



Glint and Glare Assessment

Fendyke Solar Farm

18/10/2024



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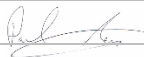
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1. EXECUTIVE SUMMARY

- 1.1 This assessment considers the potential impacts on ground-based receptors such as roads, rail and residential dwellings as well as aviation assets. A 1km survey area around the Application Site is considered adequate for the assessment of ground-based receptors, whilst a 30km study area is chosen for aviation receptors. Within 1km of the Application Site, there are 44 residential receptors, including one residential area, and 88 road receptors which were considered. As per the methodology section, where there are a number of residential receptors within close proximity, a representative dwelling or dwellings is/are chosen for the glint and glare analysis as the impacts will not vary to any significant degree. Where small groups of receptors have been evident, the receptors on either end of the group have been included in the glint and glare analysis with some context to all receptors given in the visual analysis. Two residential receptors and nine road receptors were dismissed as they are located within the no reflection zones and therefore, will not be impacted upon by the Proposed Development. There are 21 aerodromes within 30km of the Proposed Development, one of which, Fenland Airfield, required a detailed assessment due to its size and orientation in relation to the Proposed Development.
- 1.2 The solar panels will utilise a tracker system to track the position of the sun throughout the day. The maximum above ground level height of the panels is 2.9m and points at the top of the panels are used to determine the potential for glint and glare generation.
- 1.3 Geometric analysis was conducted for 44 individual residential receptors, including one residential area, and 79 road receptors as well as four runway approach paths and one air traffic control tower (ATCT).
- 1.4 Following an initial assessment, rail receptors were scoped out as assets that will be impacted upon from the Proposed Development as no rail receptors fell within the 1km study area. The assessment concludes that:
- Solar reflections are possible at one of the 42 residential receptors assessed within the 1km study area. Initial impacts were **Low** at one receptor and **None** at the remaining 41 receptors, including one residential area. Upon reviewing the actual visibility of the receptors, glint and glare impacts reduce to **None** at all receptors.
 - Solar reflections are possible at 22 of the 79 road receptors assessed within the 1km study area. Initial impacts were **High** at two receptors, **Low** at 20 receptors and **None** at the remaining 57 receptors, including one residential area. Upon reviewing the actual visibility of the receptors, glint and glare impacts remain **High** at one receptor, **Low** at one receptor and reduce to **None** at all remaining receptors. Once mitigation measures were considered, impacts reduce to **None** at all receptors.

- **No impact** on train drivers or railway infrastructure is predicted.
 - No glare was predicted to impact the Runway 26 approach path at Fenland Airfield. Only green glare was predicted to impact the Runway 08, 18 and 36 approach paths and ATCT at Fenland Airfield. Green glare is an **acceptable impact** when pilots are approaching runways/helipads and a **not acceptable impact** upon ATCTs, according to FAA guidance. Upon reviewing the actual visibility of the ATCT at Fenland Airfield, the impact upon the ATCT reduces to **None**. Therefore, the impacts upon aviation assets are **Low** and **Not Significant**.
- 1.5 Mitigation is required in order to screen the **High** impact views into the Proposed Development from Road Receptor 25. Mitigation is also included to screen the **Low** impact views from Road Receptor 54. This includes native hedgerows to be planted/infilled along the southwest boundary of Array 1 in the Proposed Development and maintained to a height of at least 3m as shown on the Glint and Glare (G&G) Mitigation Planting Plan.
- 1.6 The effects of glint and glare and their impact on local receptors has been analysed in detail and there is predicted to be only **Low** and **None** impacts, and therefore **No Significant Effects**.

2. INTRODUCTION

BACKGROUND

- 2.1 Neo Environmental Ltd has been appointed by Integrum SPV 21004 Ltd (the “Applicant”) to undertake a Glint and Glare Assessment for a proposed solar farm (the “Proposed Development”) on land at Fendyke Farm off old Fendyke, Sutton St James, South Holland (the “Application Site”).

DEVELOPMENT DESCRIPTION

- 2.2 The proposed solar farm will consist of the construction, operation and decommissioning of a solar farm and battery energy storage system (BESS), vehicular access, internal access tracks, landscaping, boundary treatment, cabling and associated infrastructure

SITE DESCRIPTION

- 2.3 The Site extends to 44.2 hectares (ha) and comprises primarily agricultural land. The Site is almost entirely bordered by watercourses and subdivided into four separate fields by virtue of the existing drainage system. Four of these adjoining drains are unnamed and South Holland Main Drain is located 250m north of the Site. The intersection of Bardling’s Drive runs east-west within the Site.
- 2.4 The Site is surrounded by multiple farms, including Wright R J Ltd 430m south west, Thistlewood Farm 180m east, Poplar Farm Flowers Ltd 290m east and Barling Deer Farm immediately west of Field 4. The settlement of Holbeach St Johns is 2.17km north west of the Site, Sutton St Edmund is 3km south west and the centre of Sutton St James is located 1.5km east.
- 2.5 The settlement of Holbeach St Johns is 2.17km north west of the Site, Sutton St Edmund is 3km south west and the centre of Sutton St James is located 1.5km east.

SCOPE OF REPORT

- 2.6 Although there may be small amounts of glint and glare from the metal structures associated with the solar farm, the main source of glint and glare will be from the panels themselves and this will be the focus of this assessment.

- 2.7 Solar panels are designed to absorb as much light as possible and not to reflect it. However, glint can be produced as a reflection of the sun from the surface of the solar PV panel. This can also be described as a momentary flash. This may be an issue due to visual impact and viewer distraction on ground-based receptors and on aviation.
- 2.8 Glare is significantly less intense in comparison to glint and can be described as a continuous source of bright light, relative to diffused lighting. This is not a direct reflection of the sun, but a reflection of the sky around the sun.
- 2.9 This report will concentrate on the effects of glint and glare and its impact on local receptors and will be supported with the following Figures and Appendices.
- Appendix A: Figures
 - Figure 1: Residential Based Receptors
 - Figure 2: Road Based Receptors
 - Figure 3: Site Layout
 - Figure 4: Panel Area Labels
 - Figure 5: G&G Mitigation Planting Plan
 - Figure 6: Fenland Airfield Aerodrome Chart
 - Appendix B: Residential Receptor Glare Results
 - Appendix C: Road Receptor Glare Results
 - Appendix D: Aviation Receptor Glare Results
 - Appendix E: Visibility Assessment Evidence
 - Appendix F: Solar Module Glare and Reflectance Technical Memo¹

STATEMENT OF AUTHORITY

- 2.10 This Glint and Glare Assessment has been produced by David Thomson, Tom Saddington and Michael McGhee of Neo Environmental.
- 2.11 Having completed a civil engineering degree in 2012, Michael has produced Glint and Glare assessments for over 1GW of solar farm developments across the UK and Ireland.

¹ Sunpower Corporation (September 2009), T09014 Solar Module Glare and Reflectance Technical Memo

- 2.12 Tom has an undergraduate degree in Bioengineering and graduated with an MSc in Environmental and Energy Engineering in January 2020. He has been working on various technical assessments including glint and glare reports for numerous solar farms in Ireland and the UK.
- 2.13 David has an undergraduate degree in physics, as well as a MSc in sensor design, a MSc in nanoscience and nanotechnology and a Diploma in acoustics and noise control. He is an Environmental Engineer who has worked on numerous glint and glare assessments for solar farms across the UK and Ireland.

DEFINITIONS

- 2.14 This study examined the potential hazard and nuisance effects of glint and glare in relation to ground-based receptors, this includes the occupants of surrounding dwellings as well as road users. The Federal Aviation Guidance (FAA) in their “Technical Guidance for Evaluating Selected Solar Technologies on Airports”² have defined the terms ‘Glint’ and ‘Glare’ as meaning;
- Glint – “A momentary flash of bright light”
 - Glare – “A continuous source of bright light”
- 2.15 Glint and glare are essentially the unwanted reflection of sunlight from reflective surfaces. This study used a multi-step process of elimination to determine which receptors have the potential to experience the effects of glint and glare. It then examined, using a computer-generated geometric model, the times of the year and the times of the day such effects could occur. This is based on the relative angles between the sun, the panels and the receptor throughout the year.

GENERAL NATURE OF REFLECTANCE FROM PHOTOVOLTAIC PANELS

- 2.16 In terms of reflectance, photovoltaic solar panels are not highly reflective surfaces. They are designed to absorb sunlight and not to reflect it. Nonetheless, photovoltaic panels have a flat polished surface, which omits ‘specular’ reflectance rather than a ‘diffuse’ reflectance, which would occur from a rough surface. Several studies have shown that photovoltaic panels (as opposed to Concentrated Solar Power) have similar reflectance characteristics to water, which is much lower than glass, steel, snow and white concrete by comparison (see **Appendix F** for details). Similar levels of reflectance can be found in rural environments from shed roofs and

² Harris, Miller, Miller & Hanson Inc. (November 2010). Technical Guidance for Evaluating Selected Solar Technologies on Airports; 3.1.2 Reflectivity. Technical Guidance for Evaluating Selected Solar Technologies on Airports. Available at: <https://documents.pub/document/technical-guidance-for-evaluating-selected-solar-technologies-on.html?page=1>

the lines of plastic mulch used in cropping. In terms of the potential for reflectance from photovoltaic panels to cause hazard and/ or nuisance effects, there have been several studies undertaken in respect of schemes in close proximity to airports. The most recent of these was compiled by the Solar Trade Association (STA) in April 2016 which used a number of case studies and expert opinions, including from Neo Environmental. The summary of this report states that *“the STA does not believe that there is cause for concern in relation to the impact of glint and glare from solar PV on aviation and airports...”*³.

TIME ZONES / DATUM'S

- 2.17 Locations in this report are given in Eastings and Northings using the 'British National Grid' grid reference system unless otherwise stated.
- 2.18 England uses British Summer Time (BST, UTC + 01:00) in the summer months and Greenwich Mean Time (UTC+0) in the winter period. For the purposes of this report all time references are in GMT.

³Solar Trade Association. (April 2016). *Summary of evidence compiled by the Solar Trade Association to help inform the debate around permitted development for non - domestic solar PV in Scotland. Impact of solar PV on aviation and airports.* Available at <https://docs.planning.org.uk/20210222/90/QNMZQ4EXINS00/i4uv1hvoemy3m7f5.pdf>

3. LEGISLATION AND GUIDANCE

NATIONAL PLANNING POLICY GUIDANCE (NPPG) ON RENEWABLE AND LOW CARBON ENERGY (UK) ⁴

3.1 Paragraph 013 (Reference ID: 5-013-20150327) sets out planning considerations that relate to large scale ground-mounted solar PV farms. This determines that the deployment of large-scale solar farms can have a negative impact on the rural environment, particularly in undulating landscapes. However, the visual impact of a well-planned and well-screened solar farm can be properly addressed within the landscape if planned sensitively. Considerations to be taken into account by local planning authorities are;

- *“the proposal’s visual impact, the effect on landscape of glint and glare and on neighbouring uses and aircraft safety;*
- *the extent to which there may be additional impacts if solar arrays follow the daily movement of the sun.”*

PLANNING GUIDANCE FOR THE DEVELOPMENT OF LARGE-SCALE GROUND MOUNTED SOLAR PV SYSTEMS

3.2 As outlined within the BRE document ‘Planning Guidance for the Development of Large-Scale Ground Mounted Solar PV Systems’⁵

“Glint may be produced as a direct reflection of the sun in the surface of the solar PV panel. It may be the source of the visual issues regarding viewer distraction. Glare is a continuous source of brightness, relative to diffused lighting. This is not a direct reflection of the sun, but rather a reflection of the bright sky around the sun. Glare is significantly less intense than glint.

Solar PV panels are designed to absorb, not reflect, irradiation. However, the sensitivities associated with glint and glare, and the landscape/ visual impact and the potential impact on aircraft safety, should be a consideration. In some instances, it may be necessary to seek a glint and glare assessment as part of a planning application. This may be particularly

⁴ NPPG Renewable and Low Carbon Energy. Available at:
http://planningguidance.communities.gov.uk/blog/guidance/renewable-and-low-carbon-energy/particular-planning-considerations-for-hydropower-active-solar-technology-solar-farms-and-wind-turbines/#paragraph_012

⁵ BRE (2013) *Planning Guidance for the Development of Large Scale Ground Mounted Solar PV Systems*. Available at:
https://www.bre.co.uk/filelibrary/pdf/other_pdfs/KN5524_Planning_Guidance_reduced.pdf

important if 'tracking' panels are proposed as these may cause differential diurnal and/or seasonal impacts.

The potential for solar PV panels, frames and supports to have a combined reflective quality should be assessed. This assessment needs to consider the likely reflective capacity of all of the materials used in the construction of the solar PV farm."

INTERIM CAA GUIDANCE – SOLAR PHOTOVOLTAIC SYSTEMS (2010)

- 3.3 There is little guidance on the assessment of glint and glare from solar farms with regards to aviation safety. The Civil Aviation Authority (CAA) has published interim guidance on 'Solar Photovoltaic Systems'⁶, they also intend to undertake a review of the potential impacts of solar PV developments upon aviation, however this is yet to be published.
- 3.4 The interim guidance identifies the key safety issues with regards to aviation, including *"glare, dazzling pilots leading them to confuse reflections with aeronautical lights."* It is outlined that solar farm developers should be aware of the requirements to comply with the Air Navigation Order (ANO), published in 2016 and amended in 2022. In particular, developers should be cognisant of the following articles of the ANO⁷, including:
- **Article 240** – *Endangering safety of an aircraft* – "A person must not recklessly or negligently act in a manner likely to endanger an aircraft, or any person in an aircraft."
 - **Article 224** - *Lights liable to endanger* – "A person must not exhibit in the United Kingdom any light which:
 - a) by reason of its glare is liable to endanger aircraft taking off or from landing at an aerodrome; or
 - b) by reason of its liability to be mistaken for an aeronautical ground light liable to endanger aircraft"
 - **Article 225** – *Lights which dazzle or distract* – "A person must not in the United Kingdom direct or shine any light at any aircraft in flight so as to dazzle or distract the pilot of the aircraft."

⁶ CAA (2010) Interim CAA Guidance – Solar Photovoltaic Systems. Available at: https://webarchive.nationalarchives.gov.uk/ukgwa/20141202114709/https://www.caa.co.uk/docs/697/srq_asd_solarphotovoltaicsystguidance.pdf

⁷ CAA (2016) Air Navigation: The Order and Regulations. Available at: <https://www.legislation.gov.uk/uksi/2017/1112/contents/made>

- 3.5 Relevant studies generally agree that there is potential for glint and glare from photovoltaic panels to cause a hazard or nuisance for surrounding receptors, but that the intensity of such reflections is similar to that emanating from still water. This is considerably lower than for other manmade materials such as glass, steel or white concrete (SunPower – 2009).
- 3.6 These Articles are considered within the assessment of glint and glare of the Proposed Development.

CAA – CAP738: SAFEGUARDING OF AERODROMES 3RD EDITION⁸

- 3.7 In 2003 the CAA first introduced the CAP738 document to help provide advice and guidance to ensure aerodrome safeguarding. Subsequently, there have been two updates to this document in 2006 and 2020.

- 3.8 Within the latest edition of CAP738, it outlines that the purpose of the document is to protect an aerodrome and to ensure safe operation. Specifically stating:

“Its purpose is to protect:

Aircraft from the risk of glint and glare e.g. solar panels.”

- 3.9 Within the section named as “Appendix C – Solar Photovoltaic Cells”, the following is stated:

“Policy

1. In 2010 the CAA published interim guidance on Solar Photovoltaic Cells (SPCs). At that time, it was agreed that we would review our policy based on research carried out by the Federal Aviation Authorities (FAA) in the United States, in addition to reviewing guidance issued by other National Aviation Authorities. New information and field experience, particularly with respect to compatibility and glare, has resulted in the FAA reviewing its original document ‘Technical Guidance for Evaluating Selected Solar Technologies on Airports’, which is likely to be subject to change, see link;

<https://www.federalregister.gov/documents/2013/10/23/2013-24729/interimpolicy-faa-review-of-solar-energy-system-projects-on-federally-obligated-airports>

2. In the United Kingdom there has been a further increase in SPV cells, including some located close to aerodrome boundaries; to date the CAA has not received any detrimental comments or issues of glare at these established sites. Whilst this early indication is encouraging, those responsible for safeguarding should remain vigilant to the possibility.”

- 3.10 The above is stating that to date, there has not been any complications on airfields due to glare originating from solar farms across the UK.

⁸ Civil Aviation Authority (2020). CAP738 – Safeguarding of Aerodromes 3rd Edition. Available at: <https://www.caa.co.uk/publication/download/12346>

US FEDERAL AVIATION ADMINISTRATION POLICY

- 3.11 As noted above, the CAA looks primarily to the USA for guidance on aviation glint and glare impacts. Due to this, the guidance provided by the US Federal Aviation Administration is industry standard.
- 3.12 The US Federal Aviation Administration (FAA) in their Solar Guide (Federal Aviation Authority, 2018)⁹ incorporates a chapter on the impact and assessment of glint from solar panels. It concludes that (although subject to revision):
- “Depending on site specifics (e.g., existing land uses, location and size of the project) an acceptable evaluation could involve one or more of the following levels of assessment:*
- (1) A qualitative analysis of potential impact in consultation with the Air Traffic Control Tower, pilots, and airport officials*
- (2) A demonstration field test with solar panels at the proposed site in coordination with Air Traffic Control Tower personnel*
- (3) A geometric analysis to determine days and times when there may be an ocular impact.”*
- 3.13 The interim policy (Federal Register, 2013)¹⁰ demands that an ocular impact assessment must be assessed at 1-minute intervals from when the sun rises above the horizon until the sun sets below the horizon. Specifically, the developer must use the ‘Solar Glare Hazard Analysis Tool’ (SGHAT) tool specifically and reference its results as this was developed by the FAA and Sandia National Laboratories as a standard and approved methodology for assessing potential impacts on aviation interests, although it notes other assessment methods may be considered. The SGHAT tool has since been licensed to a private organisation who were also involved in its development, and it is the software model used in this assessment.
- 3.14 Crucially, the policy provides a quantitative threshold which is lacking in the English guidance. This outlines that a solar development will not automatically receive an objection on glint grounds if low intensity glint is visible to pilots on final approach. In other words, low intensity glint with a low potential to form a temporary after-image (Green Glare) would be considered acceptable under US guidance. Due to the lack of legislation and guidance within England, this US document has been utilised as guidance for this report.
- 3.15 The FAA guidance states that for a solar PV development to obtain FAA approval or to receive no objection, the following two criteria must be met:

⁹ FAA (2018), Technical Guidance for Evaluating Selected Solar Technologies on Airports. Available at <https://www.faa.gov/sites/faa.gov/files/airports/environmental/FAA-Airport-Solar-Guide-2018.pdf>

¹⁰ FAA (2013), Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports. Available at <https://www.federalregister.gov/documents/2013/10/23/2013-24729/interim-policy-faa-review-of-solar-energy-system-projects-on-federally-obligated-airports>

- No potential for glint or glare in the existing or planned Air Traffic Control Tower (ATCT); and
- No potential for glare or “low potential for after-image” (Green Glare) along the final approach path for any existing or future runway landing thresholds (including planned or interim phases), as shown by the approved layout plan (ALP). The final approach path is defined as 2 miles from 50 feet above the landing threshold using a standard 3-degree glide path.

3.16 The geometric analysis included later in this report, which defines the extent and time at which glint may occur, is required by the FAA as the methodology to be used when assessing glint and glare impacts on aviation receptors. This report follows the methodology required by the FAA as it offers the most robust assessment method currently available.

FAA POLICY: REVIEW OF SOLAR ENERGY SYSTEMS PROJECTS ON FEDERALLY - OBLIGATED AIRPORTS¹¹

3.17 The FAA updated their Interim Policy from 2013 as part of their commitment to “*update policies and procedures as part of an iterative process as new information and technologies become available.*” The main development regarding Glint and Glare since the Interim Policy is the following:

“Initially, FAA believed that solar energy systems could introduce a novel glint and glare effect to pilots on final approach. FAA has subsequently concluded that in most cases, the glint and glare from solar energy systems to pilots on final approach is similar to glint and glare pilots routinely experience from water bodies, glass-façade buildings, parking lots, and similar features. However, FAA has continued to receive reports of potential glint and glare from on-airport solar energy systems on personnel working in ATCT cabs.”

3.18 This is outlining that solar panels are similar to nuisances that are already caused by other existing infrastructure, such as; car parks, glass buildings and water bodies. Furthermore, the ATCT has been outlined as the key receptor to be assessed when determining Glint and Glare impacts from a solar farm.

SOUTH EAST LINCOLNSHIRE LOCAL PLAN

¹¹ FAA (2021). FAA Policy: Review of Solar Energy Systems Projects on Federally – Obligated Airports. Available at: <https://www.federalregister.gov/documents/2021/05/11/2021-09862/federal-aviation-administration-policy-review-of-solar-energy-system-projects-on-federally-obligated>

3.19 South Holland District Council have produced a new Local Plan¹² jointly with Boston Borough Council and Lincolnshire County Council. The Plan was adopted on 8 March 2019.

3.20 The Plan states in **Policy 3: Design of New Development** that:

'All development will create distinctive places through the use of high quality and inclusive design and layout and, where appropriate, make innovative use of local traditional styles and materials. Design which is inappropriate to the local area, or which fails to maximise opportunities for improving the character and quality of an area, will not be acceptable.

Development proposals will demonstrate how the following issues, where they are relevant to the proposal, will be secured:

11. residential amenity'

3.21 The Plan states in **Policy 30: Pollution** that:

'Development proposals will not be permitted where, taking account of any proposed mitigation measures, they would lead to unacceptable adverse impacts upon:

1. health and safety of the public;

2. the amenities of the area; or

3. the natural, historic and built environment;

by way of:

11. . impact on amenity from existing uses.'

3.22 Suitable mitigation measures will be provided, if required. Proposals will be refused if impacts cannot be suitably mitigated or avoided.

3.23 The Plan states in **Policy 31: Climate Change and Renewable and Low Carbon Energy** that:

*'With the exception of Wind Energy the development of renewable energy facilities, associated infrastructure and the integration of decentralised technologies on existing or proposed structures will be permitted provided, individually, or cumulatively, there would be no significant harm to:*2. residential amenity in respect of: noise, fumes, odour, vibration, shadow flicker, sunlight reflection, broadcast interference, traffic.'

¹² South East Lincolnshire Local Plan, available at: <https://southeastlincslocalplan.org/>

4. METHODOLOGY

- 4.1 A desk-based assessment was undertaken to identify when and where glint and glare may be visible at receptors within the vicinity of the Proposed Development, throughout the day and the year.

SUN POSITION AND REFLECTION MODEL

Sun Data Model

- 4.2 The calculations in the solar position calculator are based on equations from *Astronomical Algorithms*¹³. The sunrise and sunset results are theoretically accurate to within a minute for locations between +/- 72° latitude, and within 10 minutes outside of those latitudes. However, due to variations in atmospheric composition, temperature, pressure and conditions, observed values may vary from calculations.

Solar Reflection Model

- 4.3 The position of the sun is calculated at one-minute intervals of a typical year, in this instance the year assessed is 2024.
- 4.4 In order to determine if a solar reflection will reach a receptor, the following variables are required:
- Sun position;
 - Observer location; and
 - Tilt, orientation, and extent of the modules in the solar array.
- 4.5 The model assumes that the azimuth and horizontal angle of the sun is the same across the whole solar farm. This is considered acceptable due to the distance of the sun from the Proposed Development and the miniscule differences in location of the sun over the Proposed Development.
- 4.6 Once the position of the sun is known for each time interval, a vector reflection equation determines the reflected sun vector, based on the normal vector of the solar array panels. This assumes that the angle of reflection is equal to the angle of incidence reflected across a normal plane. In this instance the plane being the vector which the solar panels are facing.

¹³ Jean Meeus, *Astronomical Algorithms* (Second Edition), 1999

- 4.7 On knowing the vector of the solar reflection, the azimuth is calculated and the horizontal reflection from multiple points within the solar farm. These are then compared with the azimuth and horizontal angle of the receptor from the solar farm to determine if it is within range to receive solar reflections.
- 4.8 The solar reflection in the model is considered to be specular as a worst-case scenario. In practice the light from the sun will not be fully reflected as solar panels are designed to absorb light rather than reflect it. The previous text and **Appendix F** outline the reflective properties of solar glass and compares it to other reflective surfaces. Although the exact figures in this report are not conclusive, it is included as a visual guide and it agrees with most other reports, in that solar glass has less reflective properties than other types of glass and that the amount of reflective energy drops as the angle of incidence decreases.
- 4.9 Most modern panels have a slight surface texture which should have a small effect on diffusing the solar radiation further; although, this has not been modelled to conform with the worst-case scenario assessment.
- 4.10 The modelling software outputs a hazard plot for each receptor predicted to be impacted by glare from the photovoltaic (PV) array. An orange dot is plotted for each minute of glare indicating the irradiance (power density) of the reflected solar light. A yellow dot is plotted to show the irradiance of the Sun when it is viewed directly. The hazard plot shows that the irradiance of the Sun is approximately three orders of magnitude greater than the reflected irradiance, i.e., the power density of solar reflections from photovoltaic panels are approximately 0.1% that of viewing the Sun. Due to the disparity in irradiance, whenever the Sun is observed in the same frame as solar reflections from a PV array, the Sun will be main source of glare impacts upon the observer. In such a case, the impact is deemed to be **Low** as a worst-case scenario.

Determination of Ocular Impact

- 4.11 The software used for this assessment is based on the Sandia Laboratories Solar Glare Hazard Analysis Tool (SGHAT). This tool is specifically mentioned in the FAA guidance as the software which should be used in this type of assessment.
- 4.12 Determination of the ocular impact requires knowledge of the direct normal irradiance, PV module reflectance, size and orientation of the array, optical properties of the PV module, and ocular parameters. These values are used to determine the retinal irradiance and subtended source angle used in the ocular hazard plot.

- 4.13 The ocular impact¹⁴ of viewed glare can be classified into three levels based on the retinal irradiance and subtended source angle: low potential for after-image (green), potential for after-image (yellow), and potential for permanent eye damage (red).
- 4.14 Green glare can be ignored when looking at ground based and some aviation receptors. Green glare does not cause temporary flash blindness and happens at an instant with very slight disturbance. As per FAA guidelines, mitigation is only required for green glare when affecting an Air Traffic Control Tower (ATCT), but not for when affecting pilots. Therefore, it can be assumed that green glare is acceptable for ground-based receptors.
- 4.15 The subtended source angle represents the size of the glare viewed by an observer, while the retinal irradiance determines the amount of energy impacting the retina of the observer. Larger source angles can result in glare of high intensity, even if the retinal irradiance is low.

Relevant Parameters of the Proposed Development

- 4.16 The photovoltaic panels will utilise a tracking system to maximise solar gain and will track the position of the sun throughout the day and during the year (i.e. they will rotate to track the movement of the sun).
- 4.17 The maximum above ground level height of the panels is 2.9m and points at the top of the panels are used to determine the potential for glint and glare generation.

IDENTIFICATION OF RECEPTORS

Ground Based Receptors

- 4.18 Glint is most likely to impact upon a ground-based receptor close to dusk and dawn when the sun is at its lowest in the sky. Therefore, any effect would likely occur early in the day or late in the day, reflected to the west at dawn and east at dusk.
- 4.19 A 1km study area from the panels was deemed appropriate for the assessment of ground-based receptors as this contains a good spread of residential and road receptors in most directions from the Proposed Development. The further distance a receptor is from a solar farm, the less chance it has of being affected by glint and glare due to scattering of the reflected beam and atmospheric attenuation, in addition to obstructions from ground sources, such as any intervening vegetation or buildings.
- 4.20 An observer height of 2m was utilised for residential receptors, as this is a typical height for a ground-floor window. Upper floor windows are not analysed geometrically; however, are

¹⁴ Ho, C.K., C.M. Ghanbari, and R.B. Diver, 2011, Methodology to Assess Potential Glint and Glare Hazards From Concentrating Solar Power Plants: Analytical Models and Experimental Validation, Journal of Solar Energy Engineering-Transactions of the Asme, 133(3).

considered as part of the visual analysis. With regards to road users, a receptor height of 1.5m was employed as this is typical of eye level. Rail driver's eye level was assumed to be 2.75m above the rail for signal signing purposes and therefore this is the height used for assessment purposes.

- 4.21 Where there are a number of residential receptors within close proximity, a representative dwelling or dwellings is/are chosen for full assessment as the impacts will not vary to any significant degree. Where small groups of receptors have been evident, the receptors on either end of the group have been analysed in detail with the worst-case impacts attributed to that receptor.

Aviation

- 4.22 Glint is only considered to be an issue with regards to aviation safety when the solar farm lies within proximity to a runway, particularly when the aircraft is descending to land. En-route activities are not considered an issue as the flight will most likely be at a higher altitude than the solar reflection.
- 4.23 Should a solar farm be proposed within the safeguarded zone of an aerodrome, a full geometric study may be required (depending on the orientation from the Proposed Development) which would determine if there is potential for glint and glare at key locations, most likely on the descent to land.
- 4.24 Buffer zones to identify aviation assets vary depending on the safeguarding criteria of that asset. All aerodromes within 30km will be identified, however generally the detailed assessments are only required within 20km for large international aerodromes, 10km for military aerodromes and 5km for small aerodromes.

MAGNITUDE OF IMPACT

Static Receptors

- 4.25 Although there is no specific guidance set out to identify the magnitude of impact from solar reflections, the following criteria has been set out for the purposes of this report:
- **High** - Solar reflections impacts of over 30 hours per year or over 30 minutes per day
 - **Medium** - Solar reflections impacts between 20 and 30 hours per year or between 20 minutes and 30 minutes per day
 - **Low** - Solar reflections impacts between 0 and 20 hours per year or between 0 minutes and 20 minutes per day

- **None** - Effects not geometrically possible or no visibility of reflective surfaces likely due to high levels of intervening screening

Moving Receptors (Road and Rail)

- 4.26 Again, no specific guidance is available to identify the magnitude of impact from solar reflections on moving receptors except in aviation, however it is thought that a similar approach should be applied to moving receptors as aviation, based on the ocular impact and the potential for after-image.
- 4.27 Due to the lack of UK guidance, and the UK authorities primarily referencing the FAA, the FAA guidance is used to determine impact ratings for other mobile receptors. The FAA guidance states that for a solar PV development to obtain FAA approval or to receive no objection the following criteria must be met:
- No potential for glare (glint) or “low potential for after-image” along the final approach path for any existing or future runway landing thresholds (including planned or interim phases), as shown by the ALP.
- 4.28 The following criteria has been set out for the purposes of this report:
- **High** - Solar reflections impacts consisting of any amount of yellow glare.
 - **Low** - Solar reflections impacts consisting of any amount of only green glare.
 - **None** - Effects not geometrically possible or no visibility of reflective surfaces likely due to high levels of intervening screening.
- 4.29 The FAA produced an evaluation of glare as a hazard and concluded in their report¹⁵ that:
- “The more forward the glare is and the longer the glare duration, the greater the impairment to the pilots’ ability to see their instruments and to fly the aircraft. These results taken together suggest that any sources of glare at an airport may be potentially mitigated if the angle of the glare is greater than 25 deg from the direction that the pilot is looking in. We therefore recommend that the design of any solar installation at an airport consider the approach of pilots and ensure that any solar installation that is developed is placed such that they will not have to face glare that is straight ahead of them or within 25 deg of straight ahead during final approach.”*
- 4.30 It is reasonable to assume that although this report was assessing pilots vision impairment that it can be also used to drivers of other vehicles. Therefore, the driver’s field of view will also be

¹⁵ Federal Aviation Authority, Evaluation of Glare as a Hazard for General Aviation Pilots on Final Approach (2015), Available at <https://libraryonline.erau.edu/online-full-text/faa-aviation-medicine-reports/AM15-12.pdf>

analysed where required and if the glare is out with 25 degrees either side of their line of sight then any impacts will reduce to **None**.

Moving Receptors (Aviation)

Approach Paths

- 4.31 Each final approach path which has the potential to receive glint is assessed using the Solar Glare Hazard Analysis Tool (SGHAT) model. The model assumes an approach bearing on the runway centreline, a 3-degree glide path with the origin 50ft (15.24m) above the runway threshold.
- 4.32 The computer model considers the pilots field of view. The azimuthal field of view (AFOV) or horizontal field of view (HFOV) as it is sometimes referred, refers to the extents of the pilot's horizontal field of view measured in degrees left and right from directly in front of the cockpit. The vertical field of view (VFOV) refers to the extents of the pilot's vertical field of view measured in degrees from directly in front of the cockpit. The HFOV is modelled at 50 degrees left and right from the front of the cockpit whilst the VFOV is modelled at 30 degrees.
- 4.33 The FAA guidance states that there should be no potential for glare or 'low potential for after-image' at any existing or future planned runway landing thresholds in order for the proposed Development to be acceptable.

Air Traffic Control Tower (ATCT)

- 4.34 An air traffic controller uses the visual control room to monitor and direct aircraft on the ground, approaching and departing the aerodrome. It is essential that air traffic controllers have a clear unobstructed view of aviation activity. The key areas on an aerodrome are the views towards the runway thresholds, taxiways and aircraft bays.
- 4.35 The FAA guidance states that no solar reflection towards the ATCT should be produced by a proposed solar development, however this should be assessed on a site by site basis and will depend on the operations at a particular aerodrome.
- 4.36 In order to determine the impact on the ATCT, the location and height of the tower will need to be fed into the SGHAT model and where there is a potential for 'low potential for After-Image' or more, then mitigation measures will be required.

ASSESSMENT LIMITATIONS

- 4.37 Below is a list of assumptions and limitations of the model and methods used within this report:

- The model does not consider obstacles (either man-made or natural) between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills, buildings, etc;
- The model does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results;
- Due to variations in atmospheric composition, temperature, pressure and conditions, observed values may vary slightly from calculated positions;
- The model does not account for the effects of diffraction; however, buffers are applied as a factor of safety; and
- The model assumes clear skies at all times and does not account for meteorological effects such as cloud cover, fog, or any other weather event which may screen the sun.

4.38 Due to these assumptions and limitations the model overestimates the number of minutes of glint and glare which are possible at each receptor and presents the worst-case scenario. Where glint and glare are predicted a visibility assessment is carried out to determine a more accurate, real-world prediction of the impacts.

5. BASELINE CONDITIONS

GROUND BASED RECEPTORS REFLECTION ZONES

- 5.1 In the northern hemisphere, there will never be solar reflections due south of a solar PV development as the position of the sun is always south. Furthermore, due to the slant of a solar panel (where the sun is due south, with an azimuth angle of 180 degrees), reflections will be directed skyward and not impact on ground-based receptors.
- 5.2 Based on the relatively flat topography in the area, solar reflections between five degrees below the horizontal plane to five degrees above it are described as near horizontal. Reflections from the Proposed Development within this arc have the potential to be seen by receptors at or near ground level.
- 5.3 Further analysis showed that this will only occur between the azimuth of 238.92 degrees and 129.27 degrees and therefore any ground-based receptor outside these arcs will not have any impact from solar reflections.
- 5.4 **Figure 1 and 2 of Appendix A** show the respective study areas whilst also subtracting from this the areas where solar reflections will not impact on ground-based receptors due to the reasons set out in **paragraphs 5.1 to 5.3**.

RESIDENTIAL RECEPTORS

- 5.5 Residential receptors located within 1km of the Application Site have been identified in **Table 5 - 1** below. Glint was assumed to be possible if the receptor is located within the ground-based receptor zones outlined previously. The number in brackets indicates which residential area the receptor belongs.
- 5.6 There are two residential receptors (Receptors 43 and 44) which are within the no-reflection zones and is clearly identifiable in **Figure 1: Appendix A**. The process of how these are calculated is explained in **paragraphs 5.1 to 5.3** of this report.

Table 5 - 1: Residential Based Receptors

Receptor	Easting	Northing	Glint and Glare Possible
1	536887	318669	Yes
2	536922	318708	Yes
3	537011	318630	Yes

Receptor	Easting	Northing	Glint and Glare Possible
4	537284	318640	Yes
5 (1)	537093	318482	Yes
6 (1)	537167	318470	Yes
7 (1)	537211	318426	Yes
8 (1)	537259	318381	Yes
9 (1)	537203	318368	Yes
10 (1)	537311	318331	Yes
11	537592	318280	Yes
12	537508	318024	Yes
13	537645	317969	Yes
14	537656	317959	Yes
15	537684	317925	Yes
16	537666	317866	Yes
17	537785	317810	Yes
18	537752	317740	Yes
19	537797	317718	Yes
20	537983	317516	Yes
21	538099	317379	Yes
22	538204	317418	Yes
23	538514	317595	Yes
24	538220	317264	Yes
25	538159	317264	Yes
26	538111	317251	Yes

Receptor	Easting	Northing	Glint and Glare Possible
27	538007	317207	Yes
28	537894	317134	Yes
29	538225	317062	Yes
30	538349	316971	Yes
31	538469	316693	Yes
32	538041	316838	Yes
33	538011	316727	Yes
34	538314	316531	Yes
35	537027	316730	Yes
36	536879	316648	Yes
37	536859	316629	Yes
38	536674	316763	Yes
39	536594	316953	Yes
40	536608	317063	Yes
41	536743	317159	Yes
42	536104	316684	Yes
43	537283	316433	No
44	537224	316376	No

ROAD / RAIL RECEPTORS

- 5.7 There are 14 roads within the 1km study area that require detailed glint and glare analysis, which are the Old Fen Dike, Green Lane, North Road, New Fen Dike, Gedney Hill Gate, Dog Drove, Inley Drove, Scalesgate Road, Bardling's Drove, Broadgate Road (north), Goochgate, Sandy Gate, Langary Gate Road and Broadgate Road (south). There are some minor roads

which serve dwellings; however, these have been dismissed as vehicle users of these roads will likely be travelling at low speeds and therefore, there is a negligible risk of safety impacts resulting from glint and glare of the Proposed Development.

5.8 The ground receptor no-reflection zones are clearly identifiable on **Figure 2: Appendix A** and the process of how these are calculated is explained in **paragraphs 5.1 to 5.3** of this report.

5.9 **Table 5 - 2** shows a list of receptors points within the study area which are 200m apart.

Table 5 - 2: Road Based Receptors

Receptor	Easting	Northing	Glint and Glare Possible
1	536876	318713	Yes
2	537023	318577	Yes
3	537170	318442	Yes
4	537311	318300	Yes
5	537447	318154	Yes
6	537582	318006	Yes
7	537709	317852	Yes
8	537835	317697	Yes
9	537950	317533	Yes
10	538064	317369	Yes
11	538163	317196	Yes
12	538279	317033	Yes
13	538389	316866	Yes
14	536983	318757	Yes
15	536871	318592	Yes
16	536771	318419	Yes
17	536671	318246	Yes

Receptor	Easting	Northing	Glint and Glare Possible
18	536580	318068	Yes
19	536516	317879	Yes
20	536460	317690	Yes
21	536488	317495	Yes
22	536487	317307	Yes
23	536546	317116	Yes
24	536632	316937	Yes
25	536706	316751	Yes
26	536799	316576	Yes
27	536927	316422	Yes
28	536452	317125	Yes
29	536381	316939	Yes
30	536401	316749	Yes
31	536321	316567	Yes
32	536234	316384	Yes
33	537857	318654	Yes
34	537729	318505	Yes
35	537603	318355	Yes
36	537552	318169	Yes
37	537454	318008	Yes
38	537331	317857	Yes
39	537181	317717	Yes

Receptor	Easting	Northing	Glint and Glare Possible
40	537037	317577	Yes
41	536899	317431	Yes
42	536765	317284	Yes
43	536628	317132	Yes
44	538219	318108	Yes
45	538076	317968	Yes
46	537933	317828	Yes
47	537720	317517	Yes
48	537574	317380	Yes
49	537428	317243	Yes
50	537287	317102	Yes
51	537150	316956	Yes
52	537012	316811	Yes
53	536871	316669	Yes
54	536637	316568	Yes
55	536581	316376	Yes
56	536524	316184	Yes
57	538621	317758	Yes
58	538476	317620	Yes
59	538329	317482	Yes
60	538189	317347	Yes
61	538045	317214	Yes

Receptor	Easting	Northing	Glint and Glare Possible
62	537884	317099	Yes
63	537759	316944	Yes
64	537621	316804	Yes
65	537489	316654	Yes
66	537367	316494	Yes
67	538133	316909	Yes
68	538013	316749	Yes
69	537883	316598	Yes
70	537745	316452	Yes
71	537617	316300	Yes
72	538360	316572	Yes
73	538241	316411	Yes
74	538110	316260	Yes
75	537973	316114	Yes
76	536024	317361	Yes
77	536079	317169	Yes
78	536112	316975	Yes
79	536091	316776	Yes
80	537055	316268	No
81	537180	316112	No
82	537304	315955	No
83	537432	315802	No

Receptor	Easting	Northing	Glint and Glare Possible
84	537240	316340	No
85	537506	316134	No
86	537396	315967	No
87	537195	315757	No
88	537853	315956	No

5.10 There are no railway lines within the 1km study area which require a detailed assessment.

AVIATION RECEPTORS

5.11 Aerodromes within 30km of the proposed solar development can be found in **Table 5 - 3**.

Table 5 - 3: Airfields within close proximity

Airfield	Distance (km)	Use
Fenland Airfield	3.57	Licensed airport
Wingland Airfield	9.69	Small grass strip
Crowland Airfield	11.27	Small grass strip
Gedney Dyke Airfield	11.31	Small grass strip
Holbeach	15.78	Helipad
Wallis International Airfield	19.21	Small grass strip
Marshland Airfield	20.29	Small grass strip
White Fen Farm	23.39	Small grass strip
Bank Farm	24.48	Small grass strip
Northorpe Airfield	24.56	Small grass strip
Poplar Farm	25.25	Small grass strip
Waterhinghill Farm	26.24	Small grass strip
Decoy Farm	26.27	Small grass strip

Airfield	Distance (km)	Use
Peterborough City Hospital	26.46	Helipad
Sempringham Fen Airfield	26.78	Small grass strip
Wyberton Fen Airfield	26.87	Small grass strip
Chatteris Airfield	26.98	Small grass strip
Kings Lynn Hospital	27.63	Helipad
Manor Farm	28.91	Small grass strip
Milton Park Airfield	28.96	Small grass strip
Helpringham Airfield	29.83	Small grass strip

- 5.12 There is one aerodrome, Fenland Airfield, which requires a detailed assessment due the Proposed Development being located within its respective safeguarding buffer zone outlined in **paragraph 4.24**.

Fenland Airfield

- 5.13 Fenland Airfield (ICAO code EGCL) is designated as visual flight rules (VFR) only Aerodrome. It is located approximately 6NM (11.11km) southeast of Spalding.
- 5.14 The elevation of the aerodrome at the Aerodrome Reference Point (ARP) is 6ft (1.8m). It has two grass strip runways, one licensed runway and one unlicensed runway (indicated with an asterisk (*)), details of which are given in **Table 5 - 4**.

Table 5 - 4: Runways at Fenland Airfield

Runway Designation	True Bearing (°)	Length (m)	Width (m)
18	180.91	600	30
36	000.91	600	30
08*	79.50	760	18
26*	259.50	760	18

- 5.15 The threshold location and height of the runways at Fenland Airfield are given in **Table 5 - 5**.

Table 5 - 5: Runway Threshold Locations and Heights

Runway Designation	Threshold Latitude	Threshold Longitude	Height AOD (m)
18	52° 44' 31.65" N	000° 01' 47.27" W	2
36	52° 44' 11.42" N	000° 01' 47.84" W	2
08*	52° 44' 09.34" N	000° 02' 12.18" W	2
26*	52° 44' 13.80" N	000° 01' 32.22" W	2

- 5.16 The ARP is located at the midpoint of Runway 18/36. The actual location of the ARP and the ATCT is given in **Table 5 - 6**. The height of the ATCT is estimated to be 5m based off Google Earth photos.

Table 5 - 6: Fenland Airfield Reference Point

	Latitude	Longitude	Eastings	Northings
ARP	52° 44' 21.87" N	000° 01' 47.57" W	533107	317577
ATCT	52° 44' 30.87" N	000° 01' 43.69" W	533169	317852

6. IMPACT ASSESSMENT

- 6.1 Following the methodology outlined earlier in this report, geometrical analysis comparing the azimuth and horizontal angle of the receptors from the Proposed Development and the solar reflection was conducted. Although this assessment did not consider obstructions such as vegetation and buildings, discussion on the potentially impacted receptors is provided where necessary.

GROUND BASED RECEPTORS

Residential Receptors

- 6.2 **Table 6 - 1** identifies the receptors that will experience solar reflections based on solar reflection modelling and whether the reflections will be experienced in the morning (AM), evening (PM), or both.
- 6.3 The two receptors which were within the no-reflection zones outlined previously have been excluded from the detailed modelling as they will never receive any glint and glare impacts from the Proposed Development.
- 6.4 **Appendix B** contains the detailed analysis of the glint and glare impacts. **Table 6 - 1** shows the worst-case impact at each receptor (bald earth scenario – not including actual visibility or actual visibility with mitigation).

Table 6 - 1: Potential for Glint and Glare Impact on Residential Receptors

Receptor	Glint Possible from Site		Potential Glare Impact (per year)		Magnitude of Impact
	AM	PM	Minutes	Hours	
1	No	No	0	0	None
2	No	No	0	0	None
3	No	No	0	0	None
4	No	No	0	0	None
5 (1)	No	No	0	0	None
6 (1)	No	No	0	0	None
7 (1)	No	No	0	0	None
8 (1)	No	No	0	0	None
9 (1)	No	No	0	0	None

Receptor	Glint Possible from Site		Potential Glare Impact (per year)		Magnitude of Impact
	AM	PM	Minutes	Hours	
10 (1)	No	No	0	0	None
11	No	No	0	0	None
12	No	No	0	0	None
13	No	No	0	0	None
14	No	No	0	0	None
15	No	No	0	0	None
16	No	No	0	0	None
17	No	No	0	0	None
18	No	No	0	0	None
19	No	No	0	0	None
20	No	No	0	0	None
21	No	No	0	0	None
22	No	No	0	0	None
23	No	No	0	0	None
24	No	No	0	0	None
25	No	No	0	0	None
26	No	No	0	0	None
27	No	No	0	0	None
28	No	No	0	0	None
29	No	No	0	0	None
30	No	No	0	0	None
31	No	No	0	0	None
32	No	No	0	0	None
33	No	No	0	0	None
34	No	No	0	0	None
35	No	No	0	0	None

Receptor	Glint Possible from Site		Potential Glare Impact (per year)		Magnitude of Impact
	AM	PM	Minutes	Hours	
36	No	No	0	0	None
37	No	No	0	0	None
38	No	No	0	0	None
39	Yes	No	5	0.08	Low
40	No	No	0	0	None
41	No	No	0	0	None
42	No	No	0	0	None

- 6.5 As detailed in **Table 6 - 1**, under the 'bald earth scenario', there is a **Low** impact at one receptor and a **None** impact at the remaining 41 receptors, including one residential area. **Appendix B** shows detailed analysis of when the glare impacts are possible, whilst also showing which parts of the solar farm glint is reflected from.
- 6.6 **Appendix E** shows Google Earth images that give an insight into how each receptor will be impacted by the glint and glare from the Proposed Development. There is a mixture of images used, which include aerial, ground level and street level. The aerial images show the location of the receptor with the solar farm drawn as a white polygon and can be seen on the images when the solar farm is theoretically visible. The area of the solar farm from where reflections may be possible has been drawn as a yellow polygon. The ground level terrain is based on the height data of the surrounding land showing no intervening vegetation or buildings. The white and yellow polygons can be seen in this view also. The street view gives a good indication as to whether the area of the solar farm where reflections are theoretically possible will be visible from the receptor point. Also, where appropriate images that have been taken from within the Application Site have been used to show up to date imagery.

Receptor 39

- 6.7 The 'Glare Reflections on PV Footprint' chart in **Appendix B** shows that reflections from a central section of the Array 1 (see **Figure 4: Appendix A**) in the Proposed Development can potentially impact on the receptor.
- 6.8 The first image in **Appendix E** is an aerial image showing the position of the receptor (yellow pin) in relation to the Proposed Development, and the location from which the second image was taken (red dot). This image shows dense vegetation between the receptor and the Proposed Development. The second image is a street view image with a view of the vegetation to the east of the receptor. This image confirms that the vegetation is sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None**.

Road Receptors

- 6.9 **Table 6 - 2** shows a summary of the modelling results for each of the Road Receptor Points, whilst the detailed results and ocular impact charts can be viewed in **Appendix C**.
- 6.10 There are nine receptors within the no-reflection zones outlined previously, and therefore have been excluded from the detailed modelling of glint and glare impacts from the Proposed Development.

Table 6 - 2: Potential for Glint and Glare Impact on Road Based Receptors

Receptor	Green Glare (mins)	Yellow Glare (mins)	Red Glare (mins)	Magnitude of Impact
1	0	0	0	None
2	0	0	0	None
3	0	0	0	None
4	0	0	0	None
5	0	0	0	None
6	0	0	0	None
7	0	0	0	None
8	0	0	0	None
9	0	0	0	None
10	59	0	0	Low
11	0	0	0	None
12	0	0	0	None
13	0	0	0	None
14	0	0	0	None
15	0	0	0	None
16	45	0	0	Low
17	340	0	0	Low
18	572	0	0	Low
19	892	0	0	Low
20	869	0	0	Low

Receptor	Green Glare (mins)	Yellow Glare (mins)	Red Glare (mins)	Magnitude of Impact
21	1636	0	0	Low
22	1270	0	0	Low
23	1627	0	0	Low
24	1536	26	0	High
25	592	3	0	High
26	0	0	0	None
27	0	0	0	None
28	1636	0	0	Low
29	1496	0	0	Low
30	1193	0	0	Low
31	767	0	0	Low
32	427	0	0	Low
33	0	0	0	None
34	0	0	0	None
35	0	0	0	None
36	0	0	0	None
37	0	0	0	None
38	0	0	0	None
39	0	0	0	None
40	0	0	0	None
41	0	0	0	None
42	0	0	0	None
43	1004	0	0	Low
44	0	0	0	None
45	0	0	0	None
46	0	0	0	None

Receptor	Green Glare (mins)	Yellow Glare (mins)	Red Glare (mins)	Magnitude of Impact
47	0	0	0	None
48	0	0	0	None
49	0	0	0	None
50	0	0	0	None
51	0	0	0	None
52	0	0	0	None
53	0	0	0	None
54	257	0	0	Low
55	0	0	0	None
56	0	0	0	None
57	0	0	0	None
58	0	0	0	None
59	0	0	0	None
60	0	0	0	None
61	0	0	0	None
62	0	0	0	None
63	0	0	0	None
64	0	0	0	None
65	0	0	0	None
66	0	0	0	None
67	0	0	0	None
68	0	0	0	None
69	0	0	0	None
70	0	0	0	None
71	0	0	0	None
72	0	0	0	None

Receptor	Green Glare (mins)	Yellow Glare (mins)	Red Glare (mins)	Magnitude of Impact
73	0	0	0	None
74	0	0	0	None
75	0	0	0	None
76	950	0	0	Low
77	918	0	0	Low
78	923	0	0	Low
79	1143	0	0	Low

- 6.11 As can be seen in **Table 6 - 2**, two out of the 79 receptor points have potential glare impacts consisting of “potential for after-image” (yellow glare) which is a **High** impact and 20 receptor points have potential glare impacts consisting of “low-potential for after-image” (green glare) which is a **Low** impact. **Appendix C** shows detailed analysis of when the glint and glare impacts are possible, whilst also showing which parts of the solar farm the solar glint is reflected from.
- 6.12 **Appendix E** shows Google Earth images that give an insight into how each receptor will be impacted by glint and glare from the Proposed Development. There is a mixture of images used, which include aerial, ground level and street level. The aerial images show the location of the receptor with the solar farm drawn as a white polygon and can be seen on the images when the solar farm is theoretically visible. The area of the solar farm from where reflections may be possible has been drawn as a yellow polygon. The ground level terrain is based on the height data of the surrounding land showing no intervening vegetation or buildings. The white and yellow polygons can be seen in this view also. The driver’s field of view, as outlined in **paragraph 4.30**, has been drawn as red cones. The street view gives a good indication as to whether the area of the solar farm where reflections are theoretically possible will be visible from the receptor point. Also, where appropriate images that have been taken from within the Application Site have been used to show up to date imaging.
- 6.13 As can be seen in **Appendix E**, all receptors, except Receptors 25 and 54, will have views of the Proposed Development blocked by intervening vegetation, topography or buildings or are outside the driver’s field of view, and therefore their impact can be reduced to **None**.

Aviation Receptors

- 6.14 **Table 6 - 3** shows a summary of the modelling results for each of the runway approach paths as well as at the ATCT whilst the detailed results and ocular impact charts can be viewed in **Appendix D**.

Table 6 - 3: Summary of Component Glare Results

Component	Green Glare (mins)	Yellow Glare (mins)	Red Glare (mins)
Fenland Airfield			
Runway 18	1736	0	0
Runway 36	1080	0	0
Runway 08	1008	0	0
Runway 26	0	0	0
ATCT	395	0	0

- 6.15 As can be seen in **Table 6 - 3**, no glare is predicted to impact the Runway 26 approach path at Fenland Airfield. Only green glare is predicted to impact the Runway 08, 18, and 36 approach paths and air traffic control tower at Fenland Airfield. Green glare is an **acceptable impact** upon pilots approaching runways/helipads and a **not acceptable impact** upon ATCTs according to the FAA guidance.
- 6.16 As can be seen in **Appendix E**, the first image shows the location of the Proposed Development in relation to the ATCT at Fenland Airfield, and the location from which the second image was taken (red dot). The second image is a street view image with a view towards the ATCT at Fenland Airfield. This image confirms that the vegetation and intervening buildings are sufficient to screen all views of the Proposed Development. Therefore, the impact upon the ATCT at Fenland Airfield reduces to **None**.
- 6.17 The impact upon aviation assets is **Low** and **Not Significant**.

7. GROUND BASED RECEPTOR MITIGATION

7.1 Mitigation is required to screen the **High** impact views into the Proposed Development from Road Receptor 25. Mitigation is also included to screen the **Low** impact views from Road Receptor 54. This includes:

- Native hedgerows to be planted/infilled along the southwest boundary of Array 1 (see **Appendix A: Figure 4**) in the Proposed Development and maintained to a height of at least 3m as shown on the G&G Mitigation Planting Plan (see **Appendix A: Figure 5**). This will screen views from Road Receptors 25 and 54. Therefore, the impacts upon Road Receptors 25 and 54 reduce to **None**.

7.2 **Table 7 - 1 and Table 7 - 2** show the impacts at each stage of the glint and glare analysis, with the final residual impacts considered once the mitigation, if any, is in place.

Table 7 - 1: Potential Residual Glint and Glare Impacts on Residential Receptors

Receptor	Magnitude of Impact		
	Theoretical Visibility	Actual Visibility (No Mitigation)	Actual Visibility with Mitigation
1	None	None	None
2	None	None	None
3	None	None	None
4	None	None	None
5 (1)	None	None	None
6 (1)	None	None	None
7 (1)	None	None	None
8 (1)	None	None	None
9 (1)	None	None	None
10 (1)	None	None	None
11	None	None	None
12	None	None	None
13	None	None	None
14	None	None	None

Receptor	Magnitude of Impact		
	Theoretical Visibility	Actual Visibility (No Mitigation)	Actual Visibility with Mitigation
15	None	None	None
16	None	None	None
17	None	None	None
18	None	None	None
19	None	None	None
20	None	None	None
21	None	None	None
22	None	None	None
23	None	None	None
24	None	None	None
25	None	None	None
26	None	None	None
27	None	None	None
28	None	None	None
29	None	None	None
30	None	None	None
31	None	None	None
32	None	None	None
33	None	None	None
34	None	None	None
35	None	None	None
36	None	None	None
37	None	None	None
38	None	None	None
39	Low	None	None

Receptor	Magnitude of Impact		
	Theoretical Visibility	Actual Visibility (No Mitigation)	Actual Visibility with Mitigation
40	None	None	None
41	None	None	None
42	None	None	None

Table 7 - 2: Potential Residual Glint and Glare Impacts on Road Receptors

Receptor	Magnitude of Impact		
	Theoretical Visibility	Actual Visibility (No Mitigation)	Actual Visibility with Mitigation
1	None	None	None
2	None	None	None
3	None	None	None
4	None	None	None
5	None	None	None
6	None	None	None
7	None	None	None
8	None	None	None
9	None	None	None
10	Low	None	None
11	None	None	None
12	None	None	None
13	None	None	None
14	None	None	None
15	None	None	None
16	Low	None	None
17	Low	None	None
18	Low	None	None

Receptor	Magnitude of Impact		
	Theoretical Visibility	Actual Visibility (No Mitigation)	Actual Visibility with Mitigation
19	Low	None	None
20	Low	None	None
21	Low	None	None
22	Low	None	None
23	Low	None	None
24	High	None	None
25	High	High	None
26	None	None	None
27	None	None	None
28	Low	None	None
29	Low	None	None
30	Low	None	None
31	Low	None	None
32	Low	None	None
33	None	None	None
34	None	None	None
35	None	None	None
36	None	None	None
37	None	None	None
38	None	None	None
39	None	None	None
40	None	None	None
41	None	None	None
42	None	None	None
43	Low	None	None

Receptor	Magnitude of Impact		
	Theoretical Visibility	Actual Visibility (No Mitigation)	Actual Visibility with Mitigation
44	None	None	None
45	None	None	None
46	None	None	None
47	None	None	None
48	None	None	None
49	None	None	None
50	None	None	None
51	None	None	None
52	None	None	None
53	None	None	None
54	Low	Low	None
55	None	None	None
56	None	None	None
57	None	None	None
58	None	None	None
59	None	None	None
60	None	None	None
61	None	None	None
62	None	None	None
63	None	None	None
64	None	None	None
65	None	None	None
66	None	None	None
67	None	None	None
68	None	None	None

Receptor	Magnitude of Impact		
	Theoretical Visibility	Actual Visibility (No Mitigation)	Actual Visibility with Mitigation
69	None	None	None
70	None	None	None
71	None	None	None
72	None	None	None
73	None	None	None
74	None	None	None
75	None	None	None
76	Low	None	None
77	Low	None	None
78	Low	None	None
79	Low	None	None

7.3 Table 7 - 3 and Table 7 - 4 show the overall impacts for all residential and road receptors.

Table 7 - 3: Solar Reflections: Residential Receptors

Magnitude	Theoretical Visibility	Actual Visibility (No Mitigation)	Actual Visibility with Mitigation
High	0	0	0
Medium	0	0	0
Low	1	0	0
None	41	42	42
High – Solar reflections impacts of over 30 hours per year or over 30 minutes per day Medium - Solar reflections impacts between 20 and 30 hours per year or between 20 minutes and 30 minutes per day Low - Solar reflections impacts between 0 and 20 hours per year or between 0 minutes and 20 minutes per day None - Effects not geometrically possible or no visibility of reflective surfaces likely due to high levels of intervening screening			

Table 7 - 4: Solar Reflections: Road Receptors

Magnitude	Theoretical Visibility	Actual Visibility (No Mitigation)	Actual Visibility with Mitigation
High	2	1	0
Low	20	1	0
None	57	77	79
• High - Solar reflections impacts with yellow glare (potential for after-image). • Low - Solar reflections impacts with only green glare (low potential for after-image) • None - Effects not geometrically possible or no visibility of reflective surfaces likely due to high levels of intervening screening or being outside the drivers field of view			

8. SUMMARY

- 8.1 This assessment considers the potential impacts on ground-based receptors such as roads, rail and residential dwellings as well as aviation assets. A 1km survey area around the Application Site is considered adequate for the assessment of ground-based receptors, whilst a 30km study area is chosen for aviation receptors. Within 1km of the Application Site, there are 44 residential receptors, including one residential area, and 88 road receptors which were considered. As per the methodology section, where there are a number of residential receptors within close proximity, a representative dwelling or dwellings is/are chosen for the glint and glare analysis as the impacts will not vary to any significant degree. Where small groups of receptors have been evident, the receptors on either end of the group have been included in the glint and glare analysis with some context to all receptors given in the visual analysis. Two residential receptors and nine road receptors were dismissed as they are located within the no reflection zones and therefore, will not be impacted upon by the Proposed Development. There are 21 aerodromes within 30km of the Proposed Development, one of which, Fenland Airfield, required a detailed assessment due to its size and orientation in relation to the Proposed Development.
- 8.2 The solar panels will utilise a tracker system to track the position of the sun throughout the day. The maximum above ground level height of the panels is 2.9m and points at the top of the panels are used to determine the potential for glint and glare generation.
- 8.3 Geometric analysis was conducted for 44 individual residential receptors, including one residential area, and 79 road receptors as well as four runway approach paths and one air traffic control tower (ATCT).
- 8.4 Following an initial assessment, rail receptors were scoped out as assets that will be impacted upon from the Proposed Development as no rail receptors fell within the 1km study area. The assessment concludes that:
- Solar reflections are possible at one of the 42 residential receptors assessed within the 1km study area. Initial impacts were **Low** at one receptor and **None** at the remaining 41 receptors, including one residential area. Upon reviewing the actual visibility of the receptors, glint and glare impacts reduce to **None** at all receptors.
 - Solar reflections are possible at 22 of the 79 road receptors assessed within the 1km study area. Initial impacts were **High** at two receptors, **Low** at 20 receptors and **None** at the remaining 57 receptors, including one residential area. Upon reviewing the actual visibility of the receptors, glint and glare impacts remain **High** at one receptor, **Low** at one receptor and reduce to **None** at all remaining receptors. Once mitigation measures were considered, impacts reduce to **None** at all receptors.

- **No impact** on train drivers or railway infrastructure is predicted.
- No glare was predicted to impact the Runway 26 approach path at Fenland Airfield. Only green glare was predicted to impact the Runway 08, 18 and 36 approach paths and ATCT at Fenland Airfield. Green glare is an **acceptable impact** when pilots are approaching runways/helipads and a **not acceptable impact** upon ATCTs, according to FAA guidance. Upon reviewing the actual visibility of the ATCT at Fenland Airfield, the impact upon the ATCT reduces to **None**. Therefore, the impacts upon aviation assets are **Low** and **Not Significant**.

8.5 Mitigation is required in order to screen the **High** impact views into the Proposed Development from Road Receptor 25. Mitigation is also included to screen the **Low** impact views from Road Receptor 54. This includes native hedgerows to be planted/infilled along the southwest boundary of Array 1 in the Proposed Development and maintained to a height of at least 3m as shown on the Glint and Glare (G&G) Mitigation Planting Plan.

8.6 The effects of glint and glare and their impact on local receptors has been analysed in detail and there is predicted to be only **Low** and **None** impacts, and therefore **No Significant Effects**.

9. APPENDICES

APPENDIX A: FIGURES

- Figure 1: Residential Based Receptors
- Figure 2: Road Based Receptors
- Figure 3: Site Layout
- Figure 4: Panel Area Label
- Figure 5: G&G Mitigation Planting Plan
- Figure 6: Fenland Airfield Aerodrome Chart

APPENDIX B: RESIDENTIAL RECEPTOR GLARE RESULTS

APPENDIX C: ROAD RECEPTOR GLARE RESULTS

APPENDIX D: AVIATION RECEPTOR GLARE RESULTS

APPENDIX E: VISIBILITY ASSESSMENT EVIDENCE

APPENDIX F: SOLAR MODULE GLARE AND REFLECTANCE TECHNICAL MEMO



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