Application by Photovolt Development Partners (PVDP) on behalf of SolarFive Ltd for an Order Granting Development Consent for the Botley West Solar Farm project.

Written summary of oral comments given at the Hearings during the week commencing 12th May 2025.

Date Thursday 15th May, Issue Specific Hearing 1 (ISH1).

Name of speaker: David Rogers

I made several comments during **Issue Specific Hearing 1, Aviation Safety**

Thermals arising from large expanses of solar panels

Comments made during the hearing cast doubt on the idea that solar panels create thermals that may affect light aircraft taking off or landing at Kidlington airport.

Thermals are created when a surface is at much higher temperature than the surrounding air. This is very likely to be the case for solar panels which are dark in colour, or even black, and therefore absorb most of the radiation that falls on them, only some of which is turned into electricity. The remainder generates heat.

A February 2024 report in NenPower[1] states:

"The average operational temperature of solar panels often reaches between 20°C to 40°C above the ambient temperature. For instance, if a solar panel is installed in an area where the ambient temperature is 30°C, it could easily reach temperatures between 50°C to 70°C under direct sunlight. This temperature range can vary based on several factors such as geographic location, the angle of inclination, and the type of solar panel installed."

A July 2024 blogpost from Solar CC[2] states:

"The temperature of PV systems is usually 15-20°C higher than the weather on a clear sunny day. It means that the air temperature should be significantly lower to achieve an optimal solar panel temperature coefficient of around 25°C. Thus:
"10-15°C On a sunny day, the module can heat up to 25-30°C, which is close to the optimal conditions.
20°C The panels may reach 40-45°C, which is higher than the optimal temperature, and their efficiency begins to decrease.
30°C The heat of the modules can reach 50-60°C, which will significantly reduce their effectiveness."

An April 2025 Slashgear article[3] states:

" Like most other electronic devices, solar panels are affected by prolonged exposure to high temperatures. They generally won't heat up to the point of becoming a danger – their surfaces can and do reach up to 149 degrees Fahrenheit"
(149 degrees Fahrenheit is 65 degrees Centigrade, but ambient temperature for this figure is not specified, although elsewhere in the article 25 degrees Centigrade is mentioned in a different context).

[1] https://nenpower.com/blog/what-is-the-normal-temperature-inside-the-solar-panel/
[2] https://solarcc.com/does-temperature-affect-solar-panel/
[3] https://www.slashgear.com/1836978/solar-panels-ideal-temperature-range-can-they-get-too-hot-work/

Finally, another April 2025 article in Solar Reviews[4] states:

“Generally speaking, solar panels are 36 degrees Fahrenheit warmer than the ambient external air temperature. "
(36 degrees Fahrenheit is equivalent to 20 degrees Centigrade).

The above articles were found during a brief web search. More would certainly be easy to find. It seems that the lowest temperature increase is about 15 degrees C above ambient and the highest is up to 40 degrees C above ambient, with a most likely possible value somewhere in the middle of this range. Such a temperature difference is bound to cause thermals but how much these would affect aircraft is uncertain.

Glint and glare effects on aircraft

During the issue specific hearing, doubt was cast on the idea that glint and glare from any nearby BWSF solar panels would affect pilots of aircraft taking off and landing at Kidlington. It was said that numerous airports have nearby solar installations that do not seem to affect aircraft navigation. No information was given supporting this claim.

In March 2025 PV Magazine reported[5] that:

"As of March 4, the Polderbaan Runway at Amsterdam Airport Schiphol, has been closed to incoming traffic between 10 am and 12 pm in sunny weather due to the glare caused by solar panels located under the approach path. While located outside the landing area, the PV installations hinder pilots' visibility when the sun is shining. “The position of the sun means that this effect occurs in the morning,” Schiphol Airport's Integrated Safety Management System (ISMS) stated, adding that pilots have made several recent reports on the matter. “Air Traffic Control the Netherlands (LVNL), KLM, easyJet and Schiphol, brought together under the Integral Safety Management System (ISMS), are compelled to take this measure in order to guarantee air traffic safety,” it added." "Since then, weather forecasts have been used daily to assess whether or not to use the Polderbaan Runway, as failure to do so impacts noise levels around Schiphol, and landing traffic will make more frequent use of the Zwanenburgbaan and Buitenveldertbaan runways. Aviation industry representatives have held prior consultations with the municipality of Haarlemmermeer regarding the installation of solar panels near Schiphol and have indicated that the use of special glass (deep-textured glass), which absorbs sunlight rather than reflecting it, is necessary for flight safety." "Solar modules typically have an anti-reflective coating. However, according to Phytonics, a technology company based in Karlsruhe, Germany, it is not enough to prevent solar module glare. Typically, anti-reflective coating only serves to increase module performance. Phytonics has developed a self-adhesive film designed to reduce the glare effect of modules as much as necessary. "

It seems clear that even major international airports may need to be temporarily closed because of glint and glare from solar panels. Schipol has alternative runways to which to direct landing aircraft. Kidlington probably does not.

[4] https://www.solarreviews.com/blog/how-hot-can-solar-panels-get
[5] https://www.pv-magazine.com/2025/03/13/solar-panel-glare-temporarily-cancels-air-traffic-at-amsterdam-airport/#:~:text=As%20of%20March%204%2C%20the%20Polderbaan%20Runway%20at,by%20solar%20panels%20located%20under%20the%20approach%20path.

Bird strike and the 'Lake Effect Hypothesis'

During this ISH and elsewhere mention was made of the possibility of birds striking solar panels. Birds thus affected may be confused and create hazards for landing aircraft. Certainly, dead birds are found within solar installations, and various American studies conclude that water birds may be especially prone to crash land into solar arrays, leading to the "Lake Effect Hypothesis" that they have mistaken the solar panels for reflective water surfaces.

Many water birds are heavily bodied and slow flying and so pose a particular danger to any sort of aircraft.

During ISH1 the developers dismissed the Lake Effect Hypothesis as having little or no observational support. No evidence was presented for their conclusion.

The following is an edited extract from a 2022 submission to Cherwell District Council in response to a planning application for a small solar farm next to the RSPB bird reserve on Otmoor, Oxfordshire.

"The significance of polarised light. *Both insects and birds can detect polarised light. Insects use it for sun-compass navigation. Birds have various navigation systems but many nocturnal migrants that start their flights at sunset or soon after apparently use polarised light to determine initial migratory direction[6]. More generally "skylight polarization pattern near the horizon at sunrise and sunset provides birds with a seasonally and latitudinally independent compass calibration reference" (Muheim, 2011[7]). Birds associated with water, or simply visiting it to drink, appear to use reflected polarised light as a cue. Bernath et al (2001)[8], trying to understand why so many birds and insects became trapped in a waste oil lake in Budapest, put down large sheets of shiny black or white plastic and found that birds including black kites, swallows, wagtails and storks apparently mistook them for water; for example, the swallows tried to 'drink' from the sheets and the storks moved their bills in the same way as when feeding in mud.*

The 'Lake Effect' hypothesis. *The above and previous findings of waterbirds in solar PV arrays led to the 'lake effect hypothesis' (LEH) that birds confuse solar PV panels with water, respond to them in the same way, and thus crash into them. This would be a particular problem for obligate waterbirds that cannot take off from land. The Lake Effect Hypothesis has been challenged by Kosciuch et al (2022)[9] although the published article (the abstract of a conference talk) does not make clear whether there were any PV facilities at the reference areas used. The authors conclude*

"Thus, the idea of a "lake effect" ….. is likely a nuanced process as a PV solar facility is unlikely to provide a signal of a lake to all aquatic habitat birds at all times."

Another article in the same symposium provides more direct experimental evidence. Robertson et al 2022[10] tested whether songbirds' known sensitivity to sky polarisation patterns might be used to locate water bodies and other terrestrial sources of polarized light. Songbirds increased their visitation rate

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[6] The Cornell Lab (2008). The Basics: How Birds Navigate When They Migrate https://www.allaboutbirds.org/news/the-basics-migration-navigation/

[7] Muheim R. Behavioural and physiological mechanisms of polarized light sensitivity in birds. Philos Trans R Soc Lond B Biol Sci. 2011 Mar 12;366(1565):763-71. doi: 10.1098/rstb.2010.0196. PMID: 21282180; PMCID: PMC3049006, or at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3049006/#:~:text=Many%20organisms%20use%20the%20skylight%20polarization%20pattern%20as,polarization%20pattern%20in%20sun-compass%20orientation%20is%20very%20weak.

[8] Bernath, B., Szedenics, G., Molnar, G., Kriska, G., & Horvath, G. (2001). Visual ecological impact of a peculiar waste oil lake on the avifauna: Dual-choice field experiments with water-seeking birds using huge shiny black and white plastic sheets. Archives of Nature Conservation & Landscape Research, 40, 1-28,available at https://arago.elte.hu/sites/default/files/PakuraBirds_ANCLR.pdf

[9] Kosciuch, K., Riser-Espinoza, D. Moqtaderi, C. & Erickson, W. Aquatic habitat bird occurrences at photovoltaic energy development in Southern California, Abstract of a talk given to Solar Power and Wildlife/Natural Resources. Symposium Proceedings presented by REWI (formerly AWWI) in 2021. Meeting Proceedings published March 2022, available at https://rewi.org/wp-content/uploads/2022/03/Solar-Symposium_Proceedings.pdf

[10] Robertson, B, Rothburg, O., Heitman, J.B. & Fraleigh, D. (2022). Testing the 'Lake Effect' hypothesis for avian attraction to solar panels. P. 50. Abstract of a talk given to Solar Power and Wildlife/Natural Resources. Symposium Proceedings presented by REWI (formerly AWWI) in 2021. Meeting Proceedings published March 2022, available at https://rewi.org/wp-content/uploads/2022/03/Solar-Symposium_Proceedings.pdf

to feeders with highly polarized light cues, (independent of their color and brightness), and reduced visits in response to the addition of a depolarizing black paint. They exhibited no differential response in visitation rates to color and polarization cues associated with ground-based (i.e. non-water) test surfaces, and visited black water baths most frequently, consistent with the use of broader-spectrum sources of polarized light to locate water. The authors showed that polycrystalline and thin- film solar panels are strong sources of polarized light that mimic the polarization properties of water bodies. These results, they claim,

"provide the first evidence that birds can visualize terrestrial sources of polarized light, and use them to locate water bodies and even guide their behaviour in other contexts (e.g. feeding). These preliminary results support key assumptions of the lake-effect hypotheses and bolster the possibility that bird-solar panel collisions result from birds misidentifying solar panels as water bodies."

Do Anti-Reflective Coatings work? *Anti-Reflective Coatings (ARCs) have been suggested as a way of reducing glare from PV panels, but they do not necessarily reduce polarised light from them[11]. The 'AR' in ARC refers to the reflection from the surface of the PV panel itself, not the origin and type of the light that reaches it.*

Experimental studies on ARCs with insects show that some species are less attracted to ARC-coated surfaces whilst others are more attracted.

From the above literature review we conclude that at least some birds use all birds' known sensitivity to polarised light in activities with survival value, such as migration, and that waterbirds may use this sensitivity to locate open water bodies – including those on migration routes. We believe there is a very strong possibility that birds confuse polarised light coming from man-made structures with polarised light from natural features such as water bodies. In responding to these man-made features, birds may crash into Solar PV panels, and some are known to be killed by them. Others may be disabled by them and will hence be prone to predation by other birds or by mammals. "

The above was written in 2022 and very little has changed since then. The situation remains unclear. Two, more recent publications that found little evidence for the Lake Effect hypothesis[12] were based on smaller, non-water birds.

A January 2025 article in the respected journal Conservation reviewed the literature just on waterbirds and included the following[13]:

"Furthermore, many of the studies involved in our review did not find strong evidence to support the "lake effect hypothesis." These results suggest that while direct mortality events could be lower than expected, the installation of photovoltaic panels could alter migratory routes. Waterfowl and other wetland-dependent species that are nocturnal migrants accounted for almost half of the avian deaths at solar facilities. The surrounding landscapes utilized by avian species may play a role in species mortality composition and numbers."

An overall conclusion in the review was:

"We highlight a significant need for more information on wetland ecosystems and the responses of migratory waterfowl that are dependent on these ecosystems. "

[11] https://www.axonoptics.com/polarization-vs-anti-glare-coatings/
[12] https://scholarworks.sjsu.edu/cgi/viewcontent.cgi?article=8856&context=etd_theses
https://www.energy.gov/eere/solar/articles/artificial-intelligence-camera-captures-bird-behavior-around-solar-panels
[13] https://www.mdpi.com/2673-7159/5/1/4

Finally, a 2024 Report for the California Energy Commission, that was co-authored by Karl Kosciuch, who in 2022 (see extract, above) had dismissed the idea, concluded[14]:

"Results from this research are largely consistent with a lake effect hypothesis and could be influential in identifying approaches for reducing impacts on birds (for example, panel technologies that disrupt polarized light transmission)."

On balance, the evidence points to a likely effect on waterbirds. The RSPB Reserve on Otmoor, with many migratory wetland birds, is about 9 kms away, and birds from there visit the Cherwell Valley – about halfway between the Reserve and the BWSF site - on a daily basis for foraging.

Confusion of waterfowl by the solar panels of BWSF cannot be ruled out entirely as a potential hazard to aircraft using Kidlington airport.

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04/06/25

[14] https://www.energy.ca.gov/sites/default/files/2024-06/CEC-500-2024-055.pdf