Solar Photovoltaic Glint and Glare Study

Aviation, Road, Rail and Residential Receptors

Cherry Orchard Point

October 2023

Executive Summary

This report assesses the potential for ocular impact of glare emanating from sunlight reflections from proposed rooftop solar PV panels on multistorey buildings and duplex residences at the proposed and its potential to cause an impact to;

- aviation users of the nearby aviation facilities at Casement Aerodrome, Weston Airport and Tallaght Hospital Helipad
- drivers of cars transiting the M50 motorway to the west of the site, and the R134 road to the south, within 500m of the extent of the site
- operators of trains transiting the railway to the south of the site, within 500m of the extent of the site
- occupants of residences in the vicinity of the site, within 500m

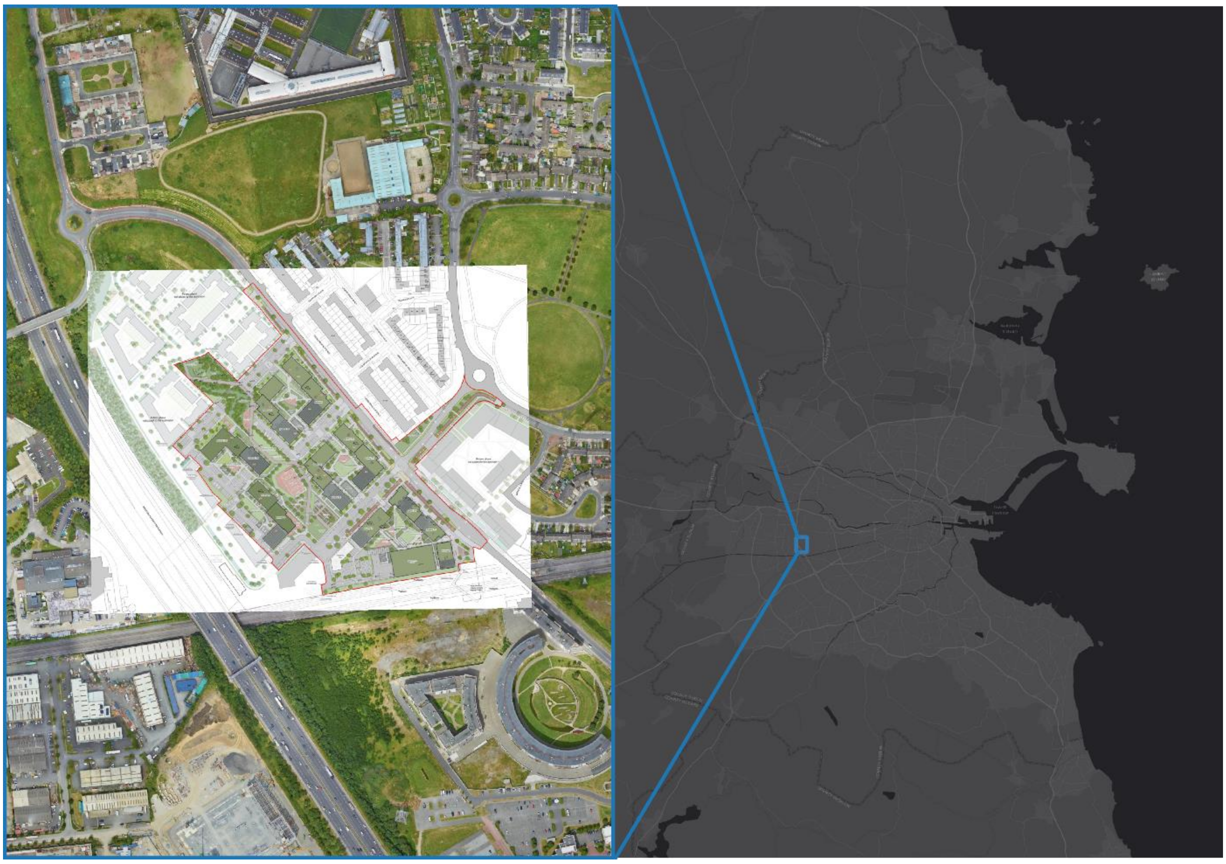

FIGURE 1 OVERVIEW MAP OF STUDY AREA

Cherry Orchard Point is a new, large mixed-use residential development to be located on a greenfield site beside Park West Avenue and the Park West/Cherry Orchard railway station.

For this analysis, the following aviation facilities were considered:

TABLE 1 AVIATION RECEPTORS ANALYSED

Location	Name	Type
Weston Airport	ATC-T	ATC Tower
	Runway 07	2-mile approach path
	Runway 25	2-mile approach path
Casement Aerodrome	ATC-T	ATC Tower
	Runway 23	2-mile approach path
	Runway 05	2-mile approach path
	Runway 29	2-mile approach path
	Runway 11	2-mile approach path
Tallaght Hospital Helipad	Approach from North	2-mile approach path
	Approach from East	2-mile approach path
	Approach from South	2-mile approach path
	Approach from West	2-mile approach path

Using sun-path algorithms for every minute of the year, it was calculated if and when hazardous glare for users of nearby airports, aerodromes or landing pads may theoretically occur at a particular receptor.

The level of potential glare from solar PV panels is similar to that of water and much less than that of materials such as concrete and vegetation. Many common elements of the Irish landscape offer similar, if not higher levels of glare than that caused by solar PV systems such as shed roofs, poly-tunnels and still lakes.

The following non-aviation receptors were considered;

Location	Name	Type
Railway Receptors	Eastbound Line	View from train operator's cab
	Westbound Line	View from train operator's cab
Roadway Receptors	M50 Northbound	View from driver's perspective
	M50 Southbound	View from driver's perspective
Residential Receptors	Houses	View from windows with visibility of arrays
	Apartments	View from windows with visibility of arrays
	Hotel	View from windows with visibility of arrays

The Republic of Ireland does not have a statutory policy on Glint and Glare, therefore the assessment has been considered on the basis of International Guidance and Best Practise policies, including the US Federal Aviation Administration's "Technical Guidance for Evaluating Selected Solar Technologies on Airports"[1] and more recently, "Review of Solar Energy System Projects on Federally-Obligated Airports, 2021"[2] which clarifies interim guidance released in 2013 with respect to the evaluation of glint and glare hazard for aviation purposes[3]. The 2013 interim guidance recommended the use of the Solar Glare Hazard Analysis Tool (SGHAT) for the consideration of whether a solar photovoltaic array could cause an aviation hazard across both Air Traffic Control towers and pilots on approach paths to runways. These two documents have been considered in the formulation of this

[1] https://www.faa.gov/airports/environmental/policy_guidance/media/FAA-Airport-Solar-Guide-2018.pdf

[2] https://www.federalregister.gov/documents/2021/05/11/2021-09862/federal-aviation-administration-policy-review-of-solar-energy-system-projects-on-federally-obligated

3 Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports, 2013 <https://www.federalregister.gov/documents/2013/10/23/2013-24729/interim-policy-faa-review-of-solar-energy-system-projects-on-federally-obligated-airports>

analysis, and more detail on this guidance can be found in the “Relevant Guidance and Studies” Section.

Aviation Receptor Results

For all arrays assessed, it was found that the proposed arrays **did not pose a theoretical glare hazard** for any of the following;

- Tallaght Hospital Helipad Approach Paths from the following directions;
    - North
    - East
    - South
    - West
- The Weston Airport 2-mile approach paths for;
    - Runway 07
    - Runway 25
- The Weston Airport Air Traffic Control Tower
- The Casement Aerodrome 2-mile approach paths for;
    - Runway 23
    - Runway 05
    - Runway 29
    - Runway 11
- The Casement Aerodrome Air Traffic Control Tower

Non-Aviation Receptor Results

For the road receptors assessed, negligible potential for hazardous glare arising from the proposed development at Cherry Orchard Point was found.

For the rail receptors assessed, negligible potential for hazardous glare arising from the proposed development at Cherry Orchard Point was found.

For the residential receptors assessed, no potential for nuisance glare arising from the proposed development at Cherry Orchard Point was found.

Conclusion

The analysis has concluded that **it is reasonable to determine that there is no potentially hazardous glint and glare effects to aviation receptors** caused by the proposed development of solar PV arrays at Cherry Orchard Point.

Furthermore, the analysis has concluded that;

- **there is negligible potential for hazardous glint and glare effects to roadway receptors**
- **there is negligible potential for hazardous glint and glare effects to railway receptors**
- **there is no potential for disturbance caused by glare to residential amenity**

arising from the proposed development of solar PV arrays at Cherry Orchard Point.

Table 2 outlines the results of the analysis, across all receptor / solar PV array combinations, for any sources that are predicted to cause glare.

TABLE 2 SUMMARY RESULTS OF GLINT AND GLARE ANALYSIS

Location	Name	Result
Weston Airport	ATC-T	No Glare
	Runway 07	Green Glare
	Runway 25	
Casement Aerodrome	ATC-T	No Glare
	Runway 23	Green Glare
	Runway 05	
	Runway 29	
	Runway 11	
Tallaght Hospital Helipad	Approach from North	Green Glare
	Approach from East	
	Approach from South	
	Approach from West	
Railway Receptors	Eastbound Line	Negligible Glare (10mins max daily glare)
	Westbound Line	Negligible Glare (10mins max daily glare)
Roadway Receptors	M50 Northbound	Negligible Glare (10mins max daily glare)
	M50 Southbound	Negligible Glare (10mins max daily glare)
Residential Receptors	Houses	15 mins max daily glare
	Apartments	15 mins max daily glare
	Hotel	15 mins max daily glare

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Introduction

LINT has been appointed by The Land Development Agency to carry out an aviation specific glint and glare study for roof mounted solar PV panels for the proposed large-scale residential development at Cherry Orchard, Dublin 10.

LINT is a leading geospatial and data analysis company. Our innovative team has over five years' experience in the GIS sector, working on a wide range of analysis and optimisation projects across the public and private sector, including numerous wind and solar farms, both in Ireland and abroad.

Using desk-based analysis, this report has assessed the potential for glare on aircraft taking off and landing at Weston Airport, and the Air Traffic Control Tower at this facility. Using sun-path algorithms for every minute of the year (assuming 100% sunshine for all daylight hours), it is determined if and when reflections may occur at these selected receptors. If reflection is found geometrically possible from a particular location, further analysis is then carried out. This further analysis determines the significance of the glare that could potentially be experienced and if, in reality, these effects are likely to be experienced by an observer at that location. In certain cases, where glare is found to be significant and a likely source of hazard or nuisance, mitigation factors can then be recommended.

Proposed Solar PV Array and Receptor Details

Solar PV Array Details

The overall development at Cherry Orchard Point, on completion of all phases, is expected to comprise approximately 1100 dwellings and c.23,400 sqm of retail, community, and cultural floor space.

Planning Application Phase 1 of Cherry Orchard Point will comprise:

- 677dwellings, of which there will be;
    - 290 no. 1 bedroom apartments
    - 341 no. 2 bedroom apartments
    - 46 no. 3 bedroom apartments
- 651 sqm creche with capacity for 91 children
- 2031 sqm anchor supermarket
- 394 sqm of complementary retail space
- 2539 sqm of internal and external community and cultural space
- New civic plaza and public bicycle parking
- Bio-diverse, natural open spaces
- Community garden
- 'Active' open space and ball courts for kick-about and games

The majority of the units will be built with Solar PV panels; the overall layout of the proposed arrays can be seen in Figure 2, with the details of the PV arrays as modelled shown in

Table 3, referencing the index for each panel shown in Figure 2.

It should be noted that each roof surface that has any solar panels specified for installation has been modelled as a single solar PV array – for example, the duplex blocks can have between 4 and 6 individual solar panels on its roof, which have been modelled as one PV array, as the parameters for inclination, orientation and height are the same for each. This does result in an overestimation of the glint and glare effect where it occurs, which can be further refined if any unacceptable results are predicted.

All duplex arrays have been modelled having the most appropriate orientation with respect to the aspect of the roof they are to be mounted to, and all other arrays have been modelled with orientations to the south.

FIGURE 2 OVERALL SITE LAYOUT

Table 3 PV Array Configuration Parameters

Array Label	Ground Height	PV Height	Pitch	Orientation
apartment_bldg1	56	80	15	173
apartmentbldg2	56	108	15	135
apartmentbldg3	57	75	15	225
apartmentbldg5a	57	77	15	138
apartmentbldg10b	57	74	15	135
apartmentbldg6b	57	80	15	135
apartmentbldg7b	57	80	15	225
apartmentbldg9b	57	77	15	135
apartmentbldg8a	57	77	15	225
duplex_a1	57	67	27	138
duplex_a2	57	64	27	138
duplex_a3	57	67	27	138
duplex_a4	57	64	27	225
duplex_a5	57	67	27	138
duplex_a7	57	67	27	138
duplex_a6	57	64	27	138
duplex_a8	57	64	27	225
duplex_b1	57	67	27	138
duplex_b2	57	64	27	138
duplex_b3	57	67	27	138
duplex_b4	57	64	27	225
duplex_b5	57	67	27	138
duplex_b7	57	67	27	138
duplex_b6	57	64	27	138
duplex_b8	57	64	27	225
duplex_c1	57	67	27	138
duplex_c2	57	64	27	138
duplex_c3	57	67	27	138
duplex_c4	57	64	27	225
duplex_c5	57	67	27	138
duplex_c7	57	67	27	138
duplex_c6	57	64	27	138
duplex_c8	57	64	27	225
duplex_e1	57	67	27	138
duplex_e2	57	64	27	225
duplex_e3	57	67	27	138
duplex_d1	57	67	27	138
duplex_d2	57	64	27	225
duplex_d3	57	67	27	138
commercial_5	57	67	15	180

commercial_4	57	67	15	180
commercial_3	57	72	15	180
commercial_2	57	72	15	180
commercial_1	57	72	15	180

Receptor Details - Aviation

Receptors for three aviation sites were assessed for the potential for hazardous glint and glare – the relative location of these sites to the proposed development can be seen in Figure 3, along with the distance between them. In the next sections, a detailed overview of each site is given.

Figure 3 Map of Relative Location of Cherry Orchard Point To Aviation Receptors

Weston Airport

Weston Airport is an Irish Aviation Authority (IAA) licensed aerodrome used predominantly by fixed wing propellor light aircraft. Figure 4 illustrates the receptors at this location, described below.

Runway Details

Weston Airport has two active runways, Runway 07 and Runway 25.

Air Traffic Control Towers

There is one ATC-Tower at Weston Airport with a base elevation of 50m and a height of 15m above ground level.

Figure 4 Aviation Receptors at Westin Airport

Casement Aerodrome

Casement Aerodrome is an airfield operated by the Irish Air Corps, for military purposes. Figure 5 illustrates the receptors at this location, described below.

Runway Details

Casement Aerodrome has four active runways, Runway 11 and Runway 29, Runway 05, and Runway 23.

Air Traffic Control Towers

There is one ATC-Tower at Casement Aerodrome with a base elevation of 93m and a height of 6m above ground level.

FIGURE 5 CASEMENT AERODROME AVIATION RECEPTORS

Tallaght Hospital Helipad

Tallaght Hospital Helipad is a helicopter landing pad at Tallaght Hospital which facilitates patient transfer by helicopter to and from the hospital. Figure 6 illustrates the receptors at this location, described below.

Approach Path Details

No guidance exists for the assessment of hazardous glint and glare from solar PV projects and its effect on helicopter approach paths; an approach replicating that for fixed wing aircraft approach paths is therefore used, and the two-mile approach paths for four cardinal directions are assessed, with a steeper glide slope (8° as opposed to 3° for runways) which is more typical for helicopter landings. The approach paths modelled for this assessment are shown in Figure 6.

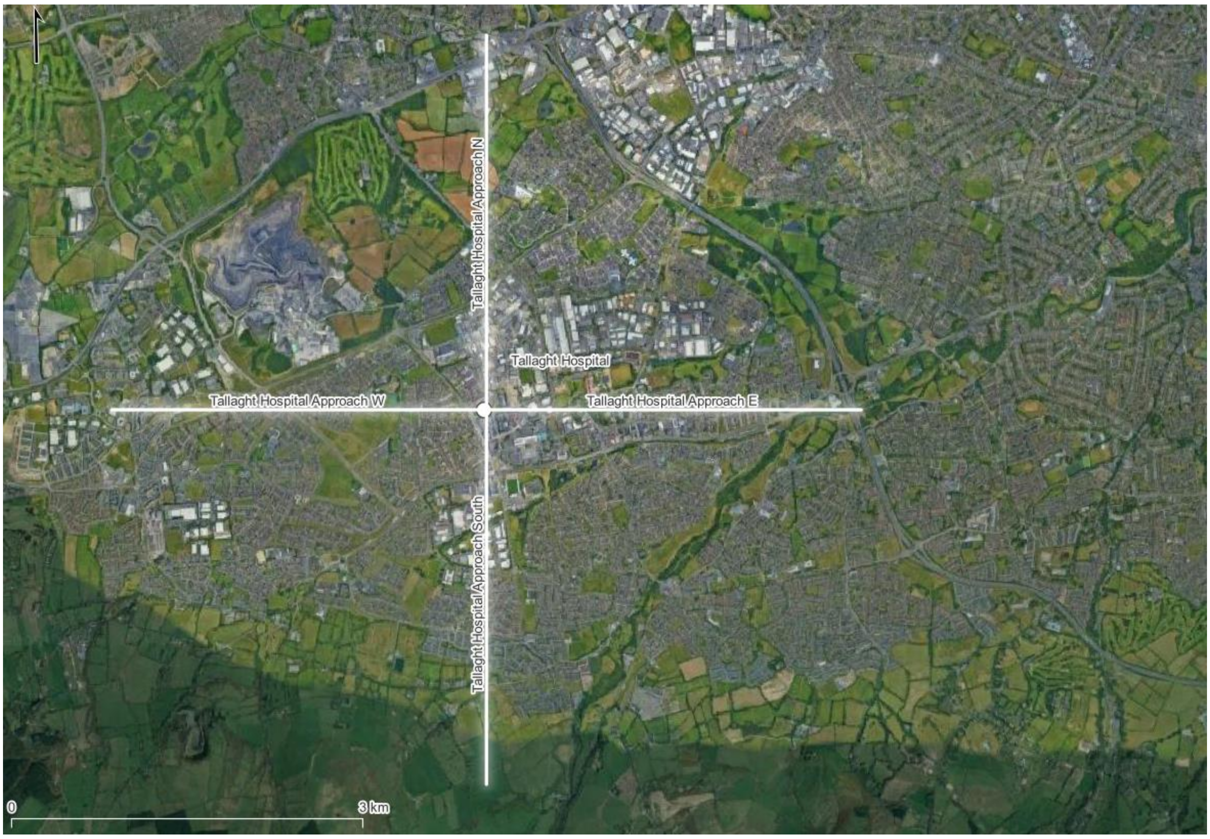


FIGURE 6 TALLAGHT HOSPITAL HELIPAD RECEPTORS

Receptor Details – Non-Aviation

Besides the aviation receptors, it is necessary to examine the potential for hazardous glint and glare to the relevant road and rail receptors, as well as the potential for nuisance glint and glare to residential receptors in the vicinity of the proposed development. This section outlines the receptors which were selected for assessment.

Rail Receptors

The rail line from Dublin to the south-west of the rest of the country is adjacent to the southern boundary of the proposed development and is orientated in an east-west direction. There are four separate tracks, with the two to the north having eastbound traffic and the two to the south having westbound traffic. Within 500m radius of the boundary of the proposed development, points were generated along the 4 lines at a separation of 100m. These were then examined and any points which would not have a view of the proposed arrays due to their relative location and orientation were set aside. The result was a set of 32 points which were analysed for glint and glare hazard. A height of 2.8m above ground was used to simulate the driver's viewpoint, and a field of view of 120° was chosen. The resulting points are shown in Figure 7

FIGURE 7 RAIL RECEPTORS

Road Receptors

The M50, an orbital motorway for Dublin is adjacent to the western boundary of the proposed development and is orientated in a north-south direction. No other national or regional road lies within the area of interest. Within 500m radius of the boundary of the proposed development, points were generated along the 2 carriageways at a separation of 100m. These were then examined and any points which would not have a view of the proposed arrays due to their relative location and orientation were set aside. The result was a set of 24 points which were analysed for glint and glare hazard. A height of 2.0m above ground level was used to simulate the driver's viewpoint (in a heavy goods vehicle as the highest likely viewpoint), and a field of view of 120° was chosen. The resulting points are shown in Figure 8

FIGURE 8 ROAD RECEPTORS

Residential Receptors

There exist residential buildings around most of the perimeter of the proposed development, with housing estates to the north-east, north-west, and east with multi-storey apartment buildings and a hotel to the south. Within 500m radius of the boundary of the proposed development, the residential buildings were examined and assessed to determine whether they would have a view of the proposed arrays. Where it was determined that there would be an uninterrupted view, an observation point was simulated at the level at which most disturbance might occur – this is typically rooms which are inhabited throughout the day such as kitchens or living spaces. For houses, this is typically at ground level so an observer height of 1.6m was utilized, but for taller buildings such as apartment blocks, the height of the highest window was used.

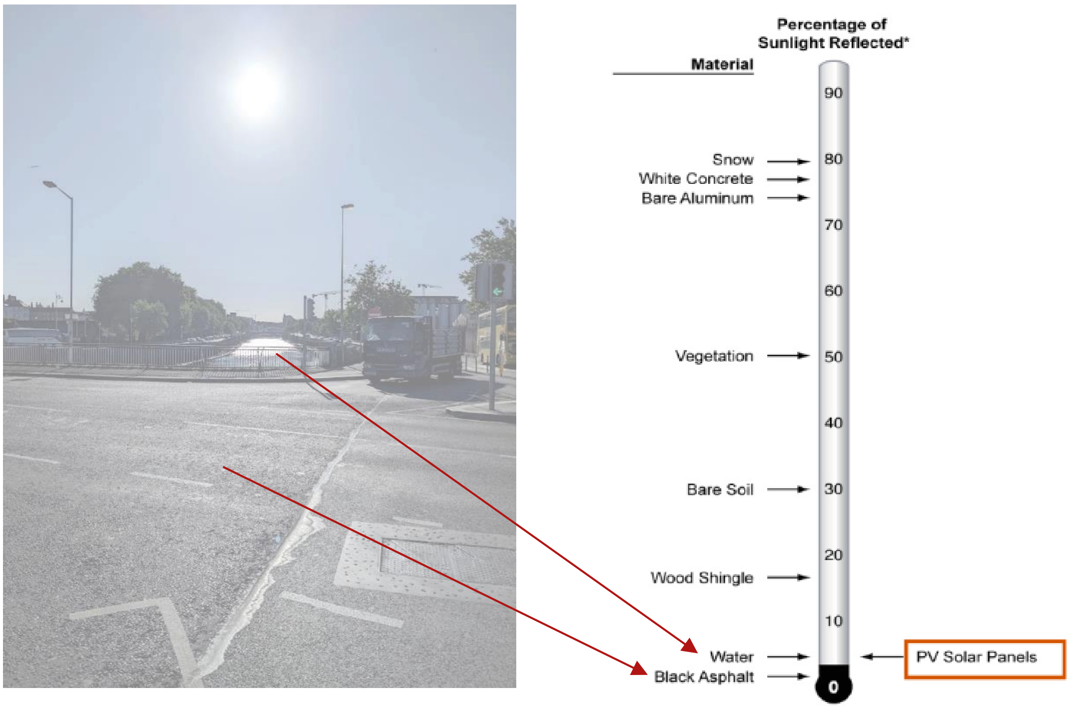
The result was a set of 119 points representing houses, 10 points representing the hotel and 25 points representing the apartments which was analysed for glint and glare hazard. A field of view of 180° was chosen. The resulting points are shown in Figure 9

FIGURE 9 RESIDENTIAL RECEPTORS

Solar Reflectance from PV Panels

Surface Reflectance

All surface types have different reflectivity characteristics. This results in varying degrees of sunlight reflection. Solar panels, by their nature, are designed to absorb as much sunlight as possible, thus converting the sun's energy to electricity. As a result, the amount of light reflected off these installations is far less than one might expect. The figure below (Figure 10) is taken from the FAA's "*Technical Guidance for Evaluating Selected Solar Technologies on Airports*"[4] and illustrates that the reflectance of solar PV panels is of a similar nature to water. Typical values for the reflectance levels of solar PV panels are far less than that of materials such as snow, concrete and even vegetation. It should be noted however, that at certain times of



the day, generally early morning and late evening, with the sun low in the sky, the amount of light reflected off solar panels can increase, causing a potential for glare in certain directions.

FIGURE 10 REFLECTIVITY PRODUCED BY DIFFERENT SURFACES (SOURCE FAA)

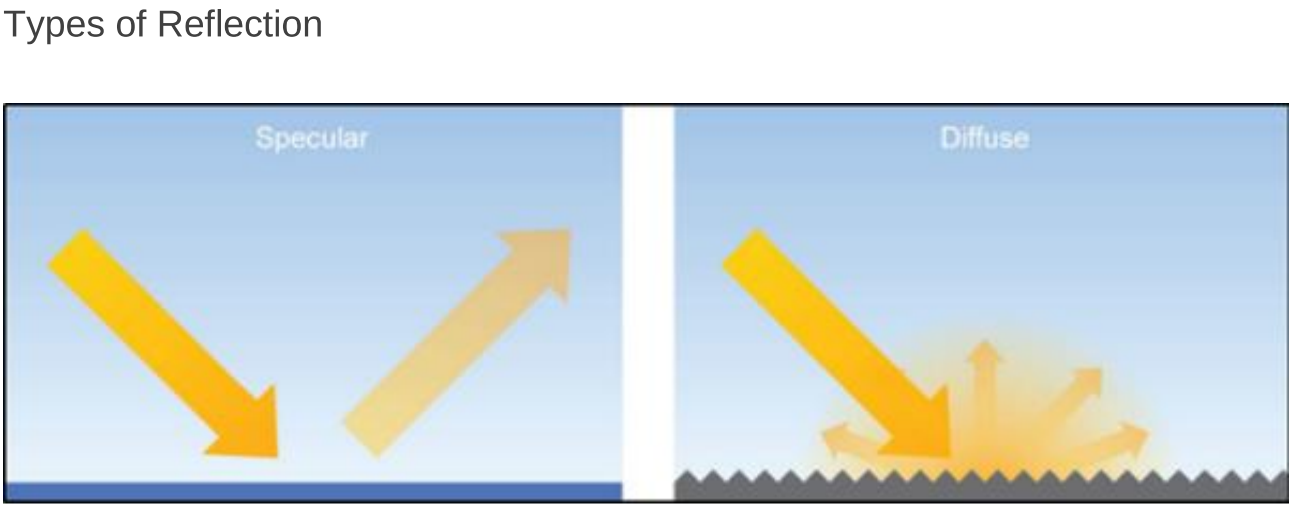


FIGURE 11 DIFFERENT TYPES OF REFLECTION (SOURCE FAA)

There are two types of reflection which can occur on a surface; specular and diffuse. Specular reflection is a direct reflection which produces a more "focused" type of light. It occurs when light reflects off a smooth or polished surface like glass or still water. Diffuse reflection, on the other hand, produces a less "focused" type of light. Diffuse reflection occurs because of light reflecting off a rough surface such as vegetation, concrete or wavy water. Figure 11 helps to illustrate the difference between these two types of reflection. The main type of reflectance from solar PV panels is specular due to the glass like texture of the outer layer of the panels. However, like all surfaces, there will be a combination of both specular and diffuse reflection.

As discussed earlier, the level of potential glare from solar PV panels is like that of water and much less than that of materials such as concrete and vegetation. Many common elements of the Irish landscape offer similar, if not higher levels of glare than that caused by solar PV systems such as shed roofs, still lakes and even the strips of plastic sheeting used on farms to produce maize (Figure 12).

FIGURE 12 PLASTIC MAIZE WRAP IN A FIELD WITH POTENTIAL TO CAUSE SIMILAR LEVELS OF GLARE AS SOLAR PV FARMS

Relevant Guidance and Studies

A comprehensive review of applicable guidance and studies is presented in Appendix I. In summary, the conclusions from these studies are as follows:

- Reflection from solar panel surfaces is possible and has been known to cause a potential for hazard to aviation in rare cases;
- Reflection from solar panel surfaces can cause disturbance, particularly if the daily duration and number of days in a year are significant.
- The amount of sunlight reflected by a solar PV panel can range from between 2% to 30% and is primarily dependent on the angle of incidence of sunlight to the panel surface.
- Studies have shown that the intensity of sunlight reflection from solar panel surfaces is similar to that of standing water, and less than that of snow, concrete or glass facades.

There is no single accepted standard for determining the acceptable level of glare that a Solar PV Project causes, but there are converging approaches.

Glint and Glare Overview

What are Glint and Glare?

Glint and glare are phenomenon caused by many reflective materials, whereby light from the sun is reflected off such materials with a potential to cause hazard, nuisance or unwanted visual impact. Glint and glare have been best defined by the United States Federal Aviation Administration (FAA) in their "*Technical Guidance for Evaluating Selected Solar Technologies on Airports*"[4]:

> ***Glint*** *is a momentary flash of bright light.*
>
> ***Glare*** *is a continuous source of bright light.*

Glint and Glare are also commonly referred to as 'solar reflection'. To determine the impact that solar reflection could potentially have on members of the public, it is sometimes necessary to carry out a glint and glare assessment for proposed solar PV farms or roof mounted arrays.

When do Glint and Glare Occur?

The sun rises in the east and sets in the west and in the northern hemisphere, tracks a southerly arc across the sky (Figure 13). The elevation angle that the sun reaches varies depending on the time of year, with high angles in the summer months and much lower angles in winter.

Once the sun reaches a certain elevation in the sky, the incident angle of the sun will reflect off the solar panels at an opposing angle that will not impact on any ground-based receptors. As a result of this, for ground-based receptors, glint and glare from solar farms will generally only occur in the mornings and the evenings. At these times, the sun will also be shining from a similar direction as any potential glare. For aviation receptors however, glare can potentially occur at any time of day depending on the location of the aircraft.

[4] Federal Aviation Administration, November 2010: *Technical Guidance for Evaluating Selected Solar Technologies on Airports*

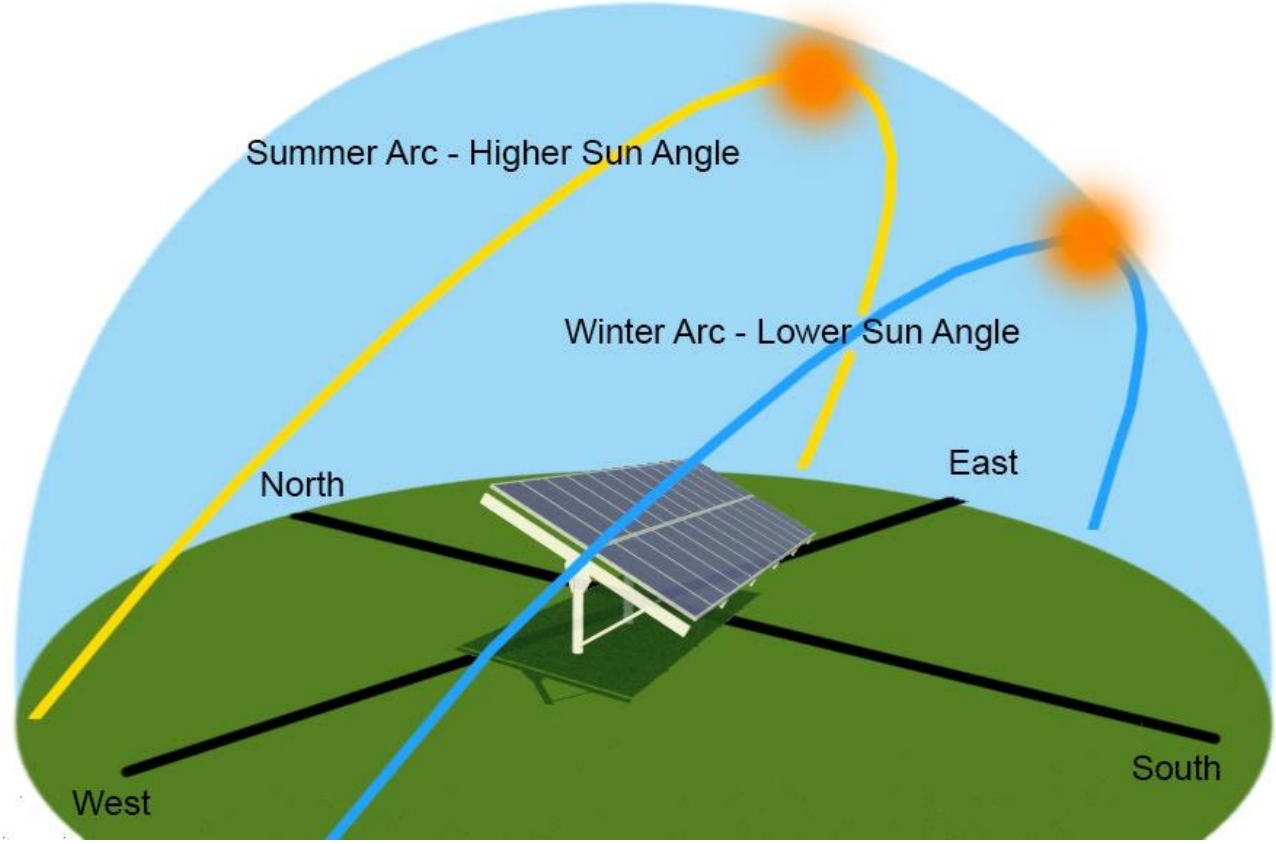


FIGURE 13 ARCS TRACKED BY SUN AT DIFFERENT TIMES OF THE YEAR

Meteorological & Atmospheric Conditions

It is also worth noting that glint and glare can only occur when there is direct sunlight reaching the solar panels. In overcast or rainy conditions, no glint or glare will occur. Met Éireann, Ireland's National Meteorological Service, suggests that due to Ireland's position off the northwest of Europe we are kept in humid, cloudy airflows for much of the time. *"Irish skies are completely covered by cloud for well over fifty percent of the time."*[5]

For this proposed development, historical sunshine duration data from 1981-2021, recorded at Dublin Airport has been analysed. Dublin Airport is the nearest Met Éireann weather station to the proposed development that records sunshine data. From looking at Figure 14 and Figure 15 below for this particular site, the number of

[5] Met Éireann "Sunshine and Solar Radiation" www.met.ie.

days glare could potentially be experienced at each receptor could realistically be reduced by 70% and still offer an overstated prediction of glare.

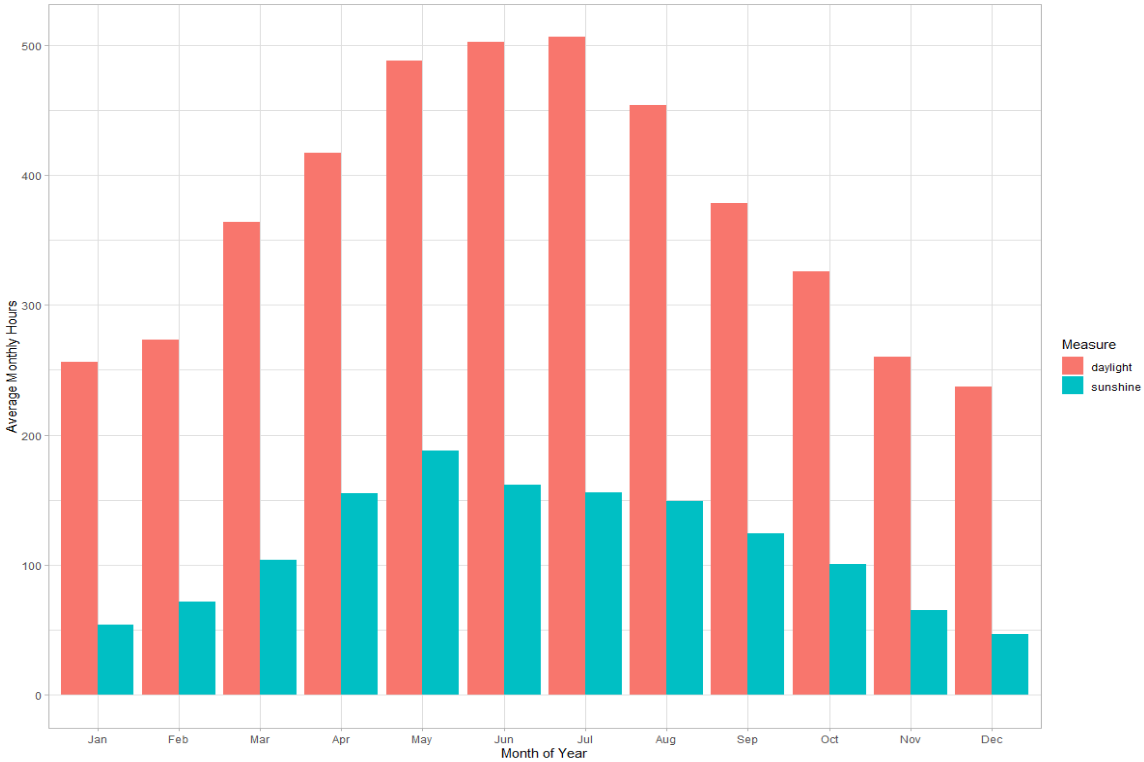


FIGURE 14 DUBLIN AIRPORT SUNSHINE VS DAYLIGHT (AVG DAILY HOURS PER MONTH)

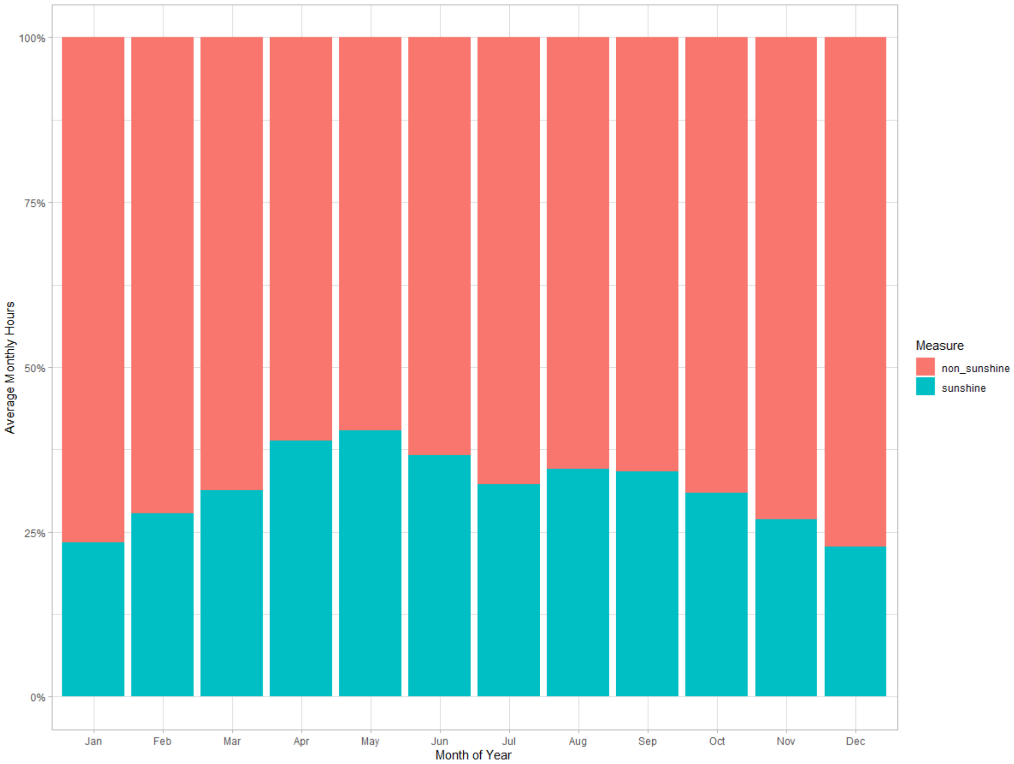


FIGURE 15 DUBLIN AIRPORT SUNSHINE AS A PERCENT OF DAYLIGHT

Methodology

LINT's methodology can be broken down into six key stages:

1. Study Area Selection
2. Receptor Identification
3. Geometric Analysis
4. Examination of Screening and Receptor Orientation
5. Determination of Impact
6. Mitigation

Study Area Selection

The location of the proposed development which will include solar PV arrays is Cherry Orchard in Dublin. Aviation receptors which lie within 10km of the boundary of the site will be analysed. Rail, Road, and Residential receptors within 500m of the site will be analysed.

Receptor Identification

The first stage of any glint and glare assessment is to identify the study area. In the case of this development, the aviation receptors at

- Weston Airport
- Casement Aerodrome
- Tallaght Hospital Helipad

are required to be assessed. Additionally, the following receptor types are required to be assessed, within a radius of 500m from the boundary of the proposed development;

- Residential
- Rail
- Road (Motorway, Regional and National)

The maps outlining the location of these receptors can be seen in Figure 3 through to Figure 9.

Airports & Airstrips

The two main receptors that need to be considered when assessing the glint and glare effects of solar PV panels on aerodromes are Air Traffic Control Towers (ATC-T) and the final approach path to a runway. An ATC-T is assessed much like any other receptor point using the correct altitude of the tower. For final runway approach paths, a line is extrapolated 2 miles back from the runway threshold (the point at which an aircraft enters the runway) at an angle of 3 degrees. This results in a continuous analysis of every point along the final approach to the runway. For this report, the above process is carried out for Shannon Airport (ATC and Runway Approaches) and Coonagh Aerodrome (Runway Approaches). It should also be noted that these calculations take the pilots field of view into consideration and thus limit the angle of view to 100 degrees in the horizontal and a downward viewing angle of 30 degrees.

Helipads

Although there are no specific guidelines to assess glint and glare impacts on helipads, LINT has employed a similar system to that used for runway approach paths. This involves a line being extrapolated 2 miles back from the helipad centre. However, the angle of approach used is steeper than that of an airplane landing on a runway. Helicopter pilots would approach the helipad at an angle close to 10 degrees. In addition, a helicopter's approach direction is not bound by a physical runway direction and depending on a number of factors including wind direction, a pilot can approach from any direction. For this reason, approaches from 4 different directions are analysed to account for the various different approaches that could be taken. It should also be noted that these calculations take the pilot's field of view into consideration and thus limit the angle of view to 100 degrees in the horizontal and a downward viewing angle of 30 degrees. This process is carried out for the helipad at Tallaght Hospital.

Geometric Analysis

Aviation Receptors

LINT employs the use of the SGHAT (via the ForgeSolar application, which uses the SGHAT methodology under license) to run the calculations for its aviation glint and glare analysis. This is currently the only widely accepted tool for measuring the ocular impact of solar PV systems on receptors.

Several parameters are considered in order to run these geometric analyses. These include, but are not limited to:

- The apparent position and height of the sun at a particular time of day and year for every minute of the year).
- The position, height, orientation & pitch of the solar PV array.
- The position and height of the receptor.

The severity of the glare is influenced mainly by two factors:

- The distance of the observer from the glare spot, and
- The angle of the sunlight hitting the solar panels relevant to the observer

Residential Receptors

As discussed previously in this document, LINT uses methodologies that are in line with international best practise to determine the potential for a particular receptor to experience hazardous or nuisance glint and glare due to reflections from a development of solar panels. In the context of the Cherry Orchard Point development, the methodology used within Germany (see "*Licht-Leitlinie*" in the Germany section of the Appendix) is the most appropriate and therefore it will be utilised. The following idealised assumptions are used:

- The sun is to be regarded as a point-source emitter
- The reflector is a perfect mirror (no scattering)
- The sun is emitting light from dawn to dusk (no exception for bad weather)
- Only time when the line of vision towards the sun and towards the PV Panel differs by 10° is considered.

If the duration of glare calculated for a residential receptor is longer than 30 minutes per day or for more than 30 hours per year, it can be considered a "considerable disturbance". In this case, further analysis is carried out to determine the most appropriate mitigation strategy for the affected receptor.

Rail and Roadway Receptors

Receptors were only considered if:

- They had a view of the front side of any solar panels

- They were within 500m of the extent of the proposed development

A geometric analysis was carried out with the field of view set at 120° centred on the direction of travel at the receptor location. The receptor locations were set at intervals of 100m along the stretch of roadway which was in the scope of the analysis. No allowance was made for the direction of glare being in line with the sun, as was made for the residential receptors. A receptor height of 2.0m above ground level was used to represent a driver sitting in a Heavy Goods Vehicle for the Road Receptors, with a height of 2.8m being used for the Rail Receptors.

Examination of Screening and Receptor Orientation

The geometrical glare analysis does not consider screening from landform such as hills and mountains, or any vegetative or built environment elements of the landscape that may screen the development from view. For this reason, once the receptors that could potentially experience glare have been identified, their level of existing screening must be assessed. This is done through a combination of desk-based analysis of both Google StreetView and aerial photography, viewshed modelling using a high-resolution Digital Surface Model and sometimes requires a site visit for further verification. Receptor orientation is also considered. Geometric analysis may suggest that a dwelling will experience glare, but the orientation of the dwelling also needs to be considered. If a dwelling is facing away from the solar array, any potential glare could have little or no impact. Similarly, a road may show up as having potential to experience glare, but unless the direction of travel is towards the source of glare, it is unlikely to cause significant impact.

Determination of Impact

Aviation Receptors

Once all of the above steps are carried out, a determination of likely impacts can be made for each receptor. The ocular impact of glare is visualized with the Glare Hazard Plot (Figure 16). This chart displays the ocular impact as a function of glare subtended source angle and retinal irradiance. The interim guidance from the FAA of 2013 concerning aviation glint and glare dictates;

- No potential for glare at ATC Towers
- Only glare in the "Green" zone allowable for 2-mile approach paths to runways

Therefore, it is necessary to determine whether any of the array / receptor combinations fall outside of these criteria.

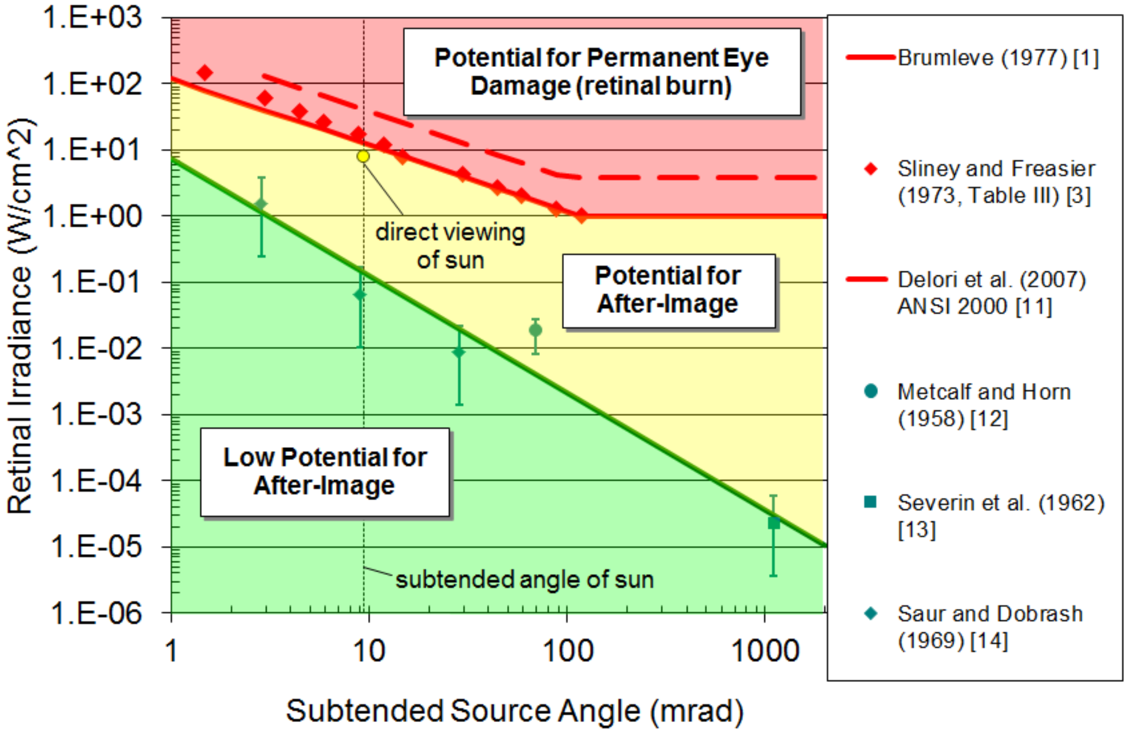


FIGURE 16 SOLAR GLARE HAZARD PLOT

Non-Aviation Receptors

As discussed, there is some guidance available on how to measure and determine the impact of glint and glare on aviation receptors. For other receptors however, there is no explicit guidance, and it is necessary to look to other fields to build a reasonable approach. The main source of information when considering the impact of reflective surfaces on railway safety is from the UK Rail Industry Standard "Signal

Sighting Assessment Requirements"[6] with the following "Compatibility Factors" identified;

- A.5 Reflection and Glare – in summary, "reflections can alter the appearance of a display so that it appears to be something else".
- C.7 Lineside Distractions – in summary, reflected light can cause a distraction to train operators and could cause the operator to "neglect to read the signaling system or read too late".

Both of the above scenarios could potentially cause a dangerous situation, meaning that it is necessary in as far as possible to eliminate the possibility for glare to be experienced by operators of trains on railway lines. This includes the necessity to assess the potential for glint and glare to arise from a new development which includes solar panels. Where the potential for glare cannot be reliably ruled out, it may be necessary for the railway operator to perform a signal sighting assessment – however, due to the time-dependent phenomenon of reflections being caused by the reflections of the sun as it transits the sky overhead and the dependence on a clear sky with unobstructed sunlight, it might be impossible to assess this – hence a geometric and viewshed analysis is the optimum way to determine the potential for hazardous glint and glare.

For road and rail receptors, due to the transient nature of a viewer experiencing glint and glare from a solar panel reflection, the duration and intensity of the glint and glare should be evaluated and considered against the characteristics of the receptor. Results of the geometric analysis and screening examination are collated into a table with comments as to the likely glint and glare impact or otherwise, of the proposed solar PV panels on all assessed receptors. An initial determination is made using the table below, based purely on the theoretical amount of time a receptor may potentially experience glare.

[6] https://www.rssb.co.uk/-/media/Project/RSSB/RssbWebsite/Documents/Registered/Standards/2020/09/16/10/47/RIS-0737-CCS-Iss-1.pdf - accessed 2023

TABLE 4 DETERMINATION OF IMPACT FOR NON-AVIATION RECEPTORS

Classification	Description
High	Potential for more than 60 mins of glare per day and/or for more than 150 days in a year
Medium	Potential for 30 to 60 mins of glare per day and/or for 60 to 90 days in a year
Low	Potential for 20 to 30 mins of glare per day and/or for 30 to 60 days in a year
Very Low	Potential for 10 to 20 mins of glare per day and/or for 15 to 30 days in a year
Negligible	Potential for 0 to 10 mins of glare per day and/or for 7 to 15 days in a year
None	No geometric potential for glare / Screening of source from receptor

Table 4 is used as a guide only and final classification is based on a combination of additional factors including level of intervening screening (vegetative or otherwise), receptor orientation, position of sun in relation to source of glare, as well as professional judgement.

As is the case for road and rail receptors, for the consideration of dwelling receptors, there is also no universally agreed guidance, or policy set out in Ireland. A document by Pager Power titled "Solar-Photovoltaic-Glint-and-Glare-Guidance-Fourth Edition"[7] outlines a rationale based on the guidance for Wind Turbine Shadow Flicker impact, recommending:

> *If visible glint and glare is predicted for a surrounding dwelling for longer than 60 minutes per day, for three or more months of the year, then the impact should be considered significant with respect to residential amenity. In this scenario, mitigation should be implemented.*

An alternative approach is to follow the recommendations laid out by *"Licht-Leitlinie"* and this is the approach taken in this analysis. Therefore, **a threshold of 30 minutes in any day or 30 hours over a year** is seen as unacceptable, when considered with the analysis parameters of the chosen methodology.

[7] https://www.pagerpower.com/wp-content/uploads/2022/09/Solar-Photovoltaic-Glint-and-Glare-Guidance-Fourth-Edition.pdf

Mitigation

If it is determined that glare will be experienced at a particular receptor and there is no screening between the receptor and the solar array, mitigation may be recommended depending on the severity of the glare. Mitigating glare impact from a solar array can be achieved in a number of different ways. The most common method is to add vegetative screening to essentially form a visual barrier between the receptor and the development. This type of mitigation is often required for ecological and visual impact reasons also. Other forms of mitigation include changing the design of the solar array, such as a change in pitch and orientation of the panels.

Assessment Results

Weston Airport Runway Results

For both the runways at Weston Airport, no potential for glare outside the recommended limits of Green Glare was found.

Weston Airport ATC Results

No potential for Glare was indicated for any proposed solar PV array at Cherry Orchard Point affecting the ATC Tower at Weston Airport, which is **acceptable** under the 2013 FAA guidance.

Casement Aerodrome Runway Results

For all of the four runways at Casement Aerodrome, no potential for glare outside the recommended limits of Green Glare was found.

Casement Aerodrome ATC Results

No potential for Glare was indicated for any proposed solar PV array at Cherry Orchard Point affecting the ATC Tower at Casement Aerodrome, which is **acceptable** under the 2013 FAA guidance.

Tallaght Hospital Helipad Approaches

For all of the four approaches analysed at Tallaght Hospital Helipad, **no potential for glare outside the recommended limits of Green Glare was found.**

Road Receptors

Some glare was predicted to occur for the road receptors, in both the southbound and northbound directions, and the maximum amount in any given day was found to be no more than 5 minutes. This falls into the **negligible category** when considered against the parameters in Table 4. Additionally, due to the relative elevation of the proposed arrays compared to the elevation of the roadway receptors, it is highly unlikely that a view of the reflective surface of the PV Panels will be possible from the adjacent roadway.

Rail Receptors

Some glare was predicted to occur for the rail receptors, in both the eastbound and westbound directions, and the maximum amount in any given day was found to be no more than 10 minutes. This falls into the **negligible category** when considered against the parameters in Table 4. A viewshed analysis was also performed which illustrated that for all of the rail receptors, the view of the proposed arrays is screened by an embankment and existing structures.

Residential Receptors

The maximum amount of glare predicted for any of the residential receptors was 15 minutes in a day and 3 hours within a given year - therefore it can be concluded that there is **no potential for nuisance glare outside of the acceptable parameters outlined in relevant guidance** (the German "*Licht-Leitlinie*" guidelines) when analysed using the specified criteria.

Conclusion

This Solar PV Array Aviation Specific Glint and Glare Analysis has sought to determine whether any aviation receptors, for;

- runway approach paths and the ATC Tower at Weston Airport
- runway approach paths and the ATC Tower at Casement Aerodrome
- helicopter approach paths at Tallaght Hospital Helipad

have the potential to experience hazardous glint and glare from the installation of solar PV panels at Cherry Orchard Point.

The analysis has concluded that **it is reasonable to determine that there is no potentially hazardous glint and glare effects to aviation receptors** caused by the proposed development of solar PV arrays at Cherry Orchard Point.

Furthermore, the analysis has concluded that;

- **there is negligible potential for hazardous glint and glare effects to roadway receptors**
- **there is negligible potential for hazardous glint and glare effects to railway receptors**
- **there is no potential for disturbance caused by glare to residential amenity**

arising from the proposed development of solar PV arrays at Cherry Orchard Point.

Appendix I: Relevant Guidance & Studies

Guidance

United Kingdom

In the United Kingdom (UK), where the development of large-scale solar PV is more mature, certain studies have been carried out which help to establish an accepted best practice and planning guidance recommends the assessment of glint and glare effects. However, there is still no specific guidance by way of a prescriptive methodology document. In the absence of formal policy, the UK's Civil Aviation Authority (CAA) provided interim guidance in 2010 in relation to the development of solar PV systems on, and in the vicinity (<15km) of aerodromes. This guidance recommends that solar PV developers should *"provide safety assurance documentation regarding the full potential impact of the SPV installation on aviation interests."* [8] More recently, Civil Aviation Publication 738, entitled "Safeguarding of Aerodromes"[9] was updated in 2020 and the policy refers to US FAA research and guidance (detailed below). It also states that despite an increase in solar panel developments, with some located close to aerodromes, the CAA has "not received any detrimental comments or issues of glare at these established sites".

Air Navigation Order 2009[10] also has several articles (137: Endangering safety of an aircraft, 221: Lights liable to endanger and 222: Lights that dazzle or distract) that relate to the effect of glare aspects that are relevant to Solar PV developments; glare with a detrimental impact on aviation safety must be avoided and should be taken care of by solar developers and Local Planning Authorities.

The Building Research Establishment (BRE) have also issued several relevant papers, however neither the BRE nor the CAA have produced a methodology for assessing the effects of glint and glare on aviation, road & rail users or residential buildings.

Republic of Ireland

In the Republic of Ireland (ROI), there is currently no guidance, policy or recommendations in relation to the assessment of glint and glare effects on aviation, road & rail users or residential buildings. Future Analytics in conjunction with the Sustainable Energy Authority of Ireland (SEAI) have produced planning and development guidance recommendations for utility scale solar photovoltaic schemes in Ireland [11]. While this is not formal guidance, it does set out recommended elements of the assessment based on international practice.

[8] Civil Aviation Authority. December 2010. "Interim CAA Guidance - Solar Photovoltaic Systems".
[9] Safeguarding of Aerodromes - Civil Aviation Authority https://publicapps.caa.co.uk/docs/33/CAP738%20Issue%203.pdf accessed June 2022
[10] https://www.legislation.gov.uk/uksi/2009/3015/contents/made
[11] Future Analytics. October 2016. Planning and Development Guidance Recommendations for Utility Scale Solar Photovoltaic Schemes in Ireland

Germany

In Germany, glare is considered an emission not unlike noise, odour or vibration. *"Licht-Leitlinie"* [12] or Light Guidelines 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 states that there is only additional impact to an observer as a result of glare from a solar array if the angle between the source of the glare and the sun is greater than ten degrees. It also places an emphasis on solar PV developments on a east-west axis relative to the receptor, rather than south-north which will cause less impact due to the nature of sun movement across the sky (no reflection possible from relatively northern sources and southern sources having the sun in the same viewing direction).

A report for the Alberta Utitlities Commision by Zehndorfer Engineering[13] goes into further detail on the approach taken in the *"Licht-Leitlinie"*, and has detail on several other jurisdictional approaches as well as recommendations on best practise when assessing various scenarios.

Switzerland

A guideline on solar glare assessment was established with the help of the Swiss Trade Association in Switzerland. This guideline sets numeric parameters on the acceptability of glint and glare, based on the incident angle of the sun, the intensity of emmitted radiation, and the luminance The solar reflections are termed as non-risky if its duration is less than 30 min per day or the solar PV installation is small, or the receptor is located far away from glare source.

Australia

No specific regiulation pertaining to glint and glare form solar PV arrays exists, but general limits on reflectivity from glass facades have been set by several local authorities, with under or equal to 20% reflectance being acceptable.

Canada

A publication by Transport Canada (TP1247E)[14] includes guidelines useful for glare assessment. It states in summary, that glare analysis must consider the movement of aircraft at landing, take-offs and during maneuvers and suggests ways for a solar PV designer to vary orientation and tilt of solar PV modules in order to mitigate the adverse impact from glare, with an application threshold of 3km from an aviation site.

[12] Leitlinie des Ministeriums fur Umwelt. Gesundheit und Verbraucherschutz zur Messung und Beurteilung von Lichtimmissionen (Licht-Leitlinie). 2014 Available: http://www.mlul.brandenburg.de/media_fast/4055/licht_leitlinie.pdf
13 Zehndorfer Engineering (2019). Solar Glare and Glint Project. Report ZE19060-AUC produced for the Alberta Utilities Commission. Available at: http://www.auc.ab.ca/regulatory_documents/Consultations/2019-11-21-Rule007-StakeholderCommentsZehndorfer.pdf (Accessed January 2021).
[14] Land Use In The Vicinity of Aerodromes, https://tc.canada.ca/sites/default/files/migrated/tp1247e.pdf accessed February 2021

United States of America

The main form of guidance in assessing the likely effects of glint and glare (on aviation infrastructure) comes from the FAA in the United States. Their document, "*Technical Guidance for Evaluating Selected Solar Technologies on Airports*"[15] is accepted internationally as the most detailed methodology for assessing the effects of glint and glare. This interim policy document[16] was produced in October 2013. The 2013 interim policy further addresses glint and glare issues and recommends the use of a particular analysis tool, the Solar Glare Hazard Analysis Tool (SGHAT), when carrying out glint & glare assessments of solar PV systems. This is a tool that was developed by the US Department of Energy research laboratories, Sandia National Laboratories, to assess the ocular impact of proposed solar energy systems.

In 2021, this interim guidance was superseded by a final policy, with the main changes being;

- There is less emphasis on the potential glint and glare hazard to pilots using a runway approach path, and specific requirements around the assessment of the ATC Tower.
- The FAA have withdrawn their pervious recommendation for a tool to assess ocular hazard – this means there is now no specific requirement to use the SGHAT methodology.

However, it is expected that national aviation regulators will continue to follow the original 2013 guidance, for which the SGHAT approach is acceptable.

Studies

Sreenath et al, 2021[17]

A comprehensive review performed by Sreenath et al, 2021of Solar PV and its relationship with airport environments lists several different methodologies that can be used for assessment of solar PV glint and glare hazard and gives comprehensive details on the SGHAT analysis approach (used by LINT Geospatial). It concludes;

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

[16] Federal Aviation Administration. October 2013. *"Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports."*

[17] Sreenath, S., Sudhakar, K. and Yusop, A.F., 2021. "*Solar PV in the airport environment: A review of glare assessment approaches & metrics."* Solar Energy, 216, pp.439-451.

- that the SGHAT approach does not factor in mitigating factors such as landscape screening or cloud cover and as such, can overestimate the likelihood for glint and glare
- the steps in a desirable methodology for glare assessment from solar PV installations are:
    1. Identification of solar reflections that can reach an observer's eye
    2. Calculation of the duration and intensity of these reflections
    3. Comparison of calculated results with threshold values for harmful glare impact

Sreenath et al, 2020a[18], 2020b[19], 2020c[20]

These studies outline the reflectivity of different materials used for Solar PV arrays, and the factors that affect glint and glare from the surfaces of these arrays.

Riley and Olson, 2011[21]

This study outlines empirical research done using a PV system in Las Vegas. It found that reflectivity of the panels varied from 5% to 30%, depending on the incidence angle, and concluded that the potential for hazardous glare from solar-PV arrays is similar to that of standing water, and that common surfaces such as Portland white cement concrete (commonly used in airport runways), snow and glass building facades all have higher reflectivity than flat plate PV arrays.

Conclusions from Guidance and Studies

LINT has created a methodology for assessing glint and glare taking all of the above studies and guidelines into consideration. Until formal and specific guidance on a preferred methodology is provided in Ireland, LINT will continue to follow international guidelines and best practice.

[18] Sreenath, S., Sudhakar, K., Ahmad Fitri, Y., 2020. Airport-based photovoltaic applications. Progress in Photovoltaics: Research and Applications. https://doi.org/10.1002/pip.3265
[19] Sreenath, S., Sudhakar, K., Yusop, A.F., 2020b. Solar photovoltaics in airport: Risk assessment and mitigation strategies. Environ. Impact Assess. Rev. 84 (May) https://doi.org/10.1016/j.eiar.2020.106418.
[20] Sreenath, S., Sudhakar, K., Yusop, A.F., Cuce, E., Solomin, E., 2020. Analysis of solar PV glare in airport environment: Potential solutions. Results in Engineering, 5 (November 2019), 100079. https://doi.org/10.1016/j.rineng.2019.100079.
[21] Riley, E. and Olson, S., 2011. A Study of the Hazardous Glare Potential to Aviators from Utility-Scale Flat-Plate Photovoltaic Systems. International Scholarly Research Notices, 2011.

FORGESOLAR GLARE ANALYSIS

Project: **Cherry Orchard Point**

Cherry Orchard Point is a new, large mixed-use residential development to be located on a greenfield site beside Park West Avenue and the Park West/Cherry Orchard railway station.

Site configuration: **apartment_commercial_v2**

Analysis conducted by Michael O'Donnell (info@lint.ie) at 19:49 on 15 Oct, 2023.

U.S. FAA 2013 Policy Adherence

The following table summarizes the policy adherence of the glare analysis based on the 2013 U.S. Federal Aviation Administration Interim Policy 78 FR 63276. This policy requires the following criteria be met for solar energy systems on airport property:

- No "yellow" glare (potential for after-image) for any flight path from threshold to 2 miles
- No glare of any kind for Air Traffic Control Tower(s) ("ATCT") at cab height.
- Default analysis and observer characteristics (see list below)

ForgeSolar does not represent or speak officially for the FAA and cannot approve or deny projects. Results are informational only.

COMPONENT	STATUS	DESCRIPTION
Analysis parameters	PASS	Analysis time interval and eye characteristics used are acceptable
2-mile flight path(s)	PASS	Flight path receptor(s) do not receive yellow glare
ATCT(s)	PASS	Receptor(s) marked as ATCT do not receive glare

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

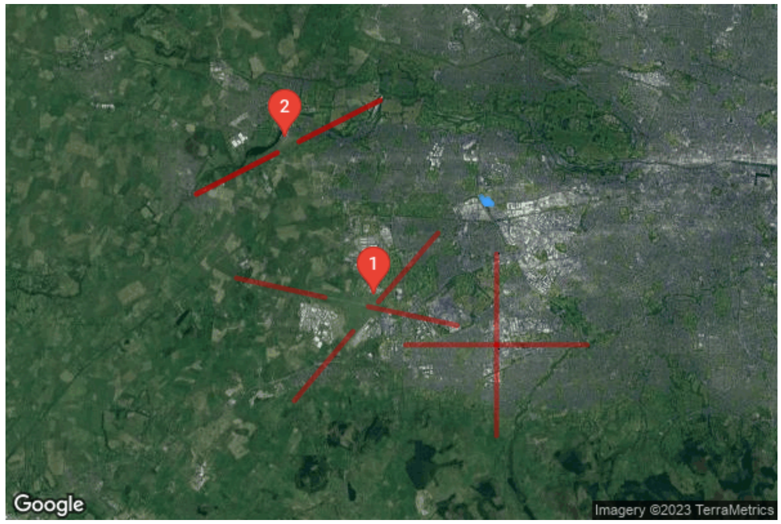
- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

FAA Policy 78 FR 63276 can be read at https://www.federalregister.gov/d/2013-24729

SITE CONFIGURATION

Analysis Parameters

DNI: peaks at 1,000.0 W/m^2
Time interval: 1 min
Ocular transmission coefficient: 0.5
Pupil diameter: 0.002 m
Eye focal length: 0.017 m
Sun subtended angle: 9.3 mrad
Site Config ID: 94902.16631
Methodology: V2



PV Array(s)

Name: apartment_bldg1
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 173.0°
Rated power: -
Panel material: Smooth glass without AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.334154	-6.379289	56.20	24.00	80.20
2	53.334282	-6.379318	56.34	24.00	80.34
3	53.334311	-6.378968	56.58	24.00	80.58
4	53.334183	-6.378940	56.37	24.00	80.37

Name: apartmentbldg10b
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 135.0°
Rated power: -
Panel material: Smooth glass without AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.335530	-6.382541	57.00	17.00	74.00
2	53.335324	-6.382213	57.00	17.00	74.00
3	53.335218	-6.382399	57.00	17.00	74.00
4	53.335423	-6.382728	57.00	17.00	74.00

Name: apartmentbldg2
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 135.0°
Rated power: -
Panel material: Smooth glass without AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.334894	-6.379718	56.97	52.00	108.97
2	53.334787	-6.379910	57.28	52.00	109.28
3	53.334501	-6.379451	56.21	52.00	108.21
4	53.334538	-6.379387	56.22	52.00	108.22
5	53.334566	-6.379334	56.27	52.00	108.27
6	53.334605	-6.379260	56.77	52.00	108.77

Name: apartmentbldg5a
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 138.0°
Rated power: -
Panel material: Smooth glass without AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.334732	-6.382041	57.00	20.00	77.00
2	53.334624	-6.381867	57.00	20.00	77.00
3	53.334430	-6.382208	57.00	20.00	77.00
4	53.334545	-6.382382	57.00	20.00	77.00

Name: apartmentbldg6b
Axis tracking: Fixed (no rotation)
Tilt: 30.0°
Orientation: 135.0°
Rated power: -
Panel material: Smooth glass without AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.335125	-6.381135	57.00	23.00	80.00
2	53.334908	-6.380788	57.00	23.00	80.00
3	53.334807	-6.380965	57.00	23.00	80.00
4	53.335012	-6.381293	57.00	23.00	80.00
5	53.335029	-6.381264	57.00	23.00	80.00
6	53.335042	-6.381285	57.00	23.00	80.00
7	53.335042	-6.381281	57.00	23.00	80.00

Name: apartmentbldg7b
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 225.0°
Rated power: -
Panel material: Smooth glass without AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.335320	-6.380430	57.00	23.00	80.00
2	53.335212	-6.380259	57.00	23.00	80.00
3	53.335020	-6.380595	57.00	23.00	80.00
4	53.335129	-6.380772	57.00	23.00	80.00

Name: apartmentbldg8a
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 225.0°
Rated power: -
Panel material: Smooth glass without AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.335841	-6.381686	57.00	20.00	77.00
2	53.335730	-6.381508	57.00	20.00	77.00
3	53.335924	-6.381169	57.00	20.00	77.00
4	53.336034	-6.381349	57.00	20.00	77.00

Name: apartmentbldg9b
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 135.0°
Rated power: -
Panel material: Smooth glass without AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.335755	-6.382198	57.00	20.00	77.00
2	53.335536	-6.381848	57.00	20.00	77.00
3	53.335642	-6.381662	57.00	20.00	77.00
4	53.335861	-6.382011	57.00	20.00	77.00

Name: apartment_building3
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 225.0°
Rated power: -
Panel material: Smooth glass without AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.334621	-6.380507	57.00	17.00	74.00
2	53.334489	-6.380764	57.00	17.00	74.00
3	53.334356	-6.380569	57.00	17.00	74.00
4	53.334485	-6.380319	57.00	17.00	74.00

Name: commercial_1
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 137.0°
Rated power: -
Panel material: Smooth glass without AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.334333	-6.381438	57.00	15.00	72.00
2	53.334451	-6.381631	57.00	15.00	72.00
3	53.334207	-6.382047	57.00	15.00	72.00
4	53.334089	-6.381854	57.00	15.00	72.00

Name: commercial_2
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 245.0°
Rated power: -
Panel material: Smooth glass without AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.334339	-6.382650	57.00	15.00	72.00
2	53.334395	-6.382513	57.00	15.00	72.00
3	53.334749	-6.382919	57.00	15.00	72.00
4	53.334692	-6.383056	57.00	15.00	72.00

Name: commercial_2
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 245.0°
Rated power: -
Panel material: Smooth glass without AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.334339	-6.382650	57.00	15.00	72.00
2	53.334395	-6.382513	57.00	15.00	72.00
3	53.334749	-6.382919	57.00	15.00	72.00
4	53.334692	-6.383056	57.00	15.00	72.00

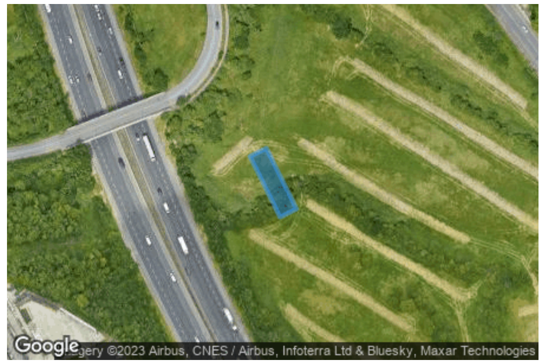
Name: commercial_3
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 245.0°
Rated power: -
Panel material: Smooth glass without AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.334940	-6.383144	57.00	15.00	72.00
2	53.334884	-6.383287	57.00	15.00	72.00
3	53.335240	-6.383679	57.00	15.00	72.00
4	53.335297	-6.383536	57.00	15.00	72.00

Name: commercial_4
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 245.0°
Rated power: -
Panel material: Smooth glass without AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.335699	-6.383960	57.00	10.00	67.00
2	53.335649	-6.384103	57.00	10.00	67.00
3	53.335972	-6.384413	57.00	10.00	67.00
4	53.336021	-6.384270	57.00	10.00	67.00

Name: commercial_5
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 245.0°
Rated power: -
Panel material: Smooth glass without AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.336428	-6.384620	57.00	10.00	67.00
2	53.336384	-6.384768	57.00	10.00	67.00
3	53.336711	-6.385041	57.00	10.00	67.00
4	53.336756	-6.384893	57.00	10.00	67.00

Flight Path Receptor(s)

Name: E
Description: None
Threshold height: 3 m
Direction: 270.0°
Glide slope: 8.0°
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	53.289509	-6.376820	103.70	3.00	106.70
Two-mile	53.289509	-6.328396	67.80	491.30	559.10

Name: N
Description: None
Threshold height: 3 m
Direction: 180.0°
Glide slope: 8.0°
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	53.289511	-6.376796	103.70	3.00	106.70
Two-mile	53.318423	-6.376796	80.40	478.70	559.10

Name: rw-05
Description: None
Threshold height: 15 m
Direction: 40.2°
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	53.293828	-6.453448	98.20	15.30	113.50
Two-mile	53.271745	-6.484707	154.40	127.80	282.20

Name: rw-07
Description: None
Threshold height: 15 m
Direction: 62.9°
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	53.350631	-6.493787	47.60	15.20	62.80
Two-mile	53.337460	-6.536956	53.80	177.70	231.50

Name: rw-07
Description: None
Threshold height: 15 m
Direction: 62.9°
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	53.350631	-6.493787	47.60	15.20	62.80
Two-mile	53.337460	-6.536956	53.80	177.70	231.50

Name: rw-11
Description: None
Threshold height: 15 m
Direction: 102.3°
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	53.304623	-6.468283	86.30	15.30	101.60
Two-mile	53.310782	-6.515612	72.90	197.30	270.20

Name: rw-23
Description: None
Threshold height: 15 m
Direction: 221.0°
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	53.303260	-6.439795	93.40	15.20	108.60
Two-mile	53.325080	-6.408016	62.40	214.90	277.30

Name: rw-25
Description: None
Threshold height: 15 m
Direction: 243.1°
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	53.354178	-6.482130	46.80	15.20	62.00
Two-mile	53.367260	-6.438881	29.00	201.70	230.70

Name: rw-25
Description: None
Threshold height: 15 m
Direction: 243.1°
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	53.354178	-6.482130	46.80	15.20	62.00
Two-mile	53.367260	-6.438881	29.00	201.70	230.70

Name: rw-29
Description: None
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	53.301694	-6.445159	96.10	15.20	111.30
Two-mile	53.295732	-6.397762	106.20	173.80	280.00

Name: S
Description: None
Threshold height: 3 m
Direction: 0.0°
Glide slope: 8.0°
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	53.289509	-6.376800	103.70	3.00	106.70
Two-mile	53.260597	-6.376800	161.90	397.20	559.10

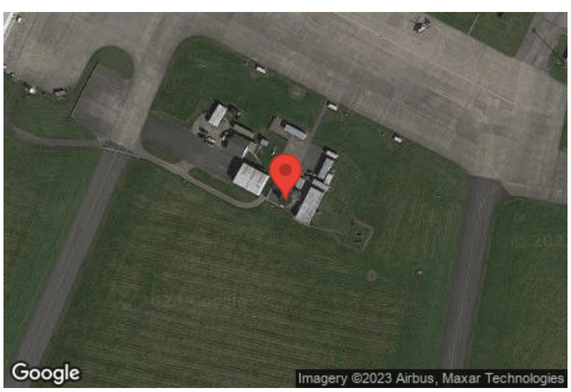
Name: W
Description: None
Threshold height: 3 m
Direction: 90.0°
Glide slope: 8.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.289511	-6.376800	103.70	3.00	106.70
Two-mile	53.289511	-6.425224	110.20	448.90	559.10

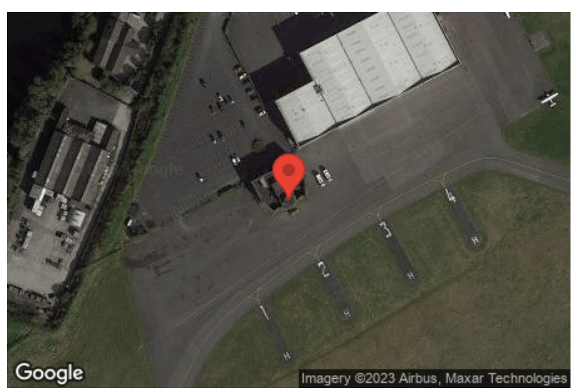
Discrete Observation Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
1-ATCT	1	53.305499	-6.441793	93.50	6.00
2-ATCT	2	53.355567	-6.489433	49.70	15.00

Map image of 1-ATCT



Map image of 2-ATCT



GLARE ANALYSIS RESULTS

Summary of Glare

PV Array Name	Tilt (°)	Orient (°)	"Green" Glare min	"Yellow" Glare min	Energy kWh
apartment_bldg1	15.0	173.0	2,189	0	-
apartmentbldg10b	15.0	135.0	0	0	-
apartmentbldg2	15.0	135.0	66	0	-
apartmentbldg5a	15.0	138.0	27	0	-
apartmentbldg6b	30.0	135.0	0	0	-
apartmentbldg7b	15.0	225.0	1,372	0	-
apartmentbldg8a	15.0	225.0	1,293	0	-
apartmentbldg9b	15.0	135.0	0	0	-
apartment_building3	15.0	225.0	1,508	0	-
commercial_1	15.0	137.0	99	0	-
commercial_2	15.0	245.0	2,037	0	-
commercial_2	15.0	245.0	2,066	0	-
commercial_3	15.0	245.0	1,968	0	-
commercial_4	15.0	245.0	2,020	0	-
commercial_5	15.0	245.0	1,902	0	-

Total annual glare received by each receptor

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
E	0	0
N	0	0
rw-05	192	0
rw-07	7181	0
rw-07	6985	0
rw-11	2189	0
rw-23	0	0
rw-25	0	0
rw-25	0	0
rw-29	0	0
S	0	0
W	0	0
1-ATCT	0	0
2-ATCT	0	0

Results for: apartment_bldg1

Receptor	Green Glare (min)	Yellow Glare (min)
E	0	0
N	0	0
rw-05	0	0
rw-07	0	0
rw-07	0	0
rw-11	2189	0
rw-23	0	0
rw-25	0	0
rw-25	0	0
rw-29	0	0
S	0	0
W	0	0
1-ATCT	0	0
2-ATCT	0	0

Flight Path: E

0 minutes of yellow glare
0 minutes of green glare

Flight Path: N

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-05

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-07

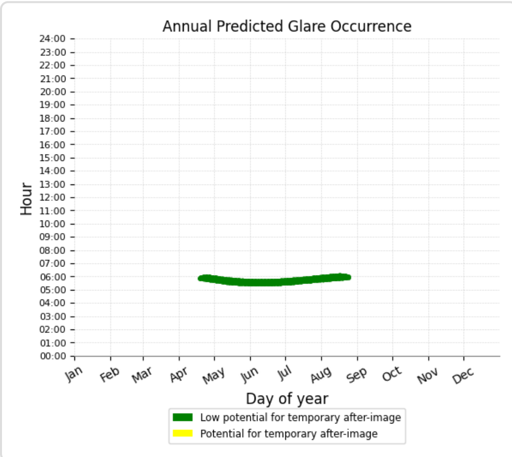
0 minutes of yellow glare
0 minutes of green glare

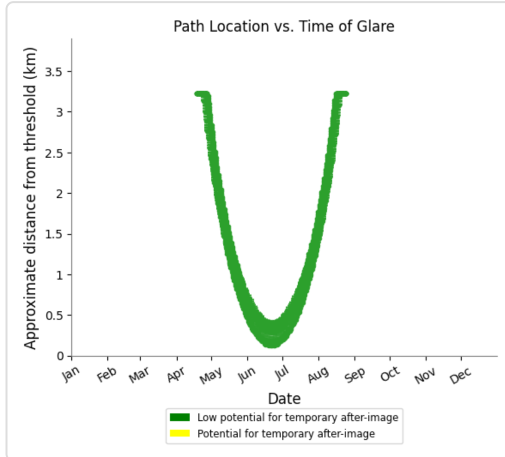
Flight Path: rw-07

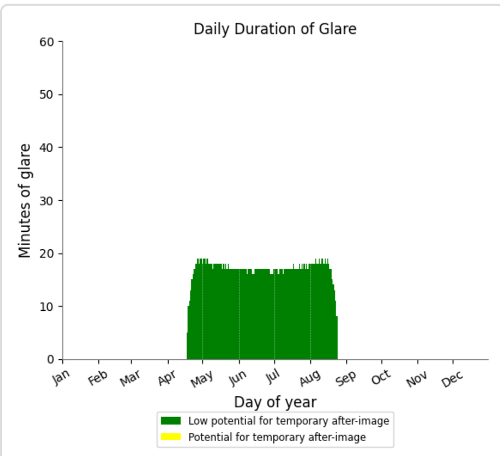
0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-11

0 minutes of yellow glare
2189 minutes of green glare







Flight Path: rw-23

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-25

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-25

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-29

0 minutes of yellow glare
0 minutes of green glare

Flight Path: S

0 minutes of yellow glare
0 minutes of green glare

Flight Path: W

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 1-ATCT

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 2-ATCT

0 minutes of yellow glare
0 minutes of green glare

Results for: apartmentbldg10b

Receptor	Green Glare (min)	Yellow Glare (min)
E	0	0
N	0	0
rw-05	0	0
rw-07	0	0
rw-07	0	0
rw-11	0	0
rw-23	0	0
rw-25	0	0
rw-25	0	0
rw-29	0	0
S	0	0
W	0	0
1-ATCT	0	0
2-ATCT	0	0

Flight Path: E

0 minutes of yellow glare
0 minutes of green glare

Flight Path: N

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-05

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-07

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-07

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-11

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-23

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-25

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-25

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-29

0 minutes of yellow glare
0 minutes of green glare

Flight Path: S

0 minutes of yellow glare
0 minutes of green glare

Flight Path: W

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 1-ATCT

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 2-ATCT

0 minutes of yellow glare
0 minutes of green glare

Results for: apartmentbldg2

Receptor	Green Glare (min)	Yellow Glare (min)
E	0	0
N	0	0
rw-05	66	0
rw-07	0	0
rw-07	0	0
rw-11	0	0
rw-23	0	0
rw-25	0	0
rw-25	0	0
rw-29	0	0
S	0	0
W	0	0
1-ATCT	0	0
2-ATCT	0	0

Flight Path: E

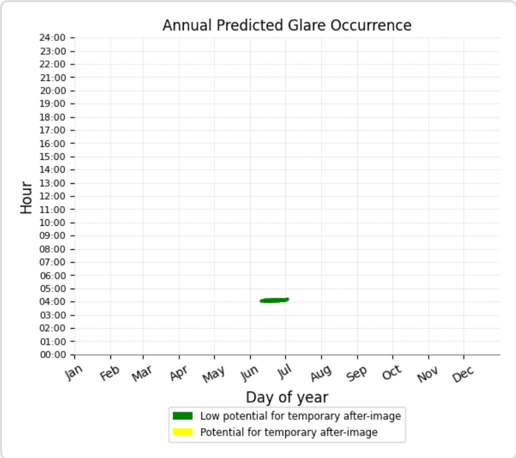
0 minutes of yellow glare
0 minutes of green glare

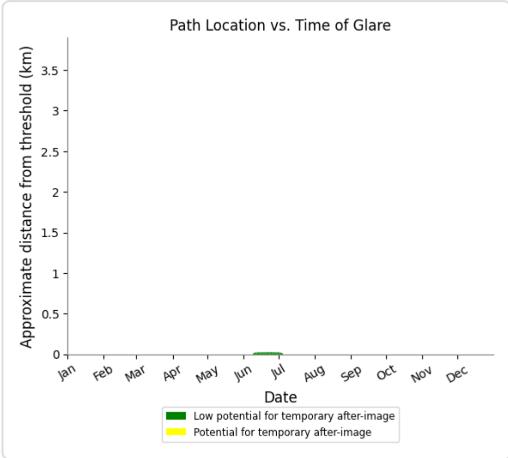
Flight Path: N

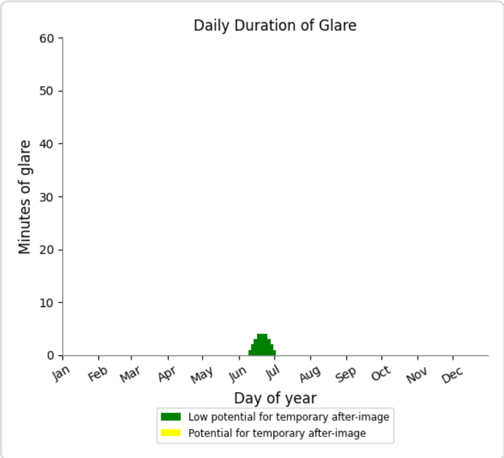
0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-05

0 minutes of yellow glare
66 minutes of green glare







Flight Path: rw-07

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-07

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-11

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-23

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-25

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-25

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-29

0 minutes of yellow glare
0 minutes of green glare

Flight Path: S

0 minutes of yellow glare
0 minutes of green glare

Flight Path: W

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 1-ATCT

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 2-ATCT

0 minutes of yellow glare
0 minutes of green glare

Results for: apartmentbldg5a

Receptor	Green Glare (min)	Yellow Glare (min)
E	0	0
N	0	0
rw-05	27	0
rw-07	0	0
rw-07	0	0
rw-11	0	0
rw-23	0	0
rw-25	0	0
rw-25	0	0
rw-29	0	0
S	0	0
W	0	0
1-ATCT	0	0
2-ATCT	0	0

Flight Path: E

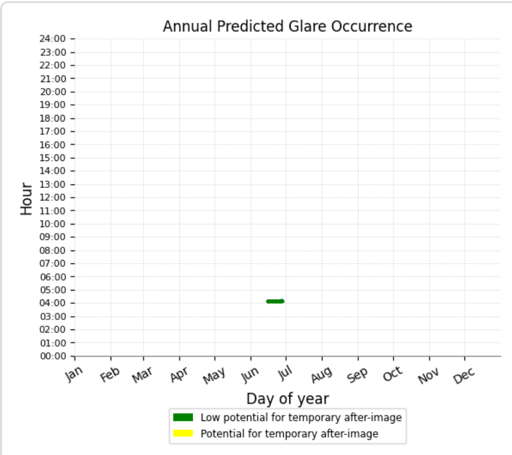
0 minutes of yellow glare
0 minutes of green glare

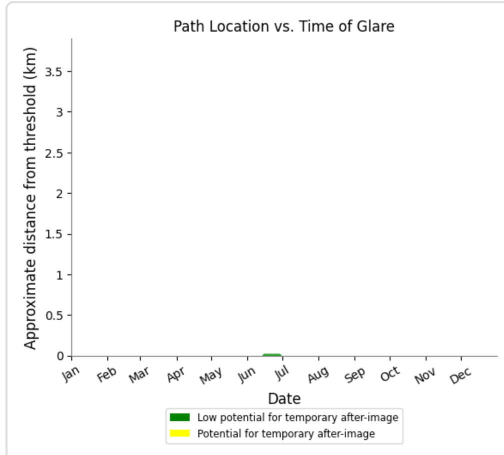
Flight Path: N

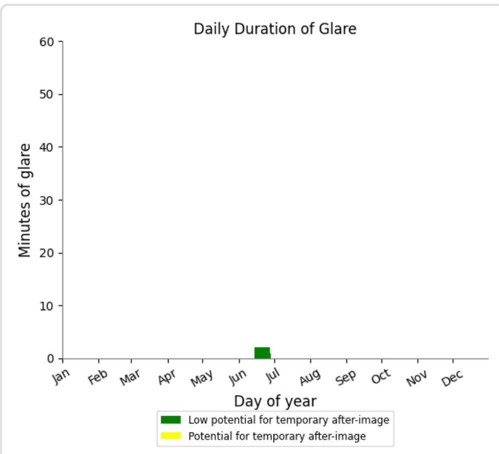
0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-05

0 minutes of yellow glare
27 minutes of green glare







Flight Path: rw-07

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-07

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-11

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-23

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-25

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-25

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-29

0 minutes of yellow glare
0 minutes of green glare

Flight Path: S

0 minutes of yellow glare
0 minutes of green glare

Flight Path: W

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 1-ATCT

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 2-ATCT

0 minutes of yellow glare
0 minutes of green glare

Results for: apartmentbldg6b

Receptor	Green Glare (min)	Yellow Glare (min)
E	0	0
N	0	0
rw-05	0	0
rw-07	0	0
rw-07	0	0
rw-11	0	0
rw-23	0	0
rw-25	0	0
rw-25	0	0
rw-29	0	0
S	0	0
W	0	0
1-ATCT	0	0
2-ATCT	0	0

Flight Path: E

0 minutes of yellow glare
0 minutes of green glare

Flight Path: N

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-05

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-07

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-07

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-11

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-23

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-25

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-25

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-29

0 minutes of yellow glare
0 minutes of green glare

Flight Path: S

0 minutes of yellow glare
0 minutes of green glare

Flight Path: W

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 1-ATCT

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 2-ATCT

0 minutes of yellow glare
0 minutes of green glare

Results for: apartmentbldg7b

Receptor	Green Glare (min)	Yellow Glare (min)
E	0	0
N	0	0
rw-05	0	0
rw-07	635	0
rw-07	737	0
rw-11	0	0
rw-23	0	0
rw-25	0	0
rw-25	0	0
rw-29	0	0
S	0	0
W	0	0
1-ATCT	0	0
2-ATCT	0	0

Flight Path: E

0 minutes of yellow glare
0 minutes of green glare

Flight Path: N

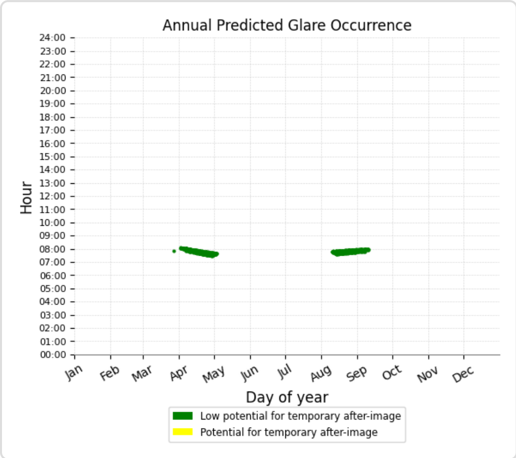
0 minutes of yellow glare
0 minutes of green glare

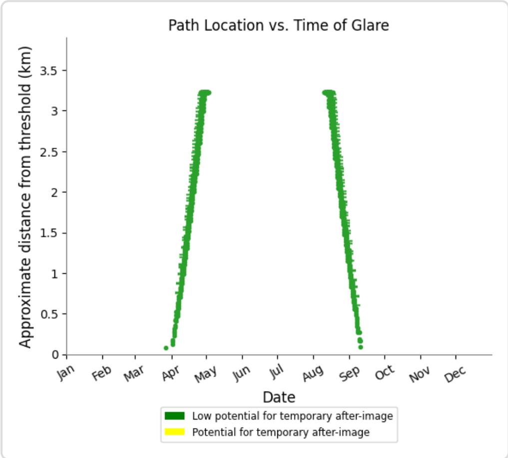
Flight Path: rw-05

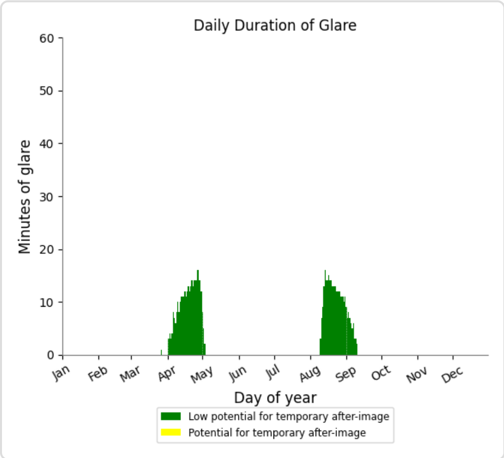
0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-07

0 minutes of yellow glare
635 minutes of green glare

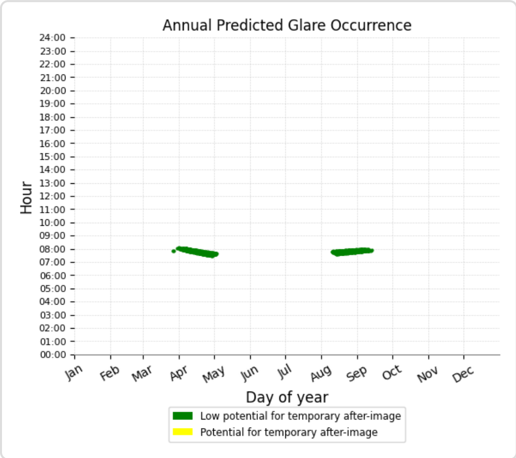


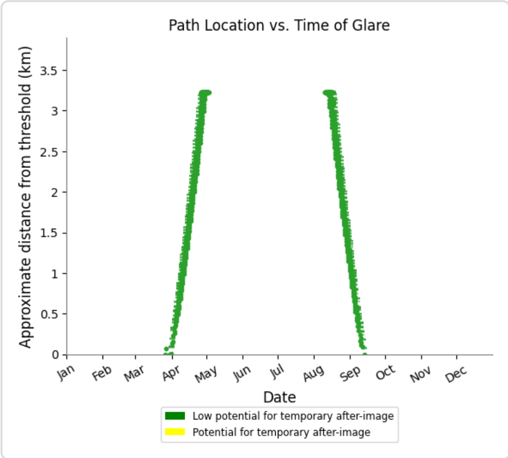


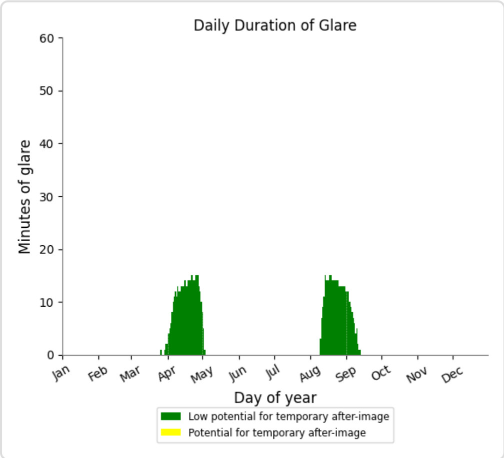


Flight Path: rw-07

0 minutes of yellow glare
737 minutes of green glare







Flight Path: rw-11

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-23

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-25

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-25

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-29

0 minutes of yellow glare
0 minutes of green glare

Flight Path: S

0 minutes of yellow glare
0 minutes of green glare

Flight Path: W

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 1-ATCT

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 2-ATCT

0 minutes of yellow glare
0 minutes of green glare

Results for: apartmentbldg8a

Receptor	Green Glare (min)	Yellow Glare (min)
E	0	0
N	0	0
rw-05	0	0
rw-07	719	0
rw-07	574	0
rw-11	0	0
rw-23	0	0
rw-25	0	0
rw-25	0	0
rw-29	0	0
S	0	0
W	0	0
1-ATCT	0	0
2-ATCT	0	0

Flight Path: E

0 minutes of yellow glare
0 minutes of green glare

Flight Path: N

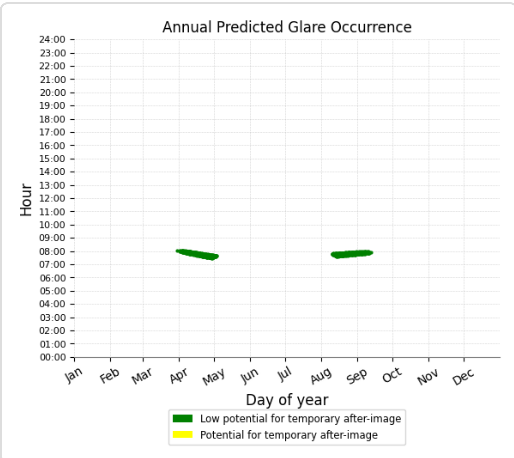
0 minutes of yellow glare
0 minutes of green glare

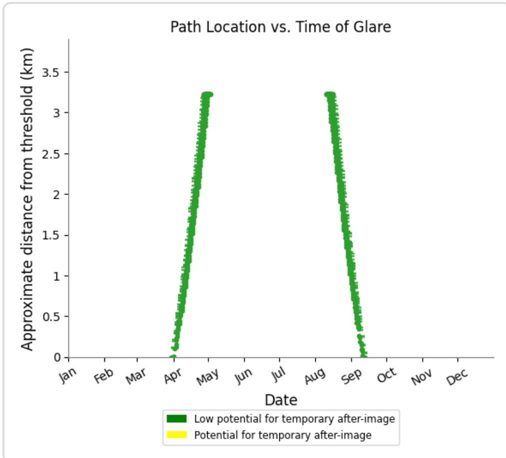
Flight Path: rw-05

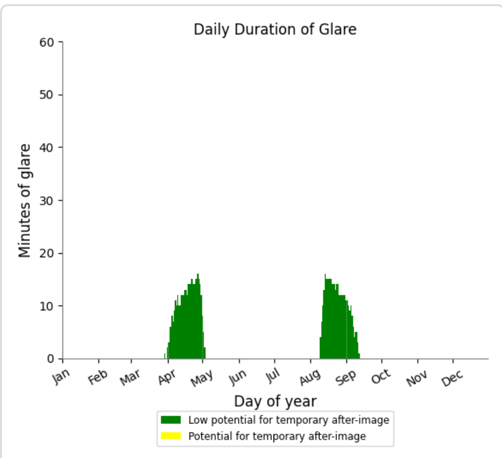
0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-07

0 minutes of yellow glare
719 minutes of green glare

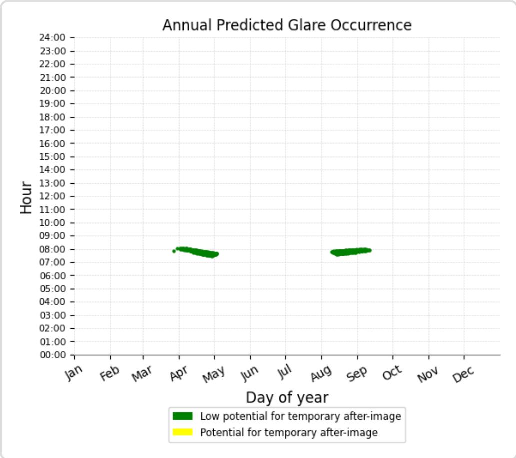


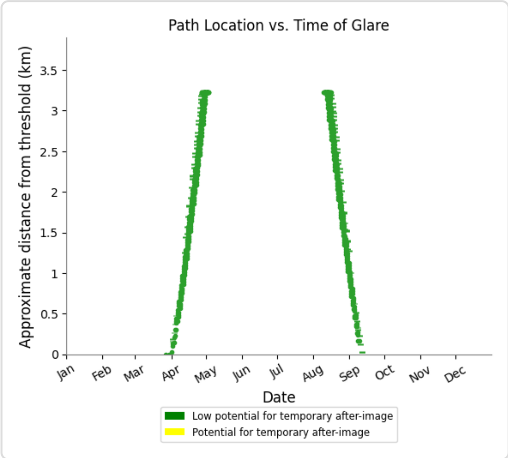


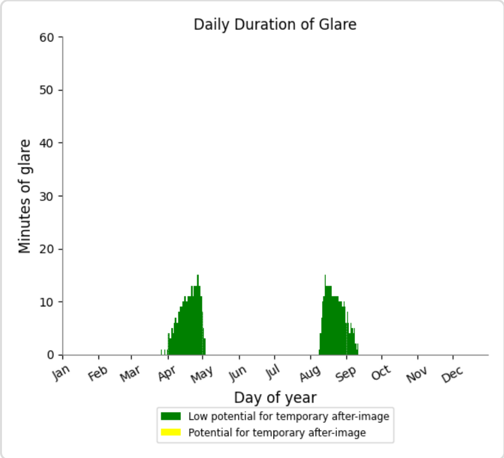


Flight Path: rw-07

0 minutes of yellow glare
574 minutes of green glare







Flight Path: rw-11

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-23

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-25

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-25

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-29

0 minutes of yellow glare
0 minutes of green glare

Flight Path: S

0 minutes of yellow glare
0 minutes of green glare

Flight Path: W

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 1-ATCT

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 2-ATCT

0 minutes of yellow glare
0 minutes of green glare

Results for: apartmentbldg9b

Receptor	Green Glare (min)	Yellow Glare (min)
E	0	0
N	0	0
rw-05	0	0
rw-07	0	0
rw-07	0	0
rw-11	0	0
rw-23	0	0
rw-25	0	0
rw-25	0	0
rw-29	0	0
S	0	0
W	0	0
1-ATCT	0	0
2-ATCT	0	0

Flight Path: E

0 minutes of yellow glare
0 minutes of green glare

Flight Path: N

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-05

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-07

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-07

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-11

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-23

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-25

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-25

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-29

0 minutes of yellow glare
0 minutes of green glare

Flight Path: S

0 minutes of yellow glare
0 minutes of green glare

Flight Path: W

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 1-ATCT

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 2-ATCT

0 minutes of yellow glare
0 minutes of green glare

Results for: apartment_building3

Receptor	Green Glare (min)	Yellow Glare (min)
E	0	0
N	0	0
rw-05	0	0
rw-07	802	0
rw-07	706	0
rw-11	0	0
rw-23	0	0
rw-25	0	0
rw-25	0	0
rw-29	0	0
S	0	0
W	0	0
1-ATCT	0	0
2-ATCT	0	0

Flight Path: E

0 minutes of yellow glare
0 minutes of green glare

Flight Path: N

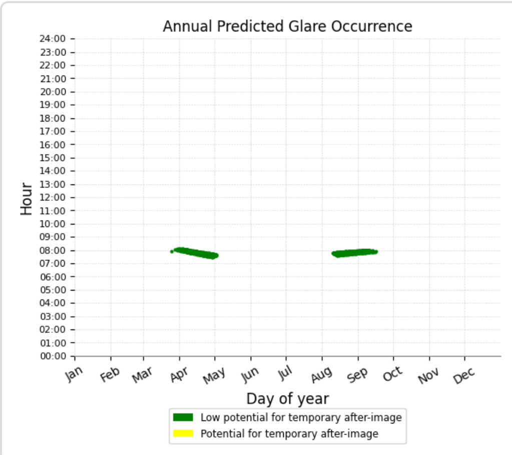
0 minutes of yellow glare
0 minutes of green glare

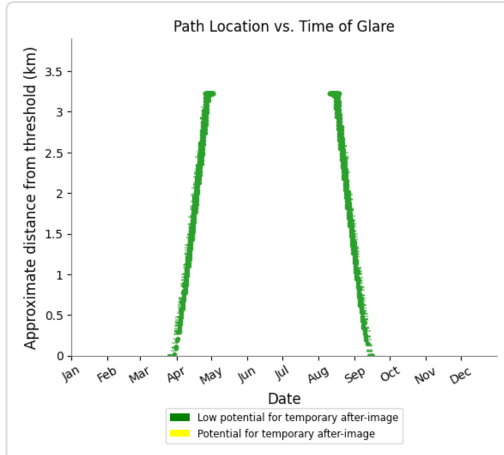
Flight Path: rw-05

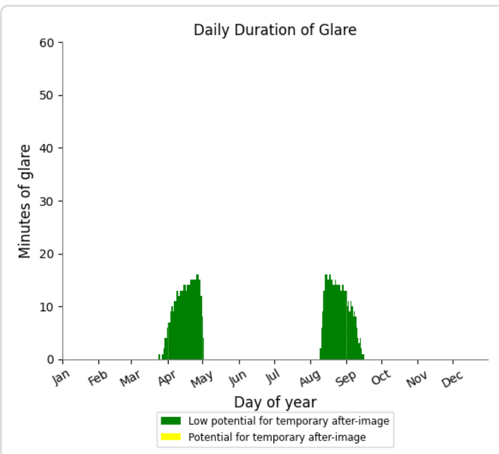
0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-07

0 minutes of yellow glare
802 minutes of green glare

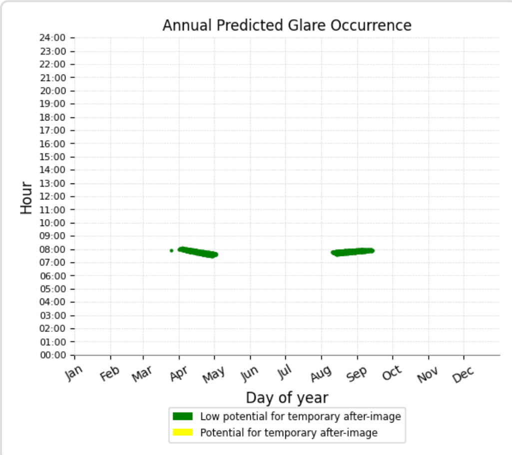


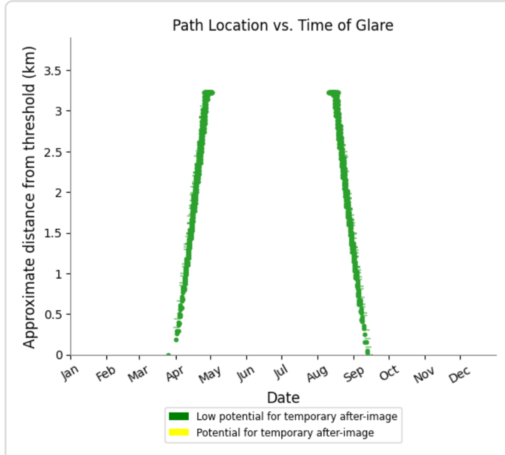


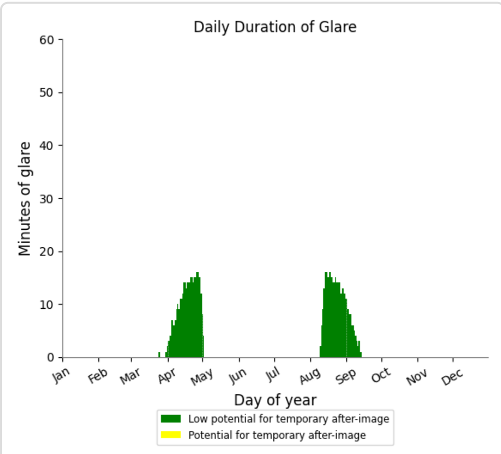


Flight Path: rw-07

0 minutes of yellow glare
706 minutes of green glare







Flight Path: rw-11

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-23

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-25

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-25

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-29

0 minutes of yellow glare
0 minutes of green glare

Flight Path: S

0 minutes of yellow glare
0 minutes of green glare

Flight Path: W

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 1-ATCT

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 2-ATCT

0 minutes of yellow glare
0 minutes of green glare

Results for: commercial_1

Receptor	Green Glare (min)	Yellow Glare (min)
E	0	0
N	0	0
rw-05	99	0
rw-07	0	0
rw-07	0	0
rw-11	0	0
rw-23	0	0
rw-25	0	0
rw-25	0	0
rw-29	0	0
S	0	0
W	0	0
1-ATCT	0	0
2-ATCT	0	0

Flight Path: E

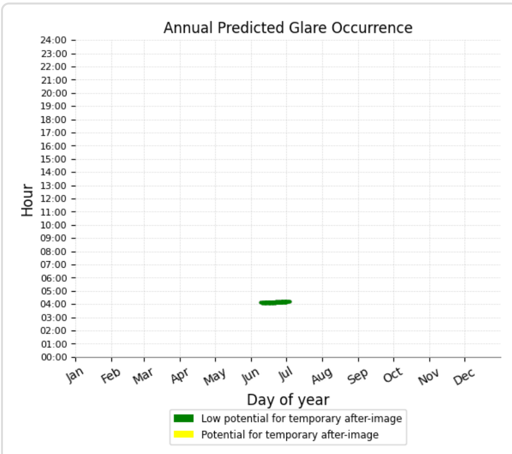
0 minutes of yellow glare
0 minutes of green glare

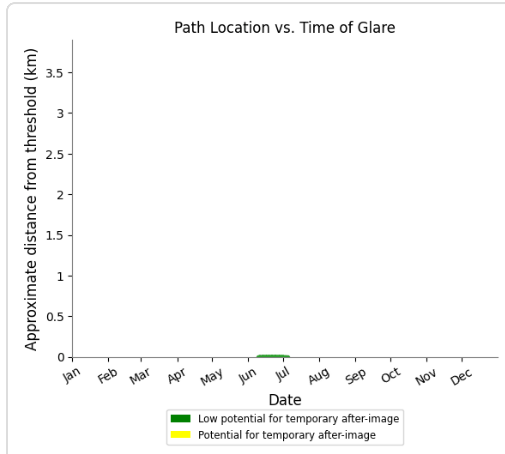
Flight Path: N

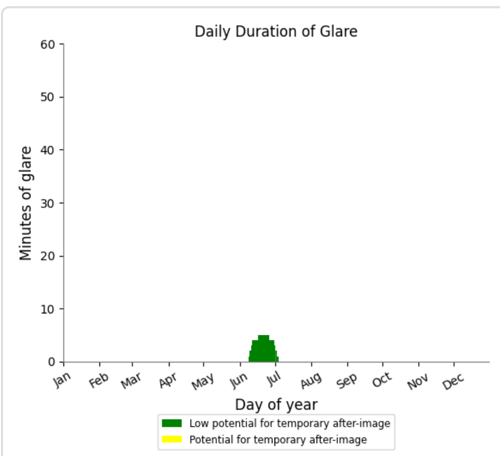
0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-05

0 minutes of yellow glare
99 minutes of green glare







Flight Path: rw-07

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-07

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-11

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-23

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-25

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-25

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-29

0 minutes of yellow glare
0 minutes of green glare

Flight Path: S

0 minutes of yellow glare
0 minutes of green glare

Flight Path: W

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 1-ATCT

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 2-ATCT

0 minutes of yellow glare
0 minutes of green glare

Results for: commercial_2

Receptor	Green Glare (min)	Yellow Glare (min)
E	0	0
N	0	0
rw-05	0	0
rw-07	1018	0
rw-07	1019	0
rw-11	0	0
rw-23	0	0
rw-25	0	0
rw-25	0	0
rw-29	0	0
S	0	0
W	0	0
1-ATCT	0	0
2-ATCT	0	0

Flight Path: E

0 minutes of yellow glare
0 minutes of green glare

Flight Path: N

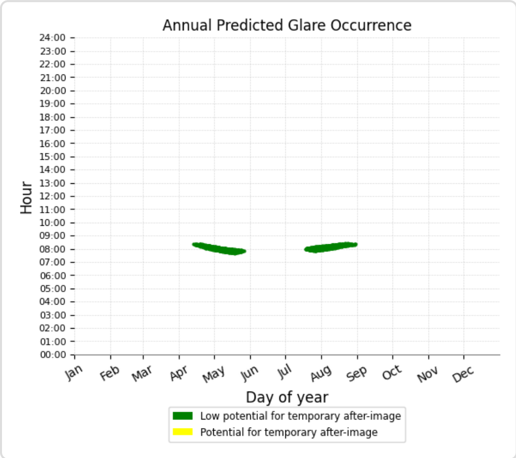
0 minutes of yellow glare
0 minutes of green glare

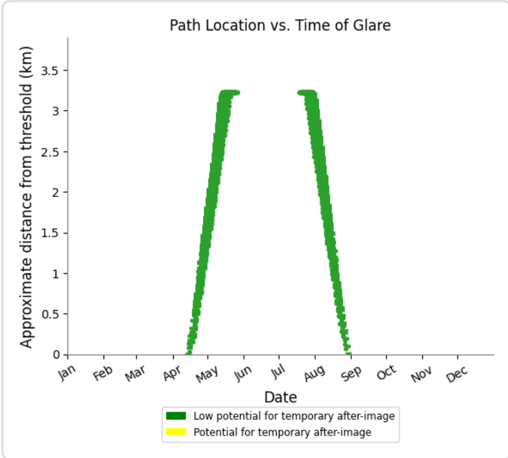
Flight Path: rw-05

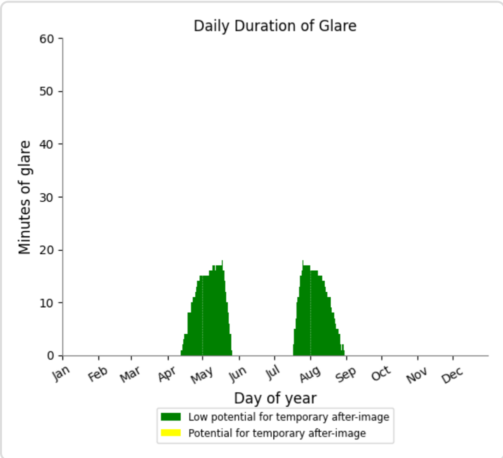
0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-07

0 minutes of yellow glare
1018 minutes of green glare

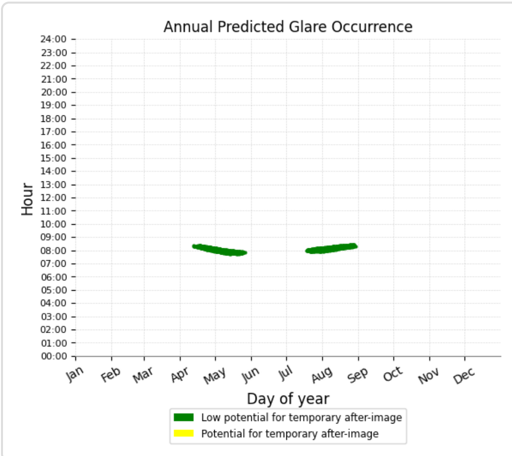


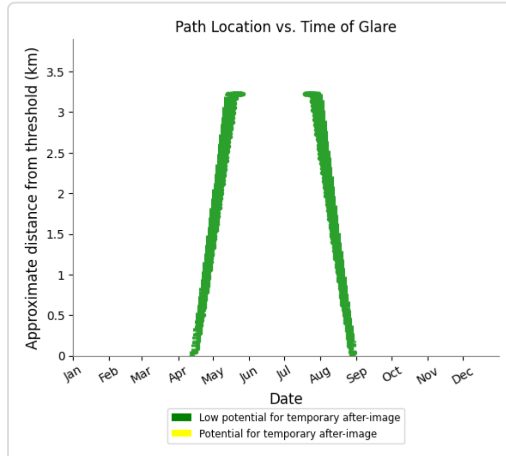


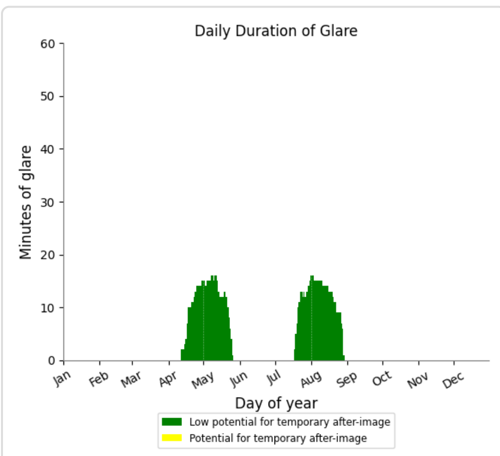


Flight Path: rw-07

0 minutes of yellow glare
1019 minutes of green glare







Flight Path: rw-11

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-23

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-25

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-25

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-29

0 minutes of yellow glare
0 minutes of green glare

Flight Path: S

0 minutes of yellow glare
0 minutes of green glare

Flight Path: W

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 1-ATCT

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 2-ATCT

0 minutes of yellow glare
0 minutes of green glare

Results for: commercial_2

Receptor	Green Glare (min)	Yellow Glare (min)
E	0	0
N	0	0
rw-05	0	0
rw-07	1001	0
rw-07	1065	0
rw-11	0	0
rw-23	0	0
rw-25	0	0
rw-25	0	0
rw-29	0	0
S	0	0
W	0	0
1-ATCT	0	0
2-ATCT	0	0

Flight Path: E

0 minutes of yellow glare
0 minutes of green glare

Flight Path: N

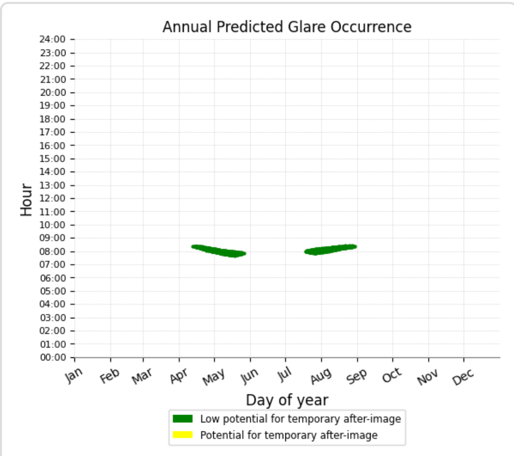
0 minutes of yellow glare
0 minutes of green glare

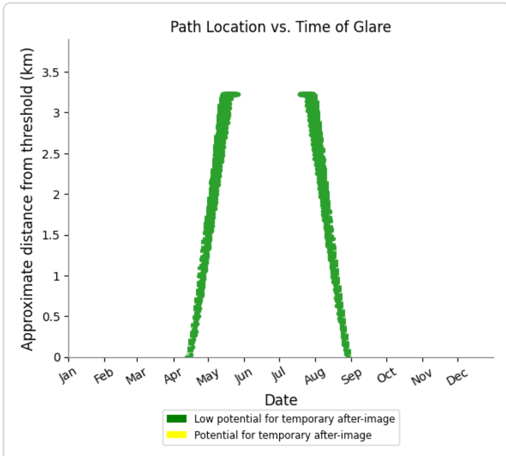
Flight Path: rw-05

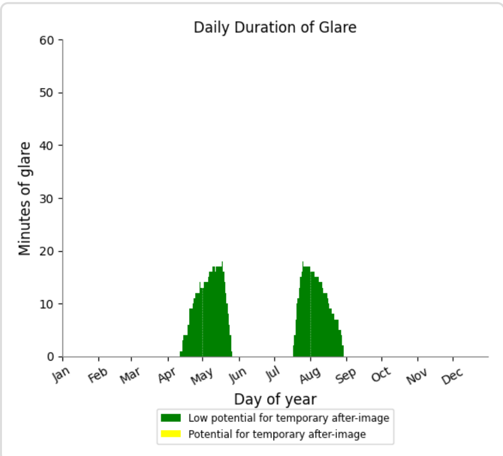
0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-07

0 minutes of yellow glare
1001 minutes of green glare

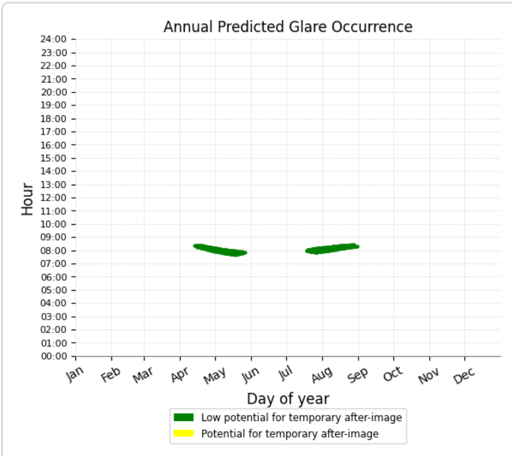


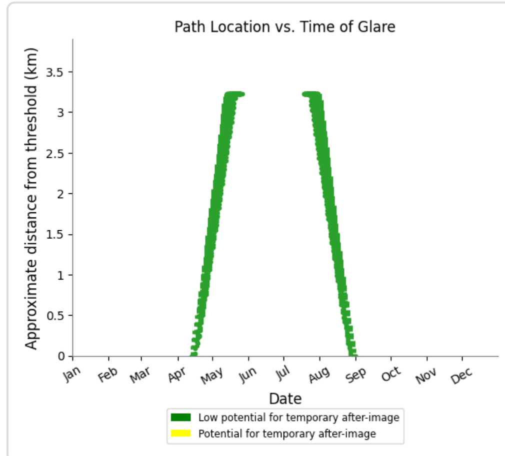


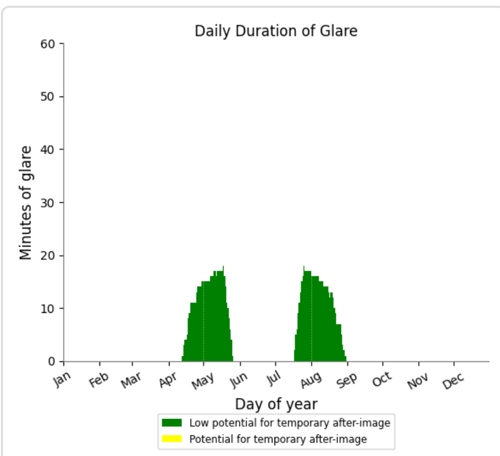


Flight Path: rw-07

0 minutes of yellow glare
1065 minutes of green glare







Flight Path: rw-11

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-23

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-25

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-25

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-29

0 minutes of yellow glare
0 minutes of green glare

Flight Path: S

0 minutes of yellow glare
0 minutes of green glare

Flight Path: W

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 1-ATCT

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 2-ATCT

0 minutes of yellow glare
0 minutes of green glare

Results for: commercial_3

Receptor	Green Glare (min)	Yellow Glare (min)
E	0	0
N	0	0
rw-05	0	0
rw-07	1026	0
rw-07	942	0
rw-11	0	0
rw-23	0	0
rw-25	0	0
rw-25	0	0
rw-29	0	0
S	0	0
W	0	0
1-ATCT	0	0
2-ATCT	0	0

Flight Path: E

0 minutes of yellow glare
0 minutes of green glare

Flight Path: N

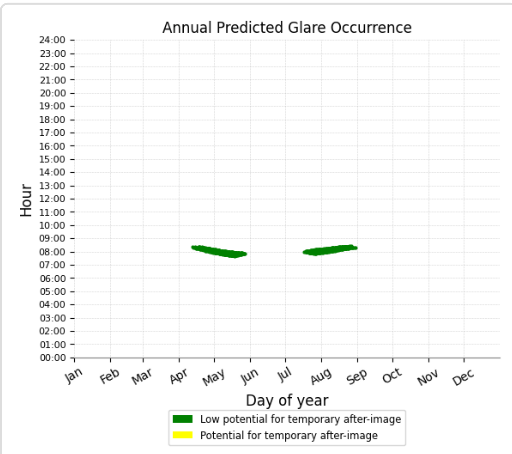
0 minutes of yellow glare
0 minutes of green glare

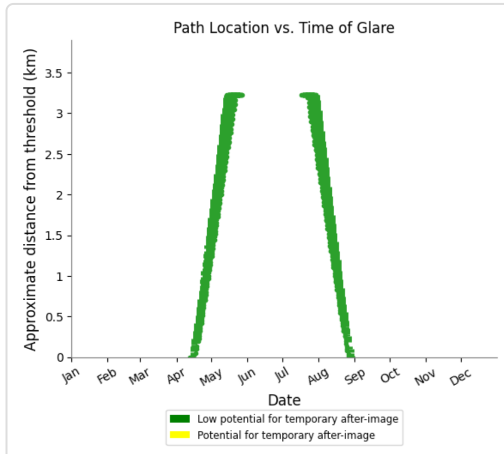
Flight Path: rw-05

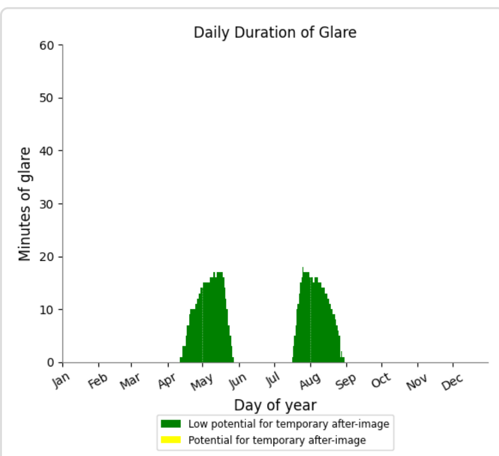
0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-07

0 minutes of yellow glare
1026 minutes of green glare

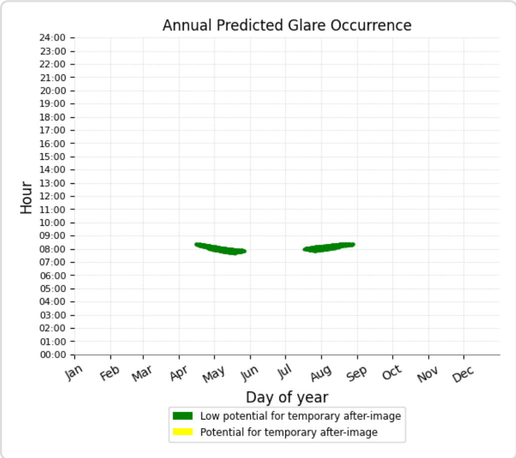


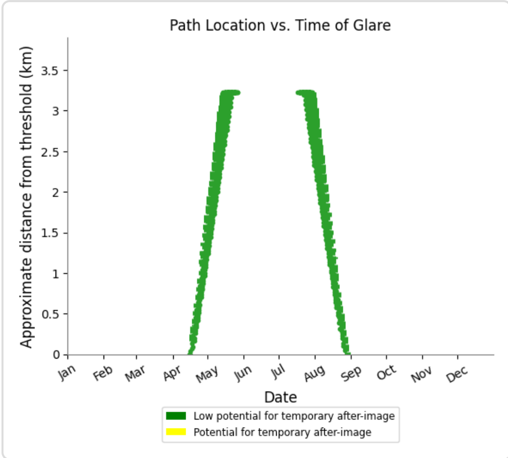


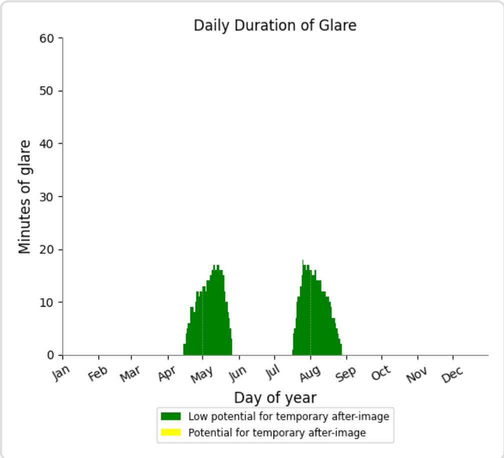


Flight Path: rw-07

0 minutes of yellow glare
942 minutes of green glare







Flight Path: rw-11

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-23

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-25

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-25

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-29

0 minutes of yellow glare
0 minutes of green glare

Flight Path: S

0 minutes of yellow glare
0 minutes of green glare

Flight Path: W

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 1-ATCT

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 2-ATCT

0 minutes of yellow glare
0 minutes of green glare

Results for: commercial_4

Receptor	Green Glare (min)	Yellow Glare (min)
E	0	0
N	0	0
rw-05	0	0
rw-07	983	0
rw-07	1037	0
rw-11	0	0
rw-23	0	0
rw-25	0	0
rw-25	0	0
rw-29	0	0
S	0	0
W	0	0
1-ATCT	0	0
2-ATCT	0	0

Flight Path: E

0 minutes of yellow glare
0 minutes of green glare

Flight Path: N

0 minutes of yellow glare

0 minutes of green glare

Flight Path: rw-05

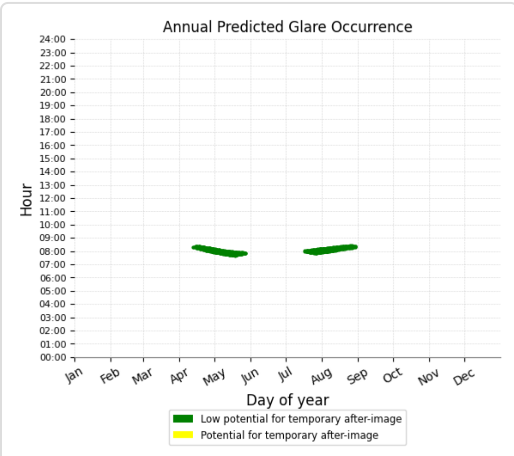
0 minutes of yellow glare

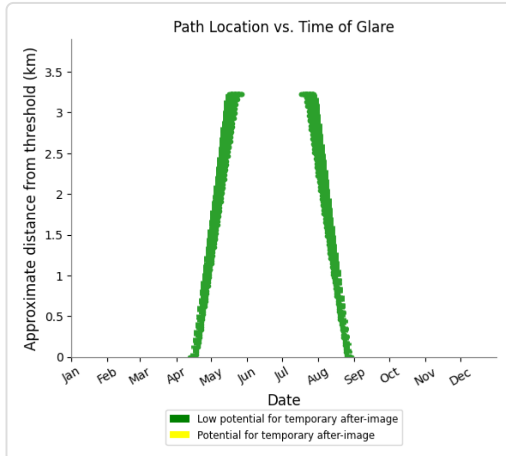
0 minutes of green glare

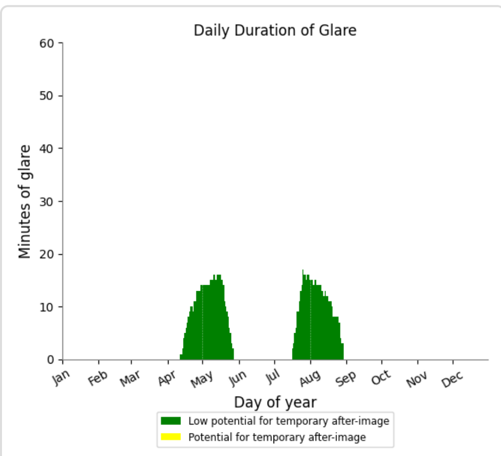
Flight Path: rw-07

0 minutes of yellow glare

983 minutes of green glare

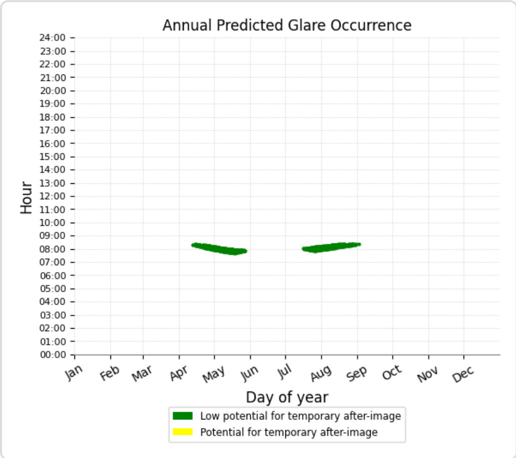


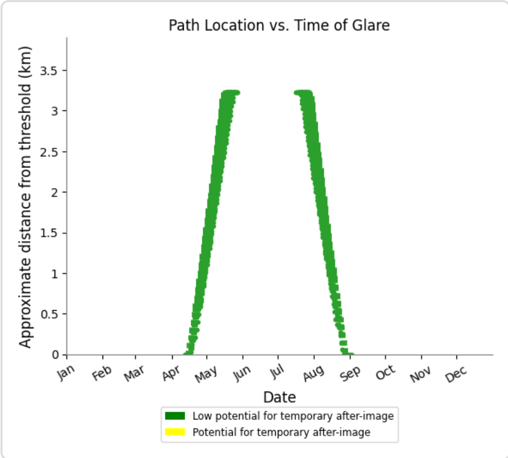


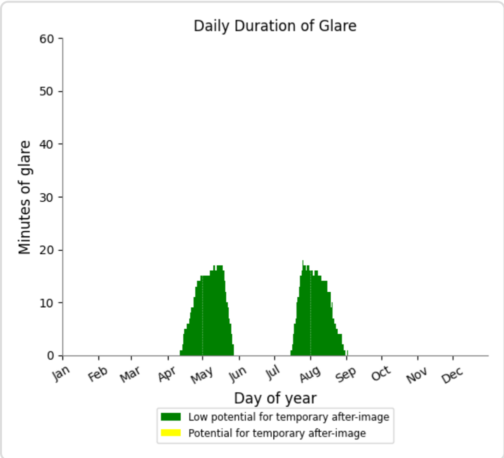


Flight Path: rw-07

0 minutes of yellow glare
1037 minutes of green glare







Flight Path: rw-11

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-23

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-25

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-25

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-29

0 minutes of yellow glare
0 minutes of green glare

Flight Path: S

0 minutes of yellow glare
0 minutes of green glare

Flight Path: W

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 1-ATCT

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 2-ATCT

0 minutes of yellow glare
0 minutes of green glare

Results for: commercial_5

Receptor	Green Glare (min)	Yellow Glare (min)
E	0	0
N	0	0
rw-05	0	0
rw-07	997	0
rw-07	905	0
rw-11	0	0
rw-23	0	0
rw-25	0	0
rw-25	0	0
rw-29	0	0
S	0	0
W	0	0
1-ATCT	0	0
2-ATCT	0	0

Flight Path: E

0 minutes of yellow glare
0 minutes of green glare

Flight Path: N

0 minutes of yellow glare

0 minutes of green glare

Flight Path: rw-05

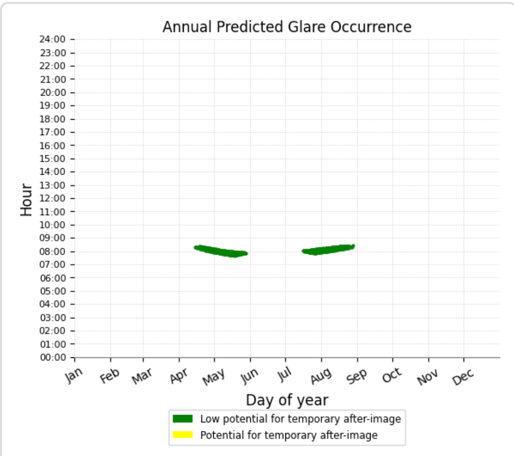
0 minutes of yellow glare

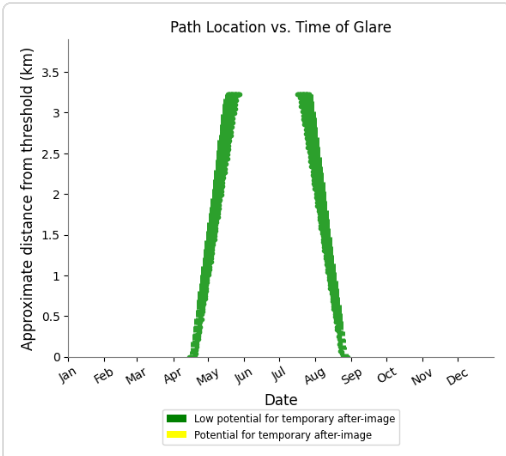
0 minutes of green glare

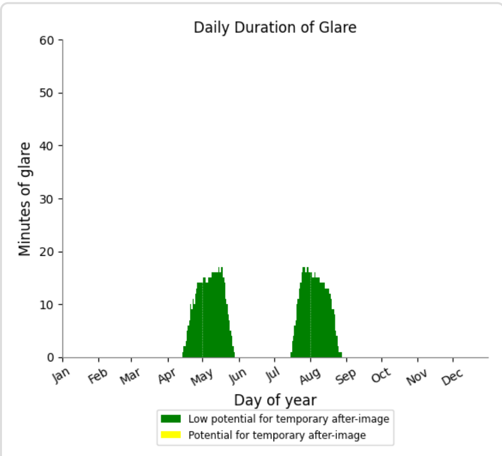
Flight Path: rw-07

0 minutes of yellow glare

997 minutes of green glare

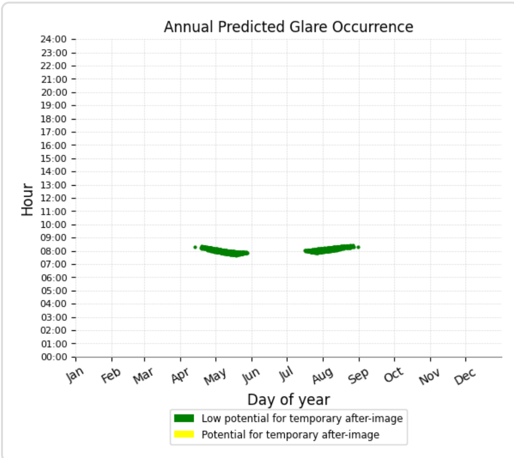


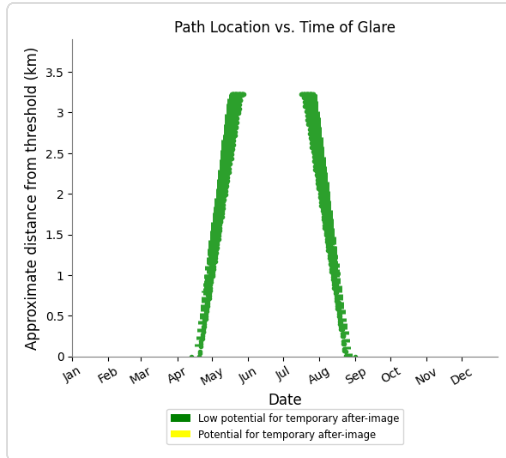


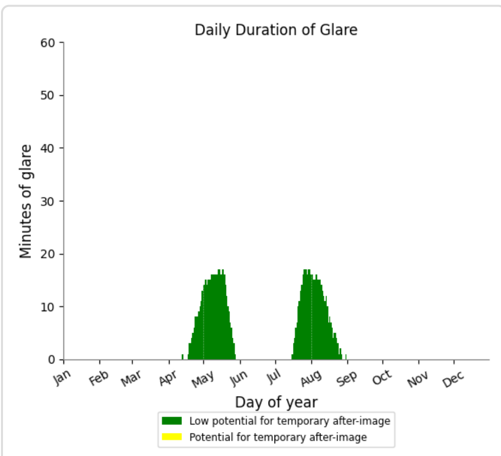


Flight Path: rw-07

0 minutes of yellow glare
905 minutes of green glare







Flight Path: rw-11

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-23

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-25

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-25

0 minutes of yellow glare
0 minutes of green glare

Flight Path: rw-29

0 minutes of yellow glare
0 minutes of green glare

Flight Path: S

0 minutes of yellow glare
0 minutes of green glare

Flight Path: W

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 1-ATCT

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 2-ATCT

0 minutes of yellow glare
0 minutes of green glare

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to V1 algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual results and glare occurrence may differ.
Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
Refer to the Help page at **www.forgesolar.com/help/** for assumptions and limitations not listed here.

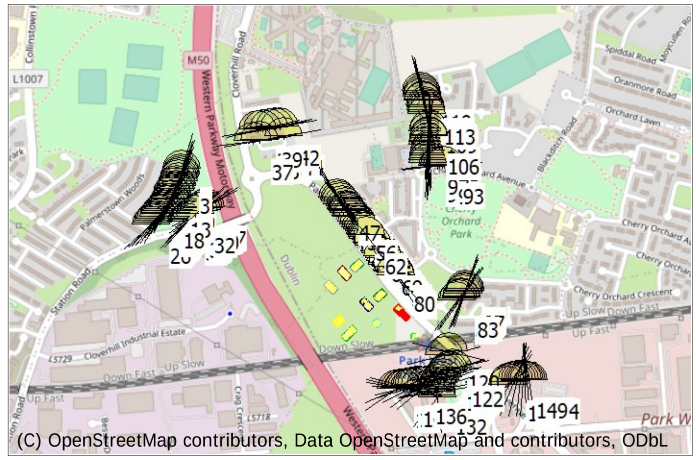
GLARE - Main result

Calculation: dwelling_glare_rev2

Setup

Distance limit	3000m
Grid Resolution	0.05°
Time Step	1 minutes
Glare ignored if closer to sun than	0.0°

All coordinates are in
Irish ITM-IRENET95 (IE), geocentric, GRS80



Scale 1:20,000

Glare receptor
Solar PV
PV Panels with Glare

Solar areas

Area description	Size	Number of PV panels	Tilt angle	Orientation	Table size	Row spacing
			[°]	[°]		[m]
apartment_bldg1 - 629 m2	190 m2	40	15.0	170.0	1.96x0.99m	2.2
apartmentbldg2 - 545 m2	785 m2	138	15.0	135.0	1.96x0.99m	2.2
apartmentbldg3 - 321 m2	291 m2	64	15.0	225.0	1.96x0.99m	2.2
apartmentbldg5a - 526 m2	420 m2	78	15.0	225.0	1.96x0.99m	2.2
apartmentbldg10b - 540 m2	540 m2	112	15.0	135.0	1.96x0.99m	2.2
apartmentbldg6b - 539 m2	539 m2	102	15.0	135.0	1.96x0.99m	2.2
apartmentbldg7b - 517 m2	517 m2	110	15.0	225.0	1.96x0.99m	2.2
apartmentbldg9b - 575 m2	575 m2	120	15.0	135.0	1.96x0.99m	2.2
apartmentbldg8a - 532 m2	532 m2	112	15.0	225.0	1.96x0.99m	2.2
commercial_1 - 708 m2	708 m2	151	15.0	225.0	1.96x0.99m	2.2
Sum	5096 m2	1027				

Glare Receptors

No.	Name	Easting	Northing	Z	Degrees from south cw	Height a.g.l	Field of view
				[m]	[°]	[m]	[°]
1	Glare OP #1 AZIMUTH: -74 FOV: 180	707,329	733,203	56.0	286.0	1.6	180.0
2	Glare OP #2 AZIMUTH: -73 FOV: 180	707,327	733,197	56.0	287.0	1.6	180.0
3	Glare OP #3 AZIMUTH: -69 FOV: 180	707,326	733,191	56.0	291.0	1.6	180.0
4	Glare OP #4 AZIMUTH: -70 FOV: 180	707,324	733,184	56.0	290.0	1.6	180.0
5	Glare OP #5 AZIMUTH: -69 FOV: 180	707,322	733,178	56.0	291.0	1.6	180.0
6	Glare OP #6 AZIMUTH: -68 FOV: 180	707,320	733,172	56.0	292.0	1.6	180.0
7	Glare OP #7 AZIMUTH: -67 FOV: 180	707,317	733,165	56.0	293.0	1.6	180.0
8	Glare OP #8 AZIMUTH: -67 FOV: 180	707,315	733,159	56.0	293.0	1.6	180.0
9	Glare OP #9 AZIMUTH: -64 FOV: 180	707,312	733,153	56.0	296.0	1.6	180.0
10	Glare OP #10 AZIMUTH: -66 FOV: 180	707,309	733,147	56.0	294.0	1.6	180.0
11	Glare OP #11 AZIMUTH: -65 FOV: 180	707,306	733,140	56.0	295.0	1.6	180.0
12	Glare OP #12 AZIMUTH: -64 FOV: 180	707,304	733,135	56.0	296.0	1.6	180.0
13	Glare OP #13 AZIMUTH: -61 FOV: 180	707,302	733,128	56.0	299.0	1.6	180.0
14	Glare OP #14 AZIMUTH: -63 FOV: 180	707,299	733,123	56.2	297.0	1.6	180.0
15	Glare OP #15 AZIMUTH: -59 FOV: 180	707,296	733,115	56.5	301.0	1.6	180.0
16	Glare OP #16 AZIMUTH: -59 FOV: 180	707,292	733,110	56.7	301.0	1.6	180.0
17	Glare OP #17 AZIMUTH: -54 FOV: 180	707,289	733,103	57.0	306.0	1.6	180.0
18	Glare OP #18 AZIMUTH: -46 FOV: 180	707,286	733,098	57.3	314.0	1.6	180.0
19	Glare OP #19 AZIMUTH: -60 FOV: 180	707,281	733,092	57.6	300.0	1.6	180.0
20	Glare OP #20 AZIMUTH: -55 FOV: 180	707,276	733,087	57.9	305.0	1.6	180.0
21	Glare OP #21 AZIMUTH: -52 FOV: 180	707,273	733,082	58.1	308.0	1.6	180.0
22	Glare OP #22 AZIMUTH: -50 FOV: 180	707,269	733,077	58.4	310.0	1.6	180.0

To be continued on next page...

GLARE - Main result

Calculation: dwelling_glare_rev2

...continued from previous page

No.	Name	Easting	Northing	Z [m]	Degrees from south cw [°]	Height a.g.l [m]	Field of view [°]
23	Glare OP #23 AZIMUTH: -49 FOV: 180	707,263	733,071	58.8	311.0	1.6	180.0
24	Glare OP #24 AZIMUTH: -46 FOV: 180	707,259	733,066	58.9	314.0	1.6	180.0
25	Glare OP #25 AZIMUTH: -42 FOV: 180	707,254	733,061	59.0	318.0	1.6	180.0
26	Glare OP #26 AZIMUTH: -42 FOV: 180	707,249	733,057	59.0	318.0	1.6	180.0
27	Glare OP #27 AZIMUTH: -32 FOV: 180	707,394	733,106	59.2	328.0	1.6	180.0
28	Glare OP #28 AZIMUTH: -29 FOV: 180	707,389	733,102	59.3	331.0	1.6	180.0
29	Glare OP #29 AZIMUTH: -37 FOV: 180	707,382	733,098	59.4	323.0	1.6	180.0
30	Glare OP #30 AZIMUTH: -36 FOV: 180	707,376	733,094	59.6	324.0	1.6	180.0
31	Glare OP #31 AZIMUTH: -44 FOV: 180	707,370	733,089	59.9	316.0	1.6	180.0
32	Glare OP #32 AZIMUTH: -41 FOV: 180	707,366	733,086	59.9	319.0	1.6	180.0
33	Glare OP #33 AZIMUTH: -44 FOV: 180	707,359	733,080	59.9	316.0	1.6	180.0
34	Glare OP #34 AZIMUTH: -47 FOV: 180	707,354	733,075	59.9	313.0	1.6	180.0
35	Glare OP #35 AZIMUTH: -49 FOV: 180	707,348	733,070	59.9	311.0	1.6	180.0
36	Glare OP #36 AZIMUTH: -45 FOV: 180	707,343	733,065	59.7	315.0	1.6	180.0
37	Glare OP #37 AZIMUTH: -8 FOV: 180	707,517	733,283	59.0	352.0	1.6	180.0
38	Glare OP #38 AZIMUTH: -10 FOV: 180	707,526	733,314	58.4	350.0	1.6	180.0
39	Glare OP #39 AZIMUTH: -14 FOV: 180	707,542	733,317	57.6	346.0	1.6	180.0
40	Glare OP #40 AZIMUTH: -11 FOV: 180	707,557	733,320	56.8	349.0	1.6	180.0
41	Glare OP #41 AZIMUTH: -12 FOV: 180	707,571	733,323	56.4	348.0	1.6	180.0
42	Glare OP #42 AZIMUTH: -10 FOV: 180	707,586	733,325	55.9	350.0	1.6	180.0
43	Glare OP #43 AZIMUTH: -10 FOV: 180	707,533	733,286	58.5	350.0	1.6	180.0
44	Glare OP #44 AZIMUTH: -11 FOV: 180	707,597	733,298	56.8	349.0	1.6	180.0
45	Glare OP #45 AZIMUTH: 59 FOV: 180	707,742	733,140	58.0	59.0	1.6	180.0
46	Glare OP #46 AZIMUTH: 60 FOV: 180	707,747	733,135	57.5	60.0	1.6	180.0
47	Glare OP #47 AZIMUTH: 56 FOV: 180	707,752	733,127	56.7	56.0	1.6	180.0
48	Glare OP #48 AZIMUTH: 53 FOV: 180	707,757	733,121	56.1	53.0	1.6	180.0
49	Glare OP #49 AZIMUTH: 56 FOV: 180	707,762	733,116	55.6	56.0	1.6	180.0
50	Glare OP #50 AZIMUTH: 52 FOV: 180	707,766	733,110	55.2	52.0	1.6	180.0
51	Glare OP #51 AZIMUTH: 52 FOV: 180	707,769	733,107	55.0	52.0	1.6	180.0
52	Glare OP #52 AZIMUTH: 52 FOV: 180	707,772	733,103	55.0	52.0	1.6	180.0
53	Glare OP #53 AZIMUTH: 54 FOV: 180	707,776	733,098	55.0	54.0	1.6	180.0
54	Glare OP #54 AZIMUTH: 55 FOV: 180	707,780	733,093	55.0	55.0	1.6	180.0
55	Glare OP #55 AZIMUTH: 58 FOV: 180	707,783	733,090	55.1	58.0	1.6	180.0
56	Glare OP #56 AZIMUTH: 59 FOV: 180	707,796	733,074	55.7	59.0	1.6	180.0
57	Glare OP #57 AZIMUTH: 60 FOV: 180	707,800	733,069	56.1	60.0	1.6	180.0
58	Glare OP #58 AZIMUTH: 56 FOV: 180	707,806	733,060	56.9	56.0	1.6	180.0
59	Glare OP #59 AZIMUTH: 53 FOV: 180	707,811	733,054	57.4	53.0	1.6	180.0
60	Glare OP #60 AZIMUTH: 56 FOV: 180	707,815	733,049	57.8	56.0	1.6	180.0
61	Glare OP #61 AZIMUTH: 52 FOV: 180	707,819	733,044	57.8	52.0	1.6	180.0
62	Glare OP #62 AZIMUTH: 52 FOV: 180	707,822	733,040	57.5	52.0	1.6	180.0
63	Glare OP #63 AZIMUTH: 52 FOV: 180	707,826	733,036	57.2	52.0	1.6	180.0
64	Glare OP #64 AZIMUTH: 54 FOV: 180	707,829	733,031	57.0	54.0	1.6	180.0
65	Glare OP #65 AZIMUTH: 55 FOV: 180	707,833	733,026	56.8	55.0	1.6	180.0
66	Glare OP #66 AZIMUTH: 58 FOV: 180	707,836	733,023	56.6	58.0	1.6	180.0
67	Glare OP #67 AZIMUTH: 59 FOV: 180	707,856	732,998	54.7	59.0	1.6	180.0
68	Glare OP #68 AZIMUTH: 60 FOV: 180	707,861	732,993	54.4	60.0	1.6	180.0
69	Glare OP #69 AZIMUTH: 56 FOV: 180	707,866	732,984	54.0	56.0	1.6	180.0
70	Glare OP #70 AZIMUTH: 53 FOV: 180	707,871	732,979	54.0	53.0	1.6	180.0
71	Glare OP #71 AZIMUTH: 56 FOV: 180	707,876	732,973	54.0	56.0	1.6	180.0
72	Glare OP #72 AZIMUTH: 52 FOV: 180	707,880	732,968	54.0	52.0	1.6	180.0
73	Glare OP #73 AZIMUTH: 52 FOV: 180	707,882	732,964	54.0	52.0	1.6	180.0
74	Glare OP #74 AZIMUTH: 52 FOV: 180	707,886	732,960	54.0	52.0	1.6	180.0
75	Glare OP #75 AZIMUTH: 54 FOV: 180	707,889	732,956	54.0	54.0	1.6	180.0
76	Glare OP #76 AZIMUTH: 55 FOV: 180	707,893	732,950	54.2	55.0	1.6	180.0
77	Glare OP #77 AZIMUTH: 58 FOV: 180	707,896	732,947	54.4	58.0	1.6	180.0
78	Glare OP #78 AZIMUTH: 57 FOV: 180	707,839	733,018	56.4	57.0	1.6	180.0
79	Glare OP #79 AZIMUTH: 61 FOV: 180	707,843	733,014	56.1	61.0	1.6	180.0
80	Glare OP #80 AZIMUTH: 51 FOV: 180	707,900	732,942	54.6	51.0	1.6	180.0
81	Glare OP #81 AZIMUTH: 57 FOV: 180	707,905	732,936	54.8	57.0	1.6	180.0
82	Glare OP #82 AZIMUTH: 127 FOV: 180	708,067	732,873	56.1	127.0	1.6	180.0
83	Glare OP #83 AZIMUTH: 124 FOV: 180	708,072	732,878	55.8	124.0	1.6	180.0
84	Glare OP #84 AZIMUTH: 126 FOV: 180	708,076	732,881	55.6	126.0	1.6	180.0
85	Glare OP #85 AZIMUTH: 125 FOV: 180	708,078	732,885	55.5	125.0	1.6	180.0
86	Glare OP #86 AZIMUTH: 113 FOV: 180	708,083	732,890	55.2	113.0	1.6	180.0
87	Glare OP #87 AZIMUTH: 111 FOV: 180	708,084	732,895	55.0	111.0	1.6	180.0

To be continued on next page...

GLARE - Main result

Calculation: dwelling_glare_rev2

...continued from previous page

No.	Name	Easting	Northing	Z	Degrees from south cw	Height a.g.l	Field of view
				[m]	[°]	[m]	[°]
88	Glare OP #88 AZIMUTH: 108 FOV: 180	708,087	732,900	54.8	108.0	1.6	180.0
89	Glare OP #89 AZIMUTH: 110 FOV: 180	708,089	732,905	54.6	110.0	1.6	180.0
90	Glare OP #99 AZIMUTH: -4 FOV: 180	708,007	733,229	52.7	356.0	1.6	180.0
91	Glare OP #100 AZIMUTH: -8 FOV: 180	708,013	733,230	52.8	352.0	1.6	180.0
92	Glare OP #101 AZIMUTH: -4 FOV: 180	708,019	733,230	52.8	356.0	1.6	180.0
93	Glare OP #102 AZIMUTH: -5 FOV: 180	708,024	733,231	52.8	355.0	1.6	180.0
94	Glare OP #103 AZIMUTH: 92 FOV: 180	707,980	733,235	53.0	92.0	1.6	180.0
95	Glare OP #104 AZIMUTH: 94 FOV: 180	707,980	733,242	53.4	94.0	1.6	180.0
96	Glare OP #105 AZIMUTH: 92 FOV: 180	707,982	733,248	53.7	92.0	1.6	180.0
97	Glare OP #106 AZIMUTH: 93 FOV: 180	707,984	733,255	54.2	93.0	1.6	180.0
98	Glare OP #107 AZIMUTH: 89 FOV: 180	707,984	733,261	54.6	89.0	1.6	180.0
99	Glare OP #108 AZIMUTH: 88 FOV: 180	707,984	733,267	55.0	88.0	1.6	180.0
100	Glare OP #109 AZIMUTH: 92 FOV: 180	707,984	733,273	55.1	92.0	1.6	180.0
101	Glare OP #110 AZIMUTH: 93 FOV: 180	707,980	733,284	55.5	93.0	1.6	180.0
102	Glare OP #111 AZIMUTH: 94 FOV: 180	707,980	733,289	55.6	94.0	1.6	180.0
103	Glare OP #112 AZIMUTH: 94 FOV: 180	707,981	733,294	55.7	94.0	1.6	180.0
104	Glare OP #113 AZIMUTH: 92 FOV: 180	707,981	733,301	55.7	92.0	1.6	180.0
105	Glare OP #114 AZIMUTH: 96 FOV: 180	707,981	733,306	55.6	96.0	1.6	180.0
106	Glare OP #115 AZIMUTH: 94 FOV: 180	707,982	733,311	55.3	94.0	1.6	180.0
107	Glare OP #116 AZIMUTH: 93 FOV: 180	707,978	733,320	55.3	93.0	1.6	180.0
108	Glare OP #117 AZIMUTH: 90 FOV: 180	707,981	733,326	54.9	90.0	1.6	180.0
109	Glare OP #118 AZIMUTH: 81 FOV: 180	707,974	733,365	54.4	81.0	1.6	180.0
110	Glare OP #119 AZIMUTH: 77 FOV: 180	707,973	733,371	54.2	77.0	1.6	180.0
111	Glare OP #120 AZIMUTH: 77 FOV: 180	707,971	733,376	54.1	77.0	1.6	180.0
112	Glare OP #121 AZIMUTH: 78 FOV: 180	707,970	733,381	54.0	78.0	1.6	180.0
113	Glare OP #122 AZIMUTH: 77 FOV: 180	707,969	733,387	53.8	77.0	1.6	180.0
114	Glare OP #123 AZIMUTH: 76 FOV: 180	707,965	733,402	53.8	76.0	1.6	180.0
115	Glare OP #124 AZIMUTH: 78 FOV: 180	707,964	733,404	53.8	78.0	1.6	180.0
116	Glare OP #125 AZIMUTH: 78 FOV: 180	707,963	733,411	53.8	78.0	1.6	180.0
117	Glare OP #126 AZIMUTH: 77 FOV: 180	707,962	733,415	53.9	77.0	1.6	180.0
118	Glare OP #127 AZIMUTH: 78 FOV: 180	707,961	733,422	53.9	78.0	1.6	180.0
119	Glare OP #128 AZIMUTH: 75 FOV: 180	707,959	733,427	53.8	75.0	1.6	180.0
120	Glare OP #143 AZIMUTH: -166 FOV: 180	708,048	732,738	55.2	194.0	16.0	180.0
121	Glare OP #144 AZIMUTH: 166 FOV: 180	708,034	732,727	55.3	166.0	16.0	180.0
122	Glare OP #145 AZIMUTH: 168 FOV: 180	708,059	732,695	55.9	168.0	16.0	180.0
123	Glare OP #146 AZIMUTH: 163 FOV: 180	708,051	732,690	55.5	163.0	16.0	180.0
124	Glare OP #147 AZIMUTH: 162 FOV: 180	708,044	732,684	55.0	162.0	16.0	180.0
125	Glare OP #148 AZIMUTH: 169 FOV: 180	708,038	732,677	54.6	169.0	16.0	180.0
126	Glare OP #149 AZIMUTH: 165 FOV: 180	708,032	732,671	54.3	165.0	16.0	180.0
127	Glare OP #150 AZIMUTH: 160 FOV: 180	708,027	732,662	53.8	160.0	16.0	180.0
128	Glare OP #151 AZIMUTH: 161 FOV: 180	708,022	732,653	53.4	161.0	16.0	180.0
129	Glare OP #152 AZIMUTH: 164 FOV: 180	708,020	732,645	53.2	164.0	16.0	180.0
130	Glare OP #153 AZIMUTH: 169 FOV: 180	708,016	732,636	53.1	169.0	16.0	180.0
131	Glare OP #129 AZIMUTH: 171 FOV: 180	708,018	732,629	53.2	171.0	17.0	180.0
132	Glare OP #130 AZIMUTH: 83 FOV: 180	708,018	732,622	53.2	83.0	17.0	180.0
133	Glare OP #154 AZIMUTH: 130 FOV: 180	708,019	732,614	53.2	130.0	20.0	180.0
134	Glare OP #155 AZIMUTH: 140 FOV: 180	707,988	732,648	53.0	140.0	20.0	180.0
135	Glare OP #156 AZIMUTH: 143 FOV: 180	707,973	732,648	53.0	143.0	20.0	180.0
136	Glare OP #157 AZIMUTH: 153 FOV: 180	707,963	732,647	53.2	153.0	20.0	180.0
137	Glare OP #158 AZIMUTH: 162 FOV: 180	707,957	732,646	53.4	162.0	20.0	180.0
138	Glare OP #159 AZIMUTH: 166 FOV: 180	707,951	732,644	53.5	166.0	20.0	180.0
139	Glare OP #160 AZIMUTH: -178 FOV: 180	707,944	732,643	53.6	182.0	20.0	180.0
140	Glare OP #161 AZIMUTH: -165 FOV: 180	707,938	732,642	53.8	195.0	20.0	180.0
141	Glare OP #162 AZIMUTH: -171 FOV: 180	707,932	732,640	53.8	189.0	20.0	180.0
142	Glare OP #163 AZIMUTH: -167 FOV: 180	707,927	732,639	53.8	193.0	20.0	180.0
143	Glare OP #131 AZIMUTH: 157 FOV: 180	707,919	732,638	53.8	157.0	21.0	180.0
144	Glare OP #132 AZIMUTH: 146 FOV: 180	707,912	732,636	53.9	146.0	21.0	180.0
145	Glare OP #133 AZIMUTH: 141 FOV: 180	708,204	732,653	51.8	141.0	21.0	180.0
146	Glare OP #134 AZIMUTH: 130 FOV: 180	708,208	732,659	51.8	130.0	21.0	180.0
147	Glare OP #135 AZIMUTH: 123 FOV: 180	708,216	732,662	51.7	123.0	21.0	180.0
148	Glare OP #136 AZIMUTH: 113 FOV: 180	708,223	732,665	51.6	113.0	21.0	180.0
149	Glare OP #137 AZIMUTH: 103 FOV: 180	708,230	732,667	51.5	103.0	21.0	180.0
150	Glare OP #138 AZIMUTH: 96 FOV: 180	708,238	732,668	51.3	96.0	21.0	180.0
151	Glare OP #139 AZIMUTH: 94 FOV: 180	708,245	732,668	51.2	94.0	21.0	180.0
152	Glare OP #140 AZIMUTH: 89 FOV: 180	708,251	732,667	51.1	89.0	21.0	180.0

To be continued on next page...

GLARE - Main result

Calculation: dwelling_glare_rev2

...continued from previous page

No.	Name	Easting	Northing	Z [m]	Degrees from south cw [°]	Height a.g.l [m]	Field of view [°]
153	Glare OP #141 AZIMUTH: 86 FOV: 180	708,256	732,666	50.9	86.0	21.0	180.0
154	Glare OP #142 AZIMUTH: 81 FOV: 180	708,262	732,666	50.8	81.0	21.0	180.0

Calculation result

Glare receptor

No.	Name	Total time with glare in a year [h/year]	Maximum daily glare duration [min/day]	Day with max glare duration [Date]
1	Glare OP #1 AZIMUTH: -74 FOV: 180	1.4	3.0	16 January 09:17-09:20
2	Glare OP #2 AZIMUTH: -73 FOV: 180	1.5	4.0	17 January 09:15-09:19
3	Glare OP #3 AZIMUTH: -69 FOV: 180	1.8	4.0	7 February 08:35-08:39
4	Glare OP #4 AZIMUTH: -70 FOV: 180	1.4	3.0	13 February 08:30-08:33
5	Glare OP #5 AZIMUTH: -69 FOV: 180	1.3	4.0	30 October 08:00-08:04
6	Glare OP #6 AZIMUTH: -68 FOV: 180	1.5	3.0	5 March 08:30-08:33
7	Glare OP #7 AZIMUTH: -67 FOV: 180	1.8	5.0	27 October 08:57-09:02
8	Glare OP #8 AZIMUTH: -67 FOV: 180	1.7	4.0	7 March 08:25-08:29
9	Glare OP #9 AZIMUTH: -64 FOV: 180	1.6	4.0	2 February 09:11-09:15
10	Glare OP #10 AZIMUTH: -66 FOV: 180	1.3	3.0	3 October 09:02-09:05
11	Glare OP #11 AZIMUTH: -65 FOV: 180	2.0	4.0	7 November 08:36-08:40
12	Glare OP #12 AZIMUTH: -64 FOV: 180	1.8	4.0	30 September 08:57-09:01
13	Glare OP #13 AZIMUTH: -61 FOV: 180	1.5	5.0	12 November 07:54-07:59
14	Glare OP #14 AZIMUTH: -63 FOV: 180	1.8	3.0	26 February 08:19-08:22
15	Glare OP #15 AZIMUTH: -59 FOV: 180	1.7	4.0	2 March 08:15-08:19
16	Glare OP #16 AZIMUTH: -59 FOV: 180	2.2	3.0	19 March 08:12-08:15
17	Glare OP #17 AZIMUTH: -54 FOV: 180	1.9	4.0	4 March 08:14-08:18
18	Glare OP #18 AZIMUTH: -46 FOV: 180	2.1	3.0	12 February 08:21-08:24
19	Glare OP #19 AZIMUTH: -60 FOV: 180	2.0	3.0	6 March 08:13-08:16
20	Glare OP #20 AZIMUTH: -55 FOV: 180	2.1	4.0	8 October 08:47-08:51
21	Glare OP #21 AZIMUTH: -52 FOV: 180	2.3	4.0	23 February 08:52-08:56
22	Glare OP #22 AZIMUTH: -50 FOV: 180	2.4	4.0	9 March 08:09-08:13
23	Glare OP #23 AZIMUTH: -49 FOV: 180	2.2	3.0	10 March 08:09-08:12
24	Glare OP #24 AZIMUTH: -46 FOV: 180	2.0	3.0	28 February 08:48-08:51
25	Glare OP #25 AZIMUTH: -42 FOV: 180	2.1	3.0	21 February 08:09-08:12
26	Glare OP #26 AZIMUTH: -42 FOV: 180	2.2	4.0	3 March 08:44-08:48
27	Glare OP #27 AZIMUTH: -32 FOV: 180	2.2	4.0	21 February 08:24-08:28
28	Glare OP #28 AZIMUTH: -29 FOV: 180	1.9	3.0	13 March 08:19-08:22
29	Glare OP #29 AZIMUTH: -37 FOV: 180	1.9	4.0	30 September 08:57-09:01
30	Glare OP #30 AZIMUTH: -36 FOV: 180	1.9	4.0	14 November 08:00-08:04
31	Glare OP #31 AZIMUTH: -44 FOV: 180	2.3	3.0	1 February 08:28-08:31
32	Glare OP #32 AZIMUTH: -41 FOV: 180	2.3	4.0	4 February 08:27-08:31
33	Glare OP #33 AZIMUTH: -44 FOV: 180	1.9	3.0	23 March 08:11-08:14
34	Glare OP #34 AZIMUTH: -47 FOV: 180	2.2	3.0	8 February 08:25-08:28
35	Glare OP #35 AZIMUTH: -49 FOV: 180	2.2	3.0	16 February 09:01-09:04
36	Glare OP #36 AZIMUTH: -45 FOV: 180	2.5	4.0	8 March 08:10-08:14
37	Glare OP #37 AZIMUTH: -8 FOV: 180	0.0	0.0	
38	Glare OP #38 AZIMUTH: -10 FOV: 180	0.0	0.0	
39	Glare OP #39 AZIMUTH: -14 FOV: 180	0.0	0.0	
40	Glare OP #40 AZIMUTH: -11 FOV: 180	0.0	0.0	
41	Glare OP #41 AZIMUTH: -12 FOV: 180	0.0	0.0	
42	Glare OP #42 AZIMUTH: -10 FOV: 180	0.0	0.0	
43	Glare OP #43 AZIMUTH: -10 FOV: 180	0.0	0.0	
44	Glare OP #44 AZIMUTH: -11 FOV: 180	0.0	0.0	
45	Glare OP #45 AZIMUTH: 59 FOV: 180	0.0	0.0	
46	Glare OP #46 AZIMUTH: 60 FOV: 180	0.0	0.0	
47	Glare OP #47 AZIMUTH: 56 FOV: 180	0.0	0.0	
48	Glare OP #48 AZIMUTH: 53 FOV: 180	0.0	0.0	
49	Glare OP #49 AZIMUTH: 56 FOV: 180	0.0	0.0	
50	Glare OP #50 AZIMUTH: 52 FOV: 180	0.0	0.0	
51	Glare OP #51 AZIMUTH: 52 FOV: 180	0.0	0.0	
52	Glare OP #52 AZIMUTH: 52 FOV: 180	0.0	0.0	
53	Glare OP #53 AZIMUTH: 54 FOV: 180	0.0	0.0	
54	Glare OP #54 AZIMUTH: 55 FOV: 180	0.0	0.0	
55	Glare OP #55 AZIMUTH: 58 FOV: 180	0.0	0.0	

To be continued on next page...

GLARE - Main result

Calculation: dwelling_glare_rev2

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No.	Name	Total time with glare in a year [h/year]	Maximum daily glare duration [min/day]	Day with max glare duration [Date]
56	Glare OP #56 AZIMUTH: 59 FOV: 180	0.0	0.0	
57	Glare OP #57 AZIMUTH: 60 FOV: 180	0.0	0.0	
58	Glare OP #58 AZIMUTH: 56 FOV: 180	0.0	0.0	
59	Glare OP #59 AZIMUTH: 53 FOV: 180	0.0	0.0	
60	Glare OP #60 AZIMUTH: 56 FOV: 180	0.0	0.0	
61	Glare OP #61 AZIMUTH: 52 FOV: 180	0.0	0.0	
62	Glare OP #62 AZIMUTH: 52 FOV: 180	0.0	0.0	
63	Glare OP #63 AZIMUTH: 52 FOV: 180	0.0	0.0	
64	Glare OP #64 AZIMUTH: 54 FOV: 180	0.0	0.0	
65	Glare OP #65 AZIMUTH: 55 FOV: 180	0.4	2.0	17 December 15:53-15:55
66	Glare OP #66 AZIMUTH: 58 FOV: 180	0.6	2.0	3 January 16:02-16:04
67	Glare OP #67 AZIMUTH: 59 FOV: 180	1.6	2.0	17 January 16:17-16:19
68	Glare OP #68 AZIMUTH: 60 FOV: 180	2.0	2.0	1 February 16:30-16:32
69	Glare OP #69 AZIMUTH: 56 FOV: 180	2.5	3.0	11 February 16:38-16:41
70	Glare OP #70 AZIMUTH: 53 FOV: 180	2.8	3.0	15 February 17:20-17:23
71	Glare OP #71 AZIMUTH: 56 FOV: 180	2.9	3.0	25 February 17:26-17:29
72	Glare OP #72 AZIMUTH: 52 FOV: 180	2.7	3.0	11 March 17:33-17:36
73	Glare OP #73 AZIMUTH: 52 FOV: 180	2.8	3.0	23 March 17:38-17:41
74	Glare OP #74 AZIMUTH: 52 FOV: 180	2.8	3.0	13 March 17:00-17:03
75	Glare OP #75 AZIMUTH: 54 FOV: 180	2.8	3.0	14 March 17:01-17:04
76	Glare OP #76 AZIMUTH: 55 FOV: 180	3.0	3.0	18 March 17:03-17:06
77	Glare OP #77 AZIMUTH: 58 FOV: 180	3.0	3.0	20 March 17:03-17:06
78	Glare OP #78 AZIMUTH: 57 FOV: 180	0.6	2.0	7 January 16:05-16:07
79	Glare OP #79 AZIMUTH: 61 FOV: 180	0.9	2.0	3 January 16:03-16:05
80	Glare OP #80 AZIMUTH: 51 FOV: 180	3.0	3.0	16 April 18:47-18:50
81	Glare OP #81 AZIMUTH: 57 FOV: 180	3.3	3.0	30 March 18:08-18:11
82	Glare OP #82 AZIMUTH: 127 FOV: 180	3.4	4.0	6 April 18:41-18:45
83	Glare OP #83 AZIMUTH: 124 FOV: 180	3.6	4.0	7 April 18:40-18:44
84	Glare OP #84 AZIMUTH: 126 FOV: 180	4.0	3.0	2 April 18:38-18:41
85	Glare OP #85 AZIMUTH: 125 FOV: 180	3.9	3.0	4 April 18:39-18:42
86	Glare OP #86 AZIMUTH: 113 FOV: 180	3.8	4.0	1 April 18:36-18:40
87	Glare OP #87 AZIMUTH: 111 FOV: 180	3.3	4.0	16 September 18:24-18:28
88	Glare OP #88 AZIMUTH: 108 FOV: 180	2.9	4.0	28 March 18:34-18:38
89	Glare OP #89 AZIMUTH: 110 FOV: 180	3.0	4.0	20 September 18:19-18:23
90	Glare OP #99 AZIMUTH: -4 FOV: 180	0.0	0.0	
91	Glare OP #100 AZIMUTH: -8 FOV: 180	0.0	0.0	
92	Glare OP #101 AZIMUTH: -4 FOV: 180	0.0	1.0	22 December 15:42-15:43
93	Glare OP #102 AZIMUTH: -5 FOV: 180	0.2	1.0	2 January 15:48-15:49
94	Glare OP #103 AZIMUTH: 92 FOV: 180	0.0	0.0	
95	Glare OP #104 AZIMUTH: 94 FOV: 180	0.0	0.0	
96	Glare OP #105 AZIMUTH: 92 FOV: 180	0.0	0.0	
97	Glare OP #106 AZIMUTH: 93 FOV: 180	0.0	0.0	
98	Glare OP #107 AZIMUTH: 89 FOV: 180	0.0	0.0	
99	Glare OP #108 AZIMUTH: 88 FOV: 180	0.0	0.0	
100	Glare OP #109 AZIMUTH: 92 FOV: 180	0.0	0.0	
101	Glare OP #110 AZIMUTH: 93 FOV: 180	0.0	0.0	
102	Glare OP #111 AZIMUTH: 94 FOV: 180	0.0	0.0	
103	Glare OP #112 AZIMUTH: 94 FOV: 180	0.0	0.0	
104	Glare OP #113 AZIMUTH: 92 FOV: 180	0.0	0.0	
105	Glare OP #114 AZIMUTH: 96 FOV: 180	0.0	0.0	
106	Glare OP #115 AZIMUTH: 94 FOV: 180	0.0	0.0	
107	Glare OP #116 AZIMUTH: 93 FOV: 180	0.0	0.0	
108	Glare OP #117 AZIMUTH: 90 FOV: 180	0.0	0.0	
109	Glare OP #118 AZIMUTH: 81 FOV: 180	0.0	0.0	
110	Glare OP #119 AZIMUTH: 77 FOV: 180	0.0	0.0	
111	Glare OP #120 AZIMUTH: 77 FOV: 180	0.0	0.0	
112	Glare OP #121 AZIMUTH: 78 FOV: 180	0.0	0.0	
113	Glare OP #122 AZIMUTH: 77 FOV: 180	0.0	0.0	
114	Glare OP #123 AZIMUTH: 76 FOV: 180	0.0	0.0	
115	Glare OP #124 AZIMUTH: 78 FOV: 180	0.0	0.0	
116	Glare OP #125 AZIMUTH: 78 FOV: 180	0.0	0.0	
117	Glare OP #126 AZIMUTH: 77 FOV: 180	0.0	0.0	
118	Glare OP #127 AZIMUTH: 78 FOV: 180	0.0	0.0	
119	Glare OP #128 AZIMUTH: 75 FOV: 180	0.0	0.0	
120	Glare OP #143 AZIMUTH: -166 FOV: 180	2.5	4.0	28 May 20:03-20:07
121	Glare OP #144 AZIMUTH: 166 FOV: 180	0.0	0.0	

To be continued on next page...

GLARE - Main result

Calculation: dwelling_glare_rev2

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No. Name	Total time with glare in a year [h/year]	Maximum daily glare duration [min/day]	Day with max glare duration [Date]
122 Glare OP #145 AZIMUTH: 168 FOV: 180	0.0	0.0	
123 Glare OP #146 AZIMUTH: 163 FOV: 180	0.0	0.0	
124 Glare OP #147 AZIMUTH: 162 FOV: 180	0.0	1.0	27 May 21:25-21:26
125 Glare OP #148 AZIMUTH: 169 FOV: 180	0.3	2.0	15 June 21:33-21:35
126 Glare OP #149 AZIMUTH: 165 FOV: 180	0.9	3.0	4 June 21:33-21:36
127 Glare OP #150 AZIMUTH: 160 FOV: 180	0.7	3.0	8 June 21:39-21:42
128 Glare OP #151 AZIMUTH: 161 FOV: 180	0.0	0.0	
129 Glare OP #152 AZIMUTH: 164 FOV: 180	0.0	0.0	
130 Glare OP #153 AZIMUTH: 169 FOV: 180	0.0	1.0	28 May 21:27-21:28
131 Glare OP #129 AZIMUTH: 171 FOV: 180	0.2	2.0	12 July 21:36-21:38
132 Glare OP #130 AZIMUTH: 83 FOV: 180	0.5	1.0	22 May 21:20-21:21
133 Glare OP #154 AZIMUTH: 130 FOV: 180	1.0	1.0	22 May 21:19-21:20
134 Glare OP #155 AZIMUTH: 140 FOV: 180	0.5	2.0	9 June 21:29-21:31
135 Glare OP #156 AZIMUTH: 143 FOV: 180	0.9	2.0	31 May 21:25-21:27
136 Glare OP #157 AZIMUTH: 153 FOV: 180	1.6	2.0	21 May 21:17-21:19
137 Glare OP #158 AZIMUTH: 162 FOV: 180	1.5	3.0	27 May 21:19-21:22
138 Glare OP #159 AZIMUTH: 166 FOV: 180	1.5	2.0	29 May 21:23-21:25
139 Glare OP #160 AZIMUTH: -178 FOV: 180	1.3	2.0	3 June 21:24-21:26
140 Glare OP #161 AZIMUTH: -165 FOV: 180	1.0	2.0	16 June 21:29-21:31
141 Glare OP #162 AZIMUTH: -171 FOV: 180	0.5	1.0	5 June 21:35-21:36
142 Glare OP #163 AZIMUTH: -167 FOV: 180	0.1	1.0	16 June 21:39-21:40
143 Glare OP #131 AZIMUTH: 157 FOV: 180	0.0	0.0	
144 Glare OP #132 AZIMUTH: 146 FOV: 180	0.0	0.0	
145 Glare OP #133 AZIMUTH: 141 FOV: 180	0.0	0.0	
146 Glare OP #134 AZIMUTH: 130 FOV: 180	0.0	0.0	
147 Glare OP #135 AZIMUTH: 123 FOV: 180	0.0	0.0	
148 Glare OP #136 AZIMUTH: 113 FOV: 180	0.3	2.0	15 June 19:56-19:58
149 Glare OP #137 AZIMUTH: 103 FOV: 180	0.7	2.0	4 June 19:52-19:54
150 Glare OP #138 AZIMUTH: 96 FOV: 180	0.9	2.0	7 June 19:52-19:54
151 Glare OP #139 AZIMUTH: 94 FOV: 180	1.0	2.0	4 June 19:51-19:53
152 Glare OP #140 AZIMUTH: 89 FOV: 180	0.9	2.0	2 June 19:50-19:52
153 Glare OP #141 AZIMUTH: 86 FOV: 180	0.9	2.0	2 June 19:50-19:52
154 Glare OP #142 AZIMUTH: 81 FOV: 180	0.8	2.0	26 May 19:48-19:50

Project:
cherry_orchard_point

Licensed user:
LINT Data and Geospatial

Calculated:
15/10/2023 22:09/4.0.422

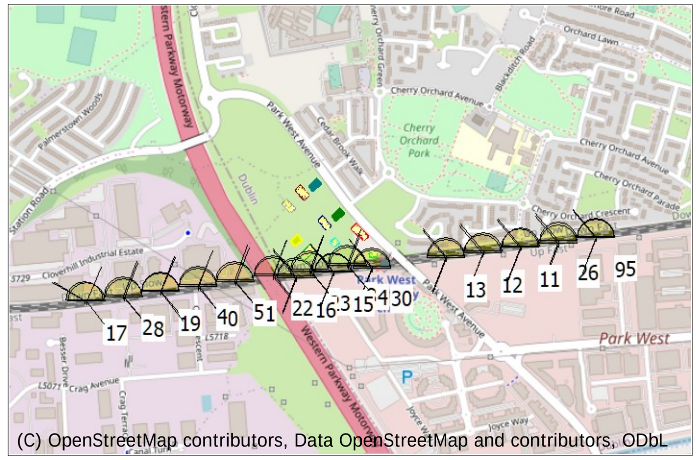
GLARE - Main result

Calculation: rail_glare_rev2

Setup

Distance limit	3000m
Grid Resolution	0.05°
Time Step	1 minutes
Glare ignored if closer to sun than	0.0°

All coordinates are in
Irish ITM-IRENET95 (IE), geocentric, GRS80



Scale 1:20,000

Glare receptor
Solar PV
PV Panels with Glare

Solar areas

Area description	Size	Number of PV panels	Tilt angle [°]	Orientation [°]	Table size	Row spacing [m]
apartment_bldg1 - 629 m2	190 m2	40	15.0	170.0	1.96x0.99m	2.2
apartmentbldg2 - 545 m2	785 m2	138	15.0	135.0	1.96x0.99m	2.2
apartmentbldg3 - 321 m2	291 m2	64	15.0	225.0	1.96x0.99m	2.2
apartmentbldg5a - 526 m2	420 m2	78	15.0	225.0	1.96x0.99m	2.2
apartmentbldg10b - 540 m2	540 m2	112	15.0	135.0	1.96x0.99m	2.2
apartmentbldg6b - 539 m2	539 m2	102	15.0	135.0	1.96x0.99m	2.2
apartmentbldg7b - 517 m2	517 m2	110	15.0	225.0	1.96x0.99m	2.2
apartmentbldg9b - 575 m2	575 m2	120	15.0	135.0	1.96x0.99m	2.2
apartmentbldg8a - 532 m2	532 m2	112	15.0	225.0	1.96x0.99m	2.2
commercial_1 - 708 m2	708 m2	151	15.0	225.0	1.96x0.99m	2.2
Sum	5096 m2	1027				

Glare Receptors

No.	Name	Easting	Northing	Z [m]	Degrees from south cw [°]	Height a.g.l [m]	Field of view [°]
1	OP 1 Azimuth: -98 FOV 120	707,197	732,640	56.3	120.0	2.8	2.7
2	OP 2 Azimuth: -99 FOV 120	707,296	732,655	57.2	261.0	2.8	120.0
3	OP 3 Azimuth: -99 FOV 120	707,395	732,670	57.2	261.0	2.8	120.0
4	OP 4 Azimuth: -98 FOV 120	707,494	732,685	58.0	262.0	2.8	120.0
5	OP 5 Azimuth: -100 FOV 120	707,592	732,702	55.6	260.0	2.8	120.0
6	OP 6 Azimuth: -99 FOV 120	707,691	732,719	57.5	261.0	2.8	120.0
7	OP 7 Azimuth: -99 FOV 120	707,789	732,735	55.9	261.0	2.8	120.0
8	OP 8 Azimuth: -99 FOV 120	707,888	732,751	55.7	261.0	2.8	120.0
9	OP 15 Azimuth: 81 FOV 120	708,546	732,836	50.8	81.0	2.8	120.0
10	OP 16 Azimuth: 81 FOV 120	708,447	732,820	51.3	81.0	2.8	120.0
11	OP 17 Azimuth: 81 FOV 120	708,348	732,805	54.8	81.0	2.8	120.0
12	OP 18 Azimuth: 81 FOV 120	708,249	732,789	54.7	81.0	2.8	120.0
13	OP 19 Azimuth: 81 FOV 120	708,151	732,773	55.9	81.0	2.8	120.0
14	OP 21 Azimuth: 82 FOV 120	707,953	732,742	55.5	82.0	2.8	120.0
15	OP 22 Azimuth: 81 FOV 120	707,854	732,727	55.2	81.0	2.8	120.0
16	OP 23 Azimuth: 81 FOV 120	707,755	732,712	56.2	81.0	2.8	120.0
17	OP 29 Azimuth: -98 FOV 120	707,199	732,637	56.2	262.0	2.8	120.0
18	OP 30 Azimuth: -99 FOV 120	707,298	732,651	57.0	261.0	2.8	120.0
19	OP 31 Azimuth: -98 FOV 120	707,397	732,667	57.0	262.0	2.8	120.0
20	OP 32 Azimuth: -99 FOV 120	707,496	732,682	57.8	261.0	2.8	120.0
21	OP 33 Azimuth: -99 FOV 120	707,594	732,697	55.4	261.0	2.8	120.0
22	OP 34 Azimuth: -100 FOV 120	707,693	732,714	57.3	260.0	2.8	120.0

To be continued on next page...

GLARE - Main result

Calculation: rail_glare_rev2

...continued from previous page

No.	Name	Easting	Northing	Z	Degrees from south cw	Height a.g.l	Field of view
				[m]	[°]	[m]	[°]
23	OP 35 Azimuth: -100 FOV 120	707,792	732,731	55.8	260.0	2.8	120.0
24	OP 36 Azimuth: -99 FOV 120	707,890	732,747	55.8	261.0	2.8	120.0
25	OP 43 Azimuth: 81 FOV 120	708,546	732,839	50.7	81.0	2.8	120.0
26	OP 44 Azimuth: 81 FOV 120	708,447	732,824	51.4	81.0	2.8	120.0
27	OP 45 Azimuth: 81 FOV 120	708,349	732,809	54.8	81.0	2.8	120.0
28	OP 46 Azimuth: 81 FOV 120	708,250	732,793	54.8	81.0	2.8	120.0
29	OP 47 Azimuth: 81 FOV 120	708,151	732,777	55.8	81.0	2.8	120.0
30	OP 49 Azimuth: 81 FOV 120	707,954	732,746	55.4	81.0	2.8	120.0
31	OP 50 Azimuth: 81 FOV 120	707,855	732,731	55.1	81.0	2.8	120.0
32	OP 51 Azimuth: 81 FOV 120	707,756	732,716	56.3	81.0	2.8	120.0

Calculation result

Glare receptor

No.	Name	Total time with glare in a year	Maximum daily glare duration	Day with max glare duration
		[h/year]	[min/day]	[Date]
1	OP 1 Azimuth: -98 FOV 120	0.0	0.0	
2	OP 2 Azimuth: -99 FOV 120	2.5	4.0	6 June 07:45-07:49
3	OP 3 Azimuth: -99 FOV 120	1.5	3.0	1 June 07:43-07:46
4	OP 4 Azimuth: -98 FOV 120	0.8	3.0	16 June 07:41-07:44
5	OP 5 Azimuth: -100 FOV 120	0.1	1.0	24 May 05:29-05:30
6	OP 6 Azimuth: -99 FOV 120	0.0	0.0	
7	OP 7 Azimuth: -99 FOV 120	0.0	0.0	
8	OP 8 Azimuth: -99 FOV 120	0.0	0.0	
9	OP 15 Azimuth: 81 FOV 120	2.0	3.0	28 April 18:42-18:45
10	OP 16 Azimuth: 81 FOV 120	3.7	3.0	20 April 18:50-18:53
11	OP 17 Azimuth: 81 FOV 120	2.0	3.0	3 May 18:56-18:59
12	OP 18 Azimuth: 81 FOV 120	3.1	3.0	21 May 18:55-18:58
13	OP 19 Azimuth: 81 FOV 120	4.5	3.0	16 May 19:42-19:45
14	OP 21 Azimuth: 82 FOV 120	0.0	0.0	
15	OP 22 Azimuth: 81 FOV 120	0.0	0.0	
16	OP 23 Azimuth: 81 FOV 120	0.0	0.0	
17	OP 29 Azimuth: -98 FOV 120	2.4	4.0	15 June 07:47-07:51
18	OP 30 Azimuth: -99 FOV 120	2.3	5.0	12 June 07:44-07:49
19	OP 31 Azimuth: -98 FOV 120	1.3	3.0	14 June 07:43-07:46
20	OP 32 Azimuth: -99 FOV 120	0.1	1.0	19 June 07:43-07:44
21	OP 33 Azimuth: -99 FOV 120	0.0	1.0	29 May 05:28-05:29
22	OP 34 Azimuth: -100 FOV 120	0.0	0.0	
23	OP 35 Azimuth: -100 FOV 120	0.0	0.0	
24	OP 36 Azimuth: -99 FOV 120	0.0	0.0	
25	OP 43 Azimuth: 81 FOV 120	2.2	3.0	17 April 18:44-18:47
26	OP 44 Azimuth: 81 FOV 120	3.5	4.0	29 April 18:48-18:52
27	OP 45 Azimuth: 81 FOV 120	2.2	4.0	3 May 18:55-18:59
28	OP 46 Azimuth: 81 FOV 120	2.9	4.0	9 May 19:10-19:14
29	OP 47 Azimuth: 81 FOV 120	4.6	4.0	2 August 19:49-19:53
30	OP 49 Azimuth: 81 FOV 120	0.0	0.0	
31	OP 50 Azimuth: 81 FOV 120	0.0	0.0	
32	OP 51 Azimuth: 81 FOV 120	0.0	0.0	

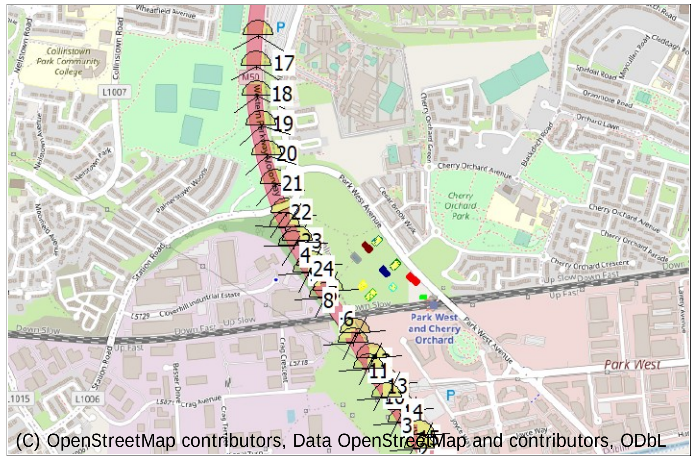
GLARE - Main result

Calculation: road_glare_rev2

Setup

Distance limit	3000m
Grid Resolution	0.05°
Time Step	1 minutes
Glare ignored if closer to sun than	0.0°

All coordinates are in
Irish ITM-IRENET95 (IE), geocentric, GRS80



Scale 1:25,000

Glare receptor   Solar PV
PV Panels with Glare

Solar areas

Area description	Size	Number of PV panels	Tilt angle [°]	Orientation [°]	Table size	Row spacing [m]
apartment_bldg1 - 629 m2	190 m2	40	15.0	170.0	1.96x0.99m	2.2
apartmentbldg2 - 545 m2	785 m2	138	15.0	135.0	1.96x0.99m	2.2
apartmentbldg3 - 321 m2	291 m2	64	15.0	225.0	1.96x0.99m	2.2
apartmentbldg5a - 526 m2	420 m2	78	15.0	225.0	1.96x0.99m	2.2
apartmentbldg10b - 540 m2	540 m2	112	15.0	135.0	1.96x0.99m	2.2
apartmentbldg6b - 539 m2	539 m2	102	15.0	135.0	1.96x0.99m	2.2
apartmentbldg7b - 517 m2	517 m2	110	15.0	225.0	1.96x0.99m	2.2
apartmentbldg9b - 575 m2	575 m2	120	15.0	135.0	1.96x0.99m	2.2
apartmentbldg8a - 532 m2	532 m2	112	15.0	225.0	1.96x0.99m	2.2
commercial_1 - 708 m2	708 m2	151	15.0	225.0	1.96x0.99m	2.2
Sum	5096 m2	1027				

Glare Receptors

No.	Name	Easting	Northing	Z [m]	Degrees from south cw [°]	Height a.g.l [m]	Field of view [°]
1	OP 2 Azimuth: 147 FOV 120	707,955	732,276	53.4	147.0	2.0	120.0
2	OP 3 Azimuth: 147 FOV 120	707,900	732,360	56.9	147.0	2.0	120.0
3	OP 4 Azimuth: 147 FOV 120	707,845	732,443	57.6	147.0	2.0	120.0
4	OP 5 Azimuth: 153 FOV 120	707,491	732,996	60.4	153.0	2.0	120.0
5	OP 22 Azimuth: -34 FOV 120	707,585	732,870	59.4	326.0	2.0	120.0
6	OP 23 Azimuth: -34 FOV 120	707,641	732,788	59.0	326.0	2.0	120.0
7	OP 24 Azimuth: 146 FOV 120	707,629	732,768	58.8	146.0	2.0	120.0
8	OP 25 Azimuth: 147 FOV 120	707,573	732,851	59.1	147.0	2.0	120.0
9	OP 26 Azimuth: 150 FOV 120	707,522	732,937	58.7	150.0	2.0	120.0
10	OP 27 Azimuth: 146 FOV 120	707,783	732,537	60.6	146.0	2.0	120.0
11	OP 28 Azimuth: 147 FOV 120	707,728	732,620	60.4	147.0	2.0	120.0
12	OP 29 Azimuth: -35 FOV 120	707,732	732,651	59.2	325.0	2.0	120.0
13	OP 30 Azimuth: -35 FOV 120	707,789	732,569	58.4	325.0	2.0	120.0
14	OP 31 Azimuth: -34 FOV 120	707,844	732,486	59.3	326.0	2.0	120.0
15	OP 32 Azimuth: -34 FOV 120	707,900	732,402	59.1	326.0	2.0	120.0
16	OP 33 Azimuth: -34 FOV 120	707,955	732,319	55.5	326.0	2.0	120.0
17	OP 36 Azimuth: 2 FOV 120	707,388	733,631	55.8	2.0	2.0	120.0
18	OP 37 Azimuth: 2 FOV 120	707,385	733,531	54.7	2.0	2.0	120.0
19	OP 38 Azimuth: -5 FOV 120	707,391	733,431	56.5	355.0	2.0	120.0
20	OP 39 Azimuth: -13 FOV 120	707,405	733,333	55.5	347.0	2.0	120.0
21	OP 40 Azimuth: -13 FOV 120	707,427	733,235	53.9	347.0	2.0	120.0
22	OP 41 Azimuth: -18 FOV 120	707,457	733,139	57.9	342.0	2.0	120.0

To be continued on next page...

GLARE - Main result

Calculation: road_glare_rev2

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No.	Name	Easting	Northing	Z [m]	Degrees from south cw [°]	Height a.g.l [m]	Field of view [°]
23	OP 42 Azimuth: -26 FOV 120	707,492	733,046	60.0	334.0	2.0	120.0
24	OP 43 Azimuth: -26 FOV 120	707,535	732,956	58.8	334.0	2.0	120.0

Calculation result

Glare receptor

No.	Name	Total time with glare in a year [h/year]	Maximum daily glare duration [min/day]	Day with max glare duration [Date]
1	OP 2 Azimuth: 147 FOV 120	0.0	0.0	
2	OP 3 Azimuth: 147 FOV 120	0.0	0.0	
3	OP 4 Azimuth: 147 FOV 120	0.0	0.0	
4	OP 5 Azimuth: 153 FOV 120	0.0	0.0	
5	OP 22 Azimuth: -34 FOV 120	4.1	5.0	18 August 08:11-08:16
6	OP 23 Azimuth: -34 FOV 120	3.0	5.0	13 April 08:07-08:12
7	OP 24 Azimuth: 146 FOV 120	0.0	0.0	
8	OP 25 Azimuth: 147 FOV 120	0.0	0.0	
9	OP 26 Azimuth: 150 FOV 120	0.0	0.0	
10	OP 27 Azimuth: 146 FOV 120	0.0	0.0	
11	OP 28 Azimuth: 147 FOV 120	0.0	0.0	
12	OP 29 Azimuth: -35 FOV 120	0.0	0.0	
13	OP 30 Azimuth: -35 FOV 120	0.0	0.0	
14	OP 31 Azimuth: -34 FOV 120	0.0	0.0	
15	OP 32 Azimuth: -34 FOV 120	0.0	0.0	
16	OP 33 Azimuth: -34 FOV 120	0.0	0.0	
17	OP 36 Azimuth: 2 FOV 120	0.0	0.0	
18	OP 37 Azimuth: 2 FOV 120	0.0	0.0	
19	OP 38 Azimuth: -5 FOV 120	0.0	0.0	
20	OP 39 Azimuth: -13 FOV 120	1.0	3.0	3 January 09:05-09:08
21	OP 40 Azimuth: -13 FOV 120	0.6	2.0	2 February 08:54-08:56
22	OP 41 Azimuth: -18 FOV 120	1.5	4.0	25 February 08:37-08:41
23	OP 42 Azimuth: -26 FOV 120	2.4	4.0	22 October 08:52-08:56
24	OP 43 Azimuth: -26 FOV 120	2.2	4.0	24 March 07:44-07:48