

Harmony Solar Project
Appendix F
Glare Analysis

MEMORANDUM

To: Alia Mohammad, Amber Miller, National Grid Renewables
From: Philip DeVita, HMMH
Date: July 18, 2024
Subject: Harmony Solar Updated Solar Glare Analysis
Reference: HMMH Job No.309700.002

Introduction

Harris Miller Miller & Hanson Inc. (HMMH) evaluated solar glare from the Proposed Harmony Solar Project in Cass County North Dakota. The proposed project consists of a single axis tracker ground mount photovoltaic (PV) project located near Kowsoski airfield. The original glare analysis was conducted dated April 16, 2018 (and is included in **Attachment A** for reference) and predicted no minutes of glare on the two runway approach paths (RWY 17/35) to the airfield. The no glare result on aircraft on approach to each runway threshold to 2 miles comply with the FAA's ocular impact standard as published in the Federal Register on October 23, 2013. For reference, the layout and design parameters assumed in the 2018 modeling analysis are shown in **Figure 1**.

PV Array(s)

Name: PV array 1
Description: Tracker
Axis tracking: Single-axis rotation
Tracking axis orientation: 180.0°
Tracking axis tilt: 0.0°
Tracking axis panel offset: 0.0°
Max tracking angle: 65.0°
Resting angle: 65.0°
Rated power: -
Panel material: Smooth glass without AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

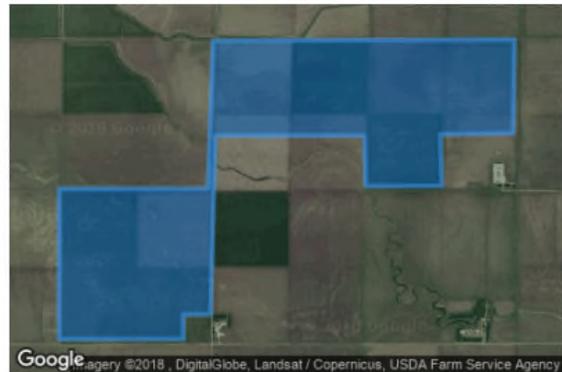
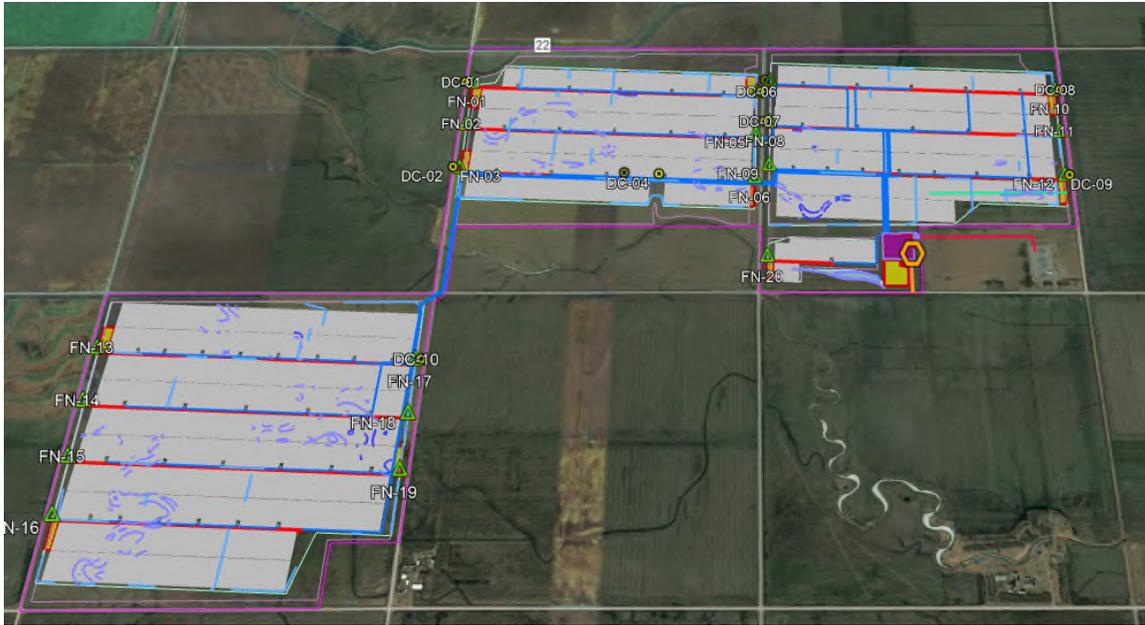


Figure 1 2018 Layout of the Harmony Solar Project as Modeled

The array was assumed at 12 feet above ground level.

Update July 2024

The project is in the process of being recertified and the panel layouts have slightly changed since the 2018 analysis. The revised layout is shown in **Figure 2**.



Source: Google Earth

Figure 1 2024 Revised Layout of the Harmony Solar Project

While the layout may have slightly changed, the extent of the PV arrays still falls within the boundary of the 2018 layout as modeled. Furthermore, the design parameters remain unchanged from those shown in **Figure 1**. Therefore, it can reasonably be concluded that the results from the 2018 modeling report would still be valid for the updated design and potential glare impacts to the approach path to Kowsoski Airfield and would still comply with the 2013 FAA standards to pilots for aircraft along final approach.

Attachment A

2018 Glare Model Output



FORGESOLAR GLARE ANALYSIS

Project: **Harmony Solar ND, LLC**

Harmony Solar ND, LLC

Site configuration: **Harmony Solar ND LLC**

Analysis conducted by Phil DeVita (pdevita@hmmh.com) at 18:05 on 16 Apr, 2018.

U.S. FAA 2013 Policy Adherence

The following table summarizes the policy adherence of the glare analysis based on the 2013 U.S. Federal Aviation Administration Interim Policy 78 FR 63276. This policy requires the following criteria be met for solar energy systems on airport property:

- No "yellow" glare (potential for after-image) for any flight path from threshold to 2 miles
- No glare of any kind for Air Traffic Control Tower(s) ("ATCT") at cab height.
- Default analysis and observer characteristics (see list below)

ForgeSolar does not represent or speak officially for the FAA and cannot approve or deny projects. Results are informational only.

COMPONENT	STATUS	DESCRIPTION
Analysis parameters	PASS	Analysis time interval and eye characteristics used are acceptable
Flight path(s)	PASS	Flight path receptor(s) do not receive yellow glare
ATCT(s)	N/A	No ATCT receptors designated

Default glare analysis and observer eye characteristics are as follows:

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

FAA Policy 78 FR 63276 can be read at <https://www.federalregister.gov/d/2013-24729>

SITE CONFIGURATION

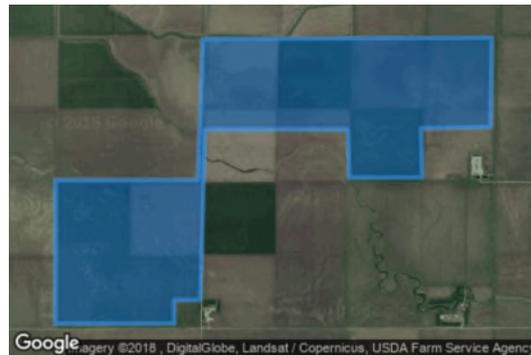
Analysis Parameters

DNI: peaks at 1,000.0 W/m²
 Time interval: 1 min
 Ocular transmission coefficient: 0.5
 Pupil diameter: 0.002 m
 Eye focal length: 0.017 m
 Sun subtended angle: 9.3 mrad
 Site Config ID: 17299.2727



PV Array(s)

Name: PV array 1
Description: Tracker
Axis tracking: Single-axis rotation
Tracking axis orientation: 180.0°
Tracking axis tilt: 0.0°
Tracking axis panel offset: 0.0°
Max tracking angle: 65.0°
Resting angle: 65.0°
Rated power: -
Panel material: Smooth glass without AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	46.935127	-97.137343	919.55	12.00	931.55
2	46.949426	-97.137343	925.75	12.00	937.75
3	46.949426	-97.116572	915.71	12.00	927.71
4	46.963486	-97.115886	916.37	12.00	928.37
5	46.963603	-97.073829	910.52	12.00	922.53
6	46.954699	-97.074000	910.51	12.00	922.51
7	46.954582	-97.084128	914.21	12.00	926.21
8	46.949660	-97.083957	914.75	12.00	926.75
9	46.949660	-97.094600	913.51	12.00	925.51
10	46.954464	-97.094771	916.29	12.00	928.29
11	46.954464	-97.115543	917.76	12.00	929.76
12	46.937472	-97.116229	917.80	12.00	929.80
13	46.937472	-97.120006	919.91	12.00	931.91
14	46.935127	-97.120006	918.51	12.00	930.51

Flight Path Receptor(s)

Name: RWY 17

Description:

Threshold height: 50 ft

Direction: °

Glide slope: 3.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 90.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	46.905566	-97.098284	911.75	50.00	961.75
Two-mile	46.934369	-97.101977	914.33	600.87	1515.21

Name: RWY 35

Description:

Threshold height: 50 ft

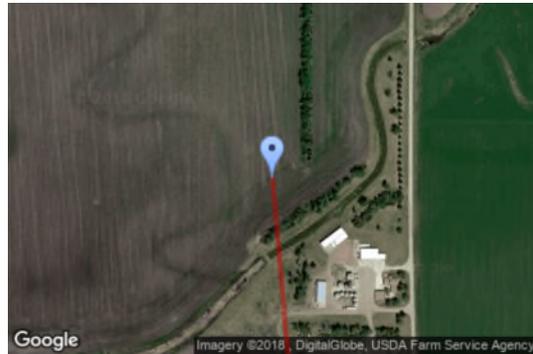
Direction: °

Glide slope: 3.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 90.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	46.899927	-97.097769	913.49	50.00	963.49
Two-mile	46.871124	-97.094077	900.90	616.05	1516.94

GLARE ANALYSIS RESULTS

Summary of Glare

PV Array Name	Tilt (°)	Orient (°)	"Green" Glare min	"Yellow" Glare min	Energy kWh
PV array 1	SA tracking	SA tracking	0	0	-

Total annual glare received by each receptor

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
RWY 17	0	0
RWY 35	0	0

Results for: PV array 1

Receptor	Green Glare (min)	Yellow Glare (min)
RWY 17	0	0
RWY 35	0	0

Flight Path: RWY 17

0 minutes of yellow glare

0 minutes of green glare

Flight Path: RWY 35

0 minutes of yellow glare

0 minutes of green glare

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.

Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.

The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual values may differ.

Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.

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