

FORGESOLAR GLARE ANALYSIS

Project: **Heiton Steel**

C shape design (in line with proposed skylight)- 232.94kWp

Site configuration: **PV Design- C shape**

Analysis conducted by Shikhar Manocha (shikhar@kra.ie) at 10:50 on 09 Feb, 2022.

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/m²
 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: 64635.11462



PV Array(s)

Name: C-shape PV array
Axis tracking: Fixed (no rotation)
Tilt: 7.0°
Orientation: 167.0°
Rated power: 232.94 kW
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.313870	-6.377726	70.38	15.70	86.08
2	53.313651	-6.377599	70.11	13.10	83.21
3	53.313677	-6.377484	70.06	13.10	83.16
4	53.313836	-6.377574	70.22	15.10	85.32
5	53.314279	-6.375405	69.46	15.10	84.56
6	53.314115	-6.375312	69.32	13.10	82.42
7	53.314140	-6.375202	69.40	13.10	82.50
8	53.314359	-6.375326	69.50	15.70	85.20

Flight Path Receptor(s)

Name: FP 04

Description:

Threshold height: 15 m

Direction: 40.0°

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	53.293833	-6.453451	98.24	15.24	113.48
Two-mile	53.271685	-6.484581	154.69	127.48	282.17

Name: FP 07

Description:

Threshold height: 15 m

Direction: 63.0°

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	53.350567	-6.494010	47.60	15.24	62.84
Two-mile	53.337441	-6.537218	53.17	178.35	231.53

Name: FP 10

Description:

Threshold height: 15 m

Direction: 101.0°

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	53.304630	-6.468291	86.28	15.24	101.52
Two-mile	53.310146	-6.515842	73.81	196.40	270.21

Name: FP 10

Description:

Threshold height: 15 m

Direction: 95.0°

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	53.422411	-6.289532	74.02	15.24	89.26
Two-mile	53.424931	-6.337922	80.65	177.29	257.95

Name: FP 22

Description:

Threshold height: 15 m

Direction: 220.0°

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	53.303274	-6.439796	93.37	15.24	108.61
Two-mile	53.325423	-6.408660	63.25	214.04	277.29

Name: FP 25

Description:

Threshold height: 15 m

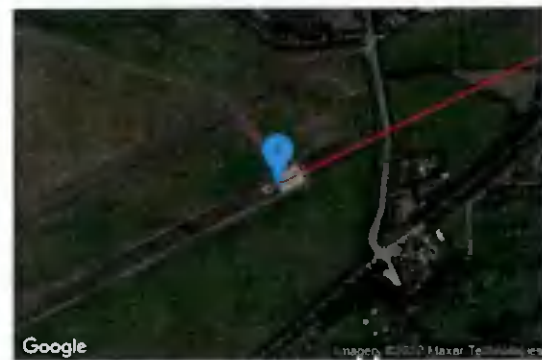
Direction: 244.0°

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	53.354040	-6.482603	46.75	15.24	61.99
Two-mile	53.366715	-6.439014	29.14	201.53	230.68

Name: FP 28

Description:

Threshold height: 15 m

Direction: 275.0°

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	53.420301	-6.251114	61.99	15.24	77.23
Two-mile	53.417781	-6.202726	42.29	203.63	245.92

Name: FP 28

Description:

Threshold height: 15 m

Direction: 280.0°

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	53.301704	-6.445143	96.10	15.24	111.34
Two-mile	53.296684	-6.397441	109.75	170.28	280.03

Name: FP 34

Description:

Threshold height: 15 m

Direction: 335.0°

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	53.420209	-6.249806	62.21	15.24	77.45
Two-mile	53.394006	-6.229279	50.16	195.98	246.14

Discrete Observation Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
1-ATCT	1	53.429073	-6.264258	65.34	87.00
OP 2	2	53.310068	-6.444549	83.50	15.00
OP 3	3	53.355571	-6.489440	49.63	12.00

Map image of 1-ATCT



Route Receptor(s)

Name: Route 1

Path type: One-way (toward increasing index)

Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.317347	-6.371700	72.45	0.00	72.45
2	53.316603	-6.375302	75.25	0.00	75.25
3	53.315798	-6.378792	76.23	0.00	76.23
4	53.315314	-6.380712	76.78	0.00	76.78
5	53.314664	-6.382960	77.78	0.00	77.78
6	53.313664	-6.387107	79.60	0.00	79.60

GLARE ANALYSIS RESULTS

Summary of Glare

PV Array Name	Tilt (°)	Orient (°)	"Green" Glare min	"Yellow" Glare min	Energy kWh
C-shape PV array	7.0	167.0	2,827	0	409,700.0

Total annual glare received by each receptor

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
FP 04	2799	0
FP 07	0	0
FP 10	25	0
FP 10	0	0
FP 22	0	0
FP 25	0	0
FP 28	0	0
FP 28	0	0
FP 34	0	0
1-ATCT	0	0
OP 2	3	0
OP 3	0	0
Route 1	0	0

Results for: C-shape PV array

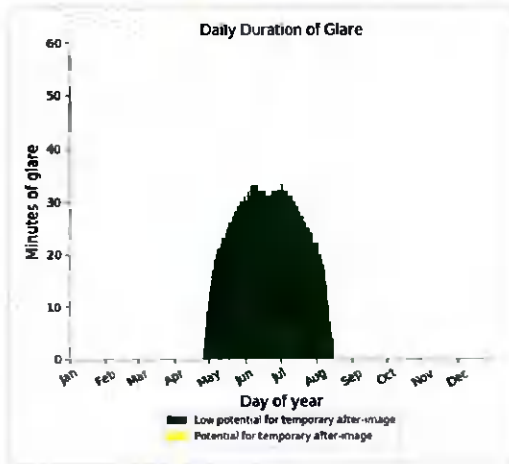
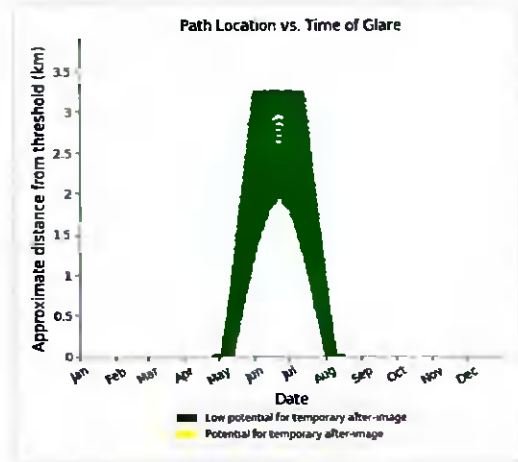
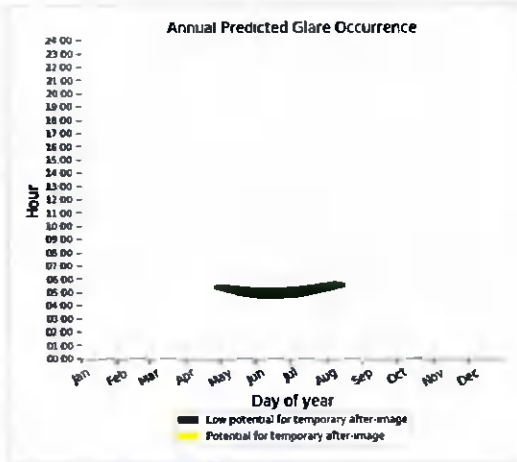
Receptor	Green Glare (min)	Yellow Glare (min)
FP 04	2799	0
FP 07	0	0
FP 10	25	0
FP 10	0	0
FP 22	0	0
FP 25	0	0
FP 28	0	0
FP 28	0	0
FP 34	0	0

Receptor	Green Glare (min)	Yellow Glare (min)
1-ATCT	0	0
OP 2	3	0
OP 3	0	0
Route 1	0	0

Flight Path: FP 04

0 minutes of yellow glare

2799 minutes of green glare



Flight Path: FP 07

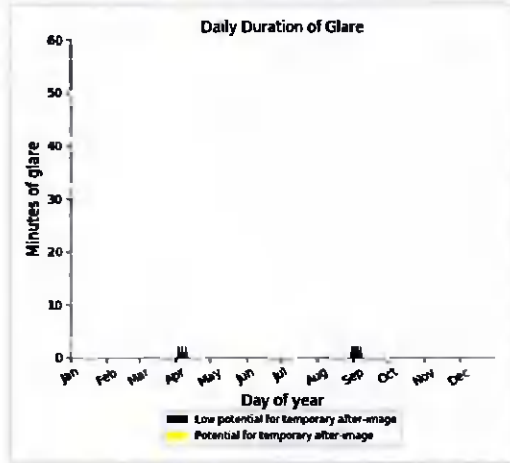
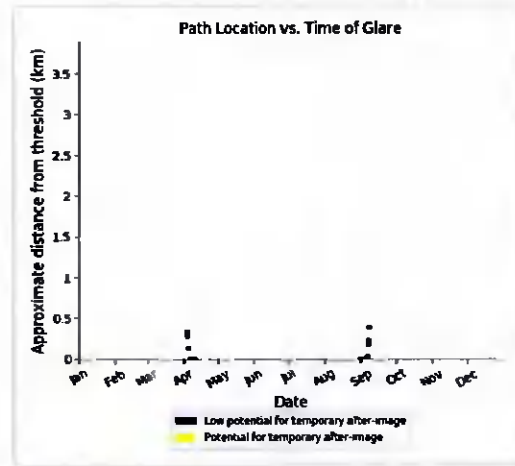
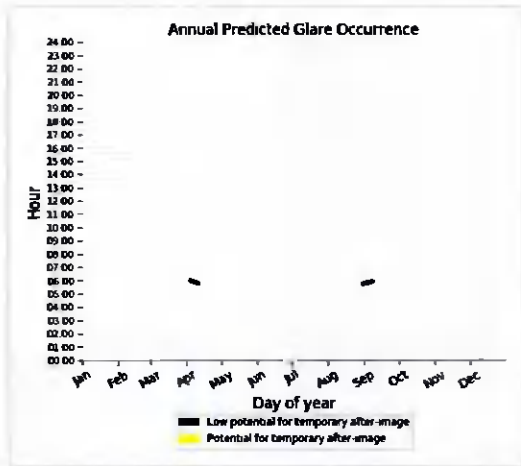
0 minutes of yellow glare

0 minutes of green glare

Flight Path: FP 10

0 minutes of yellow glare

25 minutes of green glare



Flight Path: FP 10

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 22

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 25

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 28

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 28

0 minutes of yellow glare
0 minutes of green glare

Flight Path: FP 34

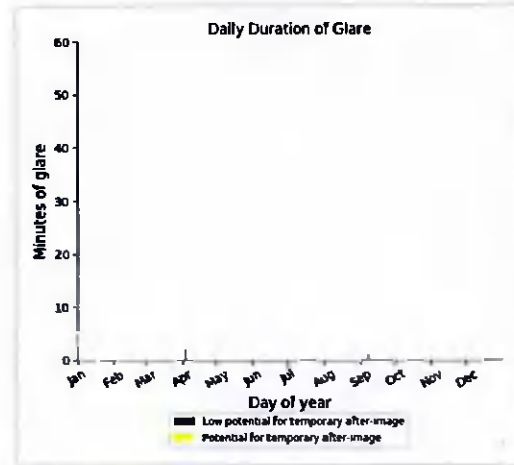
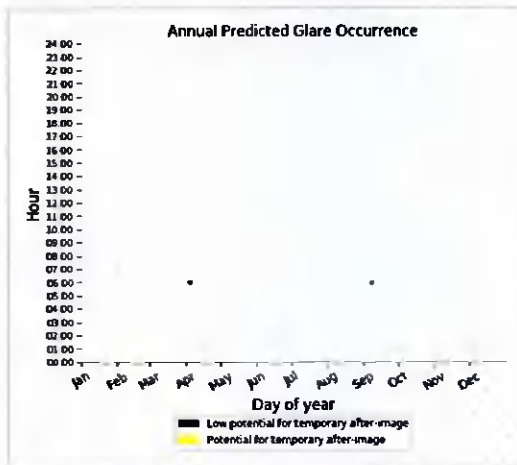
0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 1-ATCT

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 2

0 minutes of yellow glare
3 minutes of green glare



Point Receptor: OP 3

0 minutes of yellow glare
0 minutes of green glare

Route: Route 1

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.