Chapter 7: Glint and Glare

Glyn Taff Solar Farm

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EXECUTIVE SUMMARY

7.1. This assessment considers the potential impacts on ground-based receptors such as roads, rail and residential dwellings as well as aviation assets. A 1km study 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 151 identified residential receptors, including eight residential areas, 61 road receptors, five rail receptors and 13 byway 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 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 assessed in detail. 86 residential receptors, including two residential areas, 36 road receptors and 11 byway receptors were dismissed as they are located within the no reflection zones or areas of non-visibility. Eight aerodromes are located within the 30km study area, none of which required a detailed assessment due to the Proposed Development falling outside their respective safeguarding buffer zones, which is outlined in **paragraph 21**.

7.2. Geometric analysis was conducted at 65 individual residential receptors, including six residential areas, 25 road receptors, five rail receptors and two byway receptors.

7.3. The assessment concludes that:

- Solar reflections are possible at seven of the 65 residential receptors assessed within the 1km study area. The initial bald-earth scenario identified potential impacts as **High** at two receptors, **Low** at five receptors, including one residential area, and **None** at the remaining 58 receptors, including five residential areas. Upon reviewing the actual visibility of the receptor, glint and glare impacts remain **High** at one receptor and reduce to **None** at 64 receptors. Once mitigation measures were considered, glint and glare impacts reduce to **None** at all receptors. The effects from the Proposed Development are therefore **None**.

- Solar reflections are possible at 22 of the 25 road receptors assessed within the 1km study area. The initial bald-earth scenario identified potential impacts as **High** at six receptors, **Low** at 16 receptors and **None** at the remaining three receptors. Upon reviewing the actual visibility of the receptors, glint and glare impacts reduce to **Low** at two receptors and **None** at all remaining receptors. Once mitigation measures were considered all impacts reduce to **None** at all receptors. The effects from the Proposed Development are therefore **None**.

- Solar reflections are possible at all the rail receptors assessed within the 1km study area. The initial bald-earth scenario identified potential impacts as **Low** at five receptors. Upon reviewing the actual visibility of the receptors, glint and glare impacts reduce to **None** at all receptors. The effects from the Proposed Development are therefore **None**.

- Solar reflections are possible at all the byway receptors assessed within the 1km study area. The initial bald-earth scenario identified potential impacts as **Low** at two receptors. Upon reviewing the actual visibility of the receptors, glint and glare impacts reduce **None** at all receptors. The effects from the Proposed Development are therefore **None**.

7.4. Mitigation is required to ensure the **High** impact views from Residential Receptor 12 into the Proposed Development are screened, and mitigation is recommended to screen the **Low** impact views from Road Receptors 23 and 24. This includes native hedgerows/woodland to be planted/infilled along the eastern boundaries of Fields 32 and 34, along the northeast boundary of Fields 4, 7 and 11 and along the northern boundary of Fields 12, 13 and 14 and maintained to a height of at least 3m.

7.5. The effects of glint and glare and their impact on local receptors has been analysed in detail and the impact on all receptors is predicted to be **no impacts** upon residential, road, rail and byway receptors once mitigation has been considered. Residual effects on residential, road, rail and byway receptors is **None**. Therefore, the effects are **None**.

INTRODUCTION

Background

7.6. Neo Environmental Ltd has been appointed by Renantis UK Limited (the "Applicant") to undertake a Glint and Glare Assessment ("G&G") for a proposed single-field extension to a consented solar farm (the "Development") on lands at Bryntail Farm, Bryntail Lane, Pontypridd (the "Application Site"). Please see **Figure 1** for the layout of the Proposed Development.

Proposed Development Description

7.7. Installation, operation and subsequent decommissioning of a renewable energy scheme comprising ground mounted photovoltaic solar arrays together with substation compound, transformer stations, internal access track, landscaping, biodiversity measures, boundary fencing, security measures, CCTV posts, monitoring house, storage containers access improvement and ancillary infrastructure. The solar arrays will have a combined capacity of up to 39.9MWp.

7.8. The area of the Proposed Development (the "Application Site") lies at an elevation of approximately 140m – 330m AOD and covers a total area of c. 70.9 hectares. It is centred around Bryntail Farm at approximate National Grid Reference (NGR) E 309333, N 189800. It is south of Eglwysilan Road. The site extends wet of Glyn Taff Farm and east of the Bryntail Road. The site is within the administrative area of Rhondda Cynon Taf Council.

7.9. The site comprises 38 agricultural fields that are currently in use for livestock farming. It is on the east side of the Taff Valley c. 1.6 km east of Ynysangharad War Memorial Park. Access will be gained from the Bryn Tail Road.

7.10. The site is adjacent to the Twyn Hywel Energy Park, a consented wind farm including 14 turbines (DNS/3272053).

Scope of Study

7.11. 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.

7.12. 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.

7.13. 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.

7.14. This chapter concentrates on the effects of glint and glare and its impact on local receptors and will be supported with the following Figures and Appendices.

- Appendix 7A: Figures:
  - Figure 7.1: Residential Based Receptors
  - Figure 7.2: Road Based Receptors
  - Figure 7.3: Rail Based Receptors
  - Figure 7.4: Byway Based Receptors
  - Figure 7.5: Panel Area Labels
- Appendix 7B: Residential Receptor Glare Results 5 Degrees
- Appendix 7C: Residential Receptor Glare Results 25 Degrees
- Appendix 7D: Road Receptor Glare Results 5 Degrees
- Appendix 7E: Road Receptor Glare Results 25 Degrees
- Appendix 7F: Rail Receptor Glare Results 5 Degrees
- Appendix 7G: Rail Receptor Glare Results 25 Degrees
- Appendix 7H: Byway Receptor Glare Results 5 Degrees
- Appendix 7I: Byway Receptor Glare Results 25 Degrees
- Appendix 7J: Visibility Evidence Assessment
- Appendix 7K: Solar Module Glare and Reflectance Technical Memo[1]

Statement of Authority

7.15. This Glint and Glare Assessment has been produced by David Thomson, Tom Saddington and Michael McGhee of Neo Environmental. 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. Tom has an undergraduate degree in Bioengineering and graduated

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

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. 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

7.16. 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 US Federal Aviation Authority (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*"

7.17. 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

7.18. In terms of reflectance, photovoltaic solar panels are by no means a highly reflective surface. 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 the likes of glass, steel, snow and white concrete by comparison (**See Appendix 7K**). Similar levels of reflectance can be found in rural environments from the likes of shed roofs and 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 a number of 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 and used a number of case studies and expert opinions,

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://www.faa.gov/airports/environmental/policy_guidance/media/airport-solar-guide.pdf including that from Neo. 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 / Datums

7.19. Locations in this report are given in Eastings and Northings using the 'British National Grid' grid reference system unless otherwise stated.

7.20. Wales 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.

3 Solar 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: http://www.solar-trade.org.uk/wp-content/uploads/2016/04/STA-glint-and-glare-briefing-April-2016-v3.pdf

LEGISLATION AND GUIDANCE

7.21. A review of relevant legislation has been conducted to ensure the Proposed Development complies with the following:

- Future Wales – The National Plan 2040[4]
- Planning Policy Wales (PPW): Edition 11[5]
- National Planning Policy Guidance on Renewable and Low Carbon Energy (UK) [6]
- National Policy Statement for Renewable Energy Infrastructure (EN-3)[7]
- Planning Guidance for the Development of Large-Scale Ground Mounted Solar PV Systems[8]

Future Wales – The National Plan 2040[9]

7.22. Policy 17 – Renewable and Low Carbon Energy and Associated Infrastructure sets out the planning considerations that relate to large scale renewable energy infrastructure. With the policy specifically mentioning the following about visual impacts:

'New strategic grid infrastructure for the transmission and distribution of energy should be designed to minimise visual impact on nearby communities.'

7.23. Although there is no specific mention of Glint and Glare impacts, there will be a consideration towards the visual impact from a Glint and Glare perspective throughout this assessment.

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[4] Wales Government (2021) Future Wales: The national Plan 2040. Available at: https://gov.wales/sites/default/files/publications/2021-02/future-wales-the-national-plan-2040.pdf

[5] Wales Government (2021) Planning Policy Wales -Edition 11. Available at: https://gov.wales/sites/default/files/publications/2021-02/planning-policy-wales-edition-11_0.pdf

[6] 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_013

[7] UK Government, National Policy Statement for renewable energy infrastructure (EN-3). Available at: https://www.gov.uk/government/publications/national-policy-statement-for-renewable-energy-infrastructure-en-3

[8] 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

[9] Wales Government (2021) Future Wales: The national Plan 2040. Available at: https://gov.wales/sites/default/files/publications/2021-02/future-wales-the-national-plan-2040.pdf

Planning Policy Wales (PPW): Edition 11[10]

7.24. Planning Policy Wales ('PPW') Edition 11 was adopted by the Welsh Government in February 2021. This replaced the previously adopted PPW and sets out the land use planning policy for Wales. Chapter 5 of the PPW outlines the planning policy in relation to 'Renewable and Low Carbon Energy'. With regards to Glint and Glare, it states:

'Planning authorities should also identify and require suitable ways to avoid, mitigate or compensate adverse impacts of renewable and low carbon energy development. The construction, operation, decommissioning, remediation and aftercare of proposals should take into account:

- *the need to minimise impacts on local communities, such as from noise and air pollution, to safeguard quality of life for existing and future generations'*

7.25. Although there is no specific mention of Glint and Glare impacts, there will be a consideration towards the impact on local communities from a Glint and Glare perspective throughout this assessment.

National Planning Policy Guidance (NPPG) on Renewable and Low Carbon Energy (UK)

7.26. 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."*

National Policy Statement for Renewable Energy Infrastructure (EN-3)

7.27. Section 2.10 of the EN-3 provides the following commentary in relation to Glint and Glare impacts:

2.10.102 Solar panels are specifically designed to absorb, not reflect, irradiation. However, solar panels may reflect the sun's rays at certain angles, causing glint and glare. Glint is defined

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[10] Wales Government (2021) Planning Policy Wales -Edition 11. Available at: https://gov.wales/sites/default/files/publications/2021-02/planning-policy-wales-edition-11_0.pdf

as a momentary flash of light that may be produced as a direct reflection of the sun in the solar panel. Glare is a continuous source of excessive brightness experienced by a stationary observer located in the path of reflected sunlight from the face of the panel. The effect occurs when the solar panel is stationed between or at an angle of the sun and the receptor.

2.10.103 Applicants should map receptors qualitatively to identify potential glint and glare issues and determine if a glint and glare assessment is necessary as part of the application.

2.10.104 When a quantitative glint and glare assessment is necessary, applicants are expected to consider the geometric possibility of glint and glare affecting nearby receptors and provide an assessment of potential impact and impairment based on the angle and duration of incidence and the intensity of the reflection.

2.10.105 The extent of reflectivity analysis required to assess potential impacts will depend on the specific project site and design. This may need to account for 'tracking' panels if they are proposed as these may cause differential diurnal and/or seasonal impacts.

2.10.106 When a glint and glare assessment is undertaken, the potential for solar PV panels, frames and supports to have a combined reflective quality may need to be assessed, although the glint and glare of the frames and supports is likely to be significantly less than the panels.

2.10.158 Solar PV panels are designed to absorb, not reflect, irradiation. However, the Secretary of State should assess the potential impact of glint and glare on nearby homes, motorists, public rights of way, and aviation infrastructure (including aircraft departure and arrival flight paths).

2.10.159 Whilst there is some evidence that glint and glare from solar farms can be experienced by pilots and air traffic controllers in certain conditions, there is no evidence that glint and glare from solar farms results in significant impairment on aircraft safety. Therefore, unless a significant impairment can be demonstrated, the Secretary of State is unlikely to give any more than limited weight to claims of aviation interference because of glint and glare from solar farms."

7.28. This Glint and Glare Assessment will be taking account of impacts upon nearby homes, motorists, railway lines, byway and aviation receptors.

Planning Guidance for the Development of Large-Scale Ground Mounted Solar PV Systems

7.29. As outlined within the BRE document 'Planning Guidance for the Development of Large-Scale Ground Mounted Solar PV Systems'[11]

[11] 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

"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 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)

7.30. 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[12]', they also intend to undertake a review of the potential impacts of solar PV developments upon aviation, however this is yet to be published.

7.31. 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 ANO[13], 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*

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

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

– *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."*

7.32. 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).

7.33. These Articles are considered within the assessment of glint and glare of the Proposed Development.

CAA – CAP738: Safeguarding of Aerodromes 3rd Edition[14]

7.34. 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.

7.35. 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."

7.36. 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

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[14] Civil Avaition Authority (2020). CAP738 – Safeguarding of Aerodromes 3rd Edition. Available at: https://www.caa.co.uk/publication/download/12346

or issues of glare at these established sites. Whilst this early indication is encouraging, those responsible for safeguarding should remain vigilant to the possibility."

7.37. 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.

US Federal Aviation Administration Policy

7.38. The US Federal Aviation Administration (FAA) in their Solar Guide (Federal Aviation Authority, 2018)[15] 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."

7.39. The interim policy (Federal Register, 2013)[16] 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.

7.40. 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.

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[15] 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

[16] 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

7.41. 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:

- 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.

7.42. 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 Airports[17]

7.43. 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."*

7.44. 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.

[17] 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

Review of Local Plan

Rhondda Cynon Taf Local Plan

7.45. The Rhondda Cynon Taf Local Development Plan (LDP) 2006 - 2021[18] was adopted on 2nd March 2011.

7.46. There are no policies contained within the LDP which are of relevance to this Glint and Glare assessment.

7.47. Rhondda Cynon Taf County Borough Council are preparing a Revised Local Development Plan[19] for the period 2022 - 2037. This process formally began in April 2022. This will replace the current LDP for Rhondda Cynon Taf (2006 – 2021). The current LDP will remain in force until the Revised LDP is adopted.

7.48. There are currently no published policies for the Revised LDP which are of relevance to this Glint and Glare assessment.

METHODOLOGY

7.49. 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

7.50. The calculations in the solar position calculator are based on equations from Astronomical Algorithms[20]. 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

[18] Rhondda Cynon Taf Local Development Plan 2006 - 2021, available at: https://www.rctcbc.gov.uk/EN/Resident/PlanningandBuildingControl/LocalDevelopmentPlans/LocalDevelopmentPlan20062021.aspx

[19] Rhondda Cynon Taf Revised Local Development Plan 2022 – 2037, available at: https://www.rctcbc.gov.uk/EN/Resident/PlanningandBuildingControl/RevisedLocalDevelopmentPlan20222037/RevisedLocalDevelopmentPlanLDP2022%e2%80%932037.aspx

[20] Jean Meeus, Astronomical Algorithms (Second Edition), 1999

7.51. The position of the sun is calculated at one-minute intervals of a typical year, in this instance the year being assessed was 2025.

7.52. 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.

7.53. 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.

7.54. 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.

7.55. 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.

7.56. 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 text above and **Appendix 7K** outlines the reflective properties of solar glass and compares it to other reflective surfaces. Although the exact figures in this report could be argued, 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, bodies of water and snow, and that the amount of reflective energy drops as the angle of incidence decreases.

7.57. The panel reflectivity has been modelled to assume an anti-reflective coating (ARC) which is the industry standard for photo-voltaic panels and further reduces the reflective properties of the PV panels.

Determination of Ocular Impact

7.58. 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.

7.59. 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.

7.60. The ocular impact[21] 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).

7.61. Green glare can be ignored when looking at residential 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, but not for when affecting pilots. Therefore, it can be assumed that green glare is acceptable for residential receptors.

7.62. 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.

7.63. 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.

Relevant Parameters of the Proposed Development

7.64. The photovoltaic panels are oriented in a southwards direction to maximise solar gain and will remain in a fixed position throughout the day and during the year (i.e. they will not rotate to track the movement of the sun). The panels will face south and will be inclined at an angle of between 5 and 25 degrees.

7.65. The height of the panels above ground level is a maximum of 3m and points at the top of the panels are used to determine the potential for glint and glare generation.

[21] 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).

Identification of Receptors

Ground Based Receptors

7.66. 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.

7.67. A 1km study area from the panels was deemed appropriate for the assessment of ground-based receptors as this seemed to contain 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.

7.68. An observer height of 2m was utilised for residential receptors, as this is a typical height for a ground-floor window. With regards to road users, a receptor height of 1.5m was employed as this is typical of eye level.

7.69. An assessment was undertaken to determine zones where solar reflections will never be directed near ground level.

7.70. Where there are several 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

7.71. Glint is only considered to be an issue with regards to aviation safety when the solar farm lies within close 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.

7.72. Should a solar farm be proposed within the safeguarded zone of an aerodrome then a full geometric study may be required which would determine if there is potential for glint and glare at key locations, most likely on the descent to land.

7.73. 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.

Sensitivity

7.74. All receptors within this assessment will be deemed as having a **High** sensitivity. In reality, the sensitivity of a static receptor such as a dwelling, will have a lower sensitivity that a road user, due to the safety aspect. However, it is considered that categorising all receptors as **High** is the best option to present a worst case scenario in respect of glint and glare impacts.

Magnitude of Impact

Static Receptors

7.75. 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 up to 20 hours per year or up to 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)

7.76. 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.

7.77. 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 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 approved layout plan (ALP).

7.78. 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.

7.79. The FAA produced an evaluation of glare as a hazard and concluded in their report[22] 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."

7.80. 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 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

7.81. Each final approach path which has the potential to receive glint is assessed using the 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.

7.82. 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.

7.83. 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 for the Proposed Development to be acceptable.

Air Traffic Control Tower (ATCT)

7.84. 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

[22] 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

have a clear unobstructed view of the aviation activity. The key areas on an aerodrome are the views towards the runway thresholds, taxiways, and aircraft bays.

7.85. 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.

7.86. 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.

Significance of Effects

7.87. The significance of effects has been defined in accordance with the criteria outlined within **Table 7-** 1. The importance of the attribute and the magnitude of the potential impact have been combined to identify the significance of the effect.

Table 7- 1: Rating of Significant Environmental Impacts

Magnitude of Impact	Level of Significance Relative to Sensitivity of Receptor		
	High	Medium	Low
High	Major	Moderate	Minor
Medium	Moderate	Moderate	Minor
Low	Minor	Minor	Minor

7.88. Where **Table 7-** 1 is shaded red (Major), it identifies a significant effect.

Assessment Limitations

7.89. 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.

7.90. 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.

BASELINE CONDITIONS

Ground Based Receptors Reflection Zones

7.91. Based on the 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 solar farm within this arc have the potential to be seen by receptors at or near ground level.

7.92. Further analysis showed that this will only occur between the azimuth of 238.15 degrees and 298.73 degrees in the western direction (late day reflections) and 64.76 degrees and 129.14 degrees in the eastern direction (morning reflections) and therefore any ground-based receptor outside these arcs will not have any impact from solar reflections.

7.93. In addition to the non-reflection zones, a ZTV (zone of theoretical visibility) was used to determine areas within the study area from which the Proposed Development would not be visible. Receptors within these areas of non-visibility have been dismissed from the assessment as glint and glare impacts are not possible due to the topography. The observer height used in the ZTV was 1.7m.

7.94. **Figure 7.1, 7.2, 7.3 and 7.4 of Appendix 7A** 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 7.91 to 7.93.**

Residential Receptors

7.95. Residential receptors located within 1km of the Application Site have been identified (**Table 7-2**). Glint was assumed to be possible if the receptor is located within the ground-based receptor zones outlined previously. The number in brackets indicates to which residential area the receptor belongs.

7.96. There are 86 residential receptors (Receptors 66 - 151) which are within the no-reflection zones and areas of non-visibility and are clearly identifiable in **Figure 7.1: Appendix 7A.** The process of how these are calculated is explained in **paragraphs 7.91 to 7.92** of this report.

Table 7-2: Residential Based Receptors

Receptor	Easting	Northing	Glint and Glare Possible
1	308564	190385	Yes
2	308517	190322	Yes
3 (1)	308246	190548	Yes
4 (1)	308228	190471	Yes
5 (1)	308195	190427	Yes
6 (2)	308220	190363	Yes
7 (2)	307876	190147	Yes
8 (3)	308031	190044	Yes
9 (3)	308744	189489	Yes
10 (3)	308506	189350	Yes
11	308559	189300	Yes
12	309352	189828	Yes
13	309262	189578	Yes
14	309035	189516	Yes
15	309047	189487	Yes
16 (4)	307840	189680	Yes

Receptor	Easting	Northing	Glint and Glare Possible
17 (4)	307941	189696	Yes
18 (4)	308020	189627	Yes
19 (4)	308011	189533	Yes
20 (4)	308152	189470	Yes
21 (4)	308295	189468	Yes
22 (4)	308322	189380	Yes
23 (4)	308279	189320	Yes
24 (4)	308362	189305	Yes
25 (4)	308350	189225	Yes
26 (4)	308336	189131	Yes
27 (4)	308337	189040	Yes
28 (4)	308382	188970	Yes
29 (4)	308379	188899	Yes
30 (4)	308398	188819	Yes
31 (4)	308431	188727	Yes
32 (4)	308474	188672	Yes
33 (4)	308490	188618	Yes
34 (4)	308506	188559	Yes
35 (4)	308260	188892	Yes
36 (4)	308243	188968	Yes
37 (4)	308224	189065	Yes
38 (4)	308207	189164	Yes
39 (4)	308165	189224	Yes
40 (4)	308089	189305	Yes
41 (4)	308016	189385	Yes
42 (4)	307926	189448	Yes

Receptor	Easting	Northing	Glint and Glare Possible
43 (5)	308457	189041	Yes
44 (5)	308464	188987	Yes
45 (5)	308468	188925	Yes
46 (5)	308498	188878	Yes
47 (5)	308549	188806	Yes
48 (5)	308570	188764	Yes
49 (6)	308570	188970	Yes
50 (6)	308621	189009	Yes
51 (6)	308709	189005	Yes
52 (6)	308784	189002	Yes
53 (6)	308883	188963	Yes
54 (6)	308940	188921	Yes
55 (6)	308990	188865	Yes
56 (6)	308763	188744	Yes
57 (6)	308664	188691	Yes
58 (6)	308668	188825	Yes
59 (6)	308605	188892	Yes
60 (6)	309862	188661	Yes
61 (6)	309938	188595	Yes
62	309974	189276	Yes
63	310113	189170	Yes
64	310156	189175	Yes
65	310198	188777	Yes
66 (7)	308707	191375	No
67 (7)	308810	191335	No
68 (7)	308837	191412	No

Receptor	Easting	Northing	Glint and Glare Possible
69 (8)	308375	191156	No
70 (8)	308379	191066	No
71 (8)	308349	191004	No
72 (8)	308387	190885	No
73 (8)	308286	190831	No
74 (8)	308209	190791	No
75 (8)	308163	190753	No
76 (1)	308201	190609	No
77 (1)	308230	190266	No
78 (1)	308269	190196	No
79 (1)	308276	190094	No
80 (1)	308356	189992	No
81 (1)	308383	189934	No
82 (1)	308449	189862	No
83 (1)	308518	189817	No
84 (3)	308156	189919	No
85 (3)	308198	189814	No
86 (3)	308248	189731	No
87 (3)	308381	189707	No
88 (3)	308445	189633	No
89 (3)	308550	189574	No
90 (3)	308612	189538	No
91 (3)	308684	189555	No
92 (3)	308611	189461	No
93 (3)	308536	189417	No
94	308881	189326	No

Receptor	Easting	Northing	Glint and Glare Possible
95 (6)	309365	189034	No
96 (6)	309306	188961	No
97 (6)	309261	188929	No
98 (6)	309366	188909	No
99 (6)	309177	188879	No
100 (6)	309354	188842	No
101 (6)	309037	188791	No
102 (6)	309131	188806	No
103 (6)	309398	188769	No
104 (6)	309512	188780	No
105 (6)	309083	188695	No
106 (6)	309213	188702	No
107 (6)	309320	188628	No
108 (6)	309412	188685	No
109 (6)	309514	188649	No
110 (6)	309605	188706	No
111 (6)	309713	188738	No
112 (6)	309763	188662	No
113 (6)	308825	188701	No
114 (6)	308964	188666	No
115 (6)	308936	188596	No
116 (6)	309014	188531	No
117 (6)	309152	188591	No
118 (6)	309264	188534	No
119 (6)	309397	188515	No
120 (6)	309553	188489	No

Receptor	Easting	Northing	Glint and Glare Possible
121 (6)	309575	188598	No
122 (6)	309686	188539	No
123 (6)	309875	188535	No
124 (6)	309857	188483	No
125 (6)	309690	188448	No
126 (6)	309746	188412	No
127 (6)	309790	188375	No
128 (6)	309905	188402	No
129 (6)	309947	188360	No
130 (6)	308520	188507	No
131 (6)	308709	188621	No
132 (6)	308755	188565	No
133 (6)	308803	188489	No
134 (6)	308825	188387	No
135 (6)	308851	188322	No
136 (6)	308878	188261	No
137 (6)	308957	188290	No
138 (6)	309010	188246	No
139 (6)	309086	188407	No
140 (6)	309150	188333	No
141 (6)	309184	188426	No
142 (6)	309273	188413	No
143 (6)	309364	188377	No
144 (6)	309459	188355	No
145 (6)	309556	188349	No
146 (6)	309626	188321	No

Receptor	Easting	Northing	Glint and Glare Possible
147 (6)	309742	188252	No
148 (6)	309817	188292	No
149 (6)	309215	188256	No
150 (6)	309315	188197	No
151	310370	189953	No

Road / Rail Receptors

7.97. There are 16 roads within the 1km study area that require a detailed Glint and Glare Assessment; A470, Pentrebach Road, B4595, Park Street, A4054, Gwalia Grove, College Way, Eglwsilan Road, Penheol Ely Road, Tygwyn Road, Hospital Road, Graig-yr-Helfa Road, Glyntaff Road, Dyffryn Road, Masefield Way and Dynea Road. There are some minor local roads and roads which serve dwellings; however, these have been excluded from assessment 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.

7.98. The ground receptor no-reflection zones and areas of non-visibility are clearly identifiable on **Figure 7.2: Appendix 7A** and the process of how these are calculated is explained in **paragraphs 7.91 to 7.93** of this report.

7.99. **Table 7-3** shows a list of assessed receptor points within the study area which are 200m apart.

Table 7-3: Road Based Receptors

Receptor	Easting	Northing	Glint and Glare Possible
1	307831	189952	Yes
2	308426	189449	Yes
3	308463	189254	Yes
4	308499	189058	Yes
5	308561	188868	Yes
6	308636	188682	Yes
7	307883	190183	Yes
8	308018	190056	Yes
9	307852	189620	Yes

Receptor	Easting	Northing	Glint and Glare Possible
10	308020	189512	Yes
11	308171	189382	Yes
12	308315	189295	Yes
13	308434	189143	Yes
14	308469	188949	Yes
15	308322	189125	Yes
16	308330	188925	Yes
17	308375	189080	Yes
18	310650	189229	Yes
19	310317	189408	Yes
20	310048	189667	Yes
21	309980	189853	Yes
22	309942	190046	Yes
23	309798	190157	Yes
24	309632	190243	Yes
25	309553	190426	Yes
26	308010	189861	No
27	308181	189758	No
28	308321	189616	No
29	308739	188511	No
30	308819	188330	No
31	308131	189899	No
32	308785	188482	No
33	308902	188321	No
34	309028	188221	No
35	309155	188369	No
36	309292	188515	No

Receptor	Easting	Northing	Glint and Glare Possible
37	309392	188687	No
38	309540	188780	No
39	309692	188654	No
40	309845	188528	No
41	309886	188345	No
42	310482	189315	No
43	310178	189520	No
44	309490	190614	No
45	309458	190799	No
46	309277	190873	No
47	309103	190900	No
48	308927	190991	No
49	308734	190968	No
50	308560	190873	No
51	308378	190791	No
52	308226	190663	No
53	308120	190495	No
54	308100	190303	No
55	308199	190129	No
56	308284	189951	No
57	308330	189763	No
58	308454	189607	No
59	308542	189454	No
60	308269	191034	No
61	308180	190857	No

7.100. There is one railway line, Caerphilly and Pontypridd Line, within the 1km study area (see **Figure 7.3: Appendix 7A**) which requires a detailed assessment.

7.101. The ground receptor no-reflection zones and areas of non-visibility are clearly identifiable on **Figure 7.3: Appendix 7A** and the process of how these are calculated is explained in **paragraphs 7.91 to 7.93** of this report.

7.102. **Table 7-4** shows a list of assessed receptors points within the study area which are 200m apart.

Table 7-4: Rail Based Receptors

Receptor	Easting	Northing	Glint and Glare Possible
1	307861	189585	Yes
2	308016	189460	Yes
3	308149	189310	Yes
4	308263	189146	Yes
5	308313	188955	Yes

Byway Receptors

7.103. Byway receptors located within 1km of the Application Site have been identified (**Table 7-5**). Glint was assumed to be possible if the receptor is located within the ground-based receptor zones outlined previously. The number in brackets indicates to which residential area the receptor belongs.

7.104. There are 11 byway receptors (Receptors –3 - 13) which are within the no-reflection zones and areas of non-visibility and are clearly identifiable in **Figure 7.4: Appendix 7A.** The process of how these are calculated is explained in **paragraphs 7.91 to 7.93** of this report.

Table 7-5: Byway Based Receptors

Receptor	Easting	Northing	Glint and Glare Possible
1	310564	189249	Yes
2	310598	189442	Yes
3	310617	189640	No
4	310644	189837	No
5	310742	190005	No
6	310732	190200	No
7	310694	190379	No

Receptor	Easting	Northing	Glint and Glare Possible
8	310573	190538	No
9	310538	190732	No
10	309473	190802	No
11	309520	190990	No
12	309504	191188	No
13	309544	191381	No

Aviation Receptors

7.105. Aerodromes within 30km of the Proposed Development can be found in **Table 7-6.**

Table 7-6: Airfields Within Close Proximity

Airfield	Distance	Use
Tremorfa Airfield	18.11	Helicopter strip
Cardiff airport	21.67	Licensed airport
Pen-y-Parc Farm	21.84	Small grass strip
St Athan Airport	22.02	Licensed airport
Rhigos Airfield	24.38	Small grass strip
Upfield Farm	28.29	Small grass strip
Old Park Farm	28.41	Small grass strip
Little Trostrey Farm	29.28	Small grass strip

7.106. There are eight aerodromes within 30km of the Proposed Development, none of which require a detailed assessment due to the Proposed Development being outside their respective safeguarding buffer zones outlined in **paragraph 7.73**

IMPACT ASSESSMENT

7.107. 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 take into account obstructions such as vegetation and buildings, discussion on the potentially impacted receptors is provided where necessary.

Ground Based Receptors

Residential Receptors

7.108. **Table 7-7** identifies the receptors that could potentially experience solar reflections based on solar reflection modelling and whether the reflections will be experienced in the morning (AM), evening (PM), or both.

7.109. The 86 receptors which were within the no-reflection zones and areas of non-visibility outlined previously have been excluded from the detailed modelling as they will never receive any glint and glare impacts from the Proposed Development.

7.110. **Appendix 7B and 7C** shows the analysis with the solar panels at a tilt angle of between 5 and 25 degrees and a height of 3m. **Table 7-7** shows the worst-case impact at each receptor.

Table 7-7: Potential for Glint and Glare Impact on Residential Receptors

Receptor	Glint Possible from Site		Potential Glare Impact (per year)		Magnitude of Impact	Worst Case Tilt Angle (Degrees)	Significance of Effect
	AM	PM	Minutes	Hours			
1	No	No	0	0	None	N/A	None
2	No	No	0	0	None	N/A	None
3 (1)	No	No	0	0	None	N/A	None
4 (1)	No	No	0	0	None	N/A	None
5 (1)	No	No	0	0	None	N/A	None
6 (2)	No	No	0	0	None	N/A	None
7 (2)	No	No	0	0	None	N/A	None
8 (3)	No	No	0	0	None	N/A	None
9 (3)	No	No	0	0	None	N/A	None

Receptor	Glint Possible from Site		Potential Glare Impact (per year)		Magnitude of Impact	Worst Case Tilt Angle (Degrees)	Significance of Effect
	AM	PM	Minutes	Hours			
10 (3)	No	No	0	0	None	N/A	None
11	No	No	0	0	None	N/A	None
12	Yes	Yes	2890	48.17	High	25	Major
13	Yes	No	2654	44.23	High	25	Major
14	No	No	0	0	None	N/A	None
15	No	No	0	0	None	N/A	None
16 (4)	No	No	0	0	None	N/A	None
17 (4)	No	No	0	0	None	N/A	None
18 (4)	No	No	0	0	None	N/A	None
19 (4)	No	No	0	0	None	N/A	None
20 (4)	No	No	0	0	None	N/A	None
21 (4)	No	No	0	0	None	N/A	None
22 (4)	No	No	0	0	None	N/A	None
23 (4)	No	No	0	0	None	N/A	None
24 (4)	No	No	0	0	None	N/A	None
25 (4)	No	No	0	0	None	N/A	None
26 (4)	No	No	0	0	None	N/A	None
27 (4)	No	No	0	0	None	N/A	None
28 (4)	No	No	0	0	None	N/A	None
29 (4)	No	No	0	0	None	N/A	None
30 (4)	No	No	0	0	None	N/A	None
31 (4)	No	No	0	0	None	N/A	None
32 (4)	No	No	0	0	None	N/A	None
33 (4)	No	No	0	0	None	N/A	None
34 (4)	No	No	0	0	None	N/A	None

Receptor	Glint Possible from Site		Potential Glare Impact (per year)		Magnitude of Impact	Worst Case Tilt Angle (Degrees)	Significance of Effect
	AM	PM	Minutes	Hours			
35 (4)	No	No	0	0	None	N/A	None
36 (4)	No	No	0	0	None	N/A	None
37 (4)	No	No	0	0	None	N/A	None
38 (4)	No	No	0	0	None	N/A	None
39 (4)	No	No	0	0	None	N/A	None
40 (4)	No	No	0	0	None	N/A	None
41 (4)	No	No	0	0	None	N/A	None
42 (4)	No	No	0	0	None	N/A	None
43 (5)	No	No	0	0	None	N/A	None
44 (5)	No	No	0	0	None	N/A	None
45 (5)	No	No	0	0	None	N/A	None
46 (5)	No	No	0	0	None	N/A	None
47 (5)	No	No	0	0	None	N/A	None
48 (5)	No	No	0	0	None	N/A	None
49 (6)	Yes	No	186	3.10	Low	25	Minor
50 (6)	Yes	No	126	2.10	Low	25	Minor
51 (6)	No	No	0	0	None	N/A	None
52 (6)	No	No	0	0	None	N/A	None
53 (6)	No	No	0	0	None	N/A	None
54 (6)	No	No	0	0	None	N/A	None
55 (6)	No	No	0	0	None	N/A	None
56 (6)	No	No	0	0	None	N/A	None
57 (6)	No	No	0	0	None	N/A	None
58 (6)	No	No	0	0	None	N/A	None
59 (6)	No	No	0	0	None	N/A	None

Receptor	Glint Possible from Site		Potential Glare Impact (per year)		Magnitude of Impact	Worst Case Tilt Angle (Degrees)	Significance of Effect
	AM	PM	Minutes	Hours			
60 (6)	No	No	0	0	None	N/A	None
61 (6)	No	No	0	0	None	N/A	None
62	No	Yes	726	12.10	Low	25	Minor
63	No	Yes	149	2.48	Low	5	Minor
64	No	Yes	5	0.08	Low	5	Minor
65	No	No	0	0	None	N/A	None

7.111. As can be seen in **Table 7-7**, there is a predicted **High** impact at two receptors, **Low** impact at five receptors, including one residential area, and no impact for the remaining 58 receptors, including five residential areas. **Appendix 7B and 7C** shows detailed analysis of when the glare impacts are possible, whilst also showing which parts of the solar farm the solar glare is reflected from.

7.112. **Appendix 7J** 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 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.

Receptor 12

7.113. The 'Glare Reflections on PV Footprint' chart in **Appendix 7C** shows that reflections from a southwest section Array 1, a northwest section of Array 2 and a central section of Array 4 (see **Figure 7.5: Appendix 7A**) in the Proposed Development can potentially impact on the receptor.

7.114. The first image in **Appendix 7J** is an aerial image showing the position of the receptor (yellow pin) in relation to the Proposed Development, and the locations from which the second and third images were taken (blue and red dots respectively). The second image is a photo with a southwest view towards the receptor. This image confirms that the vegetation is sufficient to screen all views of Array 4 in the Proposed Development where glint and glare is possible. The third image is a photo with an eastwards view towards the receptor. This image confirms that the vegetation and topography are insufficient to screen all views of Arrays 1 and 2 in the Proposed Development where glint and glare are possible. Therefore, the impact remains **High** with the significance of effect being **Major**.

Receptor 13

7.115. The 'Glare Reflections on PV Footprint' chart in **Appendix 7C** shows that reflections from two northern sections of Array 5 (see **Figure 7.5: Appendix 7A**) in the Proposed Development can potentially impact on the receptor.

7.116. The first image in **Appendix 7J** 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). The second image is a street view image with a view towards the Proposed Development. This image confirms that the vegetation and topography are sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None** with the significance of effect being **None**.

Receptors 49 and 50

7.117. The 'Glare Reflections on PV Footprint' chart in **Appendix 7C** shows that reflections from a small eastern section of Array 5 (see **Figure 7.5: Appendix 7A**) in the Proposed Development can potentially impact on the receptor.

7.118. The first image in **Appendix 7J** is an aerial image showing the position of the receptors (yellow pins) in relation to the Proposed Development, 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 Proposed Development. This image confirms that the vegetation and topography are sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None** with the significance of effect being **None**.

Receptors 62 - 64

7.119. The 'Glare Reflections on PV Footprint' chart in **Appendix 7B and 7C** shows that reflections from a central section of Array 5 (see **Figure 7.5: Appendix 7A**) in the Proposed Development can potentially impact on the receptor.

7.120. The first image in **Appendix 7J** 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. The second image is a photo with a view towards the Proposed Development. This image confirms that the topography and vegetation is sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None** with the significance of effect being **None**.

Residential Area 1

7.121. This encompasses a number of residential receptors including those at Receptors 3 – 6 (assessed previously) (See **Figure 7.1: Appendix 7A**). Each receptor assessed represents multiple receptors as they are in close proximity of each other, so the worst-case scenario is assumed for the impact of glint and glare. All receptors were considered within the visibility analysis, and it was concluded their impacts were similar. As per the assessments of these four receptors, the impacts on the other receptors within this area are assessed as being **None** with the significance of effect being **None (worst case scenario)**.

Residential Area 2

7.122. This encompasses a number of residential receptors including those at Receptors 7 and 8 (assessed previously) (See **Figure 7.1: Appendix 7A**). Each receptor assessed represents multiple receptors as they are in close proximity of each other, so the worst-case scenario is assumed for the impact of glint and glare. All receptors were considered within the visibility analysis, and it was concluded their impacts were similar. As per the assessments of these two receptors, the impacts on the other receptors within this area are assessed as being **None** with the significance of effect being **None (worst case scenario)**.

Residential Area 3

7.123. This encompasses a number of residential receptors including those at Receptors 9 - 11 (assessed previously) (See **Figure 7.1: Appendix 7A**). Each receptor assessed represents multiple receptors as they are in close proximity of each other, so the worst-case scenario is assumed for the impact of glint and glare. All receptors were considered within the visibility analysis, and it was concluded their impacts were similar. As per the assessments of these three receptors, the impacts on the other receptors within this area are assessed as being **None** with the significance of effect being **None (worst case scenario)**.

Residential Area 4

7.124. This encompasses a number of residential receptors including those at Receptors 16 - 42 (assessed previously) (See **Figure 7.1: Appendix 7A**). Each receptor assessed represents multiple receptors as they are in close proximity of each other, so the worst-case scenario is assumed for the impact of glint and glare. All receptors were considered within the visibility analysis, and it was concluded their impacts were similar. As per the assessments of these 27 receptors, the impacts on the other receptors within this area are assessed as being **None** with the significance of effect being **None (worst case scenario)**.

Residential Area 5

7.125. This encompasses a number of residential receptors including those at Receptors 43 - 48 (assessed previously) (See **Figure 171: Appendix 7A**). Each receptor assessed represents multiple receptors as they are in close proximity of each other, so the worst-case scenario is assumed for the impact of glint and glare. All receptors were considered within the visibility analysis, and it was concluded their impacts were similar. As per the assessments of these six receptors, the impacts on the other receptors within this area are assessed as being **None** with the significance of effect being **None (worst case scenario)**.

Residential Area 6

7.126. This encompasses a number of residential receptors including those at Receptors 51 - 61 (assessed previously) (See **Figure 7.1: Appendix 7A**). Each receptor assessed represents multiple receptors as they are in close proximity of each other, so the worst-case scenario is assumed for the impact of glint and glare. All receptors were considered within the visibility analysis, and it was concluded their impacts were similar. As per the assessments of these 11 receptors, the impacts on the other receptors within this area are assessed as being **None** with the significance of effect being **None (worst case scenario)**.

Road Receptors

7.127. **Table 7-8** 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 7D and 7E**.

7.128. The 36 receptors within the no-reflection zones and areas of non-visibility outlined previously have been excluded from the detailed modelling as they will never receive glint and glare impacts from the Proposed Development.

Table 7-8: Potential for Glint and Glare Impact on Road Receptors

Receptor	Green Glare (mins)	Yellow Glare (mins)	Red Glare (mins)	Magnitude of Impact	Worst Case Tilt Angle (Degrees)	Significance of Effect
1	821	0	0	Low	25	Minor
2	1336	0	0	Low	25	Minor
3	1234	0	0	Low	25	Minor
4	1464	0	0	Low	25	Minor
5	1451	0	0	Low	25	Minor
6	0	0	0	None	N/A	None
7	0	0	0	None	N/A	None
8	0	0	0	None	N/A	None
9	2342	0	0	Low	25	Minor

Receptor	Green Glare (mins)	Yellow Glare (mins)	Red Glare (mins)	Magnitude of Impact	Worst Case Tilt Angle (Degrees)	Significance of Effect
10	5673	0	0	Low	25	Minor
11	3935	0	0	Low	25	Minor
12	2491	0	0	Low	25	Minor
13	502	0	0	Low	25	Minor
14	2130	0	0	Low	25	Minor
15	2123	0	0	Low	25	Minor
16	2873	0	0	Low	25	Minor
17	1876	0	0	Low	25	Minor
18	8580	0	0	Low	25	Minor
19	9165	0	0	Low	25	Minor
20	9162	560	0	High	5	Major
21	8397	4490	0	High	5	Major
22	9457	5416	0	High	5	Major
23	17682	6668	0	High	5	Major
24	26242	14792	0	High	5	Major
25	36982	15075	0	High	5	Major

7.129. As can be seen in **Table 7-8**, there are six receptor points which have potential glare impacts with the "potential for after-image" (yellow glare), which is a **High** impact and 16 receptor points which have potential glare impacts with the "low-potential for after-image" (green glare), which is a **Low** impact. **Appendix 7D and 7E** shows detailed analysis of when the glint and glare impacts are possible, whilst also showing from which parts of the solar farm the solar glare is reflected from.

7.130. **Appendix 7J** 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 7.80**, 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.

7.131. As can be seen in **Appendix 7J**, views of the Proposed Development from all receptors, except Receptors 23 and 24 are blocked by a mixture of intervening vegetation, topography and buildings or are outside the driver's field of view. Therefore, impacts upon these receptors reduce to **None** with the significance of effect being **None**. Ground level images taken at 17:45 UTC on March 1st and July 1st respectively confirm that the sun is the main source of glint and glare at Receptor 23 and ground level images taken at 16:00 UTC on January 15th and at 18:15 on July 1st respectively confirm that the sun is the main source of glint and glare at Receptor 24. Therefore, impacts upon these receptors reduce to **Low**.

Rail Receptors

7.132. **Table 7-9** shows a summary of the modelling results for each of the Rail Receptor Points whilst the detailed results and ocular impact charts can be viewed in **Appendix 7F and 7G**.

7.133. There are no receptors within the no-reflection zones or areas of non-visibility outlined previously, therefore none have been excluded from the detailed modelling.

Table 7-9: Potential for Glint and Glare Impact on Rail Receptors

Receptor	Green Glare (mins)	Yellow Glare (mins)	Red Glare (mins)	Magnitude of Impact	Worst Case Tilt Angle (Degrees)	Significance of Effect
1	5884	0	0	Low	25	Minor
2	6330	0	0	Low	25	Minor
3	3466	0	0	Low	25	Minor
4	2895	0	0	Low	25	Minor
5	2948	0	0	Low	25	Minor

7.134. As can be seen in **Table 7-9**, there are five receptor points which have potential glare impacts with the "low-potential for after-image" (green glare), which is a **Low** impact. **Appendix 7F and 7G** shows detailed analysis of when the glint and glare impacts are possible, whilst also showing from which parts of the solar farm the solar glare is reflected from.

7.135. **Appendix 7J** 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 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.

Receptor 1

7.136. The 'Glare Reflections on PV Footprint' chart in **Appendix 7G** shows that reflections from a northern section of Array 1, a northern section of Array 2, a central section of Array 3 and a northern section of Array 4 (see **Figure 7.5: Appendix 7A**) in the Proposed Development can potentially impact on the receptor.

7.137. The first image in **Appendix 7J** is an aerial image showing the position of the receptor (yellow pin) in relation to the Proposed Development and visibility cones from the perspective of the train driver. The second image is a ground level image taken from the position of the receptor with a view towards the Proposed Development. These images confirm that the topography is sufficient to screen all views of the Proposed Development where glint and glare is possible, and the areas of the Proposed Development where glint and glare is possible are outside the train driver's field of view. Therefore, the impact reduces to **None** with the significance of effect being **None**.

Receptor 2

7.138. The 'Glare Reflections on PV Footprint' chart in **Appendix 7G** shows that reflections from all, except a northern section, of Array 1, a northwest section of Array 2, a southern section of Array 3 and the northern half of Array 4 (see **Figure 7.5: Appendix 7A**) in the Proposed Development can potentially impact on the receptor.

7.139. The first image in **Appendix 7J** is an aerial image showing the position of the receptor (yellow pin) in relation to the Proposed Development and visibility cones from the perspective of the train driver. The second image is a ground level image taken from the position of the receptor with a view towards the Proposed Development. These images confirm that the topography is sufficient to screen all views of the Proposed Development where glint and glare is possible, and the areas of the Proposed Development where glint and glare is possible are outside the train driver's field of view. Therefore, the impact reduces to **None** with the significance of effect being **None**.

Receptor 3

7.140. The 'Glare Reflections on PV Footprint' chart in **Appendix 7G** shows that reflections from a southeast section of Array 2, a small southern section of Array 3, all, except a northwest section, of Array 4 and a northern section of Array 5 (see **Figure 7.5: Appendix 7A**) in the Proposed Development can potentially impact on the receptor.

7.141. The first image in **Appendix 7J** is an aerial image showing the position of the receptor (yellow pin) in relation to the Proposed Development and visibility cones from the perspective of the train driver, and the location from which the second image was taken (red pin). The second image is a street view image with a view towards the Receptor. These images confirm that the vegetation will filter views of the Proposed Development where glint and glare is possible, and the areas of the Proposed Development where glint and glare is possible are outside the train driver's field of view. Therefore, the impact reduces to **None** with the significance of effect being **None**.

Receptor 4

7.142. The 'Glare Reflections on PV Footprint' chart in **Appendix 7G** shows that reflections from a southeast section of Array 4 and the northern half of Array 5 (see **Figure 7.5: Appendix 7A**) in the Proposed Development can potentially impact on the receptor.

7.143. The first image in **Appendix 7J** is an aerial image showing the position of the receptor (yellow pin) in relation to the Proposed Development and visibility cones from the perspective of the train driver. The second image is a ground level image taken from the position of the receptor with a view towards the Proposed Development. These images confirm that the areas of the Proposed Development where glint and glare is possible are outside the train driver's field of view. Therefore, the impact reduces to **None** with the significance of effect being **None**.

Receptor 5

7.144. The 'Glare Reflections on PV Footprint' chart in **Appendix 7G** shows that reflections from the southern half of Array 5 (see **Figure 7.5: Appendix 7A**) in the Proposed Development can potentially impact on the receptor.

7.145. The first image in **Appendix 7J** is an aerial image showing the position of the receptor (yellow pin) in relation to the Proposed Development and visibility cones from the perspective of the train driver, 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 Proposed Development. These images confirm that the areas of the Proposed Development where glint and glare is possible are outside the train driver's field of view. Therefore, the impact reduces to **None** with the significance of effect being **None**.

Byway Receptors

7.146. **Table 7-10** shows a summary of the modelling results for each of the Byway Receptor Points whilst the detailed results and ocular impact charts can be viewed in **Appendix 7H and 7I**.

7.147. The 11 receptors within the no-reflection zones and areas of non-visibility outlined previously have been excluded from the detailed modelling as they will never receive glint and glare impacts from the Proposed Development.

Table 7-10: Potential for Glint and Glare Impact on Byway Receptors

Receptor	Green Glare (mins)	Yellow Glare (mins)	Red Glare (mins)	Magnitude of Impact	Worst Case Tilt Angle (Degrees)	Significance of Effect
1	7826	0	0	Low	25	Minor
2	13246	0	0	Low	25	Minor

7.148. As can be seen in **Table 7-10**, there is a predicted **Low** impact at two receptors. **Appendix 7H and 7I** shows detailed analysis of when the glare impacts are possible, whilst also showing which parts of the solar farm the solar glare is reflected from.

7.149. **Appendix 7J** 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 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.

Receptor 1

7.150. The 'Glare Reflections on PV Footprint' chart in **Appendix 7I** shows that reflections from all, except a northern section, of Array 1, all of Array 2, a small southern section of Array 4, and all, except a northern and southwest section, of Array 5 (see **Figure 7.5: Appendix 7A**) in the Proposed Development can potentially impact on the receptor.

7.151. The first image in **Appendix 7J** is an aerial image showing the position of the receptor (yellow pin) in relation to the Proposed Development. The second image is a ground level image taken from the position of the receptor with a view towards the Proposed Development. This image confirms that the topography is sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None** with the significance of effect being **None**.

Receptor 2

7.152. The ‘Glare Reflections on PV Footprint’ chart in **Appendix 7I** shows that reflections from all of Array 1, all of Array 2, a southern section of Array 3, a southern section of Array 4, and the northern half of Array 5 (see **Figure 7.5: Appendix 7A**) in the Proposed Development can potentially impact on the receptor.

7.153. The first image in **Appendix 7J** 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). The second image is a street view image with a view towards the Receptor. This image confirms that the topography is sufficient to screen all views of the Proposed Development where glint and glare is possible. Therefore, the impact reduces to **None** with the significance of effect being **None**.

GROUND BASED RECEPTOR MITIGATION

7.154. Mitigation is required to be put in place when there are potentially significant effects from **High** and **Medium** impact views into the Proposed Development.

7.155. Mitigation is required to ensure the **High** impact views from Residential Receptor 12 into the Proposed Development are screened. Mitigation has been included to screen the **Low** impact views from Road Receptors 23 and 24 into the Proposed Development. This includes the below and can be seen in the LEMP.

- Native hedgerows/woodland to be planted/infilled along the eastern boundaries of Fields 32 and 34 and along the northeast boundaries of Fields 4, 7 and 11 and the northern boundary of Fields 12, 13 and 14 to a height of at least 3m. When implemented this will initially reduce views intermittently and reduce the impact to **Low** and significance of effect to **Minor**. Once established this will screen views from Road Receptor 24. Therefore, reducing the impact to **None** and significance of effect to **None.**

7.156. **Table 7-11, Table 7-12, Table 7-13 and Table 7-14** show the impacts at each stage of the glint and glare analysis, with the final residual impacts considered once the mitigation is in place.

Table 7-11: Potential Residual Glint and Glare Impact on Residential Receptors

Receptor	Magnitude of Impact			
	After Geometric Analysis	After Visibility Analysis	Residual Impacts Following Mitigation	Residual Effects (When mitigation Established)
1	None	None	None	None
2	None	None	None	None
3 (1)	None	None	None	None
4 (1)	None	None	None	None
5 (1)	None	None	None	None
6 (2)	None	None	None	None
7 (2)	None	None	None	None
8 (3)	None	None	None	None
9 (3)	None	None	None	None

Receptor	Magnitude of Impact			
	After Geometric Analysis	After Visibility Analysis	Residual Impacts Following Mitigation	Residual Effects (When mitigation Established)
10 (3)	None	None	None	None
11	None	None	None	None
12	High	High	None	None
13	High	None	None	None
14	None	None	None	None
15	None	None	None	None
16 (4)	None	None	None	None
17 (4)	None	None	None	None
18 (4)	None	None	None	None
19 (4)	None	None	None	None
20 (4)	None	None	None	None
21 (4)	None	None	None	None
22 (4)	None	None	None	None
23 (4)	None	None	None	None
24 (4)	None	None	None	None
25 (4)	None	None	None	None
26 (4)	None	None	None	None
27 (4)	None	None	None	None
28 (4)	None	None	None	None
29 (4)	None	None	None	None
30 (4)	None	None	None	None
31 (4)	None	None	None	None
32 (4)	None	None	None	None
33 (4)	None	None	None	None

Receptor	Magnitude of Impact			
	After Geometric Analysis	After Visibility Analysis	Residual Impacts Following Mitigation	Residual Effects (When mitigation Established)
34 (4)	None	None	None	None
35 (4)	None	None	None	None
36 (4)	None	None	None	None
37 (4)	None	None	None	None
38 (4)	None	None	None	None
39 (4)	None	None	None	None
40 (4)	None	None	None	None
41 (4)	None	None	None	None
42 (4)	None	None	None	None
43 (5)	None	None	None	None
44 (5)	None	None	None	None
45 (5)	None	None	None	None
46 (5)	None	None	None	None
47 (5)	None	None	None	None
48 (5)	None	None	None	None
49 (6)	Low	None	None	None
50 (6)	Low	None	None	None
51 (6)	None	None	None	None
52 (6)	None	None	None	None
53 (6)	None	None	None	None
54 (6)	None	None	None	None
55 (6)	None	None	None	None
56 (6)	None	None	None	None
57 (6)	None	None	None	None

Receptor	Magnitude of Impact			
	After Geometric Analysis	After Visibility Analysis	Residual Impacts Following Mitigation	Residual Effects (When mitigation Established)
58 (6)	None	None	None	None
59 (6)	None	None	None	None
60 (6)	None	None	None	None
61 (6)	None	None	None	None
62	Low	None	None	None
63	Low	None	None	None
64	Low	None	None	None
65	None	None	None	None

Table 7-12: Potential Residual Glint and Glare Impacts on Road Receptors

Receptor	Magnitude of Impact			
	After Geometric Analysis	After Visibility Analysis	Residual Impacts Following Mitigation	Residual Effects (When mitigation Established)
1	Low	None	None	None
2	Low	None	None	None
3	Low	None	None	None
4	Low	None	None	None
5	Low	None	None	None
6	None	None	None	None
7	None	None	None	None
8	None	None	None	None
9	Low	None	None	None
10	Low	None	None	None

Receptor	Magnitude of Impact			
	After Geometric Analysis	After Visibility Analysis	Residual Impacts Following Mitigation	Residual Effects (When mitigation Established)
11	Low	None	None	None
12	Low	None	None	None
13	Low	None	None	None
14	Low	None	None	None
15	Low	None	None	None
16	Low	None	None	None
17	Low	None	None	None
18	Low	None	None	None
19	Low	None	None	None
20	High	None	None	None
21	High	None	None	None
22	High	None	None	None
23	High	Low	Low	None
24	High	High	None	None
25	High	None	None	None

Table 7-13: Potential Residual Glint and Glare Impacts on Rail Receptors

Receptor	Magnitude of Impact			
	After Geometric Analysis	After Visibility Analysis	Residual Impacts Following Mitigation	Residual Effects (When mitigation Established)
1	Low	None	None	None
2	Low	None	None	None
3	Low	None	None	None

Receptor	Magnitude of Impact			
	After Geometric Analysis	After Visibility Analysis	Residual Impacts Following Mitigation	Residual Effects (When mitigation Established)
4	Low	None	None	None
5	Low	None	None	None

Table 7-14: Potential Residual Glint and Glare Impacts on Byway Receptors

Receptor	Magnitude of Impact			
	After Geometric Analysis	After Visibility Analysis	Residual Impacts Following Mitigation	Residual Effects (When mitigation Established)
1	Low	None	None	None
2	Low	None	None	None

7.157. Table 7-15, Table 7-16, Table 7-17 and Table 7 - 18 show the overall impacts for all residential and road receptors.

Table 7-15: Solar Reflections: Residential Receptors

Magnitude	Theoretical Visibility	Actual Visibility (No Mitigation)	Actual Visibility with Mitigation
High	2	1	0
Medium	0	0	0
Low	5	0	0
None	58	64	65

- **High** – Solar reflections impact of over 30 hours per year or over 30 minutes per day
- **Medium** – Solar reflections impact between 20 and 30 hours per year or between 20 minutes and 30 minutes per day
- **Low** – Solar reflections impact 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 7-16: Solar Reflections: Road Receptors

Magnitude	Theoretical Visibility	Actual Visibility (No Mitigation)	Actual Visibility with Mitigation
High	6	0	0
Low	16	2	0
None	3	23	25

- **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

Table 7-17: Solar Reflections: Rail Receptors

Magnitude	Theoretical Visibility	Actual Visibility (No Mitigation)	Actual Visibility with Mitigation
High	0	0	0
Low	5	0	0
None	0	5	5

- **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

Table 7 - 18: Solar Reflections: Byway Receptors

Magnitude	Theoretical Visibility	Actual Visibility (No Mitigation)	Actual Visibility with Mitigation
High	0	0	0
Low	2	0	0
None	0	2	2

- **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

CUMULATIVE ASSESSMENT

7.158. The Proposed Development is not within 1km of any existing or planned solar developments. Therefore, a cumulative assessment is not required.

CONCLUSION

7.159. There is little guidance or policy available in the UK at present in relation to the assessment of glint and glare from proposed solar farm developments. However, it is recognised as a potential impact which needs to be considered for a proposed solar farm development, therefore this assessment considers the potential impacts on ground-based receptors such as roads, rail, and residential dwellings as well as aviation assets.

7.160. This assessment considers the potential impacts on ground-based receptors such as roads, rail and residential dwellings as well as aviation assets. A 1km study 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 151 identified residential receptors, including eight residential areas, 61 road receptors, five rail receptors and 13 byway 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 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 assessed in detail. 86 residential receptors, including two residential areas, 36 road receptors and 11 byway receptors were dismissed as they are located within the no reflection zones or areas of non-visibility. Eight aerodromes are located within the 30km study area, none of which required a detailed assessment due to the Proposed Development falling outside their respective safeguarding buffer zones, which is outlined in paragraph 21.

7.161. Geometric analysis was conducted at 65 individual residential receptors, including six residential areas, 25 road receptors, five rail receptors and two byway receptors.

7.162. The assessment concludes that:

- Solar reflections are possible at seven of the 65 residential receptors assessed within the 1km study area. The initial bald-earth scenario identified potential impacts as **High** at two receptors, **Low** at five receptors, including one residential area, and **None** at the remaining 58 receptors, including five residential areas. Upon reviewing the actual visibility of the receptor, glint and glare impacts remain **High** at one receptor and reduce to **None** at 64 receptors. Once mitigation measures were considered, glint and glare impacts reduce to **None** at all receptors. The effects from the Proposed Development are therefore **None**.

- Solar reflections are possible at 22 of the 25 road receptors assessed within the 1km study area. The initial bald-earth scenario identified potential impacts as **High** at six receptors, **Low** at 16 receptors and **None** at the remaining three receptors. Upon reviewing the actual visibility of the receptors, glint and glare impacts reduce to **Low** at two receptors and **None** at all remaining receptors. Once mitigation measures were considered all impacts reduce to **None** at all receptors. The effects from the Proposed Development are therefore **None**.

- Solar reflections are possible at all the rail receptors assessed within the 1km study area. The initial bald-earth scenario identified potential impacts as **Low** at five receptors. Upon reviewing the actual visibility of the receptors, glint and glare impacts reduce to **None** at all receptors. The effects from the Proposed Development are therefore **None**.
- Solar reflections are possible at all the byway receptors assessed within the 1km study area. The initial bald-earth scenario identified potential impacts as **Low** at two receptors. Upon reviewing the actual visibility of the receptors, glint and glare impacts reduce **None** at all receptors. The effects from the Proposed Development are therefore **None**.

7.163. Mitigation is required to ensure the **High** impact views from Residential Receptor 12 into the Proposed Development are screened, and mitigation is recommended to screen the **Low** impact views from Road Receptors 23 and 24. This includes native hedgerows/woodland to be planted/infilled along the eastern boundaries of Fields 32 and 34, along the northeast boundary of Fields 4, 7 and 11 and along the northern boundary of Fields 12, 13 and 14 and maintained to a height of at least 3m.

7.164. The effects of glint and glare and their impact on local receptors has been analysed in detail and the impact on all receptors is predicted to be **no impacts** upon residential, road, rail and byway receptors once mitigation has been considered. Residual effects on residential, road, rail and byway receptors is **None**. Therefore, the effects are **None**.

APPENDICES

Appendix 7A: Figures

- Figure 7.1: Residential Based Receptors
- Figure 7.2: Road Based Receptors
- Figure 7.3: Rail Based Receptors
- Figure 7.4: Byway Based Receptors
- Figure 7.5: Panel Area Labels

Appendix 7B: Residential Receptor Glare Results 5 Degrees

Appendix 7C: Residential Receptor Glare Results 25 Degrees

Appendix 7D: Road Receptor Glare Results 5 Degrees

Appendix 7E: Road Receptor Glare Results 25 Degrees

Appendix 7F: Rail Receptor Glare Results 5 Degrees

Appendix 7G: Rail Receptor Glare Results 25 Degrees

Appendix 7H: Byway Receptor Glare Results 5 Degrees

Appendix 7I: Byway Receptor Glare Results 25 Degrees

Appendix 7J: Visibility Assessment Evidence

Appendix 7K: Solar Module Glare and Reflectance Technical Memo[23]

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