Whitestown Way, Tallaght, Dublin 24

Glint & Glare Assessment Report

2020 CIBSE BUILDING PERFORMANCE CONSULTANCY

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Executive Summary

Lawler Sustainability conducted an analysis on the risk of glint and glare caused by the rooftop solar Photovoltaic (PV) array proposed as part of the development at Whitestown Way, Tallaght, Dublin 24 . This report assesses the potential for ocular impact of glare which would emanate from sunlight reflections of the four PV arrays (2 east facing and 2 west facing) and its possibility to cause an impact to observers in the surrounding area, flight paths, ATCT at Baldonnell airport and heli pad at Tallaght University hospital. Thirty-eight receptors were assessed in the vicinity of the proposed development, Four flight paths at Baldonnell airport, 1 ATCT at Baldonnell airport, 1 heli pad at Tallaght University hospital and one route receptor.

Table 1 below summarizes the findings of the glint and glare report. The results indicate that no yellow or red glare will be experienced at any of the 45 assessed receptors. Green glare may occur at certain observation point receptors; however, this is classified as low-intensity glare with limited potential to cause visual disturbance.

Table 1. Summary of results

Receptor	Potential for ocular glare
FP: FP 04	None
FP: FP 10	None
FP: FP 22	None
FP: FP 28	None
OP: OP 1	None
OP: OP 2	None
OP: OP 3	None
OP: OP 4	None
OP: OP 5	None
OP: OP 6	Low (Green glare only)
OP: OP 7	Low (Green glare only)
OP: OP 8	Low (Green glare only)
OP: OP 9	Low (Green glare only)
OP: OP 10	Low (Green glare only)
OP: OP 11	Low (Green glare only)
OP: OP 12	Low (Green glare only)
OP: OP 13	Low (Green glare only)
OP: OP 14	Low (Green glare only)
OP: OP 15	Low (Green glare only)
OP: OP 16-ATCT	None
OP: OP 17-ATCT	None
OP: OP 18	None
OP: OP 19	None
OP: OP 20	None
OP: OP 21	None
OP: OP 22	None

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OP: OP 23	Low (Green glare only)
OP: OP 24	Low (Green glare only)
OP: OP 25	Low (Green glare only)
OP: OP 26	Low (Green glare only)
OP: OP 27	Low (Green glare only)
OP: OP 28	Low (Green glare only)
OP: OP 29	None
OP: OP 30	None
OP: OP 31	None
OP: OP 32	None
OP: OP 33	Low (Green glare only)
OP: OP 34	None
OP: OP 35	Low (Green glare only)
OP: OP 36	Low (Green glare only)
OP: OP 37	None
OP: OP 38	None
OP: OP 39	None
OP: OP 40	None
Route: Route 1	None

Green glare identified in the analysis represents low-intensity reflections with minimal potential to cause after-image and is not considered a safety concern. No yellow or red glare was identified at any receptor.

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).

Table 2. Summary of Baseline results

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

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Introduction

KSNPM have requested Lawler Sustainability to conduct a Glint & Glare analysis for the Photovoltaic (PV) installation proposed as part of the development at Whitestown Way, Tallaght, Dublin 24 .

This report has assessed the potential for glare on the surrounding properties, and roads near at the proposed development at Whitestown Way, Tallaght, Dublin 24 using the ForgeSolar toolset. ForgeSolar uses GlareGauge 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 if 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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Solar Photovoltaic Array Proposal

The proposed solar photovoltaic (PV) arrays will be mounted on a flat roof and will have a tilt angle of 10° at the proposed development at Whitestown Way, Tallaght, Dublin 24 . PV arrays 1 and 2 will be orientated towards the west direction (261° azimuth angle) and PV arrays 3 and 4 will be orientated towards the east direction (81° azimuth angle). The PV panels will be fixed in position and will not track the sun throughout the day or year.

Figure 1. Site location highlighting point receptors and route receptors

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About Glint and Glare

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.

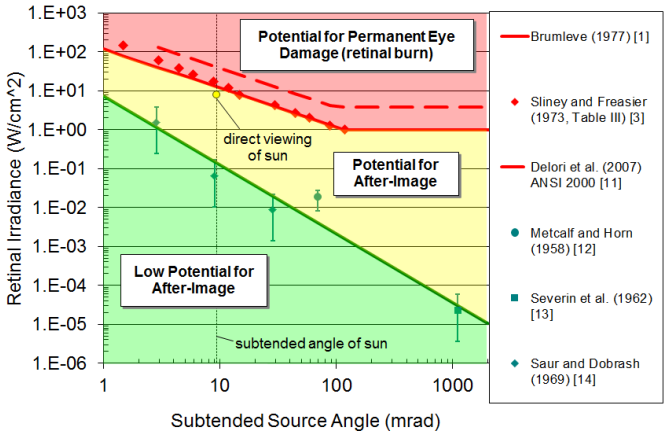

Figure 2. Sample glare hazard plot defining ocular impact as function of retinal irradiance and subtended source angle[3]

The ocular impact of glare is visualised with the Glare Hazard Plot (Figure 2). 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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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 3 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.

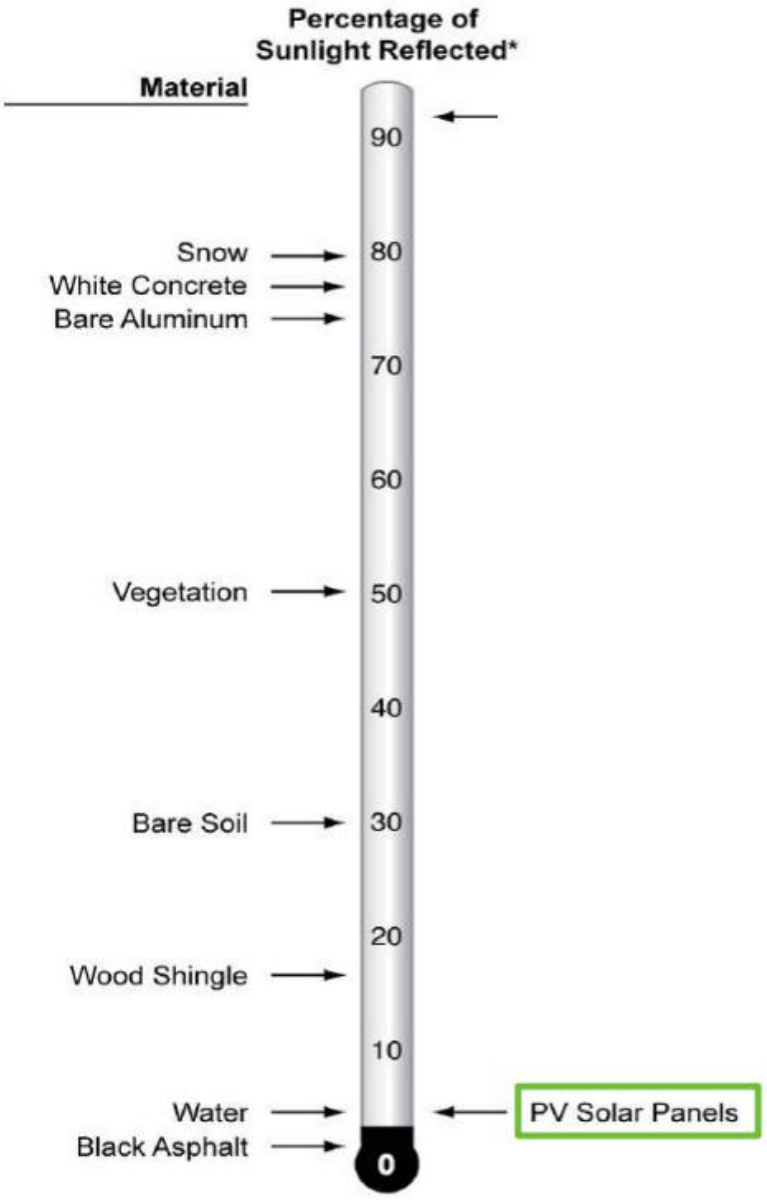

Figure 3. Reflectivity produced by different surfaces[4]

[4] FAA 2010 Solar Guidance

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Sandia National Laboratories developed five generic PV module material reflectance profiles by analysing 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, are light textured glass with anti-reflective coating. Figure 4 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.

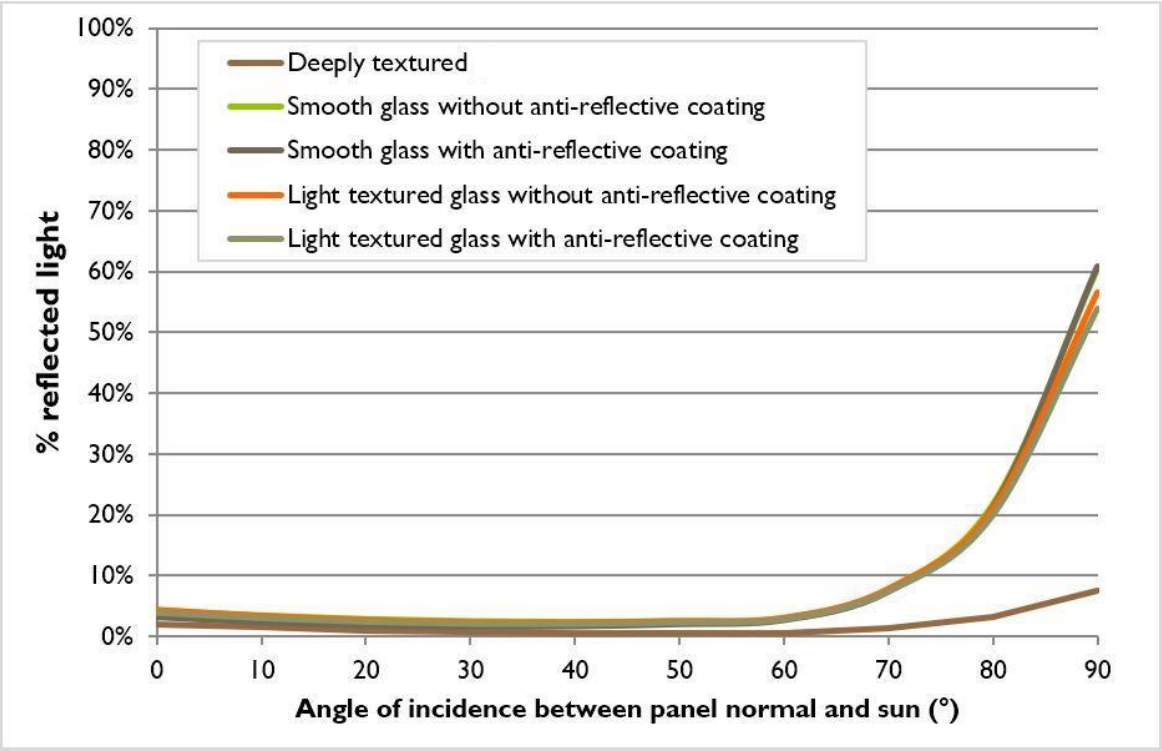

Figure 4. Reflectance profiles of typical PV module materials[5]

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.

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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].

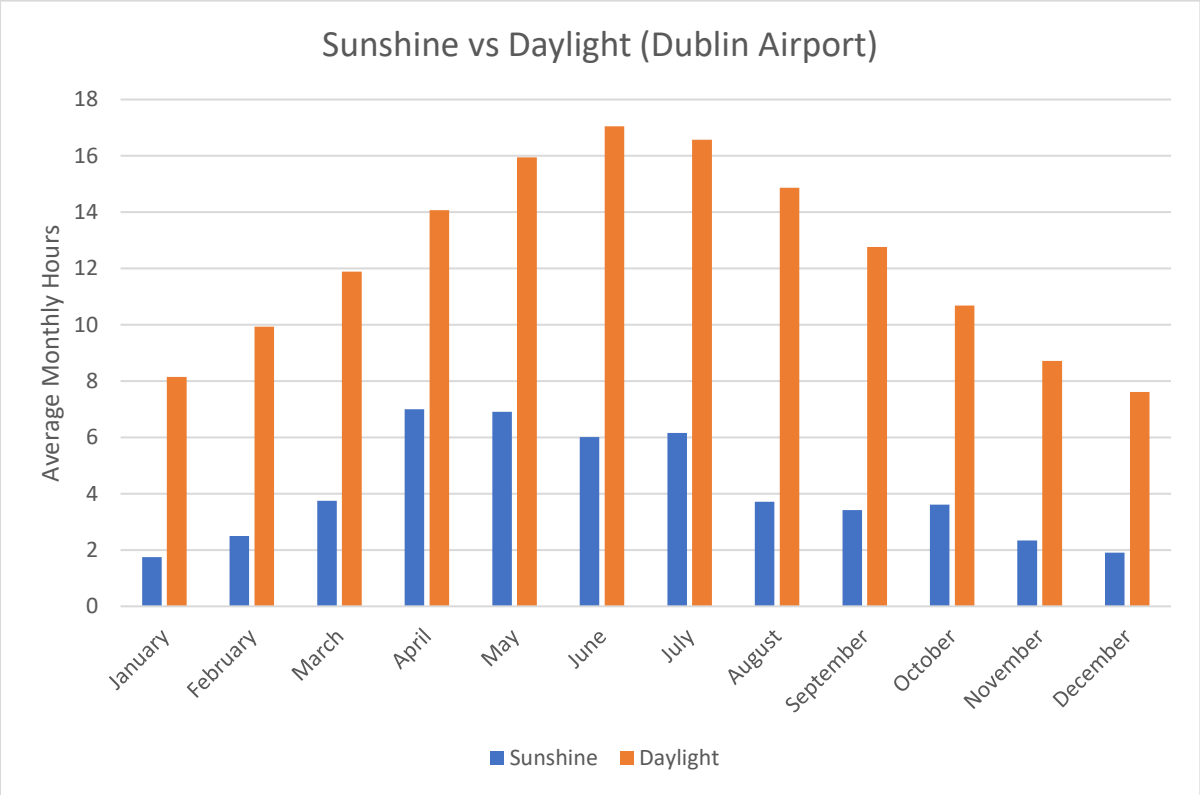

Figure 5. Sunshine vs Daylight (Dublin Airport)

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

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Relevant Guidance and Studies

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 Ireland[9]. This is not a formal guidance document, but it sets out recommended elements of the assessment based on international practice.

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 document[10] 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 or the CAA have produced a methodology for assessing the effects of glint and glare on rail and road users, aviation, or residential buildings.

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.

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.

[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"

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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

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.

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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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.

4. Geometric Evaluation

As mentioned previously in this report, Lawler Sustainability use 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. 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 Optimisation Tool can be used to conduct a module optimisation analysis. This evaluates a single PV array over a range of tilts and orientations to aid in identifying the optimal module configuration.

6. Interpretation of results

The results from the ForgeSolar tool are collated into a comprehensible 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 potentially hazardous glare (i.e. yellow or red 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.

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Table 3. Classification of Potentially Hazardous 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 intervening 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.

In addition to the duration-based classification outlined above, the intensity of glare has also been considered in accordance with the ForgeSolar (SGHAT) methodology. Glare is categorised as green, yellow, or red based on its potential ocular impact.

Green glare represents low-intensity reflections with minimal potential to cause after-image, while yellow and red glare indicate increasing levels of potential visual impairment.

This duration-based classification is primarily applicable to glare with the potential to cause visual impairment (i.e. yellow or red glare). Green glare, being low intensity in nature, is not considered hazardous and is therefore assessed separately in terms of its overall impact. This approach aligns with industry practice where duration thresholds are primarily used to assess potentially hazardous glare, while low-intensity green glare is evaluated qualitatively.

Where green glare is identified, it is generally considered to be non-hazardous and not safety-critical, particularly in the absence of yellow or red glare. Therefore, although certain receptors may experience durations of glare exceeding the thresholds outlined above, the classification of impact also takes into account the low intensity of the predicted glare and its limited potential to result in significant adverse effects.

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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Site Plan

Figure 6. Site Plan for proposed Whitestown Way, Tallaght, Dublin 24 (Not to Scale)

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Solar PV Arrays Description and Parameters

Table 4. Solar PV array 1 details

Name:	PV array 1
Footprint area:	~ 16 m^2
Axis tracking:	Fixed (no rotation)
Tilt:	10.0°
Orientation:	261°
Rated power:	
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 7. Proposed solar PV array 1

Table 5. Solar PV array 1 positioning

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	53.282230	-6.375968	96.94	19.88	116.82
2	53.282234	-6.375932	96.94	19.88	116.82
3	53.282176	-6.375911	96.95	19.88	116.83
4	53.282171	-6.375947	96.96	19.88	116.83

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Table 6. Solar PV array 2 details.

Name:	PV array 2
Footprint area:	~ 17 m^2
Axis tracking:	Fixed (no rotation)
Tilt:	10.0°
Orientation:	261°
Rated power:	
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. Proposed solar PV array 2

Table 7. Solar PV array 2 positioning.

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	53.282098	-6.375921	96.96	19.88	116.84
2	53.282102	-6.375886	96.96	19.88	116.83
3	53.282041	-6.375864	96.96	19.88	116.83
4	53.282036	-6.375898	96.97	19.88	116.84

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Table 8. Solar PV array 3 details

Name:	PV array 3
Footprint area:	~ 16 m^2
Axis tracking:	Fixed (no rotation)
Tilt:	10.0°
Orientation:	81°
Rated power:	
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. Proposed solar PV array 3

Table 9. Solar PV array 3 positioning

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	53.282235	-6.375926	96.94	19.88	116.82
2	53.282240	-6.375892	96.93	19.88	116.80
3	53.282182	-6.375867	96.95	19.88	116.82
4	53.282178	-6.375905	96.95	19.88	116.83

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Table 10. Solar PV array 1 details

Name:	PV array 4
Footprint area:	~ 16 m^2
Axis tracking:	Fixed (no rotation)
Tilt:	10.0°
Orientation:	81°
Rated power:	
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. Proposed solar PV array 4

Table 11. Solar PV array 4 positioning

Vertex	Latitude	Longitude	Ground elevation	Height above ground	Total elevation
	deg	deg	m	m	m
1	53.282103	-6.375879	96.96	19.88	116.83
2	53.282106	-6.375844	96.95	19.88	116.82
3	53.282045	-6.375822	96.95	19.88	116.82
4	53.282041	-6.375858	96.96	19.88	116.83

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Baldonnel Airport 2-mile flight path receptors

Table 12. 2-mile flight path receptor FP 04 details.

Name	FP 04
Threshold height	15 m
Direction	40.8°
Glide Slope	3.0°
Pilot view restricted?	Yes
Vertical view restriction	30.0°
Azimuthal view restriction	50.0°

Figure 11. 2-mile flight path receptor FP 04

Table 13. 2-mile flight path receptor FP 04 details

Point	Latitude	Longitude	Ground Elevation	Height above ground	Total elevation
	deg	deg	m	m	m
Threshold	53.293781	-6.453554	98.40	15.00	113.40
2-mile point	53.271895	-6.485199	154.22	127.86	282.08

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Table 14. 2-mile flight path receptor FP 10 details

Name	FP 10
Threshold height	15 m
Direction	40.8°
Glide Slope	3.0°
Pilot view restricted?	Yes
Vertical view restriction	30.0°
Azimuthal view restriction	50.0°

Figure 12. 2-mile flight path receptor FP 10

Table 15. 2-mile flight path receptor FP 10 details

Point	Latitude	Longitude	Ground Elevation	Height above ground	Total elevation
	deg	deg	m	m	m
Threshold	53.304666	-6.468535	86.24	15.24	101.48
2-mile point	53.310767	-6.515886	73.22	196.94	270.17

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Table 16. 2-mile flight path receptor FP 22 details

Name	FP 22
Threshold height	15 m
Direction	220.8°
Glide Slope	3.0°
Pilot view restricted?	Yes
Vertical view restriction	30.0°
Azimuthal view restriction	50.0°

Figure 13. 2-mile flight path receptor FP 22

Table 17. 2-mile flight path receptor FP 22 details

Point	Latitude	Longitude	Ground Elevation	Height above ground	Total elevation
	deg	deg	m	m	m
Threshold	53.303388	-6.439628	93.36	15.00	108.36
2-mile point	53.324426	-6.406401	65.14	211.90	277.04

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Table 18. 2-mile flight path receptor FP 28 details

Name	FP 28
Threshold height	15 m
Direction	281.9°
Glide Slope	3.0°
Pilot view restricted?	Yes
Vertical view restriction	30.0°
Azimuthal view restriction	50.0°

Figure 14. 2-mile flight path receptor FP 28

Table 19. 2-mile flight path receptor FP 28 details

Point	Latitude	Longitude	Ground Elevation	Height above ground	Total elevation
	deg	deg	m	m	m
Threshold	53.301689	-6.444976	96.05	15.00	111.05
2-mile point	53.295727	-6.397579	106.23	173.51	279.74

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Route Receptors

Table 20. Route receptor one details

Name:	Route 1 Whitestown Way Rd
Route type	Two-way
View angle:	50.0°

Figure 15. Whitestown Way Road

Discrete Observation Receptors

Table 21. Discrete Observation Receptors

Number	Latitude	Longitude	Ground elevation	Height above ground	Total Elevation
	deg	deg	m	m	m
OP 1	53.281614	-6.375714	97.46	4.80	102.26
OP 2	53.281289	-6.376324	98.97	4.80	103.77
OP 3	53.281297	-6.376188	98.88	4.80	103.68
OP 4	53.281305	-6.376198	98.84	7.80	106.64
OP 5	53.281296	-6.376312	98.93	7.80	106.73
OP 6	53.282028	-6.374255	97.06	4.80	101.86
OP 7	53.281998	-6.374247	97.00	4.80	101.80
OP 8	53.281998	-6.374245	97.00	7.80	104.80
OP 9	53.282030	-6.374256	97.02	7.80	104.82
OP 10	53.281869	-6.374380	97.32	4.80	102.12
OP 11	53.281906	-6.374389	97.32	4.80	102.12
OP 12	53.281941	-6.374395	97.14	4.80	101.94
OP 13	53.281942	-6.374395	97.14	7.80	104.94

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OP 14	53.281908	-6.374389	97.32	7.80	105.12
OP 15	53.281871	-6.374380	97.32	7.80	105.12
16-ATCT	53.289506	-6.376782	103.74	50.00	153.74
17-ATCT	53.305518	-6.441763	93.51	30.00	123.51
OP 18	53.281572	-6.375834	97.60	7.80	105.40
OP 19	53.281597	-6.375772	97.49	4.80	102.29
OP 20	53.281593	-6.375772	97.53	7.80	105.33
OP 21	53.281567	-6.375835	97.60	4.80	102.40
OP 22	53.281614	-6.375723	97.46	7.80	105.26
OP 23	53.281941	-6.374396	97.19	10.80	107.99
OP 24	53.281906	-6.374389	97.32	10.80	108.12
OP 25	53.281870	-6.374380	97.32	10.80	108.12
OP 26	53.281996	-6.374245	97.04	10.80	107.84
OP 27	53.282032	-6.374254	97.06	10.80	107.86
OP 28	53.282073	-6.374165	97.18	4.80	101.98
OP 29	53.282871	-6.375841	97.63	11.80	109.43
OP 30	53.282873	-6.375844	97.63	14.80	112.43
OP 31	53.282875	-6.375842	97.63	17.80	115.43
OP 32	53.282805	-6.375412	97.44	11.80	109.24
OP 33	53.282830	-6.375416	97.52	14.80	112.32
OP 34	53.282876	-6.375847	97.66	20.80	118.46
OP 35	53.282859	-6.375427	97.58	14.80	112.38
OP 36	53.282902	-6.375438	97.68	20.80	118.48
OP 37	53.282844	-6.376242	97.76	20.80	118.56
OP 38	53.282801	-6.376233	97.63	17.80	115.43
OP 39	53.282773	-6.376220	97.53	14.80	112.33
OP 40	53.282733	-6.376218	97.36	11.80	109.16

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Glint and Glare Analysis

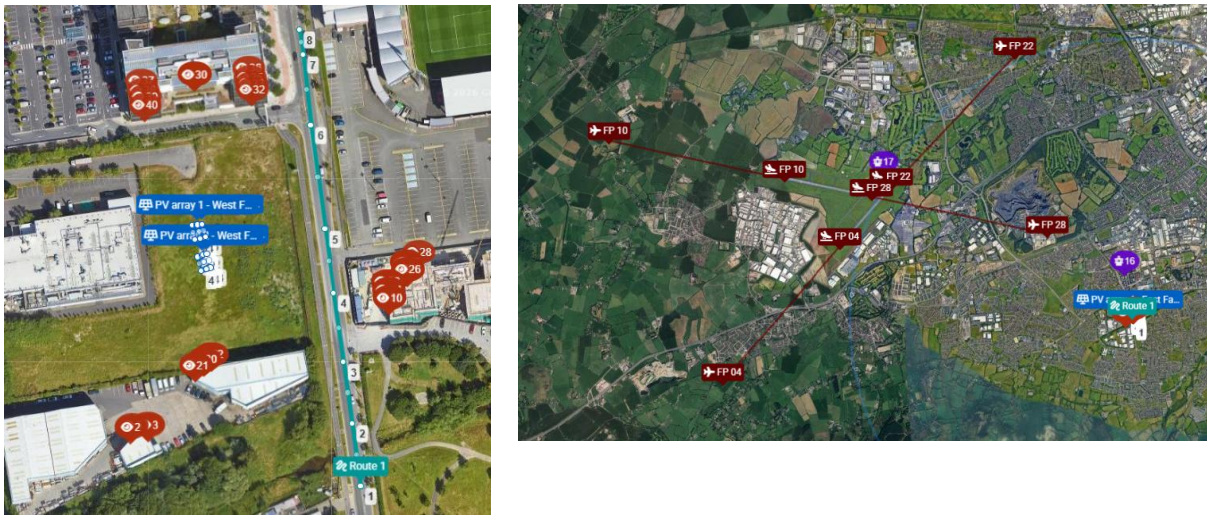

Figure 16. Glare analysis receptors surrounding the Whitestown Way, Tallaght, Dublin 24

The analysis simulated 38 receptors from neighbouring properties in the vicinity. Each floor is considered to be 3 m high for residential properties and 4 m high for commercial properties, with an eye-level at 1.8 m.

Four flight paths at Baldonnell airport, 1 ATCT at Baldonnell airport with a height of 30 m, 1 heli pad at Tallaght University hospital with a height of 50 m.

In addition, one vehicular route receptors were assessed Whitestown way. A height of 1.5 m was assumed for a car and a 2.7 m for a truck.

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Glint and Glare Results

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

Table 22. Summary of results

PV Name	Tilt	Orientation	Annual "Green" Glare	Annual "Yellow" Glare	Annual Energy Produced*
	deg	deg	min	min	kWh
PV array 1 - West Facing	10.0	261.0	0	0	-
PV array 2 - West Facing	10.0	261.0	0	0	-
PV array 3 - East Facing	10.0	81.0	35,815	0	-
PV array 4 - East Facing	10.0	81.0	24,046	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 specialised software for estimating solar energy yields.

Table 23. Distinct glare minutes per month

PV	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
pv-array-3 (green)	995	0	0	280	1666	1506	1803	783	0	0	456	1826
pv-array-3 (yellow)	0	0	0	0	0	0	0	0	0	0	0	0
pv-array-4 (green)	164	0	0	834	1460	210	985	1437	64	0	1	733
pv-array-4 (yellow)	0	0	0	0	0	0	0	0	0	0	0	0

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Table 24. Receptor analysis annual results for PV array 1

Component	Annual Green glare (min)	Annual Green glare (hours)	Annual Yellow glare (min)	Annual Yellow glare (hours)
FP: FP 04	0	0	0	0
FP: FP 10	0	0	0	0
FP: FP 22	0	0	0	0
FP: FP 28	0	0	0	0
OP: OP 1	0	0	0	0
OP: OP 2	0	0	0	0
OP: OP 3	0	0	0	0
OP: OP 4	0	0	0	0
OP: OP 5	0	0	0	0
OP: OP 6	0	0	0	0
OP: OP 7	0	0	0	0
OP: OP 8	0	0	0	0
OP: OP 9	0	0	0	0
OP: OP 10	0	0	0	0
OP: OP 11	0	0	0	0
OP: OP 12	0	0	0	0
OP: OP 13	0	0	0	0
OP: OP 14	0	0	0	0
OP: OP 15	0	0	0	0
OP: 16-ATCT	0	0	0	0
OP: 17-ATCT	0	0	0	0
OP: OP 18	0	0	0	0
OP: OP 19	0	0	0	0
OP: OP 20	0	0	0	0
OP: OP 21	0	0	0	0
OP: OP 22	0	0	0	0
OP: OP 23	0	0	0	0
OP: OP 24	0	0	0	0
OP: OP 25	0	0	0	0
OP: OP 26	0	0	0	0
OP: OP 27	0	0	0	0
OP: OP 28	0	0	0	0
OP: OP 29	0	0	0	0
OP: OP 30	0	0	0	0
OP: OP 31	0	0	0	0
OP: OP 32	0	0	0	0
OP: OP 33	0	0	0	0
OP: OP 34	0	0	0	0

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OP: OP 35	0	0	0	0
OP: OP 36	0	0	0	0
OP: OP 37	0	0	0	0
OP: OP 38	0	0	0	0
OP: OP 39	0	0	0	0
OP: OP 40	0	0	0	0
Route: Route 1	0	0	0	0

Table 25. Receptor analysis annual results for PV array 2.

Component	Annual Green glare (min)	Annual Green glare (hours)	Annual Yellow glare (min)	Annual Yellow glare (hours)
FP: FP 04	0	0	0	0
FP: FP 10	0	0	0	0
FP: FP 22	0	0	0	0
FP: FP 28	0	0	0	0
OP: OP 1	0	0	0	0
OP: OP 2	0	0	0	0
OP: OP 3	0	0	0	0
OP: OP 4	0	0	0	0
OP: OP 5	0	0	0	0
OP: OP 6	0	0	0	0
OP: OP 7	0	0	0	0
OP: OP 8	0	0	0	0
OP: OP 9	0	0	0	0
OP: OP 10	0	0	0	0
OP: OP 11	0	0	0	0
OP: OP 12	0	0	0	0
OP: OP 13	0	0	0	0
OP: OP 14	0	0	0	0
OP: OP 15	0	0	0	0
OP: 16-ATCT	0	0	0	0
OP: 17-ATCT	0	0	0	0
OP: OP 18	0	0	0	0
OP: OP 19	0	0	0	0
OP: OP 20	0	0	0	0
OP: OP 21	0	0	0	0
OP: OP 22	0	0	0	0
OP: OP 23	0	0	0	0
OP: OP 24	0	0	0	0

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OP: OP 25	0	0	0	0
OP: OP 26	0	0	0	0
OP: OP 27	0	0	0	0
OP: OP 28	0	0	0	0
OP: OP 29	0	0	0	0
OP: OP 30	0	0	0	0
OP: OP 31	0	0	0	0
OP: OP 32	0	0	0	0
OP: OP 33	0	0	0	0
OP: OP 34	0	0	0	0
OP: OP 35	0	0	0	0
OP: OP 36	0	0	0	0
OP: OP 37	0	0	0	0
OP: OP 38	0	0	0	0
OP: OP 39	0	0	0	0
OP: OP 40	0	0	0	0
Route: Route 1	0	0	0	0

Table 26. Receptor analysis annual results for PV array 3.

Component	Annual Green glare (min)	Annual Green glare (hours)	Annual Yellow glare (min)	Annual Yellow glare (hours)
FP: FP 04	0	0	0	0
FP: FP 10	0	0	0	0
FP: FP 22	0	0	0	0
FP: FP 28	0	0	0	0
OP: OP 1	0	0	0	0
OP: OP 2	0	0	0	0
OP: OP 3	0	0	0	0
OP: OP 4	0	0	0	0
OP: OP 5	0	0	0	0
OP: OP 6	1175	19.58	0	0
OP: OP 7	1232	20.53	0	0
OP: OP 8	1745	29.08	0	0
OP: OP 9	1626	27.10	0	0
OP: OP 10	1969	32.82	0	0
OP: OP 11	1556	25.93	0	0
OP: OP 12	1264	21.07	0	0
OP: OP 13	2268	37.80	0	0
OP: OP 14	2589	43.15	0	0

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OP: OP 15	2569	42.8	0	0
OP: 16-ATCT	0	0	0	0
OP: 17-ATCT	0	0	0	0
OP: OP 18	0	0	0	0
OP: OP 19	0	0	0	0
OP: OP 20	0	0	0	0
OP: OP 21	0	0	0	0
OP: OP 22	0	0	0	0
OP: OP 23	2957	29.28	0	0
OP: OP 24	2891	42.18	0	0
OP: OP 25	2599	43.32	0	0
OP: OP 26	2202	36.70	0	0
OP: OP 27	1937	32.28	0	0
OP: OP 28	1202	20.03	0	0
OP: OP 29	0	0	0	0
OP: OP 30	0	0	0	0
OP: OP 31	0	0	0	0
OP: OP 32	0	0	0	0
OP: OP 33	1229	20.48	0	0
OP: OP 34	0	0	0	0
OP: OP 35	757	12.62	0	0
OP: OP 36	2048	34.13	0	0
OP: OP 37	0	0	0	0
OP: OP 38	0	0	0	0
OP: OP 39	0	0	0	0
OP: OP 40	0	0	0	0
Route: Route 1	0	0	0	0

Table 27. Receptor analysis annual results for PV array 4.

Component	Annual Green glare (min)	Annual Green glare (hours)	Annual Yellow glare (min)	Annual Yellow glare (hours)
FP: FP 04	0	0	0	0
FP: FP 10	0	0	0	0
FP: FP 22	0	0	0	0
FP: FP 28	0	0	0	0
OP: OP 1	0	0	0	0
OP: OP 2	0	0	0	0
OP: OP 3	0	0	0	0
OP: OP 4	0	0	0	0

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OP: OP 5	0	0	0	0
OP: OP 6	1014	16.90	0	0
OP: OP 7	1032	17.20	0	0
OP: OP 8	1414	23.57	0	0
OP: OP 9	1369	22.82	0	0
OP: OP 10	1092	18.20	0	0
OP: OP 11	1009	16.82	0	0
OP: OP 12	929	15.48	0	0
OP: OP 13	1442	24.03	0	0
OP: OP 14	1573	26.22	0	0
OP: OP 15	1730	28.83	0	0
OP: 16-ATCT	0	0	0	0
OP: 17-ATCT	0	0	0	0
OP: OP 18	0	0	0	0
OP: OP 19	0	0	0	0
OP: OP 20	0	0	0	0
OP: OP 21	0	0	0	0
OP: OP 22	0	0	0	0
OP: OP 23	1852	30.83	0	0
OP: OP 24	2068	34.47	0	0
OP: OP 25	2431	40.52	0	0
OP: OP 26	1598	26.63	0	0
OP: OP 27	1518	25.30	0	0
OP: OP 28	1077	17.95	0	0
OP: OP 29	0	0	0	0
OP: OP 30	0	0	0	0
OP: OP 31	0	0	0	0
OP: OP 32	0	0	0	0
OP: OP 33	0	0	0	0
OP: OP 34	0	0	0	0
OP: OP 35	0	0	0	0
OP: OP 36	898	14.97	0	0
OP: OP 37	0	0	0	0
OP: OP 38	0	0	0	0
OP: OP 39	0	0	0	0
OP: OP 40	0	0	0	0
Route: Route 1	0	0	0	0

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Conclusion

A comprehensive glint and glare assessment was carried out for the proposed solar photovoltaic (PV) installation at the planned development in Whitestown, Co. Dublin.

The findings of the analysis are as follows:

- **Route Receptors**: No risk of glare was identified for the route receptor assessed.
- **Observation Points**: No risk of hazardous glare (yellow or red) was identified from the proposed solar PV panels. Green glare is predicted at certain observation point receptors. However, this is considered low-intensity and not safety-critical
- **FP**: No risk of glare was identified for Four flight paths.
- **ATCT**: No risk of glare was identified for two ATCT towers.

In summary, the proposed installation presents no significant glint and glare concerns at any of the observation points, the flight paths, the ATCT and the one route that was 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 cover 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 an 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 Baseline

FORGESOLAR GLARE ANALYSIS

Project: **Whitestown Way, Tallaght**
Site configuration: **Baseline-temp-0**
Calculated via ForgeSolar Radiometric Physics Engine v3.1.2

Created 21 Apr, 2026
Updated 21 Apr, 2026
Time-step 1 minute
Timezone offset UTC0
Minimum sun altitude 0.0 deg
DNI peaks at 1,000.0 W/m^2
Category 0 to 10 kW
(1,000 kW / 32,400 m^2 limit)
Site ID 176480.28170

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

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 - West Facing	10.0	261.0	0	0.0	0	0.0	-
PV array 2 - West Facing	10.0	261.0	0	0.0	0	0.0	-
PV array 3 - East Facing	10.0	81.0	35,815	596.9	0	0.0	-
PV array 4 - East Facing	10.0	81.0	24,046	400.8	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
Route 1	0	0.0	0	0.0
FP 04	0	0.0	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
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	2,189	36.5	0	0.0
OP 7	2,264	37.7	0	0.0

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Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 8	3,159	52.6	0	0.0
OP 9	2,995	49.9	0	0.0
OP 10	3,061	51.0	0	0.0
OP 11	2,565	42.8	0	0.0
OP 12	2,193	36.5	0	0.0
OP 13	3,710	61.8	0	0.0
OP 14	4,162	69.4	0	0.0
OP 15	4,299	71.7	0	0.0
16-ATCT	0	0.0	0	0.0
17-ATCT	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0
OP 22	0	0.0	0	0.0
OP 23	4,809	80.2	0	0.0
OP 24	4,959	82.7	0	0.0
OP 25	5,030	83.8	0	0.0
OP 26	3,800	63.3	0	0.0
OP 27	3,455	57.6	0	0.0
OP 28	2,279	38.0	0	0.0
OP 29	0	0.0	0	0.0
OP 30	0	0.0	0	0.0
OP 31	0	0.0	0	0.0
OP 32	0	0.0	0	0.0
OP 33	1,229	20.5	0	0.0
OP 34	0	0.0	0	0.0
OP 35	757	12.6	0	0.0
OP 36	2,946	49.1	0	0.0
OP 37	0	0.0	0	0.0
OP 38	0	0.0	0	0.0
OP 39	0	0.0	0	0.0
OP 40	0	0.0	0	0.0

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Component Data

PV Arrays

Name: PV array 1 - West Facing
Axis tracking: Fixed (no rotation)
Tilt: 10.0°
Orientation: 261.0°
Rated power: -
Panel material: Light textured glass with AR coating

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.282230	-6.375968	96.94	19.88	116.82
2	53.282234	-6.375932	96.94	19.88	116.82
3	53.282176	-6.375911	96.95	19.88	116.83
4	53.282171	-6.375947	96.96	19.88	116.83

Name: PV array 2 - West Facing
Axis tracking: Fixed (no rotation)
Tilt: 10.0°
Orientation: 261.0°
Rated power: -
Panel material: Light textured glass with AR coating

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.282098	-6.375921	96.96	19.88	116.84
2	53.282102	-6.375886	96.96	19.88	116.83
3	53.282041	-6.375864	96.96	19.88	116.83
4	53.282036	-6.375898	96.97	19.88	116.84

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Name: PV array 3 - East Facing
Axis tracking: Fixed (no rotation)
Tilt: 10.0°
Orientation: 81.0°
Rated power: -
Panel material: Light textured glass with AR coating

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.282235	-6.375926	96.94	19.88	116.82
2	53.282240	-6.375892	96.93	19.88	116.80
3	53.282182	-6.375867	96.95	19.88	116.82
4	53.282178	-6.375905	96.95	19.88	116.83

Name: PV array 4 - East Facing
Axis tracking: Fixed (no rotation)
Tilt: 10.0°
Orientation: 81.0°
Rated power: -
Panel material: Light textured glass with AR coating

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.282103	-6.375879	96.96	19.88	116.83
2	53.282106	-6.375844	96.95	19.88	116.82
3	53.282045	-6.375822	96.95	19.88	116.82
4	53.282041	-6.375858	96.96	19.88	116.83

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Route Receptors

Name: Route 1
Path type: Two-way
Azimuthal view angle: 50.0°
Downward view angle: 90.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.281077	-6.374598	97.00	0.00	97.00
2	53.281359	-6.374661	96.73	0.00	96.73
3	53.281633	-6.374727	96.99	0.00	96.99
4	53.281943	-6.374799	97.09	0.00	97.09
5	53.282231	-6.374867	96.97	0.00	96.97
6	53.282696	-6.374975	97.05	0.00	97.05
7	53.283014	-6.375032	97.92	0.00	97.92
8	53.283126	-6.375057	98.01	0.00	98.01

Flight Path Receptors

Name: FP 04
Description:
Threshold height: 15 m
Direction: 40.8°
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	53.293781	-6.453554	98.40	15.00	113.40
Two-mile	53.271895	-6.485199	154.22	127.86	282.08

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Name: FP 10
Description:
Threshold height: 15 m
Direction: 102.2°
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	53.304666	-6.468535	86.24	15.24	101.48
Two-mile	53.310767	-6.515886	73.22	196.94	270.17

Name: FP 22
Description:
Threshold height: 15 m
Direction: 223.3°
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	53.303388	-6.439628	93.36	15.00	108.36
Two-mile	53.324426	-6.406401	65.14	211.90	277.04

Name: FP 28
Description:
Threshold height: 15 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	53.301689	-6.444976	96.05	15.00	111.05
Two-mile	53.295727	-6.397579	106.23	173.51	279.74

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Discrete Observation Point Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	53.281614	-6.375714	97.46	4.80
OP 2	2	53.281289	-6.376324	98.97	4.80
OP 3	3	53.281297	-6.376188	98.88	4.80
OP 4	4	53.281305	-6.376198	98.84	7.80
OP 5	5	53.281296	-6.376312	98.93	7.80
OP 6	6	53.282028	-6.374255	97.06	4.80
OP 7	7	53.281998	-6.374247	97.00	4.80
OP 8	8	53.281998	-6.374245	97.00	7.80
OP 9	9	53.282030	-6.374256	97.02	7.80
OP 10	10	53.281869	-6.374380	97.32	4.80
OP 11	11	53.281906	-6.374389	97.32	4.80
OP 12	12	53.281941	-6.374395	97.14	4.80
OP 13	13	53.281942	-6.374395	97.14	7.80
OP 14	14	53.281908	-6.374389	97.32	7.80
OP 15	15	53.281871	-6.374380	97.32	7.80
16-ATCT	16	53.289506	-6.376782	103.74	50.00
17-ATCT	17	53.305518	-6.441763	93.51	30.00
OP 18	18	53.281572	-6.375834	97.60	7.80
OP 19	19	53.281597	-6.375772	97.49	4.80
OP 20	20	53.281593	-6.375772	97.53	7.80
OP 21	21	53.281567	-6.375835	97.60	4.80
OP 22	22	53.281614	-6.375723	97.46	7.80
OP 23	23	53.281941	-6.374396	97.19	10.80
OP 24	24	53.281906	-6.374389	97.32	10.80
OP 25	25	53.281870	-6.374380	97.32	10.80
OP 26	26	53.281996	-6.374245	97.04	10.80
OP 27	27	53.282032	-6.374254	97.06	10.80
OP 28	28	53.282073	-6.374165	97.18	4.80
OP 29	29	53.282871	-6.375841	97.63	11.80
OP 30	30	53.282873	-6.375844	97.63	14.80
OP 31	31	53.282875	-6.375842	97.63	17.80
OP 32	32	53.282805	-6.375412	97.44	11.80
OP 33	33	53.282830	-6.375416	97.52	14.80
OP 34	34	53.282876	-6.375847	97.66	20.80
OP 35	35	53.282859	-6.375427	97.58	14.80
OP 36	36	53.282902	-6.375438	97.68	20.80
OP 37	37	53.282844	-6.376242	97.76	20.80
OP 38	38	53.282801	-6.376233	97.63	17.80
OP 39	39	53.282773	-6.376220	97.53	14.80
OP 40	40	53.282733	-6.376218	97.36	11.80

Map image of 16-ATCT

Map image of 17-ATCT

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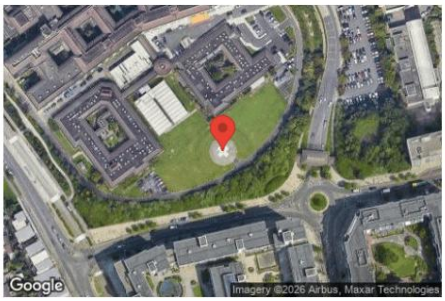

Obstruction Components

Name: Obstruction 2
Top height: 20.6 m

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	53.282349	-6.376125	96.65
2	53.281930	-6.375981	96.65

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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 - West Facing	10.0	261.0	0	0.0	0	0.0	-
PV array 2 - West Facing	10.0	261.0	0	0.0	0	0.0	-
PV array 3 - East Facing	10.0	81.0	35,815	596.9	0	0.0	-
PV array 4 - East Facing	10.0	81.0	24,046	400.8	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
Route 1	0	0.0	0	0.0
FP 04	0	0.0	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
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	2,189	36.5	0	0.0
OP 7	2,264	37.7	0	0.0
OP 8	3,159	52.6	0	0.0
OP 9	2,995	49.9	0	0.0
OP 10	3,061	51.0	0	0.0
OP 11	2,565	42.8	0	0.0
OP 12	2,193	36.5	0	0.0
OP 13	3,710	61.8	0	0.0
OP 14	4,162	69.4	0	0.0
OP 15	4,299	71.7	0	0.0
16-ATCT	0	0.0	0	0.0
17-ATCT	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0
OP 22	0	0.0	0	0.0
OP 23	4,809	80.2	0	0.0
OP 24	4,959	82.7	0	0.0

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Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 25	5,030	83.8	0	0.0
OP 26	3,800	63.3	0	0.0
OP 27	3,455	57.6	0	0.0
OP 28	2,279	38.0	0	0.0
OP 29	0	0.0	0	0.0
OP 30	0	0.0	0	0.0
OP 31	0	0.0	0	0.0
OP 32	0	0.0	0	0.0
OP 33	1,229	20.5	0	0.0
OP 34	0	0.0	0	0.0
OP 35	757	12.6	0	0.0
OP 36	2,946	49.1	0	0.0
OP 37	0	0.0	0	0.0
OP 38	0	0.0	0	0.0
OP 39	0	0.0	0	0.0
OP 40	0	0.0	0	0.0

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PV: PV array 1 - West Facing no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Route 1	0	0.0	0	0.0
FP 04	0	0.0	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
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
16-ATCT	0	0.0	0	0.0
17-ATCT	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0
OP 22	0	0.0	0	0.0
OP 23	0	0.0	0	0.0
OP 24	0	0.0	0	0.0
OP 25	0	0.0	0	0.0
OP 26	0	0.0	0	0.0
OP 27	0	0.0	0	0.0
OP 28	0	0.0	0	0.0
OP 29	0	0.0	0	0.0
OP 30	0	0.0	0	0.0
OP 31	0	0.0	0	0.0
OP 32	0	0.0	0	0.0
OP 33	0	0.0	0	0.0
OP 34	0	0.0	0	0.0

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Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 35	0	0.0	0	0.0
OP 36	0	0.0	0	0.0
OP 37	0	0.0	0	0.0
OP 38	0	0.0	0	0.0
OP 39	0	0.0	0	0.0
OP 40	0	0.0	0	0.0

PV array 1 - West Facing and Route: Route 1

No glare found

PV array 1 - West Facing and FP: FP 04

No glare found

PV array 1 - West Facing and FP: FP 10

No glare found

PV array 1 - West Facing and FP: FP 22

No glare found

PV array 1 - West Facing and FP: FP 28

No glare found

PV array 1 - West Facing and OP 1

No glare found

PV array 1 - West Facing and OP 2

No glare found

PV array 1 - West Facing and OP 3

No glare found

PV array 1 - West Facing and OP 4

No glare found

PV array 1 - West Facing and OP 5

No glare found

PV array 1 - West Facing and OP 6

No glare found

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PV array 1 - West Facing and OP 7

No glare found

PV array 1 - West Facing and OP 8

No glare found

PV array 1 - West Facing and OP 9

No glare found

PV array 1 - West Facing and OP 10

No glare found

PV array 1 - West Facing and OP 11

No glare found

PV array 1 - West Facing and OP 12

No glare found

PV array 1 - West Facing and OP 13

No glare found

PV array 1 - West Facing and OP 14

No glare found

PV array 1 - West Facing and OP 15

No glare found

PV array 1 - West Facing and 16-ATCT

No glare found

PV array 1 - West Facing and 17-ATCT

No glare found

PV array 1 - West Facing and OP 18

No glare found

PV array 1 - West Facing and OP 19

No glare found

PV array 1 - West Facing and OP 20

No glare found

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PV array 1 - West Facing and OP 21
No glare found

PV array 1 - West Facing and OP 22
No glare found

PV array 1 - West Facing and OP 23
No glare found

PV array 1 - West Facing and OP 24
No glare found

PV array 1 - West Facing and OP 25
No glare found

PV array 1 - West Facing and OP 26
No glare found

PV array 1 - West Facing and OP 27
No glare found

PV array 1 - West Facing and OP 28
No glare found

PV array 1 - West Facing and OP 29
No glare found

PV array 1 - West Facing and OP 30
No glare found

PV array 1 - West Facing and OP 31
No glare found

PV array 1 - West Facing and OP 32
No glare found

PV array 1 - West Facing and OP 33
No glare found

PV array 1 - West Facing and OP 34
No glare found

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PV array 1 - West Facing and OP 35

No glare found

PV array 1 - West Facing and OP 36

No glare found

PV array 1 - West Facing and OP 37

No glare found

PV array 1 - West Facing and OP 38

No glare found

PV array 1 - West Facing and OP 39

No glare found

PV array 1 - West Facing and OP 40

No glare found

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PV: PV array 2 - West Facing no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Route 1	0	0.0	0	0.0
FP 04	0	0.0	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
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
16-ATCT	0	0.0	0	0.0
17-ATCT	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0
OP 22	0	0.0	0	0.0
OP 23	0	0.0	0	0.0
OP 24	0	0.0	0	0.0
OP 25	0	0.0	0	0.0
OP 26	0	0.0	0	0.0
OP 27	0	0.0	0	0.0
OP 28	0	0.0	0	0.0
OP 29	0	0.0	0	0.0
OP 30	0	0.0	0	0.0
OP 31	0	0.0	0	0.0
OP 32	0	0.0	0	0.0
OP 33	0	0.0	0	0.0
OP 34	0	0.0	0	0.0

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Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 35	0	0.0	0	0.0
OP 36	0	0.0	0	0.0
OP 37	0	0.0	0	0.0
OP 38	0	0.0	0	0.0
OP 39	0	0.0	0	0.0
OP 40	0	0.0	0	0.0

PV array 2 - West Facing and Route: Route 1

No glare found

PV array 2 - West Facing and FP: FP 04

No glare found

PV array 2 - West Facing and FP: FP 10

No glare found

PV array 2 - West Facing and FP: FP 22

No glare found

PV array 2 - West Facing and FP: FP 28

No glare found

PV array 2 - West Facing and OP 1

No glare found

PV array 2 - West Facing and OP 2

No glare found

PV array 2 - West Facing and OP 3

No glare found

PV array 2 - West Facing and OP 4

No glare found

PV array 2 - West Facing and OP 5

No glare found

PV array 2 - West Facing and OP 6

No glare found

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PV array 2 - West Facing and OP 7
No glare found

PV array 2 - West Facing and OP 8
No glare found

PV array 2 - West Facing and OP 9
No glare found

PV array 2 - West Facing and OP 10
No glare found

PV array 2 - West Facing and OP 11
No glare found

PV array 2 - West Facing and OP 12
No glare found

PV array 2 - West Facing and OP 13
No glare found

PV array 2 - West Facing and OP 14
No glare found

PV array 2 - West Facing and OP 15
No glare found

PV array 2 - West Facing and 16-ATCT
No glare found

PV array 2 - West Facing and 17-ATCT
No glare found

PV array 2 - West Facing and OP 18
No glare found

PV array 2 - West Facing and OP 19
No glare found

PV array 2 - West Facing and OP 20
No glare found

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PV array 2 - West Facing and OP 21
No glare found

PV array 2 - West Facing and OP 22
No glare found

PV array 2 - West Facing and OP 23
No glare found

PV array 2 - West Facing and OP 24
No glare found

PV array 2 - West Facing and OP 25
No glare found

PV array 2 - West Facing and OP 26
No glare found

PV array 2 - West Facing and OP 27
No glare found

PV array 2 - West Facing and OP 28
No glare found

PV array 2 - West Facing and OP 29
No glare found

PV array 2 - West Facing and OP 30
No glare found

PV array 2 - West Facing and OP 31
No glare found

PV array 2 - West Facing and OP 32
No glare found

PV array 2 - West Facing and OP 33
No glare found

PV array 2 - West Facing and OP 34
No glare found

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PV array 2 - West Facing and OP 35

No glare found

PV array 2 - West Facing and OP 36

No glare found

PV array 2 - West Facing and OP 37

No glare found

PV array 2 - West Facing and OP 38

No glare found

PV array 2 - West Facing and OP 39

No glare found

PV array 2 - West Facing and OP 40

No glare found

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

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Route 1	0	0.0	0	0.0
FP 04	0	0.0	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
OP 6	1,175	19.6	0	0.0
OP 7	1,232	20.5	0	0.0
OP 8	1,745	29.1	0	0.0
OP 9	1,626	27.1	0	0.0
OP 10	1,969	32.8	0	0.0
OP 11	1,556	25.9	0	0.0
OP 12	1,264	21.1	0	0.0
OP 13	2,268	37.8	0	0.0
OP 14	2,589	43.1	0	0.0
OP 15	2,569	42.8	0	0.0
OP 23	2,957	49.3	0	0.0
OP 24	2,891	48.2	0	0.0
OP 25	2,599	43.3	0	0.0
OP 26	2,202	36.7	0	0.0
OP 27	1,937	32.3	0	0.0
OP 28	1,202	20.0	0	0.0
OP 33	1,229	20.5	0	0.0
OP 35	757	12.6	0	0.0
OP 36	2,048	34.1	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
16-ATCT	0	0.0	0	0.0
17-ATCT	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0
OP 22	0	0.0	0	0.0
OP 29	0	0.0	0	0.0
OP 30	0	0.0	0	0.0
OP 31	0	0.0	0	0.0

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Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 32	0	0.0	0	0.0
OP 34	0	0.0	0	0.0
OP 37	0	0.0	0	0.0
OP 38	0	0.0	0	0.0
OP 39	0	0.0	0	0.0
OP 40	0	0.0	0	0.0

PV array 3 - East Facing and Route: Route 1

No glare found

PV array 3 - East Facing and FP: FP 04

No glare found

PV array 3 - East Facing and FP: FP 10

No glare found

PV array 3 - East Facing and FP: FP 22

No glare found

PV array 3 - East Facing and FP: FP 28

No glare found

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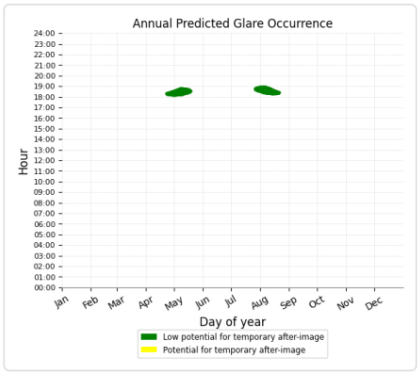
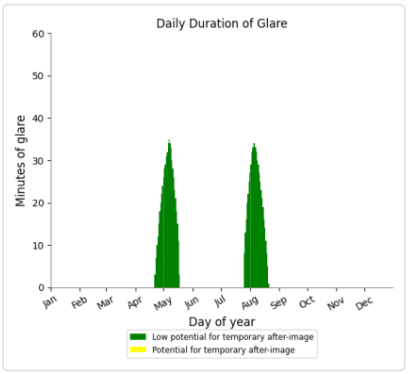
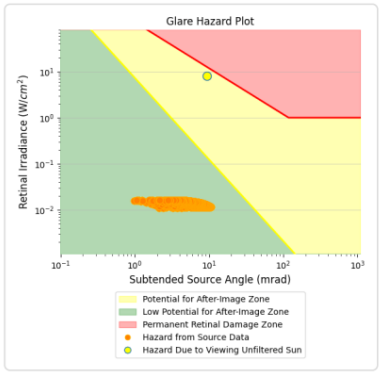
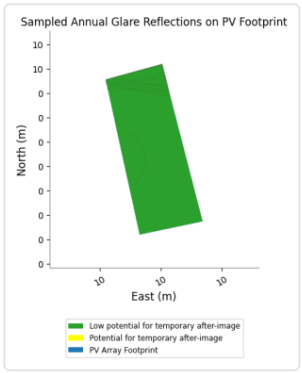
PV array 3 - East Facing and OP 6

Yellow glare: none
Green glare: 1,175 min.









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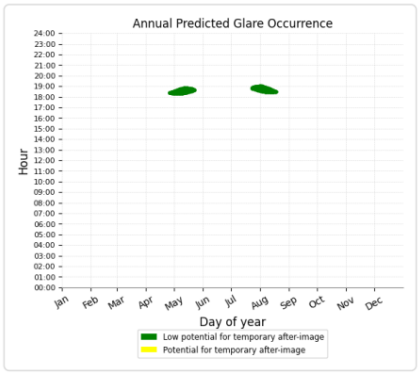
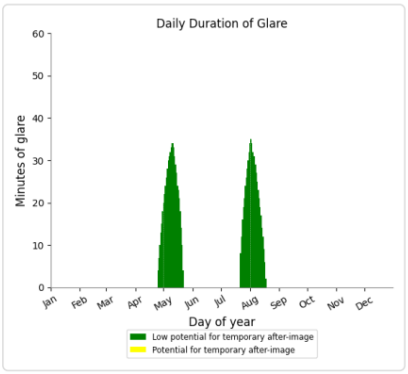
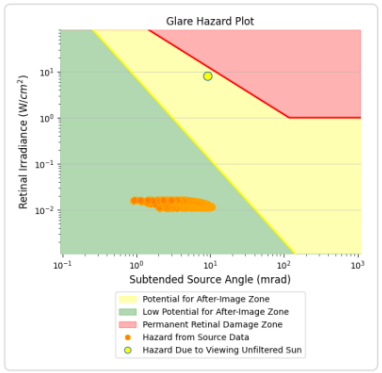
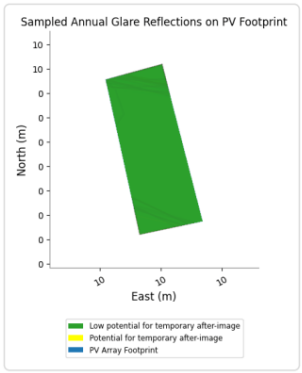
PV array 3 - East Facing and OP 7

Yellow glare: none
Green glare: 1,232 min.









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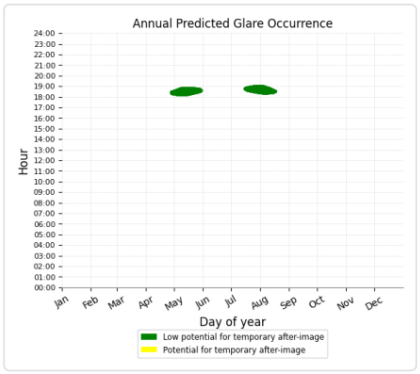
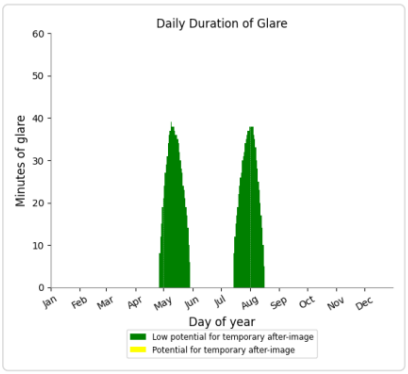
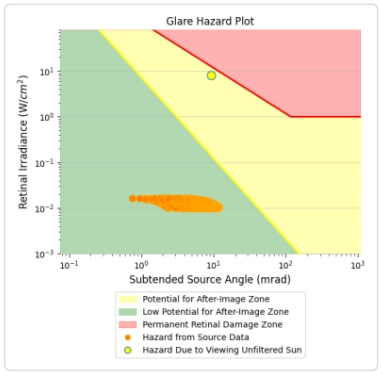
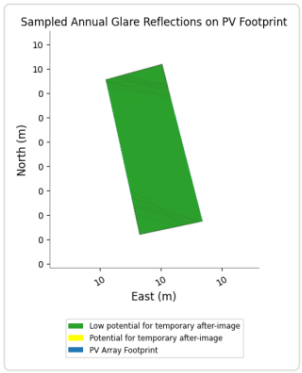
PV array 3 - East Facing and OP 8

Yellow glare: none
Green glare: 1,745 min.









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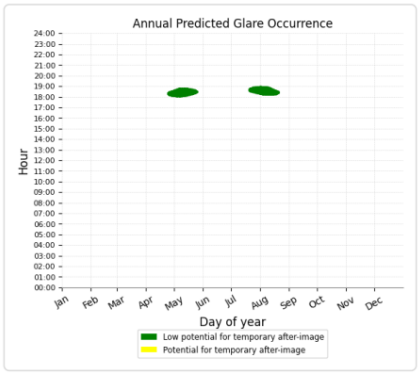
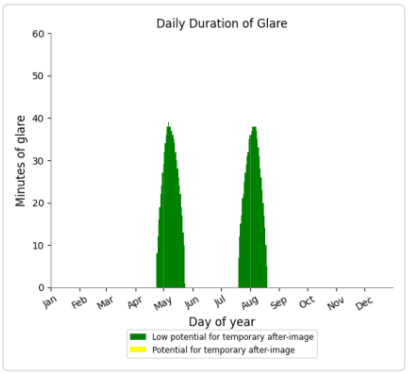
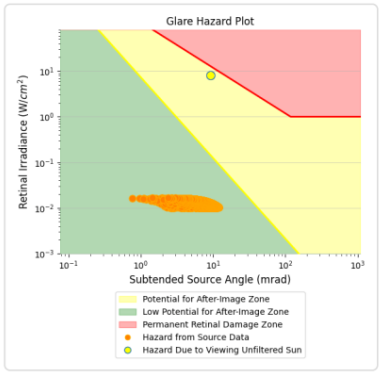
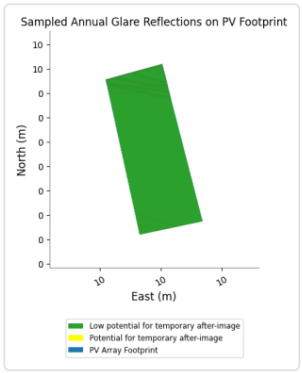
PV array 3 - East Facing and OP 9

Yellow glare: none
Green glare: 1,626 min.









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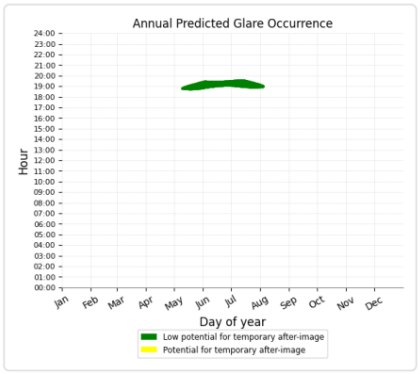
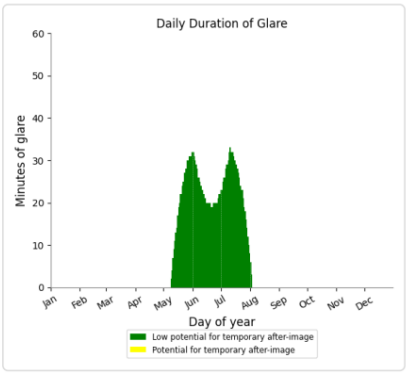
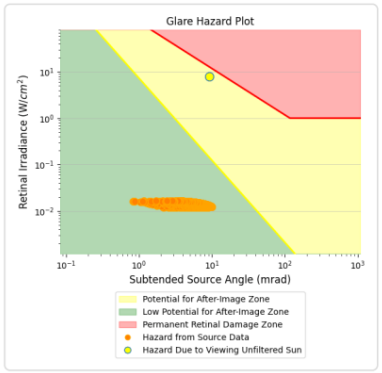
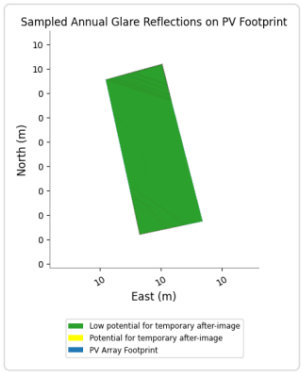
PV array 3 - East Facing and OP 10

Yellow glare: none
Green glare: 1,969 min.









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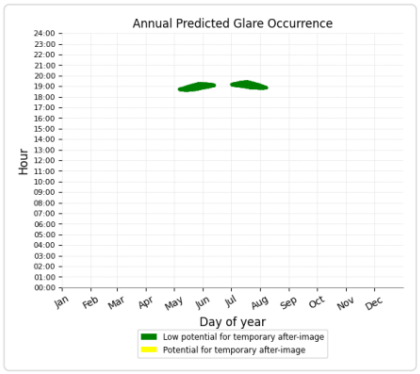
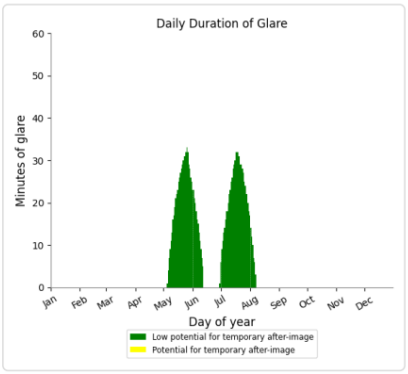
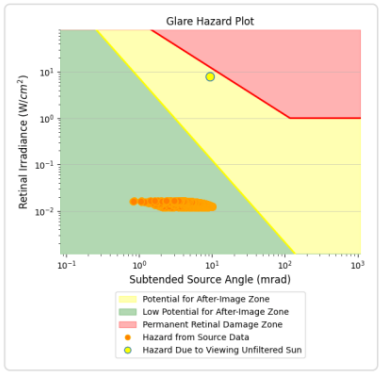
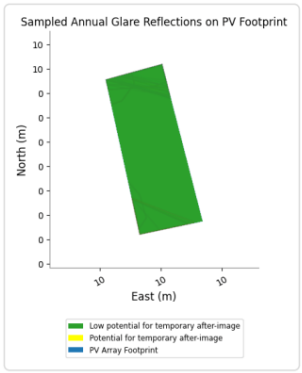
PV array 3 - East Facing and OP 11

Yellow glare: none
Green glare: 1,556 min.









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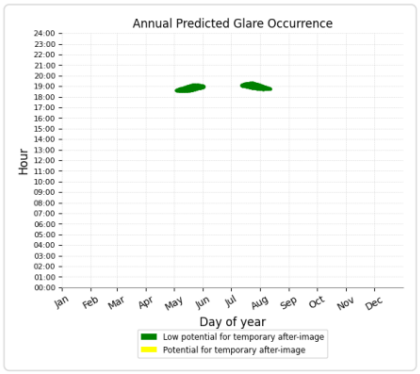
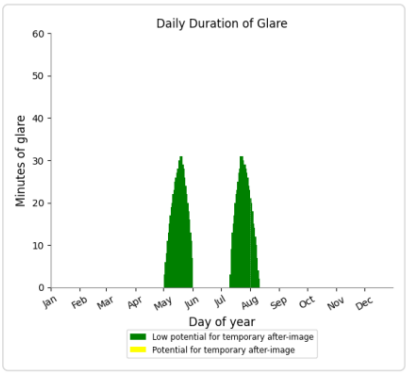
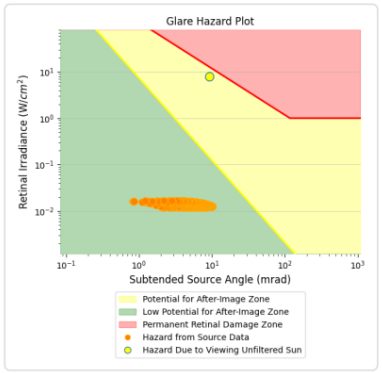
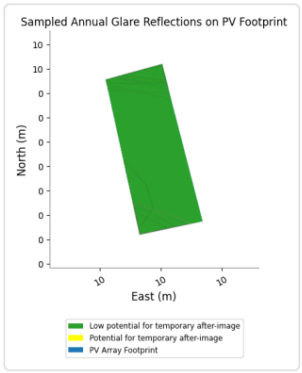
PV array 3 - East Facing and OP 12

Yellow glare: none
Green glare: 1,264 min.









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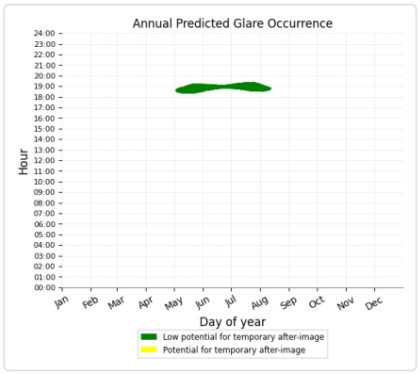
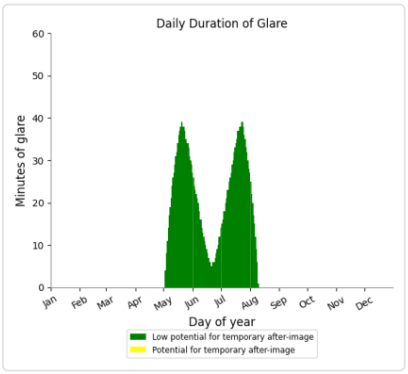
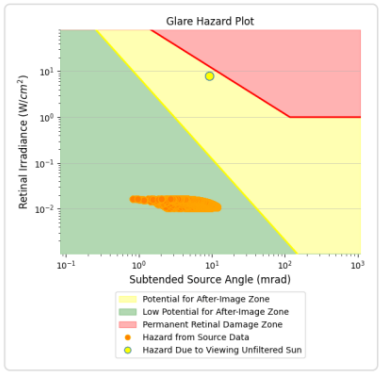
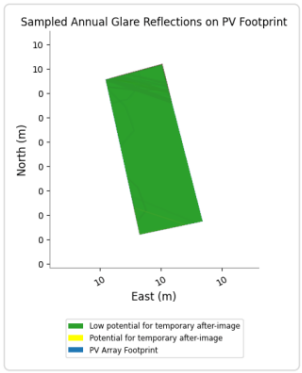
PV array 3 - East Facing and OP 13

Yellow glare: none
Green glare: 2,268 min.









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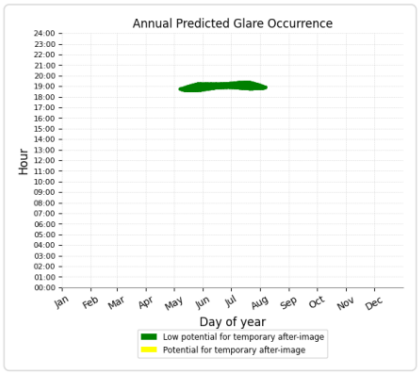
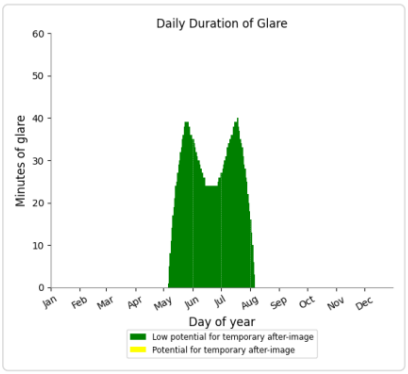
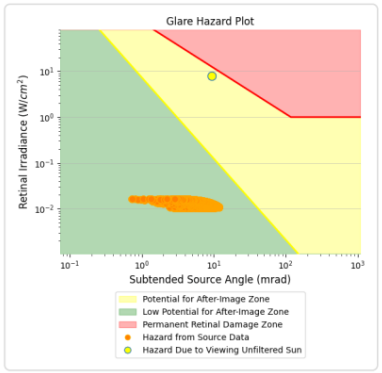
PV array 3 - East Facing and OP 14

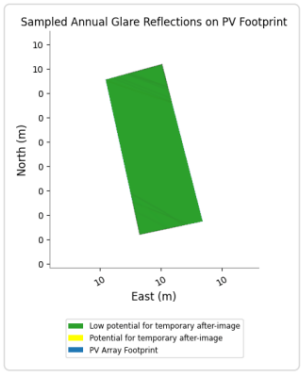
Yellow glare: none

Green glare: 2,589 min.









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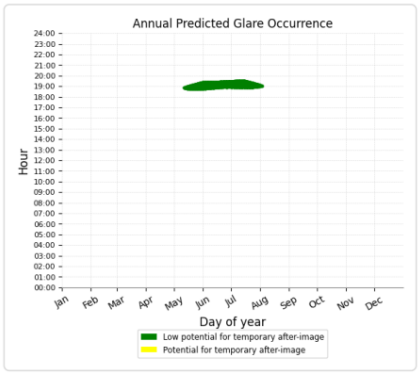
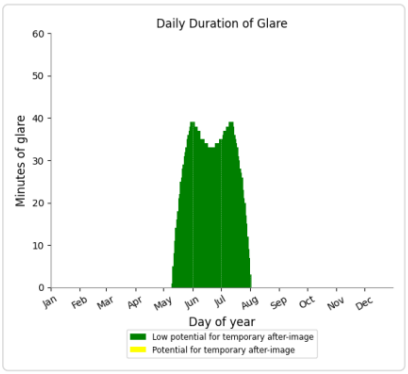
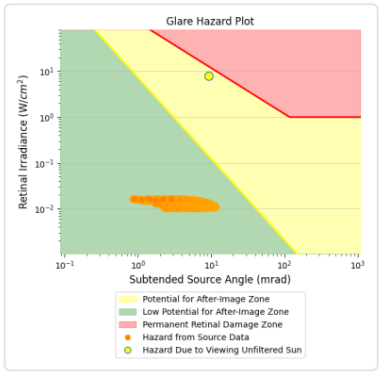
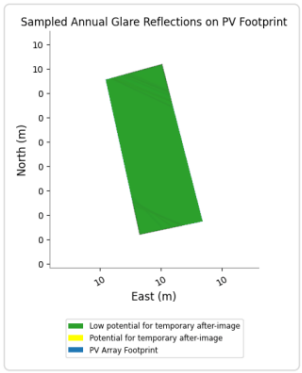
PV array 3 - East Facing and OP 15

Yellow glare: none
Green glare: 2,569 min.









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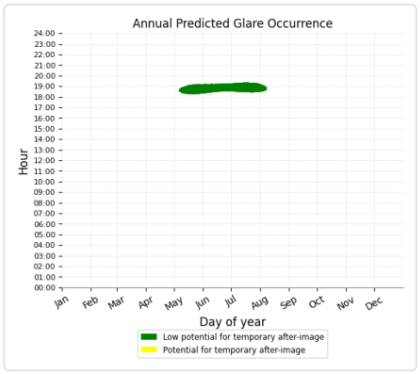
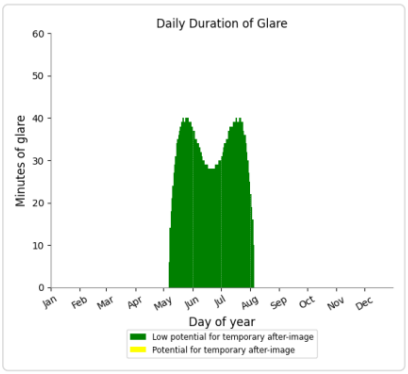
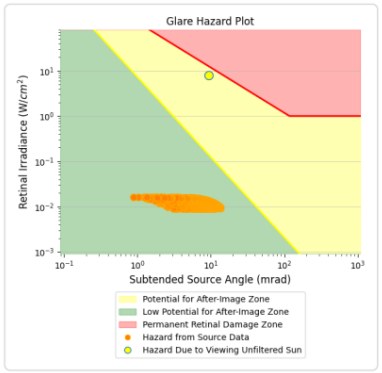
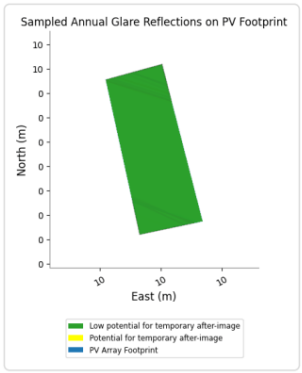
PV array 3 - East Facing and OP 23

Yellow glare: none
Green glare: 2,957 min.









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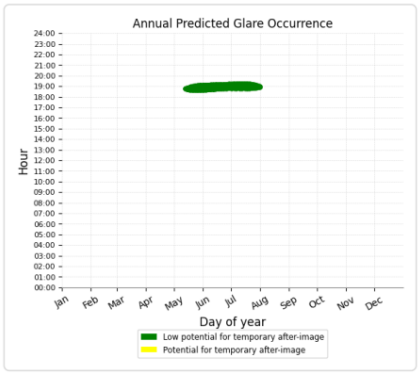
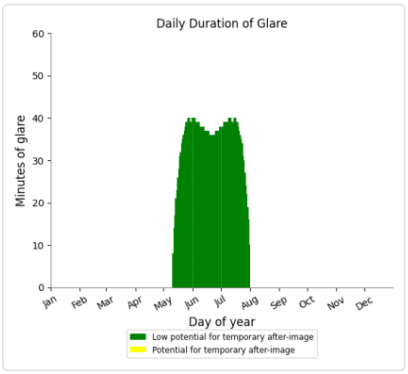
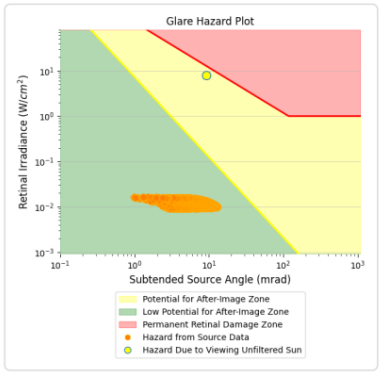
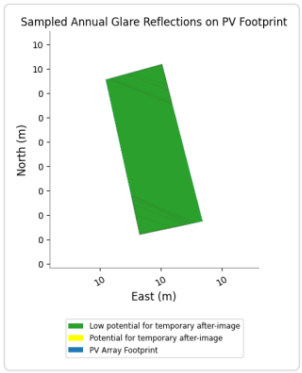
PV array 3 - East Facing and OP 24

Yellow glare: none
Green glare: 2,891 min.









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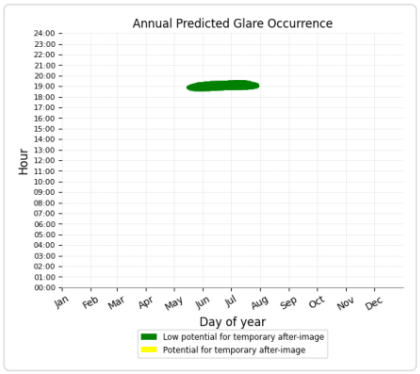
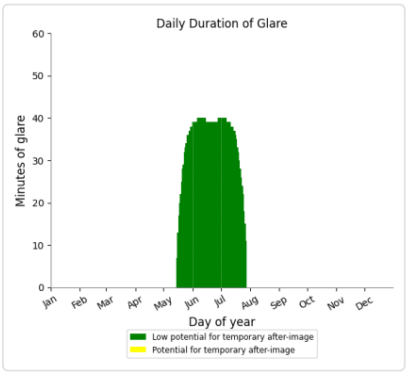
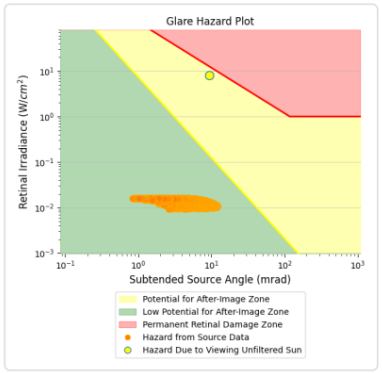
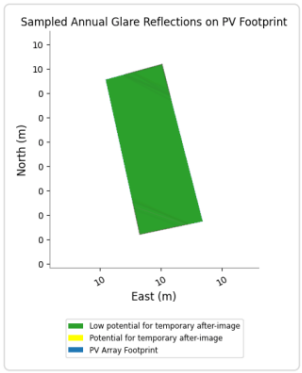
PV array 3 - East Facing and OP 25

Yellow glare: none
Green glare: 2,599 min.









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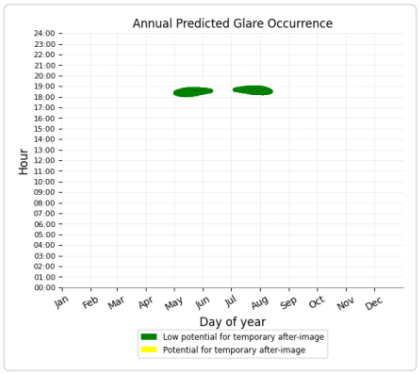
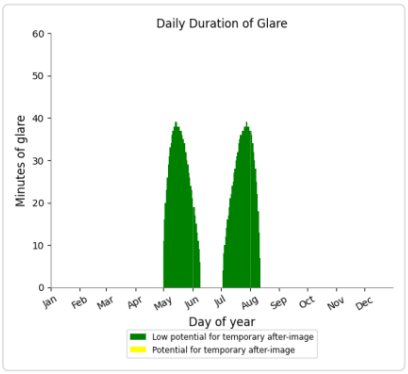
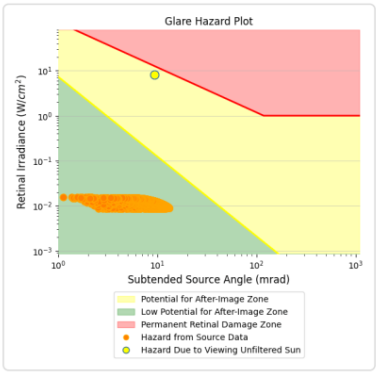
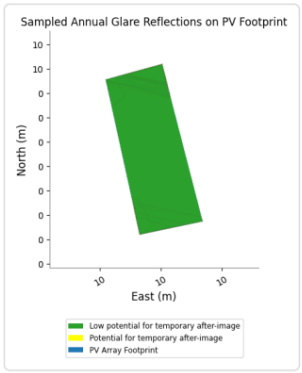
PV array 3 - East Facing and OP 26

Yellow glare: none
Green glare: 2,202 min.









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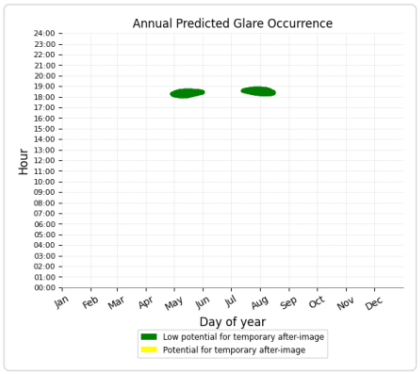
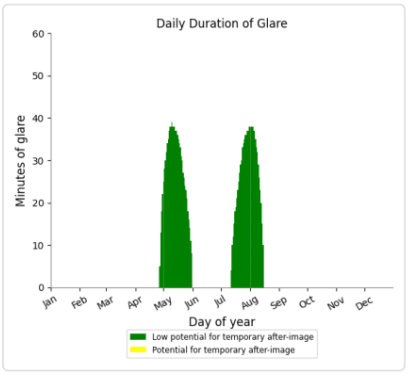
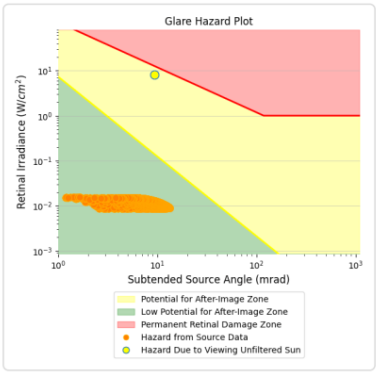
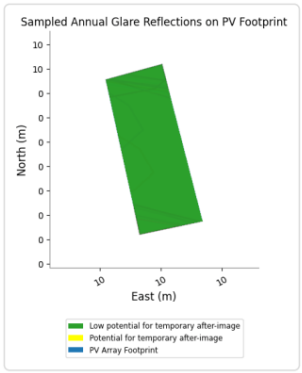
PV array 3 - East Facing and OP 27

Yellow glare: none
Green glare: 1,937 min.









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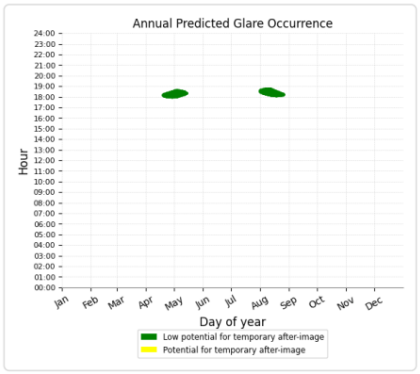
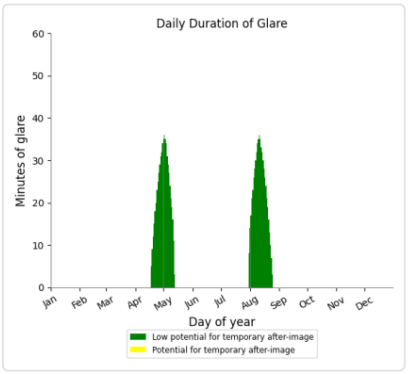
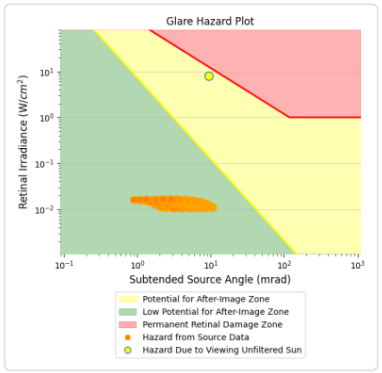
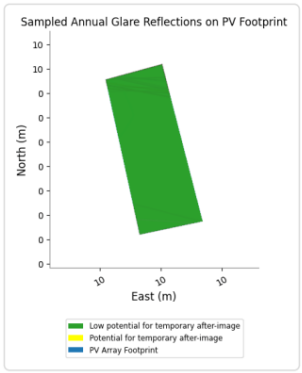
PV array 3 - East Facing and OP 28

Yellow glare: none
Green glare: 1,202 min.









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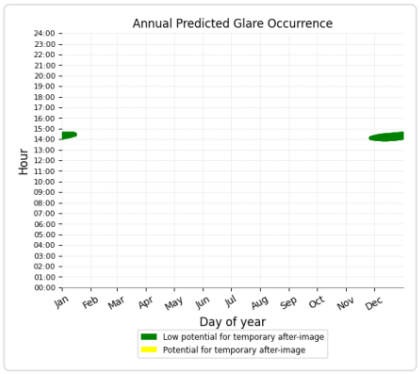
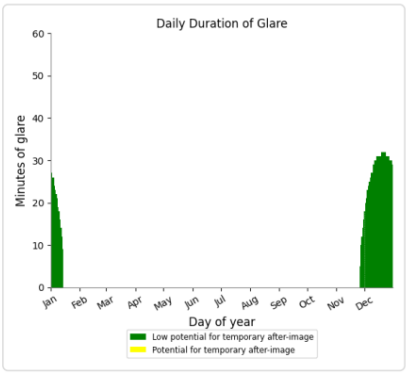
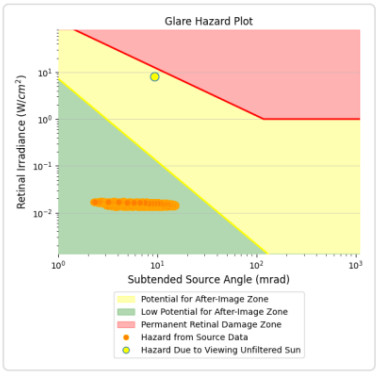
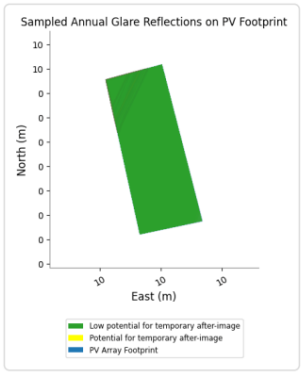
PV array 3 - East Facing and OP 33

Yellow glare: none
Green glare: 1,229 min.









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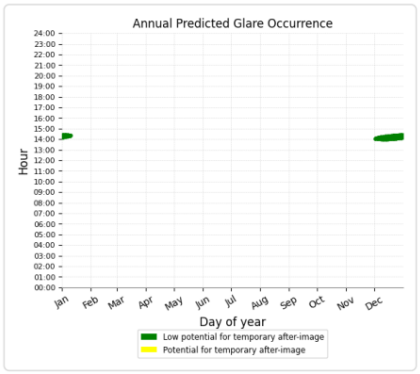
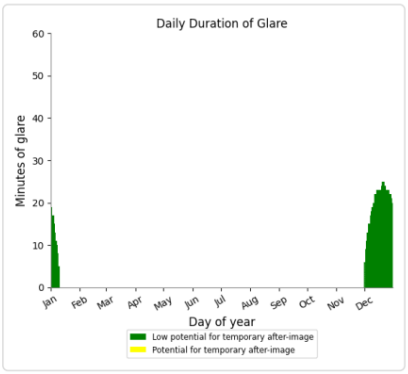
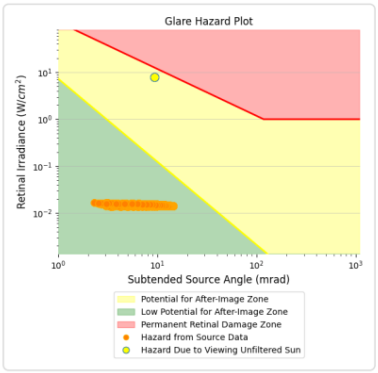
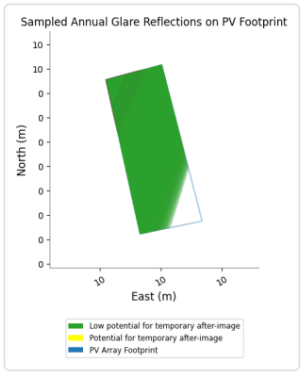
PV array 3 - East Facing and OP 35

Yellow glare: none
Green glare: 757 min.









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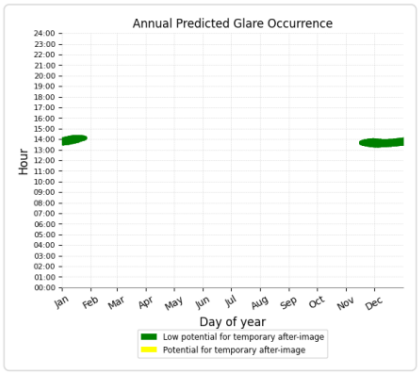
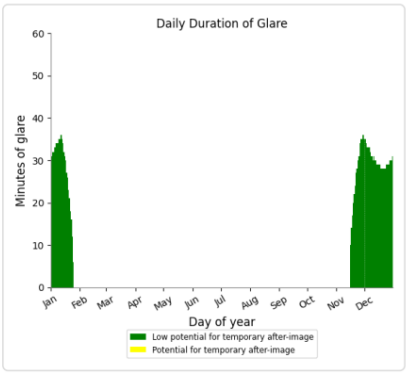
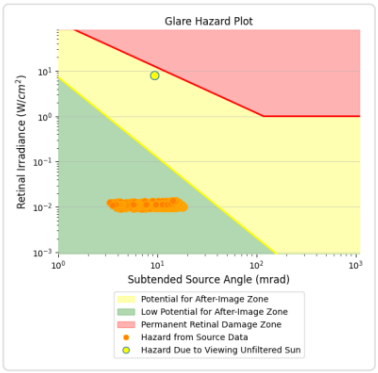
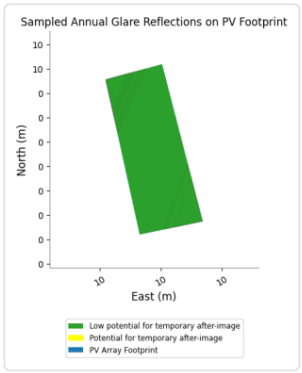
PV array 3 - East Facing and OP 36

Yellow glare: none
Green glare: 2,048 min.









PV array 3 - East Facing and OP 1

No glare found

PV array 3 - East Facing and OP 2

No glare found

PV array 3 - East Facing and OP 3

No glare found

PV array 3 - East Facing and OP 4

No glare found

PV array 3 - East Facing and OP 5

No glare found

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PV array 3 - East Facing and 16-ATCT

No glare found

PV array 3 - East Facing and 17-ATCT

No glare found

PV array 3 - East Facing and OP 18

No glare found

PV array 3 - East Facing and OP 19

No glare found

PV array 3 - East Facing and OP 20

No glare found

PV array 3 - East Facing and OP 21

No glare found

PV array 3 - East Facing and OP 22

No glare found

PV array 3 - East Facing and OP 29

No glare found

PV array 3 - East Facing and OP 30

No glare found

PV array 3 - East Facing and OP 31

No glare found

PV array 3 - East Facing and OP 32

No glare found

PV array 3 - East Facing and OP 34

No glare found

PV array 3 - East Facing and OP 37

No glare found

PV array 3 - East Facing and OP 38

No glare found

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PV array 3 - East Facing and OP 39

No glare found

PV array 3 - East Facing and OP 40

No glare found

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

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Route 1	0	0.0	0	0.0
FP 04	0	0.0	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
OP 6	1,014	16.9	0	0.0
OP 7	1,032	17.2	0	0.0
OP 8	1,414	23.6	0	0.0
OP 9	1,369	22.8	0	0.0
OP 10	1,092	18.2	0	0.0
OP 11	1,009	16.8	0	0.0
OP 12	929	15.5	0	0.0
OP 13	1,442	24.0	0	0.0
OP 14	1,573	26.2	0	0.0
OP 15	1,730	28.8	0	0.0
OP 23	1,852	30.9	0	0.0
OP 24	2,068	34.5	0	0.0
OP 25	2,431	40.5	0	0.0
OP 26	1,598	26.6	0	0.0
OP 27	1,518	25.3	0	0.0
OP 28	1,077	17.9	0	0.0
OP 36	898	15.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
16-ATCT	0	0.0	0	0.0
17-ATCT	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0
OP 22	0	0.0	0	0.0
OP 29	0	0.0	0	0.0
OP 30	0	0.0	0	0.0
OP 31	0	0.0	0	0.0
OP 32	0	0.0	0	0.0
OP 33	0	0.0	0	0.0

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Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 34	0	0.0	0	0.0
OP 35	0	0.0	0	0.0
OP 37	0	0.0	0	0.0
OP 38	0	0.0	0	0.0
OP 39	0	0.0	0	0.0
OP 40	0	0.0	0	0.0

PV array 4 - East Facing and Route: Route 1

No glare found

PV array 4 - East Facing and FP: FP 04

No glare found

PV array 4 - East Facing and FP: FP 10

No glare found

PV array 4 - East Facing and FP: FP 22

No glare found

PV array 4 - East Facing and FP: FP 28

No glare found

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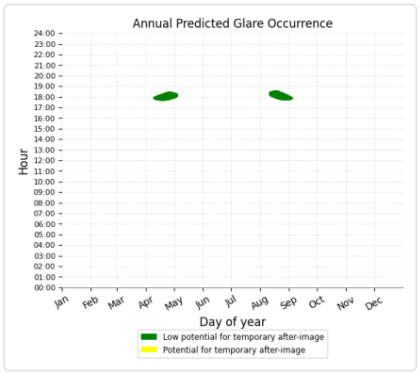
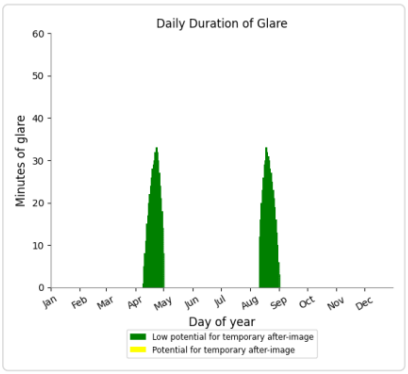
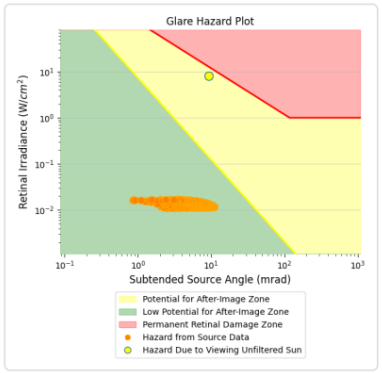
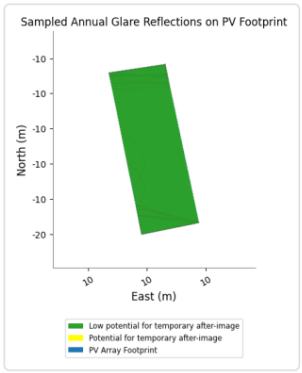
PV array 4 - East Facing and OP 6

Yellow glare: none
Green glare: 1,014 min.









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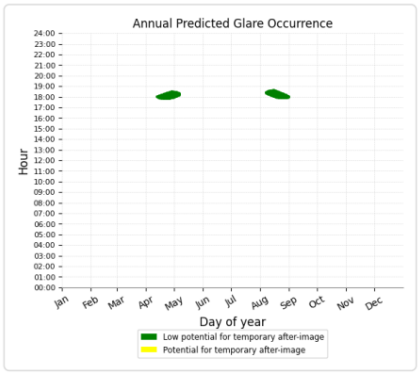
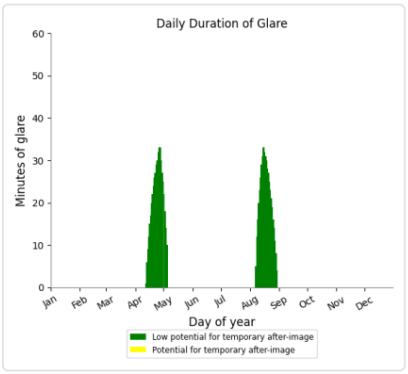
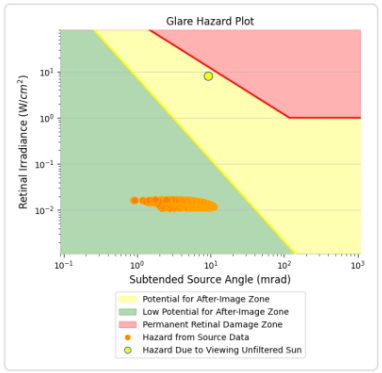
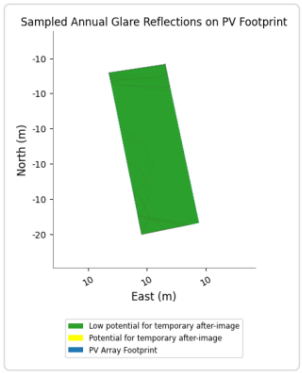
PV array 4 - East Facing and OP 7

Yellow glare: none
Green glare: 1,032 min.









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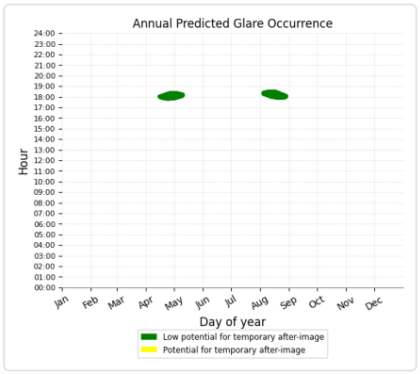
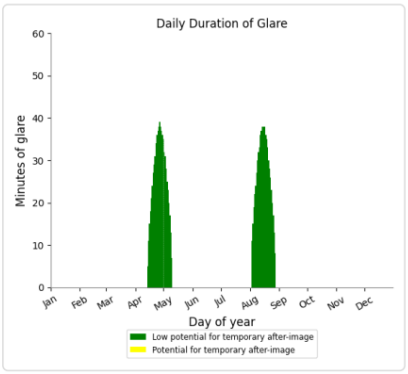
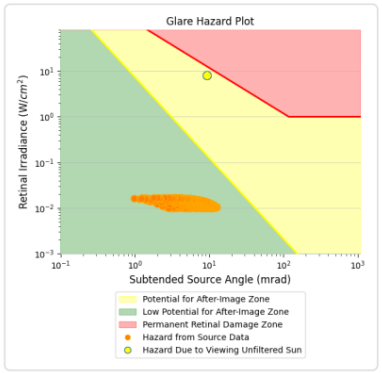
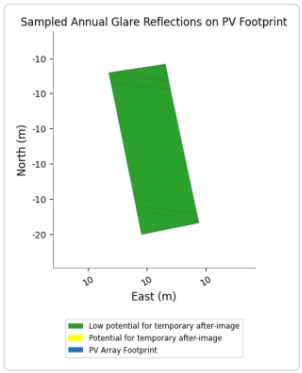
PV array 4 - East Facing and OP 8

Yellow glare: none
Green glare: 1,414 min.









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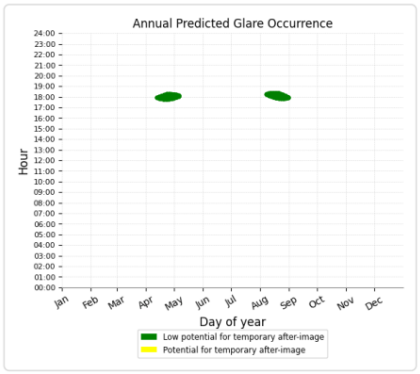
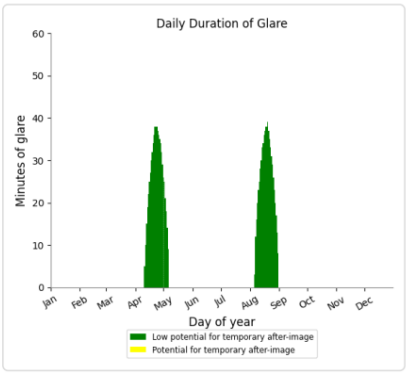
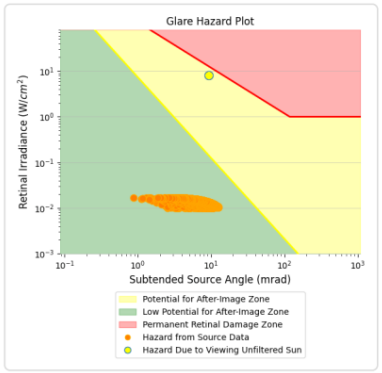
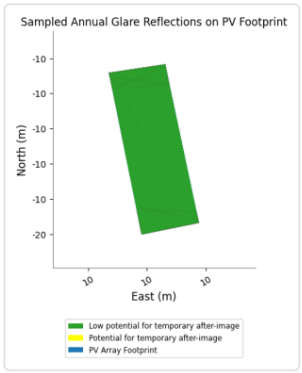
PV array 4 - East Facing and OP 9

Yellow glare: none
Green glare: 1,369 min.









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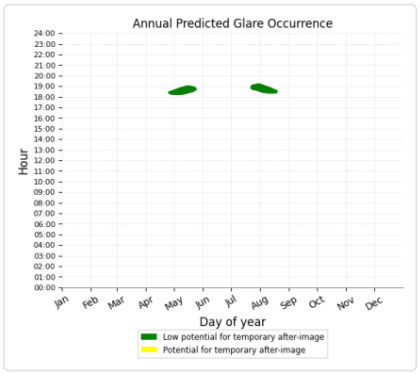
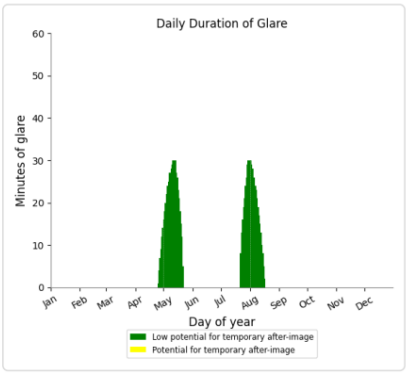
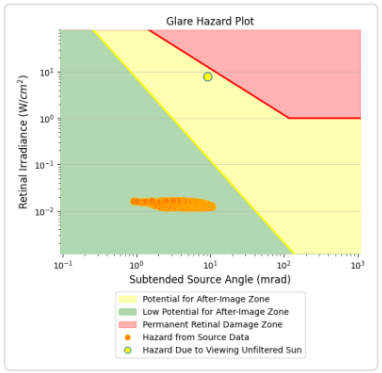
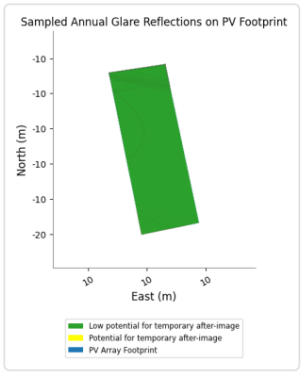
PV array 4 - East Facing and OP 10

Yellow glare: none
Green glare: 1,092 min.









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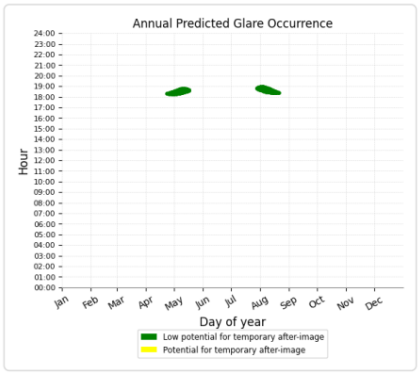
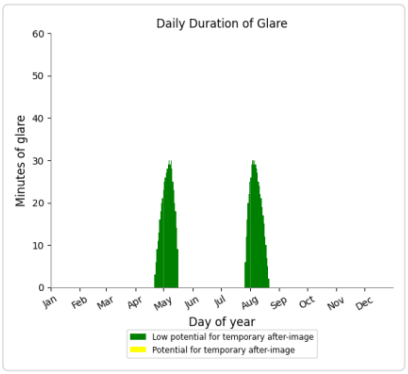
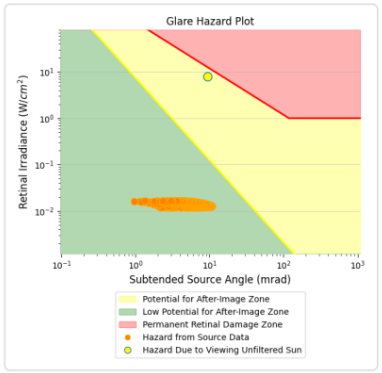
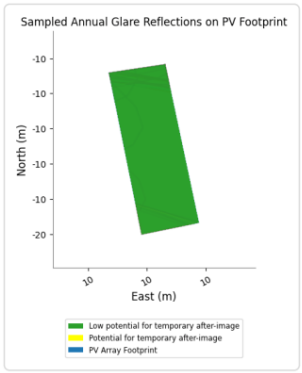
PV array 4 - East Facing and OP 11

Yellow glare: none
Green glare: 1,009 min.









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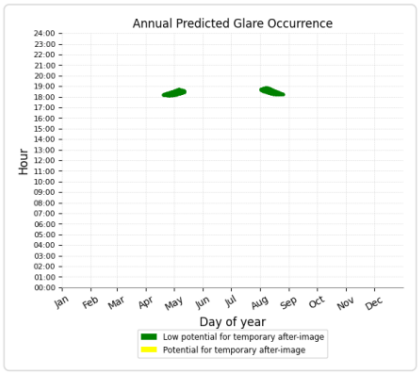
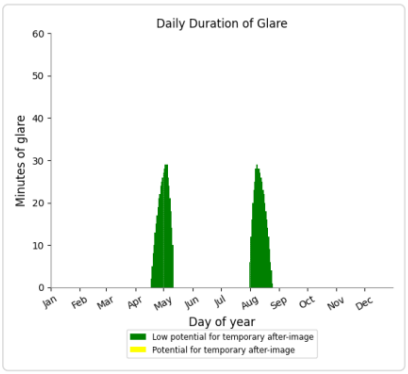
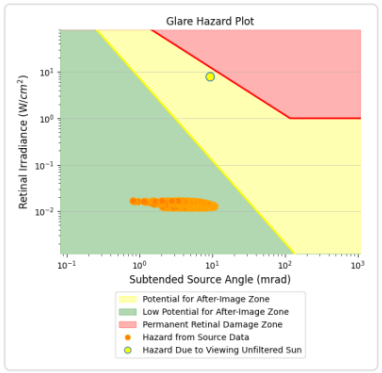
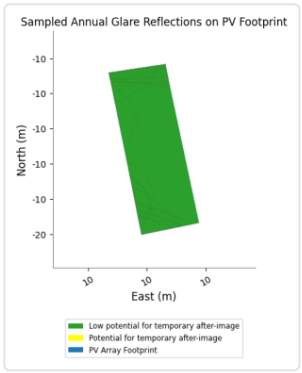
PV array 4 - East Facing and OP 12

Yellow glare: none
Green glare: 929 min.









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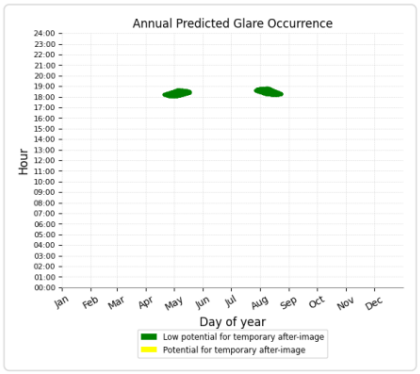
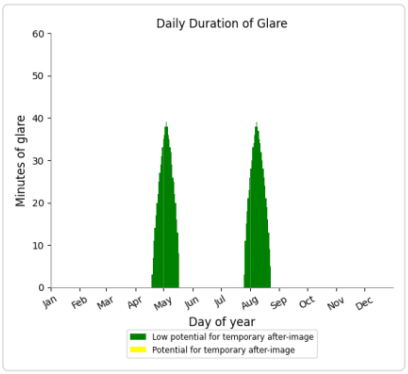
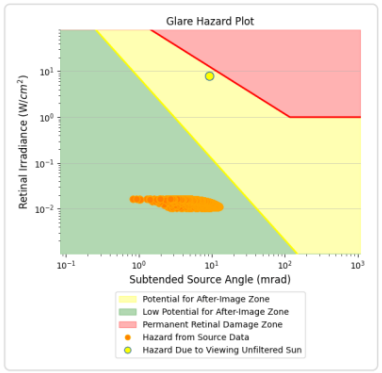
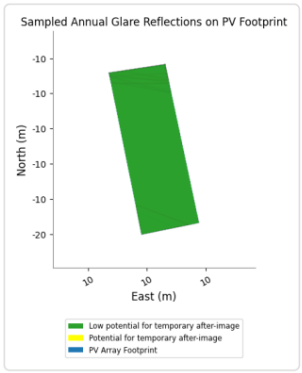
PV array 4 - East Facing and OP 13

Yellow glare: none
Green glare: 1,442 min.









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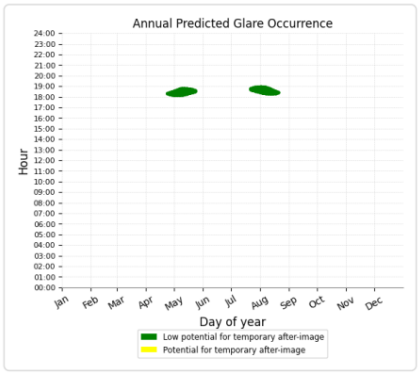
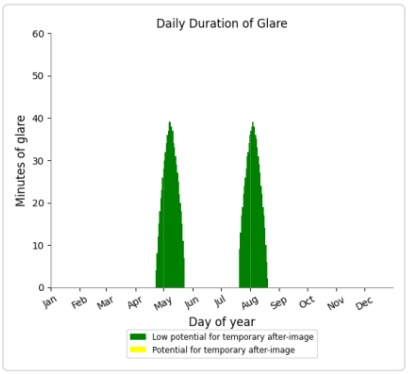
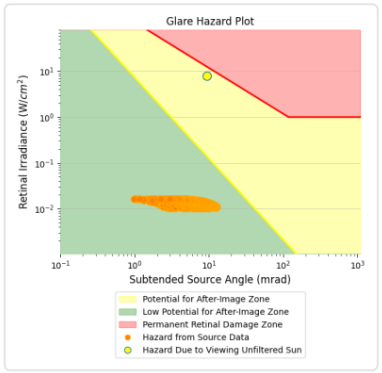
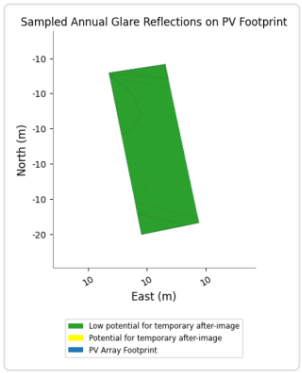
PV array 4 - East Facing and OP 14

Yellow glare: none
Green glare: 1,573 min.









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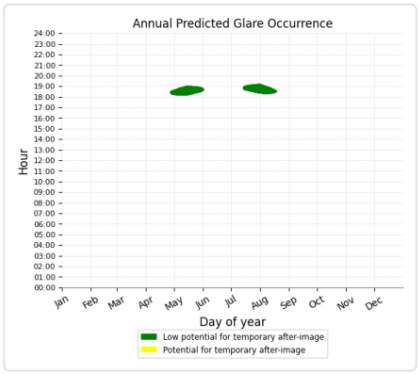
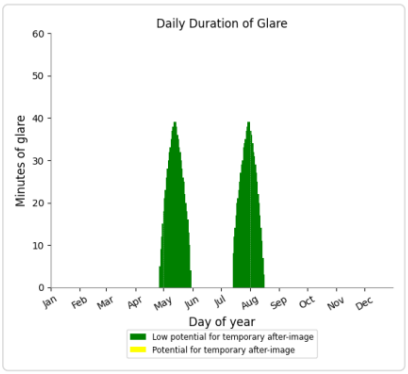
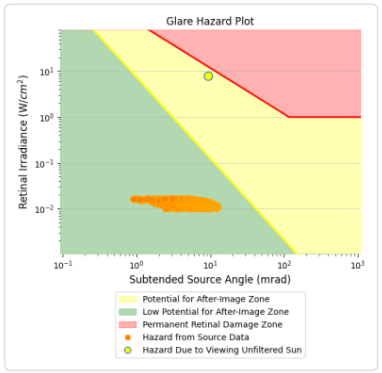
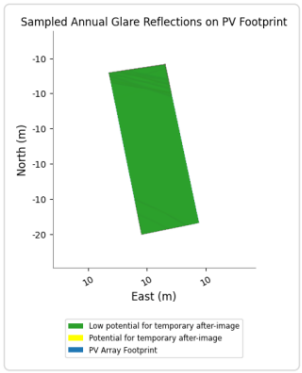
PV array 4 - East Facing and OP 15

Yellow glare: none
Green glare: 1,730 min.









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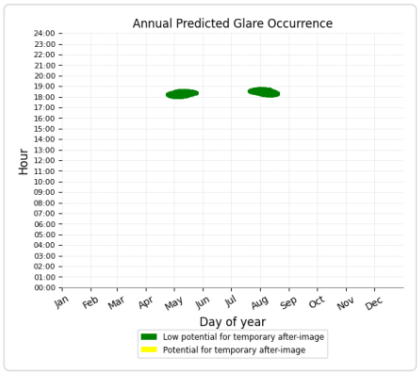
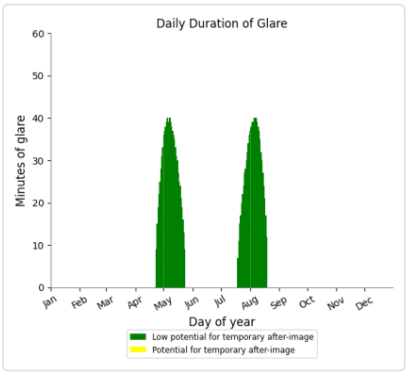
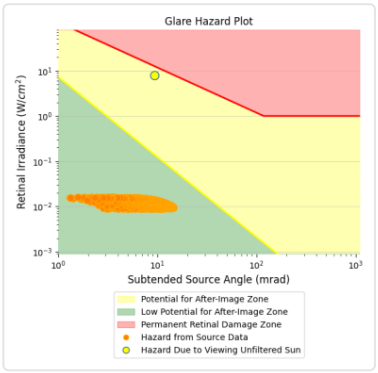
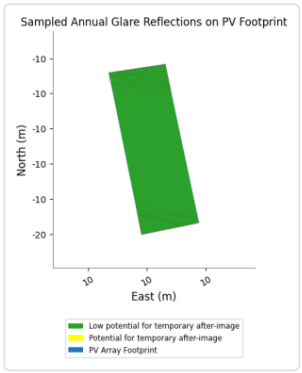
PV array 4 - East Facing and OP 23

Yellow glare: none
Green glare: 1,852 min.









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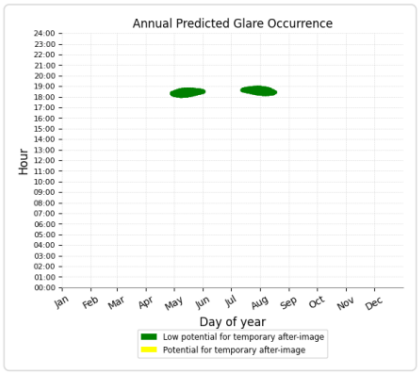
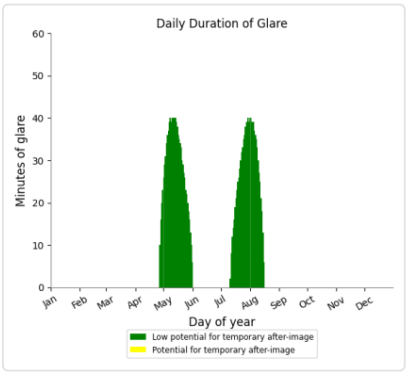
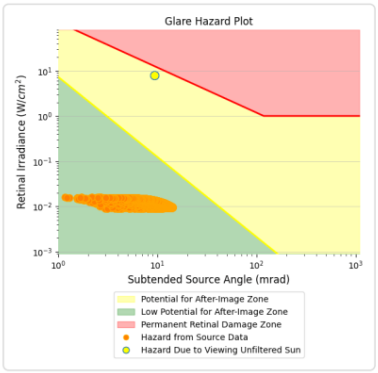
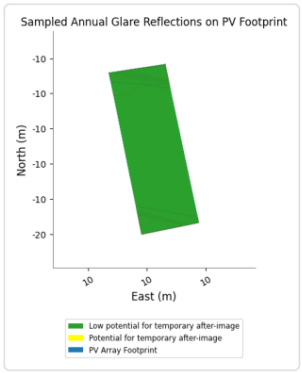
PV array 4 - East Facing and OP 24

Yellow glare: none
Green glare: 2,068 min.









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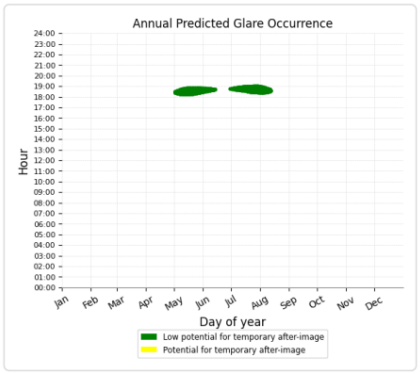
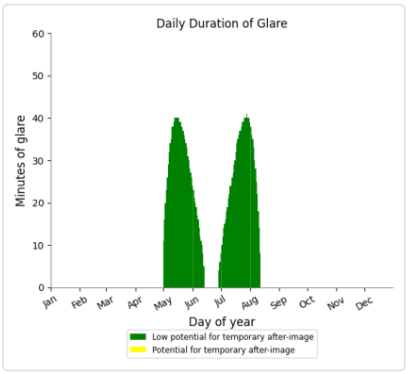
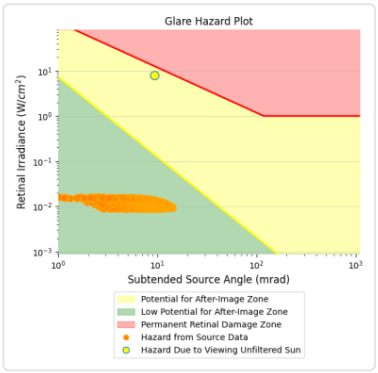
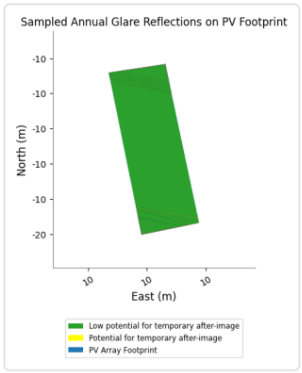
PV array 4 - East Facing and OP 25

Yellow glare: none
Green glare: 2,431 min.









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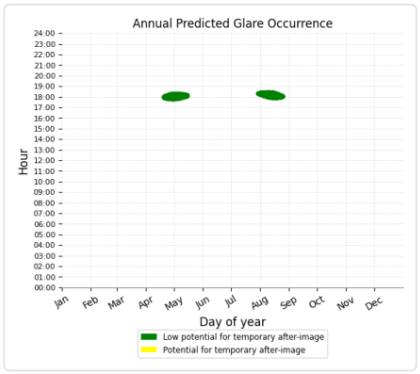
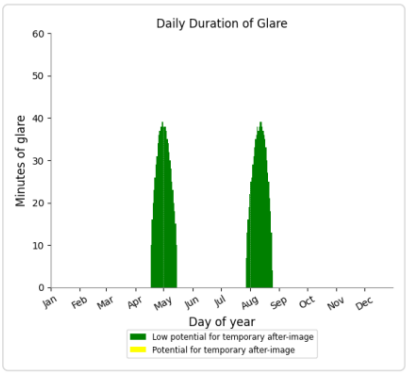
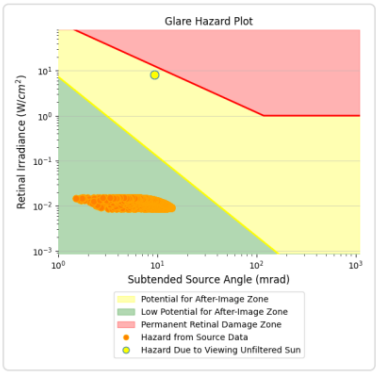
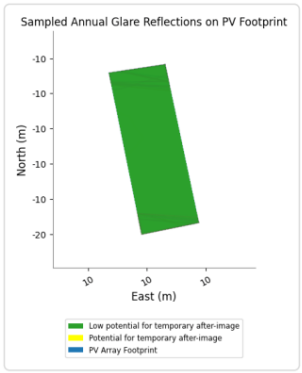
PV array 4 - East Facing and OP 26

Yellow glare: none
Green glare: 1,598 min.









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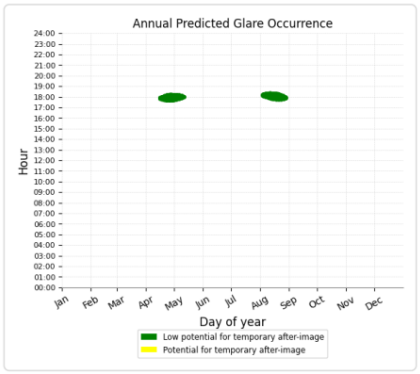
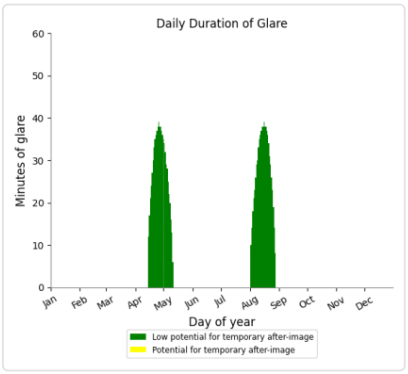
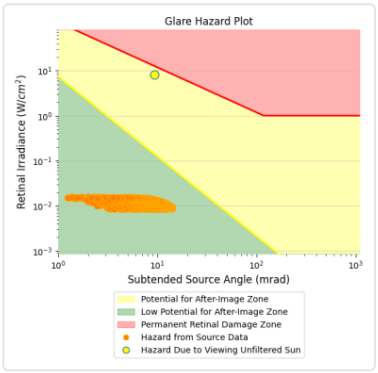
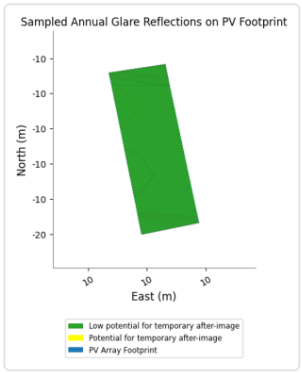
PV array 4 - East Facing and OP 27

Yellow glare: none
Green glare: 1,518 min.









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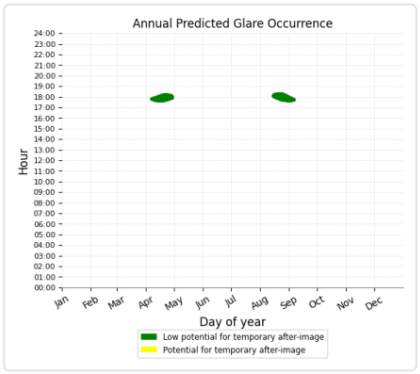
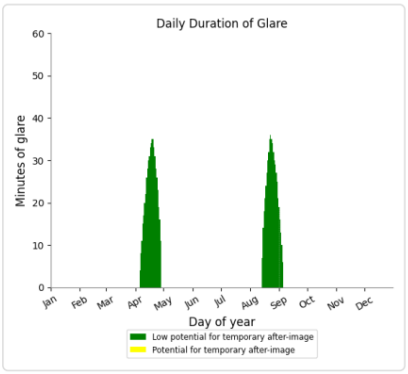
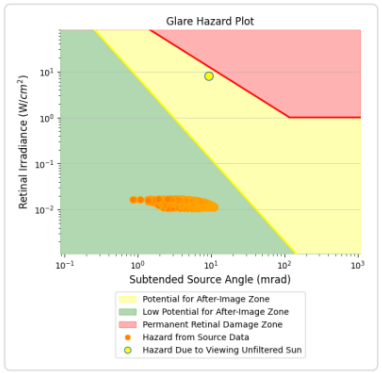
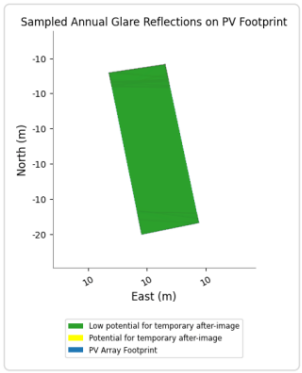
PV array 4 - East Facing and OP 28

Yellow glare: none
Green glare: 1,077 min.









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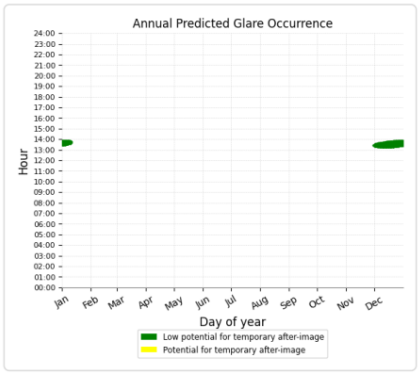
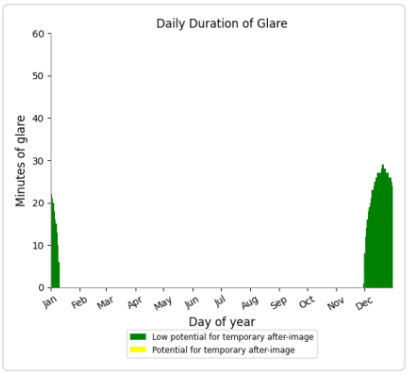
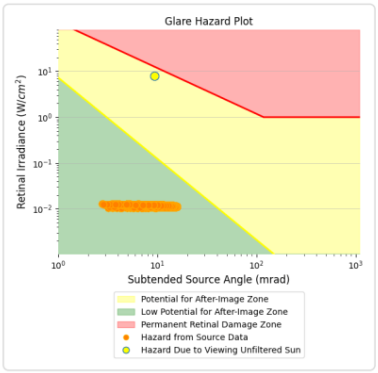
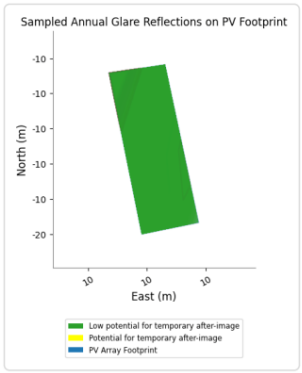
PV array 4 - East Facing and OP 36

Yellow glare: none
Green glare: 898 min.









PV array 4 - East Facing and OP 1

No glare found

PV array 4 - East Facing and OP 2

No glare found

PV array 4 - East Facing and OP 3

No glare found

PV array 4 - East Facing and OP 4

No glare found

PV array 4 - East Facing and OP 5

No glare found

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PV array 4 - East Facing and 16-ATCT

No glare found

PV array 4 - East Facing and 17-ATCT

No glare found

PV array 4 - East Facing and OP 18

No glare found

PV array 4 - East Facing and OP 19

No glare found

PV array 4 - East Facing and OP 20

No glare found

PV array 4 - East Facing and OP 21

No glare found

PV array 4 - East Facing and OP 22

No glare found

PV array 4 - East Facing and OP 29

No glare found

PV array 4 - East Facing and OP 30

No glare found

PV array 4 - East Facing and OP 31

No glare found

PV array 4 - East Facing and OP 32

No glare found

PV array 4 - East Facing and OP 33

No glare found

PV array 4 - East Facing and OP 34

No glare found

PV array 4 - East Facing and OP 35

No glare found

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PV array 4 - East Facing and OP 37

No glare found

PV array 4 - East Facing and OP 38

No glare found

PV array 4 - East Facing and OP 39

No glare found

PV array 4 - East Facing and OP 40

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.
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

This analysis was conducted using the best available radiometric modeling at the time of generation. Future updates to the modeling methodology may yield different results.

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Forgesolar Aviation Report

FORGESOLAR GLARE ANALYSIS

Project: **Whitestown Way, Tallaght**
Site configuration: **Baseline-temp-0**
Calculated via ForgeSolar Radiometric Physics Engine v3.1.2

Created 21 Apr, 2026
Updated 21 Apr, 2026
Time-step 1 minute
Timezone offset UTC0
Minimum sun altitude 0.0 deg
DNI peaks at 1,000.0 W/m^2
Site ID 176480.28170

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

Glare Policy Adherence

The following table estimates 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

This policy may require the following criteria be met for solar energy systems on airport property:

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

ForgeSolar is not affiliated with the U.S. FAA and does not represent or speak officially for the U.S. FAA. ForgeSolar cannot approve or deny projects - results are informational only. Contact the relevant airport and FAA district office for information on policy and requirements.

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

The referenced policy can be read at https://www.federalregister.gov/d/2021-09862

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Component Data

This report includes results for PV arrays and Observation Point ("OP") receptors marked as ATCTs. Components that are not pertinent to the policy, such as routes, flight paths, and vertical surfaces, are excluded.

PV Arrays

Name: PV array 1 - West Facing
Axis tracking: Fixed (no rotation)
Tilt: 10.0°
Orientation: 261.0°
Rated power: -
Panel material: Light textured glass with AR coating

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.282230	-6.375968	96.94	19.88	116.82
2	53.282234	-6.375932	96.94	19.88	116.82
3	53.282176	-6.375911	96.95	19.88	116.83
4	53.282171	-6.375947	96.96	19.88	116.83

Name: PV array 2 - West Facing
Axis tracking: Fixed (no rotation)
Tilt: 10.0°
Orientation: 261.0°
Rated power: -
Panel material: Light textured glass with AR coating

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.282098	-6.375921	96.96	19.88	116.84
2	53.282102	-6.375886	96.96	19.88	116.83
3	53.282041	-6.375864	96.96	19.88	116.83
4	53.282036	-6.375898	96.97	19.88	116.84

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Name: PV array 3 - East Facing
Axis tracking: Fixed (no rotation)
Tilt: 10.0°
Orientation: 81.0°
Rated power: -
Panel material: Light textured glass with AR coating

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.282235	-6.375926	96.94	19.88	116.82
2	53.282240	-6.375892	96.93	19.88	116.80
3	53.282182	-6.375867	96.95	19.88	116.82
4	53.282178	-6.375905	96.95	19.88	116.83

Name: PV array 4 - East Facing
Axis tracking: Fixed (no rotation)
Tilt: 10.0°
Orientation: 81.0°
Rated power: -
Panel material: Light textured glass with AR coating

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.282103	-6.375879	96.96	19.88	116.83
2	53.282106	-6.375844	96.95	19.88	116.82
3	53.282045	-6.375822	96.95	19.88	116.82
4	53.282041	-6.375858	96.96	19.88	116.83

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Observation Point ATCT Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
16-ATCT	16	53.289506	-6.376782	103.74	50.00
17-ATCT	17	53.305518	-6.441763	93.51	30.00

Map image of 16-ATCT

Map image of 17-ATCT

Obstruction Components

Name: Obstruction 2
Top height: 20.6 m

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	53.282349	-6.376125	96.65
2	53.281930	-6.375981	96.65

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Glare Analysis Results

Summary of Results No glare predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV array 1 - West Facing	10.0	261.0	0	0.0	0	0.0	-
PV array 2 - West Facing	10.0	261.0	0	0.0	0	0.0	-
PV array 3 - East Facing	10.0	81.0	0	0.0	0	0.0	-
PV array 4 - East Facing	10.0	81.0	0	0.0	0	0.0	-

Total annual 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
16-ATCT	0	0.0	0	0.0
17-ATCT	0	0.0	0	0.0

PV: PV array 1 - West Facing

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
16-ATCT	0	0.0	0	0.0
17-ATCT	0	0.0	0	0.0

PV array 1 - West Facing and 16-ATCT

Receptor type: ATCT Observation Point
No glare found

PV array 1 - West Facing and 17-ATCT

Receptor type: ATCT Observation Point
No glare found

PV: PV array 2 - West Facing

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
16-ATCT	0	0.0	0	0.0
17-ATCT	0	0.0	0	0.0

PV array 2 - West Facing and

PV array 2 - West Facing and

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16-ATCT

Receptor type: ATCT Observation Point
No glare found

17-ATCT

Receptor type: ATCT Observation Point
No glare found

PV: PV array 3 - East Facing

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
16-ATCT	0	0.0	0	0.0
17-ATCT	0	0.0	0	0.0

PV array 3 - East Facing and 16-ATCT

Receptor type: ATCT Observation Point
No glare found

PV array 3 - East Facing and 17-ATCT

Receptor type: ATCT Observation Point
No glare found

PV: PV array 4 - East Facing

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
16-ATCT	0	0.0	0	0.0
17-ATCT	0	0.0	0	0.0

PV array 4 - East Facing and 16-ATCT

Receptor type: ATCT Observation Point
No glare found

PV array 4 - East Facing and 17-ATCT

Receptor type: ATCT Observation Point
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