WPAC
Wind Power Aviation Consultants Ltd

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Assessment of the Impact of the Soay Solar Farm on Aircraft and Glider Operations at Pocklington Airfield.

Our Reference: WPAC 030/20
Your Reference: Soay Solar

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References:

A. ForgeSolar Glare Analysis of the Soay Solar Farm. Dated 24 March 2021.
(Note: Aviation Sections Only).

B. Pooleys, AFE and Lockyear's Airfield Flight Guides.
(Pocklington, Elvington and Full Sutton Entries Only).

C. CAP393 ANO and UK ROAR as aligned with the EU SERA
(In relation to Aircraft and Gliders operating VFR – see and be seen environment).

Appendices:

1. Introduction

WPAC has been commissioned to assess the potential effects of the proposed Soay Solar Farm on Pocklington Airfield. The Solar Farm will be located to the immediate south of Allerthorpe Common and 3km to the south west of Pocklington Airfield in Yorkshire.

The proposed Solar Farm is large and is in three distinct sections. Although covering around 1.3 sq km, the farm is arrayed over an area approximately 2km x 2km. (diagram 1 below).

A formal technical analysis of Glint & Glare has already been completed. However, such formal studies have the potential to generate large quantities of numerical data which can easily obscure both the practical results of the study and hide the limitations of the data insofar as direct relevance to the wider scenario.

Accordingly, this report will aim to present a straightforward analysis closely linked to the current aviation operations undertaken at Pocklington Airfield.

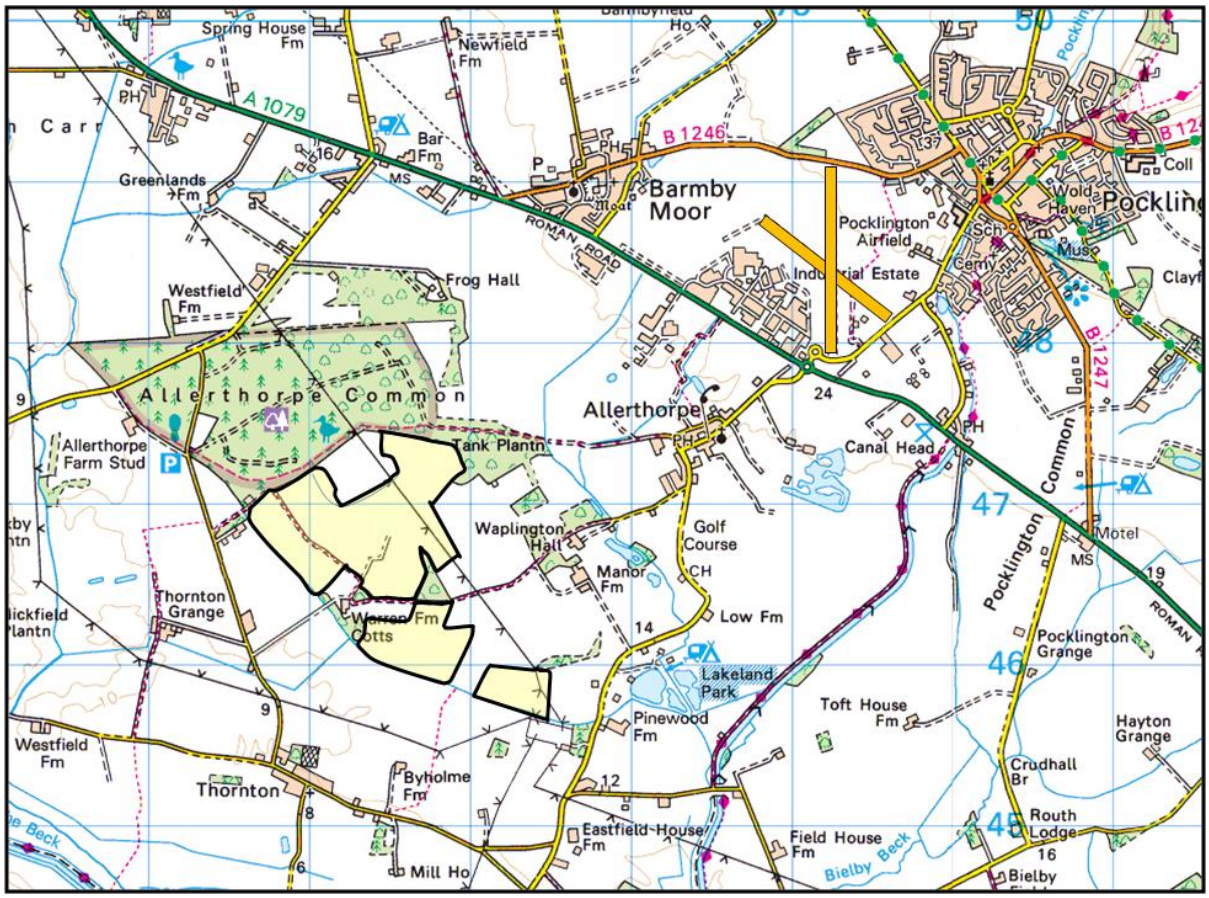


Diagram 1. Soay Solar Farm in Relation to Pocklington Airfield

2. Report Scope

The follow topic areas will be covered:

- ForgeSolar Process
- ForgeSolar Data-Results
- Analysis of ForgeSolar Results
- Pocklington Airfield Operations
- Soaring and high level flights
- Wider assessment of the Soay Solar Impact
- Risk Assessment
- Conclusion

3. ForgeSolar Process

The ForgeSolar Glare Analysis (Reference A) follows a standard industry profile which includes:

- The assumed characteristics of the human eye. This has been defined by FAA policy in the absence of current UK/CAA guidance.
- Defined receptor positions (from where glare will be observed/calculated). This involves a line of receptor positions along the approach path to each runway.
- Categorising the impact of Glare as follows:
    - Yellow – potential for temporary after-image within the eye.
    - Green – low potential for temporary after-image within the eye.
- Defining the Glare potential (Green/Yellow) for each the receptor positions in terms of both the time of day and the time of year (date).
- Defining where the Glare will be present but 'outside the pilot's field-of-view'.

3. ForgeSolar Data-Results

A significantly abridged version of the ForgeSolar Data-Results is as follows:

Note: for full results see ForgeSolar Report at Appendix A.

Runway (Heading)	Impact (Yellow/Green/Nil)	Comments
13	Nil	Nothing along defined flight path.
18	Nil	Nothing along defined flight path.
31	Yellow/Green	Late afternoon March + September
36	Present but outside pilot's normal field of view	Only visible in late afternoon during March + September

Diagram 2. Simplified ForgeSolar Results Table.

4. Analysis of ForgeSolar Data-Results

The ForgeSolar process makes some limiting assumptions, as follows.

- Aircraft will follow an accurate 3 deg glide slope to the runway.
- Aircraft will accurately track the runway centre-line.
- The pilot will focus ahead: 50° either side of forward.
- The pilot will be limited to 30° vertical view: i.e. reduced downward view.

This would be an accurate set of assumptions for a large Boeing or Airbus airliner approaching a commercial airport flying an instrumented/automatic approach in controlled (protected) airspace allowing the pilot(s) to focus their lookout directly ahead.

This scenario is not applicable at Pocklington where light aircraft and gliders will fly numerous and various approaches to the runways in light manoeuvrable aircraft with a much better view out of the cockpit, especially behind and downward, a requirement that is essential when operating in unrestricted airspace.

This will be discussed in the following section.

4. Pocklington Airfield Operations

Diagram 3 below, is the situation assumed by the ForgeSolar analysis: aircraft flying an accurate straight-in approach with the pilot(s) looking forward.

However, as a light aircraft (General Aviation) and gliding (British Gliding Association) airfield, Pocklington can expect aircraft to land from visual circuits (left and right handed), join crosswind, join base, join initials, join downwind, not to mention low level/flapless approaches, high/PFL approaches, glider competition joins etc, all conducted in a VFR see-and-be-seen environment with the pilot scanning all around for conflicting traffic.

The permutations of various heights, positions and headings are enormous. This may not be beyond an extended run by the ForgeSolar program; however, such a huge volume of data would be impossible to analyze effectively and inform a practical operating environment.

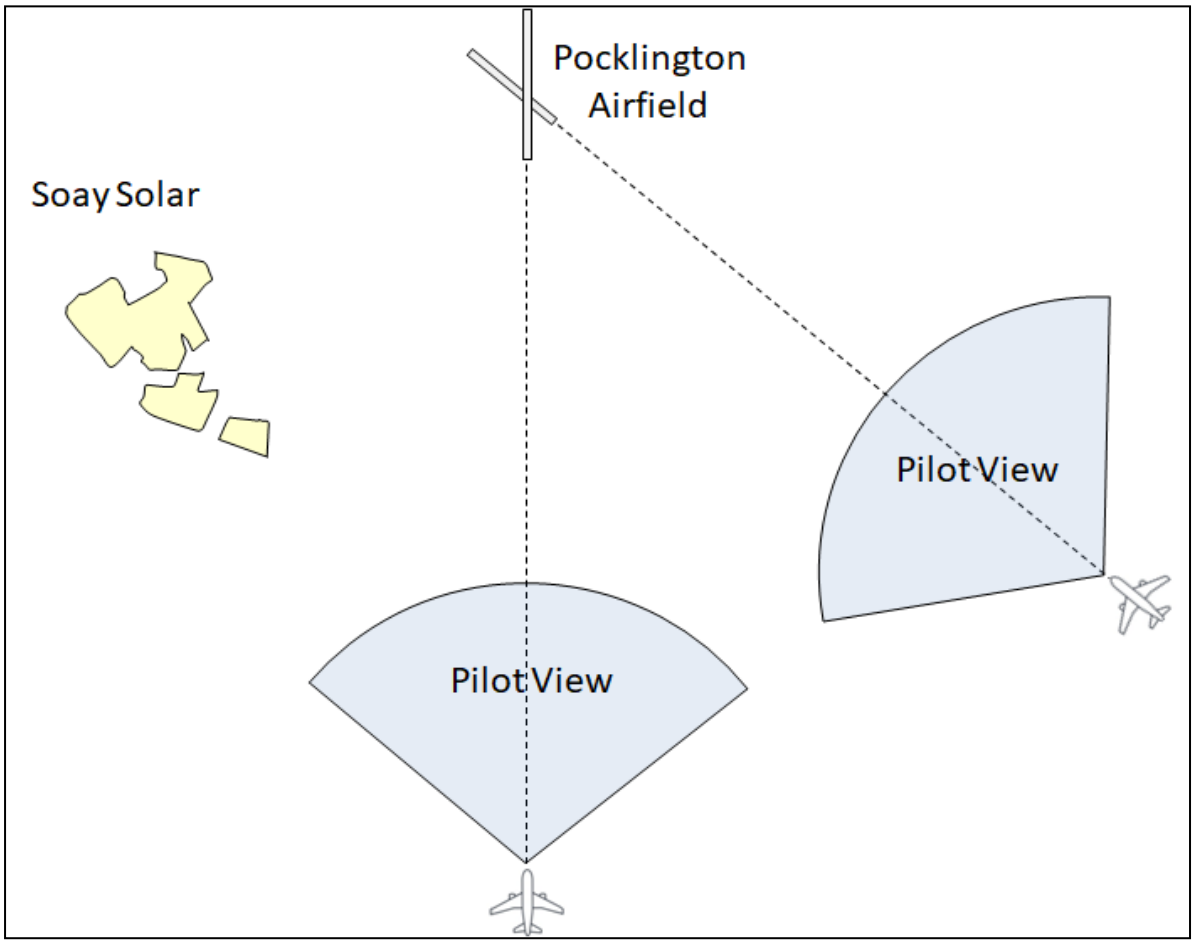


Diagram 3. Flight Profiles Assumed by the ForgeSolar Analysis.

5. Pocklington Airfield Operations (Continued)

The diagrams below show (left block of pictures) the finals turn sequence on a right hand circuit onto Runway 36 and (right block of pictures) the finals turn sequence on a left hand circuit onto Runway 18. It can be noted that, for each case, during the entire finals-turn, the Soay Solar site is the pilot's visual scan pattern. Note the pilot will be continually scanning the azimuth (shown in blue) for other local aircraft on conflicting flight paths.

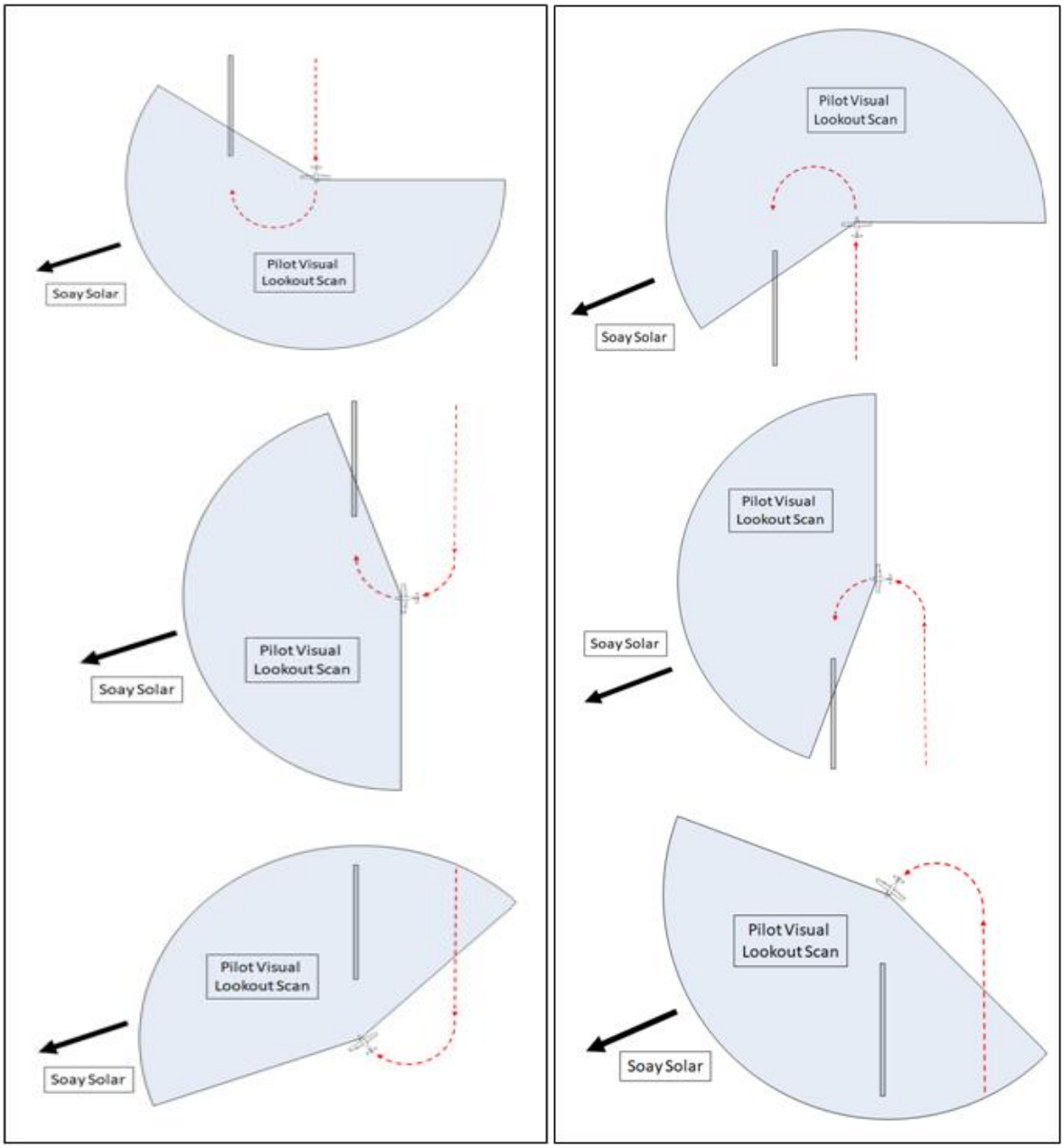


Diagram 4. Circuit Patterns and Pilot Views for Runway 18/36

6. Pocklington Airfield Operations (Continued)

Pocklington is a busy GA airfield with 4 runways (13, 18, 31 & 36). Reference B (VFR Flight Guides) indicate that various circuits are flown (left and right handed). Accordingly, there are a multitude of occasions when aircraft and gliders operating at Pocklington Airfield will be pointing directly at the Soay Solar Site or within a reflected beam of sunlight.

In addition, aircraft and gliders operating VFR in accordance with Reference C will require that pilots keep a good look-out. At Pocklington, they will not have the benefit of ATC radar assistance and must clear the airspace around themselves by their own visual means (good lookout). This means a much wider visual scan is required than the +/- 50° azimuth and 30° vertical assumed by the ForgeSolar analysis. This dictates that even when not flying towards the solar site, it will be often be within the pilot's natural wide visual scan pattern used when flying VFR.

Moreover, with glider winch launches reaching up to 2000ft, and aircraft joining the visual circuit from many directions, simple geometry dictates that these operators could be at the height necessary to intercept a reflected afternoon/evening sun on many more occasions than indicated for aircraft down low on a 3 deg straight-in approach path.

The diagrams below show the arc subtended by a midsummer sun and midwinter sun. During the year the sun will appear throughout the area between the two orange arcs. Simple geometry shows that the airspace over the solar site and Pocklington Airfield will be subject to significant solar reflection over the full year.

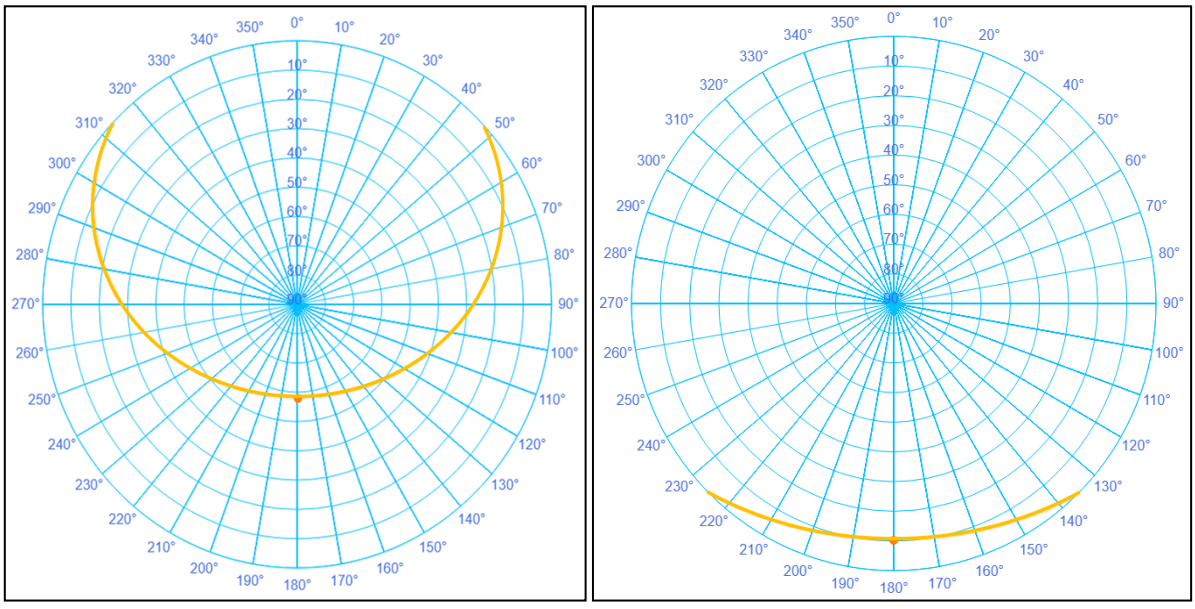


Diagram 5. Summer and Winter Sun Elevations at Pocklington

7. Pocklington Airfield Operations (Continued)

Returning to the ForgeSolar analysis of an aircraft/pilot approaching straight-in on 36.

The ForgeSolar analysis indicates that the solar site would be outside the pilot's field of view based upon the assumption that the pilot would restrict his/her field of view to +/- 50° either side of the aircraft nose. As stated earlier, this is fine in an ATC controlled environment.

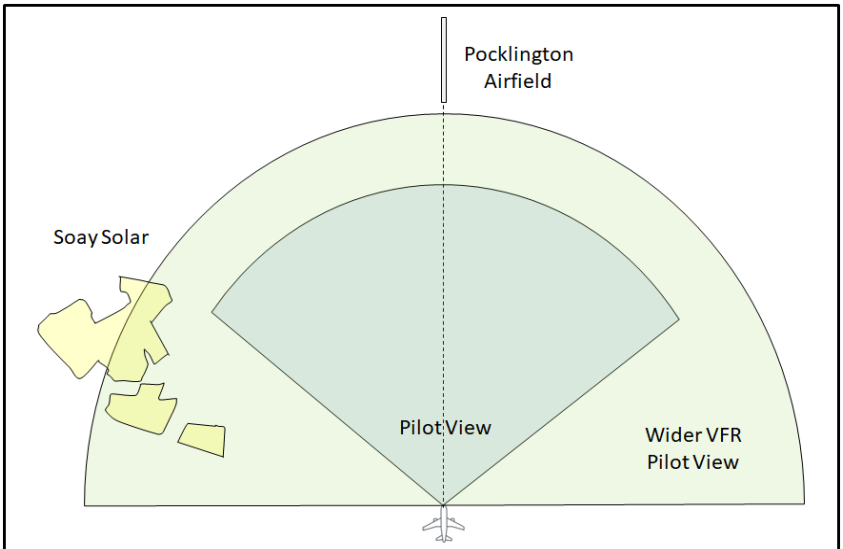


Diagram 6: Increased Visual Scan when Operating VFR

Pocklington is an unlicensed airfield, in accordance with Reference C. As a result, it does not have ATC controlled, protected or procedural airspace or even a basic ATC radio service.

Pilots operating at the airfield fly in a VFR see-and-be-seen environment. A pilot on a straight-in approach would be visually checking from wing-tip to wing-tip for aircraft on a conflicting final approach. This wider scan pattern will bring the Solar Site into direct view with the associated risk of Glare and after-image.

Accordingly, the **Present but outside pilot's normal field of view** tile in Diagram 2, and highlighted in **green** below, can be called into question.

Runway (Heading)	Impact (Yellow/Green/Nil)	Comments
13	Nil	Nothing along defined flight path.
18	Nil	Nothing along defined flight path.
31	Yellow/Green	Late afternoon March + September
36	**Present but Outside pilot's normal field of view**	Only visible in late afternoon during March + September

Diagram 2 (repeated) Simplified ForgeSolar Results Table.

The table should indicate similar Yellow/Green results as that of the tile above. The time of day would be similar but, as runway 36 is closer to the solar site than 31, the times would be slightly earlier in the day as the sun would not have to 'sink' as far to induce Glare on 36.

8. Higher Level Flying and Glider Soaring.

It is easy to assume that aircraft and gliders at higher level and away from airfields will not be affected by solar farms since the solar sites will be below their field of view, however:

When visually navigating, aircraft flying at higher levels look for unique features with horizontal spread (as opposed to vertical spread sought by aircraft at low level). A 2km x 2km solar panel site such as Soay, fits this unique feature with horizontal spread criteria: it will be an excellent navigation feature. Accordingly, the Soay Solar site will be used as a navigation feature by local light aircraft, in particular by aircraft recovering to Pocklington.

Gliders need to find lift (rising air) to stay airborne. Pockets of rising air can be triggered by ground features and these include: hills, warm ground, hot buildings and even a tree line can trigger a self sustaining column of lift going up many thousands of feet - normally ending as a cumulus (cotton wool) cloud. Glider pilots will scan the ground for lift triggers. Once lift is found, the glider orbits in this lift with the pilot looking both down and up when 'centering' in the lift. In the region of solar farms, this look-down visual scan will increase the risk of receiving Glare.

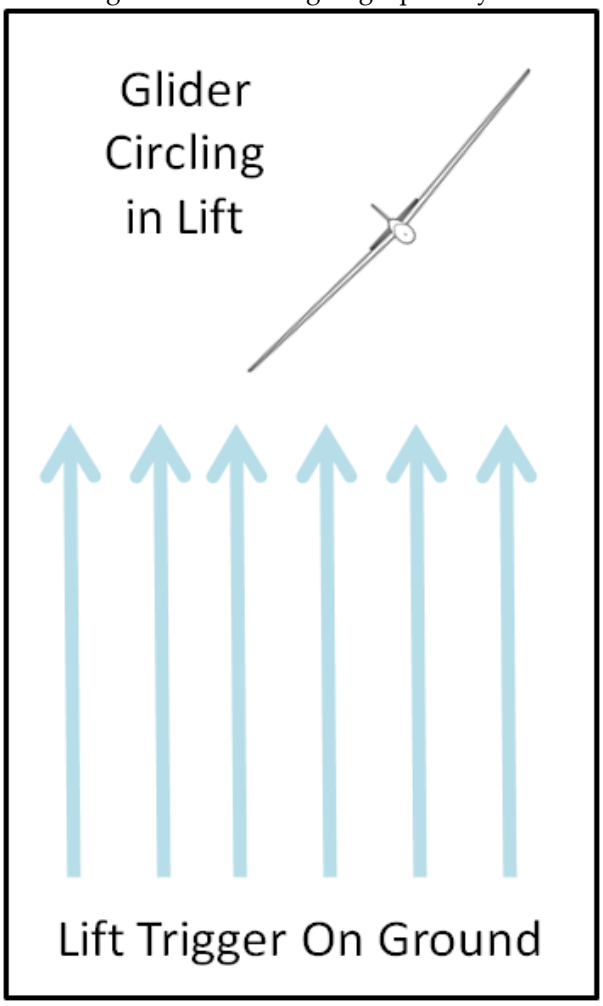


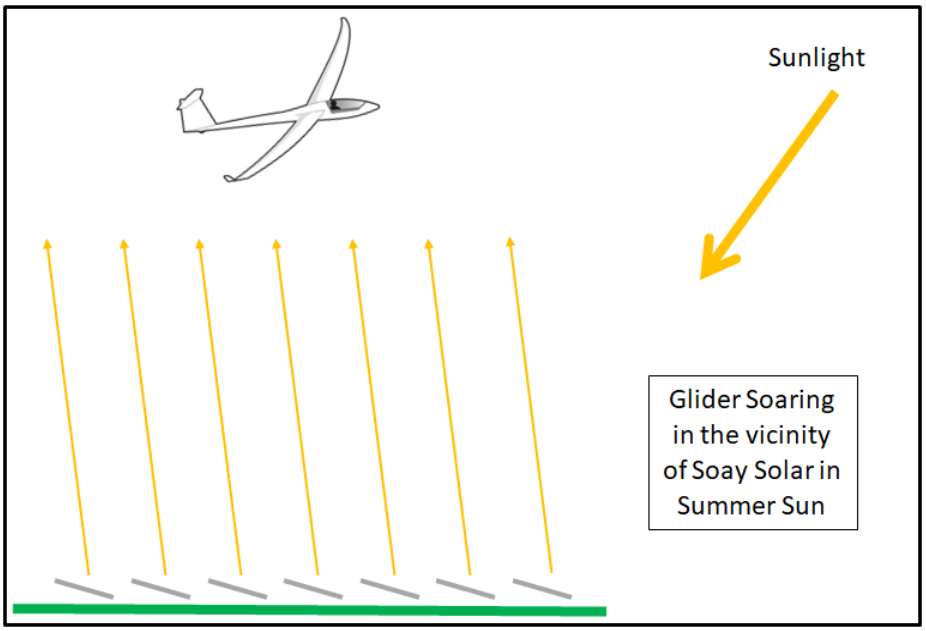
Diagram 7. Glider Circling in Lift

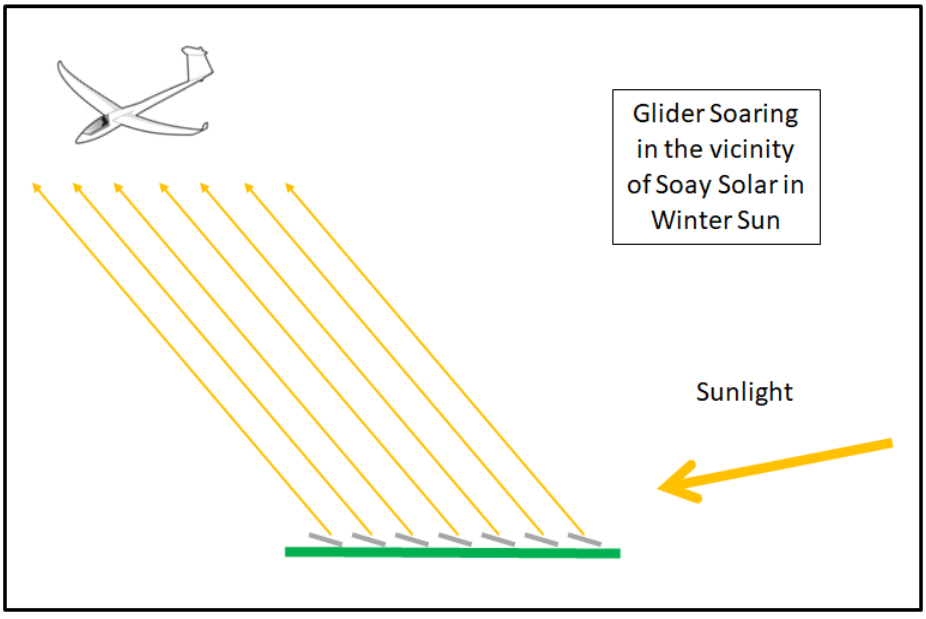
In this author's experience, solar farms are good lift triggers. In sunshine, the acres of metal alloy stands, titanium dioxide glass and silicon photocells become hot and can develop into a good lift trigger. As a result, gliders are attracted to solar farm 'overheads' or slightly down wind of the site as the rising air thermal moves with the horizontal air currents (wind).

The Gliding community has been able to accommodate the presence of solar farms effectively to date. However, where a large solar site is located close to a Gliding Club training airfield, like Pocklington, it will be necessary to adopt procedures for both experienced and abinitio pilots alike. This is normally undertaken by incorporating new procedures and local rules into the Gliding Club Flying Order Book.

This may introduce small changes in the utility of the airfield and local training airspace.

The Soay Solar panels are set to 20°. Accordingly, the mid-day summer sun (elevated 50-60°) will be reflected up quite steeply at 70-80°. In winter this will reduce to 40-50°. Diagrams 8+9 below illustrate this effect. Accordingly, gliders attracted to the solar farm 'overhead' looking for lift, are at increased risk of a Glare incident.





Diagrams 8+9. Illustration of mid-day sunlight reflected steeply up.

9. Risk Assessment.

The ForgeSolar assessment of the Soay Solar Site has indicated that the potential exists for Glare to occur in relation to aircraft approaching Pocklington Runway 31.

Looking at the wider scenarios detailed in this WPAC report, the occasions when Glare will be observed will be far more numerous than the ForgeSolar analysis suggests. Indeed, much of the activities conducted by the Gliding Club and General Aviation aircraft at Pocklington, may be subject to Glare incidences at various times of day and of the year.

Pilots flying in the local area may have the solar site in view for extended occasions; nonetheless, the exact geometry required to generate a Glare incident will be a very rare occurrence. Moreover, the impact of the Glare incident would be as described by ForgeSolar: 'potential for temporary after-image within the eye'.

This author has experienced Glare incidents from solar sites and other sources. Whilst early incidents may be disconcerting, pilots are able to adopt techniques and procedures to both minimise the risk of receiving Glare and minimise the impact of the Glare incident itself.

Accordingly, making reference to a standard probability/impact risk assessment chart, a 'Glare-incident' from a ground based reflector, would sit around the centre of the bottom of the table (the very low probability row).

Clearly, an inexperienced and unbriefed student pilot may find an unexpected Glare incident unsettling resulting in moderate risk; however, a briefed and prepared pilot operating in the full knowledge of solar sites in his/her area, would be able to take sensible precautions and modifications to the flight profile resulting in minimum or low risk. The aim would be to have all pilots suitably briefed and prepared if operating close to a solar site.

IMPACT	01	02	03	04	05
PROBABILITY	NEGLIGIBLE	MINOR	MODERATE	SIGNIFICANT	SERVERE
(81 – 100%)	Low Risk	Moderate Risk	High Risk	High Risk	Extreme Risk
(61 – 80%)	Minimum Risk	Low Risk	Moderate Risk	High Risk	Extreme Risk
(41-60%)	Minimum Risk	Low Risk	Moderate Risk	Moderate Risk	High Risk
(21-40%)	Minimum Risk	Low Risk	Moderate	Moderate Risk	High Risk
(1-20%)	Minimum Risk	Low Risk	Moderate	Moderate Risk	High Risk

Diagram 10. Risk Assessment Chart

10. Conclusion.

It is clear that the Soay Solar Farm will have an impact on the operations of aircraft and gliders at Pocklington Airfield, albeit a minor impact.

As the principle user of Pocklington, the Gliding Club has the potential to be the most affected by the solar site. At the risk of introducing something new to a conclusion, a brief outline of the concept of operations of a BGA gliding club would be useful here.

Although BGA clubs produce and train competition gliding pilots, their principle business is providing low cost flying/pilot training for young people of all backgrounds (known as ab initio pilots). As a result many (and often the majority) of flights at a gliding club will be training (dual with instructor) and solo flights by young people of a range of abilities and experience. Student pilots can go solo once aged 14. Once solo, young pilots gain a series of qualifications and can regularly be found within 10km (5nm) of their base airfield looking for lift, practicing thermalling (orbiting and climbing in lift) and preparing for the more demanding cross country flying.

With such a range of pilot abilities, and the proposed Soay Solar site effectively under its training airspace, the Wolds Gliding Club will need to review its procedures and brief its instructors, pilots and trainees.

For example, such procedure changes and briefings might include the warning that, whilst a local solar farm may be a very good heat source lift generator, at mid-day and near mid-day timings, sun reflections (Glare) could be present in the rising thermals above the site where gliders would seek to orbit and gain height. The Club may elect to generate charts highlighting susceptible areas with associated calendar dates and daily times. WPAC would be able to advise and assist the Club with this work if necessary.

Footnote

The Wolds Gliding Club was consulted on 19 July 2021 and given a copy of this WPAC Report. The Gliding Club subsequently considered the matter in committee. As a result, the Gliding club have issued the following statement: The plans, as we currently understand them, don't seem to pose a significant issue for the gliding club.

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Author

Sqn Ldr Mike Hale RAF (Rtd) has over 45 years, piloting, instructing and examining experience on numerous military fast jet aircraft through to a range of civilian and military general aviation training aircraft and gliders. He has held many posts including Training Officer, Flight Commander, Squadron Commander and Principal Tornado AD Force Examiner. He has amassed over 10,000 flying hours of experience operating at many locations around the world.

In parallel to his flying duties, Mike held the post of Officer Commanding the MOD Low Flying Operations Squadron (OC LFOS). In this post he was both Low Level Airspace Manager for the MOD & Wind and Solar Farm Subject Matter Expert for the Defence Infrastructure Organization (DIO). During that period, he assessed over 14,000 wind/solar farm pre-applications and 2000 full applications against low flying, weapons range, specialist airspace, light aircraft/gliding/parachuting operations and aerodrome safeguarding criteria.

Mike has been involved with gliding for many decades around the world and spent seven years as the Officer in Command of the College Cranwell Gliding Club.

Mike also instigated two Qinetiq ground based Infra Red vertical obstruction lighting trials. These were followed by instigating and managing the MOD Infra Red/Low Intensity (Henlow) flight trials and the CAA/MOD/Trinity House/RUK off-shore IR/Morse (North Hoyle) flight trials. In conjunction, Mike organised various ad-hoc supporting trials including night vision equipment compatibility and detailed lighting beam analysis.

In 2012, he was awarded an MBE for generating a proactive and mutually successful working relationship between the Wind/Solar Power Industry and the MOD Air Staff.

Since retiring from the RAF in 2013, Mike has retained his involvement and interests in all aspects of flying and currently lectures Aviation Operations and allied subjects.

For the past eight years. Mike has advised Wind and Solar Farm developers on military low flying concerns and mitigation solutions; lighting requirements and options; general aviation; gliding and parachuting interests and concerns. This support includes providing expert witness at planning and appeal. Moreover, having been involved in, and represented at inquiry, the wind and Solar industry on both sides of the house (aviation and developers) Mike is uniquely placed to offer unbiased and informed advice when needed.

Abbreviations and Definitions

AGL.....Above Ground Level (Height)
ANO.....Air Navigation Order
AMSL.....Above Mean Sea Level (Elevation)
CAA.....Civil Aviation Authority
CAP.....Civil Aviation Policy (Referrers to Specific Documents)
In Flight Visibility.....The distance a pilot can see ahead to fly & navigate the aircraft
RoAR.....Rules of the Air Regulations
Rule 28.....VFR Rules Outside Controlled Airspace – part of the RoAR
VFR.....Visual Flight Rules (Flight without ATC on a see-and-be-seen basis)
VMC.....Visual Meteorological Conditions (Weather suitable for VFR flight)

Appendix

A. ForgeSolar Glare Analysis of the Soay Solar Farm. Dated 24 March 2021.