

Solar Photovoltaic Glint and Glare Study

Environmena Project Management Ltd.

Chicklade Solar

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ADMINISTRATION PAGE

Job Reference:	15344A1
Author:	Phillip Charhill
Email:	phillip@pagerpower.com
Telephone:	01787 319001

Reviewed By:	Abdul Wadud; Jacob Cunningham
Email:	abdul@pagerpower.com; jacob@pagerpower.com

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1	17 December 2025	Initial issue
2	02 January 2026	Administrative revisions
3	14 January 2026	Updated site plan and landscape management
4	28 April 2026	Updated site plan

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

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

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EXECUTIVE SUMMARY

Report Purpose

Pager Power has been retained to assess the potential effects of glint and glare from a fixed ground-mounted solar photovoltaic development west of Chicklade, Wiltshire. This assessment pertains to the potential impacts upon road safety, residential amenity, and aviation activity.

Overall Conclusions

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

Guidance and Studies

Guidelines exist in the UK (produced by the Civil Aviation Authority) and in the USA (produced by the Federal Aviation Administration) with respect to solar developments and aviation activity. The UK CAA guidance is relatively high-level and does not prescribe a formal methodology. There is no formal planning guidance for the assessment of solar reflections from solar panels towards roads and nearby dwellings. Pager Power has however produced guidance for glint and glare and solar photovoltaic developments, which was published in early 2017, with the fourth edition¹ published in 2022. This methodology defines a comprehensive process for determining the impact upon road safety, residential amenity, and aviation activity.

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. For aviation activity, where a solar reflection is predicted, solar intensity calculations are undertaken where appropriate in line with the Sandia National Laboratories' FAA methodology². 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 steel³.

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

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

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



Assessment Conclusions – Road Safety

Solar reflections are possible towards a 1.2km section of the A303.

For all 1.2km of road, screening in the form of existing and proposed vegetation is predicted to significantly obstruct views of reflecting panels. Solar reflections are not predicted to be experienced in practice. No impact is predicted, and mitigation is not required.

Assessment Conclusions – Residential Amenity

Solar reflections are geometrically possible towards 14 of the 18 assessed dwellings.

For all 14 dwellings, screening in the form of existing vegetation, proposed vegetation, and/or buildings is predicted to significantly obstruct views of the reflecting panels. Solar reflections are not predicted to occur in practice. No impact is predicted upon these dwellings and mitigation is not required.

High-Level Assessment Conclusions – Aviation

Solar reflections towards the splayed approaches and final sections of visual circuits at Gutchpool Farm Airfield, Bath Wilts & North Dorset Gliding Club, Wing Farm Airfield, and Glebe Farm Airfield are predicted to occur outside a pilot's field-of-view or have intensities no greater than 'low potential for temporary after-image'. These glare scenarios are considered acceptable in accordance with the associated guidance (Appendix D) and industry best practice. No significant impacts are predicted and mitigation is not required.

LIST OF CONTENTS

Administration Page	1
Executive Summary.....	2
Report Purpose	2
Overall Conclusions.....	2
Guidance and Studies.....	2
Assessment Conclusions – Road Safety.....	3
Assessment Conclusions – Residential Amenity.....	3
High-Level Assessment Conclusions – Aviation.....	3
List of Contents	4
List of Figures	7
List of Tables	7
About Pager Power	8
1 Introduction	9
1.1 Overview.....	9
1.2 Pager Power’s Experience.....	9
1.3 Glint and Glare Definition	9
2 Solar Development Location and Details	10
2.1 Proposed Development Site Layout	10
2.2 Modelled Reflector Area	11
2.3 Technical Parameters	11
3 Glint and Glare Assessment Methodology.....	12
3.1 Overview.....	12
3.2 Background.....	12
3.3 Methodology	12
3.4 Assessment Methodology and Limitations.....	13
4 Identification of Receptors	14
4.1 Overview.....	14

4.2	Ground Based Receptors Overview	14
4.3	Road Receptors.....	16
4.4	Dwelling Receptors.....	18
5	Geometric Assessment Results and Discussion.....	20
5.1	Overview.....	20
5.2	Assessment results - Road Receptors.....	20
5.3	Assessment Results – Dwelling Receptors.....	27
6	High-Level Assessment of Aviation Activity.....	34
6.1	Overview.....	34
6.2	Airfield Details	35
6.3	Assessment	37
6.4	Conclusion	37
7	Overall Conclusions.....	38
7.1	Assessment Conclusions – Road Safety.....	38
7.2	Assessment Conclusions – Residential Amenity.....	38
7.3	High-Level Assessment Conclusions – Aviation.....	38
	Appendix A – Overview of Glint and Glare Guidance	39
	Overview	39
	UK Planning Policy	39
	Assessment Process – Ground-Based Receptors.....	41
	Aviation Assessment Guidance	42
	Civil Aviation Authority consolidation of UK Regulation 139/2014	48
	Appendix B – Overview of Glint and Glare Studies.....	49
	Overview	49
	Reflection Type from Solar Panels	49
	Solar Reflection Studies	50
	Appendix C – Overview of Sun Movements and Relative Reflections.....	53
	Appendix D – Glint and Glare Impact Significance	54
	Overview	54

Impact Significance Definition	54
Impact Significance Determination for Road Receptors	55
Impact Significance Determination for Approaching Aircraft	56
Impact Significance Determination for Dwelling Receptors	57
Appendix E – Reflection Calculations Methodology.....	58
Pager Power Methodology	58
Appendix F – Assessment Limitations and Assumptions	60
Pager Power’s Model	60
Appendix G – Receptor and Reflector Area Details	62
Overview	62
Road Receptor Data.....	62
Dwelling Receptor Data.....	63
Modelled Reflector Area	64
Appendix H – Detailed Modelling Results.....	65
Overview	65
Dwelling Receptors.....	66
Road Receptors.....	68

LIST OF FIGURES

Figure 1 Site plan and solar layout.....	10
Figure 2 Modelled reflector area	11
Figure 3 1km assessment area.....	15
Figure 4 Receptors placed along the A303	17
Figure 5 Overview of assessed dwelling receptors	19
Figure 6 Road receptors 1 to 5 – Screening.....	23
Figure 7 Road receptor 13 – Screening	24
Figure 8 Road receptors 14 to 18 – Screening.....	25
Figure 9 Road receptors 19 to 24 – Screening.....	26
Figure 10 Dwellings 1 & 2 – Screening	30
Figure 11 Dwelling 5 – Screening	31
Figure 12 Dwellings 6 to 8 – Screening.....	32
Figure 13 Dwellings 11 to 18 – Screening.....	33
Figure 14 Assessed airfields, relative to the proposed development.....	36

LIST OF TABLES

Table 1 Solar panel technical parameters	11
Table 2 Geometric modelling results - road receptors.....	22
Table 3 Geometric modelling results - dwelling receptors	29

ABOUT PAGER POWER

Pager Power is a specialist technical consultancy based in the United Kingdom and has been providing independent expertise on planning issues for solar, wind, and building developments for over 20 years.

Established in 1997, the company initially specialised in assessing the impact of wind turbines on radar systems. Pager Power has since expanded into a multidisciplinary technical planning consultancy that offers a comprehensive range of services and has supported renewable and building projects in more than 60 countries.

Pager Power's core competencies now include:

- Aviation and Radar;
- Daylight, Sunlight and Overshadowing;
- Glint and Glare;
- Shadow Flicker;
- Telecommunications.

Using proprietary modelling software, each study is tailored to the individual project, ensuring that results are relevant, defensible, and aligned with current national and international standards. The company also provides planning support and stakeholder consultation across all service areas, helping clients to understand constraints, explore potential mitigation options, and forge a path forward for their projects.

Pager Power's work helps our clients identify potential risks, inform project design, and support the decision-making process, and can provide support at any stage of a project, from initial feasibility through to completion. Pager Power's assessments – recognised for their objectivity, accuracy, and technical integrity – are designed to withstand legal scrutiny, and trusted by developers and stakeholders alike.

1 INTRODUCTION

1.1 Overview

Pager Power has been retained to assess the potential effects of glint and glare from a fixed ground-mounted solar photovoltaic development west of Chicklade, Wiltshire. This assessment pertains to the potential impacts upon road safety, residential amenity, and aviation activity.

This report contains the following:

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

1.2 Pager Power's Experience

Pager Power has undertaken over 1,800 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 definition⁴ 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.

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

⁴ Published by the Department for Energy Security and Net Zero in November 2023 and came into force on 17 January 2024



2.1 Proposed Development Site Layout

The site plan illustrates the proposed solar farm layout. A red line delineates the site boundary (0.76 acres). A yellow dashed line indicates the perimeter fence. An orange triangle marks the site access point. A black square symbolizes the transformer station. Blue rectangles represent the PV array panels, arranged in rows. Green circles along the edges denote the hedgerow. A green circle with a crosshair indicates the location of a CCTV camera. The plan also shows existing features like the 'Scrubland' area and 'Hedgerow'. A north arrow and a scale bar (0-10m) are provided for orientation and measurement.

Legend	
[Red Line]	Site Boundary (0.76 acres)
[Yellow Dashed Line]	Perimeter Fence
[Orange Triangle]	Site Access
[Black Square]	Transformer Station
[Blue Rectangles]	PV Array
[Green Circles]	Hedgerow
[Green Circle with Crosshair]	CCTV Camera

ENVIROMENA Environmental Project Management UK Ltd. 10 Colindale Avenue, London NW9 1SE Tel: 020 883 1000 Email: info@enviromena.co.uk		PROJECT: Oldfield Farm TITLE: Planning Layout NUMBER: E0000000-00 Planning Layout DATE: 10/01/2023 DRAWN: [Name] CHECKED: [Name]
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The assessment has been carried out considering a prior and larger panel layout. No increase in predicted impact is expected due to a reduction in the panel area. Therefore, the results can be read as worst-case scenario.

⁵ Source: ENV00267-02-PlanningLayout-RevL.pdf

2.2 Modelled Reflector Area

The bounding coordinates for the proposed development have been extrapolated from the site plans. The data can be found in Appendix G. Figure 2 below shows the assessed reflector area that have been used for modelling purposes. The area is shown in blue, outlined in red.



Figure 2 *Modelled reflector area*

The Pager Power model has used a resolution of 5m for this assessment. This means that a geometric calculation is undertaken for each identified receptor every 5m 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. If a reflection is experienced from an assessed panel location, then it is likely that a reflection will be viewable from similarly located panels within the proposed solar development.

2.3 Technical Parameters

The technical parameters used for geometric modelling is presented in Table 1 below. The bounding coordinates for each area are provided in Appendix G.

Height ⁶ (m) above ground level	Tilt Angle ⁷ (°)	Azimuth Angle ⁸ (°)
1.63	25	180

Table 1 *Solar panel technical parameters*

⁶ Relative to the minimum (0.6m) and maximum (2.653m) heights of panels above ground level.

⁷ Tilt angle measured relative to the horizontal.

⁸ Orientation panels face, measured clockwise, as absolute value relative to True North (0°).

3 GLINT AND GLARE ASSESSMENT METHODOLOGY

3.1 Overview

Appendices 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.

3.2 Background

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

3.3 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;
- 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.



3.4 Assessment Methodology and Limitations

Further technical details regarding the methodology of the geometric calculations and limitations are presented in Appendices E and 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 (OS) 50 Digital Terrain Model (DTM) data. The receptor details for all receptors are presented in Appendix G.

4.2 Ground Based Receptors Overview

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

The above parameters and industry experience over a significant number of glint and glare assessments undertaken, shows that a 1km assessment area is considered appropriate for glint and glare effects on ground-based receptors. The 1km assessment area is shown by the yellow bounded area in Figure 3 on the following page. The area to the north of the development is not included because solar reflections would not be geometrically possible towards the north when the azimuth angle is considered⁹.

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

⁹ For fixed, south-facing panels at this latitude, reflections towards ground-based receptors located further north than any proposed panel are not predicted to be possible.



Figure 3 1km assessment area

4.3 Road Receptors

4.3.1 Road Receptors Overview

Road types can generally be categorised as:

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

Technical modelling is not recommended for local roads, where traffic densities are likely to be relatively low. Any solar reflections from the proposed development that are experienced by a road user along a local road would be considered low impact in the worst-case in accordance with the guidance presented in Appendix D.

The analysis has also considered major national, national, and regional roads that:

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

4.3.2 Identified Road Receptors

A 2.25km section of the A303 has been identified within the assessment area. The road section is shown in blue in Figure 4 on the following page.

Receptors placed, approximately 100m apart, along these sections of road are also shown in Figure 4 on the following page. A height of 1.5m above ground level has been taken as the typical eye level of a road user¹⁰.

All other roads within the assessment area have either been determined to be local roads, or that view of the proposed development are not predicted from them, and thus have not been taken forward for technical modelling.

¹⁰ This fixed height for the road receptors is for modelling purposes. Changes to the modelling height by a few metres is not expected to significantly change the modelling results. Views for elevated drivers are also considered in the results discussion, where appropriate.



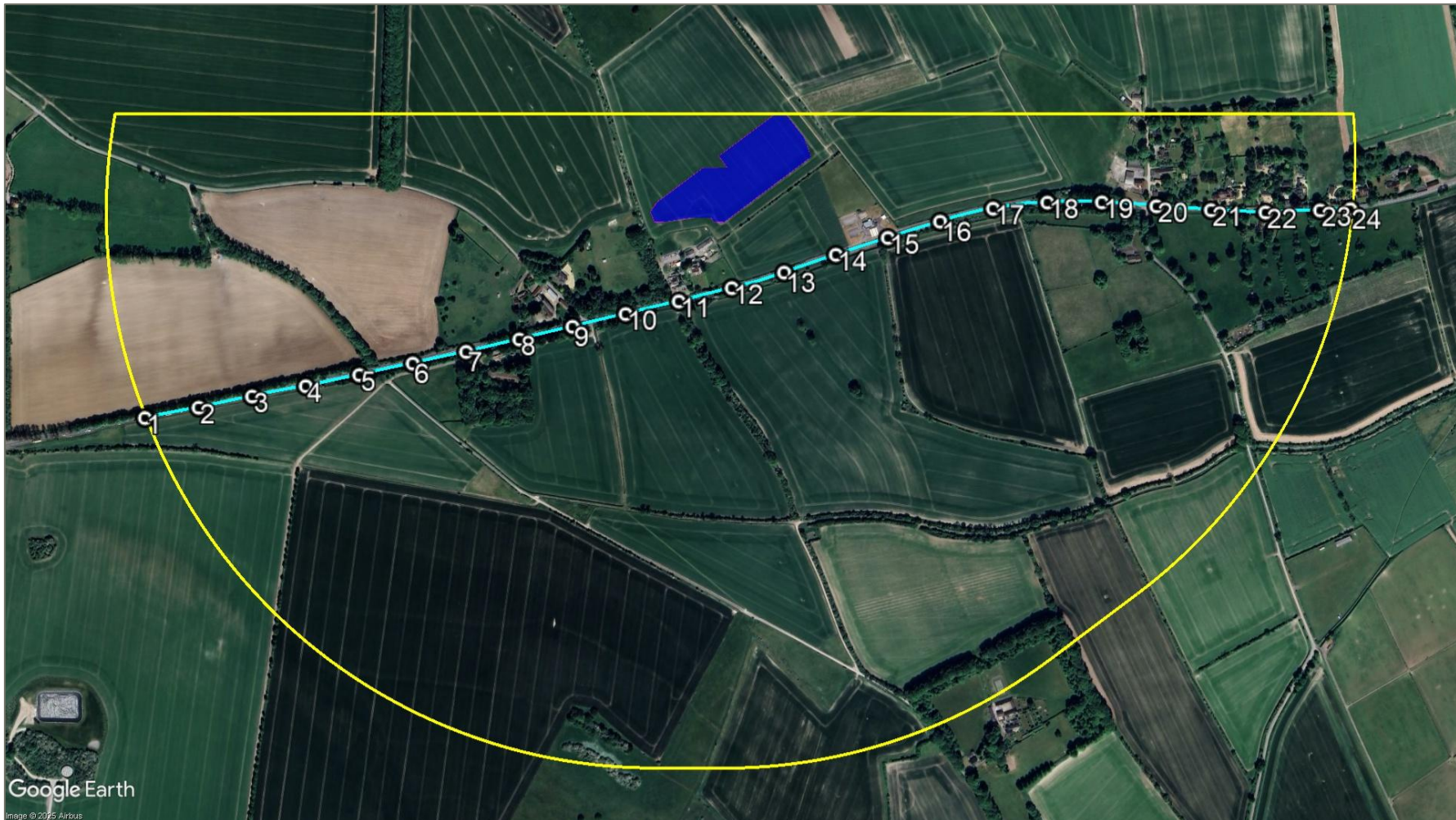


Figure 4 Receptors placed along the A303

4.4 Dwelling Receptors

4.4.1 Dwelling Receptors Overview

The analysis has considered dwellings that:

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

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

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

4.4.2 Identified Dwelling Receptors

Eighteen dwelling receptors were identified to be taken forward for geometric modelling, which are shown in Figure 5 on the following page. An additional 1.8m height above ground is used in the modelling to simulate the typical viewing height of an observer on the ground floor¹¹.

¹¹ Small changes to this height are not significant, and views above the ground floor considered are considered where appropriate





Figure 5 Overview of assessed dwelling receptors

5 GEOMETRIC ASSESSMENT RESULTS AND DISCUSSION

5.1 Overview

The tables in the following subsections summarise the results of the assessment. The predicted reflection times are based solely on bare-earth terrain i.e. without consideration of screening from buildings and vegetation. The final column summarises the predicted impact considering the level of predicted screening based on a desk-based review of the available imagery. The significance of any predicted impact is discussed in the subsequent report sections.

5.2 Assessment results - Road Receptors

5.2.1 Key Considerations

The process for quantifying impact significance is defined in the report appendices. The key considerations for road users along major national, national, and regional roads are:

- Whether a reflection is predicted to be experienced in practice;
- The location of the reflecting panel relative to a road user's direction of travel.

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 reflections originate from outside of a road user's primary field of view (50 degrees either side of the direction of travel), or where the separation distance to the nearest visible reflecting panel is over 1km, the impact significance is low, and mitigation is not recommended.

Where reflections are predicted to be experienced from inside of a road user's main field of view, expert assessment of the following factors is required to determine the impact significance:

- Whether visibility is likely for elevated drivers (applicable to dual carriageways and motorways only) – there is typically a higher density of elevated drivers (such as HGVs) along dual carriageways and motorways compared to other types of road;
- Whether a solar reflection is fleeting in nature. Small gap/s in screening (e.g., an access point to the site) may not result in a sustained reflection for a road user;
- The separation distance to the panel area – larger separation distances reduce the proportion of an observer's field of view that is affected by glare;
- The position of the Sun – effects that coincide with direct sunlight appear less prominent than those that do not;
- Whether the solar reflection originates from directly in front of a road user – a solar reflection that is directly in front of a road user is more hazardous than a solar reflection to one side.



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

Where reflections originate from directly in front of a road user and there are no mitigating factors, the impact significance is high, and mitigation is required.

5.2.2 Geometric Modelling Results

Table 2 on the following pages presents:

- Geometric modelling results (prior to consideration of screening);
- Desk-based review of identified screening;
- Consideration of mitigating factors present, where appropriate;
- Predicted impact significance.

Reference is made to a road user's primary field-of-view (FOV), which is defined as 50 degrees either side of the direction of travel.



Road Receptor	Geometric Modelling Results (screening not considered)	Identified Screening and Predicted Visibility (desk-based review)	Considering screening ¹² , do reflections remain inside the primary FOV	Mitigating Factors	Predicted Impact Classification
1 – 5	Solar reflections are <u>geometrically possible</u> and occur <u>inside</u> a road user's primary FOV	Existing vegetation is predicted to significantly obstruct views of reflecting panels Views are not predicted in practice	None	N/A	No impact
6 – 12	Solar reflections <u>are not</u> geometrically possible	N/A	N/A	N/A	No impact
13 – 24	Solar reflections are <u>geometrically possible</u> and occur <u>inside</u> a road user's primary FOV	Existing and proposed vegetation is predicted to significantly obstruct views of reflecting panels Views are not predicted in practice	None	N/A	No impact

Table 2 Geometric modelling results - road receptors

5.2.3 Desk-Based Review of Available Imagery

A desk-based review of the available imagery is presented in Figures 6 to 9 on the following pages. The cumulative reflecting panel areas are indicated by regions of yellow. The identified screening in the form of existing and proposed vegetation are highlighted in green and white respectively. Streetview images are used to show a ground-based view of screening at specific locations, with a white arrow and blue triangle to illustrate the location and direction.

¹² Assessment scenario may include an initial conservative qualitative consideration of screening. The reflecting area of the solar development may be partially screened such that it does not meet the key criteria i.e. whether the solar reflection occurs within a road users' main field of view.





Figure 6 Road receptors 1 to 5 – Screening





Figure 7 Road receptor 13 – Screening



Figure 8 Road receptors 14 to 18 – Screening



Figure 9 Road receptors 19 to 24 – Screening

5.3 Assessment Results – Dwelling Receptors

5.3.1 Key Considerations

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:
 - Three months per year;
 - 60 minutes on any given day.

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

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

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

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

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

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

5.3.2 Geometric Modelling Results

Table 3 on the following pages presents:

- Geometric modelling results (prior to consideration of screening);
- Desk-based review of identified screening;
- Consideration of mitigating factors present, where appropriate;
- Predicted impact significance.



Dwelling Receptor	Geometric Modelling Results (screening not considered)	Identified Screening and Predicted Visibility (desk-based review)	Duration of reflections (with consideration of screening) ¹³	Mitigating Factors	Predicted Impact Classification
1 – 2	Solar reflections <u>are</u> geometrically possible for: <u>Less</u> than 3 months <u>Less</u> than 60 minutes	Existing vegetation and buildings are predicted to significantly obstruct views of reflecting panels Views are not predicted in practice	None	N/A	No impact
3 – 4	Solar reflections <u>are not</u> geometrically possible	N/A	N/A	N/A	No impact
5	Solar reflections <u>are</u> geometrically possible for: <u>More</u> than 3 months <u>Less</u> than 60 minutes	Existing and proposed vegetation are predicted to significantly obstruct views of reflecting panels Views are not predicted in practice	None	N/A	No impact
6 – 8	Solar reflections <u>are</u> geometrically possible for: <u>Less</u> than 3 months <u>Less</u> than 60 minutes	Existing buildings are predicted to significantly obstruct views of reflecting panels Views are not predicted in practice	None	N/A	No impact

¹³ 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 (screening not considered)	Identified Screening and Predicted Visibility (desk-based review)	Duration of reflections (with consideration of screening) ¹³	Mitigating Factors	Predicted Impact Classification
9 – 10	Solar reflections are not geometrically possible	N/A	N/A	N/A	No impact
11 – 18	Solar reflections are geometrically possible for: Less than 3 months Less than 60 minutes	Existing vegetation is predicted to significantly obstruct views of reflecting panels Views are not predicted in practice	None	N/A	No impact

Table 3 Geometric modelling results - dwelling receptors

5.3.3 Desk-Based Review of Available Imagery

A desk-based review of the available imagery is presented in Figures 10 to 13. The cumulative reflecting panel areas are indicated by regions of yellow. The identified screening in the form of existing vegetation, proposed vegetation, and buildings are highlighted in green, white, and blue respectively. Streetview images are used to show a ground-based view of screening at specific locations, with a white arrow to illustrate the location and direction.





Figure 10 Dwellings 1 & 2 – Screening



Figure 11 *Dwelling 5 – Screening*



Figure 12 Dwellings 6 to 8 – Screening



Figure 13 Dwellings 11 to 18 – Screening

6 HIGH-LEVEL ASSESSMENT OF AVIATION ACTIVITY

6.1 Overview

Glint and glare assessment for aviation receptors are typically undertaken for licensed aerodromes within 10km of a proposed solar development. Geometric modelling for unlicensed General Aviation (GA) aerodromes is typically required within 5km of a proposed development. At ranges of 10-20km, the requirement for assessment is much less common, with typically assessment only being undertaken for licensed aerodromes at these ranges. Assessment of any aviation effects for developments over 20km is not a usual requirement.

The following sections present a high-level assessment (not geometrically modelled for given the distance between the aerodrome and proposed development).

The proposed development size, distance between the aerodrome and proposed development, and industry experience are considered to determine the impact during the assessment.

Reference to a pilot's primary field-of-view (defined as 50-degrees horizontally either side of the approach bearing) is made when determining the predicted impact significance.

With reference to the glare intensity within a pilot's primary field-of-view, the following is considered:

- For reflections with an intensity of "low potential for temporary after-image" (green glare), the associated guidance, assessment methodology (Appendix D) and industry best practice pertaining to approach paths for licensed aerodromes states this level of glare intensity is acceptable. Therefore, it can be reliably determined that this level of glare is also acceptable for these receptors;
- For reflections with an intensity of "potential for temporary after-image" (yellow glare), the glare scenario is considered in context of the aerodrome's specific operations. Where mitigating factors are not identified, mitigation would be recommended;
- For 'red' glare, mitigation would be required.

6.2 Airfield Details

6.2.1 Gutchpool Farm Airfield

The airfield is approximately 8.6km southwest of the proposed development. It is an unlicensed GA airfield and is understood to not have an Air Traffic Control (ATC) tower. The airfield has one runway, the details¹⁴ of which are presented below:

- 05/23 measuring 400m by 22m (grass).

The locations of the aerodrome and 1-mile splayed approach paths are shown relative to the proposed development in Figure 14 on the following page.

6.2.2 Bath Wilts & North Dorset Gliding Club

The airfield is approximately 7.0km northeast of the proposed development. It is an unlicensed GA airfield and is understood to not have an ATC tower. The airfield has one runway, the details¹⁵ of which are presented below:

- 08/26 measuring 1,200m by 110m (grass).

The locations of the aerodrome and 1-mile splayed approach paths are shown relative to the proposed development in Figure 14 on the following page.

6.2.3 Wing Farm Airfield

The airfield is approximately 7.4km northeast of the proposed development. It is an unlicensed GA airfield and is understood to not have an ATC tower. The airfield has one runway, the details¹⁶ of which are presented below:

- 09/27 measuring 500m by 12m (grass).

The locations of the aerodrome and 1-mile splayed approach paths are shown relative to the proposed development in Figure 14 on the following page.

6.2.4 Glebe Farm Airfield

The airfield is approximately 7.3km northeast of the proposed development. It is an unlicensed GA airfield and is understood to not have an ATC tower. The airfield has one runway, the details¹⁷ of which are presented below:

- 04/22 measuring 825m by 20m (grass).

The locations of the aerodrome and 1-mile splayed approach paths are shown relative to the proposed development in Figure 14 on the following page.

¹⁴ Source: Available aerial imagery.

¹⁵ Source: <https://www.bwnd.co.uk/visiting-pilots/index.htm>.

¹⁶ Source: Pooley's Flight Guide (2026).

¹⁷ Source: Available aerial imagery.



Figure 14 Assessed airfields, relative to the proposed development

6.3 Assessment

The following can be concluded for the assessed airfields with regards to the proposed development:

- Solar reflections originating from the proposed development towards the 1-mile splayed approach path for runways: 05 at Gutchpool Farm Airfield, 08 at North Dorset Gliding Club, 09 at Wing Farm Airfield, and 04 at Glebe Farm Airfield, are predicted to have glare intensities no greater than 'low potential for temporary after-image'. This glare intensity is considered acceptable in accordance with the associated guidance (Appendix D) and industry best practice;
- Solar reflections originating from the proposed development towards the 1-mile splayed approach path for runways: 23 at Gutchpool Farm Airfield, 26 at North Dorset Gliding Club, 27 at Wing Farm Airfield, and 22 at Glebe Farm Airfield, would occur outside a pilot's primary field-of-view. Glare which originates outside the primary field-of-view is not considered to be significant in accordance with the associated guidance (Appendix D) and industry best practice;
- Solar reflections originating from the proposed development towards the visual circuits for the runways are predicted to have glare intensities no greater than 'low potential for temporary after-image'. Considering the associated guidance (Appendix D) and industry best practice pertaining to approach paths, it can be reliably determined that this level of glare is acceptable for the visual circuits and joins.

6.4 Conclusion

No significant impacts are predicted upon aviation activity associated with Gutchpool Farm Airfield, Bath Wilts & North Dorset Gliding Club, Wing Farm Airfield, and Glebe Farm Airfield. Mitigation is not required. Detailed modelling is not recommended.

7 OVERALL CONCLUSIONS

7.1 Assessment Conclusions – Road Safety

Solar reflections are possible towards a 1.2km section of the A303.

For all 1.2km of road, screening in the form of existing and proposed vegetation is predicted to significantly obstruct views of reflecting panels. Solar reflections are not predicted to be experienced in practice. No impact is predicted, and mitigation is not required.

7.2 Assessment Conclusions – Residential Amenity

Solar reflections are geometrically possible towards 14 of the 18 assessed dwellings.

For all 14 dwellings, screening in the form of existing vegetation, proposed vegetation, and/or buildings is predicted to significantly obstruct views of the reflecting panels. Solar reflections are not predicted to be occur in practice. No impact is predicted upon these dwellings and mitigation is not required.

7.3 High-Level Assessment Conclusions – Aviation

Solar reflections towards the splayed approaches and final sections of visual circuits at Gutchpool Farm Airfield, Bath Wilts & North Dorset Gliding Club, Wing Farm Airfield, and Glebe Farm Airfield are predicted to occur outside a pilot's field-of-view or have intensities no greater than 'low potential for temporary after-image'. These glare scenarios are considered acceptable in accordance with the associated guidance (Appendix D) and industry best practice. No significant impacts are predicted and mitigation is not required.

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 and is limited to the UK; however, it is relevant from a technical and planning perspective. The section is intended to give an overview of the important parameters and considerations that have informed this assessment.

UK Planning Policy

Renewable and Low Carbon Energy

The National Planning Policy Framework under the planning practice guidance for Renewable and Low Carbon Energy¹⁸ (specifically regarding the consideration of solar farms, paragraph 013) states:

‘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.

¹⁸ Renewable and low carbon energy. Ministry of Housing, Communities & Local Government, date: 18 June 2015, accessed on: 01/11/2021

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.*
- 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.*

¹⁹ [National Policy Statement for Renewable Energy Infrastructure \(EN-3\)](#), Department for Energy Security & Net Zero, date: November 2023, accessed on: 21/12/2023

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’



2.10.136 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 document²¹ which was produced due to the absence of existing guidance and a specific standardised assessment methodology.

²¹ Solar Photovoltaic Development Glint and Glare Guidance, Fourth Edition, September 2022. Pager Power.

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, 2012²² however the advice is still applicable²³ until a formal policy is developed. The relevant aviation guidance from the CAA is presented in the section below.

CAA Interim Guidance

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

- '8. It is recommended that, as part of a planning application, the SPV developer provide safety assurance documentation (including risk assessment) regarding the full potential impact of the SPV installation on aviation interests.*
- 9. Guidance on safeguarding procedures at CAA licensed aerodromes is published within CAP 738 Safeguarding of Aerodromes and advice for unlicensed aerodromes is contained within CAP 793 Safe Operating Practices at Unlicensed Aerodromes.*
- 10. Where proposed developments in the vicinity of aerodromes require an application for planning permission the relevant LPA normally consults aerodrome operators or NATS when aeronautical interests might be affected. This consultation procedure is a statutory obligation in the case of certain major airports, and may include military establishments and certain air traffic surveillance technical sites. These arrangements are explained in Department for Transport Circular 1/2003 and for Scotland, Scottish Government Circular 2/2003.*
- 11. In the event of SPV developments proposed under the Electricity Act, the relevant government department should routinely consult with the CAA. There is therefore no requirement for the CAA to be separately consulted for such proposed SPV installations or developments.*
- 12. If an installation of SPV systems is planned on-aerodrome (i.e. within its licensed boundary) then it is recommended that data on the reflectivity of the solar panel material should be included in any assessment before installation approval can be granted. Although approval for installation is the responsibility of the ALH²⁴, 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.*

²² Archived at Pager Power.

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

²⁴ Aerodrome Licence Holder.



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 were produced initially in November 2010 by the United States Federal Aviation Administration (FAA) and updated in 2013.

The 2010 document is entitled '*Technical Guidance for Evaluating Selected Solar Technologies on Airports*'²⁵ and the 2013 update is entitled '*Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports*'²⁶. In April 2018 the FAA released a new version (Version 1.1) of the '*Technical Guidance for Evaluating Selected Solar Technologies on Airports*'²⁷.

An overview of the methodology presented within the 2013 interim guidance and adopted by the FAA is presented below. This methodology is not presented within the 2018 guidance.

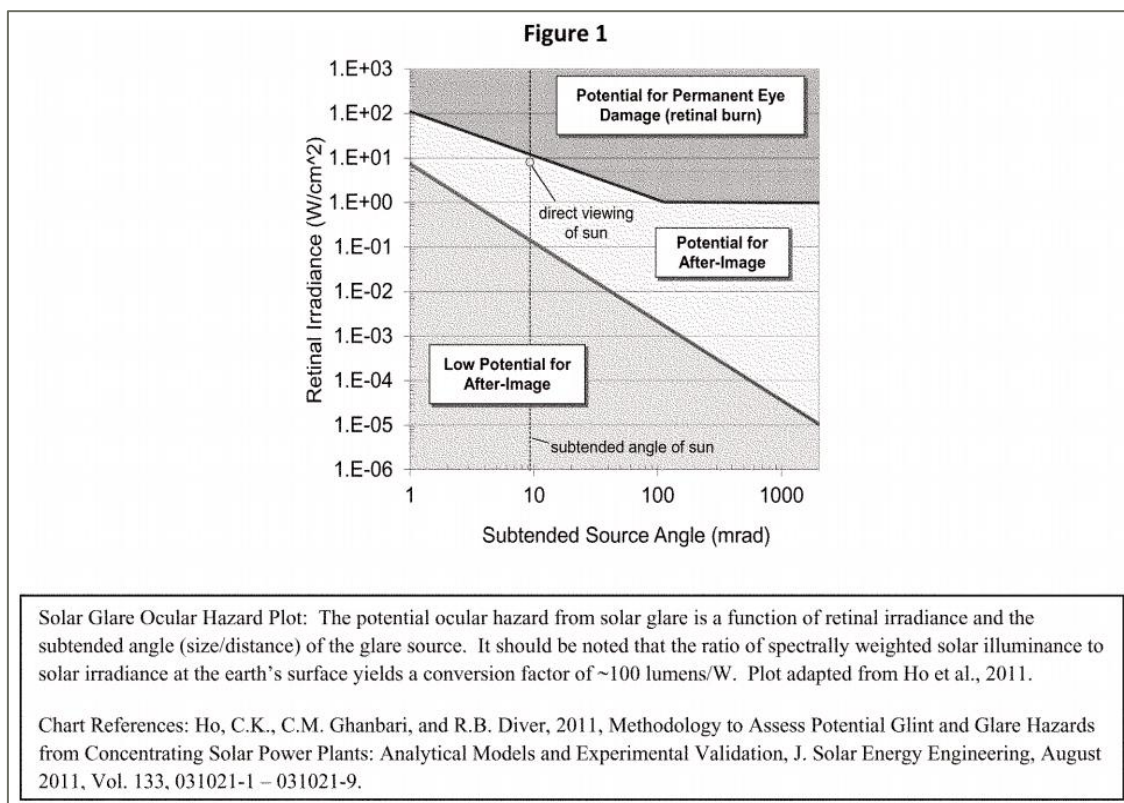
- *Solar energy systems located on an airport that is not federally-obligated or located outside the property of a federally-obligated airport are not subject to this policy.*
- *Proponents of solar energy systems located off-airport property or on non-federally-obligated airports are strongly encouraged to consider the requirements of this policy when siting such system.*
- *FAA adopts the Solar Glare Hazard Analysis Plot... as the standard for measuring the ocular impact of any proposed solar energy system on a federally-obligated airport. This is shown in the figure below.*

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: 20/03/2019

²⁷ [Technical Guidance for Evaluating Selected Solar Technologies on Airports](#), Federal Aviation Administration (FAA), date: 04/2018, accessed on: 20/03/2019





- **Solar Glare Hazard Analysis Plot (FAA)**
- **To obtain FAA approval to revise an airport layout plan to depict a solar installation and/or a “no objection” ... the airport sponsor will be required to demonstrate that the proposed solar energy system meets the following standards:**
- **No potential for glint or glare in the existing or planned Airport Traffic Control Tower (ATC) cab, and**
- **No potential for glare or “low potential for after-image” ... along the final approach path for any existing landing threshold or future landing thresholds (including any planned interim phases of the landing thresholds) as shown on the current FAA-approved Airport Layout Plan (ALP). The final approach path is defined as two (2) miles from fifty (50) feet above the landing threshold using a standard three (3) degree glidepath.**
- **Ocular impact must be analysed over the entire calendar year in one (1) minute intervals from when the sun rises above the horizon until the sun sets below the horizon.**

The bullets highlighted above state there should be ‘no potential for glare’ at that ATC Tower and ‘no’ or ‘low potential for glare’ on the approach paths.



Key points from the 2018 FAA guidance are presented below:

- *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 blindness²⁸.*
- *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 16²⁹, 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,*

²⁸ 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.

²⁹ First figure in Appendix B.



and tilt the panel in different directions to evaluate the potential for glare onto the air traffic control tower. For the two known cases where a field test was conducted, tower personnel determined the glare was not significant. If there is a significant glare impact, the project can be modified by ensuring panels are not directed in that direction.

- **3. Geometric Analysis** – Geometric studies are the most technical approach for reflectivity issues. They are conducted when glare is difficult to assess through other methods. Studies of glare can employ geometry and the known path of the sun to predict when sunlight will reflect off of a fixed surface (like a solar panel) and contact a fixed receptor (e.g., control tower). At any given site, the sun moves across the sky every day and its path in the sky changes throughout year. This in turn alters the destination of the resultant reflections since the angle of reflection for the solar panels will be the same as the angle at which the sun hits the panels. The larger the reflective surface, the greater the likelihood of glare impacts.
- Facilities placed in remote locations, like the desert, will be far from receptors and therefore potential impacts are limited to passing aircraft. Because the intensity of the light reflected from the solar panel decreases with increasing distance, an appropriate question is how far you need to be from a solar reflected surface to avoid flash blindness. It is known that this distance is directly proportional to the size of the array in question³⁰ but still requires further research to definitively answer.
- **4. 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.

³⁰ 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.



Air Navigation Order (ANO) 2016

In some instances, an aviation stakeholder can refer to the ANO 2016³¹ 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.

(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.

³¹ The Air Navigation Order 2016. [online] Available at: <<https://www.legislation.gov.uk/uksi/2016/765/contents/made>> [Accessed 4 February 2022].



Civil Aviation Authority consolidation of UK Regulation 139/2014

The Civil Aviation Authority (CAA) published a consolidating document³² 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;
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; and
5. non-aeronautical ground light near an aerodrome which may endanger the safety of aircraft and which should be extinguished, screened, or otherwise modified so as to eliminate the source of danger.

³² <https://regulatorylibrary.caa.co.uk/139-2014-pdf/PDF.pdf>



APPENDIX B – OVERVIEW OF GLINT AND GLARE STUDIES

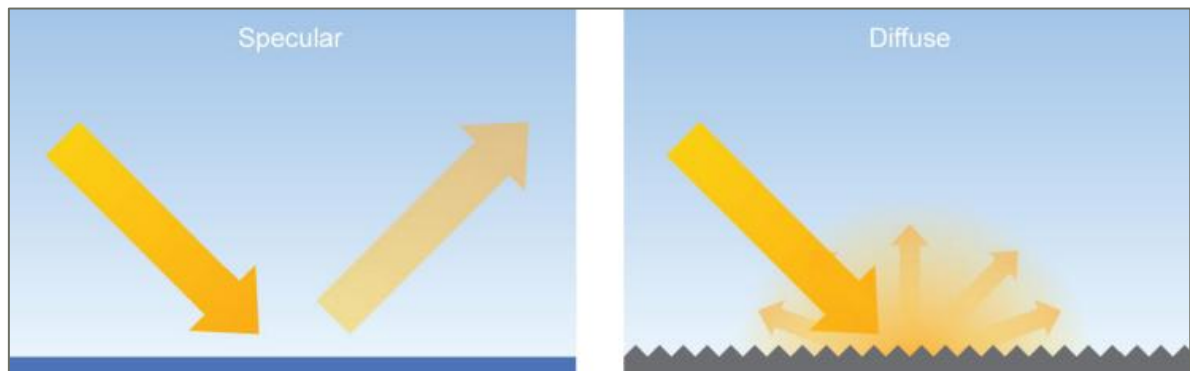
Overview

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 guidance³³, 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

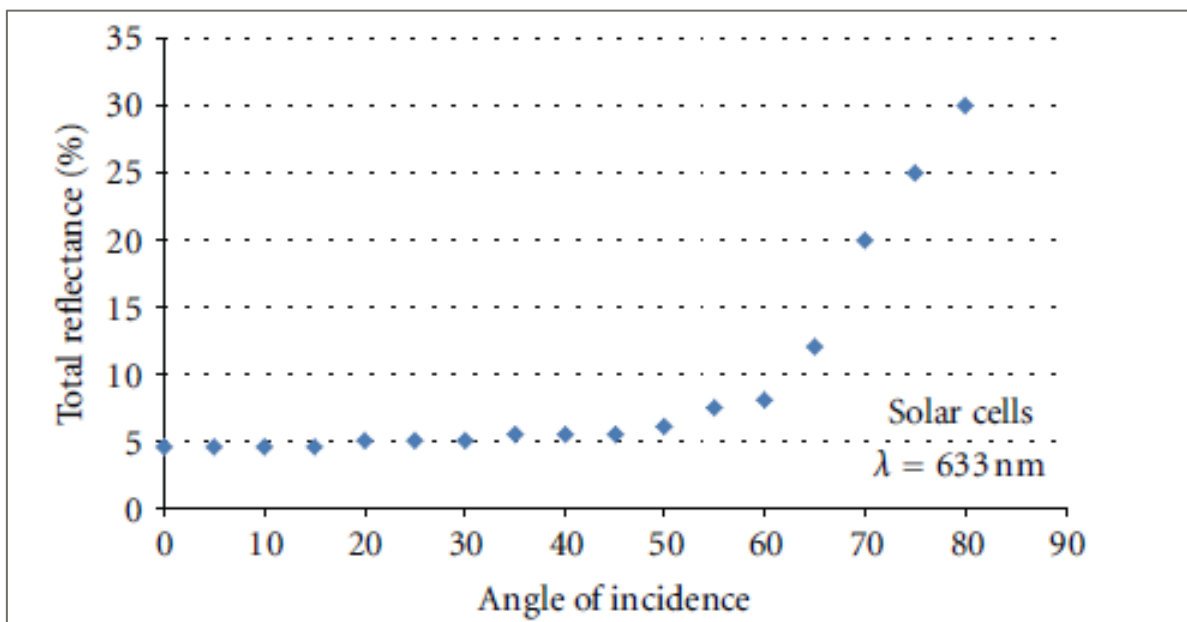
³³Technical Guidance for Evaluating Selected Solar Technologies on Airports, Federal Aviation Administration (FAA), date: 04/2018, accessed on: 08/12/2021.

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*³⁴. 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 reflections % 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.

³⁴ 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”³⁵

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 ³⁶
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.

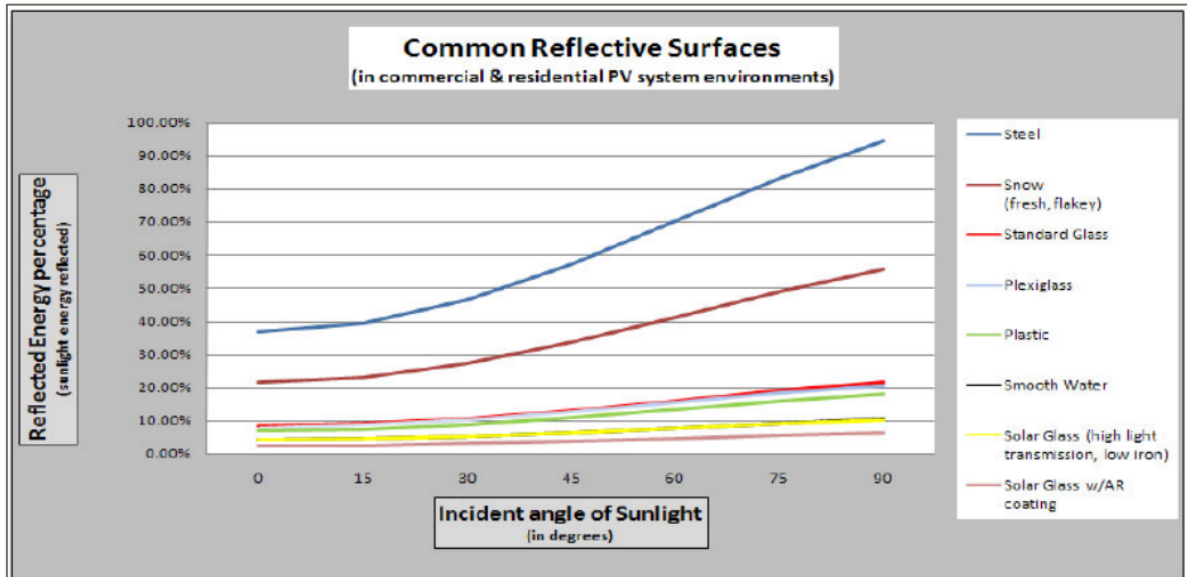
³⁵ Technical Guidance for Evaluating Selected Solar Technologies on Airports, Federal Aviation Administration (FAA), date: 04/2018, accessed on: 20/03/2019.

³⁶ Extrapolated data, baseline of 1,000 W/m² for incoming sunlight.

SunPower Technical Notification (2009)

SunPower published a technical notification³⁷ 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.

³⁷ Source: Technical Support, 2009. SunPower Technical Notification – Solar Module Glare and Reflectance.

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).

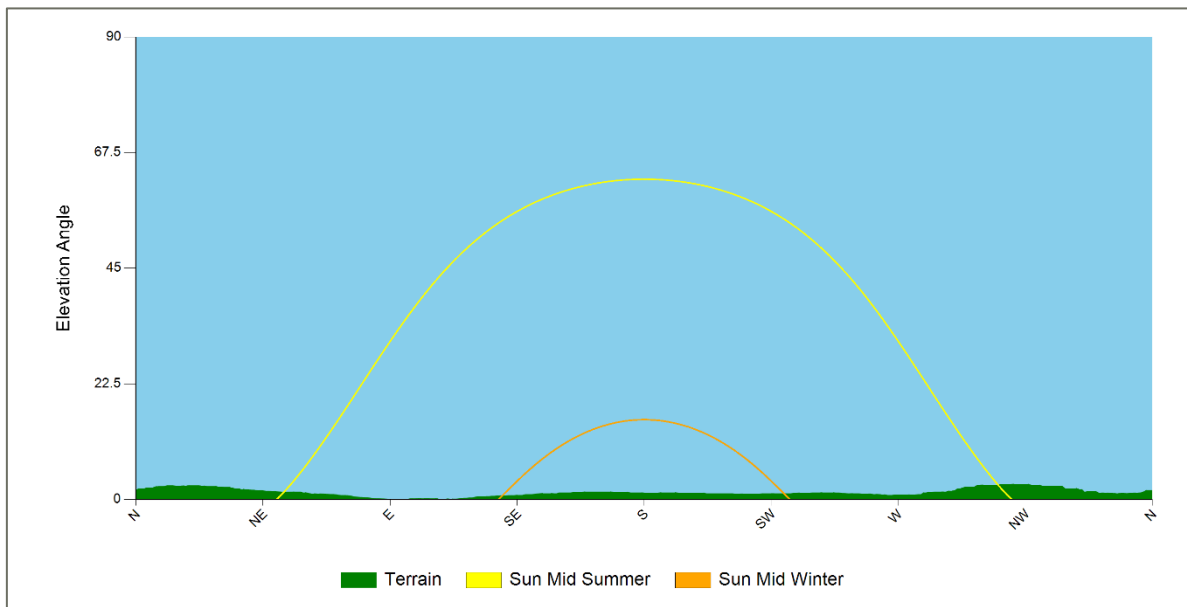
The Sun's position can be accurately calculated for a specific location. The following data being used for the calculation:

- 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.



Terrain at the visible horizon and sun paths

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

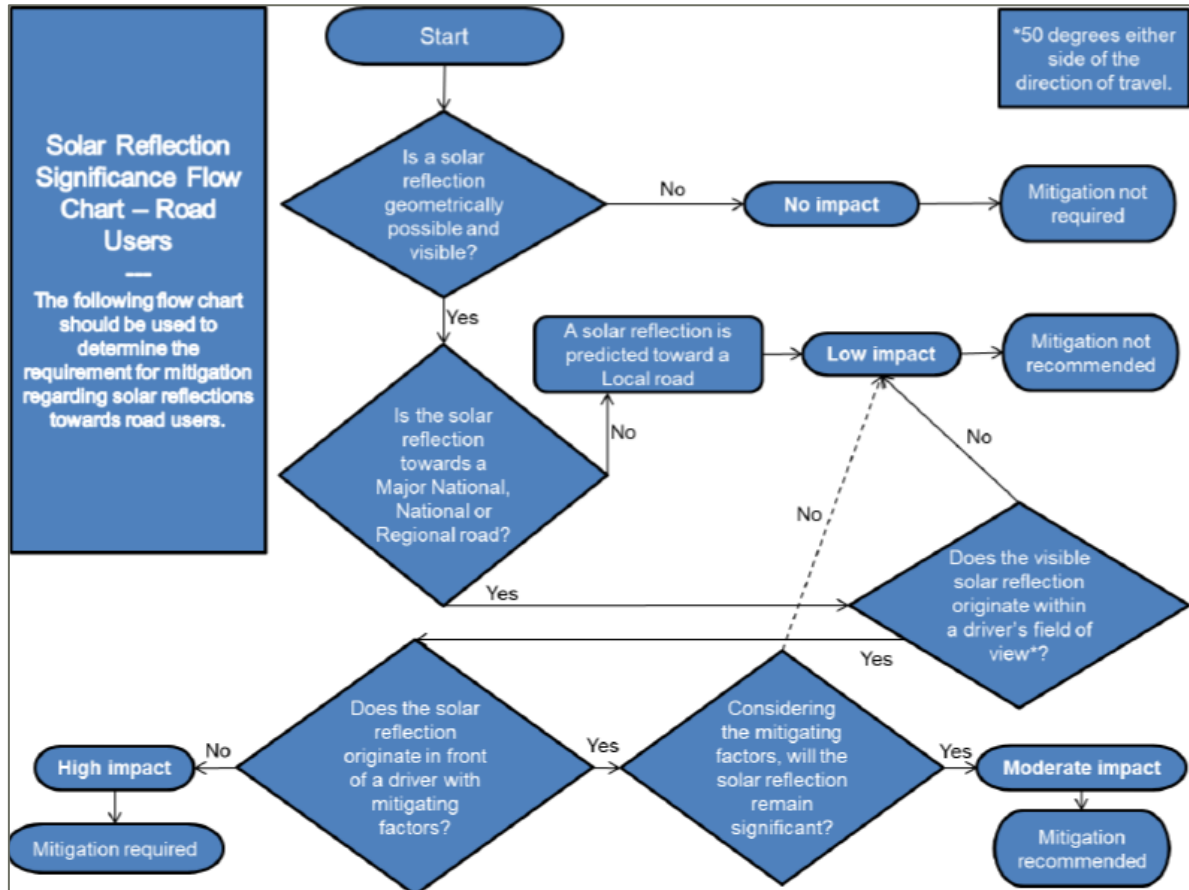
The table below presents the recommended definition of ‘impact significance’ in glint and glare terms and the requirement for mitigation under each.

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

Impact significance definition

Impact Significance Determination for Road Receptors

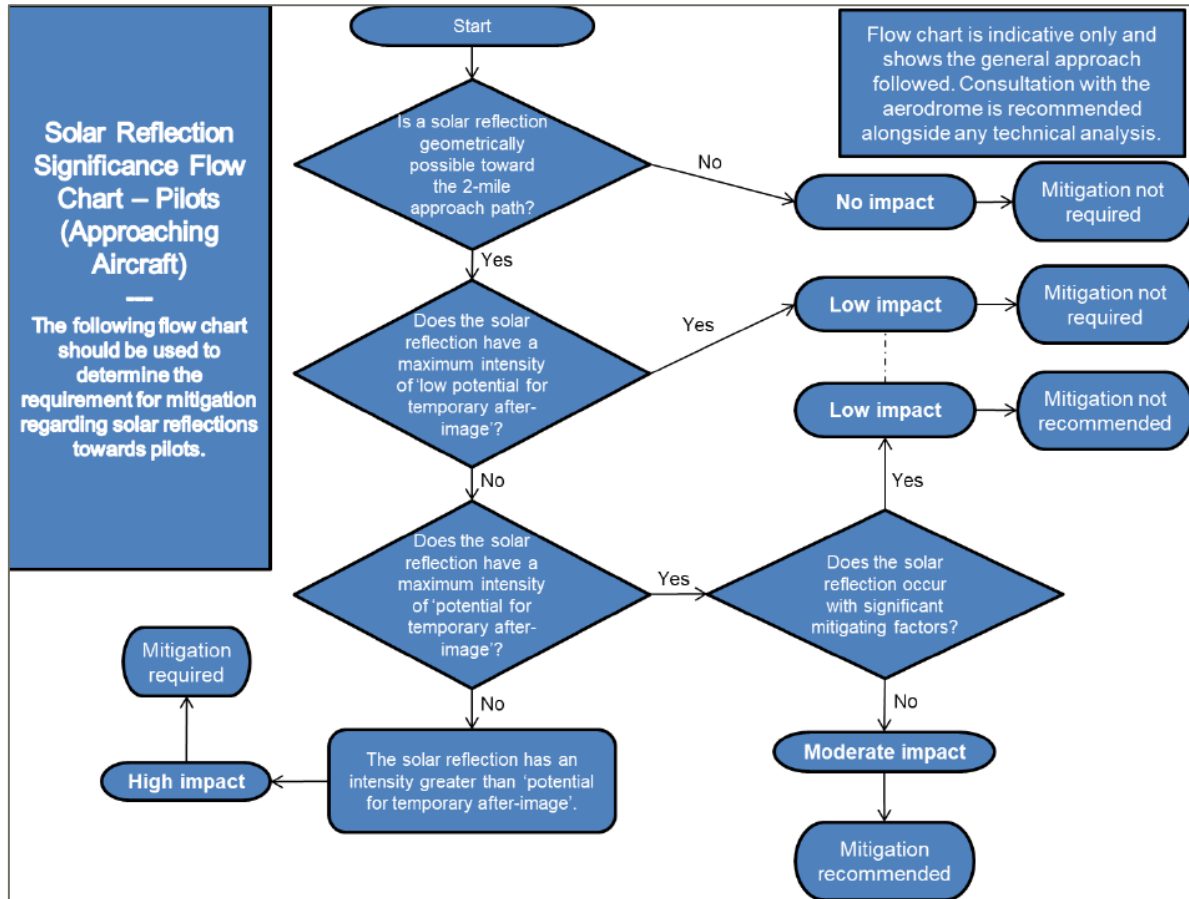
The flow chart presented below has been followed when determining the impact significance for road receptors.



Road receptor impact significance flow chart

Impact Significance Determination for Approaching Aircraft

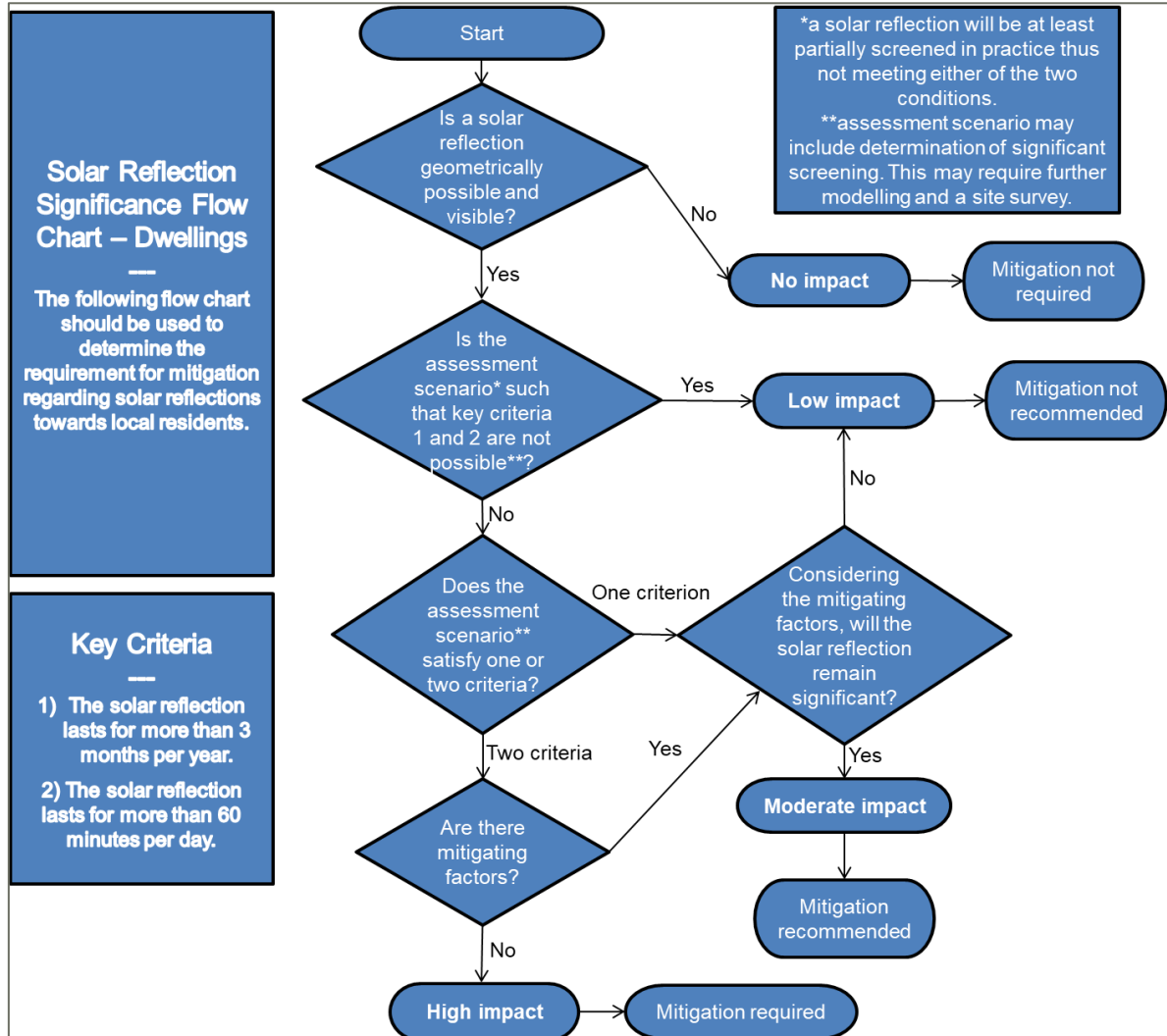
The flow chart presented below has been followed when determining the impact significance and mitigation requirement for approaching aircraft.



Approach path receptor mitigation requirement flow chart

Impact Significance Determination for Dwelling Receptors

The flow chart presented below has been followed when determining the impact significance for dwelling receptors.



Dwelling receptor impact significance flow chart

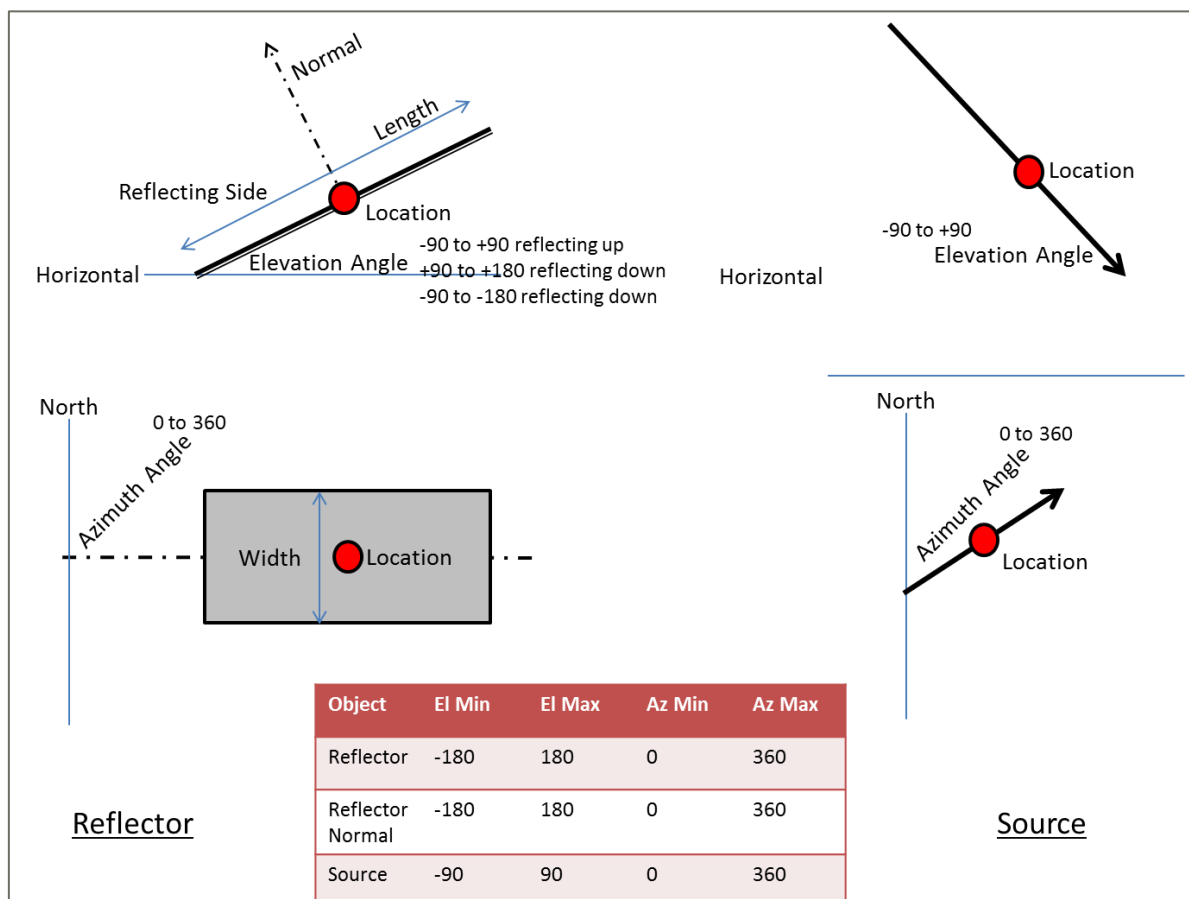
APPENDIX E – REFLECTION CALCULATIONS METHODOLOGY

Pager Power Methodology

The calculations are three dimensional and complex, accounting for:

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

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



Reflection calculation process

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

- Use the Latitude and Longitude of reflector as the reference for calculation purposes;
- Calculate the Azimuth and Elevation of the normal to the reflector;



- Calculate the 3D angle between the source and the normal;
- If this angle is less than 90 degrees a reflection will occur. If it is greater than 90 degrees no reflection will occur because the source is behind the reflector;
- Calculate the Azimuth and Elevation of the reflection in accordance with the following:
 - The angle between source and normal is equal to angle between normal and reflection;
 - Source, Normal and Reflection are in the same plane.



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)³⁸.

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

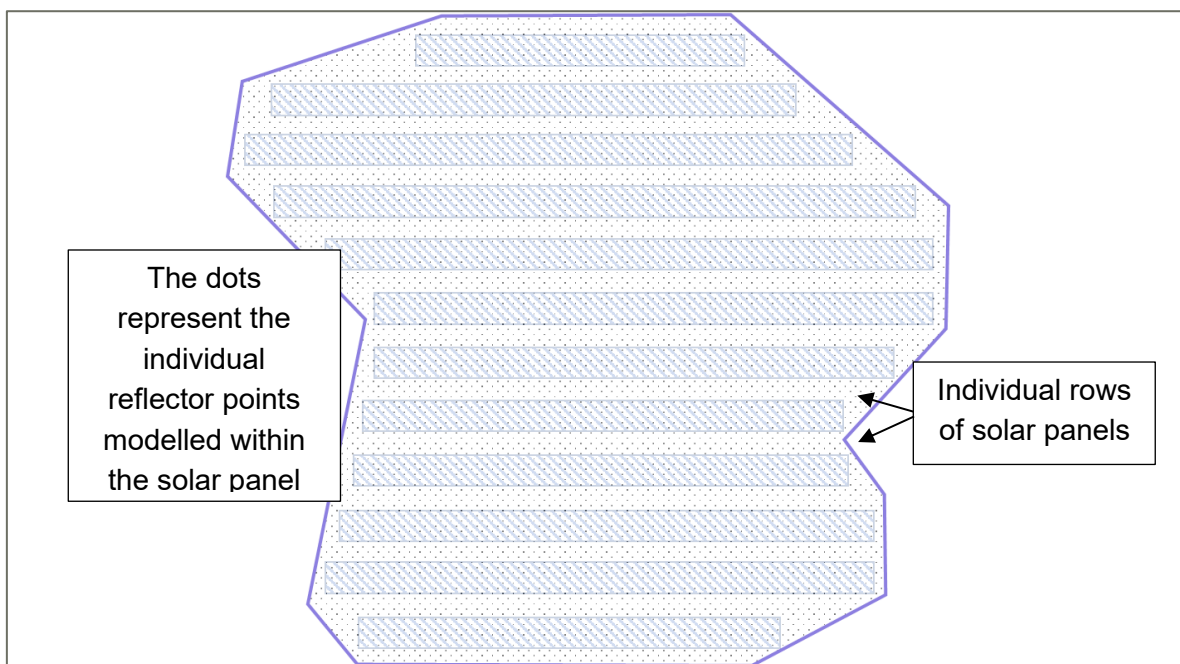
It is assumed that the panel azimuth angle assessed represents the azimuth angle for all of the panels within each solar panel area defined.

Only a reflection from the face of the panel has been considered. The frame or the reverse or 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.

³⁸ 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.

APPENDIX G – RECEPTOR AND REFLECTOR AREA DETAILS

Overview

Coordinate and terrain data has been ascertained based on Ordnance Survey (OS) 50 Digital Terrain Model (DTM) data.

Road Receptor Data

The road receptor data is presented in the table below. An additional 1.5m height has been added to the terrain elevation to account for the eye-level of a road user.

No.	Latitude (°)	Longitude (°)	Assessed Height (m amsl)	No.	Latitude (°)	Longitude (°)	Assessed Height (m amsl)
1	51.10621	-2.15639	193.50	13	51.10861	-2.13963	150.01
2	51.10638	-2.15499	192.50	14	51.10890	-2.13827	150.14
3	51.10657	-2.15359	192.39	15	51.10918	-2.13691	149.50
4	51.10674	-2.15218	190.25	16	51.10944	-2.13554	148.50
5	51.10692	-2.15077	183.64	17	51.10966	-2.13415	143.93
6	51.10711	-2.14937	169.93	18	51.10976	-2.13273	141.50
7	51.10730	-2.14797	160.18	19	51.10976	-2.13130	140.39
8	51.10751	-2.14658	156.23	20	51.10970	-2.12987	140.55
9	51.10772	-2.14518	151.76	21	51.10963	-2.12844	139.64
10	51.10792	-2.14379	151.00	22	51.10960	-2.12701	137.64
11	51.10813	-2.14239	150.73	23	51.10963	-2.12557	138.66
12	51.10835	-2.14100	150.78	24	51.10965	-2.12478	139.61

Road receptor data

Dwelling Receptor Data

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

No.	Latitude (°)	Longitude (°)	Assessed Height (m amsl)	No.	Latitude (°)	Longitude (°)	Assessed Height (m amsl)
1	51.10821	-2.14654	156.65	10	51.11102	-2.13046	145.34
2	51.10850	-2.14551	157.31	11	51.10987	-2.12809	140.42
3	51.10844	-2.14252	152.52	12	51.11037	-2.12720	139.93
4	51.10863	-2.14195	152.93	13	51.10988	-2.12702	138.24
5	51.10882	-2.13053	147.26	14	51.10992	-2.12613	139.34
6	51.10989	-2.12990	141.26	15	51.10938	-2.12715	138.50
7	51.11024	-2.12985	142.48	16	51.10948	-2.12673	138.76
8	51.11055	-2.12970	145.44	17	51.10995	-2.12529	139.60
9	51.11087	-2.12987	149.13	18	51.10973	-2.12492	139.80

Dwelling receptor data

Modelled Reflector Area

The vertices of the modelled reflector area are presented in the table below.

No.	Latitude (°)	Longitude (°)	No	Latitude (°)	Longitude (°)
1	-2.14150	51.10942	9	-2.14179	51.11031
2	-2.14123	51.10942	10	-2.14301	51.10974
3	-2.13896	51.11049	11	-2.14318	51.10959
4	-2.13915	51.11082	12	-2.14307	51.10942
5	-2.13962	51.11120	13	-2.14279	51.10942
6	-2.13988	51.11120	14	-2.14206	51.10949
7	-2.14138	51.11051	15	-2.14159	51.10949
8	-2.14116	51.11031			

Panel Area Coordinates

APPENDIX H – DETAILED MODELLING RESULTS

Overview

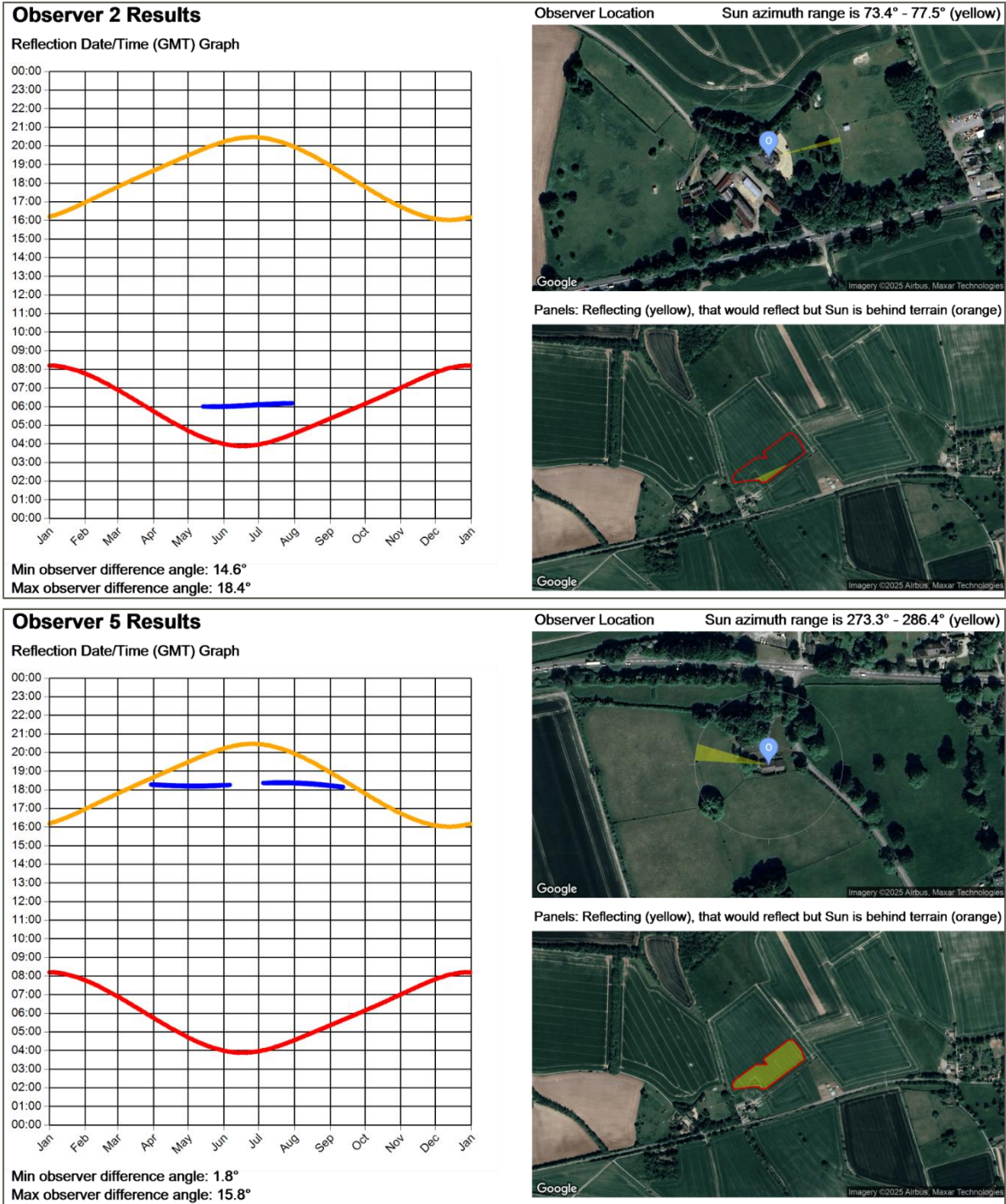
The Pager Power charts for a selection of representative receptors are shown on the following pages. Each chart shows:

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

Full modelling results for all receptors can be provided upon request.

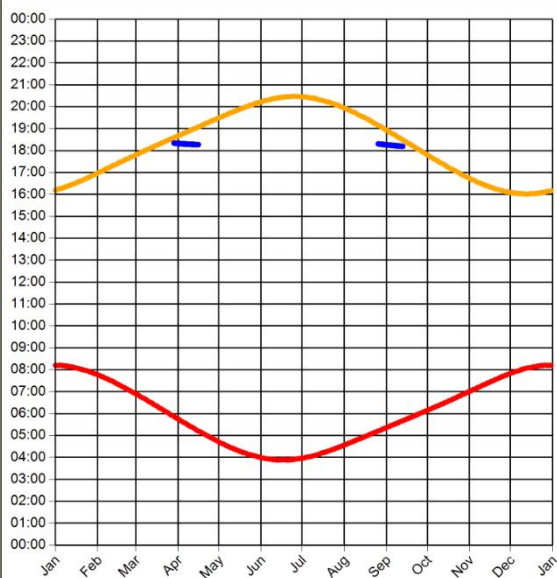
Dwelling Receptors

Results have been included for a selection of representative receptors



Observer 11 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 0.3°
Max observer difference angle: 5.5°

Observer Location Sun azimuth range is 273.6° - 278.2° (yellow)

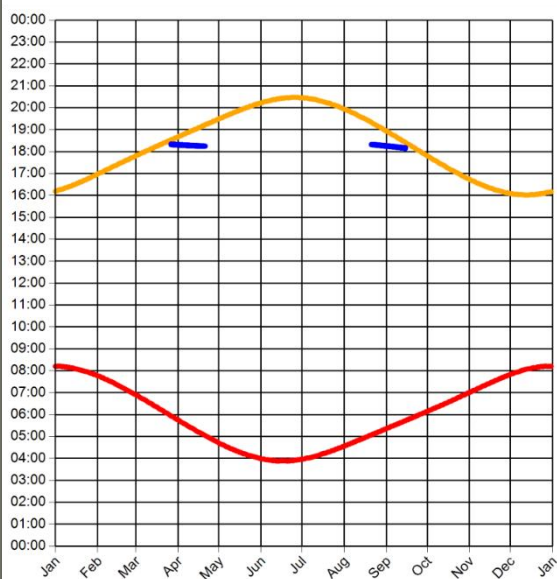


Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)



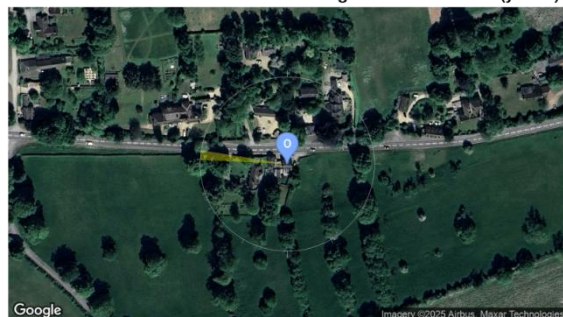
Observer 16 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 0.2°
Max observer difference angle: 7°

Observer Location Sun azimuth range is 272.9° - 279.2° (yellow)

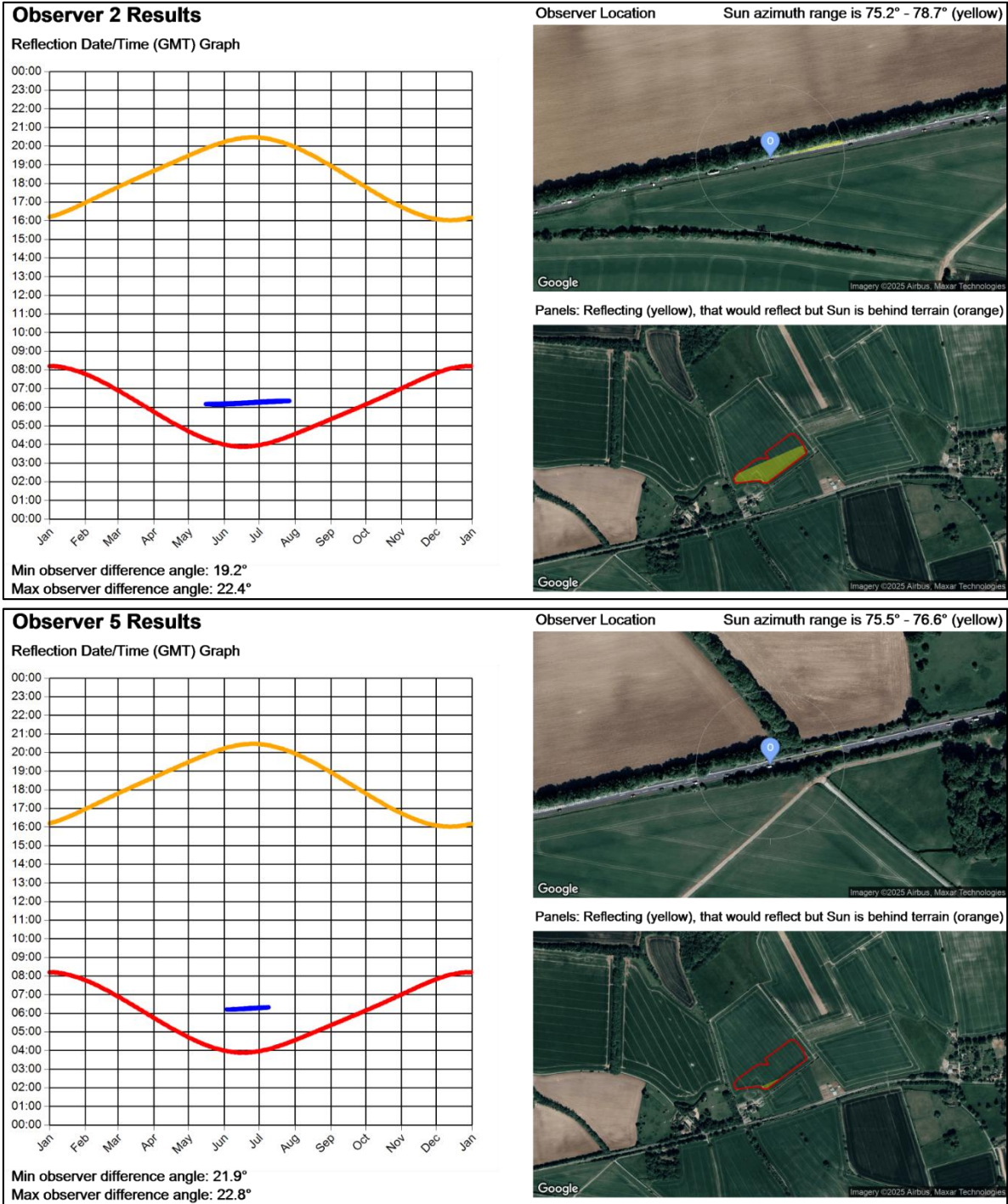


Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)



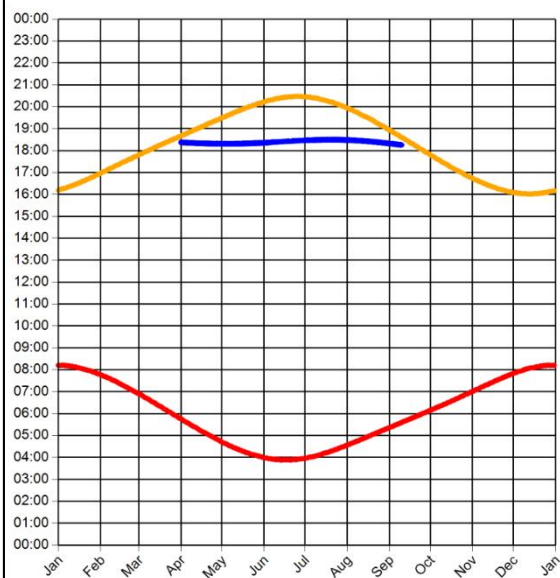
Road Receptors

Results have been included for a selection of representative receptors



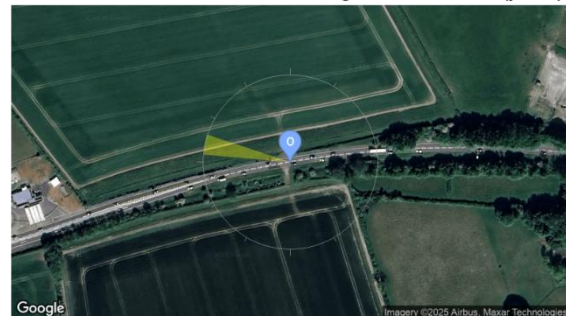
Observer 17 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 0.2°
Max observer difference angle: 13.7°

Observer Location Sun azimuth range is 274.9° - 288.3° (yellow)

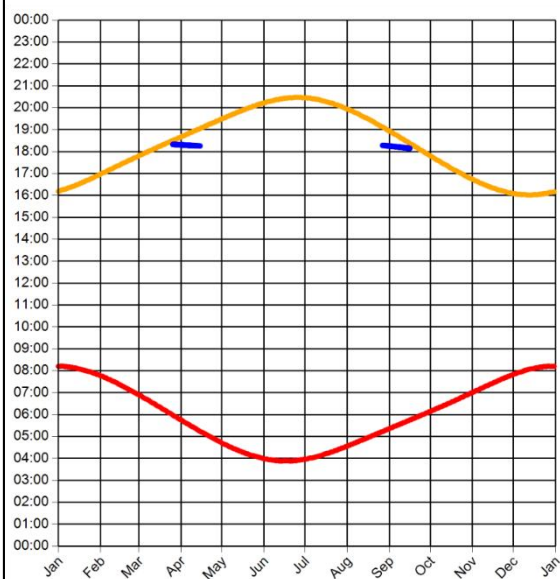


Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)



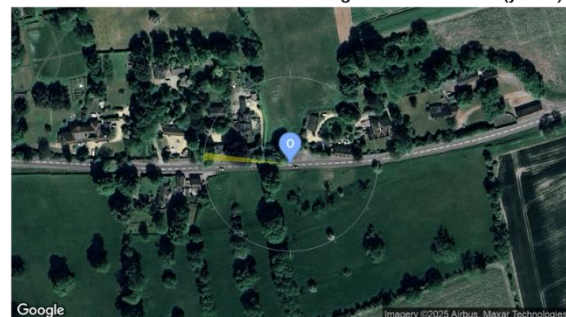
Observer 23 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 0.2°
Max observer difference angle: 5.7°

Observer Location Sun azimuth range is 272.6° - 277.7° (yellow)



Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)





Pager Power Limited
Stour Valley Business Centre
Sudbury | Suffolk | CO10 7GB
T +44 (0)1787 319001 | E info@pagerpower.com
www.pagerpower.com

Registered in England No. 3487347