HENDYS ROAD SOLAR FARM

GLINT AND GLARE IMPACT ASSESSMENT REPORT
FINAL ISSUE

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Green Gold Energy

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for Green Gold Energy

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CONTENTS

EXECUTIVE SUMMARY 1
1. INTRODUCTION 2
1.1. Location 2
2. SCOPE OF THE ASSESSMENT 2
3. METHODOLOGY 3
3.1. Glint and Glare Definitions 3
3.2. Glare Assessment Parameters 4
3.3. Glare Intensity Categories 4
3.4. Reflection and Angle of Incidence 5
3.5. Viewshed Analysis 8
3.6. Solar Glare Hazard Analysis 8
3.7. Risk Assessment 8
4. EXISTING CONDITIONS 9
4.1. Baseline Conditions 9
4.2. Atmospheric Conditions 9
5. PROJECT DESCRIPTION 9
5.1. PV modules 10
5.2. Horizontal single axis tracking system 10
5.3. Solar Inverters, Control Room, and Fencing 12
6. DESKTOP GLARE ASSESSMENT 12
6.1. Viewshed Analysis 12
6.2. Solar Glare Hazard Analysis 13
6.3. Solar Glare Hazard Analysis Tool (SGHAT) Results 14
6.4. Backtracking Operations 14
7. MANAGEMENT AND MITIGATION MEASURES 16
8. SUMMARY 16
APPENDIX A: 18
APPENDIX B: 19

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 airport to the Project is more than 20km from the site, outside the influence of potential glare impacts, therefore air traffic control towers and runway approach paths were not included in 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;
- When the glare modelling simulated the horizontal tracking system reverting directly to the stowing angle of 0 degrees once the PV modules reached maximum tilt, a small amount of glare potential was identified affecting two dwellings within 1km of the Project. However existing vegetation and buildings (sheds) between the solar farm and the dwellings are considered likely to screen this small amount of potential glare.

Under normal operation of the solar farm the risk of glare affecting roads and dwellings within 2km of the Project was identified as 'negligible'.

1. INTRODUCTION

This report has been prepared by Environmental Ethos on behalf of Green Gold Energy to assess the potential solar glint and glare impact of the proposed Hendys Road Solar Farm (the Project), located at 574 Hendys Road, Numurkah, 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 on Lot 2 of PS613623U, the footprint of the proposed PV arrays will cover an area of approximately 9.6 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 a maximum height of 4 metres.

1.1. Location

The Project site is located approximately 4 kilometres north of Numurkah, *refer Figure 1.* The Project site adjoins Naring Hall Road on the southern boundary. The site is zoned FZ1 Farming Zone and is currently used for cropping and grazing. Farming is the predominant land use within the area.

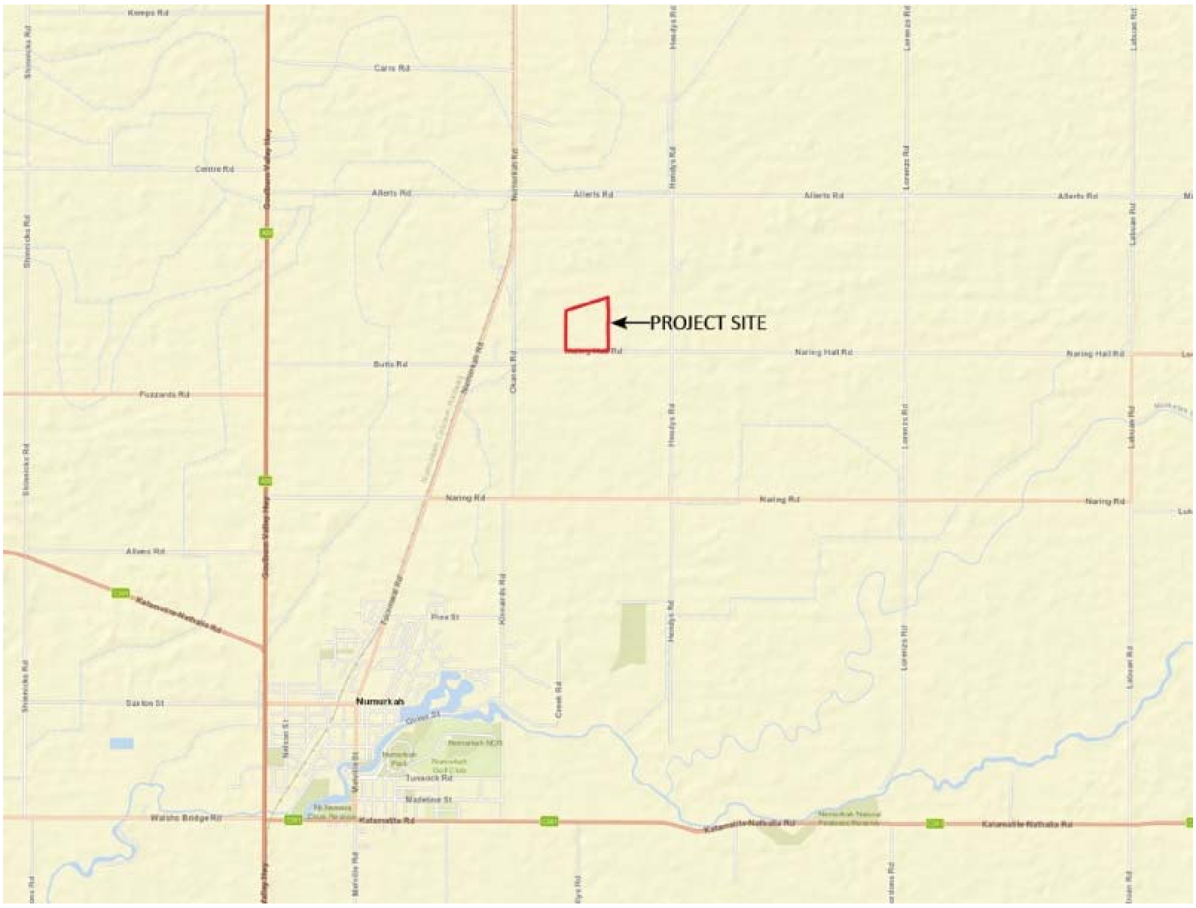


Figure 1. Location Plan

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

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:

[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

"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.

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.

[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

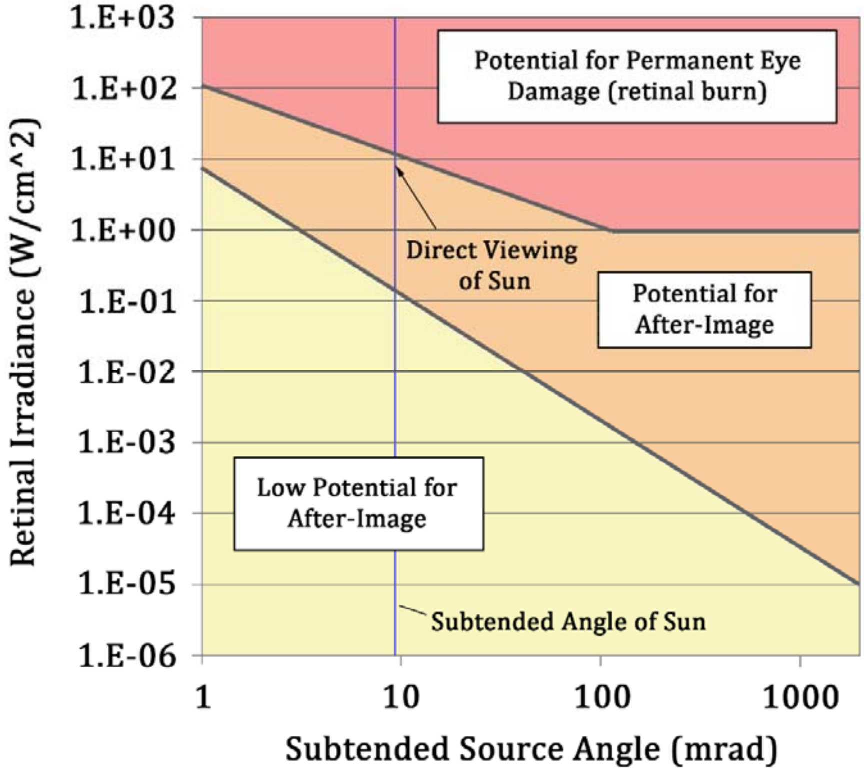


Figure 2. Ocular impacts and Hazard Ranges[4]

The amount of light reflected from a PV module depends on the amount of sunlight hitting the surface, as well as the surface reflectivity. The amount of sunlight interacting with the PV module will vary based on geographic location, time of year, cloud cover, and PV module orientation. 1000W/m^2 is generally used in most counties as an estimate of the solar energy interacting with a PV module when no other information is available. This study modelled scenarios using 2000 W/m^2 in order to cover potentially higher solar energy levels in Australia as compared to other parts of the world. Flash blindness for a period of 4-12 seconds (i.e. time to recovery of vision) occurs when 7-11 W/m^2 (or 650-1,100 lumens/m^2) reaches the eye[5].

3.4. Reflection and Angle of Incidence

PV modules are designed to maximise the absorption of solar energy and therefore minimise the extent of solar energy reflected. PV modules have low levels of reflectivity between 0.03 and 0.20 depending on the specific materials, anti-reflective coatings, and angle of incidence.[6]

The higher reflectivity values of 0.20, that is 20% of incident light being reflected, can occur when the angle of incidence is greater than 50^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

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

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.

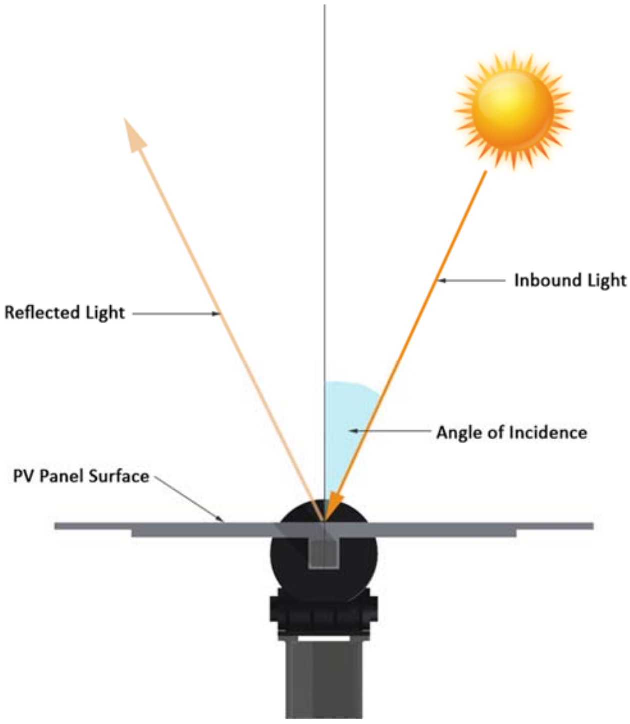


Figure 3. Angle of Incidence Relative to PV Panel Surface

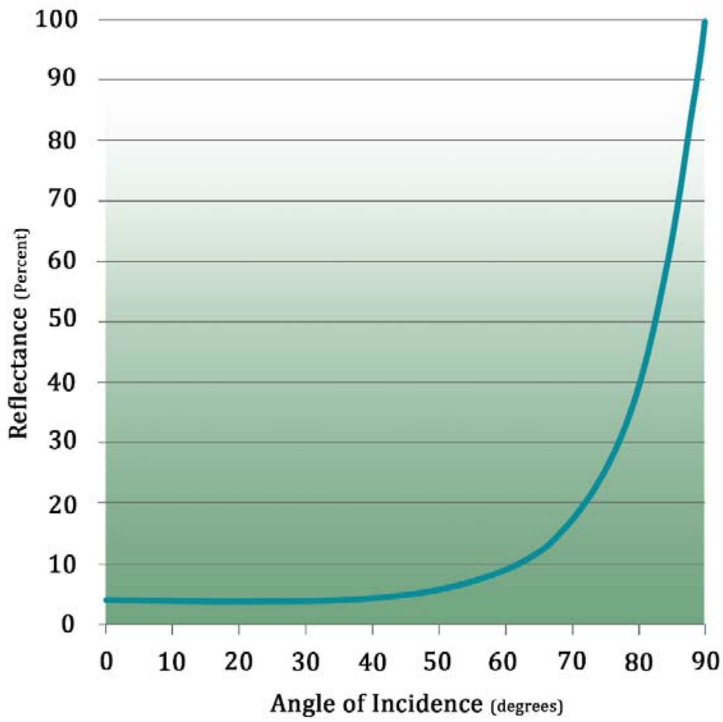


Figure 4. Angles of Incidence and Increased Levels of Reflected Light (Glass (n-1.5))

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.

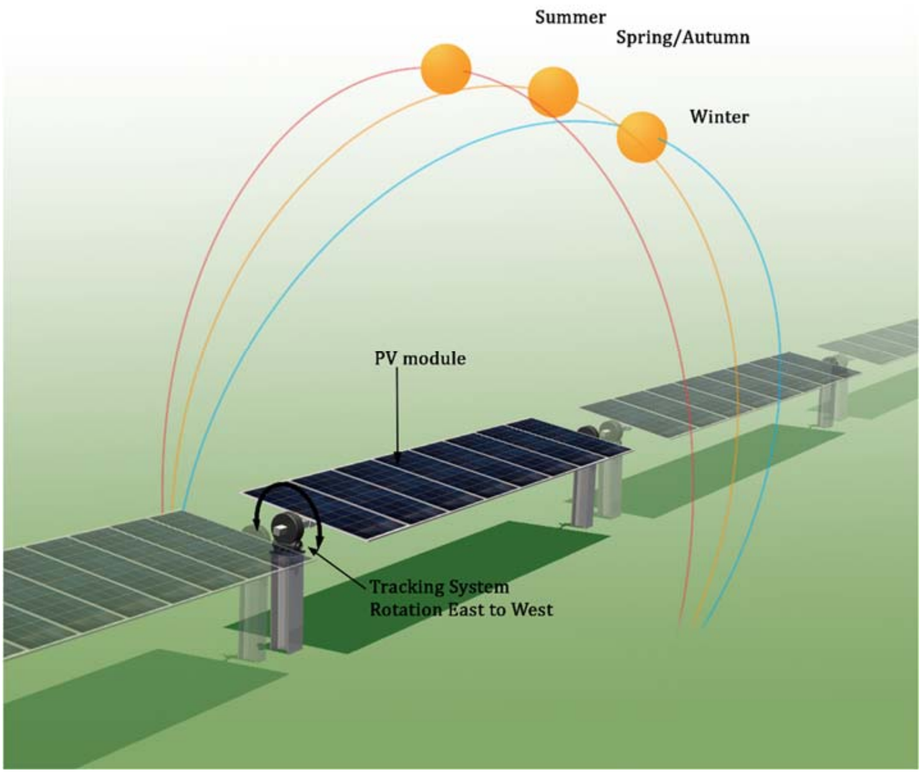


Figure 5. Diagrammatic illustration of sun position relative to PV module mounted on a horizontal single axis tracking system.

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.

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

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

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

3.7. Risk Assessment

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

[7] 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 rural landscape. Baseline conditions within this area are characteristic of a rural landscape, being flat cropping and grazing land with scattered patches of native vegetation and shelterbelt planting. Vegetation along the Naring Hall Road on the Project site's southern boundary consists of scattered native trees, providing limited screening. Some vegetation screening is provided to the south east by shelterbelt planting on the adjoining lot.

Existing dwellings in the area consist of rural homesteads and residential properties within the Rural Living Zone to the west of the Project site. In general rural and rural residential dwellings are surrounded by planted trees both native and introduced species.

Constructed elements within the landscape include roads, the rail line to the west, powerlines, rural buildings (including large sheds), and irrigation canals.

Existing features in the landscape with the potential to contribute to glare include water bodies, and the open irrigation channels hold water which may contribute to glare. However, these channels are below ground level and surrounded by vegetation such as sedges and reeds, the contribution to glare is therefore limited and not considered significant.

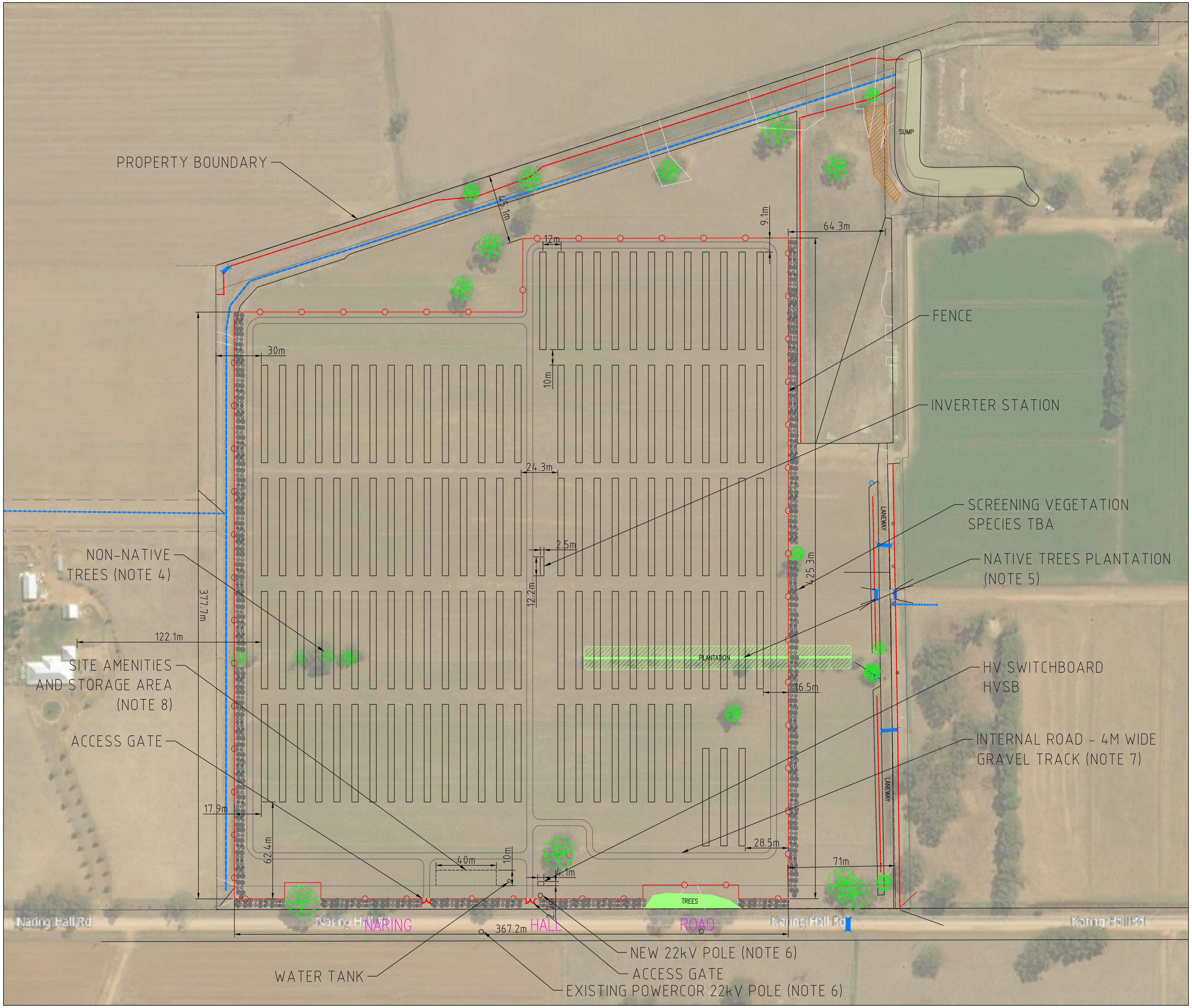
4.2. Atmospheric Conditions

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 Tocumwal Airport 29 km from the Project site (the closest BOM records for cloud cover statistics) recorded 99 cloudy days per year (mean number over the period 1970 to 2010)[8]. Cloudy days predominantly occur during the winter months, June 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.

[8] http://www.bom.gov.au/climate/averages/tables/cw_074106.shtml



LEGEND

PROPOSED PV ARRAY

SECURITY FENCE

PROPERTY BOUNDARY

4.3m

62.8m

SOURCE: GREEN GOLD ENERGY
SITE PLAN - REV K
04/09/2020

PROJECT NO. 20013
CREATED BY: SC
DATE: 12 10 2020 VERSION: A

HENDYS ROAD SOLAR FARM

GLINT AND GLARE IMPACT ASSESSMENT

PROJECT LAYOUT PLAN

FIGURE 6.0

5.1. PV modules

Each PV panel typically comprises of 72 polycrystalline silicon solar cells overlayed by a 3.2 to 4.0 mm tempered glass front and held in an anodised aluminium alloy frame. Half cut cell technology is also available which consists of 144 monocrystalline cells connected in series to reduce ribbon resistant. Dual-glass and frameless PV systems area also available. The approximate dimensions for a typical solar panel is 2 metres x 1 metre. The proposed solar array arrangement for this Project is two (2) solar panels in portrait, resulting in an array width of approximately 4 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 7.*

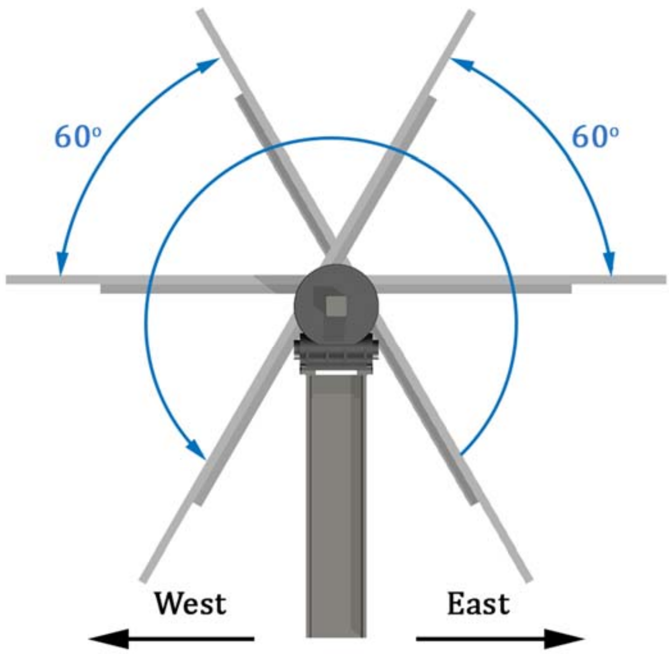


Figure 7. Illustration of PV Module Rotation Angles

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 4 metres, a height of 4 metres was used in the modelling. 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.

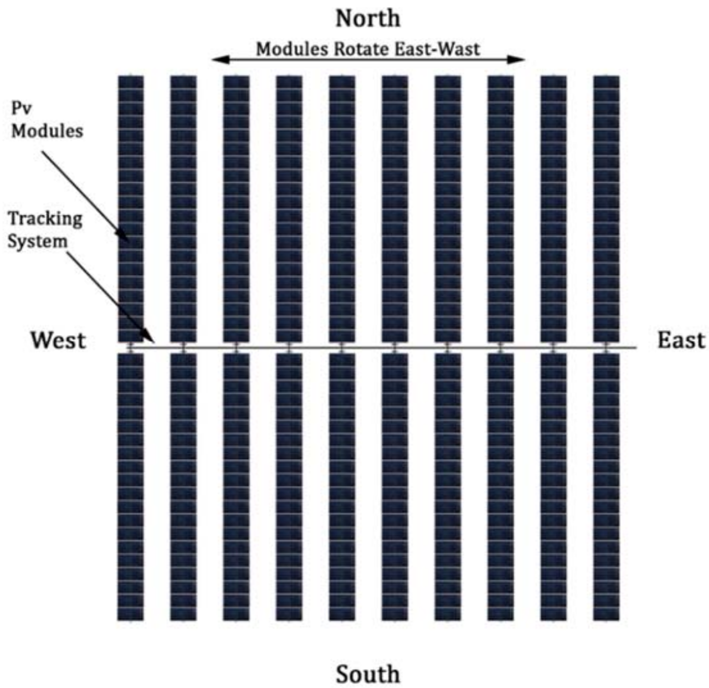


Figure 8. Illustration of PV Module Row Alignment

Plate 1. Example of a typical frameless solar array mounted on a single axis tracking system[9]

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

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.

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 (DELWP dataset) was assessed and shows the Project site is located within a generally flat landscape with minor topographic variation.

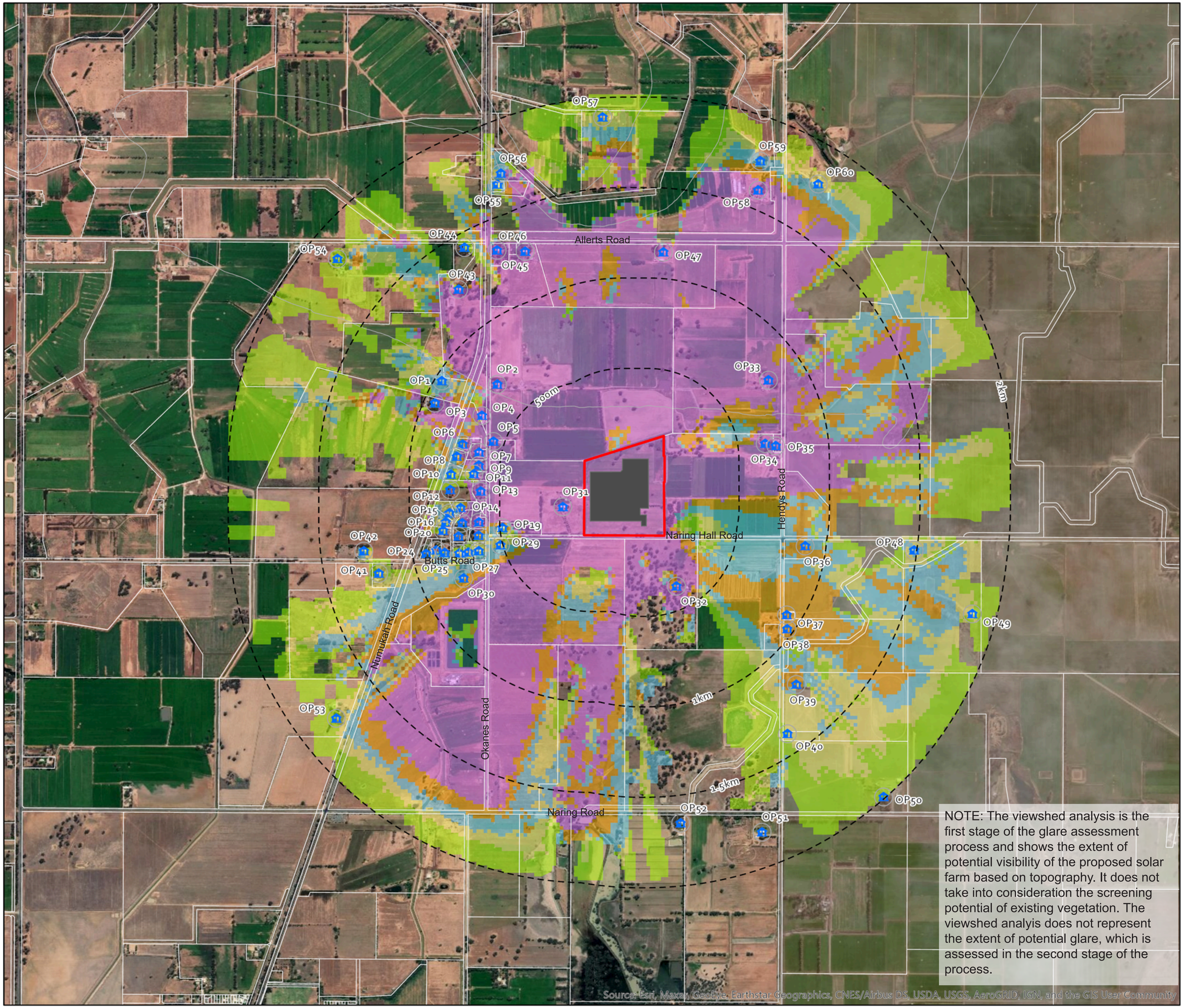
Solar Farms are characterised by their low horizontal profile. The major elements of a solar farm are the PV models, these are generally 2 to 4 metres above ground level. In this study a maximum height of 4 metres above ground level was used in the modelling. At distances greater than 1 km a 4 metre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

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

60 observation points were assessed within the viewshed; 38 were located at dwellings within 1km of the Project site and 22 at dwellings 1 - 2km from the Project site. The numbering of observation points within 1km of the Project corresponds to dwellings identified in the Site Location Plan prepared by Green Gold Energy, dated 04/09/2020. All observation point locations and numbers shown in *Figure 9* are consist with the glare modelling results provided in the appendices and detailed in *Table 1*.

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

Distance from Project	Observation Points (Rural and residential dwellings)	Identified as potentially visible in the viewshed modelling
<500m	3 (OP19, OP31 and OP32) rural properties	Yes
500m – 1km	35 (OP1 – OP18, OP20 – OP30, OP33- OP38) rural and residential properties	Yes (with exception of OP3, 12, 21, 23 and 24)
1km – 2km	22 (OP39 – OP60) rural and residential properties	Yes (with exception of OP51 and 52)



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

ENVIRONMENTAL ETHOS

N

DATUM GDA 1994,
PROJECTION MGA ZONE 56

SCALE 1:20,000 @ A3

0 0.25 0.5 1
Kilometers

Legend

- SITE BOUNDARY
- PV MODULE AREA
- DISTANCE FROM SOLAR FARM
- DWELLINGS

EXTENT OF VISIBILITY*

Less visible

More visible

*(Analysis based on Digital Terrain Model)

PROJECT No. 20013
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DATE: 10 10 2020
VERSION: A

HENDYS ROAD SOLAR FARM

GLINT AND GLARE IMPACT ASSESSMENT

VIEWSHED ANALYSIS

FIGURE
9.0

Seven (7) roads pass through the viewshed and these were included in the glare modelling, as follows:

- Allerts Road
- Butts Road
- Hendys Road
- Naring Hall Road
- Naring Road
- Numurkah Road
- Okanes Road

Tocumwal is the closest Airport to the Project site, at 29km from the Project site this facility is not considered 'close', therefore flight paths were not included in the glare modelling.

The potential glare hazard impact for identified properties and surrounding roads with potential views to the site has 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 - 0
Reflectivity	Vary with sun
Correlate slope error with surface type?	Yes
Slope error	6.55mrad
Height of panels above ground	4m maximum height

Route Parameters

Glare modelling included the assessment of potential impacts to route receptors (people travelling along roads) 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[10]. 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

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

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 within the vicinity of the solar farm.

6.3. Solar Glare Hazard Analysis Tool (SGHAT) Results

The assessment outcomes for the SGHAT modelling are detailed in *Appendix A and 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 OP60 Rural and residential dwellings	No Glare
Allerts Road	No Glare
Butts Road	No Glare
Hendys Road	No Glare
Naring Hall Road	No Glare
Naring Road	No Glare
Numurkah Road	No Glare
Okanes Road	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, *refer Appendices B.*

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) 0 degrees

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

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

Sensitive Receptor	Resting Angle 45 degrees *- Glare Potential	Stowing Angle 0 degrees **- Glare Potential
Observation Points OP1 to OP12, OP14 to OP32, OP34 to OP60 Rural and residential dwellings	No Glare – all dwellings	No Glare
Observation Point 13 Residential dwelling	No Glare	Glare potential refer table 5
Observation Point 33 Rural dwelling	No Glare	Glare potential refer table 5
Allerts Road	No Glare	No Glare
Butts Road	No Glare	No Glare
Hendys Road	No Glare	No Glare
Naring Hall Road	No Glare	No Glare
Naring Road	No Glare	No Glare
Numurkah Road	No Glare	No Glare
Okanes Road	No Glare	No Glare

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

*Modelling is based on the PV panels moving directly to 0 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 potential glare hazard may occur affecting two (2) properties within 1km of the Project when the tracking system operates a backtracking procedure from maximum tilt (60 degrees) to a resting angle of 0 degrees (horizontal to the ground). This procedure would normally occur gradually, with the panels held at 0 degrees after dark. Whist the limitations of modelling resting angles distorts the results, presenting a worst case than is considered likely, further assessment was undertaken for the two potentially affected properties to ascertain if existing vegetation and buildings between the solar farm and the properties (not considered by the modelling) would further reduce the potential for glare at these locations. This assessment was undertaken using aerial photography and 'Streetview', the results are presented in *Table 5*.

Table 5. Glare potential risk assessment for Resting Angle Analysis - 0 degrees

Sensitive Receptor	Distance from glare source	Glare Potential (based on topography)	Mitigation factors (existing)	Risk of glare hazard prior to screen planting	Risk of glare hazard after landscaping established
Observation Point 13 Residential dwelling	500m – 1km	Glare Potential (Yellow) when panels rest at 0 degrees Early morning, less than 5 minutes a day during Spring and Autumn	Existing vegetation surrounding the dwelling and along intervening road and canal – likely to provide sufficient screening to this small amount of glare	Negligible	Negligible
Observation Point 33 Rural dwelling	500m – 1km	Glare Potential (Yellow) when panels rest at 0 degrees Very low amount of glare (<5 minutes in a year)	Existing vegetation and outbuildings (sheds) surrounding the dwelling – likely to provide sufficient screening to this small amount of glare	Negligible	Negligible

The results of the desktop assessment, confirm that in the unlikely event the tracking system reverts to a resting angle of 0 degrees (stow angle) during daylight hours, the presence of existing vegetation and buildings (sheds) between the two (2) potentially affected properties and the solar farm, are considered likely to mitigate the small amount of glare identified. #

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, no glare potential was identified.

When the model simulated the horizontal tracking system reverting directly to the stowing angle of 0 degrees once the PV modules reached maximum tilt, a small amount of glare potential was identified affecting two dwellings. However existing vegetation and buildings (sheds) between the solar farm and the dwellings are considered likely to screen this small amount of potential glare, therefore further mitigation measures are not considered necessary. #

8. SUMMARY

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

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

For further explanation see images in email dated 20 November 2020 at the back of this report

- When the model simulated the horizontal tracking system reverting directly to the stowing angle of 0 degrees once the PV modules reached maximum tilt, a small amount of glare potential was identified affecting two dwellings. However existing vegetation and buildings (sheds) between the solar farm and the dwellings are considered likely to screen this small amount of potential glare.

Under normal operation of the solar farm the risk of glare affecting roads and dwellings within 2km of the Project was identified as 'negligible'.

APPENDIX A:

SOLAR GLARE HAZARD ANALYSIS –DWELLINGS

ForgeSolar

Site Configuration: Hendys Road SF_OPs

Project site configuration details and results.

Created **Oct. 9, 2020 9:46 p.m.**
Updated **Oct. 9, 2020 10:22 p.m.**
DNI **varies** and peaks at **2,000.0 W/m^2**
Analyze every **1** minute(s)
0.5 ocular transmission coefficient
0.002 m pupil diameter
0.017 m eye focal length
9.3 mrad sun subtended angle
Timezone **UTC10**
Site Configuration ID: 44283.8016

Summary of Results No glare predicted!

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

Component Data

PV Array(s)

Name: PV array 1
Axis tracking: Single-axis rotation
Tracking axis orientation: 0.0 deg
Tracking axis tilt: 0.0 deg
Tracking axis panel offset: 0.0 deg
Maximum tracking angle: 60.0 deg
Resting angle: 60.0 deg
Rated power: -
Panel material: Smooth glass without AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 6.55 mrad
Approx. area: 95,595 sq-m

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-36.051462	145.468545	110.72	4.00	114.72
2	-36.051457	145.470143	109.32	4.00	113.32
3	-36.053838	145.470141	110.65	4.00	114.65
4	-36.053834	145.469712	110.57	4.00	114.57
5	-36.054200	145.469712	110.44	4.00	114.44
6	-36.054200	145.470076	110.34	4.00	114.34
7	-36.054764	145.470074	109.67	4.00	113.67
8	-36.054758	145.469693	110.31	4.00	114.31
9	-36.054508	145.469696	110.35	4.00	114.35
10	-36.054502	145.466614	110.89	4.00	114.89
11	-36.052043	145.466614	108.45	4.00	112.45
12	-36.052034	145.468357	109.28	4.00	113.28
13	-36.051947	145.468529	109.63	4.00	113.63

Discrete Observation Receptors

Number	Latitude	Longitude	Ground elevation	Height above ground	Total Elevation
	deg	deg	m	m	m
OP 1	-36.047579	145.457558	111.09	1.50	112.59
OP 2	-36.047718	145.460948	112.26	1.50	113.76
OP 3	-36.048724	145.457150	112.75	1.50	114.25
OP 4	-36.049314	145.460015	111.80	1.50	113.30
OP 5	-36.050572	145.460841	110.75	1.50	112.25
OP 6	-36.050737	145.458867	111.30	1.50	112.80
OP 7	-36.051162	145.459875	112.00	1.50	113.50
OP 8	-36.051344	145.458523	111.57	1.50	113.07
OP 9	-36.051778	145.459897	112.21	1.50	113.71
OP 10	-36.052281	145.458191	111.19	1.50	112.69
OP 11	-36.052264	145.459596	112.72	1.50	114.22
OP 12	-36.053018	145.458126	110.24	1.50	111.74
OP 13	-36.053105	145.459961	113.37	1.50	114.87
OP 14	-36.053929	145.458706	110.74	1.50	112.24
OP 15	-36.054163	145.458084	110.46	1.50	111.96
OP 16	-36.054597	145.457848	110.03	1.50	111.53
OP 17	-36.054653	145.458883	110.94	1.50	112.44
OP 18	-36.054675	145.459859	112.00	1.50	113.50
OP 19	-36.054874	145.461324	111.57	1.50	113.07
OP 20	-36.055057	145.457681	109.11	1.50	110.61
OP 21	-36.055299	145.458647	110.68	1.50	112.18
OP 22	-36.055291	145.459859	111.68	1.50	113.18
OP 23	-36.056028	145.457268	110.40	1.50	111.90
OP 24	-36.056197	145.456646	109.56	1.50	111.06
OP 25	-36.056128	145.457821	110.62	1.50	112.12
OP 26	-36.056175	145.458695	111.36	1.50	112.86
OP 27	-36.056132	145.459253	111.33	1.50	112.83
OP 28	-36.056050	145.459918	111.00	1.50	112.50
OP 29	-36.055750	145.461238	111.00	1.50	112.50
OP 30	-36.057411	145.458963	111.00	1.50	112.50
OP 31	-36.053851	145.465047	109.04	1.50	110.54
OP 32	-36.057776	145.472030	116.84	1.50	118.34
OP 33	-36.047471	145.477666	113.26	1.50	114.76
OP 34	-36.050641	145.477462	111.36	1.50	112.86
OP 35	-36.050763	145.478089	112.10	1.50	113.60
OP 36	-36.055742	145.479924	110.95	1.50	112.45
OP 37	-36.059166	145.478830	112.04	1.50	113.54
OP 38	-36.059872	145.478819	112.11	1.50	113.61
OP 39	-36.062617	145.479425	108.22	1.50	109.72
OP 40	-36.065059	145.478883	108.00	1.50	109.50
OP 41	-36.057214	145.453777	111.47	1.50	112.97
OP 42	-36.056082	145.452892	110.06	1.50	111.56
OP 43	-36.043035	145.458627	115.17	1.50	116.67
OP 44	-36.040957	145.458933	111.00	1.50	112.50
OP 45	-36.041031	145.460917	112.82	1.50	114.32
OP 46	-36.041083	145.462634	111.00	1.50	112.50
OP 47	-36.041144	145.471118	113.00	1.50	114.50
OP 48	-36.055836	145.486496	110.81	1.50	112.31
OP 49	-36.059017	145.490138	109.85	1.50	111.35
OP 50	-36.068202	145.484779	110.38	1.50	111.88
OP 51	-36.069954	145.477398	113.06	1.50	114.56
OP 52	-36.069546	145.472398	109.42	1.50	110.92
OP 53	-36.064432	145.451213	111.00	1.50	112.50
OP 54	-36.041522	145.451206	113.68	1.50	115.18
OP 55	-36.037823	145.460965	112.00	1.50	113.50
OP 56	-36.037263	145.461233	111.75	1.50	113.25
OP 57	-36.034422	145.467370	110.21	1.50	111.71

OP 58	-36.038018	145.476903	113.66	1.50	115.16
OP 59	-36.036548	145.477074	115.70	1.50	117.20
OP 60	-36.037693	145.480593	113.63	1.50	115.13

PV Array Results

Summary of PV Glare Analysis PV configuration and predicted glare

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

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

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

PV array 1 no glare found

Component	Green glare (min)	Yellow glare (min)
OP: OP 1	0	0
OP: OP 2	0	0
OP: OP 3	0	0
OP: OP 4	0	0
OP: OP 5	0	0
OP: OP 6	0	0
OP: OP 7	0	0
OP: OP 8	0	0
OP: OP 9	0	0
OP: OP 10	0	0
OP: OP 11	0	0
OP: OP 12	0	0
OP: OP 13	0	0
OP: OP 14	0	0
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
OP: OP 22	0	0
OP: OP 23	0	0
OP: OP 24	0	0
OP: OP 25	0	0
OP: OP 26	0	0
OP: OP 27	0	0
OP: OP 28	0	0
OP: OP 29	0	0
OP: OP 30	0	0
OP: OP 31	0	0
OP: OP 32	0	0
OP: OP 33	0	0
OP: OP 34	0	0
OP: OP 35	0	0
OP: OP 36	0	0
OP: OP 37	0	0
OP: OP 38	0	0
OP: OP 39	0	0
OP: OP 40	0	0
OP: OP 41	0	0
OP: OP 42	0	0
OP: OP 43	0	0
OP: OP 44	0	0
OP: OP 45	0	0
OP: OP 46	0	0
OP: OP 47	0	0

OP: OP 48	0	0
OP: OP 49	0	0
OP: OP 50	0	0
OP: OP 51	0	0
OP: OP 52	0	0
OP: OP 53	0	0
OP: OP 54	0	0
OP: OP 55	0	0
OP: OP 56	0	0
OP: OP 57	0	0
OP: OP 58	0	0
OP: OP 59	0	0
OP: OP 60	0	0

No glare found

Assumptions

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

ForgeSolar

Site Configuration: Hendys Road SF_OPs

Project site configuration details and results.

Created **Oct. 9, 2020 9:46 p.m.**
Updated **Oct. 9, 2020 10:31 p.m.**
DNI **varies** and peaks at **2,000.0 W/m^2**
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0.5 ocular transmission coefficient
0.002 m pupil diameter
0.017 m eye focal length
9.3 mrad sun subtended angle
Timezone **UTC10**
Site Configuration ID: 44283.8016

Summary of Results No glare predicted!

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

Component Data

PV Array(s)

Name: PV array 1
Axis tracking: Single-axis rotation
Tracking axis orientation: 0.0 deg
Tracking axis tilt: 0.0 deg
Tracking axis panel offset: 0.0 deg
Maximum tracking angle: 60.0 deg
Resting angle: 45.0 deg
Rated power: -
Panel material: Smooth glass without AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 6.55 mrad
Approx. area: 95,595 sq-m

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
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5	-36.054200	145.469712	110.44	4.00	114.44
6	-36.054200	145.470076	110.34	4.00	114.34
7	-36.054764	145.470074	109.67	4.00	113.67
8	-36.054758	145.469693	110.31	4.00	114.31
9	-36.054508	145.469696	110.35	4.00	114.35
10	-36.054502	145.466614	110.89	4.00	114.89
11	-36.052043	145.466614	108.45	4.00	112.45
12	-36.052034	145.468357	109.28	4.00	113.28
13	-36.051947	145.468529	109.63	4.00	113.63

Discrete Observation Receptors

Number	Latitude	Longitude	Ground elevation	Height above ground	Total Elevation
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OP 4	-36.049314	145.460015	111.80	1.50	113.30
OP 5	-36.050572	145.460841	110.75	1.50	112.25
OP 6	-36.050737	145.458867	111.30	1.50	112.80
OP 7	-36.051162	145.459875	112.00	1.50	113.50
OP 8	-36.051344	145.458523	111.57	1.50	113.07
OP 9	-36.051778	145.459897	112.21	1.50	113.71
OP 10	-36.052281	145.458191	111.19	1.50	112.69
OP 11	-36.052264	145.459596	112.72	1.50	114.22
OP 12	-36.053018	145.458126	110.24	1.50	111.74
OP 13	-36.053105	145.459961	113.37	1.50	114.87
OP 14	-36.053929	145.458706	110.74	1.50	112.24
OP 15	-36.054163	145.458084	110.46	1.50	111.96
OP 16	-36.054597	145.457848	110.03	1.50	111.53
OP 17	-36.054653	145.458883	110.94	1.50	112.44
OP 18	-36.054675	145.459859	112.00	1.50	113.50
OP 19	-36.054874	145.461324	111.57	1.50	113.07
OP 20	-36.055057	145.457681	109.11	1.50	110.61
OP 21	-36.055299	145.458647	110.68	1.50	112.18
OP 22	-36.055291	145.459859	111.68	1.50	113.18
OP 23	-36.056028	145.457268	110.40	1.50	111.90
OP 24	-36.056197	145.456646	109.56	1.50	111.06
OP 25	-36.056128	145.457821	110.62	1.50	112.12
OP 26	-36.056175	145.458695	111.36	1.50	112.86
OP 27	-36.056132	145.459253	111.33	1.50	112.83
OP 28	-36.056050	145.459918	111.00	1.50	112.50
OP 29	-36.055750	145.461238	111.00	1.50	112.50
OP 30	-36.057411	145.458963	111.00	1.50	112.50
OP 31	-36.053851	145.465047	109.04	1.50	110.54
OP 32	-36.057776	145.472030	116.84	1.50	118.34
OP 33	-36.047471	145.477666	113.26	1.50	114.76
OP 34	-36.050641	145.477462	111.36	1.50	112.86
OP 35	-36.050763	145.478089	112.10	1.50	113.60
OP 36	-36.055742	145.479924	110.95	1.50	112.45
OP 37	-36.059166	145.478830	112.04	1.50	113.54
OP 38	-36.059872	145.478819	112.11	1.50	113.61
OP 39	-36.062617	145.479425	108.22	1.50	109.72
OP 40	-36.065059	145.478883	108.00	1.50	109.50
OP 41	-36.057214	145.453777	111.47	1.50	112.97
OP 42	-36.056082	145.452892	110.06	1.50	111.56
OP 43	-36.043035	145.458627	115.17	1.50	116.67
OP 44	-36.040957	145.458933	111.00	1.50	112.50
OP 45	-36.041031	145.460917	112.82	1.50	114.32
OP 46	-36.041083	145.462634	111.00	1.50	112.50
OP 47	-36.041144	145.471118	113.00	1.50	114.50
OP 48	-36.055836	145.486496	110.81	1.50	112.31
OP 49	-36.059017	145.490138	109.85	1.50	111.35
OP 50	-36.068202	145.484779	110.38	1.50	111.88
OP 51	-36.069954	145.477398	113.06	1.50	114.56
OP 52	-36.069546	145.472398	109.42	1.50	110.92
OP 53	-36.064432	145.451213	111.00	1.50	112.50
OP 54	-36.041522	145.451206	113.68	1.50	115.18
OP 55	-36.037823	145.460965	112.00	1.50	113.50
OP 56	-36.037263	145.461233	111.75	1.50	113.25
OP 57	-36.034422	145.467370	110.21	1.50	111.71

OP 58	-36.038018	145.476903	113.66	1.50	115.16
OP 59	-36.036548	145.477074	115.70	1.50	117.20
OP 60	-36.037693	145.480593	113.63	1.50	115.13

PV Array Results

Summary of PV Glare Analysis PV configuration and predicted glare

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

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

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

PV array 1 no glare found

Component	Green glare (min)	Yellow glare (min)
OP: OP 1	0	0
OP: OP 2	0	0
OP: OP 3	0	0
OP: OP 4	0	0
OP: OP 5	0	0
OP: OP 6	0	0
OP: OP 7	0	0
OP: OP 8	0	0
OP: OP 9	0	0
OP: OP 10	0	0
OP: OP 11	0	0
OP: OP 12	0	0
OP: OP 13	0	0
OP: OP 14	0	0
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
OP: OP 22	0	0
OP: OP 23	0	0
OP: OP 24	0	0
OP: OP 25	0	0
OP: OP 26	0	0
OP: OP 27	0	0
OP: OP 28	0	0
OP: OP 29	0	0
OP: OP 30	0	0
OP: OP 31	0	0
OP: OP 32	0	0
OP: OP 33	0	0
OP: OP 34	0	0
OP: OP 35	0	0
OP: OP 36	0	0
OP: OP 37	0	0
OP: OP 38	0	0
OP: OP 39	0	0
OP: OP 40	0	0
OP: OP 41	0	0
OP: OP 42	0	0
OP: OP 43	0	0
OP: OP 44	0	0
OP: OP 45	0	0
OP: OP 46	0	0
OP: OP 47	0	0

OP: OP 48	0	0
OP: OP 49	0	0
OP: OP 50	0	0
OP: OP 51	0	0
OP: OP 52	0	0
OP: OP 53	0	0
OP: OP 54	0	0
OP: OP 55	0	0
OP: OP 56	0	0
OP: OP 57	0	0
OP: OP 58	0	0
OP: OP 59	0	0
OP: OP 60	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.
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- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
- Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
- Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
- Glare analysis methods used: OP V1, FP V1, Route V1
- Refer to the **Help page** for assumptions and limitations not listed here.

ForgeSolar

Site Configuration: Hendys Road SF_OPs-temp-1

Project site configuration details and results.

Created **Oct. 9, 2020 10:41 p.m.**
Updated **Oct. 9, 2020 10:47 p.m.**
DNI **varies** and peaks at **2,000.0 W/m^2**
Analyze every **1** minute(s)
0.5 ocular transmission coefficient
0.002 m pupil diameter
0.017 m eye focal length
9.3 mrad sun subtended angle
Timezone **UTC10**
Site Configuration ID: 44285.8016

Summary of Results Glare with potential for temporary after-image predicted

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced
	deg	deg	min	min	kWh
PV array 1	SA tracking	SA tracking	0	140	-

Component Data

PV Array(s)

Name: PV array 1
Axis tracking: Single-axis rotation
Tracking axis orientation: 0.0 deg
Tracking axis tilt: 0.0 deg
Tracking axis panel offset: 0.0 deg
Maximum tracking angle: 60.0 deg
Resting angle: 0.0 deg
Rated power: -
Panel material: Smooth glass without AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 6.55 mrad
Approx. area: 95,595 sq-m

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-36.051462	145.468545	110.72	4.00	114.72
2	-36.051457	145.470143	109.32	4.00	113.32
3	-36.053838	145.470141	110.65	4.00	114.65
4	-36.053834	145.469712	110.57	4.00	114.57
5	-36.054200	145.469712	110.44	4.00	114.44
6	-36.054200	145.470076	110.34	4.00	114.34
7	-36.054764	145.470074	109.67	4.00	113.67
8	-36.054758	145.469693	110.31	4.00	114.31
9	-36.054508	145.469696	110.35	4.00	114.35
10	-36.054502	145.466614	110.89	4.00	114.89
11	-36.052043	145.466614	108.45	4.00	112.45
12	-36.052034	145.468357	109.28	4.00	113.28
13	-36.051947	145.468529	109.63	4.00	113.63

Discrete Observation Receptors

Number	Latitude	Longitude	Ground elevation	Height above ground	Total Elevation
	deg	deg	m	m	m
OP 1	-36.047579	145.457558	111.09	1.50	112.59
OP 2	-36.047718	145.460948	112.26	1.50	113.76
OP 3	-36.048724	145.457150	112.75	1.50	114.25
OP 4	-36.049314	145.460015	111.80	1.50	113.30
OP 5	-36.050572	145.460841	110.75	1.50	112.25
OP 6	-36.050737	145.458867	111.30	1.50	112.80
OP 7	-36.051162	145.459875	112.00	1.50	113.50
OP 8	-36.051344	145.458523	111.57	1.50	113.07
OP 9	-36.051778	145.459897	112.21	1.50	113.71
OP 10	-36.052281	145.458191	111.19	1.50	112.69
OP 11	-36.052264	145.459596	112.72	1.50	114.22
OP 12	-36.053018	145.458126	110.24	1.50	111.74
OP 13	-36.053105	145.459961	113.37	1.50	114.87
OP 14	-36.053929	145.458706	110.74	1.50	112.24
OP 15	-36.054163	145.458084	110.46	1.50	111.96
OP 16	-36.054597	145.457848	110.03	1.50	111.53
OP 17	-36.054653	145.458883	110.94	1.50	112.44
OP 18	-36.054675	145.459859	112.00	1.50	113.50
OP 19	-36.054874	145.461324	111.57	1.50	113.07
OP 20	-36.055057	145.457681	109.11	1.50	110.61
OP 21	-36.055299	145.458647	110.68	1.50	112.18
OP 22	-36.055291	145.459859	111.68	1.50	113.18
OP 23	-36.056028	145.457268	110.40	1.50	111.90
OP 24	-36.056197	145.456646	109.56	1.50	111.06
OP 25	-36.056128	145.457821	110.62	1.50	112.12
OP 26	-36.056175	145.458695	111.36	1.50	112.86
OP 27	-36.056132	145.459253	111.33	1.50	112.83
OP 28	-36.056050	145.459918	111.00	1.50	112.50
OP 29	-36.055750	145.461238	111.00	1.50	112.50
OP 30	-36.057411	145.458963	111.00	1.50	112.50
OP 31	-36.053851	145.465047	109.04	1.50	110.54
OP 32	-36.057776	145.472030	116.84	1.50	118.34
OP 33	-36.047471	145.477666	113.26	1.50	114.76
OP 34	-36.050641	145.477462	111.36	1.50	112.86
OP 35	-36.050763	145.478089	112.10	1.50	113.60
OP 36	-36.055742	145.479924	110.95	1.50	112.45
OP 37	-36.059166	145.478830	112.04	1.50	113.54
OP 38	-36.059872	145.478819	112.11	1.50	113.61
OP 39	-36.062617	145.479425	108.22	1.50	109.72
OP 40	-36.065059	145.478883	108.00	1.50	109.50
OP 41	-36.057214	145.453777	111.47	1.50	112.97
OP 42	-36.056082	145.452892	110.06	1.50	111.56
OP 43	-36.043035	145.458627	115.17	1.50	116.67
OP 44	-36.040957	145.458933	111.00	1.50	112.50
OP 45	-36.041031	145.460917	112.82	1.50	114.32
OP 46	-36.041083	145.462634	111.00	1.50	112.50
OP 47	-36.041144	145.471118	113.00	1.50	114.50
OP 48	-36.055836	145.486496	110.81	1.50	112.31
OP 49	-36.059017	145.490138	109.85	1.50	111.35
OP 50	-36.068202	145.484779	110.38	1.50	111.88
OP 51	-36.069954	145.477398	113.06	1.50	114.56
OP 52	-36.069546	145.472398	109.42	1.50	110.92
OP 53	-36.064432	145.451213	111.00	1.50	112.50
OP 54	-36.041522	145.451206	113.68	1.50	115.18
OP 55	-36.037823	145.460965	112.00	1.50	113.50
OP 56	-36.037263	145.461233	111.75	1.50	113.25
OP 57	-36.034422	145.467370	110.21	1.50	111.71

OP 58	-36.038018	145.476903	113.66	1.50	115.16
OP 59	-36.036548	145.477074	115.70	1.50	117.20
OP 60	-36.037693	145.480593	113.63	1.50	115.13

PV Array Results

Summary of PV Glare Analysis PV configuration and predicted glare

PV Name	Tilt	Orientation	"Green" Glare	"Yellow" Glare	Energy Produced	Data File
	deg	deg	min	min	kWh	
PV array 1	SA tracking	SA tracking	0	140	-	-

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

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

PV array 1 potential temporary after-image

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	136
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
OP: OP 22	0	0
OP: OP 23	0	0
OP: OP 24	0	0
OP: OP 25	0	0
OP: OP 26	0	0
OP: OP 27	0	0
OP: OP 28	0	0
OP: OP 29	0	0

OP: OP 30	0	0
OP: OP 31	0	0
OP: OP 32	0	0
OP: OP 33	0	4
OP: OP 34	0	0
OP: OP 35	0	0
OP: OP 36	0	0
OP: OP 37	0	0
OP: OP 38	0	0
OP: OP 39	0	0
OP: OP 40	0	0
OP: OP 41	0	0
OP: OP 42	0	0
OP: OP 43	0	0
OP: OP 44	0	0
OP: OP 45	0	0
OP: OP 46	0	0
OP: OP 47	0	0
OP: OP 48	0	0
OP: OP 49	0	0
OP: OP 50	0	0
OP: OP 51	0	0
OP: OP 52	0	0
OP: OP 53	0	0
OP: OP 54	0	0
OP: OP 55	0	0
OP: OP 56	0	0
OP: OP 57	0	0
OP: OP 58	0	0
OP: OP 59	0	0
OP: OP 60	0	0

PV array 1 - OP Receptor (OP 1)

No glare found

PV array 1 - OP Receptor (OP 2)

No glare found

PV array 1 - OP Receptor (OP 3)

No glare found

PV array 1 - OP Receptor (OP 4)

No glare found

PV array 1 - OP Receptor (OP 5)

No glare found

PV array 1 - OP Receptor (OP 6)

No glare found

PV array 1 - OP Receptor (OP 7)

No glare found

PV array 1 - OP Receptor (OP 8)

No glare found

PV array 1 - OP Receptor (OP 9)

No glare found

PV array 1 - OP Receptor (OP 10)

No glare found

PV array 1 - OP Receptor (OP 11)

No glare found

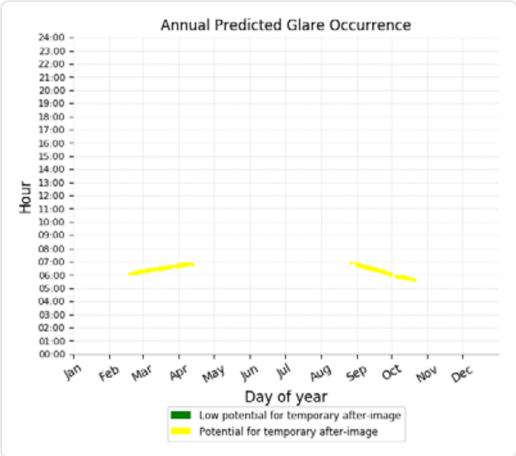
PV array 1 - OP Receptor (OP 12)

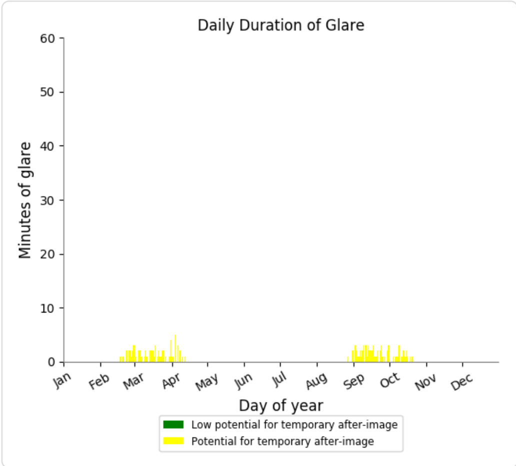
No glare found

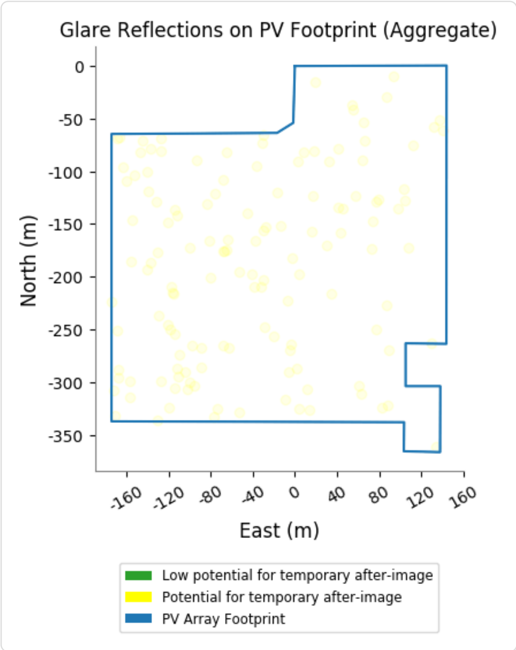
PV array 1 - OP Receptor (OP 13)

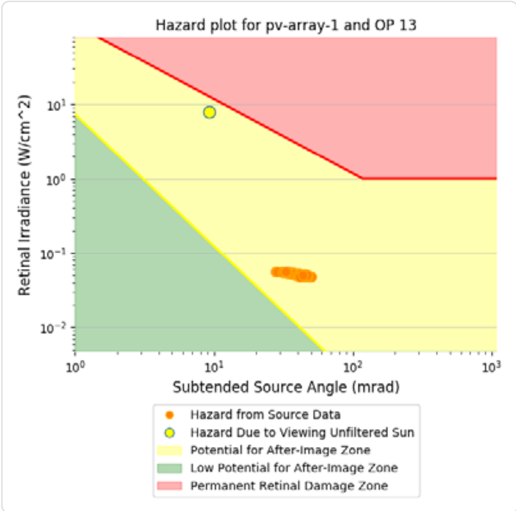
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 136 minutes of "yellow" glare with potential to cause temporary after-image.









PV array 1 - OP Receptor (OP 14)

No glare found

PV array 1 - OP Receptor (OP 15)

No glare found

PV array 1 - OP Receptor (OP 16)

No glare found

PV array 1 - OP Receptor (OP 17)

No glare found

PV array 1 - OP Receptor (OP 18)

No glare found

PV array 1 - OP Receptor (OP 19)

No glare found

PV array 1 - OP Receptor (OP 20)

No glare found

PV array 1 - OP Receptor (OP 21)

No glare found

PV array 1 - OP Receptor (OP 22)

No glare found

PV array 1 - OP Receptor (OP 23)

No glare found

PV array 1 - OP Receptor (OP 24)

No glare found

PV array 1 - OP Receptor (OP 25)

No glare found

PV array 1 - OP Receptor (OP 26)

No glare found

PV array 1 - OP Receptor (OP 27)

No glare found

PV array 1 - OP Receptor (OP 28)

No glare found

PV array 1 - OP Receptor (OP 29)

No glare found

PV array 1 - OP Receptor (OP 30)

No glare found

PV array 1 - OP Receptor (OP 31)

No glare found

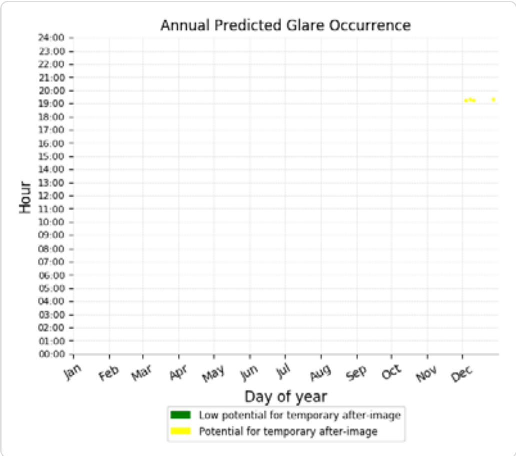
PV array 1 - OP Receptor (OP 32)

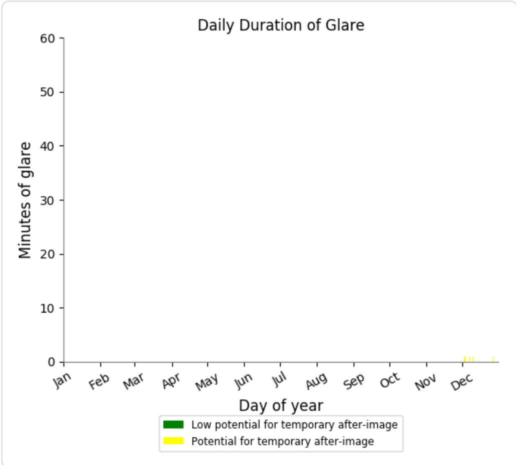
No glare found

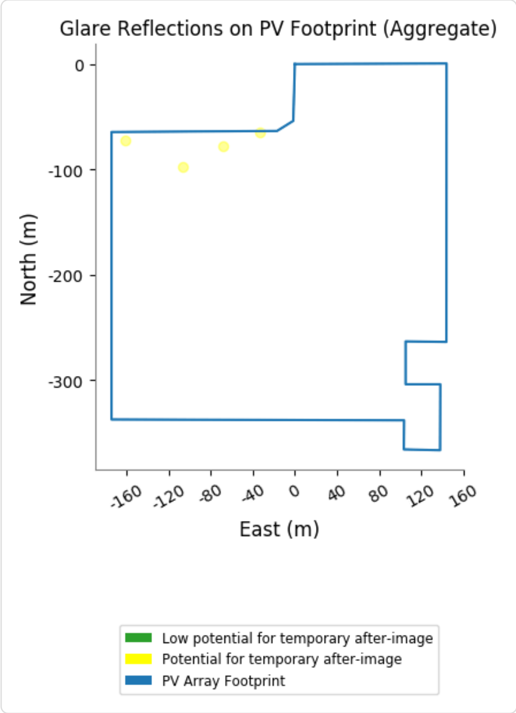
PV array 1 - OP Receptor (OP 33)

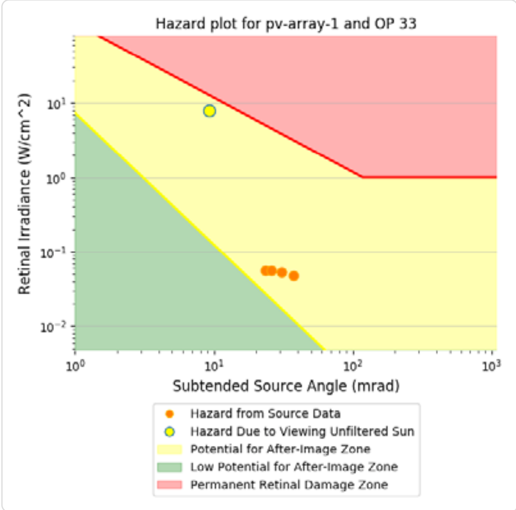
PV array is expected to produce the following glare for receptors at this location:

- 0 minutes of "green" glare with low potential to cause temporary after-image.
- 4 minutes of "yellow" glare with potential to cause temporary after-image.









PV array 1 - OP Receptor (OP 34)

No glare found

PV array 1 - OP Receptor (OP 35)

No glare found

PV array 1 - OP Receptor (OP 36)

No glare found

PV array 1 - OP Receptor (OP 37)

No glare found

PV array 1 - OP Receptor (OP 38)

No glare found

PV array 1 - OP Receptor (OP 39)

No glare found

PV array 1 - OP Receptor (OP 40)

No glare found

PV array 1 - OP Receptor (OP 41)

No glare found

PV array 1 - OP Receptor (OP 42)

No glare found

PV array 1 - OP Receptor (OP 43)

No glare found

PV array 1 - OP Receptor (OP 44)

No glare found

PV array 1 - OP Receptor (OP 45)

No glare found

PV array 1 - OP Receptor (OP 46)

No glare found

PV array 1 - OP Receptor (OP 47)

No glare found

PV array 1 - OP Receptor (OP 48)

No glare found

PV array 1 - OP Receptor (OP 49)

No glare found

PV array 1 - OP Receptor (OP 50)

No glare found

PV array 1 - OP Receptor (OP 51)

No glare found

PV array 1 - OP Receptor (OP 52)

No glare found

PV array 1 - OP Receptor (OP 53)

No glare found

PV array 1 - OP Receptor (OP 54)

No glare found

PV array 1 - OP Receptor (OP 55)

No glare found

PV array 1 - OP Receptor (OP 56)

No glare found

PV array 1 - OP Receptor (OP 57)

No glare found

PV array 1 - OP Receptor (OP 58)

No glare found

PV array 1 - OP Receptor (OP 59)

No glare found

PV array 1 - OP Receptor (OP 60)

No glare found

Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values and results may vary.
- The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.
- Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
- The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
- Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
- Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
- Glare analysis methods used: OP V1, FP V1, Route V1
- Refer to the **Help page** for assumptions and limitations not listed here.

APPENDIX B:

SOLAR GLARE HAZARD ANALYSIS – TRANSPORT ROUTES

ForgeSolar

Site Configuration: HendysRoad SF_Roads

Project site configuration details and results.

Created **Oct. 9, 2020 11:40 p.m.**
Updated **Oct. 9, 2020 11:51 p.m.**
DNI **varies** and peaks at **2,000.0 W/m^2**
Analyze every **1** minute(s)
0.5 ocular transmission coefficient
0.002 m pupil diameter
0.017 m eye focal length
9.3 mrad sun subtended angle
Timezone **UTC10**
Site Configuration ID: 44286.8016

Summary of Results No glare predicted!

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

Component Data

PV Array(s)

Name: PV array 1
Axis tracking: Single-axis rotation
Tracking axis orientation: 0.0 deg
Tracking axis tilt: 0.0 deg
Tracking axis panel offset: 0.0 deg
Maximum tracking angle: 60.0 deg
Resting angle: 60.0 deg
Rated power: -
Panel material: Smooth glass without AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 6.55 mrad
Approx. area: 95,595 sq-m

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-36.051462	145.468545	110.72	4.00	114.72
2	-36.051457	145.470143	109.32	4.00	113.32
3	-36.053838	145.470141	110.65	4.00	114.65
4	-36.053834	145.469712	110.57	4.00	114.57
5	-36.054200	145.469712	110.44	4.00	114.44
6	-36.054200	145.470076	110.34	4.00	114.34
7	-36.054764	145.470074	109.67	4.00	113.67
8	-36.054758	145.469693	110.31	4.00	114.31
9	-36.054508	145.469696	110.35	4.00	114.35
10	-36.054502	145.466614	110.89	4.00	114.89
11	-36.052043	145.466614	108.45	4.00	112.45
12	-36.052034	145.468357	109.28	4.00	113.28
13	-36.051947	145.468529	109.63	4.00	113.63

Route Receptor(s)

Name: Allerts 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	-36.040616	145.448921	110.33	2.00	112.33
2	-36.040581	145.455358	111.97	2.00	113.97
3	-36.040581	145.459628	112.04	2.00	114.04
4	-36.040581	145.463040	110.98	2.00	112.98
5	-36.040599	145.467015	111.05	2.00	113.05
6	-36.040612	145.469703	111.56	2.00	113.56
7	-36.040599	145.472927	110.76	2.00	112.76
8	-36.040620	145.474649	111.03	2.00	113.03
9	-36.040612	145.478034	110.06	2.00	112.06
10	-36.040629	145.480201	110.13	2.00	112.13
11	-36.040612	145.483226	112.24	2.00	114.24

Name: Butts 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	-36.056568	145.455803	109.12	2.00	111.12
2	-36.056572	145.456683	109.00	2.00	111.00
3	-36.056572	145.458217	110.89	2.00	112.89
4	-36.056576	145.459392	111.33	2.00	113.33
5	-36.056572	145.460363	110.81	2.00	112.81

Name: Hendys 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	-36.038514	145.478422	111.81	2.00	113.81
2	-36.042093	145.478465	110.00	2.00	112.00
3	-36.044023	145.478455	113.12	2.00	115.12
4	-36.049445	145.478379	113.05	2.00	115.05
5	-36.050156	145.478476	113.73	2.00	115.73
6	-36.052758	145.478455	112.00	2.00	114.00
7	-36.055265	145.478508	110.15	2.00	112.15
8	-36.058500	145.478422	110.00	2.00	112.00
9	-36.063010	145.478487	108.21	2.00	110.21
10	-36.068994	145.478465	109.79	2.00	111.79

Name: Naring Hall 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	-36.055301	145.460373	111.65	2.00	113.65
2	-36.055293	145.463962	109.85	2.00	111.85
3	-36.055284	145.467814	109.06	2.00	111.06
4	-36.055319	145.473747	109.37	2.00	111.37
5	-36.055319	145.478382	110.48	2.00	112.48
6	-36.055290	145.481098	109.40	2.00	111.40
7	-36.055260	145.487246	109.84	2.00	111.84

Name: Naring 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	-36.069023	145.431838	109.32	2.00	111.32
2	-36.069023	145.437846	109.13	2.00	111.13
3	-36.069058	145.441816	107.00	2.00	109.00
4	-36.069023	145.447631	107.15	2.00	109.15
5	-36.069041	145.451793	109.66	2.00	111.66
6	-36.069023	145.456192	112.27	2.00	114.27
7	-36.068989	145.465891	111.48	2.00	113.48
8	-36.069032	145.470880	111.00	2.00	113.00
9	-36.069023	145.474431	109.00	2.00	111.00
10	-36.069015	145.478476	109.79	2.00	111.79
11	-36.069006	145.481137	108.27	2.00	110.27
12	-36.069023	145.495546	110.58	2.00	112.58

Name: Numurkah 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	-36.069012	145.450549	110.22	2.00	112.22
2	-36.062542	145.453263	109.66	2.00	111.66
3	-36.059342	145.454615	110.78	2.00	112.78
4	-36.056566	145.455817	109.11	2.00	111.11
5	-36.052966	145.457308	111.45	2.00	113.45
6	-36.051076	145.458080	110.81	2.00	112.81
7	-36.047944	145.459389	110.59	2.00	112.59
8	-36.046270	145.460108	112.36	2.00	114.36
9	-36.045376	145.460334	112.15	2.00	114.15
10	-36.043962	145.460376	114.71	2.00	116.71
11	-36.038549	145.460441	111.89	2.00	113.89

Name: Okanes 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	-36.068981	145.460338	108.74	2.00	110.74
2	-36.064211	145.460402	109.06	2.00	111.06
3	-36.058730	145.460402	110.32	2.00	112.32
4	-36.055503	145.460365	111.37	2.00	113.37
5	-36.053170	145.460354	113.76	2.00	115.76
6	-36.051409	145.460359	112.00	2.00	114.00
7	-36.050541	145.460375	111.37	2.00	113.37
8	-36.047115	145.460386	111.97	2.00	113.97
9	-36.046243	145.460375	111.97	2.00	113.97
10	-36.046048	145.460193	112.24	2.00	114.24

PV Array Results

Summary of PV Glare Analysis PV configuration and predicted glare

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

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

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

PV array 1 no glare found

Component	Green glare (min)	Yellow glare (min)
Route: Allerts Road	0	0
Route: Butts Road	0	0
Route: Hendys Road	0	0
Route: Naring Hall Road	0	0
Route: Naring Road	0	0
Route: Numurkah Road	0	0
Route: Okanes Road	0	0

No glare found

Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values and results may vary.
- The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.
- Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
- The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
- Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
- Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
- Glare analysis methods used: OP V1, FP V1, Route V1
- Refer to the **Help page** for assumptions and limitations not listed here.

ForgeSolar

Site Configuration: HendysRoad SF_Roads-temp-3

Project site configuration details and results.

Created **Oct. 9, 2020 11:54 p.m.**
Updated **Oct. 9, 2020 11:59 p.m.**
DNI **varies** and peaks at **2,000.0 W/m^2**
Analyze every **1** minute(s)
0.5 ocular transmission coefficient
0.002 m pupil diameter
0.017 m eye focal length
9.3 mrad sun subtended angle
Timezone **UTC10**
Site Configuration ID: 44287.8016

Summary of Results No glare predicted!

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

Component Data

PV Array(s)

Name: PV array 1
Axis tracking: Single-axis rotation
Tracking axis orientation: 0.0 deg
Tracking axis tilt: 0.0 deg
Tracking axis panel offset: 0.0 deg
Maximum tracking angle: 60.0 deg
Resting angle: 45.0 deg
Rated power: -
Panel material: Smooth glass without AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 6.55 mrad
Approx. area: 95,595 sq-m

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-36.051462	145.468545	110.72	4.00	114.72
2	-36.051457	145.470143	109.32	4.00	113.32
3	-36.053838	145.470141	110.65	4.00	114.65
4	-36.053834	145.469712	110.57	4.00	114.57
5	-36.054200	145.469712	110.44	4.00	114.44
6	-36.054200	145.470076	110.34	4.00	114.34
7	-36.054764	145.470074	109.67	4.00	113.67
8	-36.054758	145.469693	110.31	4.00	114.31
9	-36.054508	145.469696	110.35	4.00	114.35
10	-36.054502	145.466614	110.89	4.00	114.89
11	-36.052043	145.466614	108.45	4.00	112.45
12	-36.052034	145.468357	109.28	4.00	113.28
13	-36.051947	145.468529	109.63	4.00	113.63

Route Receptor(s)

Name: Allerts 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	-36.040616	145.448921	110.33	2.00	112.33
2	-36.040581	145.455358	111.97	2.00	113.97
3	-36.040581	145.459628	112.04	2.00	114.04
4	-36.040581	145.463040	110.98	2.00	112.98
5	-36.040599	145.467015	111.05	2.00	113.05
6	-36.040612	145.469703	111.56	2.00	113.56
7	-36.040599	145.472927	110.76	2.00	112.76
8	-36.040620	145.474649	111.03	2.00	113.03
9	-36.040612	145.478034	110.06	2.00	112.06
10	-36.040629	145.480201	110.13	2.00	112.13
11	-36.040612	145.483226	112.24	2.00	114.24

Name: Butts 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	-36.056568	145.455803	109.12	2.00	111.12
2	-36.056572	145.456683	109.00	2.00	111.00
3	-36.056572	145.458217	110.89	2.00	112.89
4	-36.056576	145.459392	111.33	2.00	113.33
5	-36.056572	145.460363	110.81	2.00	112.81

Name: Hendys 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	-36.038514	145.478422	111.81	2.00	113.81
2	-36.042093	145.478465	110.00	2.00	112.00
3	-36.044023	145.478455	113.12	2.00	115.12
4	-36.049445	145.478379	113.05	2.00	115.05
5	-36.050156	145.478476	113.73	2.00	115.73
6	-36.052758	145.478455	112.00	2.00	114.00
7	-36.055265	145.478508	110.15	2.00	112.15
8	-36.058500	145.478422	110.00	2.00	112.00
9	-36.063010	145.478487	108.21	2.00	110.21
10	-36.068994	145.478465	109.79	2.00	111.79

Name: Naring Hall 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	-36.055301	145.460373	111.65	2.00	113.65
2	-36.055293	145.463962	109.85	2.00	111.85
3	-36.055284	145.467814	109.06	2.00	111.06
4	-36.055319	145.473747	109.37	2.00	111.37
5	-36.055319	145.478382	110.48	2.00	112.48
6	-36.055290	145.481098	109.40	2.00	111.40
7	-36.055260	145.487246	109.84	2.00	111.84

Name: Naring 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	-36.069023	145.431838	109.32	2.00	111.32
2	-36.069023	145.437846	109.13	2.00	111.13
3	-36.069058	145.441816	107.00	2.00	109.00
4	-36.069023	145.447631	107.15	2.00	109.15
5	-36.069041	145.451793	109.66	2.00	111.66
6	-36.069023	145.456192	112.27	2.00	114.27
7	-36.068989	145.465891	111.48	2.00	113.48
8	-36.069032	145.470880	111.00	2.00	113.00
9	-36.069023	145.474431	109.00	2.00	111.00
10	-36.069015	145.478476	109.79	2.00	111.79
11	-36.069006	145.481137	108.27	2.00	110.27
12	-36.069023	145.495546	110.58	2.00	112.58

Name: Numurkah 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	-36.069012	145.450549	110.22	2.00	112.22
2	-36.062542	145.453263	109.66	2.00	111.66
3	-36.059342	145.454615	110.78	2.00	112.78
4	-36.056566	145.455817	109.11	2.00	111.11
5	-36.052966	145.457308	111.45	2.00	113.45
6	-36.051076	145.458080	110.81	2.00	112.81
7	-36.047944	145.459389	110.59	2.00	112.59
8	-36.046270	145.460108	112.36	2.00	114.36
9	-36.045376	145.460334	112.15	2.00	114.15
10	-36.043962	145.460376	114.71	2.00	116.71
11	-36.038549	145.460441	111.89	2.00	113.89

Name: Okanes 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	-36.068981	145.460338	108.74	2.00	110.74
2	-36.064211	145.460402	109.06	2.00	111.06
3	-36.058730	145.460402	110.32	2.00	112.32
4	-36.055503	145.460365	111.37	2.00	113.37
5	-36.053170	145.460354	113.76	2.00	115.76
6	-36.051409	145.460359	112.00	2.00	114.00
7	-36.050541	145.460375	111.37	2.00	113.37
8	-36.047115	145.460386	111.97	2.00	113.97
9	-36.046243	145.460375	111.97	2.00	113.97
10	-36.046048	145.460193	112.24	2.00	114.24

PV Array Results

Summary of PV Glare Analysis PV configuration and predicted glare

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

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

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

PV array 1 no glare found

Component	Green glare (min)	Yellow glare (min)
Route: Allerts Road	0	0
Route: Butts Road	0	0
Route: Hendys Road	0	0
Route: Naring Hall Road	0	0
Route: Naring Road	0	0
Route: Numurkah Road	0	0
Route: Okanes Road	0	0

No glare found

Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values and results may vary.
- The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.
- Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
- The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
- Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
- Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
- Glare analysis methods used: OP V1, FP V1, Route V1
- Refer to the **Help page** for assumptions and limitations not listed here.

ForgeSolar

Site Configuration: HendysRoad SF_Roads-temp-5

Project site configuration details and results.

Created **Oct. 10, 2020 12:07 a.m.**
Updated **Oct. 10, 2020 12:11 a.m.**
DNI **varies** and peaks at **2,000.0 W/m^2**
Analyze every **1** minute(s)
0.5 ocular transmission coefficient
0.002 m pupil diameter
0.017 m eye focal length
9.3 mrad sun subtended angle
Timezone **UTC10**
Site Configuration ID: 44289.8016

Summary of Results No glare predicted!

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

Component Data

PV Array(s)

Name: PV array 1
Axis tracking: Single-axis rotation
Tracking axis orientation: 0.0 deg
Tracking axis tilt: 0.0 deg
Tracking axis panel offset: 0.0 deg
Maximum tracking angle: 60.0 deg
Resting angle: 0.0 deg
Rated power: -
Panel material: Smooth glass without AR coating
Vary reflectivity with sun position? Yes
Correlate slope error with surface type? Yes
Slope error: 6.55 mrad
Approx. area: 95,595 sq-m

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	-36.051462	145.468545	110.72	4.00	114.72
2	-36.051457	145.470143	109.32	4.00	113.32
3	-36.053838	145.470141	110.65	4.00	114.65
4	-36.053834	145.469712	110.57	4.00	114.57
5	-36.054200	145.469712	110.44	4.00	114.44
6	-36.054200	145.470076	110.34	4.00	114.34
7	-36.054764	145.470074	109.67	4.00	113.67
8	-36.054758	145.469693	110.31	4.00	114.31
9	-36.054508	145.469696	110.35	4.00	114.35
10	-36.054502	145.466614	110.89	4.00	114.89
11	-36.052043	145.466614	108.45	4.00	112.45
12	-36.052034	145.468357	109.28	4.00	113.28
13	-36.051947	145.468529	109.63	4.00	113.63

Route Receptor(s)

Name: Allerts 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	-36.040616	145.448921	110.33	2.00	112.33
2	-36.040581	145.455358	111.97	2.00	113.97
3	-36.040581	145.459628	112.04	2.00	114.04
4	-36.040581	145.463040	110.98	2.00	112.98
5	-36.040599	145.467015	111.05	2.00	113.05
6	-36.040612	145.469703	111.56	2.00	113.56
7	-36.040599	145.472927	110.76	2.00	112.76
8	-36.040620	145.474649	111.03	2.00	113.03
9	-36.040612	145.478034	110.06	2.00	112.06
10	-36.040629	145.480201	110.13	2.00	112.13
11	-36.040612	145.483226	112.24	2.00	114.24

Name: Butts 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	-36.056568	145.455803	109.12	2.00	111.12
2	-36.056572	145.456683	109.00	2.00	111.00
3	-36.056572	145.458217	110.89	2.00	112.89
4	-36.056576	145.459392	111.33	2.00	113.33
5	-36.056572	145.460363	110.81	2.00	112.81

Name: Hendys 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	-36.038514	145.478422	111.81	2.00	113.81
2	-36.042093	145.478465	110.00	2.00	112.00
3	-36.044023	145.478455	113.12	2.00	115.12
4	-36.049445	145.478379	113.05	2.00	115.05
5	-36.050156	145.478476	113.73	2.00	115.73
6	-36.052758	145.478455	112.00	2.00	114.00
7	-36.055265	145.478508	110.15	2.00	112.15
8	-36.058500	145.478422	110.00	2.00	112.00
9	-36.063010	145.478487	108.21	2.00	110.21
10	-36.068994	145.478465	109.79	2.00	111.79

Name: Naring Hall 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	-36.055301	145.460373	111.65	2.00	113.65
2	-36.055293	145.463962	109.85	2.00	111.85
3	-36.055284	145.467814	109.06	2.00	111.06
4	-36.055319	145.473747	109.37	2.00	111.37
5	-36.055319	145.478382	110.48	2.00	112.48
6	-36.055290	145.481098	109.40	2.00	111.40
7	-36.055260	145.487246	109.84	2.00	111.84

Name: Naring 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	-36.069023	145.431838	109.32	2.00	111.32
2	-36.069023	145.437846	109.13	2.00	111.13
3	-36.069058	145.441816	107.00	2.00	109.00
4	-36.069023	145.447631	107.15	2.00	109.15
5	-36.069041	145.451793	109.66	2.00	111.66
6	-36.069023	145.456192	112.27	2.00	114.27
7	-36.068989	145.465891	111.48	2.00	113.48
8	-36.069032	145.470880	111.00	2.00	113.00
9	-36.069023	145.474431	109.00	2.00	111.00
10	-36.069015	145.478476	109.79	2.00	111.79
11	-36.069006	145.481137	108.27	2.00	110.27
12	-36.069023	145.495546	110.58	2.00	112.58

Name: Numurkah 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	-36.069012	145.450549	110.22	2.00	112.22
2	-36.062542	145.453263	109.66	2.00	111.66
3	-36.059342	145.454615	110.78	2.00	112.78
4	-36.056566	145.455817	109.11	2.00	111.11
5	-36.052966	145.457308	111.45	2.00	113.45
6	-36.051076	145.458080	110.81	2.00	112.81
7	-36.047944	145.459389	110.59	2.00	112.59
8	-36.046270	145.460108	112.36	2.00	114.36
9	-36.045376	145.460334	112.15	2.00	114.15
10	-36.043962	145.460376	114.71	2.00	116.71
11	-36.038549	145.460441	111.89	2.00	113.89

Name: Okanes 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	-36.068981	145.460338	108.74	2.00	110.74
2	-36.064211	145.460402	109.06	2.00	111.06
3	-36.058730	145.460402	110.32	2.00	112.32
4	-36.055503	145.460365	111.37	2.00	113.37
5	-36.053170	145.460354	113.76	2.00	115.76
6	-36.051409	145.460359	112.00	2.00	114.00
7	-36.050541	145.460375	111.37	2.00	113.37
8	-36.047115	145.460386	111.97	2.00	113.97
9	-36.046243	145.460375	111.97	2.00	113.97
10	-36.046048	145.460193	112.24	2.00	114.24

PV Array Results

Summary of PV Glare Analysis PV configuration and predicted glare

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

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

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

PV array 1 no glare found

Component	Green glare (min)	Yellow glare (min)
Route: Allerts Road	0	0
Route: Butts Road	0	0
Route: Hendys Road	0	0
Route: Naring Hall Road	0	0
Route: Naring Road	0	0
Route: Numurkah Road	0	0
Route: Okanes Road	0	0

No glare found

Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values and results may vary.
- The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.
- Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
- The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
- Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
- Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
- Glare analysis methods used: OP V1, FP V1, Route V1
- Refer to the **Help page** for assumptions and limitations not listed here.

From: Sian Crawford <sian@environmentalethos.com.au>
Sent: Friday, 20 November 2020 1:08 PM
To: Gary Steigenberger <Gary.Steigenberger@csmith.com.au>
Subject: Hendys Road Solar Farm - Glint and Glare Assessment - Additional information

Hi Gary,
Further to our discussion today regarding the Glint and Glare Impact Assessment for Hendys Road Solar Farm and DELWP request for further information regarding the assessment of the 2 properties identified in Table 5 (namely, OP13 and OP33). These two rural and residential dwellings were not considered likely to be impacted by glare due to existing vegetation and buildings. As noted in the report, the assessment of existing mitigating factors was based on aerial photography and 'Streetview'.
This information is provided below:

Sensitive Receptor	Distance from glare source	Glare Potential (based on topography)	Mitigation factors (existing)	Risk of glare hazard prior to screen planting	Risk of glare hazard after landscaping established
Observation Point 13 Residential dwelling	500m – 1km	Glare Potential (Yellow) when panels rest at 0 degrees Early morning, less than 5 minutes a day during Spring and Autumn	Existing vegetation surrounding the dwelling and along intervening road and canal – likely to provide sufficient screening to this small amount of glare	Negligible	Negligible

Aerial image of OP13 showing vegetation to the east.

View of screening in front of OP13, property to the left.

View of screening in front of OP13, property to the right.

Sensitive Receptor	Distance from glare source	Glare Potential (based on topography)	Mitigation factors (existing)	Risk of glare hazard prior to screen planting	Risk of glare hazard after landscaping established
Observation Point 33 Rural dwelling	500m – 1km	Glare Potential (Yellow) when panels rest at 0 degrees Very low amount of glare (<5 minutes in a year)	Existing vegetation and outbuildings (sheds) surrounding the dwelling – likely to provide sufficient screening to this small amount of glare	Negligible	Negligible

Aerial image of OP33 showing sheds and vegetation to the south west.

View of driveway into OP33, showing screening vegetation to south.

View of screening to west of OP33, including buildings and vegetation

Kind Regards,

Sian Crawford

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