Glint and Glare Assessment

West Wyalong 1C Solar Farm

Version 01

August 2021

ENGINEERING | STRATEGY | ANALYTICS | CONSTRUCTION

DOCUMENT CONTROL

Report Title	Glint and Glare Assessment – West Wyalong 1C Solar Farm				
ITP Project Number	WWL1C – West Wyalong 1C				
Ver	Date	Status	Author/s	Reviewed By	Approved
1	25/08/2021	First issue	I Chawla	S Dedman	S Dedman

A person or organisation choosing to use documents prepared by ITP Renewables accepts the following:

(a) Conclusions and figures presented in draft documents are subject to change. ITP Renewables accepts no responsibility for use outside of the original report.
(b) The document is only to be used for purposes explicitly agreed to by ITP Renewables.
(c) All responsibility and risks associated with the use of this report lie with the person or organisation who chooses to use it.

ITP Renewables

Office: Level 1, 19-23 Moore St
Turner ACT 2612

Postal: PO Box 6127
O'Connor ACT 2602
Australia

Email: info@itpau.com.au
Phone: +61 (0) 2 6257 3511

itpau.com.au

ABOUT ITP RENEWABLES

ITP Renewables (ITP) is a global leader in renewable energy engineering, strategy, construction, and energy sector analytics. Our technical and policy expertise spans the breadth of renewable energy, energy storage, energy efficiency and smart integration technologies. Our range of services cover the entire spectrum of the energy sector value chain, from technology assessment and market forecasting right through to project operations, maintenance, and quality assurance.

We were established in 2003 and operate out of offices in Canberra (Head Office), Sydney, North Coast NSW, Adelaide and Auckland, New Zealand. We are part of the international ITPEnergised Group, one of the world's largest, most experienced, and respected specialist engineering consultancies focussing on renewable energy, energy efficiency, and carbon markets. The Group has undertaken over 2,000 contracts in energy projects encompassing over 150 countries since it was formed in 1981.

Our regular clients include governments, energy utilities, financial institutions, international development donor agencies, project developers and investors, the R&D community, and private firms.

ABBREVIATIONS

AC	Alternating current
CASA	Civil Aviation Safety Authority
DC	Direct current
FAA	Federal Aviation Administration (United States)
ha	Hectare
ITP	ITP Renewables
MW	Megawatt, unit of power (1 million Watts)
MWp	Megawatt-peak, unit of power at standard test conditions; used to indicate PV system capacity
NSW	New South Wales
OP	Observation point
PV	Photovoltaic
SGHAT	Solar Glare Hazard Analysis Tool

TABLES

FIGURES

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Overview

ITP Development has requested a glint and glare assessment for a proposed solar photovoltaic (PV) installation near West Wyalong, NSW. This assessment is to form part of the Development Application for the project. It includes:

- Identification of potential receptors of glint and glare from the proposed solar farm
- Assessment of the glint and glare hazard using the Solar Glare Hazard Analysis Tool (SGHAT) GlareGauge analysis

1.2 Glint and Glare

Glint is a momentary flash of bright light, while **glare** is a continuous source of excessive brightness relative to ambient lighting (Federal Aviation Administration [FAA], 2018). This can occur when light reflected off a surface (reflector) is viewed by a person (receptor). Typically, glint may be experienced in instances when either the receptor or the reflector is moving; while glare may occur when the reflector and receptor are completely or close to stationary, or from large reflective surfaces.

For a transparent material (e.g. glass, water) the quantity of light reflected depends on the surface itself (i.e. material and texture), and the angle at which the light intercepts it (angle of incidence). A higher angle of incidence will result in a higher proportion of light being reflected, as shown in Figure 1.

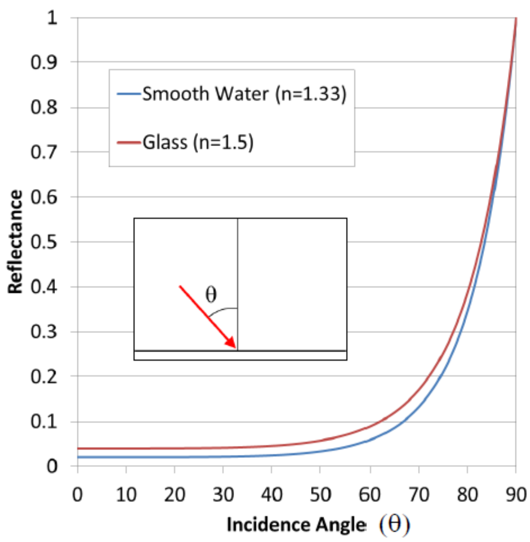

Figure 1: Angles of incidence and increased levels of reflected light

Potential visual impacts from glint and glare include distraction and temporary after-image; at its worst, it can cause retinal burn. The ocular hazard caused by glint or glare is a function of:

1. The intensity of the glare upon the eye (retinal irradiance)
2. The subtended angle of the glare source (i.e. the extent to which the glare occupies the receptor's field of vision; dependent on size and distance of the reflector).

The severity of the ocular hazard can be divided into three levels, as shown in Figure 2:

- 'Green' glare: Low potential for temporary after-image
- 'Yellow' glare: Potential for temporary after-image
- 'Red' glare: Retinal burn, not expected for PV

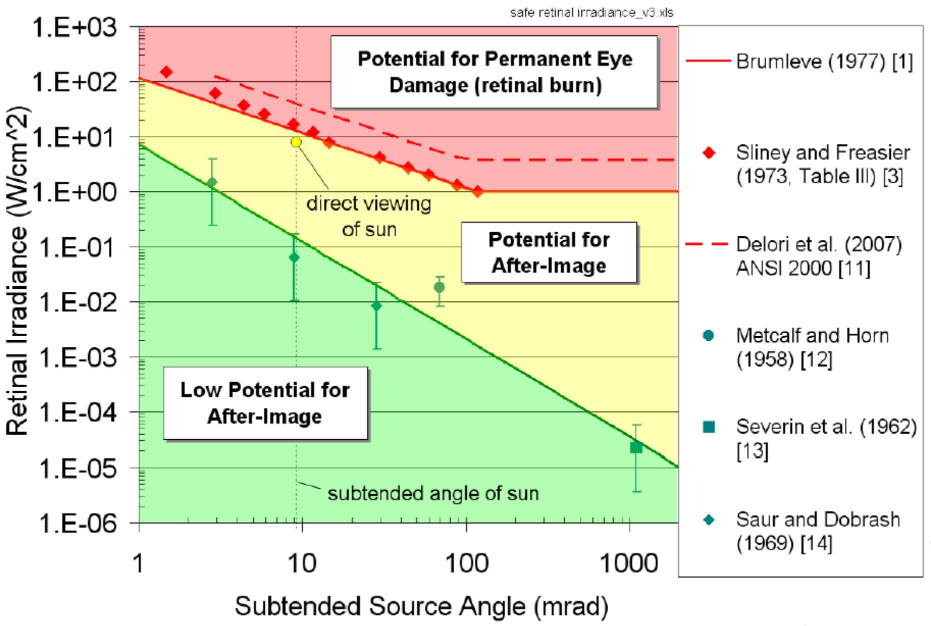

Figure 2: Classification of glare based on severity of ocular effects

1.3 Glare from Solar PV

Solar photovoltaic (PV) cells are designed to absorb as much light as possible to maximise efficiency (generally around 98% of the light received). To limit reflection, solar cells are constructed from dark, light-absorbing material and are treated with an anti-reflective coating. PV modules generate less glare than many other surfaces, as shown in Figure 3.

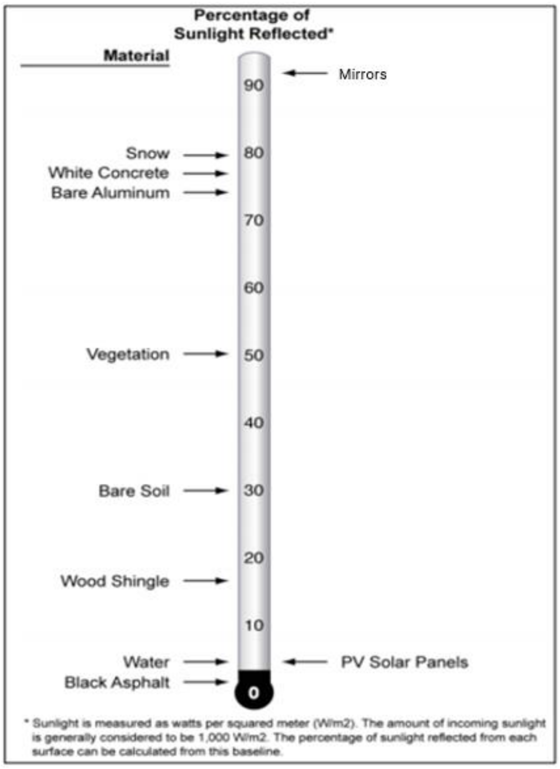

Figure 3: Typical percentage of sunlight reflected from different surfaces (Source: Adapted from Journal of Airport Management, 2014)

The small percentage of light reflected from PV modules varies depending on the angle of incidence. Figure 4 shows an example of this with a solar module. A larger angle of incidence will result in a higher percentage of reflected light.

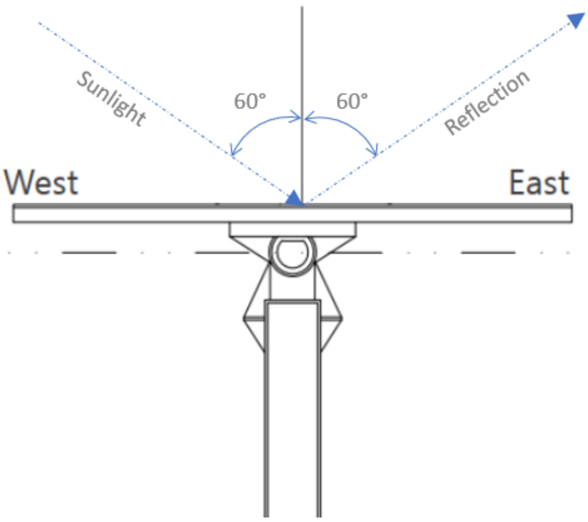

Figure 4: Typical sunlight reflection off the surface of a solar module

The two most common PV mounting structures are fixed-tilt and single axis tracking. Fixed-tilt arrays are stationary, while single-axis tracking arrays rotate the receiving surface of the modules from east to west throughout the day as the sun moves across the sky.

In a fixed-tilt PV array, since the sun is moving but the modules are stationary, the angle of incidence varies as the sun moves across the sky. It is smallest around noon when the sun is overhead and largest in the early morning and late afternoon when the sun is near the horizon. There is therefore a higher potential for glare at these times.

The angle of incidence for a single axis tracking system varies less, since the reflective surface of the modules rotates on a horizontal axis to follow the sun. Single axis tracking arrays therefore generate less glare than fixed tilt arrays. The tracking varies throughout the year to match seasonal changes in the sun's path (see Figure 5).

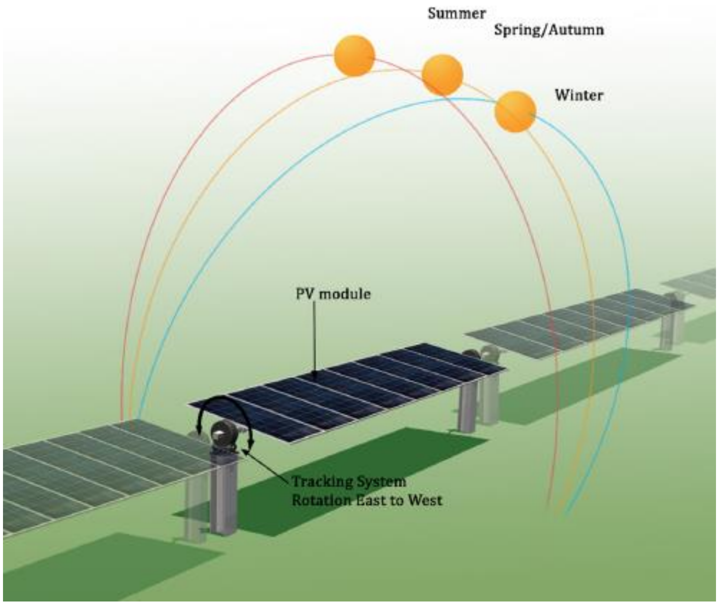

Figure 5: Sun position relative to PV module mounted on a horizontal single axis tracking system

2 PROJECT DESCRIPTION

2.1 Site Overview

ITP Development is proposing a solar farm at the location described in Table 1. The site is located on Wargin Road to the southeast of the West Wyalong township, within the Bland Shire Council area, NSW. (see Figure 6).

Table 1. Site Information

Parameter	Description
Lot/DP(s)	563/753135
Street address	364 Wargin Road Wyalong, NSW 2671
Council	Bland Shire Council
Project area	Approx. 16.17 ha
Current land use	Cropping

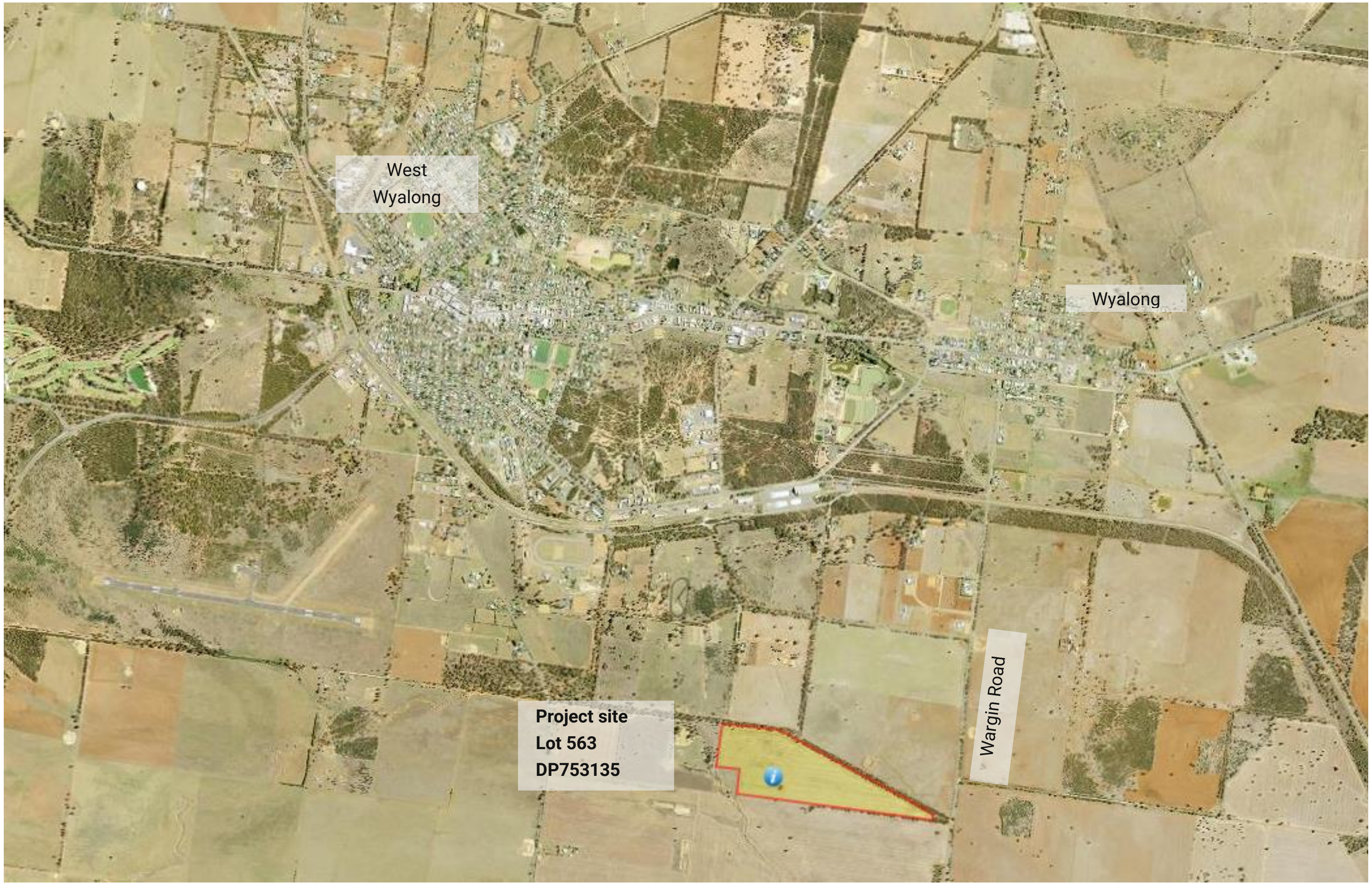

Figure 6. Proposed 34.92 ha solar farm site and surrounding area (note the project will comprise 16.17 ha within this area)

2.2 Solar Farm Details

Table 2 summarises the details of the proposed solar farm.

Table 2. Solar farm information

Parameter	Description
Solar farm name	West Wyalong Solar Farm
Site reference	WWL1C
AC capacity	5 MW
DC capacity	6.4 MW
Mounting system	Single-axis tracking

ITPD is proposing to construct a solar farm with a DC capacity of 6.4 MWp and AC output of 5.0 MW on an approximately 16.17 ha site that is currently used for crops.

There are to be approximately 12,000 solar modules installed in138 rows (each row being approximately 105 m long and 2.2 m wide) running east to west. Each row of solar photovoltaic (PV) modules will rotate to track the sun across the sky from east to west each day. There is approximately 6.25 m spacing between each row. The maximum height of each module is 2.75 m.

The solar farm will also consist of an inverter station. The inverter station incorporates the high/medium voltage switchgear and transformers and two 3.4 MW inverters. The inverter station is ground mounted and incorporated on a 12.19 m skid. Allowance is made for a 2.9 m high battery energy storage facility (BESS) alongside the inverter stations.

The mounting system is constructed on piles that are driven into the ground. During construction there is expected to be 50 personnel on site working from 7 am – 4 pm Monday to Friday. The construction is expected to take approximately 3 months. Once operational the site will be unmanned. Maintenance is expected to be carried out quarterly by a crew of 2 – 3 people.

Solar panels and related infrastructure will be decommissioned and removed upon cessation of operations. This is likely to occur within two years of the end of the project. The site will be returned to the pre-development land use of agriculture.

3 ANALYSIS

3.1 Overview

The Solar Glare Hazard Analysis Tool (SGHAT) was developed by Sandia National Laboratories to evaluate glare resulting from solar farms at different viewpoints, based on the location, orientation, and specifications of the PV modules. This tool is required by the United States FAA for glare hazard analysis near airports and is also recognised by the Australian Government Civil Aviation Safety Authority (CASA).

The GlareGauge software uses SGHAT to provide an indication of the type of glare expected at each potential receptor. It runs with a simulation timestep of one minute. Glint lasting for less than one minute is unlikely to occur from the sun on PV modules due to their slow movement and is not considered further in this assessment.

Table 3 details the parameters used in the SGHAT model. GlareGauge default settings were adopted for the analysis time interval, direct normal irradiance, observer eye characteristics and slope error. The height of the observation points was assumed to be 1.5 m for a road user (i.e. sitting in a car) and 1.65 m for a person (i.e. standing).

Table 3. SGHAT specification inputs

Parameters	Input
Time zone	UTC+10:00
Module tracking	Single axis
Module surface material	Smooth glass with ARC (anti-reflective coating)
Tracking axis tilt	0°
Tracking axis orientation	0°
Module offset angle (angle between module and tracking axis)	0°
Maximum tracking angle	60°
Resting angle	30°
Height of modules above ground	1.78m (height from the ground to the PV panel centroid)

3.2 Potential Receptors

This assessment considers potential visual receptors (e.g., residences and road users) within 2 km of the site. There is no formal guidance on the maximum distance for glint and glare assessments; however, the significance of a reflection decreases with distance for two main reasons:

1. The solar farm appears smaller (smaller subtended angle) and hence glare has less impact
2. Visual obstructions (e.g. terrain, vegetation) may block the view of the solar farm

Glint and glare impacts beyond 2 km are highly unlikely. This choice of distance is conservative and is based on existing studies and assessment experience.

Seventeen observation points and thirteen different road routes were identified as potential visual receptors, as shown in Figure 7.

While a greater number of observation points were considered, some were discounted based on large stands of trees and other structures acting as visual barriers.

Figure 7. Potential visual receptors within 2 km of the site

3.3 Assumptions

The visual impact of solar farms depends on the scale and type of infrastructure, the prominence and topography of the site relative to the surrounding environment, and any proposed screening measures to reduce visibility of the site. Some potential viewpoints were discounted because of significant existing features (such as trees or buildings), however, minor screening—such as roadside vegetation—was not assessed in detail. The GlareGauge analysis results are therefore considered conservative as the model assumes there is no screening.

Atmospheric conditions such as cloud cover will also influence light reflection and the resulting impact on visual receptors. The same is true of varying tilt angles of the modules. Varying atmospheric conditions have not been accounted for in the GlareGauge analysis, nor have the complexities of backtracking (due to the software's limitations). The GlareGauge analysis assumes clear sky conditions, with a peak direct normal irradiance (DNI) of 1,000 W/m^2 which varies throughout the day.

3.4 Results

The results of the GlareGauge analysis (attached in Appendix A) at each of the observation points are summarised in Table 4. No glare was identified.

Table 4. Glare potential at observation points

Observation Points	Location/Coordinates	'Green' glare (minutes)	'Yellow' glare (minutes)	Glare potential
OP1	-33.9414,147.2087	0	0	No glare
OP2	-33.9397,147.209	0	0	No glare
OP3	-33.9383,147.2126	0	0	No glare
OP4	-33.9378,147.2158	0	0	No glare
OP5	-33.9362,147.2177	0	0	No glare
OP6	-33.9418,147.2202	0	0	No glare
OP7	-33.9365,147.223	0	0	No glare
OP8	-33.9419,147.2237	0	0	No glare
OP9	-33.9365,147.2292	0	0	No glare
OP10	-33.937,147.2318	0	0	No glare
OP11	-33.9397,147.2339	0	0	No glare
OP12	-33.9403,147.2375	0	0	No glare
OP13	-33.9417,147.2444	0	0	No glare
OP14	-33.955,147.2391	0	0	No glare
OP15	-33.9526,147.2118	0	0	No glare
OP16	-33.9603,147.2322	0	0	No glare
OP17	-33.962,147.2158	0	0	No glare
Bellawri Rd	West	0	0	No glare
Richards Ln	South	0	0	No glare
Wargin Rd	East, adjacent	0	0	No glare
Lone Pine Rd	North	0	0	No glare

Observation Points	Location/Coordinates	'Green' glare (minutes)	'Yellow' glare (minutes)	Glare potential
Duffs Rd	North west	0	0	No glare
Showground Rd	North west	0	0	No glare
Echo Ln	North	0	0	No glare
Compton Rd	North	0	0	No glare
Fred Kalms Rd	North	0	0	No glare
Yiddah Dr	North	0	0	No glare
Mugga Rd	North	0	0	No glare
Cartwrights Ln	East	0	0	No glare
Unnamed Rd	North east	0	0	No glare

4 SUMMARY

The results of the GlareGauge analysis indicated that the selected observation points are unlikely to receive glare due to the proposed solar farm.

Existing roadside vegetation and structures are expected to provide a physical obstruction between the solar farm and road users, further minimising the visual impact of the project.

5 REFERENCES

Federal Aviation Administration (FAA), 2018. Solar Guide: Technical Guidance for Evaluating Selected Solar Technologies on Airports. Retrieved from the FAA website: https://www.faa.gov/airports/environmental/

Thompson, R., Ave, I., Anne, D., Jan, M., David, S. and Robert, C., 2013. Interim policy, FAA review of solar energy system projects on federally obligated airports.

Barrett, S., Devita, P., Ho, C. and Miller, B., 2014. Energy technologies' compatibility with airports and airspace: Guidance for aviation and energy planners. Journal of Airport Management, 8(4), pp.318-326.

APPENDIX A. FORGESOLAR GLARE ANALYSIS

FORGESOLAR GLARE ANALYSIS

Project: **West Wyalong 1C**
Site configuration: **All Receptors_WWL1C**
Analysis conducted by ITP Engineering (engineering@itpau.com.au) at 01:29 on 29 Jul, 2021.

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
2-mile flight path(s)	N/A	No flight paths analyzed
ATCT(s)	N/A	No ATCT receptors designated

Default glare analysis parameters and observer eye characteristics (for reference only):

- 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: 56794.10141

PV Array(s)

Name: PV1
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: 30.0°
Rated power: 6400.0 kW
Panel material: Smooth glass with 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	-33.950003	147.226163	247.90	1.78	249.68
2	-33.946647	147.226702	252.54	1.78	254.32
3	-33.946222	147.225760	253.99	1.78	255.77
4	-33.945816	147.222072	253.64	1.78	255.42
5	-33.948136	147.221665	248.49	1.78	250.27
6	-33.948307	147.223216	250.00	1.78	251.78
7	-33.949655	147.223002	248.24	1.78	250.02
8	-33.950003	147.226163	247.90	1.78	249.68

Discrete Observation Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	-33.941398	147.208679	253.82	1.65
OP 2	2	-33.939740	147.208969	253.80	1.65
OP 3	3	-33.938347	147.212630	256.09	1.65
OP 4	4	-33.937828	147.215799	256.50	1.65
OP 5	5	-33.936191	147.217654	254.84	1.65
OP 6	6	-33.941785	147.220230	252.69	1.65
OP 7	7	-33.936504	147.223018	251.58	1.65
OP 8	8	-33.941873	147.223665	251.56	1.65
OP 9	9	-33.936506	147.229203	249.51	1.65
OP 10	10	-33.936989	147.231768	250.29	1.65
OP 11	11	-33.939694	147.233869	249.21	1.65
OP 12	12	-33.940295	147.237481	248.02	1.65
OP 13	13	-33.941680	147.244394	255.50	1.65
OP 14	14	-33.955024	147.239135	249.59	1.65
OP 15	15	-33.952625	147.211815	251.00	1.65
OP 16	16	-33.960349	147.232216	244.04	1.65
OP 17	17	-33.962018	147.215826	249.73	1.65

Route Receptor(s)

Name: Bellawri Rd
Path type: Two-way
Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-33.914772	148.142708	365.90	1.50	367.40
2	-33.914665	148.140991	361.50	1.50	363.00
3	-33.914415	148.139875	364.00	1.50	365.50
4	-33.914487	148.139446	365.30	1.50	366.80
5	-33.916196	148.136657	361.70	1.50	363.20
6	-33.918867	148.132279	362.80	1.50	364.30
7	-33.921039	148.128374	366.80	1.50	368.30
8	-33.924529	148.121894	378.30	1.50	379.80
9	-33.925811	148.119405	385.80	1.50	387.30
10	-33.926096	148.118589	388.30	1.50	389.80
11	-33.926061	148.117946	390.40	1.50	391.90
12	-33.926132	148.117259	391.90	1.50	393.40
13	-33.925811	148.113525	400.80	1.50	402.30

Name: Cartwrights Ln
Path type: Two-way
Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-33.948650	147.237598	251.29	1.50	252.79
2	-33.949613	147.245898	253.02	1.50	254.52

Name: Compton Rd
Path type: Two-way
Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-33.934888	147.214339	258.42	1.50	259.92
2	-33.934352	147.214573	257.97	1.50	259.47
3	-33.934162	147.214773	257.40	1.50	258.90
4	-33.934123	147.214954	257.25	1.50	258.75
5	-33.933187	147.222080	253.43	1.50	254.93
6	-33.932520	147.227393	253.76	1.50	255.26
7	-33.932392	147.227881	253.23	1.50	254.73
8	-33.932132	147.228314	252.98	1.50	254.48
9	-33.930381	147.230776	251.29	1.50	252.79

Name: Duffs Rd
Path type: Two-way
Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-33.944272	147.210549	255.94	1.50	257.44
2	-33.944242	147.210588	255.89	1.50	257.39
3	-33.943694	147.211496	255.98	1.50	257.48
4	-33.943373	147.212141	255.40	1.50	256.90
5	-33.943017	147.212971	253.67	1.50	255.17
6	-33.942832	147.213579	253.17	1.50	254.67
7	-33.942655	147.213550	253.43	1.50	254.93
8	-33.939726	147.213973	256.81	1.50	258.31
9	-33.938158	147.214197	255.02	1.50	256.52
10	-33.937976	147.214340	255.48	1.50	256.98
11	-33.937598	147.214406	256.58	1.50	258.08
12	-33.935308	147.214678	258.91	1.50	260.41

Name: Echo Ln
Path type: Two-way
Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-33.934962	147.214303	258.37	1.50	259.87
2	-33.935259	147.214507	258.66	1.50	260.16
3	-33.935327	147.214629	258.84	1.50	260.34
4	-33.935341	147.214875	258.98	1.50	260.48
5	-33.935415	147.215526	258.82	1.50	260.32
6	-33.934781	147.221138	254.68	1.50	256.18

Name: Fred Kalms Rd
Path type: Two-way
Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-33.932116	147.228351	252.95	1.50	254.45
2	-33.933269	147.239384	245.00	1.50	246.50

Name: Lone Pine Rd
Path type: Two-way
Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-33.939659	147.214037	256.97	1.50	258.47
2	-33.940411	147.220422	254.97	1.50	256.47
3	-33.939394	147.223031	254.05	1.50	255.55
4	-33.939963	147.228075	252.60	1.50	254.10
5	-33.941143	147.238276	249.63	1.50	251.13

Name: Mugga Dr
Path type: Two-way
Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-33.934858	147.221134	254.68	1.50	256.18
2	-33.935515	147.221583	254.02	1.50	255.52
3	-33.939402	147.223022	254.04	1.50	255.54
4	-33.940396	147.223035	253.69	1.50	255.19
5	-33.941924	147.222761	252.65	1.50	254.15

Name: Richards Ln
Path type: Two-way
Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-33.957027	147.206109	256.36	1.50	257.86
2	-33.957333	147.209108	254.15	1.50	255.65
3	-33.957171	147.209257	253.71	1.50	255.21
4	-33.960035	147.235978	246.76	1.50	248.26

Name: Showground Rd
Path type: Two-way
Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-33.934636	147.209493	261.93	1.50	263.43
2	-33.935155	147.212673	257.70	1.50	259.20
3	-33.935234	147.213511	258.79	1.50	260.29
4	-33.935254	147.213884	258.24	1.50	259.74
5	-33.935049	147.214195	258.21	1.50	259.71
6	-33.934877	147.214301	258.37	1.50	259.87

Name: Unnamed Rd
Path type: Two-way
Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-33.940818	147.238415	249.95	1.50	251.45
2	-33.941216	147.240827	248.96	1.50	250.46
3	-33.941354	147.242113	250.55	1.50	252.05
4	-33.941584	147.243997	254.25	1.50	255.75
5	-33.941496	147.244168	254.19	1.50	255.69

Name: Wargin Rd
Path type: Two-way
Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-33.962790	147.235928	245.76	1.50	247.26
2	-33.948930	147.237548	251.22	1.50	252.72
3	-33.940829	147.238296	249.94	1.50	251.44
4	-33.934826	147.239492	245.17	1.50	246.67

Name: Yiddah Dr
Path type: Two-way
Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-33.932399	147.230472	252.08	1.50	253.58
2	-33.933017	147.230536	251.00	1.50	252.50
3	-33.933156	147.230534	251.00	1.50	252.50
4	-33.933245	147.230406	250.84	1.50	252.34
5	-33.933222	147.230052	250.42	1.50	251.92
6	-33.933290	147.229826	250.07	1.50	251.57
7	-33.933453	147.229546	250.27	1.50	251.77
8	-33.933802	147.229203	250.73	1.50	252.23
9	-33.939967	147.228056	252.66	1.50	254.16
10	-33.942206	147.227682	252.07	1.50	253.57
11	-33.944324	147.227478	251.44	1.50	252.94
12	-33.944885	147.227299	251.70	1.50	253.20
13	-33.945479	147.227127	251.96	1.50	253.46
14	-33.946298	147.226940	252.43	1.50	253.93
15	-33.951192	147.237231	249.99	1.50	251.49

GLARE ANALYSIS RESULTS

Summary of Glare

PV Array Name	Tilt (°)	Orient (°)	"Green" Glare min	"Yellow" Glare min	Energy kWh
PV1	SA tracking	SA tracking	0	0	18,690,000.0

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
Bellawri Rd	0	0
Cartwrights Ln	0	0
Compton Rd	0	0
Duffs Rd	0	0
Echo Ln	0	0
Fred Kalms Rd	0	0
Lone Pine Rd	0	0
Mugga Dr	0	0
Richards Ln	0	0
Showground Rd	0	0

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
Unnamed Rd	0	0
Wargin Rd	0	0
Yiddah Dr	0	0

Results for: PV1

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
Bellawri Rd	0	0
Cartwrights Ln	0	0
Compton Rd	0	0
Duffs Rd	0	0
Echo Ln	0	0
Fred Kalms Rd	0	0
Lone Pine Rd	0	0
Mugga Dr	0	0
Richards Ln	0	0
Showground Rd	0	0
Unnamed Rd	0	0
Wargin Rd	0	0
Yiddah Dr	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

Route: Bellawri Rd

0 minutes of yellow glare
0 minutes of green glare

Route: Cartwrights Ln

0 minutes of yellow glare
0 minutes of green glare

Route: Compton Rd

0 minutes of yellow glare

0 minutes of green glare

Route: Duffs Rd

0 minutes of yellow glare
0 minutes of green glare

Route: Echo Ln

0 minutes of yellow glare
0 minutes of green glare

Route: Fred Kalms Rd

0 minutes of yellow glare
0 minutes of green glare

Route: Lone Pine Rd

0 minutes of yellow glare
0 minutes of green glare

Route: Mugga Dr

0 minutes of yellow glare
0 minutes of green glare

Route: Richards Ln

0 minutes of yellow glare
0 minutes of green glare

Route: Showground Rd

0 minutes of yellow glare
0 minutes of green glare

Route: Unnamed Rd

0 minutes of yellow glare
0 minutes of green glare

Route: Wargin Rd

0 minutes of yellow glare
0 minutes of green glare

Route: Yiddah Dr

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.
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.)
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.
The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual results and glare occurrence 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.
Refer to the Help page at **www.forgesolar.com/help/** for assumptions and limitations not listed here.

ITP Renewables

Office: Level 1, 19-23 Moore St
Turner ACT 2612

Postal: PO Box 6127
O'Connor ACT 2602
Australia

Email: info@itpau.com.au
Phone: +61 (0) 2 6257 3511

itpau.com.au