ENVIRONMENTAL ETHOS

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CHARAM SOLAR FARM

GLINT AND GLARE IMPACT ASSESSMENT REPORT

FINAL ISSUE

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Prepared For

GREEN GOLD ENERGY

August 2021

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Prepared By Environmental Ethos
for GREEN GOLD ENERGY

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EXECUTIVE SUMMARY

The Solar Energy Facilities Design and Development Guidelines, 2019, triggers the assessment of glint and glare resulting from solar farms including potential impacts to dwellings and roads within 1 km of a proposed facility, aviation infrastructure including any air traffic control tower or runway approach path close to a proposed facility, and any other receptor to which a responsible authority considers solar reflection may be a hazard.

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 impact assessment methodology. The assessment considered dwellings and roads within 2km of the Project.

The closest aviation infrastructure to the Project is Easthope Airport at approximately 25km to the west. Approach flight paths to the runways and the aviation control tower were not tested in the glare modelling, since the Project is outside the viewshed of the airport.

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

- No dwellings were identified within the Project's viewshed up to 2km from the site;
- No glare potential was found to affect local roads up to 2km from the Project;
- No glare potential was identified for local roads when the tracking system resting angle was set at 45 degrees – simulating a backtracking operation;
- No glare potential was identified when the PV modules resting angle was set at 5 degree simulating a backtracking operation advancing to its stowing angle (normally completed after dark).

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1. INTRODUCTION

This report has been prepared by Environmental Ethos on behalf of Green Gold Energy to assess the potential solar glint and glare impact of the proposed Charam Solar Farm (the Project), located at Goroke Harrow Road, Charam, Victoria. The Project comprises of the installation and operation of a solar farm up to 4.95MWp, which will utilise photovoltaic (PV) modules to generate electricity.

The footprint of the proposed PV arrays will cover an area of approximately 9.1 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 1.63 metres high when flat, rotating to approximately 2.63 metres maximum height.

1.1. Location

The Project site is located approximately 4.9 kilometres west of Wombelano, *refer Figure 1.* The Project site adjoins Charam-Wombelano Road on the northern boundary, which runs parallel to the Hume Freeway. The site is zoned FZ Farming Zone and is currently used for grazing. Farming is the predominant land use within the area.

Figure 1. Location Plan

The closet airport to the Project site is Edenhope, approximately 25km to the west of the Project Site. This facility is not within the viewshed of the Project and, at a distance greater than 10km from the site, it is not considered 'close'. Therefore flight paths were not included in this glare assessment.

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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 likely hazard 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 their height within the landscape,
  - Aviation infrastructure including any air traffic control tower or runway approach path close to the proposed facility,
  - Any other receptor to which a responsible authority considers solar reflection may be a hazard.

3. METHODOLOGY

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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]

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

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

The Solar Energy Facilities Design and Development Guidelines, 2019[2] (Development Guidelines), identifies the difference between glint and glare as intensity:

"Glint can be caused by direct reflection of the sun from the surface of an object, whereas glare is a continuous source of brightness. Glare is much less intense than glint."(p23)

This differentiation is consistent with the descriptions of glint and glare as:

- Glint being specular reflection, a momentary flash of light produced as a direct reflection of the sun in the surface of an object (such as a PV panel); and
- Glare being a continuous source of brightness relative to the ambient lighting, glare is not a direct reflection of the sun, but rather a reflection of the bright sky around the sun.

Solar Glare Hazard Analysis software evaluates the potential impact of light produced as a direct reflection of the sun from PV modules, this is consistent with the Development Guidelines reference to 'glint', as the more intense type of solar reflectivity. However, the FAA Guidelines refers to direct solar reflection from stationary objects such as fixed frame solar systems, or relatively slow moving objects such as solar tracking systems, as 'glare' since the source of the solar reflectance occurs over a long (not momentary) duration.

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). The assessment of direct solar reflectivity from PV modules addresses the Development Guidelines requirements to consider the impacts of glint (defined as the more intense solar reflectivity), and also glare as a reflection of light surrounding the sun.

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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.[3]

[2] The State of Victoria Department of Environment, Land, Water and Planning 2019, Solar Energy Facilities Design and Development GuidelineS

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

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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.

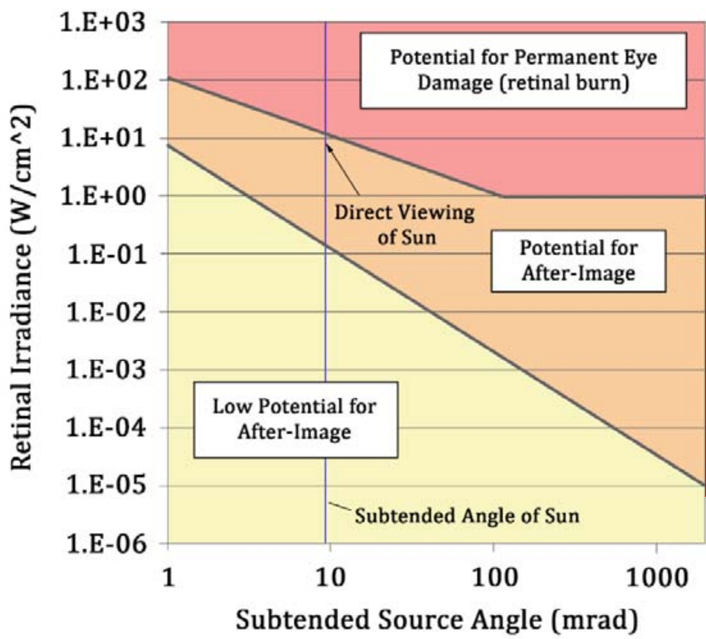

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Figure 2. Ocular impacts and Hazard Ranges[4]

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[5].

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.[6]

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

[4] Source: Solar Glare Hazard Analysis Tool (SGHAT) Presentation (2013) https://share.sandia.gov/phlux/static/references/glint-glare/SGHAT_Ho.pdf
[5] Sandia National Laboratory, SGHAT Technical Manual
[6] *Ho, C. 2013 Relieving a Glare Problem*

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.

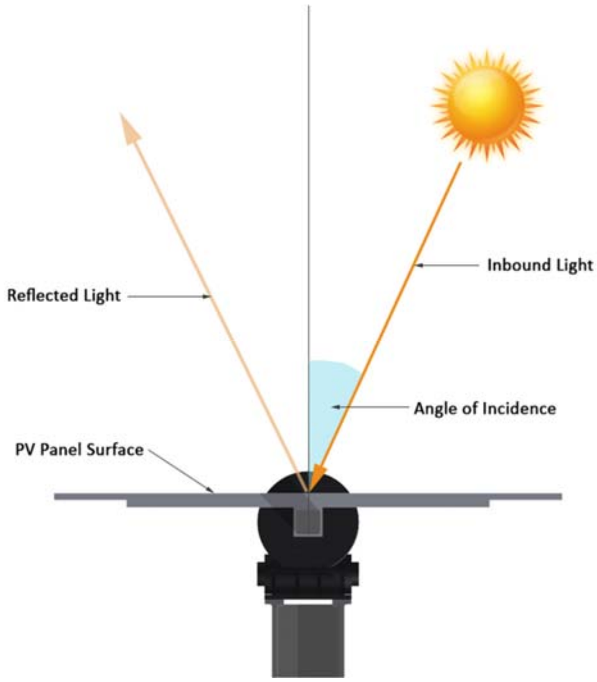

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Figure 3. Angle of Incidence Relative to PV Panel Surface

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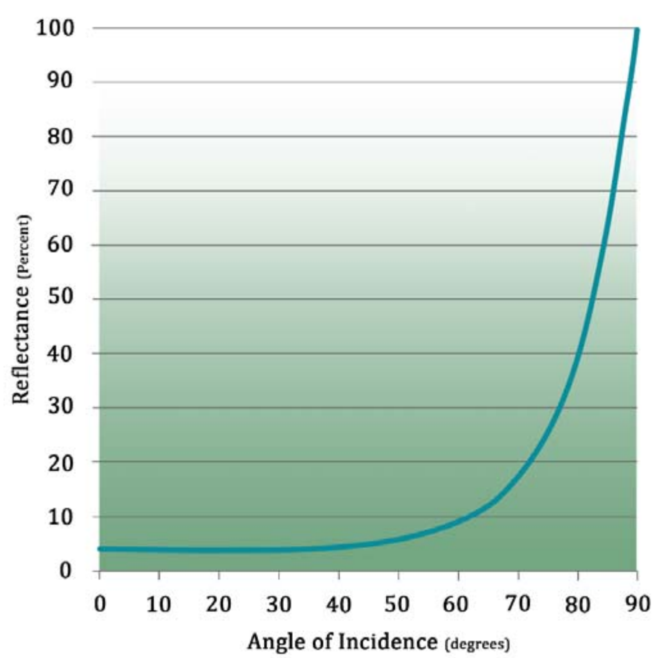

Figure 4. Angles of Incidence and Increased Levels of Reflected Light (Glass (n-1.5))

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.

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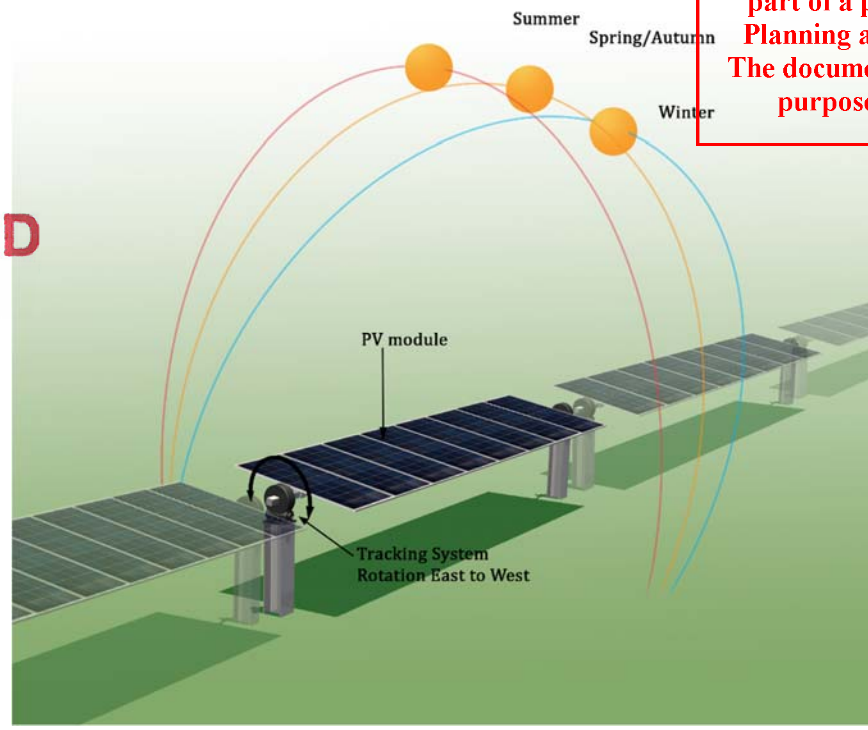

Figure 5. Diagrammatic illustration of sun position relative to PV module mounted on a horizontal single axis tracking system.

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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[7] 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.

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.

Resting Angles

A single axis horizontal tracking system can be programed to operate a 'backtracking' procedure (*refer section 3.4*). 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.

SGHAT software does not currently model backtracking, however it does 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 reached.

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

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Route Parameters

The assessment of potential glare impacts to route receptors, people travelling along roads and rail, includes the parameters of direction of travel (single or both directions) and field-of-view (FOV). FOV defines the left and right field-of-view of observers traveling along a route. A view angle of 90° means the observer has a field-of-view of 90° to their left and right, i.e. a total FOV of 180°, refer *Figure 6.*

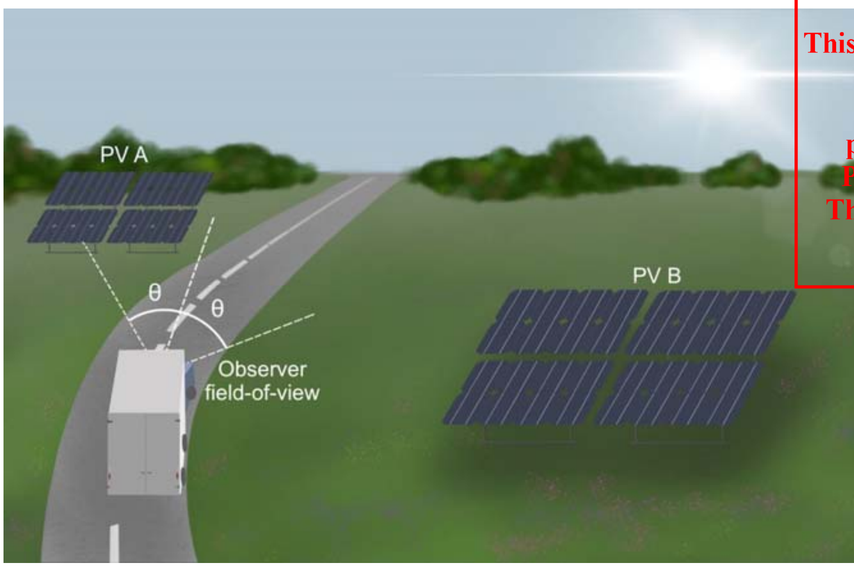

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Figure 6. Diagrammatic illustration of Observer Field of View relative to PV array (source: ForgeSolar).

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

SGHAT default parameters is FOV 50°, this assessment increased the FOV to 90°, representing a conservative assessment of potential hazard to drivers using roads and rail network within the vicinity of the solar farm.

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3.7. Hazard Assessment

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

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

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are also considered to identify residual glare potential. An assessment is then undertaken to identify the potential significance of the glare hazard based on the magnitude (amount and intensity) of the glare hazard generated, duration and frequency, distance from the Project, and the sensitivity of the receptors (viewers). Additional mitigation measures, beyond those previously considered as part of the Project, are recommended to avoid, reduce or manage the identified risks.

3.8. Limitations to the assessment

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

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

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

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

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

4. EXISTING CONDITIONS

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

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

4.1. Baseline Conditions

The Project site is located within the Wimmera Plains landscape region, which is characterised by the numerous lakes and wetlands scattered across the relatively flat plain. The site and surrounding area is used for grazing, with some areas of cropping. Large areas of State Forest are also characteristic of the area. Vegetation along the roads immediately adjoining the Project site consists of scattered native trees in the south eastern corner, with little to no screening along the south and western boundaries.

The area is sparsely populated and no rural or residential dwellings were identified within 2km of the Project.

Constructed elements within the landscape include roads, rural buildings (sheds), and transmission lines.

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Existing features in the landscape with the potential to contribute to glare include water bodies and the wetlands, which may contribute to glare when holding water. Generally, these wetlands are surrounded by native trees, and support vegetation such as sedges and reeds, the contribution to glare is dependent on the amount of water held which varies dependent on climatic conditions.

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 Horsham Polkemmet Road weather station 58 km north east of the Project site (the closest BOM records for cloud cover statistics) recorded 141 cloudy days per year (mean number over the period 1957 to 2008)[9]. Cloudy days predominantly occur during the winter months, May to September. 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 7.* 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 current selected panels for this Project are 2256 x 1133 x 35 mm. The proposed solar array arrangement for this Project is one (1) solar panels in portrait, resulting in an array width of approximately 2.3 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° (+/- 45°) or 120° (+/- 60°) depending on the system used. The Project modelling utilised a rotation range of 120° (+/- 60°), refer *Figure 8.*

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[9] http://www.bom.gov.au/climate/averages/tables/cw_079023.shtml

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LOCATION PLAN (N.T.S)

NOTES

1. ACTUAL DIMENSIONS AND CLEARANCES MAY VARY SUBJECT TO SITE CONDITIONS.
2. DIMENSIONS OF ELECTRICAL EQUIPMENT ARE INDICATIVE ONLY. ACTUAL DIMENSIONS TO BE CONFIRMED.
3. LOCATION OF POWERCOR 22kV OVERHEAD LINE AND SYSTEM CONNECTION POINT TO BE CONFIRMED.
4. EXISTING POWERCOR 22kV POLE IS FOR ILLUSTRATION ONLY. ACTUAL POSITION IS SUBJECT TO THE ACTUAL MEASUREMENT ON SITE.
5. SITE STORAGE AND AMENITY FACILITIES TO BE ON SITE ONLY DURING CONSTRUCTION PHASE. NO PERMANENT BUILDINGS TO BE KEPT ON SITE AFTER CONSTRUCTION COMPLETED.

LEGEND

- PROPOSED PV ARRAY
- SECURITY FENCE
- PROPERTY BOUNDARY

SYSTEM SPECIFICATIONS				
DC	6.16	MW	TOTAL MODULES	12312
MODULE CAPACITY	500	W	MODULES PER STRING	19
NUMBER OF INVERTERS	2	-	NUMBER OF STRINGS	648
INVERTER MODEL	SMA 2475	-	MODULE MODEL	RSM150-8

SOURCE: GREEN GOLD ENERGY
SITE PLAN
REV. D 20/07/2021

PROJECT NO. 20008
CREATED BY: SC
DATE: 14 08 2021
VERSION: A

CHARAM SOLAR FARM

GLINT AND GLARE IMPACT ASSESSMENT

PROJECT LAYOUT PLAN

FIGURE 7.0

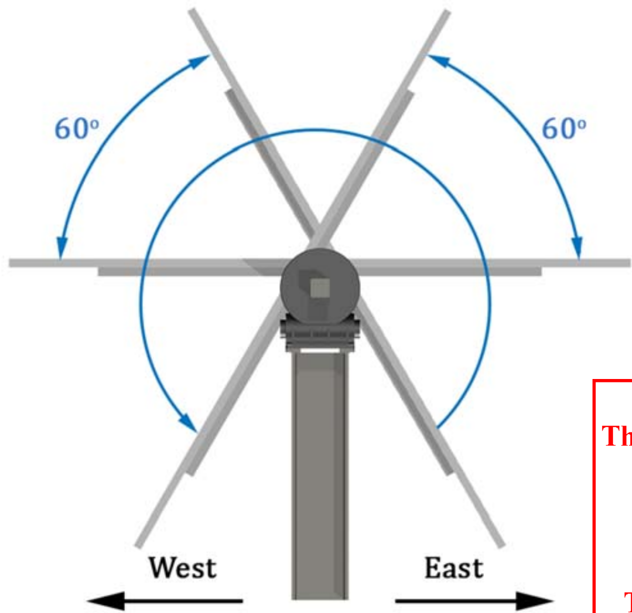

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Figure 8. Illustration of PV Module Rotation Angles

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 2.63 metres (1.63 metres when the panels are held at 0 degrees (flat) and 2.63 metres at maximum tilt). A height of 1.7 metres at the centroid 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.

The configuration of the tracking system rows vary slightly dependent on the type of system used, generally rows are approximately 5-7 metres apart, 6 metres is the current proposed distance (pitch) between piers. *Figure 9* and *Plate 1* show a typical layout for a horizontal single axis tracking system.

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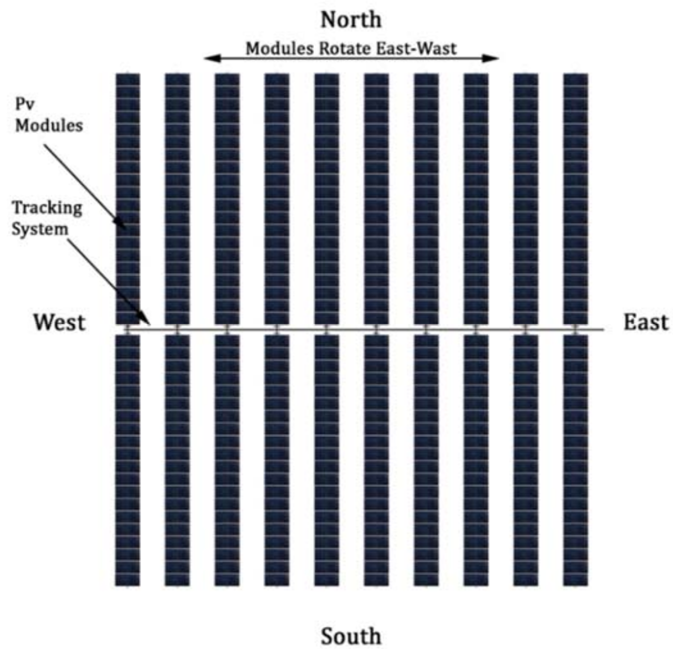

Figure 9. Illustration of PV Module Row Alignment

Plate 1. Example of a typical frameless solar array mounted on a single axis tracking system[10]

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.

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

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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 10.*

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.

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 2.7 metres above ground level was used in the modelling. At distances greater than 1 km a 2.7 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 visibility assessment identified the Project is screened by slightly undulating terrain to the east and west. The Project was identified as potentially visible to the north and south.

No dwellings were identified within the viewshed up to 2km from the Project site

Two (2) roads pass through the viewshed and these were included in the glare modelling, as follows:

- Charam Wombelano Road
- Harrow Goroke Road

Edenhope Airport is the closest aviation facilities to the Project at approximately 25km to the west of the Project site. Approach flight paths to the runways and the aviation control tower were not tested in the glare modelling, since the Project is outside the viewshed of the airport.

The potential glare hazard impact surrounding local roads have been assessed in *Section 6.3.*

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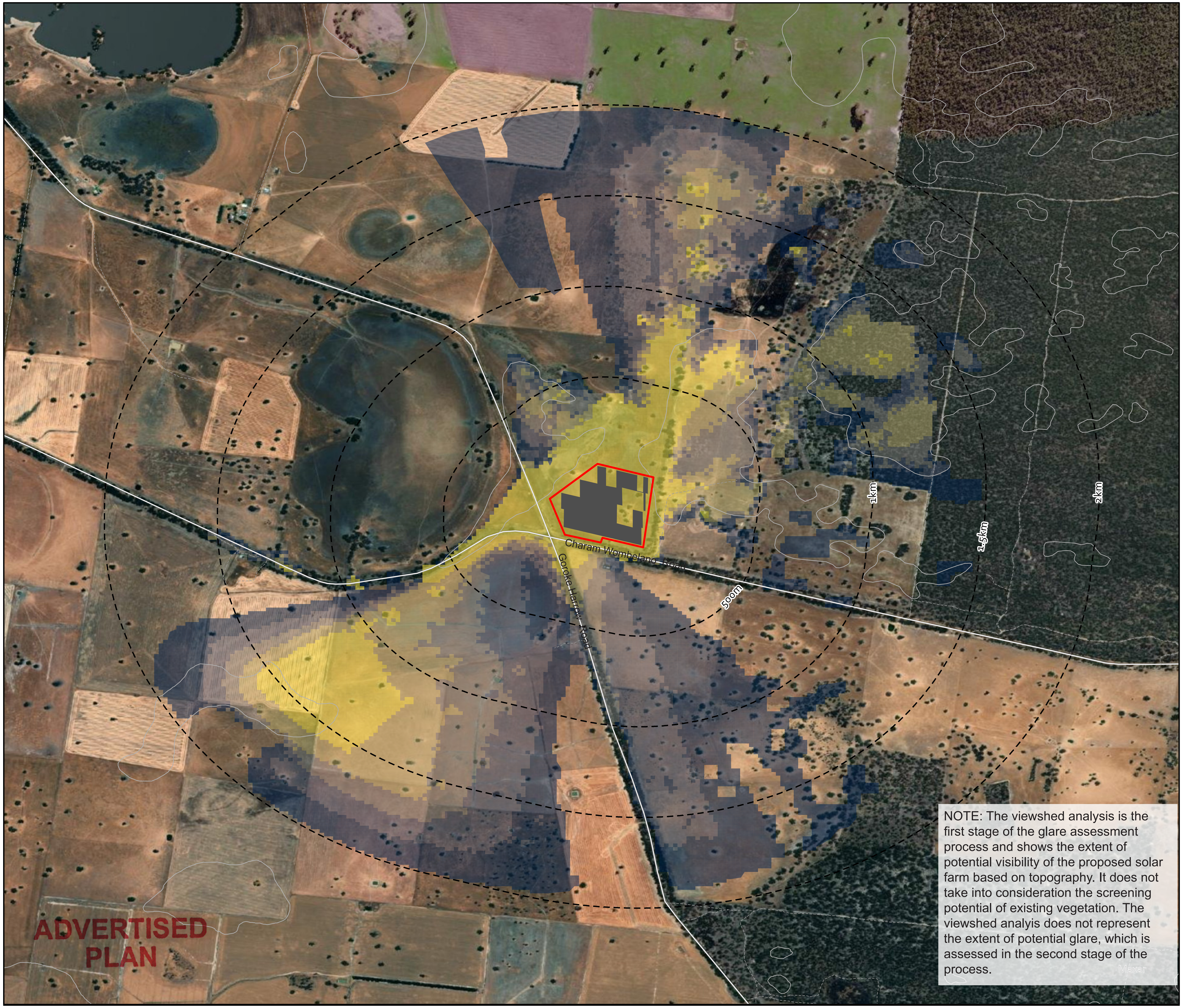
6.2. Solar Glare Hazard Analysis

The parameters used in the SGHAT model are detailed in *Tables 1.*

Table 1. 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



NOTE: The viewshed analysis is the first stage of the glare assessment process and shows the extent of potential visibility of the proposed solar farm based on topography. It does not take into consideration the screening potential of existing vegetation. The viewshed analyis does not represent the extent of potential glare, which is assessed in the second stage of the process.

ENVIRONMENTAL ETHOS

N

DATUM GDA 1994,
PROJECTION MGA ZONE 56

0 0.25 0.5 1 Kilometers

SCALE 1:20,000 @ A3

Legend

- SITE BOUNDARY
- PV MODULE AREA
- DISTANCE FROM SOLAR FARM
- EXTENT OF VISIBILITY*
  - Less visible
  - More visible

*(Analysis based on Digital Terrain Model)

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

PROJECT No. 20008
CREATED BY: SC
DATE: 13 08 2021
VERSION: A

CHARAM SOLAR FARM

GLINT AND GLARE ASSESSMENT

VIEWSHED ANALYSIS

FIGURE 10.0

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	1.7m to centroid

The proposed operational procedures of the Project tracking system were modelled based on the PV panels rotating to a maximum tilt of 60 degrees and held at 60 degrees. In addition, various 'typical' resting and stowing angles were tested in the model to assess the potential implications of changing these variables, and also identifying (in a preliminary manner) limitations should a backtracking procedure be considered in the future. As noted previously, modelling resting angles is not a true representation of a backtracking procedure since it assumes the PV models will revert immediately to the resting angle whereas in in reality this process would track gradually, therefore the model represents a worst case scenario.

6.3. Solar Glare Hazard Analysis Tool (SGHAT) Results

The assessment outcomes for the SGHAT modelling are detailed in *Appendix A* and outlined in *Table 2*.

Table 2. SGHAT Assessment Results – Horizontal Single Axis Tracking System (Resting angle 60 degrees)

Sensitive Receptor	Glare Potential
Charam Wombelano Road	No Glare
Harrow Goroke Road	No Glare

The SGHAT modelling identified no glare hazard potential is likely to affect travellers along both local roads within the Project viewshed, *refer Appendix A.*

Various resting angles were tested in the model to provide some assessment of potential glare hazard should a backtracking operation be considered, the results of this assessment are presented in *Table 3.*

Table 3. SGHAT Assessment Results – Resting Angle Analysis of 45 and 5 degrees

Sensitive Receptor	Resting Angle 45 degrees *- Glare Potential	Stowing Angle 5 degrees **- Glare Potential
Charam Wombelano Road	No Glare	No Glare
Harrow Goroke Road	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.

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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 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 dwellings were identified within the Project's viewshed up to 2km from the site;
- No glare potential was found to affect local roads up to 2km from the Project;
- No glare potential was identified for local roads when the tracking system resting angle was set at 45 degrees – simulating a backtracking operation;
- No glare potential was identified when the PV modules resting angle was set at 5 degree simulating a backtracking operation advancing to its stowing angle (normally completed after dark).
- Easthope Airport is the closest aviation facilities to the Project at approximately 25km to the west of the Project site. Approach flight paths to the runways and the aviation control tower were not tested in the glare modelling, since the Project is outside the viewshed of the airport.

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APPENDIX A:

SOLAR GLARE HAZARD ANALYSIS – TRANSPORT ROUTES

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ForgeSolar

Charam Solar Farm

Charam Solar Farm - Roads

Created Aug. 12, 2021
Updated Aug. 12, 2021
Time-step 1 minute
Timezone offset UTC10
Site ID 57328.10250

Project type Advanced
Project status: active
Category 1 MW to 5 MW

Misc. Analysis Settings

DNI: **varies (2,000.0 W/m^2 peak)**
Ocular transmission coefficient: **0.5**
Pupil diameter: **0.002 m**
Eye focal length: **0.017 m**
Sun subtended angle: **9.3 mrad**

Analysis Methodologies:

- Observation point: **Version 2**
- 2-Mile Flight Path: **Version 2**
- Route: **Version 2**

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	-

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Component Data

PV Array(s)

Total PV footprint area: 95,612 m^2

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
Footprint area: 95,612 m^2
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

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-36.992507	141.547247	177.34	1.70	179.04
2	-36.991603	141.547304	179.05	1.70	180.75
3	-36.991588	141.547135	179.10	1.70	180.80
4	-36.990693	141.547175	180.75	1.70	182.45
5	-36.990783	141.547974	178.05	1.70	179.75
6	-36.990095	141.548009	178.54	1.70	180.24
7	-36.990185	141.548747	177.62	1.70	179.32
8	-36.989572	141.548790	177.73	1.70	179.43
9	-36.989641	141.549318	178.88	1.70	180.58
10	-36.990266	141.549267	179.06	1.70	180.76
11	-36.990335	141.549833	179.93	1.70	181.63
12	-36.989707	141.549887	178.36	1.70	180.06
13	-36.989878	141.550938	178.62	1.70	180.32
14	-36.990746	141.550844	181.16	1.70	182.86
15	-36.990798	141.551236	181.50	1.70	183.20
16	-36.989953	141.551311	179.61	1.70	181.31
17	-36.990011	141.551668	180.95	1.70	182.65
18	-36.990872	141.551598	182.24	1.70	183.94
19	-36.990851	141.551456	181.96	1.70	183.66
20	-36.991642	141.551394	182.15	1.70	183.85
21	-36.991616	141.551239	182.00	1.70	183.70
22	-36.990823	141.551306	181.62	1.70	183.32
23	-36.990688	141.550206	180.68	1.70	182.38
24	-36.991451	141.550179	181.82	1.70	183.52
25	-36.991412	141.549868	181.40	1.70	183.10
26	-36.992308	141.549779	180.28	1.70	181.98
27	-36.992524	141.550876	182.24	1.70	183.94
28	-36.991691	141.550925	182.00	1.70	183.70
29	-36.991777	141.551306	182.22	1.70	183.92
30	-36.992631	141.551300	183.44	1.70	185.14
31	-36.992610	141.551201	183.19	1.70	184.89
32	-36.993377	141.551169	184.95	1.70	186.65

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Route Receptor(s)

Name: Charam Wombelano 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	-36.999227	141.574211	178.57	2.00	180.57
2	-36.998130	141.569233	179.14	2.00	181.14
3	-36.997179	141.564802	183.25	2.00	185.25
4	-36.995928	141.559448	185.32	2.00	187.32
5	-36.994582	141.553440	184.93	2.00	186.93
6	-36.993331	141.547990	178.64	2.00	180.64
7	-36.993006	141.546627	177.99	2.00	179.99
8	-36.992783	141.545512	177.19	2.00	179.19
9	-36.992714	141.544846	177.63	2.00	179.63
10	-36.992792	141.544117	177.54	2.00	179.54
11	-36.992997	141.543441	177.45	2.00	179.45
12	-36.994180	141.541531	182.28	2.00	184.28
13	-36.994711	141.540415	181.66	2.00	183.66
14	-36.994814	141.539879	180.47	2.00	182.47
15	-36.995354	141.536360	179.28	2.00	181.28
16	-36.995251	141.535351	180.32	2.00	182.32
17	-36.994829	141.534276	182.30	2.00	184.30
18	-36.992680	141.529644	183.02	2.00	185.02
19	-36.990287	141.524497	180.04	2.00	182.04

Name: Goroke Harrow 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	-37.011011	141.552374	183.51	2.00	185.51
2	-37.010437	141.552202	181.69	2.00	183.69
3	-37.008792	141.551795	182.75	2.00	184.75
4	-37.007199	141.551419	182.68	2.00	184.68
5	-37.005057	141.550657	181.04	2.00	183.04
6	-37.003420	141.550089	183.66	2.00	185.66
7	-37.001055	141.549327	184.80	2.00	186.80
8	-36.999547	141.548855	183.68	2.00	185.68
9	-36.997611	141.548200	180.51	2.00	182.51
10	-36.994723	141.547299	177.93	2.00	179.93
11	-36.993284	141.546720	177.76	2.00	179.76
12	-36.992589	141.546419	177.99	2.00	179.99
13	-36.987593	141.544413	180.08	2.00	182.08
14	-36.985057	141.543383	178.46	2.00	180.46
15	-36.983805	141.542847	177.53	2.00	179.53
16	-36.982966	141.542182	177.95	2.00	179.95
17	-36.982537	141.541516	179.63	2.00	181.63
18	-36.981954	141.539821	178.87	2.00	180.87
19	-36.980446	141.535379	178.53	2.00	180.53
20	-36.979015	141.530938	175.22	2.00	177.22

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Summary of PV Glare Analysis

PV configuration and total 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	-	

PV & Receptor Analysis Results

Results for each PV array and receptor

PV array 1 no glare found

Component	Green glare (min)	Yellow glare (min)
Route: Charam Wombelano Road	0	0
Route: Goroke Harrow Road	0	0

No glare found

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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. Actu 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 V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
- 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 combine 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.
- Refer to the **Help page** for detailed assumptions and limitations not listed here.

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ForgeSolar

Charam Solar Farm

Charam Solar Farm - Roads

Created Aug. 12, 2021
Updated Aug. 14, 2021
Time-step 1 minute
Timezone offset UTC10
Site ID 57328.10250

Project type Advanced
Project status: active
Category 1 MW to 5 MW

Misc. Analysis Settings

DNI: **varies (2,000.0 W/m^2 peak)**
Ocular transmission coefficient: **0.5**
Pupil diameter: **0.002 m**
Eye focal length: **0.017 m**
Sun subtended angle: **9.3 mrad**

Analysis Methodologies:
- Observation point: **Version 2**
- 2-Mile Flight Path: **Version 2**
- Route: **Version 2**

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	-

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Component Data

PV Array(s)

Total PV footprint area: 95,612 m^2

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
Footprint area: 95,612 m^2
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

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-36.992507	141.547247	177.34	1.70	179.04
2	-36.991603	141.547304	179.05	1.70	180.75
3	-36.991588	141.547135	179.10	1.70	180.80
4	-36.990693	141.547175	180.75	1.70	182.45
5	-36.990783	141.547974	178.05	1.70	179.75
6	-36.990095	141.548009	178.54	1.70	180.24
7	-36.990185	141.548747	177.62	1.70	179.32
8	-36.989572	141.548790	177.73	1.70	179.43
9	-36.989641	141.549318	178.88	1.70	180.58
10	-36.990266	141.549267	179.06	1.70	180.76
11	-36.990335	141.549833	179.93	1.70	181.63
12	-36.989707	141.549887	178.36	1.70	180.06
13	-36.989878	141.550938	178.62	1.70	180.32
14	-36.990746	141.550844	181.16	1.70	182.86
15	-36.990798	141.551236	181.50	1.70	183.20
16	-36.989953	141.551311	179.61	1.70	181.31
17	-36.990011	141.551668	180.95	1.70	182.65
18	-36.990872	141.551598	182.24	1.70	183.94
19	-36.990851	141.551456	181.96	1.70	183.66
20	-36.991642	141.551394	182.15	1.70	183.85
21	-36.991616	141.551239	182.00	1.70	183.70
22	-36.990823	141.551306	181.62	1.70	183.32
23	-36.990688	141.550206	180.68	1.70	182.38
24	-36.991451	141.550179	181.82	1.70	183.52
25	-36.991412	141.549868	181.40	1.70	183.10
26	-36.992308	141.549779	180.28	1.70	181.98
27	-36.992524	141.550876	182.24	1.70	183.94
28	-36.991691	141.550925	182.00	1.70	183.70
29	-36.991777	141.551306	182.22	1.70	183.92
30	-36.992631	141.551300	183.44	1.70	185.14
31	-36.992610	141.551201	183.19	1.70	184.89
32	-36.993377	141.551169	184.95	1.70	186.65

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Route Receptor(s)

Name: Charam Wombelano 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	-36.999227	141.574211	178.57	2.00	180.57
2	-36.998130	141.569233	179.14	2.00	181.14
3	-36.997179	141.564802	183.25	2.00	185.25
4	-36.995928	141.559448	185.32	2.00	187.32
5	-36.994582	141.553440	184.93	2.00	186.93
6	-36.993331	141.547990	178.64	2.00	180.64
7	-36.993006	141.546627	177.99	2.00	179.99
8	-36.992783	141.545512	177.19	2.00	179.19
9	-36.992714	141.544846	177.63	2.00	179.63
10	-36.992792	141.544117	177.54	2.00	179.54
11	-36.992997	141.543441	177.45	2.00	179.45
12	-36.994180	141.541531	182.28	2.00	184.28
13	-36.994711	141.540415	181.66	2.00	183.66
14	-36.994814	141.539879	180.47	2.00	182.47
15	-36.995354	141.536360	179.28	2.00	181.28
16	-36.995251	141.535351	180.32	2.00	182.32
17	-36.994829	141.534276	182.30	2.00	184.30
18	-36.992680	141.529644	183.02	2.00	185.02
19	-36.990287	141.524497	180.04	2.00	182.04

Name: Goroke Harrow 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	-37.011011	141.552374	183.51	2.00	185.51
2	-37.010437	141.552202	181.69	2.00	183.69
3	-37.008792	141.551795	182.75	2.00	184.75
4	-37.007199	141.551419	182.68	2.00	184.68
5	-37.005057	141.550657	181.04	2.00	183.04
6	-37.003420	141.550089	183.66	2.00	185.66
7	-37.001055	141.549327	184.80	2.00	186.80
8	-36.999547	141.548855	183.68	2.00	185.68
9	-36.997611	141.548200	180.51	2.00	182.51
10	-36.994723	141.547299	177.93	2.00	179.93
11	-36.993284	141.546720	177.76	2.00	179.76
12	-36.992589	141.546419	177.99	2.00	179.99
13	-36.987593	141.544413	180.08	2.00	182.08
14	-36.985057	141.543383	178.46	2.00	180.46
15	-36.983805	141.542847	177.53	2.00	179.53
16	-36.982966	141.542182	177.95	2.00	179.95
17	-36.982537	141.541516	179.63	2.00	181.63
18	-36.981954	141.539821	178.87	2.00	180.87
19	-36.980446	141.535379	178.53	2.00	180.53
20	-36.979015	141.530938	175.22	2.00	177.22

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Summary of PV Glare Analysis

PV configuration and total 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	-	

PV & Receptor Analysis Results

Results for each PV array and receptor

PV array 1 no glare found

Component	Green glare (min)	Yellow glare (min)
Route: Charam Wombelano Road	0	0
Route: Goroke Harrow Road	0	0

No glare found

ADVERTISED PLAN

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. Actu: 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 V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
- 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 combine 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.
- Refer to the **Help page** for detailed assumptions and limitations not listed here.

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ForgeSolar

Charam Solar Farm

Charam Solar Farm - Roads

Created Aug. 12, 2021
Updated Aug. 14, 2021
Time-step 1 minute
Timezone offset UTC10
Site ID 57328.10250

Project type Advanced
Project status: active
Category 1 MW to 5 MW

Misc. Analysis Settings

DNI: **varies (2,000.0 W/m^2 peak)**
Ocular transmission coefficient: **0.5**
Pupil diameter: **0.002 m**
Eye focal length: **0.017 m**
Sun subtended angle: **9.3 mrad**

Analysis Methodologies:
- Observation point: **Version 2**
- 2-Mile Flight Path: **Version 2**
- Route: **Version 2**

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	-

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Component Data

PV Array(s)

Total PV footprint area: 95,612 m^2

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
Footprint area: 95,612 m^2
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

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-36.992507	141.547247	177.34	1.70	179.04
2	-36.991603	141.547304	179.05	1.70	180.75
3	-36.991588	141.547135	179.10	1.70	180.80
4	-36.990693	141.547175	180.75	1.70	182.45
5	-36.990783	141.547974	178.05	1.70	179.75
6	-36.990095	141.548009	178.54	1.70	180.24
7	-36.990185	141.548747	177.62	1.70	179.32
8	-36.989572	141.548790	177.73	1.70	179.43
9	-36.989641	141.549318	178.88	1.70	180.58
10	-36.990266	141.549267	179.06	1.70	180.76
11	-36.990335	141.549833	179.93	1.70	181.63
12	-36.989707	141.549887	178.36	1.70	180.06
13	-36.989878	141.550938	178.62	1.70	180.32
14	-36.990746	141.550844	181.16	1.70	182.86
15	-36.990798	141.551236	181.50	1.70	183.20
16	-36.989953	141.551311	179.61	1.70	181.31
17	-36.990011	141.551668	180.95	1.70	182.65
18	-36.990872	141.551598	182.24	1.70	183.94
19	-36.990851	141.551456	181.96	1.70	183.66
20	-36.991642	141.551394	182.15	1.70	183.85
21	-36.991616	141.551239	182.00	1.70	183.70
22	-36.990823	141.551306	181.62	1.70	183.32
23	-36.990688	141.550206	180.68	1.70	182.38
24	-36.991451	141.550179	181.82	1.70	183.52
25	-36.991412	141.549868	181.40	1.70	183.10
26	-36.992308	141.549779	180.28	1.70	181.98
27	-36.992524	141.550876	182.24	1.70	183.94
28	-36.991691	141.550925	182.00	1.70	183.70
29	-36.991777	141.551306	182.22	1.70	183.92
30	-36.992631	141.551300	183.44	1.70	185.14
31	-36.992610	141.551201	183.19	1.70	184.89
32	-36.993377	141.551169	184.95	1.70	186.65

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Route Receptor(s)

Name: Charam Wombelano 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	-36.999227	141.574211	178.57	2.00	180.57
2	-36.998130	141.569233	179.14	2.00	181.14
3	-36.997179	141.564802	183.25	2.00	185.25
4	-36.995928	141.559448	185.32	2.00	187.32
5	-36.994582	141.553440	184.93	2.00	186.93
6	-36.993331	141.547990	178.64	2.00	180.64
7	-36.993006	141.546627	177.99	2.00	179.99
8	-36.992783	141.545512	177.19	2.00	179.19
9	-36.992714	141.544846	177.63	2.00	179.63
10	-36.992792	141.544117	177.54	2.00	179.54
11	-36.992997	141.543441	177.45	2.00	179.45
12	-36.994180	141.541531	182.28	2.00	184.28
13	-36.994711	141.540415	181.66	2.00	183.66
14	-36.994814	141.539879	180.47	2.00	182.47
15	-36.995354	141.536360	179.28	2.00	181.28
16	-36.995251	141.535351	180.32	2.00	182.32
17	-36.994829	141.534276	182.30	2.00	184.30
18	-36.992680	141.529644	183.02	2.00	185.02
19	-36.990287	141.524497	180.04	2.00	182.04

Name: Goroke Harrow 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	-37.011011	141.552374	183.51	2.00	185.51
2	-37.010437	141.552202	181.69	2.00	183.69
3	-37.008792	141.551795	182.75	2.00	184.75
4	-37.007199	141.551419	182.68	2.00	184.68
5	-37.005057	141.550657	181.04	2.00	183.04
6	-37.003420	141.550089	183.66	2.00	185.66
7	-37.001055	141.549327	184.80	2.00	186.80
8	-36.999547	141.548855	183.68	2.00	185.68
9	-36.997611	141.548200	180.51	2.00	182.51
10	-36.994723	141.547299	177.93	2.00	179.93
11	-36.993284	141.546720	177.76	2.00	179.76
12	-36.992589	141.546419	177.99	2.00	179.99
13	-36.987593	141.544413	180.08	2.00	182.08
14	-36.985057	141.543383	178.46	2.00	180.46
15	-36.983805	141.542847	177.53	2.00	179.53
16	-36.982966	141.542182	177.95	2.00	179.95
17	-36.982537	141.541516	179.63	2.00	181.63
18	-36.981954	141.539821	178.87	2.00	180.87
19	-36.980446	141.535379	178.53	2.00	180.53
20	-36.979015	141.530938	175.22	2.00	177.22

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Summary of PV Glare Analysis

PV configuration and total 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	-	

PV & Receptor Analysis Results

Results for each PV array and receptor

PV array 1 no glare found

Component	Green glare (min)	Yellow glare (min)
Route: Charam Wombelano Road	0	0
Route: Goroke Harrow Road	0	0

No glare found

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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. Actu 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 V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
- 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 combine 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.
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