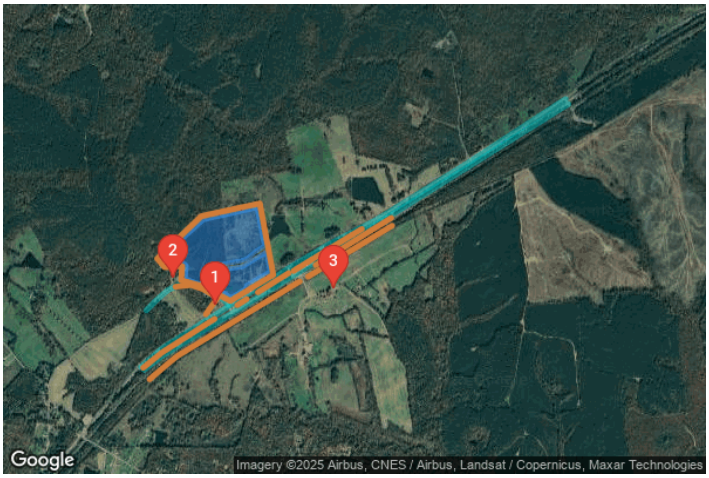
FORGESOLAR GLARE ANALYSIS

Project: **Green Bay - PE Co VA**
Site configuration: **Green Bay buildable**

Client: CEP Solar

Created 31 Aug, 2024
Updated 20 Jan, 2025
Time-step 1 minute
Timezone offset UTC-5
Minimum sun altitude 0.0 deg
DNI peaks at 1,000.0 W/m^2
Category 500 kW to 5 MW
Site ID 128117.21892

Ocular transmission coefficient 0.5
Pupil diameter 0.002 m
Eye focal length 0.017 m
Sun subtended angle 9.3 mrad
PV analysis methodology V2



Summary of Results No glare predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV array 1	SA tracking	SA tracking	0	0.0	0	0.0	13,500,000.0

Total glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

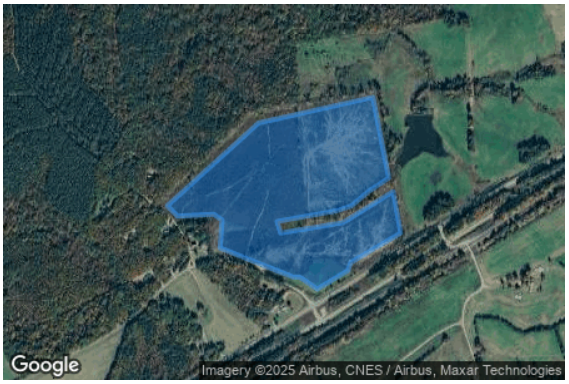
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Cheatham Road	0	0.0	0	0.0
US-360 East	0	0.0	0	0.0
US-360 West	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0

CEP Solar, LLC, is proposing a 5 MW solar project in Prince Edward County, VA, and commissioned a glint/glare analysis using ForgeSolar software to determine ocular impact on adjacent properties and roads. The analysis includes a 6' security fence to be erected by the developer, and predicts zero glare for neighbors and motorists on US-360 and Cheatham Road.

Component Data

PV Arrays

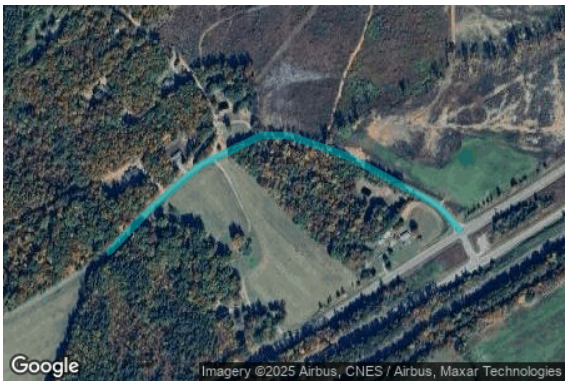
Name: PV array 1
Axis tracking: Single-axis rotation
Backtracking: Shade-slope
Tracking axis orientation: 180.0°
Max tracking angle: 60.0°
Resting angle: 0.0°
Ground Coverage Ratio: 0.5
Rated power: 10000.0 kW
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	37.146070	-78.305991	628.47	3.00	631.47
2	37.148328	-78.302860	637.00	3.00	640.00
3	37.149029	-78.298933	550.04	3.00	553.04
4	37.146832	-78.298386	563.66	3.00	566.66
5	37.146447	-78.299105	556.52	3.00	559.52
6	37.146070	-78.299663	587.72	3.00	590.72
7	37.145934	-78.300178	606.18	3.00	609.18
8	37.145643	-78.302227	620.63	3.00	623.63
9	37.145326	-78.302098	629.37	3.00	632.37
10	37.145609	-78.299953	613.17	3.00	616.17
11	37.146455	-78.298236	546.50	3.00	549.50
12	37.145328	-78.297974	558.05	3.00	561.05
13	37.144520	-78.299695	596.60	3.00	599.60
14	37.144306	-78.299787	582.13	3.00	585.13
15	37.143797	-78.300843	591.95	3.00	594.95
16	37.144113	-78.301423	587.27	3.00	590.27
17	37.144130	-78.301680	586.59	3.00	589.59
18	37.144917	-78.304180	625.46	3.00	628.46
19	37.145687	-78.304116	638.16	3.00	641.16
20	37.145841	-78.304405	652.32	3.00	655.32
21	37.145790	-78.305650	623.46	3.00	626.46

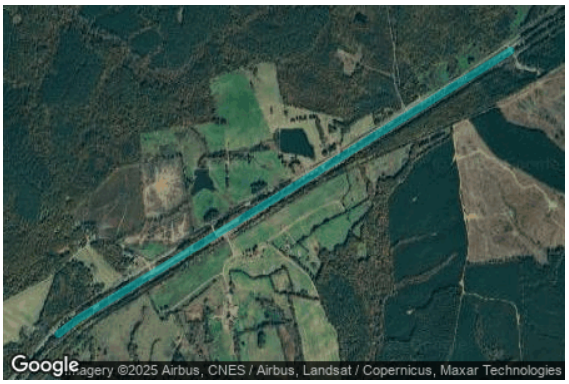
Route Receptors

Name: Cheatham Road
Path type: Two-way
Observer view angle: 50.0°



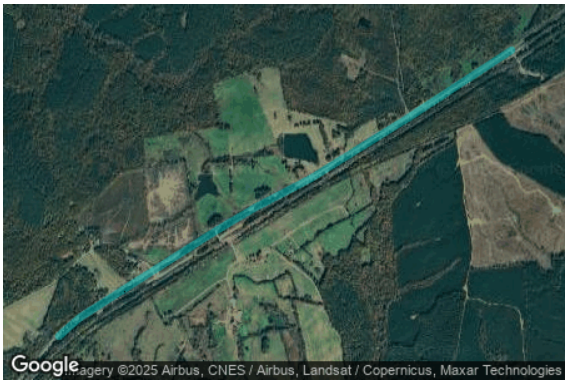
Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	37.143361	-78.301027	582.06	6.00	588.06
2	37.143688	-78.301398	590.84	6.00	596.84
3	37.144349	-78.302916	604.54	6.00	610.54
4	37.144641	-78.303947	610.90	6.00	616.90
5	37.144643	-78.304414	605.03	6.00	611.03
6	37.144236	-78.305468	613.18	6.00	619.18
7	37.143610	-78.306364	604.22	6.00	610.22
8	37.143058	-78.307035	616.55	6.00	622.55

Name: US-360 East
Path type: One-way (toward increasing index)
Observer view angle: 50.0°



Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	37.139598	-78.307215	571.13	6.00	577.13
2	37.140453	-78.305793	571.06	6.00	577.06
3	37.141835	-78.302929	581.94	6.00	587.94
4	37.147126	-78.292070	563.89	6.00	569.89
5	37.155070	-78.276122	568.99	6.00	574.99

Name: US-360 West
Path type: One-way (toward increasing index)
Observer view angle: 30.0°



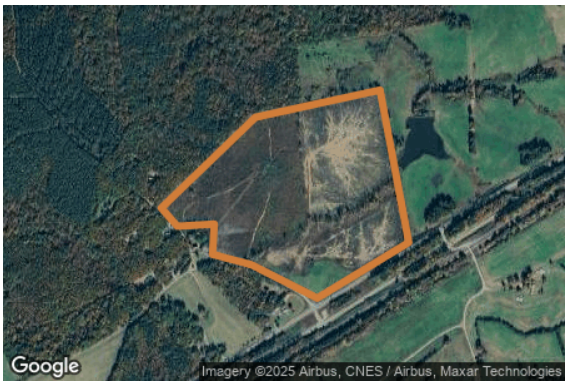
Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	37.155365	-78.276326	568.21	6.00	574.21
2	37.151647	-78.283471	590.14	6.00	596.14
3	37.148364	-78.290118	561.04	6.00	567.04
4	37.146764	-78.293970	552.69	6.00	558.69
5	37.145524	-78.296593	561.73	6.00	567.73
6	37.142346	-78.302895	580.10	6.00	586.10
7	37.140766	-78.306006	572.56	6.00	578.56
8	37.139752	-78.307432	569.83	6.00	575.83

Discrete Observation Point Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (ft)	Height (ft)
OP 1	1	37.143318	-78.301985	592.25	6.00
OP 2	2	37.144943	-78.305046	611.95	5.00
OP 3	3	37.144288	-78.293260	576.66	6.00

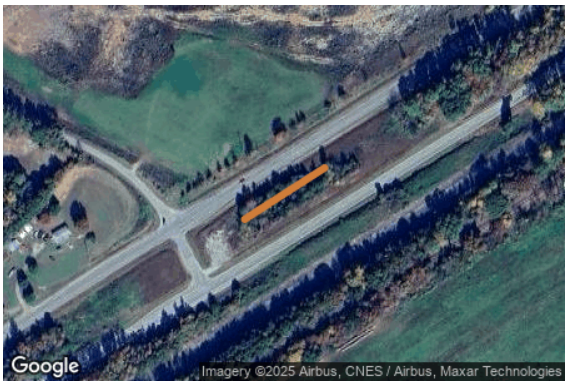
Obstruction Components

Name: Project fence
Top height: 6.0 ft



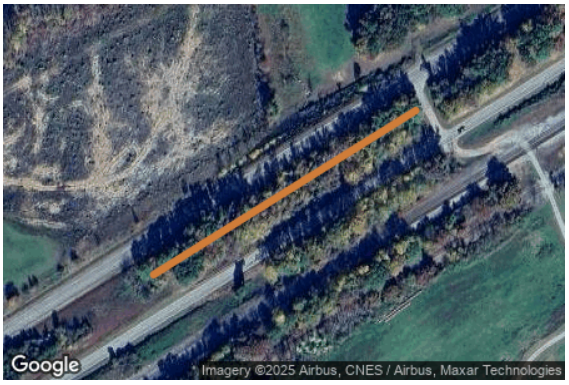
Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)
1	37.146069	-78.306243	625.02
2	37.148545	-78.303008	626.46
3	37.149289	-78.298728	523.42
4	37.145130	-78.297741	562.21
5	37.143610	-78.300884	591.30
6	37.144521	-78.303148	613.91
7	37.144804	-78.304484	614.78
8	37.145633	-78.304425	648.13
9	37.145573	-78.305691	616.76
10	37.146069	-78.306243	625.02

Name: Treeline
Top height: 32.8 ft



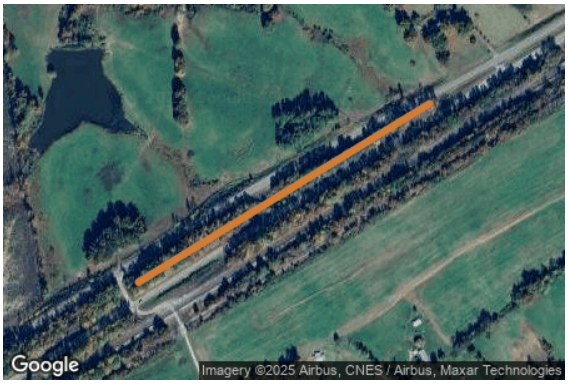
Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)
1	37.143368	-78.300375	582.08
2	37.143719	-78.299689	580.50

Name: Treeline
Top height: 32.8 ft



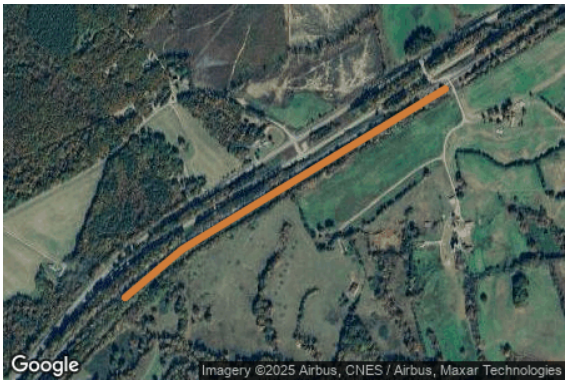
Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)
1	37.144112	-78.298862	579.64
2	37.145232	-78.296609	566.38

Name: Treeline
Top height: 32.8 ft



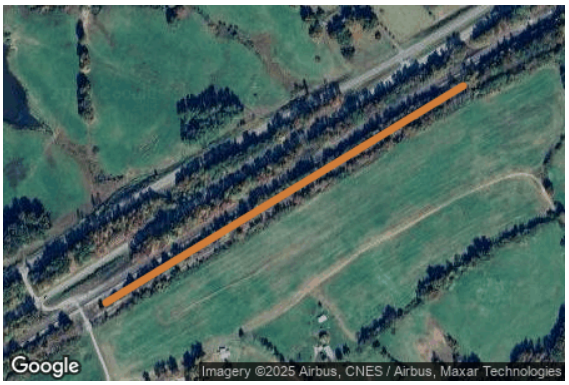
Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)
1	37.145361	-78.296255	562.60
2	37.147798	-78.291256	559.64

Name: Treeline
Top height: 32.8 ft



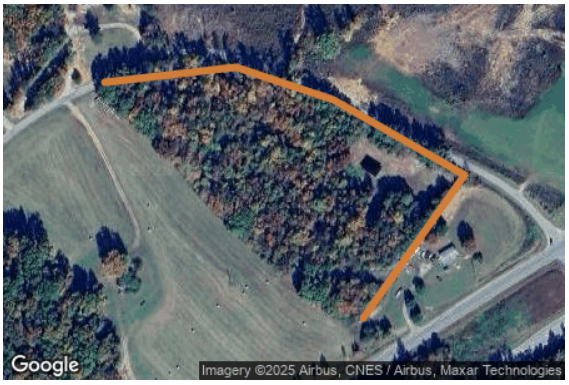
Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)
1	37.139049	-78.306802	577.17
2	37.140366	-78.304838	586.79
3	37.144745	-78.295805	570.64

Name: Treeline
Top height: 32.8 ft



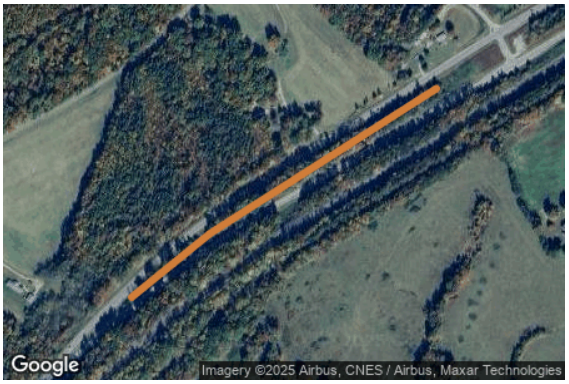
Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)
1	37.145027	-78.295182	570.62
2	37.147986	-78.289046	575.45

Name: Treeline
Top height: 32.8 ft



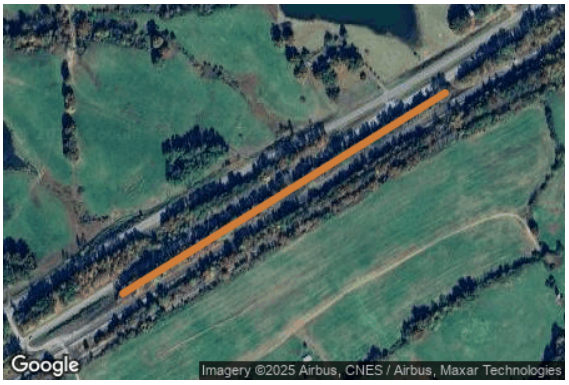
Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)
1	37.144437	-78.304903	606.47
2	37.144540	-78.303776	619.53
3	37.144317	-78.302939	606.33
4	37.143804	-78.301813	593.38
5	37.142829	-78.302682	594.90

Name: Treeline
Top height: 32.8 ft



Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)
1	37.142564	-78.302038	584.39
2	37.140588	-78.305922	571.99
3	37.139716	-78.307274	571.28

Name: Treeline
Top height: 32.8 ft



Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)
1	37.145703	-78.294635	558.01
2	37.148439	-78.289099	568.18

Glare Analysis Results

Summary of Results No glare predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV array 1	SA tracking	SA tracking	0	0.0	0	0.0	27,000,000.0

Total glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Cheatham Road	0	0.0	0	0.0
US-360 East	0	0.0	0	0.0
US-360 West	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0

PV: PV array 1 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Cheatham Road	0	0.0	0	0.0
US-360 East	0	0.0	0	0.0
US-360 West	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0

PV array 1 and Route: Cheatham Road

No glare found

PV array 1 and Route: US-360 East

No glare found

PV array 1 and Route: US-360 West

No glare found

PV array 1 and OP 1

No glare found

PV array 1 and OP 2

No glare found

PV array 1 and OP 3

No glare found

Assumptions

"Green" glare is glare with low potential to cause an after-image when observed prior to a typical blink response time.
"Yellow" glare is glare with potential to cause an after-image when observed prior to a typical blink response time.
Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.
Several V1 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. This primarily affects V1 analyses of path receptors.
Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis.
The analysis does not automatically consider obstacles (either man-made or natural) between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills, buildings, etc.
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.)
The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.
The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.
The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.
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.
Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
Refer to the Help page at **www.forgesolar.com/help/** for assumptions and limitations not listed here.

Default glare analysis parameters and observer eye characteristics (for reference only):

- 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