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GLINT AND GLARE ASSESSMENT

Proposed Solar PV Energy Development.

Social Housing Bundle 4, Development of the Church of the Annunciation, Finglas

Prepared by Macro Works Ltd.

February 2024

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Registered Landscape Architect

macroworks APEM Group

1 INTRODUCTION

1.1.1 This Glint and Glare Assessment was carried out by Macro Works Ltd to determine the potential for solar reflectance effects upon aviation receptors in respect of proposed roof-mounted solar PV installations on the roof of a proposed residential development in Finglas, Dublin 11. The proposed panels will be mounted on the top floor of the proposed development and will remain in a fixed position throughout the day and year (i.e. they will not rotate to track the movement of the sun). Figure 1 and Figure 2 refer. The aviation based glint and glare assessment will assess the proposed panels at four tilt angles; 0 degrees, 5 degrees, 10 degrees and 15 degrees.

Figure 1: Aerial view indicating the approximate location of the proposed PV panels (yellow pin).

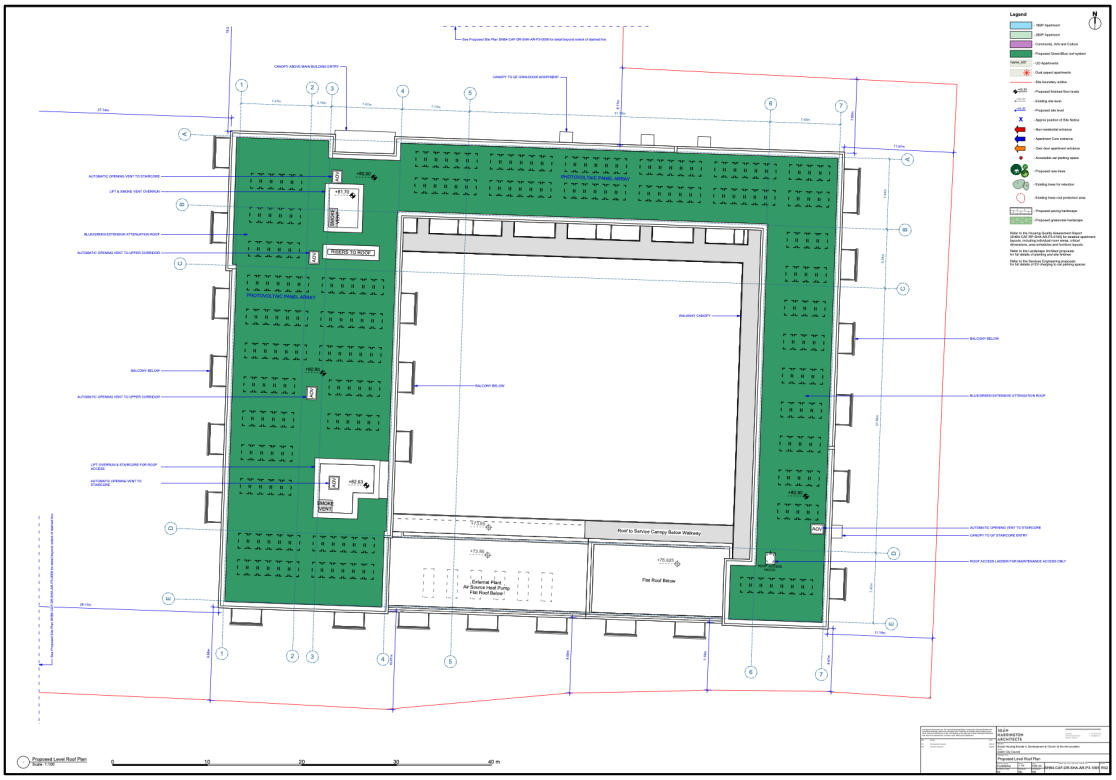

Figure 2: Extract from drawing "SHB4-CAF-DR-SHA-AR-P3-1005-Proposed Level Roof Plan" showing the proposed roof layouts with the location of the proposed PV panels.

1.2 Project Description

1.2.1 The proposed development will comprise the construction of 110 residential dwellings at a site c.0.77 ha at the site of the former Church of Annunciation on Cardiffsbridge Road, Finglas, Dublin 11, which will consist of the following:

- One apartment block ranging from 4 to 5-storeys, containing:
  - 110 residential units (106 no. 1-bed and 4 no. 2-bed); and
  - 434 sq.m. of community, arts and cultural facilities.
- 15 no. car parking spaces and 87 no. cycle spaces.
- 935 sq.m. of public open space and 609 sq.m. of communal open space.
- One vehicular and pedestrian access and one dedicated pedestrian access off Cardiffsbridge Road.
- Boundary treatments, public lighting, site drainage works, internal road surfacing and footpath, ESB meter rooms, plant rooms, stores, bin and bicycle storage, landscaping; and
- All ancillary site services and development works above and below ground.

1.3 Statement of Authority

1.3.1 Macro Works' relevant experience includes twenty years of analysing the visual effects of a wide range of infrastructural and commercial development types. This experience includes numerous domestic and international wind and solar energy developments.

1.4 Guidance and Best Practice

1.4.1 Guidance has been prepared by the Federal Aviation Authority[1] to address the potential hazards that solar developments may pose to aviation activities, and this has been adopted for use by the Irish Aviation Authority. SGHAT was developed in conjunction with the FAA in harmony with this guidance and is commonly regarded as the accepted industry standard by aviation authorities internationally when considering the glint and glare effects upon aviation related receptors.

1.4.2 By virtue of their efficiency, the intensity of reflected light from modern PV solar panels is deliberately low and currently equates with that of the reflection from still water. Recent studies generally agree, however, that there still exists the potential for hazard or nuisance upon surrounding receptors. Macro Works' glint and glare analysis methods and determination of effects are based on a combination of available studies and established best practice. This methodology has been successfully implemented on numerous previous solar farm projects that met with the approval of both Planning Authorities and An Bord Pleanála.

Federal Aviation Authority

1.4.3 Within the FAA's interim policy, a 'Review of Solar Energy System Projects on Federally Obligated Airports'[2] it states:

> *"To obtain FAA approval to revise an airport layout plan to depict a solar installation and/or a ''no objection'' to a Notice of Proposed Construction Form 7460–1, the airport sponsor will be required to demonstrate that the proposed solar energy system meets the following standards:*
>
> *No potential for glint or glare in the existing or planned Airport Traffic Control Tower (ATCT) cab, and*
>
> *No potential for glare or ''low potential for after-image'' (shown in green in Figure 1 [Figure 3 refers]) along the final approach path for any existing landing threshold or future landing thresholds (including any planned interim phases of the landing thresholds) as shown on the current FAA-approved Airport Layout Plan (ALP). The final approach path is defined as two (2) miles from fifty (50) feet above the landing threshold using a standard three (3) degree glidepath."*

1.4.4 Furthermore, in November 2021 the FAA deprioritised runway approaches as critical aviation receptors, citing the following;

> *"Initially, FAA believed that solar energy systems could introduce a novel glint and glare effect to pilots on final approach. FAA has subsequently concluded that in most cases, the glint and glare from solar energy systems to pilots on final approach is similar to glint and glare pilots routinely experience from water bodies, glass-façade buildings, parking lots, and similar features. However, FAA has continued to receive reports of potential glint and glare from on-airport solar energy systems on personnel working in ATCT cabs. Therefore, FAA has determined the scope of agency policy should be focused on the impact of on-airport solar energy systems to federally-obligated towered airports, specifically the airport's ATCT" (Federal Aviation Administration 05/11/2021).*

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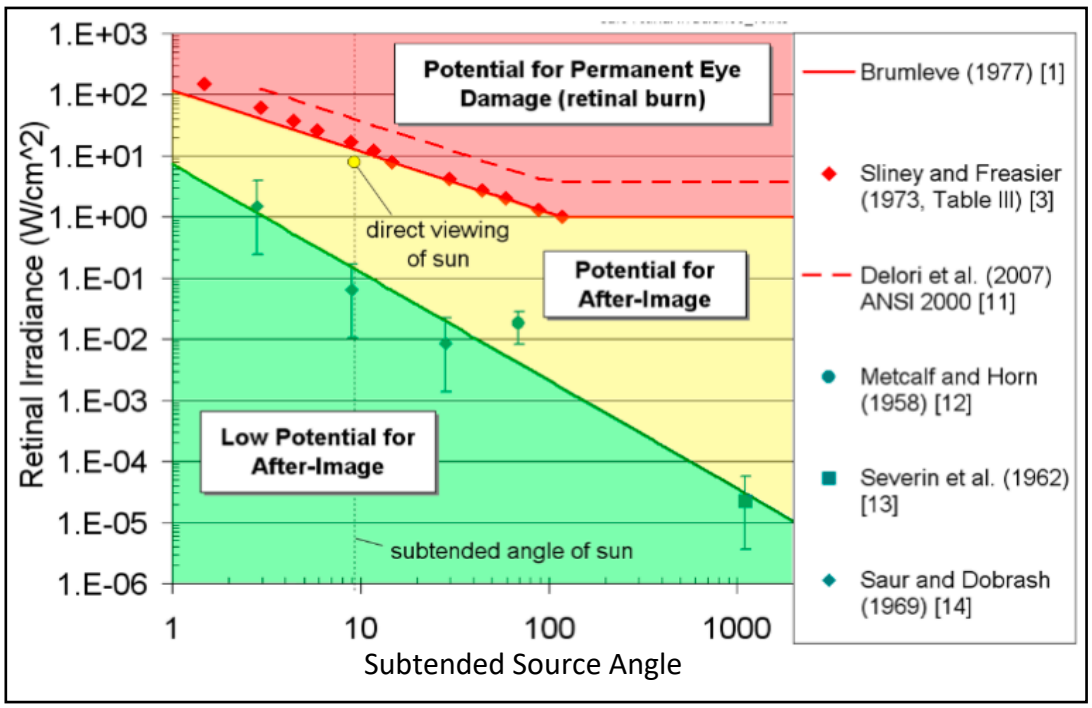
[1] Harris, Miller, Miller & Hanson Inc.. (November 2010). Technical Guidance for Evaluating Selected Solar Technologies on Airports; 3.1.2 Reflectivity. *Technical Guidance for Evaluating Selected Solar Technologies on Airports*. Available at: https://www.faa.gov/airports/environmental/policy_guidance/media/airport-solar-guide.pdf

[2] Federal Aviation Administration (FAA). (2013). Department of Transportation - Federal Aviation Administration. *Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports*. Vol 78 (No 205), 63276-63279.

1.4.5 In summary, glare at an ATCT is not acceptable and while still relevant glare with a ''low potential for after-image'' is generally acceptable along final approach paths to runways in most instances.

Solar Glare Hazard Analysis Tool

1.4.6 The SGHAT was designed to determine whether a proposed solar energy project would result in the potential for ocular impact as depicted on the Solar Glare Hazard Analysis Plot (Figure 3 refers). SGHAT analyses ocular impact over the entire calendar year in one minute intervals from when the sun rises above the horizon until the sun sets below the horizon. One of the principal outputs from the SGHAT report is a glare plot per receptor that indicates the time of day and days per year that glare has the potential to occur. SGHAT plot classifies the intensity of ocular impact as either Green Glare, Yellow Glare or Red Glare. These colour classifications are equivalent to the FAA's definitions regarding the level of ocular impact e.g. 'Green Glare' in the SGHAT is synonymous to the FAA's *''low potential for after-image','* and so forth. The various correlations are illustrated on the Solar Glare Hazard Analysis Plot.



Solar Glare Ocular Hazard Plot: The potential ocular hazard from solar glare is a function of retinal irradiance and the subtended angle (size/distance) of the glare source. It should be noted that the ratio of spectrally weighted solar illuminance to solar irradiance at the earth's surface yields a conversion factor of ~100 lumens/W. Plot adapted from Ho et al., 2011.

Chart References: Ho, C.K., C.M. Ghanbari, and R.B. Diver, 2011, Methodology to Assess Potential Glint and Glare Hazards from Concentrating Solar Power Plants: Analytical Models and Experimental Validation, J. Solar Energy Engineering, August 2011, Vol. 133, 031021-1 – 031021-9.

Figure 3: Figure 1 from the FAA Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports

2 METHODOLOGY

2.1.1 The process for dealing with aviation receptors is as follows:

1. The Federal Aviation Administration (FAA) approved Solar Glare Hazard Analysis Tool (SGHAT) is used to determine if any of these aviation receptors has the potential to theoretically experience glint or glare. This tool also calculates the intensity of such reflectance and whether it is acceptable by FAA standards.

2. SGHAT does not account for terrain screening or screening provided by surface elements such as existing vegetation or buildings, therefore the results of the SGHAT may need to be considered, in conjunction with an assessment of existing intervening screening that may be present, to establish if reflectance can actually be experienced at the receptors.
3. Finally, if necessary, additional assessment is undertaken using Macro Works' bespoke model which would into account any screening provided by any proposed mitigation measures.

2.2 Identification of Relevant Receptors

2.2.1 The Planning and Development (Solar Safeguarding Zone) Regulations 2022 set out 43 Solar Safeguarding Zones (SSZs). A SSZ is an area around an airport, aerodrome or helipad in which there is a potential for glint or glare from solar panels to impact aviation safety.

Runways & Air Traffic Control Towers

2.2.2 This SGHAT analysis was produced to assess the potential for impacts upon aviation receptors, resulting from the proposed solar installation. Dublin Airport is located slightly under 4km to the northwest of the proposed development and comprises 3 active runways.

Figure 4: Aerial view (Google Earth Pro) showing the approximate location of the proposed development (yellow pin) relative to the identified aviation receptor (red pin).

3 RESULTS

Runway Approaches

3.1.1 The SGHAT results are contained in Appendix A and show that only three of the six runway approaches analysed had potential for Green Glare to occur. None of the six runways showed any potential for Yellow Glare as a result of the proposed solar panels. As a result, the 2-mile flight path approaches at Dublin Airport receive a 'pass' status as the flight path receptors do not receive yellow glare.

Air Traffic Control Towers

3.1.2 The SGHAT results contained in Appendix A also assess the potential for reflectance at both of Dublin Airport Air Traffic Control Towers (ATCT) - Figure 5 below refers. The assessment identifies no potential for reflectance from all of the proposed panel tilt angles at either ATCT at Dublin Airport. Thus, the assessment results in a 'pass' states as the ATCT receptors do not experience glare episodes as a result of the proposed development.

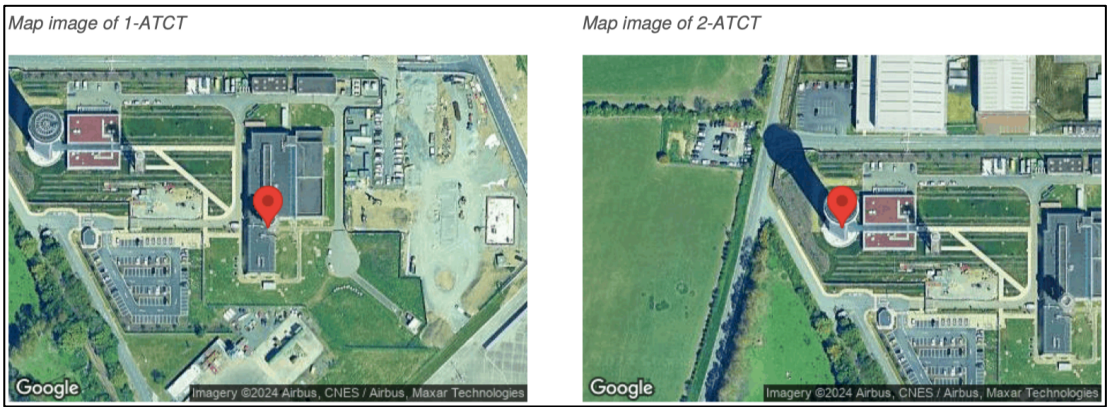


Figure 5: Aerial view (Google Earth Pro) showing the approximate location of the both Air Traffic Control Towers at Dublin Airport.

4 OVERALL CONCLUSION

4.1.1 From the analysis and discussions contained herein, it is considered that there will not be any significant nuisance effects from glint and glare at the proposed development, as a result of the proposed roof-mounted solar PV panels.

APPENDIX A

SGHAT Results

FORGESOLAR GLARE ANALYSIS

Project: **Dublin Airport SGHAT**
Site configuration: **SHB4-06 Chruch of the Annuciation_Finglas**
Analysis conducted by Luis Dominguez (luis@macroworks.ie) at 16:40 on 27 Feb, 2024.

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)	PASS	Flight path receptor(s) do not receive yellow glare
ATCT(s)	PASS	Receptor(s) marked as ATCT do not receive glare

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

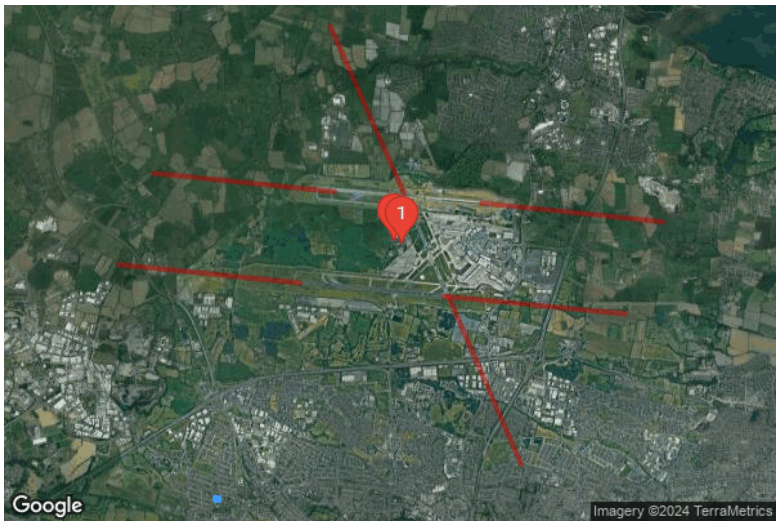
- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

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: 113126.12200
Methodology: V2



PV Array(s)

Name: PV Array 0Deg Panel Tilt
Axis tracking: Fixed (no rotation)
Tilt: 0.0°
Orientation: 182.0°
Rated power: -
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	53.387952	-6.312076	64.00	17.00	81.00
2	53.387943	-6.311826	64.00	17.00	81.00
3	53.388319	-6.311787	64.00	17.00	81.00
4	53.388299	-6.311199	64.00	17.00	81.00
5	53.387975	-6.311230	64.00	17.00	81.00
6	53.387974	-6.311272	64.00	17.00	81.00
7	53.387924	-6.311275	64.00	17.00	81.00
8	53.387919	-6.311126	64.00	17.00	81.00
9	53.388361	-6.311084	64.00	17.00	81.00
10	53.388384	-6.311779	64.00	17.00	81.00
11	53.388368	-6.311781	64.00	17.00	81.00
12	53.388372	-6.311895	64.00	17.00	81.00
13	53.388388	-6.311893	64.00	17.00	81.00
14	53.388393	-6.312040	64.00	17.00	81.00
15	53.388272	-6.312052	64.00	17.00	81.00
16	53.388272	-6.312045	64.00	17.00	81.00
17	53.387952	-6.312076	64.00	17.00	81.00

Name: PV Array 10Deg Panel Tilt
Axis tracking: Fixed (no rotation)
Tilt: 10.0°
Orientation: 182.0°
Rated power: -
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	53.387952	-6.312076	64.00	17.00	81.00
2	53.387943	-6.311826	64.00	17.00	81.00
3	53.388319	-6.311787	64.00	17.00	81.00
4	53.388299	-6.311199	64.00	17.00	81.00
5	53.387975	-6.311230	64.00	17.00	81.00
6	53.387974	-6.311272	64.00	17.00	81.00
7	53.387924	-6.311275	64.00	17.00	81.00
8	53.387919	-6.311126	64.00	17.00	81.00
9	53.388361	-6.311084	64.00	17.00	81.00
10	53.388384	-6.311779	64.00	17.00	81.00
11	53.388368	-6.311781	64.00	17.00	81.00
12	53.388372	-6.311895	64.00	17.00	81.00
13	53.388388	-6.311893	64.00	17.00	81.00
14	53.388393	-6.312040	64.00	17.00	81.00
15	53.388272	-6.312052	64.00	17.00	81.00
16	53.388272	-6.312045	64.00	17.00	81.00
17	53.387952	-6.312076	64.00	17.00	81.00

Name: PV Array 15Deg Panel Tilt
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 182.0°
Rated power: -
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	53.387952	-6.312076	64.00	17.00	81.00
2	53.387943	-6.311826	64.00	17.00	81.00
3	53.388319	-6.311787	64.00	17.00	81.00
4	53.388299	-6.311199	64.00	17.00	81.00
5	53.387975	-6.311230	64.00	17.00	81.00
6	53.387974	-6.311272	64.00	17.00	81.00
7	53.387924	-6.311275	64.00	17.00	81.00
8	53.387919	-6.311126	64.00	17.00	81.00
9	53.388361	-6.311084	64.00	17.00	81.00
10	53.388384	-6.311779	64.00	17.00	81.00
11	53.388368	-6.311781	64.00	17.00	81.00
12	53.388372	-6.311895	64.00	17.00	81.00
13	53.388388	-6.311893	64.00	17.00	81.00
14	53.388393	-6.312040	64.00	17.00	81.00
15	53.388272	-6.312052	64.00	17.00	81.00
16	53.388272	-6.312045	64.00	17.00	81.00
17	53.387952	-6.312076	64.00	17.00	81.00

Name: PV Array 5Deg Panel Tilt
Axis tracking: Fixed (no rotation)
Tilt: 5.0°
Orientation: 182.0°
Rated power: -
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	53.387952	-6.312076	64.00	17.00	81.00
2	53.387943	-6.311826	64.00	17.00	81.00
3	53.388319	-6.311787	64.00	17.00	81.00
4	53.388299	-6.311199	64.00	17.00	81.00
5	53.387975	-6.311230	64.00	17.00	81.00
6	53.387974	-6.311272	64.00	17.00	81.00
7	53.387924	-6.311275	64.00	17.00	81.00
8	53.387919	-6.311126	64.00	17.00	81.00
9	53.388361	-6.311084	64.00	17.00	81.00
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12	53.388372	-6.311895	64.00	17.00	81.00
13	53.388388	-6.311893	64.00	17.00	81.00
14	53.388393	-6.312040	64.00	17.00	81.00
15	53.388272	-6.312052	64.00	17.00	81.00
16	53.388272	-6.312045	64.00	17.00	81.00
17	53.387952	-6.312076	64.00	17.00	81.00

Flight Path Receptor(s)

Name: 10L Runway
Description: None
Threshold height: 15 m
Direction: 95.8°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 120.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.436880	-6.280253	71.90	15.20	87.10
Two-mile	53.439822	-6.328592	74.90	180.90	255.80

Name: 10 Runway
Description: None
Threshold height: 15 m
Direction: 95.8°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 120.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.422405	-6.289520	74.00	15.30	89.30
Two-mile	53.425327	-6.337846	80.30	177.60	257.90

Name: 16 Runway
Description: None
Threshold height: 15 m
Direction: 156.1°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 120.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.436699	-6.261764	66.50	15.20	81.70
Two-mile	53.463138	-6.281428	69.70	180.70	250.40

Name: 28R Runway
Description: None
Threshold height: 15 m
Direction: 275.9°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 120.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.435084	-6.240975	65.50	15.30	80.80
Two-mile	53.432097	-6.192645	34.00	215.50	249.50

Name: 28 Runway
Description: None
Threshold height: 15 m
Direction: 275.5°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 120.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.420299	-6.251111	62.00	15.20	77.20
Two-mile	53.417517	-6.202763	41.90	204.00	245.90

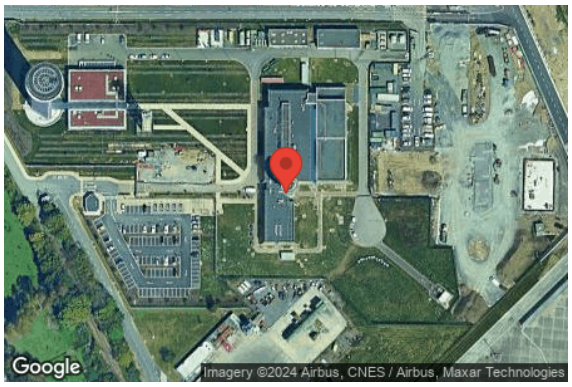
Name: 34 Runway
Description: None
Threshold height: 15 m
Direction: 336.6°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 120.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.420211	-6.249810	62.20	15.30	77.50
Two-mile	53.393680	-6.230504	49.00	197.10	246.10

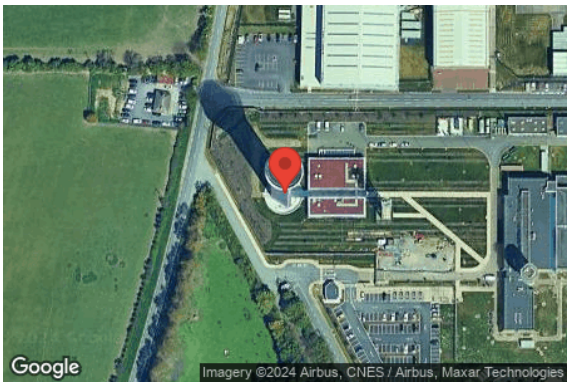
Discrete Observation Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
1-ATCT	1	53.428489	-6.262201	65.90	21.90
2-ATCT	2	53.428937	-6.264259	65.60	75.60

Map image of 1-ATCT



Map image of 2-ATCT



GLARE ANALYSIS RESULTS

Summary of Glare

PV Array Name	Tilt (°)	Orient (°)	"Green" Glare min	"Yellow" Glare min	Energy kWh
PV Array 0Deg Panel Tilt	0.0	182.0	7,990	0	-
PV Array 10Deg Panel Tilt	10.0	182.0	214	0	-
PV Array 15Deg Panel Tilt	15.0	182.0	25	0	-
PV Array 5Deg Panel Tilt	5.0	182.0	774	0	-

Total annual glare received by each receptor

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
10L Runway	0	0
10 Runway	0	0
16 Runway	0	0
28R Runway	2724	0
28 Runway	1969	0
34 Runway	4310	0
1-ATCT	0	0
2-ATCT	0	0

Results for: PV Array 0Deg Panel Tilt

Receptor	Green Glare (min)	Yellow Glare (min)
10L Runway	0	0
10 Runway	0	0
16 Runway	0	0
28R Runway	2724	0
28 Runway	1969	0
34 Runway	3297	0
1-ATCT	0	0
2-ATCT	0	0

Flight Path: 10L Runway

0 minutes of yellow glare
0 minutes of green glare

Flight Path: 10 Runway

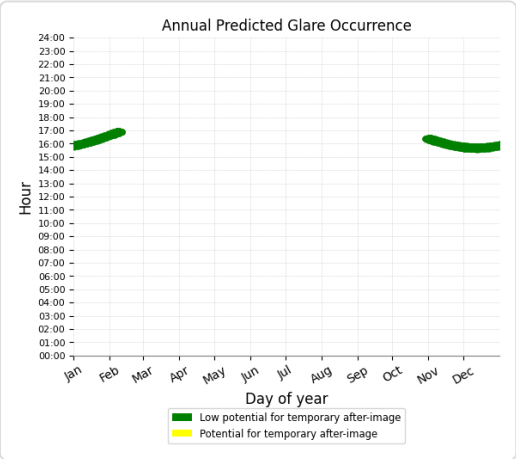
0 minutes of yellow glare
0 minutes of green glare

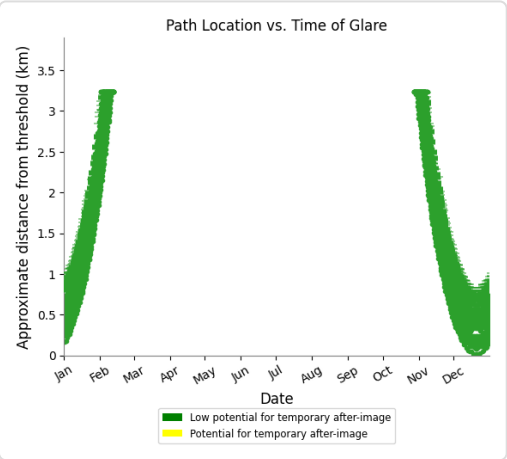
Flight Path: 16 Runway

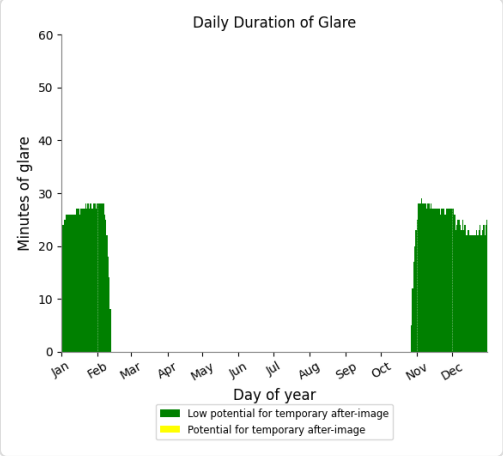
0 minutes of yellow glare
0 minutes of green glare

Flight Path: 28R Runway

0 minutes of yellow glare
2724 minutes of green glare



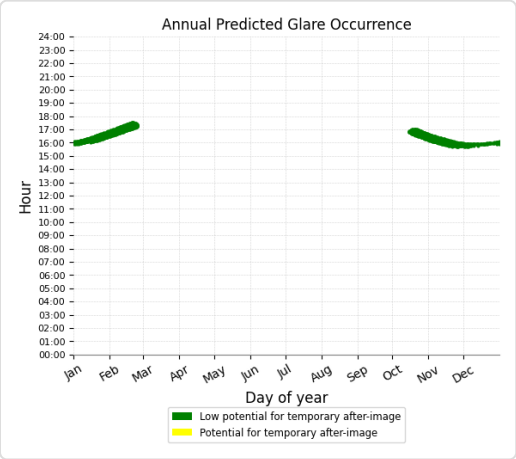


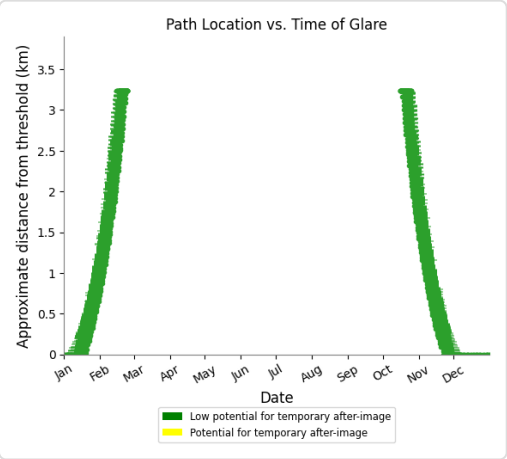


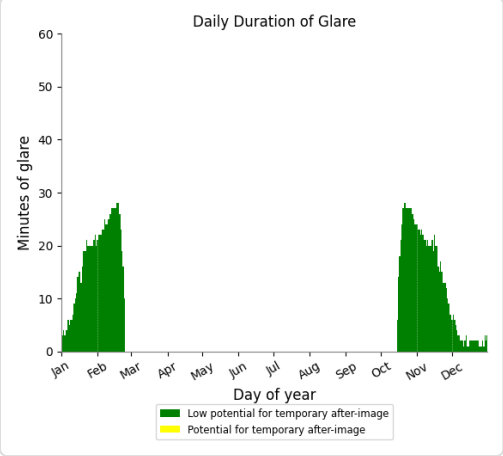
Flight Path: 28 Runway

0 minutes of yellow glare

1969 minutes of green glare

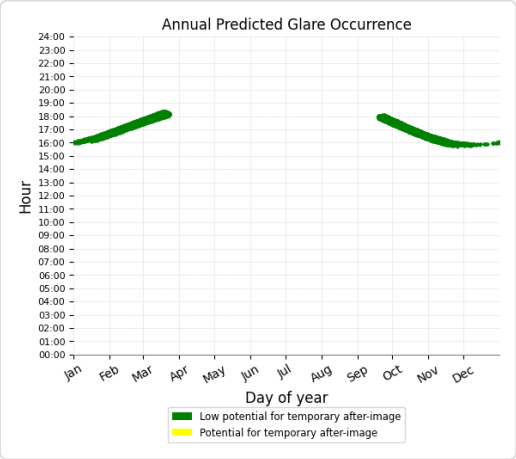


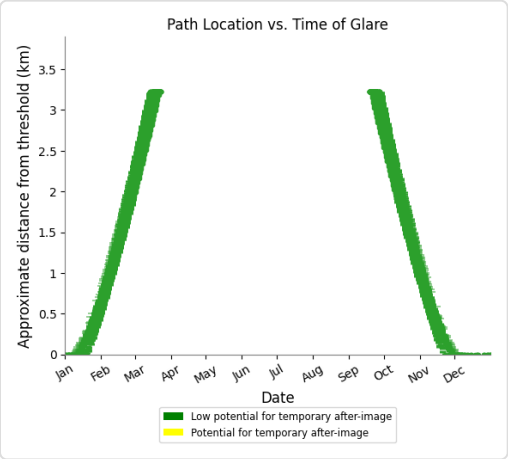


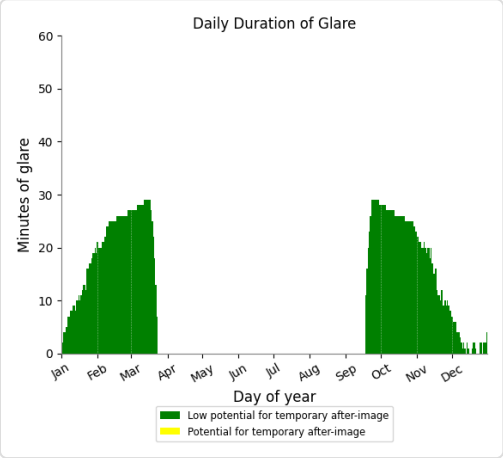


Flight Path: 34 Runway

0 minutes of yellow glare
3297 minutes of green glare







Point Receptor: 1-ATCT

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 2-ATCT

0 minutes of yellow glare
0 minutes of green glare

Results for: PV Array 10Deg Panel Tilt

Receptor	Green Glare (min)	Yellow Glare (min)
10L Runway	0	0
10 Runway	0	0
16 Runway	0	0
28R Runway	0	0
28 Runway	0	0
34 Runway	214	0
1-ATCT	0	0
2-ATCT	0	0

Flight Path: 10L Runway

0 minutes of yellow glare
0 minutes of green glare

Flight Path: 10 Runway

0 minutes of yellow glare
0 minutes of green glare

Flight Path: 16 Runway

0 minutes of yellow glare
0 minutes of green glare

Flight Path: 28R Runway

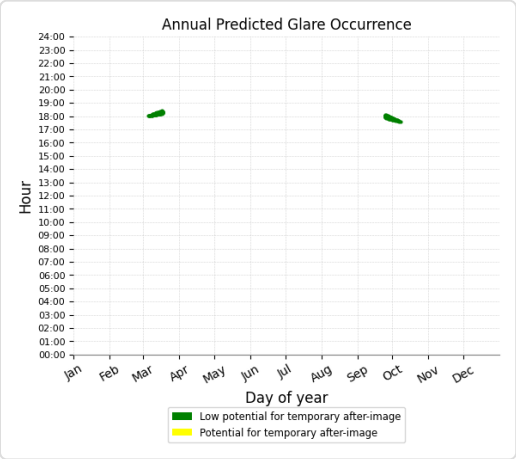
0 minutes of yellow glare
0 minutes of green glare

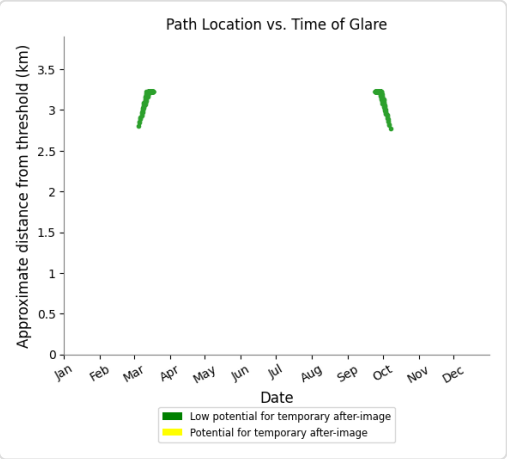
Flight Path: 28 Runway

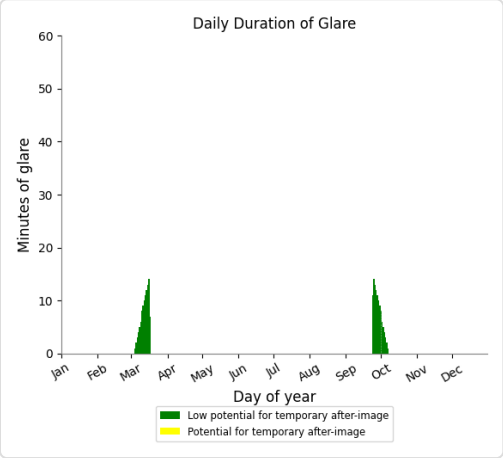
0 minutes of yellow glare
0 minutes of green glare

Flight Path: 34 Runway

0 minutes of yellow glare
214 minutes of green glare







Point Receptor: 1-ATCT

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 2-ATCT

0 minutes of yellow glare
0 minutes of green glare

Results for: PV Array 15Deg Panel Tilt

Receptor	Green Glare (min)	Yellow Glare (min)
10L Runway	0	0
10 Runway	0	0
16 Runway	0	0
28R Runway	0	0
28 Runway	0	0
34 Runway	25	0
1-ATCT	0	0
2-ATCT	0	0

Flight Path: 10L Runway

0 minutes of yellow glare
0 minutes of green glare

Flight Path: 10 Runway

0 minutes of yellow glare
0 minutes of green glare

Flight Path: 16 Runway

0 minutes of yellow glare
0 minutes of green glare

Flight Path: 28R Runway

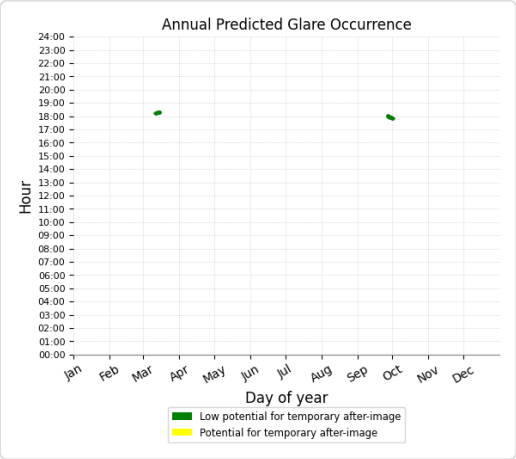
0 minutes of yellow glare
0 minutes of green glare

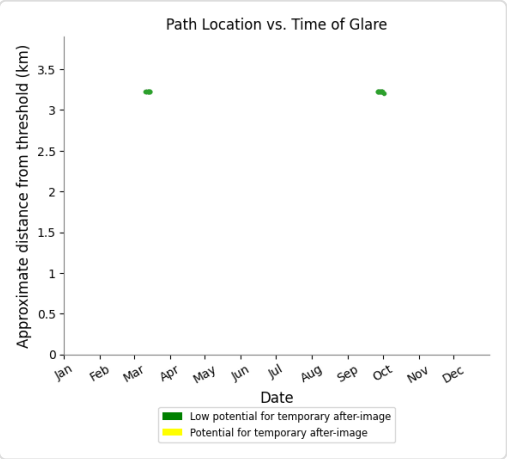
Flight Path: 28 Runway

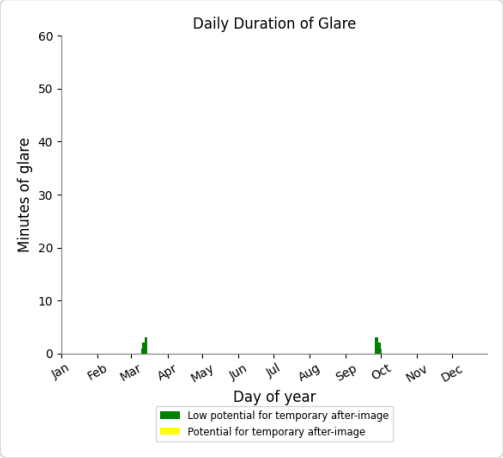
0 minutes of yellow glare
0 minutes of green glare

Flight Path: 34 Runway

0 minutes of yellow glare
25 minutes of green glare







Point Receptor: 1-ATCT

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 2-ATCT

0 minutes of yellow glare
0 minutes of green glare

Results for: PV Array 5Deg Panel Tilt

Receptor	Green Glare (min)	Yellow Glare (min)
10L Runway	0	0
10 Runway	0	0
16 Runway	0	0
28R Runway	0	0
28 Runway	0	0
34 Runway	774	0
1-ATCT	0	0
2-ATCT	0	0

Flight Path: 10L Runway

0 minutes of yellow glare
0 minutes of green glare

Flight Path: 10 Runway

0 minutes of yellow glare
0 minutes of green glare

Flight Path: 16 Runway

0 minutes of yellow glare
0 minutes of green glare

Flight Path: 28R Runway

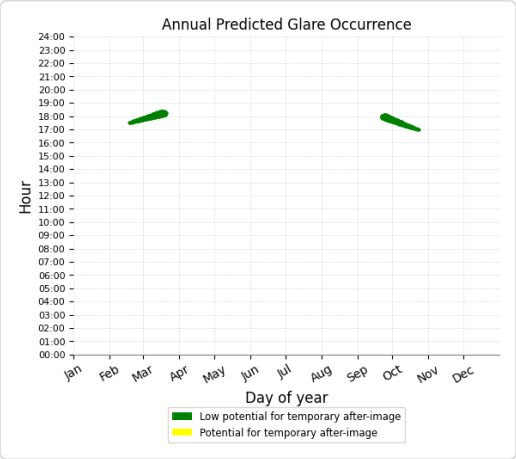
0 minutes of yellow glare
0 minutes of green glare

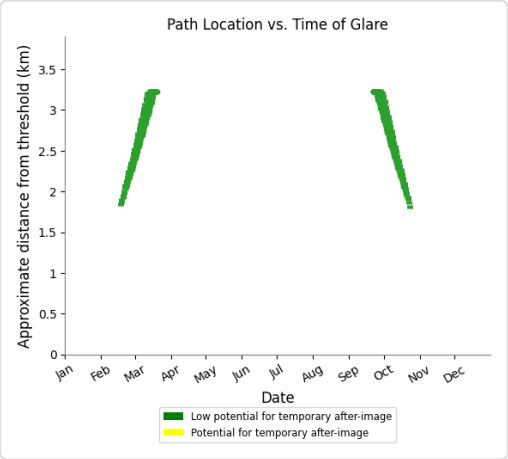
Flight Path: 28 Runway

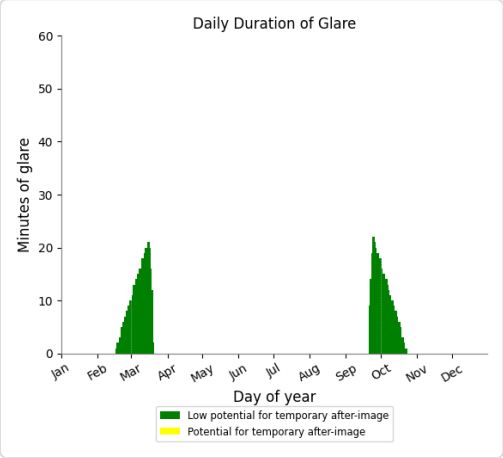
0 minutes of yellow glare
0 minutes of green glare

Flight Path: 34 Runway

0 minutes of yellow glare
774 minutes of green glare







Point Receptor: 1-ATCT

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 2-ATCT

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 V1 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.