



NARRABRI SOLAR FARM

GLINT AND GLARE ASSESSMENT REPORT FINAL ISSUE

Prepared For
Y.E.S. GROUP (SA) PTY LTD

July 2025



Prepared By Environmental Ethos
for Y.E.S. Group (SA) Pty Ltd

REF NO. 25005

FINAL ISSUE: 25/07/2025

Cover Image: John Carnemolla

This disclaimer, together with any limitations specified in the proposal, apply to use of this report. This report was prepared in accordance with the scope of services for the specific purpose stated and subject to the applicable cost, time and other constraints. In preparing this report, Environmental Ethos relied on: (a) client/third party information which was not verified by Environmental Ethos except to the extent required by the scope of services, and Environmental Ethos does not accept responsibility for omissions or inaccuracies in the client/third party information; and (b) information taken at or under the particular times and conditions specified, and Environmental Ethos does not accept responsibility for any subsequent changes. This report has been prepared solely for use by, and is confidential to, the client and Environmental Ethos accepts no responsibility for its use by other persons. This proposal is subject to copyright protection and the copyright owner reserves its rights. This proposal does not constitute legal advice.

CONTENTS

EXECUTIVE SUMMARY	2
1. INTRODUCTION	3
1.1. Location	3
2. SCOPE OF THE ASSESSMENT	4
3. METHODOLOGY	5
3.1. Glint and Glare Definitions.....	5
3.2. Solar glare Assessment Parameters	5
3.3. Viewshed Analysis	5
3.4. Solar Glare Hazard Analysis.....	5
3.5. Glare Intensity Categories.....	6
3.6. Reflection and Angle of Incidence.....	7
3.7. Sensitive Receptors.....	9
3.8. Hazard Assessment.....	11
3.9. Limitations to the assessment	11
4. EXISTING CONDITIONS	12
4.1. Baseline Conditions	12
4.2. Atmospheric Conditions	12
5. PROJECT DESCRIPTION	12
5.1. PV modules.....	12
5.2. Horizontal single axis tracking system.....	13
5.3. Associated infrastructure.....	14
6. DESKTOP GLARE ASSESSMENT	14
6.1. Viewshed Analysis	14
6.2. Solar Glare Hazard Analysis.....	14
6.3. Solar Glare Hazard Analysis Tool (SGHAT) Results.....	16
7. MANAGEMENT AND MITIGATION MEASURES.....	16
8. SUMMARY	17
APPENDIX A:	18

EXECUTIVE SUMMARY

The proposed Narrabri Solar Farm comprises of the installation and operation of a 4.95MWac solar farm, located approximately 7km east of Narrabri, within the Narrabri Shire Council Local Government Area.

The structure of the solar farm will be a single axis horizontal tracking system with PV arrays running north/south. The PV arrays will be approximately 1.8 metres high, to centroid.

This glint and glare impact assessment utilised the Solar Glare Hazard Analysis Tool (SGHAT version 2025C) in conjunction with a viewshed analysis, to undertake the glare modelling which is the basis for the impact assessment methodology.

The glint and glare assessment has been undertaken in accordance with the NSW Government's Large-scale Solar Energy Design Guideline (2024), including assessment of the following:

- All residential receivers with 3km of the proposed solar arrays with line of sight to the Project;
- All roads and rail lines within 1km of the proposed solar array; and
- All air traffic control towers and take off/landing approaches to any runway or landing strip within 5km of the proposed solar array.

Based on the assumptions and parameters of this desktop assessment, the following results were identified:

- The SGHAT modelling identified no glare is geometrically possible affecting rural dwellings within 3km of the Project, therefore no impact is likely.
- The SGHAT modelling identified no glare is geometrically possible affecting the local roads within 1km of the Project, therefore no impact is likely.
- The SGHAT modelling identified no glare is geometrically possible affecting the flight paths to the four runways at Narrabri Airport, up to a distance of 2 nautical miles, therefore no impact is likely.
- The assessment identified no railway infrastructure within 1km of the Project.

Management and mitigation measures recommended in this assessment include:

- The Project Environmental Management Plan (EMP) should detail glare management measures, including the parameters detailed in this report. In addition, the EMP should detail a process for monitoring glare hazard and managing possible complaints.
- The Project plans to use bifacial panels, which capture diffused light from the back of the panels. Whilst diffuse light reflection is considered unlikely to generate glare, SGHAT modelling is limited to analysing the more intense specular (direct) light reflection. Due to the model limitation it is recommended the Project EMP also include monitoring of diffuse reflection.

1. INTRODUCTION

This report has been prepared by Environmental Ethos on behalf of Y.E.S Group (SA) Pty Ltd to assess the potential solar glint and glare impact of the proposed Narrabri Solar Farm (the Project), located at 742 Stoney Creek Road, Narrabri, NSW (the Project). The Project comprises of the installation and operation of a 4.95MWac solar farm.

The Project site is located on Lot 3 DP1034554 and covers an area of approximately 9 hectares. The structure of the solar farm will be a single axis horizontal tracking system with PV arrays running north/south.

This glint and glare assessment has been undertaken with reference to the Large-scale Solar Energy Design Guideline (NSW Government, 2024¹), including assessment of the following:

- All residential receivers with 3km of the proposed solar arrays with line of sight to the Project;
- All roads and rail lines within 1km of the proposed solar array; and
- All air traffic control towers and take off/landing approaches to any runway or landing strip within 5km of the proposed solar array.

1.1. Location

The Project site is located approximately 7 kilometres (km) east of Narrabri, within the Narrabri Shire Council Local Government Area, *refer Figure 1*.

The site is zoned RU1 Primary Production and is currently used for grazing. Primary production, including cropping and grazing, is the predominant land use in the surrounding area.

One local road (Stoney Creek Road) runs east-west, approximately 900m from the Projects northern boundary.

There are no railway lines within a 1km radius of the Project site.

Narrabri Airport is located approximately 3.8 km to the west of the Project site, the flight paths to the runways were included in the assessment. Narrabri Airport does not have an operating control tower on site.

¹ Large-Scale Solar Energy Guideline, Updated 2024, NSW Government



Figure 1. Location Plan

2. SCOPE OF THE ASSESSMENT

The scope of this Glint and Glare Impact Assessment includes the following:

- Description of the methodology used to undertake the study;
- Assessment of the baseline conditions;
- Description of the elements of the Project with the potential to influence glare including size, height, angle and rotation of PV modules, and tracking system operation;
- Identification of the viewshed and potential visibility of the Project;
- Desktop mapping of potential glare at the location of sensitive receptors within the viewshed, based on Solar Glare Hazard Analysis and viewshed analysis;
- Assessment of the potential glare hazard affecting sensitive receptors during operation of the Project; and
- Assessment of potential mitigations measures to avoid, mitigate, or manage potential impacts.

3. METHODOLOGY

3.1. Glint and Glare Definitions

Glint and glare refers to the human experience of reflected light.

This study utilises the Solar Glare Hazard Analysis Tool (SGHAT) software developed in the USA to address policy adherence required for the 2013 U.S. Federal Aviation Administration (FAA) Interim Policy 78 FR 63276. The FAA definitions of glint and glare are as follows:

“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.”²

This definition of glint and glare is consistent with the NSW Guidelines definition:

“Glint (a momentary flash of light) and glare (a continuous, excessive brightness)”.

For the purpose of this study the term ‘glare’ is used in reference to both glint and glare resulting from direct solar reflectivity from PV modules, measurable in duration over minutes (1 minute intervals throughout the year).

3.2. Solar glare Assessment Parameters

Solar glare assessment modelling for solar farms is based on the following factors:

- the tilt, orientation, and optical properties of the PV modules in the solar array;
- sun position over time, taking into account geographic location;
- the location of sensitive receivers (dwellings, roads, rail, and aviation facilities); and
- Screening potential of surrounding topography, vegetation and buildings.

3.3. Viewshed Analysis

The desktop assessment begins with a viewshed analysis, undertaken using ArcGIS 3D, to determine the extent of visibility of the proposed solar farm and the location of sensitive receptors (dwellings, roads, etc.) with line of sight to the solar arrays. The desktop viewshed analysis is based on topography only and does not take into consideration obstructions to potential views of the Project such as existing vegetation. Sensitive receptors such as dwellings and roads that are not within the viewshed i.e. are screened from the Project by topography, will not be impacted by glare and can be excluded from the second phase of the assessment, which is the solar glare hazard analysis.

3.4. Solar Glare Hazard Analysis

This assessment has utilised the Solar Glare Hazard Analysis Tool (SGHAT version 2025C) co-developed by Sandia National Laboratory³ and ForgeSolar (Sim Industries) (referred to as GlareGauge) to assess potential glare utilising latitude and longitudinal coordinates, elevation, sun position, and vector calculations. If potential glare is identified by the model, the tool calculates the retinal irradiance and subtended angle

² Federal Aviation Administration, Version 1.1 April 2018, Technical Guidance for Evaluating Selected Solar Technologies on Airports

³ https://share.sandia.gov/phlux/static/references/glint-glare/SGHAT_Technical_Reference-v5.pdf

(size/distance) of the glare source to predict potential ocular hazards according to glare intensity categories (refer *Section 3.5*). The software is widely used in the industry for this purpose.

The SGHAT is a high level tool and does not take into consideration the following factors:

- Gaps between PV modules; and
- Atmospheric conditions.

3.5. Glare Intensity Categories

The potential hazard from solar glare is a function of retinal irradiance (power of electromagnetic radiation per unit area produced by the sun) and the subtended angle (size, distance, and geometry) of the glare source.⁴

SGHAT software broadly classifies glare into three categories: low potential for after-image (referred to as “Green Glare” in SGHAT), potential for after-image (referred to as “Yellow Glare” in SGHAT), and potential for permanent eye damage (referred to as “Red Glare” in SGHAT), *Figure 2* illustrates the glare intensity categories used in this study.

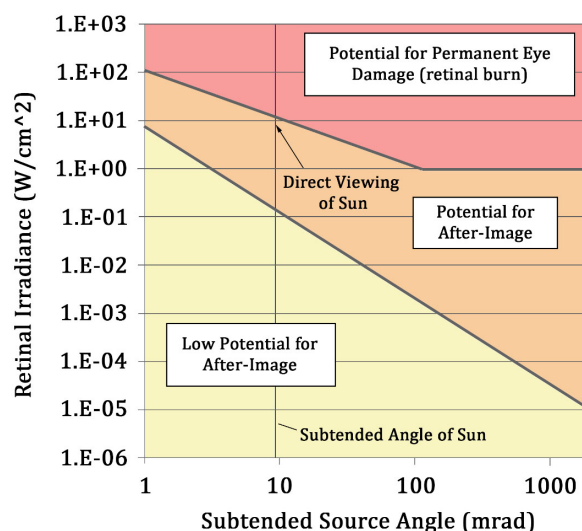


Figure 2. Ocular impacts and Hazard Ranges⁵

The Large-scale Solar Energy Design Guideline does not distinguish between different glare intensity categories, instead the Guideline focuses on the type of receptor and the significance of glare impacts. Potential glare impacts to motorists and pilots are considered a safety risk and the Guideline requires that glare should ‘not pose a significant risk’, performance objectives are to ‘eliminate the occurrence of glare’, or ‘alternatively, the applicant must demonstrate that glare would not significantly impede the safe operation of vehicles or the interpretation of signals and signage’.

The Guideline considers glare impacts to residential receivers as ‘nuisance’ and performance objectives are detailed in relation to the duration of glare over a day and a year.

⁴ HO, C.K., C.M. Ghanbari, and R.B. Diver, 2011, Methodology to Assess Potential Glint and Glare hazards from Concentrated Solar Power Plants

⁵ Source: Solar Glare Hazard Analysis Tool (SGHAT) Presentation (2013)
https://share.sandia.gov/phlux/static/references/glint-glare/SGHAT_Ho.pdf

3.6. Reflection and Angle of Incidence

PV modules are designed to maximise the absorption of solar energy and therefore minimise the extent of solar energy reflected. PV modules have low levels of reflectivity between 0.03 and 0.20 depending on the specific materials, anti-reflective coatings, and angle of incidence.

The higher reflectivity values of 0.20, that is 20% of incident light being reflected, can occur when the angle of incidence is greater than 50°. Figure 3 and 4 show the relationship between increased angles of incidence and increased levels of reflected light. Where the angle of incidence remains below 50° the amount of reflected light remains below 10%.

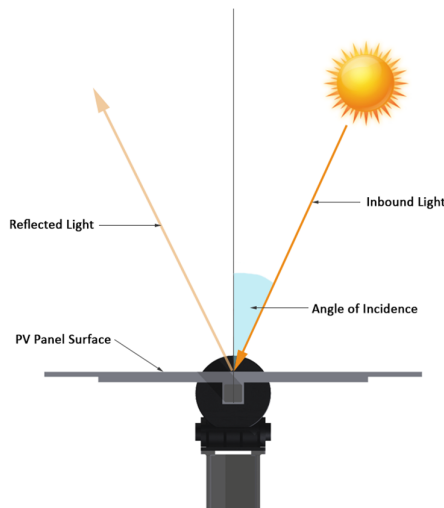


Figure 3. Angle of Incidence Relative to PV Panel Surface

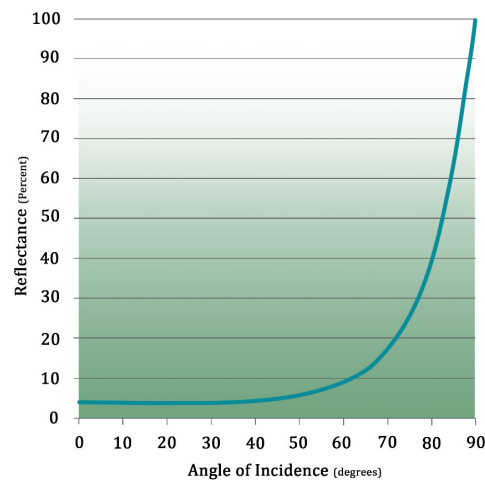


Figure 4. Angles of Incidence and Increased Levels of Reflected Light (Glass (n=1.5))

When the PV array is mounted on a tracking system, the variation in angle of incidence and therefore reflected light, is reduced because the panel is rotated to remain perpendicular to the sun. PV modular arrays using a tracking system has less potential to cause glare whilst it tracks the sun. *Figure 5* illustrates a PV module mounted horizontal single axis tracking system following the east to west path of the sun.

A single axis tracking system has a fixed maximum angle of rotation, once the tracking mechanism reaches this maximum angle, the PV modules position relative to the sun becomes fixed and therefore the angle of incidence increases and the potential for glare increases. Most tracking systems utilise a backtracking procedure (early morning and late afternoon) whereby the tracking system begins to rotate away from the sun to reduce shadow casting to adjoining PV panels, *refer Figure 6*. During the backtracking phase, higher angles of incidence will occur in comparison to the tracking phase, and this may increase the potential for glare.

Tracking systems operate from a set resting angle, resting angles define the final angle at the beginning and end of the backtracking cycle. Generally resting angles range between 0 and 30 degrees, depending on the type of system used and the site requirements. A slight angle (5 degrees) is commonly used to allow rain and dew to sheet off the panels, some systems use higher angles in more extreme climatic conditions.

Shallow resting angles increase the angle of incidence between the sun and PV model, therefore the shallower the angle the more likely glare may occur.

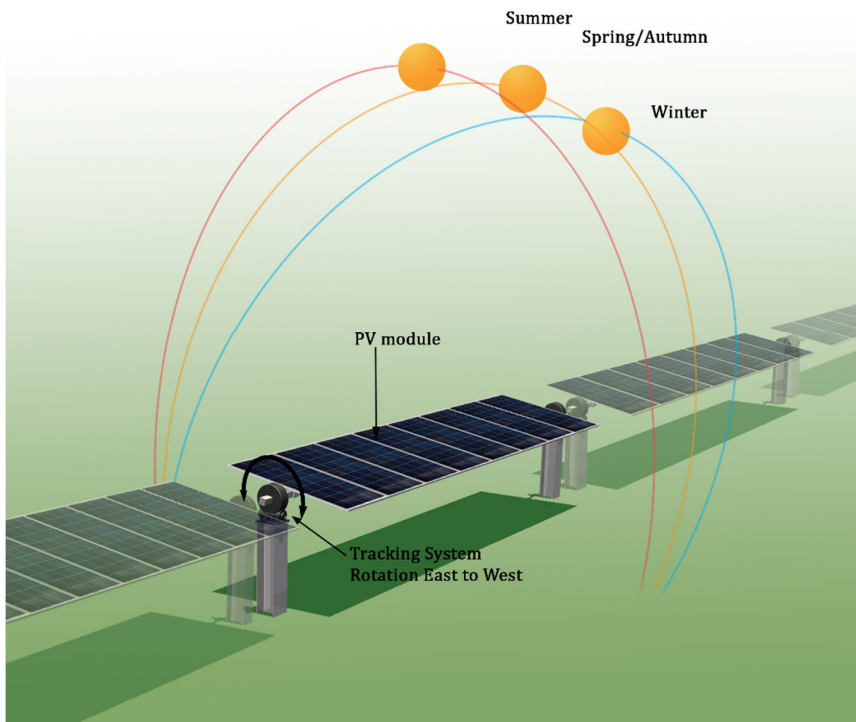


Figure 5. Diagrammatic illustration of sun position relative to PV module mounted on a horizontal single axis tracking system.

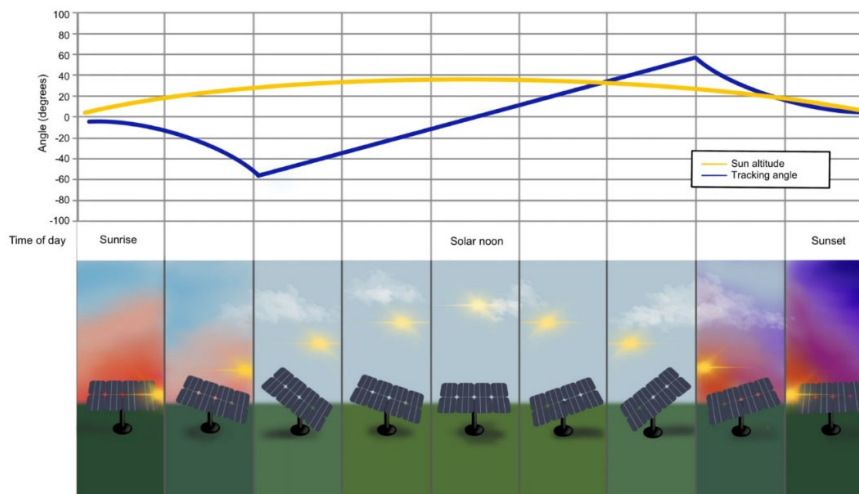


Figure 6. Diagrammatic illustration of a backtracking procedure for a horizontal single axis tracking system. (Source: ForgeSolar).

3.7. Sensitive Receptors

The Guideline requires the consideration of glare impact on the following sensitive receptors:

- All residential receivers with 3km of the proposed solar arrays with line of sight to the Project;
- All roads and rail lines within 1km of the proposed solar array; and
- All air traffic control towers and take off/landing approaches to any runway or landing strip within 5km of the proposed solar array.

Residential Receivers

In SGHAT modelling residential receivers are simulated as an observer at a single, discrete location, defined by a latitude, longitude, elevation, and height above ground, referred to as an Observation Point receptor ("OP"). Each residential receiver (OP) is subscribed a unique number in the modelling. The Guideline require all residential receivers to be assessed at a height of 1.5 m above ground level. The associated (host) properties were included in this assessment.

Roads and Rail

The Guideline requires 'solar glare analysis to identify whether glint and glare are geometrically possible within the forward looking eyeline of motorists and rail operators'. SGHAT modelling includes the parameters of direction of travel (single or both directions) and field-of-view (FOV). FOV defines the left and right field-of-view of observers traveling along a route. A view angle of 50° means the observer has a field-of-view of 50° to their left and right, i.e. a total FOV of 100°, refer *Figure 7*.

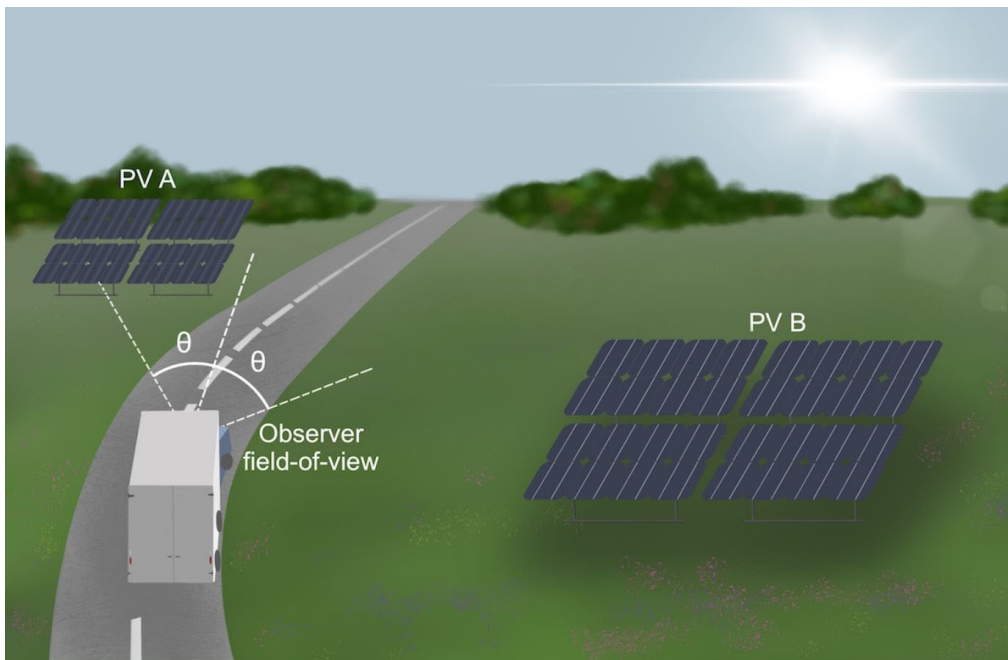


Figure 7. Diagrammatic illustration of Observer Field of View relative to PV array (source: ForgeSolar).

The SGHAT default parameter of FOV 50° was used in the glare modelling.

The modelling used a height above ground for the driver's eye height of 2.4m, which is the driver's eye height of a large vehicle such as a truck. An elevated eye height above the height of the PV panels represents a more conservative parameter.

Flight Path Parameters

SGHAT utilises a 2 mile flight path formula that simulates an aircraft following a straight-line approach path towards a runway, refer *Figure 8*.

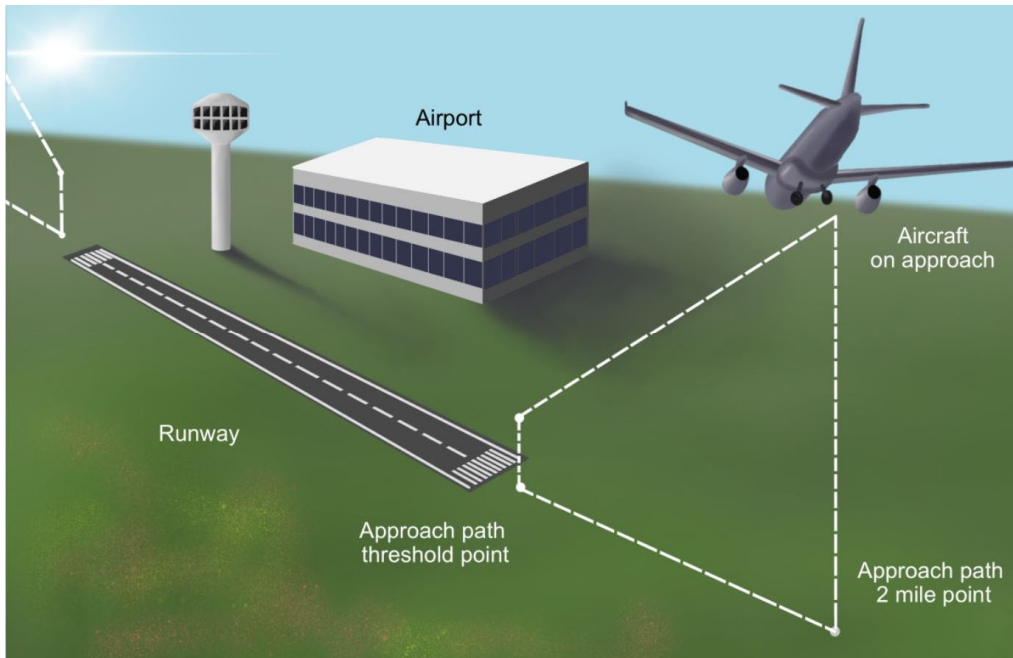


Figure 8. Diagrammatic illustration of SHGAT flight parameters (source: Forgesolar).

Airport specific flight path parameters were not available for this assessment, therefore SGHAT default parameters were used including glide slope 3° and threshold crossing height of 15 metres.

The pilot's field of view (FOV) from the cockpit can be set within the model. The vertical FOV of the pilot, measures positive downward angles from the approach path vector. Values range from 0° to 90°, where 90° implies no downward restriction. A default value of 30° assumes glare appearing beyond the corresponding FOV is mitigated. The default 30° vertical view was used in the assessment.

Azimuthal viewing angle, left and right field-of-view of the pilot during approach, range from 0° to 180°. A view angle of 180° implies the pilot can see glare emanating from behind the plane. A view angle of 50° (default) implies the pilot has a FOV of 50° to their left and right during approach, i.e. a total FOV of 100°, refer *Figure 9*. The default 50° Azimuthal view was used in the assessment.

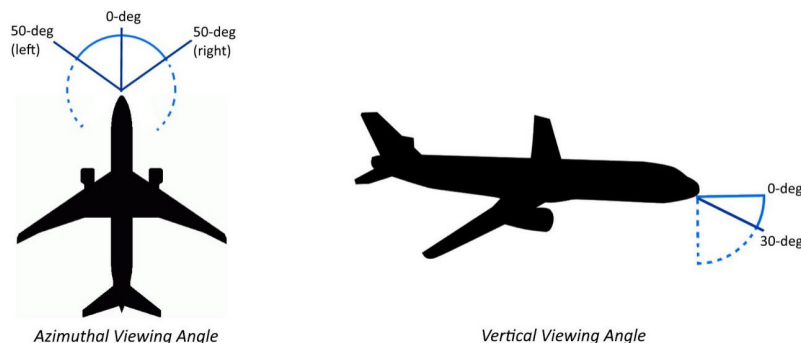


Figure 9. Diagrammatic illustration of Pilot's field of view (FOV) parameters (source: Forgesolar).

3.8. Hazard Assessment

Once the potential for solar glare has been identified through the viewshed analysis and SGHAT, which is based on topography only, an assessment of the likelihood of glare hazard occurring is undertaken, taking into consideration existing mitigating factors such as existing vegetation, buildings, and minor topographic variations outside the parameters of the modelling. Embedded mitigation measures, such as proposed vegetation screens to be undertaken as part of the Project, are also considered to identify residual glare potential.

The results are assessed against the performance objectives of the Guidelines including:

- *Demonstrate that glint and glare would not pose a significant risk to motorists or pilots*
- *Nuisance from glare is minimised for residential locations*

Impact rating and performance objectives for glare impacts to residential dwellings is based on duration and does not take into consideration the intensity categories defined in SGHAT. Therefore all glare is considered in total per day and per year. The duration and corresponding impact criteria are detailed in Table 1 below:

Table 1: NSW Guideline Impact rating and performance objectives for glare impacts to residential dwellings

High glare impact	Moderate glare impact	Low glare impact
> 30 minutes per day > 30 hours per year	< 30 minutes & > 10 minutes per day < 30 hours & > 10 hours per year	< 10 minutes per day < 10 hours per year
Significant amount of glare that should be avoided.	Implement mitigation measures to reduce impacts as far as practicable.	No mitigation required.

Where required, additional mitigation measures, beyond those previously considered as part of the Project, are recommended to avoid, reduce or manage the identified risks.

3.9. Limitations to the assessment

This desktop assessment is based on a geometric analysis of potential glare using SGHAT software modelling. The parameters of the modelling are based on the default values within the software. Where these values have been altered (generally increased), this has been noted in the assessment.

The assessment considers potential impacts of solar glare under normal operational procedures, potential impacts during construction and non-operational events have not been assessed.

Field tests has not been undertaken as part of the assessment, therefore the modelling is reliant on the algorithms contained in the software.

SGHAT software is used under license to Sims Industries d/b/a ForgeSolar, refer to assumptions and limitations listed in the data output (Appendices) and for further information refer to www.forgesolar.com/help/.

Environmental Ethos does not verify the accuracy of the SGHAT software modelling. Responsibility and accountability for the accuracy of the SGHAT software (GlareGauge) resides with Sims Industries d/b/a ForgeSolar.

4. EXISTING CONDITIONS

The baseline is a statement of the characteristics which currently exist in the Project area. The baseline glare condition assessment takes into consideration the following:

- Characteristics of the environment that may affect the potential for glare;
- Land use and human modifications to the landscape such as roads, buildings and existing infrastructure which may influence glare and sensitivity to glare.

4.1. Baseline Conditions

The Project covers an area of relatively flat cleared grazing land. The surrounding landscape is also generally flat grazing land, with some cropping areas to the north. To the south the topography rises to low hills which support native vegetation. Patches of remnant vegetation remains within the grazing areas and along road corridors.

Rural dwellings are scattered throughout the landscape, many are surrounded by shade trees and rural buildings.

Small farm dams are located within some rural properties. Visibility of these water bodies is generally limited.

Narrabri Airport is within 5km of the Project and was included in the assessment.

4.2. Atmospheric Conditions

Atmospheric conditions such as cloud cover, dust and haze will impact light reflection, however these factors have not been accounted for in this glare assessment. The Bureau of Meteorology statistics for Barraba (Clifton Lane) 71km east of the Project site (the closest BOM records for cloud cover statistics) recorded 94.6 cloudy days per year (mean number over the period 1966 to 2010)⁶. Cloudy days predominantly occur during the winter months, May to July. Since atmospheric conditions have not been factored into this assessment modelling, statistically the glare potential represents a conservative assessment.

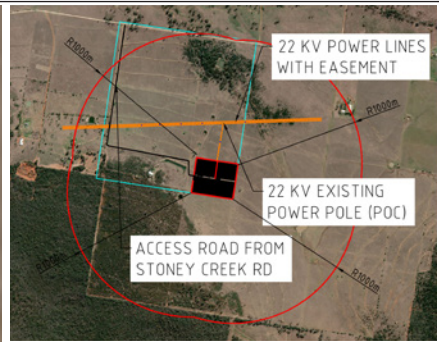
5. PROJECT DESCRIPTION

The general layout of the Project is as shown in *Figure 10*. The main elements of the solar farm with the potential to influence glare are the tilt, orientation, and optical properties of the PV modules in the solar array, and the rotational capabilities of the system. Whilst specific products are yet to be determined for the Project, the general technical properties of the main elements influencing glare are described below.

5.1. PV modules

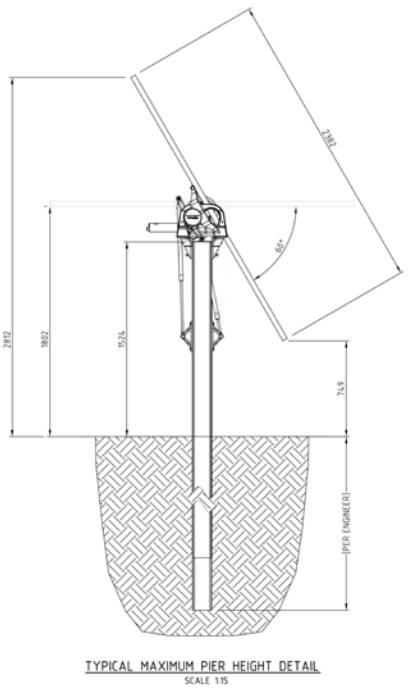
Bifacial PV modules aligned in portrait layout are currently proposed for the Project (each generally 2.4m x 1.3m). Reflectance values for the PV modules were based on the default values for smooth glass with anti-reflective coating contained in SGHAT, and vary dependent on the sun/module incidence angle (refer *Figure 11*).

⁶ http://www.bom.gov.au/climate/averages/tables/cw_054003.shtml



LEGEND

- PROPOSED PV ARRAY
- SECURITY FENCE
- PROPERTY BOUNDARY
- 22 kV POWER LINES



SOURCE: Y.E.S. Group (SA) Pty Ltd
SITE PLAN
REV. B 19/03/2025

PROJECT NO. 25005
CREATED BY: SC
DATE: 23 07 2025
VERSION: **A**

NARRABRI SOLAR FARM

GLINT AND GLARE IMPACT
ASSESSMENT

**PROJECT LAYOUT
PLAN**

FIGURE
10.0

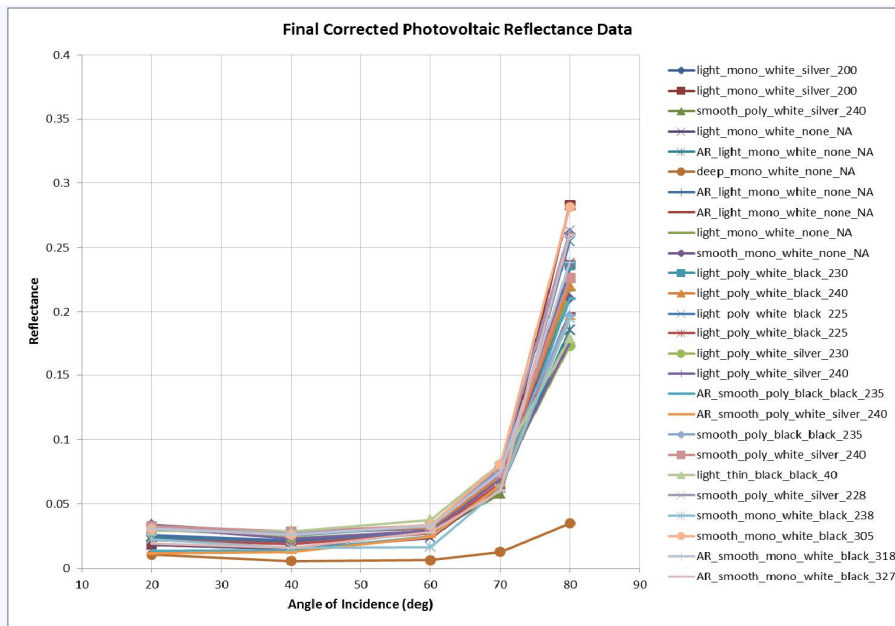


Figure 11. Photovoltaic Reflectance Data (Source Yellowhair⁷)

Bifacial PV panels include glass on the underside of the panels and are capable of absorbing indirect or diffuse sunlight, thereby increasing energy harvesting. Unlike reflectance from the top side of the panels which receive direct sunlight, the rays of indirect or diffuse sunlight captured by the underside of the panels are “scattered” and the resulting light reflection is similarly scattered. The intensity of indirect light reflection is significantly lower than direct sunlight reflection. Since the back of the panels do not receive direct sunlight, specular reflection will not occur.

This assessment focuses on the potential impact of direct sunlight reflection from the topside of the panels, which is the more intense type of reflection.

5.2. Horizontal single axis tracking system

The Project will use a horizontal single axis tracking system, with a tracking axis orientation of 8° and a maximum rotation range of 120° (+/- 60°). The zenith tilt angle of the panels was assumed to be set at zero, that is, the panels are not tilted on a north–south alignment but remain horizontal along the plane of the tracker.

The height of the PV tracking system will depend on the final design, the current proposal is a maximum height to centroid of 1.8m and maximum height at full rotation 2.8m.

The configuration of the tracking system rows vary slightly dependent on the type of system used, a ground cover ratio (defined as ratio between the PV module area and total ground area) of 0.5 (50%) was used in the modelling.

⁷ Yellowhair, J. and C.K. Ho. "Assessment of Photovoltaic Surface Texturing on Transmittance Effects and Glint/Glare Impacts". ASME 2015 9th International Conference on Energy Sustainability collocated with the ASME 2015 Power Conference

5.3. Associated infrastructure

In addition to the PV arrays, the Project will also include a central inverter and battery energy storage container. These elements do not generally create specular reflection as they comprise of non-reflective surfaces typically found in the built environment.

6. DESKTOP GLARE ASSESSMENT

The aim of the desktop glare assessment is to identify if any sensitive receptors have the potential to be impacted by glare. The software modelling systems used in the desktop assessment include viewshed modelling to identify the location of sensitive receptors with line of sight to the Project, and the SGHAT to identify the potential and ocular significance of glare.

6.1. Viewshed Analysis

The results of the viewshed analysis (based on topography) are shown in *Figure 12*.

The Digital Elevation Model (DEM) for the viewshed modelling was set as 'Finest' (> 10 m). The viewshed analysis focussed on potential visibility of the Project within 3km of the site.

Contour information for the site shows the Project site and land to the north is generally flat, with low hills to the south of the Project. The hills limit views of the Project from the south and south west.

9 residential receivers were identified within the viewshed, with line of sight to the Project, including 1 associated dwelling. In addition 3 residential receivers to the west of the Project just outside the viewshed were also included in the glare modelling. All residential receiver locations shown in *Figure 12* are consistent with the observation points (OP) in the glare modelling.

The following road passes through the viewshed within 1km of the Project site and this was included in the glare modelling (both directions of travel) as follows:

- Stoney Creek Road

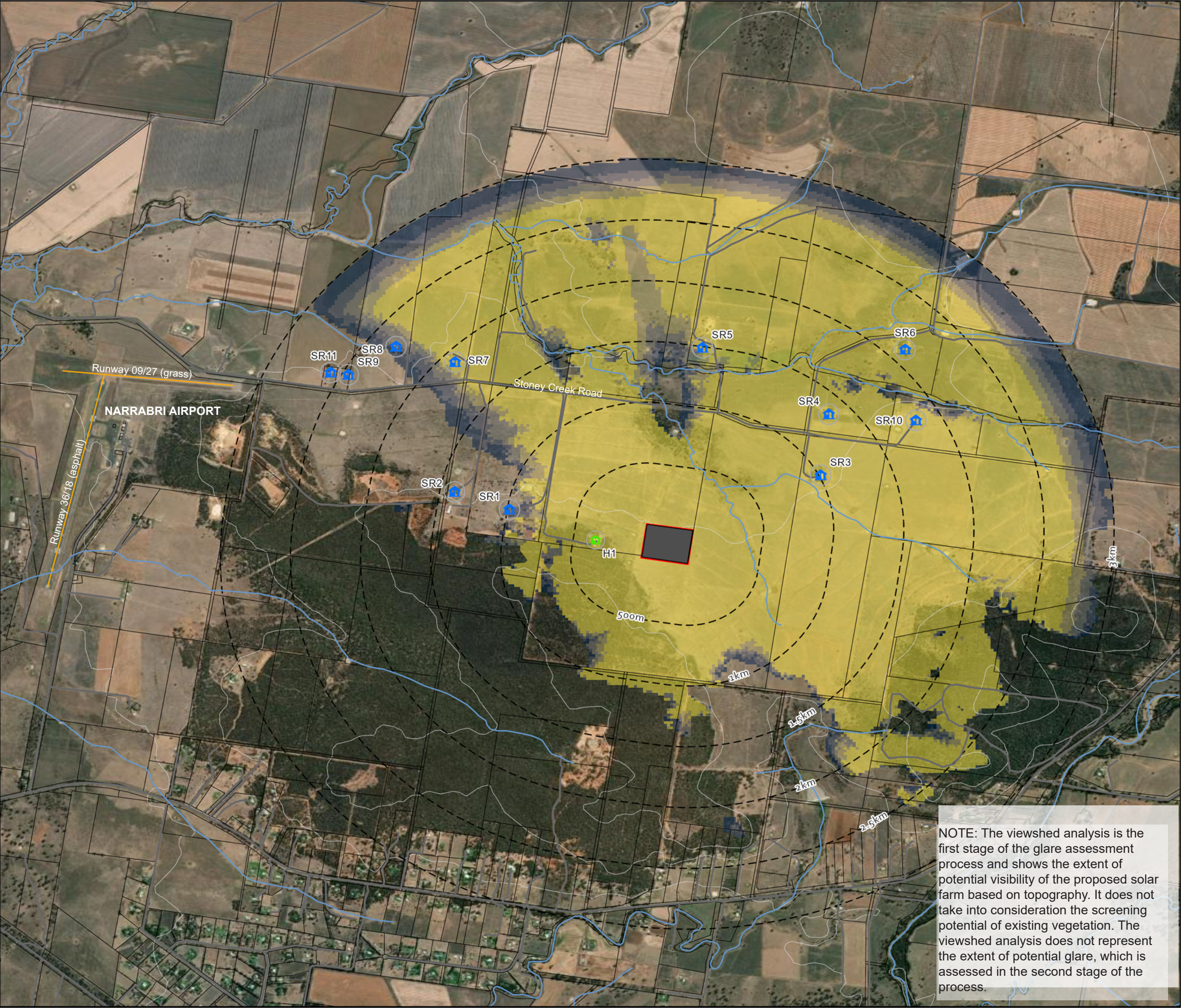
The potential glare hazard impact for travellers for the section of road within a minimum 1km radius of the Project site was assessed in accordance with the NSW Guideline.

Narrabri Airport is located approximately 3.8km to the west of the Project site, the four flight paths to the two runways were included in the glare modelling (to a distance of 2 nautical miles) as follows:

- Runway 09: alignment 95°, surface grass
- Runway 27: alignment 275°, surface grass
- Runway 18: alignment 193°, surface asphalt
- Runway 36: alignment 1°, surface asphalt

6.2. Solar Glare Hazard Analysis

The parameters used in the SGHAT model are detailed in *Table 2*.



DATUM GDA 1994,
PROJECTION MGA ZONE 56



SCALE 1:30,000 @ A3 Kilometers

Legend

- SITE BOUNDARY
- PV MODULE AREA
- DISTANCE FROM SOLAR FARM
- AIRPORT RUNWAYS
- ROADS
- DWELLINGS (NON-ASSOCIATED)
- DWELLINGS (ASSOCIATED)
- EXTENT OF VISIBILITY*
- LESS VISIBLE
- LESS VISIBLE
- LESS VISIBLE
- MORE VISIBLE

*(Analysis based on Digital Terrain Model)

*RURAL DWELLING LOCATIONS BASED
ON DESKTOP ASSESSMENT
GROUND-TRUTHING EXCLUDED

PROJECT No. 25005
CREATED BY: SC
DATE: 20 07 2025
VERSION: A

NARRABRI SOLAR FARM

GLINT AND GLARE ASSESSMENT

VIEWSHED ANALYSIS

FIGURE
12.0

Table 2. Input data for SGHAT Analysis – Single Axis Tracking System

SGHAT Model Parameters	Values
Time Zone	UTC +10
Axis Tracking	Horizontal Single Axis
Backtracking	Shade (flat land)
Tilt of tracking axis	0 (Parallel to ground)
Orientation of tracking axis	8 degrees
Offset angle of module	0
Module Surface material	Smooth glass with anti-reflective coating (ARC)
Maximum tracking angle	60 degrees
Resting (Stowing) angle	5 degrees
Reflectivity	Vary with sun
Correlate slope error with surface type?	Yes
Slope error	8.43 mrad
Height of panels above ground	1.8m to centroid

SGHAT modelling includes tracking and backtracking operations based on generic parameters. The maximum rotation angle of the tracking system was set at $\pm 60^\circ$ and the minimum resting angle was set at 5° (being the fixed angle at which the backtracking process starts and finishes during daylight hours).

The general alignment of the rotation angle over time is plotted in the Component Data File. An outline of the typical rotation angles for the model's tracking/backtracking data for summer and winter solstice is outlined in Figures 13 and 14.

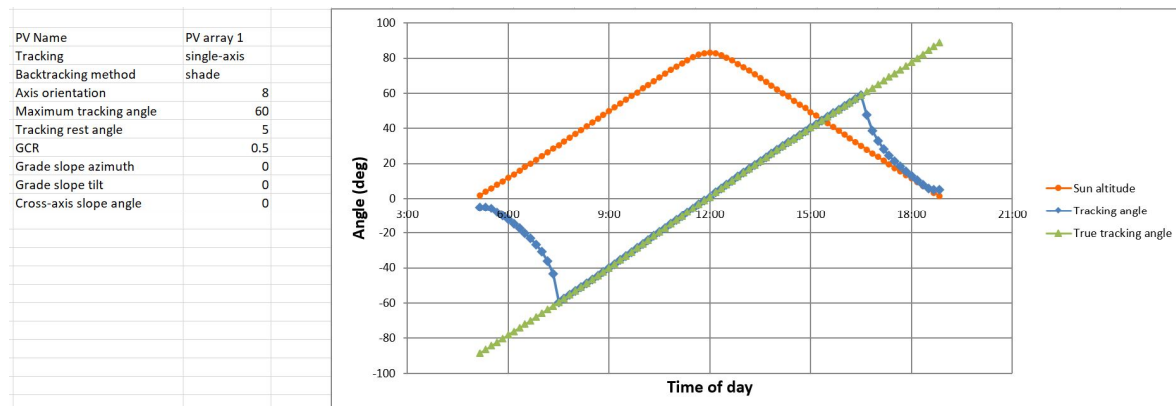


Figure 13. Tracking/backtracking angle per time slot – mid summer

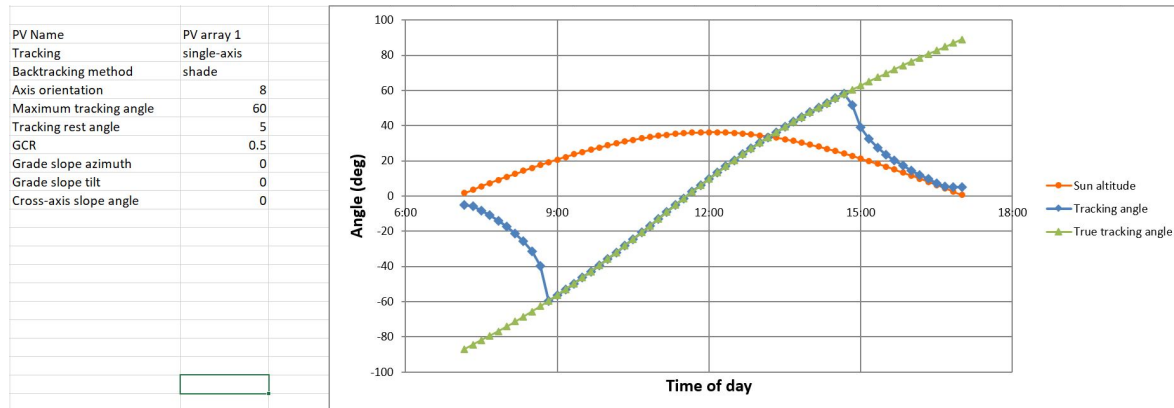


Figure 14. Tracking/backtracking angle per time slot – mid winter

6.3. Solar Glare Hazard Analysis Tool (SGHAT) Results

The assessment outcomes for the SGHAT modelling are detailed in *Appendix A* and outlined in *Table 3*.

Table 3. SGHAT Assessment Results – Horizontal Single Axis Tracking System

Sensitive Receptor	Glare Potential
Observation Points OP1 to OP12 - Rural dwellings	No Glare
Stoney Creek Road	No Glare
Narrabri Airport Runway 09 Flight Path	No Glare
Narrabri Airport Runway 18 Flight Path	No Glare
Narrabri Airport Runway 27 Flight Path	No Glare
Narrabri Airport Runway 36 Flight Path	No Glare

The SGHAT modelling identifies that under normal operation of the solar farm, based on the model parameters, no glare hazard is geometrically possible affecting sensitive receptors as defined in the Large-scale Solar Energy Design Guideline, *refer Appendix A*.

7. MANAGEMENT AND MITIGATION MEASURES

The SGHAT modelling identified that under normal operation of the solar farm tracking system, with a backtracking operation and minimum limit of 5 degree resting angle, no additional mitigation measures are required to manage the potential impacts of glare on receivers.

The Project Environmental Management Plan (EMP) should detail glare management measures required to avoid impacts to receivers, including the tracking and backtracking parameters detailed in this report. In addition, monitoring of glare hazard potential is required and a process for managing complaints, including rectification, should be included in the Project EMP.

The Project plans to use bifacial panels, which capture diffused light from the back of the panels. Whilst diffuse light reflection is considered unlikely to generate glare, SGHAT modelling is limited to analysing the more intense specular (direct) light reflection. Due to the model limitation it is recommended the Project EMP also include monitoring of diffuse reflection.

8. SUMMARY

In summary, based on the assumptions and parameters of this desktop assessment, the following results were identified:

- The SGHAT modelling identified no glare is geometrically possible affecting rural dwellings within 3km of the Project, therefore no impact is likely.
- The SGHAT modelling identified no glare is geometrically possible affecting the local roads within 1km of the Project, therefore no impact is likely.
- The SGHAT modelling identified no glare is geometrically possible affecting the flight paths to the four runways at Narrabri Airport, up to a distance of 2 nautical miles, therefore no impact is likely.
- The assessment identified no railway infrastructure within 1km of the Project.

APPENDIX A:

SOLAR GLARE HAZARD ANALYSIS RESULTS

FORGESOLAR GLARE ANALYSIS

Project: **Narrabri Solar Farm**

Site configuration: **Narrabri Solar Farm**

Created 23 Jul, 2025

Updated 25 Jul, 2025

Time-step 1 minute

Timezone offset UTC10

Minimum sun altitude 0.0 deg

DNI peaks at 2,000.0 W/m²

Category 1 MW to 5 MW

Site ID 155499.26030

Ocular transmission coefficient 0.5

Pupil diameter 0.002 m

Eye focal length 0.017 m

Sun subtended angle 9.3 mrad

PV analysis methodology V2



Summary of Results No glare predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	
PV array 1	SA tracking	SA tracking	0	0.0	0	0.0	-

Total glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Stoney Creek Road	0	0.0	0	0.0
Runway 09	0	0.0	0	0.0
Runway 18	0	0.0	0	0.0
Runway 27	0	0.0	0	0.0
Runway 36	0	0.0	0	0.0
OP 1 (SR1)	0	0.0	0	0.0
OP 2 (SR2)	0	0.0	0	0.0
OP 3 (SR3)	0	0.0	0	0.0
OP 4 (SR4)	0	0.0	0	0.0
OP 5 (SR5)	0	0.0	0	0.0
OP 6 (SR6)	0	0.0	0	0.0
OP 7 (SR7)	0	0.0	0	0.0
OP 8 (SR8)	0	0.0	0	0.0
OP 9 (SR9)	0	0.0	0	0.0
OP 10 (SR10)	0	0.0	0	0.0

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 11 (SR11)	0	0.0	0	0.0
OP 12 [H1 Associated dwelling]	0	0.0	0	0.0

Component Data

PV Arrays

Name: PV array 1
Axis tracking: Single-axis rotation
Backtracking: Shade
Tracking axis orientation: 8.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Ground Coverage Ratio: 0.5
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-30.327741	149.870971	264.95	1.80	266.75
2	-30.325290	149.871368	260.40	1.80	262.20
3	-30.324836	149.867982	261.45	1.80	263.25
4	-30.327286	149.867587	267.98	1.80	269.78

Route Receptors

Name: Stoney Creek Road
Path type: Two-way
Azimuthal view angle: 50.0°
Downward view angle: 90.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-30.314106	149.854675	243.86	2.40	246.26
2	-30.315079	149.861949	246.33	2.40	248.73
3	-30.316551	149.872979	249.23	2.40	251.63
4	-30.316644	149.873633	250.10	2.40	252.50
5	-30.316931	149.874341	251.18	2.40	253.58
6	-30.317533	149.875843	251.67	2.40	254.07
7	-30.317607	149.876229	252.28	2.40	254.68
8	-30.318070	149.879959	256.05	2.40	258.45
9	-30.318403	149.881182	256.21	2.40	258.61
10	-30.319015	149.885860	260.15	2.40	262.55

Flight Path Receptors

Name: Runway 09

Description:

Threshold height: 15 m

Direction: 95.0°

Glide slope: 3.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	-30.313785	149.828917	228.12	15.24	243.36
Two-mile	-30.311265	149.795514	215.01	197.04	412.04

Name: Runway 18

Description:

Threshold height: 15 m

Direction: 193.0°

Glide slope: 3.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	-30.314129	149.827616	226.53	15.24	241.77
Two-mile	-30.285955	149.835148	232.00	178.45	410.45

Name: Runway 27

Description:

Threshold height: 15 m

Direction: 275.0°

Glide slope: 3.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	-30.314504	149.837210	238.44	15.24	253.68
Two-mile	-30.317024	149.870614	249.72	172.64	422.36

Name: Runway 36

Description:

Threshold height: 15 m

Direction: 13.0°

Glide slope: 3.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	-30.329611	149.823461	219.61	15.24	234.85
Two-mile	-30.357782	149.815917	217.75	185.78	403.53

Discrete Observation Point Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	-30.323696	149.857750	264.28	1.50
OP 2	2	-30.322381	149.853829	260.47	1.50
OP 3	3	-30.321127	149.880812	259.27	1.50
OP 4	4	-30.316593	149.881469	256.92	1.50
OP 5	5	-30.311689	149.872043	248.21	1.50
OP 6	6	-30.311803	149.887136	258.23	1.50
OP 7	7	-30.312609	149.853747	241.94	1.50
OP 8	8	-30.311655	149.849316	239.41	1.50
OP 9	9	-30.313745	149.845795	241.55	1.50
OP 10	10	-30.317147	149.887914	259.69	1.50
OP 11	11	-30.313537	149.844506	241.29	1.50
OP 12	12	-30.325948	149.864237	269.11	1.50

Glare Analysis Results

Summary of Results No glare predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV array 1	SA tracking	SA tracking	0	0.0	0	0.0	-

Total glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Stoney Creek Road	0	0.0	0	0.0
Runway 09	0	0.0	0	0.0
Runway 18	0	0.0	0	0.0
Runway 27	0	0.0	0	0.0
Runway 36	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0

PV: PV array 1 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Stoney Creek Road	0	0.0	0	0.0
Runway 09	0	0.0	0	0.0
Runway 18	0	0.0	0	0.0
Runway 27	0	0.0	0	0.0
Runway 36	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0

PV array 1 and Route: Stoney Creek Road

No glare found

PV array 1 and FP: Runway 09

No glare found

PV array 1 and FP: Runway 18

No glare found

PV array 1 and FP: Runway 27

No glare found

PV array 1 and FP: Runway 36

No glare found

PV array 1 and OP 1

No glare found

PV array 1 and OP 2

No glare found

PV array 1 and OP 3

No glare found

PV array 1 and OP 4

No glare found

PV array 1 and OP 5

No glare found

PV array 1 and OP 6

No glare found

PV array 1 and OP 7

No glare found

PV array 1 and OP 8

No glare found

PV array 1 and OP 9

No glare found

PV array 1 and OP 10

No glare found

PV array 1 and OP 11

No glare found

PV array 1 and OP 12

No glare found

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.

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.

Several V1 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 V1 analyses of path receptors.

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.

The analysis does not automatically consider obstacles (either man-made or natural) between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills, buildings, etc.

The 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.)

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.

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.

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.

Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.

Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.

Refer to the Help page at www.forgesolar.com/help/ for assumptions and limitations not listed here.

Default glare analysis parameters and observer eye characteristics (for reference only):

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

© Sims Industries d/b/a ForgeSolar, All Rights Reserved.