MATAMATA NORTHERN SOLAR FARM

Glint and Glare Assessment

DATE: 18TH October 2024

REVISION: 0

Contents

Quality Information

Document	Matamata Ashbourne Northern SF Glint and Glare Report
Ref	Documents\Land - potential sites\Matamata\Glint & Glare
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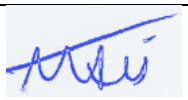
Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
0	18/10/2024	For Information	Matt Shanks / Development Manager	

1.0 Summary

Lightyears Solar Limited has conducted a thorough Glint and Glare Assessment for the proposed Northern Solar Farm located on the Northern end of 172 Station Road, Matamata, on behalf of Maven Associates. The assessment was undertaken utilising the advanced ForgeSolar Glare gauge tool and evaluated more than 39 receptors in the surrounding area.

The findings indicate that there are no impacts on these receptors, and therefore, no specific mitigation measures are necessary. Importantly, the solar farm has been shown to produce no glint or glare, with annual exposure recorded at a remarkable zero.

2.0 Glint and Glare Overview

Glint and glare are optical phenomena related to the reflection of sunlight. Glint is characterised by brief, intermittent flashes of bright light resulting from sunlight reflecting off surfaces like solar panels or water bodies. Glare, on the other hand, involves sustained and uncomfortable brightness, often causing visual discomfort or impairment due to intense and uncontrolled light sources, such as direct sunlight or reflections. In the context of a glint and glare report, particularly for projects like solar farms, it is crucial to assess and manage these phenomena to ensure safety and environmental compatibility.

The GlareGauge tool is designed to detect potential glare emanating from solar PV arrays and categorises them based on their ocular impact. It's important to clarify that this software does not consider view shedding, which involves blocking glare sources through buildings, terrain, or vegetation. Consequently, it represents a worst-case scenario.

The tool quantifies the ocular impact of solar glare into three categories, reflecting the effects on afterimages as given in Figure 1:

- Green indicates a low potential for causing after-image (flash blindness).
- Yellow suggests potential for temporary after-image.
- Red signals the potential for causing retinal burn, which may result in permanent eye damage.

Note that retinal burn is generally not a concern with PV glare because PV modules do not focus reflected sunlight. As PV modules are constructed to absorb as much solar irradiation as possible to increase their efficiency, their reflectivity is very low compared to many other common materials such as grass and house rooftops.

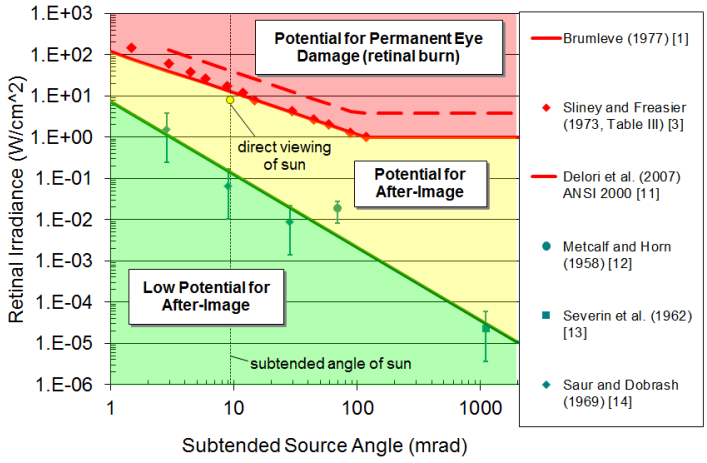


Figure 1 - Glare hazard plot defines ocular impact as function of retinal irradiance and subtended source angle (https://www.forgesolar.com/help/#ref-ho-2011-method)

3.0 Solar Farm Details

3.1 PV Arrays

The PV array was set-up in the model based on the boundaries given in Figure 2. The following parameters were used:

- Single axis trackers which follow the sun from East to West
- Tracker panel rows aligned in North – South configuration
- Maximum tracking angle 60°
- Ground Coverage Ratio: 0.48
- Module height above ground: 1.4m
- Modules made using smooth glass with anti-reflective coating.

Figure 2 - PV Array site coverage on the Northern end of 172 Station Road.

3.2 Obstruction Components

There will be planting strip around the perimeter of the solar farm as given in Figure 3. It will be grown and maintained to a height of 2.5m.

Figure 3 - Planting strip defined around the perimeter of the solar farm.

4.0 Receptors

4.1 Route Receptors

Four route receptors were identified around the proposed solar farm, each set at a height of 1.5 meters to simulate the view from a car. The names of the route receptors are provided below:

- Everad Avenue and James Avenue
- Highgrove Avenue
- Sheffield Street
- Station Road

An evaluation for all the receptors is given below in the following sections.

4.1.1 Everad Avenue and James Avenue

Everad Avenue and James Avenue are situated to the North-East of the proposed solar farm. These avenues form a residential area and can be characterised as having a significant number of residential properties as shown in Figure 4. This road was considered as the first route receptor and had the following parameters:

- Path type: Two-way Road
- Observer view angle: 50°

Figure 4- Route receptor 1 at Everad Avenue and James Avenue on the North – East of the proposed solar farm.

4.1.2 Highgrove Avenue

Highgrove Avenue is one-way road with few residential properties located on the Southern side of the proposed solar farm as shown in Figure 5. The route had the following parameters:

- Path type: One way Road
- Observer view angle: 50°

Figure 5- Route receptor 2 at Highgrove Road on the Southern side of the proposed solar farm.

4.1.3 Sheffield Street

Sheffield Street is a residential street that is located close to Matamata township and is situated on the eastern side of the proposed solar farm. The street has a significant number of residential properties as shown in Figure 6. The route had the following parameters:

- Path type: Two-way Road
- Observer view angle: 50°

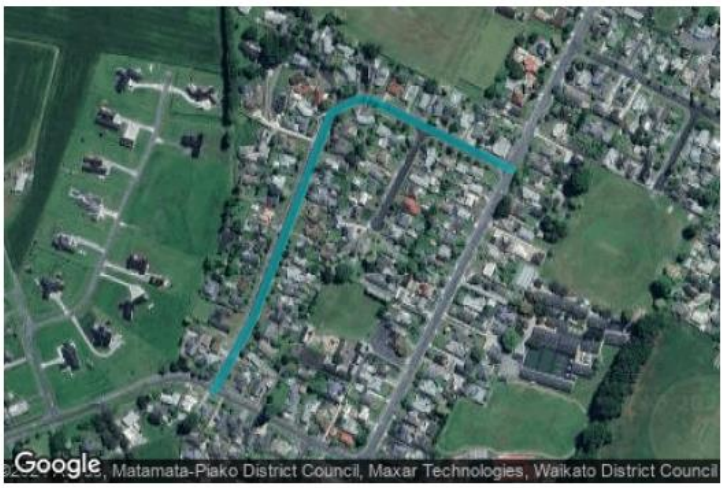


Figure 6- Route receptor 3 at Sheffield Street, located towards the East of the proposed solar farm.

4.1.4 Station Road

Station Road is the primary road running along the front of the proposed solar farm as shown in Figure 7. The route had the following parameters:

- Path type: Two – way road
- Observer view angle: 50°

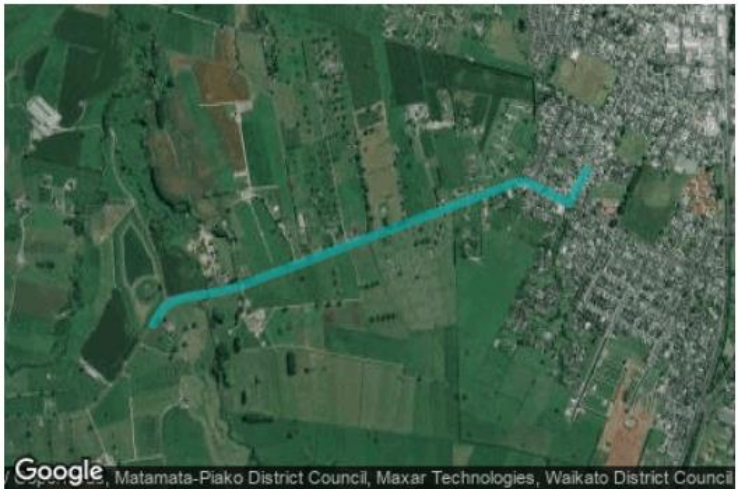


Figure 7- Route Receptor 4 at Station Road, located towards the South of the proposed solar farm.

4.2 Flight Path Receptors

To identify the flight paths necessary for the glint and glare assessment, a benchmark radius of 25 km around the proposed solar farm was established. The assessment found Matamata Aerodrome to be the only aerodrome in close proximity to the solar farm. Two regional airports—Hamilton (HZL) and Tauranga (TRG)—were noted, but their flight paths were not included in the analysis due to their locations being outside the benchmark radius, making them less relevant to potential impacts.

At Matamata Aerodrome, two flight paths were identified: FP1 and FP2 (refer to Figure 8 and Figure 9), each extending 2 miles on either side of the runway. Notably, the aerodrome does not have an Air Traffic Control Tower. The assessment concluded that there would be no significant glint or glare effects from the solar farm on Matamata Aerodrome.

Figure 8 - Flight Path 1 identified at Matamata Aerodrome.

Figure 9- Flight Path 2 identified at Matamata Aerodrome.

4.3 Discrete Observation Points

Thirty-nine discrete observation point receptors were identified, all of them represented residential properties within the surrounding areas of the proposed solar farm. Each of these points have a height set at 1.7m to simulate a view from an average person. These points are identified in Figure 10.

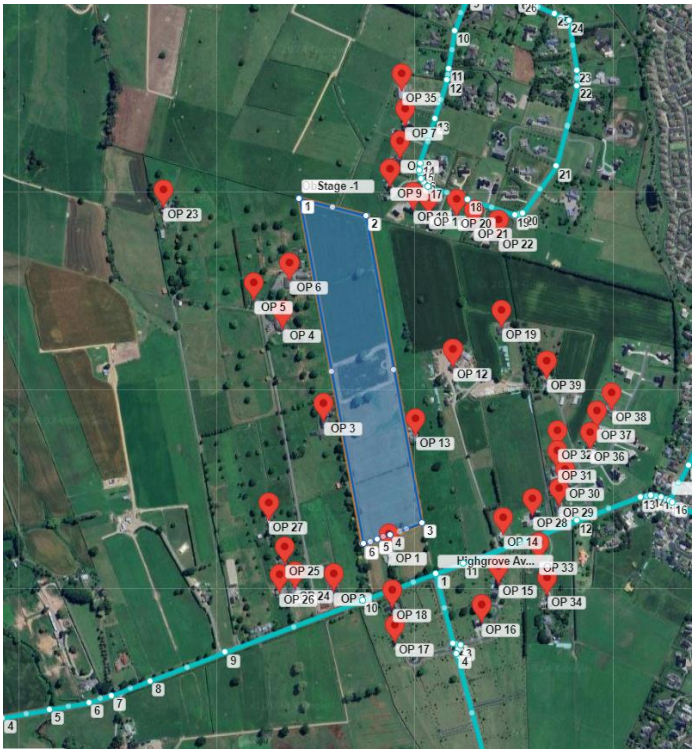


Figure 10 - All identified discrete observation points around the proposed solar farm.

5.0 Glare Analysis Results

The glint and glare analysis provided results for all 39 receptors included in the simulation. Notably, there were no glares recorded at any of the receptors, with both green and orange glare exposures consistently registering at zero. This indicates no risk of after-images and confirms that the solar farm poses no glare-related concerns for any of the observation points evaluated.

Results from every receptor showing the annual green and orange glare is given in Figure 11 and Figure 12.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Everad and James Ave	0	0.0	0	0.0
Highgrove Ave	0	0.0	0	0.0
Sheffield St	0	0.0	0	0.0
Station Road	0	0.0	0	0.0
FP 1	0	0.0	0	0.0
FP 2	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0
OP 22	0	0.0	0	0.0
OP 23	0	0.0	0	0.0
OP 24	0	0.0	0	0.0

Figure 11- Glint and Glare results – 30 Receptors.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 25	0	0.0	0	0.0
OP 26	0	0.0	0	0.0
OP 27	0	0.0	0	0.0
OP 28	0	0.0	0	0.0
OP 29	0	0.0	0	0.0
OP 30	0	0.0	0	0.0
OP 31	0	0.0	0	0.0
OP 32	0	0.0	0	0.0
OP 33	0	0.0	0	0.0
OP 34	0	0.0	0	0.0
OP 35	0	0.0	0	0.0
OP 36	0	0.0	0	0.0
OP 37	0	0.0	0	0.0
OP 38	0	0.0	0	0.0
OP 39	0	0.0	0	0.0

Figure 12- Glint and Glare results – 15 Receptors

6.0 Conclusions and Observations

The results indicate that none of the receptors are at risk of glare. The assessment confirmed no exposure at any receptor, demonstrating no potential for after-images or flash blindness. Overall, the findings show no ocular impact from solar glare.

It should be noted the software simulation uses clear sky weather data where glint and glare is not reduced due to atmospheric conditions or clouds, which provides a worst-case scenario. In reality, clouds, fog and other atmospheric conditions will result in less glare than simulated in this report.

Appendix A: ForgeSolar Glare Analysis Results

FORGESOLAR GLARE ANALYSIS

Project: **Matamata Stage 1**

A high-level Glint & Glare assessment for Stage -1 solar farm in Matamata by Maven

Site configuration: **Stage -1 Matamata**

Client: Maven Associates

Created 15 Oct, 2024
Updated 15 Oct, 2024
Time-step 1 minute
Timezone offset UTC12
Minimum sun altitude 0.0 deg
DNI peaks at 1,000.0 W/m^2
Category 5 MW to 10 MW
Site ID 131255.22386

Ocular transmission coefficient 0.5
Pupil diameter 0.002 m
Eye focal length 0.017 m
Sun subtended angle 9.3 mrad
PV analysis methodology V2

Summary of Results No glare predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
Stage -1	SA tracking	SA tracking	0	0.0	0	0.0	18,420,000.0

Total glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Everad and James Ave	0	0.0	0	0.0
Highgrove Ave	0	0.0	0	0.0
Sheffield St	0	0.0	0	0.0
Station Road	0	0.0	0	0.0
FP 1	0	0.0	0	0.0
FP 2	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0
OP 22	0	0.0	0	0.0
OP 23	0	0.0	0	0.0
OP 24	0	0.0	0	0.0
OP 25	0	0.0	0	0.0
OP 26	0	0.0	0	0.0
OP 27	0	0.0	0	0.0
OP 28	0	0.0	0	0.0
OP 29	0	0.0	0	0.0
OP 30	0	0.0	0	0.0
OP 31	0	0.0	0	0.0
OP 32	0	0.0	0	0.0
OP 33	0	0.0	0	0.0
OP 34	0	0.0	0	0.0
OP 35	0	0.0	0	0.0
OP 36	0	0.0	0	0.0
OP 37	0	0.0	0	0.0
OP 38	0	0.0	0	0.0
OP 39	0	0.0	0	0.0

Component Data

PV Arrays

Name: Stage -1
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 0.0°
Max tracking angle: 60.0°
Resting angle: 0.0°
Ground Coverage Ratio: 0.48
Rated power: 8361.0 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	-37.809940	175.750598	59.00	1.40	60.40
2	-37.810318	175.752443	59.00	1.40	60.40
3	-37.817046	175.753986	60.00	1.40	61.40
4	-37.817293	175.753102	59.00	1.40	60.40
5	-37.817392	175.752754	59.00	1.40	60.40
6	-37.817493	175.752358	59.00	1.40	60.40

Route Receptors

Name: Everad and James Ave
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.803037	175.756742	61.00	1.50	62.50
2	-37.803185	175.756708	61.00	1.50	62.50
3	-37.803289	175.756697	61.00	1.50	62.50
4	-37.804978	175.756762	61.06	1.50	62.56
5	-37.805505	175.756792	61.00	1.50	62.50
6	-37.805524	175.756590	61.00	1.50	62.50
7	-37.805267	175.755783	61.00	1.50	62.50
8	-37.805310	175.755472	61.00	1.50	62.50
9	-37.805475	175.755268	60.07	1.50	61.57
10	-37.806266	175.754890	60.00	1.50	61.50
11	-37.807089	175.754737	60.00	1.50	61.50
12	-37.807350	175.754686	60.00	1.50	61.50
13	-37.808197	175.754342	60.00	1.50	61.50
14	-37.809155	175.753940	60.00	1.50	61.50
15	-37.809302	175.753910	60.00	1.50	61.50
16	-37.809488	175.753949	60.00	1.50	61.50
17	-37.809664	175.754142	60.00	1.50	61.50
18	-37.809947	175.755244	60.00	1.50	61.50
19	-37.810296	175.756553	60.00	1.50	61.50
20	-37.810251	175.756789	61.00	1.50	62.50
21	-37.809226	175.757721	61.00	1.50	62.50
22	-37.807470	175.758298	61.00	1.50	62.50
23	-37.807130	175.758267	61.00	1.50	62.50
24	-37.806030	175.758052	61.00	1.50	62.50
25	-37.805876	175.757670	61.00	1.50	62.50
26	-37.805577	175.756770	61.00	1.50	62.50
27	-37.805502	175.756791	61.00	1.50	62.50

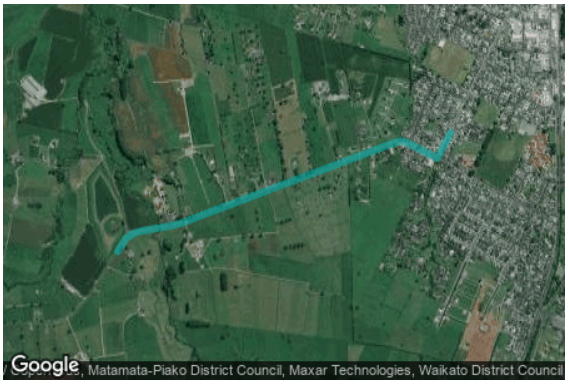
Name: Highgrove Ave
Path type: One-way (toward increasing index)
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.818146	175.754363	60.00	1.50	61.50
2	-37.819663	175.754854	60.00	1.50	61.50
3	-37.819721	175.755052	61.00	1.50	62.50
4	-37.819897	175.754936	61.00	1.50	62.50
5	-37.822491	175.755815	62.00	1.50	63.50

Name: Sheffield St
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.816554	175.760839	63.00	1.50	64.50
2	-37.815772	175.761375	63.00	1.50	64.50
3	-37.813598	175.762411	63.00	1.50	64.50
4	-37.813448	175.762765	63.58	1.50	65.08
5	-37.813464	175.762978	64.00	1.50	65.50
6	-37.814195	175.764836	64.00	1.50	65.50

Name: Station Road
Path type: Two-way
Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.822385	175.740858	65.00	1.50	66.50
2	-37.821691	175.741423	64.00	1.50	65.50
3	-37.821413	175.741958	63.00	1.50	64.50
4	-37.821307	175.742354	62.00	1.50	63.50
5	-37.821121	175.743658	60.00	1.50	61.50
6	-37.820969	175.744745	59.00	1.50	60.50
7	-37.820815	175.745380	59.00	1.50	60.50
8	-37.820497	175.746437	58.00	1.50	59.50
9	-37.819875	175.748533	58.00	1.50	59.50
10	-37.818741	175.752353	59.00	1.50	60.50
11	-37.817917	175.755139	60.00	1.50	61.50
12	-37.816983	175.758285	62.00	1.50	63.50
13	-37.816459	175.760056	63.00	1.50	64.50
14	-37.816422	175.760338	63.00	1.50	64.50
15	-37.816458	175.760599	63.00	1.50	64.50
16	-37.816582	175.760930	63.00	1.50	64.50
17	-37.817345	175.762812	64.00	1.50	65.50
18	-37.815979	175.763727	64.00	1.50	65.50

Flight Path Receptors

Name: FP 1
Description:
Threshold height: 15 m
Direction: 130.4°
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	-37.734772	175.736675	49.00	15.24	64.24
Two-mile	-37.716037	175.708797	42.00	190.92	232.92

Name: FP 2
Description:
Threshold height: 15 m
Direction: 298.3°
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	-37.740837	175.749043	50.00	15.24	65.24
Two-mile	-37.754531	175.781282	50.00	183.92	233.92

Discrete Observation Point Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	-37.817665	175.753051	59.00	1.70
OP 2	2	-37.818551	175.751529	59.00	1.70
OP 3	3	-37.814814	175.751263	59.00	1.70
OP 4	4	-37.812785	175.750115	59.00	1.70
OP 5	5	-37.812181	175.749326	59.00	1.70
OP 6	6	-37.811740	175.750305	59.00	1.70
OP 7	7	-37.808353	175.753511	60.00	1.70
OP 8	8	-37.809069	175.753377	60.00	1.70
OP 9	9	-37.809683	175.753088	60.00	1.70
OP 10	10	-37.810188	175.753731	60.00	1.70
OP 11	11	-37.810304	175.754165	60.00	1.70
OP 12	12	-37.813634	175.754841	60.00	1.70
OP 13	13	-37.815145	175.753803	60.00	1.70
OP 14	14	-37.817314	175.756229	61.00	1.70
OP 15	15	-37.818372	175.756098	61.00	1.70
OP 16	16	-37.819230	175.755636	61.00	1.70
OP 17	17	-37.819674	175.753226	60.00	1.70
OP 18	18	-37.818912	175.753170	59.84	1.70
OP 19	19	-37.812770	175.756177	60.00	1.70
OP 20	20	-37.810337	175.754933	60.00	1.70
OP 21	21	-37.810556	175.755411	60.00	1.70
OP 22	22	-37.810801	175.756097	60.00	1.70
OP 23	23	-37.810145	175.746819	59.00	1.70
OP 24	24	-37.818499	175.750458	58.61	1.70
OP 25	25	-37.817953	175.750181	58.00	1.70
OP 26	26	-37.818557	175.750026	58.00	1.70
OP 27	27	-37.816988	175.749723	58.00	1.70
OP 28	28	-37.816903	175.757046	61.00	1.70
OP 29	29	-37.816674	175.757779	61.00	1.70
OP 30	30	-37.816263	175.757956	61.00	1.70
OP 31	31	-37.815852	175.757730	61.00	1.70
OP 32	32	-37.815420	175.757730	61.00	1.70
OP 33	33	-37.817870	175.757216	61.00	1.70
OP 34	34	-37.818641	175.757458	61.08	1.70
OP 35	35	-37.807597	175.753416	60.00	1.70
OP 36	36	-37.815450	175.758628	62.00	1.70
OP 37	37	-37.814967	175.758822	62.00	1.70
OP 38	38	-37.814577	175.759235	62.00	1.70
OP 39	39	-37.813886	175.757423	61.00	1.70

Obstruction Components

Name: Planting Strip
Top height: 2.5 m

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)
1	-37.809938	175.750596	59.00
2	-37.810317	175.752444	59.00
3	-37.817046	175.753987	60.00
4	-37.817391	175.752750	59.00
5	-37.817496	175.752355	59.00
6	-37.809938	175.750596	59.00

Glare Analysis Results

Summary of Results No glare predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
Stage -1	SA tracking	SA tracking	0	0.0	0	0.0	18,420,000.0

Total glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Everad and James Ave	0	0.0	0	0.0
Highgrove Ave	0	0.0	0	0.0
Sheffield St	0	0.0	0	0.0
Station Road	0	0.0	0	0.0
FP 1	0	0.0	0	0.0
FP 2	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0
OP 22	0	0.0	0	0.0
OP 23	0	0.0	0	0.0
OP 24	0	0.0	0	0.0

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 25	0	0.0	0	0.0
OP 26	0	0.0	0	0.0
OP 27	0	0.0	0	0.0
OP 28	0	0.0	0	0.0
OP 29	0	0.0	0	0.0
OP 30	0	0.0	0	0.0
OP 31	0	0.0	0	0.0
OP 32	0	0.0	0	0.0
OP 33	0	0.0	0	0.0
OP 34	0	0.0	0	0.0
OP 35	0	0.0	0	0.0
OP 36	0	0.0	0	0.0
OP 37	0	0.0	0	0.0
OP 38	0	0.0	0	0.0
OP 39	0	0.0	0	0.0

PV: Stage -1 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Everad and James Ave	0	0.0	0	0.0
Highgrove Ave	0	0.0	0	0.0
Sheffield St	0	0.0	0	0.0
Station Road	0	0.0	0	0.0
FP 1	0	0.0	0	0.0
FP 2	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0
OP 22	0	0.0	0	0.0
OP 23	0	0.0	0	0.0
OP 24	0	0.0	0	0.0
OP 25	0	0.0	0	0.0
OP 26	0	0.0	0	0.0
OP 27	0	0.0	0	0.0
OP 28	0	0.0	0	0.0
OP 29	0	0.0	0	0.0
OP 30	0	0.0	0	0.0
OP 31	0	0.0	0	0.0

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 32	0	0.0	0	0.0
OP 33	0	0.0	0	0.0
OP 34	0	0.0	0	0.0
OP 35	0	0.0	0	0.0
OP 36	0	0.0	0	0.0
OP 37	0	0.0	0	0.0
OP 38	0	0.0	0	0.0
OP 39	0	0.0	0	0.0

Stage -1 and Route: Everad and James Ave

No glare found

Stage -1 and Route: Highgrove Ave

No glare found

Stage -1 and Route: Sheffield St

No glare found

Stage -1 and Route: Station Road

No glare found

Stage -1 and FP: FP 1

No glare found

Stage -1 and FP: FP 2

No glare found

Stage -1 and OP 1

No glare found

Stage -1 and OP 2

No glare found

Stage -1 and OP 3

No glare found

Stage -1 and OP 4

No glare found

Stage -1 and OP 5

No glare found

Stage -1 and OP 6

No glare found

Stage -1 and OP 7

No glare found

Stage -1 and OP 8

No glare found

Stage -1 and OP 9

No glare found

Stage -1 and OP 10

No glare found

Stage -1 and OP 11

No glare found

Stage -1 and OP 12

No glare found

Stage -1 and OP 13

No glare found

Stage -1 and OP 14

No glare found

Stage -1 and OP 15

No glare found

Stage -1 and OP 16

No glare found

Stage -1 and OP 17

No glare found

Stage -1 and OP 18

No glare found

Stage -1 and OP 19

No glare found

Stage -1 and OP 20

No glare found

Stage -1 and OP 21

No glare found

Stage -1 and OP 22

No glare found

Stage -1 and OP 23

No glare found

Stage -1 and OP 24

No glare found

Stage -1 and OP 25

No glare found

Stage -1 and OP 26

No glare found

Stage -1 and OP 27

No glare found

Stage -1 and OP 28

No glare found

Stage -1 and OP 29

No glare found

Stage -1 and OP 30

No glare found

Stage -1 and OP 31

No glare found

Stage -1 and OP 32

No glare found

Stage -1 and OP 33

No glare found

Stage -1 and OP 34

No glare found

Stage -1 and OP 35

No glare found

Stage -1 and OP 36

No glare found

Stage -1 and OP 37

No glare found

Stage -1 and OP 38

No glare found

Stage -1 and OP 39

No glare found

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.
Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare. This primarily affects V1 analyses of path receptors.
Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis.
The analysis does not automatically consider obstacles (either man-made or natural) between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills, buildings, etc.
The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.
The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.
The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.
Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
Refer to the Help page at **www.forgesolar.com/help/** for assumptions and limitations not listed here.

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

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