Galileo 03 Ltd.

Mynydd Ty-talwyn Energy Park - Environmental Statement Volume III

Appendix 4.6: Solar Photovoltaic Glint and Glare Study

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Urban & Renewables

Solar Photovoltaic Glint and Glare Study

Mynydd Ty-talwyn Energy Park

Galileo 03 Limited

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Job Reference:	12169B
Author:	Abdul Wadud
Email:	abdul@pagerpower.com

Reviewed By:	Phillip Charhill; Jacob Cunningham
Email:	phillip@pagerpower.com; jacob@pagerpower.com

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1	March 2025	Initial issue
2	March 2025	Administrative revisions
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5	April 2026	High-level assessment of Public Rights of Way

Stour Valley Business Centre, Brundon Lane, Sudbury, CO10 7GB

T:*+44 (0)1787 319001* E:*info@pagerpower.com* W: *www.pagerpower.com*

EXECUTIVE SUMMARY

Report Purpose

This report has been prepared by Pager Power on behalf of Galileo 03 Ltd (part of Galileo Empower UK Ltd) (hereinafter referred to as 'Galileo' or the 'Applicant').

Pager Power has been retained to assess the potential effects of glint and glare from a ground-mounted solar photovoltaic development, the 'Proposed Development', as part of the proposed Mynydd Ty-talwyn Energy Park located in Bridgend County Borough, south Wales. This assessment pertains to the potential impact upon road safety, residential amenity, and aviation activity.

Overall Conclusions

No significant impact is predicted upon road safety, residential amenity, and aviation activity. Mitigation is not recommended.

Guidance and Studies

Guidelines exist in the UK (produced by the Civil Aviation Authority) and in the USA (produced by the Federal Aviation Administration) with respect to solar developments and aviation activity. The UK CAA guidance is relatively high-level and does not prescribe a formal methodology. Pager Power has, however, produced guidance for glint and glare and solar photovoltaic developments which was published in early 2017, with the fourth edition published in 2022[1]. This methodology defines a comprehensive process for determining the impact upon road safety, residential amenity, and aviation activity.

Pager Power's approach is to identify receptors, undertake geometric reflection calculations and, where a solar reflection is predicted, consider the screening (existing and/or proposed) between the receptor and the reflecting solar panels, whilst comparing the results against available solar reflection studies. For aviation activity, where a solar reflection is predicted, solar intensity calculations are undertaken where appropriate in line with the Sandia National Laboratories' FAA methodology[2]. The scenario in which a solar reflection can occur for all receptors is then identified and discussed, and a comparison is made against the available solar panel reflection studies to determine the overall impact.

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[1] Pager Power Glint and Glare Guidance, Fourth Edition, September 2022

[2] Formerly mandatory for on-airfield solar developments in the USA under the FAA's interim policy, superseded in 2021 with a policy that effectively requires individual airports to sign off on their on-airfield development as they see fit.

Published guidance shows that the intensity of solar reflections from solar panels are equal to or less than those from still water and similar to those from glass. It also shows that reflections from solar panels are significantly less intense than many other reflective surfaces, which are common in an outdoor environment, including steel[3][4].

Assessment Results – Aviation Activity

Solar reflections with intensities 'low potential for temporary after-image' ('green' glare) are predicted towards the splayed approached paths, join, and final sections of visual circuits for runways and 01/19 and 12/30 at Old Park Farm. The glare intensity is considered acceptable in accordance with the associated guidance (**Annex D**) and industry best practice. A low impact is predicted and mitigation is not recommended.

Assessment Results – Road Safety

Views of the Proposed Development for road users along the A4063 are significantly screened by existing vegetation and intervening terrain, such that views of the Proposed Development are not considered possible. No impact is predicted upon the A4063, and mitigation is not required.

The impact upon local roads within 1km of the assessment area is considered to be low in accordance with the associate guidance presented in **Annex D**. Mitigation is not recommended.

Assessment Results – Residential Amenity

Solar reflections are geometrically possible towards 27 dwellings. Screening in the form of existing and proposed vegetation, existing buildings and/or intervening terrain is predicted to significantly obstruct views of reflecting panels, such that solar reflections are not predicted to be experienced. No impact is predicted, and mitigation is not required.

Assessment Results – Public Rights of Way

No significant effects upon public rights of way are predicted due to the sensitivity of the receptors (in terms of amenity and safety) being low and any impact being of a low magnitude, when considering the worst case (Section 6). Therefore, mitigation is not required.

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[3] SunPower, 2009, SunPower Solar Module Glare and Reflectance (appendix to Solargen Energy,2010).

[4] SunPower, 2009, SunPower Solar Module Glare and Reflectance (appendix to Solargen Energy,2010).

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ABOUT PAGER POWER

Pager Power is a dedicated consultancy company based in Suffolk, UK. The company has undertaken projects in 63 countries within Europe, Africa, America, Asia and Australasia.

The company comprises a team of experts to provide technical expertise and guidance on a range of planning issues for large and small developments.

Pager Power was established in 1997. Initially the company focus was on modelling the impact of wind turbines on radar systems. Over the years, the company has expanded into numerous fields including:

- Renewable energy projects;
- Building developments; and
- Aviation and telecommunication systems.

Pager Power prides itself on providing comprehensive, understandable and accurate assessments of complex issues in line with national and international standards. This is underpinned by its custom software, longstanding relationships with stakeholders and active role in conferences and research efforts around the world.

Pager Power's assessments withstand legal scrutiny and the company can provide support for a project at any stage.

1 INTRODUCTION

1.1 Overview

This report has been prepared by Pager Power on behalf of Galileo 03 Ltd (part of Galileo Empower UK Ltd) (hereinafter referred to as 'Galileo' or the 'Applicant').

Pager Power has been retained to assess the potential effects of glint and glare from ground-mounted solar photovoltaics as part of the proposed Mynydd Ty-talwyn Energy Park located in Bridgend, County Borough, south Wales, the 'Proposed Development'.

The Environmental Impact Assessment (EIA) Scoping Direction received by PEDW, as provided within **Environmental Statement (ES) Volume III, Appendix 1.2: Scoping Direction** determined that glint and glare should be scoped into the ES, but not as a stand alone chapter. Where relevant, the visual aspects of solar, and associated glint and glare, have been considered in the technical chapters of the ES.

This assessment pertains to the potential impact upon road safety, residential amenity, aviation activity and users of Public Rights of Way (PRoW).

This report contains the following:

- Solar development details;
- Explanation of glint and glare;
- Overview of relevant guidance and studies;
- Overview of Sun movement;
- Assessment methodology;
- Identification of receptors;
- Glint and glare assessment for identified receptors;
- Results discussion; and
- Overall conclusions.

1.2 Pager Power's Experience

Pager Power has undertaken over 1,500 Glint and Glare assessments in the UK and internationally. The studies have included assessment of civil and military aerodromes, railway infrastructure and other ground-based receptors including roads and dwellings.

1.3 Glint and Glare Definition

The definition[5] of glint and glare is as follows:

- Glint – a momentary flash of bright light typically received by moving receptors or from moving reflectors; and
- Glare – a continuous source of bright light typically received by static receptors or from large reflective surfaces.

The term 'solar reflection' is used in this report to refer to both reflection types i.e. glint and glare.

[5]These definitions are aligned with those presented within the National Policy Statement for Renewable Energy Infrastructure (EN-3) – published by the Department for Energy Security and Net Zero and the Federal Aviation Administration in the USA.

2 SOLAR DEVELOPMENT LOCATION AND DETAILS

2.1 Proposed Development Site Layout

The Site layout[6] and landscape strategy is shown in Figure 1 below. Solar panel areas are denoted by areas of blue.

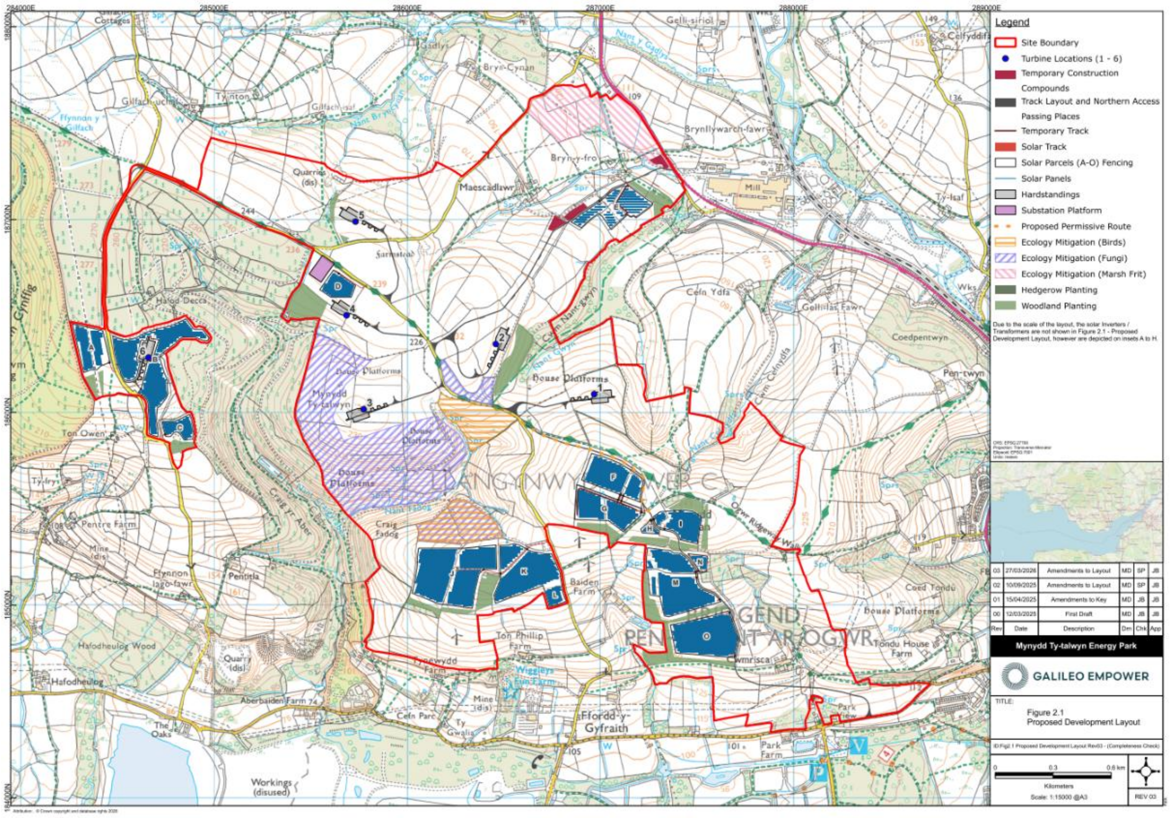

Figure 1 *Site layout*

Proposed screening as part of the landscape strategy has been considered within this assessment.

2.2 Reflector Areas

The bounding coordinates for the Proposed Development have been extrapolated from the Site plans. The data can be found in Annex G. Figure 2 on the following page shows the assessed reflector areas that have been used for modelling purposes.

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[6] Source: RSK, September 2025, 'Fig2.1 Proposed Development Layout (Post PAC Changes) rev1'

Figure 2 *Assessed reflector areas*

The Pager Power model has used a resolution of 20 m for this assessment. This means that a geometric calculation is undertaken for each identified receptor every 20 m from within the defined areas. This resolution is sufficiently high to maximise the accuracy of the results – increasing the resolution further would not significantly change the modelling output. If a reflection is experienced from an assessed panel location, then it is likely that a reflection will be viewable from similarly located panels within the Proposed Development.

2.3 Solar Panel Technical Information

The technical information of the modelled solar panels used in this assessment is summarised below:

- Azimuth angle[7]: 180°;
- Elevation angle[8]: 20°;
- Assessed height[9]: 3.0m above ground level.

Further information regarding the modelled surface material is presented in Section 5.2.1.

[7] Direction the panels are facing relative to True North (0°)

[8] Pitch above horizontal

[9] Assessed at the maximum height of the panel above ground level

3 GLINT AND GLARE ASSESSMENT METHODOLOGY

3.1 Guidance and Studies

Guidelines exist in the UK (produced by the Civil Aviation Authority) and in the USA (produced by the Federal Aviation Administration) with respect to solar developments and aviation activity. Pager Power has, however, produced guidance for glint and glare and solar photovoltaic developments, which was published in early 2017, with the fourth edition[10] published in 2022. This methodology defines a comprehensive process for determining the impact upon road safety, residential amenity, and aviation activity.

The Pager Power approach is to identify receptors, undertake geometric reflection calculations and review the scenario under which a solar reflection can occur, whilst comparing the results against available solar reflection studies.

Annex A and **B** present a review of relevant guidance and independent studies with regard to glint and glare issues from solar panels and glass. The overall conclusions from the available studies are as follows:

- Specular reflections of the Sun from solar panels and glass are possible; and
- The measured intensity of a reflection from solar panels can vary from 2% to 30% depending on the angle of incidence;

Published guidance shows that the intensity of solar reflections from solar panels are equal to or less than those from still water and similar to those from glass. It also shows that reflections from solar panels are significantly less intense than many other reflective surfaces, which are common in an outdoor environment, including steel[11].

3.2 Background

Details of the Sun's movements and solar reflections are presented in **Annex C.**

3.3 Methodology

Information regarding Pager Power's and Sandia National Laboratories' methodology is presented in the following sub-sections, Sections 3.3.1 and 3.3.2 respectively.

3.3.1 Pager Power's Methodology

The glint and glare assessment methodology has been derived from the information provided to Pager Power through consultation with stakeholders and by reviewing the

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[10] Pager Power Glint and Glare Guidance, Fourth Edition, September 2022.

[11] SunPower, 2009, SunPower Solar Module Glare and Reflectance (appendix to Solargen Energy,2010).

available guidance, studies and Pager Power's practical experience. The methodology for this glint and glare assessment is as follows:

- Identify receptors in the area surrounding the Proposed Development;
- Consider direct solar reflections from the Proposed Development towards the identified receptors by undertaking geometric calculations;
- Consider the visibility of the reflectors from the receptor's location. If the reflectors are not visible from the receptor, then no reflection can occur;
- Based on the results of the geometric calculations, determine whether a reflection can occur, and if so, at what time it will occur;
- Consider the solar reflection intensity, if appropriate;
- Consider both the solar reflection from the Proposed Development and the location of the direct sunlight with respect to the receptor's position;
- Consider the solar reflection with respect to the published studies and guidance; and
- Determine whether a significant detrimental impact is expected in line with **Annex D**.

Within the Pager Power model, the reflector area is defined, as well as the relevant receptor locations. The result is a chart that states whether a reflection can occur, the duration and the panels that can produce the solar reflection towards the receptor.

3.3.2 Sandia National Laboratories' Methodology

Sandia National Laboratories developed the Solar Glare Hazard Analysis Tool (SGHAT) which is no longer freely available, however it is now developed by Forge Solar. Pager Power uses this model where required for aviation receptors. Whilst strictly applicable in the USA and to solar photovoltaic developments only, the methodology is widely used by aviation stakeholders internationally.

3.4 Assessment Methodology and Limitations

Further technical details regarding the methodology of the geometric calculations and limitations are presented in **Annex E** and **Annex F**.

4 IDENTIFICATION OF RECEPTORS

4.1 Overview

The following sections present the relevant receptors assessed for impacts due to glint and glare from the Proposed Development. Terrain data has been interpolated based on Ordnance Survey of Great Britain (OSGB) 50 Digital Terrain Model (DTM) data. The receptor details for all receptors are presented in **Annex G**.

4.2 Aviation Receptors

4.2.1 Old Park Farm

Old Park Farm is an unlicensed General Aviation (GA) aerodrome with two operational runways (01/19 and 12/30) and not understood to have an Air Traffic Control (ATC) Tower.

Old Park Farm is approximately 3.66 km southwest of the Proposed Development. The location relative to the Proposed Development is shown in **Figure 3** below.

Figure 3 *Old Park Farm relative to Proposed Development*

4.2.2 Runway Approach Paths and Final Sections of Visual Circuits

Old Park Farm is a GA aerodrome where aviation activity is dynamic and does not necessarily follow the typical approaches / flight paths of a larger licensed aerodrome or airport. It is not possible to assess every single location of airspace that an aircraft travels in flight around an aerodrome; however, it is possible to assess the most frequently flown flight paths and the most critical stages of flight, which would cover most, or all, of the relevant locations. This is in accordance with the accepted industry practice for licensed aerodromes, and therefore provides a level confidence in professional judgement.

As such, Pager Power's methodology is to assess whether a solar reflection can be experienced on the following characteristics:

- 1-mile approach path with a splay angle of 5 degrees, considering 2.5 degrees either side of the extended runway centreline;
- A descent angle of 5 degrees;
- Circuit width of 1 nautical mile from runway centreline; and
- Maximum altitude of 500 feet above the average threshold altitude.

Figure 4 below illustrates the splayed approach and final sections of the visual circuits.

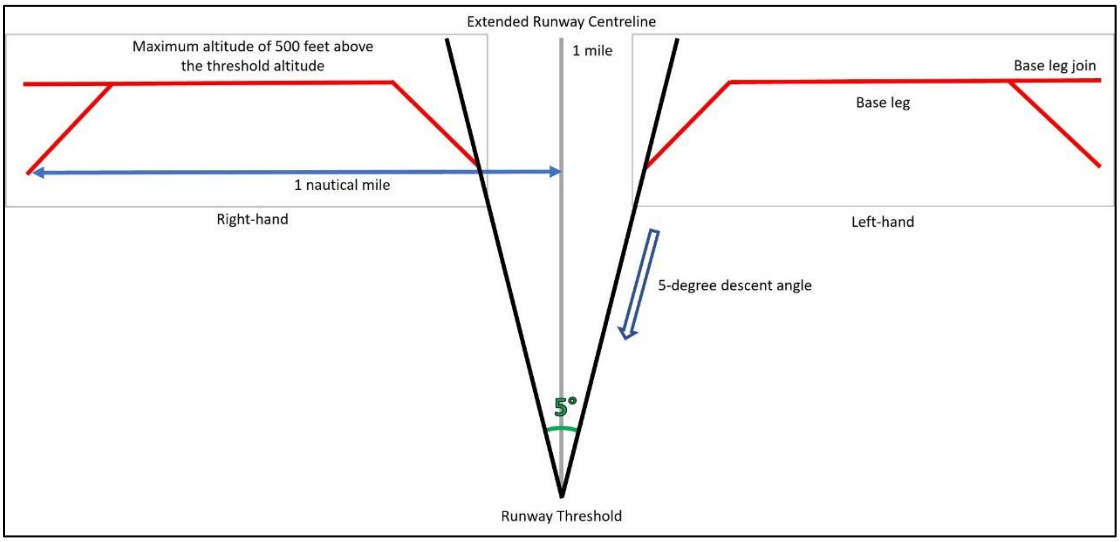

Figure 4 *Splayed approach and final sections of visual circuits*

Figure 5 on the following page shows the assessed aircraft receptor points of the splayed approach and final sections of the visual circuits for runways 01/19 (blue) and 12/30 (red) at Old Park Farm.

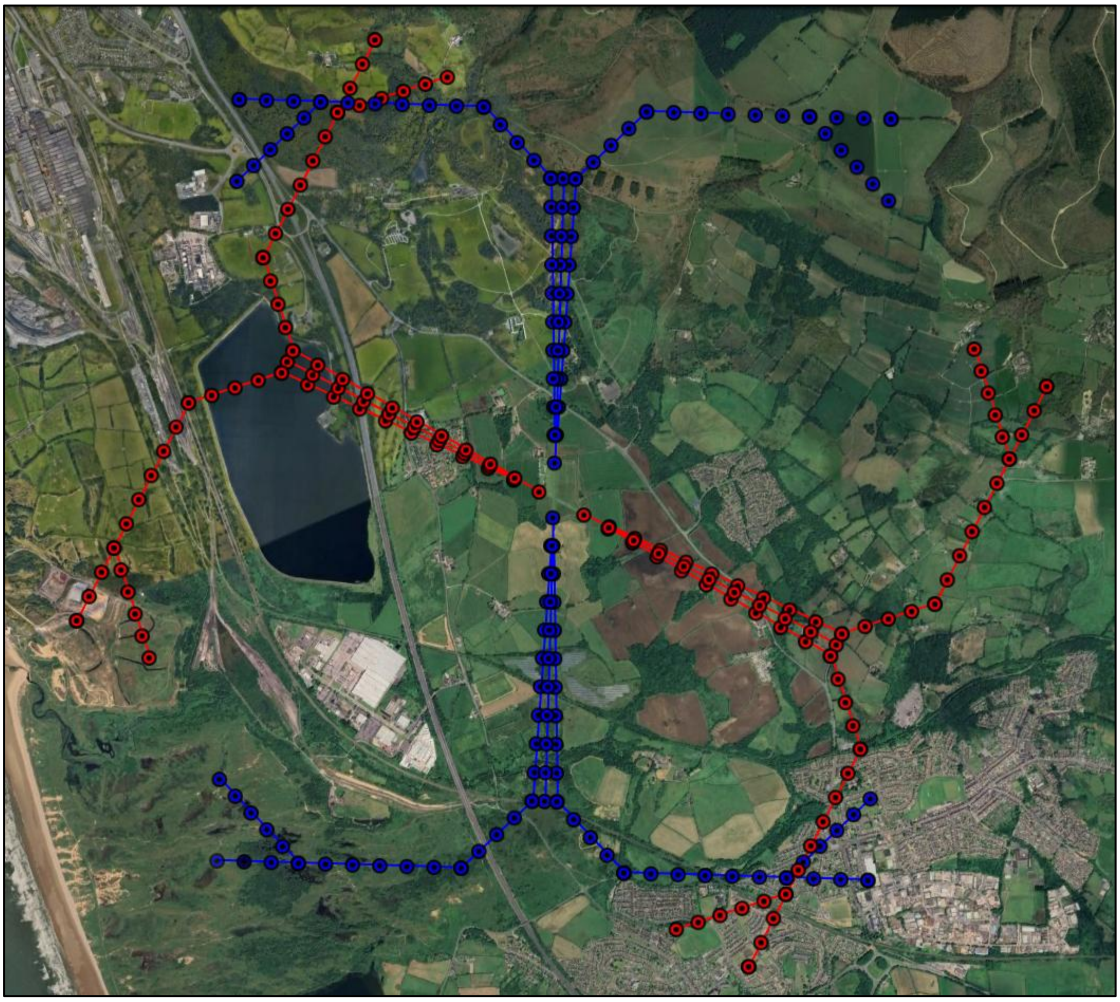

Figure 5 *Assessed receptors for Old Park Farm*

4.3 Ground Based Receptors Overview

There is no formal guidance with regard to the maximum distance at which glint and glare should be assessed. From a technical perspective, there is no maximum distance for potential reflections. The significance of a reflection, however, decreases with distance because the proportion of an observer's field of vision that is taken up by the reflecting area diminishes as the separation distance increases. Terrain and shielding by vegetation are also more likely to obstruct an observer's view at longer distances.

The above parameters and industry experience over a significant number of glint and glare assessments undertaken, shows that a 1 km assessment area from the Proposed Development is considered appropriate for glint and glare effects on road users and dwellings. Reflections towards ground-based receptors located further north than any proposed panel are highly unlikely[12]. Therefore, receptors north of the most northern

[12] For fixed, south-facing panels at this latitude.

panel areas have not been modelled. The assessment area (white outlined area in the following figures) has been designed accordingly as 1 km from the Proposed Development, excluding the area to the north of the north-most solar panels.

Potential receptors within the associated assessment area are identified based on mapping and aerial photography of the region. The initial judgement is made based on high-level consideration of aerial photography and mapping, i.e., receptors are excluded if it is clear from the outset that no visibility would be possible. A more detailed assessment is made if the modelling reveals a reflection would be geometrically possible.

4.4 Road Receptors

4.4.1 Road Receptors Overview

Road types can generally be categorised as:

- Major National – Typically a road with a minimum of two carriageways with a maximum speed limit of up to 70 mph. These roads typically have fast-moving vehicles with busy traffic;
- National – Typically a road with one or more carriageways with a maximum speed limit of 60 mph or 70 mph. These roads typically have fast-moving vehicles with moderate to busy traffic density; and
- Regional – Typically a single carriageway with a maximum speed limit of up to 60 mph. The speed of vehicles will vary with a typical traffic density of low to moderate;
- Local – Typically roads and lanes with the lowest traffic densities. Speed limits vary.

Technical modelling is not recommended for local roads, where traffic densities are likely to be relatively low. Any solar reflections from the Proposed Development that are experienced by a road user along a local road would be considered low impact in the worst case in accordance with the guidance presented in **Annex D**. The analysis has also considered major national, national, and regional roads that:

- Are within the one-kilometre assessment area; and
- Have a potential view of the panels.

Receptors along each road are placed circa 100 m apart. A height of 1.5 m above ground level has been used to model the typical eye-level[13] of a road user.

[13] This fixed height for the road receptors is for modelling purposes. Small changes to the modelling height by a few metres is not expected to significantly change the modelling results. Views for elevated drivers are also considered in the results discussion, where appropriate

4.4.2 Identified Road Receptors

An 870 m section of the A4063 has been identified within the assessment area; however, this has not been geometrically modelled in this assessment as potential views of the panels are not considered possible. Screening in the form of existing vegetation and intervening terrain is predicted to significantly obstruct views of the Proposed Development. No impact is predicted upon the A4063, and mitigation is not required.

Figures 6 and **7** shows the section of the A4063 (outlined red) within the assessment area, and a point-of-view image of the identified screening for a road user along this road respectively.

The remaining roads within the assessment area are considered local roads, where impact would be considered low impact in the worst case in accordance with the guidance presented in **Annex D**. No significant impacts upon road users are predicted, and mitigation is not recommended.

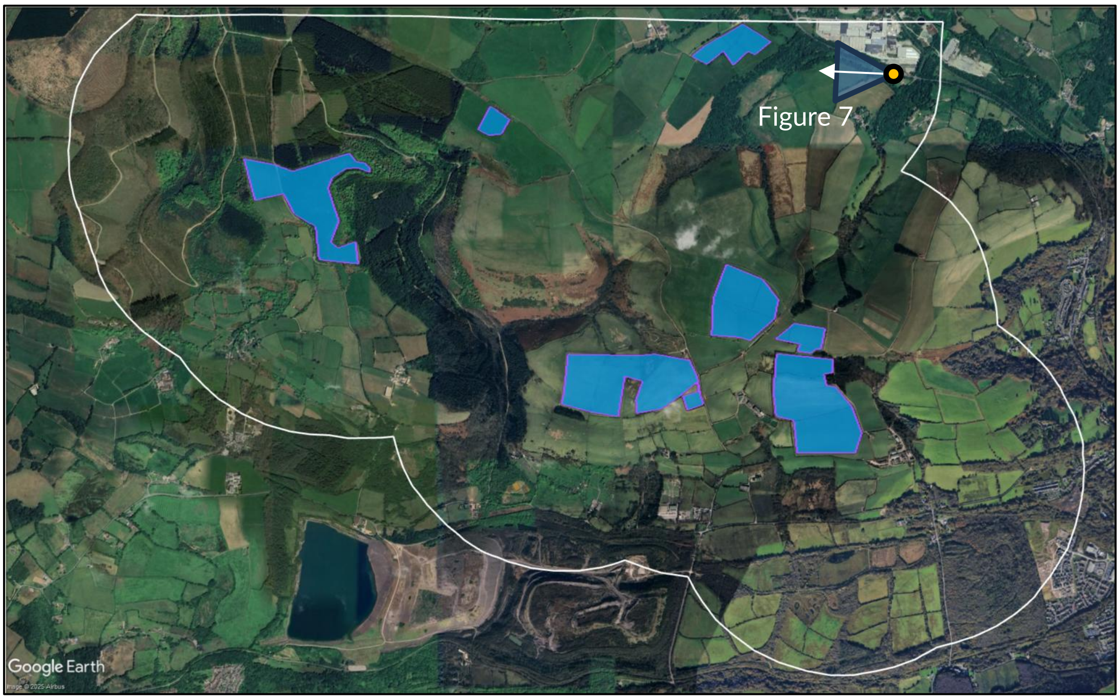

Figure 6 *Section of A4063 within assessment area*

Figure 7 *Point-of-view along A4063*

4.5 Dwelling Receptors

4.5.1 Dwelling Receptors Overview

The analysis has considered dwellings that:

- Are within the one-kilometre assessment area; and
- Have a potential view of the panels.

In residential areas with multiple layers of dwellings, only the outer dwellings have been considered for assessment. This is because they will mostly obscure views of the solar panels to the dwellings behind them, which will therefore not be impacted by the Proposed Development because line of sight will be removed, or they will experience comparable effects to the closest assessed dwelling.

Additionally, in some cases, a single receptor point may be used to represent a small number of separate addresses. In such cases, the results for the receptor will be representative of the adjacent observer locations, such that the overall level of effect in each area is captured reliably.

A height of 1.8 metres above ground level has been used to model the typical eye-level from the ground floor[14].

[14] Changes to this height are not significant, and views considered above the ground floor are considered where appropriate

4.5.2 Identified Dwelling Receptors

In total, 35 dwelling receptors[15] have been assessed. An overview of the dwelling receptors is shown in Figure 8 below. Detailed identification of dwelling receptors is presented in **Annex H**.

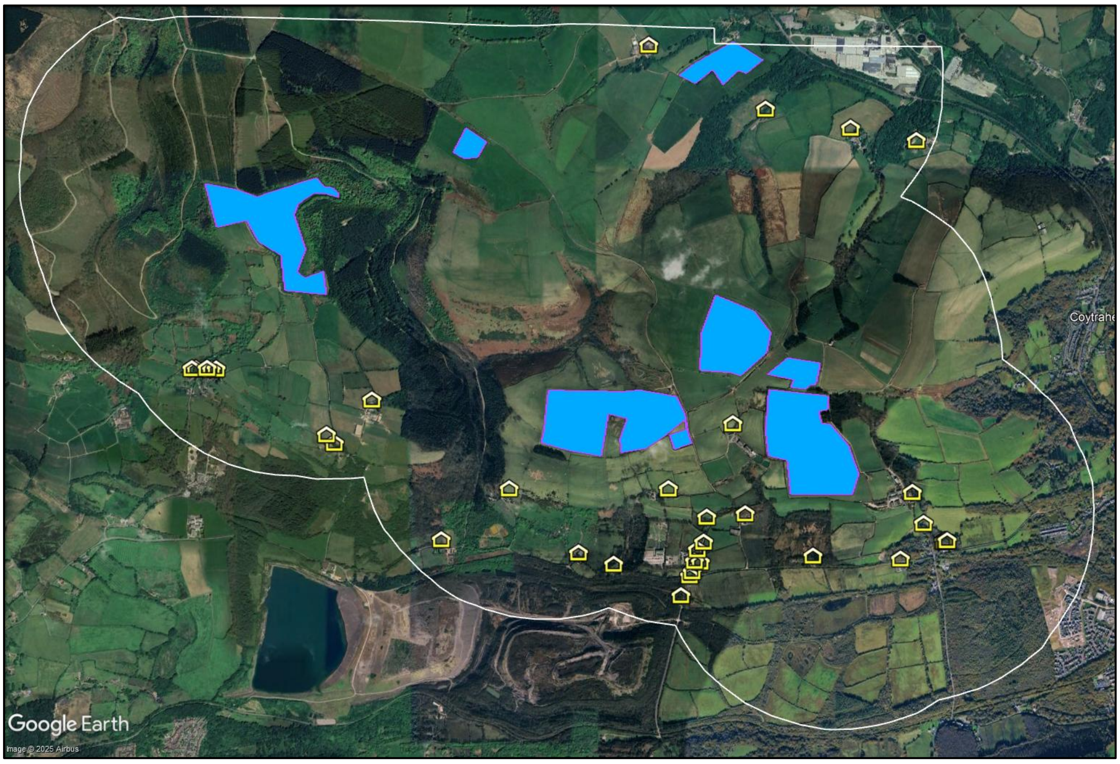

Figure 8 *Overview of dwelling receptors*

[15] Dwelling receptors 1, 2, 6, 11, 13, 14, 15, 18, 22, and 24 represent multiple addresses

5 GEOMETRIC ASSESSMENT RESULTS AND DISCUSSION

5.1 Overview

The following sub-sections summarise the results of the assessment:

- The key considerations for each receptor type. The criteria are determined by the assessment process for each receptor, which are set out in **Annex D**.
- Geometric results of the assessment, based solely on bare-earth terrain, i.e., without consideration of screening in the form of buildings, dwellings, (existing or proposed) vegetation, and/or terrain. The modelling output for receptors, shown in **Annex H**, presents the precise predicted times and the reflecting panel areas.
- Whether a reflection will be experienced in practice. When determining the visibility of the reflecting panels for an observer, a conservative review of the available imagery, landscape strategy plan, google earth viewshed (high-level terrain analysis), and/or site photography (if available) is undertaken, whereby it is assumed views of the panels are possible if it cannot be reliably determined that existing and/or proposed screening will remove effects. Detailed screening analysis may be undertaken to determine visibility, where appropriate.
- The impact significance and any mitigation recommendations/requirements.
- The desk-based review of the available imagery, where appropriate.

5.2 Aviation Receptors

5.2.1 Glare Intensity Categorisation

The Pager Power and Forge models have been used to determine whether reflections are possible for aviation receptors. Intensity calculations (Forge Model) in line with the Sandia National Laboratories methodology have been undertaken. These calculations are routinely required for solar photovoltaic developments on or near aerodromes. The intensity model calculates the expected intensity of a reflection with respect to the potential for an after-image (or worse) occurring. The designation used by the model is presented in **Table 1** along with the associated colour coding.

Coding Used	Intensity Key
Glare beyond 50°	'Glare outside a pilot's field-of-view'
'Green'	'Low potential for temporary after-image'
'Yellow'	'Potential for temporary after-image'
'Red'	'Potential for permanent eye damage'

Table 1 *Glare Intensity Designation*

This coding has been used in the table where a reflection has been calculated and is in accordance with Sandia National Laboratories' methodology.

This coding has been used in the table where a reflection has been calculated and is in accordance with Sandia National Laboratories' methodology. In addition, the intensity model allows for the assessment of a variety of solar panel surface materials. This assessment has considered solar panels with a surface material of 'smooth glass with an anti-reflective coating'. It is understood that this is the most commonly used solar panel surface material. Other surfaces that could be modelled include:

- Smooth glass without an anti-reflective coating;
- Light textured glass without an anti-reflective coating;
- Light textured glass with an anti-reflective coating; or
- Deeply textured glass.

Annex H presents the results charts showing specific times and dates.

5.2.2 Key Considerations – Runway Approach Paths

The process for determining impact significance is defined in Annex D. For the runway approach paths, the key considerations are:

- Whether a reflection is predicted to be experienced in practice;
- The location of glare relative to a pilot's primary field of view (50 degrees either side of the approach bearing).
- The intensity of glare for the solar reflections:
  - Glare with 'low potential for temporary after-image' ('green' glare).
  - Glare with 'potential for temporary after-image' ('yellow' glare).
  - Glare with 'potential for permanent eye damage' ('red' glare).
- Whether a reflection is predicted to be operationally significant in practice or not.

Where no solar reflections are geometrically possible, or where solar reflections are predicted to be significantly screened, no impact is predicted, and mitigation is not required.

Where solar reflections are of an intensity no greater than 'low potential for temporary after-image' (green glare) or occur outside of a pilot's primary field-of-view (50 degrees either side of the runway approach relative to the approach bearing), the impact significance is low, and mitigation is not required.

Aerodromes are tasked with determining safety requirements themselves, including acceptable glare intensity[16]. Pager Power recommends a pragmatic approach whereby instances of 'yellow' glare are evaluated in a technical and operational context. Where solar reflections are of an intensity no greater than 'potential for temporary after-image' expert assessment of the following mitigating factors is required to determine the impact significance[17]:

- The likely traffic volumes and level of safeguarding at the aerodrome – licensed aerodromes typically have higher traffic volumes and are formally safeguarded;
- The time of day at which glare is predicted and whether the aerodrome will be operational such that pilots can be on the approach at these times;
- The duration of any predicted glare – glare that occurs for low durations throughout the year is less likely to be experienced than glare that occurs for longer durations throughout the year;
- The location and size of the reflecting panel area relative to a pilot's primary field-of-view;
- The location of the source of glare relative to the position of the sun at the times and dates in which solar reflections are geometrically possible – effects that coincide with direct sunlight appear less prominent than those that do not;
- The level of predicted effect relative to existing sources of glare – a solar reflection is less noticeable by pilots when there are existing reflective surfaces in the surrounding environment.

Following consideration of these mitigating factors, where the solar reflection does not remain significant, a low impact is predicted, and mitigation is not recommended.

[16] FAA Guidance, 2021

[17] This approach taken is reflective of the changes made in the 2021 FAA guidance; however, it should be noted that this guidance states that it is up to the airport to determine the safety requirements themselves. Therefore, an airport may not accept any yellow glare towards approach paths.

Where the solar reflection remains significant, the impact significance is moderate, and mitigation is recommended. Where solar reflections are of an intensity greater than 'potential for temporary after-image', the impact significance is high, and mitigation is required.

5.2.3 Assessment Results

Table 2 on the following page presents the geometric modelling results for receptors associated with Old Park Farm.

Receptor	Geometric Modelling Result	Glare Intensity	Predicted Impact
Splayed Approach Runway 01/19	Solar reflections are geometrically possible	'Green'	Considering the associated guidance (**Annex D**) and industry best practice pertaining to 2-mile approach paths, which states that this level of glare intensity is acceptable, it can be concluded that this level of glare is also acceptable for these receptors. The impact is not significant and mitigation is not required. Low impact
Splayed Approach Runway 12/30	Solar reflections are geometrically possible	'Green'	
Final Sections of Visual Circuits Runways 01/19 and 12/30	Solar reflections are geometrically possible	'Green'	

Table 2 *Geometric Modelling Results - Old Park Farm*

5.4 Assessment Results – Dwelling Receptors

5.4.1 Key Considerations

The key considerations for residential dwellings are:

- Whether a reflection is predicted to be experienced in practice; and
- The duration of the predicted effects, relative to thresholds[18] of:
    - Three months per year;
    - 60 minutes on any given day.

Where solar reflections are not geometrically possible, or the reflecting panels are predicted to be significantly obstructed from view, no impact is predicted, and mitigation is not required.

Where effects occur for less than three months per year and less than 60 minutes on any given day, or the closest reflecting panel is over 1km from the dwelling, the impact significance is low, and mitigation is not recommended.

Where reflections are predicted to be experienced for more than three months per year and/or for more than 60 minutes on any given day, expert assessment of the following factors is required to determine the impact significance and mitigation requirement:

- The separation distance to the panel area – larger separation distances reduce the proportion of an observer's field of view that is affected by glare;
- The position of the Sun – effects that coincide with direct sunlight appear less prominent than those that do not;
- Whether visibility is likely from all storeys – the ground floor is typically considered the main living space and has a greater significance with respect to residential amenity; and
- Whether the dwelling appears to have windows facing the reflecting area – factors that restrict potential views of a reflecting area reduce the level of impact.

Following consideration of these mitigating factors, where the solar reflection is not deemed significant, a low impact is predicted, and mitigation is not recommended. Where the solar reflection is deemed significant, the impact significance is moderate, and mitigation is recommended.

If effects last for more than three months per year and for more than 60 minutes on any given day, and there are no mitigating factors, the impact significance is high, and mitigation is required.

[18] In accordance with the associated guidance (Annex D) and industry experience

5.4.2 Geometric Modelling Results and Discussion

Table 3 on the following pages presents the geometric modelling results and predicted impact significance for the assessed dwelling receptors. The screening review is presented in Annex J.

Dwelling Receptor	Geometric Modelling Results (without consideration of screening)	Identified Screening and Predicted Visibility (desk-based review)	Duration of effects (with consideration of screening)[19]	Mitigating Factors	Predicted Impact Classification
1 – 2	Solar reflections are geometrically possible for **more** than three months per year but **less** than 60 minutes on any given day	Existing vegetation is predicted to significantly obstruct views of reflecting panels	None	N/A	No impact
3 – 10	Solar reflections are not geometrically possible	N/A	None	N/A	No impact
11 – 13	Solar reflections are geometrically possible for **more** than three months per year but **less** than 60 minutes on any given day	Existing and proposed vegetation is predicted to significantly obstruct views of reflecting panels	None	N/A	No impact

[19] Assessment scenario may include an initial conservative qualitative consideration of screening in determining the duration of predicated effects in practice. The reflecting area of the solar development may be partially screened such that it does not meet the two key criteria i.e. 1) The solar reflection occurs for more than three months per year 2) and/or for more than 60 minutes on any given day.

Dwelling Receptor	Geometric Modelling Results (without consideration of screening)	Identified Screening and Predicted Visibility (desk-based review)	Duration of effects (with consideration of screening)[19]	Mitigating Factors	Predicted Impact Classification
14 – 19	Solar reflections are geometrically possible for <u>**less**</u> than three months per year and <u>**less**</u> than 60 minutes on any given day	Existing vegetation and intervening terrain is predicted to significantly obstruct views of reflecting panels	None	N/A	No impact
20 – 22	Solar reflections are geometrically possible for <u>**more**</u> than three months per year but <u>**less**</u> than 60 minutes on any given day	Existing and proposed vegetation is predicted to significantly obstruct views of reflecting panels	None	N/A	No impact
23	Solar reflections are geometrically possible for <u>**more**</u> than three months per year but <u>**less**</u> than 60 minutes on any given day	Existing buildings are predicted to significantly obstruct views of reflecting panels	None	N/A	No impact

Dwelling Receptor	Geometric Modelling Results (without consideration of screening)	Identified Screening and Predicted Visibility (desk-based review)	Duration of effects (with consideration of screening)[19]	Mitigating Factors	Predicted Impact Classification
24	Solar reflections are geometrically possible for **more** than three months per year but **less** than 60 minutes on any given day	Existing and proposed vegetation is predicted to significantly obstruct views of reflecting panels	None	N/A	No impact
25	Solar reflections are geometrically possible for **more** than three months per year but **less** than 60 minutes on any given day	Existing and proposed vegetation is predicted to significantly obstruct views of reflecting panels	None	N/A	No impact
26 – 27	Solar reflections are geometrically possible for **less** than three months per year but **less** than 60 minutes on any given day	Existing and proposed vegetation is predicted to significantly obstruct views of reflecting panels	None	N/A	No impact

Dwelling Receptor	Geometric Modelling Results (without consideration of screening)	Identified Screening and Predicted Visibility (desk-based review)	Duration of effects (with consideration of screening)[19]	Mitigating Factors	Predicted Impact Classification
28 – 34	Solar reflections are geometrically possible for **more** than three months per year but **less** than 60 minutes on any given day	Existing and proposed vegetation is predicted to significantly obstruct views of reflecting panels	None	N/A	No impact
35	Solar reflections are geometrically possible for **less** than three months per year but **less** than 60 minutes on any given day	Existing and proposed vegetation is predicted to significantly obstruct views of reflecting panels	None	N/A	No impact

Table 3 *Geometric modelling results - dwelling receptors*

6 HIGH-LEVEL ASSESSMENT OF PUBLIC RIGHTS OF WAY

6.1 Overview

The following sections present an overview of considerations for PRoW for the Proposed Development.

6.2 Assessment

Several PRoW run through and around the Site, though it is likely that effects on users of these would be minimised by existing and proposed vegetation. In the event that reflections are visible, the following section discusses the predicted effects.

Based on professional experience, significant impacts from glint and glare are not possible upon pedestrians/observers along PRoW. The reasoning is due to the sensitivity of the receptors (in terms of amenity and safety) being concluded to be of low and the low consequence of impact (magnitude).

The receptors are assigned low sensitivity due to:

- The typical number of pedestrians at these locations is usually low;
- The susceptibility of the receptor (pedestrians/observers along PRoW) to change is low. Effects would typically coincide with direct sunlight. As such, observers would have a higher tolerance to glare when their eyes are adapted to direct sunlight, and the sun would be a far more significant source of glare than the photovoltaics, as it is more intense than reflected sunlight;
- Glint and glare effects towards receptors are transient, and therefore time and location sensitive, whereby a pedestrian could move beyond the solar reflection zone with ease, with little to no impact upon amenity. Additionally, given the transient nature of the receptor, there would be less potential for repeat exposure (as with a dwelling, where effects may occur for several consecutive days);
- When considering PRoW receptors, it is important to note that the receptors themselves are footpath users travelling at a slow speed (typical walking pace is approximately 5 km/h[20]), compared to other receptors such as road users. Therefore, there is no safety hazard associated with reflections towards an observer on a footpath.

Furthermore, any impact will be of a low magnitude when considering the worst case due to:

- The existing screening and in some locations proposed planting within the Site is predicted to reduce/obstruct the visibility of the Proposed Development for pedestrians/observers;

[20] British Heart Foundation (online). Walking and trekking FAQs. Available: https://www.bhf.org.uk/how-you-can-help/events/walking-and-trekking-faqs

- Solar reflections towards observers could be experienced under certain conditions (typically within a few hours of sunrise/sunset, i.e. when the sun is low in the sky beyond the panels). Therefore, if effects are possible and unscreened, they would typically coincide with the sun, a far more significant source of light;
- Any resultant effect is considered less significant with fewer consequences than, for example, solar reflections experienced towards a road network, whereby the resultant impacts of a solar reflection can be much more serious to safety. The worst-case scenario for PRoW users would be discomfort when looking towards a reflecting panel and a potential temporary after-image;
- The reflection intensity is similar for solar panels and still water (and significantly less than reflections from glass and steel[21]) which is frequently a feature of the outdoor environment. Therefore, the reflections are likely to be comparable to those from common outdoor sources whilst navigating the natural and built environment on a regular basis.

6.3 Conclusions

No significant impact is predicted upon PRoW as receptors would experience no impact or a low level of effect, and mitigation is not required. Any effects on the PRoW would be short term, and likely only for the duration that the path user is in close proximity to the panels.

[21] SunPower, 2009, SunPower Solar Module Glare and Reflectance (appendix to Solargen Energy, 2010).

7 OVERALL CONCLUSIONS

7.1 Assessment Results – Aviation Activity

Solar reflections with intensities 'low potential for temporary after-image' ('green' glare) are predicted towards the splayed approached paths, join, and final sections of visual circuits for runways and 01/19 and 12/30 at Old Park Farm. The glare intensity is considered acceptable in accordance with the associated guidance (Annex D) and industry best practice. A low impact is predicted and mitigation is not recommended.

7.2 Assessment Results – Road Safety

Views of the Proposed Development for road users along the A4063 are significantly screened by existing vegetation and intervening terrain, such that views of the Proposed Development are not considered possible. No impact is predicted upon the A4063, and mitigation is not required.

The impact upon local roads within 1km of the assessment area is considered to be low in accordance with the associate guidance presented in **Annex D**. Mitigation is not recommended.

7.3 Assessment Results – Residential Amenity

Solar reflections are geometrically possible towards 27 dwellings. Screening in the form of existing and proposed vegetation, existing buildings and/or intervening terrain is predicted to significantly obstruct views of reflecting panels, such that solar reflections are not predicted to be experienced. No impact is predicted, and mitigation is not required.

7.4 Assessment Results – Public Rights of Way

No significant effects upon PRoW are predicted due to the sensitivity of the receptors (in terms of amenity and safety) being low and any impact being of a low magnitude when considering the worst case (Section 6). Consequently, no mitigation is required.

7.5 Overall Conclusions

No significant impact is predicted upon road safety, residential amenity, aviation activity and users of PRoW. Mitigation is not recommended.

ANNEX A – OVERVIEW OF GLINT AND GLARE GUIDANCE

Overview

This section presents details regarding the relevant guidance and studies with respect to the considerations and effects of solar reflections from solar panels, known as 'Glint and Glare'.

This is not a comprehensive review of the data sources, rather it is intended to give an overview of the important parameters and considerations that have informed this assessment.

UK Planning Policy

National Policy Statement for Renewable Energy Infrastructure

The National Policy Statement for Renewable Energy Infrastructure (EN-3)[22] sets out the primary policy for decisions by the Secretary of State for nationally significant renewable energy infrastructure. Sections 2.10.102-106 state:

'2.10.102 Solar panels are specifically designed to absorb, not reflect, irradiation.[23] However, solar panels may reflect the sun's rays at certain angles, causing glint and glare. Glint is defined 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 to qualitatively 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.

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[22] National Policy Statement for Renewable Energy Infrastructure (EN-3), Department for Energy Security & Net Zero, date: January 2024.

[23] *'Most commercially available solar panels are designed with anti-reflective glass or are produced with anti-reflective coating and have a reflective capacity that is generally equal to or less hazardous than other objects typically found in the outdoor environment, such as bodies of water or glass buildings.'*

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.'

The EN-3 does not state which receptors should be considered as part of a quantitative glint and glare assessment. Based on Pager Power's extensive project experience, typical receptors include residential dwellings, road users, aviation infrastructure, and railway infrastructure.

Sections 2.10.134-136 state:

'2.10.134 Applicants should consider using, and in some cases the Secretary of State may require, solar panels to comprise of (or be covered with) anti-glare/anti-reflective coating with a specified angle of maximum reflection attenuation for the lifetime of the permission.

2.10.135 Applicants may consider using screening between potentially affected receptors and the reflecting panels to mitigate the effects.

2.10.136 Applicants may consider adjusting the azimuth alignment of or changing the elevation tilt angle of a solar panel, within the economically viable range, to alter the angle of incidence. In practice this is unlikely to remove the potential impact altogether but in marginal cases may contribute to a mitigation strategy.'

The mitigation strategies listed within the EN-3 are relevant strategies that are frequently utilised to eliminate or reduce glint and glare effects towards surrounding observers. The most common form of mitigation is the implementation of screening along the Site Boundary.

Sections 2.10.158-159 state:

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.

The EN-3 goes some way in acknowledging that the issue is more complex than presented in the early draft issues; though, this is still unlikely to be welcomed by aviation stakeholders, who will still request a glint and glare assessment on the basis that glare may lead to a potentially significant impact upon aviation safety.

Finally, the EN-3 relates solely to nationally significant renewable energy infrastructure and therefore does not apply to all planning applications for solar farms.

Assessment Process – Ground-Based Receptors

No process for determining and contextualising the effects of glint and glare has been determined when assessing the impact of solar reflections upon surrounding roads and dwellings. Therefore, the Pager Power approach is to determine whether a reflection from the proposed solar development is geometrically possible and then to compare the results against the relevant guidance/studies to determine whether the reflection is significant.

The Pager Power approach has been informed by the policy presented above, current studies (presented in **Annex B**) and stakeholder consultation. Further information can be found in Pager Power's Glint and Glare Guidance document[24] which was produced due to the absence of existing guidance and a specific standardised assessment methodology.

Aviation Assessment Guidance

The UK Civil Aviation Authority (CAA) issued interim guidance relating to Solar Photovoltaic Systems (SPV) on 17 December 2010 and was subject to a CAA information alert 2010/53. The formal policy was cancelled on September 7th, 2012[25] however the advice is still applicable[26] until a formal policy is developed. The relevant aviation guidance from the CAA is presented in the section below.

CAA Interim Guidance

This interim guidance makes the following recommendations (p.2-3):

'8. It is recommended that, as part of a planning application, the SPV developer provide safety assurance documentation (including risk assessment) regarding the full potential impact of the SPV installation on aviation interests.

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[24] Solar Photovoltaic Development Glint and Glare Guidance, Fourth Edition, September 2022. Pager Power.

[25] Archived at Pager Power

[26] Reference email from the CAA dated 19/05/2014.

9. Guidance on safeguarding procedures at CAA licensed aerodromes is published within CAP 738 Safeguarding of Aerodromes and advice for unlicensed aerodromes is contained within CAP 793 Safe Operating Practices at Unlicensed Aerodromes.

10. Where proposed developments in the vicinity of aerodromes require an application for planning permission the relevant LPA normally consults aerodrome operators or NATS when aeronautical interests might be affected. This consultation procedure is a statutory obligation in the case of certain major airports, and may include military establishments and certain air traffic surveillance technical sites. These arrangements are explained in Department for Transport Circular 1/2003 and for Scotland, Scottish Government Circular 2/2003.

11. In the event of SPV developments proposed under the Electricity Act, the relevant government department should routinely consult with the CAA. There is therefore no requirement for the CAA to be separately consulted for such proposed SPV installations or developments.

12. If an installation of SPV systems is planned on-aerodrome (i.e. within its licensed boundary) then it is recommended that data on the reflectivity of the solar panel material should be included in any assessment before installation approval can be granted. Although approval for installation is the responsibility of the ALH[27]*, as part of a condition of a CAA Aerodrome Licence, the ALH is required to obtain prior consent from CAA Aerodrome Standards Department before any work is begun or approval to the developer or LPA is granted, in accordance with the procedures set out in CAP 791 Procedures for Changes to Aerodrome Infrastructure.*

13. During the installation and associated construction of SPV systems there may also be a need to liaise with nearby aerodromes if cranes are to be used; CAA notification and permission is not required.

14. The CAA aims to replace this informal guidance with formal policy in due course and reserves the right to cancel, amend or alter the guidance provided in this document at its discretion upon receipt of new information.

15. Further guidance may be obtained from CAA's Aerodrome Standards Department via aerodromes@caa.co.uk.'

FAA Guidance

The most comprehensive guidelines available for the assessment of solar developments near aerodromes has been produced by the United States Federal Aviation Administration (FAA). The first guidelines were produced initially in November 2010

[27] Aerodrome Licence Holder.

and updated in 2013. A final policy was released in 2021, which superseded the interim guidance.

The 2010 document is entitled '*Technical Guidance for Evaluating Selected Solar Technologies on Airports'*[28], the 2013 update is entitled '*Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports'*[29], and the 2021 final policy is entitled '*Federal Aviation Administration Policy: Review of Solar Energy System Projects on Federally-Obligated Airports'*[30].

Key excerpts from the final policy are presented below:

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. Therefore, FAA has determined the scope of agency policy should be focused on the impact of on-airport solar energy systems to federally-obligated towered airports, specifically the airport's ATCT cab.

The policy in this document updates and replaces the previous policy by encouraging airport sponsors to conduct an ocular analysis of potential impacts to ATCT cabs prior to submittal of a Notice of Proposed Construction or Alteration Form 7460-1 (hereinafter Form 7460-1). Airport sponsors are no longer required to submit the results of an ocular analysis to FAA. Instead, to demonstrate compliance with 14 CFR 77.5(c), FAA will rely on the submittal of Form 7460-1 in which the sponsor confirms that it has analyzed the potential for glint and glare and determined there is no potential for ocular impact to the airport's ATCT cab. This process will enable FAA to evaluate the solar energy system project, with assurance that the system will not impact the ATCT cab.

FAA encourages airport sponsors of federally-obligated towered airports to conduct a sufficient analysis to support their assertion that a proposed solar energy system will not result in ocular impacts. There are several tools available on the open market to airport sponsors that can analyze potential glint and glare to an ATCT cab. For proposed systems that will clearly not impact ATCT cabs (e.g., on-airport solar energy systems that are blocked from the ATCT cab's view by another structure), the use of such tools may not be necessary to support the assertion that a proposed solar energy system will not result in ocular impacts.

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[28] Archived at Pager Power

[29] Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports, Department of Transportation, Federal Aviation Administration (FAA), date: 10/2013, accessed on: 08/12/2021.

[30] Federal Aviation Administration Policy: Review of Solar Energy System Projects on Federally-Obligated Airports, Federal Aviation Administration, date: May 2021, accessed on: 08/12/2021.

The excerpt above states where a solar PV development is to be located on a federally obligated aerodrome with an ATC Tower, it will require a glint and glare assessment to accompany its application. It states that pilots on approach are no longer a specific assessment requirement due to effects from solar energy systems being similar to glint and glare pilots routinely experience from water bodies, glass-façade buildings, parking lots, and similar features. Ultimately it comes down to the specific aerodrome to ensure it is adequately safeguarded, and it is on this basis that glint and glare assessments are routinely still requested.

The policy also states that several different tools and methodologies can be used to assess the impacts of glint and glare, which was previously required to be undertaken by the Solar Glare Hazard Analysis Tool (SGHAT) using the Sandia National Laboratories methodology.

In 2018, the FAA released the latest version (Version 1.1) of the '*Technical Guidance for Evaluating Selected Solar Technologies on Airports*'[31]. Whilst the 2021 final policy also supersedes this guidance, many of the points are still relevant because aerodromes are still safeguarding against glint and glare irrespective of the FAA guidance. The key points are presented below for reference:

- *Reflectivity refers to light that is reflected off surfaces. The potential effects of reflectivity are glint (a momentary flash of bright light) and glare (a continuous source of bright light). These two effects are referred to hereinafter as "glare," which can cause a brief loss of vision, also known as flash blindness*[32].
- *The amount of light reflected off a solar panel surface depends on the amount of sunlight hitting the surface, its surface reflectivity, geographic location, time of year, cloud cover, and solar panel orientation.*
- *As illustrated on Figure 16*[33]*, flat, smooth surfaces reflect a more concentrated amount of sunlight back to the receiver, which is referred to as specular reflection. The more a surface is polished, the more it shines. Rough or uneven surfaces reflect light in a diffused or scattered manner and, therefore, the light will not be received as bright.*
- *Because the FAA has no specific standards for airport solar facilities and potential glare, the type of glare analysis may vary. Depending on site specifics (e.g., existing*

[31] Technical Guidance for Evaluating Selected Solar Technologies on Airports, Federal Aviation Administration (FAA), date: 04/2018, accessed on: 08/12/2021.
[32] Flash Blindness, as described in the FAA guidelines, can be described as a temporary visual interference effect that persists after the source of illumination has ceased. This occurs from many reflective materials in the ambient environment.
[33] First figure in Annex B.

land uses, location and size of the project) an acceptable evaluation could involve one or more of the following levels of assessment:

  - *A qualitative analysis of potential impact in consultation with the Control Tower, pilots and airport officials;*
  - *A demonstration field test with solar panels at the proposed site in coordination with FAA Tower personnel;*
  - *A geometric analysis to determine days and times when an impact is predicted.*

- *The extent of reflectivity analysis required to assess potential impacts will depend on the specific project site and system design.*
- ***1. Assessing Baseline Reflectivity Conditions** – Reflection in the form of glare is present in current aviation operations. The existing sources of glare come from glass windows, auto surface parking, rooftops, and water bodies. At airports, existing reflecting surfaces may include hangar roofs, surface parking, and glassy office buildings. To minimize unexpected glare, windows of air traffic control towers and airplane cockpits are coated with anti-reflective glazing. Operators also wear polarized eye wear. Potential glare from solar panels should be viewed in this context. Any airport considering a solar PV project should first review existing sources of glare at the airport and the effectiveness of measures used to mitigate that glare.*
- ***2. Tests in the Field** – Potential glare from solar panels can easily be viewed at the airport through a field test. A few airports have coordinated these tests with FAA Air Traffic Controllers to assess the significance of glare impacts. To conduct such a test, a sponsor can take a solar panel out to proposed location of the solar project, and tilt the panel in different directions to evaluate the potential for glare onto the air traffic control tower. For the two known cases where a field test was conducted, tower personnel determined the glare was not significant. If there is a significant glare impact, the project can be modified by ensuring panels are not directed in that direction.*
- ***3. Geometric Analysis** – Geometric studies are the most technical approach for reflectivity issues. They are conducted when glare is difficult to assess through other methods. Studies of glare can employ geometry and the known path of the sun to predict when sunlight will reflect off of a fixed surface (like a solar panel) and contact a fixed receptor (e.g., control tower). At any given site, the sun moves across the sky every day and its path in the sky changes throughout year. This in turn alters the destination of the resultant reflections since the angle of reflection for the solar panels will be the same as the angle at which the sun hits the panels. The larger the reflective surface, the greater the likelihood of glare impacts.*

- *Facilities placed in remote locations, like the desert, will be far from receptors and therefore potential impacts are limited to passing aircraft. Because the intensity of the light reflected from the solar panel decreases with increasing distance, an appropriate question is how far you need to be from a solar reflected surface to avoid flash blindness. It is known that this distance is directly proportional to the size of the array in question*[34] *but still requires further research to definitively answer.*
- ***Experiences of Existing Airport Solar Projects*** *– Solar installations are presently operating at a number of airports, including megawatt-sized solar facilities covering multiple acres. Air traffic control towers have expressed concern about glint and glare from a small number of solar installations. These were often instances when solar installations were sited between the tower and airfield, or for installations with inadequate or no reflectivity analysis. Adequate reflectivity analysis and alternative siting addressed initial issues at those installations.*

Air Navigation Order (ANO) 2016

In some instances, an aviation stakeholder can refer to the ANO 2016[35] with regard to safeguarding. Key points from the document are presented below.

Lights liable to endanger

224. (1) 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 from or landing at an aerodrome; or

(b) by reason of its liability to be mistaken for an aeronautical ground light is liable to endanger aircraft.

(2) If any light which appears to the CAA to be a light described in paragraph (1) is exhibited, the CAA may direct the person who is the occupier of the place where the light is exhibited or who has charge of the light, to take such steps within a reasonable time as are specified in the direction—

(a) to extinguish or screen the light; and

(b) to prevent in the future the exhibition of any other light which may similarly endanger aircraft.

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[34] Ho, Clifford, Cheryl Ghanbari, and Richard Diver. 2009. Hazard Analysis of Glint and Glare From Concentrating Solar Power Plants. SolarPACES 2009, Berlin Germany. Sandia National Laboratories.
[35] The Air Navigation Order 2016. [online] Available at: <https://www.legislation.gov.uk/uksi/2016/765/contents/made> [Accessed 4 February 2022].

(3) The direction may be served either personally or by post, or by affixing it in some conspicuous place near to the light to which it relates.

(4) In the case of a light which is or may be visible from any waters within the area of a general lighthouse authority, the power of the CAA under this article must not be exercised except with the consent of that authority.

Lights which dazzle or distract

225. 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.'

The document states that no 'light', 'dazzle' or 'glare' should be produced which will create a detrimental impact upon aircraft safety.

Endangering safety of an aircraft

240. A person must not recklessly or negligently act in a manner likely to endanger an aircraft, or any person in an aircraft.

Endangering safety of any person or property

241. A person must not recklessly or negligently cause or permit an aircraft to endanger any person or property.

Civil Aviation Authority consolidation of UK Regulation 139/2014

The Civil Aviation Authority (CAA) published a consolidating document[36] of UK regulations, (Implementing Rules, Acceptable Means of Compliance and Guidance Material), in 2023. A summary of material relevant to aerodrome safeguarding is presented below:

(a) The aerodrome operator should have procedures to monitor the changes in the obstacle environment, marking and lighting, and in human activities or land use on the aerodrome and the areas around the aerodrome, as defined in coordination with the CAA. The scope, limits, tasks and responsibilities for the monitoring should be defined in coordination with the relevant air traffic services providers, and with the CAA and other relevant authorities.

(b) The limits of the aerodrome surroundings that should be monitored by the aerodrome operator are defined in coordination with the CAA and should include the areas that can be visually monitored during the inspections of the manoeuvring area.

(c) The aerodrome operator should have procedures to mitigate the risks associated with changes on the aerodrome and its surroundings identified with the monitoring

[36] https://regulatorylibrary.caa.co.uk/139-2014-pdf/PDF.pdf

procedures. The scope, limits, tasks, and responsibilities for the mitigation of risks associated to obstacles or hazards outside the perimeter fence of the aerodrome should be defined in coordination with the relevant air traffic services providers, and with the CAA and other relevant authorities.

(d) The risks caused by human activities and land use which should be assessed and mitigated should include:

1. obstacles and the possibility of induced turbulence;
2. the use of hazardous, confusing, and misleading lights;
3. <u>the dazzling caused by large and highly reflective surfaces;</u>
4. sources of non-visible radiation, or the presence of moving, or fixed objects which may interfere with, or adversely affect, the performance of aeronautical communications, navigation and surveillance systems; and
5. non-aeronautical ground light near an aerodrome which may endanger the safety of aircraft and which should be extinguished, screened, or otherwise modified so as to eliminate the source of danger.

ANNEX B – OVERVIEW OF GLINT AND GLARE STUDIES

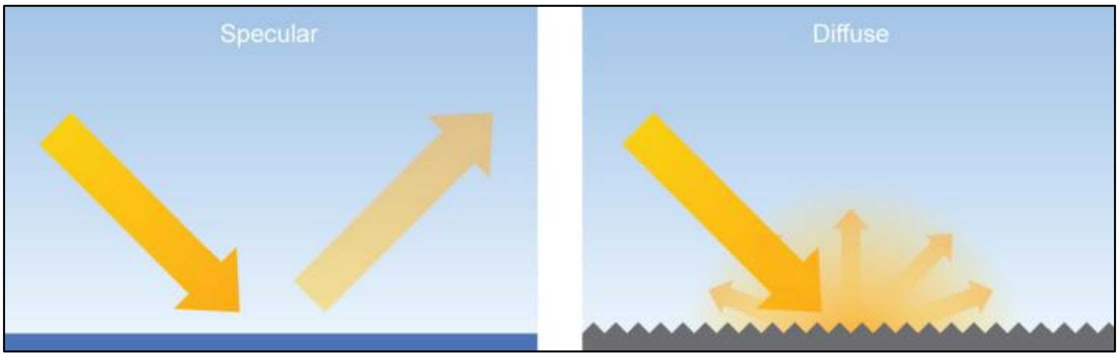
Overview

Studies have been undertaken assessing the type and intensity of solar reflections from various surfaces including solar panels and glass. An overview of these studies is presented below.

The guidelines presented are related to aviation safety. The results are applicable for the purpose of this analysis.

Reflection Type from Solar Panels

Based on the surface conditions reflections from light can be specular and diffuse. A specular reflection has a reflection characteristic similar to that of a mirror; a diffuse will reflect the incoming light and scatter it in many directions. The figure below, taken from the FAA guidance[37], illustrates the difference between the two types of reflections. Because solar panels are flat and have a smooth surface most of the light reflected is specular, which means that incident light from a specific direction is reradiated in a specific direction.



Specular and diffuse reflections

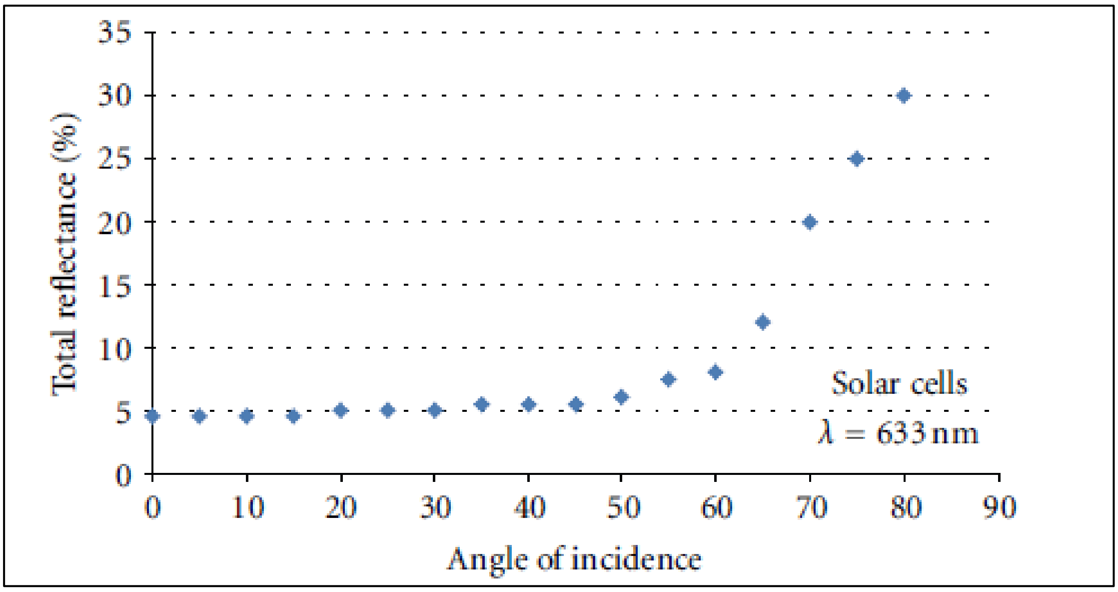
[37] Technical Guidance for Evaluating Selected Solar Technologies on Airports, Federal Aviation Administration (FAA), date: 04/2018, accessed on: 20/03/2019.

Solar Reflection Studies

An overview of content from identified solar panel reflectivity studies is presented in the subsections below.

Evan Riley and Scott Olson, "A Study of the Hazardous Glare Potential to Aviators from Utility-Scale Flat-Plate Photovoltaic Systems"

Evan Riley and Scott Olson published in 2011 their study titled: *A Study of the Hazardous Glare Potential to Aviators from Utility-Scale Flat-Plate Photovoltaic Systems*[38]". They researched the potential glare that a pilot could experience from a 25 degree fixed tilt PV system located outside of Las Vegas, Nevada. The theoretical glare was estimated using published ocular safety metrics which quantify the potential for a postflash glare after-image. This was then compared to the postflash glare after-image caused by smooth water. The study demonstrated that the reflectance of the solar cell varied with angle of incidence, with maximum values occurring at angles close to 90 degrees. The reflectance values varied from approximately 5% to 30%. This is shown on the figure below.



Total reflectance % when compared to angle of incidence

The conclusions of the research study were:

- The potential for hazardous glare from flat-plate PV systems is similar to that of smooth water;

[38] Evan Riley and Scott Olson, "A Study of the Hazardous Glare Potential to Aviators from Utility-Scale Flat-Plate Photovoltaic Systems," ISRN Renewable Energy, vol. 2011, Article ID 651857, 6 pages, 2011. doi:10.5402/2011/651857

- Portland white cement concrete (which is a common concrete for runways), snow, and structural glass all have a reflectivity greater than water and flat plate PV modules.

FAA Guidance – "Technical Guidance for Evaluating Selected Solar Technologies on Airports"[39]

The 2010 FAA Guidance included a diagram which illustrates the relative reflectance of solar panels compared to other surfaces. The figure shows the relative reflectance of solar panels compared to other surfaces. Surfaces in this figure produce reflections which are specular and diffuse. A specular reflection (those made by most solar panels) has a reflection characteristic similar to that of a mirror. A diffuse reflection will reflect the incoming light and scatter it in many directions. A table of reflectivity values, sourced from the figure within the FAA guidance, is presented below.

Surface	Approximate Percentage of Light Reflected[40]
Snow	80
White Concrete	77
Bare Aluminium	74
Vegetation	50
Bare Soil	30
Wood Shingle	17
Water	5
Solar Panels	5
Black Asphalt	2

Relative reflectivity of various surfaces

Note that the data above does not appear to consider the reflection type (specular or diffuse).

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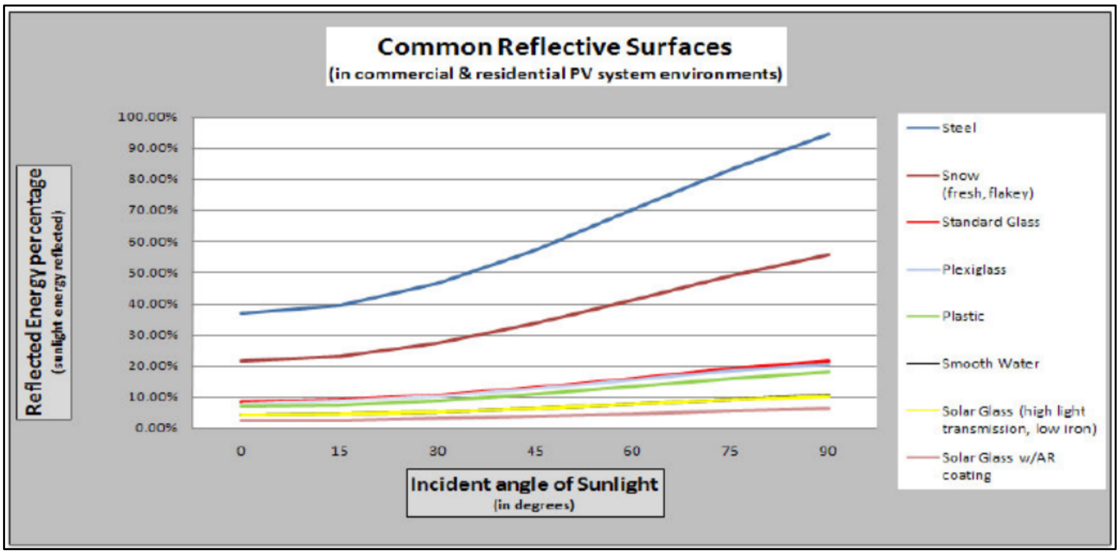
[39] Technical Guidance for Evaluating Selected Solar Technologies on Airports, Federal Aviation Administration (FAA), date: 04/2018, accessed on: 20/03/2019.
[40] Extrapolated data, baseline of 1,000 W/m^2 for incoming sunlight.

An important comparison in this table is the reflectivity compared to water which will produce a reflection of very similar intensity when compared to that from a solar panel. The study by Riley and Olsen study (2011) also concludes that still water has a very similar reflectivity to solar panels.

SunPower Technical Notification (2009)

SunPower published a technical notification[41] to '*increase awareness concerning the possible glare and reflectance impact of PV Systems on their surrounding environment*'.

The figure presented below shows the relative reflectivity of solar panels compared to other natural and manmade materials including smooth water, standard glass and steel.



Common reflective surfaces

The results, similarly to those from Riley and Olsen study (2011) and the FAA (2010), show that solar panels produce a reflection that is less intense than those of '*standard glass and other common reflective surfaces*'.

With respect to aviation and solar reflections observed from the air, SunPower has developed several large installations near airports or on Air Force bases. It is stated that these developments have all passed FAA or Air Force standards with all developments considered "No Hazard to Air Navigation". The note suggests that developers discuss any possible concerns with stakeholders near proposed solar farms.

[41] Source: Technical Support, 2009. SunPower Technical Notification – Solar Module Glare and Reflectance.

ANNEX C – OVERVIEW OF SUN MOVEMENTS AND RELATIVE REFLECTIONS

The Sun's position in the sky can be accurately described by its azimuth and elevation. Azimuth is a direction relative to true north (horizontal angle i.e. from left to right) and elevation describes the Sun's angle relative to the horizon (vertical angle i.e. up and down).

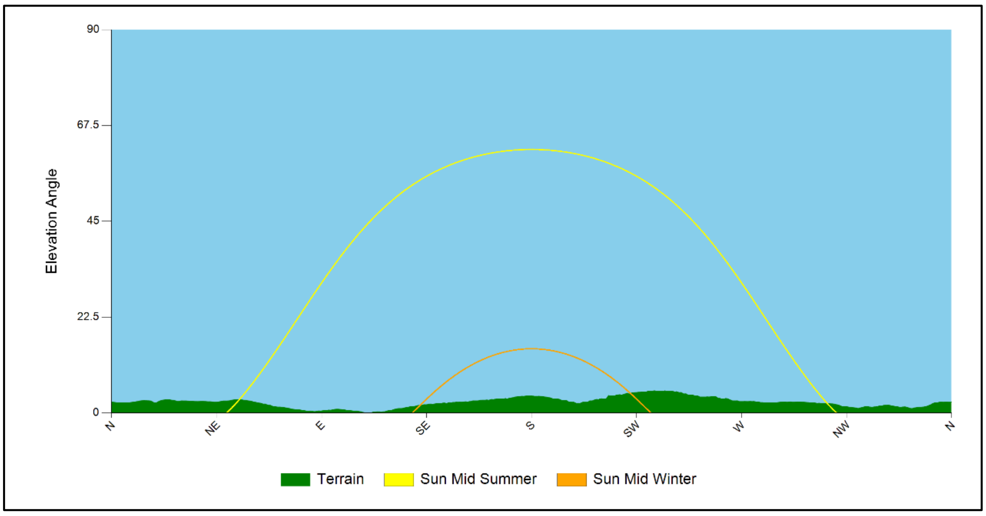
The Sun's position can be accurately calculated for a specific location. The following data being used for the calculation:

- Time;
- Date;
- Latitude;
- Longitude.

The following is true at the location of the solar development:

- The Sun is at its highest around midday and is to the south at this time;
- The Sun rises highest on 21 June (longest day);
- On 21 December, the maximum elevation reached by the Sun is at its lowest (shortest day).

The combination of the Sun's azimuth angle and vertical elevation will affect the direction and angle of the reflection from a reflector. The figure below shows terrain at the horizon from the Proposed Development location as well as the sunrise and sunset curves throughout the year.



Terrain at Sun horizon at location of the Proposed Development

ANNEX D – GLINT AND GLARE IMPACT SIGNIFICANCE

Overview

The significance of glint and glare will vary for different receptors. The following section presents a general overview of the significance criteria with respect to experiencing a solar reflection.

Impact Significance Definition

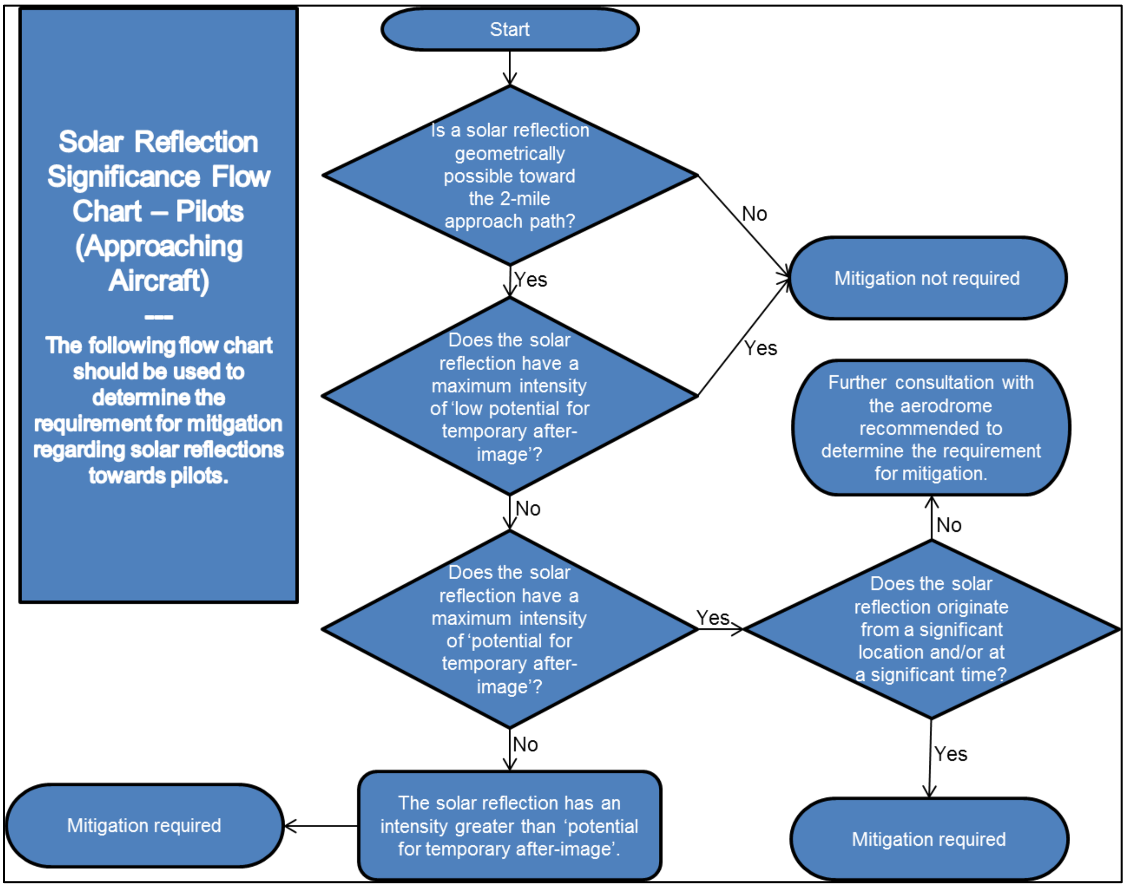
The table below presents the recommended definition of 'impact significance' in glint and glare terms and the requirement for mitigation under each.

Impact Significance	Definition	Mitigation Requirement
No Impact	A solar reflection is not geometrically possible or will not be visible from the assessed receptor.	No mitigation required.
Low	A solar reflection is geometrically possible however any impact is considered to be small such that mitigation is not required e.g. intervening screening will limit the view of the reflecting solar panels significantly.	No mitigation recommended.
Moderate	A solar reflection is geometrically possible and visible however it occurs under conditions that do not represent a worst-case given individual receptor criteria.	Mitigation recommended.
High	A solar reflection is geometrically possible and visible under worst-case conditions that will produce a significant impact given individual receptor criteria	Mitigation will be required if the Proposed Development is to proceed.

Impact significance definition

Impact Significance Determination for Approaching Aircraft

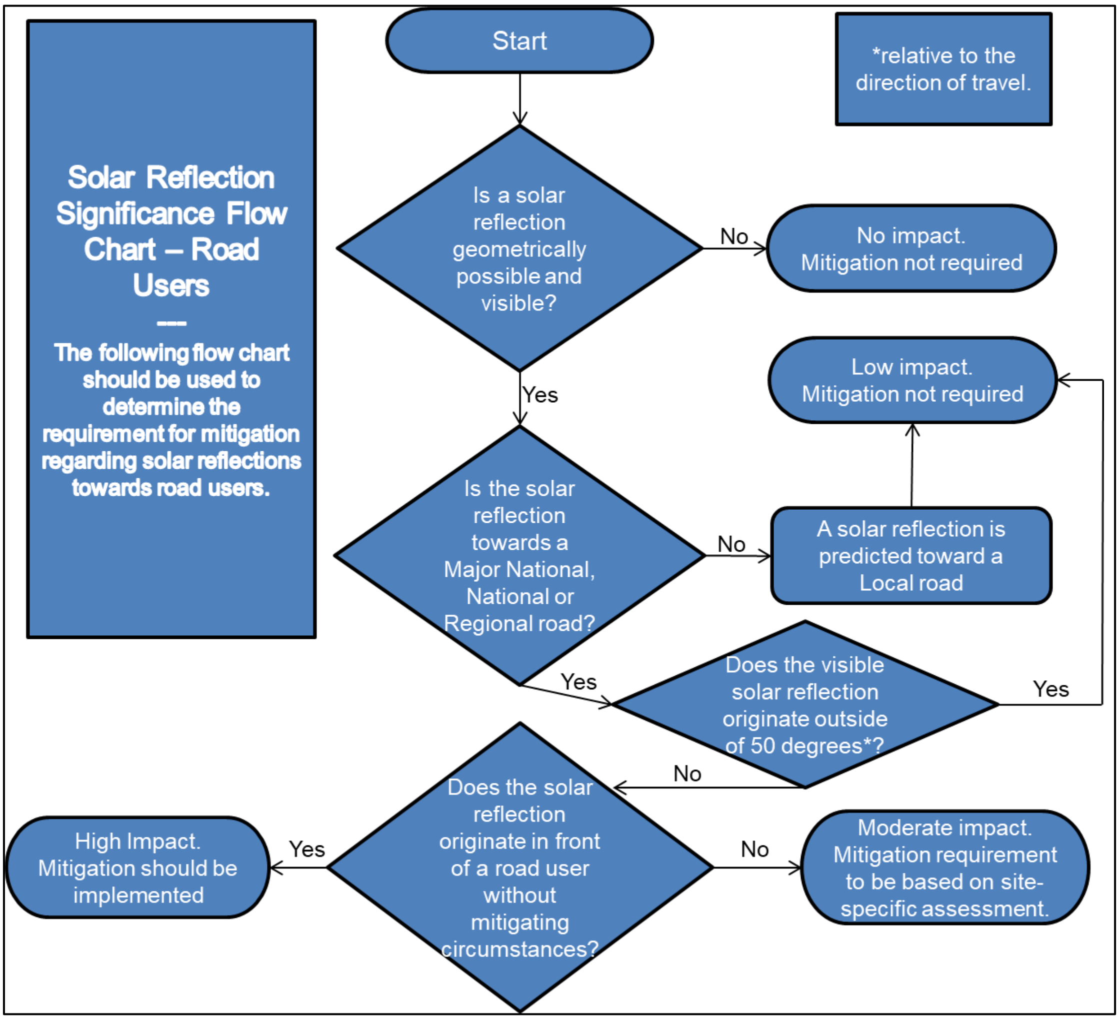
The flow chart presented below has been followed when determining the mitigation requirement for approaching aircraft.



Approaching aircraft receptor mitigation requirement flow chart

Impact Significance Determination for Road Receptors

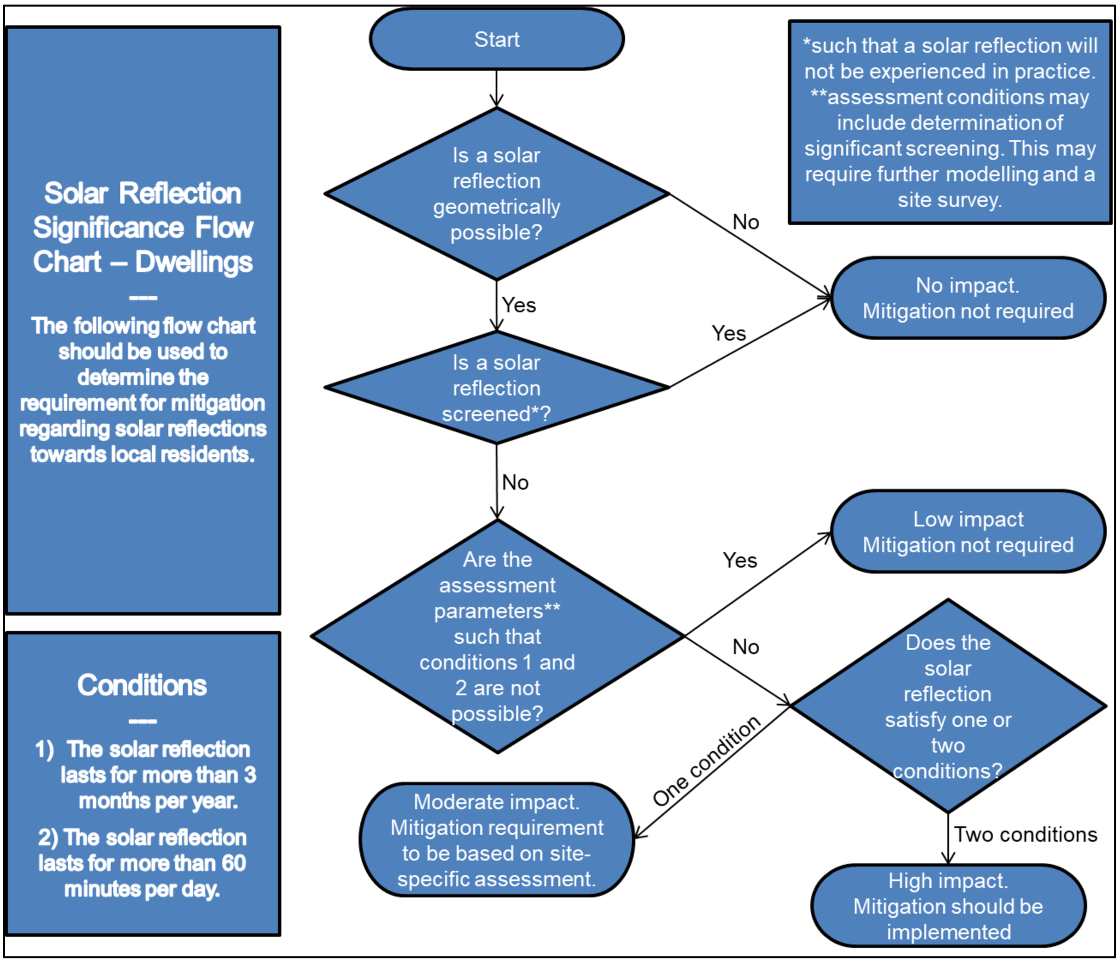
The flow chart presented below has been followed when determining the mitigation requirement for road receptors.



Road user impact significance flow chart

Impact Significance Determination for Dwelling Receptors

The flow chart presented below has been followed when determining the mitigation requirement for dwelling receptors.



Dwelling impact significance flow chart

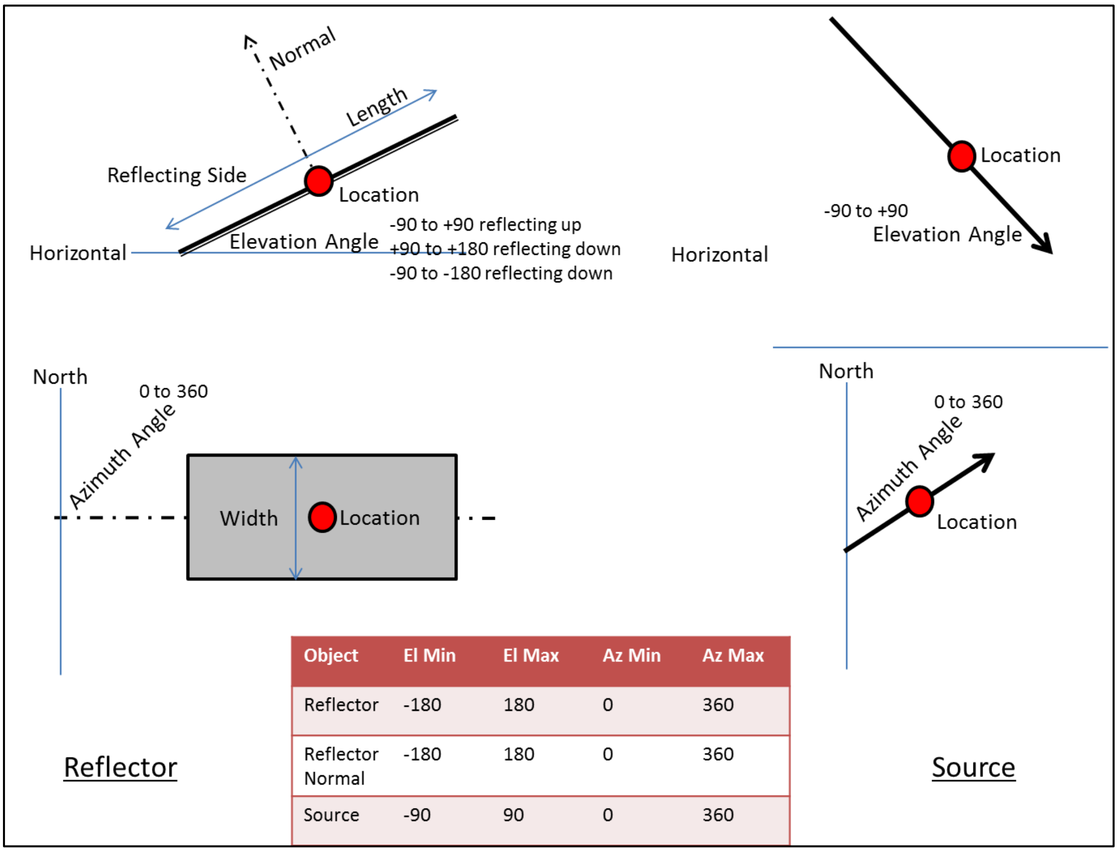
ANNEX E – REFLECTION CALCULATIONS METHODOLOGY

Pager Power Methodology

The calculations are three dimensional and complex, accounting for:

- The Earth's orbit around the Sun;
- The Earth's rotation;
- The Earth's orientation;
- The reflector's location;
- The reflector's 3D Orientation.

Reflections from a flat reflector are calculated by considering the normal which is an imaginary line that is perpendicular to the reflective surface and originates from it. The diagram below may be used to aid understanding of the reflection calculation process.



Object	El Min	El Max	Az Min	Az Max
Reflector	-180	180	0	360
Reflector Normal	-180	180	0	360
Source	-90	90	0	360

Reflection calculation process

The following process is used to determine the 3D Azimuth and Elevation of a reflection:

- Use the Latitude and Longitude of reflector as the reference for calculation purposes;
- Calculate the Azimuth and Elevation of the normal to the reflector;
- Calculate the 3D angle between the source and the normal;
- If this angle is less than 90 degrees a reflection will occur. If it is greater than 90 degrees no reflection will occur because the source is behind the reflector;
- Calculate the Azimuth and Elevation of the reflection in accordance with the following:
    - The angle between source and normal is equal to angle between normal and reflection;

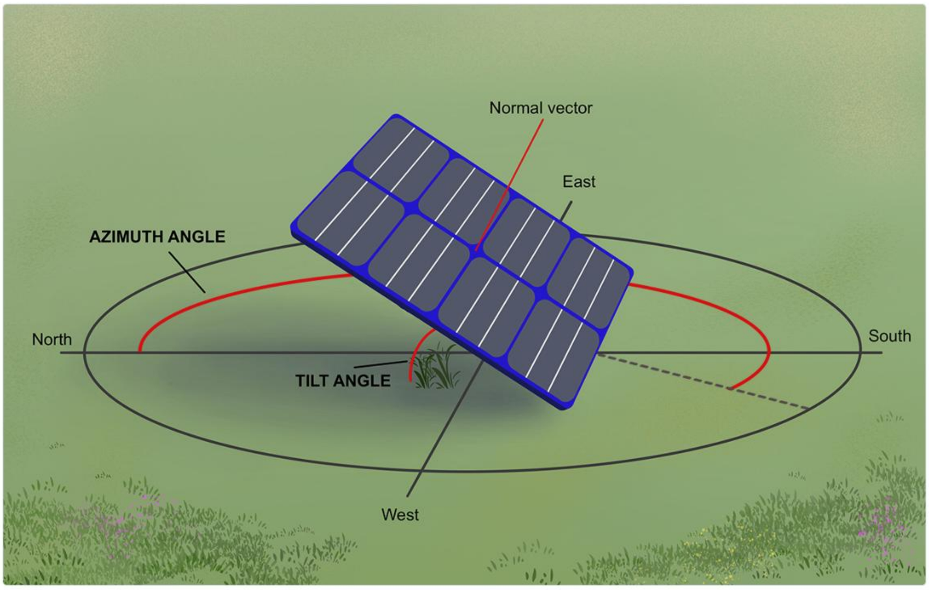
Source, Normal and Reflection are in the same plane.

Forge Reflection Calculations Methodology

Extracts taken from the Forge Solar Model are shown in the figures below and on the following page.

Fixed-Mount Parameters

Fixed-mount PV panels are described by a tilt and orientation. These parameters are referred to as the **module configuration** of the PV array.



PV module orientation/azimuth and tilt. Sample illustrates south-facing module typical in northern hemisphere

Module orientation/azimuth (°)
The azimuthal facing or direction toward which the PV panels are positioned. Orientation is measured clockwise from true north. Panels which face north, which is typical in the southern hemisphere, have an orientation of 0°. Panels which face south, which is typical in the northern hemisphere, have an orientation of 180°. If a known orientation is based on magnetic north, the location-specific declination must be used to determine the orientation from true north.

Module tilt (°)
The elevation angle of the panels, measured up from flat ground. Panels lying flat on the ground (facing up) have a tilt of 0°. Tilt values between 0° and 40° are typical.

Fixed System Parameters

ANNEX F – ASSESSMENT LIMITATIONS AND ASSUMPTIONS

Forge's Sandia National Laboratories' (SGHAT) Model[42]

Summary of assumptions and abstractions required by the SGHAT/ForgeSolar analysis methodology

1. Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
2. Result data files and plots are now retained for two years after analysis completion. Files should be downloaded and saved if additional persistence is required.
3. The algorithm 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. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.
4. Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare. This primarily affects analyses of path receptors.
5. Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis.
6. The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
7. The algorithm assumes that the PV array is aligned with a plane defined by the total heights of the coordinates outlined in the Google map. For more accuracy, the user should perform runs using minimum and maximum values for the vertex heights to bound the height of the plane containing the solar array. Doing so will expand the range of observed solar glare when compared to results using a single height value.
8. The algorithm 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.
9. The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.
10. The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.
11. The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.
12. Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
13. Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
14. Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
15. PV array tracking assumes the modules move instantly when tracking the sun, and when reverting to the rest position.

[42] https://www.forgesolar.com/help/#assumptions

ANNEX G – RECEPTOR AND REFLECTOR AREA DETAILS

Aviation Receptor Data

Full receptor data is available upon request.

Threshold	Longitude (°)	Latitude (°)	Elevation (m amsl)
01	-3.71737	51.54596	51.24
19	-3.71723	51.54879	62.24
12	-3.71851	51.54729	58.24
30	-3.71477	51.54610	52.24

Aviation Receptor Data

Dwelling Receptor Data

The dwelling receptor data is presented in the table below. An additional 1.8m height has been added to the terrain height to account for the eye-level of an observer at these dwellings.

No.	Latitude (°)	Longitude (°)	Assessed Height (m)	No.	Latitude (°)	Longitude (°)	Assessed Height (m)
1	51.57155	-3.63697	143.20	13	51.54852	-3.63240	131.21
2	51.56750	-3.62117	143.40	14	51.54729	-3.63262	118.17
3	51.55579	-3.67292	113.52	15	51.54691	-3.63311	115.80
4	51.55577	-3.67261	110.66	16	51.54634	-3.63333	111.73
5	51.55580	-3.67167	125.05	17	51.54629	-3.63287	111.50
6	51.55574	-3.67131	128.89	18	51.54582	-3.63350	107.99
7	51.55577	-3.67092	131.87	19	51.54562	-3.63370	106.11
8	51.55256	-3.66224	135.92	20	51.54464	-3.63438	101.39
9	51.55214	-3.66164	132.29	21	51.54868	-3.62937	126.98

No.	Latitude (°)	Longitude (°)	Assessed Height (m)	No.	Latitude (°)	Longitude (°)	Assessed Height (m)
10	51.55425	-3.65864	146.17	22	51.54658	-3.62398	109.56
11	51.54990	-3.64793	123.15	23	51.54974	-3.61631	138.12
12	51.54994	-3.63546	159.42	24	51.54819	-3.61530	112.74
13	51.54852	-3.6324	131.21	31	51.54734	-3.61340	105.94
14	51.54729	-3.63262	118.17	32	51.54731	-3.61368	106.00
15	51.54691	-3.63311	115.80	33	51.54735	-3.65334	77.75
16	51.54634	-3.63333	111.73	34	51.54733	-3.61348	105.64
17	51.54629	-3.63287	111.50	35	51.56847	-3.62777	126.54
18	51.54582	-3.6335	107.99				

Dwelling receptor data

Modelled Reflector Areas

The modelled reflector areas are presented in the table below.

Panel Area 1

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-3.66149	51.57169	8	-3.65612	51.57195
2	-3.66026	51.57134	9	-3.65615	51.57218
3	-3.65975	51.57163	10	-3.65803	51.57263
4	-3.65427	51.56975	11	-3.65986	51.57238
5	-3.65383	51.56977	12	-3.65981	51.57269
6	-3.65340	51.57017	13	-3.66107	51.57296
7	-3.65331	51.57090			

Panel Area 1

Panel Area 2

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-3.65369	51.56736	5	-3.65139	51.56772
2	-3.65179	51.56661	6	-3.65182	51.56727
3	-3.65033	51.56663	7	-3.65338	51.56789
4	-3.65006	51.56715			

Panel Area 2

Panel Area 3

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-3.67017	51.56283	14	-3.66461	51.56063
2	-3.66776	51.56338	15	-3.66455	51.56122
3	-3.66719	51.56253	16	-3.66382	51.56197
4	-3.66653	51.56211	17	-3.66449	51.56367
5	-3.66538	51.56161	18	-3.66319	51.56460
6	-3.66517	51.56005	19	-3.66096	51.56456
7	-3.66459	51.55992	20	-3.66142	51.56493
8	-3.66354	51.55993	21	-3.66201	51.56494
9	-3.66316	51.56017	22	-3.66265	51.56540
10	-3.66257	51.55986	23	-3.66669	51.56444
11	-3.66190	51.55987	24	-3.66800	51.56453
12	-3.66222	51.56096	25	-3.67107	51.56507
13	-3.66327	51.56064			

Panel Area 3

Panel Area 4

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-3.63330	51.57012	5	-3.62801	51.57132
2	-3.63200	51.57081	6	-3.62980	51.57209

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
3	-3.63034	51.56962	7	-3.63089	51.57192
4	-3.62793	51.57073	8	-3.63402	51.57037

Panel Area 4

Panel Area 5

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-3.64528	51.55291	9	-3.63545	51.55314
2	-3.64330	51.55243	10	-3.63502	51.55247
3	-3.64080	51.55229	11	-3.63387	51.55269
4	-3.64013	51.55411	12	-3.63497	51.55486
5	-3.63871	51.55408	13	-3.63766	51.55529
6	-3.63915	51.55286	14	-3.63914	51.55520
7	-3.63892	51.55230	15	-3.64483	51.55493
8	-3.63671	51.55263			

Panel Area 5

Panel Area 6

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-3.63287	51.55815	14	-3.62536	51.55567
2	-3.63334	51.55797	15	-3.62410	51.55551
3	-3.63633	51.55796	16	-3.62382	51.55672
4	-3.63514	51.55662	17	-3.62446	51.55699
5	-3.63072	51.55651	18	-3.62524	51.55705
6	-3.62968	51.55600	19	-3.62692	51.55694
7	-3.62881	51.55647	20	-3.62739	51.55671
8	-3.62846	51.55631	21	-3.62775	51.55682
9	-3.62820	51.55595	22	-3.62824	51.55711

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
10	-3.62701	51.55591	23	-3.62847	51.55759
11	-3.62696	51.55622	24	-3.62839	51.55794
12	-3.62598	51.55610	25	-3.63246	51.55890
13	-3.62553	51.55590			

Panel Area 6

Panel Area 7

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-3.62777	51.55525	9	-3.62088	51.55117
2	-3.62775	51.55435	10	-3.62157	51.55230
3	-3.62749	51.55308	11	-3.62266	51.55311
4	-3.62677	51.55298	12	-3.62387	51.55350
5	-3.62642	51.55212	13	-3.62412	51.55407
6	-3.62611	51.55205	14	-3.62335	51.55430
7	-3.62553	51.55040	15	-3.62335	51.55490
8	-3.62112	51.55024			

Panel Area 7

Panel Area 8

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-3.62186	51.54833	7	-3.61615	51.54852
2	-3.62171	51.54741	8	-3.61623	51.54881
3	-3.61984	51.54764	9	-3.61793	51.54886
4	-3.61993	51.54719	10	-3.61926	51.54865
5	-3.61858	51.54732	11	-3.62153	51.54852
6	-3.61733	51.54773			

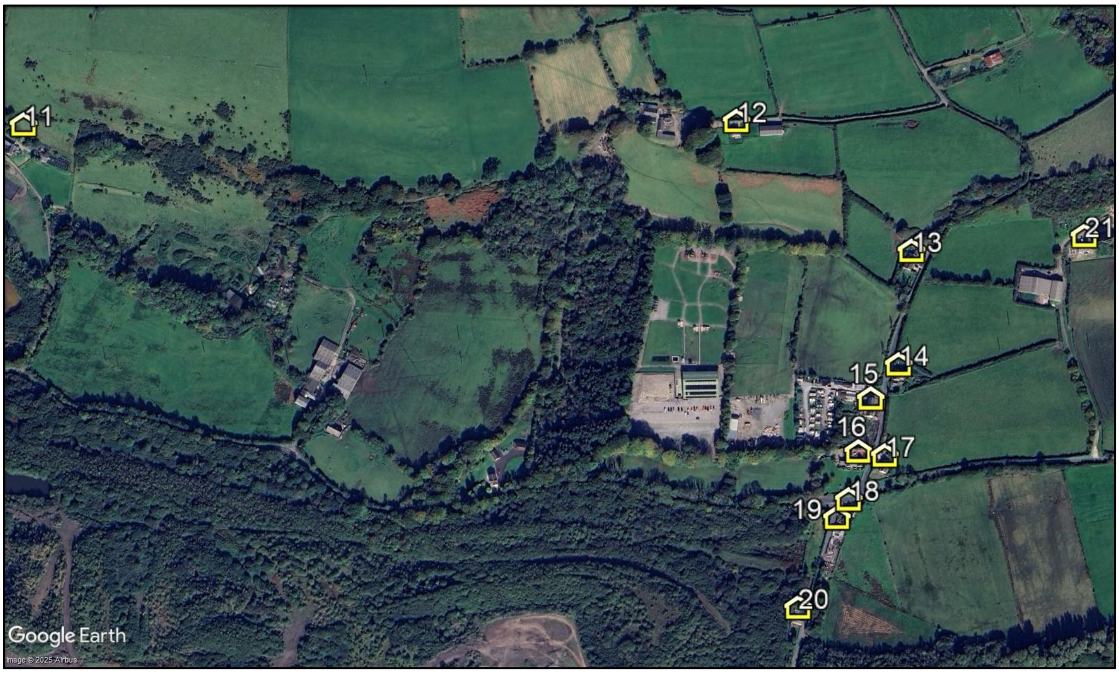
Panel Area 8

ANNEX H – DETAILED IDENTIFICATION OF DWELLING RECEPTORS

Detailed identification of dwelling receptors is presented in the following figures in this section.

Dwelling receptors 1 to 2

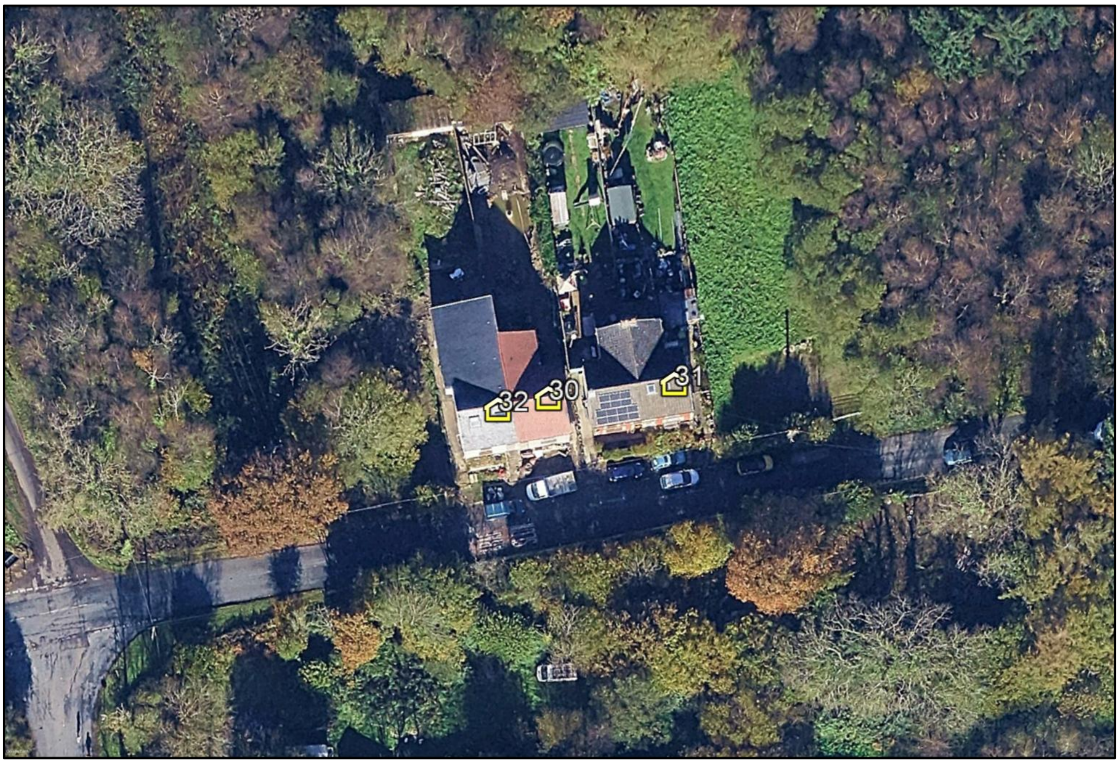
Dwelling receptors 3 to 10



Dwelling receptors 11 to 21

Dwelling receptors 22 to 24

Dwelling receptors 25 to 29



Dwelling receptors 30 to 32

Dwelling receptor 33

Dwelling receptor 34

Dwelling receptor 35

ANNEX I – DETAILED MODELLING RESULTS

Overview

The Pager Power charts for the assessed receptors are shown on the following pages. Each chart shows:

- The receptor (observer) location – top right image. This also shows the azimuth range of the Sun itself at times when reflections are possible. If sunlight is experienced from the same direction as the reflecting panels, the overall impact of the reflection is reduced as discussed within the body of the report;
- The reflecting panels – bottom right image. The reflecting area is shown in yellow. If the yellow panels are not visible from the observer location, no issues will occur in practice. Additional obstructions which may obscure the panels from view are considered separately within the analysis;
- The reflection date/time graph – left hand side of the page. The blue line indicates the dates and times at which geometric reflections are possible. This relates to reflections from the yellow areas.
- The sunrise and sunset curves throughout the year (red and yellow lines).

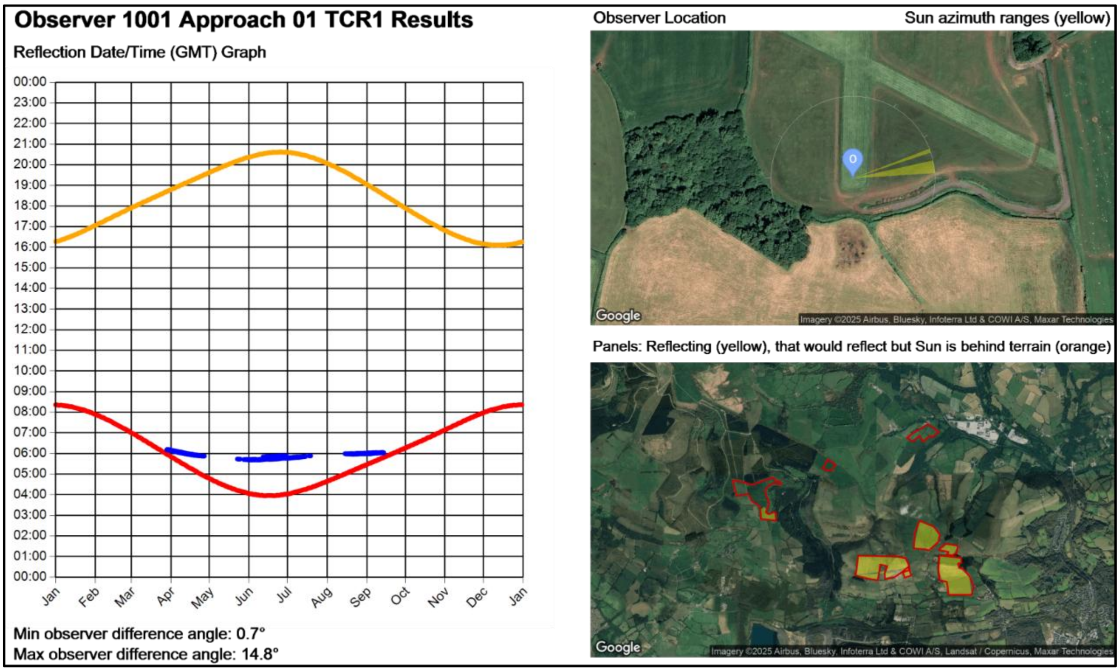
The Forge charts for the aviation receptors are shown on the following pages. Each chart shows:

- The annual predicted solar reflections.
- The daily duration of the solar reflections.
- The location of the Proposed Development where glare will originate.
- The calculated intensity of the predicted solar reflections.

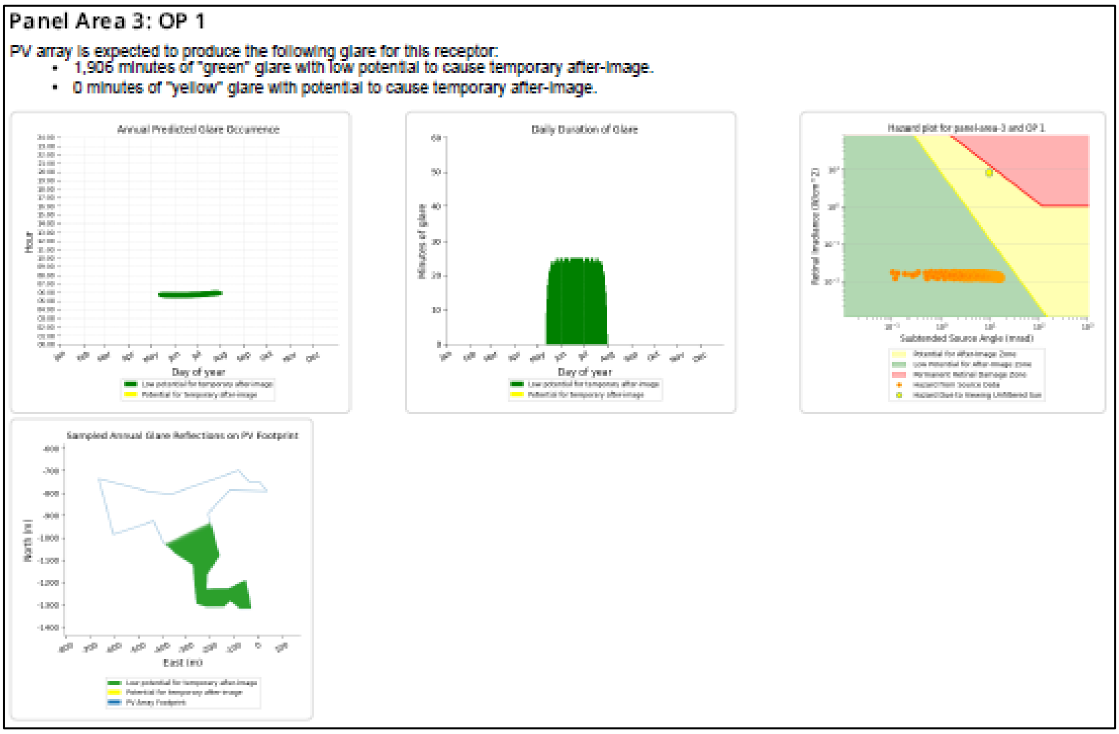
Aviation Receptors

Selective results are presented for reference. Full modelling results are available upon request.

Pager Power

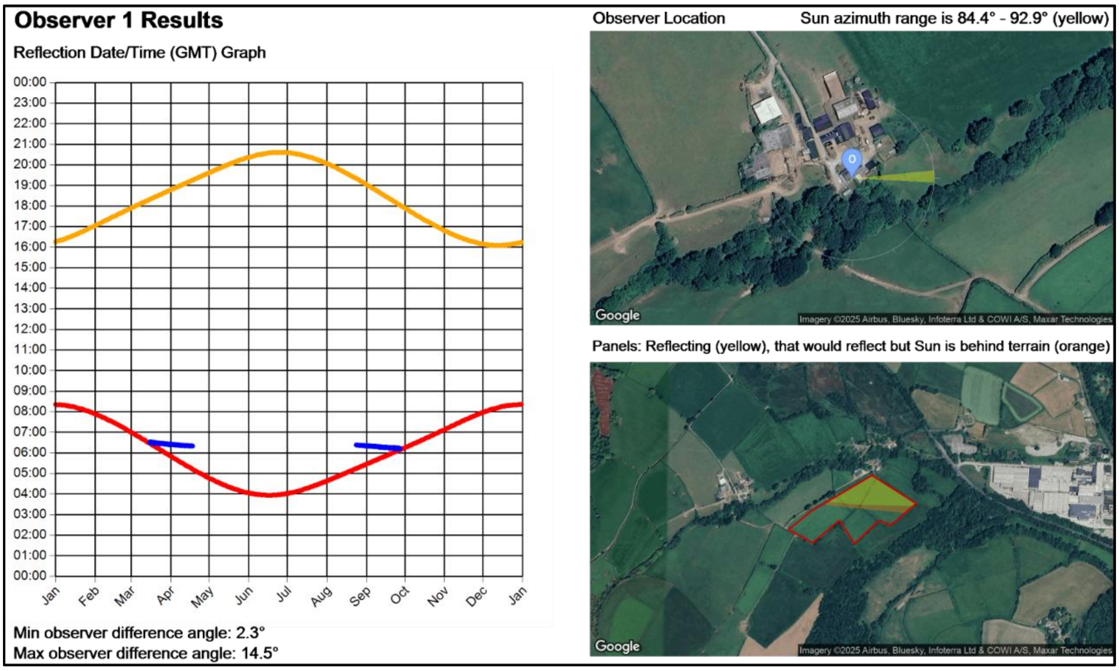


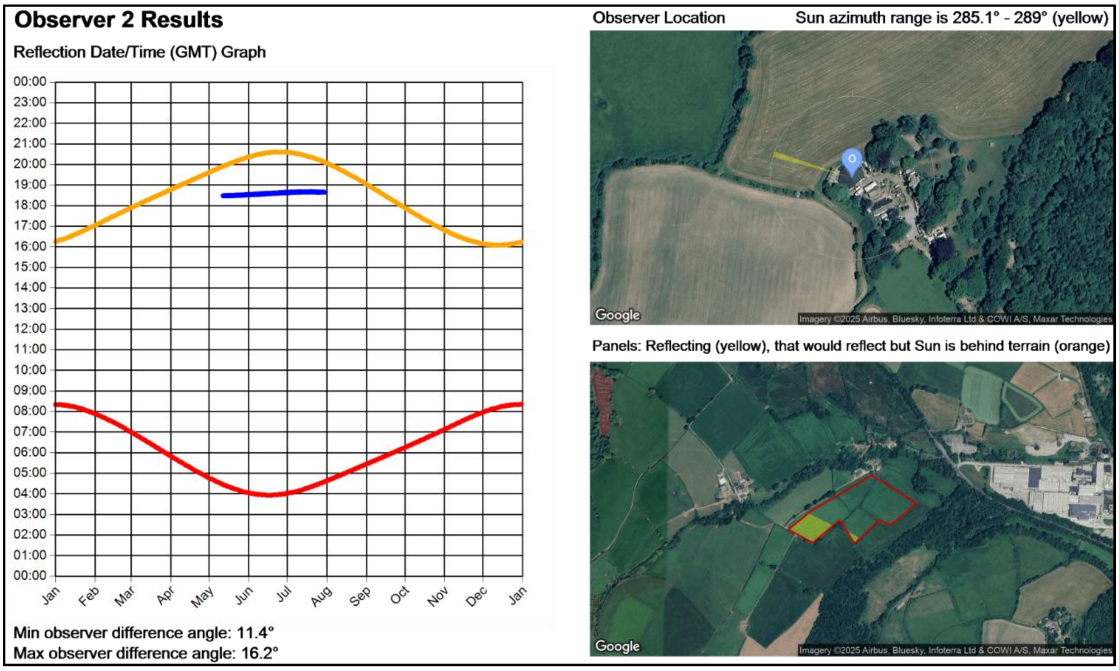
Forge

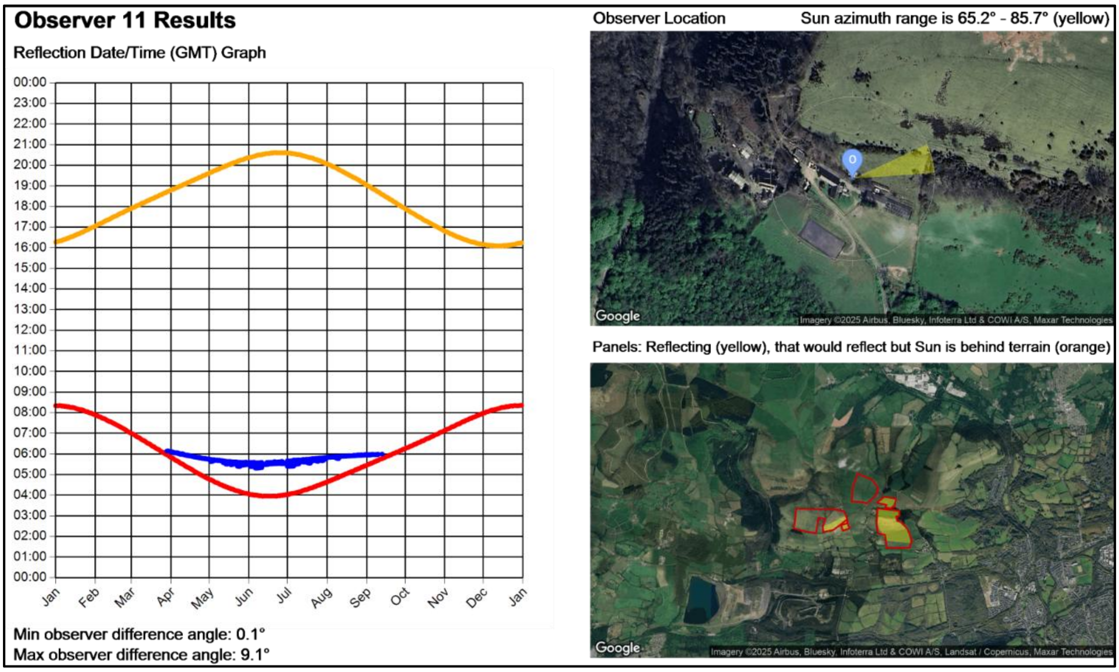


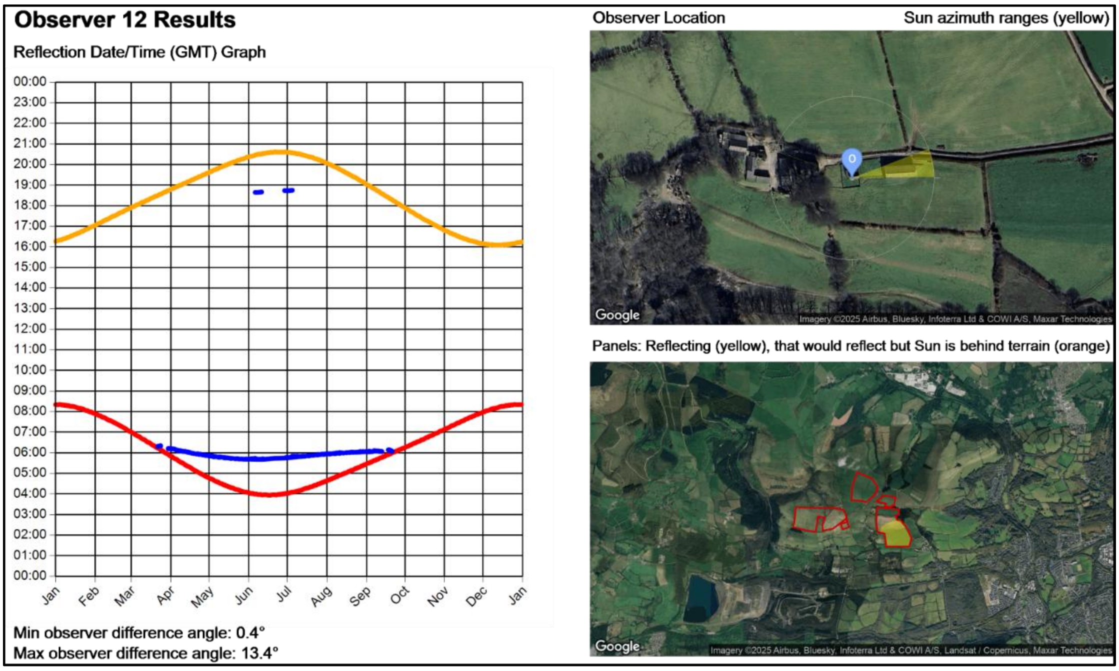
Dwelling Receptors

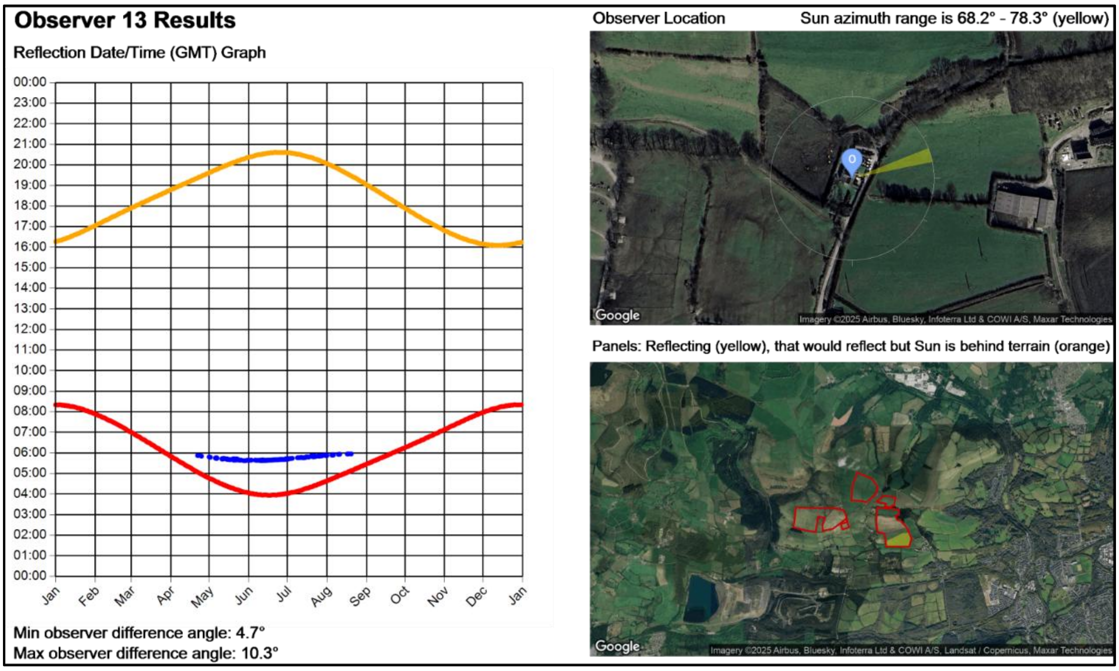
Full modelling results are provided for completeness.

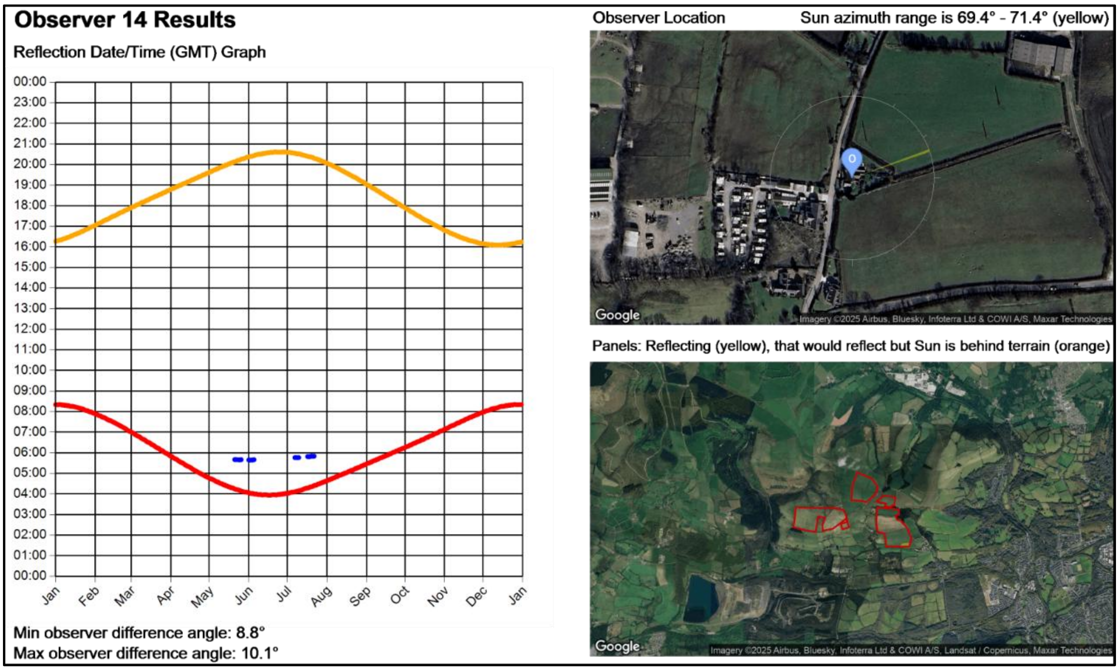


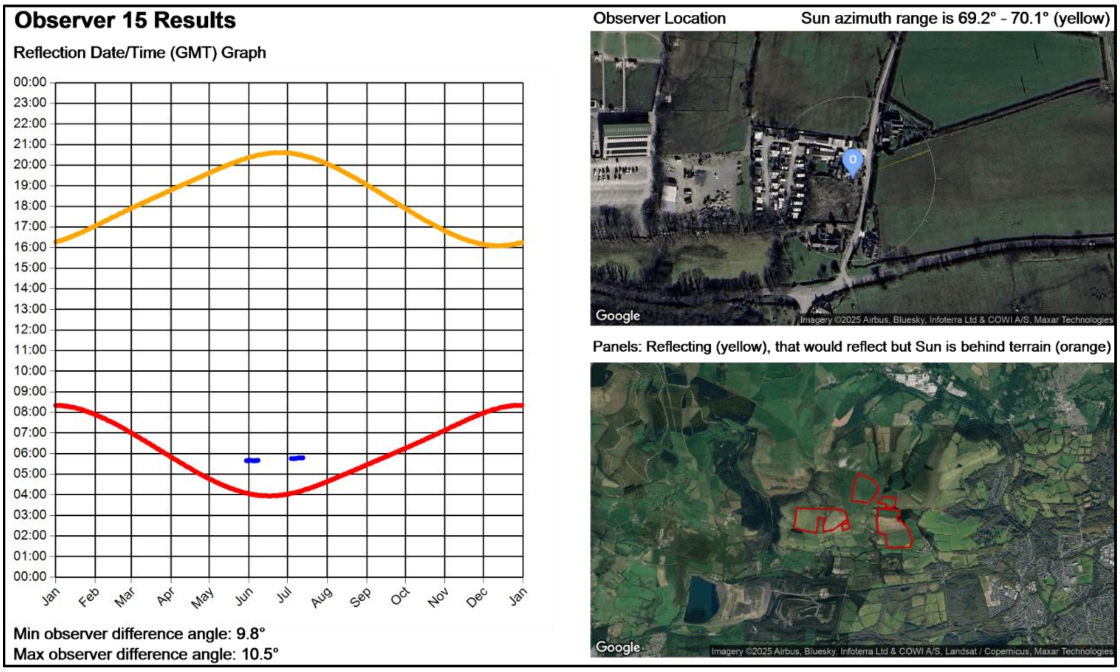


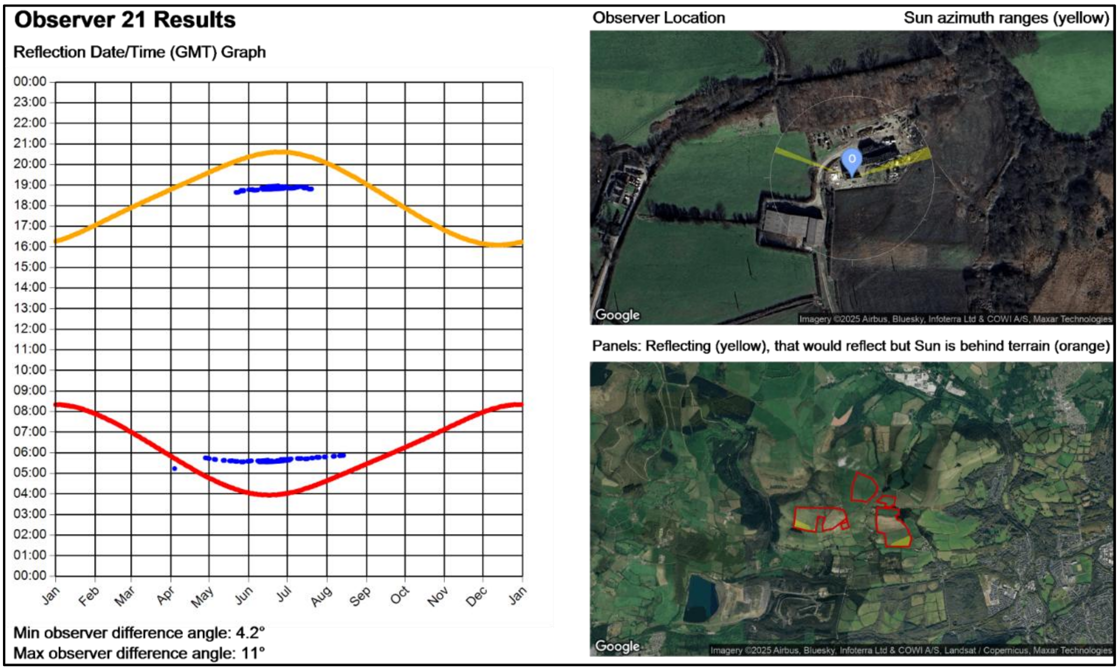

Observer 11 Results
Reflection Date/Time (GMT) Graph
Min observer difference angle: 0.1°
Max observer difference angle: 9.1°
Observer Location
Sun azimuth range is 65.2° - 85.7° (yellow)
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

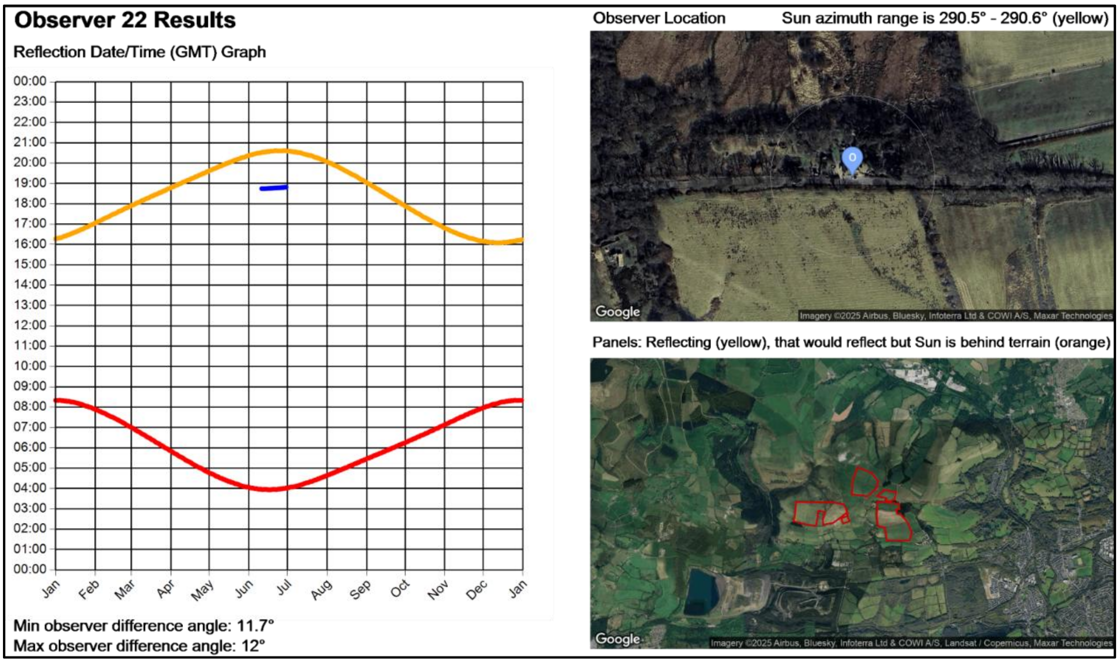

Observer 12 Results
Reflection Date/Time (GMT) Graph
Min observer difference angle: 0.4°
Max observer difference angle: 13.4°
Observer Location
Sun azimuth ranges (yellow)
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

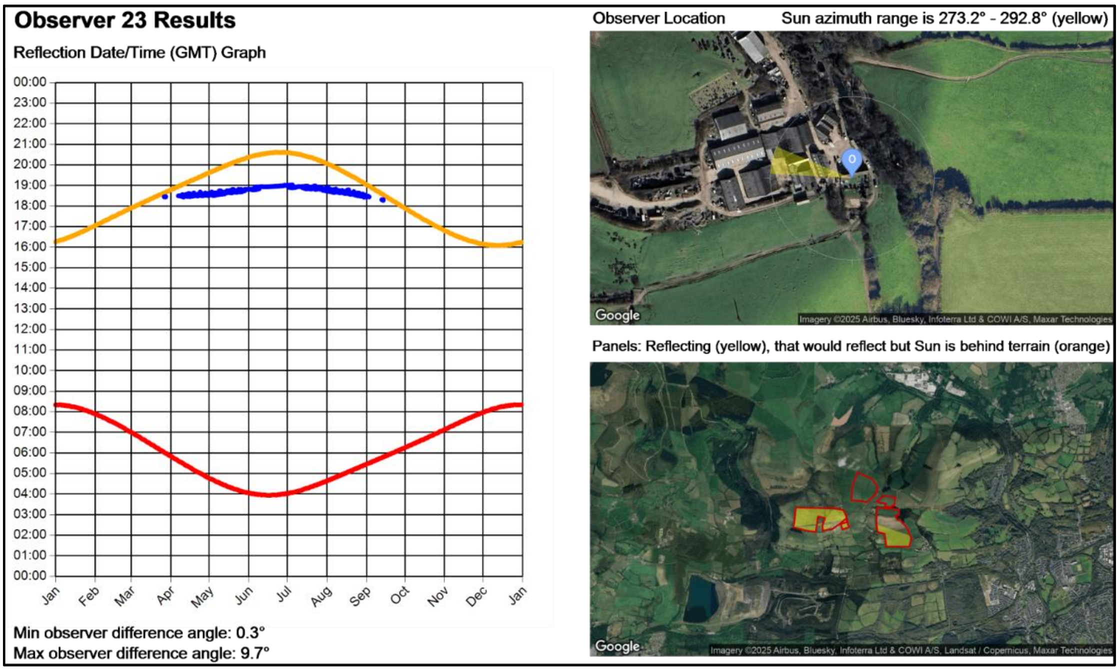

Observer 13 Results
Reflection Date/Time (GMT) Graph
00:00
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 4.7°
Max observer difference angle: 10.3°
Observer Location
Sun azimuth range is 68.2° - 78.3° (yellow)
Google
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google

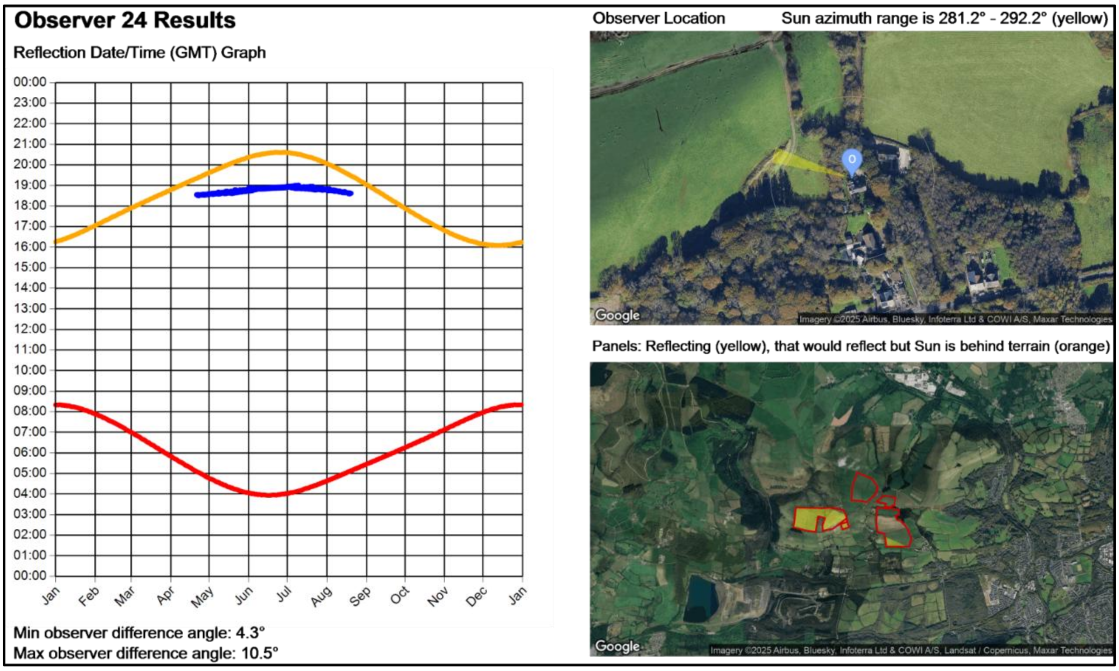

Observer 14 Results
Reflection Date/Time (GMT) Graph
00:00
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 8.8°
Max observer difference angle: 10.1°
Observer Location
Sun azimuth range is 69.4° - 71.4° (yellow)
Google
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google

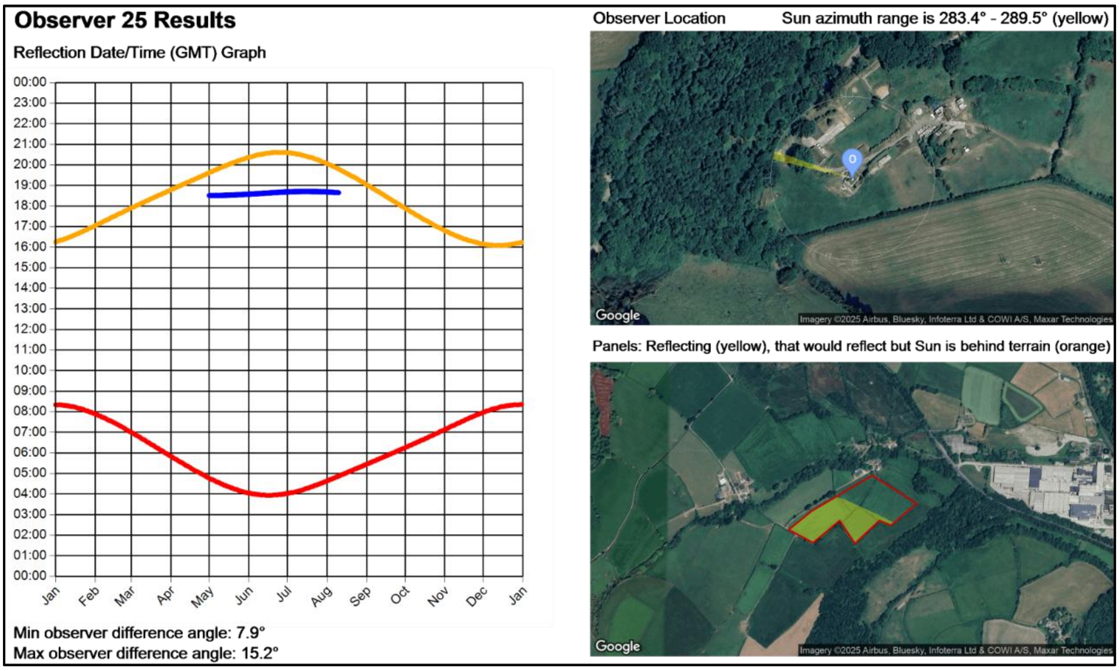

Observer 15 Results
Reflection Date/Time (GMT) Graph
Observer Location
Sun azimuth range is 69.2° - 70.1° (yellow)
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Min observer difference angle: 9.8°
Max observer difference angle: 10.5°

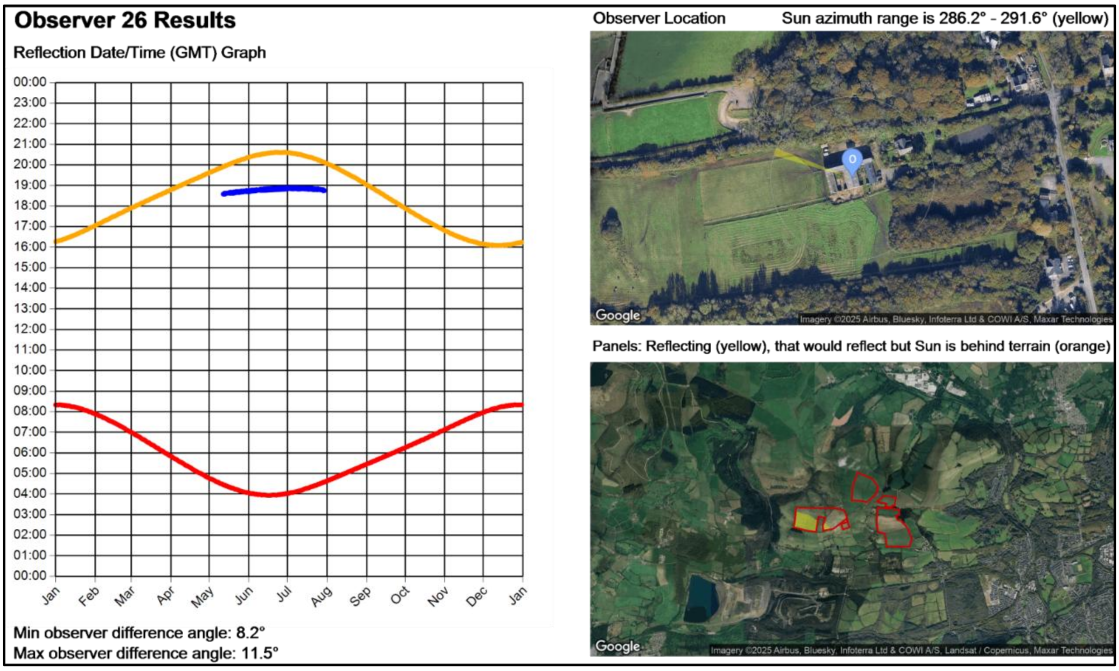

Observer 21 Results
Reflection Date/Time (GMT) Graph
Observer Location
Sun azimuth ranges (yellow)
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Min observer difference angle: 4.2°
Max observer difference angle: 11°

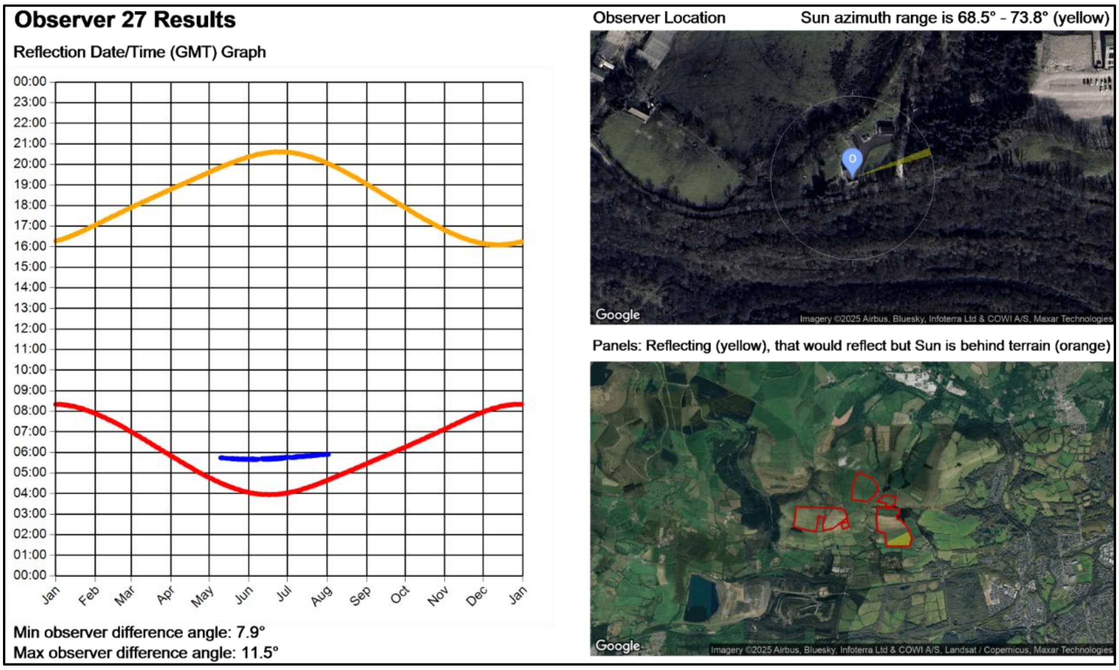

Observer 22 Results
Reflection Date/Time (GMT) Graph
Min observer difference angle: 11.7°
Max observer difference angle: 12°
Observer Location
Sun azimuth range is 290.5° - 290.6° (yellow)
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

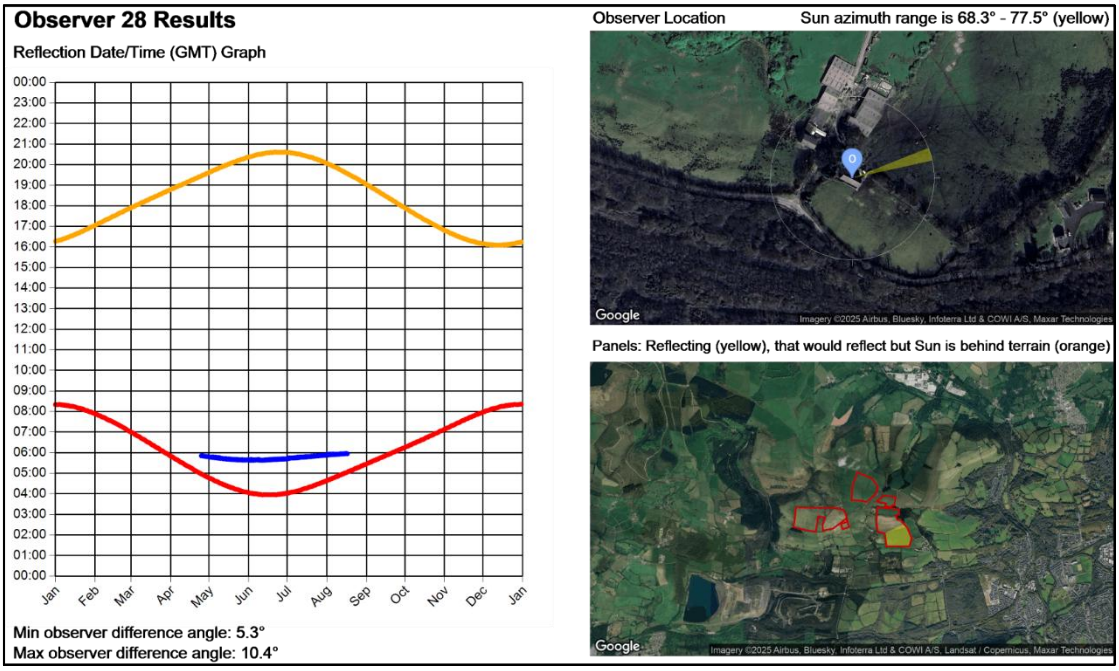

Observer 23 Results
Reflection Date/Time (GMT) Graph
Min observer difference angle: 0.3°
Max observer difference angle: 9.7°
Observer Location
Sun azimuth range is 273.2° - 292.8° (yellow)
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

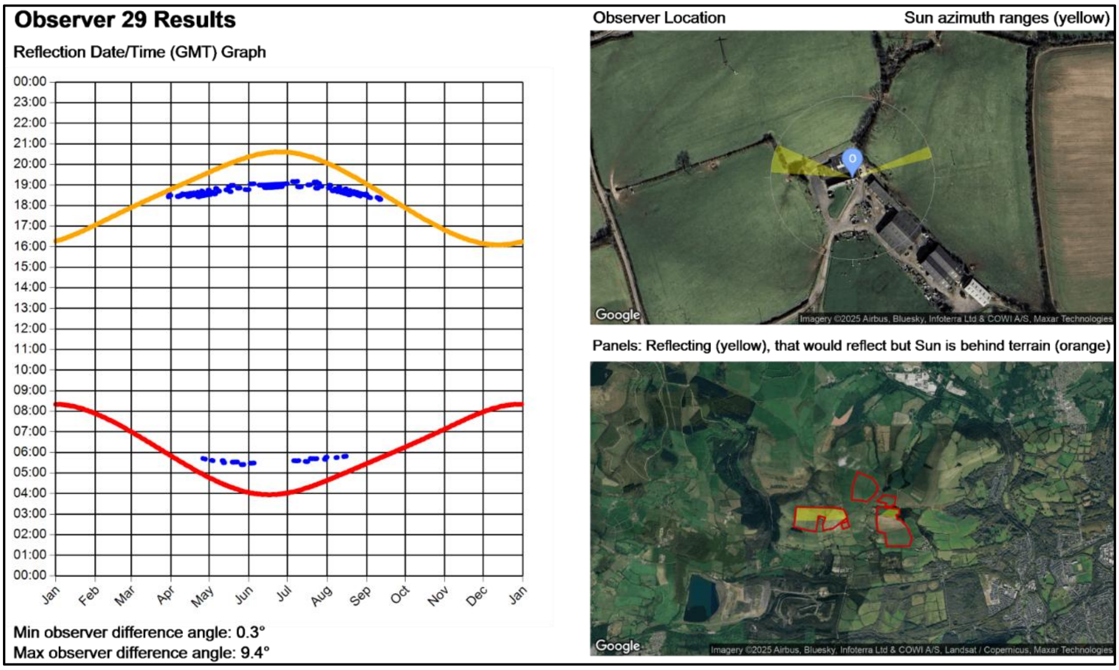

Observer 24 Results
Reflection Date/Time (GMT) Graph
Min observer difference angle: 4.3°
Max observer difference angle: 10.5°
Observer Location
Sun azimuth range is 281.2° - 292.2° (yellow)
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

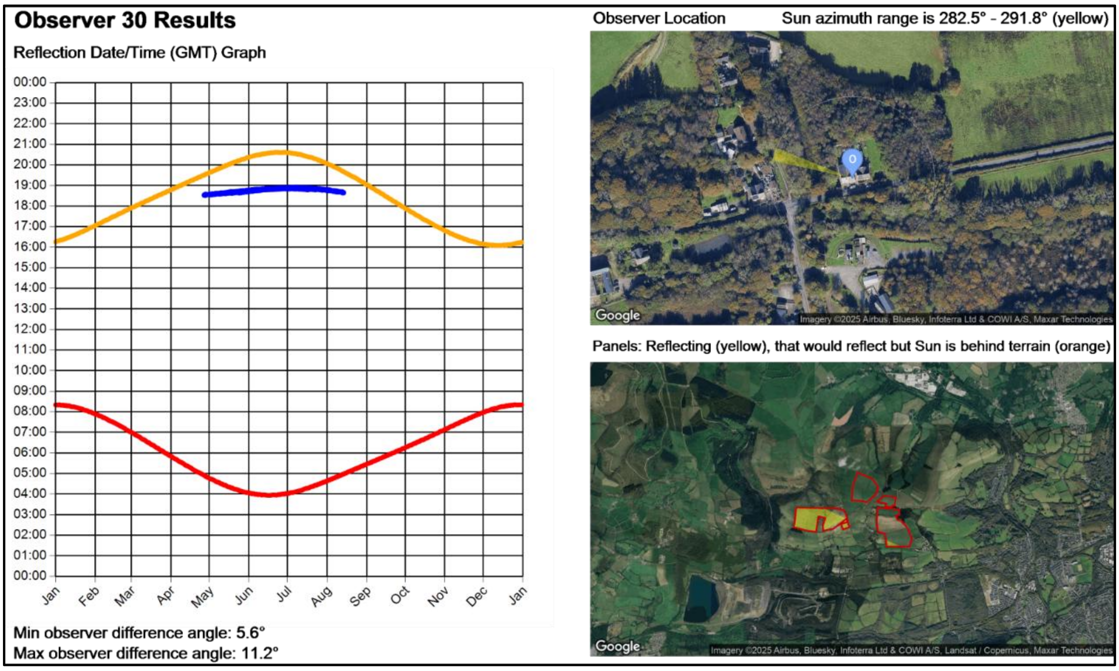

Observer 25 Results
Reflection Date/Time (GMT) Graph
Min observer difference angle: 7.9°
Max observer difference angle: 15.2°
Observer Location
Sun azimuth range is 283.4° - 289.5° (yellow)
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

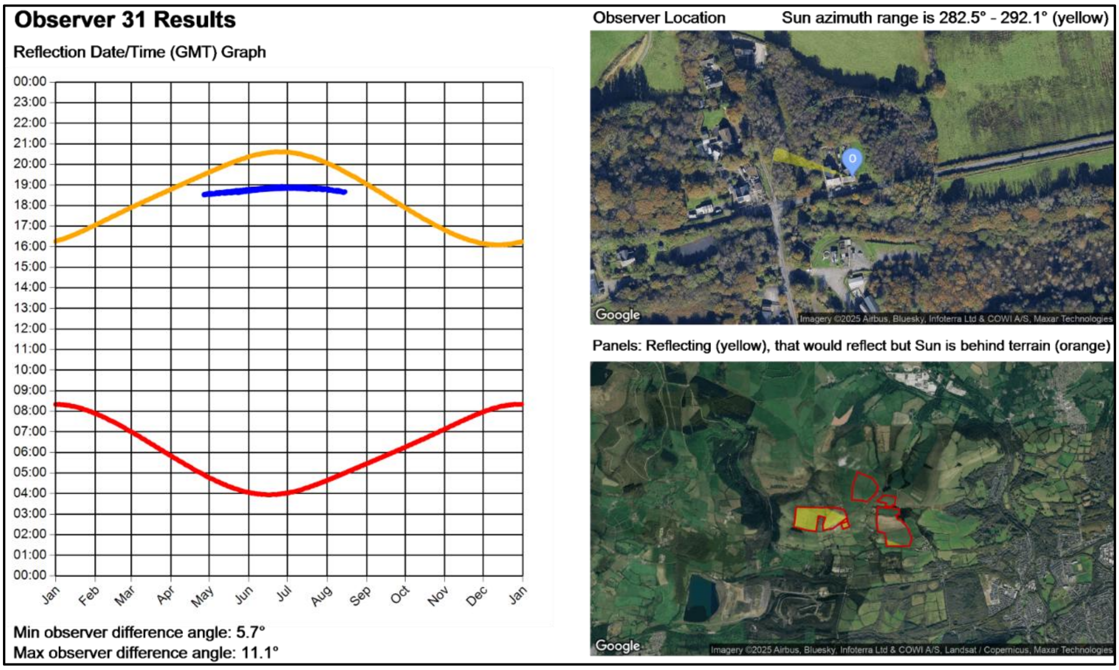

Observer 26 Results
Reflection Date/Time (GMT) Graph
Min observer difference angle: 8.2°
Max observer difference angle: 11.5°
Observer Location
Sun azimuth range is 286.2° - 291.6° (yellow)
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google

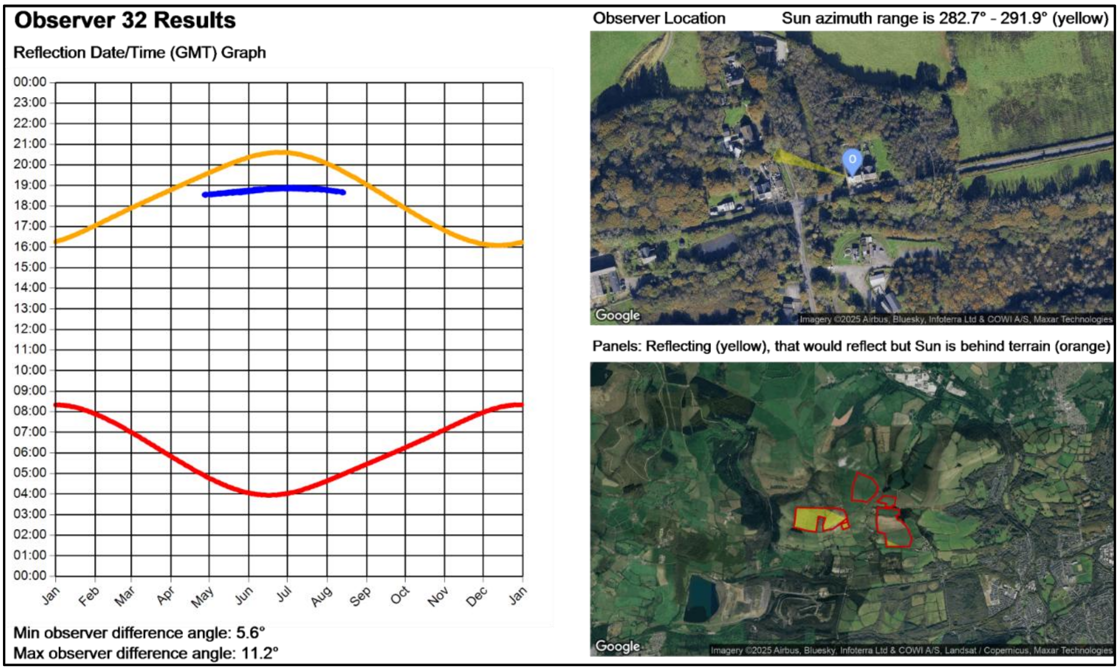

Observer 27 Results
Reflection Date/Time (GMT) Graph
Min observer difference angle: 7.9°
Max observer difference angle: 11.5°
Observer Location
Sun azimuth range is 68.5° - 73.8° (yellow)
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google

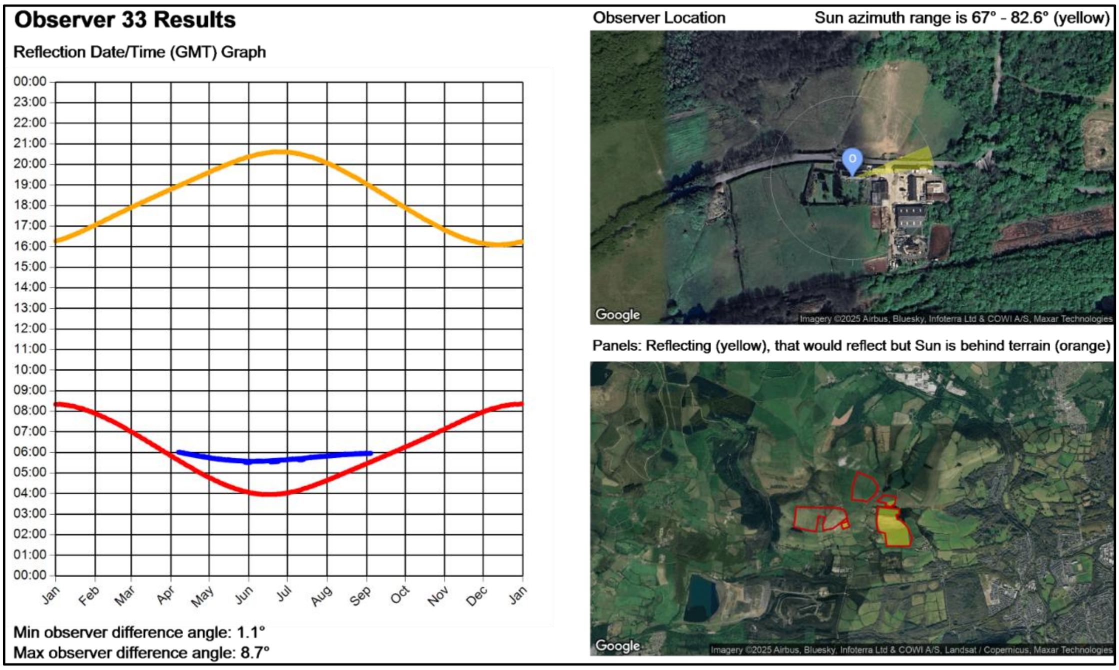

Observer 28 Results
Reflection Date/Time (GMT) Graph
Min observer difference angle: 5.3°
Max observer difference angle: 10.4°
Observer Location
Sun azimuth range is 68.3° - 77.5° (yellow)
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

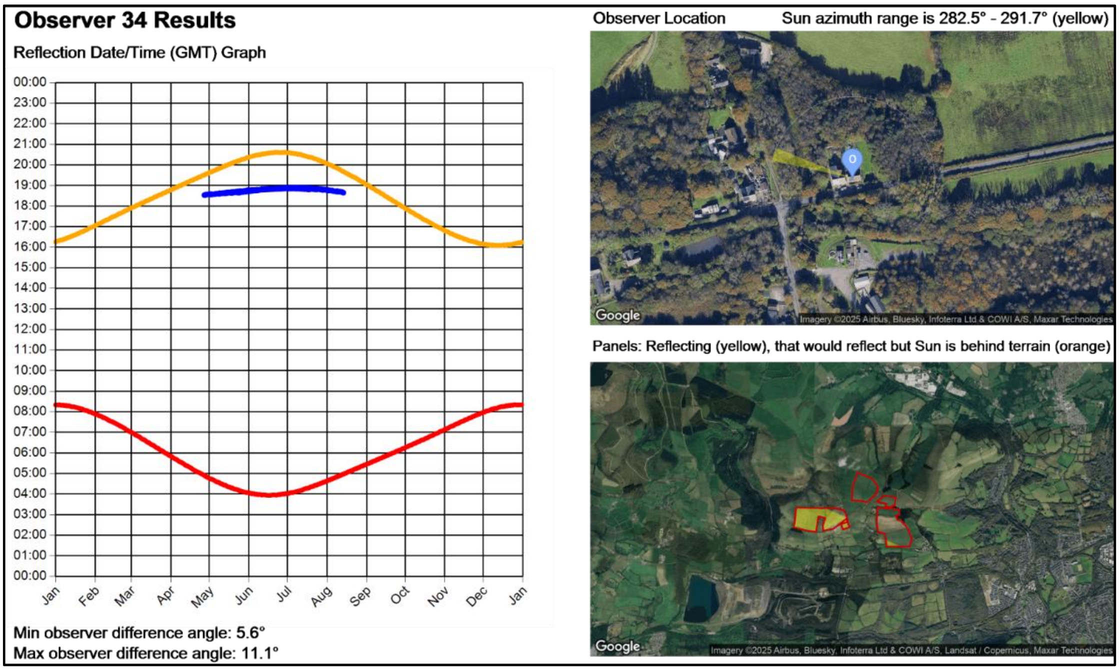

Observer 29 Results
Reflection Date/Time (GMT) Graph
Min observer difference angle: 0.3°
Max observer difference angle: 9.4°
Observer Location
Sun azimuth ranges (yellow)
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

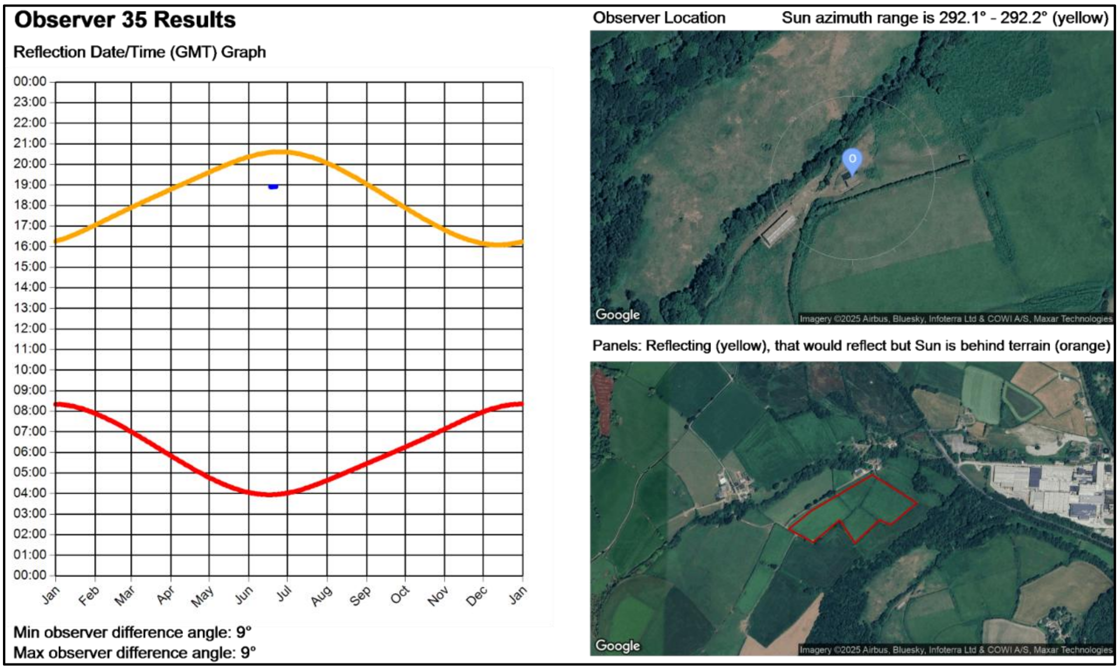

Observer 30 Results
Reflection Date/Time (GMT) Graph
00:00
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 5.6°
Max observer difference angle: 11.2°
Observer Location
Sun azimuth range is 282.5° - 291.8° (yellow)
Google
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google


Observer 31 Results
Reflection Date/Time (GMT) Graph
00:00
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 5.7°
Max observer difference angle: 11.1°
Observer Location
Sun azimuth range is 282.5° - 292.1° (yellow)
Google
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google


Observer 32 Results
Reflection Date/Time (GMT) Graph
Observer Location
Sun azimuth range is 282.7° - 291.9° (yellow)
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Min observer difference angle: 5.6°
Max observer difference angle: 11.2°


Observer 33 Results
Reflection Date/Time (GMT) Graph
Observer Location
Sun azimuth range is 67° - 82.6° (yellow)
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Min observer difference angle: 1.1°
Max observer difference angle: 8.7°


Observer 34 Results
Reflection Date/Time (GMT) Graph
00:00
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 5.6°
Max observer difference angle: 11.1°
Observer Location
Sun azimuth range is 282.5° - 291.7° (yellow)
Google
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google


Observer 35 Results
Reflection Date/Time (GMT) Graph
00:00
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Min observer difference angle: 9°
Max observer difference angle: 9°
Observer Location
Sun azimuth range is 292.1° - 292.2° (yellow)
Google
Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)
Google

ANNEX J – SCREENING REVIEW

Overview

A desk-based review of the available imagery is presented in the following subsections.

Dwelling Receptors

A desk-based review of the available imagery is presented in the figures (in this subsection) on the following pages. The cumulative reflecting panel areas are indicated by regions of yellow within the figures. The identified screening in the form of existing vegetation, buildings and proposed vegetation is outlined in pink, blue and orange respectively. High-level Zones of Visible Terrain[43] (ZTV) show regions visible from a point and are indicated by shaded regions of green.

[43] Generated by Google Earth Viewshed at a height of 5.0m above ground level

Screening Review 1 for dwelling receptor 1

Screening Review 2 for dwelling receptor 2

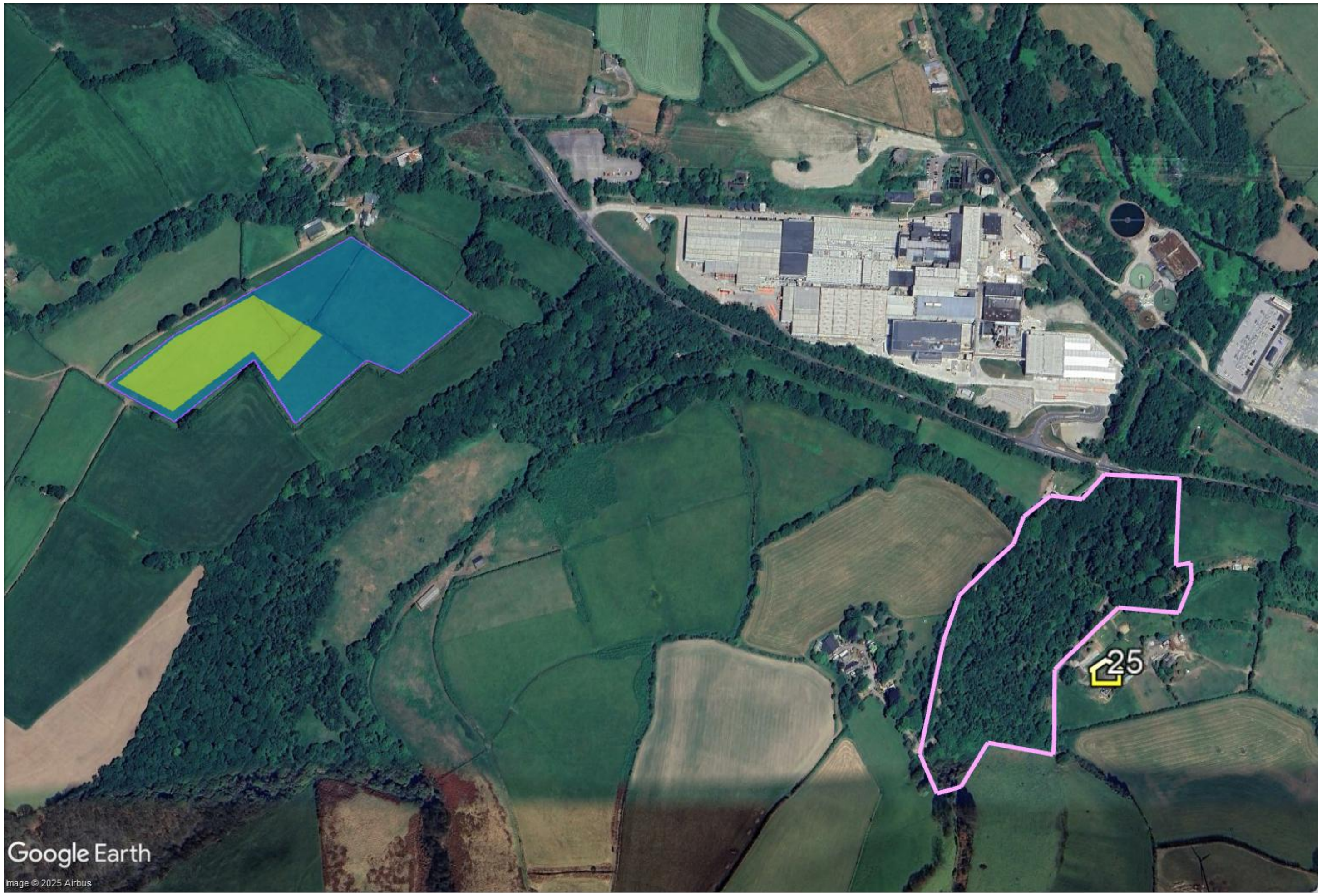
Screening Review 3 for dwelling receptor 11

Screening Review 4 for dwelling receptors 12 to 13

Screening Review 5 for dwelling receptors 14 to 20

Screening Review 6 for dwelling receptors 21 to 22

Screening Review 7 for dwelling receptors 23 to 24



Screening Review 8 for dwelling receptor 25

Screening Review 9 for dwelling receptor 26

Screening Review 10 for dwelling receptors 27 to 28

Screening Review for dwelling receptor 29

Screening Review for dwelling receptors 30 to 32 and 34

Screening Review 13 for dwelling receptor 33

Screening Review 15 for dwelling receptor 35

PAGERPOWER
Urban & Renewables

Pager Power Limited
Stour Valley Business Centre
Sudbury
Suffolk
CO10 7GB

Tel: +44 1787 319001 **Email:** info@pagerpower.com **Web:** www.pagerpower.com