images to be viewed at a comfortable arm's length.

Sunnica Energy Farm

10.90F

Viewpoint 5: View south-east from Beck Road – Type 4 Visualisation Year 5

5° 10° 15° 20° 25° 30° 35° 40° 45° 50° 55° 60°

60° 55° 50° 45° 40° 35° 30° 25° 20° 15° 10° 5° 0°

AECOM Imagine it. Delivered.

Visualisation Type:	4
Projection:	Cylindrical
Enlargement Factor:	96%
Paper Size:	A1
Correct printed image size:	547 x 146mm

Date / Time:	17/07/2020 08:31
Camera:	Canon EOS 5D Mark III
Lens:	Canon EF50mm f/1.8 STM
Horizontal Field of View:	120°
Direction of View:	south-west

Location:	E569018 N272602
Eye level:	12.6m AOD
Height of Camera:	1.6m
Distance to Site:	36m

Note:
Images to be viewed at a comfortable arm's length.

Sunnica Energy Farm

10.95F

Viewpoint 15A: View south from U6006 – Type 4 Visualisation Year 5

5° 10° 15° 20° 25° 30° 35° 40° 45° 50° 55° 60°

45° 40° 35° 30° 25° 20° 15° 10° 5° 0° 5° 10° 15° 20° 25° 30° 35° 40° 45°

AECOM Imagine it. Delivered.

Visualisation Type:	4
Projection:	Cylindrical
Enlargement Factor:	96%
Paper Size:	A1
Correct printed image size:	820 x 146mm

Date / Time:	04/04/2020 10:22
Camera:	Canon EOS 5D Mark III
Lens:	Canon EF50mm f/1.8 STM
Horizontal Field of View:	90°
Direction of View:	south

Location:	E567156 N268575
Eye level:	21.9m AOD
Height of Camera:	1.6m
Distance to Site:	417m

Note:
Images to be viewed at a comfortable arm's length.

Sunnica Energy Farm

10.98F

Viewpoint 32: View south-west from La Hogue Road – Type 4 Visualisation Year 5

45° 40° 35° 30° 25° 20° 15° 10° 5° 0° 5° 10° 15° 20° 25° 30° 35° 40° 45°

AECOM Imagine it. Delivered.

Visualisation Type:	3
Projection:	Cylindrical
Enlargement Factor:	96%
Paper Size:	A1
Correct printed image size:	820 x 146mm

Date / Time:	16/03/2020 10:36
Camera:	Canon EOS 5D Mark III
Lens:	Canon EF50mm f/1.8 STM
Horizontal Field of View:	90°
Direction of View:	north

Location:	E563947 N268178
Eye level:	15.388m AOD
Height of Camera:	1.6m
Distance to Site:	193m

Note:
Images to be viewed at a comfortable arm's length.

Sunnica Energy Farm

10.102F

Viewpoint 46 - Type 3 Visualisation Year 5