Glint and Glare Considerations for FNSF Solar Farms

Introduction

Far North Solar Farm Limited (FNSF) has commissioned Renewable Engineering Group Ltd (REG) to investigate the effects of glint and glare from solar farms for each of FNSF's sites being consented. This has provided insight into the causes and mitigation of these effects on neighbours, nearby roads and in one case, an adjacent airstrip.

The investigation has included running a full glint and glare study at one site, and reviewing studies and mitigation plans from other solar farms in New Zealand and overseas.

The conclusion that has been drawn is that glint and glare is less of a concern as more experience with solar farms is gained. This is demonstrated by the case of solar farms being constructed and operated by airports, with studies recommending mitigation that is similar or less than the standard visual screening that FNSF plans for every solar farm proposed.

With each new solar farm, FNSF proposes a high degree of screen planting on all boundaries, with a target height that exceeds the height of the panels, the use of tracking panels in many sites, which removes most of the glint and glare potential, and siting solar farm away from populated areas.

Cause of glint and glare

Solar panels have a large, flat glass panel that faces the sun. A large number of panels can create multiple opportunities for a reflection (similar to a window flash from a car or house).
People could consider that the effect could be many times that of a single window glint, and occur more often or for longer than what may have been experienced without being near a solar farm.

We consider that solar farm glint and glare is less than expected for several reasons:

- The solar panel glass is a matt finish, which is designed to absorb light rather than reflect it;
- The panels are not mounted at an angle that is as likely to reflect towards an observer due to the panel facing directly towards the sun, as much as possible; and
- The solar farms are located in generally flat and rural sites.

Reflectivity

As the solar panels are very carefully designed to absorb light, rather than reflect it, research has shown that panels reflect less than glass, bodies of water, many house roofs and even some sealed surfaces. The small patterns and pits in the glass, as well as the glass material itself, means that any reflections are more random in direction and of less of a magnitude than experienced from window glass. The papers referenced below cover this matter well.

Angle of refraction

The angle of incidence determines the angle of refraction, so the positioning of the panel is a key factor. The experience at the site with the adjacent airstrip showed that fixed tilt, north facing panels can create glint and glare as the panels do not turn towards the sun, so have reflections towards some points of view, including on the ground, at a few times per year.

The higher the angle of tilt towards the north, the greater the chance of a downwards reflection at some times of the day on specific days of the year. This can occur at very low or very high sun angles. The low angles tended to be mornings and evenings in summer, and the higher angles when the sun was at or above the angle of the panels, causing a ground reflection.

This effect is greatly reduced with tracking solar systems, as the panels face either east or west, and are flat at noon. This means the reflection is always upwards (away from all ground based observation points) once the sun is even slightly above the horizon. The reflection is also generally to the south, and in-line with the sun itself, which is a direction that is already receiving natural glare.

Screening

In all the studies we have reviewed, the mitigation for glint and glare was to propose screening to a height equal to the panel height. This was to prevent the worst-case situations from very low sun angles being reflected at a low angle towards observation points. With screening in place, the low angles of reflection will be stopped by the trees.

In all FNSF's solar farms, trees are proposed for screening on all sides, planted early in the project and maintained at either 3m or 4m height. Where trees already are in place on the boundaries, these will be trimmed to a similar height, possibly higher if they are on a southern boundary.

Use of backtracking to maximise solar production and minimise glint and glare

Tracking solar systems (single axis trackers, which have a north south axis and tilt from east to west) aim to maximise the angle of incidence of the sun on the panels. This places the panels flat at noon (causing the glint to be upwards at an angle equal to the sun angle, but southwards into the sky) and have higher tilt angles earlier in the day. If the system did not allow for self-shading (where one row of tilted panels would shade the rows behind) the reflections at dawn and dusk would be low and not in the same position as the real sun.

However, there is no value in having panels shade each other, as this would reduce electricity generation significantly. To avoid this, the trackers use a backtracking algorithm, which lowers the panels to prevent shading. The result is that low angles of the sun generate low panel angles, reflecting the sunlight upwards, rather than forward towards the sun (and possible observers). The reflections that do occur are caught by the screening and are unlikely to be an issue due to the screening in the line of the sun. Backtracking prevents the very high angles of panels that are most likely to cause glint and glare.

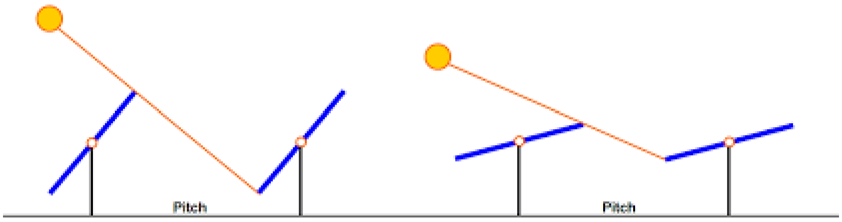


Figure 1. Example of how panel tilt decreasing after the start of shading, therefore avoiding high tilt angles that may cause low angle reflections (i.e. towards ground observers).

Summary

FNSF's solar farms are located on flat locations that minimise the number of locations that overlook the solar panels.

All FNSF's solar farms are designed and consented with high levels of tree screening, covering as many boundaries as possible, and maintained to a height that exceeds the height of the panels.

In areas where fixed tilt panels are used and there is a chance of glint and glare, studies have been conducted to minimise the issue. This was adjacent to an airstrip, where screening would not be between the solar farm and the approaching aircraft. The panels have been re-orientated to minimise the effect.

Even with screening, single axis tracking systems minimise glint and glare by directing the reflection upwards and towards the sun. Back-tracking algorithms reduce the high angles of the panel early and late in the day, preventing any low angle reflections.

All glint and glare studies with tracking solar systems have recommended screening to remove the effects. As all FNSF's solar farms are screened by design, we consider that they have already achieved the outcomes that such a study might recommend.

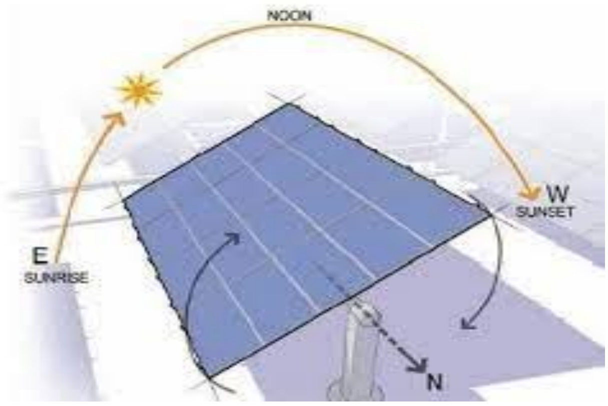
References:

Glint and glare study for Tauhei solar farm:
https://www.epa.govt.nz/assets/Uploads/Documents/Fast-track-consenting/Tauhei-Solar-Farm/Application-documents/Appendix-H-Solar-Photovoltaic-Glint-and-Glare-Study-25Aug21.pdf

National Renewable Energy Laboratories:
https://www.nrel.gov/state-local-tribal/blog/posts/research-and-analysis-demonstrate-the-lack-of-impacts-of-glare-from-photovoltaic-modules.html

Solar Photovoltaic Glint and Glare Study - GOV.UK (Page 47 has table)
https://www.nottinghamshire.gov.uk/planningsearch/DisplayImage.aspx?doc=cmVjb3JkX251bWJlcj02NjY5JmZpbGVuYW1lPVxcbnMwMS0wMDI5XGZpbGVkYXRhMiRcREIwMy0wMDMwXFNoYXJlZEFwcHNcRExHU1xQbGFuc1xQTEFOTklOR1xGLTMzNzNcMTMgQXBwZW5kaXggRSBHbGludCBhbmQgR2xhcmUgQXNzZXNzbWVudC5wZGYmaW1hZ2VfbnVtYmVyPTEzJmltYWdlX3R5cGU9cGxhbm5pbmcmbGFzdF9tb2RpZmllZF9mcm9tX2Rpc2s9MTcvMDkvMjAxNSAwODo0OTozMA==

Solar mounting options:



Single Axis tracker


Fixed tilt solar farm


East-West solar mounting