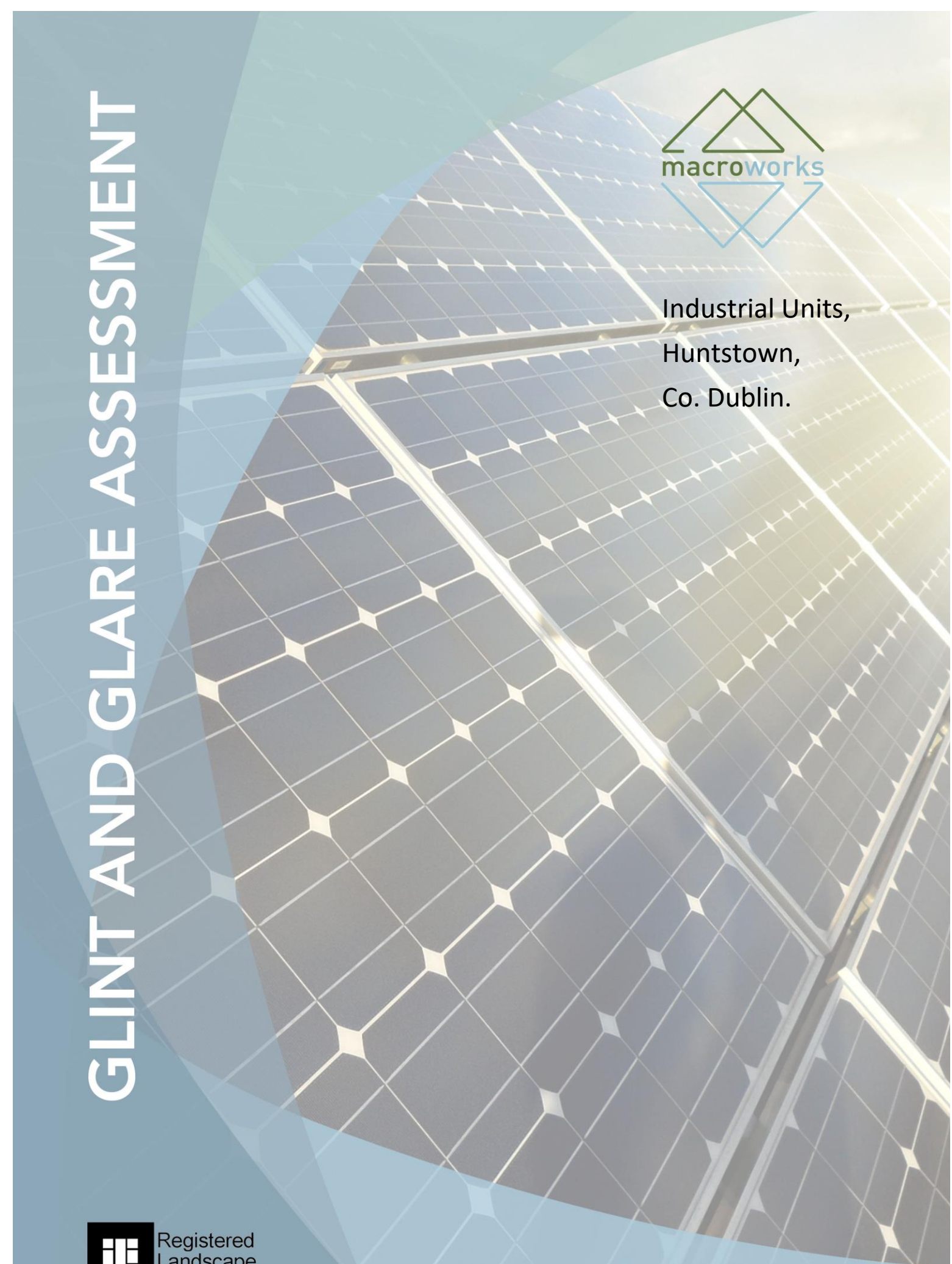
GLINT AND GLARE ASSESSMENT



macroworks

Industrial Units,
Huntstown,
Co. Dublin.

Registered Landscape Architect

April 2023

GLINT AND GLARE ASSESSMENT

Executive Summary

The proposal is for a roof mounted photovoltaic solar panel installation on the roof of the proposed industrial units in Huntstown and Coldwinters Townlands, County Dublin. The proposed solar arrays were assessed to determine whether they will have the potential to cause any glint or glare impacts upon specific aviation receptors at Dublin Airport – notably the air traffic control tower and the runway approaches.

An in-depth analysis of the proposed photovoltaic panel installation with regard to the indicated aviation receptors has predicted that there is the potential for glare effects upon aircraft approaching all the runways at Dublin Airport, however, it is of a lower-level of intensity, that is deemed by the Federal Aviation Authority (FAA) to be of low risk to this category of receptor, thus deemed an acceptable level of glare. The analysis also indicated the potential for a level of glare at the new, taller Air Traffic Control Tower which is considered unacceptable by the FAA. However, a detailed visibility analysis determined that the design and orientation of the proposed buildings upon which the array is proposed, affords the panels additional screening, preventing any potential glint or glare at the Air Traffic Control Tower as a result of the proposed roof mounted installation of photovoltaic panels.

1 INTRODUCTION

Macro Works Ltd. was commissioned to undertake a glint and glare assessment report for a proposed roof mounted photovoltaic (PV) panel installation on the roofs of two proposed industrial units in Huntstown and Coldwinters Townlands, County Dublin (Figure 1 and Figure 2 refer). The proposed development is located approximately 500m west of the N2 national primary road and approximately 600m north of the M50 motorway. The PV panels 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: Aerial view (Google Earth Pro) showing the location of the proposed PV panels (red pin).

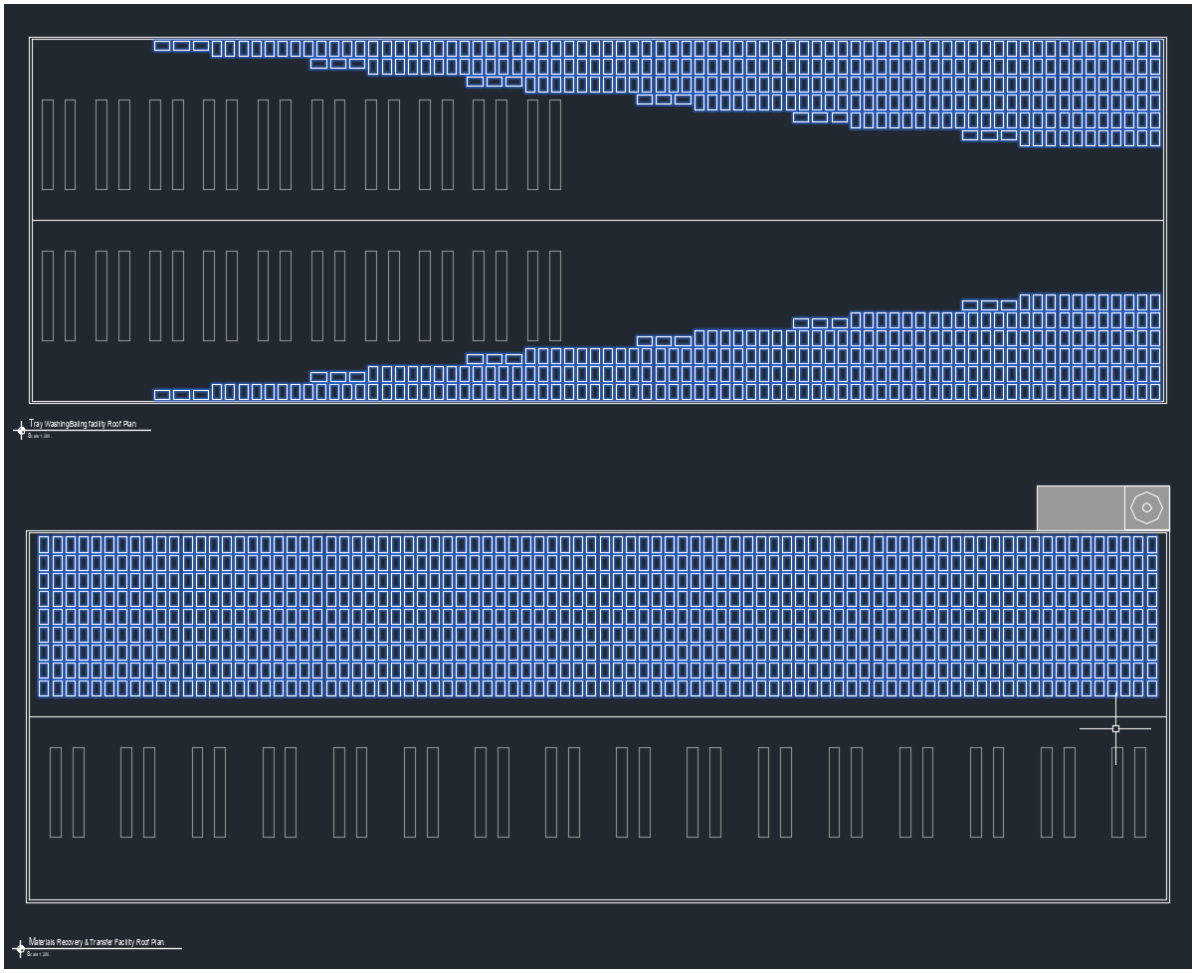


Figure 2: Extract from drawing "22-039 S Industrial units REV E.dwg" showing the proposed roof layouts of with the proposed PV panels (blue).

2 STATEMENT OF AUTHORITY

Macro Works' relevant experience includes nineteen 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. Macro Works has assessed the effects of glint and glare for many solar development sites throughout Ireland to date.

3 METHODOLOGY

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.

4 GUIDANCE

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.

4.1 FEDERAL AVIATION AUTHORITY

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."*

In summary, glare at an ATCT is not acceptable but glare with a *''low potential for after-image''* is acceptable along final approach paths to runways.

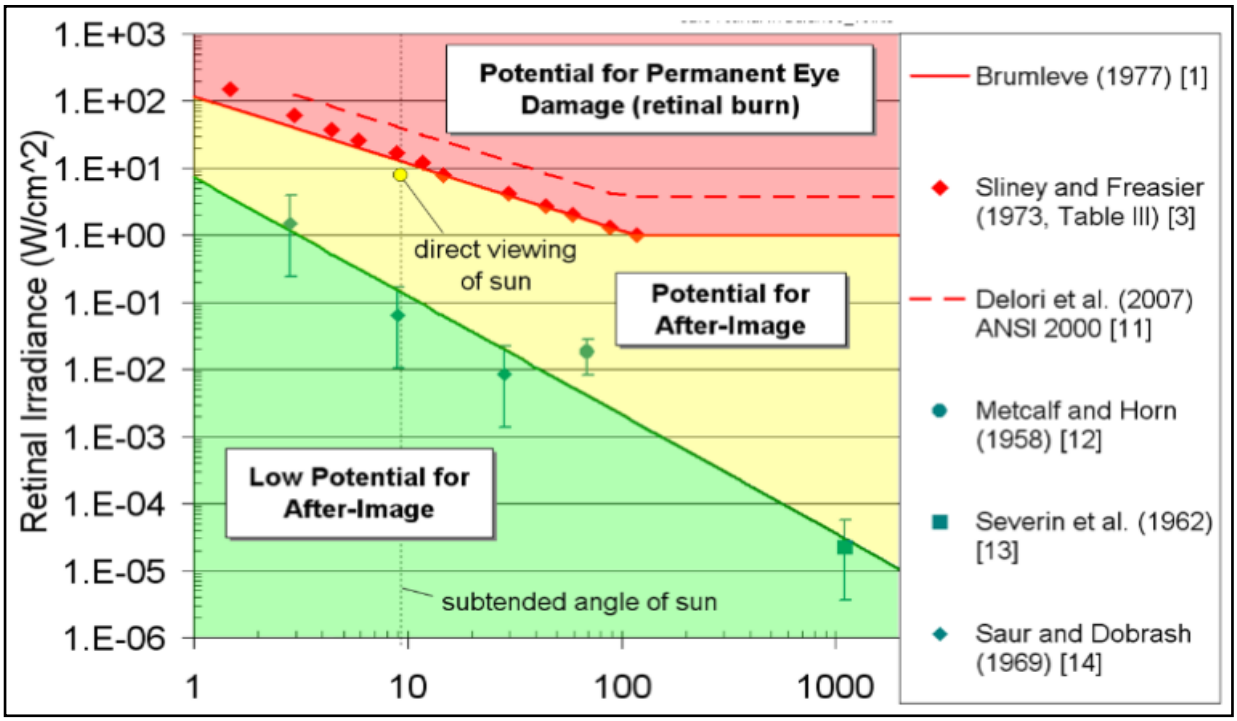
---

[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.

4.2 SOLAR GLARE HAZARD ANALYSIS TOOL

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

5 IDENTIFICATION OF RELEVANT RECEPTORS

5.1 RUNWAY APPROACHES

Dublin Airport is an international airport operated by the Dublin Airport Authority. Dublin Airport currently hosts 3 operational runways 10/28 and 16/34 and 10L/28R which was recently constructed and commenced operations in August 2022. 10L/28R was constructed to the north of the Airport to help accommodate increasing passenger numbers and runs parallel to runway 10/28, to the south. It is envisaged that this will eventually render the 16/34 runway as a purely taxiing runway (**Error! Reference source not found.**6 refers). All 6 runway approaches will be assessed.

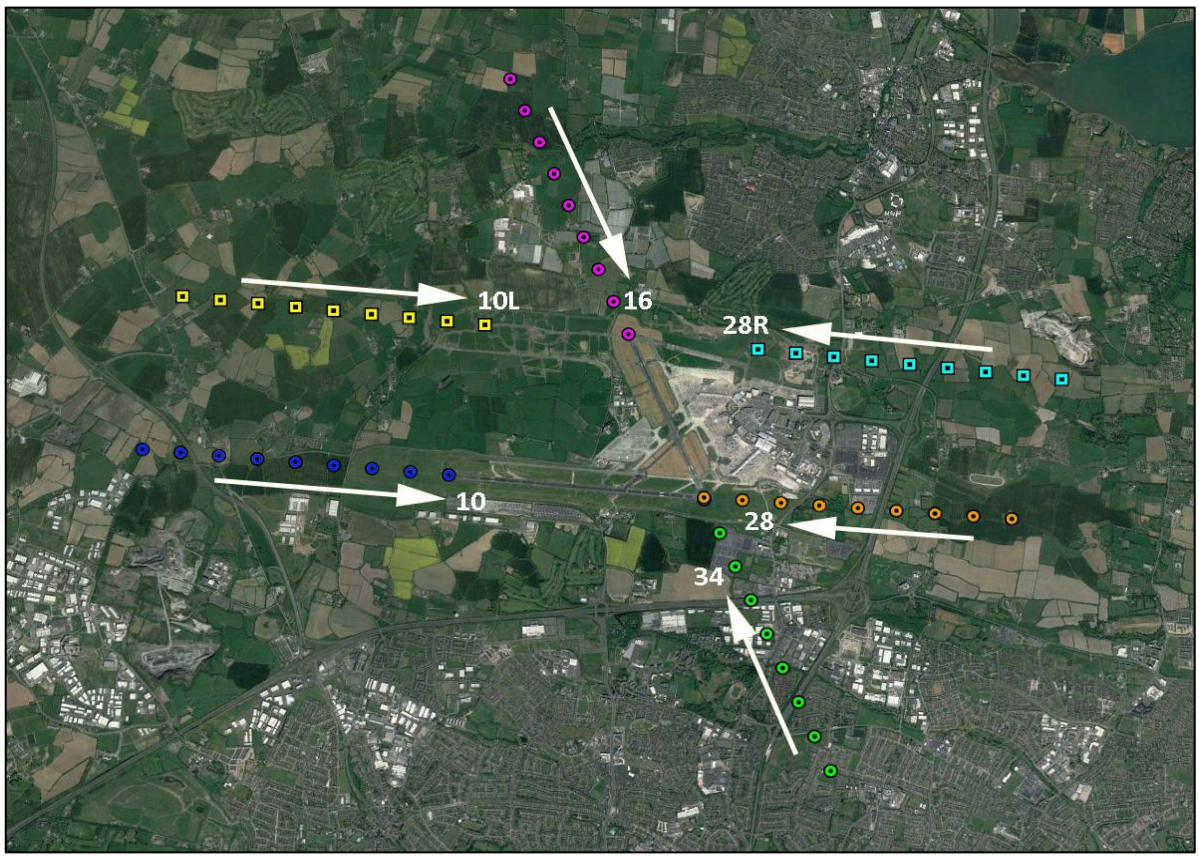


Figure 4: Aerial view (Google Earth Pro) showing 2 mile approach lines to runways at Dublin Airport (at ¼ mile intervals) as assessed by SGHAT. Includes the newly opened northern runway (10L and 28R.)

5.2 AIR TRAFFIC CONTROL TOWERS

Dublin Airport has two Air Traffic Control Towers (ATCT). The older ATCT has a viewing height of 21.9m Above Ground Level (AGL) (Ref: '1-ATCT' in SGHAT) and is located to the west of the main terminal buildings (Figure 5 refers). The second, newer ATCT has a viewing height of 75.6m Above Ground Level (AGL) (Ref: '2-ATCT' in SGHAT) and is also located to the west of the main terminal buildings (Figure 5 refers). Both ATCTs will be assessed.

Figure 5: Location of the Air Traffic Control Towers at Dublin Airport (red centre icons).

6 RESULTS

6.1 RUNWAY APPROACHES

The SGHAT results are contained in Appendix A and show that of the six runway approaches analysed, all six have the theoretical potential to receive glare (10L, 10, 16, 28R, 28 and 34). In all instances SGHAT calculated the potential glare to be '*Green Glare*'. SGHATs '*Green Glare*' classification regarding the intensity of the potential glare is synonymous with FAA's *'low potential for temporary after image'*. *'Green Glare'* / glare with a *'low potential for temporary after image,'* regardless of the number of minutes per year, is considered by the FAA to be an **acceptable level of reflectance effect for runway approaches**.

6.2 AIR TRAFFIC CONTROL TOWERS

The SGHAT results contained in Appendix A also show the theoretical potential for glare at both of the ATCT's at Dublin Airport (1-ATCT and 2-ATCT). SGHAT calculated this potential glare to be '*Green Glare*'. SGHATs '*Green Glare*' classification regarding the intensity of the potential glare is synonymous with FAA's *'low potential for temporary after image'*. *'Green Glare'* / glare with a *'low*

potential for temporary after image,' regardless of the number of minutes per year, is considered by the FAA to be an **unacceptable intensity of reflectance effect for an ATCT**.

These results are not unexpected or uncommon as the SGHAT software does not account for screening as a result of intervening terrain, buildings or vegetation, therefore a 3D visibility analysis was undertaken from the new, taller ATCT at Dublin Airport. Furthermore, it should also be noted that visibility of panels is not a precursor for glare impacts as panels may be visible but not cause any glare, depending on a number of factors i.e. panel orientation.

6.2.1 Visibility Analysis

A viewshed analysis was carried out for the taller Air Traffic Control Tower at Dublin Airport (2-ATCT) to identify what portions of the proposed development are theoretically visible. In the case of Dublin Airport where there are two ATCTs, if there is no potential for visibility from the taller ATCT (worst-case scenario), there will be no potential for visibility from the smaller ATCT, thus a visibility analysis from the smaller ATCT (1-ATCT) is not required. This analysis was undertaken with the aid of a high resolution digital surface model (DSM) to produce a Zone of Theoretical Visibility (ZTV) map (Figure 6 refers). The proposed buildings and PV panels were incorporated into the DSM model. The result of this analysis shows that there is no potential for inter-visibility between the ATCT (2-ATCT) and the areas of PV panels at the proposed development – potentially visible area are indicated in yellow on Figure 6. Thus, there will be **no potential for glint or glare to occur at either of the ATCTs**.

Figure 6: Viewshed / Zone of Theoretical Visibility (ZTV) map, showing the areas within the application site that are potentially visible (yellow pattern) from the taller air traffic control tower (2-ATCT) at Dublin Airport.

6.3 OVERALL CONCLUSION

From the analysis and discussions contained herein, it is considered that there will not be any hazardous glint and glare effects upon the Dublin Airport aviation receptors identified as a result of the proposed roof mounted solar PV panels.

APPENDIX A:

SGHAT RESULTS

RUNWAYS APPROACHES AND AIR TRAFFIC CONTROL TOWERS (ATCT)

FORGESOLAR GLARE ANALYSIS

Project: **Dublin Airport SGHAT**
Site configuration: **Hunststown Td**
Analysis conducted by Luis Dominguez (luis@macroworks.ie) at 09:29 on 21 Mar, 2023.

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)	FAIL	Receptor(s) marked as ATCT receive green and/or yellow 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: 86659.12200
Methodology: V2

PV Array(s)

Name: Array 1
Axis tracking: Fixed (no rotation)
Tilt: 5.0°
Orientation: 352.0°
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	53.408324	-6.319673	78.70	13.19	91.89
2	53.408306	-6.319904	78.70	13.19	91.89
3	53.408312	-6.319912	78.70	13.12	91.82
4	53.408305	-6.320002	78.70	13.12	91.82
5	53.408316	-6.320016	78.70	12.99	91.69
6	53.408303	-6.320189	78.70	12.99	91.69
7	53.408308	-6.320197	78.70	12.93	91.63
8	53.408302	-6.320287	78.70	12.93	91.63
9	53.408312	-6.320301	78.70	12.80	91.50
10	53.408301	-6.320453	78.70	12.80	91.50
11	53.408307	-6.320461	78.70	12.73	91.43
12	53.408300	-6.320550	78.70	12.73	91.43
13	53.408310	-6.320571	78.70	12.60	91.30
14	53.408297	-6.320738	78.70	12.60	91.30
15	53.408303	-6.320746	78.70	12.53	91.23
16	53.408296	-6.320835	78.70	12.53	91.23
17	53.408307	-6.320850	78.70	12.41	91.11
18	53.408296	-6.321001	78.70	12.41	91.11
19	53.408301	-6.321009	78.70	12.34	91.04
20	53.408295	-6.321099	78.70	12.34	91.04
21	53.408305	-6.321113	78.70	12.21	90.91
22	53.408294	-6.321264	78.70	12.21	90.91
23	53.408299	-6.321273	78.70	12.14	90.84
24	53.408293	-6.321362	78.70	12.14	90.84
25	53.408302	-6.321364	78.70	12.04	90.74
26	53.408428	-6.319695	78.70	12.04	90.74
27	53.408324	-6.319673	78.70	13.19	91.89

Name: Array 2
Axis tracking: Fixed (no rotation)
Tilt: 5.0°
Orientation: 172.0°
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	53.408176	-6.319642	78.70	13.19	91.89
2	53.408072	-6.319619	78.70	12.04	90.74
3	53.407946	-6.321289	78.70	12.04	90.74
4	53.407955	-6.321290	78.70	12.14	90.84
5	53.407961	-6.321201	78.70	12.14	90.84
6	53.407968	-6.321196	78.70	12.21	90.91
7	53.407979	-6.321044	78.70	12.21	90.91
8	53.407983	-6.321033	78.70	12.24	90.94
9	53.407992	-6.321035	78.70	12.34	91.04
10	53.407999	-6.320945	78.70	12.34	91.04
11	53.408005	-6.320940	78.70	12.41	91.11
12	53.408017	-6.320788	78.70	12.41	91.11
13	53.408029	-6.320779	78.70	12.53	91.23
14	53.408036	-6.320689	78.70	12.53	91.23
15	53.408043	-6.320684	78.70	12.60	91.30
16	53.408056	-6.320511	78.70	12.60	91.30
17	53.408069	-6.320501	78.70	12.73	91.43
18	53.408075	-6.320412	78.70	12.73	91.43
19	53.408082	-6.320406	78.70	12.80	91.50
20	53.408094	-6.320255	78.70	12.80	91.50
21	53.408106	-6.320245	78.70	12.93	91.63
22	53.408113	-6.320156	78.70	12.93	91.63
23	53.408120	-6.320150	78.70	12.99	91.69
24	53.408133	-6.319977	78.70	12.99	91.69
25	53.408145	-6.319968	78.70	13.12	91.82
26	53.408152	-6.319878	78.70	13.12	91.82
27	53.408159	-6.319873	78.70	13.19	91.89
28	53.408176	-6.319642	78.70	13.19	91.89

Name: Array 3
Axis tracking: Fixed (no rotation)
Tilt: 4.0°
Orientation: 248.0°
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	53.407488	-6.321343	78.70	13.60	92.30
2	53.407555	-6.321073	78.70	15.08	93.78
3	53.406540	-6.320362	78.70	15.08	93.78
4	53.406473	-6.320632	78.70	13.60	92.30
5	53.407488	-6.321343	78.70	13.60	92.30

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

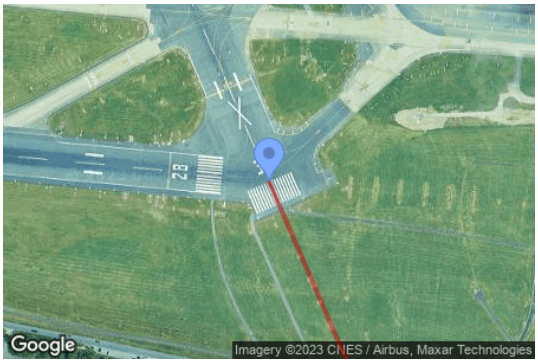
Name: 28R Runway
Description: None
Threshold height: 15 m
Direction: 275.9°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 120.0°

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°

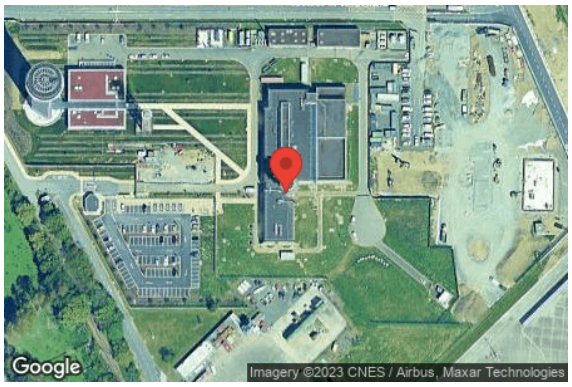


Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.420211	-6.249810	62.20	15.30	77.50
Two-mile	53.393680	-6.230504	49.00	197.10	246.10

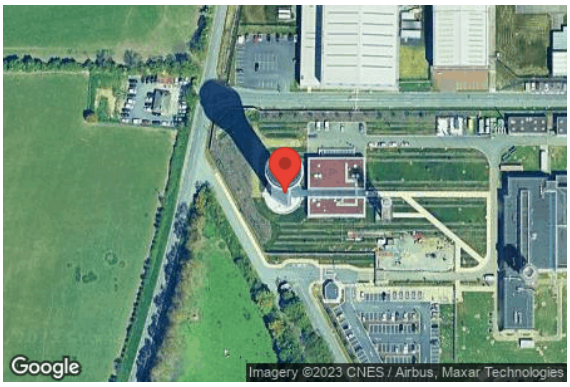
Discrete Observation Receptors

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
Array 1	5.0	352.0	49,122	0	-
Array 2	5.0	172.0	3,348	0	-
Array 3	4.0	248.0	0	0	-

Total annual glare received by each receptor

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
10L Runway	12868	0
10 Runway	21805	0
16 Runway	9173	0
28R Runway	1809	0
28 Runway	1597	0
34 Runway	3729	0
1-ATCT	678	0
2-ATCT	811	0

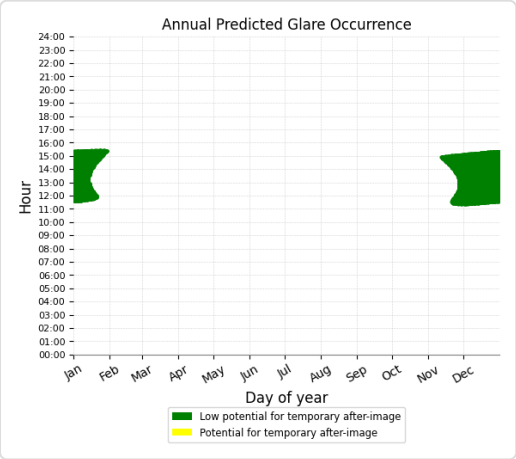
Results for: Array 1

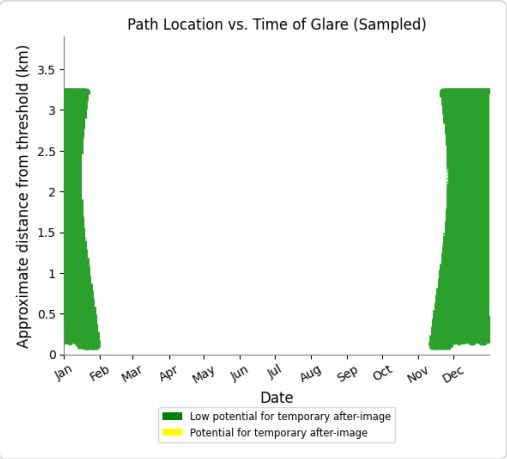
Receptor	Green Glare (min)	Yellow Glare (min)
10L Runway	12868	0
10 Runway	21805	0
16 Runway	9173	0
28R Runway	1807	0
28 Runway	1000	0
34 Runway	980	0
1-ATCT	678	0
2-ATCT	811	0

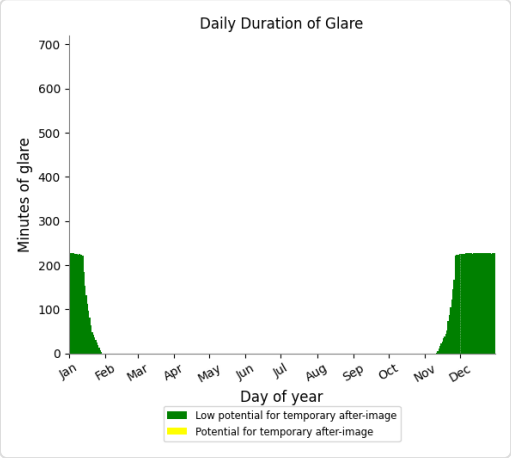
Flight Path: 10L Runway

0 minutes of yellow glare

12868 minutes of green glare



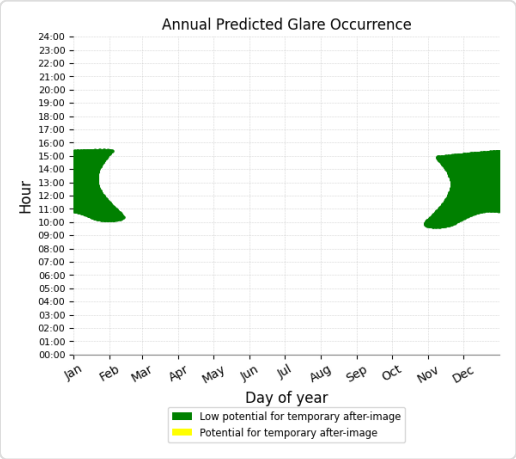


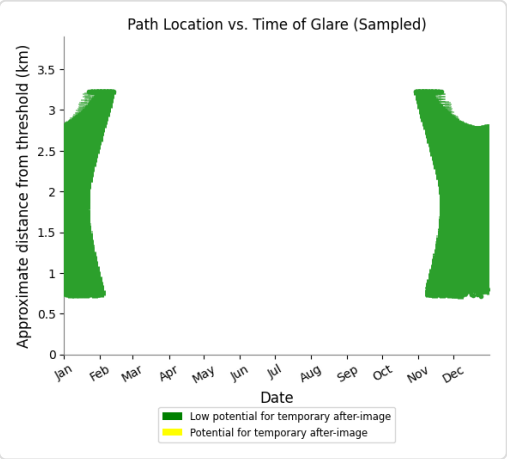


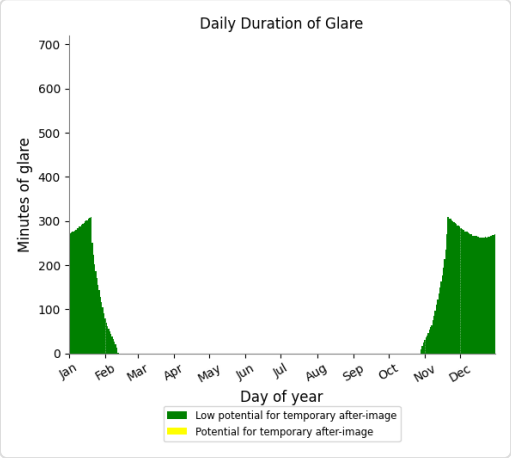
Flight Path: 10 Runway

0 minutes of yellow glare

21805 minutes of green glare



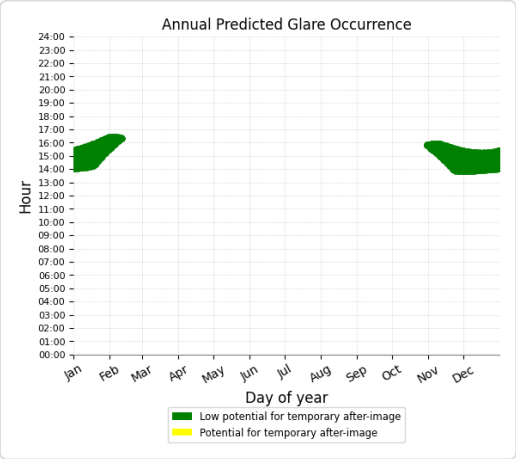


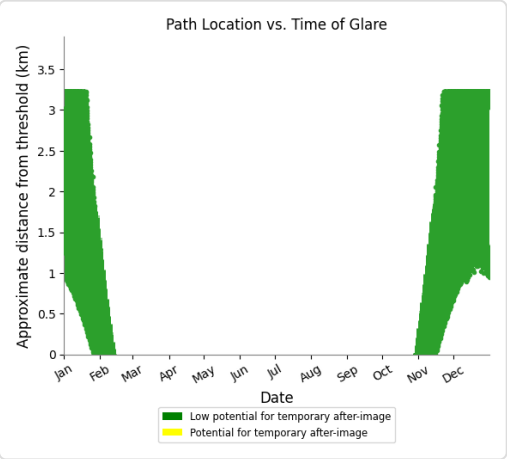


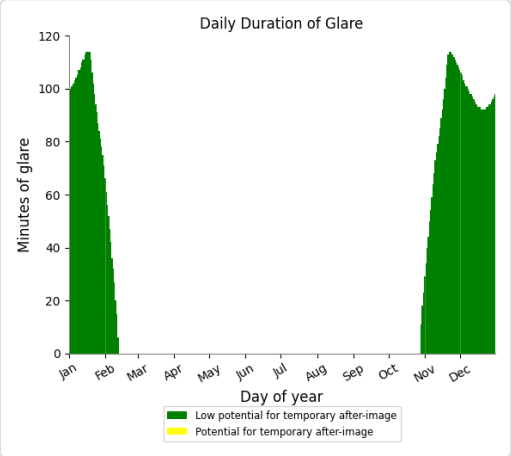
Flight Path: 16 Runway

0 minutes of yellow glare

9173 minutes of green glare



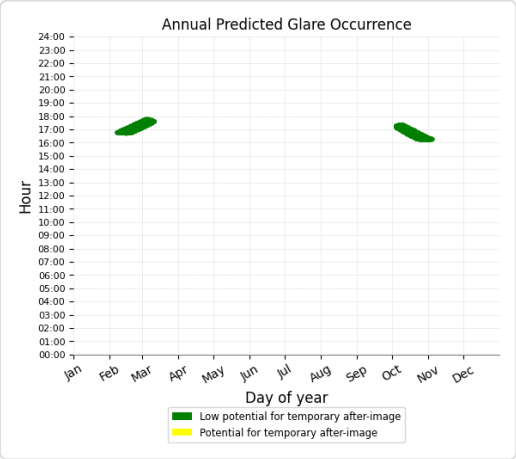


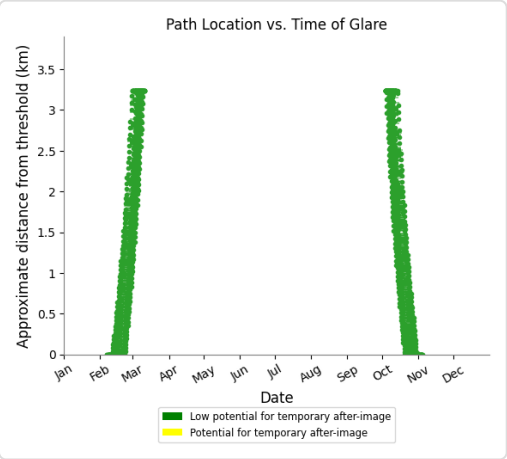


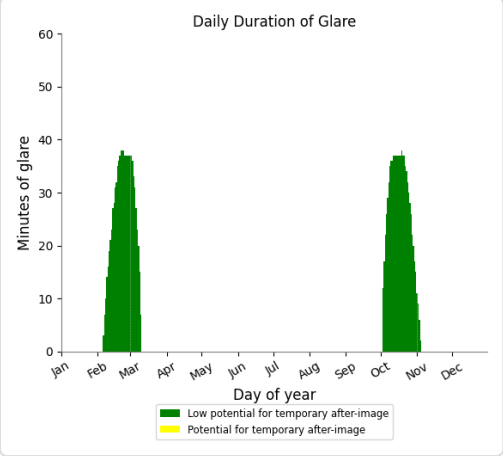
Flight Path: 28R Runway

0 minutes of yellow glare

1807 minutes of green glare



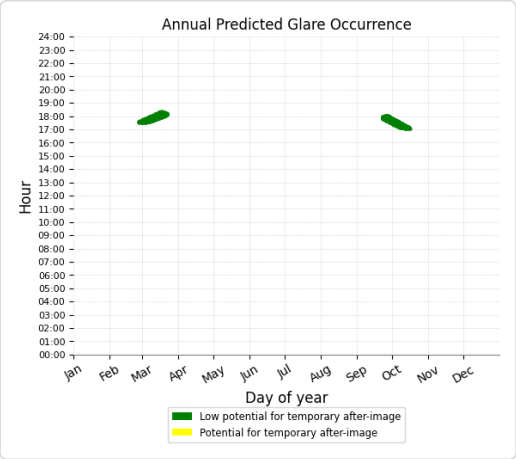


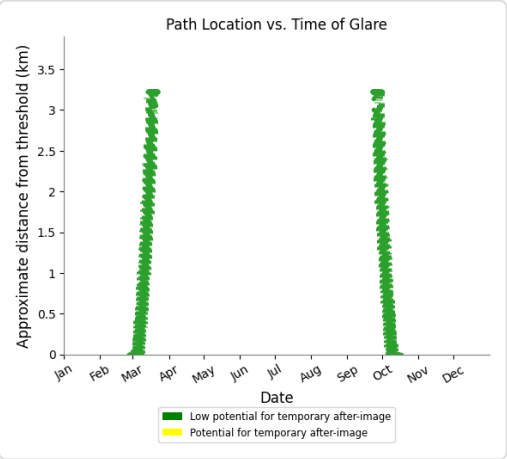


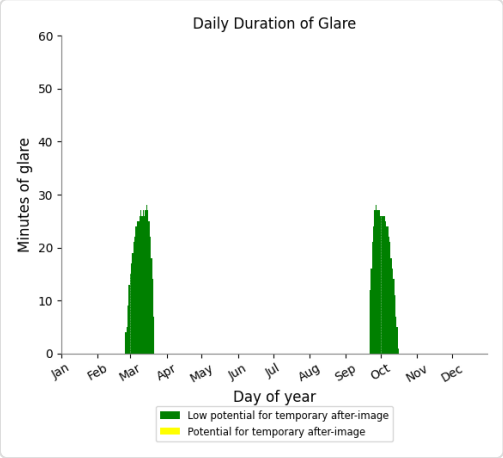
Flight Path: 28 Runway

0 minutes of yellow glare

1000 minutes of green glare

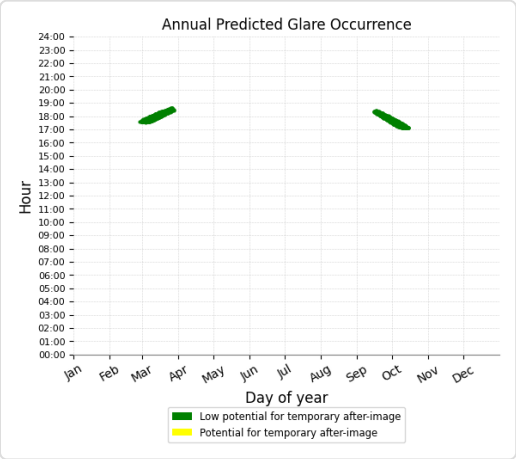


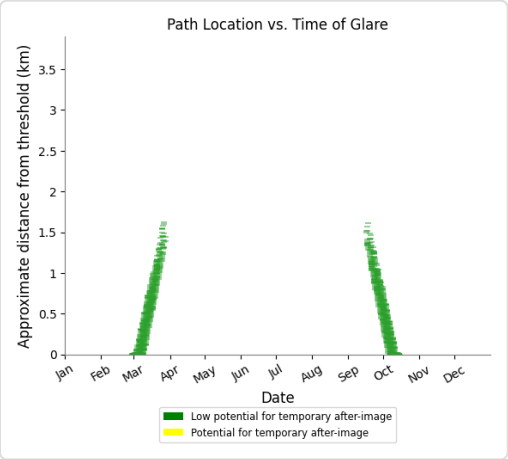


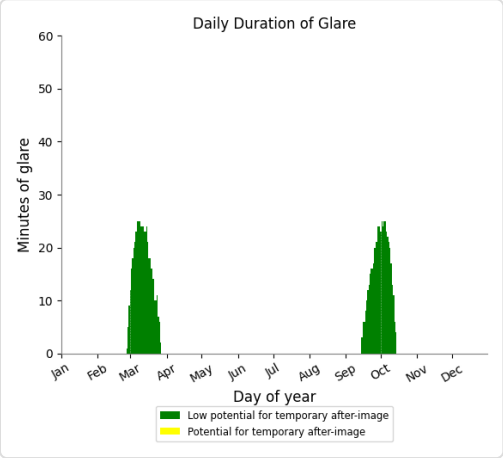


Flight Path: 34 Runway

0 minutes of yellow glare
980 minutes of green glare

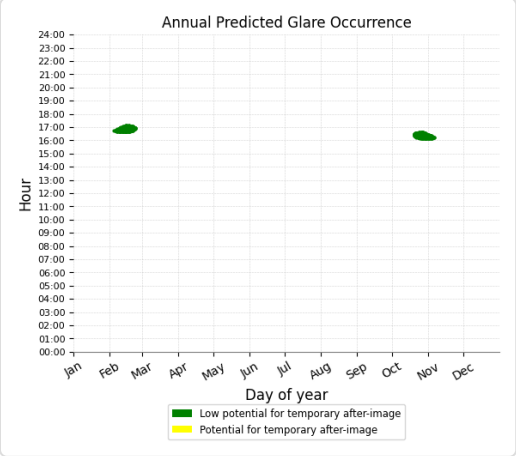


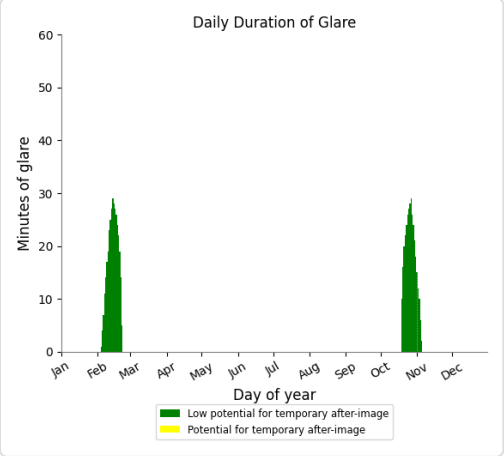




Point Receptor: 1-ATCT

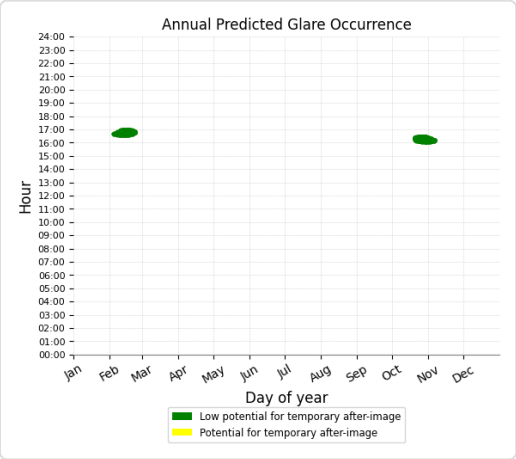
0 minutes of yellow glare
678 minutes of green glare

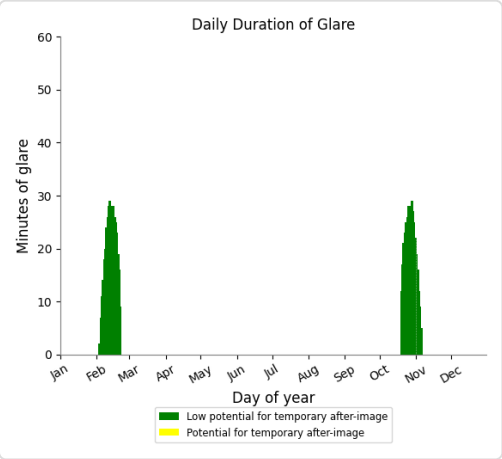




Point Receptor: 2-ATCT

0 minutes of yellow glare
811 minutes of green glare





Results for: Array 2

Receptor	Green Glare (min)	Yellow Glare (min)
10L Runway	0	0
10 Runway	0	0
16 Runway	0	0
28R Runway	2	0
28 Runway	597	0
34 Runway	2749	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

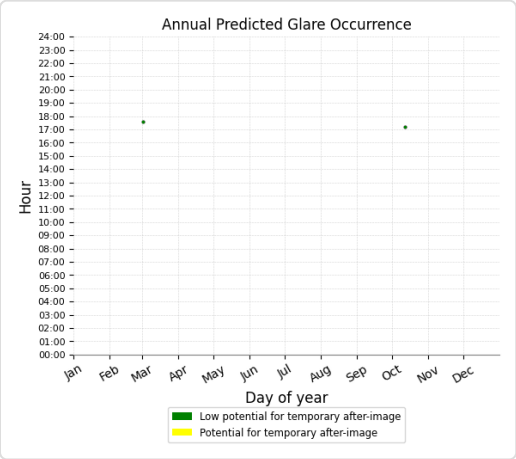
Flight Path: 16 Runway

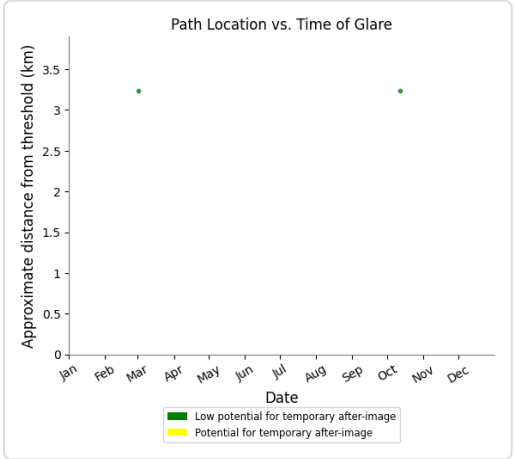
0 minutes of yellow glare
0 minutes of green glare

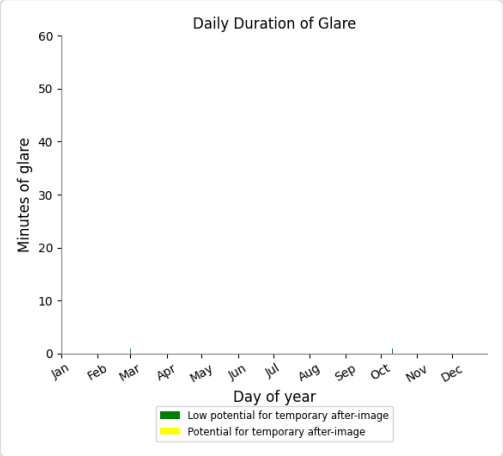
Flight Path: 28R Runway

0 minutes of yellow glare

2 minutes of green glare



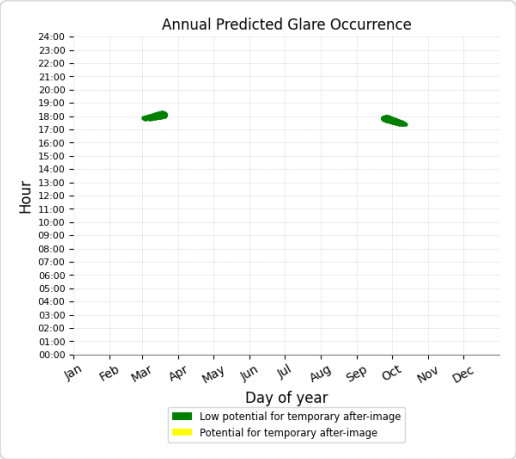


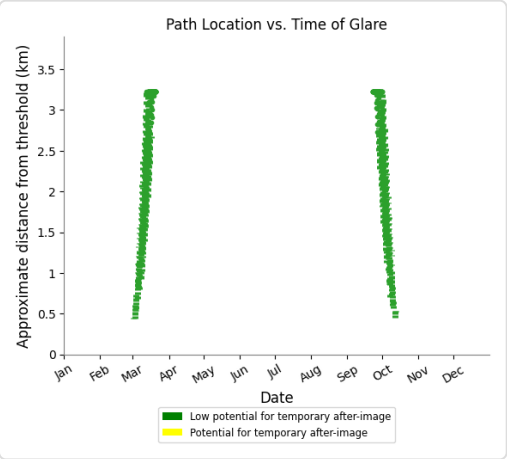


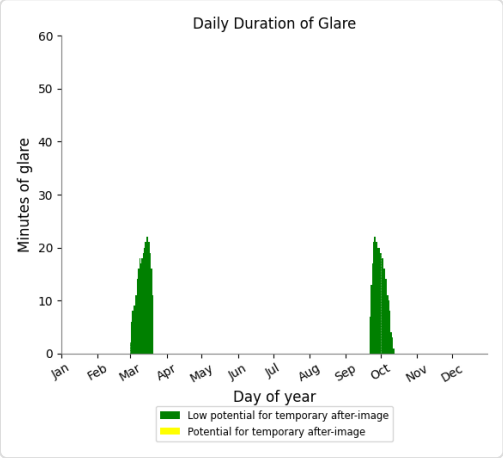
Flight Path: 28 Runway

0 minutes of yellow glare

597 minutes of green glare

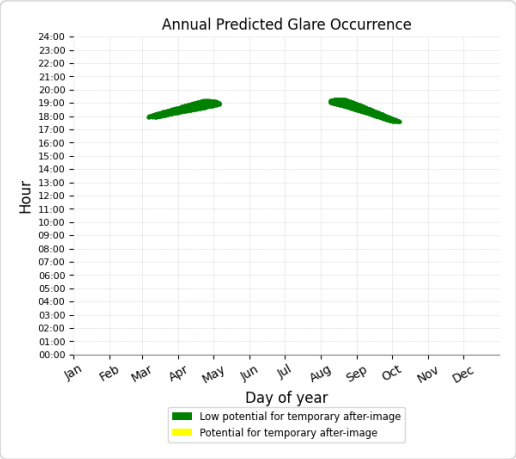


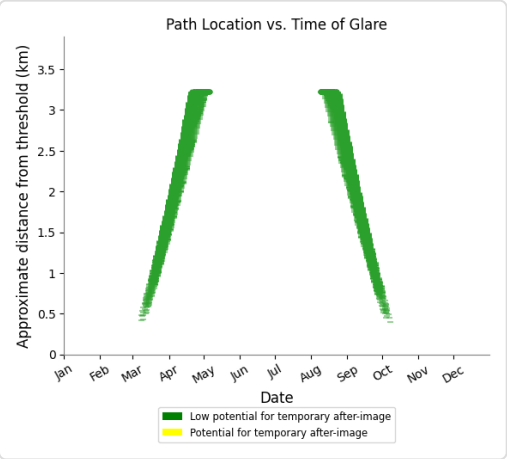


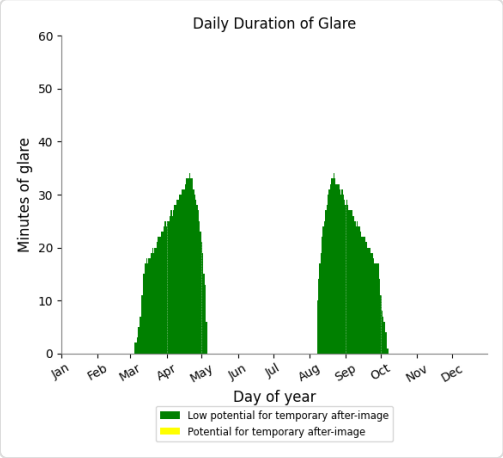


Flight Path: 34 Runway

0 minutes of yellow glare
2749 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: Array 3

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	0	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
0 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.