1. Policies & Guidance

1.1 Buildings

In the UK at the domestic level the closest guidelines regarding glint are the BRE guidelines on 'Site layout planning for Daylight and Sunlight'[1]. Regarding solar dazzle, these state that:

"Glare or dazzle can occur when sunlight is reflected from a glazed façade or an area of metal cladding. This can affect road users outside and the occupants of adjoining buildings. The problem can occur where there are large areas of reflective glass or cladding on the façade, or where there are areas of glass or cladding slope back so that high altitude sunlight can be reflected along the ground. Thus solar dazzle is only a long-term problem for some heavily glazed (or mirror clad) buildings. Photovoltaic panels tend to cause less dazzle because they are designed to absorb light.

If it is likely that a building may cause solar dazzle the exact scale of the problem should be evaluated. This is done by identifying key locations such as road junctions and windows of nearby buildings and working out the numbers of hours of the year that sunlight can be reflected to these points. BRE information paper IP 3/87 gives details.

Glare to motorists approaching the building can be an issue. The worst problems occur when drivers are travelling directly towards the building and sunlight can reflect off surfaces in the driver's direct line of sight (usually this will be off the lower parts of the building)."

After setting out a methodology for calculating solar reflections from sloping glazed facades, BRE information paper IP 3/87[2] summarises effects as follows:

"Initial experience suggests that, in Europe and the USA at least, the greatest problems occur with facades facing within 90^o of due south, sloping back at angles between 5^o and 30^o to the vertical. Where the façade slopes at more than 40^o to the vertical (less than 50^o to the horizontal) solar reflections are likely to be less of a problem, unless nearby buildings are very high; and facades which slope forward, so that the top of the building forms an effective overhang, should also cause few problems in this respect. In the northern hemisphere, north facing facades should only cause reflected solar glare on a few occasions during the year, if at all."

In the domestic setting the guidelines therefore suggest that glare and dazzle are only likely to be issues if the facade (or panel in this case) is within 40 degrees of the vertical or 50 degrees of the horizontal. Beyond this angle, incident light will be reflected primarily skywards. This is because the angle of reflection of light from a point source will always be the same as the angle of incidence.

1.2 Aviation

The fact that this incident light will be reflected skywards is of principle concern for aircraft. The health and safety of passengers and crew on flights into and out of airports is of paramount

[1] Site Layout Planning for Daylight and Sunlight: A guide to good practice. (2nd Edition) Paul Littlefair, BRE Trust, First published 2011

[2] Building Research Establishment IP 3/87 "Solar dazzle reflected from sloping glazed facades" P J Littlefair, April 1987

importance and it is therefore critical to demonstrate that the effects of the proposed solar farm will not compromise this.

Civil Aviation Authority

In the UK the guidance offers detail as it relates to solar PV directly. In 2010 the Civil Aviation Authority (CAA)[3] issued interim guidance on Solar Photovoltaic Systems on and near to licensed aerodromes while formal policy was being developed (Civil Aviation Authority, 2010). This covers development:

> *"principally on or in the vicinity of licensed aerodromes but will also include guidance on installations away from aerodromes (or 'en-route')."*

'Vicinity' in the above statement is defined as within 15km of an aerodrome.

The CAA identified the key issue as being:

> *"perceived to be the potential for reflection from SPV (solar photo-voltaic) to cause glare, dazzling pilots or leading them to confuse reflections with aeronautical lights."*

It gives the following articles of the Air Navigation Order that should be considered.

- Article 137 - Endangering safety of an aircraft.
- Article 221 - Lights liable to endanger.
- Article 222 – Lights which dazzle or distract.

It is not considered that there is opportunity for pilots to confuse reflections with aeronautical lighting. The times when aeronautical lighting is lit and is most prominent in the pilot's view are times when there are low light levels such as at night-time or when weather conditions like cloud or fog reduce visibility. At these times panels will produce no glint or glare due to low light levels. The CAA has not yet adopted formal policy regarding this issue.

European Aviation Safety Agency (EASA)

The European Aviation Safety Agency (EASA) Notice of Proposed Amendments NPA 2011-20 (B.III) (2011)[4] provides notice and advice on the effect of dazzle to aircraft on final approach and ascent, with specific reference to solar panels. It should be noted that this document does not constitute formal policy but does provide an indication as to the EASAs position on the effects of glint from solar farms while formal policy is developed. It states: -

"A safety assessment is conducted in order to identify situations where the risk of dazzling becomes unacceptable. Thus, it is noted that dazzle represents such a risk in the following situations:

(1) during approach, especially after the aircraft has descended below the decision height: the pilot shall not lose any visual cue;
(2) at touchdown the pilot shall not be surprised by a flash;

[3] Civil Aviation Authority, 2010. '*Interim Solar Photovoltaic Guidance*', s.l.: s.n.

[4] EASA, 2011. 'Notice of Proposed Amendments NPA 2011-20 (B.III) NPA 2011-20 - Authority, Organisation and Operations Requirements for Aerodromes | EASA (europa.eu)

(3) during rolling (landing or take-off), the pilot shall be able to perceive his environment and detect any deviation from the centre line: the pilot shall not lose any visual cue.

(4) Thus:

(i) prejudicial dazzle due to veiling luminance shall not occur during approach (slightly before the decision height) and rolling;

(ii) surprise effect shall not occur at touchdown."

The document then places the above into perspective in direct reference to solar panels.

"(l) The following assumptions can be made:

(1) solar panels are inclined so as to efficiently capture the sunlight, conducting to a range of cross section surfaces;

(2) the maximum acceptable luminance value has been fixed to 20,000 cd/m2;

(3) the surfaces varied from 100 m^2 to several hectares;

(m) It is assumed that the aircraft maintains precisely its trajectory whereas in reality the approach is conducted into a conical envelop around the expected trajectory."

US Federal Aviation Administration (FAA)

Research into the effects of glint and glare from solar PV is much more mature in the United States where significant work has been undertaken. The US Federal Aviation Administration (FAA) in their Solar Guide (Federal Aviation Administration, 2010[5]) incorporates a chapter on the impact and assessment of glint from solar panels. It concludes that (although subject to revision):

"…evidence suggests that either significant glare is not occurring during times of operation or if glare is occurring, it is not a negative effect and is a minor part of the landscape to which pilots and tower personnel are exposed."

The geometric analysis (full details in Appendix 4), which defines the extent and time at which glint may occur, is required by the FAA as the methodology to be used when assessing glint and glare impacts on aviation receptors. This report will follow the methodology required by the FAA as it offers the most robust assessment method available.

At very close distances to the site – when glint is at its strongest - the solar farm will appear below the aircraft, out of view of the crew. Similarly, if climbing or flying away from the solar farm any glint will strike the underside of the fuselage and will not be visible to the crew.

The significance of an effect is defined as a function of the receptor's sensitivity and the magnitude of the effect. There are no current formal guidelines internationally as to what constitutes a significant effect. However, the FAA, which utilises the analytical method used in this report, states in guidance that it will consider issuing an objection if the glint has the potential to form a temporary

[5] Federal Aviation Administration, Nov 2010. '*Technical Guidance for Evaluating Selected Solar Technologies on Airports*', Washington DC: s.n.

after image (medium intensity glint), other factors, such as the direction of frequency of the glint, also play a role in the choice of issuing an objection or not.

Since the FAA's initial research and policy statements, there have been some developments and revisions to what is determined as a glint and glare effect to pilots on final approach. In May 2021, the FAA[6] reviewed their policy on Solar Energy Systems and determined that:

"the glint and glare from solar energy systems to pilots on final approach is similar to glint and glare pilots routinely experience from water bodies, glass facade buildings, parking lots, and similar features."

This highlights that the FAA has determined that pilots are able to tolerate glint effects and reflections from solar panels as they are considered no worse than reflections that pilots are commonly exposed to from other sources in the environment during final approach.

1.3 Operational Examples

There are a considerable number of large-scale solar installations that are already operating and located near to airports overseas. These include Newquay Airport in Cornwall, UK and Dunsfold Aerodrome in Surrey, also in the UK. Figure 1 shows a large-scale solar farm similar to the proposed scheme constructed at Dusseldorf Airport, glint from the solar farm has not affected flight operations.

Figure 1: Solar Farm Adjacent to the Runway at Dusseldorf Airport (Aviation Pros, 2013[7])

A ground-mounted array of panels has also been installed at London Gatwick on land adjacent to the runway and taxiway (see Figure 2). Consultation was undertaken between the developer and the Gatwick aerodrome safeguarding team, National Air Traffic Services (NATS), and NATS (En Route) Plc

[6] Federal Aviation Administration, May 2021. '*14CRF Part 77 - FAA Policy: Review of Solar Energy System Projects on Federally Obligated Airports'*, Washington DC: s.n.

[7] Aviation Pros, 2013. '*Düsseldorf International Airport Goes Solar*' [Online] Available at: http://www.aviationpros.com/news/10599152/dsseldorf-international-airport-goes-solar [Accessed 23 July 2022]

(NERL) (Crawley Borough Council, Planning Ref: CR/2011/0602/CON). These consultees did not object to the proposal on any grounds including glint.

Figure 2: Solar Array next to Gatwick Runway (Business Green, 2013[8])

It is not expected that the potential for glint generated by the proposed solar farm could cause any serious operational effects to aircraft but since the position of the sun in the sky and the angle of the panels will be known, it is possible to predict exactly when there would be any chance of affecting a particular flight path and hence it would be possible to forewarn any pilots.

[8] Business Green, 2013. '*Gatwick solar system hailed a runway success*'. [Online] Available at: http://www.businessgreen.com/bg/news/2156392/gatwick-solar-cleared [Accessed 23 July 2022].