BARNAWARTHA SOLAR FARM

GLINT AND GLARE IMPACT ASSESSMENT REPORT
DRAFT ISSUE

Prepared For
Southern Sustainable Electric Pty Ltd

May 2021

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for Southern Sustainable Electric Pty Ltd

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Cover Image: ToGa Wanderings

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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 Albury Airport at approximately 23km to the east. 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 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).

1. INTRODUCTION

This report has been prepared by Environmental Ethos on behalf of Southern Sustainable Electric (SSE Australia) to assess the potential solar glint and glare impact of the proposed Barnawartha Solar Farm (the Project), located at 1377 Plunketts Road, Barnawartha, Victoria. The Project comprises of the installation and operation of a solar farm up to 6.24MWp, which will utilise photovoltaic (PV) modules to generate electricity.

The Project site is located over part of Lot 1 PS309491, the footprint of the proposed PV arrays will cover an area of approximately 10 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 1.2 to 1.66 metres high when flat, rotating to approximately 2.66 metres maximum height.

1.1. Location

The Project site is located approximately 1 kilometres north east of Barnawartha, *refer Figure 1.* The Project site adjoins Plunketts 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. To the south and west of the Project site, the land rises steeply to Barnawartha Scenic Reserve.

Figure 1. Location Plan

The closet airport to the Project site is Albury, approximately 23km to the east. 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.

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

3.1. Glint and Glare Definitions

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

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

"Reflectivity refers to light that is reflected off surfaces. The potential effects of reflectivity are glint (a momentary flash of bright light) and glare (a continuous source of bright light). These two effects

are referred to hereinafter as "glare," which can cause a brief loss of vision, also known as flash blindness."[1]

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

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.

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.

[1] Federal Aviation Administration, Version 1.1 April 2018, Technical Guidance for Evaluating Selected Solar Technologies on Airports
[2] The State of Victoria Department of Environment, Land, Water and Planning 2019, Solar Energy Facilities Design and Development GuidelineS

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]

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

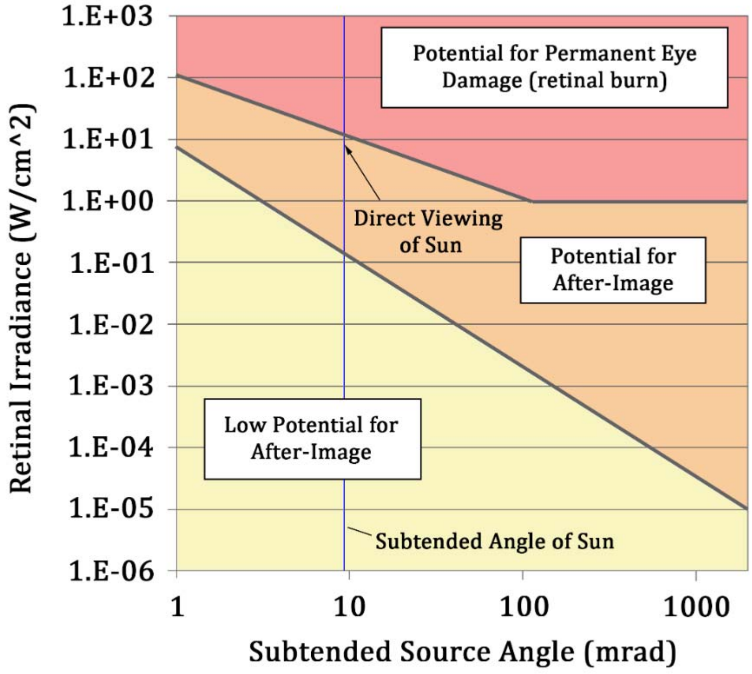


Figure 2. Ocular impacts and Hazard Ranges[4]

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

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^{o}. *Figure 3 and 4* show the relationship between increased angles of incidence and increased levels of reflected light. Where the angle of incidence remains below 50° the amount of reflected light remains below 10%. The angle of incidence is particularly relevant to specular reflection (light reflection from a smooth surface). Diffuse reflection (light reflection from a rough surface) may also occur in PV modules, however this is typically a result of dust or similar materials building up on the PV module surface, which would potentially reduce the reflection.

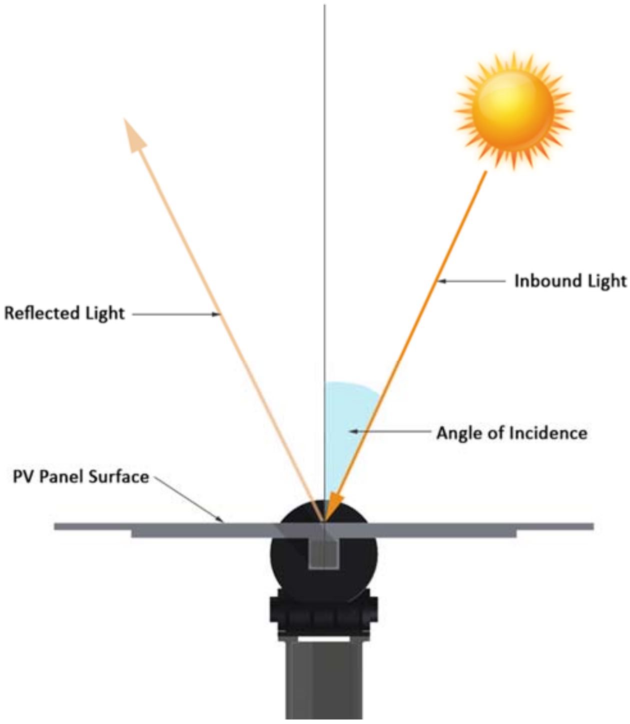


Figure 3. Angle of Incidence Relative to PV Panel Surface

[6] *Ho, C. 2013 Relieving a Glare Problem*

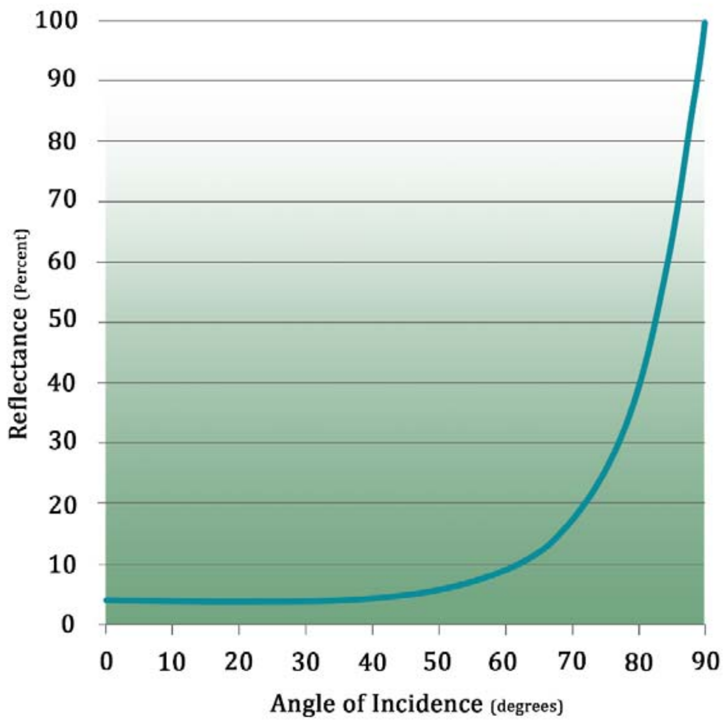


Figure 4. Angles of Incidence and Increased Levels of Reflected Light (Glass (n-1.5))

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

In a fixed PV solar array, the angle of incidence varies as the sun moves across the sky, that is the angle of incidence are at their lowest around noon where the sun is directly overhead, and increase in the early mornings and late evenings as the incidence angles increase. If the PV array is mounted on a tracking system, this variation is reduced because the panel is rotated to remain perpendicular to the sun. Therefore a PV modular array using a tracking system has less potential to cause glare whilst it tracks the sun. *Figure 5* illustrates a PV module mounted horizontal single axis tracking system following the east to west path of the sun.

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

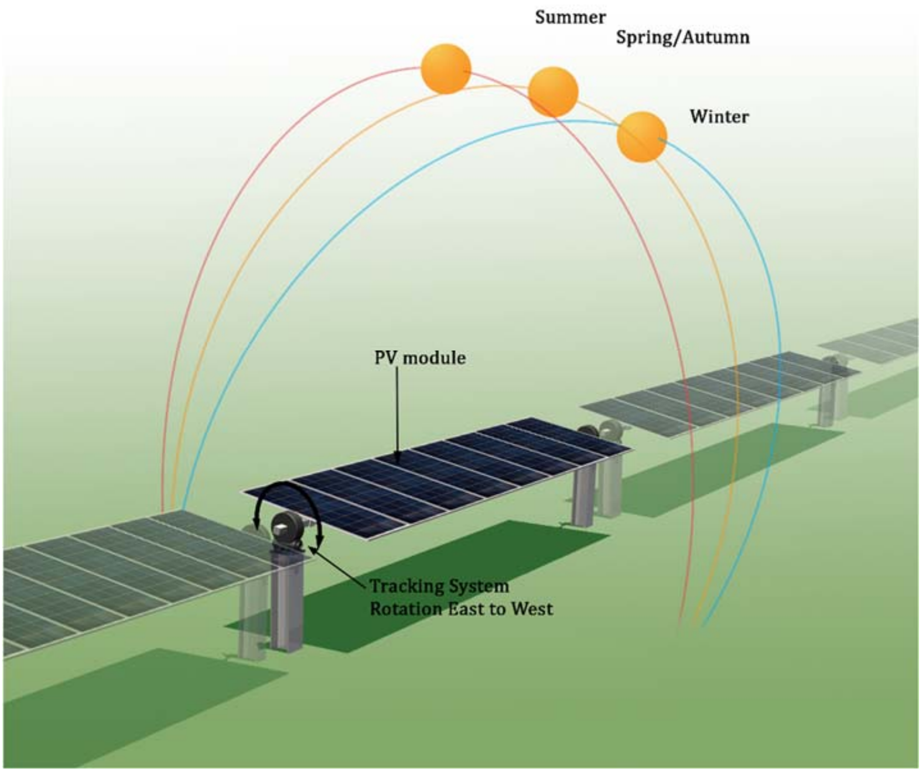


Figure 5. Diagrammatic illustration of sun position relative to PV module mounted on a horizontal single axis tracking system.

3.5. Viewshed Analysis

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

3.6. Solar Glare Hazard Analysis

This assessment has utilised the Solar Glare Hazard Analysis Tool (SGHAT 3.0) co-developed by Sandi National Laboratory[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.

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

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

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

SGHAT has been used extensively in the United States to assess the potential impact of solar arrays located in close proximity to airports.

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.

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.*

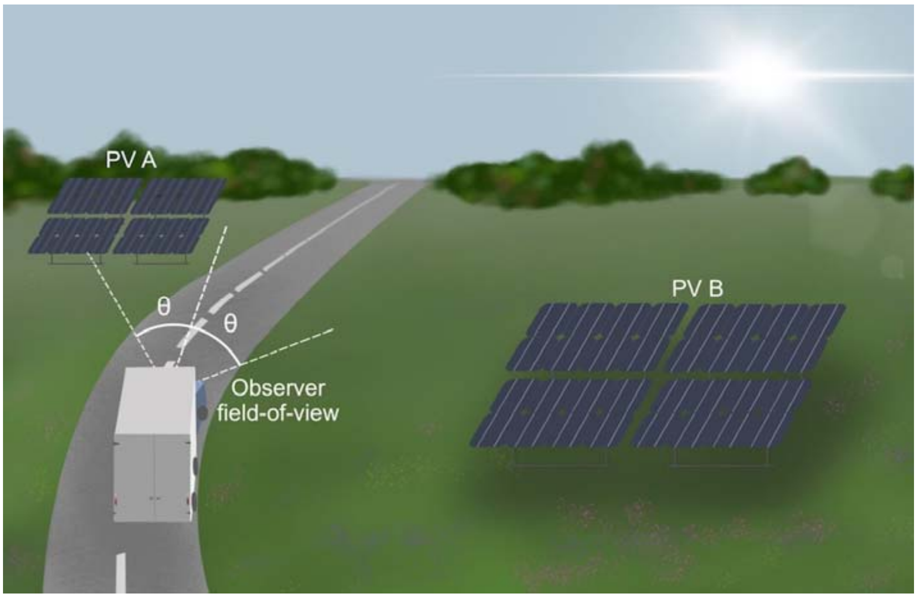


Figure 6. Diagrammatic illustration of Observer Field of View relative to PV array (source: ForgeSolar).

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.

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, 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.

[8] https://www.faa.gov/data_research/research/med_humanfacs/oamtechreports/2010s/media/201512.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, at the base of an east-west ridgeline. Baseline conditions within this area are characteristic of a rural landscape, being grazing land with scattered patches of native vegetation and farm buildings. Barnawartha Scenic Reserve to the south west of the Project site is steep hilly land supporting native vegetation.

Existing dwellings in the area consist of rural homesteads scattered throughout the landscape and residential dwellings centred on Barnawartha township.

Infrastructure elements within the landscape include the Hume Freeway and rail line to the north, local roads 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 Rutherglen Research Centre 22.3 km north west of the Project site (the closest BOM records for cloud cover statistics) recorded 91.2 cloudy days per year (mean number over the period 1974 to 1998)[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.

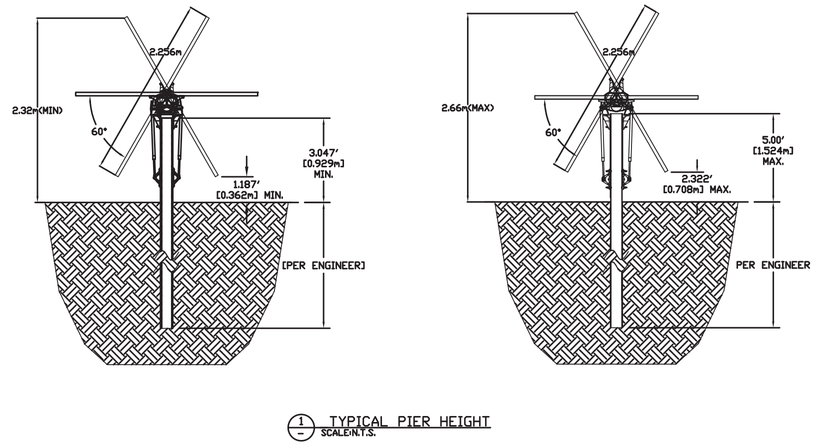
5. PROJECT DESCRIPTION

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

[9] http://www.bom.gov.au/climate/averages/tables/cw_082039.shtml



PROJECT INFORMATION	
DC CAPACITY	5.24MWp
AC CAPACITY	4.95MW(Output limited to 4.95MW)
DC/AC RATIO	1.26
INVERTERS	2*2.475MWac
MOUNTING	NEXTRACKER SINGLE AXIS TRACKER
MODULE CAPACITY	Longi LR5-72HBD-535M
STRING CONFIGURATION	27 MODULES PER STRING
TRACKER	2-STRING
NO TRACKERS	216(2-STRING)
TRACKER SPACING(N-S)	5.0m
ARRAY PITCH	5.0m
SPECIFIC YIELD	1974 kWh/kWp/year
ANNUAL GENERATION	12317MWh
CONNECTION VOLTAGE	22KV
CONNECTION FEEDER	TBC
CONNECTION SUBSTATION	BWA Barnawartha 66kV/22kV
SECURITY FENCE SETBACK	14m from Plunketts Rd, 19m from West Vegetation area
ARRAY SETBACK	10m FROM SECURITY FENCE

SITE INFORMATION	
LOT/DP	Lot 1 PS309491
ADDRESS	1377 Plunketts Rd Barnawartha,VIC 3688
LGA	Indigo Shire Council
LAT/LONG	-36.098873,146.689770
ELEVATION	179m
LOT AREA	90 hectares
FENCE AREA	10.6hectares

ENVIRONMENTAL ETHOS

LEGEND

PV ARRAY

SOURCE: MPOWER
JM-E2011013-B01-XX
REV. A 25/11/2020

PROJECT NO. 21001
CREATED BY: SC
DATE: 02 05 2021
VERSION: A

BARNAWARTHA SOLAR FARM

GLINT AND GLARE IMPACT ASSESSMENT

PROJECT LAYOUT PLAN

FIGURE 7.0

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 2.25 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.*

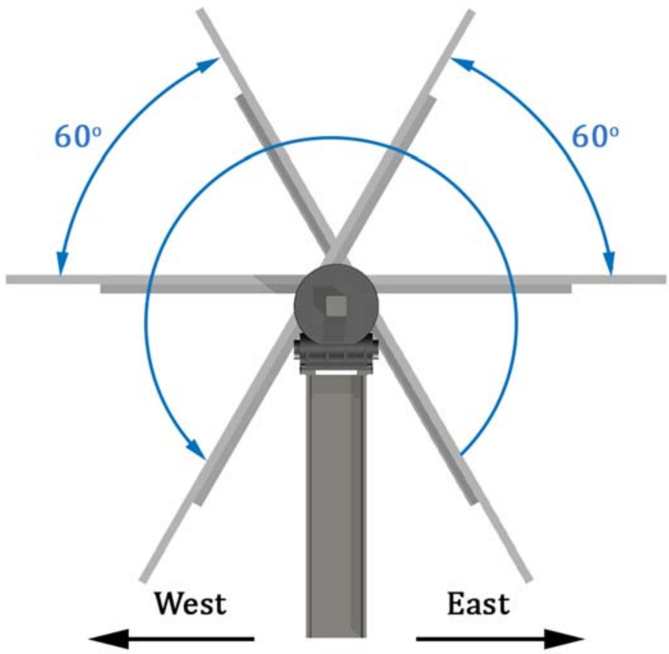


Figure 8. Illustration of PV Module Rotation Angles

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 2.66 metres (1.66 metres when the panels are held at 0 degrees (flat) and 2.66 metres at maximum tilt). A height of 2.7 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, 5 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.

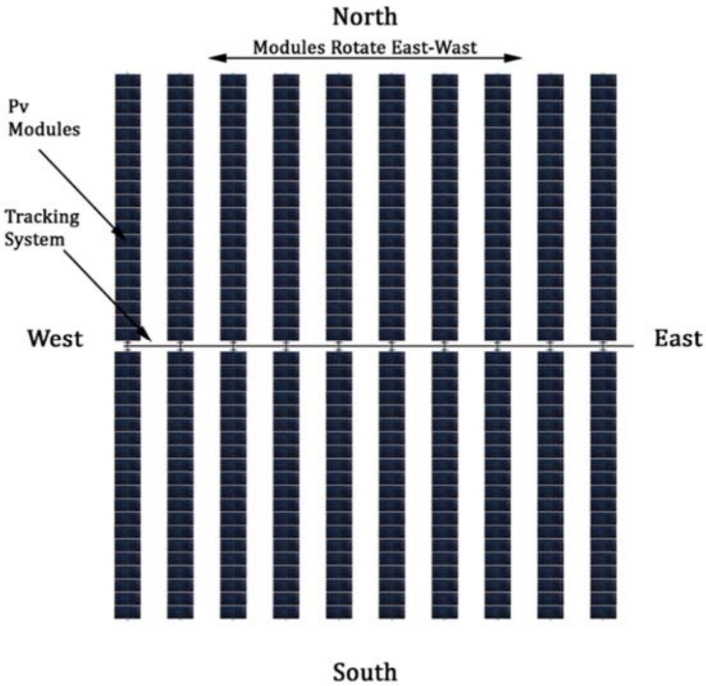


Figure 9. Illustration of PV Module Row Alignment

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/

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 to undulating landscape with an east-west ridgeline to the south of the Project site.

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 the ridgeline to the south and west including the majority of Barnawartha township. The Project was identified as potentially visible to the north, and partially visible to the east.

21 observation points were assessed within the viewshed; 12 were located at dwellings within 1km of the Project site, 9 at dwellings 1 - 2km from the Project site. All observation point locations and numbers shown in *Figure 10* are consist with the glare modelling results provided in the appendices and detailed in *Table 1*.

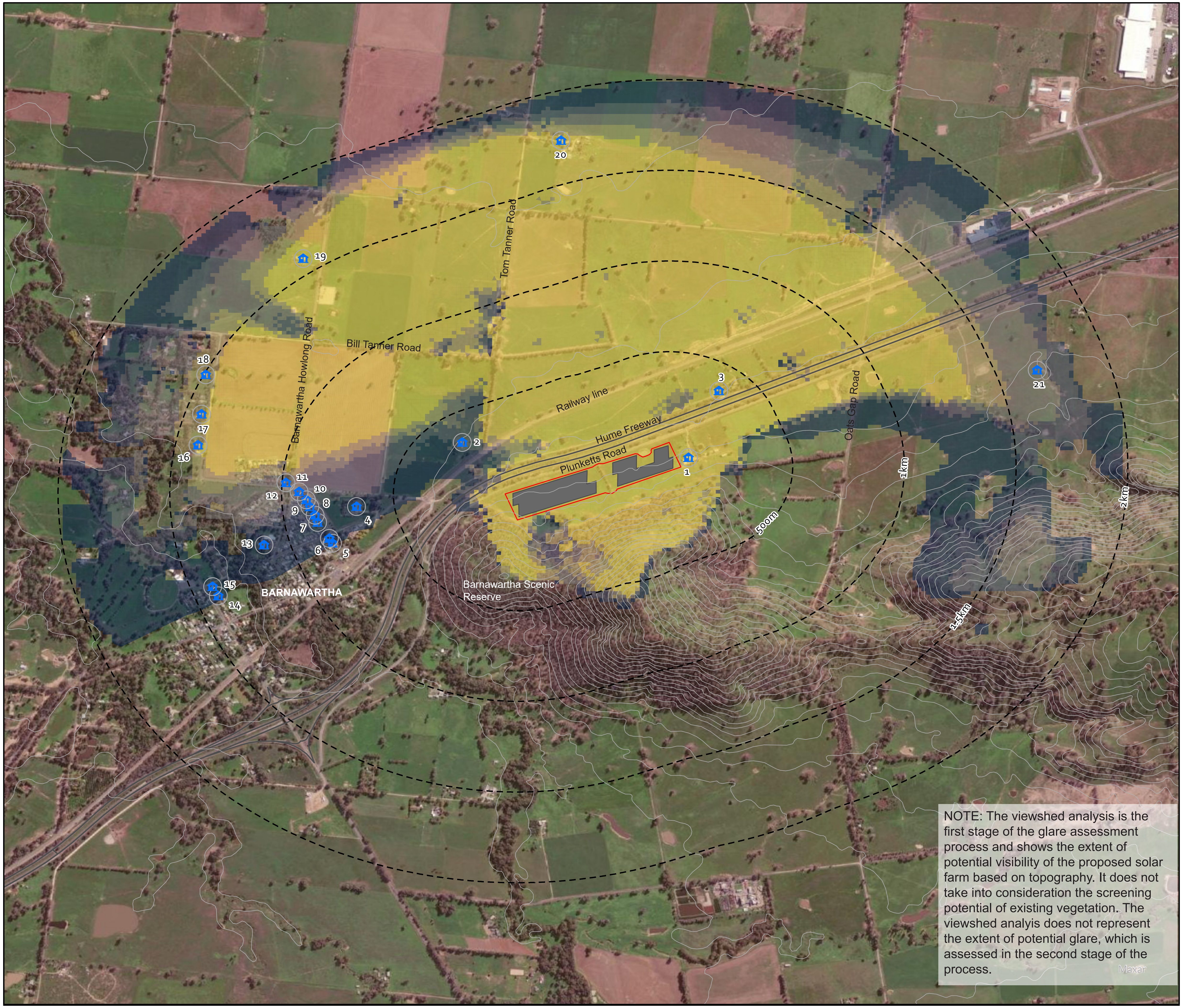
Table 1. Location of Observation Points relative to distance from the Project

Distance from Project	Observation Points (Rural and residential dwellings)	Identified as potentially visible in the viewshed modelling
<500m	3 (OP1 to OP3) rural properties	Yes
500m – 1km	9 (OP4 to OP12) residential properties	Yes
1km – 2km	9 (OP13 to OP21) rural and residential properties	Yes

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

- Hume Freeway
- Plunketts Road
- Oats Gap Road
- Barnawartha Howlong Road
- Bill Tanner and Tom Tanner Roads

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



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 analysis does not represent the extent of potential glare, which is assessed in the second stage of the process.

ENVIRONMENTAL ETHOS

N

0 0.25 0.5 1 Kilometers

SCALE 1:20,000 @ A3

Legend

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

*(Analysis based on Digital Terrain Model)

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

PROJECT No. 21001
CREATED BY: SC
DATE: 02 05 2021
VERSION: A

BARNAWARTHA SOLAR FARM

GLINT AND GLARE ASSESSMENT

VIEWSHED ANALYSIS

FIGURE 10.0

Albury Airport is the closest aviation facilities to the Project at approximately 23km to the east 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 for identified dwellings, the freeway, surrounding local roads, and the rail line with potential views to the site, 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	2.7m maximum height

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 to B*, 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 OP21 Rural and residential dwellings	No Glare
Hume Freeway	No Glare

Sensitive Receptor	Glare Potential
Plunketts Road	No Glare
Oats Gap Road	No Glare
Barnawartha Howlong Road	No Glare
Bill Tanner and Tom Tanner Roads	No Glare
Railway Line	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 freeway, surrounding local roads and rail line, *refer Appendix B.*

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 4.*

Table 4. 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
Observation Points OP1 to OP21 Rural and residential dwellings	No Glare – all dwellings	No Glare – all dwellings
Hume Freeway	No Glare	No Glare
Plunketts Road	No Glare	No Glare
Oats Gap Road	No Glare	No Glare
Barnawartha Howlong Road	No Glare	No Glare
Bill Tanner and Tom Tanner Roads	No Glare	No Glare
Railway Line	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 degrees after dark. Whist the limitations of modelling resting angles distorts the results, presenting a worst case than is considered likely, the model indicates a normal backtracking procedure does not increase the likelihood of glare hazard affecting sensitive receptors.

7. MANAGEMENT AND MITIGATION MEASURES

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

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

8. SUMMARY

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

- No glare potential was 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).
- Albury Airport is the closest aviation facilities to the Project at approximately 23km to the east 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.

APPENDIX A:

SOLAR GLARE HAZARD ANALYSIS –DWELLINGS

ForgeSolar

ForgeSolar

Barnawartha SF

Barnawartha SF Dwellings

Created April 16, 2021
Updated April 16, 2021
Time-step 1 minute
Timezone offset UTC10
Site ID 52529.9423

Project type Advanced
Project status: active
Category 0 to 10 kW

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	-
PV array 2	SA tracking	SA tracking	0	0	-

Component Data

PV Array(s)

Total PV footprint area: 73,595 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: 44,633 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	-36.099087	146.687790	199.71	2.70	202.41
2	-36.098017	146.691373	199.20	2.70	201.90
3	-36.098550	146.691389	203.26	2.70	205.96
4	-36.098385	146.691969	202.81	2.70	205.51
5	-36.099087	146.691963	209.40	2.70	212.10
6	-36.100171	146.688428	212.95	2.70	215.65
7	-36.099542	146.688439	205.25	2.70	207.95
8	-36.099742	146.687801	208.11	2.70	210.81

Name: PV array 2
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: 28,962 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	-36.097631	146.692629	198.79	2.70	201.49
2	-36.097141	146.693975	198.04	2.70	200.74
3	-36.097700	146.694018	201.47	2.70	204.17
4	-36.097371	146.694882	201.11	2.70	203.81
5	-36.096799	146.694850	197.11	2.70	199.81
6	-36.096560	146.695509	196.63	2.70	199.33
7	-36.097154	146.695552	201.03	2.70	203.73
8	-36.097065	146.695796	200.92	2.70	203.62
9	-36.097687	146.695826	206.04	2.70	208.74
10	-36.098663	146.693026	207.74	2.70	210.44
11	-36.098025	146.693026	202.11	2.70	204.81
12	-36.098155	146.692666	202.54	2.70	205.24

Discrete Observation Receptors

Number	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total Elevation m
OP 1	-36.097178	146.696502	204.65	1.50	206.15
OP 2	-36.096409	146.685228	181.95	1.50	183.45
OP 3	-36.093849	146.697968	190.88	1.50	192.38
OP 4	-36.099614	146.680020	178.02	1.50	179.52
OP 5	-36.101469	146.678858	179.73	1.50	181.23
OP 6	-36.101226	146.678662	179.65	1.50	181.15
OP 7	-36.100498	146.678072	177.61	1.50	179.11
OP 8	-36.100043	146.678056	177.19	1.50	178.69
OP 9	-36.099605	146.677740	176.90	1.50	178.40
OP 10	-36.099284	146.677595	176.40	1.50	177.90
OP 11	-36.098912	146.677225	178.35	1.50	179.85
OP 12	-36.098379	146.676511	178.38	1.50	179.88
OP 13	-36.101176	146.675807	178.34	1.50	179.84
OP 14	-36.104080	146.673168	180.05	1.50	181.55
OP 15	-36.103608	146.672905	178.64	1.50	180.14
OP 16	-36.096594	146.672173	177.82	1.50	179.32
OP 17	-36.095035	146.672313	176.88	1.50	178.38
OP 18	-36.093059	146.672549	175.51	1.50	177.01
OP 19	-36.087193	146.677380	173.82	1.50	175.32
OP 20	-36.081369	146.690102	171.75	1.50	173.25
OP 21	-36.093815	146.710905	208.71	1.50	210.21

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 array 2	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)
OP: OP 1	0	0
OP: OP 2	0	0
OP: OP 3	0	0
OP: OP 4	0	0
OP: OP 5	0	0
OP: OP 6	0	0
OP: OP 7	0	0
OP: OP 8	0	0
OP: OP 9	0	0
OP: OP 10	0	0
OP: OP 11	0	0
OP: OP 12	0	0
OP: OP 13	0	0
OP: OP 14	0	0
OP: OP 15	0	0
OP: OP 16	0	0
OP: OP 17	0	0
OP: OP 18	0	0
OP: OP 19	0	0
OP: OP 20	0	0
OP: OP 21	0	0

No glare found

PV array 2 no glare found

Component	Green glare (min)	Yellow glare (min)
OP: OP 1	0	0
OP: OP 2	0	0
OP: OP 3	0	0
OP: OP 4	0	0
OP: OP 5	0	0
OP: OP 6	0	0
OP: OP 7	0	0
OP: OP 8	0	0
OP: OP 9	0	0
OP: OP 10	0	0
OP: OP 11	0	0
OP: OP 12	0	0
OP: OP 13	0	0
OP: OP 14	0	0
OP: OP 15	0	0
OP: OP 16	0	0
OP: OP 17	0	0
OP: OP 18	0	0
OP: OP 19	0	0
OP: OP 20	0	0
OP: OP 21	0	0

No glare found

Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actua 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.

ForgeSolar

Barnawartha SF

Barnawartha SF Dwellings-temp-0

Created April 19, 2021
Updated April 19, 2021
Time-step 1 minute
Timezone offset UTC10
Site ID 52650.9423

Project type Advanced
Project status: active
Category 0 to 10 kW

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	-
PV array 2	SA tracking	SA tracking	0	0	-

Component Data

PV Array(s)

Total PV footprint area: 73,595 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: 44,633 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	-36.099087	146.687790	199.71	2.70	202.41
2	-36.098017	146.691373	199.20	2.70	201.90
3	-36.098550	146.691389	203.26	2.70	205.96
4	-36.098385	146.691969	202.81	2.70	205.51
5	-36.099087	146.691963	209.40	2.70	212.10
6	-36.100171	146.688428	212.95	2.70	215.65
7	-36.099542	146.688439	205.25	2.70	207.95
8	-36.099742	146.687801	208.11	2.70	210.81

Name: PV array 2
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: 28,962 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	-36.097631	146.692629	198.79	2.70	201.49
2	-36.097141	146.693975	198.04	2.70	200.74
3	-36.097700	146.694018	201.47	2.70	204.17
4	-36.097371	146.694882	201.11	2.70	203.81
5	-36.096799	146.694850	197.11	2.70	199.81
6	-36.096560	146.695509	196.63	2.70	199.33
7	-36.097154	146.695552	201.03	2.70	203.73
8	-36.097065	146.695796	200.92	2.70	203.62
9	-36.097687	146.695826	206.04	2.70	208.74
10	-36.098663	146.693026	207.74	2.70	210.44
11	-36.098025	146.693026	202.11	2.70	204.81
12	-36.098155	146.692666	202.54	2.70	205.24

Discrete Observation Receptors

Number	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total Elevation m
OP 1	-36.097178	146.696502	204.65	1.50	206.15
OP 2	-36.096409	146.685228	181.95	1.50	183.45
OP 3	-36.093849	146.697968	190.88	1.50	192.38
OP 4	-36.099614	146.680020	178.02	1.50	179.52
OP 5	-36.101469	146.678858	179.73	1.50	181.23
OP 6	-36.101226	146.678662	179.65	1.50	181.15
OP 7	-36.100498	146.678072	177.61	1.50	179.11
OP 8	-36.100043	146.678056	177.19	1.50	178.69
OP 9	-36.099605	146.677740	176.90	1.50	178.40
OP 10	-36.099284	146.677595	176.40	1.50	177.90
OP 11	-36.098912	146.677225	178.35	1.50	179.85
OP 12	-36.098379	146.676511	178.38	1.50	179.88
OP 13	-36.101176	146.675807	178.34	1.50	179.84
OP 14	-36.104080	146.673168	180.05	1.50	181.55
OP 15	-36.103608	146.672905	178.64	1.50	180.14
OP 16	-36.096594	146.672173	177.82	1.50	179.32
OP 17	-36.095035	146.672313	176.88	1.50	178.38
OP 18	-36.093059	146.672549	175.51	1.50	177.01
OP 19	-36.087193	146.677380	173.82	1.50	175.32
OP 20	-36.081369	146.690102	171.75	1.50	173.25
OP 21	-36.093815	146.710905	208.71	1.50	210.21

Summary of PV Glare Analysis

PV configuration and total predicted glare

PV Name	Tilt deg	Orientation deg	"Green" Glare min	"Yellow" Glare min	Energy Produced kWh	Data File
PV array 1	SA tracking	SA tracking	0	0	-	-
PV array 2	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)
OP: OP 1	0	0
OP: OP 2	0	0
OP: OP 3	0	0
OP: OP 4	0	0
OP: OP 5	0	0
OP: OP 6	0	0
OP: OP 7	0	0
OP: OP 8	0	0
OP: OP 9	0	0
OP: OP 10	0	0
OP: OP 11	0	0
OP: OP 12	0	0
OP: OP 13	0	0
OP: OP 14	0	0
OP: OP 15	0	0
OP: OP 16	0	0
OP: OP 17	0	0
OP: OP 18	0	0
OP: OP 19	0	0
OP: OP 20	0	0
OP: OP 21	0	0

No glare found

PV array 2 no glare found

Component	Green glare (min)	Yellow glare (min)
OP: OP 1	0	0
OP: OP 2	0	0
OP: OP 3	0	0
OP: OP 4	0	0
OP: OP 5	0	0
OP: OP 6	0	0
OP: OP 7	0	0
OP: OP 8	0	0
OP: OP 9	0	0
OP: OP 10	0	0
OP: OP 11	0	0
OP: OP 12	0	0
OP: OP 13	0	0
OP: OP 14	0	0
OP: OP 15	0	0
OP: OP 16	0	0
OP: OP 17	0	0
OP: OP 18	0	0
OP: OP 19	0	0
OP: OP 20	0	0
OP: OP 21	0	0

No glare found

Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. 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.

ForgeSolar

Barnawartha SF

Barnawartha SF Dwellings-temp-1

Created April 19, 2021
Updated April 19, 2021
Time-step 1 minute
Timezone offset UTC10
Site ID 52653.9423

Project type Advanced
Project status: active
Category 0 to 10 kW

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	-
PV array 2	SA tracking	SA tracking	0	0	-

Component Data

PV Array(s)

Total PV footprint area: 73,595 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: 44,633 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	-36.099087	146.687790	199.71	2.70	202.41
2	-36.098017	146.691373	199.20	2.70	201.90
3	-36.098550	146.691389	203.26	2.70	205.96
4	-36.098385	146.691969	202.81	2.70	205.51
5	-36.099087	146.691963	209.40	2.70	212.10
6	-36.100171	146.688428	212.95	2.70	215.65
7	-36.099542	146.688439	205.25	2.70	207.95
8	-36.099742	146.687801	208.11	2.70	210.81

Name: PV array 2
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: 28,962 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	-36.097631	146.692629	198.79	2.70	201.49
2	-36.097141	146.693975	198.04	2.70	200.74
3	-36.097700	146.694018	201.47	2.70	204.17
4	-36.097371	146.694882	201.11	2.70	203.81
5	-36.096799	146.694850	197.11	2.70	199.81
6	-36.096560	146.695509	196.63	2.70	199.33
7	-36.097154	146.695552	201.03	2.70	203.73
8	-36.097065	146.695796	200.92	2.70	203.62
9	-36.097687	146.695826	206.04	2.70	208.74
10	-36.098663	146.693026	207.74	2.70	210.44
11	-36.098025	146.693026	202.11	2.70	204.81
12	-36.098155	146.692666	202.54	2.70	205.24

Discrete Observation Receptors

Number	Latitude	Longitude	Ground elevation	Height above ground	Total Elevation
	deg	deg	m	m	m
OP 1	-36.097178	146.696502	204.65	1.50	206.15
OP 2	-36.096409	146.685228	181.95	1.50	183.45
OP 3	-36.093849	146.697968	190.88	1.50	192.38
OP 4	-36.099614	146.680020	178.02	1.50	179.52
OP 5	-36.101469	146.678858	179.73	1.50	181.23
OP 6	-36.101226	146.678662	179.65	1.50	181.15
OP 7	-36.100498	146.678072	177.61	1.50	179.11
OP 8	-36.100043	146.678056	177.19	1.50	178.69
OP 9	-36.099605	146.677740	176.90	1.50	178.40
OP 10	-36.099284	146.677595	176.40	1.50	177.90
OP 11	-36.098912	146.677225	178.35	1.50	179.85
OP 12	-36.098379	146.676511	178.38	1.50	179.88
OP 13	-36.101176	146.675807	178.34	1.50	179.84
OP 14	-36.104080	146.673168	180.05	1.50	181.55
OP 15	-36.103608	146.672905	178.64	1.50	180.14
OP 16	-36.096594	146.672173	177.82	1.50	179.32
OP 17	-36.095035	146.672313	176.88	1.50	178.38
OP 18	-36.093059	146.672549	175.51	1.50	177.01
OP 19	-36.087193	146.677380	173.82	1.50	175.32
OP 20	-36.081369	146.690102	171.75	1.50	173.25
OP 21	-36.093815	146.710905	208.71	1.50	210.21

Summary of PV Glare Analysis

PV configuration and total predicted glare

PV Name	Tilt deg	Orientation deg	"Green" Glare min	"Yellow" Glare min	Energy Produced kWh	Data File
PV array 1	SA tracking	SA tracking	0	0	-	-
PV array 2	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)
OP: OP 1	0	0
OP: OP 2	0	0
OP: OP 3	0	0
OP: OP 4	0	0
OP: OP 5	0	0
OP: OP 6	0	0
OP: OP 7	0	0
OP: OP 8	0	0
OP: OP 9	0	0
OP: OP 10	0	0
OP: OP 11	0	0
OP: OP 12	0	0
OP: OP 13	0	0
OP: OP 14	0	0
OP: OP 15	0	0
OP: OP 16	0	0
OP: OP 17	0	0
OP: OP 18	0	0
OP: OP 19	0	0
OP: OP 20	0	0
OP: OP 21	0	0

No glare found

PV array 2 no glare found

Component	Green glare (min)	Yellow glare (min)
OP: OP 1	0	0
OP: OP 2	0	0
OP: OP 3	0	0
OP: OP 4	0	0
OP: OP 5	0	0
OP: OP 6	0	0
OP: OP 7	0	0
OP: OP 8	0	0
OP: OP 9	0	0
OP: OP 10	0	0
OP: OP 11	0	0
OP: OP 12	0	0
OP: OP 13	0	0
OP: OP 14	0	0
OP: OP 15	0	0
OP: OP 16	0	0
OP: OP 17	0	0
OP: OP 18	0	0
OP: OP 19	0	0
OP: OP 20	0	0
OP: OP 21	0	0

No glare found

Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. 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.

APPENDIX B:

SOLAR GLARE HAZARD ANALYSIS – TRANSPORT ROUTES

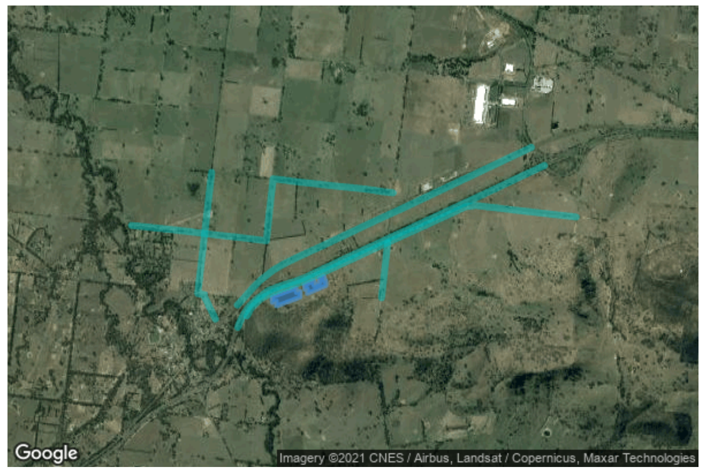
ForgeSolar

Barnawartha SF

Barnawartha SF Roads

Created April 16, 2021
Updated April 16, 2021
Time-step 1 minute
Timezone offset UTC10
Site ID 52563.9423

Project type Advanced
Project status: active
Category 0 to 10 kW



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	-
PV array 2	SA tracking	SA tracking	0	0	-

Component Data

PV Array(s)

Total PV footprint area: 73,595 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: 44,633 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	-36.099087	146.687790	199.71	2.70	202.41
2	-36.098017	146.691373	199.20	2.70	201.90
3	-36.098550	146.691389	203.26	2.70	205.96
4	-36.098385	146.691969	202.81	2.70	205.51
5	-36.099087	146.691963	209.40	2.70	212.10
6	-36.100171	146.688428	212.95	2.70	215.65
7	-36.099542	146.688439	205.25	2.70	207.95
8	-36.099742	146.687801	208.11	2.70	210.81

Name: PV array 2
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: 28,962 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	-36.097631	146.692629	198.79	2.70	201.49
2	-36.097141	146.693975	198.04	2.70	200.74
3	-36.097700	146.694018	201.47	2.70	204.17
4	-36.097371	146.694882	201.11	2.70	203.81
5	-36.096799	146.694850	197.11	2.70	199.81
6	-36.096560	146.695509	196.63	2.70	199.33
7	-36.097154	146.695552	201.03	2.70	203.73
8	-36.097065	146.695796	200.92	2.70	203.62
9	-36.097687	146.695826	206.04	2.70	208.74
10	-36.098663	146.693026	207.74	2.70	210.44
11	-36.098025	146.693026	202.11	2.70	204.81
12	-36.098155	146.692666	202.54	2.70	205.24

Route Receptor(s)

Name: Barnawartha Howlong 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	-36.101724	146.679343	177.76	2.00	179.76
2	-36.098958	146.677669	176.85	2.00	178.85
3	-36.098785	146.677691	176.24	2.00	178.24
4	-36.098655	146.676693	177.26	2.00	179.26
5	-36.095265	146.677197	176.00	2.00	178.00
6	-36.091435	146.677729	178.62	2.00	180.62
7	-36.087776	146.678255	173.94	2.00	175.94
8	-36.084074	146.678769	171.52	2.00	173.52

Name: Bill Tanner and Tom Tanner 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	-36.090464	146.666838	174.32	2.00	176.32
2	-36.090846	146.671387	172.01	2.00	174.01
3	-36.091245	146.675786	175.64	2.00	177.64
4	-36.091591	146.679262	177.84	2.00	179.84
5	-36.091921	146.682996	175.00	2.00	177.00
6	-36.092164	146.685399	175.29	2.00	177.29
7	-36.092302	146.686944	176.20	2.00	178.20
8	-36.090378	146.687180	174.44	2.00	176.44
9	-36.087031	146.687631	172.26	2.00	174.26
10	-36.084846	146.687953	170.90	2.00	172.90
11	-36.085124	146.690485	171.58	2.00	173.58
12	-36.085696	146.696777	174.21	2.00	176.21
13	-36.086112	146.701905	179.37	2.00	181.37
14	-36.086424	146.704437	179.93	2.00	181.93
15	-36.086545	146.705810	181.21	2.00	183.21

Name: Hume Fwy
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	-36.083260	146.728367	180.30	2.00	182.30
2	-36.086806	146.719086	189.30	2.00	191.30
3	-36.089337	146.712316	198.29	2.00	200.29
4	-36.090907	146.708121	194.90	2.00	196.90
5	-36.095519	146.695837	190.86	2.00	192.86
6	-36.096715	146.692768	192.61	2.00	194.61
7	-36.097235	146.691030	193.64	2.00	195.64
8	-36.097773	146.688906	194.29	2.00	196.29
9	-36.098328	146.687189	193.72	2.00	195.72
10	-36.099299	146.685537	191.29	2.00	193.29
11	-36.100166	146.684421	189.00	2.00	191.00
12	-36.101119	146.683584	186.78	2.00	188.78
13	-36.102229	146.682898	183.98	2.00	185.98
14	-36.102714	146.682683	183.15	2.00	185.15

Name: Oats Gap 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	-36.099170	146.704106	211.58	2.00	213.58
2	-36.096595	146.704460	202.55	2.00	204.55
3	-36.092555	146.705018	192.24	2.00	194.24

Name: Plunketts 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	-36.089456	146.733119	200.08	2.00	202.08
2	-36.088641	146.724150	195.79	2.00	197.79
3	-36.088069	146.718163	191.57	2.00	193.57
4	-36.088207	146.716661	193.79	2.00	195.79
5	-36.090930	146.709366	195.94	2.00	197.94
6	-36.092664	146.704602	192.19	2.00	194.19
7	-36.094450	146.699882	193.91	2.00	195.91
8	-36.095906	146.695998	193.74	2.00	195.74
9	-36.096686	146.693788	195.68	2.00	197.68
10	-36.097311	146.692050	196.75	2.00	198.75
11	-36.097692	146.690667	197.58	2.00	199.58
12	-36.098507	146.687856	196.86	2.00	198.86
13	-36.099304	146.686053	195.06	2.00	197.06
14	-36.100345	146.684723	193.49	2.00	195.49
15	-36.101333	146.684036	191.95	2.00	193.95

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

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-36.081080	146.726437	174.13	2.00	176.13
2	-36.088552	146.706864	186.90	2.00	188.90
3	-36.089631	146.703902	186.14	2.00	188.14
4	-36.091114	146.699992	185.44	2.00	187.44
5	-36.092124	146.697353	185.00	2.00	187.00
6	-36.092926	146.695260	183.76	2.00	185.76
7	-36.094161	146.691908	184.61	2.00	186.61
8	-36.095075	146.689601	185.47	2.00	187.47
9	-36.095860	146.687927	185.27	2.00	187.27
10	-36.097047	146.686066	182.83	2.00	184.83
11	-36.098009	146.684880	181.24	2.00	183.24
12	-36.099245	146.683518	180.01	2.00	182.01
13	-36.100042	146.682606	178.98	2.00	180.98

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 array 2	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: Barnawartha Howlong Road	0	0
Route: Bill Tanner and Tom Tanner Road	0	0
Route: Hume Fwy	0	0
Route: Oats Gap Road	0	0
Route: Plunketts Road	0	0
Route: Railway Line	0	0

No glare found

PV array 2 no glare found

Component	Green glare (min)	Yellow glare (min)
Route: Barnawartha Howlong Road	0	0
Route: Bill Tanner and Tom Tanner Road	0	0
Route: Hume Fwy	0	0
Route: Oats Gap Road	0	0
Route: Plunketts Road	0	0
Route: Railway Line	0	0

No glare found

Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. 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.

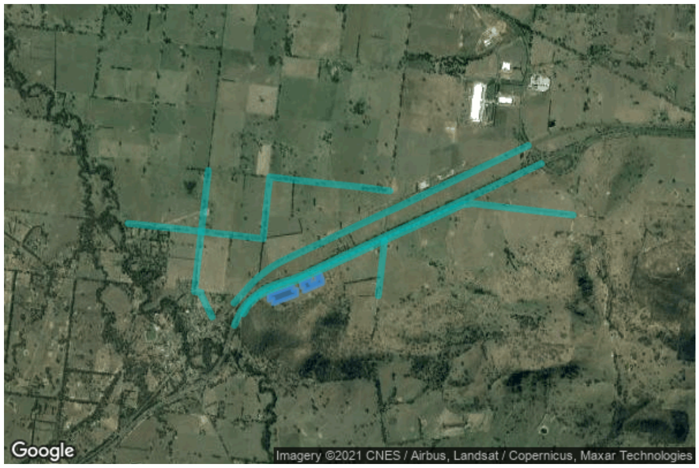
ForgeSolar

Barnawartha SF

Barnawartha SF Roads-temp-3

Created April 19, 2021
Updated April 19, 2021
Time-step 1 minute
Timezone offset UTC10
Site ID 52667.9423

Project type Advanced
Project status: active
Category 0 to 10 kW



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	-
PV array 2	SA tracking	SA tracking	0	0	-

Component Data

PV Array(s)

Total PV footprint area: 73,595 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: 44,633 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 deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
1	-36.099087	146.687790	199.71	2.70	202.41
2	-36.098017	146.691373	199.20	2.70	201.90
3	-36.098550	146.691389	203.26	2.70	205.96
4	-36.098385	146.691969	202.81	2.70	205.51
5	-36.099087	146.691963	209.40	2.70	212.10
6	-36.100171	146.688428	212.95	2.70	215.65
7	-36.099542	146.688439	205.25	2.70	207.95
8	-36.099742	146.687801	208.11	2.70	210.81

Name: PV array 2
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: 28,962 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 deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
1	-36.097631	146.692629	198.79	2.70	201.49
2	-36.097141	146.693975	198.04	2.70	200.74
3	-36.097700	146.694018	201.47	2.70	204.17
4	-36.097371	146.694882	201.11	2.70	203.81
5	-36.096799	146.694850	197.11	2.70	199.81
6	-36.096560	146.695509	196.63	2.70	199.33
7	-36.097154	146.695552	201.03	2.70	203.73
8	-36.097065	146.695796	200.92	2.70	203.62
9	-36.097687	146.695826	206.04	2.70	208.74
10	-36.098663	146.693026	207.74	2.70	210.44
11	-36.098025	146.693026	202.11	2.70	204.81
12	-36.098155	146.692666	202.54	2.70	205.24

Route Receptor(s)

Name: Barnawartha Howlong 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	-36.101724	146.679343	177.76	2.00	179.76
2	-36.098958	146.677669	176.85	2.00	178.85
3	-36.098785	146.677691	176.24	2.00	178.24
4	-36.098655	146.676693	177.26	2.00	179.26
5	-36.095265	146.677197	176.00	2.00	178.00
6	-36.091435	146.677729	178.62	2.00	180.62
7	-36.087776	146.678255	173.94	2.00	175.94
8	-36.084074	146.678769	171.52	2.00	173.52

Name: Bill Tanner and Tom Tanner 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	-36.090464	146.666838	174.32	2.00	176.32
2	-36.090846	146.671387	172.01	2.00	174.01
3	-36.091245	146.675786	175.64	2.00	177.64
4	-36.091591	146.679262	177.84	2.00	179.84
5	-36.091921	146.682996	175.00	2.00	177.00
6	-36.092164	146.685399	175.29	2.00	177.29
7	-36.092302	146.686944	176.20	2.00	178.20
8	-36.090378	146.687180	174.44	2.00	176.44
9	-36.087031	146.687631	172.26	2.00	174.26
10	-36.084846	146.687953	170.90	2.00	172.90
11	-36.085124	146.690485	171.58	2.00	173.58
12	-36.085696	146.696777	174.21	2.00	176.21
13	-36.086112	146.701905	179.37	2.00	181.37
14	-36.086424	146.704437	179.93	2.00	181.93
15	-36.086545	146.705810	181.21	2.00	183.21

Name: Hume Fwy
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	-36.083260	146.728367	180.30	2.00	182.30
2	-36.086806	146.719086	189.30	2.00	191.30
3	-36.089337	146.712316	198.29	2.00	200.29
4	-36.090907	146.708121	194.90	2.00	196.90
5	-36.095519	146.695837	190.86	2.00	192.86
6	-36.096715	146.692768	192.61	2.00	194.61
7	-36.097235	146.691030	193.64	2.00	195.64
8	-36.097773	146.688906	194.29	2.00	196.29
9	-36.098328	146.687189	193.72	2.00	195.72
10	-36.099299	146.685537	191.29	2.00	193.29
11	-36.100166	146.684421	189.00	2.00	191.00
12	-36.101119	146.683584	186.78	2.00	188.78
13	-36.102229	146.682898	183.98	2.00	185.98
14	-36.102714	146.682683	183.15	2.00	185.15

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

Vertex	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
1	-36.099170	146.704106	211.58	2.00	213.58
2	-36.096595	146.704460	202.55	2.00	204.55
3	-36.092555	146.705018	192.24	2.00	194.24

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

Vertex	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
1	-36.089456	146.733119	200.08	2.00	202.08
2	-36.088641	146.724150	195.79	2.00	197.79
3	-36.088069	146.718163	191.57	2.00	193.57
4	-36.088207	146.716661	193.79	2.00	195.79
5	-36.090930	146.709366	195.94	2.00	197.94
6	-36.092664	146.704602	192.19	2.00	194.19
7	-36.094450	146.699882	193.91	2.00	195.91
8	-36.095906	146.695998	193.74	2.00	195.74
9	-36.096686	146.693788	195.68	2.00	197.68
10	-36.097311	146.692050	196.75	2.00	198.75
11	-36.097692	146.690667	197.58	2.00	199.58
12	-36.098507	146.687856	196.86	2.00	198.86
13	-36.099304	146.686053	195.06	2.00	197.06
14	-36.100345	146.684723	193.49	2.00	195.49
15	-36.101333	146.684036	191.95	2.00	193.95

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

Vertex	Latitude deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
1	-36.081080	146.726437	174.13	2.00	176.13
2	-36.088552	146.706864	186.90	2.00	188.90
3	-36.089631	146.703902	186.14	2.00	188.14
4	-36.091114	146.699992	185.44	2.00	187.44
5	-36.092124	146.697353	185.00	2.00	187.00
6	-36.092926	146.695260	183.76	2.00	185.76
7	-36.094161	146.691908	184.61	2.00	186.61
8	-36.095075	146.689601	185.47	2.00	187.47
9	-36.095860	146.687927	185.27	2.00	187.27
10	-36.097047	146.686066	182.83	2.00	184.83
11	-36.098009	146.684880	181.24	2.00	183.24
12	-36.099245	146.683518	180.01	2.00	182.01
13	-36.100042	146.682606	178.98	2.00	180.98

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 array 2	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: Barnawartha Howlong Road	0	0
Route: Bill Tanner and Tom Tanner Road	0	0
Route: Hume Fwy	0	0
Route: Oats Gap Road	0	0
Route: Plunketts Road	0	0
Route: Railway Line	0	0

No glare found

PV array 2 no glare found

Component	Green glare (min)	Yellow glare (min)
Route: Barnawartha Howlong Road	0	0
Route: Bill Tanner and Tom Tanner Road	0	0
Route: Hume Fwy	0	0
Route: Oats Gap Road	0	0
Route: Plunketts Road	0	0
Route: Railway Line	0	0

No glare found

Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. 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.

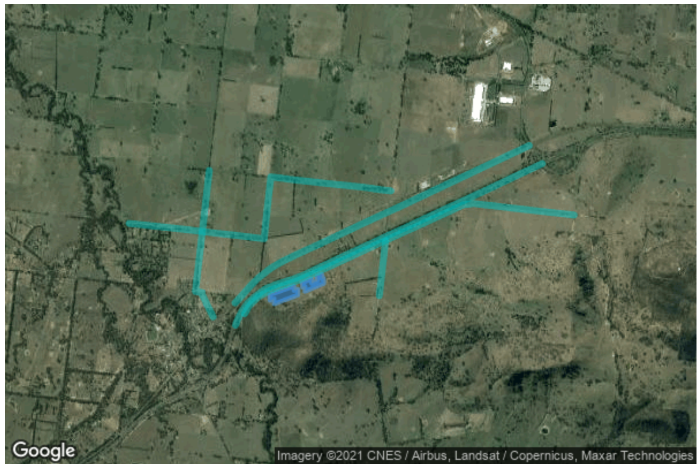
ForgeSolar

Barnawartha SF

Barnawartha SF Roads-temp-4

Created April 19, 2021
Updated April 19, 2021
Time-step 1 minute
Timezone offset UTC10
Site ID 52669.9423

Project type Advanced
Project status: active
Category 0 to 10 kW



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	-
PV array 2	SA tracking	SA tracking	0	0	-

Component Data

PV Array(s)

Total PV footprint area: 73,595 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: 44,633 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 deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
1	-36.099087	146.687790	199.71	2.70	202.41
2	-36.098017	146.691373	199.20	2.70	201.90
3	-36.098550	146.691389	203.26	2.70	205.96
4	-36.098385	146.691969	202.81	2.70	205.51
5	-36.099087	146.691963	209.40	2.70	212.10
6	-36.100171	146.688428	212.95	2.70	215.65
7	-36.099542	146.688439	205.25	2.70	207.95
8	-36.099742	146.687801	208.11	2.70	210.81

Name: PV array 2
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: 28,962 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 deg	Longitude deg	Ground elevation m	Height above ground m	Total elevation m
1	-36.097631	146.692629	198.79	2.70	201.49
2	-36.097141	146.693975	198.04	2.70	200.74
3	-36.097700	146.694018	201.47	2.70	204.17
4	-36.097371	146.694882	201.11	2.70	203.81
5	-36.096799	146.694850	197.11	2.70	199.81
6	-36.096560	146.695509	196.63	2.70	199.33
7	-36.097154	146.695552	201.03	2.70	203.73
8	-36.097065	146.695796	200.92	2.70	203.62
9	-36.097687	146.695826	206.04	2.70	208.74
10	-36.098663	146.693026	207.74	2.70	210.44
11	-36.098025	146.693026	202.11	2.70	204.81
12	-36.098155	146.692666	202.54	2.70	205.24

Route Receptor(s)

Name: Barnawartha Howlong 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	-36.101724	146.679343	177.76	2.00	179.76
2	-36.098958	146.677669	176.85	2.00	178.85
3	-36.098785	146.677691	176.24	2.00	178.24
4	-36.098655	146.676693	177.26	2.00	179.26
5	-36.095265	146.677197	176.00	2.00	178.00
6	-36.091435	146.677729	178.62	2.00	180.62
7	-36.087776	146.678255	173.94	2.00	175.94
8	-36.084074	146.678769	171.52	2.00	173.52

Name: Bill Tanner and Tom Tanner 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	-36.090464	146.666838	174.32	2.00	176.32
2	-36.090846	146.671387	172.01	2.00	174.01
3	-36.091245	146.675786	175.64	2.00	177.64
4	-36.091591	146.679262	177.84	2.00	179.84
5	-36.091921	146.682996	175.00	2.00	177.00
6	-36.092164	146.685399	175.29	2.00	177.29
7	-36.092302	146.686944	176.20	2.00	178.20
8	-36.090378	146.687180	174.44	2.00	176.44
9	-36.087031	146.687631	172.26	2.00	174.26
10	-36.084846	146.687953	170.90	2.00	172.90
11	-36.085124	146.690485	171.58	2.00	173.58
12	-36.085696	146.696777	174.21	2.00	176.21
13	-36.086112	146.701905	179.37	2.00	181.37
14	-36.086424	146.704437	179.93	2.00	181.93
15	-36.086545	146.705810	181.21	2.00	183.21

Name: Hume Fwy
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	-36.083260	146.728367	180.30	2.00	182.30
2	-36.086806	146.719086	189.30	2.00	191.30
3	-36.089337	146.712316	198.29	2.00	200.29
4	-36.090907	146.708121	194.90	2.00	196.90
5	-36.095519	146.695837	190.86	2.00	192.86
6	-36.096715	146.692768	192.61	2.00	194.61
7	-36.097235	146.691030	193.64	2.00	195.64
8	-36.097773	146.688906	194.29	2.00	196.29
9	-36.098328	146.687189	193.72	2.00	195.72
10	-36.099299	146.685537	191.29	2.00	193.29
11	-36.100166	146.684421	189.00	2.00	191.00
12	-36.101119	146.683584	186.78	2.00	188.78
13	-36.102229	146.682898	183.98	2.00	185.98
14	-36.102714	146.682683	183.15	2.00	185.15

Name: Oats Gap 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	-36.099170	146.704106	211.58	2.00	213.58
2	-36.096595	146.704460	202.55	2.00	204.55
3	-36.092555	146.705018	192.24	2.00	194.24

Name: Plunketts 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	-36.089456	146.733119	200.08	2.00	202.08
2	-36.088641	146.724150	195.79	2.00	197.79
3	-36.088069	146.718163	191.57	2.00	193.57
4	-36.088207	146.716661	193.79	2.00	195.79
5	-36.090930	146.709366	195.94	2.00	197.94
6	-36.092664	146.704602	192.19	2.00	194.19
7	-36.094450	146.699882	193.91	2.00	195.91
8	-36.095906	146.695998	193.74	2.00	195.74
9	-36.096686	146.693788	195.68	2.00	197.68
10	-36.097311	146.692050	196.75	2.00	198.75
11	-36.097692	146.690667	197.58	2.00	199.58
12	-36.098507	146.687856	196.86	2.00	198.86
13	-36.099304	146.686053	195.06	2.00	197.06
14	-36.100345	146.684723	193.49	2.00	195.49
15	-36.101333	146.684036	191.95	2.00	193.95

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

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-36.081080	146.726437	174.13	2.00	176.13
2	-36.088552	146.706864	186.90	2.00	188.90
3	-36.089631	146.703902	186.14	2.00	188.14
4	-36.091114	146.699992	185.44	2.00	187.44
5	-36.092124	146.697353	185.00	2.00	187.00
6	-36.092926	146.695260	183.76	2.00	185.76
7	-36.094161	146.691908	184.61	2.00	186.61
8	-36.095075	146.689601	185.47	2.00	187.47
9	-36.095860	146.687927	185.27	2.00	187.27
10	-36.097047	146.686066	182.83	2.00	184.83
11	-36.098009	146.684880	181.24	2.00	183.24
12	-36.099245	146.683518	180.01	2.00	182.01
13	-36.100042	146.682606	178.98	2.00	180.98

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 array 2	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: Barnawartha Howlong Road	0	0
Route: Bill Tanner and Tom Tanner Road	0	0
Route: Hume Fwy	0	0
Route: Oats Gap Road	0	0
Route: Plunketts Road	0	0
Route: Railway Line	0	0

No glare found

PV array 2 no glare found

Component	Green glare (min)	Yellow glare (min)
Route: Barnawartha Howlong Road	0	0
Route: Bill Tanner and Tom Tanner Road	0	0
Route: Hume Fwy	0	0
Route: Oats Gap Road	0	0
Route: Plunketts Road	0	0
Route: Railway Line	0	0

No glare found

Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actu values and results may vary.
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- 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.)
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