CARISBROOK SOLAR FARM

GLARE IMPACT ASSESSMENT REPORT

Prepared For
ib vogt GmbH

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Prepared By Environmental Ethos
for ib vogt GmbH

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1. INTRODUCTION

This report has been prepared by Environmental Ethos on behalf of the proponent ib vogt GmbH to assess the potential glare impact of the Carisbrook Solar Farm (the Project). The Project comprises the installation and operation of a solar farm up to 90 MW, which will utilise photovoltaic (PV) modules to generate electricity.

The Project site is part of a rural property located at Lots 1, 3, 5, 6, and 7 TP98420, and Lots 13A, 13B, 13C, 14A, 14B, and 14B1 4/PP3155, within the Central Goldfields Shire area. The footprint of the proposed development will cover an area of approximately 300 hectares (ha). The PV panels will run north/south, and 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 5 kilometres east of the town of Carisbrook, *refer Figure 1.* The study area is bounded by Pyrenees Highway on the southern boundary. The site is zoned Farm Zone, and is currently used for crop production, which is the primary land use within the Project surrounds.

Figure 1. Location Plan (Source – Google Earth)

2. SCOPE OF THE ASSESSMENT

The scope of this Glare Assessment includes the following:

- Description of the methodology used to undertake the study;
- Description of the elements of the Project with the potential to influence glare including size, height, and angle of PV modules, and type and operation of the tracking system;

- Identification of the viewshed and potential visibility of the Project;
- Desktop mapping of potential glare at the location of sensitive receptors within the viewshed, based on Solar Glare Hazard Analysis and viewshed analysis,
- Assessment of the baseline conditions; and
- Assessment of the potential risk of glare on sensitive receptors during operation of the Project.

3. METHODOLOGY

3.1. 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.

3.2. Glare Intensity Categories

Glare refers to the human experience of reflected light. 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. [1]

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.

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

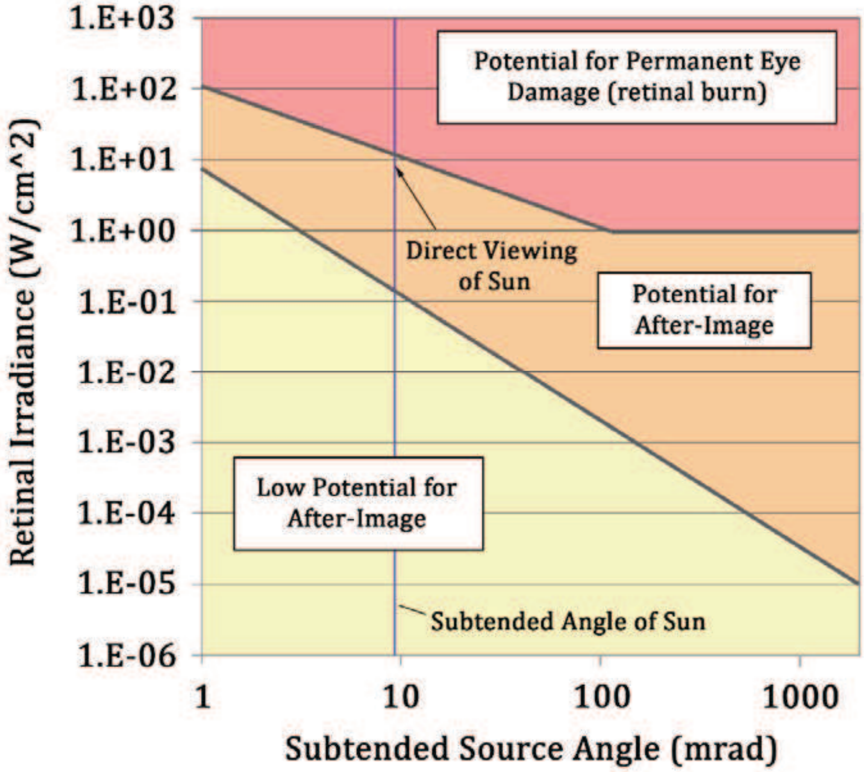


Figure 2. Ocular impacts and Hazard Ranges[2]

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[3].

3.3. 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.[4]

The higher reflectivity values of 0.20, that is 20% of incident light being reflected, can occur when the angle of incidence is greater than 50°. *Figure 3 and 4* show the relationship between increased angles of incidence and increased levels of reflected light. Where the angle of incidence remains below 50° the amount of reflected light remains below 10%. The angle of incidence is particularly

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

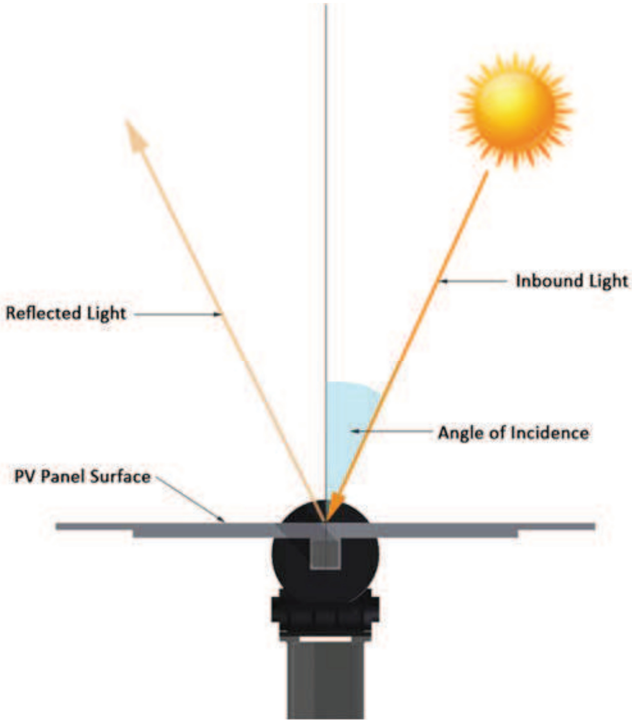


Figure 3. Angle of Incidence Relative to PV Panel Surface

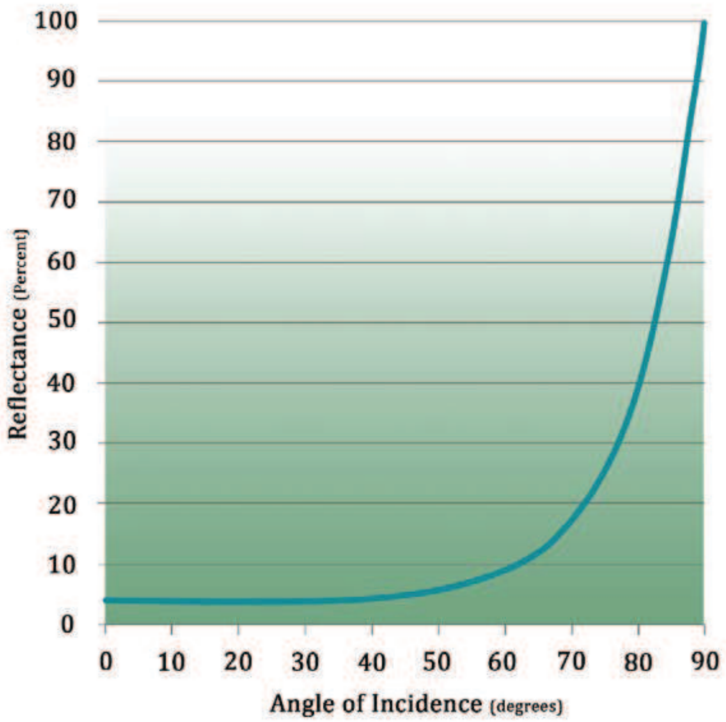


Figure 4. Angles of Incidence and Increased Levels of Reflected Light (Glass (n-1.5))

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.

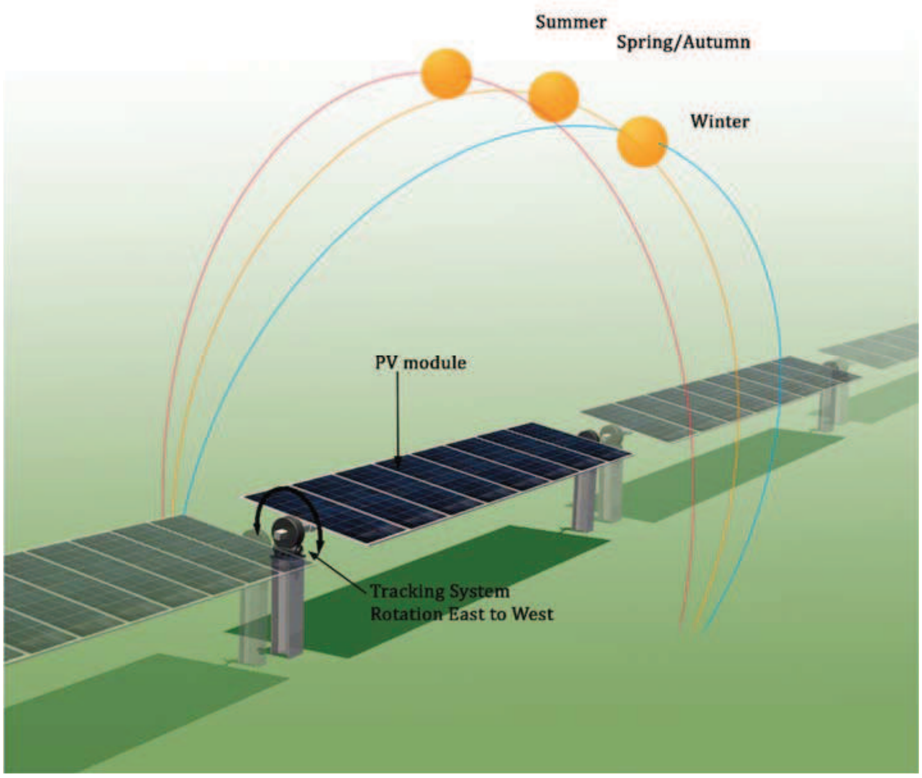


Figure 5. Diagrammatic illustration of sun position relative to PV module mounted on a horizontal single axis tracking system.

3.4. View shed Analysis

The Digital Terrain Model (DTM) used in this study is based on a contour interval of 10 metres. The location of sensitive receptors (dwellings, roads, etc.) are located relative to the location of the solar farm and view lines between the two assessed taken into consideration intervening topography. The viewshed analysis is used in conjunction with solar hazard assessment software to assess the potential for solar glare hazard.

3.5. Solar Glare Hazard Analysis

This assessment has utilised the Solar Glare Hazard Analysis Tool (SGHAT 3.0) co-developed by Sandi National Laboratory[5] and ForgeSolar (Sim Industries) 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 3.2*).

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
- 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.

3.6. Baseline 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.

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

3.7. Risk Assessment Approach

Once the potential for glare has been identified through the viewshed analysis and SGHAT, the potential magnitude of the glare hazard is considered relative to background conditions. A risk assessment approach is then used to identify the potential significance of the risk based on the magnitude of the glare hazard generated and the sensitivity of the receptors (viewers).

4. PROJECT DESCRIPTION

The general layout of the solar farm is as show 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 tracking 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.

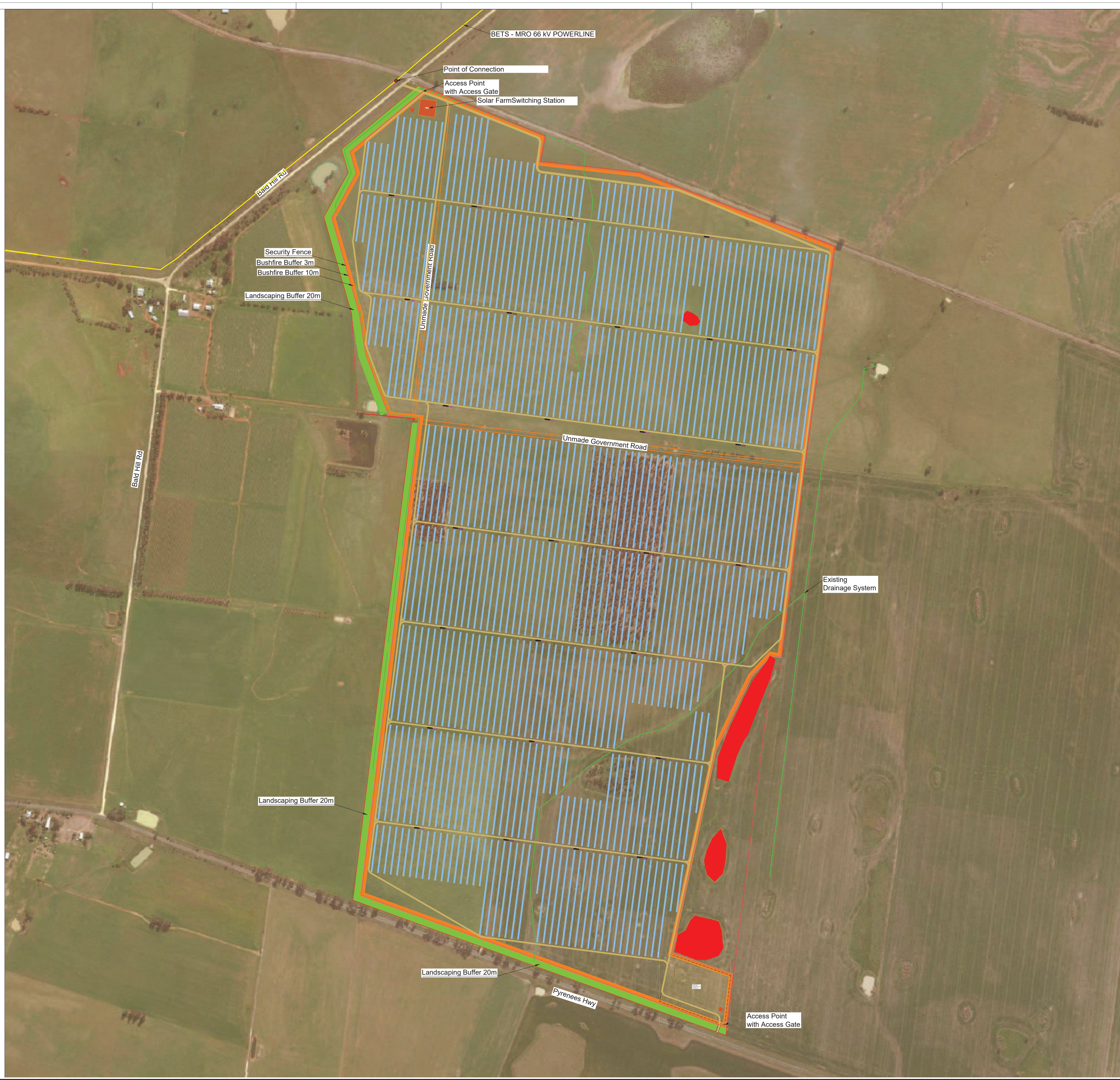
4.1. PV modules

Each PV panel typically comprises of approximately 72 polycrystalline silicon solar cell overlayed by a 3.2 to 4.0 mm tempered glass front and held in an anodised aluminium alloy frame. Alternatively dual-glass and frameless systems area available. The approximate dimensions for a typical solar panel is 2 metres x 1 metre. The proposed solar array arrangement for this Project is 2 solar panels wide resulting in an array width of approximately 4.025 metres.

Photo 1. *Example of a typical frameless solar array*[6]

The PV modules are mounted on a horizontal single axis tracking system with rows aligned north-south, refer *Figure 7.*

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



scale 1:4000

100 m 200 m 300 m 400 m 500 m 600 m

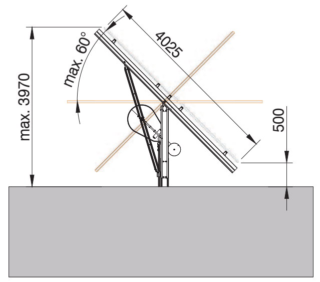
Location		Coordinates			
Country:	Australia	WGS 84		Projected	
Address:	Victoria	Latitude:	37.03° S	Eastings:	
	Carisbrook	Longitude:	143.90° E	Northings:	

Areas						
	Fenced Area		Length		Area	Length
	[m²]	[ha]	[m]		[m²]	[m]
Total	2.987.911,4	298,8	7.853	Access Road		
				Maintenance Road		
				Construction Compound		

System Configuration System Voltage @1500V

Modules			Strings		Inverter		Substructure	
	Allocation							
[Wp]	350		Mdls/String	28	Type	Central	Type	Tracker
No.			No.	9,180	Model AC [kVA]	3600	Config	2P
Total No.	257,040				No.	27	Azimuth [°]	6°East
DC [kWp]	89.964 MWp				Total AC [kVA]	75000 kVA	Pitch [m]	17.00

2 Tracker Cross Section



Legend			
	Planing Boundary		Single Axis Tracker for Panels
	Fence		Solar Farm Switching Station
	Access Gate		Point of Connection
	Access Roads [Width of 4m / 6m]		Construction Compound = 30,000m²
	PV Panel Area	Converter	40ft Battery Container plus spacing for DC/DC converters
	Bushfire Buffer [3m / 10m]		Inverter Transformer Station
	Ecological Constraints		Drainage System
	Landscaping Buffer [20m]		Water Storage Tank [2 x 45,000 l]

DOCUMENT SOURCE:
ib vogt GmbH
Module Array Layout
ISSUE F: 02/07/2018

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PROJECT
CARISBROOK SOLAR FARM

CLIENT
ib vogt GmbH

ISSUE	DESCRIPTION	DATE
A	DRAFT	01/07/18
B	UPDATED LAYOUT	18/07/18

APPROVED BY
S CRAWFORD

DATE OF FIRST ISSUE
01/07/2018

NORTH

DRAWING NAME
LAYOUT PLAN

DRAWING NUMBER
18008-FIGURE 6

ISSUE
B

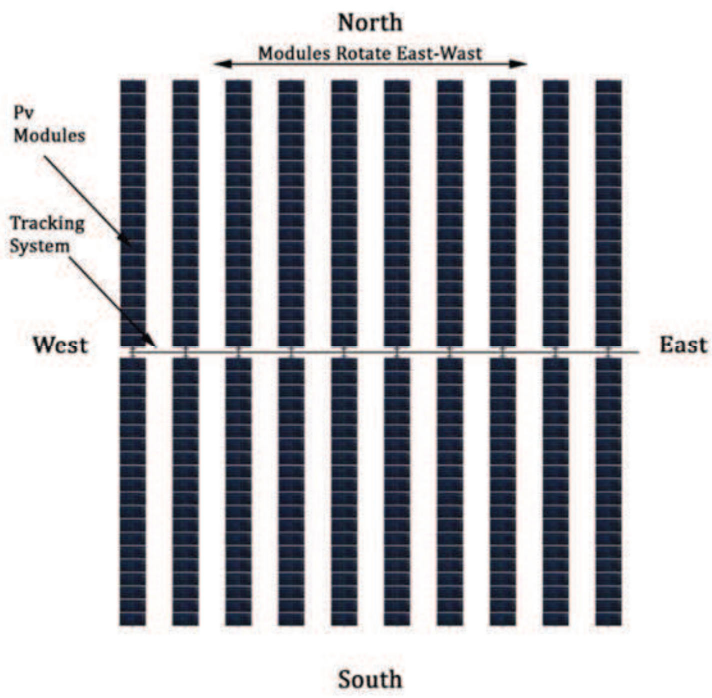

Figure 7. Illustration of PV Module Row Alignment

4.2. Horizontal single axis tracking system

The 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. For the purpose of this study a rotation range of 120° (+/- 60°) has been used, refer *Figure 8.*

This study has assumed the tracking system will utilise a 'backtracking' procedure to reduce the potential for over shadowing between panels.

The zenith tilt angle of the panels are 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 is up to 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 the 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 may vary slightly dependent on the type of system used, in general the rows will be approximately 15 metres apart.

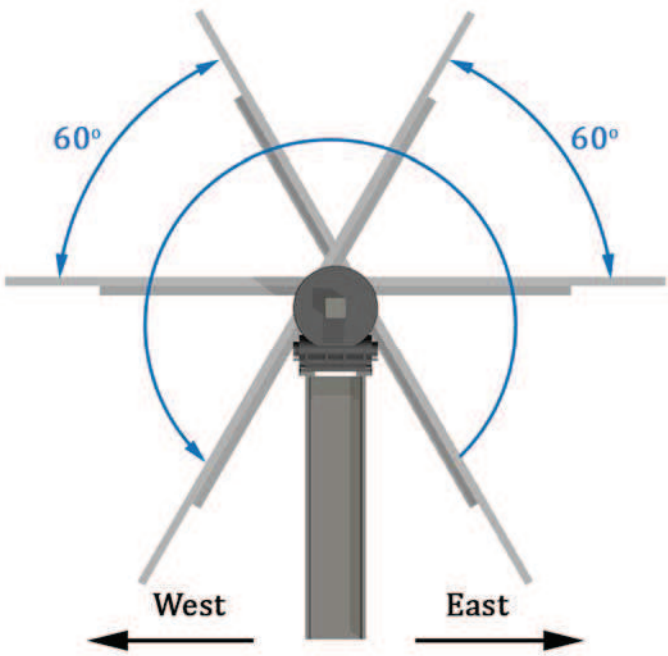

Figure 8. Illustration of PV Module Rotation Angles

5. 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.

5.1. Viewshed Analysis

The results of the viewshed analysis are shown in *Figure 9.*

A detailed DTM model of the site was used in addition to Vicmap Elevation data 10-20m contours. The topography within the Project site is flat, falling slightly from the south east corner (243.5 AHD) to the north west corner (219.40 AHD). The surrounding land is generally flat, with the exception of Bald Hill to the west, which rises to a height of approximately 320 metres.

The Project is not visible from Carisbrook due to intervening topography (Bald Hill) and distance.

Solar Farms are characterised by their low horizontal profile. The major elements of a solar farm are the PV models and trackers, these are generally 3 to 4 metres above ground level. In this study a 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. Since the topography to the north, south and east of the Project site is relatively flat, the Project has the potential of being visible within 1 km of the Project site, visually insignificant at distances greater than 1 km, and barely visible at 2 km from the Project site. Bald hill to the west of the Project site provides some topographic screening from

ENVIRONMENTAL ETHOS ABN: 65 054 076 046 TEL: +61 (0) 419 407 882 Email: Info@environmentalethos.com.au	PROJECT CARISBROOK SOLAR FARM	CLIENT ib vogt GmbH		DRAWING NAME VIEWSHED & OBSERVATION POINTS

ISSUE	DESCRIPTION	DATE
A	DRAFT	01/07/18
B	UPDATED PROJECT LAYOUT	18/07/18

APPROVED BY S CRAWFORD

DATE OF FIRST ISSUE 01/07/2018

NORTH

DRAWING NUMBER 18008-FIGURE 9

ISSUE B

this direction, however, the hill slope facing the Project site provides vantage points above the Project, and this increases the potential visibility.

The viewshed analysis in this study has utilised the detailed visibility assessment undertaken in the *Landscape and Visual Assessment*[7], to confirm screening provided by topographic features, and the screening potential of existing vegetation.

The results of the viewshed analysis are summarised below:

- The Pyrenees Highway adjoins the southern boundary of the Project site. The approach to the Project site in both directions is flat, existing vegetation provides partial screening. The proposed landscape screen planting will screen the project once established.
- There are eight (8) rural dwellings and one (1) industrial complex within 2 kilometres of the Project site as follows:
    - Two (2) rural dwellings are located within 500 metres of the Project site (OP01 & OP02), existing vegetation provides partial screening to the site. The proposed landscape screen planting will screen the solar farm once established.
    - Five (5) rural dwellings are located between 500 metres to 1 kilometres from the Project (OP03, OP04, OP05, OP07, and OP13), the majority of these dwellings are likely to be partially screened by existing vegetation. OP04 is elevated above the Project site and the Project will be visible from this location.
    - One (1) rural dwelling is located between 1 to 1.5 kilometres from the Project (OP14). Existing vegetation is considered likely to provide partial screening.
    - One (1) industrial complex (Hanson Quarry) is located between 1.5 to 2 kilometres from the Project (OP06). Existing vegetation is considered likely to provide partial screening.
- The Five (5) rural dwellings and one (1) grain loading siding located at distances greater than 2 kilometres from the Project (OP08, OP09, OP10, OP11, OP12 and OP15) are not considered likely to be within the viewshed of the Project due to distance, minor topographic relief and vegetation.
- Donovans Road and Bald Hills Road are within 2km, these roads together with Moolort-Baringhup Road to the east were assessed in the study.

The potential glare hazard impact for identified rural dwellings, industrial complexes, the Pyrenees Highway and surrounding roads has been assessed in *Section 5.2.*

5.2. Solar Glare Hazard Analysis

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

[7] Xurban, June 2018, Carisbrook Solar Farm Landscape & Visual Assessment

Table 1. Input data for SGHAT Analysis

SGHAT Model Parameters	Values
Time Zone	UTC +10
Axis Tracking	Single
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 angle	60-0
Reflectivity	Vary with sun
Height of panels above ground	4 m maximum height to top of panels 0.5 minimum height to bottom of panels

The assessment outcomes for the SGHAT are outlined in *Table 2:*

Table 2. SGHAT Assessment Results.

Sensitive Receptor	Glare Potential
Observation Point 01- Rural Dwelling	No Glare
Observation Point 02 - Rural Dwelling	No Glare
Observation Point 03 - Rural Dwelling	No Glare
Observation Point 04 – Rural Dwelling	No Glare
Observation Point 05 - Rural Dwelling	No Glare
Observation Point 06 – Quarry	No Glare
Observation Point 07 - Rural Dwelling	No Glare
Observation Point 08 - Rural Dwelling	No Glare
Observation Point 09 - Rural Dwelling	No Glare
Observation Point 10 - Rural Dwelling	No Glare
Observation Point 11 - Rural Dwelling	No Glare
Observation Point 12 – Grain loading silos	No Glare
Observation Point 13 - Rural Dwelling	No Glare
Observation Point 14 - Rural Dwelling	No Glare
Observation Point 15 - Rural Dwelling	No Glare
Travel Path – Pyrenees Highway	No Glare
Travel Path – Donovans Road	No Glare
Travel Path – Bald Hill Road	No Glare
Travel Path – Moolort-Baringhup Road	No Glare

5.3. Baseline Conditions

The baseline condition within the vicinity of the Project site is characterised by a flat rural landscape. The landscape is predominately cleared with some native vegetation remaining along creeks and road reserves.

Existing dwellings in the area include homesteads scattered across the landscape and are generally located in association with agricultural buildings. A quarry is located to the south west of the Project site. There are a number of small dams within the vicinity of the Project site.

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

5.4. 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 Maryborough 11.5 km west of the Project site (the closest BOM records for cloud cover statistics) recorded 140 cloudy days per year (mean number over the period 1969 to 2010)[8]. Cloudy days predominately occur during the winter months, May to October. Since atmospheric conditions have not been factored into this assessment modelling, statistically the glare potential represents a conservative assessment.

6. ASSESSMENT RESULTS

6.1. Solar Glare Hazard Analysis Tool (SGHAT) Results

The results of the SGHAT modelling identified no glare hazard potential is likely to affect rural dwellings and industrial complexes within the vicinity of the Project, *refer Appendix A*.

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

6.2. 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.

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. In addition, the parameters for the backtracking procedure are dependent on the final layout of the solar farm and this has yet to be confirmed. 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

[8] http://www.bom.gov.au/climate/averages/tables/cw_088043.shtml

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 3.*

Table 3. SGHAT Assessment Results – Resting Angle Analysis

Sensitive Receptor	Resting Angle 30 degrees *- Glare Potential	Resting Angle 0 degrees **- Glare Potential	Mitigation Factors
Rural Dwellings and Industrial Complexes	No Glare	No Glare	N/A
Travel Path – Pyrenees Highway	No Glare	No Glare	N/A
Travel Path – Bald Hill Road	No Glare	Glare Potential	Mitigated by existing vegetation and proposed landscape screen
Travel Path – Donovans Road	No Glare	Glare Potential	Mitigated by existing vegetation and proposed landscape screen
Travel Path – Moolort-Baringhup Road	No Glare	No Glare	N/A

*Assumes the PV panels are moved directly to 30 degrees once maximum tilt of 60 degrees is reached.

**Assumes the PV panels are moved directly to 0 degrees (horizontal) once maximum tilt of 60 degrees is reached

7. MANAGEMENT AND MITIGATION MEASURES

Under normal operation of the solar farm no glare potential was identified in this desktop assessment. Where the backtracking procedure was simulated in the model using a resting angle of 30 degrees, no glare potential was identified. When the model simulated the panels reverting directly to horizontal (resting angle of 0 degrees) once the panels reached maximum tilt, potential glare was identified affecting Bald Hill Road (section directly west of the proposed solar farm) and Donovans Roads. In both cases glare potential is likely to be partially mitigated by existing vegetation. Once the proposed landscape screen planting is established, potential glare will be fully mitigated by the proposed planting. However during the planting establishment stage, some glare potential may remain if the solar panels are set to a resting angle of 0 degrees during early morning and late afternoon. A backtracking procedure typically maintains the solar panels facing the sun as much as possible, therefore rotating immediately to 0 degrees represents an unlikely scenario. Atypical or non-operational management of the system should however take into consideration the potential for glare when determining the resting angle of the solar panels until the western boundary becomes fully screened by vegetation.

8. CONCLUSION

This assessment took into consideration the operation of the Solar Farm during daylight hours throughout the year (SGHAT modelling calculates the potential for glare at 1 minute intervals). SGHAT testing was undertaken for assumed sun energy intensity of 2000 W/m^2, which is 2x the US Federal Aviation Administration modelling requirement standards. In addition no allowance was made for atmospheric conditions.

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

- No glare potential was identified for surrounding existing rural dwellings and industrial complexes during normal operation of the solar farm, therefore the likely impact on these sensitive receptors within the viewshed was identified as insignificant;
- No glare potential was identified for the Pyrenees Highway during normal operation of the solar farm;
- No glare potential was identified for the surrounding roads during normal operation of the solar farm;
- Operation of a backtracking process up to an angle of 30 degrees was tested in the modelling with no increase in glare potential;
- Reverting or 'resting' the solar panels in a horizontal position (resting angle of 0 degrees) during the early morning and late afternoon resulted in the model identifying increased angles of incidence of the sun relative to the panels causing potential glare affecting minor roads (Bald Hill and Donovans Road) to the west of the Project;
- The proposed landscape screen planting on the western boundary will mitigate this glare potential.
- To avoid potential glare impacts prior to the establishment of the screen planting, the solar farm should be operated within the recommended parameters of this study, these parameters are:
    - Operation of a single axis tracking system with a maximum rotation of 60 degrees and a resting angle of 60 degrees.
    - Backtracking procedures to operate within normal parameters to maintain low angles of incidence relative to the sun.
    - Avoid 'resting' PV modules at 0 degrees, horizontal to the ground, notably during the early morning due to potential increase in glare as identified in the modelling.

APPENDIX A:

SOLAR GLARE HAZARD ANALYSIS – RURAL DWELLINGS AND INDUSTRIAL COMPLEXES

FORGESOLAR GLARE ANALYSIS

Project: **Carisbrook**
Site configuration: **Residential dwellings**
Analysis conducted by Sian Crawford (sian@environmentalethos.com.au) at 21:28 on 02 Jul, 2018.

U.S. FAA 2013 Policy Adherence

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

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

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

COMPONENT	STATUS	DESCRIPTION
Analysis parameters	PASS	Analysis time interval and eye characteristics used are acceptable
Flight path(s)	N/A	No flight paths analyzed
ATCT(s)	N/A	No ATCT receptors designated

Default glare analysis and observer eye characteristics are as follows:

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

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

SITE CONFIGURATION

Analysis Parameters

DNI: peaks at 2,000.0 W/m^2
Time interval: 1 min
Ocular transmission coefficient: 0.5
Pupil diameter: 0.002 m
Eye focal length: 0.017 m
Sun subtended angle: 9.3 mrad
Site Config ID: 19426.3169

PV Array(s)

Name: PV array 1
Axis tracking: Single-axis rotation
Tracking axis orientation: 0.0°
Tracking axis tilt: 0.0°
Tracking axis panel offset: 0.0°
Max tracking angle: 60.0°
Resting angle: 60.0°
Rated power: -
Panel material: Smooth glass without AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.038392	143.874198	219.29	4.00	223.29
2	-37.039317	143.872267	219.22	4.00	223.22
3	-37.042760	143.871709	220.87	4.00	224.87
4	-37.046023	143.872718	223.38	4.00	227.38
5	-37.046541	143.873887	224.02	4.00	228.02
6	-37.058396	143.871838	233.99	4.00	237.99
7	-37.058995	143.876022	234.19	4.00	238.19
8	-37.060442	143.875883	237.18	4.00	241.18
9	-37.061341	143.882395	239.94	4.00	243.94
10	-37.055108	143.884112	228.05	4.00	232.05
11	-37.051546	143.886794	220.19	4.00	224.19
12	-37.042229	143.888532	221.25	4.00	225.25
13	-37.041801	143.883253	221.58	4.00	225.58
14	-37.040799	143.883318	221.22	4.00	225.22
15	-37.040161	143.877985	219.59	4.00	223.59
16	-37.039191	143.878023	218.63	4.00	222.63

Discrete Observation Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	-37.042907	143.866975	228.21	1.50
OP 2	2	-37.046196	143.867278	231.64	1.50
OP 3	3	-37.043130	143.864596	233.93	1.50
OP 4	4	-37.045147	143.863952	252.58	1.50
OP 5	5	-37.057224	143.860551	232.91	1.50
OP 6	6	-37.061001	143.850428	227.85	1.50
OP 7	7	-37.067047	143.867617	234.31	1.50
OP 8	8	-37.084704	143.894769	254.56	1.50
OP 9	9	-37.086759	143.892951	252.17	1.50
OP 10	10	-37.076118	143.917721	249.26	1.50
OP 11	11	-37.076432	143.922582	249.67	1.50
OP 12	12	-37.032520	143.885263	222.61	1.50
OP 13	13	-37.027231	143.880462	216.55	1.50
OP 14	14	-37.028379	143.923719	229.30	1.50
OP 15	15	-37.052650	143.921412	234.57	1.50
OP 16	16	-37.051994	143.925065	232.79	1.50
OP 17	17	-37.021839	143.860062	211.09	1.50

GLARE ANALYSIS RESULTS

Summary of Glare

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

Total annual glare received by each receptor

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
OP 4	0	0
OP 5	0	0
OP 6	0	0
OP 7	0	0
OP 8	0	0
OP 9	0	0

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
OP 10	0	0
OP 11	0	0
OP 12	0	0
OP 13	0	0
OP 14	0	0
OP 15	0	0
OP 16	0	0
OP 17	0	0

Results for: PV array 1

Receptor	Green Glare (min)	Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
OP 4	0	0
OP 5	0	0
OP 6	0	0
OP 7	0	0
OP 8	0	0
OP 9	0	0
OP 10	0	0
OP 11	0	0
OP 12	0	0
OP 13	0	0
OP 14	0	0
OP 15	0	0
OP 16	0	0
OP 17	0	0

Point Receptor: OP 1

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 2

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 3

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 4

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 5

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 6

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 7

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 8

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 9

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 10

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 11

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 12

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: OP 13

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 14

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 15

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 16

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 17

0 minutes of yellow glare
0 minutes of green glare

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values may differ.
Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.

APPENDIX B:

SOLAR GLARE HAZARD ANALYSIS – HIGHWAY

FORGESOLAR GLARE ANALYSIS

Project: **Carisbrook**
Site configuration: **Highway-temp-10**
Analysis conducted by Sian Crawford (sian@environmentalethos.com.au) at 21:35 on 02 Jul, 2018.

U.S. FAA 2013 Policy Adherence

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

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

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

COMPONENT	STATUS	DESCRIPTION
Analysis parameters	PASS	Analysis time interval and eye characteristics used are acceptable
Flight path(s)	N/A	No flight paths analyzed
ATCT(s)	N/A	No ATCT receptors designated

Default glare analysis and observer eye characteristics are as follows:

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

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

SITE CONFIGURATION

Analysis Parameters

DNI: peaks at 2,000.0 W/m^2
Time interval: 1 min
Ocular transmission coefficient: 0.5
Pupil diameter: 0.002 m
Eye focal length: 0.017 m
Sun subtended angle: 9.3 mrad
Site Config ID: 19483.3169

PV Array(s)

Name: PV array 1
Axis tracking: Single-axis rotation
Tracking axis orientation: 0.0°
Tracking axis tilt: 0.0°
Tracking axis panel offset: 0.0°
Max tracking angle: 60.0°
Resting angle: 60.0°
Rated power: -
Panel material: Smooth glass without AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.038392	143.874198	219.29	4.00	223.29
2	-37.039317	143.872267	219.22	4.00	223.22
3	-37.042760	143.871709	220.87	4.00	224.87
4	-37.046023	143.872718	223.38	4.00	227.38
5	-37.046541	143.873887	224.02	4.00	228.02
6	-37.058396	143.871838	233.99	4.00	237.99
7	-37.058995	143.876022	234.19	4.00	238.19
8	-37.060442	143.875883	237.18	4.00	241.18
9	-37.061341	143.882395	239.94	4.00	243.94
10	-37.055108	143.884112	228.05	4.00	232.05
11	-37.051546	143.886794	220.19	4.00	224.19
12	-37.042229	143.888532	221.25	4.00	225.25
13	-37.041801	143.883253	221.58	4.00	225.58
14	-37.040799	143.883318	221.22	4.00	225.22
15	-37.040161	143.877985	219.59	4.00	223.59
16	-37.039191	143.878023	218.63	4.00	222.63

Discrete Observation Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	-37.044262	143.827691	206.07	1.50
OP 2	2	-37.045358	143.830309	207.86	1.50
OP 3	3	-37.046488	143.832755	203.90	1.50
OP 4	4	-37.047653	143.834987	210.96	1.50
OP 5	5	-37.048886	143.837133	224.50	1.50
OP 6	6	-37.049948	143.839665	231.91	1.50
OP 7	7	-37.051181	143.842626	233.86	1.50
OP 8	8	-37.052105	143.844900	228.57	1.50
OP 9	9	-37.053201	143.847175	231.12	1.50
OP 10	10	-37.054366	143.849836	232.20	1.50
OP 11	11	-37.055530	143.852196	237.89	1.50
OP 12	12	-37.056352	143.854771	240.50	1.50
OP 13	13	-37.056476	143.857517	239.74	1.50
OP 14	14	-37.056784	143.860693	232.23	1.50
OP 15	15	-37.057161	143.863182	226.76	1.50
OP 16	16	-37.058086	143.865972	228.14	1.50
OP 17	17	-37.059147	143.869105	234.79	1.50
OP 18	18	-37.059832	143.871680	237.05	1.50
OP 19	19	-37.060483	143.874126	237.55	1.50
OP 20	20	-37.061339	143.876744	238.53	1.50
OP 21	21	-37.062230	143.879619	239.71	1.50
OP 22	22	-37.062709	143.881507	242.59	1.50
OP 23	23	-37.063428	143.884125	242.92	1.50
OP 24	24	-37.064216	143.886614	243.86	1.50
OP 25	25	-37.064901	143.888545	243.07	1.50
OP 26	26	-37.065688	143.891120	243.77	1.50
OP 27	27	-37.066134	143.892794	245.83	1.50
OP 28	28	-37.066681	143.895111	245.63	1.50
OP 29	29	-37.067366	143.897128	245.42	1.50
OP 30	30	-37.067914	143.898974	244.03	1.50
OP 31	31	-37.068496	143.900862	243.68	1.50
OP 32	32	-37.069147	143.902879	244.36	1.50
OP 33	33	-37.069763	143.905111	243.92	1.50
OP 34	34	-37.070414	143.907213	243.98	1.50
OP 35	35	-37.071064	143.909574	244.32	1.50
OP 36	36	-37.071818	143.911934	243.72	1.50
OP 37	37	-37.072537	143.913951	245.33	1.50
OP 38	38	-37.073119	143.915839	246.57	1.50
OP 39	39	-37.074043	143.917685	244.74	1.50
OP 40	40	-37.075105	143.919015	245.54	1.50

GLARE ANALYSIS RESULTS

Summary of Glare

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

Total annual glare received by each receptor

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
OP 4	0	0
OP 5	0	0
OP 6	0	0
OP 7	0	0
OP 8	0	0
OP 9	0	0
OP 10	0	0
OP 11	0	0
OP 12	0	0
OP 13	0	0
OP 14	0	0
OP 15	0	0
OP 16	0	0
OP 17	0	0
OP 18	0	0
OP 19	0	0
OP 20	0	0
OP 21	0	0
OP 22	0	0
OP 23	0	0
OP 24	0	0
OP 25	0	0
OP 26	0	0
OP 27	0	0

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
OP 28	0	0
OP 29	0	0
OP 30	0	0
OP 31	0	0
OP 32	0	0
OP 33	0	0
OP 34	0	0
OP 35	0	0
OP 36	0	0
OP 37	0	0
OP 38	0	0
OP 39	0	0
OP 40	0	0

Results for: PV array 1

Receptor	Green Glare (min)	Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
OP 4	0	0
OP 5	0	0
OP 6	0	0
OP 7	0	0
OP 8	0	0
OP 9	0	0
OP 10	0	0
OP 11	0	0
OP 12	0	0
OP 13	0	0
OP 14	0	0
OP 15	0	0
OP 16	0	0
OP 17	0	0
OP 18	0	0
OP 19	0	0
OP 20	0	0
OP 21	0	0
OP 22	0	0
OP 23	0	0

Receptor	Green Glare (min)	Yellow Glare (min)
OP 24	0	0
OP 25	0	0
OP 26	0	0
OP 27	0	0
OP 28	0	0
OP 29	0	0
OP 30	0	0
OP 31	0	0
OP 32	0	0
OP 33	0	0
OP 34	0	0
OP 35	0	0
OP 36	0	0
OP 37	0	0
OP 38	0	0
OP 39	0	0
OP 40	0	0

Point Receptor: OP 1

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 2

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 3

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 4

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 5

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 6

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 7

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 8

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 9

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 10

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 11

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 12

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 13

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 14

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 15

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: OP 16

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 17

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 18

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 19

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 20

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 21

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 22

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 23

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 24

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 25

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 26

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 27

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 28

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 29

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 30

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 31

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 32

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 33

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 34

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: OP 35

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 36

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 37

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 38

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 39

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 40

0 minutes of yellow glare
0 minutes of green glare

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values may differ.
Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.

APPENDIX C:

SOLAR GLARE HAZARD ANALYSIS – ROADS

FORGESOLAR GLARE ANALYSIS

Project: **Carisbrook**
Site configuration: **Roads**
Analysis conducted by Sian Crawford (sian@environmentalethos.com.au) at 08:51 on 01 Jul, 2018.

U.S. FAA 2013 Policy Adherence

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

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

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

COMPONENT	STATUS	DESCRIPTION
Analysis parameters	PASS	Analysis time interval and eye characteristics used are acceptable
Flight path(s)	N/A	No flight paths analyzed
ATCT(s)	N/A	No ATCT receptors designated

Default glare analysis and observer eye characteristics are as follows:

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

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

SITE CONFIGURATION

Analysis Parameters

DNI: peaks at 1,000.0 W/m^2
Time interval: 1 min
Ocular transmission coefficient: 0.5
Pupil diameter: 0.002 m
Eye focal length: 0.017 m
Sun subtended angle: 9.3 mrad
Site Config ID: 19432.3169

PV Array(s)

Name: PV array 1
Axis tracking: Single-axis rotation
Tracking axis orientation: 0.0°
Tracking axis tilt: 0.0°
Tracking axis panel offset: 0.0°
Max tracking angle: 60.0°
Resting angle: 60.0°
Rated power: 60.0 kW
Panel material: Smooth glass without AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.038392	143.874198	219.29	4.00	223.29
2	-37.039317	143.872267	219.22	4.00	223.22
3	-37.042760	143.871709	220.87	4.00	224.87
4	-37.046023	143.872718	223.38	4.00	227.38
5	-37.046541	143.873887	224.02	4.00	228.02
6	-37.058396	143.871838	233.99	4.00	237.99
7	-37.058995	143.876022	234.19	4.00	238.19
8	-37.060442	143.875883	237.18	4.00	241.18
9	-37.061341	143.882395	239.94	4.00	243.94
10	-37.055108	143.884112	228.05	4.00	232.05
11	-37.051546	143.886794	220.19	4.00	224.19
12	-37.042229	143.888532	221.25	4.00	225.25
13	-37.041801	143.883253	221.58	4.00	225.58
14	-37.040799	143.883318	221.22	4.00	225.22
15	-37.040161	143.877985	219.59	4.00	223.59
16	-37.039191	143.878023	218.63	4.00	222.63

Discrete Observation Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	-37.057136	143.862999	226.66	1.50
OP 2	2	-37.055642	143.863281	229.30	1.50
OP 3	3	-37.053985	143.863565	233.05	1.50
OP 4	4	-37.052316	143.863860	236.12	1.50
OP 5	5	-37.049697	143.864329	241.55	1.50
OP 6	6	-37.047385	143.864732	246.70	1.50
OP 7	7	-37.044885	143.865155	238.29	1.50
OP 8	8	-37.042992	143.865445	228.44	1.50
OP 9	9	-37.041571	143.867183	225.50	1.50
OP 10	10	-37.040457	143.868953	221.71	1.50
OP 11	11	-37.039413	143.870616	218.81	1.50
OP 12	12	-37.038308	143.872247	219.02	1.50
OP 13	13	-37.037314	143.873889	219.75	1.50
OP 14	14	-37.036193	143.875788	218.57	1.50
OP 15	15	-37.035156	143.877365	217.08	1.50
OP 16	16	-37.034283	143.878770	217.70	1.50
OP 17	17	-37.033161	143.880530	217.88	1.50
OP 18	18	-37.032124	143.882150	217.88	1.50
OP 19	19	-37.031199	143.883673	219.10	1.50
OP 20	20	-37.030360	143.885047	218.90	1.50
OP 21	21	-37.029315	143.886034	219.59	1.50
OP 22	22	-37.028664	143.887707	219.69	1.50
OP 23	23	-37.027551	143.889402	218.21	1.50
OP 24	24	-37.026677	143.890733	217.32	1.50
OP 25	25	-37.040408	143.844277	248.61	1.50
OP 26	26	-37.040750	143.847710	251.29	1.50
OP 27	27	-37.041110	143.850671	252.69	1.50
OP 28	28	-37.041401	143.853783	257.31	1.50
OP 29	29	-37.041795	143.856293	258.71	1.50
OP 30	30	-37.042112	143.859072	252.58	1.50
OP 31	31	-37.042309	143.861132	245.59	1.50
OP 32	32	-37.042557	143.863149	237.24	1.50
OP 33	33	-37.070982	143.910177	244.24	1.50
OP 34	34	-37.068123	143.910660	239.16	1.50
OP 35	35	-37.064716	143.911282	238.66	1.50
OP 36	36	-37.061129	143.911948	234.40	1.50
OP 37	37	-37.057601	143.912581	229.06	1.50
OP 38	38	-37.054450	143.913149	227.44	1.50
OP 39	39	-37.051959	143.913611	223.24	1.50

GLARE ANALYSIS RESULTS

Summary of Glare

PV Array Name	Tilt (°)	Orient (°)	"Green" Glare min	"Yellow" Glare min	Energy kWh
PV array 1	SA tracking	SA tracking	0	0	187,000.0

Total annual glare received by each receptor

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
OP 4	0	0
OP 5	0	0
OP 6	0	0
OP 7	0	0
OP 8	0	0
OP 9	0	0
OP 10	0	0
OP 11	0	0
OP 12	0	0
OP 13	0	0
OP 14	0	0
OP 15	0	0
OP 16	0	0
OP 17	0	0
OP 18	0	0
OP 19	0	0
OP 20	0	0
OP 21	0	0
OP 22	0	0
OP 23	0	0
OP 24	0	0
OP 25	0	0
OP 26	0	0
OP 27	0	0

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
OP 28	0	0
OP 29	0	0
OP 30	0	0
OP 31	0	0
OP 32	0	0
OP 33	0	0
OP 34	0	0
OP 35	0	0
OP 36	0	0
OP 37	0	0
OP 38	0	0
OP 39	0	0

Results for: PV array 1

Receptor	Green Glare (min)	Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
OP 4	0	0
OP 5	0	0
OP 6	0	0
OP 7	0	0
OP 8	0	0
OP 9	0	0
OP 10	0	0
OP 11	0	0
OP 12	0	0
OP 13	0	0
OP 14	0	0
OP 15	0	0
OP 16	0	0
OP 17	0	0
OP 18	0	0
OP 19	0	0
OP 20	0	0
OP 21	0	0
OP 22	0	0
OP 23	0	0
OP 24	0	0

Receptor	Green Glare (min)	Yellow Glare (min)
OP 25	0	0
OP 26	0	0
OP 27	0	0
OP 28	0	0
OP 29	0	0
OP 30	0	0
OP 31	0	0
OP 32	0	0
OP 33	0	0
OP 34	0	0
OP 35	0	0
OP 36	0	0
OP 37	0	0
OP 38	0	0
OP 39	0	0

Point Receptor: OP 1

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 2

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 3

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 4

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 5

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 6

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 7

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 8

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 9

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 10

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 11

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 12

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 13

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 14

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 15

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 16

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: OP 17

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 18

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 19

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 20

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 21

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 22

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 23

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 24

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 25

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 26

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 27

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 28

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 29

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 30

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 31

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 32

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 33

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 34

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 35

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: OP 36

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 37

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 38

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 39

0 minutes of yellow glare
0 minutes of green glare

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values may differ.
Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.