PAGERPOWER
Urban & Renewables

Solar Photovoltaic Glint and Glare Study

Derrygrogan Little, Ballycommon

RPS Group Plc

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ADMINISTRATION PAGE

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1	30th October 2025	Initial issue
2	13th November 2025	Administrative amendments
3	26th November 2025	Administrative amendments
4	3rd December 2025	Administrative amendments

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EXECUTIVE SUMMARY

Report Purpose

Pager Power has been retained to assess the potential effects of glint and glare from the proposed solar photovoltaic (PV) development which will be located in Derrygrogan Little, Ballycommon, Ireland. The assessment pertains to the potential impact upon surrounding road safety, residential amenity, and aviation activity associated with Spollens Airstrip. Cumulative impacts of the proposed development in combination with three consented solar developments located nearby (See Section 4.2.2) have been considered where appropriate.

Overall Conclusions

No significant impacts are predicted on surrounding road safety, residential amenity, and aviation activity associated with Spollens Airstrip. Mitigation is not recommended.

An overview of the assessment results is presented on the following page.

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. There is no known specific guidance with respect to glint and glare from solar developments in the Republic of Ireland.

Pager Power has, however, produced guidance for glint and glare and solar photovoltaic developments, which was first published in early 2017, with the fourth edition produced in 2022[1]. The guidance document sets out the methodology for assessing road safety, residential amenity, and aviation safety with respect to solar reflections from solar panels.

Pager Power's approach is to 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/ façades. 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.

The available studies have measured the intensity of reflections from solar panels with respect to other naturally occurring and manmade surfaces. The results show that the reflections produced are of intensity similar to or less than those produced from still water and significantly less than reflections from glass and steel[2].

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

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

Assessment Conclusions – Roads

All roads within the 1km assessment area are considered to be local roads. 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 Appendix D.

Assessment Conclusions – Dwellings

The modelling has shown that solar reflections are geometrically possible towards 18 of the 35 assessed dwelling locations.

No impacts are predicted on any of these dwellings because there is significant existing screening such that views of reflecting panels in the proposed development are not expected to be possible in practice. Mitigation is not required.

Assessment Conclusions – Spollens Airstrip

Solar reflections originating from the proposed development towards the final one-mile splayed approaches, and the final sections of the visual circuits and joins, are predicted to have glare intensities no greater than 'low potential for temporary after-image'. Considering the associated guidance pertaining to approach paths at licensed airfields, which states that this level of glare is acceptable, it can be reliably concluded that this glare intensity is acceptable for these receptors. A low impact is predicted, and no mitigation is recommended.

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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 internationally.

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;
- 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

Pager Power has been retained to assess the potential effects of glint and glare from the proposed solar photovoltaic (PV) development which will be located in Derrygrogan Little, Ballycommon, Ireland. The assessment pertains to the potential impact upon surrounding road safety, residential amenity, and aviation activity associated with Spollens Airstrip. Cumulative impacts of the proposed development in combination with three consented solar developments located nearby (See Section 4.2.2) have been considered where appropriate.

This report contains the following:

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

1.2 Pager Power's Experience

Pager Power has undertaken over 1,600 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 of glint and glare is as follows:

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

These definitions are aligned with those presented within the National Policy Statement for Renewable Energy Infrastructure (EN-3)[3] in England and the Federal Aviation Administration in the USA. The term 'solar reflection' is used in this report to refer to both reflection types. The definitions for glint and glare proposed by the ISEA Best Practice Guidance Report for Large Scale Solar Energy Development report are given in Appendix A for reference.

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[3] Published by the Department for Energy Security and Net Zero in November 2023 and came into force in January 2024.

2 PROPOSED SOLAR DEVELOPMENT LOCATION AND DETAILS

2.1 Proposed Development Site Plan

The modelled site plan[4] is shown in Figure 1 on the following page.

Figure 2 on page 14 shows the proposed development and existing developments outlined on aerial imagery.

[4] Source: Figure 4 Site layout 05554-RES-LAY-DR-PT-003(cropped)

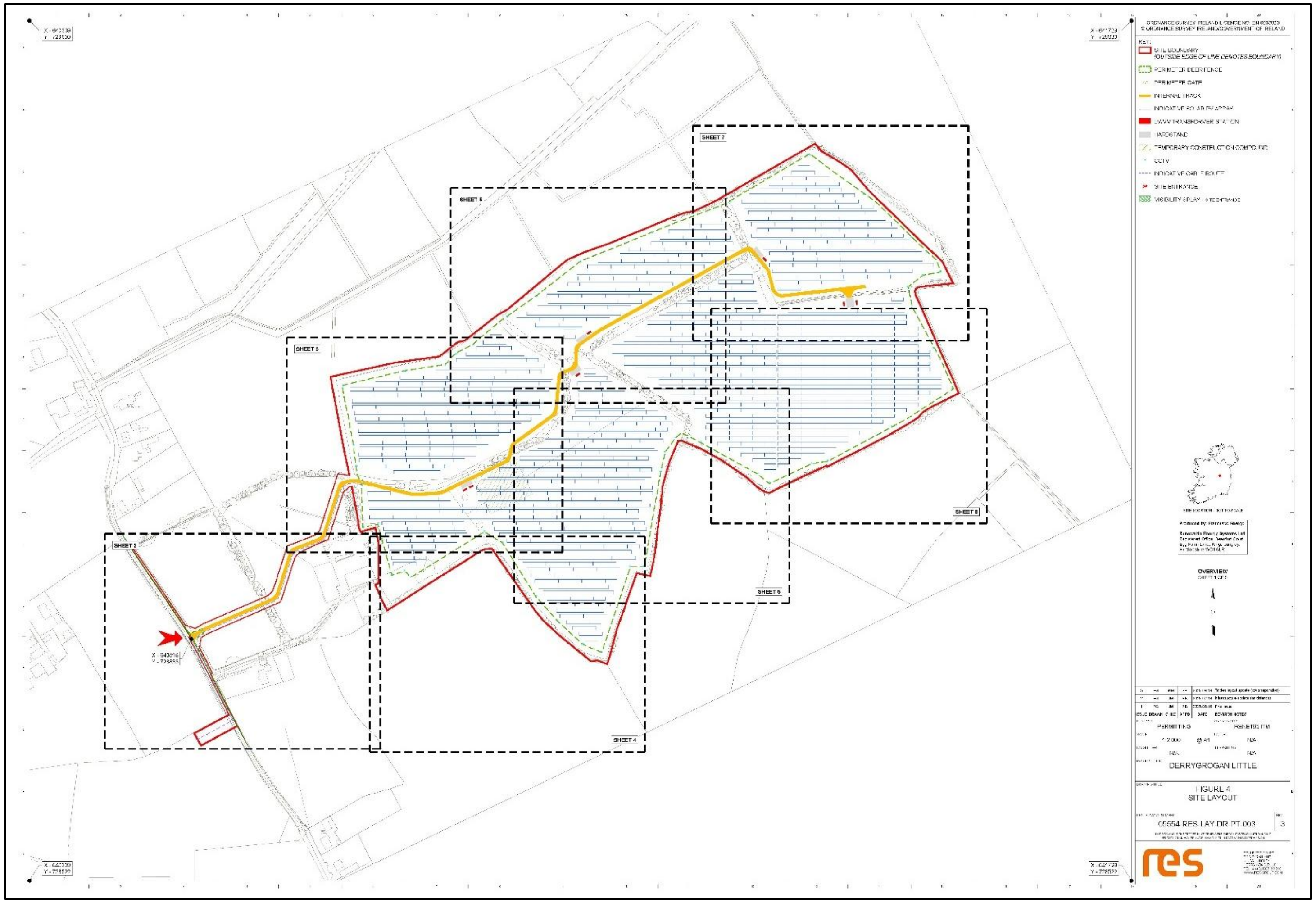

Figure 1 *Site Layout Plan (Proposed Development)*

Figure 2 *Consented (green) and proposed (pink) development– aerial image*

2.2 Modelled Reflector Area

Figure 3 below shows the assessed reflector area that has been used for modelling purposes.

Figure 3 *Assessed reflector area – aerial image*

A resolution of 10m has been chosen for this assessment. This means that a geometric calculation is undertaken for each identified receptor from a point every 10m from within the defined area. This resolution is sufficiently high to maximise the accuracy of the results; increasing the resolution further would not significantly change the modelling output. The number of modelled reflector points are determined by the size of the reflector areas and the assessment resolution. The bounding coordinates for the proposed solar development have been extrapolated from the site plans. The data can be provided on request.

2.3 Solar Panel Technical Information

The technical information used for the modelling is presented in Table 1 below. The centre of the solar panel has been used as the assessed height in metres above ground level (agl).

	Proposed Development
Azimuth angle[5]	180°
Elevation (tilt) angle[6]	20°
Assessed height (agl)	3 metres[7]

Table 1 *Solar panel information*

[5] Clockwise orientation the panels are facing relative to True North (0°)

[6] Relative to the horizontal. Modelled at the midpoint of the given 10 to 30 degrees range.

[7] Modelled at the maximum height

3 GLINT AND GLARE ASSESSMENT METHODOLOGY

3.1 Overview

Appendix 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;
- 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[8].

3.2 Background

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

3.3 Methodology

Information regarding the methodology of Pager Power's and Sandia National Laboratories' methodology is presented on the following page.

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 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;

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

- Consider the solar reflection with respect to the published studies and guidance;
- Determine whether a significant detrimental impact is expected in line with Appendix 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 Appendix E and Appendix F.

4 IDENTIFICATION OF RECEPTORS

4.1 Overview

The following sections present the relevant receptors assessed within this report. 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 Appendix G.

4.2 Ground-Based Receptors

4.2.1 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 extensive experience over a significant number of glint and glare assessments undertaken show that consideration of receptors within 1km of panel areas is appropriate for glint and glare effects on roads and dwellings. The panels are fixed south facing and solar reflections at ground level towards the north at this latitude are highly unlikely. Therefore, the area to the north of the northern-most solar panels has been excluded.

Potential receptors are identified based on mapping and aerial photography of the region. The initial judgement is made based on 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.

4.2.2 Consideration of cumulative impacts

There are three consented solar developments nearby the proposed development:

1. Derrgrogan Big Solar Farm (Offaly County Council Planning Reference: 22378) shown in green in Figure 4 on page 20;
2. Ballyteige Solar Farm (Offaly County Council Planning Reference: 2198 and subsequent planning amendment application in planning) shown in purple in Figure 5 on page 21;
3. Tullamore Solar Farm (Offaly County Council Planning Reference: 218) shown in yellow in Figure 6 on page 22;

The 1km assessment area has been constructed for the proposed development (white polygon), and each of the two consented developments.

The 1km assessment areas of Derrygrogan Big Solar Farm and the proposed development do overlap (see Figure 4 on page 20) so cumulative modelling has been undertaken where appropriate.

The 1km assessment areas of Ballyteige Solar Farm and the proposed development do not overlap (see Figure 5 on page 21) so there are no shared road or dwelling receptors. Therefore no significant cumulative impacts are predicted and no further analysis is recommended.

The 1km assessment areas of Tullamore Solar Farm and the proposed development do overlap (see Figure 6 on page 22) and there is one shared dwelling receptor. Solar reflections are not geometrically possible towards this dwelling from Tullamore Solar Farm[9], nor from the proposed development, therefore no cumulative impacts are possible and no further analysis is required.

[9] Pager Power completed the glint and glare assessment for this development.

Figure 4 *Constructed 1km assessment areas for proposed development and consented Derrygrogan Big Solar Farm – aerial image*

Figure 5 *Constructed 1km assessment areas for proposed development and consented Ballyteige Solar Farm – aerial image*

Figure 6 *Constructed 1km assessment areas for proposed development and consented Tullamore Solar Farm – aerial image*

4.2.3 Road Receptors Overview

Road types can generally be categorised as:

- National Primary – Typically a road with a minimum of two carriageways with a maximum speed limit of up to 120km/h. These roads typically have fast-moving vehicles with busy traffic;
- National Secondary – Typically a road with a one carriageway with a maximum speed limit of up to 100km/h. These roads typically have fast-moving vehicles with moderate to busy traffic density;
- Regional – Typically a single carriageway with a maximum speed limit of up to 80km/h. The speed of vehicles will vary with a typical traffic density of low to moderate; and
- Local - Typically roads and lanes with the lowest traffic densities. Speed limits vary, with a maximum speed limit of up to 60km/h.

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 Appendix D.

The analysis considers any major national, national, and regional roads that:

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

4.2.4 Road Receptors Identification

Following a review of the available imagery, there are no major national, national, or regional roads within the 1km assessment area that are considered to have a potential view of the panels. A nearest major national, national, or regional roads to the assessment area are shown in Figure 7 on the following page. Therefore no roads have been taken forward for technical modelling. No significant impacts are predicted and no mitigation is recommended.

Figure 7 *Major national, national, or regional roads nearest to the 1km assessment area – aerial image*

4.2.5 Dwelling Receptors Overview

The analysis typically considers dwellings that:

- Are within the one-kilometre assessment area;
- 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 the line of sight will be removed, or they will experience comparable effects to the closest assessed dwelling.

In some cases, one physical structure is split into multiple separate addresses. In such cases, the results for the assessed location will be applicable to all associated addresses. The sampling resolution is sufficiently high to capture the level of effect for all potentially affected dwellings.

4.2.6 Dwelling Receptors Identification

In total, 35 dwelling receptors were identified[10] for assessment, as shown in Figure 8 to Figure 12 on the following pages. A height of 1.8 metres above ground level has been taken as typical eye level for an observer on the ground floor[11] of the dwelling since this is typically the most occupied floor of a dwelling throughout the day.

[10] The initial modelling included an additional 3 receptors (20, 25, and 27). The landowner has since confirmed that the building at receptor 20 is in ruins and has not been inhabited for over 50 years. The landowner has no plans to re-develop the building. Landscaping has been proposed in the Landscape Mitigation plan to the east of receptor 20. The developer has also since confirmed that receptors 25 and 27 are not dwellings. The results for these three receptors have been excluded from any further analysis.

[11] This fixed height for the dwelling 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 above ground floor are considered in the results discussion where necessary.

Figure 8 *All assessed dwelling receptors– aerial image*

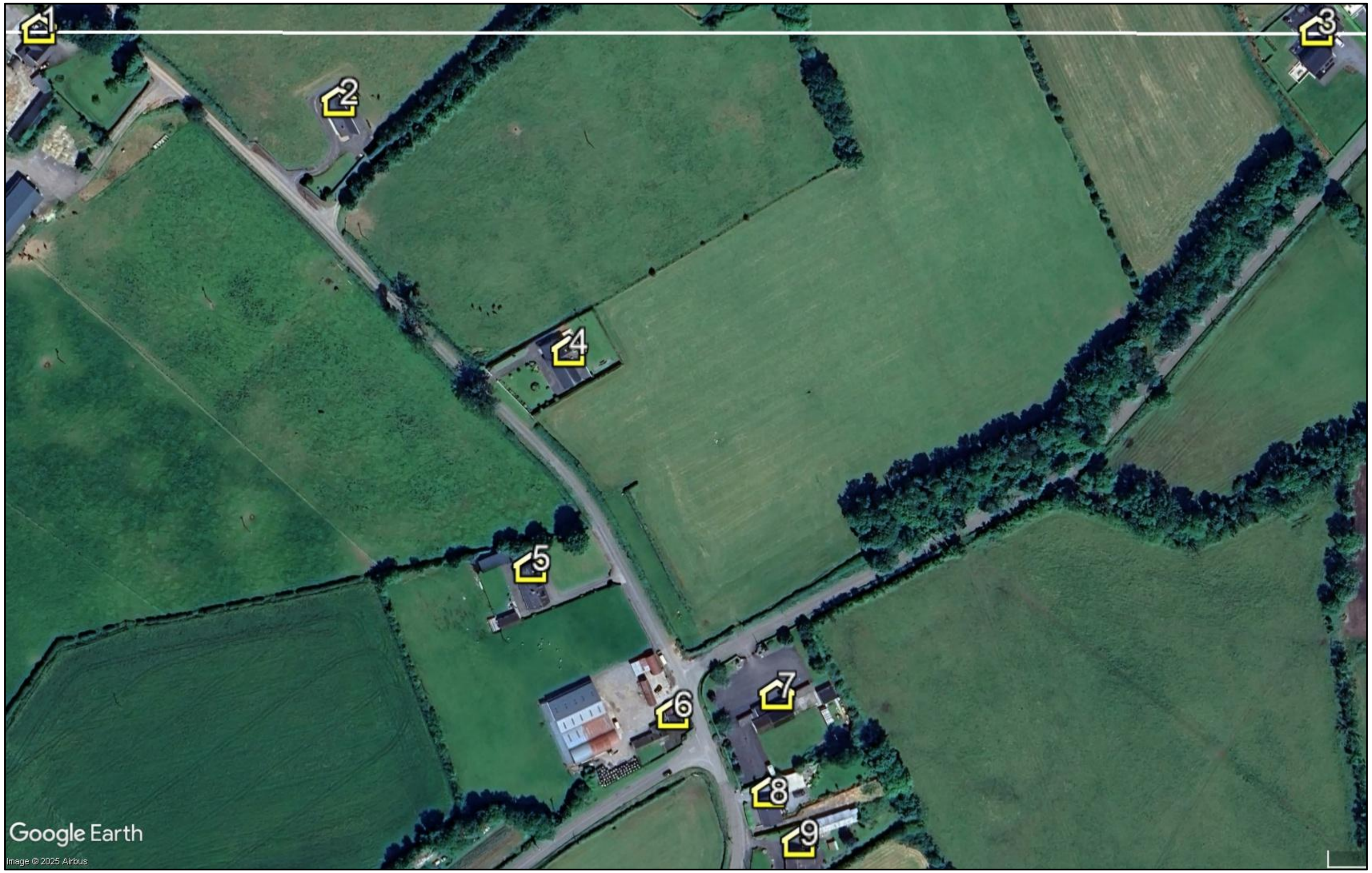

Figure 9 *Assessed dwelling receptor locations 1 to 9*

Figure 10 *Assessed dwelling receptor locations 10 to 19*

Figure 11 *Assessed dwelling receptor locations 21 to 24, 26, 28 to 29*

Figure 12 *Assessed dwelling receptor locations 30 to 38*

4.3 Aviation Receptors

4.3.1 Overview

Glint and glare analysis is often undertaken for solar developments that are adjacent to large aerodromes. The most common concerns are:

1. Potential reflections towards an Air Traffic Control (ATC) tower;
2. Potential reflections towards approaching pilots of powered aircraft for the final two miles of the approach.

With regard to Point 2, these reflections are typically evaluated in the context of:

- Whether they are in a pilot's primary horizontal field of view (50° either side of the direction of travel);
- The intensity of the solar reflection.

There is no formal assessment distance within which aviation effects must be modelled. However, in practice, concerns are most often raised for developments within 10km of a licensed airport. Requests for modelling at ranges of 10-20km are far less common. Assessment of aviation effects for developments over 20km away is a very unusual requirement.

Spollens Airstrip is an unlicensed general aviation (GA) airfields located within 10km of the proposed development. This has been identified for assessment with technical modelling. There is one operational runway, the details of which are presented below:

- 08/26 measuring 800 by 60 metres (grass)[12].

4.3.2 Aviation Receptors Identification

The airfield identified for assessment is a GA airfield 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.

Figure 13 on page 33 illustrates a typical 1-mile splayed approach and final sections of visual circuits/joins.

For GA airfields, it is Pager Power's methodology is to assess whether a solar reflection can be experienced on the 1-mile approach path with a splay angle of 5 degrees, considering 2.5 degrees either side of the extended runway centreline.

The assessment has considered whether a solar reflection can be experienced on the final sections of the visual circuits/joins using the following characteristics:

- A descent angle of 5 degrees;
- Circuit width of 1 nautical mile from runway centreline;

[12] Source: Approximated from aerial imagery at extremities

- Maximum altitude of 500 feet above the average threshold altitude.

No Air Traffic Control Towers were identified at the assessed airfield.

Figure 14 on page 34 gives a breakdown of all aircraft receptor points assessed. The runway threshold details used can be found in Appendix G.

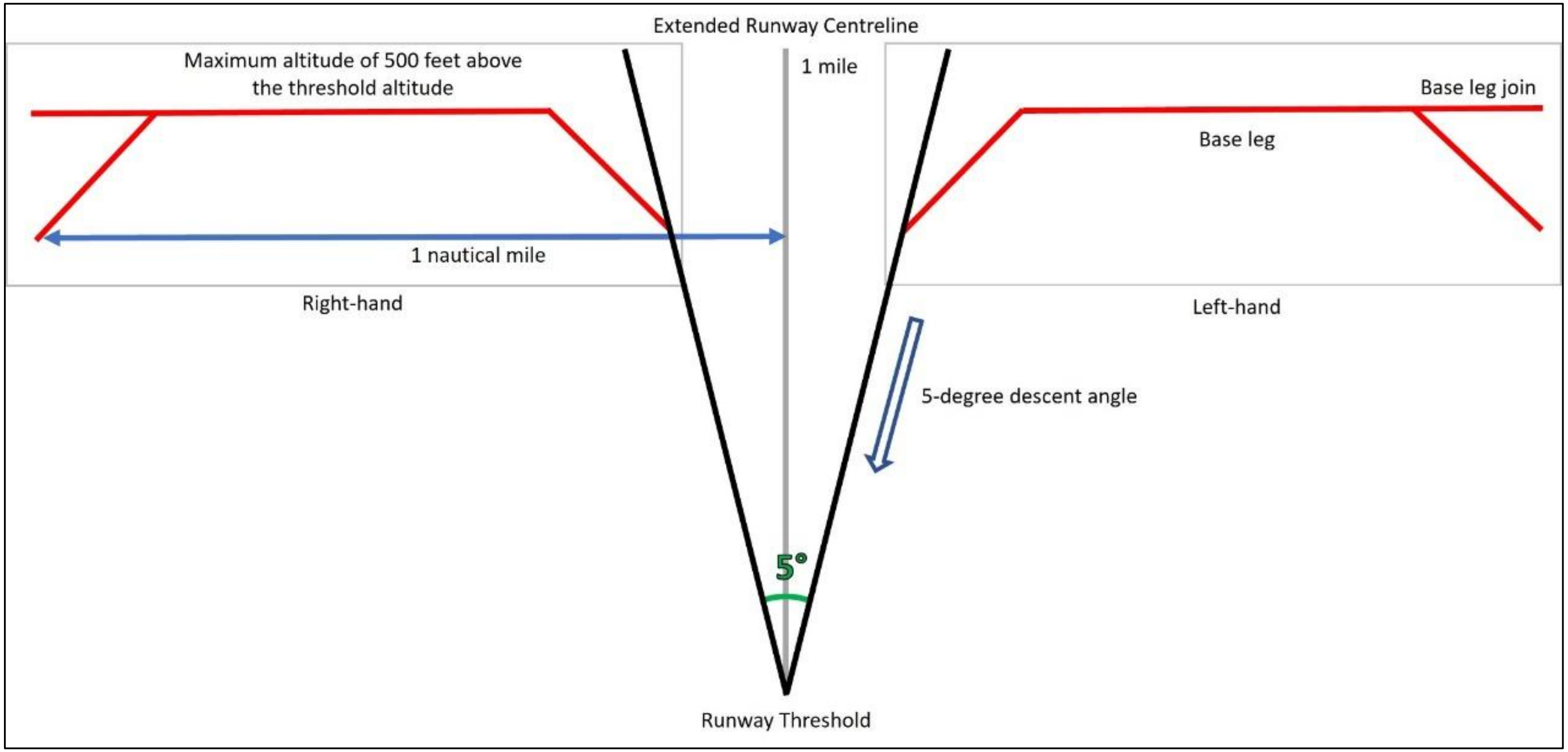

Figure 13 *Typical splayed approach and final sections of visual circuits*

Figure 14 *1-mile splayed approach path and final sections of visual circuit/join receptors – aerial image*

5 GEOMETRIC ASSESSMENT RESULTS AND DISCUSSION

5.1 Overview

The following sub-sections present the modelling results as well as the significance of any predicted impact in the context of existing screening, as well as the relevant criteria set out in the next subsection. The criteria are determined by the assessment process for each receptor, which are set out in Appendix D.

When determining the visibility of the reflecting panels for an observer, a conservative review of the available imagery is undertaken, whereby it is assumed views of the panels are possible if it cannot be reliably determined that existing screening will remove effects.

The modelling output showing the precise predicted times and the reflecting panel areas are presented in Appendix H.

5.2 Dwellings

5.2.1 Impact Significance Methodology

The key considerations for residential dwellings are:

- Whether a reflection is predicted to be experienced in practice;
- The duration of the predicted effects, relative to thresholds of:
  - 3 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 solar reflections are experienced 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 mitigating factors is required to determine the impact significance and mitigation requirement:

- 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;
- 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;
- 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;
- The position of the Sun – effects that coincide with direct sunlight appear less prominent than those that do not.

If following consideration of the relevant factors, the solar reflections do not remain significant, the impact significance is low, and mitigation is not recommended. If following consideration of the relevant factors, the solar reflections remain significant, then 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.

5.2.2 Geometric Modelling Results

The modelling predicts that solar reflections are geometrically possible towards 18 of the 35 assessed dwelling locations.

The modelling results for dwelling receptors are analysed in Table 2 on the following pages.

Dwelling Receptor	Geometric modelling results from panel areas (without consideration of screening)	Identified screening and predicted visibility (desk-based review)	Duration of effects[13] (with consideration of screening)[14]	Relevant Factors	Predicted Impact Classification	Further Mitigation Recommended?
1 – 2	Solar reflections **are geometrically possible** from solar panels in the proposed development for: **Less** than three months per year **Less** than 60 minutes per any one day	Existing vegetation, terrain, and/or building screening Views of reflecting panels within the proposed development are **not expected to be possible** in practice	None	N/A	**No impact from the proposed development** No cumulative impact therefore possible	No

[13] With respect to the ground floor only

[14] 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 3 months per year. 2) and/or for more than 60 minutes on any given day.

Dwelling Receptor	Geometric modelling results from panel areas (without consideration of screening)	Identified screening and predicted visibility (desk-based review)	Duration of effects[13] (with consideration of screening)[14]	Relevant Factors	Predicted Impact Classification	Further Mitigation Recommended?
3	Solar reflections are **not geometrically possible** from solar panels in the proposed development	N/A	N/A	N/A	**No impact from the proposed development** No cumulative impact therefore possible	No
4 – 5	Solar reflections **are geometrically possible** from solar panels in the proposed development for: **Less** than three months per year **Less** than 60 minutes per any one day	Existing vegetation and terrain screening Views of reflecting panels within the proposed development are **not expected to be possible** in practice	None	N/A	**No impact from the proposed development** No cumulative impact therefore possible	No

Dwelling Receptor	Geometric modelling results from panel areas (without consideration of screening)	Identified screening and predicted visibility (desk-based review)	Duration of effects[13] (with consideration of screening)[14]	Relevant Factors	Predicted Impact Classification	Further Mitigation Recommended?
6 – 19	Solar reflections **are geometrically possible** from solar panels in the proposed development for: **More** than three months per year **Less** than 60 minutes per any one day	Existing vegetation, terrain, and/or building screening Views of reflecting panels within the proposed development are **not expected to be possible** in practice	N/A	N/A	**No impact from the proposed development** No cumulative impact therefore possible	No
21 – 24	Solar reflections are **not geometrically possible** from solar panels in the proposed development	N/A	N/A	N/A	**No impact from the proposed development** No cumulative impact therefore possible	No

Dwelling Receptor	Geometric modelling results from panel areas (without consideration of screening)	Identified screening and predicted visibility (desk-based review)	Duration of effects[13] (with consideration of screening)[14]	Relevant Factors	Predicted Impact Classification	Further Mitigation Recommended?
26	Solar reflections are **not geometrically possible** from solar panels in the proposed development	N/A	N/A	N/A	**No impact from the proposed development** No cumulative impact therefore possible	No
28 – 38	Solar reflections are **not geometrically possible** from solar panels in the proposed development	N/A	N/A	N/A	**No impact from the proposed development** No cumulative impact therefore possible	No

Table 2 *Geometric modelling results, assessment of impact significance, and mitigation recommendation/requirement – dwelling receptors*

5.2.3 Desk-Based Review of Imagery

The figure on the following page shows analysis of aerial imagery with particular relevance to dwelling receptors where solar reflections are geometrically possible from solar panels in the proposed development for **more** than three months per year and **less** than 60 minutes per any one day. Green polygons are used to represent existing vegetation screening, and red polygons are used to present building screening.

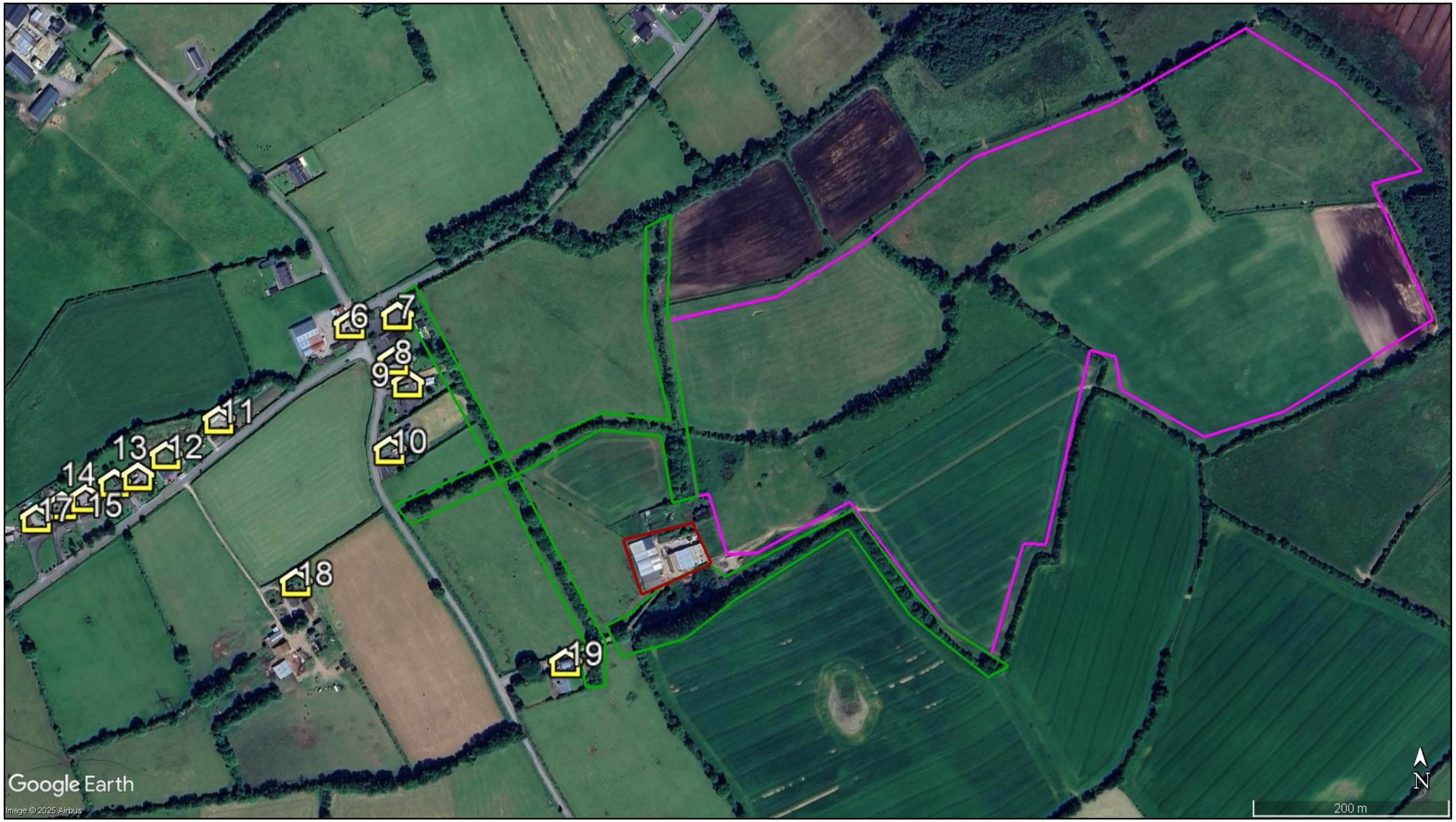

Figure 15 *Existing vegetation screening for dwelling receptors 6 to 19*

5.3 Aviation

5.3.1 Glare Intensity Categorisation

The Pager Power and Forge models have been used to determine whether reflections are possible. Intensity calculations in line with the Sandia National Laboratories methodology have been undertaken for aviation receptors. 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 3 below along with the associated colour coding.

Coding Used	Intensity Key
Glare beyond 50°	'Glare outside of a pilot's primary field-of-view (50 degrees horizontally either side of the direction of travel)'
'Green' glare	'Low potential for temporary after-image'
'Yellow' glare	'Potential for temporary after-image'
'Red' glare	'Potential for permanent eye damage'

Table 3 *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. 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.

If significant glare is predicted, modelling of less reflective surfaces could be undertaken.

5.3.2 Key Considerations - Runway Approach Paths

The process for determining impact significance is defined in Appendix 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 have 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 approach bearing), the impact significance is low, and mitigation is not required.

Glare with 'potential for a temporary after-image' (yellow glare) was formerly not permissible under the interim guidance provided by the Federal Aviation Administration in the USA[15] for on-airfield solar. Whilst this guidance was never formally applicable outside of the USA, it has been a common point of reference internationally. Pager Power recommends a pragmatic approach whereby instances of 'yellow' glare are evaluated in a technical and operational context. As per Pager Power's glint and glare guidance document[16], where solar reflections are of an intensity of 'potential for temporary after-image', expert assessment of the following relevant 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. Unlicensed aerodromes have greater capacity for operational acceptance;
- 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 the time of day at which glare is predicted;
- 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 a year;
- The location of the source of glare relative to a pilot's primary field-of-view;
- The relative size of the reflecting panel area and whether the reflecting area takes up a large percentage of 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 intensity of the predicted glare;

[15] This FAA guidance from 2013 has since been superseded by the FAA guidance in 2021 whereby airports are tasked with determining safety requirements themselves.

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

[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.

- 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 relevant factors, where the solar reflection is deemed not significant, a low impact is predicted, and mitigation is not recommended; however, consultation with the aerodrome is recommended to understand their position along with any feedback or comments regarding the proposed development. Where the solar reflection is deemed significant, the impact significance is moderate, and mitigation is recommended.

Where solar reflections have an intensity of 'potential for permanent eye damage', the impact significance is high, and mitigation is required.

5.3.3 Assessment Results – Aviation Receptors

Table 4 on the following pages presents the following:

- Geometric modelling results;
- Glare intensity;
- Relevant factors, visibility and predicted impact significance.

The detailed modelling results have been provided in Appendix H.

Receptor/Runway	Geometric Modelling Result	Maximum intensity as per Table 3	Comment	Impact Classification	Mitigation Recommended?
Spollens Airstrip 1-mile splayed approaches, final sections of visual circuits and joins	Solar reflections are geometrically possible from the proposed development	'Green'	Solar reflections with a maximum intensity of 'low potential for temporary after-image' are possible Considering the associated guidance (Appendix D) and industry best practice pertaining to approach paths, which states that this level of glare is acceptable, it can be concluded that this level of glare is also acceptable for these receptors	**Low impact from the proposed development** No significant cumulative impact predicted due to the distance between the proposed and consented developments (>300 metres)	No

Table 4 *Geometric analysis results – Aviation*

6 CONCLUSIONS

6.1 Overall Conclusions

No significant impacts are predicted on surrounding road safety, residential amenity, and aviation activity associated with Spollens Airstrip. Mitigation is not recommended.

An overview of the assessment results is presented below.

6.2 Assessment Conclusions – Roads

All roads within the 1km assessment area are considered to be local roads. 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 Appendix D.

6.3 Assessment Conclusions – Dwellings

The modelling has shown that solar reflections are geometrically possible towards 18 of the 35 assessed dwelling locations.

No impacts are predicted on any of these dwellings because there is significant existing screening such that views of reflecting panels in the proposed development are not expected to be possible in practice. Mitigation is not required.

6.4 Assessment Conclusions – Spollens Airstrip

Solar reflections originating from the proposed development towards the final one-mile splayed approaches, and the final sections of the visual circuits and joins, are predicted to have glare intensities no greater than 'low potential for temporary after-image'. Considering the associated guidance pertaining to approach paths at licensed airfields, which states that this level of glare is acceptable, it can be reliably concluded that this glare intensity is acceptable for these receptors. A low impact is predicted, and no mitigation is recommended.

APPENDIX 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.

Ireland Guidance

Offaly DMS-110 Solar Farms

A relevant excerpt from Chapter 13 Development Management Standards of the Offaly County Development Plan 2021-2027 is presented below, confirming that glint and glare would be a consideration:

'The Council will consider the following factors in assessing a planning application for a solar farm…

- *The effect of glint and glare on landscapes, traffic and aircraft safety'*

Best Practice Guidance Report on Solar Energy Development for Applicants and Planning Authorities

The ISEA Best Practice Guidance Report for Large Scale Solar Energy Development report was researched and prepared by Fehily Timoney and Company, supported by the Sustainable Energy Authority of Ireland (SEAI) and published by the Irish Solar Energy Association (ISEA).

Section 5.2.8 presents the following:

'Glint and glare are defined as:

- *"Glint" gives out or reflects small flashes of light.*
- *"Glare" shine with a strong or dazzling light.*

Glint and glare are essentially the reflection of sunlight from reflective surfaces. Glint may be produced as a direct reflection of the sun on the surface of the solar panels. It may be the source of the visual issues regarding viewer distraction. Glare is a continuous source of brightness, relative to diffused lighting. This is not a direct reflection of the sun, but rather a reflection of the bright sky around the sun. Glare is significantly less intense than glint. In the case of solar farms, glint and glare are minimal. PV modules reflect a similar amount of sunlight as water bodies, less than other materials that make up the built environment, namely, aluminium (and other metals), concrete and even vegetation.

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

In terms of reflectance, photovoltaic solar panels are not considered to be a highly reflective surface. They are designed to absorb sunlight and not to reflect it. Nonetheless, photovoltaic panels have a flat, *polished surface, which emits 'specular' reflectance rather than a 'diffuse' reflectance, which would occur from a rough surface.*

'Glint and glare' is not a new feature in the Irish landscape as buildings, cars and other reflective surfaces have produced this phenomenon for some time. The assessment and quantification of the glint and glare implications of a solar farm is a relatively new consideration. A review of consented planning applications suggests that stakeholders are most concerned with potential impacts on the following receptors:

- *Residential dwellings;*
- *Historical monuments/heritage landscapes;*
- *Road networks; and*
- *Aviation infrastructure.*

The preparation and submission of a Glint and Glare Assessment with a planning application for solar farms is often required by many Planning Authorities and stipulated in policies and objectives in Local Authority Development Plans.

Glint and Glare assessment methodologies typically follow a rational sequence of steps to identify receptors that might potentially be affected by glint and glare. These are then further filtered to yield those receptors to those likely to actually experience such effects.

These steps are as follows:

1. *Identify and analyse study area;*
2. *Identify relevant receptors;*
3. *Undertake the glint and glare assessment;*
4. *Where instances of glint and glare remain, determine whether they are likely to cause a hazard /*
5. *nuisance;*
6. *If hazard / substantial nuisance is likely to occur, recommend appropriate mitigation measures;*
7. *If necessary, re-run the glint and glare calculations with mitigation in place.*

The table below presents an example of the magnitude for Glint and Glare on surrounding receptors and the typical requirement for mitigation under each:

Magnitude of Change	***Description***	***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*	*No mitigation required.*

	mitigation is not required e.g., Intervening screening will limit the view of the reflecting solar panels or small periods of reflection	
Moderate/Medium	*A solar reflection is geometrically possible and visible however it occurs under conditions that do not represent a worst-case.*	*Impact may be acceptable. Further analysis should be undertaken to determine the requirement for mitigation.*
Major/High	*A solar reflection is geometrically possible and visible under conditions that will produce a significant impact. Mitigation and consultation is recommended.*	*Mitigation will be required if the proposed development is to proceed.*

Magnitude of Glint and Glare and relevant mitigation

Typical mitigation measures include additional planting to screen potential Glint and Glare effects or in some instance the removal of panels where mitigation is not considered appropriate.

The sensitivities associated with glint and glare as regards landscape, visual impact and the potential impact on aircraft safety, should be a key consideration in a glint and glare assessment. The inclusion of a glint and glare assessment in any planning application for solar farms is recommended as best practice.

The Federal Aviation Authority (FAA) have produced guidelines addressing the safety concerns of solar farms in the proximity of airports. Additionally, the FFA approved Solar Glare Hazard Analysis Tool (SGHAT) is commonly associated together to be regarded at the accepted industry standard by aviation authorities internationally when considering the glint and glare effects upon aviation-related receptors. These two documents are referred to by both the Irish Aviation Authority (IAA) and 'daa' for proposed solar farms in Ireland.

The IAA requires the referral to it of all solar PV development submissions within 10km of an approved airport or aerodrome. As of August 2017, 'daa' has specifically expanded this extent for both Dublin Airport and Cork Airport to a radius of 15km.'

UK Planning Policy

Renewable and Low Carbon Energy

The National Planning Policy Framework under the planning practice guidance for Renewable and Low Carbon Energy[18] (specifically regarding the consideration of solar farms, paragraph 013) states:

[18] Renewable and low carbon energy, Ministry of Housing, Communities & Local Government, last updated: 14 August 2023, accessed on: 17/05/2024

'What are the particular planning considerations that relate to large scale ground-mounted solar photovoltaic Farms?

The deployment of large-scale solar farms can have a negative impact on the rural environment, particularly in undulating landscapes. However, the visual impact of a well-planned and well-screened solar farm can be properly addressed within the landscape if planned sensitively.

Particular factors a local planning authority will need to consider include:

…

- *the proposal's visual impact, the effect on landscape of glint and glare (see guidance on landscape assessment) and on **neighbouring uses and aircraft safety**;*
- *the extent to which there may be additional impacts if solar arrays follow the daily movement of the sun;*

…

The approach to assessing cumulative landscape and visual impact of large scale solar farms is likely to be the same as assessing the impact of wind turbines. However, in the case of ground-mounted solar panels it should be noted that with effective screening and appropriate land topography the area of a zone of visual influence could be zero.'

National Policy Statement for Renewable Energy Infrastructure

The National Policy Statement for Renewable Energy Infrastructure (EN-3)[19] 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.[20] 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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[19] National Policy Statement for Renewable Energy Infrastructure (EN-3), Department for Energy Security & Net Zero, date: January 2024, accessed on: 17/01/2024.

[20] *'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 Appendix B) and stakeholder consultation. Further information can be found in Pager Power's Glint and Glare Guidance document[21] 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[22] however the advice is still applicable[23] until a formal policy is developed. The relevant aviation guidance from the CAA is presented in the section below.

UK 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.

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.

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

[22] Archived at Pager Power

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

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[24]*, 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 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'*[25], the 2013 update is entitled '*Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports'*[26], and the 2021 final policy is entitled '*Federal Aviation Administration Policy: Review of Solar Energy System Projects on Federally-Obligated Airports'*[27].

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.

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[24] Aerodrome Licence Holder.

[25] Archived at Pager Power

[26] 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.

[27] 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 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.

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*'[28]. 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*[29].

[28] Technical Guidance for Evaluating Selected Solar Technologies on Airports, Federal Aviation Administration (FAA), date: 04/2018, accessed on: 08/12/2021.

[29] 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.

- *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*[30]*, 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 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*

[30] First figure in Appendix B.

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*[31] *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[32] 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.

(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.

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[31] 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.

[32] The Air Navigation Order 2016. [online] Available at: https://www.legislation.gov.uk/uksi/2016/765/contents/made [Accessed 4 February 2022].

(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[33] 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 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;

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

2. the use of hazardous, confusing, and misleading lights;
3. the dazzling caused by large and highly reflective surfaces;
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;
5. and 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.

APPENDIX B – OVERVIEW OF GLINT AND GLARE STUDIES

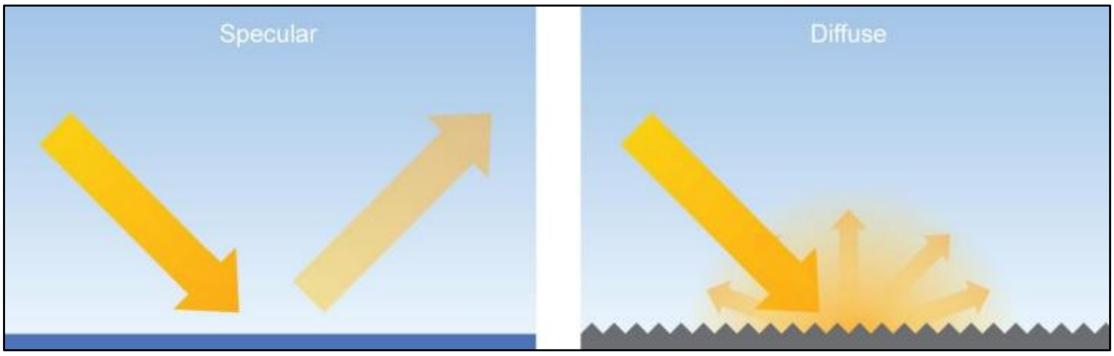
Overview

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[34], 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

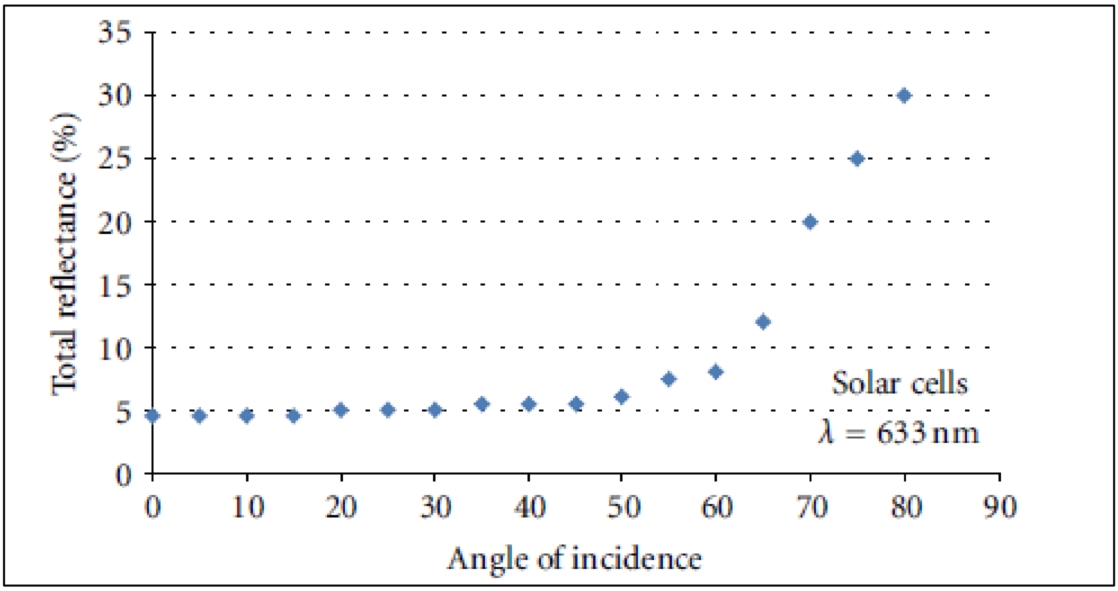
[34] Technical Guidance for Evaluating Selected Solar Technologies on Airports, Federal Aviation Administration (FAA), date: 04/2018, accessed on: 08/12/2021.

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[35]". 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;
- 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.

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[35] 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

FAA Guidance – "Technical Guidance for Evaluating Selected Solar Technologies on Airports"[36]

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[37]
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).

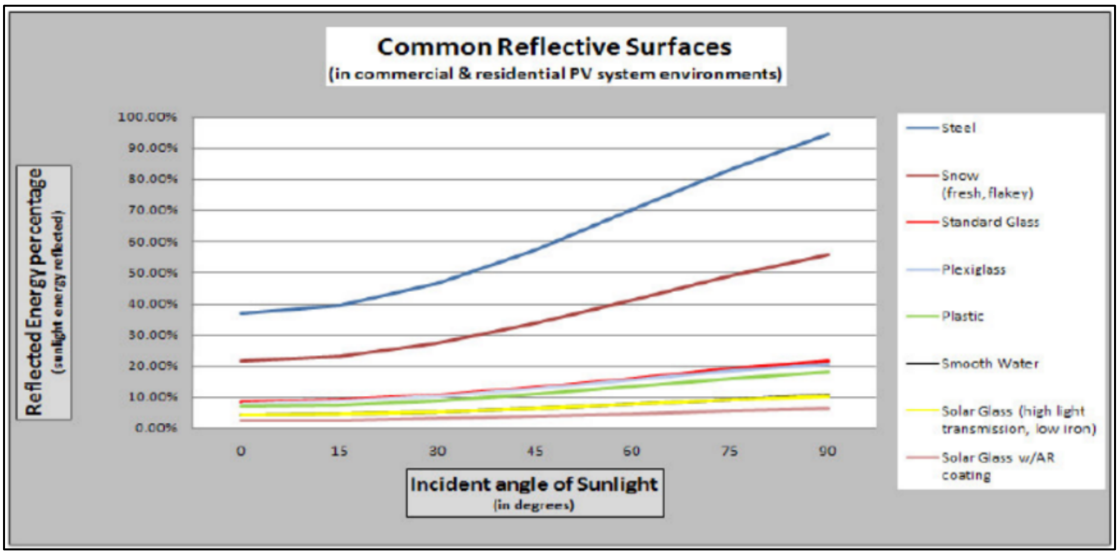
An important comparison in this table is the reflectivity compared to water which will produce a reflection of very similar intensity when compared to that from a solar panel. The study by Riley and Olsen study (2011) also concludes that still water has a very similar reflectivity to solar panels.

[36] Technical Guidance for Evaluating Selected Solar Technologies on Airports, Federal Aviation Administration (FAA), date: 04/2018, accessed on: 08/12/2021.
[37] Extrapolated data, baseline of 1,000 W/m^2 for incoming sunlight.

SunPower Technical Notification (2009)

SunPower published a technical notification[38] 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.

38 Source: Technical Support, 2009. SunPower Technical Notification – Solar Module Glare and Reflectance.

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APPENDIX 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 is 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.

APPENDIX 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

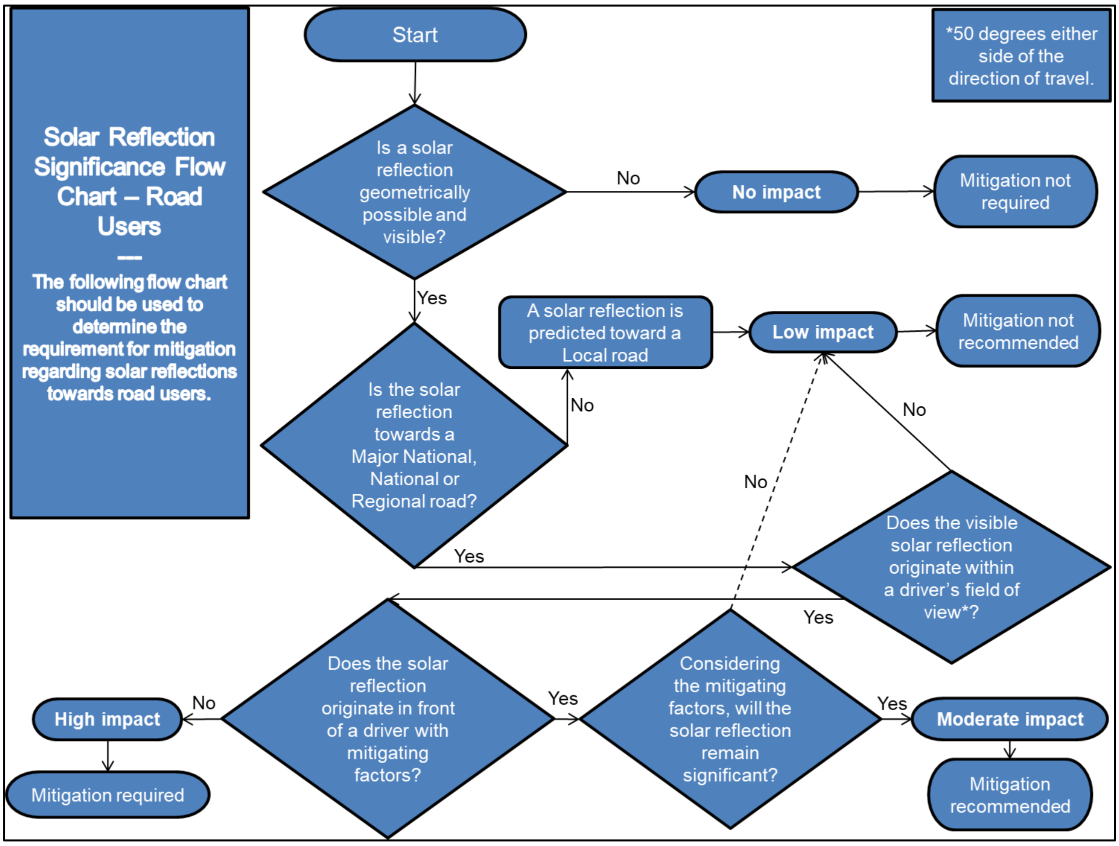
The table below presents the recommended definition of 'impact significance' in glint and glare terms and the requirement for mitigation under each.

Impact Significance	Definition	Mitigation
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

Assessment Process for Road Receptors

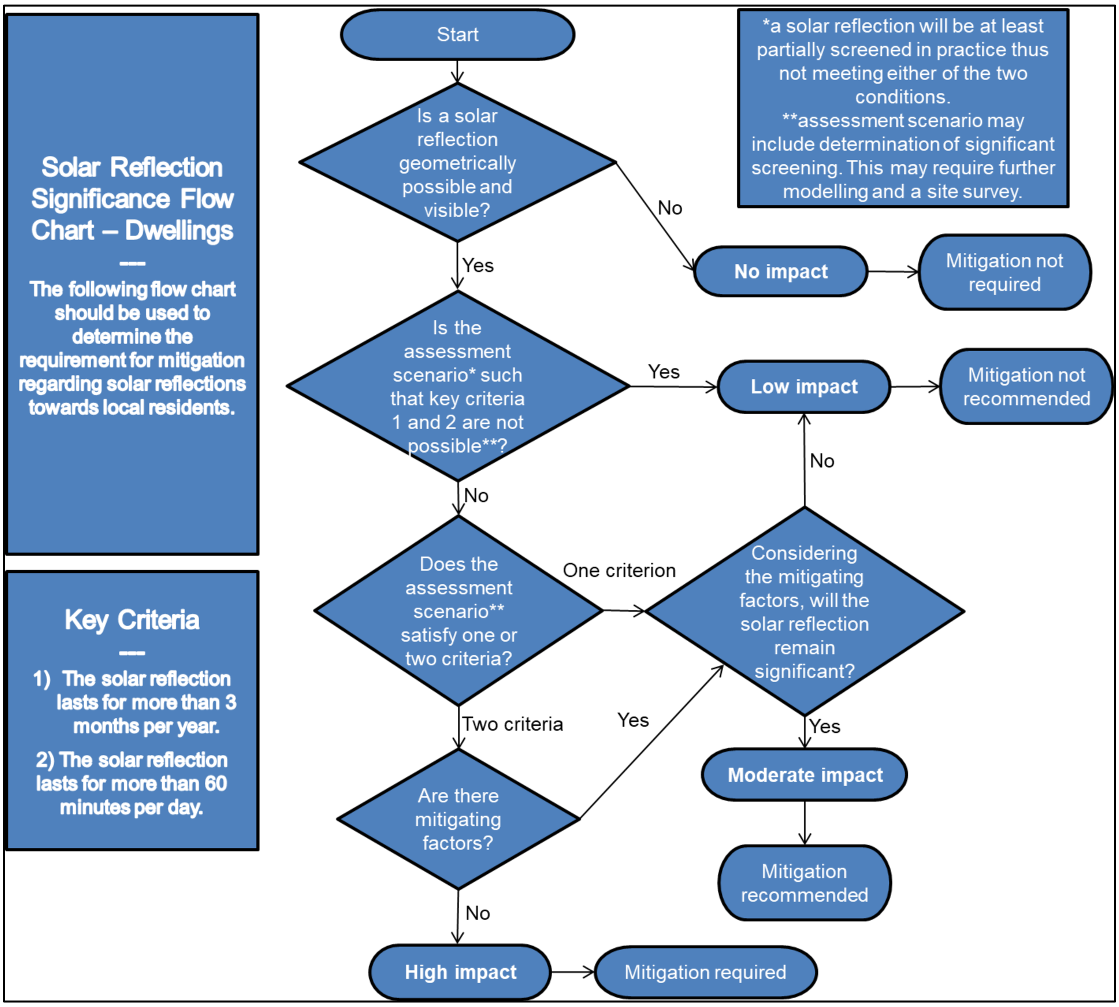
The flow chart presented below has been followed when determining the mitigation requirement for road receptors.



Road receptor mitigation requirement flow chart

Assessment Process for Dwelling Receptors

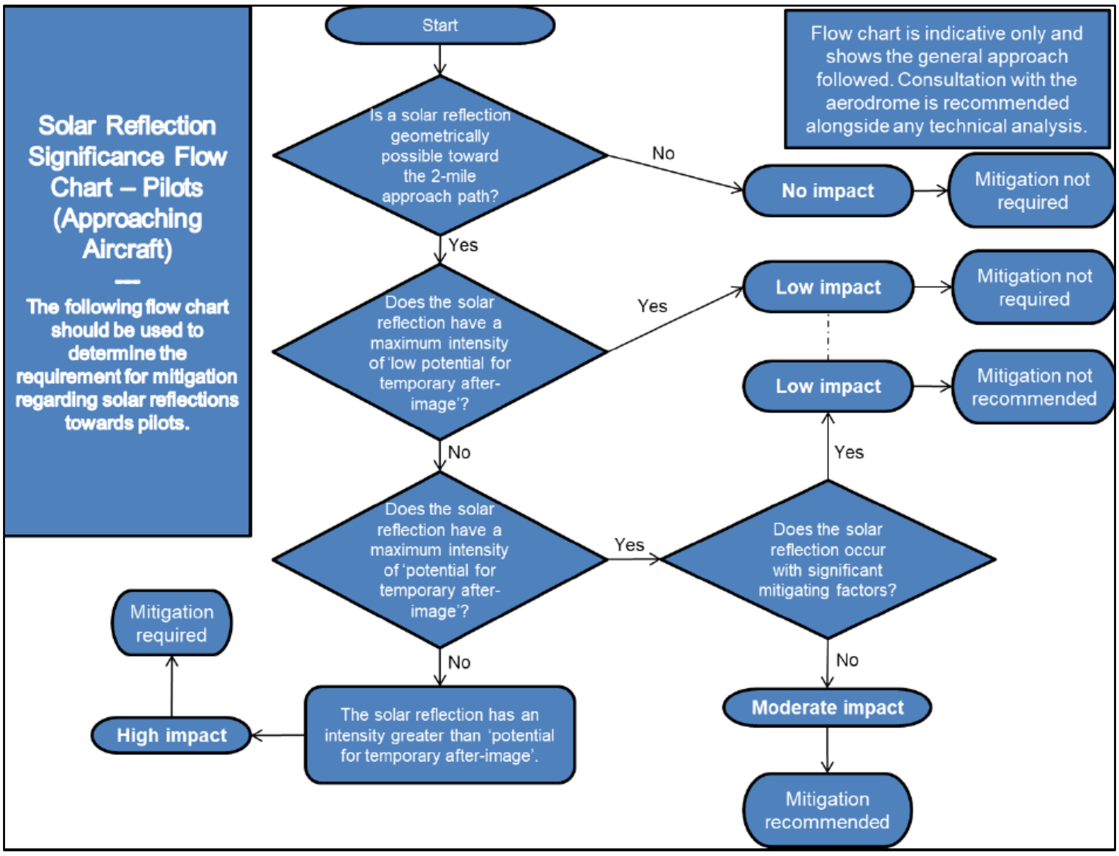
The flow chart presented below has been followed when determining the mitigation requirement for dwelling receptors.



Dwelling receptor mitigation requirement flow chart

Impact Significance Determination for Approaching Aircraft

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



Approach path receptor mitigation requirement flow chart

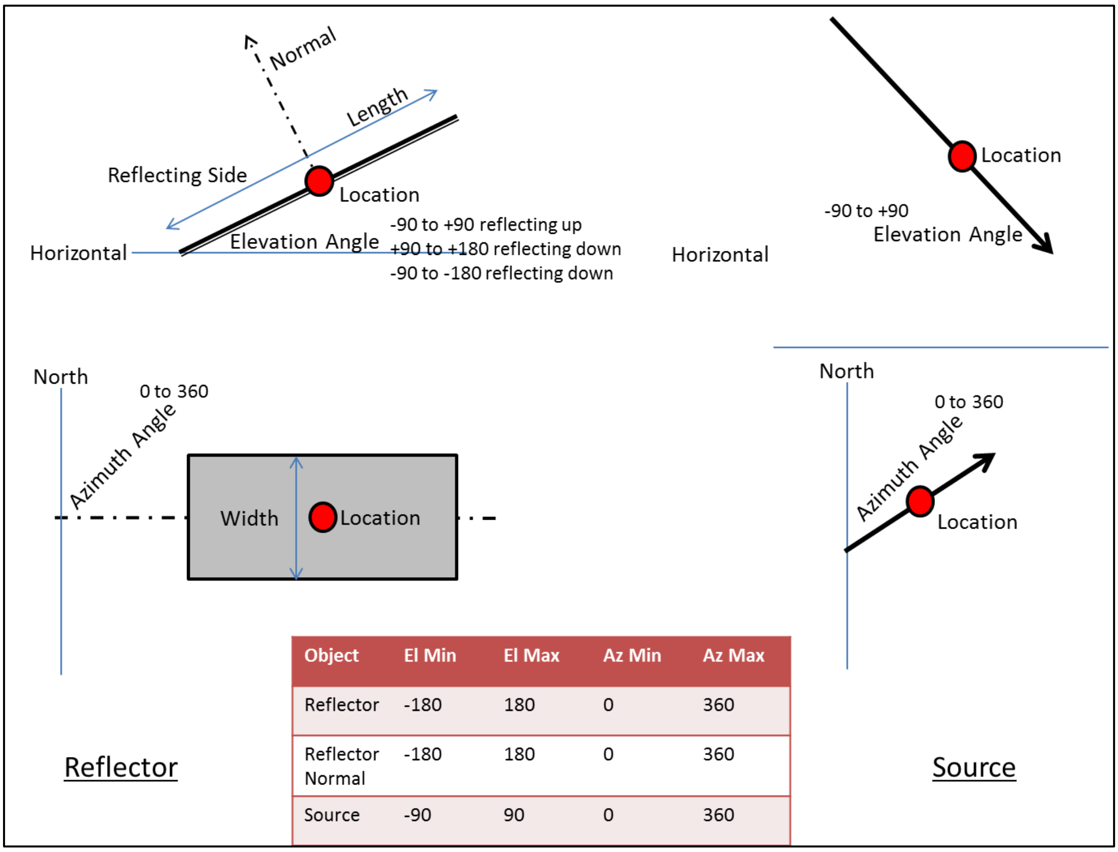
APPENDIX E – REFLECTION CALCULATIONS METHODOLOGY

Pager Power's Reflection Calculations 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

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;

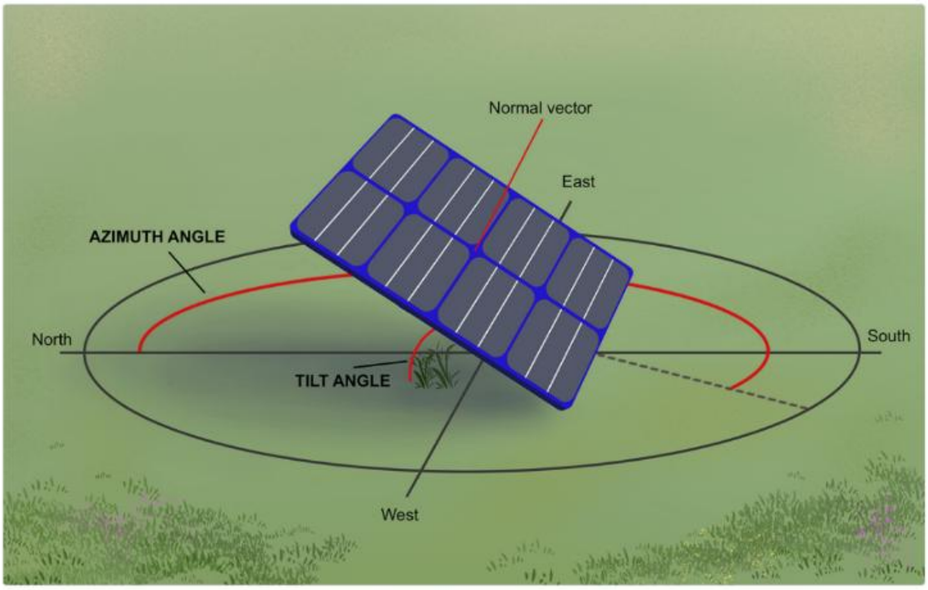
- If this angle is less than 90 degrees a reflection will occur. If it is greater than 90 degrees no reflection will occur because the source is behind the reflector;
- Calculate the Azimuth and Elevation of the reflection in accordance with the following:
    - The angle between source and normal is 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 figure below.

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

APPENDIX F – ASSESSMENT LIMITATIONS AND ASSUMPTIONS

Pager Power's Model

The model considers 100% sunlight during daylight hours which is highly conservative.

The model does not account for terrain between the reflecting solar panels and the assessed receptor where a solar reflection is geometrically possible.

The model considers terrain between the reflecting solar panels and the visible horizon (where the sun may be obstructed from view of the panels)[39].

It is assumed that the panel elevation angle assessed represents the elevation angle for all of the panels within each solar panel area defined.

It is assumed that the panel azimuth angle assessed represents the azimuth angle for all of the panels within each solar panel area defined.

Only a reflection from the face of the panel has been considered. The frame or the reverse of the frame of the solar panel has not been considered.

The model assumes that a receptor can view the face of every panel (point, defined in the following paragraph) within the development area whilst in reality this, in the majority of cases, will not occur. Therefore any predicted solar reflection from the face of a solar panel that is not visible to a receptor will not occur in practice.

A finite number of points within each solar panel area defined is chosen based on an assessment resolution so that a comprehensive understanding of the entire development can be formed. This determines whether a solar reflection could ever occur at a chosen receptor. The model does not consider the specific panel rows or the entire face of the solar panel within the development outline, rather a single point is defined every 'x' metres (based on the assessment resolution) with the geometric characteristics of the panel. A panel area is however defined to encapsulate all possible panel locations. See the figure below which illustrates this process.

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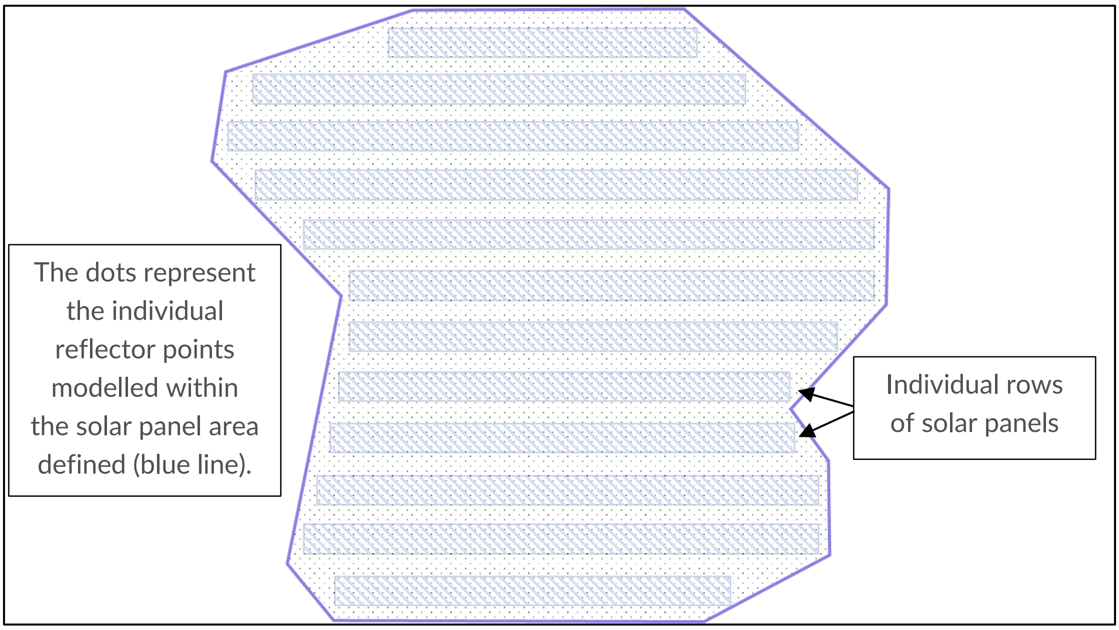
[39] UK only.



Solar panel area modelling overview

A single reflection point is chosen for the geometric calculations. This suitably determines whether a solar reflection can be experienced at a receptor location and the time of year and duration of the solar reflection. Increased accuracy could be achieved by increasing the number of heights assessed however this would only marginally change the results and is not considered significant.

The available street view imagery, satellite mapping, terrain and any site imagery provided by the developer has been used to assess line of sight from the assessed receptors to the modelled solar panel area, unless stated otherwise. In some cases, this imagery may not be up to date and may not give the full perspective of the installation from the location of the assessed receptor.

Any screening in the form of trees, buildings etc. that may obstruct the Sun from view of the solar panels is not within the modelling unless stated otherwise. The terrain profile at the horizon is considered if stated.

Forge's Sandia National Laboratories' (SGHAT) Model

The following text is taken from Forge[40] and is presented for reference.

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.

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

APPENDIX G – RECEPTOR AND REFLECTOR AREA DETAILS

Terrain Height

Terrain Height was calculated from Pager Power's database (established on OSGB 50m) based on the coordinates of the point of interest.

Dwelling Receptor Data

The table below and on the following pages presents the coordinates for the assessed dwelling receptors.

Location	Latitude (°)	Longitude (°)
1	53.313765	-7.398355
2	53.313467	-7.396274
3	53.313766	-7.389418
4	53.312427	-7.394681
5	53.311514	-7.394954
6	53.310897	-7.393947
7	53.310979	-7.393215
8	53.310567	-7.393273
9	53.310358	-7.393059
10	53.309748	-7.393331
11	53.310025	-7.395977
12	53.309699	-7.396796
13	53.309503	-7.397241
14	53.309444	-7.397604
15	53.309302	-7.398054
16	53.309237	-7.398424
17	53.309116	-7.398819
18	53.308533	-7.394788

Location	Latitude (°)	Longitude (°)
19	53.307811	-7.390624
20	53.30932	-7.388515
21	53.305887	-7.389428
22	53.305582	-7.389203
23	53.305215	-7.388852
24	53.304952	-7.388482
25	53.305027	-7.391727
26	53.302615	-7.394003
27	53.301595	-7.394374
28	53.30158	-7.383722
29	53.301285	-7.383401
30	53.300927	-7.381231
31	53.301187	-7.379734
32	53.300041	-7.379135
33	53.299983	-7.378603
34	53.300656	-7.378294
35	53.299935	-7.377907
36	53.300175	-7.377594
37	53.302388	-7.375237
38	53.304576	-7.37948

Dwelling Receptor Data

Airfield Runway Details

The table below presents the assessed runway details. Full receptor details can be provided upon request.

Runway	Longitude (°)	Latitude (°)	Threshold Altitude (metres amsl)
08	-7.535907	53.293033	62.79
26	-7.524233	53.293707	69.74

Spollens Airstrip Runway details

APPENDIX H – DETAILED MODELLING RESULTS

Overview

The results charts for a selection of receptors are shown on the following pages (all dwelling receptors and example results for aviation receptor). Full results are available on request.

Each Pager Power results 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).

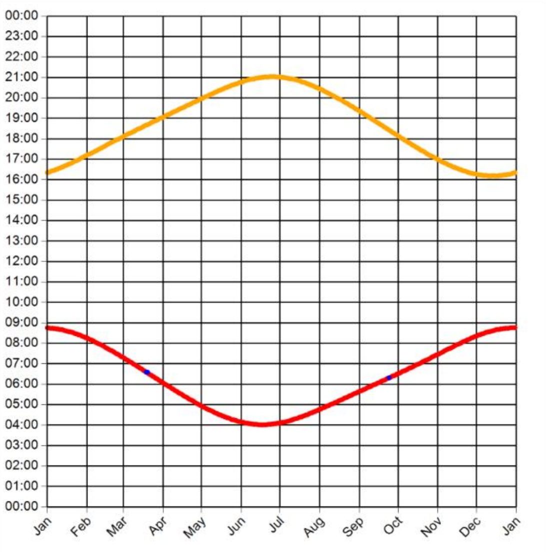
Each Forge chart shows:

- 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.

Dwelling Receptors

Observer 1 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 0.2°
Max observer difference angle: 0.3°

Observer Location   Sun azimuth range is 89.8° - 89.9° (yellow)

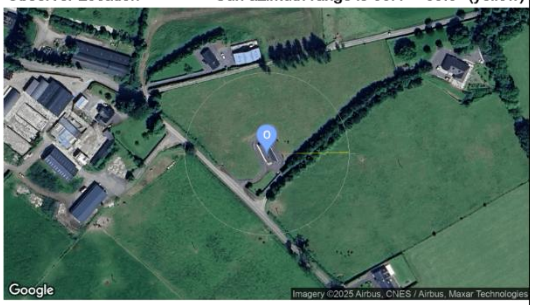
Reflecting panels (yellow)

Observer 2 Results

Reflection Date/Time (GMT) Graph

Min observer difference angle: 0.1°
Max observer difference angle: 1°

Observer Location   Sun azimuth range is 88.4° - 89.5° (yellow)



Reflecting panels (yellow)

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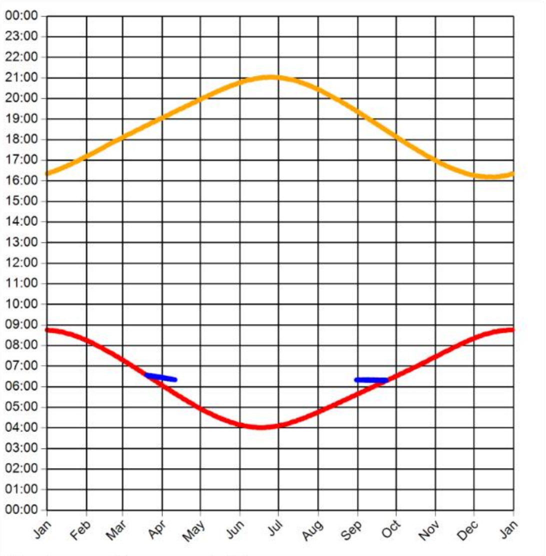
Observer 4 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 0°
Max observer difference angle: 5.7°

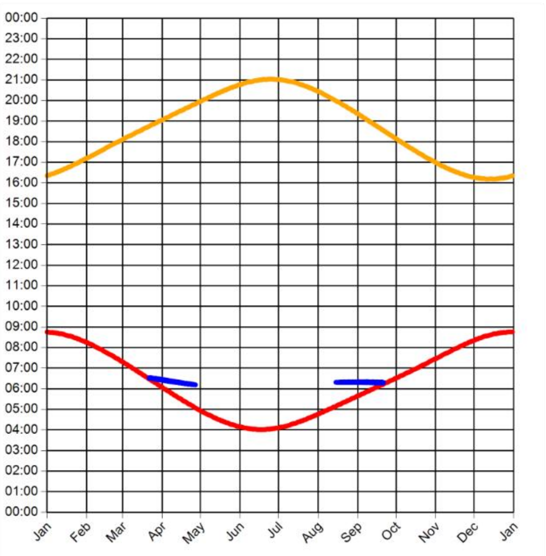
Observer Location

Sun azimuth range is 82.9° - 89.5° (yellow)

Reflecting panels (yellow)

Observer 5 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 0°
Max observer difference angle: 9.3°

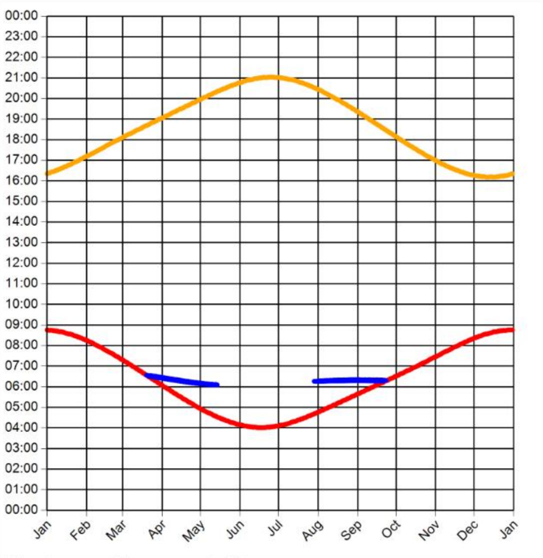
Observer Location

Sun azimuth range is 78.5° - 88.8° (yellow)

Reflecting panels (yellow)

Observer 6 Results

Reflection Date/Time (GMT) Graph



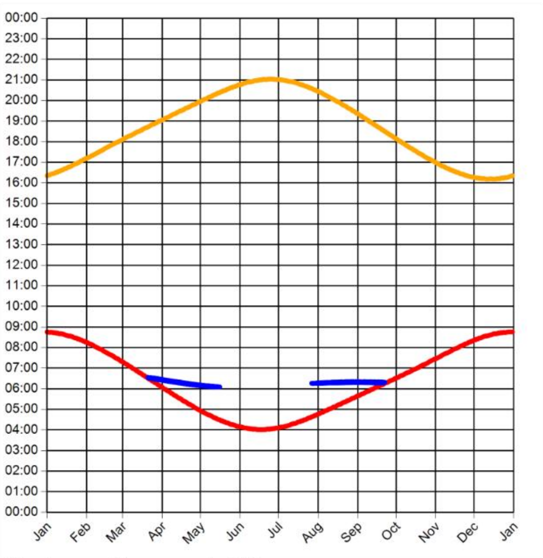
Min observer difference angle: 0°
Max observer difference angle: 12.5°

Observer Location | Sun azimuth range is 74.7° - 89.4° (yellow)

Reflecting panels (yellow)

Observer 7 Results

Reflection Date/Time (GMT) Graph



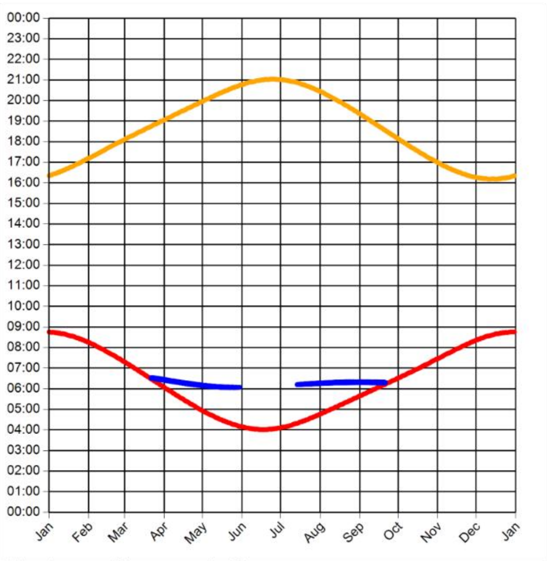
Min observer difference angle: 0.1°
Max observer difference angle: 13°

Observer Location | Sun azimuth range is 74.4° - 89.2° (yellow)

Reflecting panels (yellow)

Observer 8 Results

Reflection Date/Time (GMT) Graph



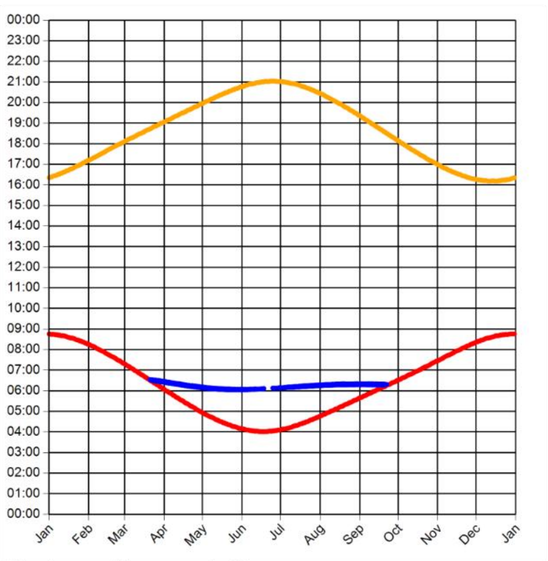
Min observer difference angle: 0°
Max observer difference angle: 14.7°

Observer Location — Sun azimuth range is 72.3° - 88.8° (yellow)

Reflecting panels (yellow)

Observer 9 Results

Reflection Date/Time (GMT) Graph



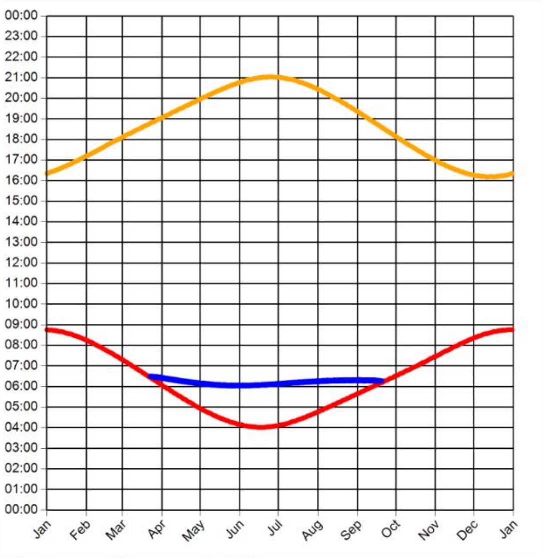
Min observer difference angle: 0°
Max observer difference angle: 15.9°

Observer Location — Sun azimuth range is 70.9° - 89.1° (yellow)

Reflecting panels (yellow)

Observer 10 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 0.1°
Max observer difference angle: 15.7°

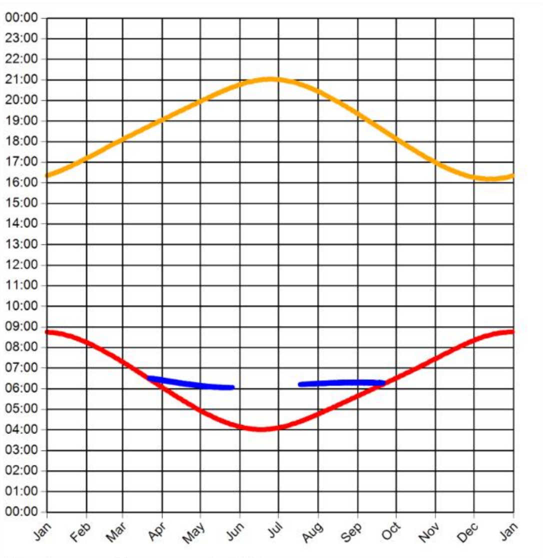
Observer Location

Sun azimuth range is 70.4° - 88.2° (yellow)

Reflecting panels (yellow)

Observer 11 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 0.1°
Max observer difference angle: 14°

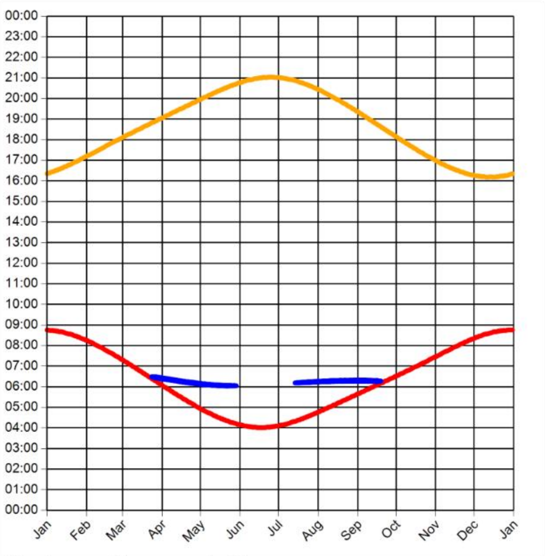
Observer Location

Sun azimuth range is 72.7° - 88.6° (yellow)

Reflecting panels (yellow)

Observer 12 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 0°
Max observer difference angle: 14.2°

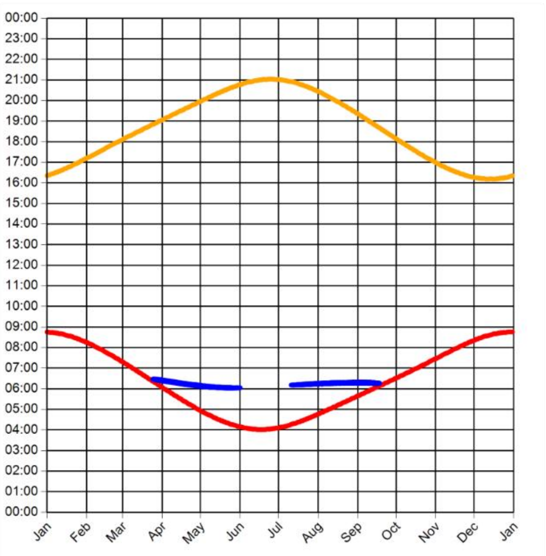
Observer Location

Sun azimuth range is 72.1° - 87.9° (yellow)

Reflecting panels (yellow)

Observer 13 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 0°
Max observer difference angle: 14.5°

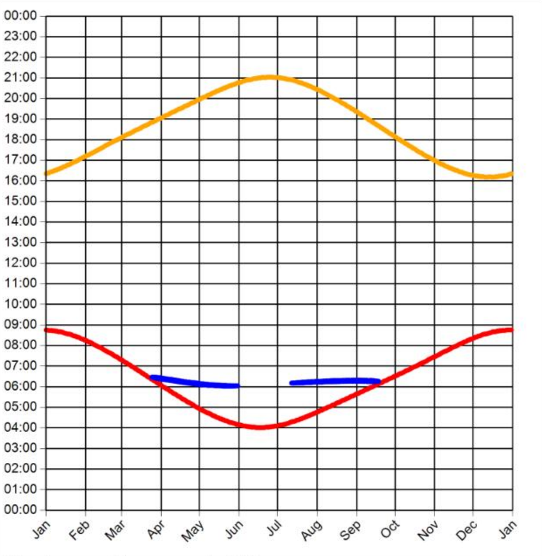
Observer Location

Sun azimuth range is 71.8° - 87.4° (yellow)

Reflecting panels (yellow)

Observer 14 Results

Reflection Date/Time (GMT) Graph



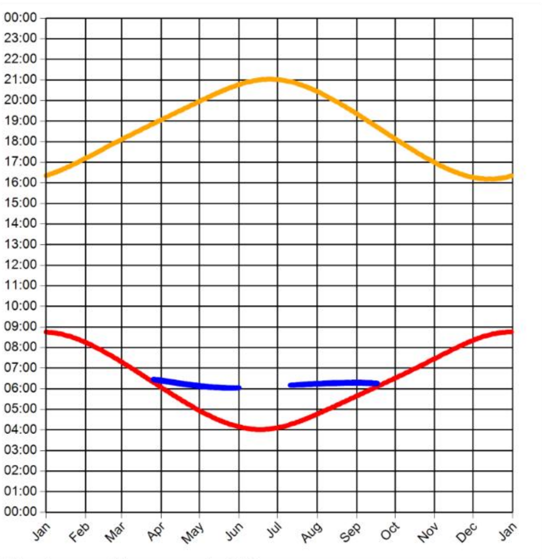
Min observer difference angle: 0.1°
Max observer difference angle: 14.3°

Observer Location — Sun azimuth range is 71.9° - 87.4° (yellow)

Reflecting panels (yellow)

Observer 15 Results

Reflection Date/Time (GMT) Graph



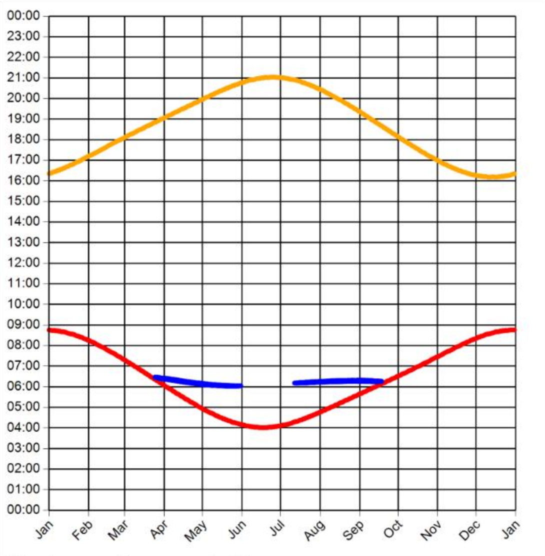
Min observer difference angle: 0.1°
Max observer difference angle: 14.4°

Observer Location — Sun azimuth range is 71.7° - 87.2° (yellow)

Reflecting panels (yellow)

Observer 16 Results

Reflection Date/Time (GMT) Graph



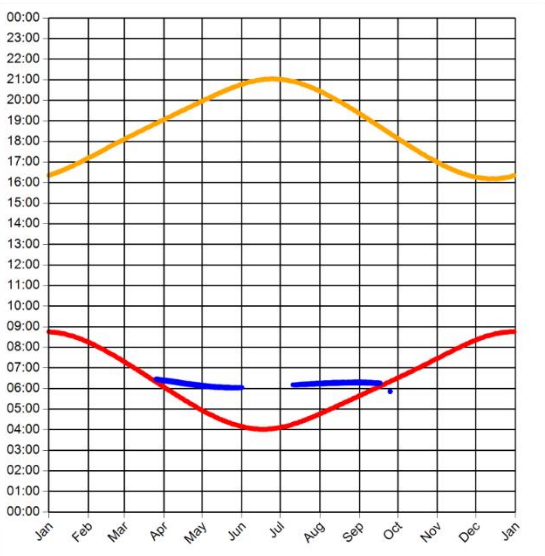
Min observer difference angle: 0°
Max observer difference angle: 14.3°

Observer Location — Sun azimuth range is 71.8° - 87.4° (yellow)

Reflecting panels (yellow)

Observer 17 Results

Reflection Date/Time (GMT) Graph



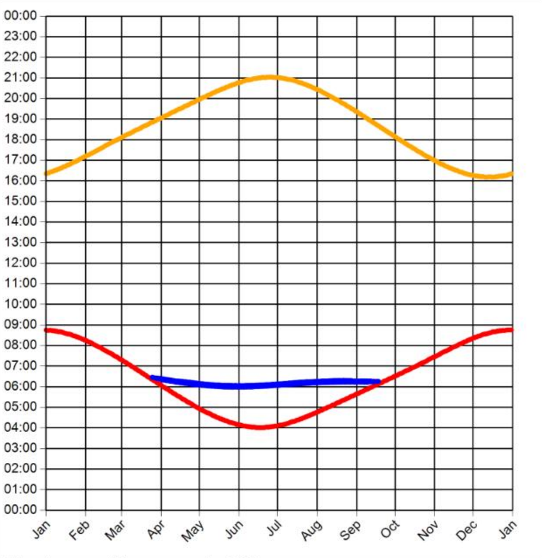
Min observer difference angle: 0.1°
Max observer difference angle: 14.4°

Observer Location — Sun azimuth range is 71.8° - 87.1° (yellow)

Reflecting panels (yellow)

Observer 18 Results

Reflection Date/Time (GMT) Graph



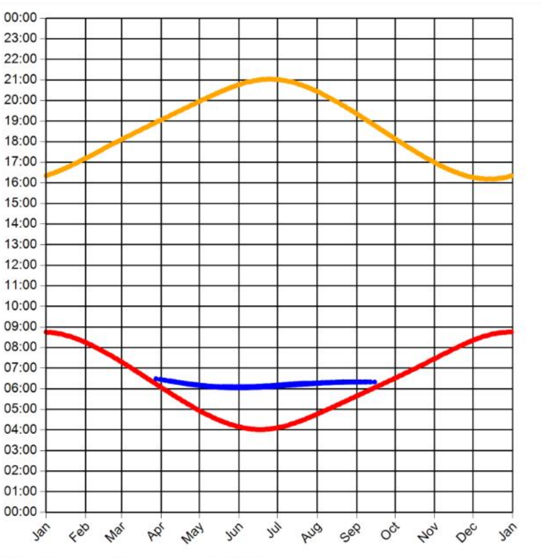
Min observer difference angle: 0.2°
Max observer difference angle: 15.6°

Observer Location | Sun azimuth range is 69.9° - 87.4° (yellow)

Reflecting panels (yellow)

Observer 19 Results

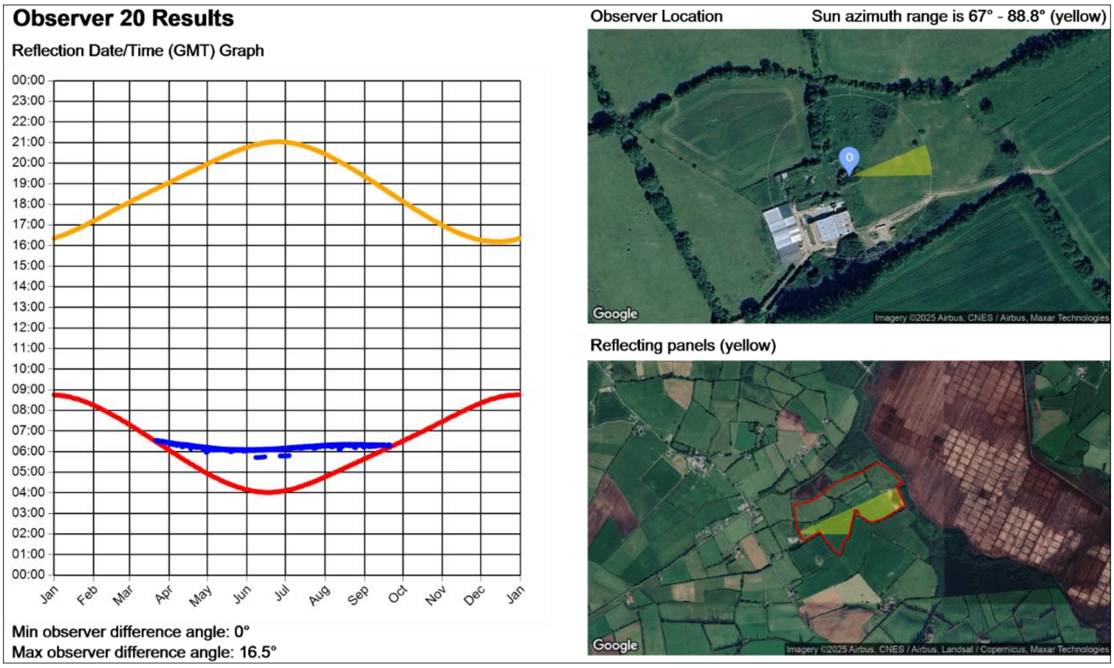
Reflection Date/Time (GMT) Graph



Min observer difference angle: 1.9°
Max observer difference angle: 16.4°

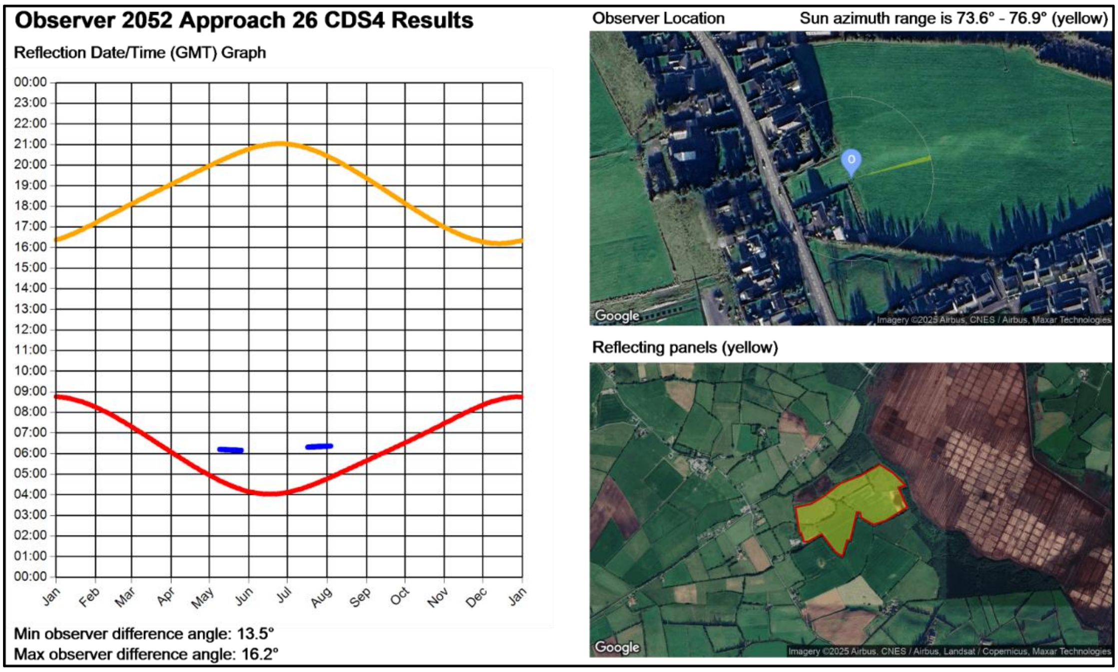
Observer Location | Sun azimuth range is 70.6° - 87.2° (yellow)

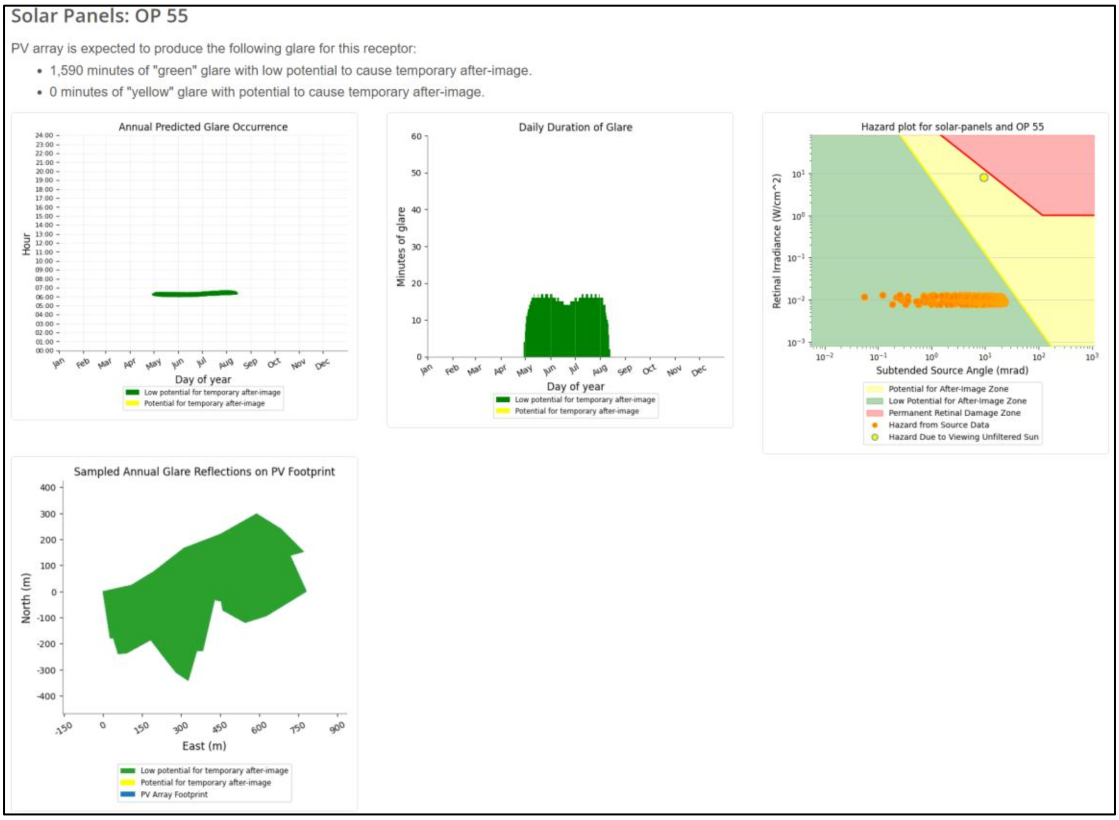
Reflecting panels (yellow)


Observer 20 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: 0°
Max observer difference angle: 16.5°
Observer Location
Sun azimuth range is 67° - 88.8° (yellow)
Google
Imagery ©2025 Airbus, CNES / Airbus, Maxar Technologies
Reflecting panels (yellow)
Google
Imagery ©2025 Airbus, CNES / Airbus, Landsat / Copernicus, Maxar Technologies

Aviation Receptors

Example Result – Spollens Airstrip





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