

Glint and Glare Analysis

Arche Solar

Gorham Township,
Fulton County, Ohio

Prepared by:



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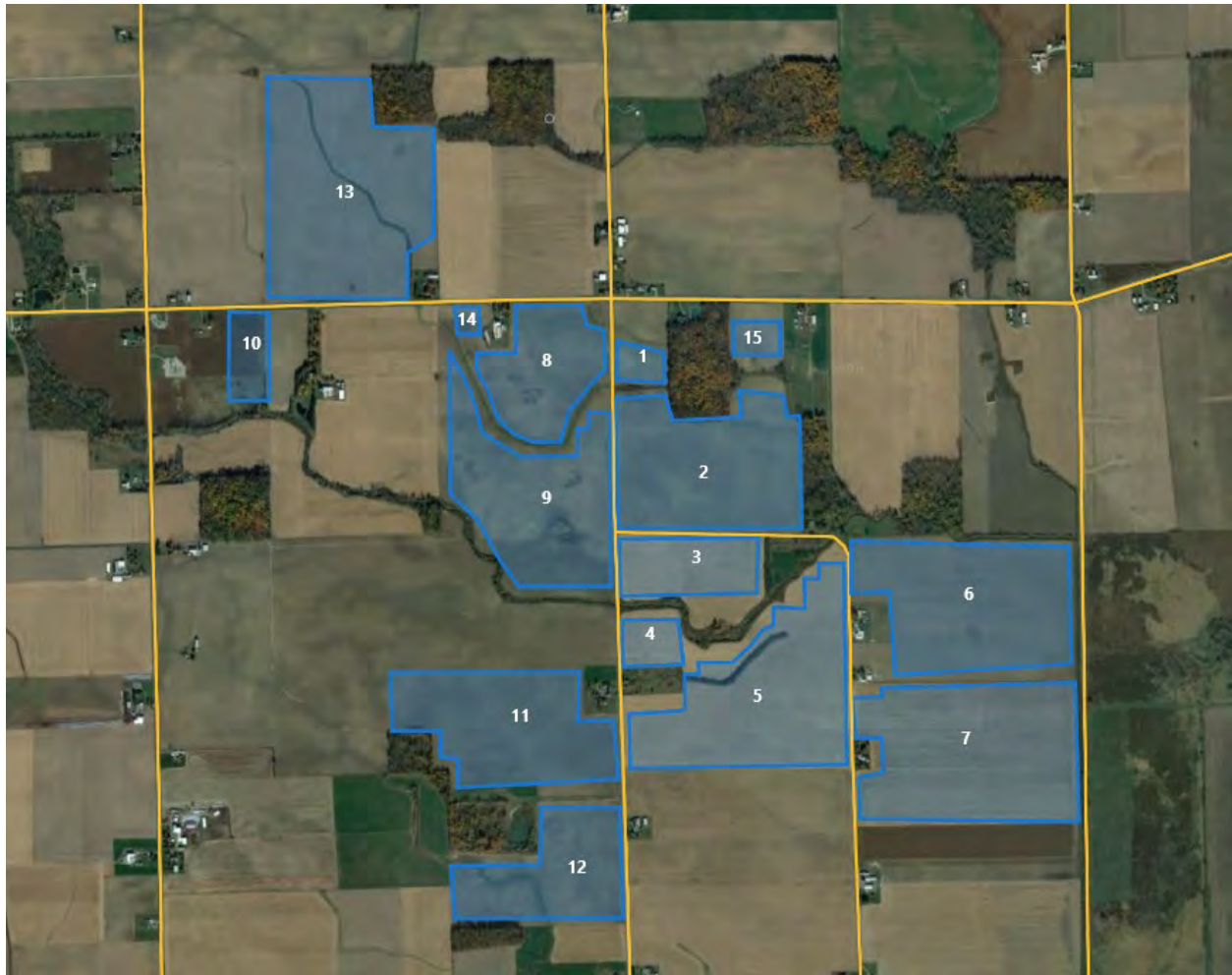
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Summary

Arche Energy Project, LLC (Arche), a wholly-owned subsidiary of 7X Energy, Inc., is proposing to construct Arche Solar (the Facility), which includes solar arrays in Gorham Township, Fulton County, Ohio (Figure 1). 7X Energy performed a Glint and Glare Analysis using the Solar Glare Hazard Analysis Tool (SGHAT) (now available through ForgeSolar) in order to identify any potential impacts on residences and vehicles on the routes surrounding the Facility.

There is no predicted glare for residences with an estimated first story viewing height of 8 feet or a second story viewing height of 16 feet. There was also no predicted glare from the solar arrays along the identified routes for cars with an estimated viewing height of 4 feet and for large trucks with an estimated viewing height of 8 feet. 7X Energy has applied FAA's glint and glare standards to vehicular operations due to the absence of non-aviation regulatory guidelines.

Figure 1: Locations of Arche Solar PV Arrays



Methodology

The results of this analysis conform to, and are in accordance with, the FAA's interim policy for *Solar Energy System Projects on Federally Obligated Airports*. The FAA adopted this interim policy in order to enhance safety for pilots, air-traffic control personnel, motorists and residents that may be impacted by a proposed solar energy installation. In cooperation with the Department of Energy (DOE), the FAA developed and validated the Sandia National Laboratories'

“Solar Glare Hazard Analysis Tool” (SGHAT), now licensed through ForgeSolar. The FAA requires the use of the SGHAT to demonstrate compliance with the standards for measuring ocular impact.

The ForgeSolar tool employs an interactive Google map with abilities to specify site location, PV array boundaries and locations of observers. The tool provides a quantified assessment of when and where the glare will occur for a proposed solar installation and potential effects on the human eye at locations where glare occurs. Ocular impact is analyzed over the entire calendar year in one (1) minute intervals from when the sun rises above the horizon until the sun sets below the horizon.

SGHAT 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.
- Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
- The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size.
- Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
- Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
- Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
- The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual results and glare occurrence 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.

The Facility arrays are single axis tracking solar arrays. 7X Energy utilized the SGHAT based guidance provided in User’s Manual v.3. Specifically, the module for discrete observation points was utilized for residences and the module for routes was used for roads that are adjacent or near the solar arrays.

Data

The following data were used as input parameters by 7X Energy for the Facility.

Table 1: Arche Solar Input Parameters

Parameter	Value
Axis tracking:	Single-axis rotation
Tracking axis orientation:	180.0°
Tracking axis tilt:	0.0°
Max tracking angle:	60.0°
Resting angle:	30.0°
Panel material:	Smooth glass with AR coating
Reflectivity:	Varies with sun
Slope error:	Correlate with material

Table 2: Arche Solar Array 01 Vertices

Vertex/ID	Latitude (deg)	Longitude (deg)	Ground Elevation (feet)	Height Above Ground (feet)	Total Elevation
1	41.67409	-84.288	751.4	5	756.4
2	41.67249	-84.2881	747.3	5	752.3
3	41.67246	-84.2862	746.1	5	751.1
4	41.67403	-84.2862	746.5	5	751.5

Table 3: Arche Solar Array 02 Vertices

Vertex/ID	Latitude (deg)	Longitude (deg)	Ground Elevation (feet)	Height Above Ground (feet)	Total Elevation
1	41.67136	-84.2879	740.6	5	745.6
2	41.66729	-84.288	742.6	5	747.6
3	41.66714	-84.281	738.5	5	743.5
4	41.67033	-84.2809	736.9	5	741.9
5	41.67035	-84.2814	739.5	5	744.5
6	41.67114	-84.2813	739	5	744
7	41.67123	-84.2831	746	5	751
8	41.67035	-84.2832	746.1	5	751.1
9	41.67043	-84.2865	747.6	5	752.6
10	41.67135	-84.2865	738.4	5	743.4

Table 4: Arche Solar Array 03 Vertices

Vertex/ID	Latitude (deg)	Longitude (deg)	Ground Elevation (feet)	Height Above Ground (feet)	Total Elevation
1	41.66686	-84.288	743.5	5	748.5
2	41.66535	-84.288	738.2	5	743.2
3	41.66531	-84.2854	736.7	5	741.7
4	41.6653	-84.2846	740.8	5	745.8
5	41.66467	-84.2846	740.6	5	745.6
6	41.66467	-84.2832	737.5	5	742.5
7	41.66527	-84.2832	739.1	5	744.1
8	41.66527	-84.2829	737.6	5	742.6
9	41.66609	-84.2829	739.6	5	744.6
10	41.66611	-84.2824	738.5	5	743.5
11	41.66681	-84.2823	741.6	5	746.6

Table 5: Arche Solar Array 04 Vertices

Vertex/ID	Latitude (deg)	Longitude (deg)	Ground Elevation (feet)	Height Above Ground (feet)	Total Elevation
1	41.66131	-84.2877	750.2	5	755.2
2	41.65979	-84.2877	748.9	5	753.9
3	41.65986	-84.2787	736	5	741
4	41.66604	-84.2787	732.8	5	737.8
5	41.66605	-84.2797	733.7	5	738.7
6	41.66563	-84.2796	734	5	739
7	41.66563	-84.2804	733.9	5	738.9
8	41.66468	-84.2804	734.5	5	739.5
9	41.66466	-84.2819	734.8	5	739.8
10	41.66377	-84.2819	735	5	740
11	41.66369	-84.2831	735	5	740
12	41.66294	-84.2831	735.6	5	740.6
13	41.66293	-84.2852	735.6	5	740.6
14	41.66202	-84.2851	747.6	5	752.6
15	41.662	-84.2857	748.1	5	753.1
16	41.66199	-84.2869	748.3	5	753.3
17	41.66198	-84.2876	748.6	5	753.6

Table 6: Arche Solar Array 05 Vertices

Vertex/ID	Latitude (deg)	Longitude (deg)	Ground Elevation (feet)	Height Above Ground (feet)	Total Elevation
1	41.66458	-84.2878	738.1	5	743.1
2	41.6631	-84.2878	741.8	5	746.8
3	41.66306	-84.2854	736.3	5	741.3
4	41.66367	-84.2854	737.7	5	742.7
5	41.66373	-84.2857	737.5	5	742.5
6	41.66458	-84.2856	737	5	742

Table 7: Arche Solar Array 06 Vertices

Vertex/ID	Latitude (deg)	Longitude (deg)	Ground Elevation (feet)	Height Above Ground (feet)	Total Elevation
1	41.66672	-84.2782	730.9	5	735.9
2	41.66537	-84.2782	732.8	5	737.8
3	41.66537	-84.2763	731.5	5	736.5
4	41.66455	-84.2763	732.7	5	737.7
5	41.66452	-84.2765	732.9	5	737.9
6	41.66371	-84.2765	736.8	5	741.8
7	41.66368	-84.2762	736.5	5	741.5
8	41.66245	-84.2762	737	5	742
9	41.66255	-84.2692	726.1	5	731.1
10	41.66466	-84.2692	726.4	5	731.4
11	41.66467	-84.271	727.8	5	732.8
12	41.66505	-84.271	727.9	5	732.9
13	41.66506	-84.2724	727.5	5	732.5
14	41.66542	-84.2724	728.4	5	733.4
15	41.66564	-84.2724	728.5	5	733.5
16	41.66563	-84.2729	728.5	5	733.5
17	41.66608	-84.2729	728.2	5	733.2
18	41.66608	-84.2738	729	5	734
19	41.66664	-84.2738	729.4	5	734.4

Table 8: Arche Solar Array 07 Vertices

Vertex/ID	Latitude (deg)	Longitude (deg)	Ground Elevation (feet)	Height Above Ground (feet)	Total Elevation
1	41.66224	-84.2768	736	5	741
2	41.66224	-84.2779	737.8	5	742.8
3	41.66088	-84.2779	735.5	5	740.5
4	41.66088	-84.2773	735	5	740
5	41.65961	-84.2773	735.7	5	740.7
6	41.65966	-84.2779	735.5	5	740.5
7	41.65812	-84.2778	733.2	5	738.2
8	41.65805	-84.2763	731.5	5	736.5
9	41.6585	-84.2762	732.4	5	737.4
10	41.65849	-84.2755	730.8	5	735.8
11	41.65825	-84.2694	726.4	5	731.4
12	41.66228	-84.2693	725.9	5	730.9

Table 9: Arche Solar Array 08 Vertices

Vertex/ID	Latitude (deg)	Longitude (deg)	Ground Elevation (feet)	Height Above Ground (feet)	Total Elevation
1	41.67169	-84.2934	748.4	5	753.4
2	41.67168	-84.2929	750.6	5	755.6
3	41.67093	-84.2929	746.2	5	751.2
4	41.67095	-84.292	756.1	5	761.1
5	41.67007	-84.2919	745.6	5	750.6
6	41.67008	-84.2905	744.1	5	749.1
7	41.67092	-84.2904	744.2	5	749.2
8	41.67095	-84.29	742.7	5	747.7
9	41.67176	-84.29	745.6	5	750.6
10	41.67176	-84.2893	742.5	5	747.5
11	41.67216	-84.2887	744.5	5	749.5
12	41.6732	-84.2887	747.1	5	752.1
13	41.67338	-84.2895	749.3	5	754.3
14	41.67409	-84.2897	748.1	5	753.1
15	41.67411	-84.2923	756.9	5	761.9
16	41.67257	-84.2924	753.8	5	758.8
17	41.67255	-84.2934	750.5	5	755.5
18	41.67195	-84.2934	748.2	5	753.2

Table 10: Arche Solar Array 09 Vertices

Vertex/ID	Latitude (deg)	Longitude (deg)	Ground Elevation (feet)	Height Above Ground (feet)	Total Elevation
1	41.67222	-84.2954	749.7	5	754.7
2	41.66848	-84.2954	742.1	5	747.1
3	41.66838	-84.2938	757.9	5	762.9
4	41.66718	-84.2937	743.4	5	748.4
5	41.66716	-84.293	750.6	5	755.6
6	41.66654	-84.293	740.3	5	745.3
7	41.66647	-84.2925	739.5	5	744.5
8	41.66565	-84.2924	740.2	5	745.2
9	41.66558	-84.2886	738.3	5	743.3
10	41.67071	-84.2885	750.7	5	755.7
11	41.67074	-84.2892	744.9	5	749.9
12	41.67032	-84.2892	748.5	5	753.5
13	41.67033	-84.2897	743.7	5	748.7
14	41.66939	-84.2898	747.5	5	752.5
15	41.66938	-84.2932	747	5	752
16	41.67004	-84.2933	746.6	5	751.6
17	41.67008	-84.2938	748.1	5	753.1
18	41.67034	-84.2938	747.4	5	752.4
19	41.67108	-84.2939	746.8	5	751.8
20	41.67109	-84.2942	748.3	5	753.3
21	41.67161	-84.2942	746.5	5	751.5
22	41.67164	-84.2944	747.2	5	752.2
23	41.6722	-84.2945	747	5	752

Table 11: Arche Solar Array 10 Vertices

Vertex/ID	Latitude (deg)	Longitude (deg)	Ground Elevation (feet)	Height Above Ground (feet)	Total Elevation
1	41.67389	-84.3047	765.4	5	770.4
2	41.67396	-84.303	761.2	5	766.2
3	41.67126	-84.303	749.6	5	754.6
4	41.67123	-84.3045	755.1	5	760.1

Table 12: Arche Solar Array 11 Vertices

Vertex/ID	Latitude (deg)	Longitude (deg)	Ground Elevation (feet)	Height Above Ground (feet)	Total Elevation
1	41.66139	-84.2957	755.3	5	760.3
2	41.66004	-84.2954	754.9	5	759.9
3	41.65979	-84.2948	755.4	5	760.4
4	41.65915	-84.2948	754.1	5	759.1
5	41.65927	-84.2884	749.1	5	754.1
6	41.66113	-84.2884	751.1	5	756.1
7	41.66101	-84.2903	752	5	757
8	41.66286	-84.2903	745.6	5	750.6
9	41.6628	-84.2976	757.1	5	762.1
10	41.6612	-84.2974	749.6	5	754.6

Table 13: Arche Solar Array 12 Vertices

Vertex/ID	Latitude (deg)	Longitude (deg)	Ground Elevation (feet)	Height Above Ground (feet)	Total Elevation
1	41.65836	-84.2906	750.3	5	755.3
2	41.65838	-84.2883	748.6	5	753.6
3	41.65507	-84.2882	741.2	5	746.2
4	41.65509	-84.2949	744.4	5	749.4
5	41.65668	-84.2947	739.4	5	744.4
6	41.6567	-84.2907	743.5	5	748.5

Table 14: Arche Solar Array 13 Vertices

Vertex/ID	Latitude (deg)	Longitude (deg)	Ground Elevation (feet)	Height Above Ground (feet)	Total Elevation
1	41.67477	-84.3027	756.3	5	761.3
2	41.67474	-84.2974	753.2	5	758.2
3	41.67615	-84.2973	754.4	5	759.4
4	41.67663	-84.2963	755.8	5	760.8
5	41.6798	-84.2962	762	5	767
6	41.67967	-84.2984	768.2	5	773.2
7	41.68131	-84.2985	769.1	5	774.1
8	41.68131	-84.3031	769.4	5	774.4

Table 15: Arche Solar Array 14 Vertices

Vertex/ID	Latitude (deg)	Longitude (deg)	Ground Elevation (feet)	Height Above Ground (feet)	Total Elevation
1	41.6741	-84.2948	754	5	759
2	41.6741	-84.2941	755.9	5	760.9
3	41.67347	-84.2941	750	5	755
4	41.67347	-84.2948	747.5	5	752.5

Table 16: Arche Solar Array 15 Vertices

Vertex/ID	Latitude (deg)	Longitude (deg)	Ground Elevation (feet)	Height Above Ground (feet)	Total Elevation
1	41.67386	-84.2833	744.7	5	749.7
2	41.67286	-84.2833	742.4	5	747.4
3	41.67282	-84.2815	740.5	5	745.5
4	41.67385	-84.2815	751.7	5	756.7

Discrete Observation Points

Figure 2 and the tables that follow show the discrete observation points used in the glare analysis.

Figure 2: Arche Solar Discrete Observation Points

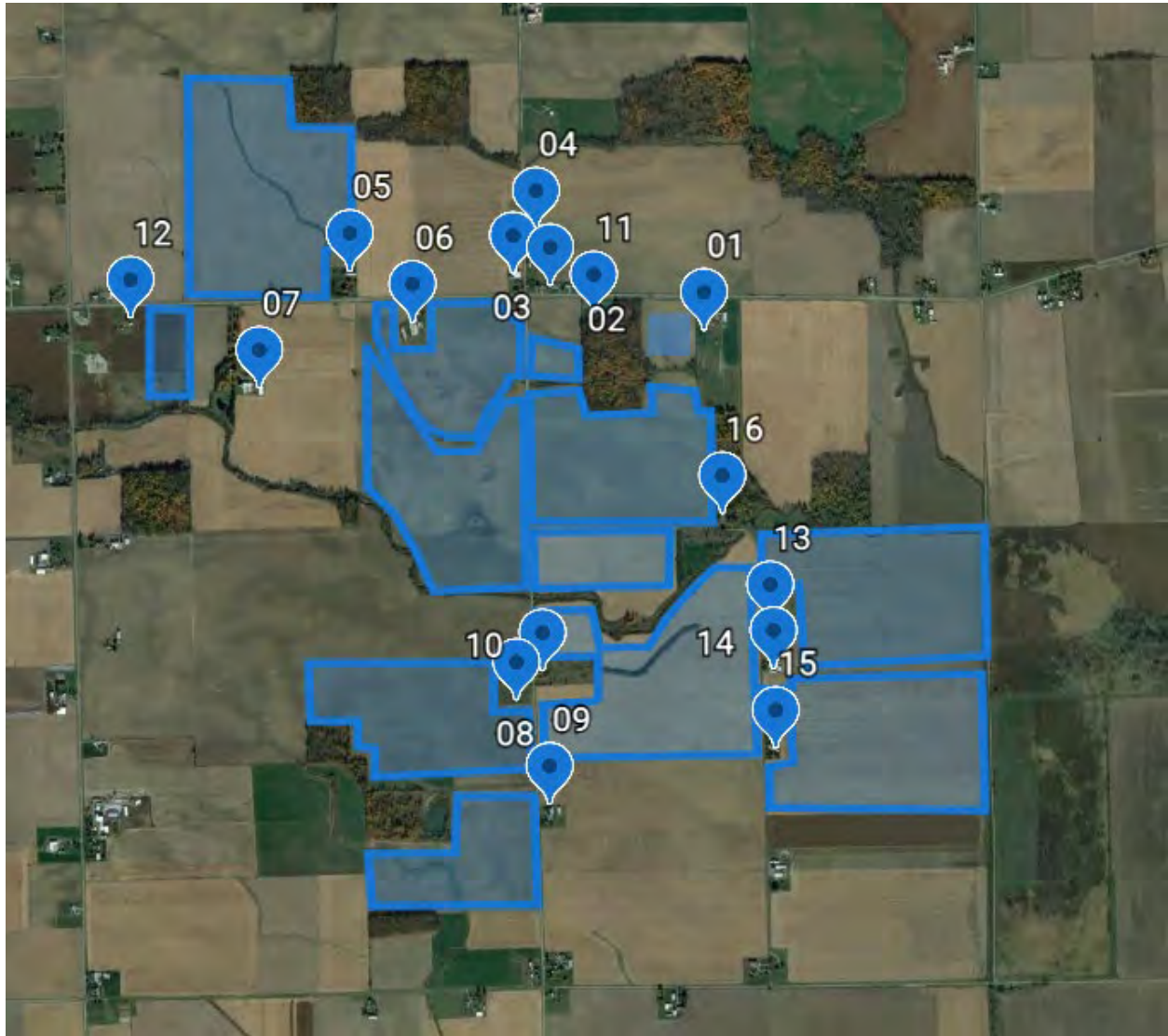


Table 17: Arche Solar Discrete Observation Points

Vertex/ID	Latitude (deg)	Longitude (deg)	Ground Elevation (feet)	Height Above Ground - First Story (feet)	Total Elevation - First Story (feet)	Height Above Ground - Second Story (feet)	Total Elevation - Second Story
01	41.67366	-84.2807	751.5	8	759.5	16	767.5
02	41.67462	-84.2876	754.1	8	762.1	16	770.1
03	41.67499	-84.2888	756.9	8	764.9	16	772.9
04	41.67645	-84.288	762	8	770	16	778
05	41.67502	-84.2957	758.6	8	766.6	16	774.6

Vertex/ID	Latitude (deg)	Longitude (deg)	Ground Elevation (feet)	Height Above Ground - First Story (feet)	Total Elevation - First Story (feet)	Height Above Ground - Second Story (feet)	Total Elevation - Second Story (feet)
06	41.67324	-84.2931	758.9	8	766.9	16	774.9
07	41.67137	-84.2996	761.8	8	769.8	16	777.8
08	41.66179	-84.2888	751.3	8	759.3	16	767.3
09	41.65807	-84.2873	747.1	8	755.1	16	763.1
10	41.6624	-84.2877	749.5	8	757.5	16	765.5
11	41.67376	-84.2854	746.4	8	754.4	16	762.4
12	41.67345	-84.3050	776.4	8	784.4	16	792.4
13	41.66394	-84.278	739.4	8	747.4	16	755.4
14	41.66254	-84.2776	738.1	8	746.4	16	754.1
15	41.66006	-84.2779	737.4	8	745.4	16	753.4
16	41.66741	-84.28	737.2	8	745.2	16	753.2

Figure 3: Locations of Routes near Arche Solar Arrays

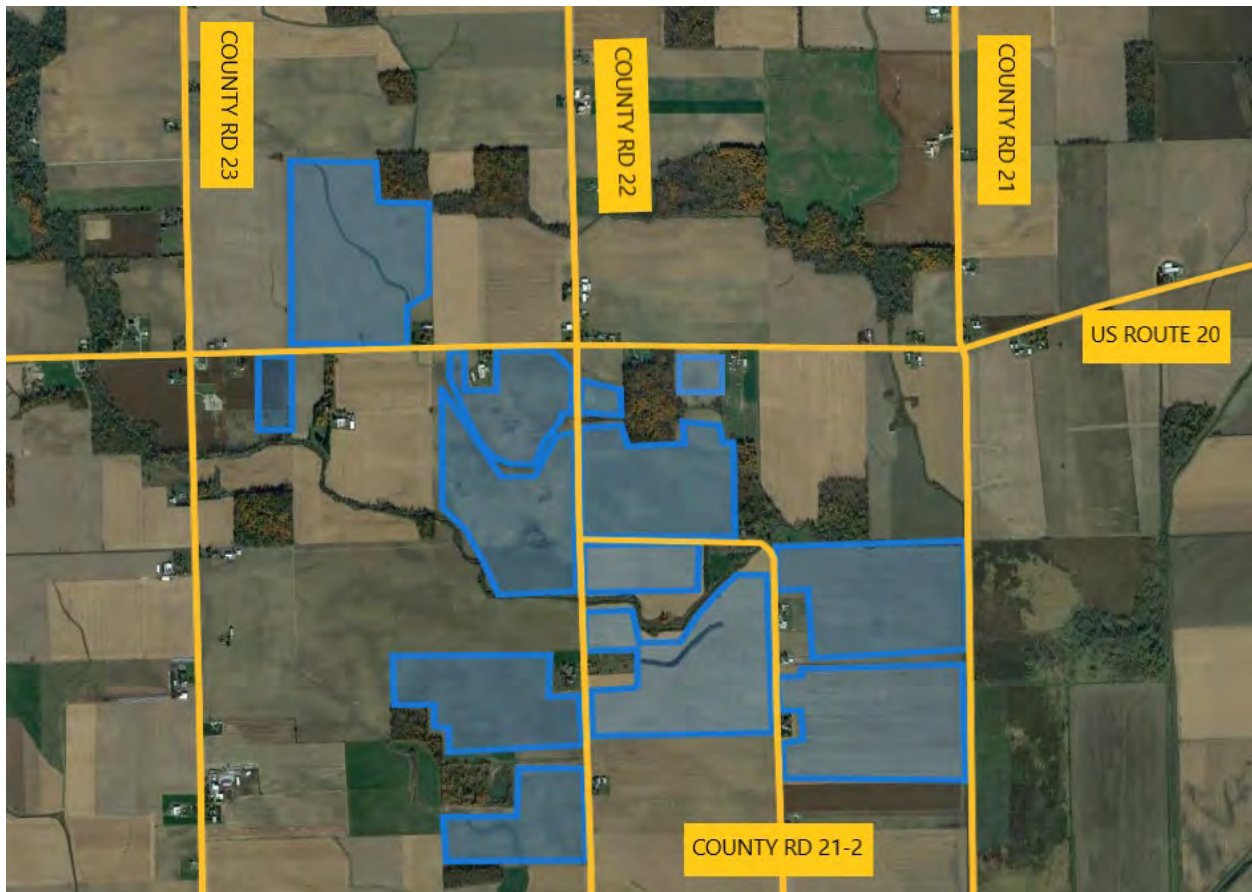


Table 18: Arche Solar Observation Receptors - County Road 21

Vertex/ID	Latitude (deg)	Longitude (deg)	Elevation	Height Above Ground - Cars (feet)	Total Elevation - Cars (feet)	Height Above Ground - Trucks (feet)	Total Elevation - Trucks (feet)
1	41.68112	-84.2694	744.8	4	748.8	8	752.8
2	41.65657	-84.2685	727.6	4	731.6	8	735.6
3	41.65246	-84.2684	726.7	4	730.7	8	734.7
4	41.65269	-84.2685	728.2	4	732.2	8	736.2

Table 19: Arche Solar Observation Receptors - County Road 21-2

Vertex/ID	Latitude (deg)	Longitude (deg)	Elevation	Height Above Ground - Cars (feet)	Total Elevation - Cars (feet)	Height Above Ground - Trucks (feet)	Total Elevation - Trucks (feet)
1	41.66706	-84.2882	746.2	4	750.2	8	754.2
2	41.66703	-84.2859	749.5	4	753.5	8	757.5
3	41.667	-84.2836	743.1	4	747.1	8	751.1
4	41.66696	-84.2791	734.4	4	738.4	8	742.4
5	41.66676	-84.2788	733.1	4	737.1	8	741.1
6	41.66644	-84.2785	734.2	4	738.2	8	742.2
7	41.65944	-84.2783	734.7	4	738.7	8	742.7
8	41.65243	-84.278	727.4	4	731.4	8	735.4

Table 20: Arche Solar Observation Receptors - County Road 22

Vertex/ID	Latitude (deg)	Longitude (deg)	Elevation	Height Above Ground - Cars (feet)	Total Elevation - Cars (feet)	Height Above Ground - Trucks (feet)	Total Elevation - Trucks (feet)
1	41.65187	-84.2876	735.5	4	739.5	8	743.5
2	41.66504	-84.2882	742	4	746	8	750
3	41.67392	-84.2884	750.5	4	754.5	8	758.5
4	41.68277	-84.2887	762.6	4	766.6	8	770.6

Table 21: Arche Solar Observation Receptors - County Road 23

Vertex/ID	Latitude (deg)	Longitude (deg)	Elevation	Height Above Ground - Cars (feet)	Total Elevation - Cars (feet)	Height Above Ground - Trucks (feet)	Total Elevation - Trucks (feet)
1	41.6521	-84.307	759.5	4	763.5	8	767.5
2	41.67419	-84.3076	771.2	4	775.2	8	779.2
3	41.68436	-84.308	782.8	4	786.8	8	790.8
4	41.69386	-84.3082	794.5	4	798.5	8	802.5

Table 22: Arche Solar Observation Receptors – US Route 20

Vertex/ID	Latitude (deg)	Longitude (deg)	Elevation	Height Above Ground - Cars (feet)	Total Elevation - Cars (feet)	Height Above Ground - Trucks (feet)	Total Elevation - Trucks (feet)
1	41.67391	-84.3137	763.5	4	767.5	8	771.5
2	41.6742	-84.2969	752.8	4	756.8	8	760.8
3	41.67439	-84.2882	755.4	4	759.4	8	763.4
4	41.67426	-84.2691	738.1	4	742.1	8	746.1
5	41.67657	-84.2585	735.1	4	739.1	8	743.1

Results

7X Energy utilized the previous inputs to analyze potential glint and glare at various points along the roadways and at houses utilizing the SGHAT route tool for roadways and discrete observation points for residents. If glare is detected, “Glare Occurrence Plots” are generated by SGHAT. The plots show when glare can occur (as viewed from the prescribed observation point) throughout the year. The color indicates the potential ocular hazard. The colors are defined as:

- Green: Low potential for temporary after-image
- Yellow: Potential for temporary after-image
- Red: Potential for permanent eye damage

The results of this analysis indicate no predicted glare on the roadways or houses.

Table 23: Arche Solar Glint and Glare Analysis Summary

Receptor	Green Glare (minutes/year)	Yellow Glare (minutes/year)	Red Glare (minutes/year)
Residences First Story	0	0	0
Residences Second Story	0	0	0
County Road 21	0	0	0
County Road 21-2	0	0	0
County Road 22	0	0	0
County Road 23	0	0	0
US Route 20	0	0	0

Conclusion

There was no predicted glare for residences with an estimated single story viewing height of 8 feet or a second story viewing height of 16 feet as a result of the Facility. Additionally, there was no predicted glare from the solar arrays along the routes mentioned above for cars and large trucks. 7X Energy has applied FAA's glint and glare standards to vehicular operations due to the absence of non-aviation regulatory guidelines. As noted in the assumptions, the glint and glare analysis does not consider vegetation, fencing, or other natural obstructions. This glint and glare report has taken the most conservative approach in calculating the possibility for glint and glare.