Site Boundary of Belgard Square East, Old Blessington Road and Belgard Road, Tallaght, Dublin 24

Glint & Glare Assessment Report

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Current Revision

Issue No.:	R3	Issue Date:	15/11/2025
	Originator:	**Checker(s):**	**Reason for Issue**
	Darren Costello	Rohan Deshpande	Updated PV layout from five to eight arrays within the existing Solar Safeguarding Zone.
Role:	Sustainability Engineer	Senior Sustainability Engineer	
Date:	15/11/2025	15/11/2025	

Previous Revisions

Issue No.:	Date:	Originator	Checker:	Reason for Issue:
R1	11/02/2025	Kevin Fitzgerald	Kevin Fitzgerald	First Revision
R2	13/03/2025	Kevin Fitzgerald	Kevin Fitzgerald	Second Revision

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Executive Summary

Lawler Sustainability conducted an analysis on the risk of glint and glare for the proposed rooftop solar Photovoltaic (PV) arrays of the proposed development at the Site Boundary of Belgard Square East, Old Blessington Road and Belgard Road, Tallaght, Dublin 24. This report assesses the potential for ocular impact of glare which would emanate from sunlight reflections of the PV arrays and its possibility to cause an impact to pilots landing or taking off from Four 2 mile flight paths and nearby helipads. The development is located within one Solar Safeguarding Zone as identified by The Planning and Development (Solar Safeguarding Zone) Regulations 2022 of which it is required to undergo a Glint and Glare assessment.

A glint and glare assessment was carried out for the proposed fixed-mount PV arrays located on the roofs of the development. The panels were modelled at a tilt of 15° and orientated towards the south (164° azimuth), in line with the proposed design. These parameters were used directly in the Forge Solar or SGHAT analysis, and no optimization or alternative tilt or orientation study was undertaken. Based on the proposed configuration, the results indicate that no aviation-critical glare is predicted at the assessed receptor, in accordance with the 2021 U.S. Federal Aviation Administration Policy: *Review of Solar Energy System Projects on Federally Obligated Airports.*

It is recommended that the PV arrays remain fixed in place at the proposed 15° tilt and 164° azimuth, with no sun-tracking, and utilize low-texture glass with an anti-reflective coating. These parameters reflect the configuration assessed in this study.

The table below demonstrates the policy adherence of this glare analysis according to the 2021 U.S. Federal Aviation Administration Policy: Review of Solar Energy System Projects on Federally Obligated Airports. The policy may require the following criteria be met for solar energy systems on airport property:

- No glare of any kind for ATCT(s) at cab height
- Default analysis and observer characteristics, including 1-minute time step

The above policy has been used as a guide in relation to glint and glare assessments performed in Ireland for consideration by the Planning Authority, the Irish Aviation Association (IAA), and Dublin Airport Authority (DAA). More details on the analysis can be found in the body of this report and in the Appendix.

Component	Status	Description
Analysis parameters	PASS	Analysis time interval and eye characteristics used are acceptable
ATCT(s)	PASS	Receptor(s) marked as ATCT do not receive glare

1. Introduction

Lawler Sustainability has been requested to conduct a Glint & Glare analysis on the proposed Photovoltaic (PV) installations on the roofs of the development proposed at the Site Boundary of Belgard Square East, and Old Belgard Road, Tallaght, Dublin 24.

The development is located within one Solar Safeguarding Zone, as identified by the Planning and Development (Solar Safeguarding Zone) Regulations 2022, and is therefore required to undergo a Glint and Glare assessment. This report assesses the potential for glare toward the nearby helipad at Tallaght University Hospital, as well as the four 2-mile flight path approach receptors associated with Casement Aerodrome (Baldonnel Airport).
The receptors assessed are:

- Tallaght University Hospital
  - Nearby helipad
- Casement Aerodrome (Baldonnel Airport)
  - Four 2-mile flight path approach receptors (FP04, FP10, FP22, FP28)

The glint and glare assessment was conducted using the Forge Solar toolset. Forge Solar uses Glare Gauge which is the leading solar glare analysis tool used globally to satisfy local standards and policies. The tool uses the Solar Glare Hazard Analysis Tool (SGHAT) developed by Sandia National Laboratories which uses a sun-path algorithm for every minute of the year (assuming 100% sunshine for all daylight hours) to determine if and when reflections may occur at selected receptors. If reflection is found to be present, further analysis is then conducted to determine the significance of the potential glare that could be experienced and whether these effects are likely to be experienced by an observer in that location. In some cases, where there is significant glare found in the analysis, mitigation factors can then be discussed and assessed further.

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2. Solar Photovoltaic Array Proposal

The proposed solar photovoltaic (PV) arrays will be mounted on the roofs of the proposed development at the Site Boundary of Old Belgard Square East, Old Blessington Road and Belgard Road, Tallaght, Dublin 24. There is a total of 8 No. PV arrays which will be fixed in position and will not track the sun throughout the day or year.

Figure 1. Proposed location of PV arrays

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3. About Glint and Glare

3.1. What are Glint and Glare?

The United States Federal Aviation Administration (FAA) have best defined glint and glare as[1]:

- Glint is a momentary flash of bright light, and
- Glare is a continuous source of bright light.

The difference between glint and glare is duration. Glint is often caused by a reflection off a moving source, whereas glare is generally associated with stationary objects that reflect sunlight.
The ocular impact of solar glare is split into three categories[2]:

- Green – low potential to cause after-image (flash blindness)
- Yellow – potential to cause temporary after-image
- Red – potential to cause retinal burn (permanent eye damage)

These categories assume a typical blink response in the observer. Note that retinal burn is generally not possible for PV glare since PV modules do not focus reflected sunlight.

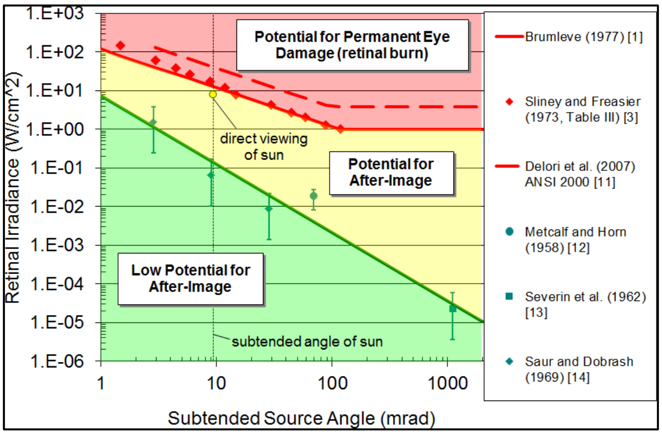

Figure 3. Sample glare hazard plot defining ocular impact as function of retinal irradiance and subtended source angle[3]

The ocular impact of glare is visualized with the Glare Hazard Plot (Figure 3). This chart displays the ocular impact as a function of glare subtended source angle and retinal irradiance. Each minute of glare is displayed on the chart as a small circle in its respective hazard zone. For convenience, a reference point is highlighted which illustrates the hazard from viewing the sun without filtering, i.e., looking at the sun. Each plot includes predicted glare for one PV array and one receptor.

[1] Federal Aviation Administration, November 2010: Technical Guidance for Evaluating Selected Solar Technologies on Airports October 2019.
[2] Ho, C. K., Ghanbari, C. M., and Diver, R. B., 2011, "Methodology to Assess Potential Glint and Glare Hazards from Concentrating Solar Power Plants: Analytical Models and Experimental Validation", ASME J. Sol. Energy Eng., 133.
[3] Federal Aviation Administration, November 2010: Technical Guidance for Evaluating Selected Solar Technologies on Airports October 2019.

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3.2. Solar Reflectance of PV Panels

PV panels have low reflectivity characteristics, as sunlight is used to induce electrical generation in the PV panels, the panels' function is to absorb the light, not to reflect it. The material used for this function is therefore black or dark blue. Figure 4 below displays that the reflectance of PV panels is remarkably like that of water. However, the amount of light reflected off solar PV panels can increase during certain times of the day, generally early morning, or late evening, which can have the potential for glare in certain directions.

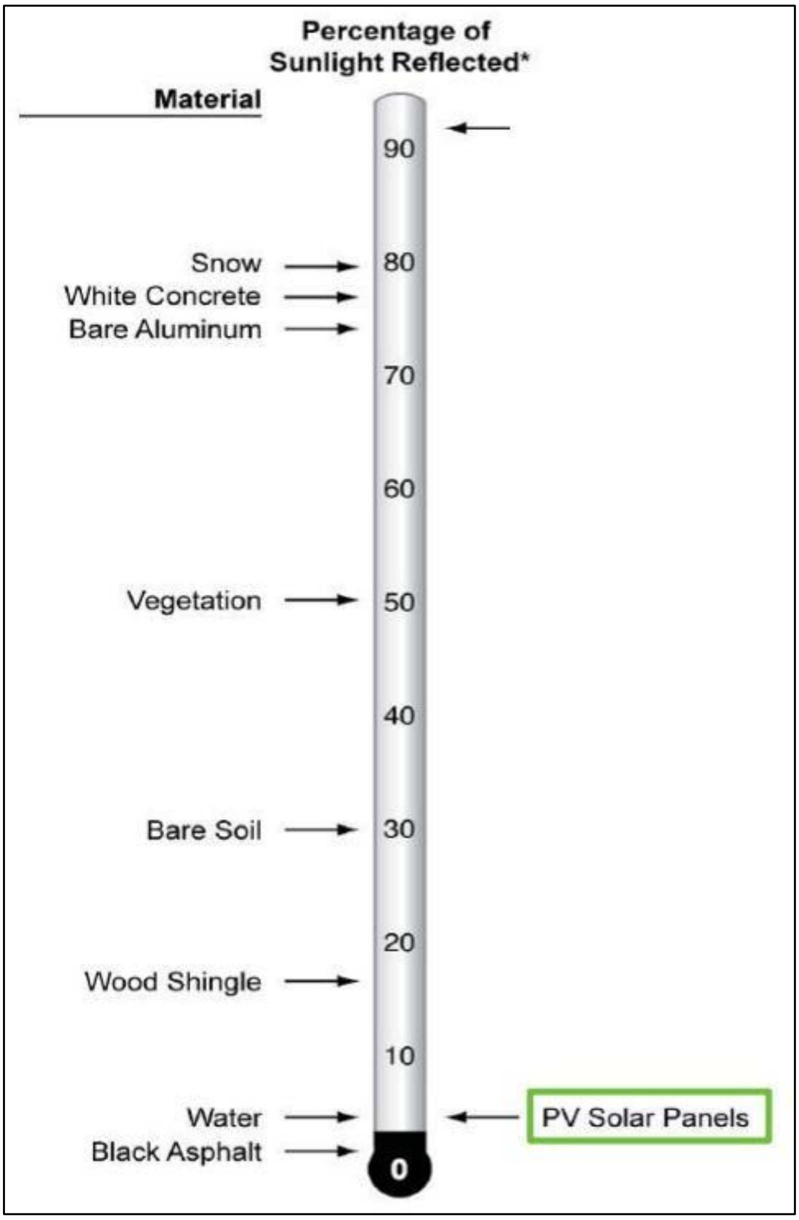

Figure 4. Reflectivity produced by different surfaces[4]

Sandia National Laboratories developed five generic PV module material reflectance profiles by analyzing over twenty PV module samples. These profiles are available in ForgeSolar and allow for customizing the material properties of the PV array during analysis. It is known from the current PV supplier that the reflectivity of their PV modules, which will be used for the proposed development,

[4] FAA 2010 Solar Guidance

are light textured glass with anti-reflective coating. Figure 5 below highlights the reflectance of each material profile as a function of incidence angle, where an angle of 0° implies the panels are directly facing the sun.

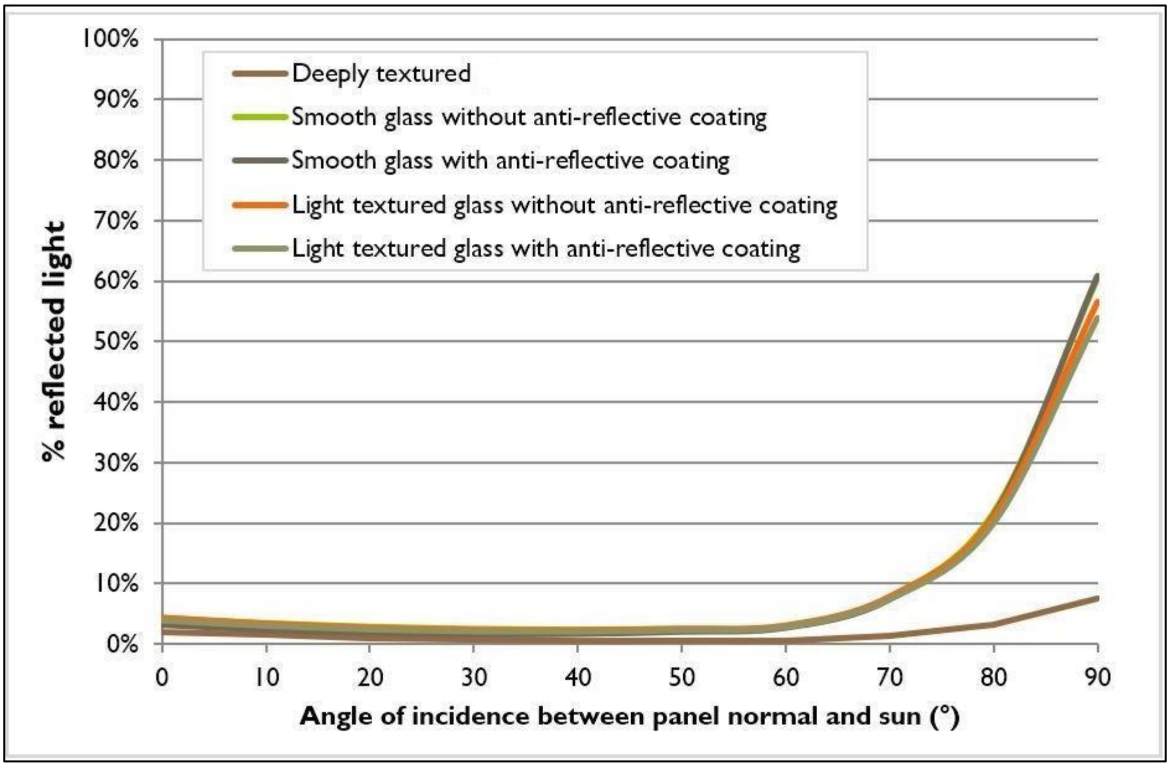

Figure 5. Reflectance profiles of typical PV module materials[5]

Studies have found that 7 W/m^2 is enough to cause an after-image lasting 4 to 12 seconds[6]. This represents a reflection of only 1-2% of typical solar irradiance for a given location, which generally ranges between 800-1000 W/m^2. A panel that absorbs 90% of direct sunlight may reflect up to 60% when not directly facing the sun. This is common for low-tilt panels during sunrise and sunset. The claim that PV panels reflect less than 5% of sunlight only holds true when the panels are directly facing the sun, which for fixed-mount panels, only applies for a few minutes of the day at most.

[5] Yellowhair, J. and C.K. Ho. "Assessment of Photovoltaic Surface Texturing on Transmittance Effects and Glint/Glare Impacts". ASME 2015 9th International Conference on Energy Sustainability collocated with the ASME 2015 Power Conference, the ASME 2015 13th International Conference on Fuel Cell Science, Engineering and Technology, and the ASME 2015 Nuclear Forum. 2015. American Society of Mechanical Engineers.

[6] Ho, C. K., Ghanbari, C. M., and Diver, R. B., 2009, "Hazard Analyses of Glint and Glare from Concentrating Solar Power Plants", SAND2009-4131C, in proceedings of SolarPACES 2009, Berlin, Germany, Sept. 15 -18.

3.3. Sunshine Hours in Ireland

According to Met Eireann[7], Ireland normally gets between 1100 and 1600 hours of sunshine each year with the sunniest months being May and June. Also, Irish skies are estimated to be completely covered by cloud for well over 50% of the time. The graph below represents the amount of average monthly sunshine hours that Ireland receives which is based on data from Dublin Airport and world data website[8].

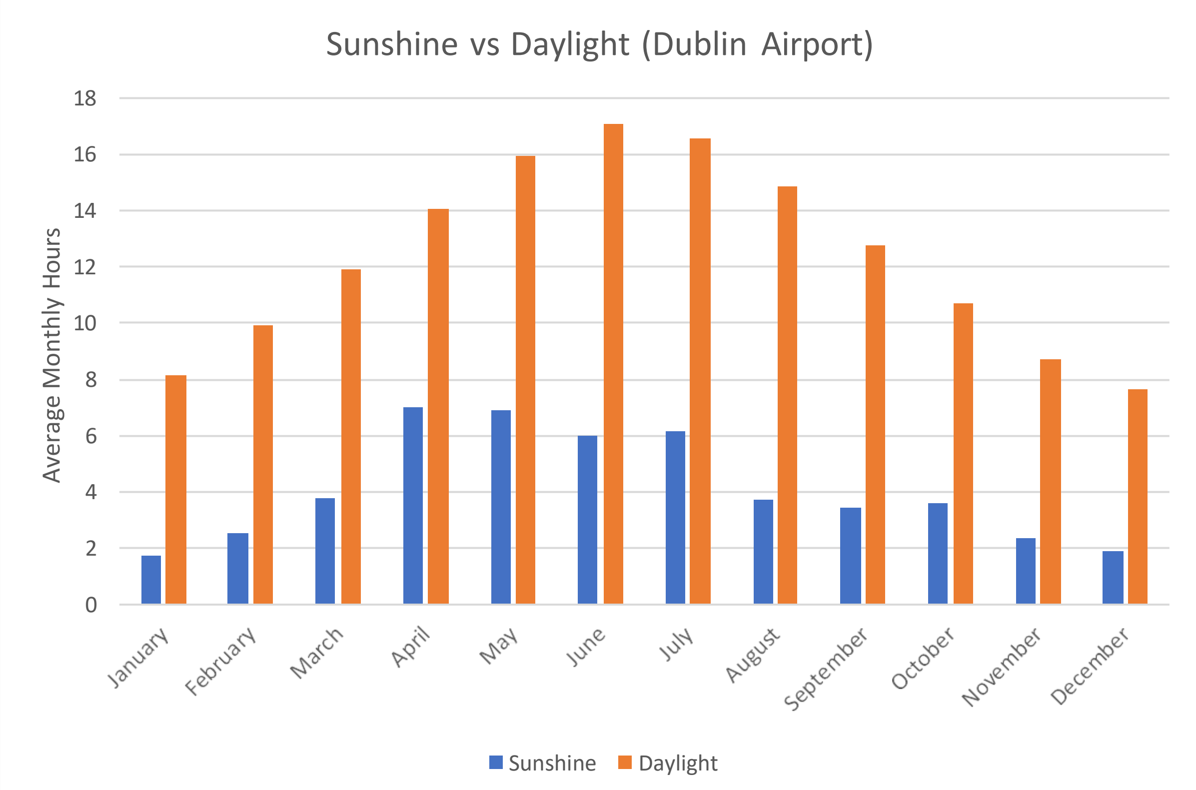

Figure 6. Sunshine vs Daylight (Dublin Airport)

[7] https://www.met.ie/climate/what-we-measure/sunshine
[8] https://www.worlddata.info/europe/ireland/sunset.php

4. Relevant Guidance and Studies

4.1. Ireland

There are currently no policy, guidance, or recommendations in Ireland in relation to the assessment of glint and glare effects on residential buildings, road and rail users, and aviation. A report produced by Future Analytics, in conjunction with the Sustainable Energy Authority of Ireland (SEAI), contains a set of planning policy and development guidance recommendations for utility scale solar PV schemes in Ireland9. This is not a formal guidance document, but it sets out recommended elements of the assessment based on international practice.

4.2. United Kingdom (UK)

Studies have been conducted in the UK which helps to establish an accepted best practice and planning guidance recommends the assessment of glint and glare effects. However, there currently is no specific guidance by way of a prescriptive methodology document. The Civil Aviation Authority (CAA) have produced an interim guidance document10 in relation to the development of solar PV systems on, and in the vicinity (<15 km) of aerodromes. The Building Research Establishment (BRE) have also developed several relevant papers, however neither the BRE nor the CAA have produced a methodology for assessing the effects of glint and glare on rail and road users, aviation, or residential buildings.

4.3. Germany

The Light Guidelines[11] produced by The Federal Ministry of the Environment defines acceptable levels of glare as being anything less than 30 minutes per day or 30 hours per year. The guidance also stipulates that there is only additional impact to an observer because of glare from a solar PV array if the angle between the source of the glare and the sun is greater than ten degrees.

4.4. United States of America (USA)

The FAA in the USA have produced a document called the "Technical Guidance for Evaluating Selected Solar Technologies on Airports"[12] which is accepted internationally as the most detailed methodology for assessing the effects of glint and glare. This document recommends the use of a particular analysis tool, the Solar Glare Hazard Analysis Tool (SGHAT), when conducting glint and glare assessments of solar PV systems.

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[9] Future Analytics. October 2016. Planning and Development Guidance Recommendations for Utility Scale Solar Photovoltaic Schemes in Ireland

[10] Civil Aviation Authority. December 2010. "Interim CAA Guidance - Solar Photovoltaic Systems".

[11] Leitlinie des Ministeriums fur Umwelt. Gesundheit und Verbraucherschutz zur Messung und Beurteilung von Lichtimmissionen (LichtLeitlinie). 2014 Available : http://www.mlul.brandenburg.de/media_fast/4055/licht_leitlinie.pdf

[12] Federal Aviation Administration. November 2010. "Technical Guidance for Evaluating Selected Solar Technologies on Airports"

5. Methodology

Lawler Sustainability, considering all the studies and guidelines mentioned in the previous section, have created a methodology for assessing the effects of glint and glare. The ForgeSolar tool has been used to satisfy aviation policy throughout the world, including that of the FAA, hence, this is the tool that Lawler Sustainability has employed and prescribed a methodology to all receptor types including road and rail, aviation, and residential buildings. Until formal guidance is provided in Ireland, the methodology that is described in this section will be used and is broken down into the following seven key stages:

1. Study area assessment
2. Solar PV array layout
3. Identifying receptors to suit analysis
4. Geometric evaluation
5. Glare analysis
6. Interpretation of results
7. Mitigation measures

5.1. Study area assessment

In the first stage of the glint and glare assessment, the area of the proposed development is identified along with any high-risk areas that could be susceptible to glare e.g. airport runways and air traffic control towers.

5.2. Solar PV array layout

The next stage identifies the size of the proposed solar PV array and its assumed area. Consideration is also given to the PV system if it is fixed mount or on a tracking system, and if it is roof mounted or mounted on the ground. Where possible, the characteristics of the proposed PV modules to be installed are determined e.g., if the panel has anti-reflective coating.

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5.3. Identifying receptors to suit analysis

Once the study area and solar PV system have been defined, the location of potential receptors can be identified in the surrounding area which may include, but is not limited to, roads, railways, residential buildings, commercial buildings, runways, and air traffic control towers. The potential receptors undergo a geometrical analysis to consider if landform such as mountains, vegetive, hills, or built environment elements of the landscape may screen the development from view. This is accomplished using desk-based analysis of Google Street view and Google Earth. The orientation of the receptors is also considered as it may dictate whether the receptors are in direct line of sight of the solar PV array. For example, a dwelling may be located within the surrounding area of the solar PV array, but the orientation of the dwelling's glazing may be facing away from the panels which would receive little or no impact of glare.

5.4. Geometric Evaluation

As mentioned previously in this report, Lawler Sustainability uses the ForgeSolar tool to perform calculations for glint and glare analysis. A number of parameters are considered to run these calculations which include, but are not limited to:

- The time zone for the proposed development.
- The apparent height and position of the sun at a particular moment in time of day and year.
- The orientation, height, and pitch of the solar PV array.
- The height and location of each receptor.

5.5. Glare analysis

Once all parameters and receptors are set within the ForgeSolar tool, the glare analysis can commence. The software performs an annual analysis of the proposed development to determine expected glare from PV arrays towards receptors. Another tool within ForgeSolar that is called GlaReduce Optimization Tool can be used to conduct a module optimization analysis. This evaluates a single PV array over a range of tilts and orientations to aid in identifying the optimal module configuration.

5.6. Interpretation of results

The results from the ForgeSolar tool are collated into a comprehendible table and graph with comments as to the likely impact of glint and glare of the proposed solar PV array on all assessed receptors. Based on the theoretical amount of time a receptor may potentially experience glare, a determination of the classification of glare is made using the table below. This table has been inspired by the German light guidelines as mentioned previously.

Table 1. Classification of Glare based on theoretical amount of time of glare from results

Glare Classification	Description
High	Potential for more than 30 mins of glare per day and/or more than 30 hours per year.
Low	Potential for less than 30 mins of glare per day and/or less than 30 hours per year
None	No geometric potential for glare / Any potential for glare fully screened by interviewing landform, vegetation, or the built environment

The above table is a guide only as additional factors such as intervening screening (vegetative, built environment elements, and hills) and receptor orientation may better determine a more realistic classification of glare.

5.7. Mitigation measures

Depending on the severity of the glare experienced at any of the receptors, mitigation measures may be recommended to reduce the impact of glare. This can be achieved in a number of ways such as recommending that vegetative screening be added to form a visual barrier between the solar PV array and the receptor or suggesting that the PV modules be orientated or positioned differently to reduce the effect of glare. Tracking systems can also be installed on PV systems which can help to reduce the impact of glare.

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6. Site Layout Software Setup

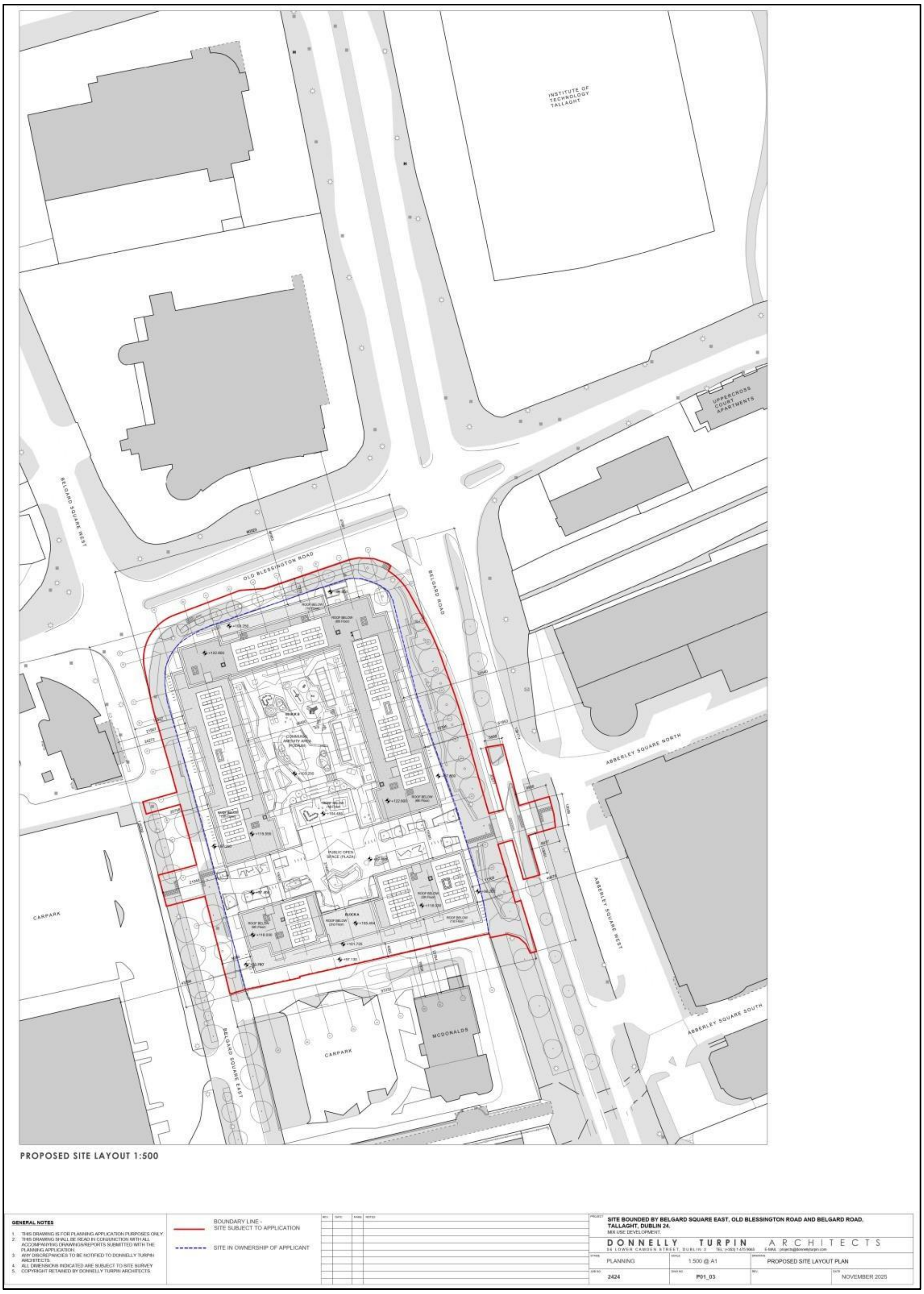

Figure 7. Proposed Site Layout for development at Site Boundary of Belgard Square East, Old Blessington Road and Belgard Road, Tallaght, Dublin 24 [Source: Donnelly Turpin Architects] (Not to Scale)

6.1. Solar PV Arrays and Parameters

This section describes the details and parameters used in the Forge Solar SGHAT tool for the proposed PV arrays.

6.1.1. PV Array 1

Table 2. PV Array 1 details

Name:	PV Array 1
Footprint area:	~295 m^2
Axis tracking:	Fixed (no rotation)
Tilt:	15.0°
Orientation:	164.0°
Rated power:	- kW
Panel material:	Light textured glass with AR coating
Vary reflectivity with sun position?	Yes
Correlate slope error with surface type?	Yes
Slope error:	9.16 mrad

Figure 8. PV Array 1

Table 3. PV Array 1 positioning

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	53.28847	-6.36899	97	22	119
2	53.28849	-6.36887	97	22	119
3	53.28818	-6.36873	97	22	119
4	53.28816	-6.36885	97	22	119

6.1.2. PV Array 2

Table 4. PV Array 2 details

Name:	PV Array 2
Footprint area:	~310 m^2
Axis tracking:	Fixed (no rotation)
Tilt:	15.0°
Orientation:	164.0°
Rated power:	- kW
Panel material:	Light textured glass with AR coating
Vary reflectivity with sun position?	Yes
Correlate slope error with surface type?	Yes
Slope error:	9.16 mrad

Figure 9. PV Array 2

Table 5. PV Array 2 positioning

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	53.28862	-6.36879	98	25	123
2	53.28871	-6.36834	98	25	123
3	53.28862	-6.3683	98	25	123
4	53.28854	-6.36875	98	25	123

6.1.3. PV Array 3

Table 6. PV Array 3 details

Name:	PV Array 3
Footprint area:	~314 m^2
Axis tracking:	Fixed (no rotation)
Tilt:	15.0°
Orientation:	164.0°
Rated power:	- kW
Panel material:	Light textured glass with AR coating
Vary reflectivity with sun position?	Yes
Correlate slope error with surface type?	Yes
Slope error:	9.16 mrad

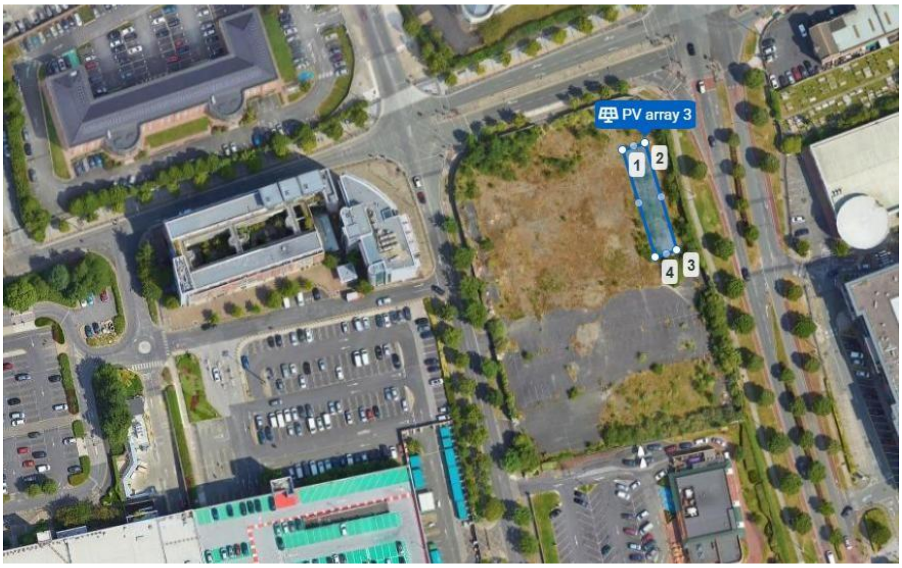

Figure 10. PV Array 3

Table 7. PV Array 3 positioning

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	53.28863	-6.36821	97	25	122
2	53.28865	-6.3681	97	25	122
3	53.28832	-6.36793	97	25	122
4	53.28832	-6.36804	97	25	122

6.1.4. PV Array 4

Table 8. PV Array 4 details

Name:	PV Array 4
Footprint area:	~162 m^2
Axis tracking:	Fixed (no rotation)
Tilt:	15.0°
Orientation:	164.0°
Rated power:	- kW
Panel material:	Light textured glass with AR coating
Vary reflectivity with sun position?	Yes
Correlate slope error with surface type?	Yes
Slope error:	9.16 mrad

Figure 11. PV Array 4

Table 9. PV Array 4 positioning

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	53.288	-6.36775	96	22.4	118.4
2	53.28786	-6.36769	96	22.4	118.4
3	53.28784	-6.36784	96	22.4	118.4
4	53.28797	-6.3679	96	22.4	118.4

6.1.5. PV Array 5

Table 10. PV Array 5 details

Name:	PV Array 5
Footprint area:	~162 m^2
Axis tracking:	Fixed (no rotation)
Tilt:	15.0°
Orientation:	164.0°
Rated power:	- kW
Panel material:	Light textured glass with AR coating
Vary reflectivity with sun position?	Yes
Correlate slope error with surface type?	Yes
Slope error:	9.16 mrad

Figure 12. PV Array 5

Table 11. PV Array 5 positioning

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	53.28783	-6.36795	96	22.4	118.4
2	53.28796	-6.368	96	22.4	118.4
3	53.28794	-6.36816	96	22.4	118.4
4	53.2878	-6.3681	96	22.4	118.4

6.1.6. PV Array 6

Table 12. PV Array 6 details

Name:	PV Array 6
Footprint area:	~111 m^2
Axis tracking:	Fixed (no rotation)
Tilt:	15.0°
Orientation:	164.0°
Rated power:	- kW
Panel material:	Light textured glass with AR coating
Vary reflectivity with sun position?	Yes
Correlate slope error with surface type?	Yes
Slope error:	9.16 mrad

Figure 13. PV Array 6

Table 13. PV Array 6 positioning

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	53.2883	-6.36801	97	25	122
2	53.28833	-6.36787	97	25	122
3	53.28823	-6.36782	97	25	122
4	53.28821	-6.36796	97	25	122

6.1.7. PV Array 7

Table 14. PV Array 7 details

Name:	PV Array 7
Footprint area:	~149 m^2
Axis tracking:	Fixed (no rotation)
Tilt:	15.0°
Orientation:	164.0°
Rated power:	- kW
Panel material:	Light textured glass with AR coating
Vary reflectivity with sun position?	Yes
Correlate slope error with surface type?	Yes
Slope error:	9.16 mrad

Figure 14. PV Array 7

Table 15. PV Array 7 positioning

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	53.28818	-6.36878	97	22	119
2	53.28805	-6.36872	97	22	119
3	53.28802	-6.36887	97	22	119
4	53.28815	-6.36893	97	22	119

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6.1.8. PV Array 8

Table 16. PV Array 8 details

Name:	PV Array 8
Footprint area:	~172 m^2
Axis tracking:	Fixed (no rotation)
Tilt:	15.0°
Orientation:	164.0°
Rated power:	- kW
Panel material:	Light textured glass with AR coating
Vary reflectivity with sun position?	Yes
Correlate slope error with surface type?	Yes
Slope error:	9.16 mrad

Figure 15. PV Array 8

Table 17. PV Array 8 positioning

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	53.28787	-6.3686	97	22	119
2	53.2879	-6.36843	97	22	119
3	53.28777	-6.36838	97	22	119
4	53.28774	-6.36854	97	22	119

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6.2. Observation Points ATCT Receptors

Table 18. Discrete Observation Receptors

Number	Latitude	Longitude	Ground elevation	Height above ground	Total Elevation
	deg	deg	m	m	m
1-ATCT	53.305512	-6.441756	93.50	10	103.5
2-ATCT	53.289503	-6.376773	102.80	70.00	172.80

Figure 16. 1-ATCT Casement Aerodrome (Baldonnel Airport)

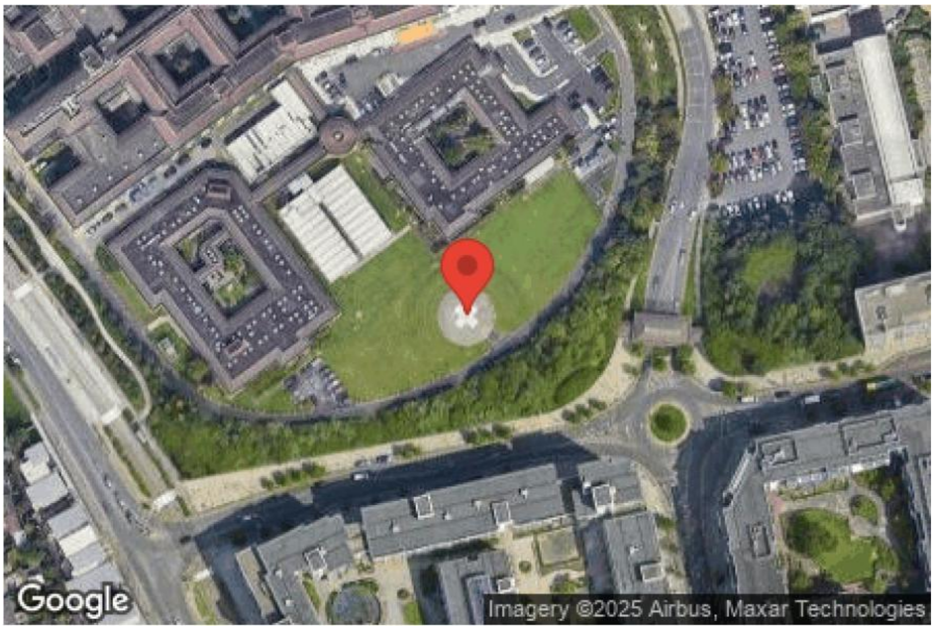

Figure 17. 2-ATCT Helipad of Tallaght University Hospital

6.3. 2-Mile Flight Path Receptors

Table 19. 2-Mile flight path FP 04 details

Name:	FP 04
Threshold Height:	16.5m
Direction:	40.8°
Glide Slope:	4.5°
Vertical view restriction:	30.0°
Azimuthal view restriction:	50.0°

Figure 18. 2-Mile Flight Path FP 04

Table 20. 2-Mile flight path FP 04 parameters

Point	Latitude	Longitude	Ground elevation	Height above ground	Total Elevation
	deg	deg	m	m	m
Threshold	53.293731	-6.453601	98.43	16.50	114.93
2-mile point	53.271845	-6.485245	154.30	213.95	368.25

Table 21. 2-Mile flight path FP 10 details

Name:	FP 10
Threshold Height:	16.5m
Direction:	101.9°
Glide Slope:	3.0°
Vertical view restriction:	30.0°
Azimuthal view restriction:	50.0°

Figure 19. 2-Mile Flight Path FP 10

Table 22. 2-Mile flight path FP 10 parameters

Point	Latitude	Longitude	Ground elevation	Height above ground	Total Elevation
	deg	deg	m	m	m
Threshold	53.304655	-6.468515	86.24	16.50	102.74
2-mile point	53.310617	-6.515916	73.40	198.02	271.42

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Table 23. 2-Mile flight path FP 22 details

Name:	FP 22
Threshold Height:	16.5m
Direction:	220.8°
Glide Slope:	3.0°
Vertical view restriction:	30.0°
Azimuthal view restriction:	50.0°

Figure 20. 2-Mile Flight Path FP 22

Table 24. 2-Mile flight path FP 22 parameters

Point	Latitude	Longitude	Ground elevation	Height above ground	Total Elevation
	deg	deg	m	m	m
Threshold	53.303368	-6.439654	93.36	16.50	109.86
2-mile point	53.325255	-6.408003	62.70	215.85	278.55

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Table 25. 2-Mile flight path FP 28 details

Name:	FP 28
Threshold Height:	16.5m
Direction:	281.9°
Glide Slope:	3.0°
Vertical view restriction:	30.0°
Azimuthal view restriction:	50.0°

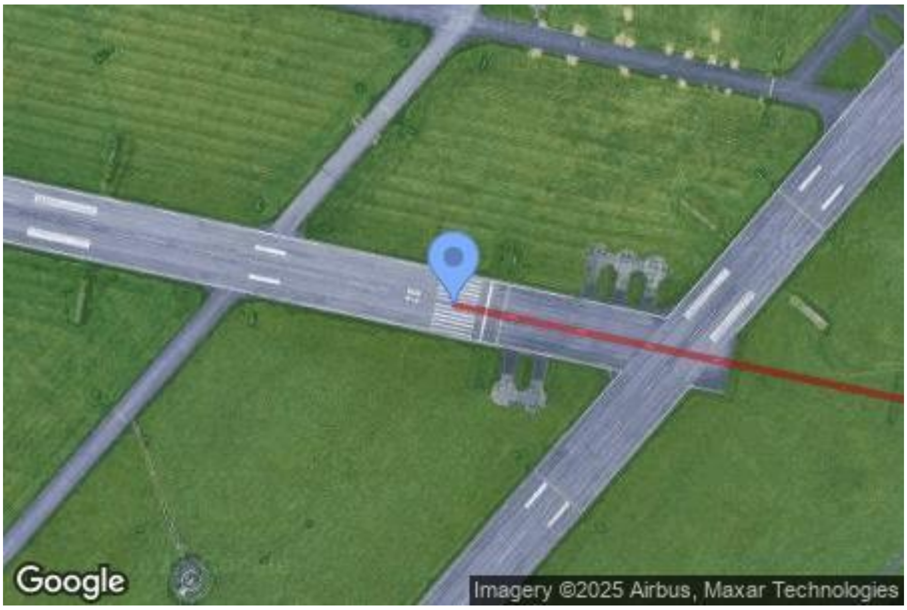

Figure 21. 2-Mile Flight Path FP 28

Table 26. 2-Mile flight path FP 28 parameters

Point	Latitude	Longitude	Ground elevation	Height above ground	Total Elevation
	deg	deg	m	m	m
Threshold	53.301675	-6.444954	96.05	16.50	112.55
2-mile point	53.295713	-6.397557	106.18	175.05	281.23

7. Glint and Glare Analysis

The proposed PV arrays were modelled as designed, with a fixed 15° tilt and a 164° south-facing azimuth. No optimisation or alternative orientation studies were carried out. The analysis included four 2-mile flight-path receptors (FP04, FP10, FP22 and FP28) at Casement Aerodrome (Baldonnel Airport), along with the Air Traffic Control Tower, which has a height of 10 m above ground level. It also incorporated a nearby helipad receptor at Tallaght University Hospital, set at 70 m above ground level to represent the critical helicopter take-off and landing phase.

A baseline assessment was first completed with the parapet omitted to represent a fully unobstructed line of sight between the PV arrays and all receptors. Additional assessments including the parapet (see figure below) were then undertaken to understand the level of natural screening provided. The results presented in the following section correspond to the baseline scenario, representing the worst- case condition with no obstruction between the PV arrays and the assessed receptors.

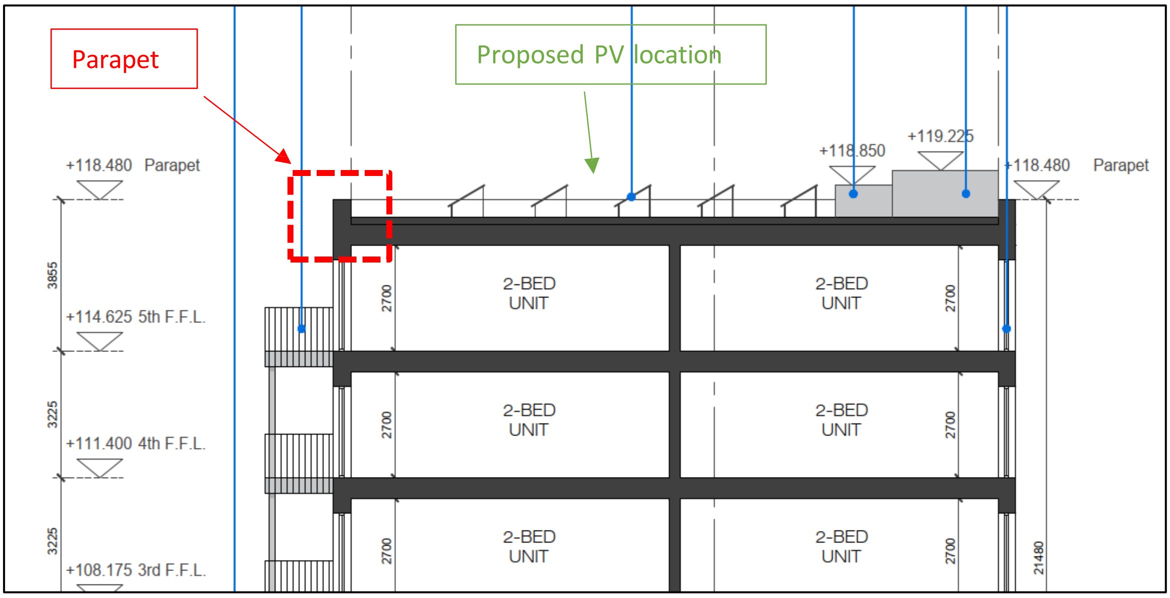

Figure 22. Extract from drawing PROPOSEDSECTION A-A AND B-B (Source: Donnelly Turpin Architects) [Not to scale]

7.1. Glint and Glare Results

The results indicated in the following tables highlight the potential for green and yellow hazard glare from the solar PV arrays at the development.

Table 27. Summary of results

PV Name	Tilt	Orientation	Annual "Green" Glare	Annual "Yellow" Glare	Annual Energy Produced*
	deg	deg	min	min	kWh
PV array 1	15.0	164.0	503	0	-
PV array 2	15.0	164.0	503	0	-
PV array 3	15.0	164.0	494	0	-
PV array 4	15.0	164.0	451	0	-
PV array 5	15.0	164.0	449	0	-
PV array 6	15.0	164.0	262	0	-
PV array 7	15.0	164.0	266	0	-
PV array 8	15.0	164.0	245	0	-

*Please note that the value listed here is an approximate of the potential yield from the proposed solar PV array. Please refer to more specialized software for estimating solar energy yields.

Table 28. Distinct glare (minutes) per month

PV	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
pv-array-1 (green)	0	0	0	252	0	0	0	164	87	0	0	0
pv-array-1 (yellow)	0	0	0	0	0	0	0	0	0	0	0	0
pv-array-2 (green)	0	0	0	251	0	0	0	170	82	0	0	0
pv-array-2 (yellow)	0	0	0	0	0	0	0	0	0	0	0	0
pv-array-3 (green)	0	0	0	248	0	0	0	164	82	0	0	0
pv-array-3 (yellow)	0	0	0	0	0	0	0	0	0	0	0	0
pv-array-4 (green)	0	0	0	224	0	0	0	140	87	0	0	0
pv-array-4 (yellow)	0	0	0	0	0	0	0	0	0	0	0	0
pv-array-5 (green)	0	0	0	222	0	0	0	140	87	0	0	0
pv-array-5 (yellow)	0	0	0	0	0	0	0	0	0	0	0	0
pv-array-6 (green)	0	0	0	130	0	0	0	81	51	0	0	0
pv-array-6 (yellow)	0	0	0	0	0	0	0	0	0	0	0	0
pv-array-7 (green)	0	0	0	135	0	0	0	80	51	0	0	0
pv-array-7 (yellow)	0	0	0	0	0	0	0	0	0	0	0	0
pv-array-8 (green)	0	0	0	124	0	0	0	69	52	0	0	0
pv-array-8 (yellow)	0	0	0	0	0	0	0	0	0	0	0	0

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Table 29. PV Array & Receptor analysis annual results

Component	Annual Green glare (min)	Annual Green glare (hours)	Annual Yellow glare (min)	Annual Yellow glare (hours)
PV Array 1				
FP: FP 04	503	8.4 hr	0	0
FP: FP 10	0	0	0	0
FP: FP 22	0	0	0	0
FP: FP 28	0	0	0	0
OP: 1-ATCT	0	0	0	0
OP: 2-ATCT	0	0	0	0
PV Array 2				
FP: FP 04	503	8.4 hr	0	0
FP: FP 10	0	0	0	0
FP: FP 22	0	0	0	0
FP: FP 28	0	0	0	0
OP: 1-ATCT	0	0	0	0
OP: 2-ATCT	0	0	0	0
PV Array 3				
FP: FP 04	494	8.2 hr	0	0
FP: FP 10	0	0	0	0
FP: FP 22	0	0	0	0
FP: FP 28	0	0	0	0
OP: 1-ATCT	0	0	0	0
OP: 2-ATCT	0	0	0	0
PV Array 4				
FP: FP 04	451	7.5 hr	0	0
FP: FP 10	0	0	0	0
FP: FP 22	0	0	0	0
FP: FP 28	0	0	0	0
OP: 1-ATCT	0	0	0	0
OP: 2-ATCT	0	0	0	0
PV Array 5				
FP: FP 04	449	7.5 hr	0	0
FP: FP 10	0	0	0	0
FP: FP 22	0	0	0	0
FP: FP 28	0	0	0	0
OP: 1-ATCT	0	0	0	0
OP: 2-ATCT	0	0	0	0
PV Array 6				
FP: FP 04	262	4.4 hr	0	0
FP: FP 10	0	0	0	0
FP: FP 22	0	0	0	0
FP: FP 28	0	0	0	0

OP: 1-ATCT	0	0	0	0
OP: 2-ATCT	0	0	0	0
PV Array 7				
FP: FP 04	266	4.4 hr	0	0
FP: FP 10	0	0	0	0
FP: FP 22	0	0	0	0
FP: FP 28	0	0	0	0
OP: 1-ATCT	0	0	0	0
OP: 2-ATCT	0	0	0	0
PV Array 8				
FP: FP 04	245	4.1 hr	0	0
FP: FP 10	0	0	0	0
FP: FP 22	0	0	0	0
FP: FP 28	0	0	0	0
OP: 1-ATCT	0	0	0	0
OP: 2-ATCT	0	0	0	0

8. Conclusion

A comprehensive glint and glare assessment was carried out for the proposed solar photovoltaic (PV) installation at Site Boundary of Belgard Square East, Old Blessington Road and Belgard Road, Tallaght, Dublin 24. The development is located within one Solar Safeguarding Zone as identified by The Planning and Development (Solar Safeguarding Zone) Regulations 2022. The report has assessed the required nearby helipad receptor and ATC Tower located at Casement Aerodrome.

The findings of the analysis are as follows:

- 2-Mile Flight Path Receptors: No risk of glare was identified for the 4 Flight paths assessed.
- Observation Point ATCT Receptors: No risk of glint or glare was identified from the proposed solar PV panels.

In summary, the proposed installation presents no significant glint and glare concerns at any of the 2 Observation points and 4 Flight paths assessed.

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Appendix

Please note the following assumptions will apply to the following graphs:

- 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 covers 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 modelling methods.
- Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
- The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the 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 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.

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FORGESOLAR GLARE ANALYSIS

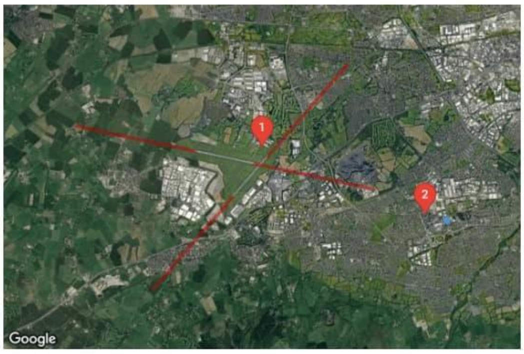
Project: **Belgard Square East**

Proposed Solar PV systems on the roofs of the proposed buildings/site bounded by Belgard Square East, Blessington Road and Belgard Road, Tallaght, Dublin 24

Site configuration: **Baseline_R1-temp-1**

Created 14 Nov, 2025
Updated 14 Nov, 2025
Time-step 1 minute
Timezone offset UTC0
Minimum sun altitude 0.0 deg
DNI peaks at 1,000.0 W/m^2
Category 10 to 100 kW
(1,000 kW / 32,400 m^2 limit)
Site ID 164679.23842

Ocular transmission coefficient 0.5
Pupil diameter 0.002 m
Eye focal length 0.017 m
Sun subtended angle 9.3 mrad
PV analysis methodology V2



Summary of Results

Glare with low potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV array 1	15.0	164.0	503	8.4	0	0.0	-
PV array 2	15.0	164.0	503	8.4	0	0.0	-
PV array 3	15.0	164.0	494	8.2	0	0.0	-
PV array 4	15.0	164.0	451	7.5	0	0.0	-
PV array 5	15.0	164.0	449	7.5	0	0.0	-
PV array 6	15.0	164.0	262	4.4	0	0.0	-
PV array 7	15.0	164.0	266	4.4	0	0.0	-
PV array 8	15.0	164.0	245	4.1	0	0.0	-

Total glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
FP 04	3,173	52.9	0	0.0
FP 10	0	0.0	0	0.0
FP 22	0	0.0	0	0.0
FP 28	0	0.0	0	0.0
1-ATCT	0	0.0	0	0.0
2-ATCT	0	0.0	0	0.0

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Component Data

PV Arrays

Name: PV array 1
Description: Solar Panels Area 1
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 164.0°
Rated power: -
Panel material: Light textured 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	53.288469	-6.368992	97.00	22.00	119.00
2	53.288491	-6.368874	97.00	22.00	119.00
3	53.288184	-6.368727	97.00	22.00	119.00
4	53.288163	-6.368847	97.00	22.00	119.00

Name: PV array 2
Description: Solar Panels Area 2
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 164.0°
Rated power: -
Panel material: Light textured 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	53.288625	-6.368789	98.00	25.00	123.00
2	53.288710	-6.368345	98.00	25.00	123.00
3	53.288625	-6.368297	98.00	25.00	123.00
4	53.288540	-6.368751	98.00	25.00	123.00

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Name: PV array 3
Description: Solar Panels Area 3
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 164.0°
Rated power: -
Panel material: Light textured 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	53.288633	-6.368211	97.00	25.00	122.00
2	53.288655	-6.368096	97.00	25.00	122.00
3	53.288316	-6.367927	97.00	25.00	122.00
4	53.288296	-6.368041	97.00	25.00	122.00

Name: PV array 4
Description: Solar Panels Area 4
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 164.0°
Rated power: -
Panel material: Light textured 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	53.287996	-6.367748	96.00	22.40	118.40
2	53.287862	-6.367691	96.00	22.40	118.40
3	53.287838	-6.367843	96.00	22.40	118.40
4	53.287972	-6.367901	96.00	22.40	118.40

Name: PV array 5
Description: Solar Panels Area 5
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 164.0°
Rated power: -
Panel material: Light textured 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	53.287825	-6.367949	96.00	22.40	118.40
2	53.287960	-6.368002	96.00	22.40	118.40
3	53.287937	-6.368156	96.00	22.40	118.40
4	53.287803	-6.368102	96.00	22.40	118.40

Name: PV array 6
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 164.0°
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	53.288302	-6.368013	97.00	25.00	122.00
2	53.288328	-6.367865	97.00	25.00	122.00
3	53.288234	-6.367818	97.00	25.00	122.00
4	53.288208	-6.367963	97.00	25.00	122.00

Name: PV array 7
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 164.0°
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	53.288176	-6.368784	97.00	22.00	119.00
2	53.288048	-6.368724	97.00	22.00	119.00
3	53.288024	-6.368874	97.00	22.00	119.00
4	53.288149	-6.368927	97.00	22.00	119.00

Name: PV array 8
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 164.0°
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	53.287870	-6.368596	97.00	22.00	119.00
2	53.287897	-6.368430	97.00	22.00	119.00
3	53.287767	-6.368376	97.00	22.00	119.00
4	53.287738	-6.368542	97.00	22.00	119.00

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Flight Path Receptors

Name: FP 04
Description:
Threshold height: 16 m
Direction: 40.8°
Glide slope: 4.5°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.293731	-6.453601	98.43	16.50	114.93
Two-mile	53.271845	-6.485245	154.30	213.95	368.25

Name: FP 10
Description:
Threshold height: 16 m
Direction: 101.9°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.304655	-6.468515	86.24	16.50	102.74
Two-mile	53.310617	-6.515916	73.40	198.02	271.42

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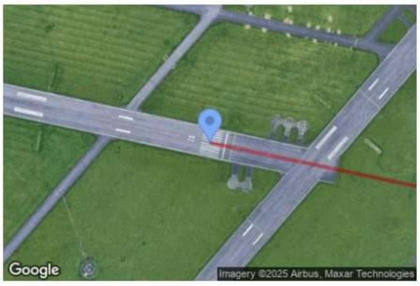
Name: FP 22
Description:
Threshold height: 16 m
Direction: 220.8°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.303368	-6.439654	93.36	16.50	109.86
Two-mile	53.325255	-6.408003	62.70	215.85	278.55

Name: FP 28
Description:
Threshold height: 16 m
Direction: 281.9°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.301675	-6.444954	96.05	16.50	112.55
Two-mile	53.295713	-6.397557	106.18	175.05	281.23

Discrete Observation Point Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
1-ATCT	1	53.305512	-6.441756	93.50	10.00
2-ATCT	2	53.289503	-6.376773	102.80	70.00

Map image of 1-ATCT

Map image of 2-ATCT

Glare Analysis Results

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

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV array 1	15.0	164.0	503	8.4	0	0.0	-
PV array 2	15.0	164.0	503	8.4	0	0.0	-
PV array 3	15.0	164.0	494	8.2	0	0.0	-
PV array 4	15.0	164.0	451	7.5	0	0.0	-
PV array 5	15.0	164.0	449	7.5	0	0.0	-
PV array 6	15.0	164.0	262	4.4	0	0.0	-
PV array 7	15.0	164.0	266	4.4	0	0.0	-
PV array 8	15.0	164.0	245	4.1	0	0.0	-

Total glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
FP 04	3,173	52.9	0	0.0
FP 10	0	0.0	0	0.0
FP 22	0	0.0	0	0.0
FP 28	0	0.0	0	0.0
1-ATCT	0	0.0	0	0.0
2-ATCT	0	0.0	0	0.0

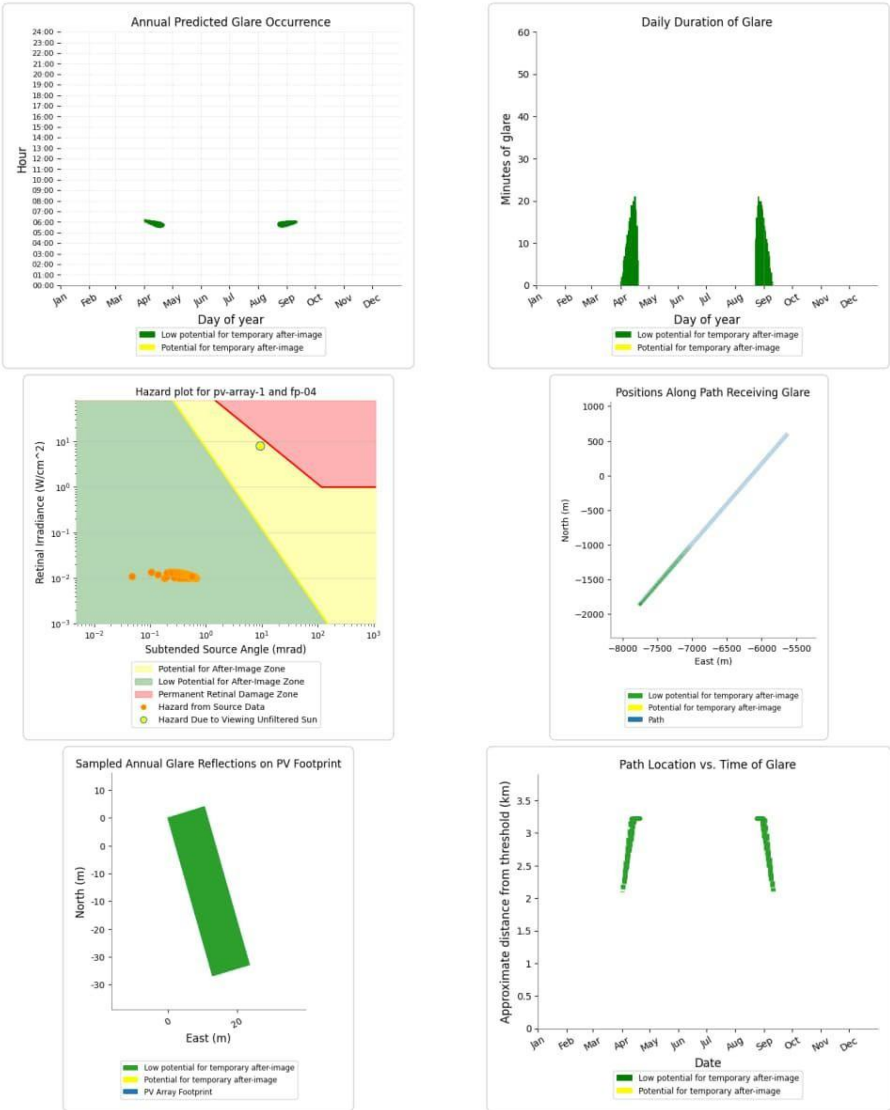
PV: PV array 1 low potential for temporary after-image

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
FP 04	503	8.4	0	0.0
FP 10	0	0.0	0	0.0
FP 22	0	0.0	0	0.0
FP 28	0	0.0	0	0.0
1-ATCT	0	0.0	0	0.0
2-ATCT	0	0.0	0	0.0

PV array 1 and FP: FP 04

Yellow glare: none
Green glare: 503 min.



PV array 1 and FP: FP 10

No glare found

PV array 1 and FP: FP 22

No glare found

PV array 1 and FP: FP 28

No glare found

PV array 1 and 1-ATCT

No glare found

PV array 1 and 2-ATCT

No glare found

PV: PV array 2 low potential for temporary after-image

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
FP 04	503	8.4	0	0.0
FP 10	0	0.0	0	0.0
FP 22	0	0.0	0	0.0
FP 28	0	0.0	0	0.0
1-ATCT	0	0.0	0	0.0
2-ATCT	0	0.0	0	0.0

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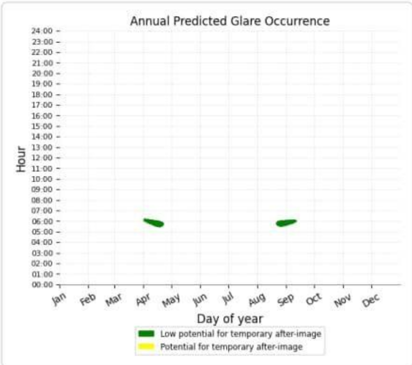
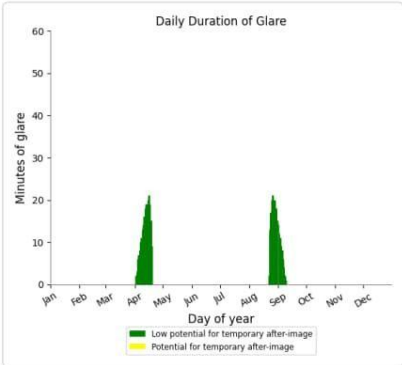
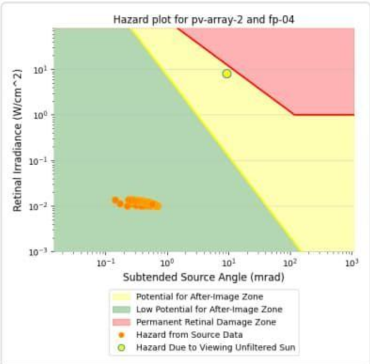
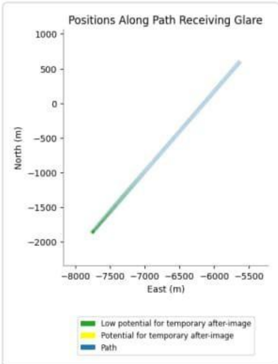
PV array 2 and FP: FP 04

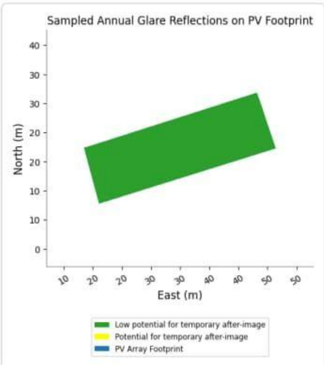
Yellow glare: none
Green glare: 503 min.

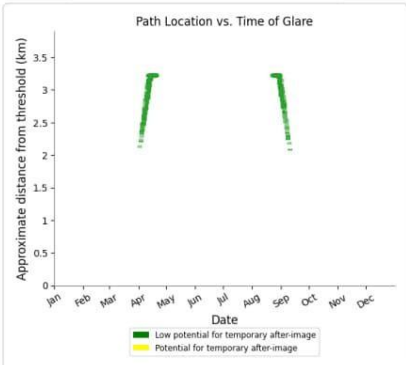












PV array 2 and FP: FP 10

No glare found

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PV array 2 and FP: FP 22

No glare found

PV array 2 and FP: FP 28

No glare found

PV array 2 and 1-ATCT

No glare found

PV array 2 and 2-ATCT

No glare found

PV: PV array 3 low potential for temporary after-image

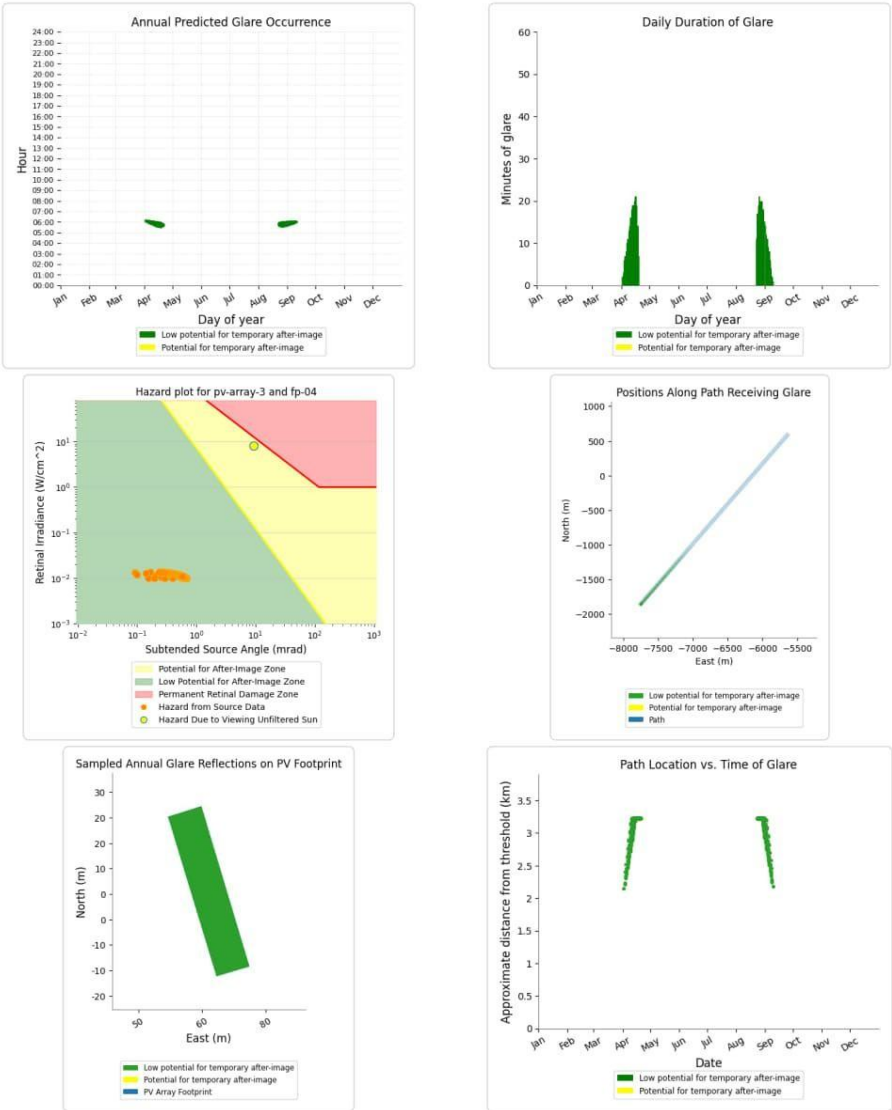
Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
FP 04	494	8.2	0	0.0
FP 10	0	0.0	0	0.0
FP 22	0	0.0	0	0.0
FP 28	0	0.0	0	0.0
1-ATCT	0	0.0	0	0.0
2-ATCT	0	0.0	0	0.0

PV array 3 and FP: FP 04

Yellow glare: none

Green glare: 494 min.



PV array 3 and FP: FP 10

No glare found

PV array 3 and FP: FP 22

No glare found

PV array 3 and FP: FP 28

No glare found

PV array 3 and 1-ATCT

No glare found

PV array 3 and 2-ATCT

No glare found

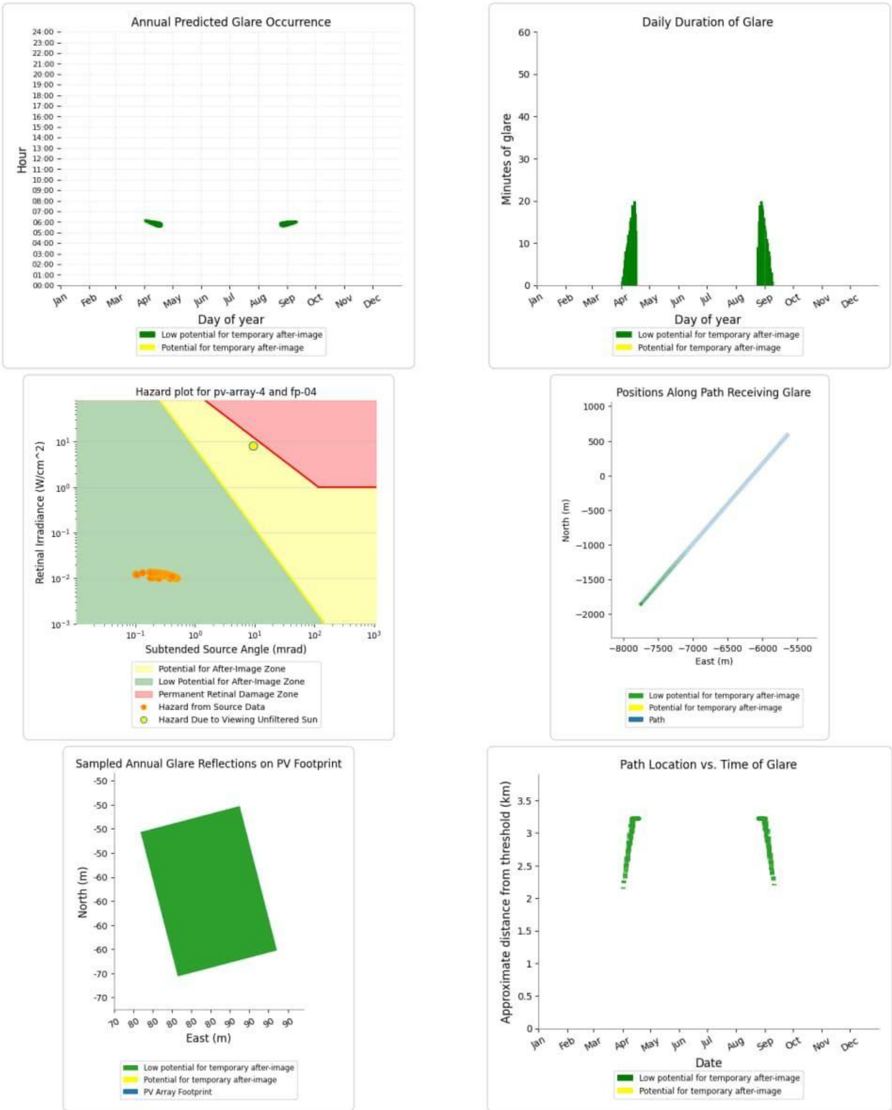
PV: PV array 4 low potential for temporary after-image

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
FP 04	451	7.5	0	0.0
FP 10	0	0.0	0	0.0
FP 22	0	0.0	0	0.0
FP 28	0	0.0	0	0.0
1-ATCT	0	0.0	0	0.0
2-ATCT	0	0.0	0	0.0

PV array 4 and FP: FP 04

Yellow glare: none
Green glare: 451 min.



PV array 4 and FP: FP 10

No glare found

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PV array 4 and FP: FP 22

No glare found

PV array 4 and FP: FP 28

No glare found

PV array 4 and 1-ATCT

No glare found

PV array 4 and 2-ATCT

No glare found

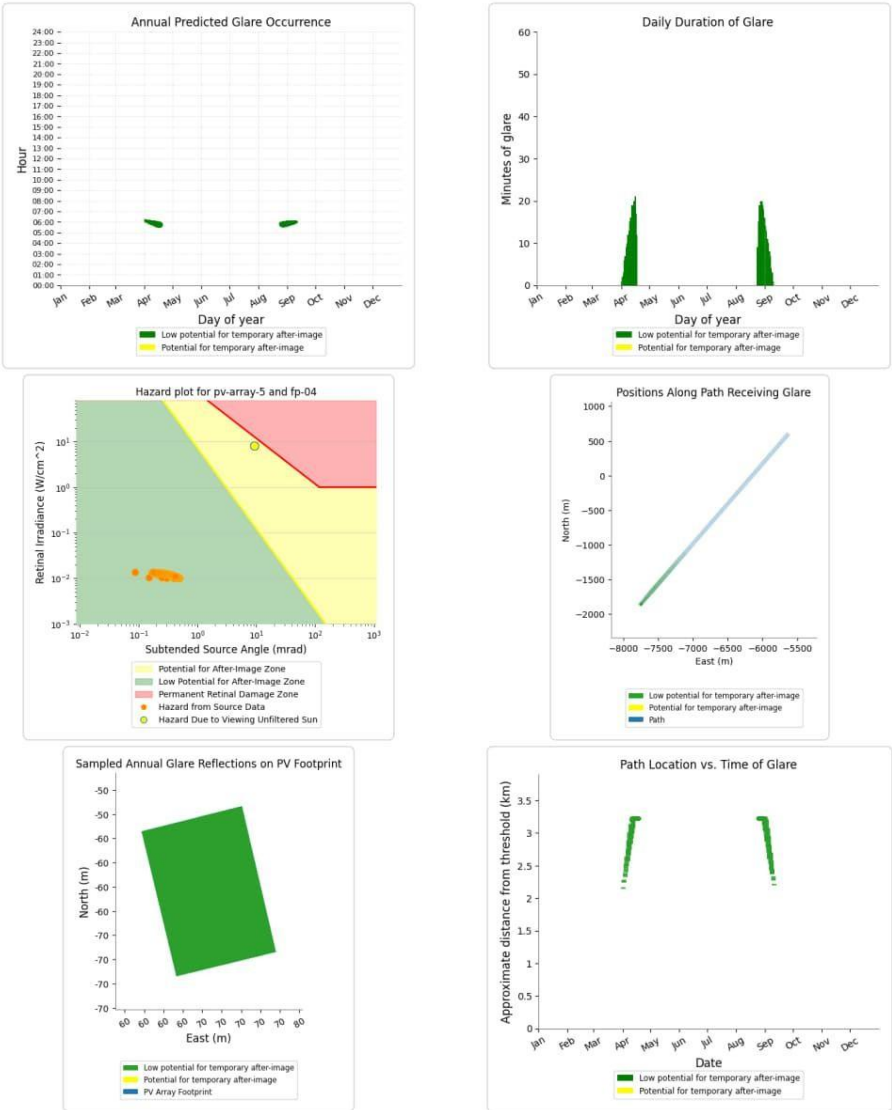
PV: PV array 5 low potential for temporary after-image

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
FP 04	449	7.5	0	0.0
FP 10	0	0.0	0	0.0
FP 22	0	0.0	0	0.0
FP 28	0	0.0	0	0.0
1-ATCT	0	0.0	0	0.0
2-ATCT	0	0.0	0	0.0

PV array 5 and FP: FP 04

Yellow glare: none
Green glare: 449 min.



PV array 5 and FP: FP 10

No glare found

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PV array 5 and FP: FP 22

No glare found

PV array 5 and FP: FP 28

No glare found

PV array 5 and 1-ATCT

No glare found

PV array 5 and 2-ATCT

No glare found

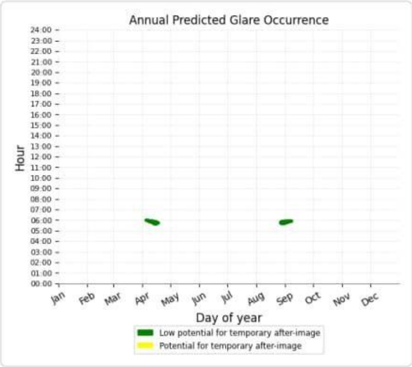
PV: PV array 6 low potential for temporary after-image

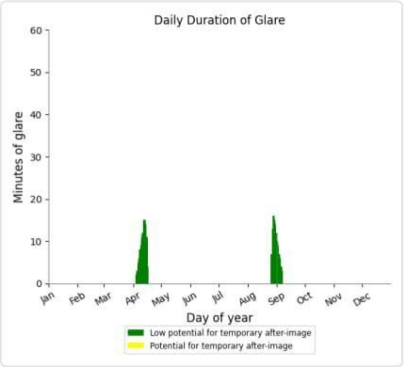
Receptor results ordered by category of glare

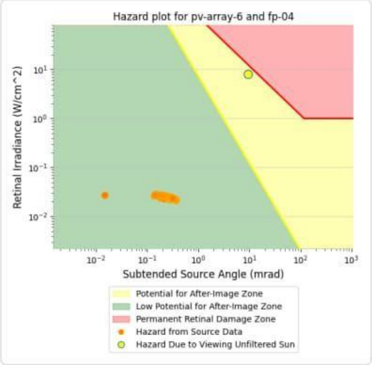
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
FP 04	262	4.4	0	0.0
FP 10	0	0.0	0	0.0
FP 22	0	0.0	0	0.0
FP 28	0	0.0	0	0.0
1-ATCT	0	0.0	0	0.0
2-ATCT	0	0.0	0	0.0

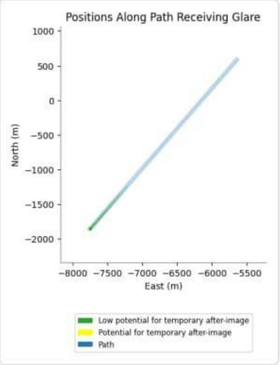
PV array 6 and FP: FP 04

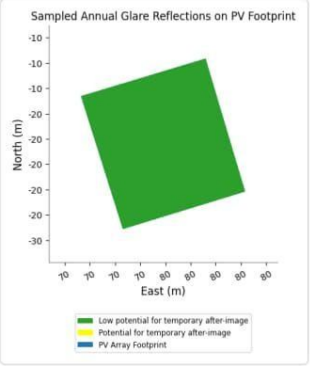
Yellow glare: none
Green glare: 262 min.

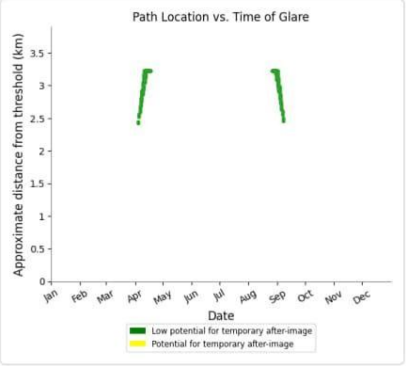












PV array 6 and FP: FP 10

No glare found

PV array 6 and FP: FP 22

No glare found

PV array 6 and FP: FP 28

No glare found

PV array 6 and 1-ATCT

No glare found

PV array 6 and 2-ATCT

No glare found

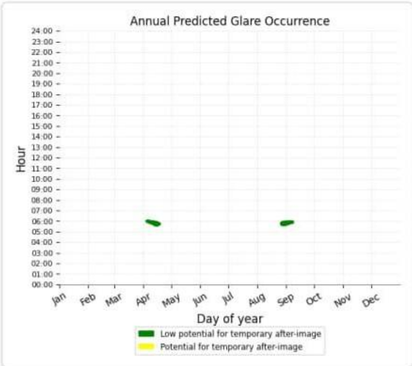
PV: PV array 7 low potential for temporary after-image

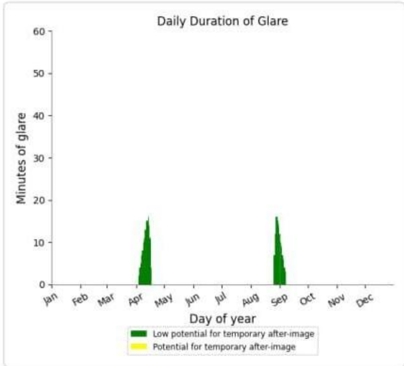
Receptor results ordered by category of glare

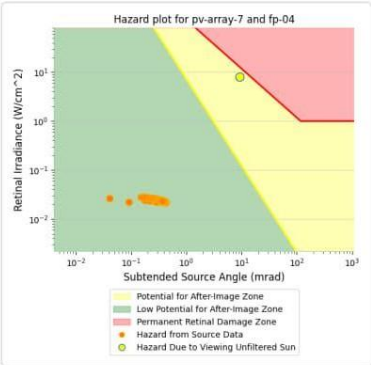
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
FP 04	266	4.4	0	0.0
FP 10	0	0.0	0	0.0
FP 22	0	0.0	0	0.0
FP 28	0	0.0	0	0.0
1-ATCT	0	0.0	0	0.0
2-ATCT	0	0.0	0	0.0

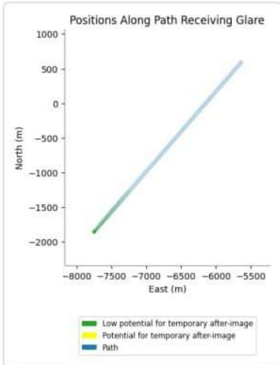
PV array 7 and FP: FP 04

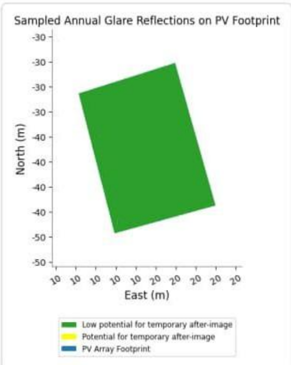
Yellow glare: none
Green glare: 266 min.

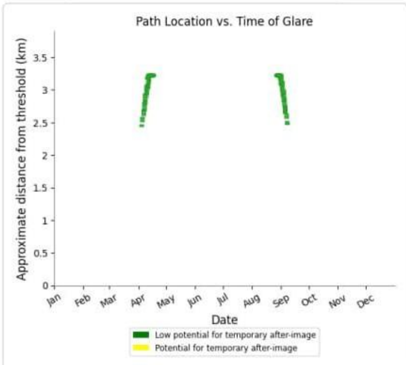












PV array 7 and FP: FP 10

No glare found

PV array 7 and FP: FP 22

No glare found

PV array 7 and FP: FP 28

No glare found

PV array 7 and 1-ATCT

No glare found

PV array 7 and 2-ATCT

No glare found

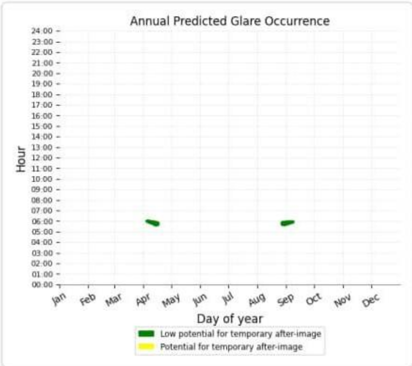
PV: PV array 8 low potential for temporary after-image

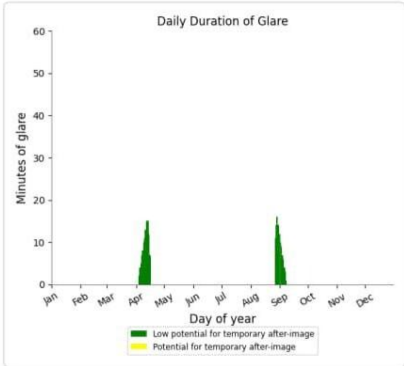
Receptor results ordered by category of glare

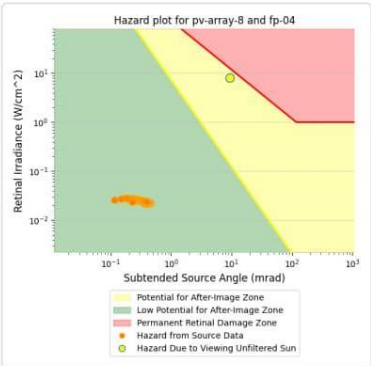
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
FP 04	245	4.1	0	0.0
FP 10	0	0.0	0	0.0
FP 22	0	0.0	0	0.0
FP 28	0	0.0	0	0.0
1-ATCT	0	0.0	0	0.0
2-ATCT	0	0.0	0	0.0

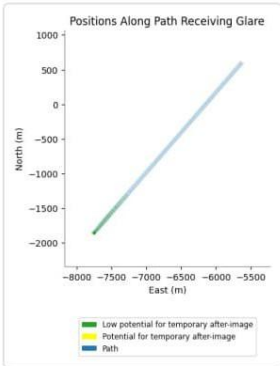
PV array 8 and FP: FP 04

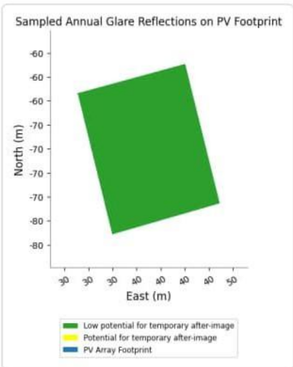
Yellow glare: none
Green glare: 245 min.

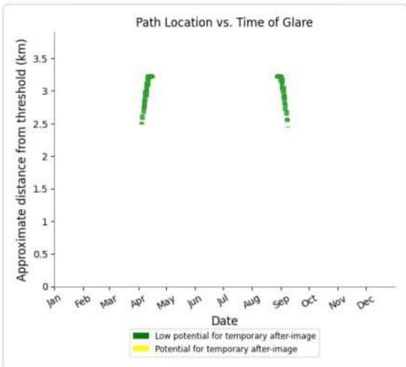












PV array 8 and FP: FP 10

No glare found

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PV array 8 and FP: FP 22

No glare found

PV array 8 and FP: FP 28

No glare found

PV array 8 and 1-ATCT

No glare found

PV array 8 and 2-ATCT

No glare found

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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.
The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.
Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare. This primarily affects V1 analyses of path receptors.
Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis.
The analysis does not automatically consider obstacles (either man-made or natural) between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills, buildings, etc.
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.)
The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.
The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.
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.
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.
Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
Refer to the Help page at **www.forgesolar.com/help/** for assumptions and limitations not listed here.

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