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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 the Bendigo Gliding Club at 4.2km to the east of the Project site, runway approach paths were assessed as part of the glare modelling. The gliding club does not have a traffic control tower therefore this aviation infrastructure element is not applicable to the assessment.

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

- No glare potential was found to affect dwellings and roads within 1km of the Project when the solar farm is operating normally using a horizontal single axis tracking system;
- In addition, no glare potential was found to affect dwellings and roads up to 2km from the Project;
- No glare potential was identified for dwellings and 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).
- No glare potential was found to affect runway approach paths at Bendigo Gliding Club, when the solar farm is operating normally using a horizontal single axis tracking system.

Under normal operation of the solar farm the risk of glare affecting roads and dwellings within 1km of the Project was identified as 'negligible'.

## 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 Raywood Solar Farm (the Project), located at McQualters Road, Raywood, Victoria. 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 4 TP346399, the footprint of the proposed PV arrays will cover an area of approximately 15 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 1.5 kilometres south west of Raywood, *refer Figure 1*. The Project site adjoins Bridgewater Raywood Road on the northern boundary. The site is zoned FZ Farming Zone and is currently used for grazing. Farming is the predominant land use within the area.

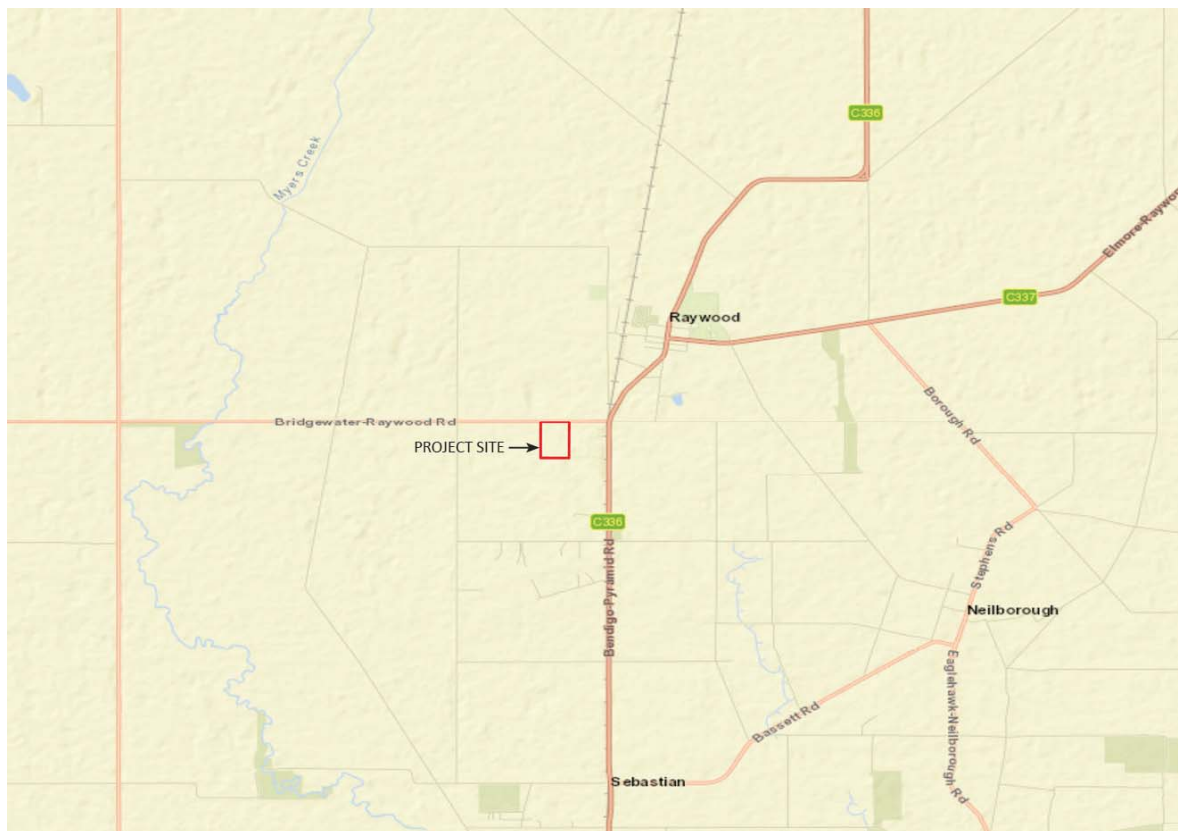


Figure 1. Location Plan

## 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 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

#### 3.1. Glint and Glare Definitions

#### 3.2. 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.”<sup>1</sup>*

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

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<sup>1</sup> Federal Aviation Administration, Version 1.1 April 2018, Technical Guidance for Evaluating Selected Solar Technologies on Airports

The Solar Energy Facilities Design and Development Guidelines, 2019<sup>2</sup> (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.

### 3.3. 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.

### 3.4. 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.<sup>3</sup>

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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<sup>2</sup> The State of Victoria Department of Environment, Land, Water and Planning 2019, Solar Energy Facilities Design and Development Guidelines

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

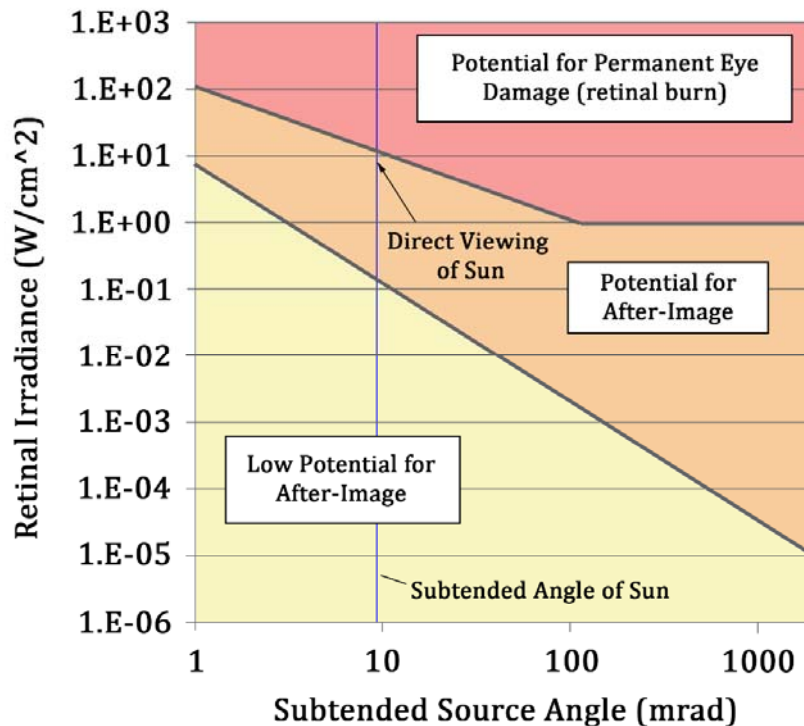


Figure 2. Ocular impacts and Hazard Ranges<sup>4</sup>

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<sup>2</sup> 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<sup>2</sup> 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<sup>2</sup> (or 650-1,100 lumens/m<sup>2</sup>) reaches the eye<sup>5</sup>.

### 3.5. 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.<sup>6</sup>

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

<sup>4</sup> Source: Solar Glare Hazard Analysis Tool (SGHAT) Presentation (2013)  
[https://share.sandia.gov/phlux/static/references/glnt-glare/SGHAT\\_Ho.pdf](https://share.sandia.gov/phlux/static/references/glnt-glare/SGHAT_Ho.pdf)

<sup>5</sup> Sandia National Laboratory, SGHAT Technical Manual

<sup>6</sup> Ho, C. 2013 *Relieving a Glare Problem*

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.

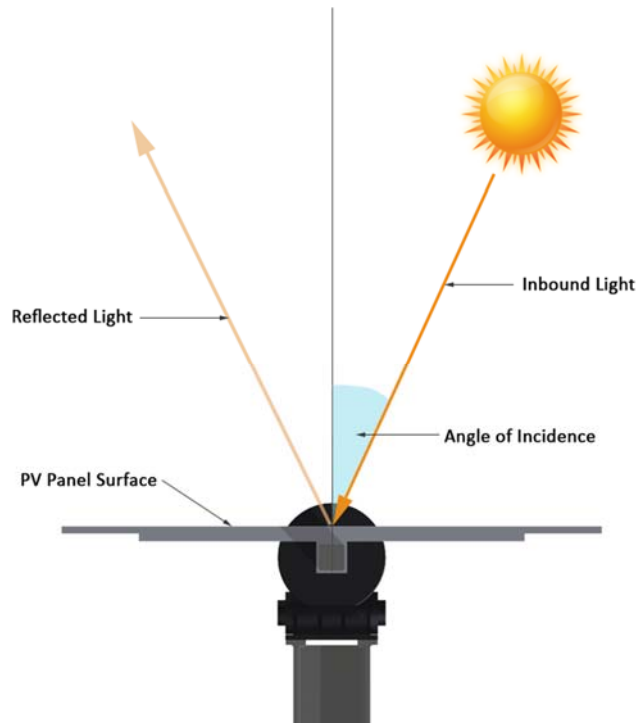


Figure 3. Angle of Incidence Relative to PV Panel Surface

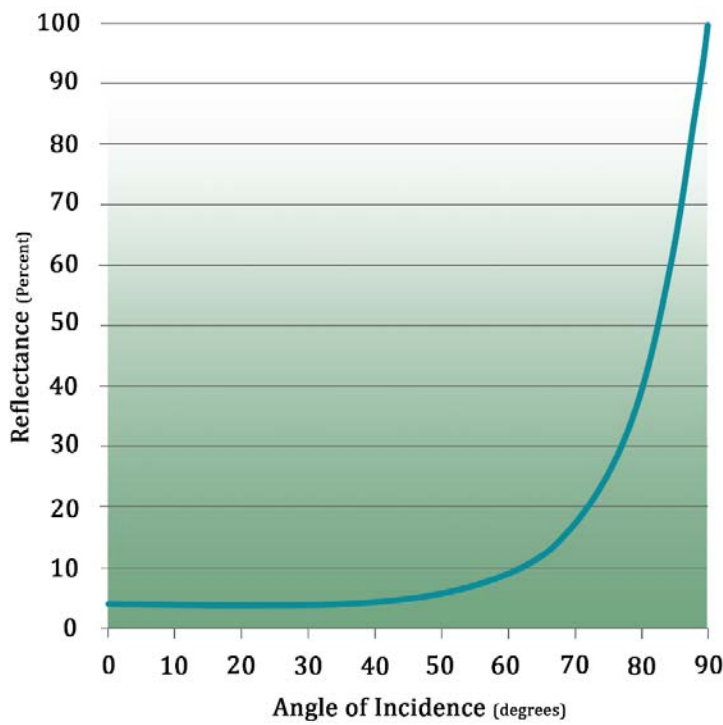
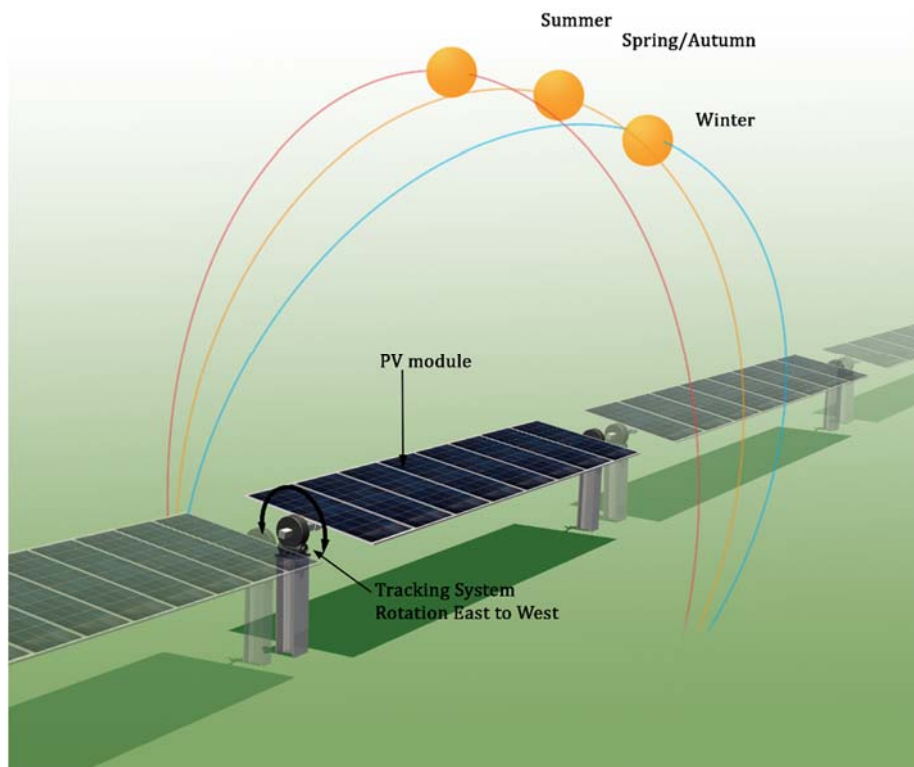


Figure 4. Angles of Incidence and Increased Levels of Reflected Light (Glass (n=1.5))

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.*



### 3.6. 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.

### 3.7. Solar Glare Hazard Analysis

This assessment has utilised the Solar Glare Hazard Analysis Tool (SGHAT 3.0) co-developed by Sandia National Laboratory<sup>7</sup> 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. The US Federal Aviation Administration requires the use of SGHAT to demonstrate 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.

### 3.8. 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.

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<sup>7</sup> [https://share.sandia.gov/phlux/static/references/glint-glare/SGHAT\\_Technical\\_Reference-v5.pdf](https://share.sandia.gov/phlux/static/references/glint-glare/SGHAT_Technical_Reference-v5.pdf)

## 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 slightly 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 scattered throughout the landscape and residential dwellings centred on Raywood township.

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

There are no existing features in the landscape with the potential to contribute to glare.

### 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 Bendigo Airport 30 km south of the Project site (the closest BOM records for cloud cover statistics) recorded 105.5 cloudy days per year (mean number over the period 1991 to 2010)<sup>8</sup>. 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 overlaid 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 are also available. The approximate dimensions for

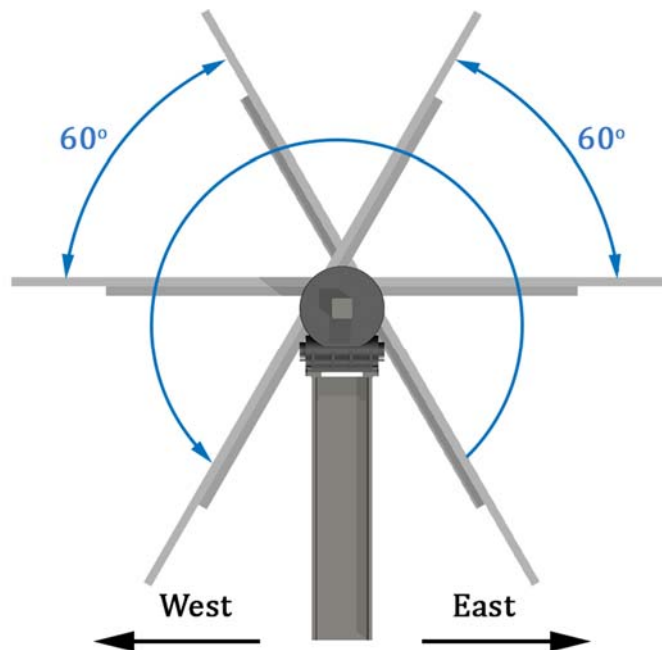
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<sup>8</sup> [http://www.bom.gov.au/climate/averages/tables/cw\\_081123.shtml](http://www.bom.gov.au/climate/averages/tables/cw_081123.shtml)

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  $90^\circ$  (+/-  $45^\circ$ ) or  $120^\circ$  (+/-  $60^\circ$ ) depending on the system used. The Project modelling utilised a rotation range of  $120^\circ$  (+/-  $60^\circ$ ), refer *Figure 7*.

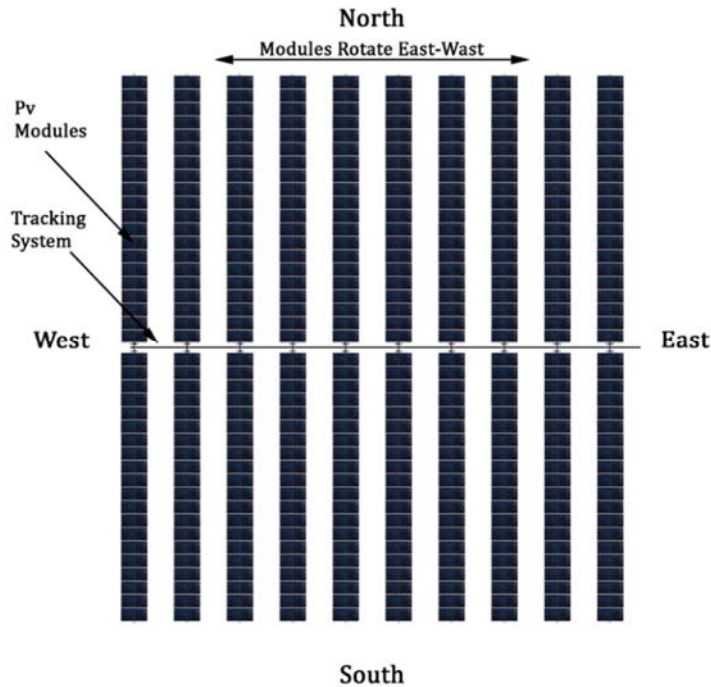


*Figure 7. Illustration of PV Module Rotation Angles*

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<sup>9</sup>*

### 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.

<sup>9</sup> 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 focused on potential visibility of the Project within 2km of the site.

The desktop visibility assessment identified the Project is generally screened by terrain to the south west and north east including the majority of Raywood township. The Project was identified as potentially visible to the north west and to the south east.

15 observation points were assessed within the viewshed; 4 were located at dwellings within 1km of the Project site, 11 at dwellings 1 - 2km from the Project site. All observation point locations and numbers shown in *Figure 9* are consistent 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	4 (OP1 to OP4) rural properties	Yes
1km – 2km	11 (OP5 to OP15 ) rural and residential properties	Yes

Four (4) roads pass through the viewshed and these were included in the glare modelling, as follows:

- Bendigo Pyramid Road
- Bridgewater Raywood Highway
- Gunes Lane
- McQualters Road

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

Bendigo Gliding Club is the closest aviation facilities to the Project at 4.2km to the east of the Project site. Approach flight paths to the runways were tested in the glare modelling. The gliding club 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 airstrip, 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<sup>10</sup>. 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 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.

<sup>10</sup> [https://www.faa.gov/data\\_research/research/med\\_humanfacs/oamtechreports/2010s/media/201512.pdf](https://www.faa.gov/data_research/research/med_humanfacs/oamtechreports/2010s/media/201512.pdf)

### 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 OP15 Rural and residential dwellings	No Glare
Bendigo Pyramid Road	No Glare
Bridgewater Raywood Highway	No Glare
Gunes Lane	No Glare
McQualters Road	No Glare
Railway Line	No Glare
Flight Path 1 – Bendigo Gliding Club Grass Runway (south)	No Glare
Flight Path 2 – Bendigo Gliding Club Grass Runway (north)	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 Appendix B*.

The SGHAT modelling also identified no glare hazard potential is likely to affect defined flight paths at the approach to runways at Bendigo Gliding Club, *refer Appendix 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 reached. 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 OP15 Rural and residential dwellings	No Glare – all dwellings	No Glare – all dwellings
Bendigo Pyramid Road	No Glare	No Glare
Bridgewater Raywood Highway	No Glare	No Glare
Gunes Lane	No Glare	No Glare
McQualters Road	No Glare	No Glare
Railway Line	No Glare	No Glare
Flight Path 1 – Bendigo Gliding Club Grass Runway (south)	No Glare	No Glare
Flight Path 2 – Bendigo Gliding Club Grass Runway (north)	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. Whilst 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 found to affect dwellings and roads within 1km of the Project when the solar farm is operating normally using a horizontal single axis tracking system;
- In addition, no glare potential was found to affect dwellings and roads up to 2km from the Project;



- No glare potential was identified for dwellings and 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).
- No glare potential was found to affect runway approach paths at Bendigo Gliding Club, when the solar farm is operating normally using a horizontal single axis tracking system.

Under normal operation of the solar farm the risk of glare affecting roads and dwellings within 1km of the Project was identified as 'negligible'.

## APPENDIX A:

### SOLAR GLARE HAZARD ANALYSIS –DWELLINGS

## APPENDIX B:

### SOLAR GLARE HAZARD ANALYSIS – TRANSPORT ROUTES

## APPENDIX C:

### SOLAR GLARE HAZARD ANALYSIS – FLIGHT PATHS