## ANNEXURE F

## GLINT/GLARE REPORT

# SOLAR BAY – ASHLEY
# Glint/Glare Assessment

## INLAND RTE 72, ASHLEY, CANTERBURY

Date of issue: 29/09/2023

## Document Version

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## Related Documents

| Document Type | Document Title (Number & Title) |
|---|---|
| ForgeSolar Report | APPENDIX I – 2m FT G&G Report |
| ForgeSolar Report | APPENDIX II – 2m 1P SAT G&G Report |
| ForgeSolar Report | APPENDIX III – 2m 2P SAT G&G Report |

## Stakeholder Consultation

| Name | Position |
|---|---|
| | |
| | |

# 1. Executive Summary

Vector PowerSmart (**VPS**) was engaged by Solar Bay (**SB**) to prepare a Glint and Glare Assessment at Ashley, Canterbury.

Conclusions:

- Three ForgeSolar Glint and Glare reports were produced, for a fixed tilt, 1P single axis tracking and a 2P single axis tracking array.
- The fixed tilt and 1P single axis tracking arrays are predicted to produce green and yellow glare on several of the OPs.
- The 2P single axis tracking array is predicted to produce green glare on several of the OPs.
- No red glare is predicted in any of the scenarios.
- As yellow glare is predicted, additional consultation may be required to assess mitigation requirements.
- If a stow alarm occurs due to an isolated event such extreme weather or failure of equipment, the mounting system may stow into a manufacturer determined angle and orientation to protect the Single Axis Tracking array.

# 2. GlareGauge Glint and Glare Assessment Report

## 2.1. Glint and Glare from PV Modules

Light reflects off all surfaces with the potential of causing glint (a momentary flash of bright light) and glare (a continuous source of bright light) and can possibly occur when reflected of a surface. Both phenomena can cause a brief loss of vision and a potential for after imaging. After image is define as an impression of a vivid image retained by the eye after viewing of the light source has ceased. Glint is usually experienced from moving reflectors whereas glare may occur when the reflector is slow or stationary.

As PV modules are constructed from light-absorbing material to absorb as much solar irradiation as possible to increase their efficiency and often include an anti-reflective coating therefore reflectivity is low compared to many other common materials such as vegetation and equal to water. This can be seen in Figure 1 below:


*Figure 1: Chart indicating reflectivity of common surfaces. https://www.forgesolar.com/help/*

The position of the PV modules relative to the sun has the largest effect on the module's reflectivity. As shown in Figure 2 below, the larger the angle of incidence the higher the percentage of light is reflected.

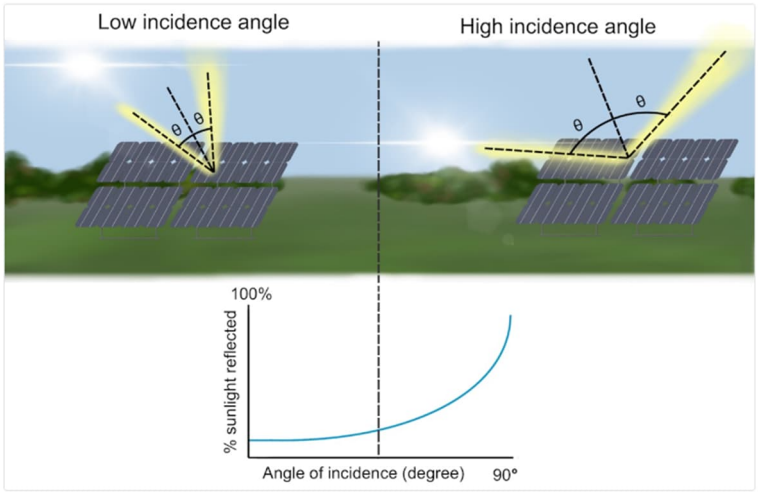



*Figure 2: Angle of incidence effect on PV module reflectivity. https://www.forgesolar.com/help/*

Single axis tracking systems tend to have a smaller angle of incidence as they follow the sun therefore reflecting less light than fixed-tilt systems that are stationary. As fixed-tilt systems are stationary the angle of incidence varies throughout the day (higher reflectivity generally occurs during sunrise and sunset) and will often reflect more light than single axis tracking systems.

## 2.2. GlareGauge Glint and Glare Assessment Tool

As it is possible for PV modules to create glint and glare, a comprehensive analysis was undertaken by Vector PowerSmart (VPS). There is currently no guidance from New Zealand's Civil Aviation Authority (CAA) or any other local organisations around assessment methods for glint and glare caused by solar farms however the American Federal Aviation Administration (FAA) previously recommended the Solar Glaze Hazard Analysis Tool (SGHAT). This tool has since been developed into GlareGauge by ForgeSolar.

The GlareGauge tool identifies possible glare from PV arrays and classifies them regarding their ocular impact. It should be noted that this software doesn't consider view shedding, (the blocking of the glare source from buildings, terrain, or vegetation, therefore representing a worst-case scenario unless stated otherwise).

The ocular impact of solar glare is quantified into three categories showing effect of after image:

- Green - low potential to cause after-image.
- Yellow - potential to cause temporary after-image.
- Red - potential to cause retinal burn.

If any glare occurs in the model, it is classified into the three colour-coded categories as seen in Figure 3 below:

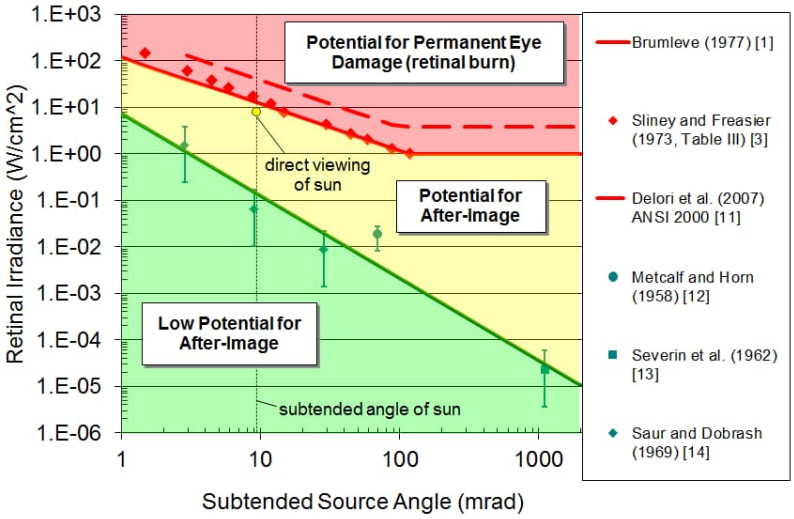



*Figure 3: Sample glare hazard plot showing after image potential. https://www.forgesolar.com/help/#ref-ho-2011-method.*

Essentially if the simulation predicts glare, the ocular impact of the glare is plotted onto the graph shown in Figure 3 to determine the category it belongs to.

The subtended source angle represents the size of the object producing glare (in this case the PV array) viewed by an observer, while the retinal irradiance determines the amount of energy impacting the retina of the observer. Larger source angles (closer to the array) can result in glare of high intensity, even if the retinal irradiance is low. The further away the observer is to the array, the smaller the subtended angle will be thus decreasing the glare intensity.

*It is important to note that the ForgeSolar GlareGauge simulation uses a "Clear Sky" model for the simulation which is the worst-case scenario i.e., does not include clouds or other atmospheric conditions which would reduce glint and glare.*

### 2.2.1. Impact Significant Definition

Table 1 below presents the recommended definition of 'impact significance' and the requirement for mitigation.

| Impact Significance | Definition | Mitigation Requirement |
|---|---|---|
| No Impact | The assessed receptor will not experience any solar reflection due to lack of visibility. | No mitigation is necessary. |
| Low/Green | The assessed receptor may have a small visual impact from solar reflection, but it is considered insignificant. | No mitigation is necessary. |
| Moderate/Yellow | The assessed receptor may experience solar reflection, which is visible and considered to have a moderate impact. | Further analysis and consultation should be conducted to determine if mitigation measures are required. |
| High/Red | The assessed receptor will experience a significant impact from solar reflection. | Mitigation measures and consultation are strongly recommended.<br>If the proposed development is to proceed it is highly likely mitigation will be necessary. |

*Table 1: Impact Significant Definition*

## 2.3. FAA Glare Requirements

In 2013 the FAA released the "Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports"[1] which endorsed and required a SGHAT tool (now GlareGauge) analysis of the ocular impact of a proposed solar energy system on federally obligated airport. The FAA adopted the Glare Hazard Plot shown in Figure 3, and required the following standards to be met:

1. No potential for any glare (i.e., No SGHAT "Green", "Yellow" or "Red" glare) in the existing or planned Airport Traffic Control Tower (ATCT) cab, and

2. Glare NOT to exceed ''low potential for after-image'' along the final approach path for any existing landing threshold or future landing thresholds (i.e., SGHAT "Green" glare is acceptable, SGHAT "Yellow" or "Red" glare are not acceptable).

To summarize, the FAA allows the construction of a PV array that may produce green glare that can impact the pilots or other airport personal unless there is an impact on the ATCT. The FAA will not allow a PV array that produces "potential for after-image" (shown in yellow in Figure 3).

As there is no guidance from the CAA or Waka Kotahi, it is assumed the FAA guidance applies to Glint and Glare analysis in New Zealand. Therefore, predicted green glare should not require mitigation whereas yellow glare potentially would.

*Note: the 2013 "Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports" was replaced in 2021 by the "Federal Aviation Administration Policy: Review of Solar Energy System Projects on Federally Obligated Airports"[2] which no longer recommends or requires a SGHAT tool (GlareGauge) analysis. Stating "The tool is no longer available to all users at no cost. There are several glint and glare analysis tools available to airport sponsors on the open market." Instead, the FAA requires the sponsor to confirm they have completed a glint and glare analysis and determined there is no impact on an ATCT.*

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

[2] Federal Aviation Administration Policy: Review of Solar Energy System Projects on Federally-Obligated Airports: https://www.federalregister.gov/documents/2021/05/11/2021-09862/federal-aviation-administration-policy-review-of-solar-energy-system-projects-on-federally-obligated

## 2.4. Sample Graph Cluster

Figure 4 below is a sample graph cluster, these graphs are the visual representation of the predicted glare effecting a receptor caused by the solar farm. Each OP and route receptor will have a graph cluster for each array that produces glare:

*Note: Figure 4 only shows green and yellow glare. If red glare is present, it would also be represented on this example.*

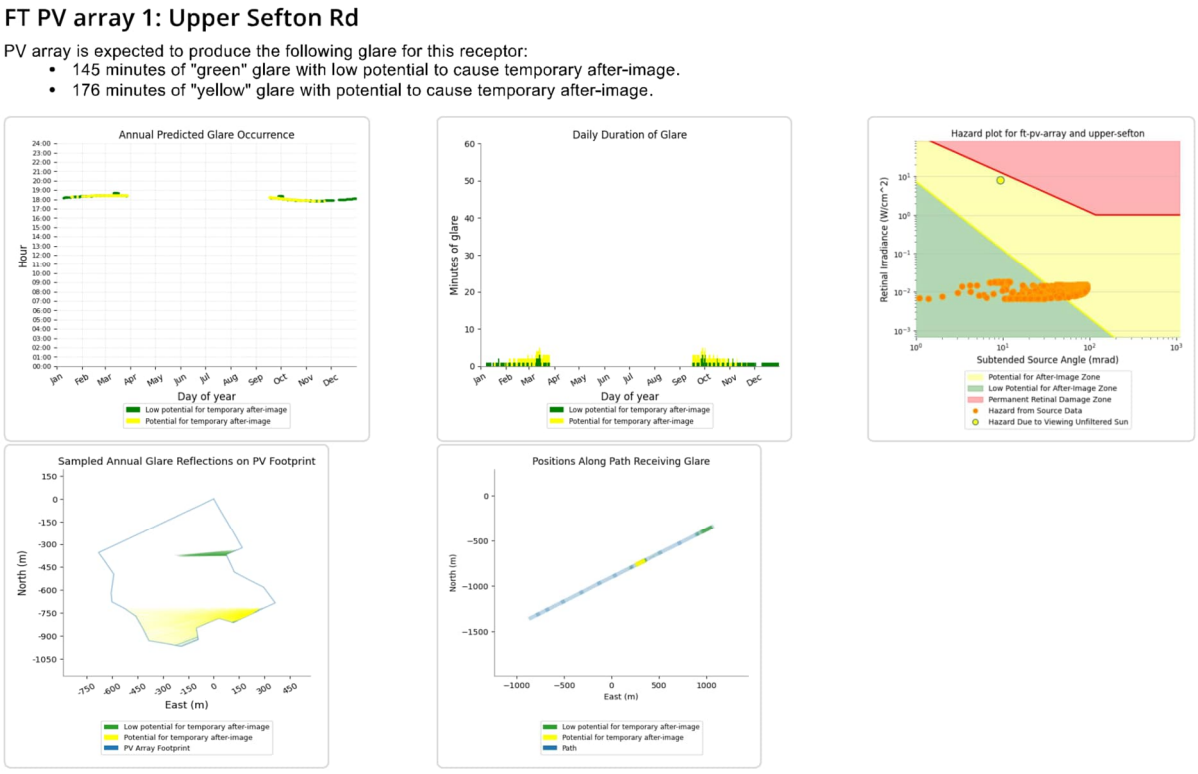



*Figure 4: Sample Graph Cluster*

**Annual Predicted Glare Occurrence:** This graph shows the time of day that glare occurs throughout the year. In this example, green and yellow glare is predicted between 6.30pm and 7pm from mid-September to late March.

**Daily Duration of Glare:** This graph shows the duration of predicted glare in minutes throughout the year of which the longest period is approximately 3 minutes.

**Hazard Plot for ft-pv-array and upper-sefton:** Utilizes the same graph shown in Figure 3. As shown on the hazard plot in Figure 4, the orange plot points represent the intensity of the glare by the zone the plot appears in. In this case the glare is predicted to be green and yellow.

**Sampled Annual Glare Reflections on PV Footprint:** The blue outline shows the solar farm footprint. The area of the PV footprint that produces the received glare is represented by the colour spread across the footprint (either yellow or green glare). This example shows green glare is produced in the central area and yellow glare in the southern area of array.

**Positions Along Path Receiving Glare:** Here the route is shown with the areas where the glint and glare is received. The blue line shows no glare, whereas green and yellow will show where glare is received. In this case, green glare is received on the north-eastern section and yellow glare is shown near the centre of the road.

*Note: Route Receptors are analysed by tracing a path between each point along the route and aggregating the resulting glare in minutes.*

## 2.5. ForgeSolar Report

VPS used the ForgeSolar software tool to evaluate the potential for and duration of glare for receptors surrounding the proposed solar arrays. The receptors and obstructions were identified by the client.

The following ForgeSolar reports were generated:

- Appendix I, Fixed tilt PV array with 2m high proposed shelterbelts
- Appendix II, 1P single axis tracking PV array with 2m high proposed shelterbelts.
- Appendix III, 2P single axis tracking PV array with 2m high proposed shelterbelts.

The obstructions and PV array footprint is the same in both reports, the only variables are the array type.

Figure 5 below shows the site configuration for all three reports consisting of:

- The PV arrays. (blue area footprints)
- Various Observation Points (OPs). (red markers)
- Shelterbelts. (orange lines)
- Route receptors. (blue lines)


*Figure 5: Site Configuration of Ashley Solar Farm with Ops, route receptors and shelterbelts*

# 3. Reported Glare

Full results are available in attached Appendices I, II and III.

*Note: Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour. This software does not include viewshed analysis (therefore not accounting for terrain, buildings or vegetation blocking the glare source) thus representing a worst-case scenario.*

## 3.1. Fixed Tilt Array Results

### 3.1.1. FT PV Array 1

Tables 2 and 3 report the predicted glare for **FT PV array 1** based on the observations in Appendix I. Green and yellow glare is reported at several of the receptors as shown:

| OP | Time (Hours) | Duration (Month of year) | Approx. Max. Minutes of Glare per day | Glare | | Total Minutes Annually |
|---|---|---|---|---|---|---|
| | | | | Green | Yellow | |
| OP1 | No Glare Found | | | | | |
| OP2 | 6.30am-7.30am | Mid-February to early April and early September to late October | 4 | 271 | 0 | 271 |
| OP3 | No Glare Found | | | | | |
| OP4 | 6.30am-7.30am | Early February to early March and late September to early November | 1 | 19 | 0 | 19 |
| OP5 | 6.30am-7.30am | Mid-October to mid-February | 1 | 30 | 0 | 30 |
| OP6 | 6.30am-7.30am | Early October to Early March | 1 | 58 | 0 | 58 |
| OP7 | 6.30am-7.30am | Mid-September to late March | 2 | 145 | 0 | 145 |
| OP8 | 6.30am-7.30am | Early October to early March | 1 | 78 | 0 | 78 |
| OP9 | 6.30am-7am | Mid-March and late September | 2 | 23 | 0 | 23 |
| OP10 | No Glare Found | | | | | |
| OP11 | No Glare Found | | | | | |
| OP12 | No Glare Found | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| OP13 | 6pm-6.30pm | March and mid-September to mid-October | 4 | 139 | 5 | 144 |
| OP14 | No Glare Found | | | | | |
| OP15 | No Glare Found | | | | | |
| OP16 | No Glare Found | | | | | |
| OP17 | 5.30pm-6.30pm | Late September to late March | 3 | 312 | 0 | 312 |
| OP18 | No Glare Found | | | | | |
| OP19 | 5.30pm-6.30pm | Late September to early December and early January to late March | 2 | 78 | 0 | 78 |
| OP20 | No Glare Found | | | | | |
| OP21 | No Glare Found | | | | | |

*Table 2: Total annual glare predicted per OP caused by FT PV array 1.*

| **Route Receptors** | **Time (Hours)** | **Duration (Month of year)** | **Max. Minutes of Glare per day** | **Glare** | | **Total Minutes Annually** |
|---|---|---|---|---|---|---|
| | | | | **Green** | **Yellow** | |
| Route: Beatties Rd | No Glare found | | | | | |
| Route: Marshmans Rd | 6.30am-7am | Late March and mid-September | 2 | 15 | 0 | 15 |
| Route: Upper Sefton Rd | 5.30pm-7pm | Mid-September to late March | 5 | 145 | 176 | 321 |

*Table 3: Total annual glare predicted per route receptor caused by FT PV array 1.*

### 3.1.2. FT PV Array 2

Tables 4 and 5 report the predicted glare for **FT PV array 1** based on the observations in Appendix I. Green glare is reported at several of the receptors as shown:

| OP | Time (Hours) | Duration (Month of year) | Approx. Max. Minutes of Glare per day | Glare | | Total Minutes Annually |
|---|---|---|---|---|---|---|
| | | | | Green | Yellow | |
| OP1 | No Glare Found | | | | | |
| OP2 | 6.30am-7.30am | Early September to early April | 5 | 792 | 0 | 792 |
| OP3 | No Glare Found | | | | | |
| OP4 | No Glare Found | | | | | |
| OP5 | No Glare Found | | | | | |
| OP6 | No Glare Found | | | | | |
| OP7 | No Glare Found | | | | | |
| OP8 | No Glare Found | | | | | |
| OP9 | No Glare Found | | | | | |
| OP10 | No Glare Found | | | | | |
| OP11 | No Glare Found | | | | | |
| OP12 | No Glare Found | | | | | |
| OP13 | No Glare Found | | | | | |
| OP14 | No Glare Found | | | | | |
| OP15 | No Glare Found | | | | | |
| OP16 | No Glare Found | | | | | |
| OP17 | 5.30pm-6.30pm | Early October to early December and early January to mid-March | 1 | 20 | 0 | 20 |
| OP18 | No Glare Found | | | | | |
| OP19 | 5.30pm-6.30pm | Early October to mid-March | 2 | 71 | 0 | 71 |
| OP20 | No Glare Found | | | | | |
| OP21 | No Glare Found | | | | | |

*Table 4: Total annual glare predicted per OP caused by FT PV array 2.*

| Route Receptors | Time (Hours) | Duration (Month of year) | Max. Minutes of Glare per day | Glare | | Total Minutes Annually |
|---|---|---|---|---|---|---|
| | | | | Green | Yellow | |
| Route: Beatties Rd | No Glare found | | | | | |
| Route: Marshmans Rd | No Glare found | | | | | |
| Route: Upper Sefton Rd | 5.30pm-6.30pm | Late September to mid-March | 2 | 76 | 0 | 76 |

*Table 5: Total annual glare predicted per route receptor caused by FT PV array 2.*

### 3.1.3. SAT 1P PV Array 1

Tables 6 and 7 report the predicted glare for **SAT 1P PV array 1** based on the observations in Appendix II. Green and yellow glare is reported at several of the receptors as shown:

| OP | Time (Hours) | Duration (Month of year) | Approx. Max. Minutes of Glare per day | Glare | | Total Minutes Annually |
|---|---|---|---|---|---|---|
| | | | | Green | Yellow | |
| OP1 | No Glare Found | | | | | |
| OP2 | 5.30am-9.30am | Late February to Late October | 6 | 478 | 0 | 478 |
| OP3 | No Glare Found | | | | | |
| OP4 | No Glare Found | | | | | |
| OP5 | No Glare Found | | | | | |
| OP6 | No Glare Found | | | | | |
| OP7 | No Glare Found | | | | | |
| OP8 | No Glare Found | | | | | |
| OP9 | No Glare Found | | | | | |
| OP10 | No Glare Found | | | | | |
| OP11 | No Glare Found | | | | | |
| OP12 | No Glare Found | | | | | |
| OP13 | No Glare Found | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| OP14 | 4.30pm-5.30pm | Mid-July to mid-August | 3 | 44 | 0 | 44 |
| OP15 | No Glare Found | | | | | |
| OP16 | No Glare Found | | | | | |
| OP17 | No Glare Found | | | | | |
| OP18 | No Glare Found | | | | | |
| OP19 | No Glare Found | | | | | |
| OP20 | No Glare Found | | | | | |
| OP21 | No Glare Found | | | | | |

*Table 6: Total annual glare predicted per OP caused by SAT 1P PV array 1.*

| Route Receptors | Time (Hours) | Duration (Month of year) | Max. Minutes of Glare per day | Glare | | Total Minutes Annually |
|---|---|---|---|---|---|---|
| | | | | Green | Yellow | |
| Route: Beatties Rd | 4.30pm-5.30pm | Early May to early August | 7 | 90 | 307 | 397 |
| Route: Marshmans Rd | No Glare found | | | | | |
| Route: Upper Sefton Rd | 8am-9am and 5pm-6pm | Late April to mid-August | 3 | 74 | 32 | 106 |

*Table 7: Total annual glare predicted per route receptor caused by SAT 1P PV array 1.*

### 3.1.1. SAT 1P PV Array 2

Tables 8 and 9 report the predicted glare for **SAT 1P PV array 2** based on the observations in Appendix II. Green and yellow glare is reported at several of the receptors as shown:

| OP | Time (Hours) | Duration (Month of year) | Approx. Max. Minutes of Glare per day | Glare | | Total Minutes Annually |
|---|---|---|---|---|---|---|
| | | | | Green | Yellow | |
| OP1 | No Glare Found | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| OP2 | 6am-3pm | Early March to early October | 68 | 574 | 0 | 574 |
| OP3 | No Glare Found | | | | | |
| OP4 | No Glare Found | | | | | |
| OP5 | No Glare Found | | | | | |
| OP6 | No Glare Found | | | | | |
| OP7 | No Glare Found | | | | | |
| OP8 | No Glare Found | | | | | |
| OP9 | No Glare Found | | | | | |
| OP10 | No Glare Found | | | | | |
| OP11 | No Glare Found | | | | | |
| OP12 | No Glare Found | | | | | |
| OP13 | No Glare Found | | | | | |
| OP14 | No Glare Found | | | | | |
| OP15 | No Glare Found | | | | | |
| OP16 | No Glare Found | | | | | |
| OP17 | No Glare Found | | | | | |
| OP18 | No Glare Found | | | | | |
| OP19 | No Glare Found | | | | | |
| OP20 | No Glare Found | | | | | |
| OP21 | 8.30am-3pm | Mid-April to late August | 28 | 418 | 19 | 437 |

*Table 8: Total annual glare predicted per OP caused by SAT 1P PV array 2.*

| Route Receptors | Time (Hours) | Duration (Month of year) | Max. Minutes of Glare per day | Glare | | Total Minutes Annually |
|---|---|---|---|---|---|---|
| | | | | Green | Yellow | |
| Route: Beatties Rd | No Glare found | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Route: Marshmans Rd | No Glare found | | | | | |
| Route: Upper Sefton Rd | 8.30am-3pm | Early April to early September | 56 | 664 | 498 | 1162 |

*Table 9: Total annual glare predicted per route receptor caused by SAT 1P PV array 2.*

### 3.1.1. SAT 2P PV Array 1

Tables 10 and 11 report the predicted glare for **SAT 2P PV array 1** based on the observations in Appendix III. Green and yellow glare is reported at several of the receptors as shown:

| OP | Time (Hours) | Duration (Month of year) | Approx. Max. Minutes of Glare per day | Glare | | Total Minutes Annually |
|---|---|---|---|---|---|---|
| | | | | Green | Yellow | |
| OP1 | No Glare Found | | | | | |
| OP2 | 6am-9am | Mid-February to early October | 6 | 403 | 0 | 403 |
| OP3 | No Glare Found | | | | | |
| OP4 | No Glare Found | | | | | |
| OP5 | 6.30am-7.30am | Late March and mid-September | 2 | 16 | 0 | 16 |
| OP6 | 6.30am-7.30am | Late March and mid-September | 2 | 26 | 0 | 26 |
| OP7 | 5am-7am | Mid-March, late September & early November | 7 | 62 | 0 | 62 |
| OP8 | 5am-7.30am | Late March & early October to early November | 3 | 44 | 0 | 44 |
| OP9 | 5am-7am | Mid-March, late September & late October to early November | 6 | 47 | 0 | 47 |
| OP10 | No Glare Found | | | | | |
| OP11 | No Glare Found | | | | | |
| OP12 | No Glare Found | | | | | |
| OP13 | 4.30pm-5.30pm | Early May to mid-august | 6 | 125 | 0 | 125 |

| | | | | | | |
|---|---|---|---|---|---|---|
| OP14 | No Glare Found | | | | | |
| OP15 | 4.30pm-5.30pm | Early May to late July | 4 | 73 | 0 | 73 |
| OP16 | No Glare Found | | | | | |
| OP17 | No Glare Found | | | | | |
| OP18 | No Glare Found | | | | | |
| OP19 | No Glare Found | | | | | |
| OP20 | No Glare Found | | | | | |
| OP21 | No Glare Found | | | | | |

*Table 10: Total annual glare predicted per OP caused by SAT 2P PV array 1.*

| Route Receptors | Time (Hours) | Duration (Month of year) | Max. Minutes of Glare per day | Glare | | Total Minutes Annually |
|---|---|---|---|---|---|---|
| | | | | Green | Yellow | |
| Route: Beatties Rd | 4.30pm-6pm | Late April to mid-August | 7 | 126 | 304 | 430 |
| Marshmans Rd | 6.30am-7.30am | Mid-March to mid-April & late August to late September | 3 | 71 | 0 | 71 |
| Route: Upper Sefton Rd | 8am-9am, 5pm-5.30pm | Early May to early August | 1 | 25 | 4 | 29 |

*Table 11: Total annual glare predicted per route receptor caused by SAT 2P PV array 1.*

### 3.1.1. SAT 2P PV Array 2

Tables 12 and 13 report the predicted glare for **SAT 2P PV array 2** based on the observations in Appendix III. Green glare is reported at several of the receptors as shown:

| OP | Time (Hours) | Duration (Month of year) | Approx. Max. Minutes of Glare per day | Glare | | Total Minutes Annually |
|---|---|---|---|---|---|---|
| | | | | Green | Yellow | |
| OP1 | 11am-12am | Sporadic April, May and August | 15 | 30 | 0 | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| OP2 | 6.30am-3pm | Early March to early October | 118 | 1773 | 0 | 1773 |
| OP3 | No Glare Found | | | | | |
| OP4 | No Glare Found | | | | | |
| OP5 | No Glare Found | | | | | |
| OP6 | No Glare Found | | | | | |
| OP7 | No Glare Found | | | | | |
| OP8 | No Glare Found | | | | | |
| OP9 | No Glare Found | | | | | |
| OP10 | No Glare Found | | | | | |
| OP11 | No Glare Found | | | | | |
| OP12 | No Glare Found | | | | | |
| OP13 | No Glare Found | | | | | |
| OP14 | No Glare Found | | | | | |
| OP15 | No Glare Found | | | | | |
| OP16 | No Glare Found | | | | | |
| OP17 | No Glare Found | | | | | |
| OP18 | No Glare Found | | | | | |
| OP19 | No Glare Found | | | | | |
| OP20 | No Glare Found | | | | | |
| OP21 | No Glare Found | | | | | |

*Table 12: Total annual glare predicted per OP caused by SAT 2P PV array 2.*

| Route Receptors | Time (Hours) | Duration (Month of year) | Max. Minutes of Glare per day | Glare | | Total Minutes Annually |
|---|---|---|---|---|---|---|
| | | | | Green | Yellow | |
| Route: Beatties Rd | No Glare Found | | | | | |
| Marshmans Rd | No Glare Found | | | | | |
| Route: Upper Sefton Rd | 8.30am-9.30am | April & mid-August to mid-September | 4 | 32 | 0 | 0 |

*Table 13: Total annual glare predicted per route receptor caused by SAT 2P PV array 2.*

## 3.2. Stow Alarm

At times during situations such as isolated extreme weather events or failure of certain equipment a stow alarm will cause the Single Axis Tracking mounting system to stow at a predetermined orientation and angle (often 0°) to protect the array. Due to such an event, there may be additional glare produced outside of the ForgeSolar predictions.

Typically, high wind >= 55km/hour events are predominant with clouds/storms rather than cloudless, with isolated events where high wind prevail in a cloudless scenario, the actual glare at the receptors should be less than the simulation suggests.

Stow alarm conditions are determined by the mounting system manufacturer.

# 4. Conclusions and Observations

To conclude, the fixed tilt and 1P single axis tracking arrays are predicted to produce green and yellow glare on several of the OPs whereas the 2P single axis tracking array is predicted to produce green glare.

No red glare was predicted in any of the scenarios.

Due to the absence of New Zealand guidance documentation (CAA or Waka Kotahi) or prior examples of acceptance criteria relating to glint and glare, the American FAA guidelines have been applied. Based on those guidelines, additional consultation may be required to mitigate yellow glare.

If a stow alarm occurs due to an isolated event such extreme weather or failure of equipment, the Single Axis Tracking mounting system may stow into a manufacturer determined angle and orientation to protect the array. This rare event could produce unforeseen glint or glare depending on stow angle and orientation.

Simulation uses “Clear Sky” weather data where glint and glare are not reduced due to atmospheric conditions or clouds obstructing the sun, essentially providing a worst-case scenario.

# Appendices

APPENDIX I – 2m FT G&G Report

APPENDIX II – 2m 1P SAT G&G Report

APPENDIX III – 2m 2P SAT G&G Report

ForgeSolar

# 2933 - Ashley

## FT Shelterbelts 2m 21092023

**Client:** Solar Bay

**Created** Sep 21, 2023
**Updated** Sep 28, 2023
**Time-step** 1 minute
**Timezone offset** UTC12
**Minimum sun altitude** 0.0 deg
**Site ID** 101110.13897

**Project type** Advanced
**Project status:** active
**Category** 10 MW to 100 MW


### Misc. Analysis Settings

DNI: **varies (1,000.0 W/m^2 peak)**
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: **Version 2**
Enhanced subtended angle calculation: **On**

## Summary of Results Glare with potential for temporary after-image predicted

| PV Name | Tilt | Orientation | "Green" Glare | "Yellow" Glare | Energy Produced |
|---|---|---|---|---|---|
| | deg | deg | min | min | kWh |
| FT PV array 1 | 25.0 | 0.0 | 1,313 | 181 | - |
| FT PV array 2 | 25.0 | 0.0 | 993 | 0 | - |

## Component Data

## PV Array(s)

**Total PV footprint area:** 634,085 m^2

**Name**: FT PV array 1
**Footprint area**: 552,626 m^2
**Axis tracking**: Fixed (no rotation)
**Tilt**: 25.0 deg
**Orientation**: 0.0 deg

**Rated power**: -
**Panel material**: Smooth glass with AR coating
**Vary reflectivity with sun position?** Yes
**Correlate slope error with surface type?** Yes
**Slope error**: 8.43 mrad


| Vertex | Latitude | Longitude | Ground elevation | Height above ground | Total elevation |
|---|---|---|---|---|---|
| | deg | deg | m | m | m |
| 1 | -43.258957 | 172.620736 | 44.00 | 1.80 | 45.80 |
| 2 | -43.259366 | 172.619701 | 45.00 | 1.80 | 46.80 |
| 3 | -43.259759 | 172.618645 | 45.00 | 1.80 | 46.80 |
| 4 | -43.260159 | 172.617611 | 44.61 | 1.80 | 46.41 |
| 5 | -43.260560 | 172.616555 | 44.40 | 1.80 | 46.20 |
| 6 | -43.260961 | 172.615531 | 45.00 | 1.80 | 46.80 |
| 7 | -43.261362 | 172.614464 | 45.00 | 1.80 | 46.80 |
| 8 | -43.261763 | 172.613419 | 45.00 | 1.80 | 46.80 |
| 9 | -43.262148 | 172.612374 | 45.00 | 1.80 | 46.80 |
| 10 | -43.262785 | 172.612937 | 42.00 | 1.80 | 43.80 |
| 11 | -43.263421 | 172.613479 | 40.00 | 1.80 | 41.80 |
| 12 | -43.263972 | 172.613393 | 40.00 | 1.80 | 41.80 |
| 13 | -43.264539 | 172.613286 | 38.34 | 1.80 | 40.14 |
| 14 | -43.265050 | 172.613350 | 37.00 | 1.80 | 38.80 |
| 15 | -43.265432 | 172.614255 | 36.21 | 1.80 | 38.01 |
| 16 | -43.265895 | 172.615084 | 35.00 | 1.80 | 36.80 |
| 17 | -43.266612 | 172.615592 | 32.79 | 1.80 | 34.59 |
| 18 | -43.267329 | 172.616035 | 30.00 | 1.80 | 31.80 |
| 19 | -43.267489 | 172.617221 | 28.00 | 1.80 | 29.80 |
| 20 | -43.267665 | 172.618385 | 26.00 | 1.80 | 27.80 |
| 21 | -43.267462 | 172.619013 | 26.00 | 1.80 | 27.80 |
| 22 | -43.267259 | 172.619619 | 26.00 | 1.80 | 27.80 |
| 23 | -43.266587 | 172.619468 | 28.69 | 1.80 | 30.49 |
| 24 | -43.266294 | 172.620284 | 29.00 | 1.80 | 30.80 |
| 25 | -43.266017 | 172.621121 | 29.00 | 1.80 | 30.80 |
| 26 | -43.266267 | 172.622172 | 27.00 | 1.80 | 28.80 |
| 27 | -43.265970 | 172.622926 | 27.00 | 1.80 | 28.80 |
| 28 | -43.265689 | 172.623680 | 28.00 | 1.80 | 29.80 |
| 29 | -43.265400 | 172.624423 | 28.00 | 1.80 | 29.80 |
| 30 | -43.265110 | 172.625208 | 28.00 | 1.80 | 29.80 |
| 31 | -43.264188 | 172.624362 | 31.00 | 1.80 | 32.80 |
| 32 | -43.263751 | 172.623289 | 33.00 | 1.80 | 34.80 |
| 33 | -43.263297 | 172.622238 | 35.00 | 1.80 | 36.80 |
| 34 | -43.262269 | 172.621648 | 38.00 | 1.80 | 39.80 |
| 35 | -43.262069 | 172.622232 | 38.00 | 1.80 | 39.80 |
| 36 | -43.261870 | 172.622817 | 38.00 | 1.80 | 39.80 |
| 37 | -43.261142 | 172.622313 | 40.00 | 1.80 | 41.80 |
| 38 | -43.260414 | 172.621787 | 42.00 | 1.80 | 43.80 |
| 39 | -43.259701 | 172.621261 | 43.00 | 1.80 | 44.80 |

**Name**: FT PV array 2
**Footprint area**: 81,460 m^2
**Axis tracking**: Fixed (no rotation)
**Tilt**: 25.0 deg
**Orientation**: 0.0 deg

**Rated power**: -
**Panel material**: Smooth glass with AR coating
**Vary reflectivity with sun position?** Yes
**Correlate slope error with surface type?** Yes
**Slope error**: 8.43 mrad


| Vertex | Latitude | Longitude | Ground elevation | Height above ground | Total elevation |
|---|---|---|---|---|---|
| | deg | deg | m | m | m |
| 1 | -43.262470 | 172.611571 | 45.00 | 1.80 | 46.80 |
| 2 | -43.262723 | 172.610857 | 45.00 | 1.80 | 46.80 |
| 3 | -43.262977 | 172.610165 | 45.00 | 1.80 | 46.80 |
| 4 | -43.263752 | 172.610726 | 43.00 | 1.80 | 44.80 |
| 5 | -43.264526 | 172.611286 | 41.49 | 1.80 | 43.29 |
| 6 | -43.265285 | 172.611847 | 40.00 | 1.80 | 41.80 |
| 7 | -43.266075 | 172.612408 | 39.00 | 1.80 | 40.80 |
| 8 | -43.266850 | 172.612979 | 37.00 | 1.80 | 38.80 |
| 9 | -43.267624 | 172.613529 | 33.42 | 1.80 | 35.22 |
| 10 | -43.268398 | 172.614068 | 29.19 | 1.80 | 30.99 |
| 11 | -43.269173 | 172.614650 | 26.00 | 1.80 | 27.80 |
| 12 | -43.268966 | 172.615235 | 26.00 | 1.80 | 27.80 |
| 13 | -43.268759 | 172.615819 | 26.00 | 1.80 | 27.80 |
| 14 | -43.267743 | 172.615272 | 29.53 | 1.80 | 31.33 |
| 15 | -43.266727 | 172.614704 | 33.98 | 1.80 | 35.78 |
| 16 | -43.266048 | 172.613700 | 36.00 | 1.80 | 37.80 |
| 17 | -43.265352 | 172.612719 | 38.05 | 1.80 | 39.85 |
| 18 | -43.264360 | 172.612552 | 39.00 | 1.80 | 40.80 |
| 19 | -43.263368 | 172.612429 | 40.00 | 1.80 | 41.80 |

## Route Receptor(s)

**Name**: Beatties Rd
**Route type** Two-way
**View angle**: 50.0 deg


| Vertex | Latitude | Longitude | Ground elevation | Height above ground | Total elevation |
|---|---|---|---|---|---|
| | deg | deg | m | m | m |
| 1 | -43.265179 | 172.625535 | 28.00 | 1.80 | 29.80 |
| 2 | -43.263691 | 172.624451 | 32.00 | 1.80 | 33.80 |
| 3 | -43.262712 | 172.623788 | 35.00 | 1.80 | 36.80 |
| 4 | -43.261384 | 172.622801 | 39.00 | 1.80 | 40.80 |
| 5 | -43.260040 | 172.621878 | 43.00 | 1.80 | 44.80 |
| 6 | -43.258961 | 172.621110 | 44.00 | 1.80 | 45.80 |
| 7 | -43.257672 | 172.620133 | 45.00 | 1.80 | 46.80 |
| 8 | -43.257414 | 172.619930 | 46.00 | 1.80 | 47.80 |

**Name**: Marshmans Rd
**Route type** Two-way
**View angle**: 50.0 deg


| Vertex | Latitude | Longitude | Ground elevation | Height above ground | Total elevation |
|---|---|---|---|---|---|
| | deg | deg | m | m | m |
| 1 | -43.266119 | 172.603133 | 42.00 | 1.80 | 43.80 |
| 2 | -43.264067 | 172.604619 | 47.00 | 1.80 | 48.80 |
| 3 | -43.262145 | 172.606142 | 50.00 | 1.80 | 51.80 |
| 4 | -43.260958 | 172.607043 | 52.45 | 1.80 | 54.25 |
| 5 | -43.259458 | 172.608503 | 55.00 | 1.80 | 56.80 |
| 6 | -43.258395 | 172.609554 | 56.00 | 1.80 | 57.80 |
| 7 | -43.256598 | 172.611356 | 58.90 | 1.80 | 60.70 |
| 8 | -43.256160 | 172.611762 | 58.05 | 1.80 | 59.85 |

**Name**: Upper Sefton Rd
**Route type** Two-way
**View angle**: 50.0 deg


| Vertex | Latitude | Longitude | Ground elevation | Height above ground | Total elevation |
|---|---|---|---|---|---|
| | deg | deg | m | m | m |
| 1 | -43.271146 | 172.610237 | 27.00 | 1.80 | 28.80 |
| 2 | -43.270779 | 172.611197 | 25.00 | 1.80 | 26.80 |
| 3 | -43.270314 | 172.612409 | 25.78 | 1.80 | 27.58 |
| 4 | -43.269533 | 172.614437 | 25.44 | 1.80 | 27.24 |
| 5 | -43.268603 | 172.616840 | 25.00 | 1.80 | 26.80 |
| 6 | -43.267697 | 172.619136 | 25.00 | 1.80 | 26.80 |
| 7 | -43.266932 | 172.621175 | 26.00 | 1.80 | 27.80 |
| 8 | -43.266088 | 172.623363 | 27.00 | 1.80 | 28.80 |
| 9 | -43.265428 | 172.625069 | 28.00 | 1.80 | 29.80 |
| 10 | -43.264666 | 172.627033 | 28.00 | 1.80 | 29.80 |
| 11 | -43.263713 | 172.629565 | 28.00 | 1.80 | 29.80 |
| 12 | -43.262838 | 172.631818 | 26.38 | 1.80 | 28.18 |
| 13 | -43.262072 | 172.633792 | 24.35 | 1.80 | 26.15 |

## Discrete Observation Receptors

| Number | Latitude | Longitude | Ground elevation | Height above ground | Total Elevation |
|---|---|---|---|---|---|
| | deg | deg | m | m | m |
| OP 1 | -43.268484 | 172.612208 | 31.00 | 1.70 | 32.70 |
| OP 2 | -43.266681 | 172.612443 | 39.00 | 1.70 | 40.70 |
| OP 3 | -43.263330 | 172.603729 | 49.00 | 1.70 | 50.70 |
| OP 4 | -43.261518 | 172.603644 | 54.00 | 1.70 | 55.70 |
| OP 5 | -43.260127 | 172.603987 | 57.00 | 1.70 | 58.70 |
| OP 6 | -43.259721 | 172.606090 | 56.22 | 1.70 | 57.92 |
| OP 7 | -43.258846 | 172.607978 | 58.00 | 1.70 | 59.70 |
| OP 8 | -43.259440 | 172.609759 | 53.99 | 1.70 | 55.69 |
| OP 9 | -43.258814 | 172.610596 | 54.00 | 1.70 | 55.70 |
| OP 10 | -43.259752 | 172.616089 | 46.87 | 1.70 | 48.57 |
| OP 11 | -43.257809 | 172.621124 | 44.00 | 1.70 | 45.70 |
| OP 12 | -43.258637 | 172.620984 | 44.00 | 1.70 | 45.70 |
| OP 13 | -43.259540 | 172.621966 | 43.00 | 1.70 | 44.70 |
| OP 14 | -43.263540 | 172.626363 | 31.00 | 1.70 | 32.70 |
| OP 15 | -43.259653 | 172.621726 | 43.00 | 1.70 | 44.70 |
| OP 16 | -43.261388 | 172.622761 | 39.00 | 1.70 | 40.70 |
| OP 17 | -43.263825 | 172.624652 | 32.00 | 1.70 | 33.70 |
| OP 18 | -43.264786 | 172.625350 | 29.00 | 1.70 | 30.70 |
| OP 19 | -43.265302 | 172.625789 | 27.72 | 1.70 | 29.42 |
| OP 20 | -43.267800 | 172.619154 | 25.00 | 1.70 | 26.70 |
| OP 21 | -43.269435 | 172.614568 | 25.49 | 1.70 | 27.19 |

## Obstruction Components

**Name**: 2m Shelterbelt 1
**Upper edge height**: 2.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.262746 | 172.623675 | 35.00 |
| 2 | -43.263957 | 172.624539 | 31.33 |
| 3 | -43.264554 | 172.624965 | 30.00 |
| 4 | -43.265152 | 172.625402 | 28.00 |
| 5 | -43.265857 | 172.623646 | 27.14 |
| 6 | -43.266500 | 172.621932 | 27.00 |
| 7 | -43.267150 | 172.620207 | 26.00 |
| 8 | -43.267832 | 172.618461 | 25.24 |
| 9 | -43.268252 | 172.617428 | 25.00 |
| 10 | -43.268658 | 172.616414 | 25.00 |

**Name**: 2m Shelterbelt 2
**Upper edge height**: 2.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.261934 | 172.623039 | 37.00 |
| 2 | -43.261150 | 172.622489 | 40.00 |
| 3 | -43.260366 | 172.621918 | 42.00 |
| 4 | -43.259590 | 172.621368 | 43.00 |
| 5 | -43.258779 | 172.620802 | 44.00 |

**Name**: 2m Shelterbelt 3
**Upper edge height**: 2.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.262930 | 172.609931 | 45.00 |
| 2 | -43.262567 | 172.610870 | 45.00 |
| 3 | -43.262227 | 172.611800 | 45.00 |
| 4 | -43.261887 | 172.612720 | 45.00 |
| 5 | -43.261547 | 172.613619 | 45.00 |

**Name**: 2m Shelterbelt 4
**Upper edge height**: 2.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.261047 | 172.614853 | 45.00 |
| 2 | -43.260688 | 172.615791 | 45.00 |
| 3 | -43.260360 | 172.616709 | 45.00 |

**Name**: 2m Shelterbelt 5
**Upper edge height**: 2.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.262914 | 172.609943 | 45.00 |
| 2 | -43.263729 | 172.610531 | 43.00 |
| 3 | -43.264532 | 172.611109 | 42.00 |
| 4 | -43.265342 | 172.611687 | 40.05 |
| 5 | -43.266137 | 172.612265 | 39.29 |
| 6 | -43.266952 | 172.612833 | 37.00 |
| 7 | -43.267750 | 172.613421 | 33.00 |
| 8 | -43.268557 | 172.614010 | 29.00 |
| 9 | -43.269348 | 172.614577 | 26.00 |
| 10 | -43.268707 | 172.616294 | 25.00 |

**Name**: 2m Shelterbelt 6
**Upper edge height**: 2.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.261540 | 172.613603 | 45.00 |
| 2 | -43.261038 | 172.614858 | 45.00 |

**Name**: 2m Shelterbelt 7
**Upper edge height**: 2.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.260352 | 172.616693 | 45.00 |
| 2 | -43.259957 | 172.617733 | 45.00 |
| 3 | -43.259578 | 172.618758 | 45.00 |
| 4 | -43.259176 | 172.619772 | 45.00 |
| 5 | -43.258772 | 172.620834 | 44.00 |

**Name**: 2m Shelterbelt 8
**Upper edge height**: 2.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.261941 | 172.623037 | 37.00 |
| 2 | -43.262340 | 172.621953 | 37.21 |
| 3 | -43.263164 | 172.622516 | 35.00 |
| 4 | -43.262723 | 172.623664 | 35.00 |

# Summary of PV Glare Analysis

*PV configuration and total predicted glare*

| PV Name | Tilt | Orientation | "Green" Glare | "Yellow" Glare | Energy Produced | Data File |
|---|---|---|---|---|---|---|
| | deg | deg | min | min | kWh | |
| FT PV array 1 | 25.0 | 0.0 | 1,313 | 181 | - | - |
| FT PV array 2 | 25.0 | 0.0 | 993 | 0 | - | - |

## Distinct glare per month

Excludes overlapping glare from PV array for multiple receptors at matching time(s)

| PV | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ft-pv-array (green) | 99 | 79 | 168 | 2 | 0 | 0 | 0 | 0 | 115 | 120 | 86 | 119 |
| ft-pv-array (yellow) | 4 | 32 | 55 | 0 | 0 | 0 | 0 | 0 | 30 | 45 | 11 | 0 |
| ft-pv-array (green) | 126 | 115 | 140 | 18 | 0 | 0 | 0 | 0 | 108 | 134 | 118 | 132 |
| ft-pv-array (yellow) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# PV & Receptor Analysis Results

*Results for each PV array and receptor*

## FT PV array 1 potential temporary after-image

| Component | Green glare (min) | Yellow glare (min) |
|---|---|---|
| OP: OP 1 | 0 | 0 |
| OP: OP 2 | 271 | 0 |
| OP: OP 3 | 0 | 0 |
| OP: OP 4 | 19 | 0 |
| OP: OP 5 | 30 | 0 |
| OP: OP 6 | 58 | 0 |
| OP: OP 7 | 145 | 0 |
| OP: OP 8 | 78 | 0 |
| OP: OP 9 | 23 | 0 |
| OP: OP 10 | 0 | 0 |
| OP: OP 11 | 0 | 0 |
| OP: OP 12 | 0 | 0 |
| OP: OP 13 | 139 | 5 |
| OP: OP 14 | 0 | 0 |
| OP: OP 15 | 0 | 0 |
| OP: OP 16 | 0 | 0 |
| OP: OP 17 | 312 | 0 |
| OP: OP 18 | 0 | 0 |
| OP: OP 19 | 78 | 0 |
| OP: OP 20 | 0 | 0 |
| OP: OP 21 | 0 | 0 |
| Route: Beatties Rd | 0 | 0 |
| Route: Marshmans Rd | 15 | 0 |
| Route: Upper Sefton Rd | 145 | 176 |

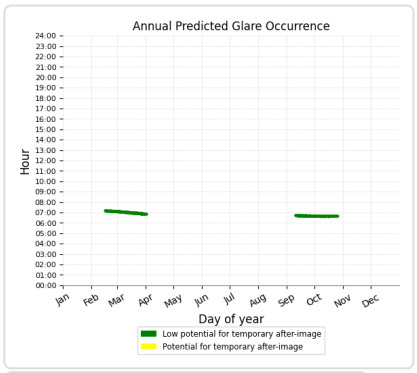
## FT PV array 1: OP 1

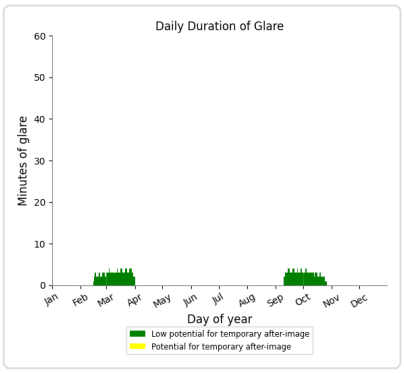
*No glare found*

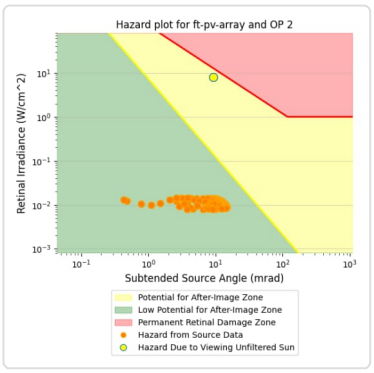
## FT PV array 1: OP 2

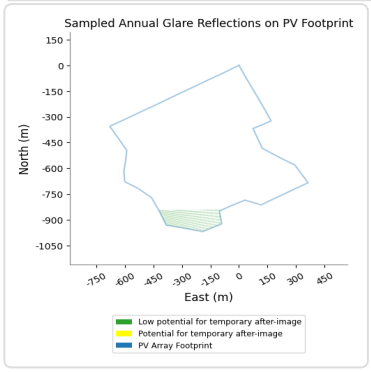
PV array is expected to produce the following glare for this receptor:

- 271 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.



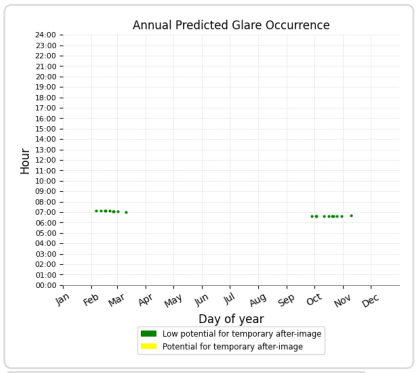

## FT PV array 1: OP 3

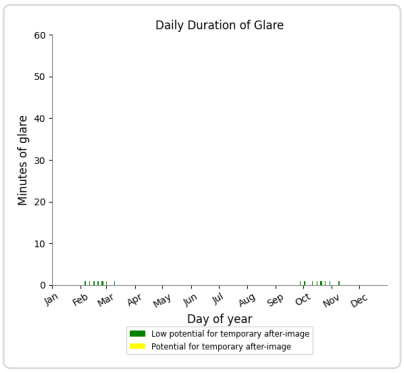
*No glare found*

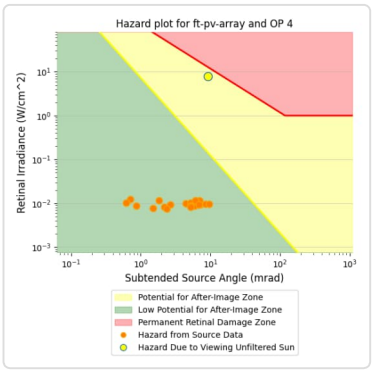
## FT PV array 1: OP 4

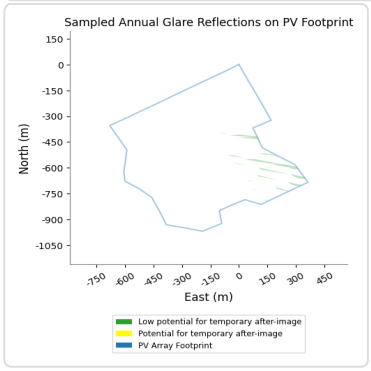
PV array is expected to produce the following glare for this receptor:

- 19 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.



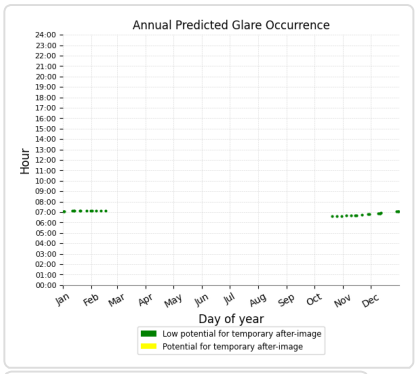



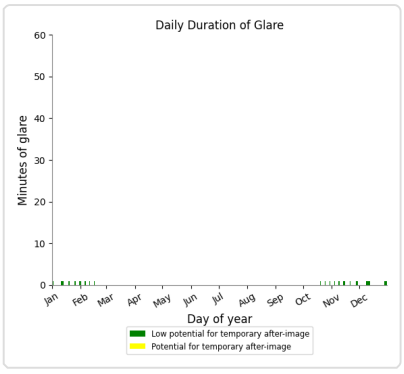



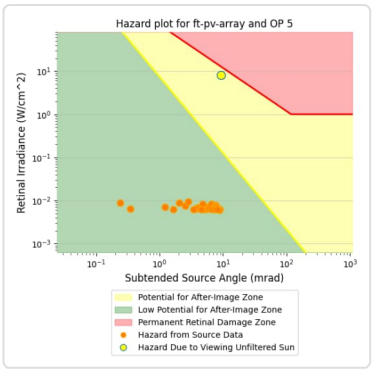

## FT PV array 1: OP 5

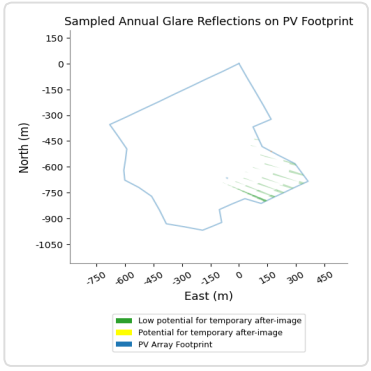
PV array is expected to produce the following glare for this receptor:

- 30 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.



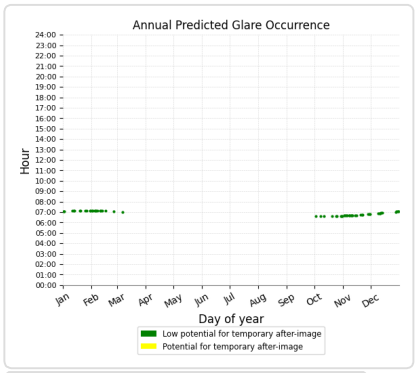



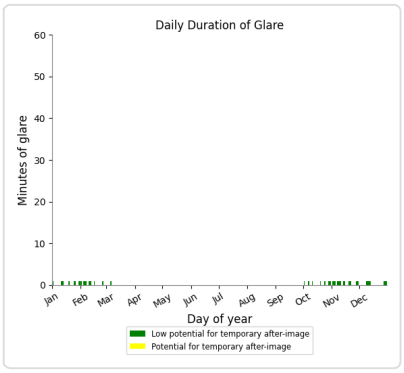



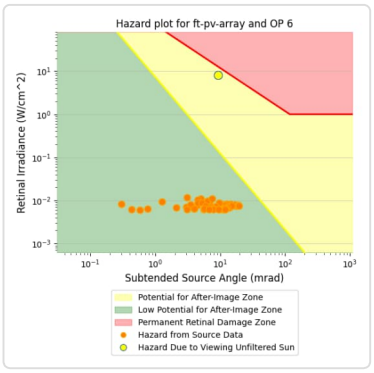
## FT PV array 1: OP 6

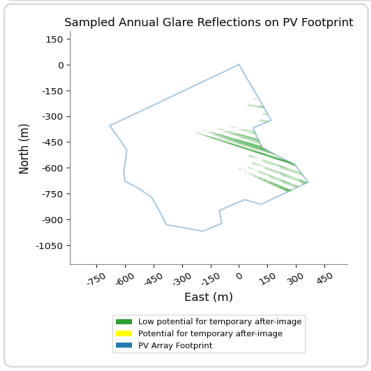
PV array is expected to produce the following glare for this receptor:

- 58 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.



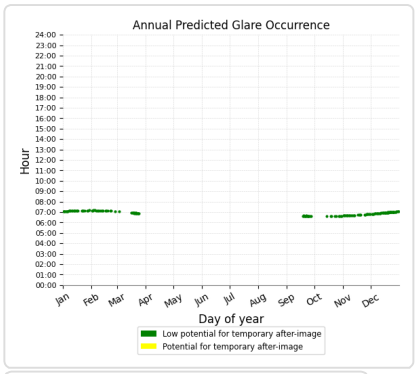



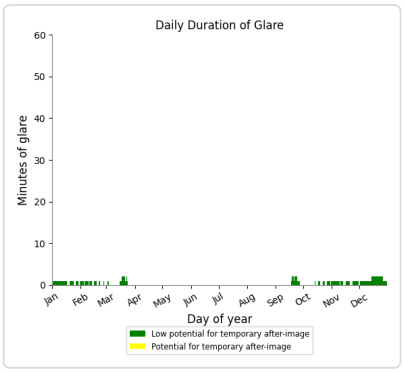



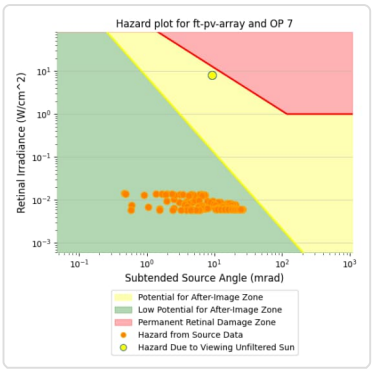

## FT PV array 1: OP 7

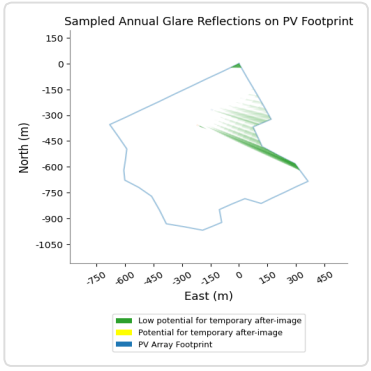
PV array is expected to produce the following glare for this receptor:

- 145 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.



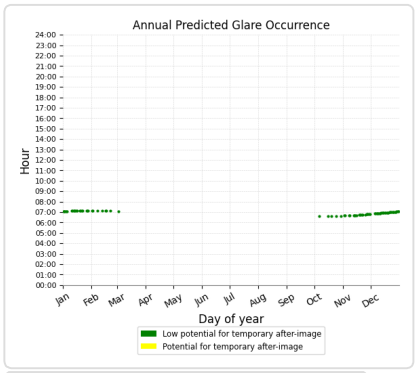



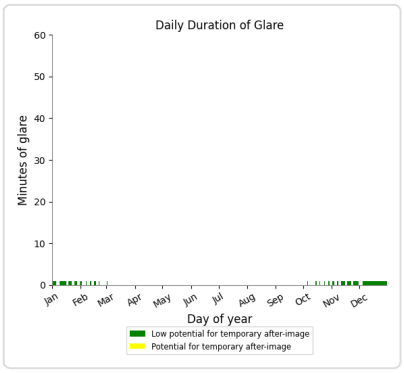



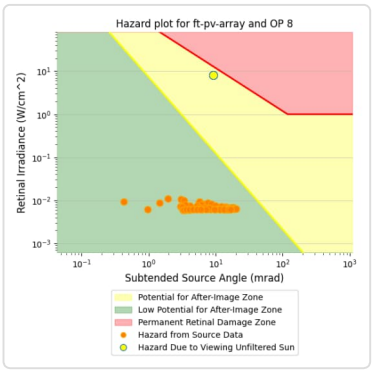
## FT PV array 1: OP 8

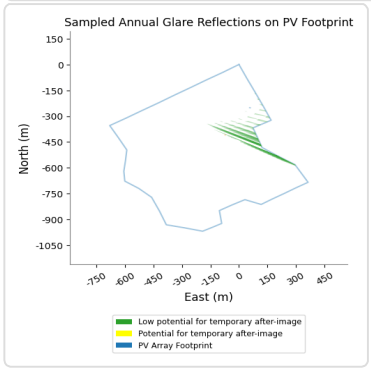
PV array is expected to produce the following glare for this receptor:

- 78 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.



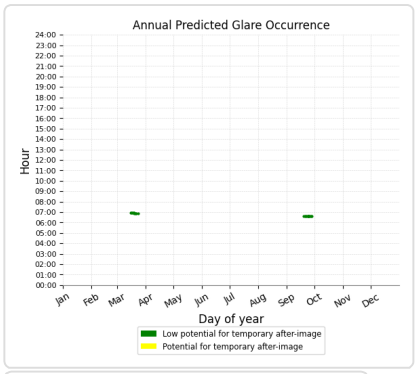



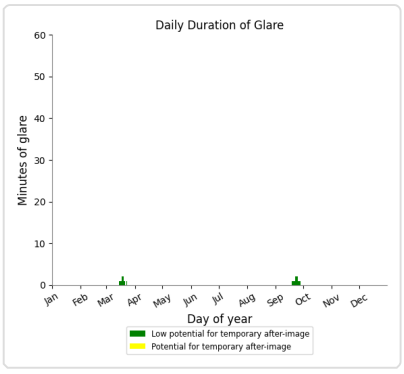



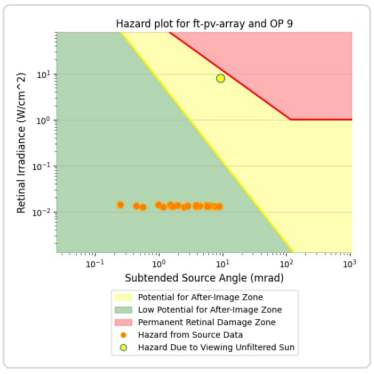

## FT PV array 1: OP 9

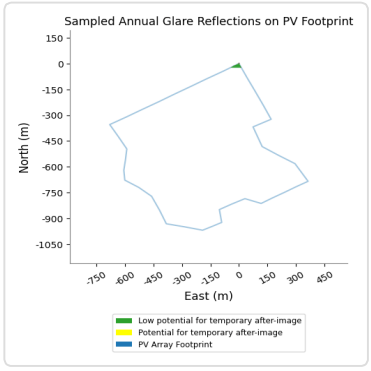
PV array is expected to produce the following glare for this receptor:

- 23 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.




## FT PV array 1: OP 10

*No glare found*

## FT PV array 1: OP 11

*No glare found*

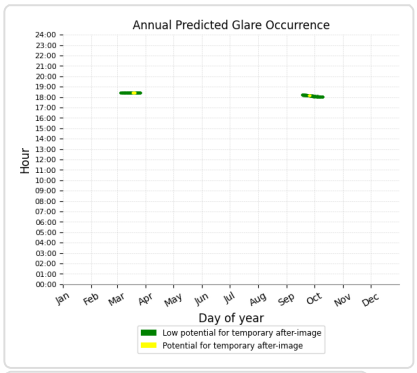
## FT PV array 1: OP 12

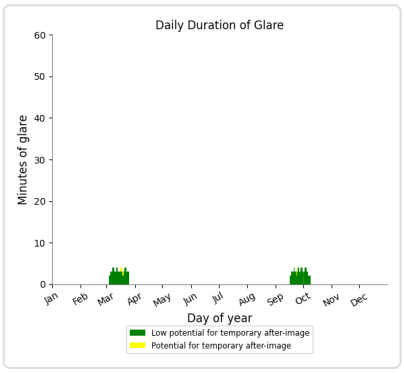
*No glare found*

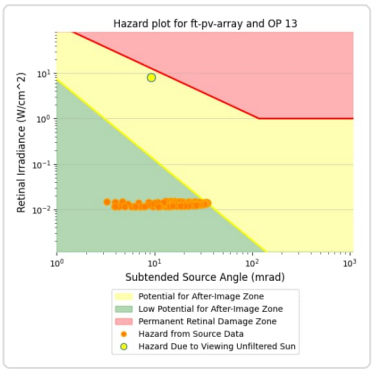
## FT PV array 1: OP 13

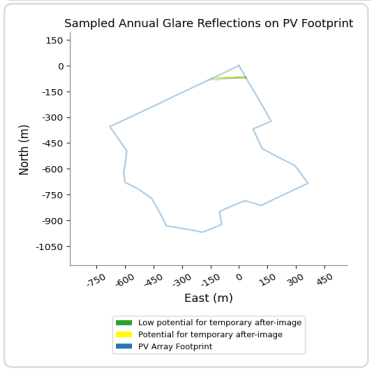
PV array is expected to produce the following glare for this receptor:

- 139 minutes of "green" glare with low potential to cause temporary after-image.
- 5 minutes of "yellow" glare with potential to cause temporary after-image.




## FT PV array 1: OP 14

*No glare found*

## FT PV array 1: OP 15

*No glare found*

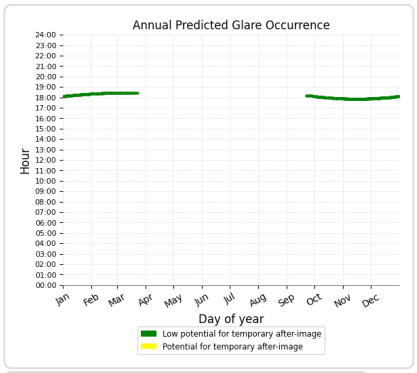
## FT PV array 1: OP 16

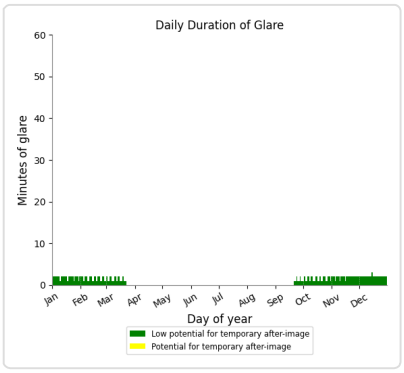
*No glare found*

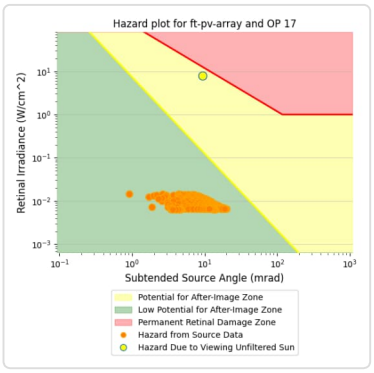
## FT PV array 1: OP 17

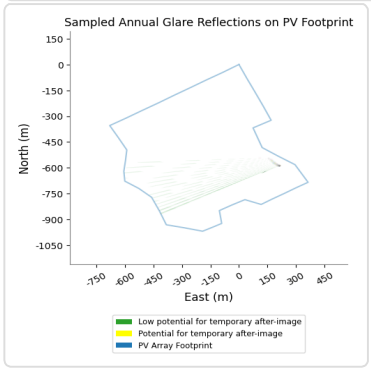
PV array is expected to produce the following glare for this receptor:

- 312 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.



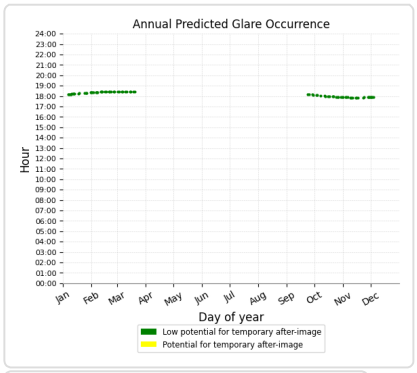

## FT PV array 1: OP 18

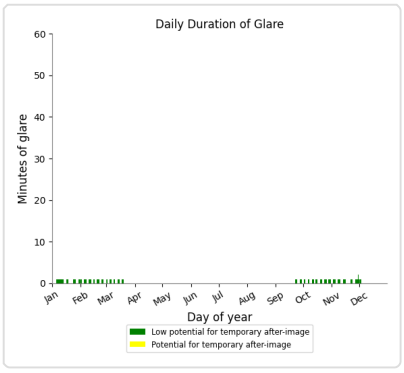
*No glare found*

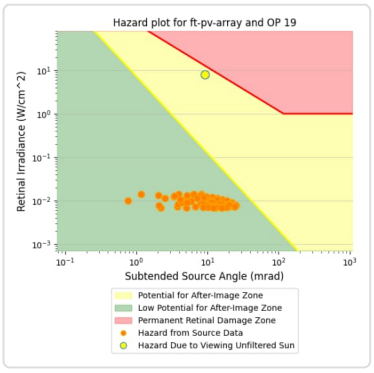
## FT PV array 1: OP 19

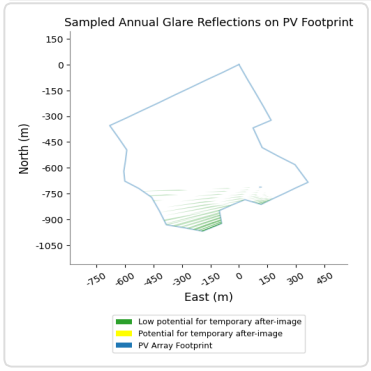
PV array is expected to produce the following glare for this receptor:

- 78 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.



## FT PV array 1: OP 20

*No glare found*

## FT PV array 1: OP 21

*No glare found*

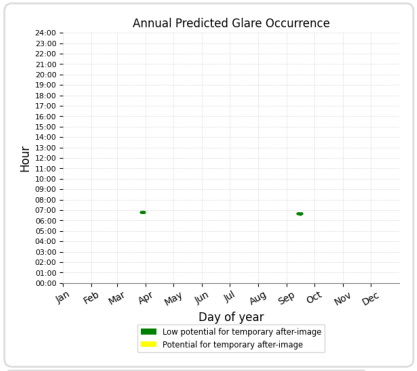
## FT PV array 1: Beatties Rd

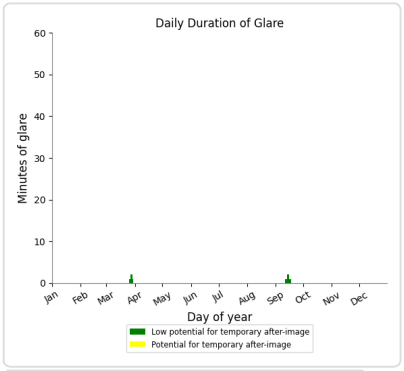
*No glare found*

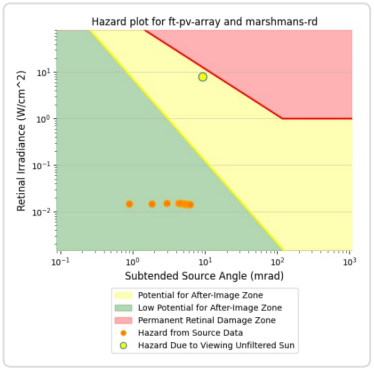
## FT PV array 1: Marshmans Rd

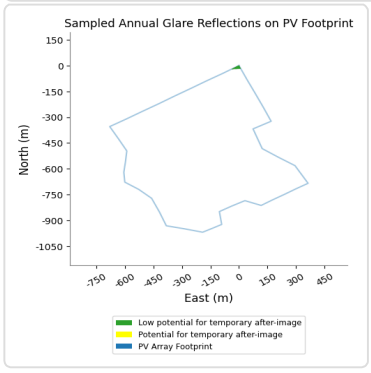
PV array is expected to produce the following glare for this receptor:

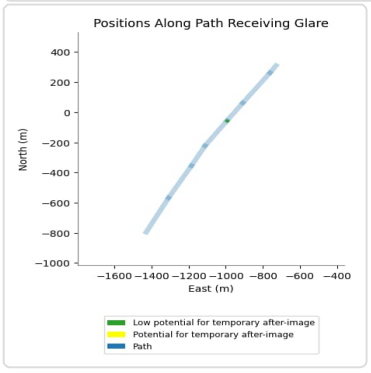
- 15 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.



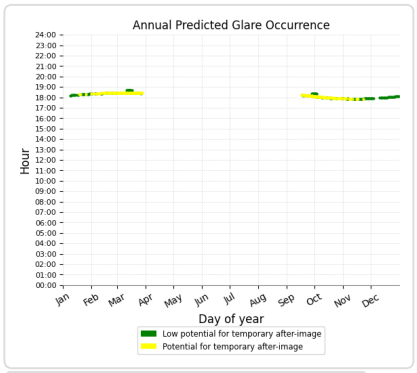



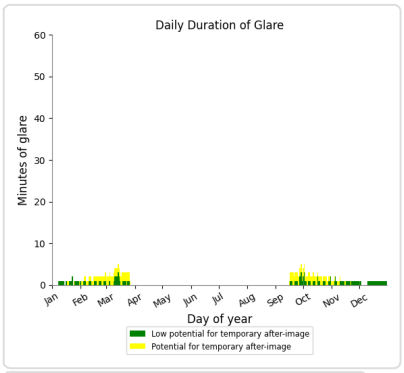



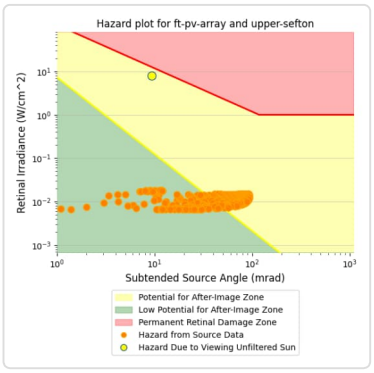
## FT PV array 1: Upper Sefton Rd

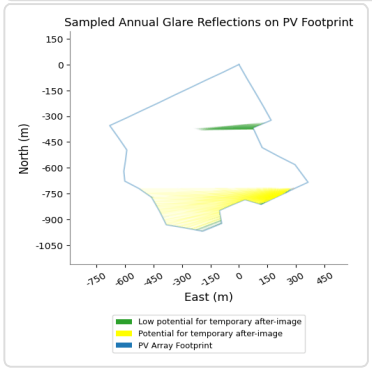
PV array is expected to produce the following glare for this receptor:

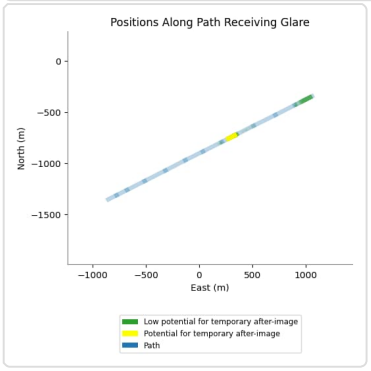
- 145 minutes of "green" glare with low potential to cause temporary after-image.
- 176 minutes of "yellow" glare with potential to cause temporary after-image.




## FT PV array 2 low potential for temporary after-image

| Component | Green glare (min) | Yellow glare (min) |
|---|---|---|
| OP: OP 1 | 0 | 0 |
| OP: OP 2 | 792 | 0 |
| OP: OP 3 | 0 | 0 |
| OP: OP 4 | 0 | 0 |
| OP: OP 5 | 0 | 0 |
| OP: OP 6 | 0 | 0 |
| OP: OP 7 | 0 | 0 |
| OP: OP 8 | 0 | 0 |
| OP: OP 9 | 0 | 0 |
| OP: OP 10 | 0 | 0 |
| OP: OP 11 | 0 | 0 |
| OP: OP 12 | 0 | 0 |
| OP: OP 13 | 0 | 0 |
| OP: OP 14 | 0 | 0 |
| OP: OP 15 | 0 | 0 |
| OP: OP 16 | 0 | 0 |
| OP: OP 17 | 34 | 0 |
| OP: OP 18 | 20 | 0 |
| OP: OP 19 | 71 | 0 |
| OP: OP 20 | 0 | 0 |
| OP: OP 21 | 0 | 0 |
| Route: Beatties Rd | 0 | 0 |
| Route: Marshmans Rd | 0 | 0 |
| Route: Upper Sefton Rd | 76 | 0 |

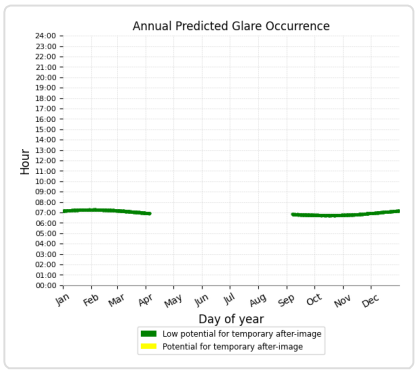
## FT PV array 2: OP 1

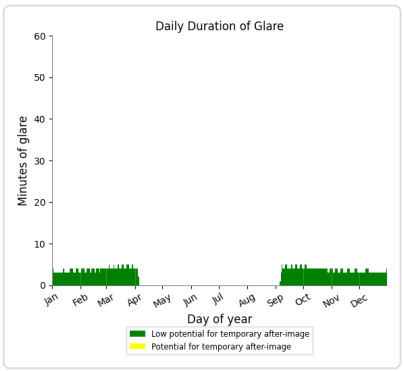
*No glare found*

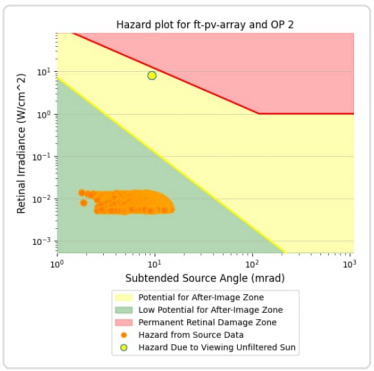
## FT PV array 2: OP 2

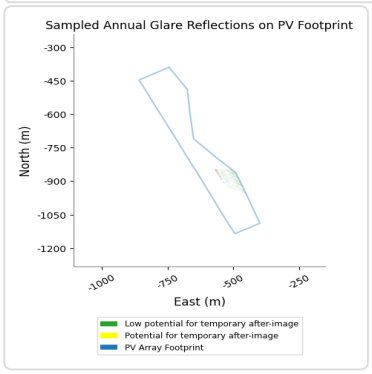
PV array is expected to produce the following glare for this receptor:

- 792 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.




## FT PV array 2: OP 3

*No glare found*

## FT PV array 2: OP 4

*No glare found*

## FT PV array 2: OP 5

*No glare found*

## FT PV array 2: OP 6

*No glare found*

## FT PV array 2: OP 7

*No glare found*

## FT PV array 2: OP 8

*No glare found*

## FT PV array 2: OP 9

*No glare found*

## FT PV array 2: OP 10

*No glare found*

## FT PV array 2: OP 11

*No glare found*

## FT PV array 2: OP 12

*No glare found*

## FT PV array 2: OP 13

*No glare found*

## FT PV array 2: OP 14

*No glare found*

## FT PV array 2: OP 15

*No glare found*

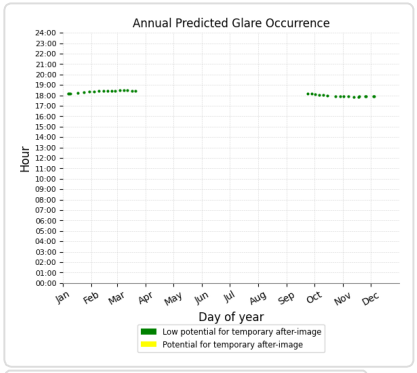
## FT PV array 2: OP 16

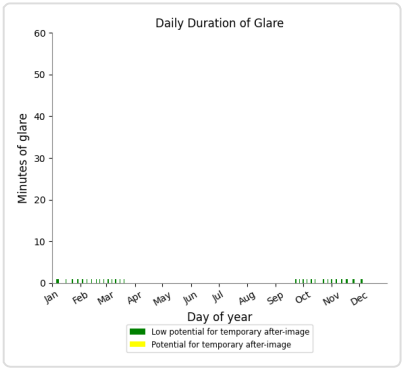
*No glare found*

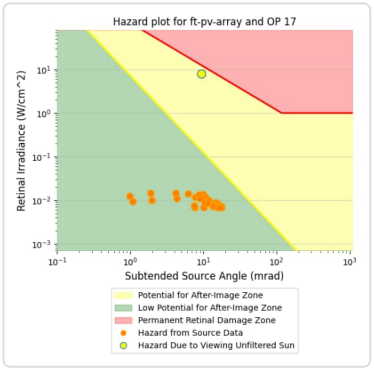
## FT PV array 2: OP 17

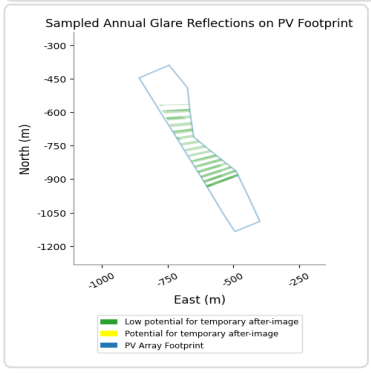
PV array is expected to produce the following glare for this receptor:

- 34 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.



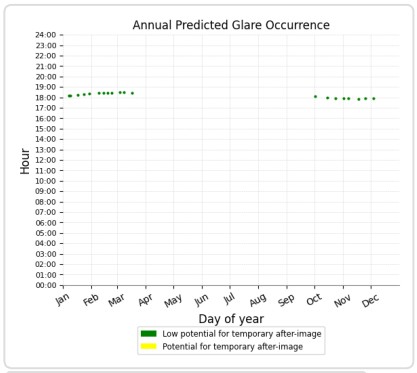



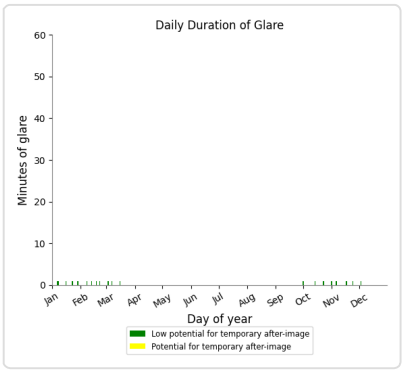



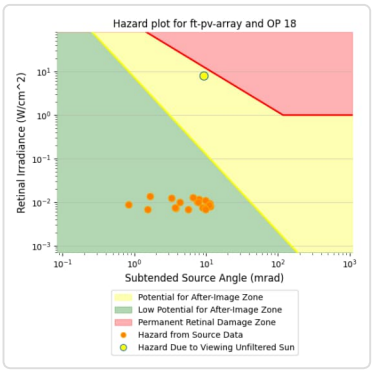
## FT PV array 2: OP 18

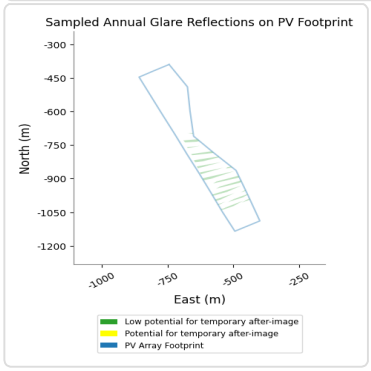
PV array is expected to produce the following glare for this receptor:

- 20 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.



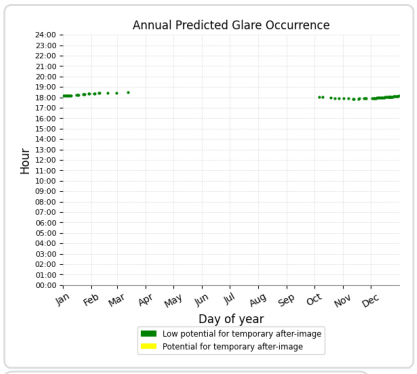



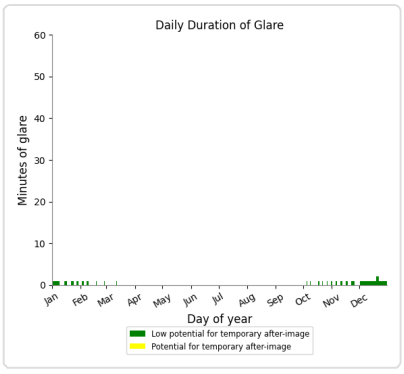



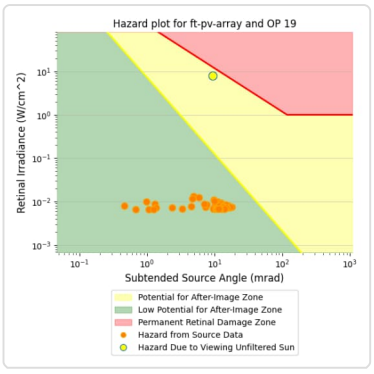

## FT PV array 2: OP 19

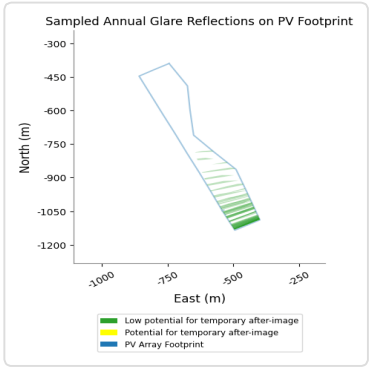
PV array is expected to produce the following glare for this receptor:

- 71 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.




## FT PV array 2: OP 20

*No glare found*

### FT PV array 2: OP 21

*No glare found*

### FT PV array 2: Beatties Rd

*No glare found*

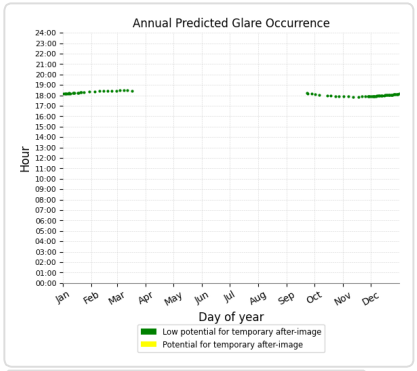
### FT PV array 2: Marshmans Rd

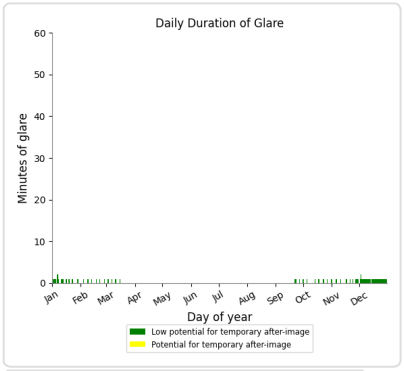
*No glare found*

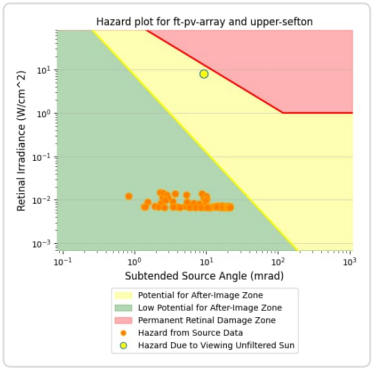
### FT PV array 2: Upper Sefton Rd

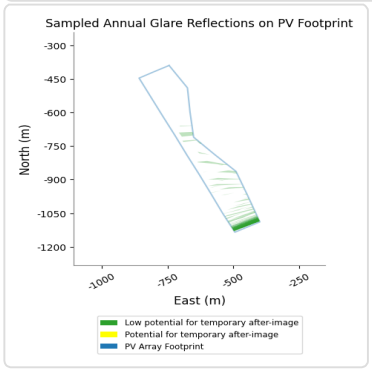
PV array is expected to produce the following glare for this receptor:

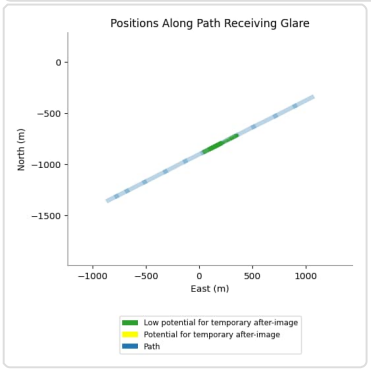
- 76 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.




# Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not automatically account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values and results may vary.
- The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorou modeling methods.
- Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
- The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
- Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
- Refer to the **Help page** for detailed assumptions and limitations not listed here.

ForgeSolar

# 2933 - Ashley

## SAT 1P - Shelterbelts 2m 21092023

**Client:** Solar Bay

**Created** Aug 29, 2023
**Updated** Sep 28, 2023
**Time-step** 1 minute
**Timezone offset** UTC12
**Minimum sun altitude** 0.0 deg
**Site ID** 99101.13897

**Project type** Advanced
**Project status:** active
**Category** 10 MW to 100 MW


### Misc. Analysis Settings

DNI: **varies (1,000.0 W/m^2 peak)**
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: **Version 2**
Enhanced subtended angle calculation: **On**

## Summary of Results Glare with potential for temporary after-image predicted

| PV Name | Tilt | Orientation | "Green" Glare | "Yellow" Glare | Energy Produced |
|---|---|---|---|---|---|
| | deg | deg | min | min | kWh |
| SAT 1P PV array 1 | SA tracking | SA tracking | 686 | 339 | 1,408,000.0 |
| SAT 1P PV array 2 | SA tracking | SA tracking | 1,656 | 517 | 1,234,000.0 |

## Component Data

## PV Array(s)

**Total PV footprint area:** 634,086 m^2

**Name**: SAT 1P PV array 1
**Footprint area**: 552,624 m^2
**Axis tracking**: Single-axis rotation
**Backtracking**: Shade-slope
**Tracking axis orientation**: 0.0 deg
**Maximum tracking angle**: 60.0 deg
**Resting angle**: 0.0 deg
**Ground Coverage Ratio**: 0.404

**Rated power**: 565.0 kW
**Panel material**: Smooth glass with AR coating
**Vary reflectivity with sun position?** Yes
**Correlate slope error with surface type?** Yes
**Slope error**: 8.43 mrad


| Vertex | Latitude | Longitude | Ground elevation | Height above ground | Total elevation |
|---|---|---|---|---|---|
| | deg | deg | m | m | m |
| 1 | -43.258957 | 172.620736 | 44.00 | 1.50 | 45.50 |
| 2 | -43.259366 | 172.619701 | 45.00 | 1.50 | 46.50 |
| 3 | -43.259759 | 172.618645 | 45.00 | 1.50 | 46.50 |
| 4 | -43.260159 | 172.617611 | 44.61 | 1.50 | 46.11 |
| 5 | -43.260560 | 172.616555 | 44.40 | 1.50 | 45.90 |
| 6 | -43.260961 | 172.615531 | 45.00 | 1.50 | 46.50 |
| 7 | -43.261362 | 172.614464 | 45.00 | 1.50 | 46.50 |
| 8 | -43.261763 | 172.613419 | 45.00 | 1.50 | 46.50 |
| 9 | -43.262148 | 172.612374 | 45.00 | 1.50 | 46.50 |
| 10 | -43.262785 | 172.612937 | 42.00 | 1.50 | 43.50 |
| 11 | -43.263421 | 172.613479 | 40.00 | 1.50 | 41.50 |
| 12 | -43.263972 | 172.613393 | 40.00 | 1.50 | 41.50 |
| 13 | -43.264539 | 172.613286 | 38.34 | 1.50 | 39.84 |
| 14 | -43.265050 | 172.613350 | 37.00 | 1.50 | 38.50 |
| 15 | -43.265432 | 172.614255 | 36.21 | 1.50 | 37.71 |
| 16 | -43.265895 | 172.615084 | 35.00 | 1.50 | 36.50 |
| 17 | -43.266612 | 172.615592 | 32.79 | 1.50 | 34.29 |
| 18 | -43.267329 | 172.616035 | 30.00 | 1.50 | 31.50 |
| 19 | -43.267489 | 172.617221 | 28.00 | 1.50 | 29.50 |
| 20 | -43.267665 | 172.618385 | 26.00 | 1.50 | 27.50 |
| 21 | -43.267462 | 172.619013 | 26.00 | 1.50 | 27.50 |
| 22 | -43.267259 | 172.619619 | 26.00 | 1.50 | 27.50 |
| 23 | -43.266587 | 172.619468 | 28.69 | 1.50 | 30.19 |
| 24 | -43.266294 | 172.620284 | 29.00 | 1.50 | 30.50 |
| 25 | -43.266017 | 172.621121 | 29.00 | 1.50 | 30.50 |
| 26 | -43.266267 | 172.622172 | 27.00 | 1.50 | 28.50 |
| 27 | -43.265970 | 172.622926 | 27.00 | 1.50 | 28.50 |
| 28 | -43.265689 | 172.623680 | 28.00 | 1.50 | 29.50 |
| 29 | -43.265400 | 172.624423 | 28.00 | 1.50 | 29.50 |
| 30 | -43.265110 | 172.625208 | 28.00 | 1.50 | 29.50 |
| 31 | -43.264188 | 172.624362 | 31.00 | 1.50 | 32.50 |
| 32 | -43.263751 | 172.623289 | 33.00 | 1.50 | 34.50 |
| 33 | -43.263297 | 172.622238 | 35.00 | 1.50 | 36.50 |
| 34 | -43.262269 | 172.621648 | 38.00 | 1.50 | 39.50 |
| 35 | -43.262069 | 172.622232 | 38.00 | 1.50 | 39.50 |
| 36 | -43.261870 | 172.622817 | 38.00 | 1.50 | 39.50 |
| 37 | -43.261142 | 172.622313 | 40.00 | 1.50 | 41.50 |
| 38 | -43.260414 | 172.621787 | 42.00 | 1.50 | 43.50 |
| 39 | -43.259701 | 172.621261 | 43.00 | 1.50 | 44.50 |

**Name**: SAT 1P PV array 2
**Footprint area**: 81,462 m^2
**Axis tracking**: Single-axis rotation
**Backtracking**: Shade-slope
**Tracking axis orientation**: 0.0 deg
**Maximum tracking angle**: 60.0 deg
**Resting angle**: 0.0 deg
**Ground Coverage Ratio**: 0.404

**Rated power**: 565.0 kW
**Panel material**: Smooth glass with AR coating
**Vary reflectivity with sun position?** Yes
**Correlate slope error with surface type?** Yes
**Slope error**: 8.43 mrad


| Vertex | Latitude | Longitude | Ground elevation | Height above ground | Total elevation |
|---|---|---|---|---|---|
| | deg | deg | m | m | m |
| 1 | -43.262470 | 172.611571 | 45.00 | 1.50 | 46.50 |
| 2 | -43.262723 | 172.610857 | 45.00 | 1.50 | 46.50 |
| 3 | -43.262977 | 172.610165 | 45.00 | 1.50 | 46.50 |
| 4 | -43.263752 | 172.610726 | 43.00 | 1.50 | 44.50 |
| 5 | -43.264526 | 172.611286 | 41.49 | 1.50 | 42.99 |
| 6 | -43.265285 | 172.611847 | 40.00 | 1.50 | 41.50 |
| 7 | -43.266075 | 172.612408 | 39.00 | 1.50 | 40.50 |
| 8 | -43.266850 | 172.612979 | 37.00 | 1.50 | 38.50 |
| 9 | -43.267624 | 172.613529 | 33.42 | 1.50 | 34.92 |
| 10 | -43.268398 | 172.614068 | 29.19 | 1.50 | 30.69 |
| 11 | -43.269173 | 172.614650 | 26.00 | 1.50 | 27.50 |
| 12 | -43.268966 | 172.615235 | 26.00 | 1.50 | 27.50 |
| 13 | -43.268759 | 172.615819 | 26.00 | 1.50 | 27.50 |
| 14 | -43.267743 | 172.615272 | 29.53 | 1.50 | 31.03 |
| 15 | -43.266727 | 172.614704 | 33.98 | 1.50 | 35.48 |
| 16 | -43.266048 | 172.613700 | 36.00 | 1.50 | 37.50 |
| 17 | -43.265352 | 172.612719 | 38.05 | 1.50 | 39.55 |
| 18 | -43.264360 | 172.612552 | 39.00 | 1.50 | 40.50 |
| 19 | -43.263368 | 172.612429 | 40.00 | 1.50 | 41.50 |

## Route Receptor(s)

**Name**: Beatties Rd
**Route type** Two-way
**View angle**: 50.0 deg


| Vertex | Latitude | Longitude | Ground elevation | Height above ground | Total elevation |
|---|---|---|---|---|---|
| | deg | deg | m | m | m |
| 1 | -43.265179 | 172.625535 | 28.00 | 1.80 | 29.80 |
| 2 | -43.263691 | 172.624451 | 32.00 | 1.80 | 33.80 |
| 3 | -43.262712 | 172.623788 | 35.00 | 1.80 | 36.80 |
| 4 | -43.261384 | 172.622801 | 39.00 | 1.80 | 40.80 |
| 5 | -43.260040 | 172.621878 | 43.00 | 1.80 | 44.80 |
| 6 | -43.258961 | 172.621110 | 44.00 | 1.80 | 45.80 |
| 7 | -43.257672 | 172.620133 | 45.00 | 1.80 | 46.80 |
| 8 | -43.257414 | 172.619930 | 46.00 | 1.80 | 47.80 |

**Name**: Marshmans Rd
**Route type** Two-way
**View angle**: 50.0 deg


| Vertex | Latitude | Longitude | Ground elevation | Height above ground | Total elevation |
|---|---|---|---|---|---|
| | deg | deg | m | m | m |
| 1 | -43.266119 | 172.603133 | 42.00 | 1.80 | 43.80 |
| 2 | -43.264067 | 172.604619 | 47.00 | 1.80 | 48.80 |
| 3 | -43.262145 | 172.606142 | 50.00 | 1.80 | 51.80 |
| 4 | -43.260958 | 172.607043 | 52.45 | 1.80 | 54.25 |
| 5 | -43.259458 | 172.608503 | 55.00 | 1.80 | 56.80 |
| 6 | -43.258395 | 172.609554 | 56.00 | 1.80 | 57.80 |
| 7 | -43.256598 | 172.611356 | 58.90 | 1.80 | 60.70 |
| 8 | -43.256160 | 172.611762 | 58.05 | 1.80 | 59.85 |

**Name**: Upper Sefton Rd
**Route type** Two-way
**View angle**: 50.0 deg


| Vertex | Latitude | Longitude | Ground elevation | Height above ground | Total elevation |
|---|---|---|---|---|---|
| | deg | deg | m | m | m |
| 1 | -43.271146 | 172.610237 | 27.00 | 1.80 | 28.80 |
| 2 | -43.270779 | 172.611197 | 25.00 | 1.80 | 26.80 |
| 3 | -43.270314 | 172.612409 | 25.78 | 1.80 | 27.58 |
| 4 | -43.269533 | 172.614437 | 25.44 | 1.80 | 27.24 |
| 5 | -43.268603 | 172.616840 | 25.00 | 1.80 | 26.80 |
| 6 | -43.267697 | 172.619136 | 25.00 | 1.80 | 26.80 |
| 7 | -43.266932 | 172.621175 | 26.00 | 1.80 | 27.80 |
| 8 | -43.266088 | 172.623363 | 27.00 | 1.80 | 28.80 |
| 9 | -43.265428 | 172.625069 | 28.00 | 1.80 | 29.80 |
| 10 | -43.264666 | 172.627033 | 28.00 | 1.80 | 29.80 |
| 11 | -43.263713 | 172.629565 | 28.00 | 1.80 | 29.80 |
| 12 | -43.262838 | 172.631818 | 26.38 | 1.80 | 28.18 |
| 13 | -43.262072 | 172.633792 | 24.35 | 1.80 | 26.15 |

## Discrete Observation Receptors

| Number | Latitude | Longitude | Ground elevation | Height above ground | Total Elevation |
|---|---|---|---|---|---|
| | deg | deg | m | m | m |
| OP 1 | -43.268484 | 172.612208 | 31.00 | 1.70 | 32.70 |
| OP 2 | -43.266681 | 172.612443 | 39.00 | 1.70 | 40.70 |
| OP 3 | -43.263330 | 172.603729 | 49.00 | 1.70 | 50.70 |
| OP 4 | -43.261518 | 172.603644 | 54.00 | 1.70 | 55.70 |
| OP 5 | -43.260127 | 172.603987 | 57.00 | 1.70 | 58.70 |
| OP 6 | -43.259721 | 172.606090 | 56.22 | 1.70 | 57.92 |
| OP 7 | -43.258846 | 172.607978 | 58.00 | 1.70 | 59.70 |
| OP 8 | -43.259440 | 172.609759 | 53.99 | 1.70 | 55.69 |
| OP 9 | -43.258814 | 172.610596 | 54.00 | 1.70 | 55.70 |
| OP 10 | -43.259752 | 172.616089 | 46.87 | 1.70 | 48.57 |
| OP 11 | -43.257809 | 172.621124 | 44.00 | 1.70 | 45.70 |
| OP 12 | -43.258637 | 172.620984 | 44.00 | 1.70 | 45.70 |
| OP 13 | -43.259540 | 172.621966 | 43.00 | 1.70 | 44.70 |
| OP 14 | -43.263540 | 172.626363 | 31.00 | 1.70 | 32.70 |
| OP 15 | -43.259653 | 172.621726 | 43.00 | 1.70 | 44.70 |
| OP 16 | -43.261388 | 172.622761 | 39.00 | 1.70 | 40.70 |
| OP 17 | -43.263825 | 172.624652 | 32.00 | 1.70 | 33.70 |
| OP 18 | -43.264786 | 172.625350 | 29.00 | 1.70 | 30.70 |
| OP 19 | -43.265302 | 172.625789 | 27.72 | 1.70 | 29.42 |
| OP 20 | -43.267800 | 172.619154 | 25.00 | 1.70 | 26.70 |
| OP 21 | -43.269435 | 172.614568 | 25.49 | 1.70 | 27.19 |

## Obstruction Components

**Name**: 2m Shelterbelt 1
**Upper edge height**: 2.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.262746 | 172.623675 | 35.00 |
| 2 | -43.263957 | 172.624539 | 31.33 |
| 3 | -43.264554 | 172.624965 | 30.00 |
| 4 | -43.265152 | 172.625402 | 28.00 |
| 5 | -43.265857 | 172.623646 | 27.14 |
| 6 | -43.266500 | 172.621932 | 27.00 |
| 7 | -43.267150 | 172.620207 | 26.00 |
| 8 | -43.267832 | 172.618461 | 25.24 |
| 9 | -43.268252 | 172.617428 | 25.00 |
| 10 | -43.268658 | 172.616414 | 25.00 |

**Name**: 2m Shelterbelt 2
**Upper edge height**: 2.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.261934 | 172.623039 | 37.00 |
| 2 | -43.261150 | 172.622489 | 40.00 |
| 3 | -43.260366 | 172.621918 | 42.00 |
| 4 | -43.259590 | 172.621368 | 43.00 |
| 5 | -43.258779 | 172.620802 | 44.00 |

**Name**: 2m Shelterbelt 3
**Upper edge height**: 2.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.262930 | 172.609931 | 45.00 |
| 2 | -43.262567 | 172.610870 | 45.00 |
| 3 | -43.262227 | 172.611800 | 45.00 |
| 4 | -43.261887 | 172.612720 | 45.00 |
| 5 | -43.261547 | 172.613619 | 45.00 |

**Name**: 2m Shelterbelt 4
**Upper edge height**: 2.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.261047 | 172.614853 | 45.00 |
| 2 | -43.260688 | 172.615791 | 45.00 |
| 3 | -43.260360 | 172.616709 | 45.00 |

**Name**: 2m Shelterbelt 5
**Upper edge height**: 2.0 m


| Vertex | Latitude deg | Longitude deg | Ground elevation m |
|---|---|---|---|
| 1 | -43.262914 | 172.609943 | 45.00 |
| 2 | -43.263729 | 172.610531 | 43.00 |
| 3 | -43.264532 | 172.611109 | 42.00 |
| 4 | -43.265342 | 172.611687 | 40.05 |
| 5 | -43.266137 | 172.612265 | 39.29 |
| 6 | -43.266952 | 172.612833 | 37.00 |
| 7 | -43.267750 | 172.613421 | 33.00 |
| 8 | -43.268557 | 172.614010 | 29.00 |
| 9 | -43.269348 | 172.614577 | 26.00 |
| 10 | -43.268707 | 172.616294 | 25.00 |

**Name**: 2m Shelterbelt 6
**Upper edge height**: 2.0 m


| Vertex | Latitude deg | Longitude deg | Ground elevation m |
|---|---|---|---|
| 1 | -43.261540 | 172.613603 | 45.00 |
| 2 | -43.261038 | 172.614858 | 45.00 |

**Name**: 2m Shelterbelt 7
**Upper edge height**: 2.0 m


| Vertex | Latitude deg | Longitude deg | Ground elevation m |
|---|---|---|---|
| 1 | -43.260352 | 172.616693 | 45.00 |
| 2 | -43.259957 | 172.617733 | 45.00 |
| 3 | -43.259578 | 172.618758 | 45.00 |
| 4 | -43.259176 | 172.619772 | 45.00 |
| 5 | -43.258772 | 172.620834 | 44.00 |

**Name**: 2m Shelterbelt 8
**Upper edge height**: 2.0 m


| Vertex | Latitude deg | Longitude deg | Ground elevation m |
|---|---|---|---|
| 1 | -43.261941 | 172.623037 | 37.00 |
| 2 | -43.262340 | 172.621953 | 37.21 |
| 3 | -43.263164 | 172.622516 | 35.00 |
| 4 | -43.262723 | 172.623664 | 35.00 |

# Summary of PV Glare Analysis

*PV configuration and total predicted glare*

| PV Name | Tilt | Orientation | "Green" Glare | "Yellow" Glare | Energy Produced | Data File |
|---|---|---|---|---|---|---|
| | deg | deg | min | min | kWh | |
| SAT 1P PV array 1 | SA tracking | SA tracking | 686 | 339 | 1,408,000.0 | - |
| SAT 1P PV array 2 | SA tracking | SA tracking | 1,656 | 517 | 1,234,000.0 | - |

## Distinct glare per month

Excludes overlapping glare from PV array for multiple receptors at matching time(s)

| PV | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| sat-1p-pv-ar (green) | 0 | 3 | 41 | 61 | 123 | 137 | 135 | 97 | 17 | 31 | 0 | 0 |
| sat-1p-pv-ar (yellow) | 0 | 0 | 0 | 0 | 70 | 148 | 117 | 4 | 0 | 0 | 0 | 0 |
| sat-1p-pv-ar (green) | 0 | 0 | 85 | 380 | 137 | 18 | 90 | 431 | 84 | 26 | 0 | 0 |
| sat-1p-pv-ar (yellow) | 0 | 0 | 0 | 106 | 116 | 62 | 104 | 110 | 0 | 0 | 0 | 0 |

# PV & Receptor Analysis Results

*Results for each PV array and receptor*

## SAT 1P PV array 1 potential temporary after-image

Predicted energy output: 1,408,000.0 kWh (assuming sunny, clear skies)

| Component | Green glare (min) | Yellow glare (min) |
|---|---|---|
| OP: OP 1 | 0 | 0 |
| OP: OP 2 | 478 | 0 |
| OP: OP 3 | 0 | 0 |
| OP: OP 4 | 0 | 0 |
| OP: OP 5 | 0 | 0 |
| OP: OP 6 | 0 | 0 |
| OP: OP 7 | 0 | 0 |
| OP: OP 8 | 0 | 0 |
| OP: OP 9 | 0 | 0 |
| OP: OP 10 | 0 | 0 |
| OP: OP 11 | 0 | 0 |
| OP: OP 12 | 0 | 0 |
| OP: OP 13 | 0 | 0 |
| OP: OP 14 | 44 | 0 |
| OP: OP 15 | 0 | 0 |
| OP: OP 16 | 0 | 0 |
| OP: OP 17 | 0 | 0 |
| OP: OP 18 | 0 | 0 |
| OP: OP 19 | 0 | 0 |
| OP: OP 20 | 0 | 0 |
| OP: OP 21 | 0 | 0 |
| Route: Beatties Rd | 90 | 307 |
| Route: Marshmans Rd | 0 | 0 |
| Route: Upper Sefton Rd | 74 | 32 |

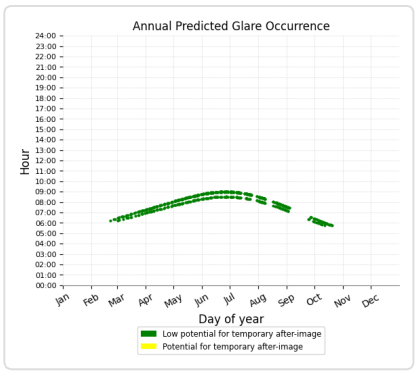
## SAT 1P PV array 1: OP 1

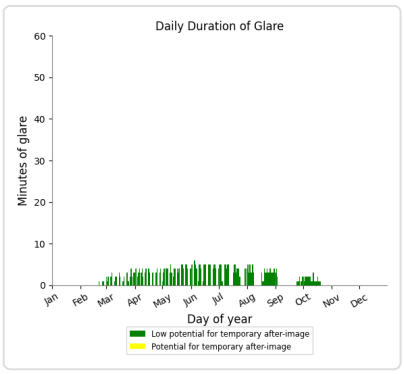
*No glare found*

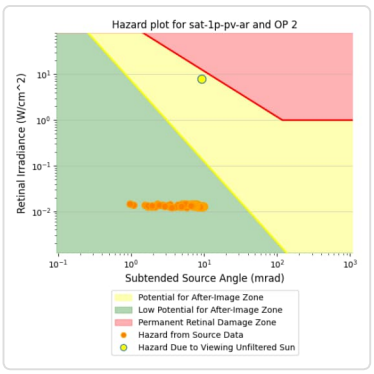
## SAT 1P PV array 1: OP 2

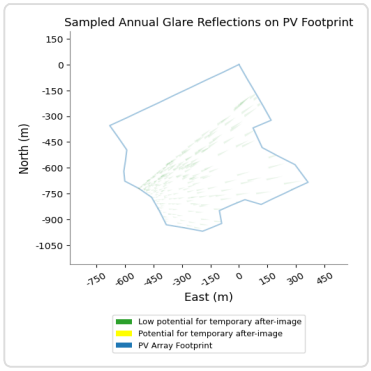
PV array is expected to produce the following glare for this receptor:

- 478 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.




## SAT 1P PV array 1: OP 3

*No glare found*

## SAT 1P PV array 1: OP 4

*No glare found*

## SAT 1P PV array 1: OP 5

*No glare found*

## SAT 1P PV array 1: OP 6

*No glare found*

## SAT 1P PV array 1: OP 7

*No glare found*

## SAT 1P PV array 1: OP 8

*No glare found*

## SAT 1P PV array 1: OP 9

*No glare found*

## SAT 1P PV array 1: OP 10

*No glare found*

## SAT 1P PV array 1: OP 11

*No glare found*

## SAT 1P PV array 1: OP 12

*No glare found*

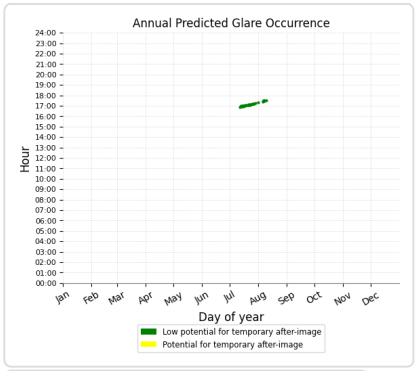
## SAT 1P PV array 1: OP 13

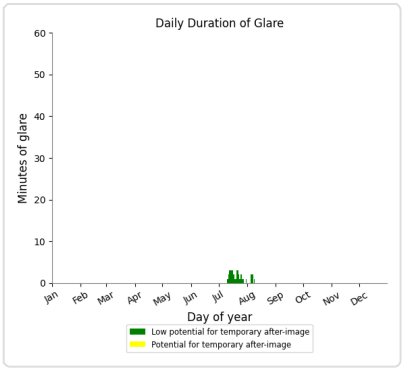
*No glare found*

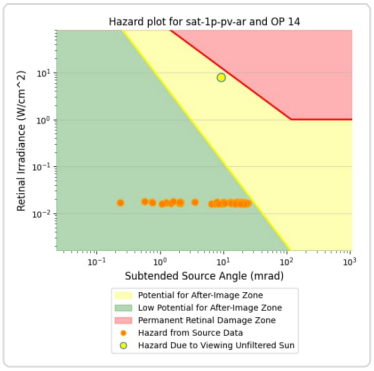
## SAT 1P PV array 1: OP 14

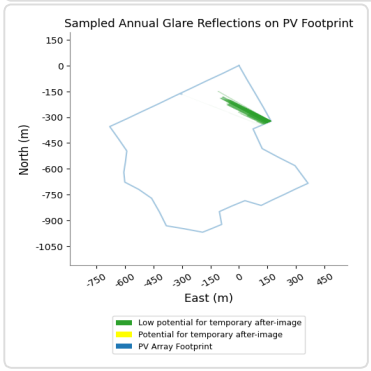
PV array is expected to produce the following glare for this receptor:

- 44 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.




## SAT 1P PV array 1: OP 15

*No glare found*

## SAT 1P PV array 1: OP 16

*No glare found*

## SAT 1P PV array 1: OP 17

*No glare found*

## SAT 1P PV array 1: OP 18

*No glare found*

## SAT 1P PV array 1: OP 19

*No glare found*

## SAT 1P PV array 1: OP 20

*No glare found*

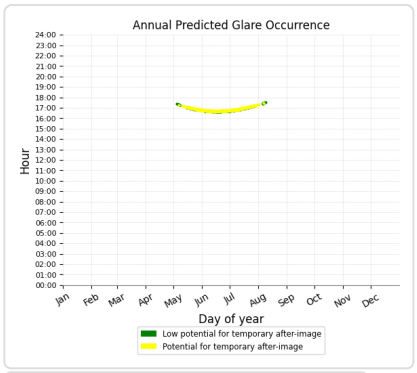
## SAT 1P PV array 1: OP 21

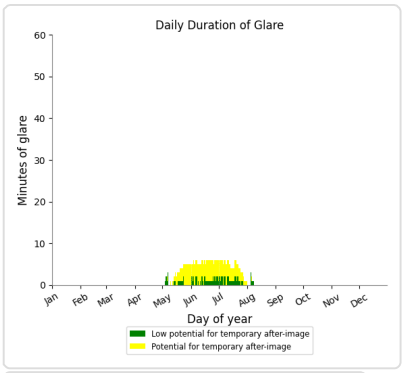
*No glare found*

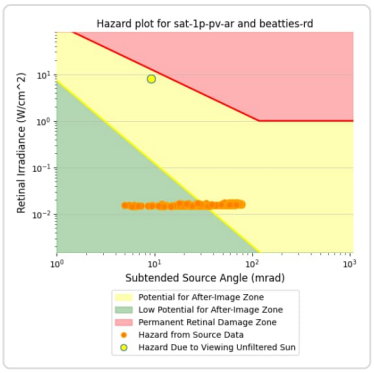
## SAT 1P PV array 1: Beatties Rd

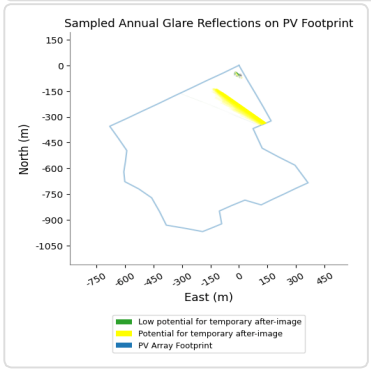
PV array is expected to produce the following glare for this receptor:

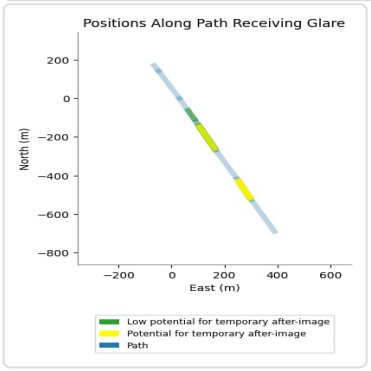
- 90 minutes of "green" glare with low potential to cause temporary after-image.
- 307 minutes of "yellow" glare with potential to cause temporary after-image.



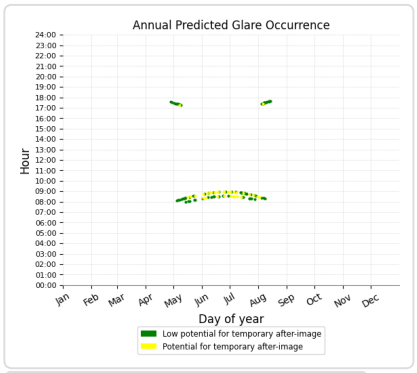

## SAT 1P PV array 1: Marshmans Rd

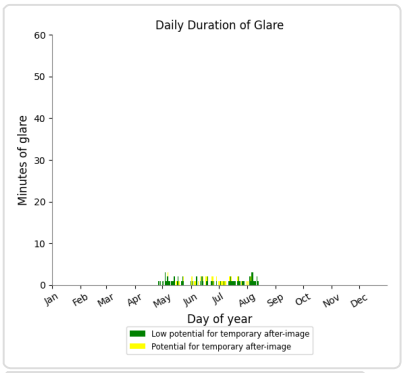
*No glare found*

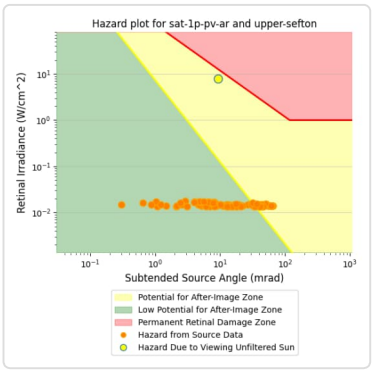
## SAT 1P PV array 1: Upper Sefton Rd

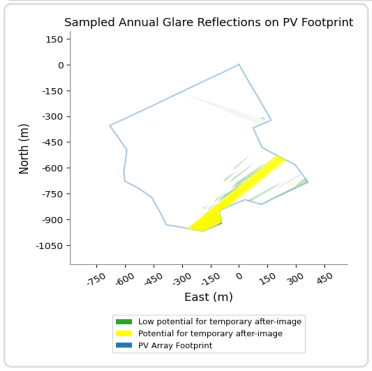
PV array is expected to produce the following glare for this receptor:

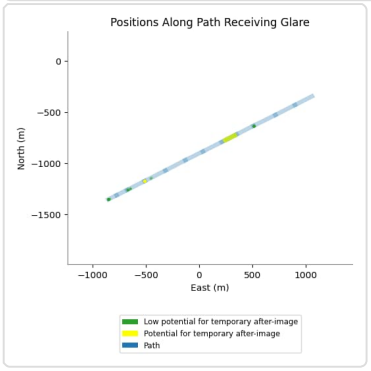
- 74 minutes of "green" glare with low potential to cause temporary after-image.
- 32 minutes of "yellow" glare with potential to cause temporary after-image.




## SAT 1P PV array 2 potential temporary after-image

Predicted energy output: 1,234,000.0 kWh (assuming sunny, clear skies)

| Component | Green glare (min) | Yellow glare (min) |
|---|---|---|
| OP: OP 1 | 0 | 0 |
| OP: OP 2 | 574 | 0 |
| OP: OP 3 | 0 | 0 |
| OP: OP 4 | 0 | 0 |
| OP: OP 5 | 0 | 0 |
| OP: OP 6 | 0 | 0 |
| OP: OP 7 | 0 | 0 |
| OP: OP 8 | 0 | 0 |
| OP: OP 9 | 0 | 0 |
| OP: OP 10 | 0 | 0 |
| OP: OP 11 | 0 | 0 |
| OP: OP 12 | 0 | 0 |
| OP: OP 13 | 0 | 0 |
| OP: OP 14 | 0 | 0 |
| OP: OP 15 | 0 | 0 |
| OP: OP 16 | 0 | 0 |
| OP: OP 17 | 0 | 0 |
| OP: OP 18 | 0 | 0 |
| OP: OP 19 | 0 | 0 |
| OP: OP 20 | 0 | 0 |
| OP: OP 21 | 418 | 19 |
| Route: Beatties Rd | 0 | 0 |
| Route: Marshmans Rd | 0 | 0 |
| Route: Upper Sefton Rd | 664 | 498 |

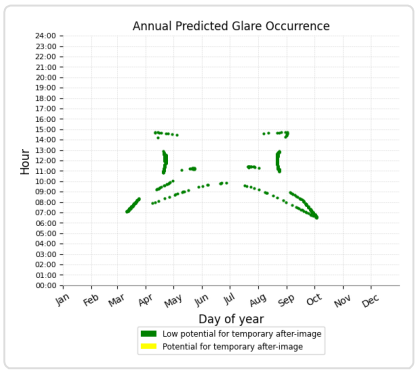
## SAT 1P PV array 2: OP 1

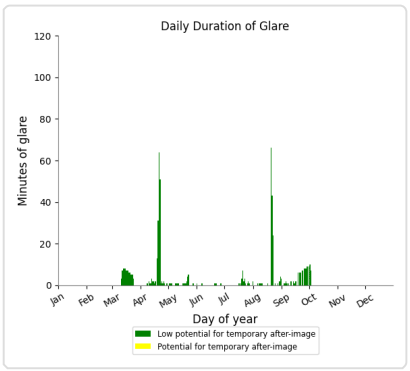
*No glare found*

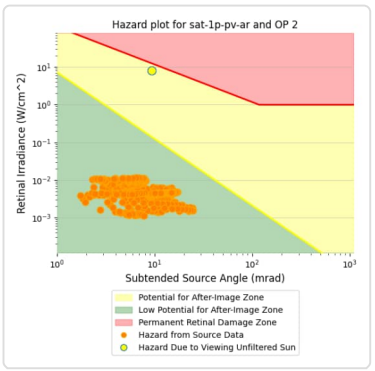
## SAT 1P PV array 2: OP 2

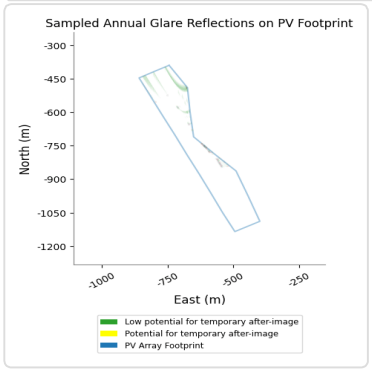
PV array is expected to produce the following glare for this receptor:

- 574 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.




## SAT 1P PV array 2: OP 3

*No glare found*

## SAT 1P PV array 2: OP 4

*No glare found*

## SAT 1P PV array 2: OP 5

*No glare found*

## SAT 1P PV array 2: OP 6

*No glare found*

## SAT 1P PV array 2: OP 7

*No glare found*

## SAT 1P PV array 2: OP 8

*No glare found*

## SAT 1P PV array 2: OP 9

*No glare found*

## SAT 1P PV array 2: OP 10

*No glare found*

### SAT 1P PV array 2: OP 11

*No glare found*

### SAT 1P PV array 2: OP 12

*No glare found*

### SAT 1P PV array 2: OP 13

*No glare found*

### SAT 1P PV array 2: OP 14

*No glare found*

### SAT 1P PV array 2: OP 15

*No glare found*

### SAT 1P PV array 2: OP 16

*No glare found*

### SAT 1P PV array 2: OP 17

*No glare found*

### SAT 1P PV array 2: OP 18

*No glare found*

### SAT 1P PV array 2: OP 19

*No glare found*

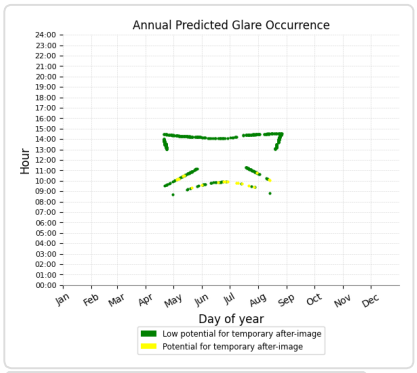
### SAT 1P PV array 2: OP 20

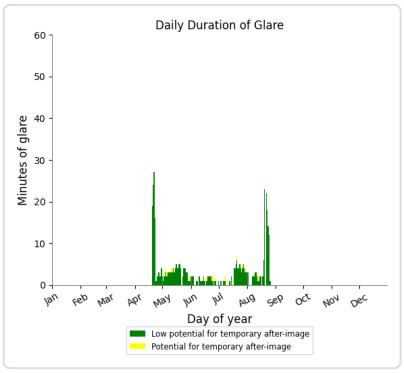
*No glare found*

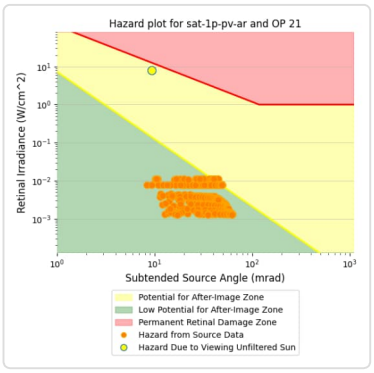
## SAT 1P PV array 2: OP 21

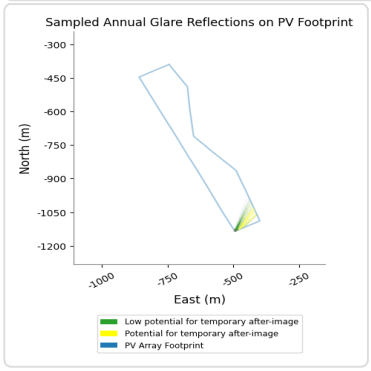
PV array is expected to produce the following glare for this receptor:

- 418 minutes of "green" glare with low potential to cause temporary after-image.
- 19 minutes of "yellow" glare with potential to cause temporary after-image.




## SAT 1P PV array 2: Beatties Rd

*No glare found*

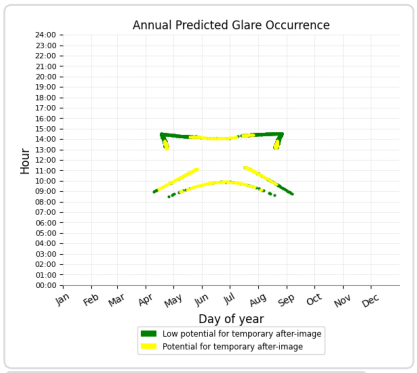
## SAT 1P PV array 2: Marshmans Rd

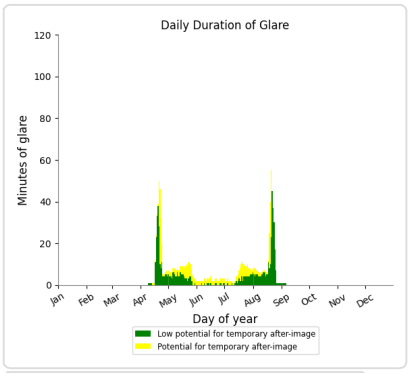
*No glare found*

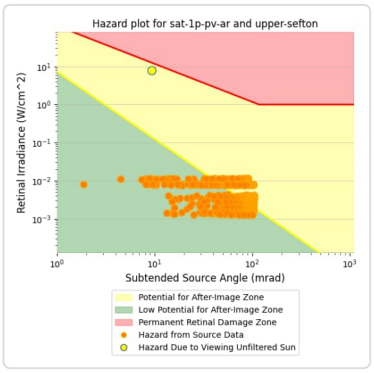
## SAT 1P PV array 2: Upper Sefton Rd

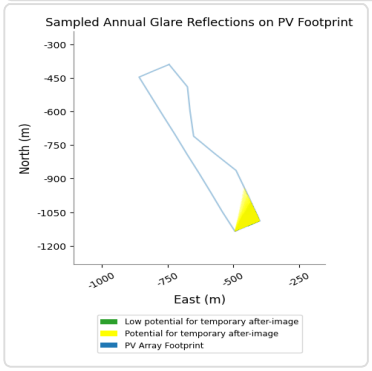
PV array is expected to produce the following glare for this receptor:

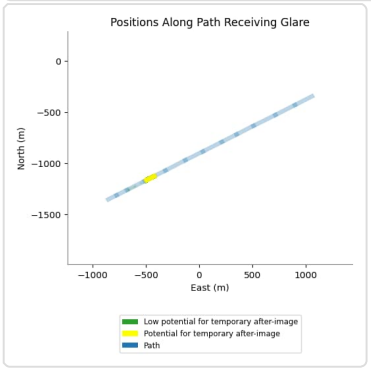
- 664 minutes of "green" glare with low potential to cause temporary after-image.
- 498 minutes of "yellow" glare with potential to cause temporary after-image.




# Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not automatically account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values and results may vary.
- The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorou modeling methods.
- Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
- The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
- Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
- Refer to the **Help page** for detailed assumptions and limitations not listed here.

ForgeSolar

# 2933 - Ashley

## SAT 2P - Shelterbelts 2m 21092023

**Client:** Solar Bay

**Created** Sep 20, 2023
**Updated** Sep 28, 2023
**Time-step** 1 minute
**Timezone offset** UTC12
**Minimum sun altitude** 0.0 deg
**Site ID** 101106.13897

**Project type** Advanced
**Project status:** active
**Category** 10 MW to 100 MW


### Misc. Analysis Settings

DNI: **varies (1,000.0 W/m^2 peak)**
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: **Version 2**
Enhanced subtended angle calculation: **On**

## Summary of Results Glare with potential for temporary after-image predicted

| PV Name | Tilt | Orientation | "Green" Glare | "Yellow" Glare | Energy Produced |
|---|---|---|---|---|---|
| | deg | deg | min | min | kWh |
| SAT 2P PV array 1 | SA tracking | SA tracking | 1,018 | 308 | - |
| SAT 2P PV array 2 | SA tracking | SA tracking | 1,835 | 0 | - |

## Component Data

## PV Array(s)

**Total PV footprint area:** 634,087 m^2

**Name**: SAT 2P PV array 1
**Footprint area**: 552,625 m^2
**Axis tracking**: Single-axis rotation
**Backtracking**: Shade-slope
**Tracking axis orientation**: 0.0 deg
**Maximum tracking angle**: 60.0 deg
**Resting angle**: 0.0 deg
**Ground Coverage Ratio**: 0.404

**Rated power**: -
**Panel material**: Smooth glass with AR coating
**Vary reflectivity with sun position?** Yes
**Correlate slope error with surface type?** Yes
**Slope error**: 8.43 mrad


| Vertex | Latitude | Longitude | Ground elevation | Height above ground | Total elevation |
|---|---|---|---|---|---|
| | deg | deg | m | m | m |
| 1 | -43.258957 | 172.620736 | 44.00 | 2.40 | 46.40 |
| 2 | -43.259366 | 172.619701 | 45.00 | 2.40 | 47.40 |
| 3 | -43.259759 | 172.618645 | 45.00 | 2.40 | 47.40 |
| 4 | -43.260159 | 172.617611 | 44.61 | 2.40 | 47.01 |
| 5 | -43.260560 | 172.616555 | 44.40 | 2.40 | 46.80 |
| 6 | -43.260961 | 172.615531 | 45.00 | 2.40 | 47.40 |
| 7 | -43.261362 | 172.614464 | 45.00 | 2.40 | 47.40 |
| 8 | -43.261763 | 172.613419 | 45.00 | 2.40 | 47.40 |
| 9 | -43.262148 | 172.612374 | 45.00 | 2.40 | 47.40 |
| 10 | -43.262785 | 172.612937 | 42.00 | 2.40 | 44.40 |
| 11 | -43.263421 | 172.613479 | 40.00 | 2.40 | 42.40 |
| 12 | -43.263972 | 172.613393 | 40.00 | 2.40 | 42.40 |
| 13 | -43.264539 | 172.613286 | 38.34 | 2.40 | 40.74 |
| 14 | -43.265050 | 172.613350 | 37.00 | 2.40 | 39.40 |
| 15 | -43.265432 | 172.614255 | 36.21 | 2.40 | 38.61 |
| 16 | -43.265895 | 172.615084 | 35.00 | 2.40 | 37.40 |
| 17 | -43.266612 | 172.615592 | 32.79 | 2.40 | 35.19 |
| 18 | -43.267329 | 172.616035 | 30.00 | 2.40 | 32.40 |
| 19 | -43.267489 | 172.617221 | 28.00 | 2.40 | 30.40 |
| 20 | -43.267665 | 172.618385 | 26.00 | 2.40 | 28.40 |
| 21 | -43.267462 | 172.619013 | 26.00 | 2.40 | 28.40 |
| 22 | -43.267259 | 172.619619 | 26.00 | 2.40 | 28.40 |
| 23 | -43.266587 | 172.619468 | 28.69 | 2.40 | 31.09 |
| 24 | -43.266294 | 172.620284 | 29.00 | 2.40 | 31.40 |
| 25 | -43.266017 | 172.621121 | 29.00 | 2.40 | 31.40 |
| 26 | -43.266267 | 172.622172 | 27.00 | 2.40 | 29.40 |
| 27 | -43.265970 | 172.622926 | 27.00 | 2.40 | 29.40 |
| 28 | -43.265689 | 172.623680 | 28.00 | 2.40 | 30.40 |
| 29 | -43.265400 | 172.624423 | 28.00 | 2.40 | 30.40 |
| 30 | -43.265110 | 172.625208 | 28.00 | 2.40 | 30.40 |
| 31 | -43.264188 | 172.624362 | 31.00 | 2.40 | 33.40 |
| 32 | -43.263751 | 172.623289 | 33.00 | 2.40 | 35.40 |
| 33 | -43.263297 | 172.622238 | 35.00 | 2.40 | 37.40 |
| 34 | -43.262269 | 172.621648 | 38.00 | 2.40 | 40.40 |
| 35 | -43.262069 | 172.622232 | 38.00 | 2.40 | 40.40 |
| 36 | -43.261870 | 172.622817 | 38.00 | 2.40 | 40.40 |
| 37 | -43.261142 | 172.622313 | 40.00 | 2.40 | 42.40 |
| 38 | -43.260414 | 172.621787 | 42.00 | 2.40 | 44.40 |
| 39 | -43.259701 | 172.621261 | 43.00 | 2.40 | 45.40 |

**Name**: SAT 2P PV array 2
**Footprint area**: 81,462 m^2
**Axis tracking**: Single-axis rotation
**Backtracking**: Shade-slope
**Tracking axis orientation**: 0.0 deg
**Maximum tracking angle**: 60.0 deg
**Resting angle**: 0.0 deg
**Ground Coverage Ratio**: 0.404

**Rated power**: -
**Panel material**: Smooth glass with AR coating
**Vary reflectivity with sun position?** Yes
**Correlate slope error with surface type?** Yes
**Slope error**: 8.43 mrad


| Vertex | Latitude | Longitude | Ground elevation | Height above ground | Total elevation |
|---|---|---|---|---|---|
| | deg | deg | m | m | m |
| 1 | -43.262470 | 172.611571 | 45.00 | 2.40 | 47.40 |
| 2 | -43.262723 | 172.610857 | 45.00 | 2.40 | 47.40 |
| 3 | -43.262977 | 172.610165 | 45.00 | 2.40 | 47.40 |
| 4 | -43.263752 | 172.610726 | 43.00 | 2.40 | 45.40 |
| 5 | -43.264526 | 172.611286 | 41.49 | 2.40 | 43.89 |
| 6 | -43.265285 | 172.611847 | 40.00 | 2.40 | 42.40 |
| 7 | -43.266075 | 172.612408 | 39.00 | 2.40 | 41.40 |
| 8 | -43.266850 | 172.612979 | 37.00 | 2.40 | 39.40 |
| 9 | -43.267624 | 172.613529 | 33.42 | 2.40 | 35.82 |
| 10 | -43.268398 | 172.614068 | 29.19 | 2.40 | 31.59 |
| 11 | -43.269173 | 172.614650 | 26.00 | 2.40 | 28.40 |
| 12 | -43.268966 | 172.615235 | 26.00 | 2.40 | 28.40 |
| 13 | -43.268759 | 172.615819 | 26.00 | 2.40 | 28.40 |
| 14 | -43.267743 | 172.615272 | 29.53 | 2.40 | 31.93 |
| 15 | -43.266727 | 172.614704 | 33.98 | 2.40 | 36.38 |
| 16 | -43.266048 | 172.613700 | 36.00 | 2.40 | 38.40 |
| 17 | -43.265352 | 172.612719 | 38.05 | 2.40 | 40.45 |
| 18 | -43.264360 | 172.612552 | 39.00 | 2.40 | 41.40 |
| 19 | -43.263368 | 172.612429 | 40.00 | 2.40 | 42.40 |

## Route Receptor(s)

**Name**: Beatties Rd
**Route type** Two-way
**View angle**: 50.0 deg


| Vertex | Latitude | Longitude | Ground elevation | Height above ground | Total elevation |
|---|---|---|---|---|---|
| | deg | deg | m | m | m |
| 1 | -43.265179 | 172.625535 | 28.00 | 1.80 | 29.80 |
| 2 | -43.263691 | 172.624451 | 32.00 | 1.80 | 33.80 |
| 3 | -43.262712 | 172.623788 | 35.00 | 1.80 | 36.80 |
| 4 | -43.261384 | 172.622801 | 39.00 | 1.80 | 40.80 |
| 5 | -43.260040 | 172.621878 | 43.00 | 1.80 | 44.80 |
| 6 | -43.258961 | 172.621110 | 44.00 | 1.80 | 45.80 |
| 7 | -43.257672 | 172.620133 | 45.00 | 1.80 | 46.80 |
| 8 | -43.257414 | 172.619930 | 46.00 | 1.80 | 47.80 |

**Name**: Marshmans Rd
**Route type** Two-way
**View angle**: 50.0 deg


| Vertex | Latitude | Longitude | Ground elevation | Height above ground | Total elevation |
|---|---|---|---|---|---|
| | deg | deg | m | m | m |
| 1 | -43.266119 | 172.603133 | 42.00 | 1.80 | 43.80 |
| 2 | -43.264067 | 172.604619 | 47.00 | 1.80 | 48.80 |
| 3 | -43.262145 | 172.606142 | 50.00 | 1.80 | 51.80 |
| 4 | -43.260958 | 172.607043 | 52.45 | 1.80 | 54.25 |
| 5 | -43.259458 | 172.608503 | 55.00 | 1.80 | 56.80 |
| 6 | -43.258395 | 172.609554 | 56.00 | 1.80 | 57.80 |
| 7 | -43.256598 | 172.611356 | 58.90 | 1.80 | 60.70 |
| 8 | -43.256160 | 172.611762 | 58.05 | 1.80 | 59.85 |

**Name**: Upper Sefton Rd
**Route type** Two-way
**View angle**: 50.0 deg


| Vertex | Latitude | Longitude | Ground elevation | Height above ground | Total elevation |
|---|---|---|---|---|---|
| | deg | deg | m | m | m |
| 1 | -43.271146 | 172.610237 | 27.00 | 1.80 | 28.80 |
| 2 | -43.270779 | 172.611197 | 25.00 | 1.80 | 26.80 |
| 3 | -43.270314 | 172.612409 | 25.78 | 1.80 | 27.58 |
| 4 | -43.269533 | 172.614437 | 25.44 | 1.80 | 27.24 |
| 5 | -43.268603 | 172.616840 | 25.00 | 1.80 | 26.80 |
| 6 | -43.267697 | 172.619136 | 25.00 | 1.80 | 26.80 |
| 7 | -43.266932 | 172.621175 | 26.00 | 1.80 | 27.80 |
| 8 | -43.266088 | 172.623363 | 27.00 | 1.80 | 28.80 |
| 9 | -43.265428 | 172.625069 | 28.00 | 1.80 | 29.80 |
| 10 | -43.264666 | 172.627033 | 28.00 | 1.80 | 29.80 |
| 11 | -43.263713 | 172.629565 | 28.00 | 1.80 | 29.80 |
| 12 | -43.262838 | 172.631818 | 26.38 | 1.80 | 28.18 |
| 13 | -43.262072 | 172.633792 | 24.35 | 1.80 | 26.15 |

## Discrete Observation Receptors

| Number | Latitude | Longitude | Ground elevation | Height above ground | Total Elevation |
|---|---|---|---|---|---|
| | deg | deg | m | m | m |
| OP 1 | -43.268484 | 172.612208 | 31.00 | 1.70 | 32.70 |
| OP 2 | -43.266681 | 172.612443 | 39.00 | 1.70 | 40.70 |
| OP 3 | -43.263330 | 172.603729 | 49.00 | 1.70 | 50.70 |
| OP 4 | -43.261518 | 172.603644 | 54.00 | 1.70 | 55.70 |
| OP 5 | -43.260127 | 172.603987 | 57.00 | 1.70 | 58.70 |
| OP 6 | -43.259721 | 172.606090 | 56.22 | 1.70 | 57.92 |
| OP 7 | -43.258846 | 172.607978 | 58.00 | 1.70 | 59.70 |
| OP 8 | -43.259440 | 172.609759 | 53.99 | 1.70 | 55.69 |
| OP 9 | -43.258814 | 172.610596 | 54.00 | 1.70 | 55.70 |
| OP 10 | -43.259752 | 172.616089 | 46.87 | 1.70 | 48.57 |
| OP 11 | -43.257809 | 172.621124 | 44.00 | 1.70 | 45.70 |
| OP 12 | -43.258637 | 172.620984 | 44.00 | 1.70 | 45.70 |
| OP 13 | -43.259540 | 172.621966 | 43.00 | 1.70 | 44.70 |
| OP 14 | -43.263540 | 172.626363 | 31.00 | 1.70 | 32.70 |
| OP 15 | -43.259653 | 172.621726 | 43.00 | 1.70 | 44.70 |
| OP 16 | -43.261388 | 172.622761 | 39.00 | 1.70 | 40.70 |
| OP 17 | -43.263825 | 172.624652 | 32.00 | 1.70 | 33.70 |
| OP 18 | -43.264786 | 172.625350 | 29.00 | 1.70 | 30.70 |
| OP 19 | -43.265302 | 172.625789 | 27.72 | 1.70 | 29.42 |
| OP 20 | -43.267800 | 172.619154 | 25.00 | 1.70 | 26.70 |
| OP 21 | -43.269435 | 172.614568 | 25.49 | 1.70 | 27.19 |

## Obstruction Components

**Name**: 2m Shelterbelt 1
**Upper edge height**: 2.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.262746 | 172.623675 | 35.00 |
| 2 | -43.263957 | 172.624539 | 31.33 |
| 3 | -43.264554 | 172.624965 | 30.00 |
| 4 | -43.265152 | 172.625402 | 28.00 |
| 5 | -43.265857 | 172.623646 | 27.14 |
| 6 | -43.266500 | 172.621932 | 27.00 |
| 7 | -43.267150 | 172.620207 | 26.00 |
| 8 | -43.267832 | 172.618461 | 25.24 |
| 9 | -43.268252 | 172.617428 | 25.00 |
| 10 | -43.268658 | 172.616414 | 25.00 |

**Name**: 2m Shelterbelt 2
**Upper edge height**: 2.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.261934 | 172.623039 | 37.00 |
| 2 | -43.261150 | 172.622489 | 40.00 |
| 3 | -43.260366 | 172.621918 | 42.00 |
| 4 | -43.259590 | 172.621368 | 43.00 |
| 5 | -43.258779 | 172.620802 | 44.00 |

**Name**: 2m Shelterbelt 3
**Upper edge height**: 2.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.262930 | 172.609931 | 45.00 |
| 2 | -43.262567 | 172.610870 | 45.00 |
| 3 | -43.262227 | 172.611800 | 45.00 |
| 4 | -43.261887 | 172.612720 | 45.00 |
| 5 | -43.261547 | 172.613619 | 45.00 |

**Name**: 2m Shelterbelt 4
**Upper edge height**: 2.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.261047 | 172.614853 | 45.00 |
| 2 | -43.260688 | 172.615791 | 45.00 |
| 3 | -43.260360 | 172.616709 | 45.00 |

**Name**: 2m Shelterbelt 5
**Upper edge height**: 2.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.262914 | 172.609943 | 45.00 |
| 2 | -43.263729 | 172.610531 | 43.00 |
| 3 | -43.264532 | 172.611109 | 42.00 |
| 4 | -43.265342 | 172.611687 | 40.05 |
| 5 | -43.266137 | 172.612265 | 39.29 |
| 6 | -43.266952 | 172.612833 | 37.00 |
| 7 | -43.267750 | 172.613421 | 33.00 |
| 8 | -43.268557 | 172.614010 | 29.00 |
| 9 | -43.269348 | 172.614577 | 26.00 |
| 10 | -43.268707 | 172.616294 | 25.00 |

**Name**: 2m Shelterbelt 6
**Upper edge height**: 2.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.261540 | 172.613603 | 45.00 |
| 2 | -43.261038 | 172.614858 | 45.00 |

**Name**: 2m Shelterbelt 7
**Upper edge height**: 2.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.260352 | 172.616693 | 45.00 |
| 2 | -43.259957 | 172.617733 | 45.00 |
| 3 | -43.259578 | 172.618758 | 45.00 |
| 4 | -43.259176 | 172.619772 | 45.00 |
| 5 | -43.258772 | 172.620834 | 44.00 |

**Name**: 2m Shelterbelt 8
**Upper edge height**: 2.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.261941 | 172.623037 | 37.00 |
| 2 | -43.262340 | 172.621953 | 37.21 |
| 3 | -43.263164 | 172.622516 | 35.00 |
| 4 | -43.262723 | 172.623664 | 35.00 |

# Summary of PV Glare Analysis

*PV configuration and total predicted glare*

| PV Name | Tilt | Orientation | "Green" Glare | "Yellow" Glare | Energy Produced | Data File |
|---|---|---|---|---|---|---|
| | deg | deg | min | min | kWh | |
| SAT 2P PV array 1 | SA tracking | SA tracking | 1,018 | 308 | - | - |
| SAT 2P PV array 2 | SA tracking | SA tracking | 1,835 | 0 | - | - |

## Distinct glare per month

Excludes overlapping glare from PV array for multiple receptors at matching time(s)

| PV | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| sat-2p-pv-ar (green) | 0 | 3 | 108 | 59 | 123 | 124 | 141 | 78 | 125 | 20 | 12 | 0 |
| sat-2p-pv-ar (yellow) | 0 | 0 | 0 | 0 | 76 | 116 | 108 | 8 | 0 | 0 | 0 | 0 |
| sat-2p-pv-ar (green) | 0 | 0 | 274 | 473 | 138 | 42 | 103 | 501 | 249 | 55 | 0 | 0 |
| sat-2p-pv-ar (yellow) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# PV & Receptor Analysis Results

*Results for each PV array and receptor*

## SAT 2P PV array 1 potential temporary after-image

| Component | Green glare (min) | Yellow glare (min) |
|---|---|---|
| OP: OP 1 | 0 | 0 |
| OP: OP 2 | 403 | 0 |
| OP: OP 3 | 0 | 0 |
| OP: OP 4 | 0 | 0 |
| OP: OP 5 | 16 | 0 |
| OP: OP 6 | 26 | 0 |
| OP: OP 7 | 62 | 0 |
| OP: OP 8 | 44 | 0 |
| OP: OP 9 | 47 | 0 |
| OP: OP 10 | 0 | 0 |
| OP: OP 11 | 0 | 0 |
| OP: OP 12 | 0 | 0 |
| OP: OP 13 | 125 | 0 |
| OP: OP 14 | 0 | 0 |
| OP: OP 15 | 73 | 0 |
| OP: OP 16 | 0 | 0 |
| OP: OP 17 | 0 | 0 |
| OP: OP 18 | 0 | 0 |
| OP: OP 19 | 0 | 0 |
| OP: OP 20 | 0 | 0 |
| OP: OP 21 | 0 | 0 |
| Route: Beatties Rd | 126 | 304 |
| Route: Marshmans Rd | 71 | 0 |
| Route: Upper Sefton Rd | 25 | 4 |

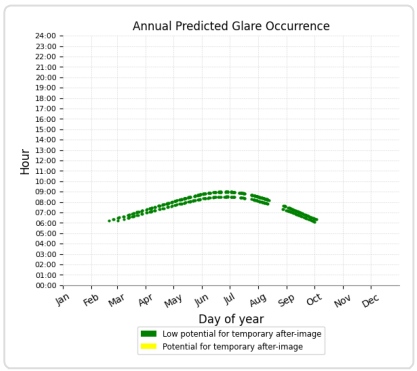
## SAT 2P PV array 1: OP 1

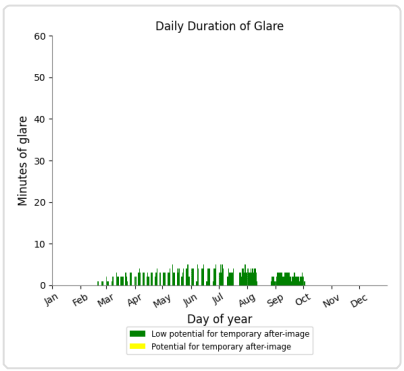
*No glare found*

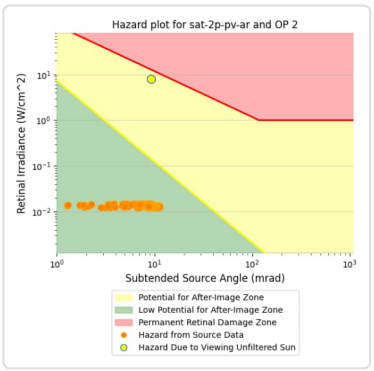
## SAT 2P PV array 1: OP 2

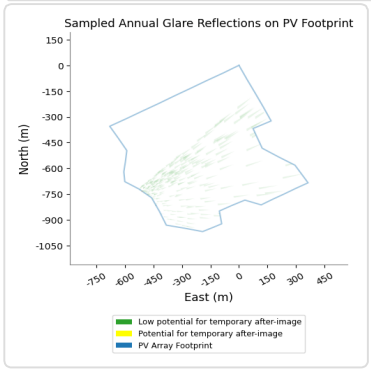
PV array is expected to produce the following glare for this receptor:

- 403 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.




## SAT 2P PV array 1: OP 3

*No glare found*

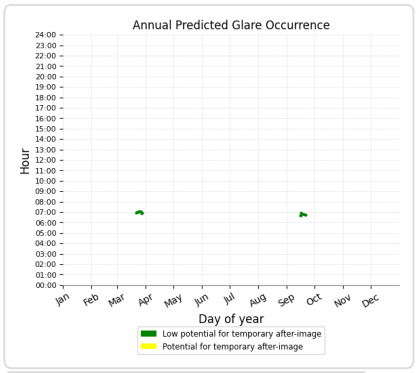
## SAT 2P PV array 1: OP 4

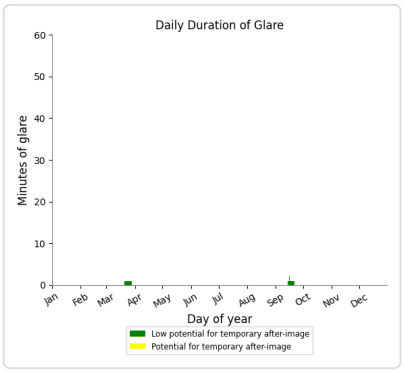
*No glare found*

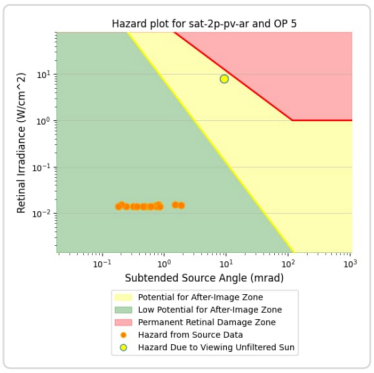
## SAT 2P PV array 1: OP 5

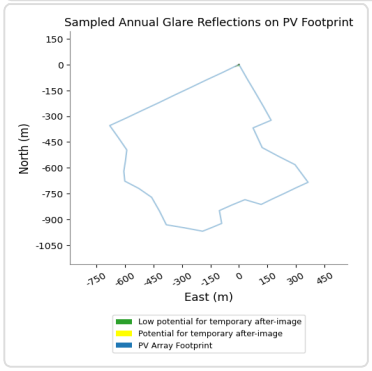
PV array is expected to produce the following glare for this receptor:

- 16 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.



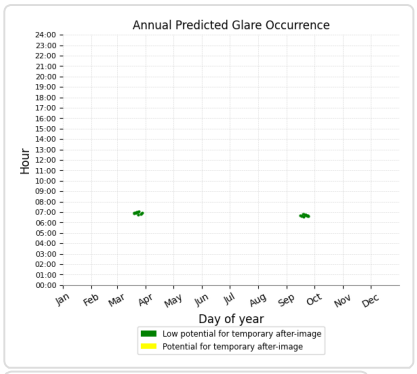



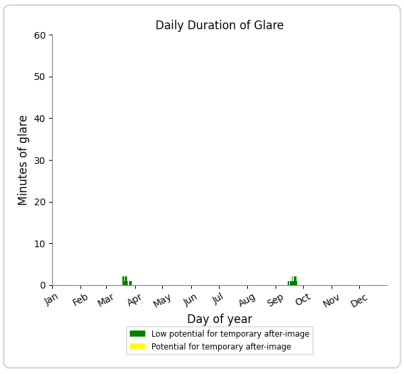



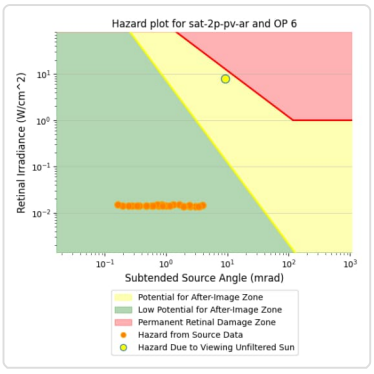

## SAT 2P PV array 1: OP 6

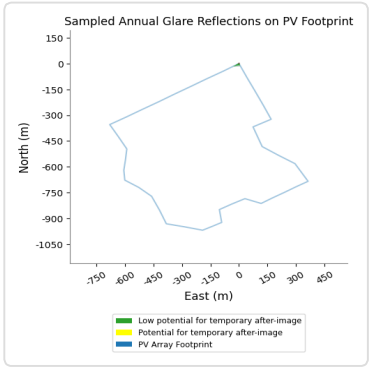
PV array is expected to produce the following glare for this receptor:

- 26 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.



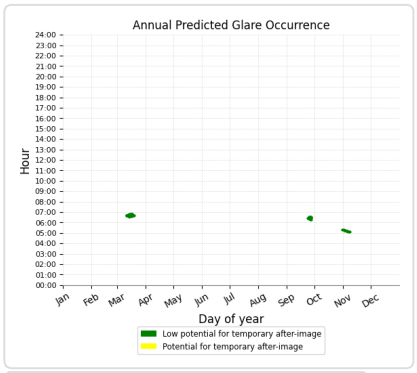



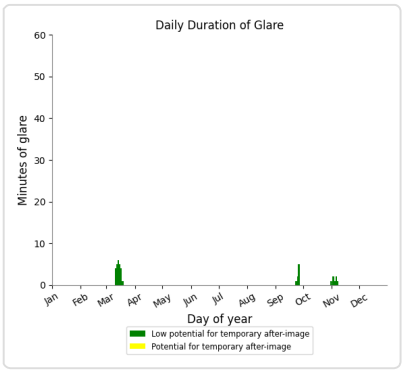



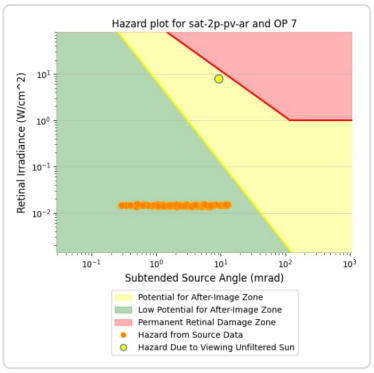
## SAT 2P PV array 1: OP 7

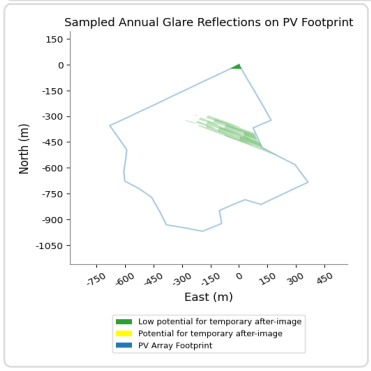
PV array is expected to produce the following glare for this receptor:

- 62 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.



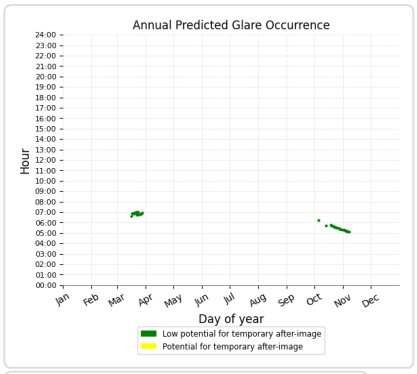



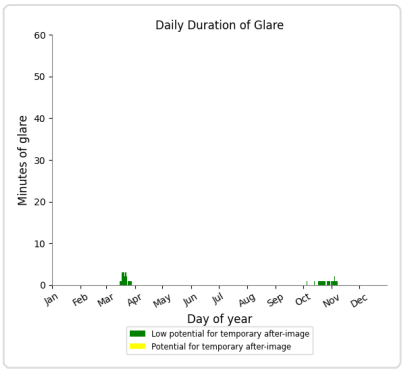



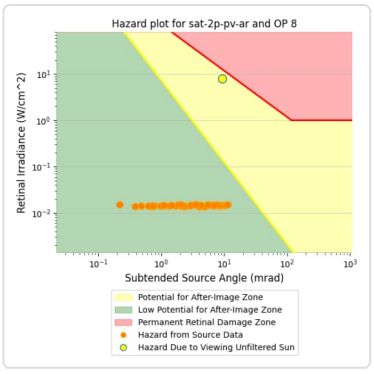

## SAT 2P PV array 1: OP 8

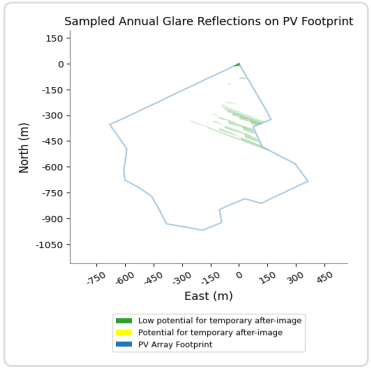
PV array is expected to produce the following glare for this receptor:

- 44 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.



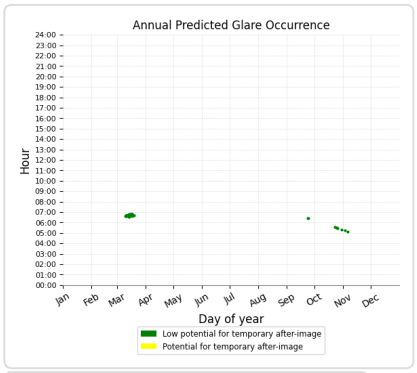



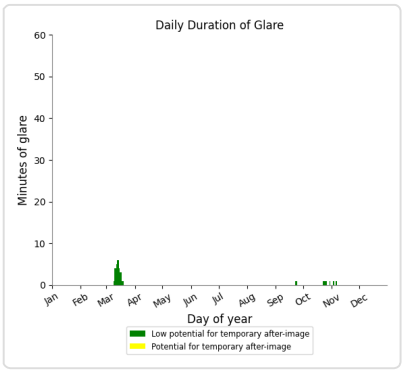



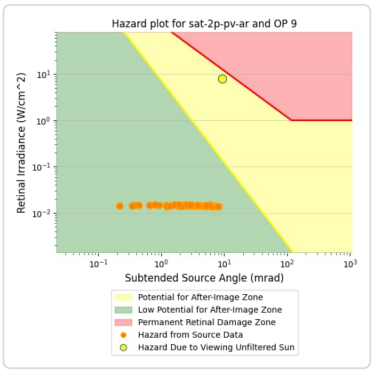
## SAT 2P PV array 1: OP 9

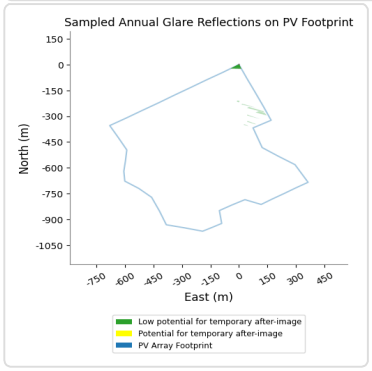
PV array is expected to produce the following glare for this receptor:

- 47 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.




## SAT 2P PV array 1: OP 10

*No glare found*

## SAT 2P PV array 1: OP 11

*No glare found*

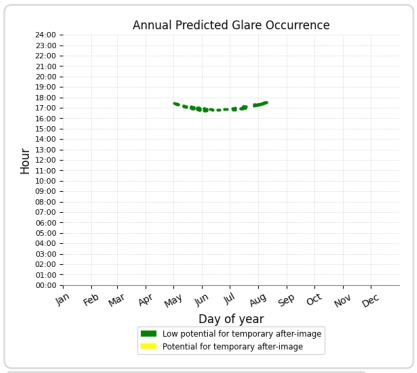
## SAT 2P PV array 1: OP 12

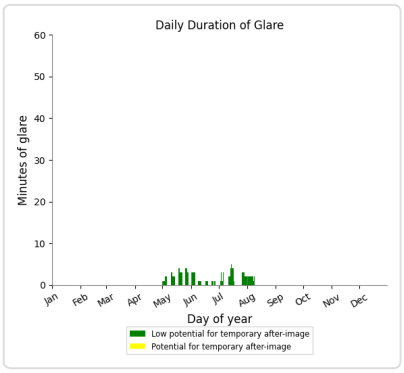
*No glare found*

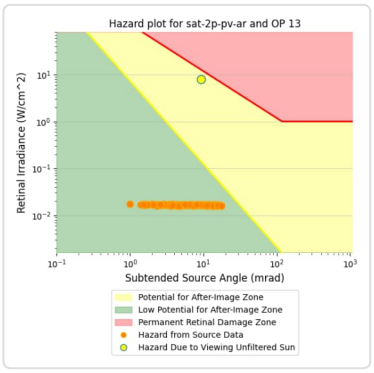
## SAT 2P PV array 1: OP 13

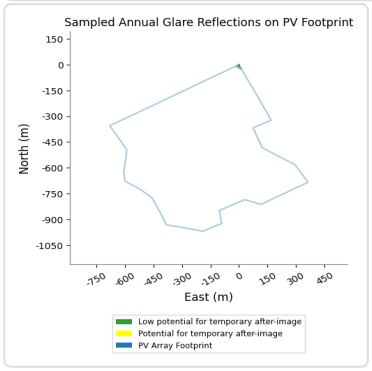
PV array is expected to produce the following glare for this receptor:

- 125 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.



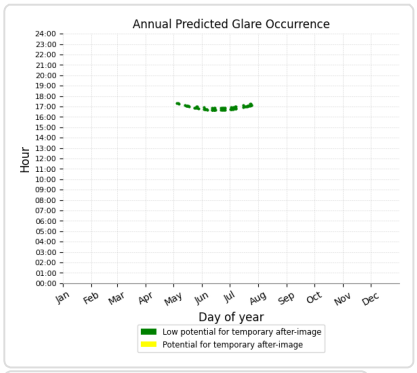

## SAT 2P PV array 1: OP 14

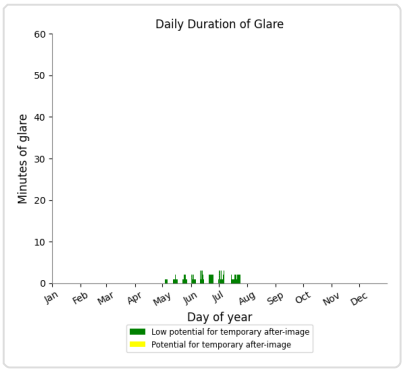
*No glare found*

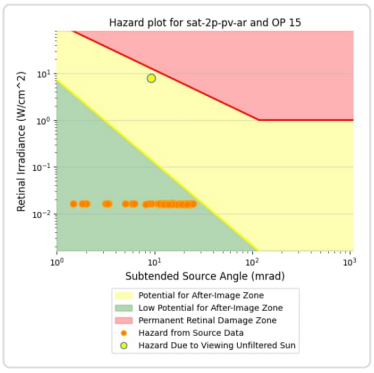
## SAT 2P PV array 1: OP 15

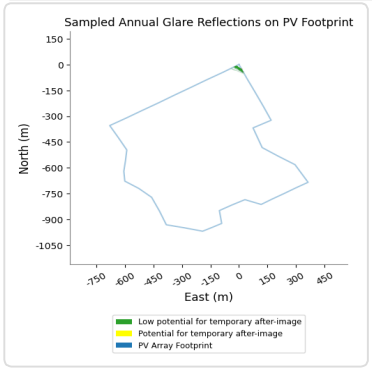
PV array is expected to produce the following glare for this receptor:

- 73 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.



## SAT 2P PV array 1: OP 16

*No glare found*

## SAT 2P PV array 1: OP 17

*No glare found*

## SAT 2P PV array 1: OP 18

*No glare found*

## SAT 2P PV array 1: OP 19

*No glare found*

## SAT 2P PV array 1: OP 20

*No glare found*

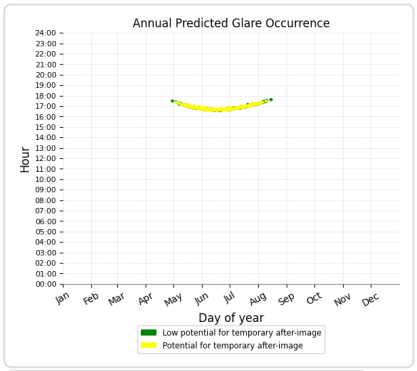
## SAT 2P PV array 1: OP 21

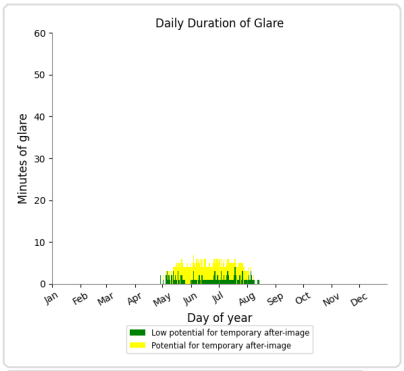
*No glare found*

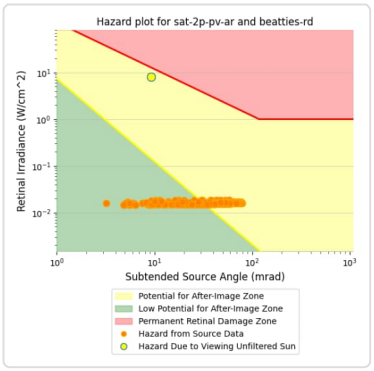
## SAT 2P PV array 1: Beatties Rd

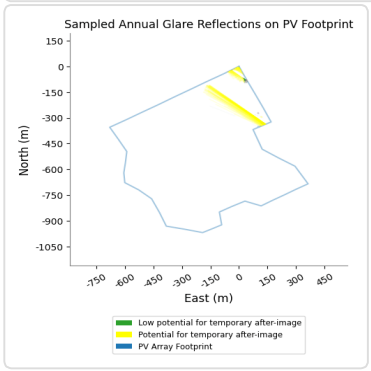
PV array is expected to produce the following glare for this receptor:

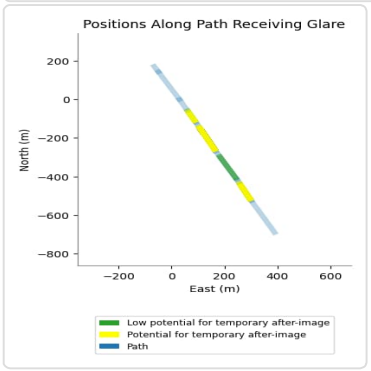
- 126 minutes of "green" glare with low potential to cause temporary after-image.
- 304 minutes of "yellow" glare with potential to cause temporary after-image.



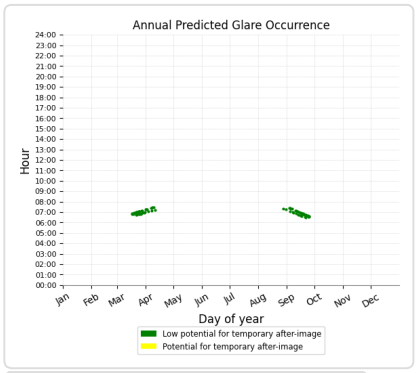



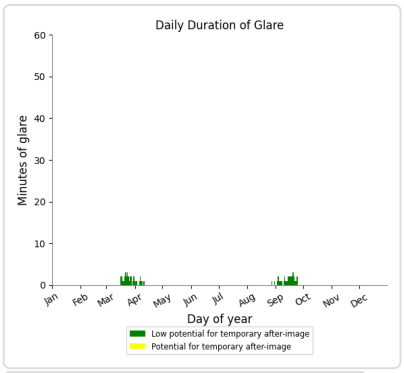



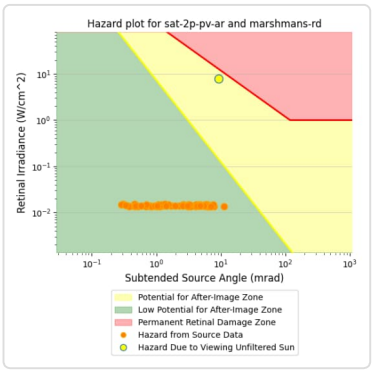
## SAT 2P PV array 1: Marshmans Rd

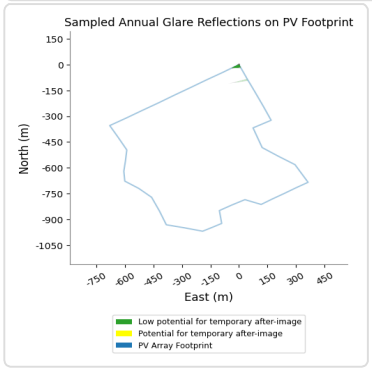
PV array is expected to produce the following glare for this receptor:

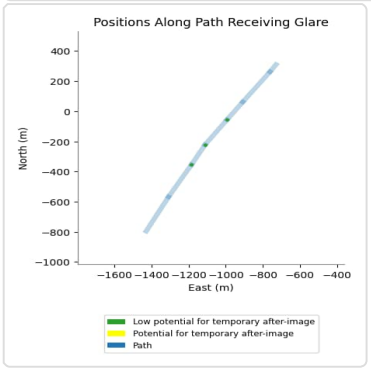
- 71 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.



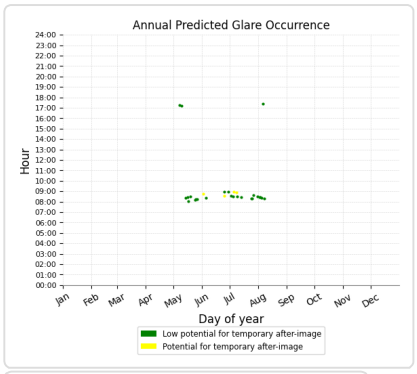



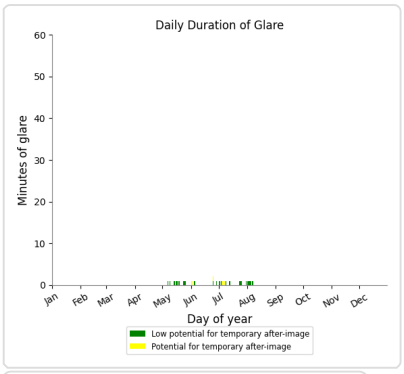



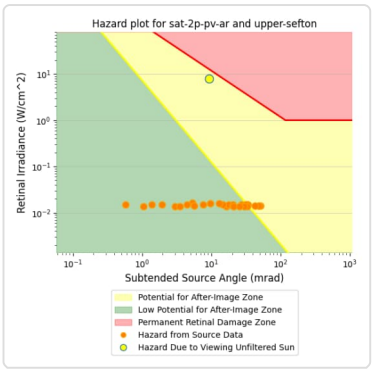

## SAT 2P PV array 1: Upper Sefton Rd

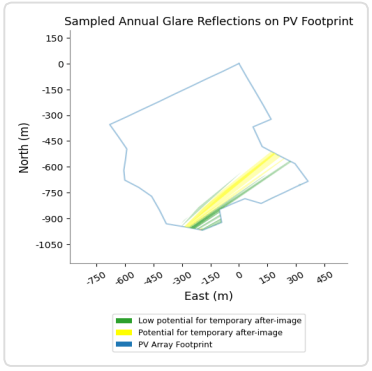
PV array is expected to produce the following glare for this receptor:

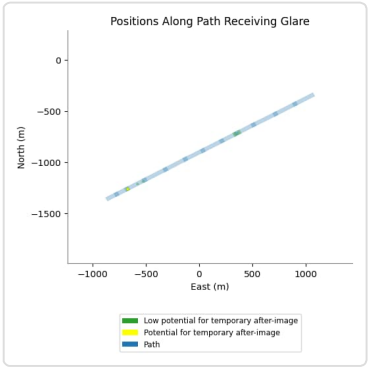
- 25 minutes of "green" glare with low potential to cause temporary after-image.
- 4 minutes of "yellow" glare with potential to cause temporary after-image.




## SAT 2P PV array 2 low potential for temporary after-image

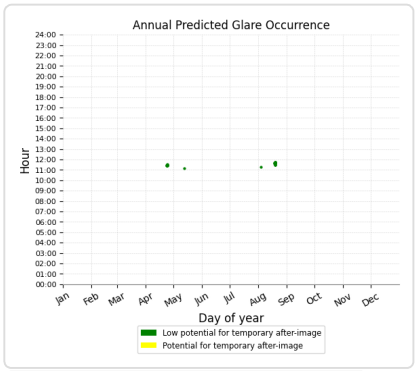
| Component | Green glare (min) | Yellow glare (min) |
|---|---|---|
| OP: OP 1 | 30 | 0 |
| OP: OP 2 | 1773 | 0 |

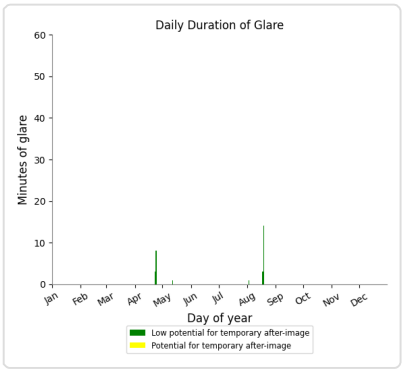
| | | |
|---|---|---|
| OP: OP 3 | 0 | 0 |
| OP: OP 4 | 0 | 0 |
| OP: OP 5 | 0 | 0 |
| OP: OP 6 | 0 | 0 |
| OP: OP 7 | 0 | 0 |
| OP: OP 8 | 0 | 0 |
| OP: OP 9 | 0 | 0 |
| OP: OP 10 | 0 | 0 |
| OP: OP 11 | 0 | 0 |
| OP: OP 12 | 0 | 0 |
| OP: OP 13 | 0 | 0 |
| OP: OP 14 | 0 | 0 |
| OP: OP 15 | 0 | 0 |
| OP: OP 16 | 0 | 0 |
| OP: OP 17 | 0 | 0 |
| OP: OP 18 | 0 | 0 |
| OP: OP 19 | 0 | 0 |
| OP: OP 20 | 0 | 0 |
| OP: OP 21 | 0 | 0 |
| Route: Beatties Rd | 0 | 0 |
| Route: Marshmans Rd | 0 | 0 |
| Route: Upper Sefton Rd | 32 | 0 |

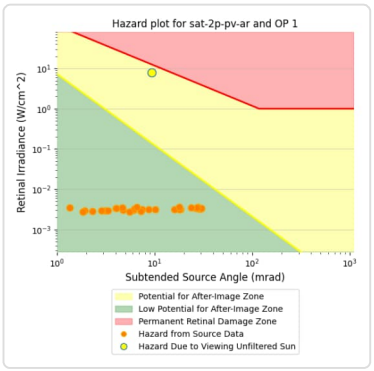
## SAT 2P PV array 2: OP 1

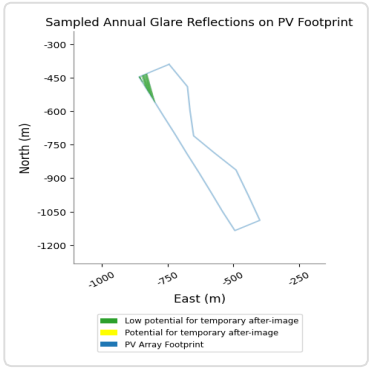
PV array is expected to produce the following glare for this receptor:

- 30 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.



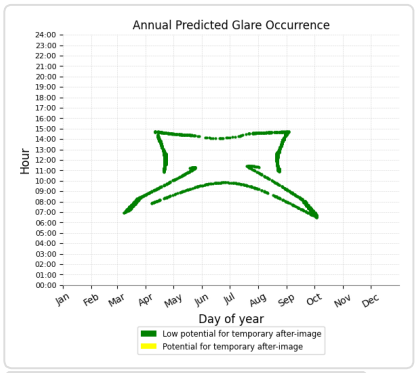



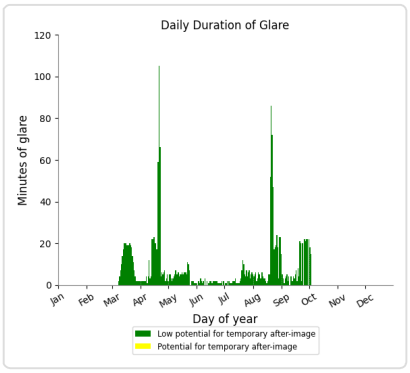



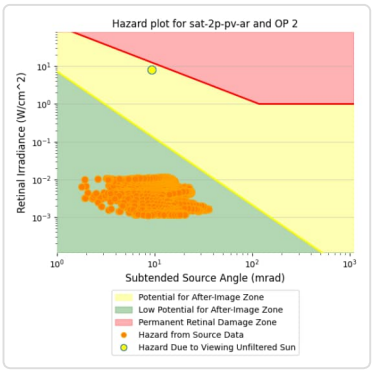
## SAT 2P PV array 2: OP 2

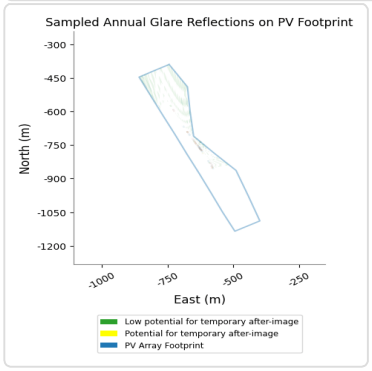
PV array is expected to produce the following glare for this receptor:

- 1,773 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.




## SAT 2P PV array 2: OP 3

*No glare found*

## SAT 2P PV array 2: OP 4

*No glare found*

## SAT 2P PV array 2: OP 5

*No glare found*

## SAT 2P PV array 2: OP 6

*No glare found*

## SAT 2P PV array 2: OP 7

*No glare found*

## SAT 2P PV array 2: OP 8

*No glare found*

## SAT 2P PV array 2: OP 9

*No glare found*

## SAT 2P PV array 2: OP 10

*No glare found*

## SAT 2P PV array 2: OP 11

*No glare found*

### SAT 2P PV array 2: OP 12
*No glare found*

### SAT 2P PV array 2: OP 13
*No glare found*

### SAT 2P PV array 2: OP 14
*No glare found*

### SAT 2P PV array 2: OP 15
*No glare found*

### SAT 2P PV array 2: OP 16
*No glare found*

### SAT 2P PV array 2: OP 17
*No glare found*

### SAT 2P PV array 2: OP 18
*No glare found*

### SAT 2P PV array 2: OP 19
*No glare found*

### SAT 2P PV array 2: OP 20
*No glare found*

### SAT 2P PV array 2: OP 21
*No glare found*

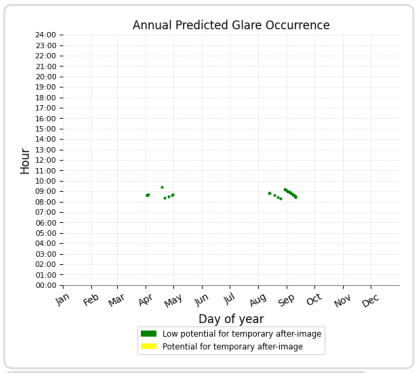
### SAT 2P PV array 2: Beatties Rd
*No glare found*

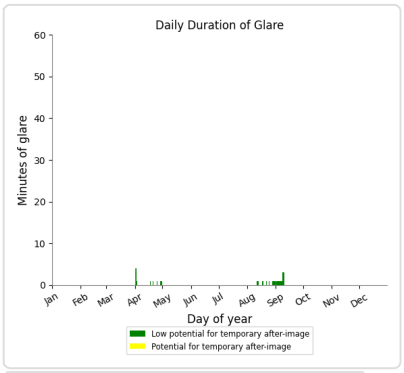
### SAT 2P PV array 2: Marshmans Rd
*No glare found*

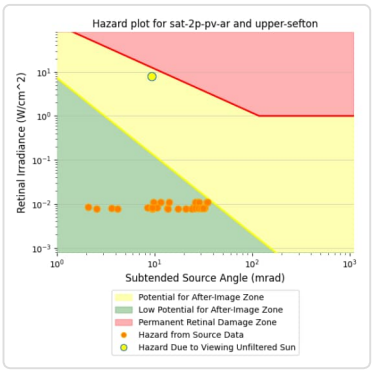
## SAT 2P PV array 2: Upper Sefton Rd

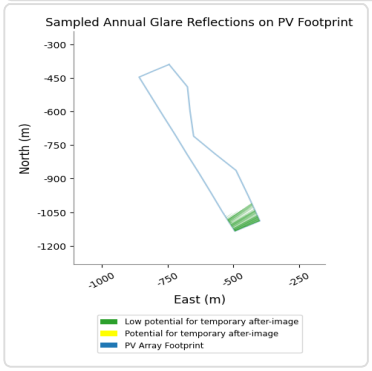
PV array is expected to produce the following glare for this receptor:

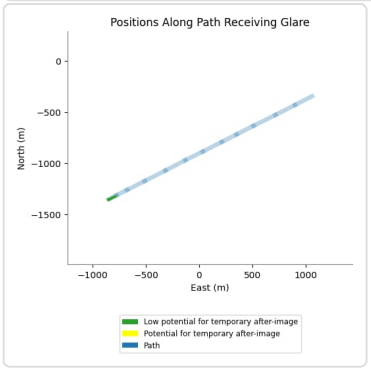
- 32 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.




# Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not automatically account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values and results may vary.
- The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorou modeling methods.
- Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
- The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
- Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
- Refer to the **Help page** for detailed assumptions and limitations not listed here.

# SOLAR BAY – ASHLEY
# Glint/Glare Assessment

## INLAND RTE 72, ASHLEY, CANTERBURY

Date of issue: 03/10/2023

## Document Version

| Version | Date | Revision Notes |
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## Document Contributors

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## Approval

| Contributor Type | Name | Position | Date |
|---|---|---|---|
| Document Author | Apoorva Menon | Engineer | 03/10/2023 |
| Technical Reviewer | Pranay Kar | Principal Engineer | 04/10/2023 |

## Related Documents

| Document Type | Document Title (Number & Title) |
|---|---|
| ForgeSolar Report | APPENDIX I – 4m FT G&G Report |
| ForgeSolar Report | APPENDIX II – 4m 1P SAT G&G Report |
| ForgeSolar Report | APPENDIX III – 4m 2P SAT G&G Report |

## Stakeholder Consultation

| Name | Position |
|---|---|
| | |
| | |

# 1. Executive Summary

Vector PowerSmart (**VPS**) was engaged by Solar Bay (**SB**) to prepare a Glint and Glare Assessment at Ashley, Canterbury.

Conclusions:

- Three ForgeSolar Glint and Glare reports were produced, for a fixed tilt, 1P single axis tracking, and a 2P single axis tracking array.
- The Fixed Tilt array is predicted to produce green glare on one of the OPs.
- The 1P Single Axis Tracking array is predicted to produce green glare on one of the OPs and green and yellow glare on two Route receptors.
- The 2P Single Axis Tracking array is predicted to produce green and yellow glare on one of the Route receptors.
- No red glint and/or glare is predicted in any of the scenarios.
- As yellow glare is predicted, additional consultation may be required to assess mitigation requirements.
- If a stow alarm occurs due to an isolated event such extreme weather or failure of equipment, the mounting system may stow into a manufacturer determined angle and orientation to protect the Single Axis Tracking array.

# 2. GlareGauge Glint and Glare Assessment Report

## 2.1. Glint and Glare from PV Modules

Light reflects off all surfaces with the potential of causing glint (a momentary flash of bright light) and glare (a continuous source of bright light) and can possibly occur when reflected of a surface. Both phenomena can cause a brief loss of vision and a potential for after imaging. After image is define as an impression of a vivid image retained by the eye after viewing of the light source has ceased. Glint is usually experienced from moving reflectors whereas glare may occur when the reflector is slow or stationary.

As PV modules are constructed from light-absorbing material to absorb as much solar irradiation as possible to increase their efficiency and often include an anti-reflective coating therefore reflectivity is low compared to many other common materials such as vegetation and equal to water. This can be seen in Figure 1 below:


*Figure 1: Chart indicating reflectivity of common surfaces. https://www.forgesolar.com/help/*

The position of the PV modules relative to the sun has the largest effect on the module's reflectivity. As shown in Figure 2 below, the larger the angle of incidence the higher the percentage of light is reflected.

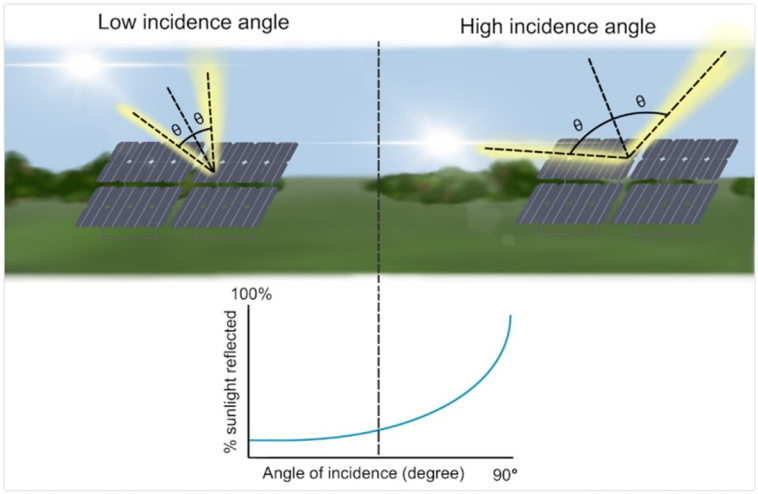



*Figure 2: Angle of incidence effect on PV module reflectivity. https://www.forgesolar.com/help/*

Single axis tracking systems tend to have a smaller angle of incidence as they follow the sun therefore reflecting less light than fixed-tilt systems that are stationary. As fixed-tilt systems are stationary the angle of incidence varies throughout the day (higher reflectivity generally occurs during sunrise and sunset) and will often reflect more light than single axis tracking systems.

## 2.2. GlareGauge Glint and Glare Assessment Tool

As it is possible for PV modules to create glint and glare, a comprehensive analysis was undertaken by Vector PowerSmart (VPS). There is currently no guidance from New Zealand's Civil Aviation Authority (CAA) or any other local organisations around assessment methods for glint and glare caused by solar farms however the American Federal Aviation Administration (FAA) previously recommended the Solar Glaze Hazard Analysis Tool (SGHAT). This tool has since been developed into GlareGauge by ForgeSolar.

The GlareGauge tool identifies possible glare from PV arrays and classifies them regarding their ocular impact. It should be noted that this software doesn't consider view shedding, (the blocking of the glare source from buildings, terrain, or vegetation, therefore representing a worst-case scenario unless stated otherwise).

The ocular impact of solar glare is quantified into three categories showing effect of after image:

- Green - low potential to cause after-image.
- Yellow - potential to cause temporary after-image.
- Red - potential to cause retinal burn.

If any glare occurs in the model, it is classified into the three colour-coded categories as seen in Figure 3 below:

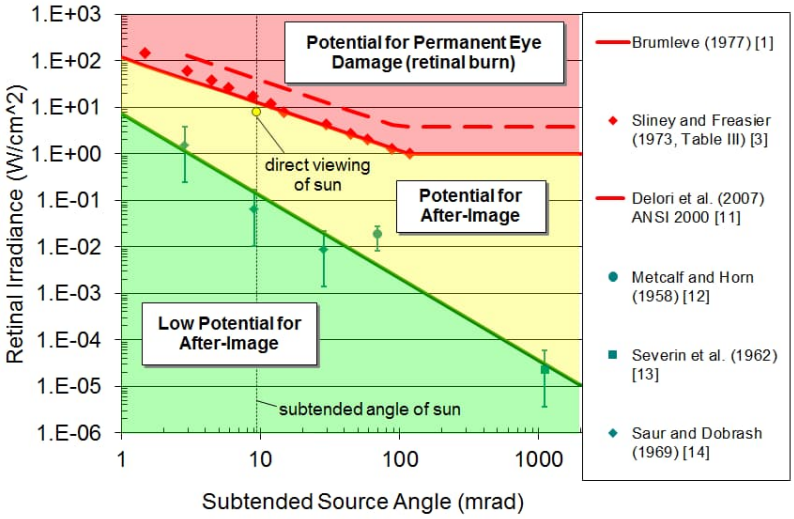



*Figure 3: Sample glare hazard plot showing after image potential. https://www.forgesolar.com/help/#ref-ho-2011-method.*

Essentially if the simulation predicts glare, the ocular impact of the glare is plotted onto the graph shown in Figure 3 to determine the category it belongs to.

The subtended source angle represents the size of the object producing glare (in this case the PV array) viewed by an observer, while the retinal irradiance determines the amount of energy impacting the retina of the observer. Larger source angles (closer to the array) can result in glare of high intensity, even if the retinal irradiance is low. The further away the observer is to the array, the smaller the subtended angle will be thus decreasing the glare intensity.

*It is important to note that the ForgeSolar GlareGauge simulation uses a "Clear Sky" model for the simulation which is the worst-case scenario i.e., does not include clouds or other atmospheric conditions which would reduce glint and glare.*

### 2.2.1. Impact Significant Definition

Table 1 below presents the recommended definition of 'impact significance' and the requirement for mitigation.

| Impact Significance | Definition | Mitigation Requirement |
|---|---|---|
| No Impact | The assessed receptor will not experience any solar reflection due to lack of visibility. | No mitigation is necessary. |
| Low/Green | The assessed receptor may have a small visual impact from solar reflection, but it is considered insignificant. | No mitigation is necessary. |
| Moderate/Yellow | The assessed receptor may experience solar reflection, which is visible and considered to have a moderate impact. | Further analysis and consultation should be conducted to determine if mitigation measures are required. |
| High/Red | The assessed receptor will experience a significant impact from solar reflection. | Mitigation measures and consultation are strongly recommended.<br>If the proposed development is to proceed it is highly likely mitigation will be necessary. |

*Table 1: Impact Significant Definition*

## 2.3. FAA Glare Requirements

In 2013 the FAA released the "Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports"[1] which endorsed and required a SGHAT tool (now GlareGauge) analysis of the ocular impact of a proposed solar energy system on federally obligated airport. The FAA adopted the Glare Hazard Plot shown in Figure 3, and required the following standards to be met:

3. No potential for any glare (i.e., No SGHAT "Green", "Yellow" or "Red" glare) in the existing or planned Airport Traffic Control Tower (ATCT) cab, and

4. Glare NOT to exceed ''low potential for after-image'' along the final approach path for any existing landing threshold or future landing thresholds (i.e., SGHAT "Green" glare is acceptable, SGHAT "Yellow" or "Red" glare are not acceptable).

To summarize, the FAA allows the construction of a PV array that may produce green glare that can impact the pilots or other airport personal unless there is an impact on the ATCT. The FAA will not allow a PV array that produces "potential for after-image" (shown in yellow in Figure 3).

As there is no guidance from the CAA or Waka Kotahi, it is assumed the FAA guidance applies to Glint and Glare analysis in New Zealand. Therefore, predicted green glare should not require mitigation whereas yellow glare potentially would.

*Note: the 2013 "Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports" was replaced in 2021 by the "Federal Aviation Administration Policy: Review of Solar Energy System Projects on Federally Obligated Airports"[2] which no longer recommends or requires a SGHAT tool (GlareGauge) analysis. Stating "The tool is no longer available to all users at no cost. There are several glint and glare analysis tools available to airport sponsors on the open market." Instead, the FAA requires the sponsor to confirm they have completed a glint and glare analysis and determined there is no impact on an ATCT.*

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

[2] Federal Aviation Administration Policy: Review of Solar Energy System Projects on Federally-Obligated Airports: https://www.federalregister.gov/documents/2021/05/11/2021-09862/federal-aviation-administration-policy-review-of-solar-energy-system-projects-on-federally-obligated

## 2.4. Sample Graph Cluster

Figure 4 below is a sample graph cluster, these graphs are the visual representation of the predicted glare effecting a receptor caused by the Solar Farm. Each OP will have a graph cluster for each array that produces glare:

*Note: Figure 4 only shows green glare. If red or yellow glare is present, it would also be represented on this example.*

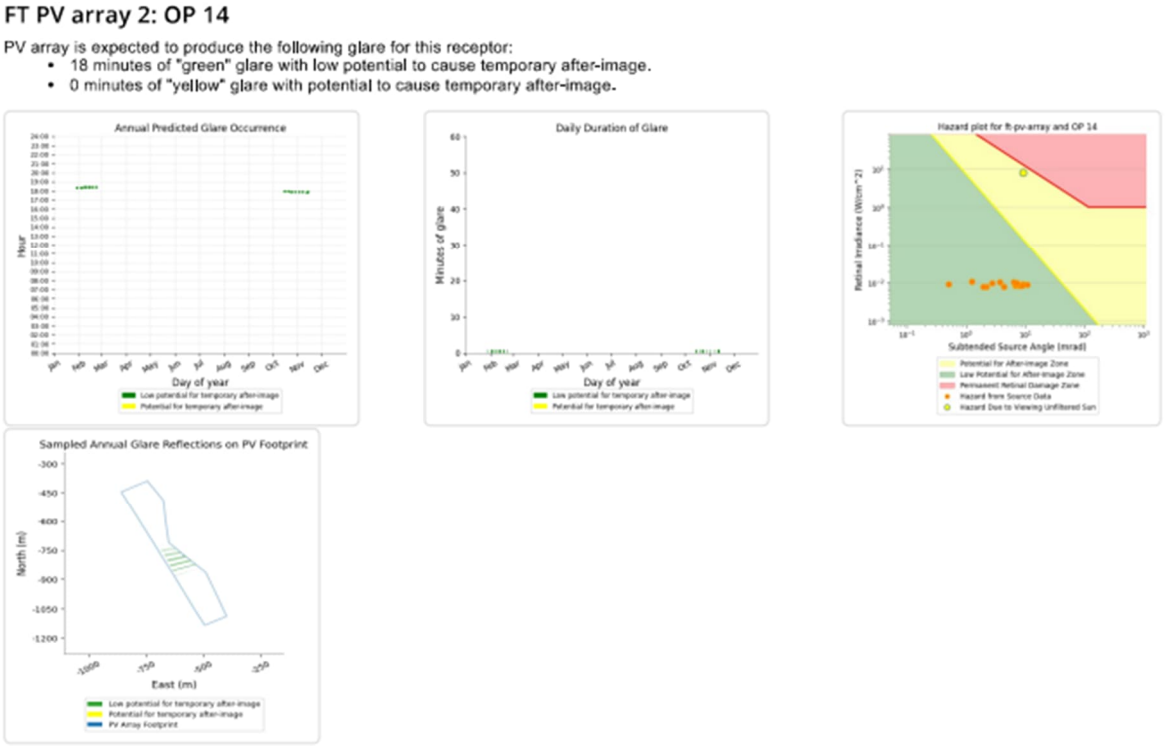



*Figure 4: Sample Graph Cluster*

**Annual Predicted Glare Occurrence:** This graph shows the time of day that glare occurs throughout the year. In this example, green glare is predicted between 4.30pm and 6pm during mid-November to late January.

**Daily Duration of Glare:** This graph shows the duration of predicted glare in minutes throughout the year of which the longest period is approximately 14 minutes.

**Hazard Plot for ft-pv-array and OP 5:** Utilizes the same graph shown in Figure 3. As shown on the hazard plot in Figure 4, the orange plot points represent the intensity of the glare by the zone the plot appears in. In this case the glare is predicted to be green. **Sampled Annual Glare Reflections on PV Footprint:** The blue outline shows the Solar Farm footprint. The area of the PV footprint that produces the received glare is represented by the colour spread across the footprint (either yellow or green glare). This example shows green glare is produced in an area on the upper section of the array.

**Positions Along Path Receiving Glare:** Here the route is shown with the areas where the glint and glare is received. The blue line shows no glare, whereas green and yellow will show where glare is received. In this case, green glare is received on the north-eastern section and yellow glare is shown near the centre of the road.

*Note: Route Receptors are analysed by tracing a path between each point along the route and aggregating the resulting glare in minutes.*

## 2.5. ForgeSolar Report

VPS used the ForgeSolar software tool to evaluate the potential for and duration of glare for receptors surrounding the proposed solar arrays. The receptors and obstructions were identified by the client.

The following ForgeSolar reports were generated:

- Appendix I, Fixed Tilt PV array with 4m high proposed shelterbelts
- Appendix II, 1P single axis tracking PV array with 4m high proposed shelterbelts.
- Appendix III, 2P single axis tracking PV array with 4m high proposed shelterbelts.

The obstructions and PV array footprint is the same in both reports, the only variables are the array type.

Figure 5 below shows the site configuration for all three reports consisting of:

- The PV arrays. (blue area footprint)
- Various Observation Points (OPs). (red markers)
- Shelterbelts. (orange lines)
- Route Receptors. (blue lines)


*Figure 5: Site Configuration of Ashley Solar Farm with Ops, route receptors and shelterbelts*

# 3. Reported Glare

Full results are available in attached Appendices I, II and III.

*Note: Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour. This software does not include viewshed analysis (therefore not accounting for terrain, buildings or vegetation blocking the glare source) thus representing a worst-case scenario.*

## 3.1. Fixed Tilt Array Results

### 3.1.1. FT PV Array 1

Refer to Appendix I for FT PV array 1 observations. No glare is reported for any of the receptors.

### 3.1.2. FT PV Array 2

Tables 2 report the predicted glare for FT PV array 2 based on the observations in Appendix I. Green glare is reported at just one of the OPs and no glare reported for any road receptors as shown.

| OP | Time (Hours) | Duration (Month of year) | Approx. Max. Minutes of Glare per day | Glare | | Total Minutes Annually |
|---|---|---|---|---|---|---|
| | | | | Green | Yellow | |
| OP1 | No Glare found | | | | | |
| OP2 | No Glare found | | | | | |
| OP3 | No Glare found | | | | | |
| OP4 | No Glare found | | | | | |
| OP5 | No Glare found | | | | | |
| OP6 | No Glare found | | | | | |
| OP7 | No Glare found | | | | | |
| OP8 | No Glare found | | | | | |
| OP9 | No Glare found | | | | | |
| OP10 | No Glare found | | | | | |
| OP11 | No Glare found | | | | | |
| OP12 | No Glare found | | | | | |
| OP13 | No Glare found | | | | | |
| OP14 | 6:00pm - 7:00pm | Late January to end of February | 2 | 18 | 0 | 18 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | and mid-October till mid-November | | | | |
| OP15 | No Glare found | | | | | |
| OP16 | No Glare found | | | | | |
| OP17 | No Glare found | | | | | |
| OP18 | No Glare found | | | | | |
| OP19 | No Glare found | | | | | |
| OP20 | No Glare found | | | | | |
| OP21 | No Glare found | | | | | |

*Table 2: Total annual glare predicted per OP caused by FT PV array 2.*

## 3.2. Single Axis Tracker Array Results

### 3.2.1. SAT 1P PV Array 1

Tables 3 and 4 report the predicted glare for SAT 1P PV array 1 based on the observations in Appendix II. Green and yellow glare is reported at several of the receptors as shown:

| OP | Time (Hours) | Duration (Month of year) | Approx. Max. Minutes of Glare per day | Glare | | Total Minutes Annually |
|---|---|---|---|---|---|---|
| | | | | Green | Yellow | |
| OP1 | No Glare found | | | | | |
| OP2 | No Glare found | | | | | |
| OP3 | No Glare found | | | | | |
| OP4 | No Glare found | | | | | |
| OP5 | No Glare found | | | | | |
| OP6 | No Glare found | | | | | |
| OP7 | No Glare found | | | | | |
| OP8 | No Glare found | | | | | |
| OP9 | No Glare found | | | | | |
| OP10 | No Glare found | | | | | |
| OP11 | No Glare found | | | | | |
| OP12 | No Glare found | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| OP13 | No Glare found | | | | | |
| OP14 | 4:30pm - 6:00pm | Through Mid-July and few in early August | 3 | 37 | 0 | 37 |
| OP15 | No Glare found | | | | | |
| OP16 | No Glare found | | | | | |
| OP17 | No Glare found | | | | | |
| OP18 | No Glare found | | | | | |
| OP19 | No Glare found | | | | | |
| OP20 | No Glare found | | | | | |
| OP21 | No Glare found | | | | | |

*Table 3: Total annual glare predicted per OP caused by SAT 1P PV array 1.*

| Road Receptors | Time (Hours) | Duration (Month of year) | Max. Minutes of Glare per day | Glare | | Total Minutes Annually |
|---|---|---|---|---|---|---|
| | | | | Green | Yellow | |
| Route: Beatties Rd | 4.30pm-5:30pm | Early May to Early August | 5 | 36 | 229 | 265 |
| Route: Marshmans Rd | No Glare found | | | | | |
| Route: Upper Sefton Rd | 5:00pm-6:00pm | Late April to early May and early August to mid-August | 2 | 19 | 0 | 19 |

*Table 4: Total annual glare predicted per road receptor caused by SAT 1P PV array 1*

### 3.2.2. SAT 1P PV Array 2

Refer to Appendix II for SAT 1P PV array 2 observations. No glare is reported for any of the receptors.

### 3.2.3. SAT 2P PV Array 1

Tables 5 report the predicted glare for SAT 2P PV array 1 based on the observations in Appendix III. Green and yellow glare is reported at just one of the road receptors and no glare reported for any OPs as shown.

| Road Receptors | Time (Hours) | Duration (Month of year) | Max. Minutes of Glare per day | Glare | | Total Minutes Annually |
|---|---|---|---|---|---|---|
| | | | | Green | Yellow | |
| Route: Beatties Rd | 4.30pm-5:30pm | Early May to Early August | 5 | 50 | 127 | 265 |
| Route: Marshmans Rd | No Glare found | | | | | |
| Route: Upper Sefton Rd | No Glare found | | | | | |

*Table 5: Total annual glare predicted per road receptor caused by SAT 2P PV array 1*

### 3.2.4. SAT 2P PV Array 2

Refer to Appendix III for SAT 2P PV array 2 observations. No glare is reported for any of the receptors.

## 3.3. Stow Alarm

At times during situations such as isolated extreme weather events or failure of certain equipment a stow alarm will cause the Single Axis Tracking mounting system to stow at a predetermined orientation and angle (often 0°) to protect the array. Due to such an event, there may be additional glare produced outside of the ForgeSolar predictions.

Typically, high wind >= 55km/hour events are predominant with clouds/storms rather than cloudless, with isolated events where high wind prevail in a cloudless scenario, the actual glare at the receptors should be less than the simulation suggests.

Stow alarm conditions are determined by the mounting system manufacturer.

# 4. Conclusions and Observations

To conclude, the 1P single axis tracking array and 2P single axis tracking array is predicted to produce green and yellow glare on some OPs and route receptors whereas Fixed Tilt array is predicted to produce only green glare on one of the OPs.

No red glare was predicted in any of the scenarios.

Due to the absence of New Zealand guidance documentation (CAA or Waka Kotahi) or prior examples of acceptance criteria relating to glint and glare, the American FAA guidelines have been applied. Based on those guidelines, no mitigation is required based on the absence of yellow or red glare.

If a stow alarm occurs due to an isolated event such extreme weather or failure of equipment, the Single Axis Tracking mounting system may stow into a manufacturer determined angle and orientation to protect the array. This rare event could produce unforeseen glint or glare depending on stow angle and orientation.

Simulation uses “Clear Sky” weather data where glint and glare are not reduced due to atmospheric conditions or clouds obstructing the sun, essentially providing a worst-case scenario.

# 5. Appendices

APPENDIX I – 4m FT G&G Report

APPENDIX II – 4m 1P SAT G&G Report

APPENDIX III – 4m 2P SAT G&G Report

ForgeSolar

# 2933 - Ashley

## FT Shelterbelts 4m 21092023

**Client:** Solar Bay

**Created** Sep 21, 2023
**Updated** Sep 29, 2023
**Time-step** 1 minute
**Timezone offset** UTC12
**Minimum sun altitude** 0.0 deg
**Site ID** 101109.13897

**Project type** Advanced
**Project status:** active
**Category** 10 MW to 100 MW


### Misc. Analysis Settings

DNI: **varies (1,000.0 W/m^2 peak)**
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: **Version 2**
Enhanced subtended angle calculation: **On**

## Summary of Results Glare with low potential for temporary after-image predicted

| PV Name | Tilt | Orientation | "Green" Glare | "Yellow" Glare | Energy Produced |
|---|---|---|---|---|---|
| | deg | deg | min | min | kWh |
| FT PV array 1 | 25.0 | 0.0 | 0 | 0 | - |
| FT PV array 2 | 25.0 | 0.0 | 18 | 0 | - |

## Component Data

## PV Array(s)

**Total PV footprint area:** 634,085 m^2

**Name**: FT PV array 1
**Footprint area**: 552,626 m^2
**Axis tracking**: Fixed (no rotation)
**Tilt**: 25.0 deg
**Orientation**: 0.0 deg

**Rated power**: -
**Panel material**: Smooth glass with AR coating
**Vary reflectivity with sun position?** Yes
**Correlate slope error with surface type?** Yes
**Slope error**: 8.43 mrad


| Vertex | Latitude | Longitude | Ground elevation | Height above ground | Total elevation |
|---|---|---|---|---|---|
| | deg | deg | m | m | m |
| 1 | -43.258957 | 172.620736 | 44.00 | 1.80 | 45.80 |
| 2 | -43.259366 | 172.619701 | 45.00 | 1.80 | 46.80 |
| 3 | -43.259759 | 172.618645 | 45.00 | 1.80 | 46.80 |
| 4 | -43.260159 | 172.617611 | 44.61 | 1.80 | 46.41 |
| 5 | -43.260560 | 172.616555 | 44.40 | 1.80 | 46.20 |
| 6 | -43.260961 | 172.615531 | 45.00 | 1.80 | 46.80 |
| 7 | -43.261362 | 172.614464 | 45.00 | 1.80 | 46.80 |
| 8 | -43.261763 | 172.613419 | 45.00 | 1.80 | 46.80 |
| 9 | -43.262148 | 172.612374 | 45.00 | 1.80 | 46.80 |
| 10 | -43.262785 | 172.612937 | 42.00 | 1.80 | 43.80 |
| 11 | -43.263421 | 172.613479 | 40.00 | 1.80 | 41.80 |
| 12 | -43.263972 | 172.613393 | 40.00 | 1.80 | 41.80 |
| 13 | -43.264539 | 172.613286 | 38.34 | 1.80 | 40.14 |
| 14 | -43.265050 | 172.613350 | 37.00 | 1.80 | 38.80 |
| 15 | -43.265432 | 172.614255 | 36.21 | 1.80 | 38.01 |
| 16 | -43.265895 | 172.615084 | 35.00 | 1.80 | 36.80 |
| 17 | -43.266612 | 172.615592 | 32.79 | 1.80 | 34.59 |
| 18 | -43.267329 | 172.616035 | 30.00 | 1.80 | 31.80 |
| 19 | -43.267489 | 172.617221 | 28.00 | 1.80 | 29.80 |
| 20 | -43.267665 | 172.618385 | 26.00 | 1.80 | 27.80 |
| 21 | -43.267462 | 172.619013 | 26.00 | 1.80 | 27.80 |
| 22 | -43.267259 | 172.619619 | 26.00 | 1.80 | 27.80 |
| 23 | -43.266587 | 172.619468 | 28.69 | 1.80 | 30.49 |
| 24 | -43.266294 | 172.620284 | 29.00 | 1.80 | 30.80 |
| 25 | -43.266017 | 172.621121 | 29.00 | 1.80 | 30.80 |
| 26 | -43.266267 | 172.622172 | 27.00 | 1.80 | 28.80 |
| 27 | -43.265970 | 172.622926 | 27.00 | 1.80 | 28.80 |
| 28 | -43.265689 | 172.623680 | 28.00 | 1.80 | 29.80 |
| 29 | -43.265400 | 172.624423 | 28.00 | 1.80 | 29.80 |
| 30 | -43.265110 | 172.625208 | 28.00 | 1.80 | 29.80 |
| 31 | -43.264188 | 172.624362 | 31.00 | 1.80 | 32.80 |
| 32 | -43.263751 | 172.623289 | 33.00 | 1.80 | 34.80 |
| 33 | -43.263297 | 172.622238 | 35.00 | 1.80 | 36.80 |
| 34 | -43.262269 | 172.621648 | 38.00 | 1.80 | 39.80 |
| 35 | -43.262069 | 172.622232 | 38.00 | 1.80 | 39.80 |
| 36 | -43.261870 | 172.622817 | 38.00 | 1.80 | 39.80 |
| 37 | -43.261142 | 172.622313 | 40.00 | 1.80 | 41.80 |
| 38 | -43.260414 | 172.621787 | 42.00 | 1.80 | 43.80 |
| 39 | -43.259701 | 172.621261 | 43.00 | 1.80 | 44.80 |

**Name**: FT PV array 2
**Footprint area**: 81,460 m^2
**Axis tracking**: Fixed (no rotation)
**Tilt**: 25.0 deg
**Orientation**: 0.0 deg

**Rated power**: -
**Panel material**: Smooth glass with AR coating
**Vary reflectivity with sun position?** Yes
**Correlate slope error with surface type?** Yes
**Slope error**: 8.43 mrad


| Vertex | Latitude | Longitude | Ground elevation | Height above ground | Total elevation |
|---|---|---|---|---|---|
| | deg | deg | m | m | m |
| 1 | -43.262470 | 172.611571 | 45.00 | 1.80 | 46.80 |
| 2 | -43.262723 | 172.610857 | 45.00 | 1.80 | 46.80 |
| 3 | -43.262977 | 172.610165 | 45.00 | 1.80 | 46.80 |
| 4 | -43.263752 | 172.610726 | 43.00 | 1.80 | 44.80 |
| 5 | -43.264526 | 172.611286 | 41.49 | 1.80 | 43.29 |
| 6 | -43.265285 | 172.611847 | 40.00 | 1.80 | 41.80 |
| 7 | -43.266075 | 172.612408 | 39.00 | 1.80 | 40.80 |
| 8 | -43.266850 | 172.612979 | 37.00 | 1.80 | 38.80 |
| 9 | -43.267624 | 172.613529 | 33.42 | 1.80 | 35.22 |
| 10 | -43.268398 | 172.614068 | 29.19 | 1.80 | 30.99 |
| 11 | -43.269173 | 172.614650 | 26.00 | 1.80 | 27.80 |
| 12 | -43.268966 | 172.615235 | 26.00 | 1.80 | 27.80 |
| 13 | -43.268759 | 172.615819 | 26.00 | 1.80 | 27.80 |
| 14 | -43.267743 | 172.615272 | 29.53 | 1.80 | 31.33 |
| 15 | -43.266727 | 172.614704 | 33.98 | 1.80 | 35.78 |
| 16 | -43.266048 | 172.613700 | 36.00 | 1.80 | 37.80 |
| 17 | -43.265352 | 172.612719 | 38.05 | 1.80 | 39.85 |
| 18 | -43.264360 | 172.612552 | 39.00 | 1.80 | 40.80 |
| 19 | -43.263368 | 172.612429 | 40.00 | 1.80 | 41.80 |

## Route Receptor(s)

**Name**: Beatties Rd
**Route type** Two-way
**View angle**: 50.0 deg


| Vertex | Latitude | Longitude | Ground elevation | Height above ground | Total elevation |
|---|---|---|---|---|---|
| | deg | deg | m | m | m |
| 1 | -43.265179 | 172.625535 | 28.00 | 1.80 | 29.80 |
| 2 | -43.263691 | 172.624451 | 32.00 | 1.80 | 33.80 |
| 3 | -43.262712 | 172.623788 | 35.00 | 1.80 | 36.80 |
| 4 | -43.261384 | 172.622801 | 39.00 | 1.80 | 40.80 |
| 5 | -43.260040 | 172.621878 | 43.00 | 1.80 | 44.80 |
| 6 | -43.258961 | 172.621110 | 44.00 | 1.80 | 45.80 |
| 7 | -43.257672 | 172.620133 | 45.00 | 1.80 | 46.80 |
| 8 | -43.257414 | 172.619930 | 46.00 | 1.80 | 47.80 |

**Name**: Marshmans Rd
**Route type** Two-way
**View angle**: 50.0 deg


| Vertex | Latitude | Longitude | Ground elevation | Height above ground | Total elevation |
|---|---|---|---|---|---|
| | deg | deg | m | m | m |
| 1 | -43.266119 | 172.603133 | 42.00 | 1.80 | 43.80 |
| 2 | -43.264067 | 172.604619 | 47.00 | 1.80 | 48.80 |
| 3 | -43.262145 | 172.606142 | 50.00 | 1.80 | 51.80 |
| 4 | -43.260958 | 172.607043 | 52.45 | 1.80 | 54.25 |
| 5 | -43.259458 | 172.608503 | 55.00 | 1.80 | 56.80 |
| 6 | -43.258395 | 172.609554 | 56.00 | 1.80 | 57.80 |
| 7 | -43.256598 | 172.611356 | 58.90 | 1.80 | 60.70 |
| 8 | -43.256160 | 172.611762 | 58.05 | 1.80 | 59.85 |

**Name**: Upper Sefton Rd
**Route type** Two-way
**View angle**: 50.0 deg


| Vertex | Latitude | Longitude | Ground elevation | Height above ground | Total elevation |
|---|---|---|---|---|---|
| | deg | deg | m | m | m |
| 1 | -43.271146 | 172.610237 | 27.00 | 1.80 | 28.80 |
| 2 | -43.270779 | 172.611197 | 25.00 | 1.80 | 26.80 |
| 3 | -43.270314 | 172.612409 | 25.78 | 1.80 | 27.58 |
| 4 | -43.269533 | 172.614437 | 25.44 | 1.80 | 27.24 |
| 5 | -43.268603 | 172.616840 | 25.00 | 1.80 | 26.80 |
| 6 | -43.267697 | 172.619136 | 25.00 | 1.80 | 26.80 |
| 7 | -43.266932 | 172.621175 | 26.00 | 1.80 | 27.80 |
| 8 | -43.266088 | 172.623363 | 27.00 | 1.80 | 28.80 |
| 9 | -43.265428 | 172.625069 | 28.00 | 1.80 | 29.80 |
| 10 | -43.264666 | 172.627033 | 28.00 | 1.80 | 29.80 |
| 11 | -43.263713 | 172.629565 | 28.00 | 1.80 | 29.80 |
| 12 | -43.262838 | 172.631818 | 26.38 | 1.80 | 28.18 |
| 13 | -43.262072 | 172.633792 | 24.35 | 1.80 | 26.15 |

## Discrete Observation Receptors

| Number | Latitude | Longitude | Ground elevation | Height above ground | Total Elevation |
|---|---|---|---|---|---|
| | deg | deg | m | m | m |
| OP 1 | -43.268484 | 172.612208 | 31.00 | 1.70 | 32.70 |
| OP 2 | -43.266681 | 172.612443 | 39.00 | 1.70 | 40.70 |
| OP 3 | -43.263330 | 172.603729 | 49.00 | 1.70 | 50.70 |
| OP 4 | -43.261518 | 172.603644 | 54.00 | 1.70 | 55.70 |
| OP 5 | -43.260127 | 172.603987 | 57.00 | 1.70 | 58.70 |
| OP 6 | -43.259721 | 172.606090 | 56.22 | 1.70 | 57.92 |
| OP 7 | -43.258846 | 172.607978 | 58.00 | 1.70 | 59.70 |
| OP 8 | -43.259440 | 172.609759 | 53.99 | 1.70 | 55.69 |
| OP 9 | -43.258814 | 172.610596 | 54.00 | 1.70 | 55.70 |
| OP 10 | -43.259752 | 172.616089 | 46.87 | 1.70 | 48.57 |
| OP 11 | -43.257809 | 172.621124 | 44.00 | 1.70 | 45.70 |
| OP 12 | -43.258637 | 172.620984 | 44.00 | 1.70 | 45.70 |
| OP 13 | -43.259540 | 172.621966 | 43.00 | 1.70 | 44.70 |
| OP 14 | -43.263540 | 172.626363 | 31.00 | 1.70 | 32.70 |
| OP 15 | -43.259653 | 172.621726 | 43.00 | 1.70 | 44.70 |
| OP 16 | -43.261388 | 172.622761 | 39.00 | 1.70 | 40.70 |
| OP 17 | -43.263825 | 172.624652 | 32.00 | 1.70 | 33.70 |
| OP 18 | -43.264786 | 172.625350 | 29.00 | 1.70 | 30.70 |
| OP 19 | -43.265302 | 172.625789 | 27.72 | 1.70 | 29.42 |
| OP 20 | -43.267800 | 172.619154 | 25.00 | 1.70 | 26.70 |
| OP 21 | -43.269435 | 172.614568 | 25.49 | 1.70 | 27.19 |

## Obstruction Components

**Name**: 4m Shelterbelt 1
**Upper edge height**: 4.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.262746 | 172.623675 | 35.00 |
| 2 | -43.263957 | 172.624539 | 31.33 |
| 3 | -43.264554 | 172.624965 | 30.00 |
| 4 | -43.265152 | 172.625402 | 28.00 |
| 5 | -43.265857 | 172.623646 | 27.14 |
| 6 | -43.266500 | 172.621932 | 27.00 |
| 7 | -43.267150 | 172.620207 | 26.00 |
| 8 | -43.267832 | 172.618461 | 25.24 |
| 9 | -43.268252 | 172.617428 | 25.00 |
| 10 | -43.268658 | 172.616414 | 25.00 |

**Name**: 4m Shelterbelt 2
**Upper edge height**: 4.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.261934 | 172.623039 | 37.00 |
| 2 | -43.261150 | 172.622489 | 40.00 |
| 3 | -43.260366 | 172.621918 | 42.00 |
| 4 | -43.259590 | 172.621368 | 43.00 |
| 5 | -43.258779 | 172.620802 | 44.00 |

**Name**: 4m Shelterbelt 3
**Upper edge height**: 4.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.262930 | 172.609931 | 45.00 |
| 2 | -43.262567 | 172.610870 | 45.00 |
| 3 | -43.262227 | 172.611800 | 45.00 |
| 4 | -43.261887 | 172.612720 | 45.00 |
| 5 | -43.261547 | 172.613619 | 45.00 |

**Name**: 4m Shelterbelt 4
**Upper edge height**: 4.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.261047 | 172.614853 | 45.00 |
| 2 | -43.260688 | 172.615791 | 45.00 |
| 3 | -43.260360 | 172.616709 | 45.00 |

**Name**: 4m Shelterbelt 5
**Upper edge height**: 4.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.262914 | 172.609943 | 45.00 |
| 2 | -43.263729 | 172.610531 | 43.00 |
| 3 | -43.264532 | 172.611109 | 42.00 |
| 4 | -43.265342 | 172.611687 | 40.05 |
| 5 | -43.266137 | 172.612265 | 39.29 |
| 6 | -43.266952 | 172.612833 | 37.00 |
| 7 | -43.267750 | 172.613421 | 33.00 |
| 8 | -43.268557 | 172.614010 | 29.00 |
| 9 | -43.269348 | 172.614577 | 26.00 |
| 10 | -43.268707 | 172.616294 | 25.00 |

**Name**: 4m Shelterbelt 6
**Upper edge height**: 4.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.261540 | 172.613603 | 45.00 |
| 2 | -43.261038 | 172.614858 | 45.00 |

**Name**: 4m Shelterbelt 7
**Upper edge height**: 4.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.260352 | 172.616693 | 45.00 |
| 2 | -43.259957 | 172.617733 | 45.00 |
| 3 | -43.259578 | 172.618758 | 45.00 |
| 4 | -43.259176 | 172.619772 | 45.00 |
| 5 | -43.258772 | 172.620834 | 44.00 |

**Name**: 4m Shelterbelt 8
**Upper edge height**: 4.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.261941 | 172.623037 | 37.00 |
| 2 | -43.262340 | 172.621953 | 37.21 |
| 3 | -43.263164 | 172.622516 | 35.00 |
| 4 | -43.262723 | 172.623664 | 35.00 |

# Summary of PV Glare Analysis

*PV configuration and total predicted glare*

| PV Name | Tilt | Orientation | "Green" Glare | "Yellow" Glare | Energy Produced | Data File |
|---|---|---|---|---|---|---|
| | deg | deg | min | min | kWh | |
| FT PV array 1 | 25.0 | 0.0 | 0 | 0 | - | - |
| FT PV array 2 | 25.0 | 0.0 | 18 | 0 | - | - |

## Distinct glare per month

Excludes overlapping glare from PV array for multiple receptors at matching time(s)

| PV | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ft-pv-array (green) | 1 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 4 | 0 |
| ft-pv-array (yellow) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# PV & Receptor Analysis Results

*Results for each PV array and receptor*

## FT PV array 1 no glare found

| Component | Green glare (min) | Yellow glare (min) |
|---|---|---|
| OP: OP 1 | 0 | 0 |
| OP: OP 2 | 0 | 0 |
| OP: OP 3 | 0 | 0 |
| OP: OP 4 | 0 | 0 |
| OP: OP 5 | 0 | 0 |
| OP: OP 6 | 0 | 0 |
| OP: OP 7 | 0 | 0 |
| OP: OP 8 | 0 | 0 |
| OP: OP 9 | 0 | 0 |
| OP: OP 10 | 0 | 0 |
| OP: OP 11 | 0 | 0 |
| OP: OP 12 | 0 | 0 |
| OP: OP 13 | 0 | 0 |
| OP: OP 14 | 0 | 0 |
| OP: OP 15 | 0 | 0 |
| OP: OP 16 | 0 | 0 |
| OP: OP 17 | 0 | 0 |
| OP: OP 18 | 0 | 0 |
| OP: OP 19 | 0 | 0 |
| OP: OP 20 | 0 | 0 |
| OP: OP 21 | 0 | 0 |
| Route: Beatties Rd | 0 | 0 |
| Route: Marshmans Rd | 0 | 0 |
| Route: Upper Sefton Rd | 0 | 0 |

*No glare found*

## FT PV array 2 low potential for temporary after-image

| Component | Green glare (min) | Yellow glare (min) |
|---|---|---|
| OP: OP 1 | 0 | 0 |
| OP: OP 2 | 0 | 0 |
| OP: OP 3 | 0 | 0 |
| OP: OP 4 | 0 | 0 |
| OP: OP 5 | 0 | 0 |
| OP: OP 6 | 0 | 0 |
| OP: OP 7 | 0 | 0 |
| OP: OP 8 | 0 | 0 |
| OP: OP 9 | 0 | 0 |
| OP: OP 10 | 0 | 0 |
| OP: OP 11 | 0 | 0 |
| OP: OP 12 | 0 | 0 |
| OP: OP 13 | 0 | 0 |
| OP: OP 14 | 18 | 0 |
| OP: OP 15 | 0 | 0 |
| OP: OP 16 | 0 | 0 |
| OP: OP 17 | 0 | 0 |
| OP: OP 18 | 0 | 0 |
| OP: OP 19 | 0 | 0 |
| OP: OP 20 | 0 | 0 |
| OP: OP 21 | 0 | 0 |
| Route: Beatties Rd | 0 | 0 |
| Route: Marshmans Rd | 0 | 0 |
| Route: Upper Sefton Rd | 0 | 0 |

### FT PV array 2: OP 1

*No glare found*

### FT PV array 2: OP 2

*No glare found*

### FT PV array 2: OP 3

*No glare found*

### FT PV array 2: OP 4

*No glare found*

### FT PV array 2: OP 5

*No glare found*

### FT PV array 2: OP 6

*No glare found*

### FT PV array 2: OP 7

*No glare found*

## FT PV array 2: OP 8

*No glare found*

## FT PV array 2: OP 9

*No glare found*

## FT PV array 2: OP 10

*No glare found*

## FT PV array 2: OP 11

*No glare found*

## FT PV array 2: OP 12

*No glare found*

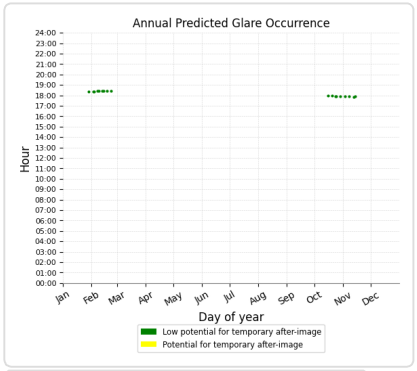
## FT PV array 2: OP 13

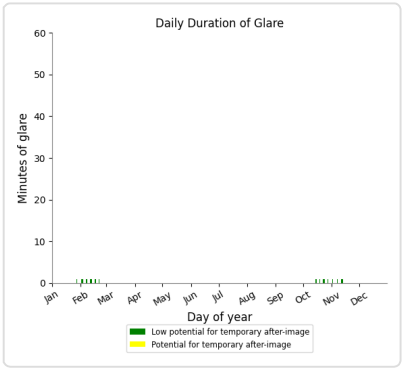
*No glare found*

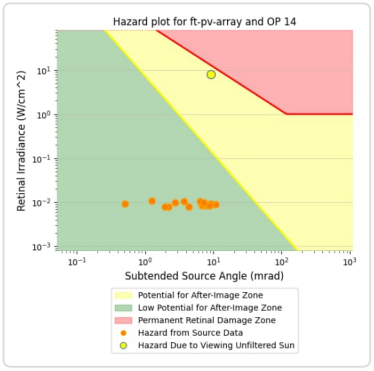
## FT PV array 2: OP 14

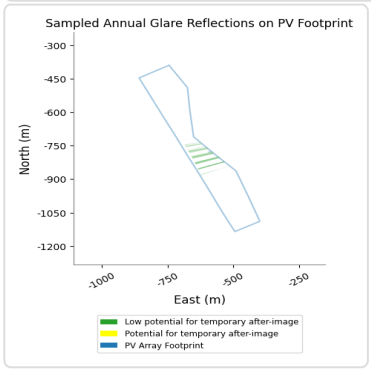
PV array is expected to produce the following glare for this receptor:

- 18 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.




## FT PV array 2: OP 15

*No glare found*

## FT PV array 2: OP 16

*No glare found*

## FT PV array 2: OP 17

*No glare found*

### FT PV array 2: OP 18

*No glare found*

### FT PV array 2: OP 19

*No glare found*

### FT PV array 2: OP 20

*No glare found*

### FT PV array 2: OP 21

*No glare found*

### FT PV array 2: Beatties Rd

*No glare found*

### FT PV array 2: Marshmans Rd

*No glare found*

### FT PV array 2: Upper Sefton Rd

*No glare found*

## Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not automatically account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values and results may vary.
- The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.
- Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
- The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
- Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
- Refer to the **Help page** for detailed assumptions and limitations not listed here.

ForgeSolar

# 2933 - Ashley

## SAT 1P - Shelterbelts 4m 21092023

**Client:** Solar Bay

**Created** Sep 20, 2023
**Updated** Sep 29, 2023
**Time-step** 1 minute
**Timezone offset** UTC12
**Minimum sun altitude** 0.0 deg
**Site ID** 101105.13897

**Project type** Advanced
**Project status:** active
**Category** 10 MW to 100 MW


### Misc. Analysis Settings

DNI: **varies (1,000.0 W/m^2 peak)**
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: **Version 2**
Enhanced subtended angle calculation: **On**

## Summary of Results Glare with potential for temporary after-image predicted

| PV Name | Tilt | Orientation | "Green" Glare | "Yellow" Glare | Energy Produced |
|---|---|---|---|---|---|
| | deg | deg | min | min | kWh |
| SAT 1P PV array 1 | SA tracking | SA tracking | 92 | 229 | 1,400,000.0 |
| SAT 1P PV array 2 | SA tracking | SA tracking | 0 | 0 | 1,225,000.0 |

## Component Data

## PV Array(s)

**Total PV footprint area:** 634,086 m^2

**Name**: SAT 1P PV array 1
**Footprint area**: 552,624 m^2
**Axis tracking**: Single-axis rotation
**Backtracking**: Shade-slope
**Tracking axis orientation**: 0.0 deg
**Maximum tracking angle**: 60.0 deg
**Resting angle**: 0.0 deg
**Ground Coverage Ratio**: 0.416

**Rated power**: 565.0 kW
**Panel material**: Smooth glass with AR coating
**Vary reflectivity with sun position?** Yes
**Correlate slope error with surface type?** Yes
**Slope error**: 8.43 mrad


| Vertex | Latitude | Longitude | Ground elevation | Height above ground | Total elevation |
|---|---|---|---|---|---|
| | deg | deg | m | m | m |
| 1 | -43.258957 | 172.620736 | 44.00 | 1.50 | 45.50 |
| 2 | -43.259366 | 172.619701 | 45.00 | 1.50 | 46.50 |
| 3 | -43.259759 | 172.618645 | 45.00 | 1.50 | 46.50 |
| 4 | -43.260159 | 172.617611 | 44.61 | 1.50 | 46.11 |
| 5 | -43.260560 | 172.616555 | 44.40 | 1.50 | 45.90 |
| 6 | -43.260961 | 172.615531 | 45.00 | 1.50 | 46.50 |
| 7 | -43.261362 | 172.614464 | 45.00 | 1.50 | 46.50 |
| 8 | -43.261763 | 172.613419 | 45.00 | 1.50 | 46.50 |
| 9 | -43.262148 | 172.612374 | 45.00 | 1.50 | 46.50 |
| 10 | -43.262785 | 172.612937 | 42.00 | 1.50 | 43.50 |
| 11 | -43.263421 | 172.613479 | 40.00 | 1.50 | 41.50 |
| 12 | -43.263972 | 172.613393 | 40.00 | 1.50 | 41.50 |
| 13 | -43.264539 | 172.613286 | 38.34 | 1.50 | 39.84 |
| 14 | -43.265050 | 172.613350 | 37.00 | 1.50 | 38.50 |
| 15 | -43.265432 | 172.614255 | 36.21 | 1.50 | 37.71 |
| 16 | -43.265895 | 172.615084 | 35.00 | 1.50 | 36.50 |
| 17 | -43.266612 | 172.615592 | 32.79 | 1.50 | 34.29 |
| 18 | -43.267329 | 172.616035 | 30.00 | 1.50 | 31.50 |
| 19 | -43.267489 | 172.617221 | 28.00 | 1.50 | 29.50 |
| 20 | -43.267665 | 172.618385 | 26.00 | 1.50 | 27.50 |
| 21 | -43.267462 | 172.619013 | 26.00 | 1.50 | 27.50 |
| 22 | -43.267259 | 172.619619 | 26.00 | 1.50 | 27.50 |
| 23 | -43.266587 | 172.619468 | 28.69 | 1.50 | 30.19 |
| 24 | -43.266294 | 172.620284 | 29.00 | 1.50 | 30.50 |
| 25 | -43.266017 | 172.621121 | 29.00 | 1.50 | 30.50 |
| 26 | -43.266267 | 172.622172 | 27.00 | 1.50 | 28.50 |
| 27 | -43.265970 | 172.622926 | 27.00 | 1.50 | 28.50 |
| 28 | -43.265689 | 172.623680 | 28.00 | 1.50 | 29.50 |
| 29 | -43.265400 | 172.624423 | 28.00 | 1.50 | 29.50 |
| 30 | -43.265110 | 172.625208 | 28.00 | 1.50 | 29.50 |
| 31 | -43.264188 | 172.624362 | 31.00 | 1.50 | 32.50 |
| 32 | -43.263751 | 172.623289 | 33.00 | 1.50 | 34.50 |
| 33 | -43.263297 | 172.622238 | 35.00 | 1.50 | 36.50 |
| 34 | -43.262269 | 172.621648 | 38.00 | 1.50 | 39.50 |
| 35 | -43.262069 | 172.622232 | 38.00 | 1.50 | 39.50 |
| 36 | -43.261870 | 172.622817 | 38.00 | 1.50 | 39.50 |
| 37 | -43.261142 | 172.622313 | 40.00 | 1.50 | 41.50 |
| 38 | -43.260414 | 172.621787 | 42.00 | 1.50 | 43.50 |
| 39 | -43.259701 | 172.621261 | 43.00 | 1.50 | 44.50 |

**Name**: SAT 1P PV array 2
**Footprint area**: 81,462 m^2
**Axis tracking**: Single-axis rotation
**Backtracking**: Shade-slope
**Tracking axis orientation**: 0.0 deg
**Maximum tracking angle**: 60.0 deg
**Resting angle**: 0.0 deg
**Ground Coverage Ratio**: 0.416

**Rated power**: 565.0 kW
**Panel material**: Smooth glass with AR coating
**Vary reflectivity with sun position?** Yes
**Correlate slope error with surface type?** Yes
**Slope error**: 8.43 mrad


| Vertex | Latitude | Longitude | Ground elevation | Height above ground | Total elevation |
|---|---|---|---|---|---|
| | deg | deg | m | m | m |
| 1 | -43.262470 | 172.611571 | 45.00 | 1.50 | 46.50 |
| 2 | -43.262723 | 172.610857 | 45.00 | 1.50 | 46.50 |
| 3 | -43.262977 | 172.610165 | 45.00 | 1.50 | 46.50 |
| 4 | -43.263752 | 172.610726 | 43.00 | 1.50 | 44.50 |
| 5 | -43.264526 | 172.611286 | 41.49 | 1.50 | 42.99 |
| 6 | -43.265285 | 172.611847 | 40.00 | 1.50 | 41.50 |
| 7 | -43.266075 | 172.612408 | 39.00 | 1.50 | 40.50 |
| 8 | -43.266850 | 172.612979 | 37.00 | 1.50 | 38.50 |
| 9 | -43.267624 | 172.613529 | 33.42 | 1.50 | 34.92 |
| 10 | -43.268398 | 172.614068 | 29.19 | 1.50 | 30.69 |
| 11 | -43.269173 | 172.614650 | 26.00 | 1.50 | 27.50 |
| 12 | -43.268966 | 172.615235 | 26.00 | 1.50 | 27.50 |
| 13 | -43.268759 | 172.615819 | 26.00 | 1.50 | 27.50 |
| 14 | -43.267743 | 172.615272 | 29.53 | 1.50 | 31.03 |
| 15 | -43.266727 | 172.614704 | 33.98 | 1.50 | 35.48 |
| 16 | -43.266048 | 172.613700 | 36.00 | 1.50 | 37.50 |
| 17 | -43.265352 | 172.612719 | 38.05 | 1.50 | 39.55 |
| 18 | -43.264360 | 172.612552 | 39.00 | 1.50 | 40.50 |
| 19 | -43.263368 | 172.612429 | 40.00 | 1.50 | 41.50 |

## Route Receptor(s)

**Name**: Beatties Rd
**Route type** Two-way
**View angle**: 50.0 deg


| Vertex | Latitude | Longitude | Ground elevation | Height above ground | Total elevation |
|---|---|---|---|---|---|
| | deg | deg | m | m | m |
| 1 | -43.265179 | 172.625535 | 28.00 | 1.80 | 29.80 |
| 2 | -43.263691 | 172.624451 | 32.00 | 1.80 | 33.80 |
| 3 | -43.262712 | 172.623788 | 35.00 | 1.80 | 36.80 |
| 4 | -43.261384 | 172.622801 | 39.00 | 1.80 | 40.80 |
| 5 | -43.260040 | 172.621878 | 43.00 | 1.80 | 44.80 |
| 6 | -43.258961 | 172.621110 | 44.00 | 1.80 | 45.80 |
| 7 | -43.257672 | 172.620133 | 45.00 | 1.80 | 46.80 |
| 8 | -43.257414 | 172.619930 | 46.00 | 1.80 | 47.80 |

**Name**: Marshmans Rd
**Route type** Two-way
**View angle**: 50.0 deg


| Vertex | Latitude | Longitude | Ground elevation | Height above ground | Total elevation |
|---|---|---|---|---|---|
| | deg | deg | m | m | m |
| 1 | -43.266119 | 172.603133 | 42.00 | 1.80 | 43.80 |
| 2 | -43.264067 | 172.604619 | 47.00 | 1.80 | 48.80 |
| 3 | -43.262145 | 172.606142 | 50.00 | 1.80 | 51.80 |
| 4 | -43.260958 | 172.607043 | 52.45 | 1.80 | 54.25 |
| 5 | -43.259458 | 172.608503 | 55.00 | 1.80 | 56.80 |
| 6 | -43.258395 | 172.609554 | 56.00 | 1.80 | 57.80 |
| 7 | -43.256598 | 172.611356 | 58.90 | 1.80 | 60.70 |
| 8 | -43.256160 | 172.611762 | 58.05 | 1.80 | 59.85 |

**Name**: Upper Sefton Rd
**Route type** Two-way
**View angle**: 50.0 deg


| Vertex | Latitude | Longitude | Ground elevation | Height above ground | Total elevation |
|---|---|---|---|---|---|
| | deg | deg | m | m | m |
| 1 | -43.271146 | 172.610237 | 27.00 | 1.80 | 28.80 |
| 2 | -43.270779 | 172.611197 | 25.00 | 1.80 | 26.80 |
| 3 | -43.270314 | 172.612409 | 25.78 | 1.80 | 27.58 |
| 4 | -43.269533 | 172.614437 | 25.44 | 1.80 | 27.24 |
| 5 | -43.268603 | 172.616840 | 25.00 | 1.80 | 26.80 |
| 6 | -43.267697 | 172.619136 | 25.00 | 1.80 | 26.80 |
| 7 | -43.266932 | 172.621175 | 26.00 | 1.80 | 27.80 |
| 8 | -43.266088 | 172.623363 | 27.00 | 1.80 | 28.80 |
| 9 | -43.265428 | 172.625069 | 28.00 | 1.80 | 29.80 |
| 10 | -43.264666 | 172.627033 | 28.00 | 1.80 | 29.80 |
| 11 | -43.263713 | 172.629565 | 28.00 | 1.80 | 29.80 |
| 12 | -43.262838 | 172.631818 | 26.38 | 1.80 | 28.18 |
| 13 | -43.262072 | 172.633792 | 24.35 | 1.80 | 26.15 |

## Discrete Observation Receptors

| Number | Latitude | Longitude | Ground elevation | Height above ground | Total Elevation |
|---|---|---|---|---|---|
| | deg | deg | m | m | m |
| OP 1 | -43.268484 | 172.612208 | 31.00 | 1.70 | 32.70 |
| OP 2 | -43.266681 | 172.612443 | 39.00 | 1.70 | 40.70 |
| OP 3 | -43.263330 | 172.603729 | 49.00 | 1.70 | 50.70 |
| OP 4 | -43.261518 | 172.603644 | 54.00 | 1.70 | 55.70 |
| OP 5 | -43.260127 | 172.603987 | 57.00 | 1.70 | 58.70 |
| OP 6 | -43.259721 | 172.606090 | 56.22 | 1.70 | 57.92 |
| OP 7 | -43.258846 | 172.607978 | 58.00 | 1.70 | 59.70 |
| OP 8 | -43.259440 | 172.609759 | 53.99 | 1.70 | 55.69 |
| OP 9 | -43.258814 | 172.610596 | 54.00 | 1.70 | 55.70 |
| OP 10 | -43.259752 | 172.616089 | 46.87 | 1.70 | 48.57 |
| OP 11 | -43.257809 | 172.621124 | 44.00 | 1.70 | 45.70 |
| OP 12 | -43.258637 | 172.620984 | 44.00 | 1.70 | 45.70 |
| OP 13 | -43.259540 | 172.621966 | 43.00 | 1.70 | 44.70 |
| OP 14 | -43.263540 | 172.626363 | 31.00 | 1.70 | 32.70 |
| OP 15 | -43.259653 | 172.621726 | 43.00 | 1.70 | 44.70 |
| OP 16 | -43.261388 | 172.622761 | 39.00 | 1.70 | 40.70 |
| OP 17 | -43.263825 | 172.624652 | 32.00 | 1.70 | 33.70 |
| OP 18 | -43.264786 | 172.625350 | 29.00 | 1.70 | 30.70 |
| OP 19 | -43.265302 | 172.625789 | 27.72 | 1.70 | 29.42 |
| OP 20 | -43.267800 | 172.619154 | 25.00 | 1.70 | 26.70 |
| OP 21 | -43.269435 | 172.614568 | 25.49 | 1.70 | 27.19 |

## Obstruction Components

**Name**: 4m Shelterbelt 1
**Upper edge height**: 4.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.262746 | 172.623675 | 35.00 |
| 2 | -43.263957 | 172.624539 | 31.33 |
| 3 | -43.264554 | 172.624965 | 30.00 |
| 4 | -43.265152 | 172.625402 | 28.00 |
| 5 | -43.265857 | 172.623646 | 27.14 |
| 6 | -43.266500 | 172.621932 | 27.00 |
| 7 | -43.267150 | 172.620207 | 26.00 |
| 8 | -43.267832 | 172.618461 | 25.24 |
| 9 | -43.268252 | 172.617428 | 25.00 |
| 10 | -43.268658 | 172.616414 | 25.00 |

**Name**: 4m Shelterbelt 2
**Upper edge height**: 4.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.261934 | 172.623039 | 37.00 |
| 2 | -43.261150 | 172.622489 | 40.00 |
| 3 | -43.260366 | 172.621918 | 42.00 |
| 4 | -43.259590 | 172.621368 | 43.00 |
| 5 | -43.258779 | 172.620802 | 44.00 |

**Name**: 4m Shelterbelt 3
**Upper edge height**: 4.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.262930 | 172.609931 | 45.00 |
| 2 | -43.262567 | 172.610870 | 45.00 |
| 3 | -43.262227 | 172.611800 | 45.00 |
| 4 | -43.261887 | 172.612720 | 45.00 |
| 5 | -43.261547 | 172.613619 | 45.00 |

**Name**: 4m Shelterbelt 4
**Upper edge height**: 4.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.261047 | 172.614853 | 45.00 |
| 2 | -43.260688 | 172.615791 | 45.00 |
| 3 | -43.260360 | 172.616709 | 45.00 |

**Name**: 4m Shelterbelt 5
**Upper edge height**: 4.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.262914 | 172.609943 | 45.00 |
| 2 | -43.263729 | 172.610531 | 43.00 |
| 3 | -43.264532 | 172.611109 | 42.00 |
| 4 | -43.265342 | 172.611687 | 40.05 |
| 5 | -43.266137 | 172.612265 | 39.29 |
| 6 | -43.266952 | 172.612833 | 37.00 |
| 7 | -43.267750 | 172.613421 | 33.00 |
| 8 | -43.268557 | 172.614010 | 29.00 |
| 9 | -43.269348 | 172.614577 | 26.00 |
| 10 | -43.268707 | 172.616294 | 25.00 |

**Name**: 4m Shelterbelt 6
**Upper edge height**: 4.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.261540 | 172.613603 | 45.00 |
| 2 | -43.261038 | 172.614858 | 45.00 |

**Name**: 4m Shelterbelt 7
**Upper edge height**: 4.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.260352 | 172.616693 | 45.00 |
| 2 | -43.259957 | 172.617733 | 45.00 |
| 3 | -43.259578 | 172.618758 | 45.00 |
| 4 | -43.259176 | 172.619772 | 45.00 |
| 5 | -43.258772 | 172.620834 | 44.00 |

**Name**: 4m Shelterbelt 8
**Upper edge height**: 4.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.261941 | 172.623037 | 37.00 |
| 2 | -43.262340 | 172.621953 | 37.21 |
| 3 | -43.263164 | 172.622516 | 35.00 |
| 4 | -43.262723 | 172.623664 | 35.00 |

# Summary of PV Glare Analysis

*PV configuration and total predicted glare*

| PV Name | Tilt | Orientation | "Green" Glare | "Yellow" Glare | Energy Produced | Data File |
|---|---|---|---|---|---|---|
| | deg | deg | min | min | kWh | |
| SAT 1P PV array 1 | SA tracking | SA tracking | 92 | 229 | 1,400,000.0 | - |
| SAT 1P PV array 2 | SA tracking | SA tracking | 0 | 0 | 1,225,000.0 | - |

## Distinct glare per month

Excludes overlapping glare from PV array for multiple receptors at matching time(s)

| PV | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| sat-1p-pv-ar (green) | 0 | 0 | 0 | 3 | 16 | 5 | 18 | 13 | 0 | 0 | 0 | 0 |
| sat-1p-pv-ar (yellow) | 0 | 0 | 0 | 0 | 29 | 128 | 72 | 0 | 0 | 0 | 0 | 0 |

# PV & Receptor Analysis Results

*Results for each PV array and receptor*

## SAT 1P PV array 1 potential temporary after-image

Predicted energy output: 1,400,000.0 kWh (assuming sunny, clear skies)

| Component | Green glare (min) | Yellow glare (min) |
|---|---|---|
| OP: OP 1 | 0 | 0 |
| OP: OP 2 | 0 | 0 |
| OP: OP 3 | 0 | 0 |
| OP: OP 4 | 0 | 0 |
| OP: OP 5 | 0 | 0 |
| OP: OP 6 | 0 | 0 |
| OP: OP 7 | 0 | 0 |
| OP: OP 8 | 0 | 0 |
| OP: OP 9 | 0 | 0 |
| OP: OP 10 | 0 | 0 |
| OP: OP 11 | 0 | 0 |
| OP: OP 12 | 0 | 0 |
| OP: OP 13 | 0 | 0 |
| OP: OP 14 | 37 | 0 |
| OP: OP 15 | 0 | 0 |
| OP: OP 16 | 0 | 0 |
| OP: OP 17 | 0 | 0 |
| OP: OP 18 | 0 | 0 |
| OP: OP 19 | 0 | 0 |
| OP: OP 20 | 0 | 0 |
| OP: OP 21 | 0 | 0 |
| Route: Beatties Rd | 36 | 229 |
| Route: Marshmans Rd | 0 | 0 |
| Route: Upper Sefton Rd | 19 | 0 |

### SAT 1P PV array 1: OP 1

*No glare found*

### SAT 1P PV array 1: OP 2

*No glare found*

### SAT 1P PV array 1: OP 3

*No glare found*

### SAT 1P PV array 1: OP 4

*No glare found*

### SAT 1P PV array 1: OP 5

*No glare found*

### SAT 1P PV array 1: OP 6

*No glare found*

### SAT 1P PV array 1: OP 7

*No glare found*

### SAT 1P PV array 1: OP 8

*No glare found*

### SAT 1P PV array 1: OP 9

*No glare found*

### SAT 1P PV array 1: OP 10

*No glare found*

### SAT 1P PV array 1: OP 11

*No glare found*

### SAT 1P PV array 1: OP 12

*No glare found*

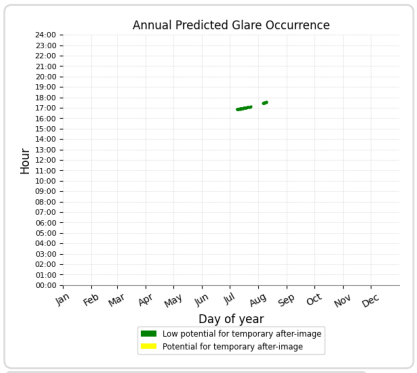
### SAT 1P PV array 1: OP 13

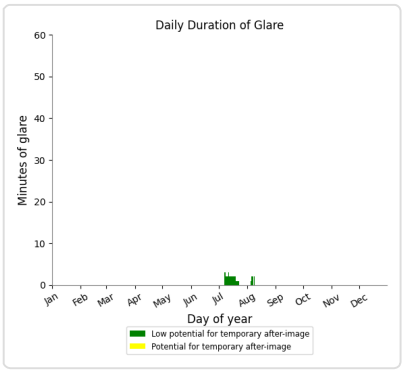
*No glare found*

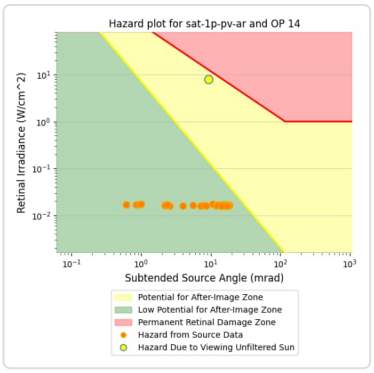
## SAT 1P PV array 1: OP 14

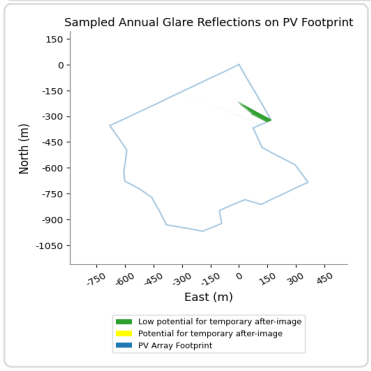
PV array is expected to produce the following glare for this receptor:

- 37 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.




## SAT 1P PV array 1: OP 15

*No glare found*

## SAT 1P PV array 1: OP 16

*No glare found*

## SAT 1P PV array 1: OP 17

*No glare found*

## SAT 1P PV array 1: OP 18

*No glare found*

## SAT 1P PV array 1: OP 19

*No glare found*

## SAT 1P PV array 1: OP 20

*No glare found*

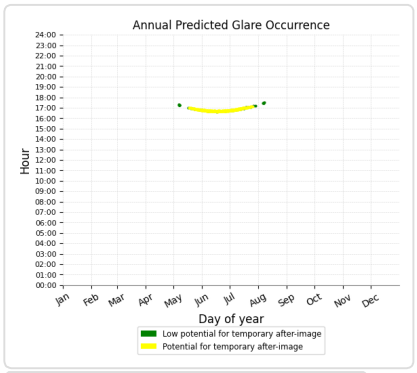
## SAT 1P PV array 1: OP 21

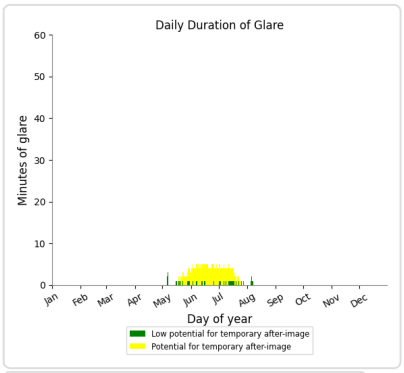
*No glare found*

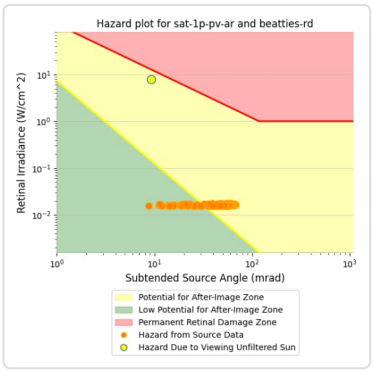
## SAT 1P PV array 1: Beatties Rd

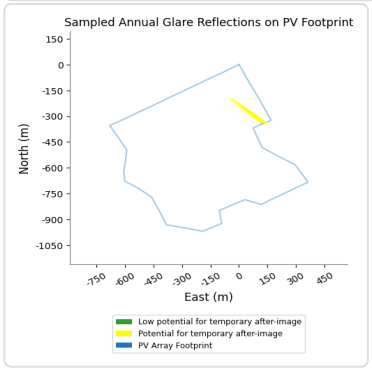
PV array is expected to produce the following glare for this receptor:

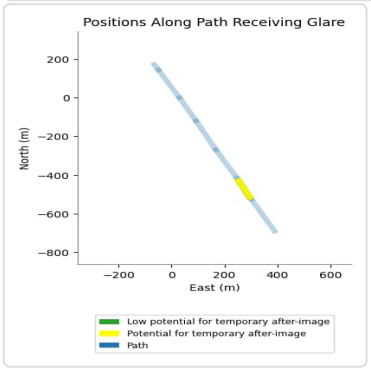
- 36 minutes of "green" glare with low potential to cause temporary after-image.
- 229 minutes of "yellow" glare with potential to cause temporary after-image.



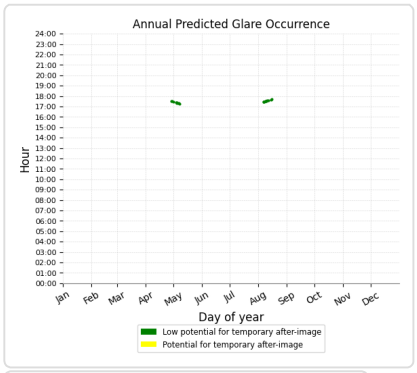

## SAT 1P PV array 1: Marshmans Rd

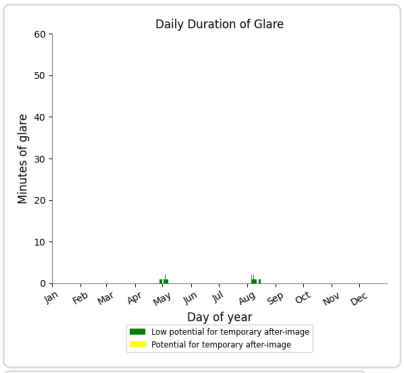
*No glare found*

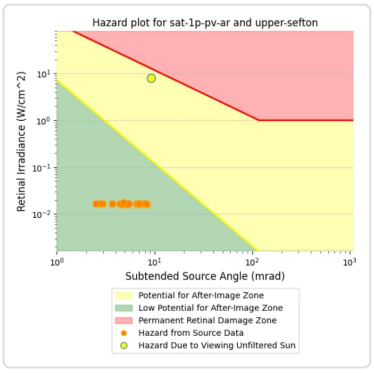
## SAT 1P PV array 1: Upper Sefton Rd

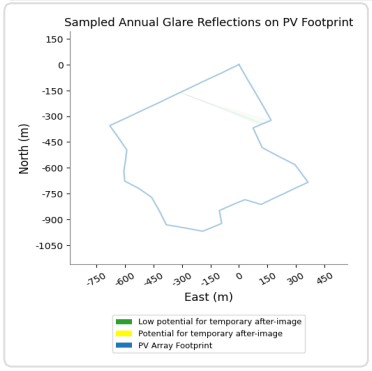
PV array is expected to produce the following glare for this receptor:

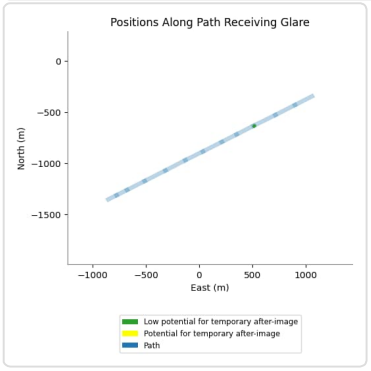
- 19 minutes of "green" glare with low potential to cause temporary after-image.
- 0 minutes of "yellow" glare with potential to cause temporary after-image.




## SAT 1P PV array 2 no glare found

Predicted energy output: 1,225,000.0 kWh (assuming sunny, clear skies)

| Component | Green glare (min) | Yellow glare (min) |
|---|---|---|
| OP: OP 1 | 0 | 0 |
| OP: OP 2 | 0 | 0 |
| OP: OP 3 | 0 | 0 |
| OP: OP 4 | 0 | 0 |
| OP: OP 5 | 0 | 0 |
| OP: OP 6 | 0 | 0 |
| OP: OP 7 | 0 | 0 |
| OP: OP 8 | 0 | 0 |
| OP: OP 9 | 0 | 0 |
| OP: OP 10 | 0 | 0 |
| OP: OP 11 | 0 | 0 |
| OP: OP 12 | 0 | 0 |
| OP: OP 13 | 0 | 0 |
| OP: OP 14 | 0 | 0 |
| OP: OP 15 | 0 | 0 |
| OP: OP 16 | 0 | 0 |
| OP: OP 17 | 0 | 0 |
| OP: OP 18 | 0 | 0 |
| OP: OP 19 | 0 | 0 |
| OP: OP 20 | 0 | 0 |
| OP: OP 21 | 0 | 0 |
| Route: Beatties Rd | 0 | 0 |
| Route: Marshmans Rd | 0 | 0 |
| Route: Upper Sefton Rd | 0 | 0 |

*No glare found*

## Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not automatically account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values and results may vary.
- The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.
- Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
- The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
- Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
- Refer to the **Help page** for detailed assumptions and limitations not listed here.

ForgeSolar

# 2933 - Ashley

## SAT 2P - Shelterbelts 4m 21092023

**Client:** Solar Bay

**Created** Sep 20, 2023
**Updated** Sep 29, 2023
**Time-step** 1 minute
**Timezone offset** UTC12
**Minimum sun altitude** 0.0 deg
**Site ID** 101107.13897

**Project type** Advanced
**Project status:** active
**Category** 10 MW to 100 MW


### Misc. Analysis Settings

DNI: **varies (1,000.0 W/m^2 peak)**
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: **Version 2**
Enhanced subtended angle calculation: **On**

## Summary of Results Glare with potential for temporary after-image predicted

| PV Name | Tilt | Orientation | "Green" Glare | "Yellow" Glare | Energy Produced |
|---|---|---|---|---|---|
| | deg | deg | min | min | kWh |
| SAT 2P PV array 1 | SA tracking | SA tracking | 50 | 127 | - |
| SAT 2P PV array 2 | SA tracking | SA tracking | 0 | 0 | - |

## Component Data

## PV Array(s)

**Total PV footprint area:** 634,087 m^2

**Name**: SAT 2P PV array 1
**Footprint area**: 552,625 m^2
**Axis tracking**: Single-axis rotation
**Backtracking**: Shade-slope
**Tracking axis orientation**: 0.0 deg
**Maximum tracking angle**: 60.0 deg
**Resting angle**: 0.0 deg
**Ground Coverage Ratio**: 0.416

**Rated power**: -
**Panel material**: Smooth glass with AR coating
**Vary reflectivity with sun position?** Yes
**Correlate slope error with surface type?** Yes
**Slope error**: 8.43 mrad


| Vertex | Latitude | Longitude | Ground elevation | Height above ground | Total elevation |
|---|---|---|---|---|---|
| | deg | deg | m | m | m |
| 1 | -43.258957 | 172.620736 | 44.00 | 2.40 | 46.40 |
| 2 | -43.259366 | 172.619701 | 45.00 | 2.40 | 47.40 |
| 3 | -43.259759 | 172.618645 | 45.00 | 2.40 | 47.40 |
| 4 | -43.260159 | 172.617611 | 44.61 | 2.40 | 47.01 |
| 5 | -43.260560 | 172.616555 | 44.40 | 2.40 | 46.80 |
| 6 | -43.260961 | 172.615531 | 45.00 | 2.40 | 47.40 |
| 7 | -43.261362 | 172.614464 | 45.00 | 2.40 | 47.40 |
| 8 | -43.261763 | 172.613419 | 45.00 | 2.40 | 47.40 |
| 9 | -43.262148 | 172.612374 | 45.00 | 2.40 | 47.40 |
| 10 | -43.262785 | 172.612937 | 42.00 | 2.40 | 44.40 |
| 11 | -43.263421 | 172.613479 | 40.00 | 2.40 | 42.40 |
| 12 | -43.263972 | 172.613393 | 40.00 | 2.40 | 42.40 |
| 13 | -43.264539 | 172.613286 | 38.34 | 2.40 | 40.74 |
| 14 | -43.265050 | 172.613350 | 37.00 | 2.40 | 39.40 |
| 15 | -43.265432 | 172.614255 | 36.21 | 2.40 | 38.61 |
| 16 | -43.265895 | 172.615084 | 35.00 | 2.40 | 37.40 |
| 17 | -43.266612 | 172.615592 | 32.79 | 2.40 | 35.19 |
| 18 | -43.267329 | 172.616035 | 30.00 | 2.40 | 32.40 |
| 19 | -43.267489 | 172.617221 | 28.00 | 2.40 | 30.40 |
| 20 | -43.267665 | 172.618385 | 26.00 | 2.40 | 28.40 |
| 21 | -43.267462 | 172.619013 | 26.00 | 2.40 | 28.40 |
| 22 | -43.267259 | 172.619619 | 26.00 | 2.40 | 28.40 |
| 23 | -43.266587 | 172.619468 | 28.69 | 2.40 | 31.09 |
| 24 | -43.266294 | 172.620284 | 29.00 | 2.40 | 31.40 |
| 25 | -43.266017 | 172.621121 | 29.00 | 2.40 | 31.40 |
| 26 | -43.266267 | 172.622172 | 27.00 | 2.40 | 29.40 |
| 27 | -43.265970 | 172.622926 | 27.00 | 2.40 | 29.40 |
| 28 | -43.265689 | 172.623680 | 28.00 | 2.40 | 30.40 |
| 29 | -43.265400 | 172.624423 | 28.00 | 2.40 | 30.40 |
| 30 | -43.265110 | 172.625208 | 28.00 | 2.40 | 30.40 |
| 31 | -43.264188 | 172.624362 | 31.00 | 2.40 | 33.40 |
| 32 | -43.263751 | 172.623289 | 33.00 | 2.40 | 35.40 |
| 33 | -43.263297 | 172.622238 | 35.00 | 2.40 | 37.40 |
| 34 | -43.262269 | 172.621648 | 38.00 | 2.40 | 40.40 |
| 35 | -43.262069 | 172.622232 | 38.00 | 2.40 | 40.40 |
| 36 | -43.261870 | 172.622817 | 38.00 | 2.40 | 40.40 |
| 37 | -43.261142 | 172.622313 | 40.00 | 2.40 | 42.40 |
| 38 | -43.260414 | 172.621787 | 42.00 | 2.40 | 44.40 |
| 39 | -43.259701 | 172.621261 | 43.00 | 2.40 | 45.40 |

**Name**: SAT 2P PV array 2
**Footprint area**: 81,462 m^2
**Axis tracking**: Single-axis rotation
**Backtracking**: Shade-slope
**Tracking axis orientation**: 0.0 deg
**Maximum tracking angle**: 60.0 deg
**Resting angle**: 0.0 deg
**Ground Coverage Ratio**: 0.416

**Rated power**: -
**Panel material**: Smooth glass with AR coating
**Vary reflectivity with sun position?** Yes
**Correlate slope error with surface type?** Yes
**Slope error**: 8.43 mrad


| Vertex | Latitude | Longitude | Ground elevation | Height above ground | Total elevation |
|---|---|---|---|---|---|
| | deg | deg | m | m | m |
| 1 | -43.262470 | 172.611571 | 45.00 | 2.40 | 47.40 |
| 2 | -43.262723 | 172.610857 | 45.00 | 2.40 | 47.40 |
| 3 | -43.262977 | 172.610165 | 45.00 | 2.40 | 47.40 |
| 4 | -43.263752 | 172.610726 | 43.00 | 2.40 | 45.40 |
| 5 | -43.264526 | 172.611286 | 41.49 | 2.40 | 43.89 |
| 6 | -43.265285 | 172.611847 | 40.00 | 2.40 | 42.40 |
| 7 | -43.266075 | 172.612408 | 39.00 | 2.40 | 41.40 |
| 8 | -43.266850 | 172.612979 | 37.00 | 2.40 | 39.40 |
| 9 | -43.267624 | 172.613529 | 33.42 | 2.40 | 35.82 |
| 10 | -43.268398 | 172.614068 | 29.19 | 2.40 | 31.59 |
| 11 | -43.269173 | 172.614650 | 26.00 | 2.40 | 28.40 |
| 12 | -43.268966 | 172.615235 | 26.00 | 2.40 | 28.40 |
| 13 | -43.268759 | 172.615819 | 26.00 | 2.40 | 28.40 |
| 14 | -43.267743 | 172.615272 | 29.53 | 2.40 | 31.93 |
| 15 | -43.266727 | 172.614704 | 33.98 | 2.40 | 36.38 |
| 16 | -43.266048 | 172.613700 | 36.00 | 2.40 | 38.40 |
| 17 | -43.265352 | 172.612719 | 38.05 | 2.40 | 40.45 |
| 18 | -43.264360 | 172.612552 | 39.00 | 2.40 | 41.40 |
| 19 | -43.263368 | 172.612429 | 40.00 | 2.40 | 42.40 |

## Route Receptor(s)

**Name**: Beatties Rd
**Route type** Two-way
**View angle**: 50.0 deg


| Vertex | Latitude | Longitude | Ground elevation | Height above ground | Total elevation |
|---|---|---|---|---|---|
| | deg | deg | m | m | m |
| 1 | -43.265179 | 172.625535 | 28.00 | 1.80 | 29.80 |
| 2 | -43.263691 | 172.624451 | 32.00 | 1.80 | 33.80 |
| 3 | -43.262712 | 172.623788 | 35.00 | 1.80 | 36.80 |
| 4 | -43.261384 | 172.622801 | 39.00 | 1.80 | 40.80 |
| 5 | -43.260040 | 172.621878 | 43.00 | 1.80 | 44.80 |
| 6 | -43.258961 | 172.621110 | 44.00 | 1.80 | 45.80 |
| 7 | -43.257672 | 172.620133 | 45.00 | 1.80 | 46.80 |
| 8 | -43.257414 | 172.619930 | 46.00 | 1.80 | 47.80 |

**Name**: Marshmans Rd
**Route type** Two-way
**View angle**: 50.0 deg


| Vertex | Latitude | Longitude | Ground elevation | Height above ground | Total elevation |
|---|---|---|---|---|---|
| | deg | deg | m | m | m |
| 1 | -43.266119 | 172.603133 | 42.00 | 1.80 | 43.80 |
| 2 | -43.264067 | 172.604619 | 47.00 | 1.80 | 48.80 |
| 3 | -43.262145 | 172.606142 | 50.00 | 1.80 | 51.80 |
| 4 | -43.260958 | 172.607043 | 52.45 | 1.80 | 54.25 |
| 5 | -43.259458 | 172.608503 | 55.00 | 1.80 | 56.80 |
| 6 | -43.258395 | 172.609554 | 56.00 | 1.80 | 57.80 |
| 7 | -43.256598 | 172.611356 | 58.90 | 1.80 | 60.70 |
| 8 | -43.256160 | 172.611762 | 58.05 | 1.80 | 59.85 |

**Name**: Upper Sefton Rd
**Route type** Two-way
**View angle**: 50.0 deg


| Vertex | Latitude | Longitude | Ground elevation | Height above ground | Total elevation |
|---|---|---|---|---|---|
| | deg | deg | m | m | m |
| 1 | -43.271146 | 172.610237 | 27.00 | 1.80 | 28.80 |
| 2 | -43.270779 | 172.611197 | 25.00 | 1.80 | 26.80 |
| 3 | -43.270314 | 172.612409 | 25.78 | 1.80 | 27.58 |
| 4 | -43.269533 | 172.614437 | 25.44 | 1.80 | 27.24 |
| 5 | -43.268603 | 172.616840 | 25.00 | 1.80 | 26.80 |
| 6 | -43.267697 | 172.619136 | 25.00 | 1.80 | 26.80 |
| 7 | -43.266932 | 172.621175 | 26.00 | 1.80 | 27.80 |
| 8 | -43.266088 | 172.623363 | 27.00 | 1.80 | 28.80 |
| 9 | -43.265428 | 172.625069 | 28.00 | 1.80 | 29.80 |
| 10 | -43.264666 | 172.627033 | 28.00 | 1.80 | 29.80 |
| 11 | -43.263713 | 172.629565 | 28.00 | 1.80 | 29.80 |
| 12 | -43.262838 | 172.631818 | 26.38 | 1.80 | 28.18 |
| 13 | -43.262072 | 172.633792 | 24.35 | 1.80 | 26.15 |

## Discrete Observation Receptors

| Number | Latitude | Longitude | Ground elevation | Height above ground | Total Elevation |
|---|---|---|---|---|---|
| | deg | deg | m | m | m |
| OP 1 | -43.268484 | 172.612208 | 31.00 | 1.70 | 32.70 |
| OP 2 | -43.266681 | 172.612443 | 39.00 | 1.70 | 40.70 |
| OP 3 | -43.263330 | 172.603729 | 49.00 | 1.70 | 50.70 |
| OP 4 | -43.261518 | 172.603644 | 54.00 | 1.70 | 55.70 |
| OP 5 | -43.260127 | 172.603987 | 57.00 | 1.70 | 58.70 |
| OP 6 | -43.259721 | 172.606090 | 56.22 | 1.70 | 57.92 |
| OP 7 | -43.258846 | 172.607978 | 58.00 | 1.70 | 59.70 |
| OP 8 | -43.259440 | 172.609759 | 53.99 | 1.70 | 55.69 |
| OP 9 | -43.258814 | 172.610596 | 54.00 | 1.70 | 55.70 |
| OP 10 | -43.259752 | 172.616089 | 46.87 | 1.70 | 48.57 |
| OP 11 | -43.257809 | 172.621124 | 44.00 | 1.70 | 45.70 |
| OP 12 | -43.258637 | 172.620984 | 44.00 | 1.70 | 45.70 |
| OP 13 | -43.259540 | 172.621966 | 43.00 | 1.70 | 44.70 |
| OP 14 | -43.263540 | 172.626363 | 31.00 | 1.70 | 32.70 |
| OP 15 | -43.259653 | 172.621726 | 43.00 | 1.70 | 44.70 |
| OP 16 | -43.261388 | 172.622761 | 39.00 | 1.70 | 40.70 |
| OP 17 | -43.263825 | 172.624652 | 32.00 | 1.70 | 33.70 |
| OP 18 | -43.264786 | 172.625350 | 29.00 | 1.70 | 30.70 |
| OP 19 | -43.265302 | 172.625789 | 27.72 | 1.70 | 29.42 |
| OP 20 | -43.267800 | 172.619154 | 25.00 | 1.70 | 26.70 |
| OP 21 | -43.269435 | 172.614568 | 25.49 | 1.70 | 27.19 |

## Obstruction Components

**Name**: 4m Shelterbelt 1
**Upper edge height**: 4.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.262746 | 172.623675 | 35.00 |
| 2 | -43.263957 | 172.624539 | 31.33 |
| 3 | -43.264554 | 172.624965 | 30.00 |
| 4 | -43.265152 | 172.625402 | 28.00 |
| 5 | -43.265857 | 172.623646 | 27.14 |
| 6 | -43.266500 | 172.621932 | 27.00 |
| 7 | -43.267150 | 172.620207 | 26.00 |
| 8 | -43.267832 | 172.618461 | 25.24 |
| 9 | -43.268252 | 172.617428 | 25.00 |
| 10 | -43.268658 | 172.616414 | 25.00 |

**Name**: 4m Shelterbelt 2
**Upper edge height**: 4.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.261934 | 172.623039 | 37.00 |
| 2 | -43.261150 | 172.622489 | 40.00 |
| 3 | -43.260366 | 172.621918 | 42.00 |
| 4 | -43.259590 | 172.621368 | 43.00 |
| 5 | -43.258779 | 172.620802 | 44.00 |

**Name**: 4m Shelterbelt 3
**Upper edge height**: 4.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.262930 | 172.609931 | 45.00 |
| 2 | -43.262567 | 172.610870 | 45.00 |
| 3 | -43.262227 | 172.611800 | 45.00 |
| 4 | -43.261887 | 172.612720 | 45.00 |
| 5 | -43.261547 | 172.613619 | 45.00 |

**Name**: 4m Shelterbelt 4
**Upper edge height**: 4.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.261047 | 172.614853 | 45.00 |
| 2 | -43.260688 | 172.615791 | 45.00 |
| 3 | -43.260360 | 172.616709 | 45.00 |

**Name**: 4m Shelterbelt 5
**Upper edge height**: 4.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.262914 | 172.609943 | 45.00 |
| 2 | -43.263729 | 172.610531 | 43.00 |
| 3 | -43.264532 | 172.611109 | 42.00 |
| 4 | -43.265342 | 172.611687 | 40.05 |
| 5 | -43.266137 | 172.612265 | 39.29 |
| 6 | -43.266952 | 172.612833 | 37.00 |
| 7 | -43.267750 | 172.613421 | 33.00 |
| 8 | -43.268557 | 172.614010 | 29.00 |
| 9 | -43.269348 | 172.614577 | 26.00 |
| 10 | -43.268707 | 172.616294 | 25.00 |

**Name**: 4m Shelterbelt 6
**Upper edge height**: 4.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.261540 | 172.613603 | 45.00 |
| 2 | -43.261038 | 172.614858 | 45.00 |

**Name**: 4m Shelterbelt 7
**Upper edge height**: 4.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.260352 | 172.616693 | 45.00 |
| 2 | -43.259957 | 172.617733 | 45.00 |
| 3 | -43.259578 | 172.618758 | 45.00 |
| 4 | -43.259176 | 172.619772 | 45.00 |
| 5 | -43.258772 | 172.620834 | 44.00 |

**Name**: 4m Shelterbelt 8
**Upper edge height**: 4.0 m


| Vertex | Latitude | Longitude | Ground elevation |
|---|---|---|---|
| | deg | deg | m |
| 1 | -43.261941 | 172.623037 | 37.00 |
| 2 | -43.262340 | 172.621953 | 37.21 |
| 3 | -43.263164 | 172.622516 | 35.00 |
| 4 | -43.262723 | 172.623664 | 35.00 |

# Summary of PV Glare Analysis

*PV configuration and total predicted glare*

| PV Name | Tilt | Orientation | "Green" Glare | "Yellow" Glare | Energy Produced | Data File |
|---|---|---|---|---|---|---|
| | deg | deg | min | min | kWh | |
| SAT 2P PV array 1 | SA tracking | SA tracking | 50 | 127 | - | - |
| SAT 2P PV array 2 | SA tracking | SA tracking | 0 | 0 | - | - |

## Distinct glare per month

Excludes overlapping glare from PV array for multiple receptors at matching time(s)

| PV | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| sat-2p-pv-ar (green) | 0 | 0 | 0 | 0 | 8 | 24 | 15 | 3 | 0 | 0 | 0 | 0 |
| sat-2p-pv-ar (yellow) | 0 | 0 | 0 | 0 | 19 | 70 | 38 | 0 | 0 | 0 | 0 | 0 |

# PV & Receptor Analysis Results

*Results for each PV array and receptor*

## SAT 2P PV array 1 potential temporary after-image

| Component | Green glare (min) | Yellow glare (min) |
|---|---|---|
| OP: OP 1 | 0 | 0 |
| OP: OP 2 | 0 | 0 |
| OP: OP 3 | 0 | 0 |
| OP: OP 4 | 0 | 0 |
| OP: OP 5 | 0 | 0 |
| OP: OP 6 | 0 | 0 |
| OP: OP 7 | 0 | 0 |
| OP: OP 8 | 0 | 0 |
| OP: OP 9 | 0 | 0 |
| OP: OP 10 | 0 | 0 |
| OP: OP 11 | 0 | 0 |
| OP: OP 12 | 0 | 0 |
| OP: OP 13 | 0 | 0 |
| OP: OP 14 | 0 | 0 |
| OP: OP 15 | 0 | 0 |
| OP: OP 16 | 0 | 0 |
| OP: OP 17 | 0 | 0 |
| OP: OP 18 | 0 | 0 |
| OP: OP 19 | 0 | 0 |
| OP: OP 20 | 0 | 0 |
| OP: OP 21 | 0 | 0 |
| Route: Beatties Rd | 50 | 127 |
| Route: Marshmans Rd | 0 | 0 |
| Route: Upper Sefton Rd | 0 | 0 |

### SAT 2P PV array 1: OP 1
*No glare found*

### SAT 2P PV array 1: OP 2
*No glare found*

### SAT 2P PV array 1: OP 3
*No glare found*

### SAT 2P PV array 1: OP 4
*No glare found*

### SAT 2P PV array 1: OP 5
*No glare found*

### SAT 2P PV array 1: OP 6
*No glare found*

### SAT 2P PV array 1: OP 7
*No glare found*

### SAT 2P PV array 1: OP 8
*No glare found*

### SAT 2P PV array 1: OP 9
*No glare found*

### SAT 2P PV array 1: OP 10
*No glare found*

### SAT 2P PV array 1: OP 11
*No glare found*

### SAT 2P PV array 1: OP 12
*No glare found*

### SAT 2P PV array 1: OP 13
*No glare found*

### SAT 2P PV array 1: OP 14
*No glare found*

### SAT 2P PV array 1: OP 15
*No glare found*

### SAT 2P PV array 1: OP 16
*No glare found*

## SAT 2P PV array 1: OP 17

*No glare found*

## SAT 2P PV array 1: OP 18

*No glare found*

## SAT 2P PV array 1: OP 19

*No glare found*

## SAT 2P PV array 1: OP 20

*No glare found*

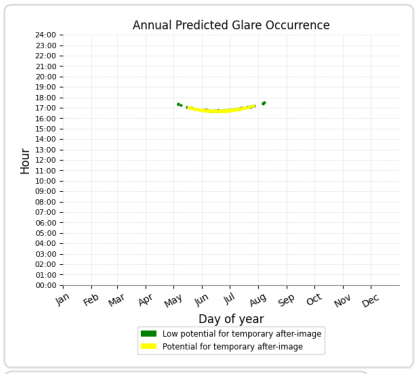
## SAT 2P PV array 1: OP 21

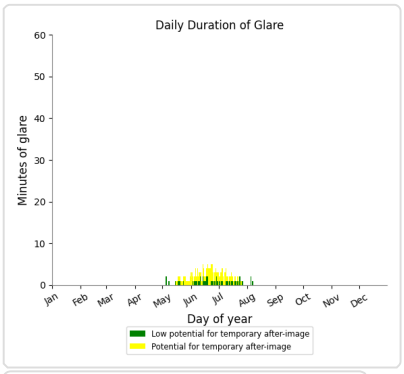
*No glare found*

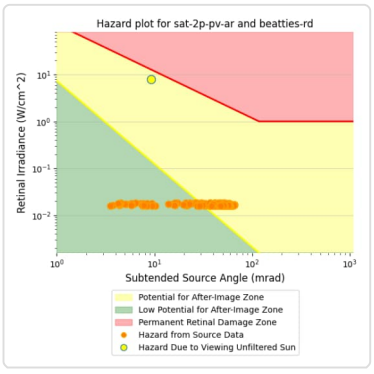
## SAT 2P PV array 1: Beatties Rd

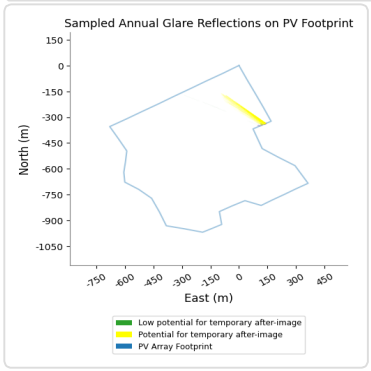
PV array is expected to produce the following glare for this receptor:

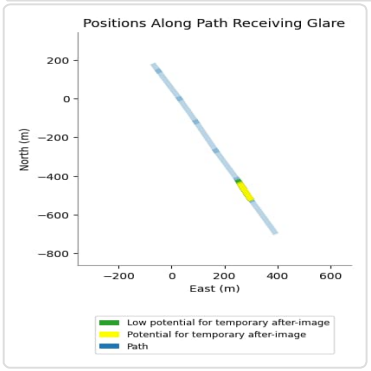
- 50 minutes of "green" glare with low potential to cause temporary after-image.
- 127 minutes of "yellow" glare with potential to cause temporary after-image.




## SAT 2P PV array 1: Marshmans Rd

*No glare found*

## SAT 2P PV array 1: Upper Sefton Rd

*No glare found*

## SAT 2P PV array 2 no glare found

| Component | Green glare (min) | Yellow glare (min) |
|---|---|---|
| OP: OP 1 | 0 | 0 |
| OP: OP 2 | 0 | 0 |
| OP: OP 3 | 0 | 0 |
| OP: OP 4 | 0 | 0 |
| OP: OP 5 | 0 | 0 |
| OP: OP 6 | 0 | 0 |
| OP: OP 7 | 0 | 0 |
| OP: OP 8 | 0 | 0 |
| OP: OP 9 | 0 | 0 |
| OP: OP 10 | 0 | 0 |
| OP: OP 11 | 0 | 0 |
| OP: OP 12 | 0 | 0 |
| OP: OP 13 | 0 | 0 |
| OP: OP 14 | 0 | 0 |
| OP: OP 15 | 0 | 0 |
| OP: OP 16 | 0 | 0 |
| OP: OP 17 | 0 | 0 |
| OP: OP 18 | 0 | 0 |
| OP: OP 19 | 0 | 0 |
| OP: OP 20 | 0 | 0 |
| OP: OP 21 | 0 | 0 |
| Route: Beatties Rd | 0 | 0 |
| Route: Marshmans Rd | 0 | 0 |
| Route: Upper Sefton Rd | 0 | 0 |

*No glare found*

## Assumptions

- Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
- Glare analyses do not automatically account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
- Detailed system geometry is not rigorously simulated.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values and results may vary.
- The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.
- Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
- The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
- Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
- Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
- Refer to the **Help page** for detailed assumptions and limitations not listed here.