DUBBO SOLAR FARM

GLINT AND GLARE IMPACT ASSESSMENT REPORT
FINAL ISSUE

Prepared For
ACEnergy

March 2021

ENVIRONMENTAL
ETHOS

Prepared By Environmental Ethos
for ACEnergy Pty Ltd

REF NO. 21002

FINAL ISSUE: 11 March 2021

Cover Image: ToGa Wanderings

CONTENTS

EXECUTIVE SUMMARY

This glint and glare impact assessment utilised the Solar Glare Hazard Analysis Tool (SGHAT 3.0) in conjunction with a viewshed analysis, to prepare the glint and glare modelling which is the basis for the desktop based impact assessment methodology. The assessment considered dwellings and transport routes within 2km of the Project, and runway approach paths to Dubbo City Regional Airport.

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

- No glare potential was found to affect dwellings and transport routes within 2km of the Project when the solar farm is operating normally using a horizontal single axis tracking system;
- No glare potential was identified for dwellings and transport routes when the tracking system resting angle was set at 45 degrees and 5 degrees – simulating a backtracking operation;
- No glare potential was found to affect flight paths at the approach to runways at Dubbo City Regional Airport, 7.5km from the Project site;

In summary, under normal operation of the solar farm, this assessment found no potential impact of glare affecting transport routes and dwellings within 2km of the Project; and no potential glare impacts to runway approach paths at Dubbo City Regional Airport.

1. INTRODUCTION

This report has been prepared by Environmental Ethos on behalf of ACEnergy Pty Ltd to assess the potential solar glint and glare impact of the proposed Dubbo Solar Farm (the Project), located at 47R Wellington Road, Dubbo, New South Wales. The Project comprises of the installation and operation of a solar farm up to 5MW AC, which will utilise photovoltaic (PV) modules to generate electricity.

The Project site is located over part of Lot 190, DP754308, the footprint of the proposed PV arrays will cover an area of approximately 16.2 hectares (ha). The PV arrays will run north/south and will be mounted on a single axis horizontal tracking system. The solar panels, including the mounting structures, will be approximately 1.4 metres high when flat, rotating to approximately 2.25 metres maximum height.

1.1. Location

The Project site is located approximately 4 kilometres south east of Dubbo, *refer Figure 1.* The Project site adjoins a road easement (DP252285) on the western boundary, which will be developed as the access road to the site. The site is zoned RU2 Rural Landscape and is currently used for grazing. Farming is the predominant land use within the area.

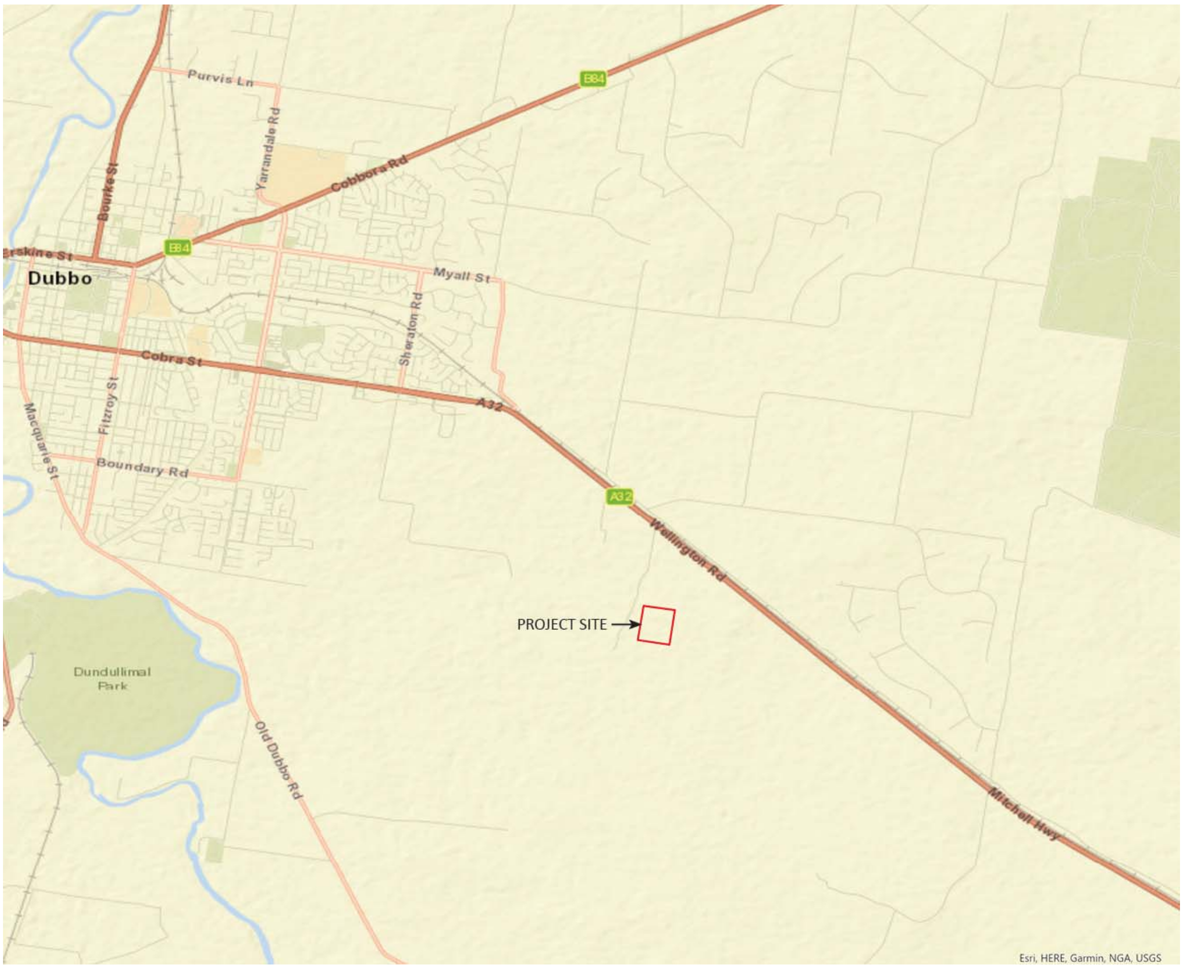


Figure 1. Location Plan

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 glint and glare including size, height, and angle of PV modules, the type of framing system, as well as operational considerations for the tracking system;
- Identification of the viewshed and potential visibility of the Project;
- Desktop mapping of potential glint and glare at the location of sensitive receptors within the viewshed, based on Solar Glare Hazard Analysis and viewshed analysis;
- Assessment of the potential risk of glint and glare on sensitive receptors during operation of the Project;
- Assessment of potential mitigations measures to avoid, mitigate, or manage potential impacts; and
- Consideration of impacts, before and after mitigation measures are established, on surrounding sensitive receptors including:
  - Dwellings and roads within 1km of the proposed facility, taking into consideration visibility of the Project,
  - Aviation infrastructure including any air traffic control tower or runway approach path close to the proposed facility.

3. METHODOLOGY

3.1. Glint and Glare Definitions

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

This study utilises Solar Glare Hazard Analysis 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."[1]

The FAA Technical Guidelines distinguishes between glint and glare according to time duration, without correlation to light intensity.

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

For the purpose of this study the term 'glare' is used in reference to the more intense light impact of direct solar reflectivity from PV modules over potentially long duration (consistent with terminology used by Solar Glare Hazard Analysis software based on FAA Guidelines).

3.2. Glare Assessment Parameters

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 receptors (viewers); and
- Screening potential of surrounding topography and vegetation.

3.3. 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 and distance) of the glare source.[2]

Glare can be broadly classified into three categories: low potential for after-image, potential for after-image, and potential for permanent eye damage, *Figure 2* illustrates the glare intensity categories used in this study.

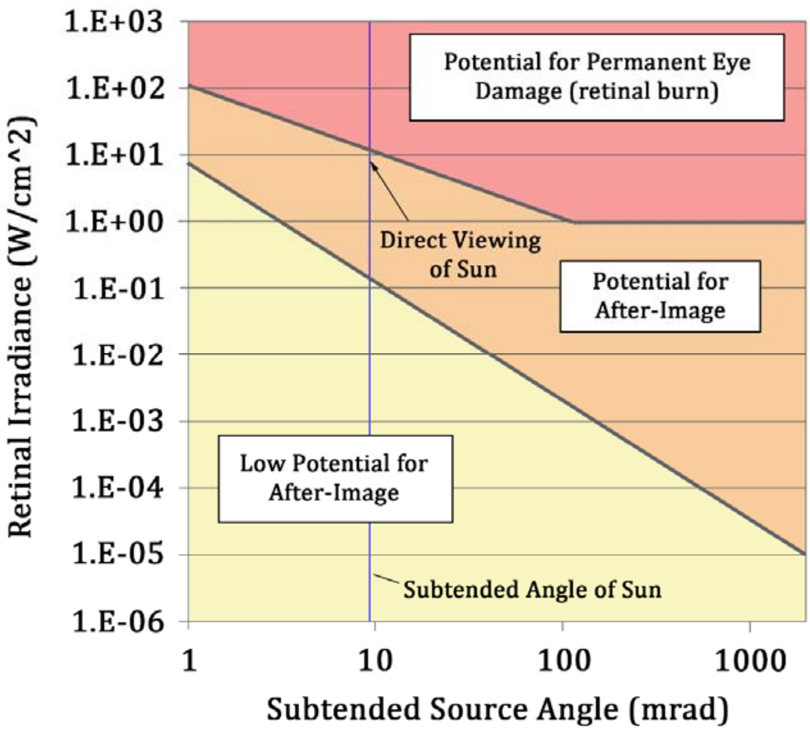


Figure 2. Ocular impacts and Hazard Ranges[3]

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

[3] Source: Solar Glare Hazard Analysis Tool (SGHAT) Presentation (2013)

The amount of light reflected from a PV module depends on the amount of sunlight hitting the surface, as well as the surface reflectivity. The amount of sunlight interacting with the PV module will vary based on geographic location, time of year, cloud cover, and PV module orientation. 1000W/m^2 is generally used in most counties as an estimate of the solar energy interacting with a PV module when no other information is available. This study modelled scenarios using 2000 W/m^2 in order to cover potentially higher solar energy levels in Australia as compared to other parts of the world. Flash blindness for a period of 4-12 seconds (i.e. time to recovery of vision) occurs when 7-11 W/m^2 (or 650-1,100 lumens/m^2) reaches the eye[4].

3.4. 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.[5]

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%. The angle of incidence is particularly relevant to specular reflection (light reflection from a smooth surface). Diffuse reflection (light reflection from a rough surface) may also occur in PV modules, however this is typically a result of dust or similar materials building up on the PV module surface, which would potentially reduce the reflection.

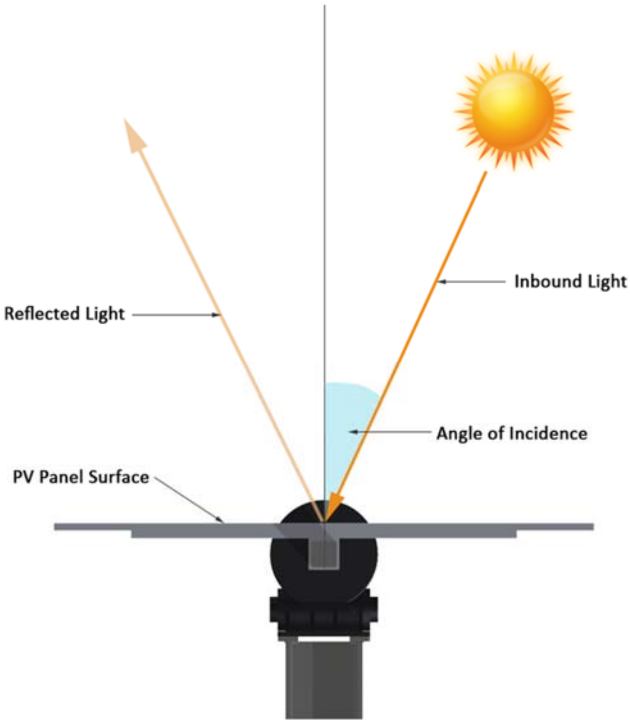


Figure 3. Angle of Incidence Relative to PV Panel Surface

https://share.sandia.gov/phlux/static/references/glint-glare/SGHAT_Ho.pdf
[4] Sandia National Laboratory, SGHAT Technical Manual
[5] *Ho, C. 2013 Relieving a Glare Problem*

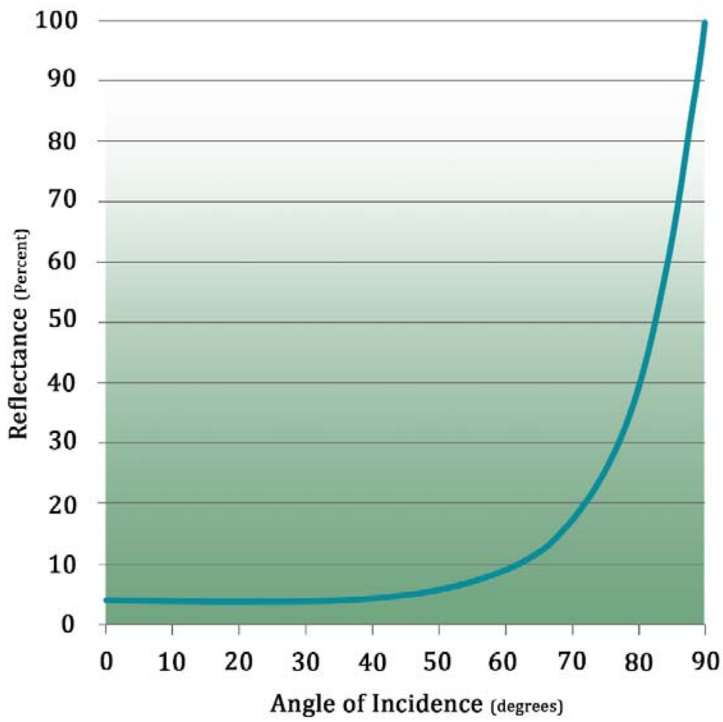


Figure 4. Angles of Incidence and Increased Levels of Reflected Light (Glass (n-1.5))

The sun changes its east-west orientation throughout the day, and the sun's north-south position in the sky changes throughout the year. The sun reaches its highest position at noon on the Summer Solstice (21 December in the Southern Hemisphere) and its lowest position at sunrise and sunset on the Winter Solstice (21 June in the Southern Hemisphere).

In a fixed PV solar array, the angle of incidence varies as the sun moves across the sky, that is the angle of incidence are at their lowest around noon where the sun is directly overhead, and increase in the early mornings and late evenings as the incidence angles increase. If the PV array is mounted on a tracking system, this variation is reduced because the panel is rotated to remain perpendicular to the sun. Therefore a PV modular array 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. Some tracking systems utilise 'backtracking' to avoid PV modules over-shadowing each other. During the backtracking procedure (early morning and late afternoon) the tracking system begins to rotate away from the sun to reduce shadow casting to adjoining PV panels. During the backtracking phase, higher angles of incidence will occur in comparison to the tracking phase, and this may increase the potential for glare.

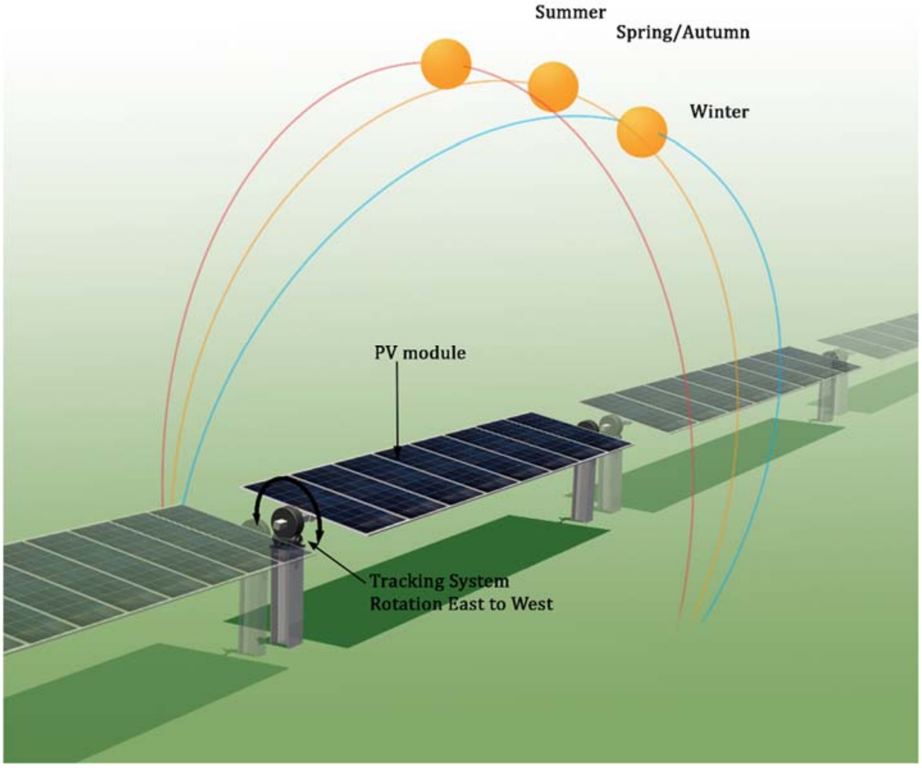


Figure 5. Diagrammatic illustration of sun position relative to PV module mounted on a horizontal single axis tracking system.

3.5. Viewshed Analysis

A desktop viewshed analysis was undertaken using ArcGIS 3D modelling. The extent of visibility of the proposed solar farm was assessed relative to the location of sensitive receptors (dwellings, roads, etc.) The desktop viewshed analysis is based on topography only and does not take into consideration the screening effect of vegetation.

3.6. Solar Glare Hazard Analysis

This assessment has utilised the Solar Glare Hazard Analysis Tool (SGHAT 3.0) co-developed by Sandi National Laboratory[6] and ForgeSolar (Sim Industries) (referred to as GlareGauge) to assess potential glare utilising latitude and longitudinal coordinates, elevation, sun position, and vector calculations. The PV module orientation, reflectance environment and ocular factors are also considered by the software. If potential glare is identified by the model, the tool calculates the retinal irradiance and subtended angle (size/distance) of the glare source to predict potential ocular hazards according to the glare intensity categories (refer *Section 3.3*).

The sun position algorithm used by SGHAT calculates the sun position in two forms: first as a unit vector extending from the Cartesian origin toward the sun, and second as azimuthal and altitudinal angles. The algorithm enables determination of the sun position at one (1) minute intervals throughout the year.

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

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

- Backtracking or the effect of shading in relation to the PV array tracking system;
- Gaps between PV modules;
- Atmospheric conditions; and
- Vegetation between the solar panels and the viewer (sensitive receptor).

SGHAT has been used extensively in the United States to assess the potential impact of solar arrays located in close proximity to airports. The US Federal Aviation Administration requires the use of SGHAT to demonstrated compliance with the safety requirements of all proposed solar energy systems located at federally obligated airports. Used in conjunction with a viewshed analysis, the two tools represent a conservative assessment.

3.7. Risk Assessment

Once the potential for glare has been identified through the viewshed analysis and SGHAT, a risk assessment approach is used to identify the potential significance of the hazard based on the magnitude of the glare hazard generated, distance from the Project, existing vegetation, and the sensitivity of the receptors (viewers). Mitigation measures are then considered to avoid, reduce or manage the identified risks.

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 site is located within a flat to gently undulating rural landscape. Baseline conditions within this area are characteristic of a rural landscape, being grazing land with scattered patches of native vegetation and farm buildings.

Existing dwellings in the area consist of rural homesteads and residential properties within the Large Lot Residential area to the east of the Project site.

To the west of the Project site are existing mining/quarry operations, and to the north-west an existing solar farm.

Infrastructure elements within the landscape include roads, the rail line to the north, and power lines.

Existing features in the landscape with the potential to contribute to glare include the existing solar farm located approximately 1.5km from the Project site. The distance between the two solar farms, slight variations in terrain, and intervening vegetation, results in the two projects being visually separate.

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 Dubbo (Darling Street) 7.4 km from the Project site (the closest BOM records for cloud cover statistics) recorded 90 cloudy days per year (mean number over the period 1921 to 1999)[7]. Cloudy days predominantly occur during the winter months, May to August. 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 solar farm is as shown in *Figure 6.* 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.

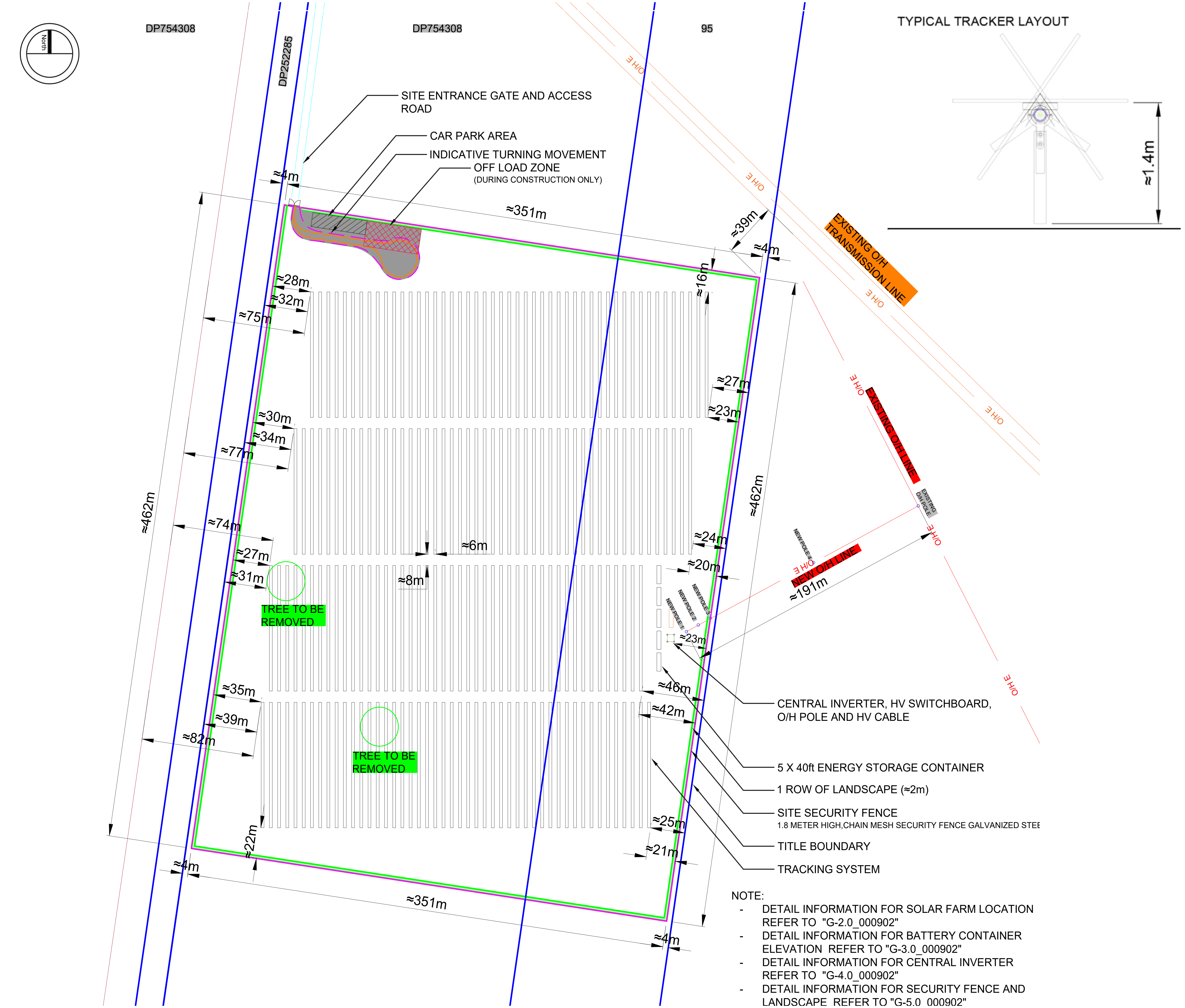
5.1. PV modules

Each PV panel typically comprises of 72 polycrystalline silicon solar cells overlayed by a 3.2 to 4.0 mm tempered glass front and held in an anodised aluminium alloy frame. Half cut cell technology is also available which consists of 144 monocrystalline cells connected in series to reduce ribbon resistant. Dual-glass and frameless PV systems area also available. The approximate dimensions for a typical solar panel is 2 metres x 1 metre. The proposed solar array arrangement for this Project is one (1) solar panels in portrait, resulting in an array width of approximately 2 metres.

5.2. Horizontal single axis tracking system

A horizontal single axis tracking system rotates the PV panels across an east to west arc, following the sun's trajectory across the sky. The purpose of the tracking system is to optimize solar energy collection by holding the PV module perpendicular to the sun. The tracking system is capable of a maximum rotation range of 90^o (+/- 45^o) or 120^o (+/- 60^o) depending on the system used. The Project modelling utilised a rotation range of 120^o (+/- 60^o), refer *Figure 7.*

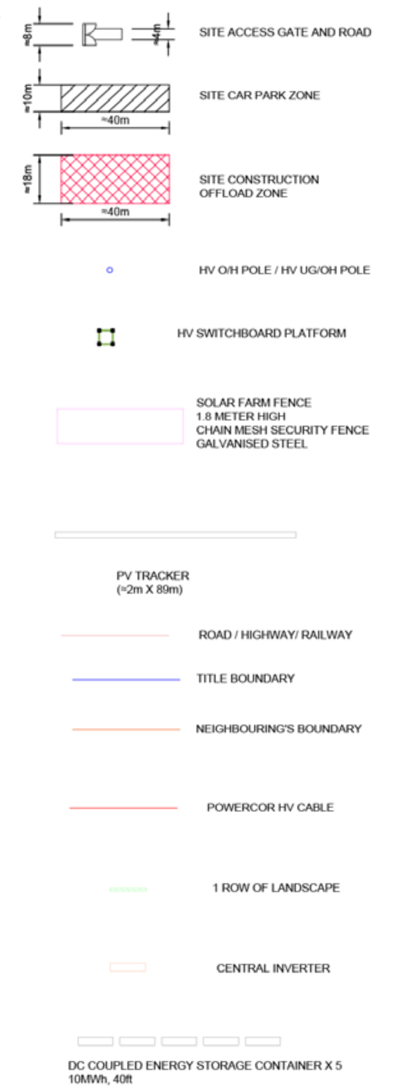
[7] http://www.bom.gov.au/climate/averages/tables/cw_065012.shtml



NOTE:
- DETAIL INFORMATION FOR SOLAR FARM LOCATION REFER TO "G-2.0_000902"
- DETAIL INFORMATION FOR BATTERY CONTAINER ELEVATION REFER TO "G-3.0_000902"
- DETAIL INFORMATION FOR CENTRAL INVERTER REFER TO "G-4.0_000902"
- DETAIL INFORMATION FOR SECURITY FENCE AND LANDSCAPE REFER TO "G-5.0 000902"

ENVIRONMENTAL ETHOS

LEGEND



SOURCE: ACEnergy G-1.0 - 000902
REV A
08/02/2021

PROJECT NO. 21002
CREATED BY: SC
DATE: 06 03 2021
VERSION: A

DUBBO SOLAR FARM

GLINT AND GLARE IMPACT ASSESSMENT

PROJECT LAYOUT PLAN

FIGURE 6.0

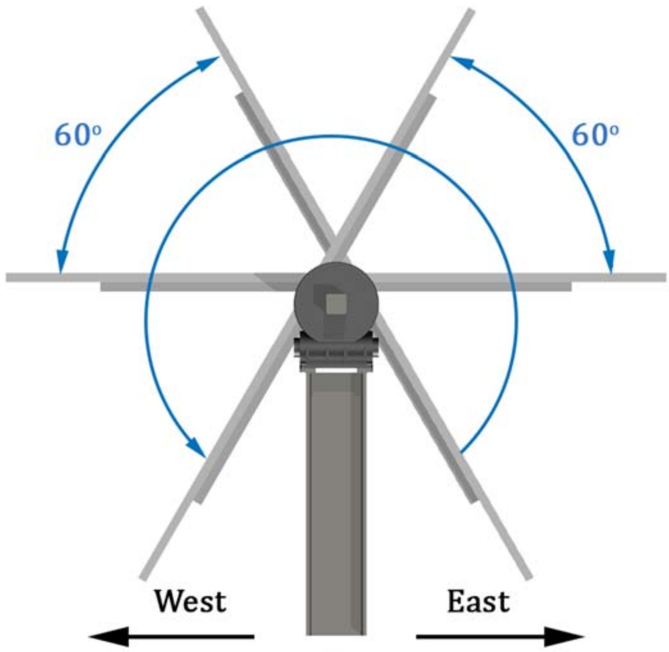


Figure 7. Illustration of PV Module Rotation Angles

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. This enables the height of the panel to remain consistent relative to each other and avoids potential over shadowing.

The maximum height of the PV modules above natural ground was assumed to be approximately 2.25 metres (1.4 metres when the panels are held at 0 degrees (flat) and 2.25 metres at maximum tilt). A height of 2.4 metres was used in the modelling to allow for any slight variation in the height of the mounting system and maximum angle of the PV modules. The glare assessment modelling uses an analytical approach to simulate light reflection from a planar PV footprint relative to the location of sensitive receptors. By using a maximum height above ground, the model represents a worst case scenario since the panels are considered likely to be slightly lower than the maximum.

The configuration of the tracking system rows vary slightly dependent on the type of system used, generally rows are approximately 5-7 metres apart. *Figure 8* and *Plate 1* show a typical layout for a horizontal single axis tracking system.

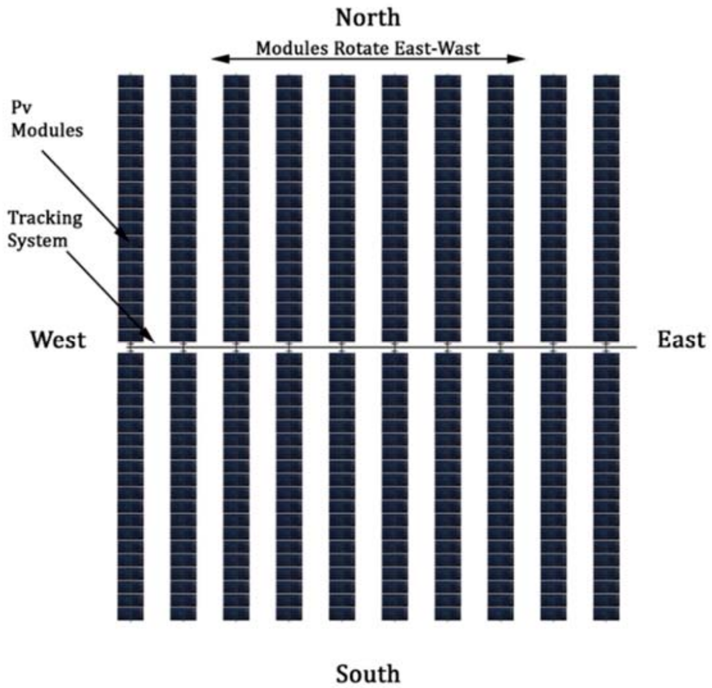


Figure 8. Illustration of PV Module Row Alignment

Plate 1. Example of a typical frameless solar array mounted on a single axis tracking system[8]

5.3. Solar Inverters, Control Room, and Fencing

The proposed solar farm will also include solar inverters, a control/switch building, and perimeter fencing. These elements are not considered likely to influence glare as they generally comprise of non-reflective surfaces typically found in the built environment.

[8] Source: http://solarbuildermag.com/featured/frameless-modules-mount/

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 solar farm, 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 9.*

The Digital Elevation Model (DEM) for the viewshed modelling was set as 'Finest' (> 10 m). Contour information for the site was assessed and shows the Project site is located within a generally flat landscape with minor topographic variation.

Solar Farms are characterised by their low horizontal profile. The major elements of a solar farm are the PV models, these are generally 2 to 4 metres above ground level. In this study a maximum height of 2.4 metres above ground level was used in the modelling. At distances greater than 1 km a 2.4 metre high horizontal object in the landscape becomes visually insignificant (perceived as a narrow line in the distance) when viewed across a flat plain. At distances greater than 2 km the Project will be barely visible, therefore the viewshed analysis focussed on potential visibility of the Project within 2km of the site.

The desktop assessment identified the Project is generally more visible to the south and to the north west.

14 observation points were assessed within the viewshed; 2 were located at dwellings within 1km of the Project site, 10 at dwellings 1 - 2km from the Project site, and another 2 at 2.5 – 3km from the Project site in the vicinity of the existing solar farm. The numbering of observation points 1 to 8 corresponds to dwellings identified in the Visibility Analysis (LVIA) prepared by DWC, dated 25/02/2021. All observation point locations and numbers shown in *Figure 9* are consist with the glare modelling results provided in the appendices and detailed in *Table 1*.

Table 1. Location of Observation Points relative to distance from the Project

Distance from Project	Observation Points (Rural and residential dwellings)	Identified as potentially visible in the viewshed modelling
<500m	None	N/A
500m – 1km	2 (OP2 and OP3) rural properties	Yes (Negligible visibility in the LVIA)
1km – 2km	10 (OP1, OP4, OP5, OP6,OP9 to OP14) rural and residential properties	Yes (OP1, 4, 5, 6 - low to negligible visibility in the LVIA)
2km – 3km	2 (OP7 and OP8) rural properties	Yes (Low visibility in the LVIA)

Five (5) roads (including the Project access driveway) pass through the viewshed and these were included in the glare modelling, as follows:

- Existing driveway and access road to the site
- Eulomogo Road

ENVIRONMENTAL ETHOS

N

0 0.25 0.5 1 Kilometers

SCALE 1: 24,000 @ A3

Legend

- SITE BOUNDARY
- PV MODULE AREA
- DISTANCE FROM SOLAR FARM
- DWELLINGS*
- ROADS
- RAILWAY LINE
- TRANSMISSION LINES

EXTENT OF VISIBILITY*

- Less visible
- More visible

*(Analysis based on Digital Terrain Model)

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

PROJECT No. 21002
CREATED BY: SC
DATE: 22 02 2021
VERSION: A

DUBBO SOLAR FARM

GLINT AND GLARE ASSESSMENT

VIEWSHED ANALYSIS

FIGURE 9.0

- Mitchell Highway
- Peachville Road
- Sheraton Road

In addition the rail line was also included in the glare modelling.

Dubbo is the closest Airport to the Project at 11.5km from the Project site. Whilst this facility is not considered 'close' to the Project, approach flight paths to the runways were tested in the glare modelling. Dubbo Airport does not have an aviation control tower therefore no modelling was undertaken for this type of aviation infrastructure.

The potential glare hazard impact for identified dwellings, surrounding roads and rail line with potential views to the site, and flight paths at the closest airport, have been assessed in *Section 6.3.*

6.2. Solar Glare Hazard Analysis

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

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

SGHAT Model Parameters	Values
Time Zone	UTC +10
Axis Tracking	Horizontal Single Axis
Tilt of tracking axis	0
Orientation of tracking axis	0
Offset angle of module	0
Module Surface material	Smooth glass without anti-reflective coating (ARC)
Maximum tracking angle	60
Resting angles	60 – 45 – 5
Reflectivity	Vary with sun
Correlate slope error with surface type?	Yes
Slope error	6.55mrad
Height of panels above ground	2.4m maximum height

Route Parameters

Glare modelling included the assessment of potential impacts to route receptors (people travelling along roads and rail) in both directions of travel with a field-of-view (FOV) angle of 90°. FOV defines the left and right field-of-view of observers traveling along a route. A view angle of 90° means the observer has a field-of-view of 90° to their left and right, i.e. a total FOV of 180°. FAA research has identified 'impairment ratings' based on simulations of glare at various angles and duration, and the effect on a pilot's ability to fly a plane[9]. The research identified impairment was highest when the glare source was within a FOV of 25° or less. The impact of glare fell below 'slight impairment' rating when the glare source was at an angle of 50° from the direction of travel. When the glare source was located at an angle of 90° the impairment rating reduced further. In relation to piloting a plane, the report noted there was no significant difference in impairment when the source of glare angle was increased from 50° to 90°. In conclusion the research noted 'these results taken together

[9] https://www.faa.gov/data_research/research/med_humanfacs/oamtechreports/2010s/media/201512.pdf

suggest that any sources of glare at an airport may be potentially mitigated if the angle of the glare is greater than 25 deg from the direction that the pilot is looking in'.

Since this assessment used a FOV of 90°, it represents a conservative assessment of potential risk to drivers using roads and rail network within the vicinity of the solar farm.

6.3. Solar Glare Hazard Analysis Tool (SGHAT) Results

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

Table 3. SGHAT Assessment Results – Horizontal Single Axis Tracking System (Resting angle 60 degrees)

Sensitive Receptor	Glare Potential
Observation Points OP1 to OP14 Rural and residential dwellings	No Glare
Access Road	No Glare
Eulomogo Road	No Glare
Mitchell Highway	No Glare
Peachville Road	No Glare
Railway Line	No Glare
Sheraton Road	No Glare
Flight Path 1 – Dubbo City Regional Airport Asphalt Runway (south-west)	No Glare
Flight Path 2 – Dubbo City Regional Airport Asphalt Runway (north-east)	No Glare
Flight Path 3 – Dubbo City Regional Asphalt Runway (west)	No Glare
Flight Path 4 – Dubbo City Regional Airport Asphalt Runway (east)	No Glare

The results of the SGHAT modelling identified no glare hazard potential is likely to affect rural and residential dwellings within the vicinity of the Project when the tracking system operates under normal procedures, *refer Appendix A*.

The SGHAT modelling also identified no glare hazard potential is likely to affect travellers along the surrounding roads and rail line, *refer Appendices B.*

The SGHAT modelling also identified no glare hazard potential is likely to affect defined flight paths at the approach to runways at Dubbo City Regional Airport, *refer Appendices C.*

6.4. Backtracking Operations

A single axis horizontal tracking system can be programed to operate a 'backtracking' procedure (*refer section 2.4*), that is, during the early morning and late afternoon when the sun is low in the sky, the tracking system can adjust the panels to maximise solar capture whilst minimising overshadowing. There are several backtracking algorithms developed for this purpose, with each system optimised dependent on the distance between panels, the width of each panel, the incidence angle of the sun, and the field slope angle.

The anticipated backtracking procedure for the Project is as follows:

- Maximum tracking angle – 60 degrees
- Backtracking angle to 45 degrees
- Stow angle (after dark) 5 to 0 degrees

When the tracking system is operating a backtracking procedure, variable angles of incidence of the sun relative to the panels may occur and this variation is not currently modelled by SGHAT software. SGHAT 3.0 does however include a 'resting angle' feature which models the effect of the panels reverting (resting) to a specified angle once the maximum tilt angle is reached. Modelling resting angles is not a true representation of how a backtracking procedure would operate under normal circumstances. However, the 'resting angle' feature does provide some indication of the potential glare implications of moving the PV panels away from the sun once the maximum tilt is reach. Various resting angles were tested in the model to provide some assessment of potential glare risk, the results of this assessment are presented in *Table 4.*

Table 4. SGHAT Assessment Results – Resting Angle Analysis of 45 and 0 degrees

Sensitive Receptor	Resting Angle 45 degrees *- Glare Potential	Stowing Angle 5 degrees **- Glare Potential
Observation Points OP1 to OP13 Rural and residential dwellings	No Glare – all dwellings	No Glare – all dwellings
Observation Point 14 rural dwelling	No Glare	No Glare
Access Road	No Glare	No Glare
Eulomogo Road	No Glare	No Glare
Mitchell Highway	No Glare	No Glare
Peachville Road	No Glare	No Glare
Railway Line	No Glare	No Glare
Sheraton Road	No Glare	No Glare
Flight Path 1 – Dubbo City Regional Airport Asphalt Runway (south-west)	No Glare	No Glare
Flight Path 2 – Dubbo City Regional Airport Asphalt Runway (north-east)	No Glare	No Glare
Flight Path 3 – Dubbo City Regional Asphalt Runway (west)	No Glare	No Glare
Flight Path 4 – Dubbo City Regional Airport Asphalt Runway (east)	No Glare	No Glare

*Modelling is based on the PV panels moving directly to 45 degrees once maximum tilt of 60 degrees is reached, in reality this process would track gradually, therefore this represents a worst case scenario.

**Modelling is based on the PV panels moving directly to 5 degrees once maximum tracking of 60 degrees is reached, in reality this process would track gradually, therefore this represents a worst case scenario.

The SGHAT modelling found no potential glare hazard is likely when the panels rotate from a maximum tilt angle of 60 degrees, to 45 degrees and 5 degrees. This procedure would normally occur gradually, with the panels reaching their stowing angle of 5 to 0 degrees after dark. Whist the limitations of modelling resting angles distorts the results, presenting a worst case than is considered likely, the model indicates a normal backtracking procedure does not increase the likelihood of glare hazard affecting sensitive receptors.

7. MANAGEMENT AND MITIGATION MEASURES

Under normal operation of the solar farm no glare potential was identified, therefore no mitigation measures are considered necessary.

Where the backtracking procedure was simulated in the model using a resting angle of 45 degrees and 5 degrees, no glare potential was identified.

8. SUMMARY

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

- No glare potential was identified in the assessment modelling when the Project utilises a single axis tracking system;
- No glare potential was identified when the resting angle of the PV modules was set at 45 degrees – simulating a backtracking operation; and
- No glare potential was identified when the PV modules reverted to a 5 degree stowing angle.

Under normal operation of the solar farm no glare potential was identified in this desktop assessment.

APPENDIX A:

SOLAR GLARE HAZARD ANALYSIS –DWELLINGS

ForgeSolar

Site Configuration: DubboSF_Dwellings

Project site configuration details and results.

Created **March 3, 2021 10:54 p.m.**
Updated **March 3, 2021 11:20 p.m.**
DNI **varies** and peaks at **2,000.0 W/m^2**
Analyze every **1** minute(s)
0.5 ocular transmission coefficient
0.002 m pupil diameter
0.017 m eye focal length
9.3 mrad sun subtended angle
Timezone **UTC10**
Site Configuration ID: 50517.9053

Summary of Results No glare predicted!

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced
	deg	deg	min	min	kWh
PV array 1	SA tracking	SA tracking	0	0	-

Component Data

PV Array(s)

Name: PV array 1
Axis tracking: Single-axis rotation
Tracking axis orientation: 0.0 deg
Tracking axis tilt: 0.0 deg
Tracking axis panel offset: 0.0 deg
Maximum tracking angle: 60.0 deg
Resting angle: 60.0 deg
Rated power: -
Panel material: Smooth glass without AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 6.55 mrad
Approx. area: 116,882 sq-m

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-32.286057	148.676065	320.82	2.40	323.22
2	-32.286119	148.679311	323.95	2.40	326.35
3	-32.286831	148.679289	323.09	2.40	325.49
4	-32.286831	148.679091	323.03	2.40	325.43
5	-32.287669	148.679091	322.73	2.40	325.13
6	-32.287669	148.678737	321.85	2.40	324.25
7	-32.288663	148.678732	320.33	2.40	322.73
8	-32.288658	148.678892	320.56	2.40	322.96
9	-32.289570	148.678892	319.23	2.40	321.63
10	-32.289511	148.675448	316.99	2.40	319.39
11	-32.288608	148.675481	318.86	2.40	321.26
12	-32.288608	148.675631	319.01	2.40	321.41
13	-32.287756	148.675647	319.34	2.40	321.74
14	-32.287760	148.675888	318.96	2.40	321.36
15	-32.286654	148.675907	320.17	2.40	322.57
16	-32.286656	148.676047	320.12	2.40	322.52

Discrete Observation Receptors

Number	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total Elevation m
OP 1	-32.276317	148.675572	321.69	1.50	323.19
OP 2	-32.280490	148.675661	320.62	1.50	322.12
OP 3	-32.293488	148.685746	321.59	1.50	323.09
OP 4	-32.297217	148.690228	325.69	1.50	327.19
OP 5	-32.273515	148.672558	319.11	1.50	320.61
OP 6	-32.273370	148.669859	314.26	1.50	315.76
OP 7	-32.266281	148.661508	313.00	1.50	314.50
OP 8	-32.269959	148.654634	308.46	1.50	309.96
OP 9	-32.276248	148.669696	313.56	1.50	315.06
OP 10	-32.277518	148.672333	316.00	1.50	317.50
OP 11	-32.273669	148.682302	330.28	1.50	331.78
OP 12	-32.277810	148.686258	338.09	1.50	339.59
OP 13	-32.277760	148.688260	343.84	1.50	345.34
OP 14	-32.280309	148.689596	357.24	1.50	358.74

PV Array Results

Summary of PV Glare Analysis PV configuration and predicted glare

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced	Data File
	deg	deg	min	min	kWh	
PV array 1	SA tracking	SA tracking	0	0	-	-

Click the name of the PV array to scroll to its results

PV & Receptor Analysis Results detailed results for each PV array and receptor

PV array 1 no glare found

Component	Green glare (min)	Yellow glare (min)
OP: OP 1	0	0
OP: OP 2	0	0
OP: OP 3	0	0
OP: OP 4	0	0
OP: OP 5	0	0
OP: OP 6	0	0
OP: OP 7	0	0
OP: OP 8	0	0
OP: OP 9	0	0
OP: OP 10	0	0
OP: OP 11	0	0
OP: OP 12	0	0
OP: OP 13	0	0
OP: OP 14	0	0

No glare found

Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographi obstructions.
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values and results may vary.
- 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.
- Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
- 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. Addition analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on relate limitations.)
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
- Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
- Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
- Glare analysis methods used: OP V1, FP V1, Route V1
- Refer to the **Help page** for assumptions and limitations not listed here.

ForgeSolar

Site Configuration: DubboSF_Dwellings

Project site configuration details and results.

Created **March 3, 2021 10:54 p.m.**
Updated **March 3, 2021 11:39 p.m.**
DNI **varies** and peaks at **2,000.0 W/m^2**
Analyze every **1** minute(s)
0.5 ocular transmission coefficient
0.002 m pupil diameter
0.017 m eye focal length
9.3 mrad sun subtended angle
Timezone **UTC10**
Site Configuration ID: 50517.9053

Summary of Results No glare predicted!

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced
	deg	deg	min	min	kWh
PV array 1	SA tracking	SA tracking	0	0	-

Component Data

PV Array(s)

Name: PV array 1
Axis tracking: Single-axis rotation
Tracking axis orientation: 0.0 deg
Tracking axis tilt: 0.0 deg
Tracking axis panel offset: 0.0 deg
Maximum tracking angle: 60.0 deg
Resting angle: 45.0 deg
Rated power: -
Panel material: Smooth glass without AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 6.55 mrad
Approx. area: 116,882 sq-m

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-32.286057	148.676065	320.82	2.40	323.22
2	-32.286119	148.679311	323.95	2.40	326.35
3	-32.286831	148.679289	323.09	2.40	325.49
4	-32.286831	148.679091	323.03	2.40	325.43
5	-32.287669	148.679091	322.73	2.40	325.13
6	-32.287669	148.678737	321.85	2.40	324.25
7	-32.288663	148.678732	320.33	2.40	322.73
8	-32.288658	148.678892	320.56	2.40	322.96
9	-32.289570	148.678892	319.23	2.40	321.63
10	-32.289511	148.675448	316.99	2.40	319.39
11	-32.288608	148.675481	318.86	2.40	321.26
12	-32.288608	148.675631	319.01	2.40	321.41
13	-32.287756	148.675647	319.34	2.40	321.74
14	-32.287760	148.675888	318.96	2.40	321.36
15	-32.286654	148.675907	320.17	2.40	322.57
16	-32.286656	148.676047	320.12	2.40	322.52

Discrete Observation Receptors

Number	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total Elevation m
OP 1	-32.276317	148.675572	321.69	1.50	323.19
OP 2	-32.280490	148.675661	320.62	1.50	322.12
OP 3	-32.293488	148.685746	321.59	1.50	323.09
OP 4	-32.297217	148.690228	325.69	1.50	327.19
OP 5	-32.273515	148.672558	319.11	1.50	320.61
OP 6	-32.273370	148.669859	314.26	1.50	315.76
OP 7	-32.266281	148.661508	313.00	1.50	314.50
OP 8	-32.269959	148.654634	308.46	1.50	309.96
OP 9	-32.276248	148.669696	313.56	1.50	315.06
OP 10	-32.277518	148.672333	316.00	1.50	317.50
OP 11	-32.273669	148.682302	330.28	1.50	331.78
OP 12	-32.277810	148.686258	338.09	1.50	339.59
OP 13	-32.277760	148.688260	343.84	1.50	345.34
OP 14	-32.280309	148.689596	357.24	1.50	358.74

PV Array Results

Summary of PV Glare Analysis PV configuration and predicted glare

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced	Data File
	deg	deg	min	min	kWh	
PV array 1	SA tracking	SA tracking	0	0	-	-

Click the name of the PV array to scroll to its results

PV & Receptor Analysis Results detailed results for each PV array and receptor

PV array 1 no glare found

Component	Green glare (min)	Yellow glare (min)
OP: OP 1	0	0
OP: OP 2	0	0
OP: OP 3	0	0
OP: OP 4	0	0
OP: OP 5	0	0
OP: OP 6	0	0
OP: OP 7	0	0
OP: OP 8	0	0
OP: OP 9	0	0
OP: OP 10	0	0
OP: OP 11	0	0
OP: OP 12	0	0
OP: OP 13	0	0
OP: OP 14	0	0

No glare found

Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values and results may vary.
- 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.
- Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
- 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.)
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
- Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
- Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
- Glare analysis methods used: OP V1, FP V1, Route V1
- Refer to the **Help page** for assumptions and limitations not listed here.

ForgeSolar

Site Configuration: DubboSF_Dwellings

Project site configuration details and results.

Created **March 3, 2021 10:54 p.m.**
Updated **March 4, 2021 1:45 a.m.**
DNI **varies** and peaks at **2,000.0 W/m^2**
Analyze every **1** minute(s)
0.5 ocular transmission coefficient
0.002 m pupil diameter
0.017 m eye focal length
9.3 mrad sun subtended angle
Timezone **UTC10**
Site Configuration ID: 50517.9053

Summary of Results No glare predicted!

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced
	deg	deg	min	min	kWh
PV array 1	SA tracking	SA tracking	0	0	-

Component Data

PV Array(s)

Name: PV array 1
Axis tracking: Single-axis rotation
Tracking axis orientation: 0.0 deg
Tracking axis tilt: 0.0 deg
Tracking axis panel offset: 0.0 deg
Maximum tracking angle: 60.0 deg
Resting angle: 5.0 deg
Rated power: -
Panel material: Smooth glass without AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 6.55 mrad
Approx. area: 116,882 sq-m

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-32.286057	148.676065	320.82	2.40	323.22
2	-32.286119	148.679311	323.95	2.40	326.35
3	-32.286831	148.679289	323.09	2.40	325.49
4	-32.286831	148.679091	323.03	2.40	325.43
5	-32.287669	148.679091	322.73	2.40	325.13
6	-32.287669	148.678737	321.85	2.40	324.25
7	-32.288663	148.678732	320.33	2.40	322.73
8	-32.288658	148.678892	320.56	2.40	322.96
9	-32.289570	148.678892	319.23	2.40	321.63
10	-32.289511	148.675448	316.99	2.40	319.39
11	-32.288608	148.675481	318.86	2.40	321.26
12	-32.288608	148.675631	319.01	2.40	321.41
13	-32.287756	148.675647	319.34	2.40	321.74
14	-32.287760	148.675888	318.96	2.40	321.36
15	-32.286654	148.675907	320.17	2.40	322.57
16	-32.286656	148.676047	320.12	2.40	322.52

Discrete Observation Receptors

Number	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total Elevation m
OP 1	-32.276317	148.675572	321.69	1.50	323.19
OP 2	-32.280490	148.675661	320.62	1.50	322.12
OP 3	-32.293488	148.685746	321.59	1.50	323.09
OP 4	-32.297217	148.690228	325.69	1.50	327.19
OP 5	-32.273515	148.672558	319.11	1.50	320.61
OP 6	-32.273370	148.669859	314.26	1.50	315.76
OP 7	-32.266281	148.661508	313.00	1.50	314.50
OP 8	-32.269959	148.654634	308.46	1.50	309.96
OP 9	-32.276248	148.669696	313.56	1.50	315.06
OP 10	-32.277518	148.672333	316.00	1.50	317.50
OP 11	-32.273669	148.682302	330.28	1.50	331.78
OP 12	-32.277810	148.686258	338.09	1.50	339.59
OP 13	-32.277760	148.688260	343.84	1.50	345.34
OP 14	-32.280309	148.689596	357.24	1.50	358.74

PV Array Results

Summary of PV Glare Analysis PV configuration and predicted glare

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced	Data File
	deg	deg	min	min	kWh	
PV array 1	SA tracking	SA tracking	0	0	-	-

Click the name of the PV array to scroll to its results

PV & Receptor Analysis Results detailed results for each PV array and receptor

PV array 1 no glare found

Component	Green glare (min)	Yellow glare (min)
OP: OP 1	0	0
OP: OP 2	0	0
OP: OP 3	0	0
OP: OP 4	0	0
OP: OP 5	0	0
OP: OP 6	0	0
OP: OP 7	0	0
OP: OP 8	0	0
OP: OP 9	0	0
OP: OP 10	0	0
OP: OP 11	0	0
OP: OP 12	0	0
OP: OP 13	0	0
OP: OP 14	0	0

No glare found

Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographi obstructions.
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values and results may vary.
- 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.
- Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
- 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. Addition analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on relate limitations.)
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
- Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
- Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
- Glare analysis methods used: OP V1, FP V1, Route V1
- Refer to the **Help page** for assumptions and limitations not listed here.

APPENDIX B:

SOLAR GLARE HAZARD ANALYSIS – TRANSPORT ROUTES

ForgeSolar

Site Configuration: DubboSF_Roads

Project site configuration details and results.

Created **March 4, 2021 2:11 a.m.**
Updated **March 4, 2021 2:16 a.m.**
DNI **varies** and peaks at **2,000.0 W/m^2**
Analyze every **1** minute(s)
0.5 ocular transmission coefficient
0.002 m pupil diameter
0.017 m eye focal length
9.3 mrad sun subtended angle
Timezone **UTC10**
Site Configuration ID: 50521.9053

Summary of Results No glare predicted!

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced
	deg	deg	min	min	kWh
PV array 1	SA tracking	SA tracking	0	0	-

Component Data

PV Array(s)

Note: PV array encompasses a large surface area (greater than 25 acres). Accuracy of path receptor glare analysis may be affected by footprint size. Additional analyses of array sub-sections may provide more information on expected glare.

Name: PV array 1
Axis tracking: Single-axis rotation
Tracking axis orientation: 0.0 deg
Tracking axis tilt: 0.0 deg
Tracking axis panel offset: 0.0 deg
Maximum tracking angle: 60.0 deg
Resting angle: 60.0 deg
Rated power: -
Panel material: Smooth glass without AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 6.55 mrad
Approx. area: 116,882 sq-m

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-32.286057	148.676065	320.82	2.40	323.22
2	-32.286119	148.679311	323.95	2.40	326.35
3	-32.286831	148.679289	323.09	2.40	325.49
4	-32.286831	148.679091	323.03	2.40	325.43
5	-32.287669	148.679091	322.73	2.40	325.13
6	-32.287669	148.678737	321.85	2.40	324.25
7	-32.288663	148.678732	320.33	2.40	322.73
8	-32.288658	148.678892	320.56	2.40	322.96
9	-32.289570	148.678892	319.23	2.40	321.63
10	-32.289511	148.675448	316.99	2.40	319.39
11	-32.288608	148.675481	318.86	2.40	321.26
12	-32.288608	148.675631	319.01	2.40	321.41
13	-32.287756	148.675647	319.34	2.40	321.74
14	-32.287760	148.675888	318.96	2.40	321.36
15	-32.286654	148.675907	320.17	2.40	322.57
16	-32.286656	148.676047	320.12	2.40	322.52

Route Receptor(s)

Name: Access Road
Route type Two-way
View angle: 90.0 deg

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-32.275925	148.677472	324.00	2.00	326.00
2	-32.276224	148.677247	323.98	2.00	325.98
3	-32.277068	148.677075	322.53	2.00	324.53
4	-32.280061	148.676560	320.29	2.00	322.29
5	-32.281512	148.676313	321.57	2.00	323.57

Name: Eulomogo Road
Route type Two-way
View angle: 90.0 deg

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-32.274339	148.675579	322.04	2.00	324.04
2	-32.274072	148.675909	322.47	2.00	324.47
3	-32.273877	148.676185	322.85	2.00	324.85
4	-32.273800	148.676344	322.95	2.00	324.95
5	-32.273444	148.677392	324.00	2.00	326.00
6	-32.273177	148.678202	324.72	2.00	326.72
7	-32.273041	148.678680	326.11	2.00	328.11
8	-32.272830	148.679483	330.19	2.00	332.19
9	-32.272712	148.680047	330.99	2.00	332.99
10	-32.272648	148.680454	330.73	2.00	332.73
11	-32.272657	148.680766	330.50	2.00	332.50
12	-32.272784	148.682021	329.37	2.00	331.37
13	-32.273143	148.684794	332.09	2.00	334.09
14	-32.273474	148.687558	332.31	2.00	334.31
15	-32.273954	148.691296	337.09	2.00	339.09
16	-32.274418	148.695083	345.84	2.00	347.84
17	-32.274799	148.698366	352.45	2.00	354.45
18	-32.275144	148.700426	360.20	2.00	362.20

Name: Mitchell Hwy
Route type Two-way
View angle: 90.0 deg

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-32.307667	148.717528	361.04	2.00	363.04
2	-32.300193	148.708052	361.34	2.00	363.34
3	-32.292690	148.698549	332.59	2.00	334.59
4	-32.275847	148.677482	324.00	2.00	326.00
5	-32.264489	148.663109	312.63	2.00	314.63
6	-32.262021	148.659828	310.57	2.00	312.57
7	-32.261448	148.658447	308.94	2.00	310.94
8	-32.261055	148.656899	308.28	2.00	310.28
9	-32.258247	148.637367	295.38	2.00	297.38

Name: Peachville Road
Route type Two-way
View angle: 90.0 deg

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-32.273826	148.676195	322.90	2.00	324.90
2	-32.272347	148.674361	320.75	2.00	322.75
3	-32.270786	148.672390	319.03	2.00	321.03
4	-32.270115	148.671590	317.00	2.00	319.00
5	-32.269720	148.671333	317.00	2.00	319.00
6	-32.268799	148.671403	317.27	2.00	319.27
7	-32.260605	148.672937	308.60	2.00	310.60

Name: Railway line
Route type Two-way
View angle: 90.0 deg

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-32.307036	148.717684	359.72	2.00	361.72
2	-32.302711	148.711954	361.31	2.00	363.31
3	-32.298221	148.706200	351.87	2.00	353.87
4	-32.294367	148.701415	339.88	2.00	341.88
5	-32.291084	148.697178	329.82	2.00	331.82
6	-32.287284	148.692435	337.27	2.00	339.27
7	-32.284862	148.689431	345.61	2.00	347.61
8	-32.280935	148.684400	335.40	2.00	337.40
9	-32.278957	148.681846	328.91	2.00	330.91
10	-32.276223	148.678464	324.70	2.00	326.70
11	-32.272748	148.674086	320.94	2.00	322.94
12	-32.268700	148.669028	314.31	2.00	316.31
13	-32.264291	148.663396	312.94	2.00	314.94
14	-32.259111	148.656883	305.73	2.00	307.73
15	-32.253576	148.649867	304.24	2.00	306.24

Name: Sheraton Road
Route type Two-way
View angle: 90.0 deg

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-32.259623	148.646183	301.69	2.00	303.69
2	-32.264232	148.645389	299.45	2.00	301.45
3	-32.268024	148.644638	298.76	2.00	300.76
4	-32.271145	148.644101	289.81	2.00	291.81
5	-32.272669	148.643780	285.52	2.00	287.52
6	-32.272886	148.645625	288.07	2.00	290.07
7	-32.273140	148.647256	292.36	2.00	294.36
8	-32.273249	148.648050	294.91	2.00	296.91
9	-32.273993	148.647942	293.36	2.00	295.36

PV Array Results

Summary of PV Glare Analysis PV configuration and predicted glare

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced	Data File
	deg	deg	min	min	kWh	
PV array 1	SA tracking	SA tracking	0	0	-	-

Click the name of the PV array to scroll to its results

PV & Receptor Analysis Results detailed results for each PV array and receptor

PV array 1 no glare found

Component	Green glare (min)	Yellow glare (min)
Route: Access Road	0	0
Route: Eulomogo Road	0	0
Route: Mitchell Hwy	0	0
Route: Peachville Road	0	0
Route: Railway line	0	0
Route: Sheraton Road	0	0

No glare found

Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values and results may vary.
- 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.
- Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
- 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. Additiona analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on relate limitations.)
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
- Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
- Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
- Glare analysis methods used: OP V1, FP V1, Route V1
- Refer to the **Help page** for assumptions and limitations not listed here.

ForgeSolar

Site Configuration: DubboSF_Roads

Project site configuration details and results.

Created **March 4, 2021 2:11 a.m.**
Updated **March 4, 2021 2:23 a.m.**
DNI **varies** and peaks at **2,000.0 W/m^2**
Analyze every **1** minute(s)
0.5 ocular transmission coefficient
0.002 m pupil diameter
0.017 m eye focal length
9.3 mrad sun subtended angle
Timezone **UTC10**
Site Configuration ID: 50521.9053

Summary of Results No glare predicted!

PV Name	Tilt deg	Orientation deg	"Green" Glare min	"Yellow" Glare min	Energy Produced kWh
PV array 1	SA tracking	SA tracking	0	0	-

Component Data

PV Array(s)

Note: PV array encompasses a large surface area (greater than 25 acres). Accuracy of path receptor glare analysis may be affected by footprint size. Additional analyses of array sub-sections may provide more information on expected glare.

Name: PV array 1
Axis tracking: Single-axis rotation
Tracking axis orientation: 0.0 deg
Tracking axis tilt: 0.0 deg
Tracking axis panel offset: 0.0 deg
Maximum tracking angle: 60.0 deg
Resting angle: 45.0 deg
Rated power: -
Panel material: Smooth glass without AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 6.55 mrad
Approx. area: 116,882 sq-m

Vertex	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
1	-32.286057	148.676065	320.82	2.40	323.22
2	-32.286119	148.679311	323.95	2.40	326.35
3	-32.286831	148.679289	323.09	2.40	325.49
4	-32.286831	148.679091	323.03	2.40	325.43
5	-32.287669	148.679091	322.73	2.40	325.13
6	-32.287669	148.678737	321.85	2.40	324.25
7	-32.288663	148.678732	320.33	2.40	322.73
8	-32.288658	148.678892	320.56	2.40	322.96
9	-32.289570	148.678892	319.23	2.40	321.63
10	-32.289511	148.675448	316.99	2.40	319.39
11	-32.288608	148.675481	318.86	2.40	321.26
12	-32.288608	148.675631	319.01	2.40	321.41
13	-32.287756	148.675647	319.34	2.40	321.74
14	-32.287760	148.675888	318.96	2.40	321.36
15	-32.286654	148.675907	320.17	2.40	322.57
16	-32.286656	148.676047	320.12	2.40	322.52

Route Receptor(s)

Name: Access Road
Route type Two-way
View angle: 90.0 deg

Vertex	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
1	-32.275925	148.677472	324.00	2.00	326.00
2	-32.276224	148.677247	323.98	2.00	325.98
3	-32.277068	148.677075	322.53	2.00	324.53
4	-32.280061	148.676560	320.29	2.00	322.29
5	-32.281512	148.676313	321.57	2.00	323.57

Name: Eulomogo Road
Route type Two-way
View angle: 90.0 deg

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-32.274339	148.675579	322.04	2.00	324.04
2	-32.274072	148.675909	322.47	2.00	324.47
3	-32.273877	148.676185	322.85	2.00	324.85
4	-32.273800	148.676344	322.95	2.00	324.95
5	-32.273444	148.677392	324.00	2.00	326.00
6	-32.273177	148.678202	324.72	2.00	326.72
7	-32.273041	148.678680	326.11	2.00	328.11
8	-32.272830	148.679483	330.19	2.00	332.19
9	-32.272712	148.680047	330.99	2.00	332.99
10	-32.272648	148.680454	330.73	2.00	332.73
11	-32.272657	148.680766	330.50	2.00	332.50
12	-32.272784	148.682021	329.37	2.00	331.37
13	-32.273143	148.684794	332.09	2.00	334.09
14	-32.273474	148.687558	332.31	2.00	334.31
15	-32.273954	148.691296	337.09	2.00	339.09
16	-32.274418	148.695083	345.84	2.00	347.84
17	-32.274799	148.698366	352.45	2.00	354.45
18	-32.275144	148.700426	360.20	2.00	362.20

Name: Mitchell Hwy
Route type Two-way
View angle: 90.0 deg

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-32.307667	148.717528	361.04	2.00	363.04
2	-32.300193	148.708052	361.34	2.00	363.34
3	-32.292690	148.698549	332.59	2.00	334.59
4	-32.275847	148.677482	324.00	2.00	326.00
5	-32.264489	148.663109	312.63	2.00	314.63
6	-32.262021	148.659828	310.57	2.00	312.57
7	-32.261448	148.658447	308.94	2.00	310.94
8	-32.261055	148.656899	308.28	2.00	310.28
9	-32.258247	148.637367	295.38	2.00	297.38

Name: Peachville Road
Route type Two-way
View angle: 90.0 deg

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-32.273826	148.676195	322.90	2.00	324.90
2	-32.272347	148.674361	320.75	2.00	322.75
3	-32.270786	148.672390	319.03	2.00	321.03
4	-32.270115	148.671590	317.00	2.00	319.00
5	-32.269720	148.671333	317.00	2.00	319.00
6	-32.268799	148.671403	317.27	2.00	319.27
7	-32.260605	148.672937	308.60	2.00	310.60

Name: Railway line
Route type Two-way
View angle: 90.0 deg

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-32.307036	148.717684	359.72	2.00	361.72
2	-32.302711	148.711954	361.31	2.00	363.31
3	-32.298221	148.706200	351.87	2.00	353.87
4	-32.294367	148.701415	339.88	2.00	341.88
5	-32.291084	148.697178	329.82	2.00	331.82
6	-32.287284	148.692435	337.27	2.00	339.27
7	-32.284862	148.689431	345.61	2.00	347.61
8	-32.280935	148.684400	335.40	2.00	337.40
9	-32.278957	148.681846	328.91	2.00	330.91
10	-32.276223	148.678464	324.70	2.00	326.70
11	-32.272748	148.674086	320.94	2.00	322.94
12	-32.268700	148.669028	314.31	2.00	316.31
13	-32.264291	148.663396	312.94	2.00	314.94
14	-32.259111	148.656883	305.73	2.00	307.73
15	-32.253576	148.649867	304.24	2.00	306.24

Name: Sheraton Road
Route type Two-way
View angle: 90.0 deg

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-32.259623	148.646183	301.69	2.00	303.69
2	-32.264232	148.645389	299.45	2.00	301.45
3	-32.268024	148.644638	298.76	2.00	300.76
4	-32.271145	148.644101	289.81	2.00	291.81
5	-32.272669	148.643780	285.52	2.00	287.52
6	-32.272886	148.645625	288.07	2.00	290.07
7	-32.273140	148.647256	292.36	2.00	294.36
8	-32.273249	148.648050	294.91	2.00	296.91
9	-32.273993	148.647942	293.36	2.00	295.36

PV Array Results

Summary of PV Glare Analysis PV configuration and predicted glare

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced	Data File
	deg	deg	min	min	kWh	
PV array 1	SA tracking	SA tracking	0	0	-	-

Click the name of the PV array to scroll to its results

PV & Receptor Analysis Results detailed results for each PV array and receptor

PV array 1 no glare found

Component	Green glare (min)	Yellow glare (min)
Route: Access Road	0	0
Route: Eulomogo Road	0	0
Route: Mitchell Hwy	0	0
Route: Peachville Road	0	0
Route: Railway line	0	0
Route: Sheraton Road	0	0

No glare found

Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values and results may vary.
- 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.
- Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
- 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.)
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
- Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
- Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
- Glare analysis methods used: OP V1, FP V1, Route V1
- Refer to the **Help page** for assumptions and limitations not listed here.

ForgeSolar

Site Configuration: DubboSF_Roads

Project site configuration details and results.

Created **March 4, 2021 2:11 a.m.**
Updated **March 4, 2021 2:29 a.m.**
DNI **varies** and peaks at **2,000.0 W/m^2**
Analyze every **1** minute(s)
0.5 ocular transmission coefficient
0.002 m pupil diameter
0.017 m eye focal length
9.3 mrad sun subtended angle
Timezone **UTC10**
Site Configuration ID: 50521.9053

Summary of Results No glare predicted!

PV Name	Tilt deg	Orientation deg	"Green" Glare min	"Yellow" Glare min	Energy Produced kWh
PV array 1	SA tracking	SA tracking	0	0	-

Component Data

PV Array(s)

Note: PV array encompasses a large surface area (greater than 25 acres). Accuracy of path receptor glare analysis may be affected by footprint size. Additional analyses of array sub-sections may provide more information on expected glare.

Name: PV array 1
Axis tracking: Single-axis rotation
Tracking axis orientation: 0.0 deg
Tracking axis tilt: 0.0 deg
Tracking axis panel offset: 0.0 deg
Maximum tracking angle: 60.0 deg
Resting angle: 5.0 deg
Rated power: -
Panel material: Smooth glass without AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 6.55 mrad
Approx. area: 116,882 sq-m

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-32.286057	148.676065	320.82	2.40	323.22
2	-32.286119	148.679311	323.95	2.40	326.35
3	-32.286831	148.679289	323.09	2.40	325.49
4	-32.286831	148.679091	323.03	2.40	325.43
5	-32.287669	148.679091	322.73	2.40	325.13
6	-32.287669	148.678737	321.85	2.40	324.25
7	-32.288663	148.678732	320.33	2.40	322.73
8	-32.288658	148.678892	320.56	2.40	322.96
9	-32.289570	148.678892	319.23	2.40	321.63
10	-32.289511	148.675448	316.99	2.40	319.39
11	-32.288608	148.675481	318.86	2.40	321.26
12	-32.288608	148.675631	319.01	2.40	321.41
13	-32.287756	148.675647	319.34	2.40	321.74
14	-32.287760	148.675888	318.96	2.40	321.36
15	-32.286654	148.675907	320.17	2.40	322.57
16	-32.286656	148.676047	320.12	2.40	322.52

Route Receptor(s)

Name: Access Road
Route type Two-way
View angle: 90.0 deg

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-32.275925	148.677472	324.00	2.00	326.00
2	-32.276224	148.677247	323.98	2.00	325.98
3	-32.277068	148.677075	322.53	2.00	324.53
4	-32.280061	148.676560	320.29	2.00	322.29
5	-32.281512	148.676313	321.57	2.00	323.57

Name: Eulomogo Road
Route type Two-way
View angle: 90.0 deg

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-32.274339	148.675579	322.04	2.00	324.04
2	-32.274072	148.675909	322.47	2.00	324.47
3	-32.273877	148.676185	322.85	2.00	324.85
4	-32.273800	148.676344	322.95	2.00	324.95
5	-32.273444	148.677392	324.00	2.00	326.00
6	-32.273177	148.678202	324.72	2.00	326.72
7	-32.273041	148.678680	326.11	2.00	328.11
8	-32.272830	148.679483	330.19	2.00	332.19
9	-32.272712	148.680047	330.99	2.00	332.99
10	-32.272648	148.680454	330.73	2.00	332.73
11	-32.272657	148.680766	330.50	2.00	332.50
12	-32.272784	148.682021	329.37	2.00	331.37
13	-32.273143	148.684794	332.09	2.00	334.09
14	-32.273474	148.687558	332.31	2.00	334.31
15	-32.273954	148.691296	337.09	2.00	339.09
16	-32.274418	148.695083	345.84	2.00	347.84
17	-32.274799	148.698366	352.45	2.00	354.45
18	-32.275144	148.700426	360.20	2.00	362.20

Name: Mitchell Hwy
Route type Two-way
View angle: 90.0 deg

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-32.307667	148.717528	361.04	2.00	363.04
2	-32.300193	148.708052	361.34	2.00	363.34
3	-32.292690	148.698549	332.59	2.00	334.59
4	-32.275847	148.677482	324.00	2.00	326.00
5	-32.264489	148.663109	312.63	2.00	314.63
6	-32.262021	148.659828	310.57	2.00	312.57
7	-32.261448	148.658447	308.94	2.00	310.94
8	-32.261055	148.656899	308.28	2.00	310.28
9	-32.258247	148.637367	295.38	2.00	297.38

Name: Peachville Road
Route type Two-way
View angle: 90.0 deg

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-32.273826	148.676195	322.90	2.00	324.90
2	-32.272347	148.674361	320.75	2.00	322.75
3	-32.270786	148.672390	319.03	2.00	321.03
4	-32.270115	148.671590	317.00	2.00	319.00
5	-32.269720	148.671333	317.00	2.00	319.00
6	-32.268799	148.671403	317.27	2.00	319.27
7	-32.260605	148.672937	308.60	2.00	310.60

Name: Railway line
Route type Two-way
View angle: 90.0 deg

Vertex	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
1	-32.307036	148.717684	359.72	2.00	361.72
2	-32.302711	148.711954	361.31	2.00	363.31
3	-32.298221	148.706200	351.87	2.00	353.87
4	-32.294367	148.701415	339.88	2.00	341.88
5	-32.291084	148.697178	329.82	2.00	331.82
6	-32.287284	148.692435	337.27	2.00	339.27
7	-32.284862	148.689431	345.61	2.00	347.61
8	-32.280935	148.684400	335.40	2.00	337.40
9	-32.278957	148.681846	328.91	2.00	330.91
10	-32.276223	148.678464	324.70	2.00	326.70
11	-32.272748	148.674086	320.94	2.00	322.94
12	-32.268700	148.669028	314.31	2.00	316.31
13	-32.264291	148.663396	312.94	2.00	314.94
14	-32.259111	148.656883	305.73	2.00	307.73
15	-32.253576	148.649867	304.24	2.00	306.24

Name: Sheraton Road
Route type Two-way
View angle: 90.0 deg

Vertex	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
1	-32.259623	148.646183	301.69	2.00	303.69
2	-32.264232	148.645389	299.45	2.00	301.45
3	-32.268024	148.644638	298.76	2.00	300.76
4	-32.271145	148.644101	289.81	2.00	291.81
5	-32.272669	148.643780	285.52	2.00	287.52
6	-32.272886	148.645625	288.07	2.00	290.07
7	-32.273140	148.647256	292.36	2.00	294.36
8	-32.273249	148.648050	294.91	2.00	296.91
9	-32.273993	148.647942	293.36	2.00	295.36

PV Array Results

Summary of PV Glare Analysis PV configuration and predicted glare

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced	Data File
	deg	deg	min	min	kWh	
PV array 1	SA tracking	SA tracking	0	0	-	-

Click the name of the PV array to scroll to its results

PV & Receptor Analysis Results detailed results for each PV array and receptor

PV array 1 no glare found

Component	Green glare (min)	Yellow glare (min)
Route: Access Road	0	0
Route: Eulomogo Road	0	0
Route: Mitchell Hwy	0	0
Route: Peachville Road	0	0
Route: Railway line	0	0
Route: Sheraton Road	0	0

No glare found

Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographi obstructions.
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values and results may vary.
- 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.
- Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
- 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. Addition analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on relate limitations.)
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
- Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
- Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
- Glare analysis methods used: OP V1, FP V1, Route V1
- Refer to the **Help page** for assumptions and limitations not listed here.

APPENDIX C:

SOLAR GLARE HAZARD ANALYSIS – FLIGHT PATHS

FORGESOLAR GLARE ANALYSIS

Project: **DubboSF**
Site configuration: **DubboSF_Aviation-temp-1**
Analysis conducted by Sian Crawford (sian@environmentalethos.com.au) at 10:11 on 04 Mar, 2021.

U.S. FAA 2013 Policy Adherence

The following table summarizes the policy adherence of the glare analysis based on the 2013 U.S. Federal Aviation Administration Interim Policy 78 FR 63276. This policy requires the following criteria be met for solar energy systems on airport property:

- No "yellow" glare (potential for after-image) for any flight path from threshold to 2 miles
- No glare of any kind for Air Traffic Control Tower(s) ("ATCT") at cab height.
- Default analysis and observer characteristics (see list below)

ForgeSolar does not represent or speak officially for the FAA and cannot approve or deny projects. Results are informational only.

COMPONENT	STATUS	DESCRIPTION
Analysis parameters	PASS	Analysis time interval and eye characteristics used are acceptable
2-mile flight path(s)	PASS	Flight path receptor(s) do not receive yellow glare
ATCT(s)	N/A	No ATCT receptors designated

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

FAA Policy 78 FR 63276 can be read at https://www.federalregister.gov/d/2013-24729

SITE CONFIGURATION

Analysis Parameters

DNI: peaks at 2,000.0 W/m^2
Time interval: 1 min
Ocular transmission coefficient: 0.5
Pupil diameter: 0.002 m
Eye focal length: 0.017 m
Sun subtended angle: 9.3 mrad
Site Config ID: 50527.9053

PV Array(s)

Name: PV array 1
Axis tracking: Single-axis rotation
Tracking axis orientation: 0.0°
Tracking axis tilt: 0.0°
Tracking axis panel offset: 0.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Rated power: -
Panel material: Smooth glass without 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	-32.286057	148.676065	320.82	2.40	323.22
2	-32.286119	148.679311	323.95	2.40	326.35
3	-32.286831	148.679289	323.09	2.40	325.49
4	-32.286831	148.679091	323.03	2.40	325.43
5	-32.287669	148.679091	322.73	2.40	325.13
6	-32.287669	148.678737	321.85	2.40	324.25
7	-32.288663	148.678732	320.33	2.40	322.73
8	-32.288658	148.678892	320.56	2.40	322.96
9	-32.289570	148.678892	319.23	2.40	321.63
10	-32.289511	148.675448	316.99	2.40	319.39
11	-32.288608	148.675481	318.86	2.40	321.26
12	-32.288608	148.675631	319.01	2.40	321.41
13	-32.287756	148.675647	319.34	2.40	321.74
14	-32.287760	148.675888	318.96	2.40	321.36
15	-32.286654	148.675907	320.17	2.40	322.57
16	-32.286656	148.676047	320.12	2.40	322.52

Flight Path Receptor(s)

Name: FP 1
Description:
Threshold height: 15 m
Direction: 54.7°
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	-32.222799	148.568814	284.86	15.24	300.10
Two-mile	-32.239519	148.540899	286.20	182.59	468.79

Name: FP 2
Description:
Threshold height: 15 m
Direction: 237.4°
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	-32.213708	148.583442	275.36	15.24	290.60
Two-mile	-32.198144	148.612275	257.31	201.98	459.29

Name: FP 3
Description:
Threshold height: 15 m
Direction: 118.2°
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	-32.214370	148.573420	277.42	15.24	292.66
Two-mile	-32.200708	148.543268	261.55	199.79	461.34

Name: FP 4
Description:
Threshold height: 15 m
Direction: 297.9°
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	-32.219026	148.583338	279.25	15.24	294.49
Two-mile	-32.232573	148.613565	264.66	198.52	463.18

GLARE ANALYSIS RESULTS

Summary of Glare

PV Array Name	Tilt (°)	Orient (°)	"Green" Glare min	"Yellow" Glare min	Energy kWh
PV array 1	SA tracking	SA tracking	0	0	-

Total annual glare received by each receptor

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
FP 1	0	0
FP 2	0	0
FP 3	0	0
FP 4	0	0

Results for: PV array 1

Receptor	Green Glare (min)	Yellow Glare (min)
FP 1	0	0

Receptor	Green Glare (min)	Yellow Glare (min)
FP 2	0	0
FP 3	0	0
FP 4	0	0

Flight Path: FP 1

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 2

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 3

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 4

0 minutes of yellow glare
0 minutes of green glare

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.
Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
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.)
Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual results and glare occurrence may differ.
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.
Refer to the Help page at **www.forgesolar.com/help/** for assumptions and limitations not listed here.

FORGESOLAR GLARE ANALYSIS

Project: **DubboSF**
Site configuration: **DubboSF_Aviation**
Analysis conducted by Sian Crawford (sian@environmentalethos.com.au) at 10:14 on 04 Mar, 2021.

U.S. FAA 2013 Policy Adherence

The following table summarizes the policy adherence of the glare analysis based on the 2013 U.S. Federal Aviation Administration Interim Policy 78 FR 63276. This policy requires the following criteria be met for solar energy systems on airport property:

- No "yellow" glare (potential for after-image) for any flight path from threshold to 2 miles
- No glare of any kind for Air Traffic Control Tower(s) ("ATCT") at cab height.
- Default analysis and observer characteristics (see list below)

ForgeSolar does not represent or speak officially for the FAA and cannot approve or deny projects. Results are informational only.

COMPONENT	STATUS	DESCRIPTION
Analysis parameters	PASS	Analysis time interval and eye characteristics used are acceptable
2-mile flight path(s)	PASS	Flight path receptor(s) do not receive yellow glare
ATCT(s)	N/A	No ATCT receptors designated

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

FAA Policy 78 FR 63276 can be read at https://www.federalregister.gov/d/2013-24729

SITE CONFIGURATION

Analysis Parameters

DNI: peaks at 2,000.0 W/m^2
Time interval: 1 min
Ocular transmission coefficient: 0.5
Pupil diameter: 0.002 m
Eye focal length: 0.017 m
Sun subtended angle: 9.3 mrad
Site Config ID: 50526.9053

PV Array(s)

Name: PV array 1
Axis tracking: Single-axis rotation
Tracking axis orientation: 0.0°
Tracking axis tilt: 0.0°
Tracking axis panel offset: 0.0°
Max tracking angle: 60.0°
Resting angle: 0.0°
Rated power: -
Panel material: Smooth glass without 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	-32.286057	148.676065	320.82	2.40	323.22
2	-32.286119	148.679311	323.95	2.40	326.35
3	-32.286831	148.679289	323.09	2.40	325.49
4	-32.286831	148.679091	323.03	2.40	325.43
5	-32.287669	148.679091	322.73	2.40	325.13
6	-32.287669	148.678737	321.85	2.40	324.25
7	-32.288663	148.678732	320.33	2.40	322.73
8	-32.288658	148.678892	320.56	2.40	322.96
9	-32.289570	148.678892	319.23	2.40	321.63
10	-32.289511	148.675448	316.99	2.40	319.39
11	-32.288608	148.675481	318.86	2.40	321.26
12	-32.288608	148.675631	319.01	2.40	321.41
13	-32.287756	148.675647	319.34	2.40	321.74
14	-32.287760	148.675888	318.96	2.40	321.36
15	-32.286654	148.675907	320.17	2.40	322.57
16	-32.286656	148.676047	320.12	2.40	322.52

Flight Path Receptor(s)

Name: FP 1
Description:
Threshold height: 15 m
Direction: 54.7°
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	-32.222799	148.568814	284.86	15.24	300.10
Two-mile	-32.239519	148.540899	286.20	182.59	468.79

Name: FP 2
Description:
Threshold height: 15 m
Direction: 237.4°
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	-32.213708	148.583442	275.36	15.24	290.60
Two-mile	-32.198144	148.612275	257.31	201.98	459.29

Name: FP 3
Description:
Threshold height: 15 m
Direction: 118.2°
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	-32.214370	148.573420	277.42	15.24	292.66
Two-mile	-32.200708	148.543268	261.55	199.79	461.34

Name: FP 4
Description:
Threshold height: 15 m
Direction: 297.9°
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	-32.219026	148.583338	279.25	15.24	294.49
Two-mile	-32.232573	148.613565	264.66	198.52	463.18

GLARE ANALYSIS RESULTS

Summary of Glare

PV Array Name	Tilt (°)	Orient (°)	"Green" Glare min	"Yellow" Glare min	Energy kWh
PV array 1	SA tracking	SA tracking	0	0	-

Total annual glare received by each receptor

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
FP 1	0	0
FP 2	0	0
FP 3	0	0
FP 4	0	0

Results for: PV array 1

Receptor	Green Glare (min)	Yellow Glare (min)
FP 1	0	0

Receptor	Green Glare (min)	Yellow Glare (min)
FP 2	0	0
FP 3	0	0
FP 4	0	0

Flight Path: FP 1

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 2

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 3

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 4

0 minutes of yellow glare
0 minutes of green glare

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.
Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
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.)
Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual results and glare occurrence may differ.
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.
Refer to the Help page at **www.forgesolar.com/help/** for assumptions and limitations not listed here.

FORGESOLAR GLARE ANALYSIS

Project: **DubboSF**
Site configuration: **DubboSF_Aviation**
Analysis conducted by Sian Crawford (sian@environmentalethos.com.au) at 09:36 on 04 Mar, 2021.

U.S. FAA 2013 Policy Adherence

The following table summarizes the policy adherence of the glare analysis based on the 2013 U.S. Federal Aviation Administration Interim Policy 78 FR 63276. This policy requires the following criteria be met for solar energy systems on airport property:

- No "yellow" glare (potential for after-image) for any flight path from threshold to 2 miles
- No glare of any kind for Air Traffic Control Tower(s) ("ATCT") at cab height.
- Default analysis and observer characteristics (see list below)

ForgeSolar does not represent or speak officially for the FAA and cannot approve or deny projects. Results are informational only.

COMPONENT	STATUS	DESCRIPTION
Analysis parameters	PASS	Analysis time interval and eye characteristics used are acceptable
2-mile flight path(s)	PASS	Flight path receptor(s) do not receive yellow glare
ATCT(s)	N/A	No ATCT receptors designated

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

FAA Policy 78 FR 63276 can be read at https://www.federalregister.gov/d/2013-24729

SITE CONFIGURATION

Analysis Parameters

DNI: peaks at 2,000.0 W/m^2
Time interval: 1 min
Ocular transmission coefficient: 0.5
Pupil diameter: 0.002 m
Eye focal length: 0.017 m
Sun subtended angle: 9.3 mrad
Site Config ID: 50525.9053

PV Array(s)

Name: PV array 1
Axis tracking: Single-axis rotation
Tracking axis orientation: 0.0°
Tracking axis tilt: 0.0°
Tracking axis panel offset: 0.0°
Max tracking angle: 60.0°
Resting angle: 60.0°
Rated power: -
Panel material: Smooth glass without 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	-32.286057	148.676065	320.82	2.40	323.22
2	-32.286119	148.679311	323.95	2.40	326.35
3	-32.286831	148.679289	323.09	2.40	325.49
4	-32.286831	148.679091	323.03	2.40	325.43
5	-32.287669	148.679091	322.73	2.40	325.13
6	-32.287669	148.678737	321.85	2.40	324.25
7	-32.288663	148.678732	320.33	2.40	322.73
8	-32.288658	148.678892	320.56	2.40	322.96
9	-32.289570	148.678892	319.23	2.40	321.63
10	-32.289511	148.675448	316.99	2.40	319.39
11	-32.288608	148.675481	318.86	2.40	321.26
12	-32.288608	148.675631	319.01	2.40	321.41
13	-32.287756	148.675647	319.34	2.40	321.74
14	-32.287760	148.675888	318.96	2.40	321.36
15	-32.286654	148.675907	320.17	2.40	322.57
16	-32.286656	148.676047	320.12	2.40	322.52

Flight Path Receptor(s)

Name: FP 1
Description:
Threshold height: 15 m
Direction: 54.7°
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	-32.222799	148.568814	284.86	15.24	300.10
Two-mile	-32.239519	148.540899	286.20	182.59	468.79

Name: FP 2
Description:
Threshold height: 15 m
Direction: 237.4°
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	-32.213708	148.583442	275.36	15.24	290.60
Two-mile	-32.198144	148.612275	257.31	201.98	459.29

Name: FP 3
Description:
Threshold height: 15 m
Direction: 118.2°
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	-32.214370	148.573420	277.42	15.24	292.66
Two-mile	-32.200708	148.543268	261.55	199.79	461.34

Name: FP 4
Description:
Threshold height: 15 m
Direction: 297.9°
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	-32.219026	148.583338	279.25	15.24	294.49
Two-mile	-32.232573	148.613565	264.66	198.52	463.18

GLARE ANALYSIS RESULTS

Summary of Glare

PV Array Name	Tilt (°)	Orient (°)	"Green" Glare min	"Yellow" Glare min	Energy kWh
PV array 1	SA tracking	SA tracking	0	0	-

Total annual glare received by each receptor

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
FP 1	0	0
FP 2	0	0
FP 3	0	0
FP 4	0	0

Results for: PV array 1

Receptor	Green Glare (min)	Yellow Glare (min)
FP 1	0	0

Receptor	Green Glare (min)	Yellow Glare (min)
FP 2	0	0
FP 3	0	0
FP 4	0	0

Flight Path: FP 1

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 2

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 3

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 4

0 minutes of yellow glare
0 minutes of green glare

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.
Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
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.)
Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual results and glare occurrence may differ.
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.
Refer to the Help page at **www.forgesolar.com/help/** for assumptions and limitations not listed here.