Solar Photovoltaic Glint and Glare Study

Prepared for:

Metz Solar Farm Pty Ltd

Metz Solar Farm

May, 2017

ADMINISTRATION PAGE

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Issue	Date	Detail of Changes
1	May, 2017	Draft issue
2	May, 2017	First Edition

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EXECUTIVE SUMMARY

Report Purpose

This report has assessed the potential glint and glare impacts associated with the proposed Metz Solar Farm on surrounding dwellings. The analysis includes modelling of a tracking system that optimises the panel angle throughout the day to maximise electricity generation. A fixed-panel option has also been considered.

Understanding Glint and Glare

When sunlight illuminates an object, an amount of the incident light is reflected. This reflected light, when directed towards the eye of an observer, can become noticeable and cause a distraction or a nuisance. The unwanted reflection of sunlight in this fashion is referred to as 'glint' (a momentary flash of bright light) or 'glare' (a continuous source of bright light). Where reflected sunlight may be visible to an observer, it can be concluded that glint and glare effects are possible.

Conclusions

- Glint and glare effects are not predicted for either of the assessed dwelling locations (to the south of the development). It is likely that any properties in the immediate vicinity of these dwellings would also be unaffected. This is because of the relatively large separation distance and consistent topography, which indicates modelling results would be similar for neighbouring properties at these locations.

Mitigation

- No mitigation requirement has been identified for the dwelling receptors within this report because impacts are not predicted.
- Further screening to the south of the panel areas is already proposed by the developer. This would limit potential views of the site further.

Fixed Panel Option

- This report has assessed panels on a single axis tracker. In the event that a fixed panel option is progressed, the solar modules will face north.
- All assessed receptors are located to the south of the development area. This means that:
    - Reflections would not be likely towards the assessed observer locations for north-facing panels.
    - Observers would be unlikely to have a view of the module faces for north-facing panels.
- Overall, glint and glare impacts would not be predicted for the assessed receptors if a fixed panel option were to be progressed.

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ABOUT PAGER POWER

Pager Power is a dedicated consultancy company based in Suffolk, UK. The company has undertaken projects in 43 countries within Europe, Africa, America, Asia and Australia.

The company comprises a team of experts to provide technical expertise and guidance on a range of planning issues for large and small developments.

Pager Power was established in 1997. Initially the company focus was on modelling the impact of wind turbines on radar systems. Over the years, the company has expanded into numerous fields including:

- Renewable energy projects.
- Building developments.
- Aviation and telecommunication systems.

Pager Power prides itself on providing comprehensive, understandable and accurate assessments of complex issues in line with national and international standards. This is underpinned by its custom software, longstanding relationships with stakeholders and active role in conferences and research efforts around the world.

Pager Power's assessments withstand legal scrutiny and the company can provide support for a project at any stage.

1 INTRODUCTION

1.1 Introduction

Pager Power has been retained to assess the possible effects of glint and glare from the proposed Metz Solar Farm located in New South Wales, Australia.

This assessment pertains to the possible effects upon local dwellings. A high-level assessment of potential aviation issues has also been undertaken. This report contains the following:

- Solar farm details.
- Explanation of glint and glare.
- Overview of relevant guidance.
- Overview of relevant studies.
- Overview of Sun movement.
- Assessment methodology.
- Identification of receptors.
- Glint and glare assessment for identified receptors.
- Results discussion.
- Mitigation.

1.2 Pager Power's Experience

Pager Power has undertaken over 250 Glint and Glare assessments in the United Kingdom and internationally. The studies have included assessment of UK civil and military aerodromes, Network Rail infrastructure, radar installations and other ground based receptors including roads and dwellings.

1.3 Glint and Glare Definition

The definition of glint and glare can vary. The definition used by Pager Power is as follows[1]:

- Glint – a momentary flash of bright light.
- Glare – a continuous source of bright light.

In context, glint will be witnessed by moderate to fast moving receptors whilst glare would be encountered by static or slow moving receptors with respect to a solar farm. The term 'solar reflection' is used in this report to refer to both reflection types i.e. glint and glare.

[1] This definition is in line with FAA guidance.

2 PROPOSED SOLAR FARM LOCATION AND DETAILS

2.1 Photovoltaic Panel Mounting Arrangements and Orientation

The solar panels will be mounted to the ground and fitted to a single-axis tracking system that tilts the panels from east to west throughout the day.

2.2 Tracking System

Based on consultation with the manufacturer of the tracking system and the project developer it is understood that:

- The azimuth angle of the panels will be 90 degrees in the morning and 270 degrees in the evening. During the middle of the day the panels will be flat, directed immediately upwards.
- The tilt of the panels throughout the day is programmed, based on the known path of the Sun and shading considerations i.e. the tilt angle is optimised to avoid having one row of panels cast a shadow on another row.
- The range of elevation angles will be ±60°.

The panel details are illustrated in Figure 1 below.

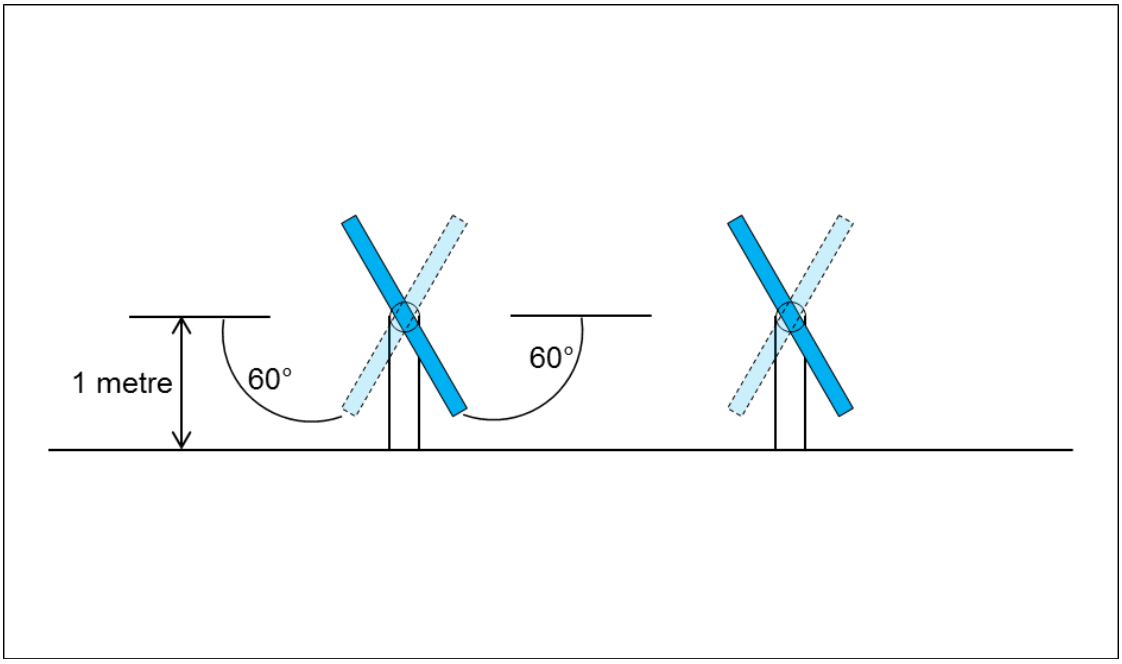

Figure 1 *Panel details*

Shading considerations that dictate the panel tilt. This is affected by:

- The elevation angle of the Sun.
- The vertical tilt of the panels.
- The spacing between the panel rows.

This means that early in the morning and late in the evening, the panels will not be directed exactly towards the Sun. Figure 2 on the following page illustrates this.

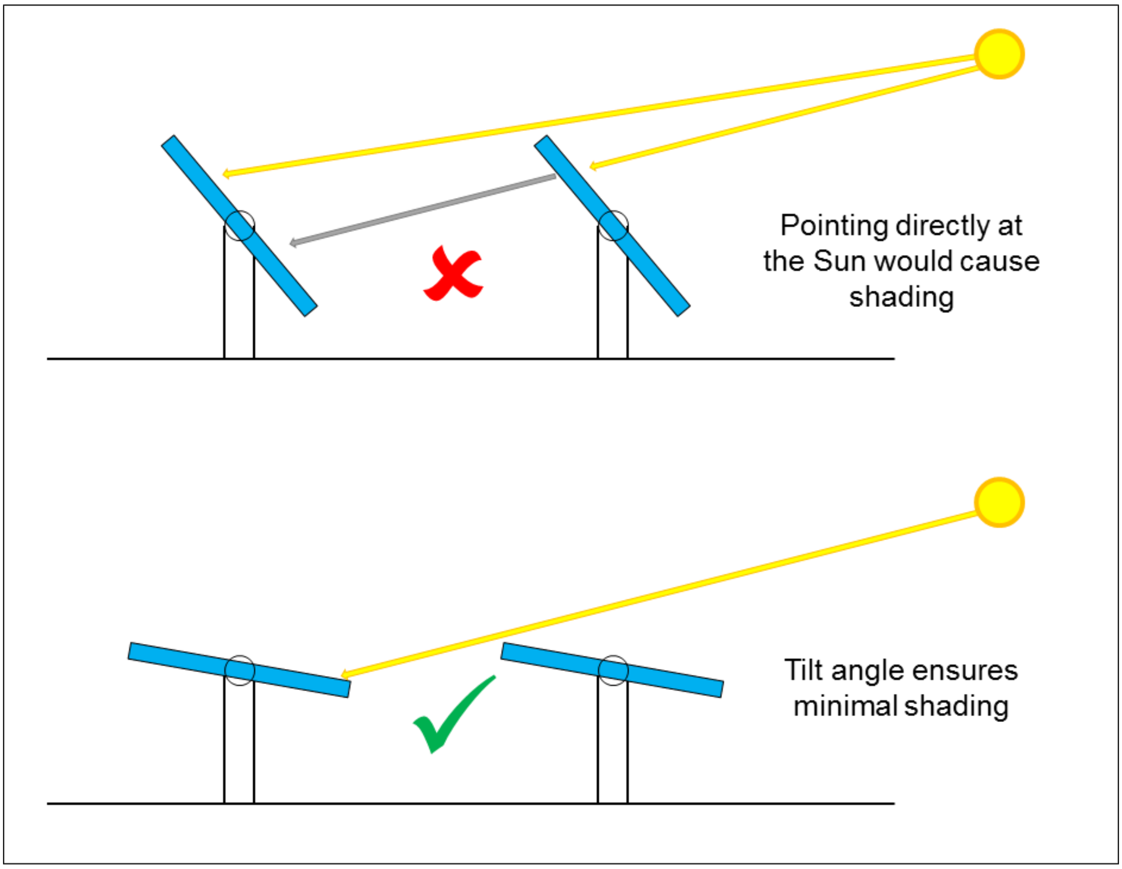

Figure 2 *Shading considerations*

Later on in the day, the panels can be directed towards the Sun without any shading issues. This is illustrated in Figure 3 below.

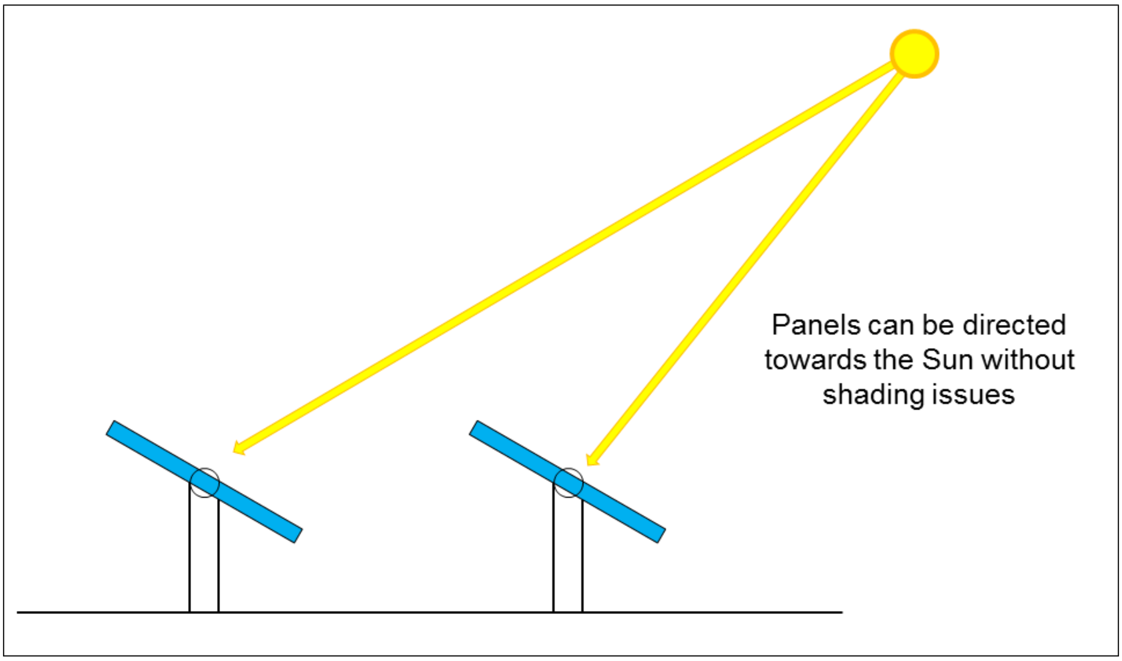

Figure 3 *Panel alignment at high solar angles*

Note that in reality the lines from the Sun to each panel would be effectively parallel due to the large separation distance. The three previous figures are for illustrative purposes only.

2.3 Proposed Solar Farm Panel Areas

Figure 4 below shows[2] the proposed panel areas.

Figure 4 *Panel areas*

Due to the large distance between some of the panel areas and the identified receptors, detailed modelling has only been a requirement for the south-eastern group of panel areas (discussed fully in Section 4).

[2] ©2017 Google/CNES/Airbus

3 GLINT AND GLARE ASSESSMENT METHODOLOGY

3.1 Guidance and Studies

Appendix A and Appendix B present a review of relevant guidance and independent studies with regard to glint and glare issues from solar panels. The overall conclusions from the available studies are as follows:

- The results of the available studies state that reflections of the Sun from solar panels are possible.
- The measured intensity of a reflection from solar panels can vary from 2% to 30% depending on the angle of incidence.
- Published guidance shows that the intensity of reflections from solar panels are equal to or less than those from water. It also shows that reflections from solar panels are significantly less intense than many other reflective surfaces which are common in an outdoor environment.

3.2 Background

Details of the Sun's movements and solar reflections are presented in Appendix C.

3.3 Methodology

The assessment methodology is based on guidance, studies, previous discussions with stakeholders and Pager Power's practical experience. Information regarding the methodology of the Pager Power glint and glare assessment is presented below:

- Identify receptors in the area surrounding the proposed solar farm.
- Consider direct solar reflections from the proposed solar farm towards the identified receptors by undertaking geometric calculations – accounting for the tracker system;
- Consider the visibility of the panels from the receptor's location. If the panels are not visible from the receptor then no reflection can occur.
- Based on the results of the geometric calculations, determine whether a reflection can occur, and if so, at what time it will occur.
- Consider both the solar reflection from the proposed solar farm and the location of the direct sunlight with respect to the receptor's position.
- Consider the solar reflection with respect to the published studies and guidance.
- Determine whether a significant detrimental impact is expected based on the methodology set out in Appendix F.

Within the model, representative points within each solar panel area are modelled, as well as the relevant receptor locations. The result is a chart that illustrates whether a reflection can occur and the approximate duration of any effects. Calculations were undertaken at a resolution of 10 day steps with 10 minute intervals within each assessed day. Further technical details relating to the methodology of the geometric calculations can be found in Appendix D.

3.4 Assessment Limitations

The list of assumptions and limitations are presented in Appendix E.

4 IDENTIFICATION OF RECEPTORS & MODELLING OVERVIEW

4.1 Ground Level Receptors – Overview

There is no legal or formal guidance with regard to the maximum distance at which glint and glare should be assessed. There is also no technical limit to the distance at which reflections could occur.

However, the significance of a reflection decreases with distance. This is because the proportion of an observer's field of vision that is taken up by the reflecting area diminishes as the separation distance increases.

Terrain and shielding by vegetation are also more likely to obstruct an observer's view at longer distances.

A 1km buffer is therefore considered appropriate for glint and glare effects on ground-based receptors[3].

4.2 Dwelling Receptors

The developer has provided details of the dwellings in the area that require assessment. These dwellings are shown in the Figure 5 below[4].

The co-ordinates of the assessed dwellings are presented in the Appendix G.

Figure 5 *Dwelling receptors*

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[3] Note that this radius is centred on Area 01 – the central portion of the solar farm.
[4] ©2017 Google/CNES/Airbus.

4.3 Modelling Overview

The recommended approach is to assess receptors within 1 kilometre. Figure 6 below shows an approximate combined 1 km buffer for the assessed receptors[5].

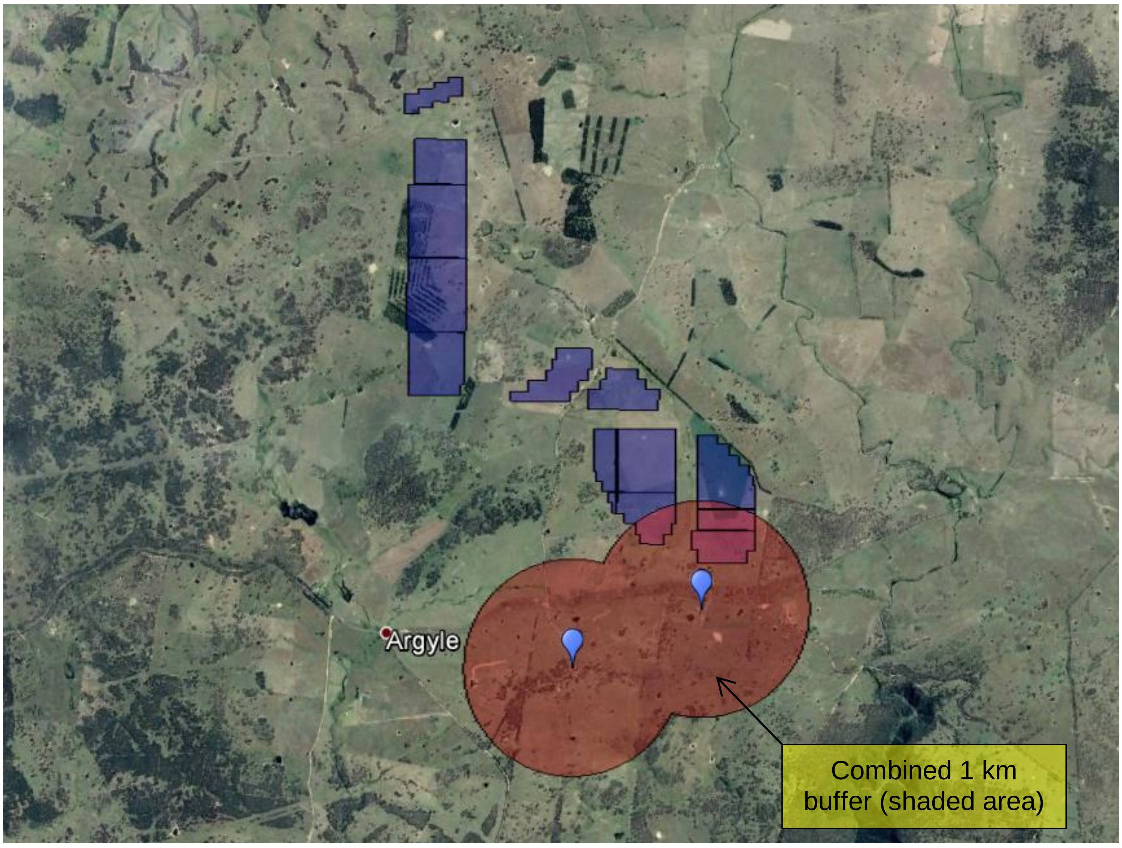

Figure 6 *Receptors and buffers*

It can be seen that the south-eastern group of panels are the only ones within a kilometre of any receptor. Furthermore, visibility of the panels is likely to be restricted for the panels that are further away. A number of representative panel locations are selected within the proposed solar farm site boundary for modelling purposes.

Figure 7 on the following page shows the points within the development that have been used for modelling purposes (pink icons). These are distributed within the south-eastern areas that have the greatest potential to cause an impact.

[5] ©2017 Google/CNES/Airbus.

Figure 7 *Modelled points within the solar farm*

All ground heights have been taken from Pager Power's database, based on interpolated SRTM data. Coordinate data is shown in Appendix G.

4.4 Conditions for a Reflection

The model calculates the angular separation between a reflection and the line from the observer to the reflecting panel. This is illustrated in Figure 8 below.

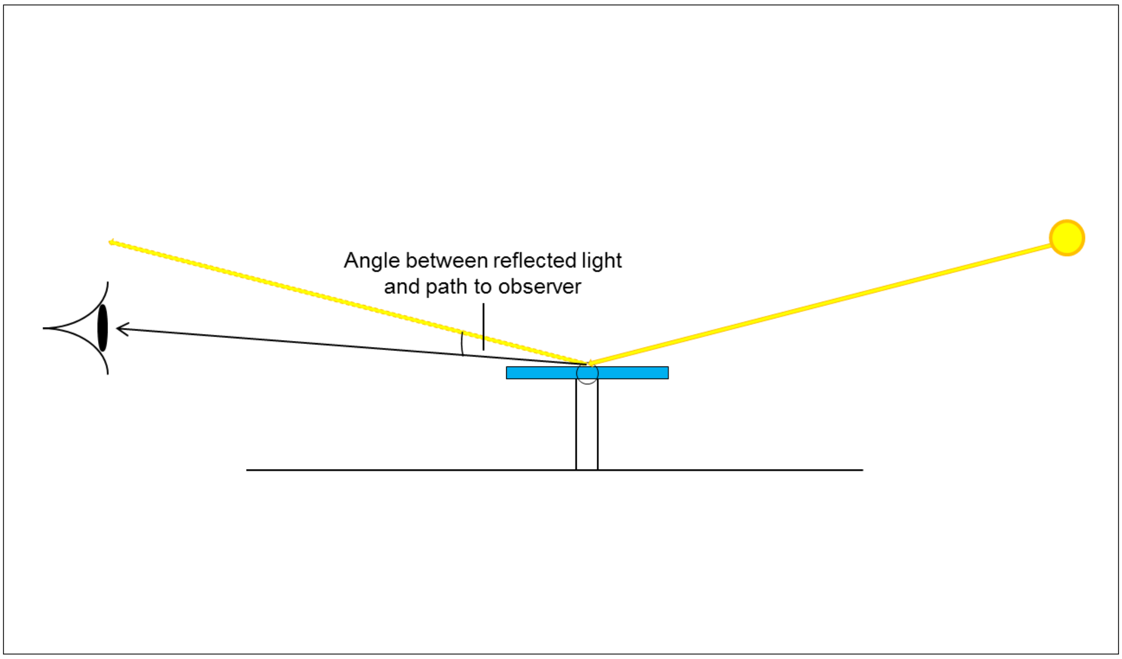

Figure 8 *Calculating reflections*

It can be seen that if the angle is zero, the observer will experience a direct reflection. Angles above zero indicate that the reflection will pass over the observer, and no reflection would be experienced. It is important to remember that:

- The Sun is not a point source, but has an angular size of approximately 0.5 degrees as seen from Earth.
- The receptor height above ground level is based on a typical value (1.8 metres for dwellings). In practice this may vary by, typically[6], one or two metres.
- The terrain height above mean sea level is based on a database, and may vary in practice by a few metres.
- The modelling considers panel locations at each boundary point of the site, and the approximate site centre.

To accommodate for the above, the model identifies scenarios where the separation angle illustrated in Figure 8 is up to 10 degrees. This is considered a conservative approach, and the significance of the separation angle is discussed further in the results interpretation (Section 6).

[6] e.g. due to an observer on an upper floor.

5 GLINT AND GLARE ASSESSMENT

5.1 Results

Table 1 in the following subsection summarises the months and times during which a solar reflection could be experienced by a receptor.

This does not mean that reflections would occur continuously between the times shown.

The range of times at which reflections are geometrically possible is generally greater than the length of time for any particular day. This is because the times of day at which reflections could start and stop vary throughout the days/months.

Note that the results show the combined effects for all modelled panel areas.

Appendix H presents the detailed modelling output in cases where effects are possible.

5.2 Geometric Reflection Calculation Results – Dwellings

The result of the geometric calculations for the dwelling receptors are presented in Table 1 below. The model determines whether a reflection towards the receptor would be within 10 degrees of an observer position. If so, an assessment of the likely panel visibility is made based on available imagery and the separation distance.

Receptor	Reflection possible towards dwellings?		Comments
	am	pm	
01	No.	No.	No reflections are predicted towards this dwelling.
02	Yes (approx. between 06:30-07:00 GMT+10 for May and June).	No.	The modelled reflections would be from the south-eastern corner of the south-eastern panel area. These panels are approximately 1.7 km from the dwelling location. Based on the separation distance and the presence of vegetation/trees , it is unlikely that a significant view of the panels would be available from these receptors. No effects are predicted in practice.

Table 1 *Analysis results for dwellings*

6 RESULTS DISCUSSION

6.1 Dwelling Results

Based on a review of the geometric analysis, the terrain elevation data and the available imagery, no impact is predicted for either of the identified dwellings.

It is likely that any observer locations in the immediate vicinity of the assessed dwellings would be unaffected. This is because the extent of geometric reflections and site visibility would be consistent for neighbouring properties given the separation distance and the local topography.

6.2 Discussion Regarding Reflections from Solar Panels

In scenarios where a solar reflection is geometrically possible towards a receptor, direct sunlight would coincide with the solar reflection. This means that the viewer will likely be able to see the glare from the reflecting solar panels as well as the Sun directly. Direct sunlight would be a significantly brighter source of light when compared to the solar reflection.

6.3 Fixed Panel Option

This report has assessed panels on a single axis tracker. In the event that a fixed panel option is progressed, the solar modules will face north.

All assessed receptors are located to the south of the development area. This means that:

- Reflections would not be likely towards the assessed observer locations for north-facing panels.
- Observers would be unlikely to have a view of the module faces for north-facing panels.

Overall, glint and glare impacts would not be predicted for the assessed receptors if a fixed panel option were to be progressed.

7 MITIGATION

7.1 Overview

The assessment has not identified a mitigation requirement for the dwelling receptors because impacts are not predicted. The developer is proposing additional screening to the south of the modelled areas as part of the draft landscaping plan, which would limit views further.

7.2 Proposed Screening

Figure 9 below[7] shows the location of the proposed screening:

Figure 9 *Proposed screening location*

Specific comments on the draft landscaping plan, taken from the EIA, are shown in Appendix I.

[7] ©2017 Google/CNES/Airbus.

8 OVERALL CONCLUSIONS

8.1 Analysis Results

- Glint and glare effects are not predicted for either of the assessed dwelling locations (to the south of the development). It is likely that any properties in the immediate vicinity of these dwellings would also be unaffected. This is because of the relatively large separation distance and consistent topography, which indicates modelling results would be similar for neighbouring properties at these locations.

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APPENDIX A – OVERVIEW OF GLINT AND GLARE GUIDANCE

This section presents details regarding the relevant guidance and studies with respect to the considerations and effects of solar reflections from solar panels, known as 'Glint and Glare'. Whilst there is little formal guidance with regard to the assessment of this issue, Pager Power has reviewed relevant publications pertaining to glint and glare. Relevant extracts from guidance published in the UK is presented below for reference.

This is not a comprehensive review of the data sources, rather it is intended to give an overview of the important parameters and considerations that have informed this assessment.

UK Planning Policy

UK National Planning Practice Guidance dictates that in some instances a glint and glare assessment is required however, there is no specific guidance with respect to the methodology for assessing the impact of glint and glare.

The planning policy from the Department for Communities and Local Government (paragraph 27[8]) states:

'Particular factors a local planning authority will need to consider include… the effect on landscape of glint and glare and on ***neighbouring uses and aircraft safety****.'*

The National Planning Policy Framework for Renewable and Low Carbon Energy[9] (specifically regarding the consideration of solar farms) states:

'What are the particular planning considerations that relate to large scale ground-mounted solar photovoltaic Farms?

The deployment of large-scale solar farms can have a negative impact on the rural environment, particularly in undulating landscapes. However, the visual impact of a well-planned and well-screened solar farm can be properly addressed within the landscape if planned sensitively.

Particular factors a local planning authority will need to consider include:

- *the proposal's visual impact, the effect on landscape of glint and glare (see guidance on landscape assessment) and on* ***neighbouring uses and aircraft safety****;*
- *the extent to which there may be additional impacts if solar arrays follow the daily movement of the sun;*

The approach to assessing cumulative landscape and visual impact of large scale solar farms is likely to be the same as assessing the impact of wind turbines. However, in the case of ground-mounted solar panels it should be noted that with effective screening and appropriate land topography the area of a zone of visual influence could be zero.'

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[8] http://planningguidance.planningportal.gov.uk/blog/guidance/renewable-and-low-carbon-energy/
[9] Reference ID: 5-013-20140306, paragraph 13-13,http://planningguidance.planningportal.gov.uk/blog/guidance/renewable-and-low-carbon-energy/particular-planning-considerations-for-hydropower-active-solar-technology-solar-farms-and-wind-turbines/

Assessment Process

No process for determining and contextualising the effects of glint and glare are, however, provided. Therefore, the Pager Power approach is to determine whether a reflection from the proposed solar farm is geometrically possible and then to compare the results against the relevant guidance/studies to determine whether the reflection is significant.

Assessment Guidelines –Dwellings

There are no specific guidelines for assessing the impact of solar reflections upon surrounding dwellings. Therefore, the Pager Power approach has been informed by the policy presented above, current studies (presented in Appendix B) and stakeholder consultation.

APPENDIX B – OVERVIEW OF GLINT AND GLARE STUDIES

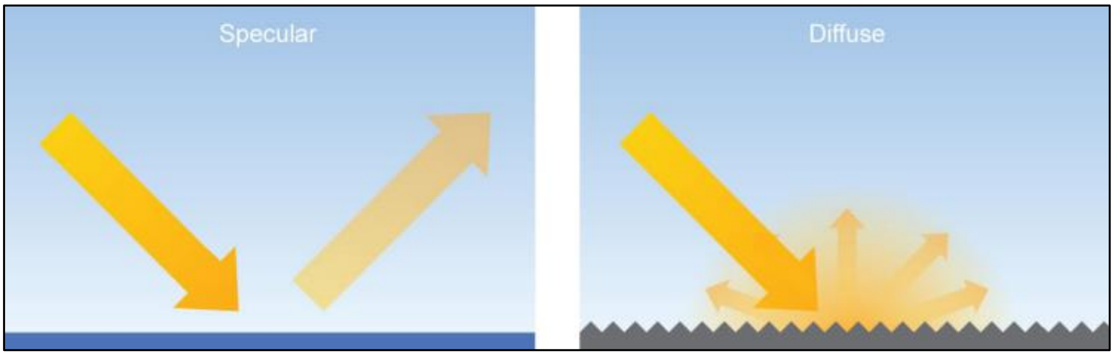
Overview

Studies have been undertaken assessing the type and intensity of solar reflections from various surfaces including solar panels. An overview of these studies is presented below.

There are no specific studies for determining the effect of reflections from solar panels with respect to dwellings. The guidelines presented are related to aviation safety. The results are applicable for the purpose of this analysis.

Reflection Type from Solar Panels

Based on the surface conditions reflections from light can be specular and diffuse. A specular reflection has a reflection characteristic similar to that of a mirror; a diffuse will reflect the incoming light and scatter it in many directions. The figure below[10], taken from the FAA guidance, illustrates the difference between the two types of reflections. Because solar panels are flat and have a smooth surface most of the light reflected is specular, which means that incident light from a specific direction is reradiated in a specific direction.



Specular and diffuse reflections

Solar Reflection Studies

An overview of content from identified solar panel reflectivity studies is presented in the subsections below.

Evan Riley and Scott Olson, "A Study of the Hazardous Glare Potential to Aviators from Utility-Scale Flat-Plate Photovoltaic Systems"

Evan Riley and Scott Olson published in 2011 their study titled: *A Study of the Hazardous Glare Potential to Aviators from Utility-Scale Flat-Plate Photovoltaic Systems*[11]". They researched the potential glare that a pilot could experience from a 25 degree fixed tilt PV system located outside of Las Vegas, Nevada. The theoretical glare was estimated using published ocular safety metrics which quantify the potential for a postflash glare after-image. This was then compared to the postflash glare after-image caused by smooth water. The study demonstrated that the reflectance of the solar cell varied with angle of incidence, with maximum values occurring at angles close to 90 degrees. The reflectance values varied from approximately 5% to 30%. This is shown on the figure on the following page.

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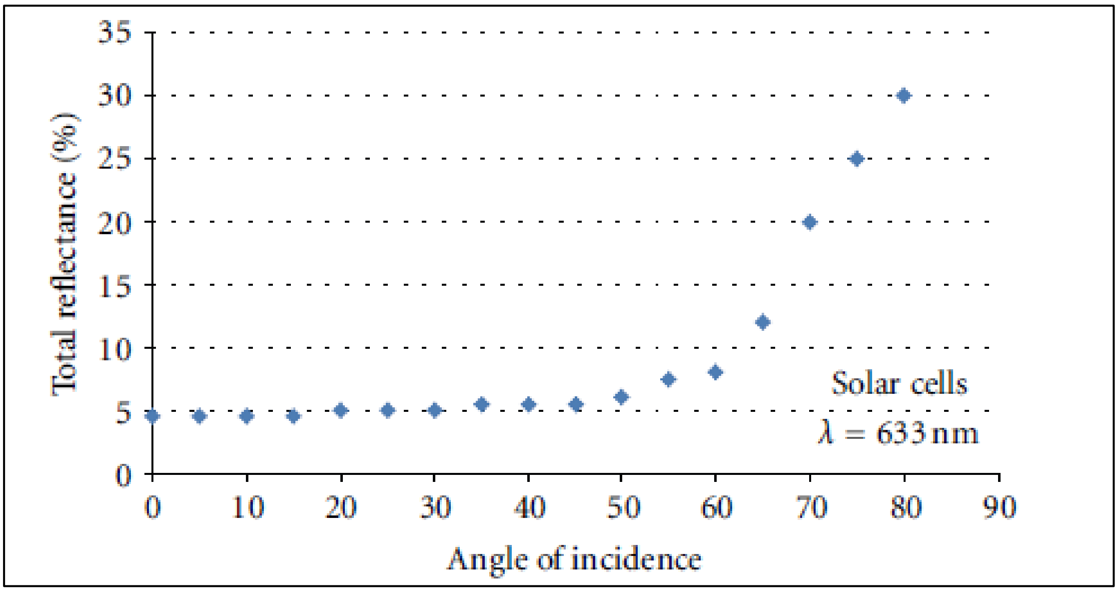
[10] http://www.faa.gov/airports/environmental/policy_guidance/media/airport_solar_guide_print.pdf

[11] Evan Riley and Scott Olson, "A Study of the Hazardous Glare Potential to Aviators from Utility-Scale Flat-Plate Photovoltaic Systems," ISRN Renewable Energy, vol. 2011, Article ID 651857, 6 pages, 2011. doi:10.5402/2011/651857



Total reflectance % when compared to angle of incidence

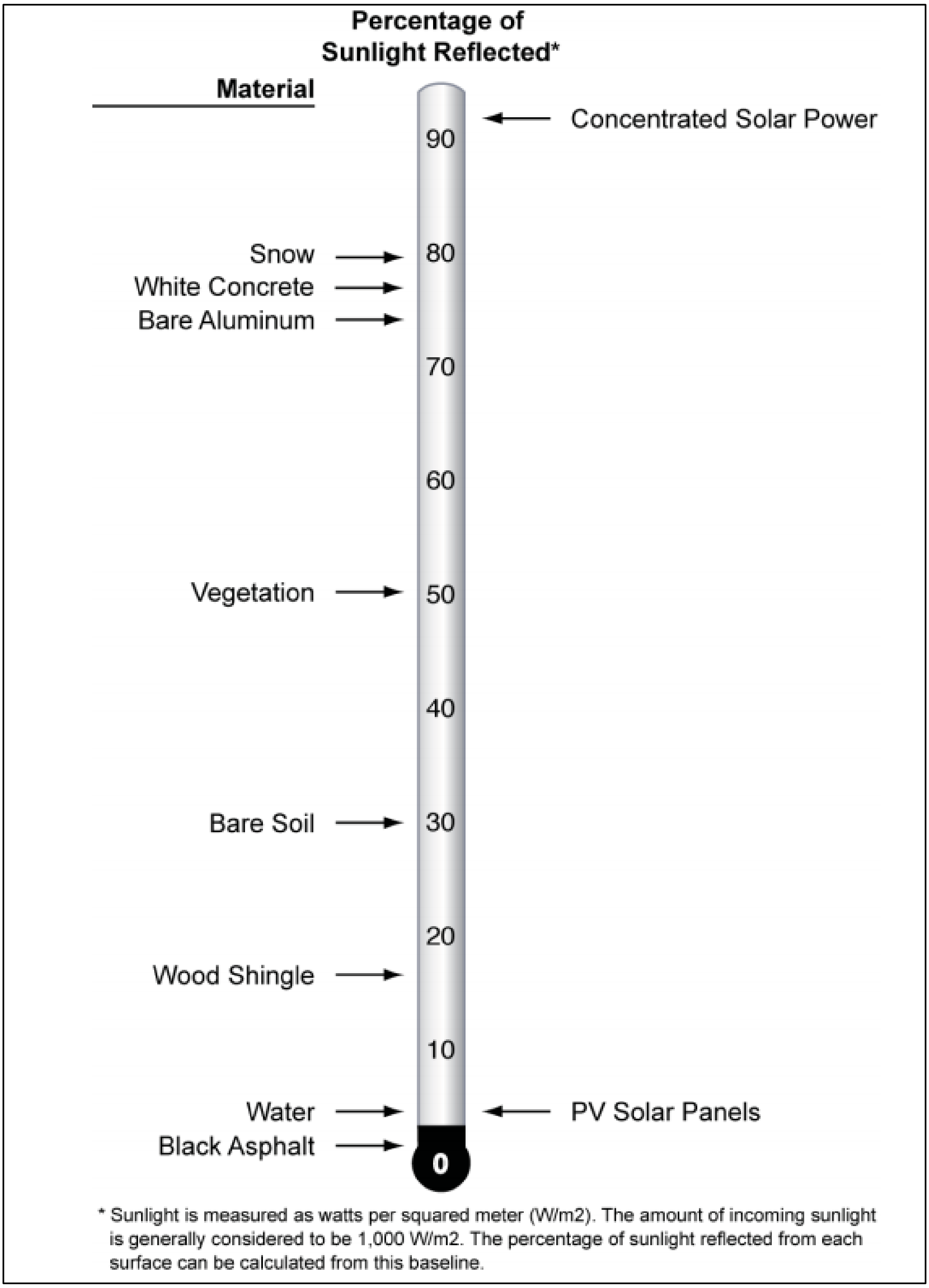
The conclusions of the research study were:

- The potential for hazardous glare from flat-plate PV systems is similar to that of smooth water;
- Portland white cement concrete (which is a common concrete for runways), snow, and structural glass all have a reflectivity greater than water and flat plate PV modules.

FAA Guidance- "Technical Guidance for Evaluating Selected Solar Technologies on Airports"[12]

The 2010 FAA Guidance (discussed in section 4) included a diagram which illustrates the relative reflectance of solar panels compared to other surfaces. The figure shows the relative reflectance of solar panels compared to other surfaces. Surfaces in this figure produce reflections which are specular and diffuse. A specular reflection (those made by most solar panels) has a reflection characteristic similar to that of a mirror. A diffuse reflection will reflect the incoming light and scatter it in many directions. The figure[13] is presented on the following page.

[12] FAA, November (2010): *Technical Guidance for Evaluating Selected Solar Technologies on Airports.*
[13] http://www.faa.gov/airports/environmental/policy_guidance/media/airport_solar_guide_print.pdf



Relative reflectivity of various surfaces

The most important comparison in this table is the reflectivity compared to water which will produce a reflection of very similar intensity when compared to that from a solar panel. The study by Riley and Olsen study (2011) also concludes that still water has a very similar reflectivity to solar panels.

SunPower Technical Notification (2009)
SunPower published a technical notification[14] to '*increase awareness concerning the possible glare and reflectance impact of PV Systems on their surrounding environment'.* The study revealed that the reflectivity of a solar panel is considerably lower than that of '*standard glass and other common reflective surfaces'.* With respect to aviation and solar reflections observed from the air, SunPower has developed several large installations near airports or on Air Force bases. It is stated that these developments have all passed FAA or Air Force standards with all developments considered "No Hazard to Air Navigation". The note suggests that developers discuss any possible concerns with stakeholders near proposed solar farms.

Figures within the document show the relative reflectivity of solar panels compared to other natural and manmade materials including smooth water, standard glass and steel. The results, similarly to those from Riley and Olsen study (2011) and the FAA (2010), show that solar panels produce a reflection that is less intense than those produced from these surfaces.

[14] Technical Support, 2009. SunPower Technical Notification- Solar Module Glare and Reflectance.

APPENDIX C – OVERVIEW OF SUN MOVEMENTS AND RELATIVE REFLECTIONS

The Sun's position in the sky can be accurately described by its azimuth and elevation. Azimuth is a direction relative to true north (horizontal angle i.e. from left to right) and elevation describes the Sun's angle relative to the horizon (vertical angle i.e. up and down).

The Sun's position can be accurately calculated for a specific location. The following data being used for the calculation:

- Time;
- Date;
- Latitude;
- Longitude.

The following is true at the location of the solar farm:

- The Sun is at its highest around midday and is to the south at this time;
- The Sun rises highest on 21 December (2017) reaching a maximum elevation of approximately 77 degrees (longest day);
- On 21 June (2017) the maximum elevation reached by the Sun is approximately 36 degrees (shortest day).

Sun position parameters for 2016 and 2017 are shown in the table below:

Date	Solar elevation at Solar Noon	Azimuth at Sunrise	Azimuth at Sunset
21 June 2017	36.0°	63.1°	297.0°
21 September 2017	58.8°	89.6°	270.2°
21 December 2017	82.9°	118.9°	241.9°
21 March 2018	59.3°	90.4°	269.8°

The combination of the Sun's azimuth angle and vertical elevation will affect the direction and angle of the reflection from a solar panel.

APPENDIX D – PAGER POWER'S REFLECTION CALCULATIONS METHODOLOGY

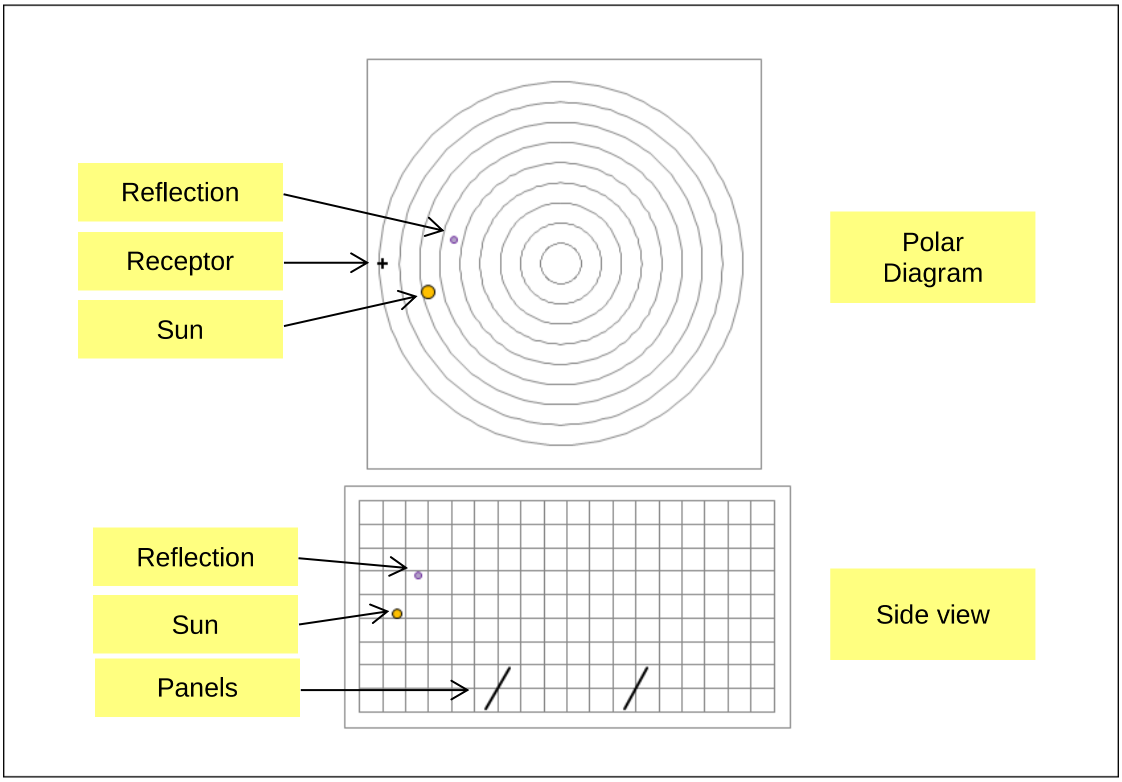
The calculations are three dimensional and complex, accounting for:

- The Earth's orbit around the Sun;
- The Earth's rotation;
- The Earth's orientation;
- The reflector's location;
- The reflector's 3D Orientation – including consideration of the tracking mechanism.

Reflections from a flat reflector are calculated by considering the normal which is an imaginary line that is perpendicular to the reflective surface and originates from it.

A single axis system such as NexTracker rotates panels from east to west so that they face the Sun as it passes through the sky during the day. At very low solar altitudes the panels flatten so that one row of panels does not cast a shadow on the next. Pager Power's computer algorithm determines the amount of panel tilt based on (1) the predicted position of the Sun; (2) how far the panel can actually tilt - determined by the physical characteristics of the tilting mechanism and (3) the shadow that will be cast on the neighbouring row of panels.

The diagram below illustrates one step in the iterative modelling process, showing the position of the Sun, the angle of the panels and the direction of the reflection at a single point in time.



APPENDIX E – ASSESSMENT LIMITATIONS AND ASSUMPTIONS

Calculations have been undertaken for panel locations at each boundary point of the site, and the site centre. In each case, the modelled altitude of the panels is the same across the development. This is an appropriate assumption because the modelled area is relatively flat.

Only a reflection from the face of the panel has been considered. The frame or the reverse of the solar panel has not been considered.

The model assumes that a receptor can view the face of every panel within the proposed solar farm area whilst in reality this, in the majority of cases, will not occur.

Therefore any predicted reflection from the face of a solar panel that is not visible to a receptor will not occur.

A finite number of points within the proposed solar farm are chosen in order to build a comprehensive understanding of the entire solar farm. This determines whether a reflection could ever occur at a chosen receptor. The calculations do not incorporate all of the possible panel locations within the solar farm outline.

A single reflection point on the panel has been chosen for the geometric calculations. This will suitably determine whether a reflection can be experienced at a location and the general time of year and duration of this reflection. Increased accuracy could be achieved by increasing the number of heights assessed however this would only marginally change the results and is not considered significant.

Whilst line of sight to the solar farm from receptors has been considered, only available street view imagery and satellite mapping has been used. In some cases this imagery may not be up to date and may not give the full perspective of the installation from the location of the assessed receptor.

Any screening in the form of trees, buildings etc. that may obstruct the Sun from view of the solar panels is not considered unless stated.

APPENDIX F – ASSESSMENT METHODOLOGY

Overview

The significance of glint and glare will vary for different receptors. The following section presents a general overview of the significance criteria with respect to experiencing a solar reflection.

Impact significance definition

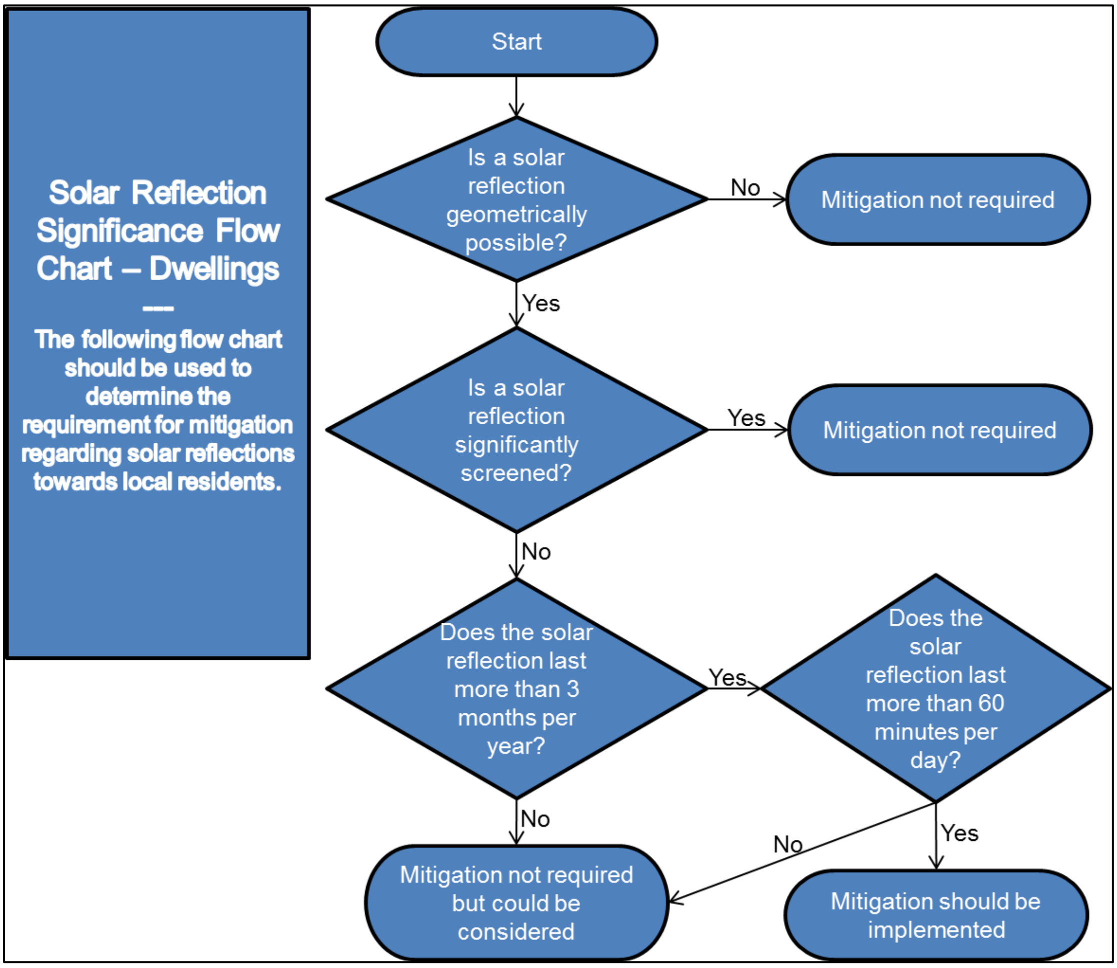
The table below presents the recommended definition of 'impact significance' in glint and glare terms and the requirement for mitigation under each.

Impact Significance	Definition	Mitigation Requirement
No Impact	A solar reflection is not geometrically possible or will not be visible from the assessed receptor.	No mitigation required.
Low	A solar reflection is geometrically possible however any impact is considered to be small such that mitigation is not required e.g. intervening screening will limit the view of the reflecting solar panels.	No mitigation required.
Moderate	A solar reflection is geometrically possible and visible however it occurs under conditions that do not represent a worst-case.	Whilst the impact may be acceptable, consultation and/or further analysis should be undertaken to determine the requirement for mitigation.
Major	A solar reflection is geometrically possible and visible under conditions that will produce a significant impact. Mitigation and consultation is recommended.	Mitigation will be required if the proposed solar development is to proceed.

Impact significance definition

Assessment process for dwelling receptors

The flow chart presented below has been followed when determining the mitigation requirement for dwelling receptors.



Dwelling receptor mitigation requirement flow chart

APPENDIX G – COORDINATE DATA

Dwellings

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
01	151.873518	-30.535978	02	151.861106	-30.540831

Panel Locations

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
01	151.864350	-30.521749	25	151.873809	-30.523069
02	151.866326	-30.521749	26	151.875503	-30.523069
03	151.868016	-30.521749	27	151.873809	-30.524507
04	151.870003	-30.521749	28	151.875503	-30.524507
05	151.864350	-30.523153	29	151.877042	-30.524507
06	151.866326	-30.523153	30	151.873809	-30.525858
07	151.868016	-30.523153	31	151.875503	-30.525858
08	151.870003	-30.523153	32	151.877042	-30.525858
09	151.864350	-30.524524	33	151.878303	-30.525858
10	151.866326	-30.524524	34	151.873809	-30.527100
11	151.868016	-30.524524	35	151.875503	-30.527100
12	151.870003	-30.524524	36	151.877042	-30.527100
13	151.864350	-30.526081	37	151.878303	-30.527100
14	151.866326	-30.526081	38	151.873809	-30.528470
15	151.868016	-30.526081	39	151.875503	-30.528470
16	151.870003	-30.526081	40	151.877042	-30.528470
17	151.866326	-30.527620	41	151.878303	-30.528470
18	151.868016	-30.527620	42	151.873809	-30.529996
19	151.870003	-30.527620	43	151.875503	-30.529996
20	151.868016	-30.528786	44	151.877042	-30.529996
21	151.870003	-30.528786	45	151.878303	-30.529996
22	151.868016	-30.530287	46	151.873809	-30.531589
23	151.869370	-30.530287	47	151.875503	-30.531589
24	151.874232	-30.521960	48	151.877042	-30.531589

APPENDIX H – GEOMETRIC CALCULATION RESULTS

The charts for the receptors are shown on the following pages. Each chart shows the reflection date/time graph. The blue icons indicate the dates and times at which geometric reflections are possible. This is based on a 10 degree criteria (discussed in Section 4.6). The results are combined for all assessed points within the solar farm.

Dwelling Locations

Effects are not predicted in practice for either dwelling following modelling and a desk-based assessment of existing screening.

APPENDIX H – DRAFT LANDSCAPING PLAN INFORMATION

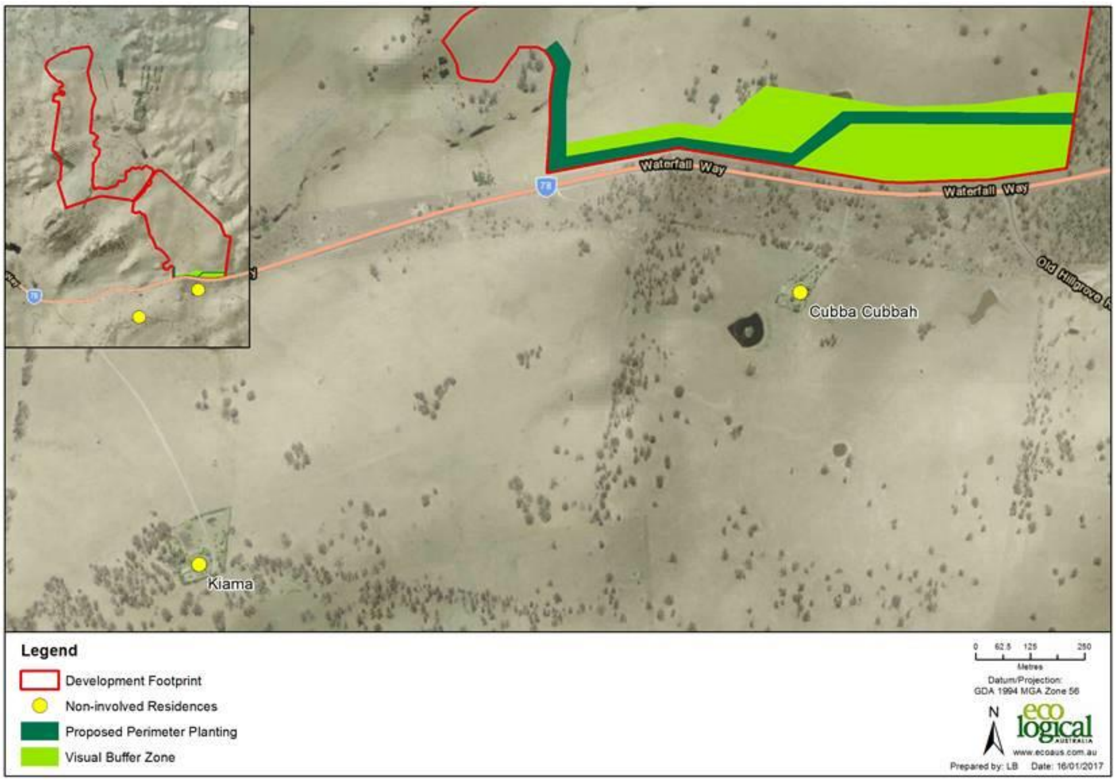
The draft landscaping plan has been developed in response to the findings of this assessment and in consultation with affected landholders, with the objective of minimising visual impacts at sensitive receptors, particularly viewpoints 'A', 'R1' and 'R2'.

The draft landscaping plan responds directly to concerns raised during stakeholder consultation undertaken by Eco Logical Australia staff on the 6th of January 2017 and by Infinergy Pacific personnel on the 10th of August 2016 and 11th of January 2017.

The proposed planting area comprises a 20 m vegetation buffer running the entire length of the frontage with Waterfall Way and up along the edge of the Site boundary which faces R2. The buffer is located to compliment changes in topography, with the intention of maximising the effectiveness of the Visual Buffer Zone from impacted viewpoints (Figure 6-23). It is proposed that the planting screens be revaluated both pre and post-construction to ensure that the effects of screening are optimised with respect to the final design.

The following preparation, planting, care and maintenance program will maximise the effectiveness of the proposed vegetation screening:

- Tree planting is to be carried out as early as possible in the construction process to maximise growth over this period;
- Tree planting within the buffer areas should be undertaken in prepared planting beds with a density to achieve roughly one tree every 5 m;
- Bed preparation shall include weed removal and cultivation to a depth of at least 300 mm;
- Selected plants should be at least 700 mm high at the time of planting and protected with plant guards suitable to enhance plant growth and protection from vertebrate pests;
- Watering and maintenance shall be undertaken for at least 3 years, including weed management to ensure a weed-free area of 1 m around each trunk;
- Plant species establishment success shall assessed following planting and modified as appropriate;
- Plants that fail shall be replaced, and alternative species considered if plant failure is an ongoing issue throughout the operational period; and
- Local endemic plants should be selected in consultation with Armidale Tree Group or a similar organisation. Suitable species could include:
  - *Eucalyptus blakelyi*;
  - *Eucalyptus melliodora*;
  - *Eucalyptus bridgesiana*;
  - *Acacia filicifolia*;
  - *Acacia rubida*; and
  - *Jacksonia scoparia*.



Draft perimeter landscaping plan (green buffer strip adjacent to Waterfall Way – nearby residences circled red).

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