GOLDER
MEMBER OF WSP

REPORT

Nova Solar Power Project

Glare Assessment

Submitted to:

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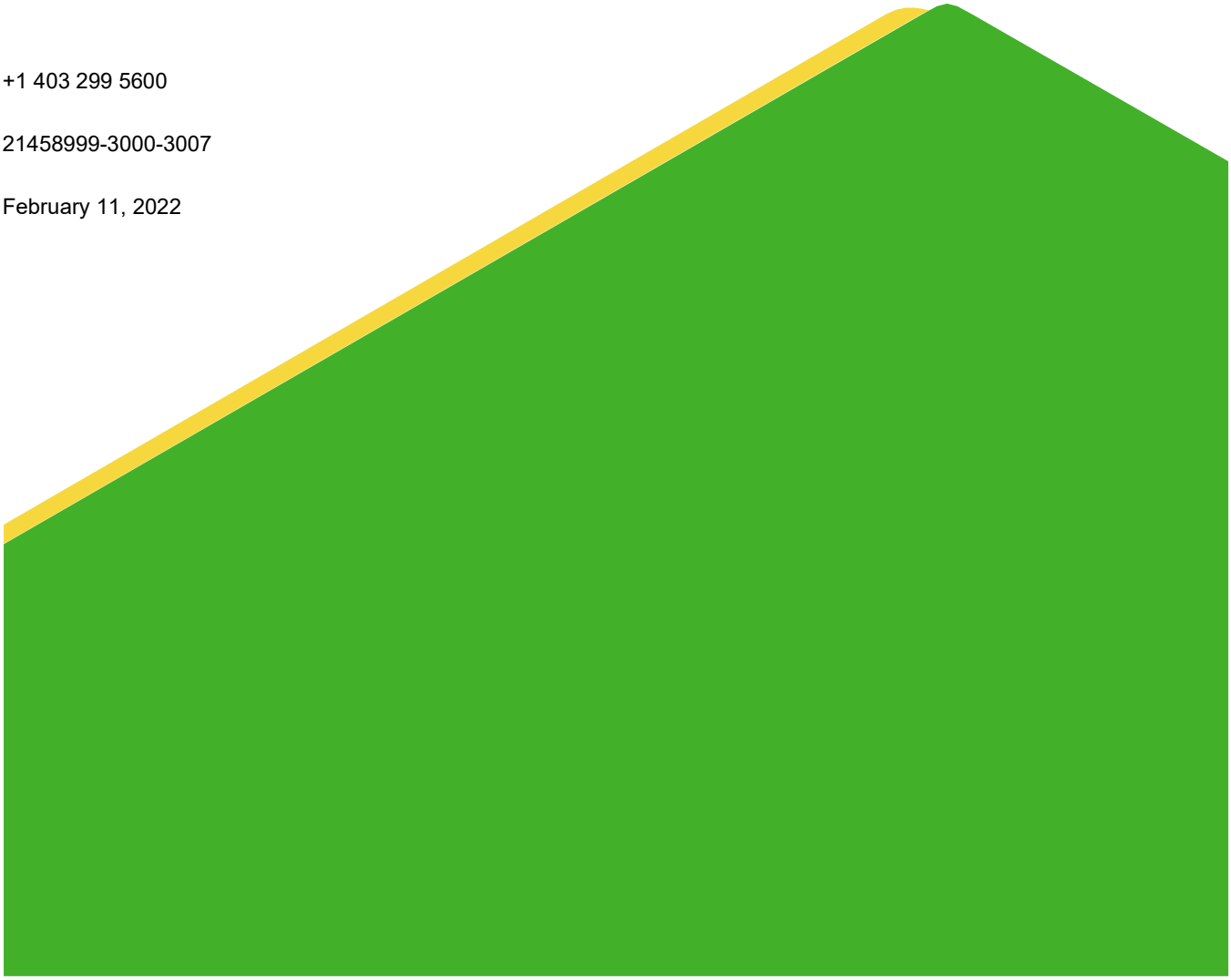

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1.0 INTRODUCTION

Renewable Energy Systems (RES) Canada Inc. (the Proponent) is proposing the develop the Nova Solar Power Project (the Project) in Wheatland County, Alberta. The Project will be located approximately 1.2 kilometres (km) west of the Hamlet of Carseland, in portions of Section 2 and 3, Township 22, Range 26, West of the Fourth Meridian. The maximum generating capacity of the Project will be 150 megawatts alternating current (MWac).

Alberta Utilities Commission (AUC) Rule 007 requires that applications for new solar power facilities in Alberta include a solar glare assessment (AUC 2021). According to Rule 007, applicants must:

> *"Submit a solar glare assessment report that predicts solar glare at receptors within 800 metres from the boundary of the project and registered aerodromes and known unregistered aerodromes within 4,000 metres from the boundary of the project where the potential for glare is possible."* (AUC 2021)

The Proponent retained Golder Associates Ltd. (Golder) to prepare a glare assessment for the Project, in accordance with Rule 007. The results of Golder's glare assessment are summarized in this report.

2.0 ASSESSMENT METHODS

Rule 007 requires preparation of a glare assessment for the Project and sets out general assessment requirements. However, the AUC does not recommend or endorse a specific approach for modelling glare and does not establish specific criteria for assessing potential glare effects.

In the absence of detailed technical guidance for modelling or assessing glare, glare assessments for solar projects in Alberta typically make use of the Solar Glare Hazard Analysis Tool (SGHAT) developed by the United States Federal Aviation Administration (FAA). The FAA's SGHAT provides a method for modelling glare from solar power facilities, as well as criteria limits for assessing the magnitude of potential glare effects. When predicting glare levels, the SGHAT modelling method accounts for the path of the sun through the sky and the intensity of solar radiation, as well as the location, orientation, inclination, and reflectivity of the solar panels. The SGHAT then classifies potential glare effects at receptors based on the predicted brightness and size of the glare spot formed on the retina of an observer's eye. For each receptor, the magnitude of the potential glare effect is characterized using a colour-coded classification system:

- no glare – there are no glare effects
- green glare – glare is present but there is low potential for temporary after image
- yellow glare – glare is present with potential for temporary after image
- red glare – glare is present with potential for permanent eye damage

Figure 1 (reproduced from ForgeSolar 2022) presents a graph showing how the SGHAT classifies potential glare effects based on retinal irradiance (i.e., brightness of the glare spot on an observer's retina) and subtended source angle (i.e., size of the glare spot on the observer's retina).

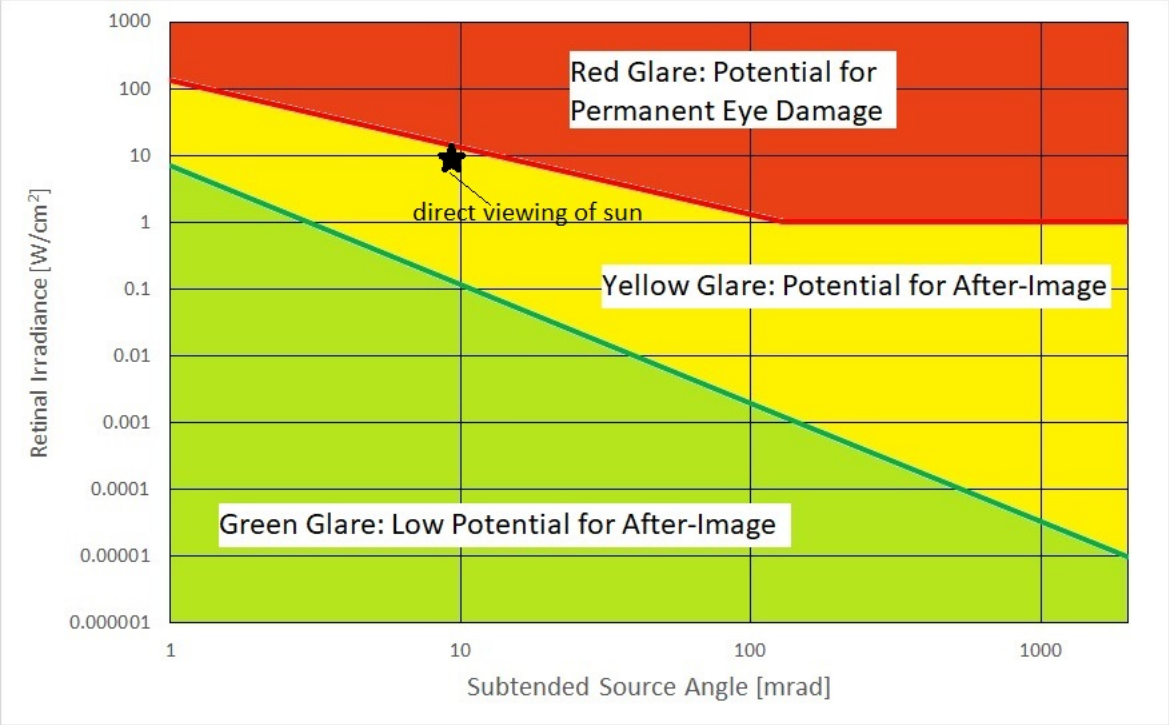

Figure 1: Glare Effect Classification System (reproduced from ForgeSolar 2022)

The Project glare assessment made use of the FAA's SGHAT as implemented in the ForgeSolar Glare Gauge® software program. Model inputs used to represent the Project in the modelling software are summarized in Table 1. The model inputs presented in Table 1 are a conservative representation of the Project; these model inputs will tend to overestimate Project glare effects.

Table 1: Model Input Parameters for the Nova Solar Project Glare Assessment

Model Input	Parameter Value	Comment
Direct normal irradiance	Peak value of 1,000 watts per square metre (W/m^2); varies with time of day	This parameter represents the amount of solar radiation received by a surface normal to the sun.
Ocular transmission coefficient	0.5	This parameter represents the amount of light typically absorbed within the human eye before reaching the retina.
Pupil diameter	0.002 m	This is a typical value for the human eye under daytime conditions.
Eye focal length	0.017 m	This parameter represents the distance at which light rays intersect within the eye; this is a typical value for the human eye.
Sun subtended angle	9.3 milliradians (mrad)	This parameter represents the apparent size of the sun for an observer on the surface of the earth.
Number of solar arrays	4	The Project will consist of thousands of individual photovoltaic solar panels distributed across two Sections of land; the SGHAT model breaks the Project up into four solar arrays to improve the accuracy of glare predictions.

Table 1: Model Input Parameters for the Nova Solar Project Glare Assessment

Model Input	Parameter Value	Comment
Axis tracking	Single	Project solar panels will be mounted on a tracking system that adjusts their inclination as the sun moves across the sky; use of axis tracking increases the amount of sunlight absorbed by the Project solar panels and thus reduces the amount of sunlight that is reflected to receptors in the environment.
Tilt of tracking axis	0°	This parameter represents the elevation of the tracking axis on which the Project solar panels rotate; a value of 0° indicates the Project solar panels will be installed on level ground.
Orientation	180°	This parameter represents the azimuthal orientation of the tracking axis measured clockwise from true north; a value of 180° indicates the Project solar panels will face south.
Maximum tracking angle	±60°	This parameter represents the maximum inclination of the Project solar panels around the tracking axis.
Backtracking angle limit	±6°	The Project will make use of a backtracking system during early morning and late afternoon periods when the sun is beyond the maximum tracking angle of the single axis system; 6° represents the panel tilt angle at "first light" in the morning and "last light" in the evening.
Panel material	Smooth glass with anti-reflective coating	Anti-reflective coating increases the amount of sunlight absorbed by the Project solar panels and thus reduces the amount of sunlight that is reflected to receptors in the environment.
Height above ground	0.50 m (panel bottom) 1.55 m (panel centre) 2.45 m (panel top)	Project solar panels were modelled at minimum height above ground, average height above ground, and maximum height above ground to fully account for potential glare effects.

Rule 007 requires that glare assessments consider potential effects to *"…[dwelling] receptors within 800 metres from the boundary of the project…"*, *"…highways, major roadways and railways…"*, and *"…registered and known unregistered aerodromes within 4,000 metres from the boundary of the project…"* (AUC 2021). In accordance with this guidance, the Project glare assessment considered potential effects at 19 receptors:

- the five occupied dwellings located within 800 m of the Project
- the 11 closest roadways to the Project
- the three closest railways to the Project

Note there are no registered or known unregistered aerodromes within 4,000 m of the Project, so these types of receptors were not considered in the glare assessment. The locations of the 19 receptors that were considered in the Project glare assessment are presented in Figure 2. Table 2 provides a short description of each receptor.

320000
322000
324000
326000
5635000
5634000
TWP 22
TWP 21
RGE 26 W4M
RGE 25 W4M
9
10
11
12
4
3
2
1
33
34
35
36
CARGILL SIDING
CARGILL ACCESS ROAD
TOWNSHIP ROAD 221
STELLA-JONES ACCESS ROAD
RAILWAY MAIN LINE
PIONEER SIDING
PIONEER ACCESS ROAD
HIGHWAY 24
MCKINNON DRIVE
CARSELAND
RAILWAY AVENUE
RANGE ROAD 263
RANGE ROAD 261
RANGE ROAD 262
TOWNSHIP ROAD 220
R01
R02
R03
R04
R05

LEGEND

- HAMLET
- PRIMARY HIGHWAY
- LOCAL ROAD
- RAILWAY
- LIMIT OF DISTURBANCE
- LIMIT OF DISTURBANCE - 800 M BUFFER

GLARE RECEPTORS

- DWELLING
- RAILWAY
- ROAD

0 400 800
1:17,500 METRES

REFERENCE(S)

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PROJECTION: UTM ZONE 12 DATUM: NAD 83

CLIENT
RENEWABLE ENERGY SYSTEMS CANADA INC.

PROJECT
NOVA SOLAR PROJECT

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2022-02-03
DESIGNED	VY
PREPARED	LMS
REVIEWED	BMS
APPROVED	TC

TITLE
GLARE RECEPTORS

PROJECT NO.	PHASE	REV.	FIGURE
21458999	3000	0	2

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25mm

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Table 2: Glare Receptors

Receptor Type	Receptor Name	Universal Transverse Mercator Coordinates [Zone 12]		Receptor Height(s) [m]	Description / Comment
		Easting [m]	Northing [m]		
Occupied Dwelling	R01	322738	5634334	1.5	Occupied one-storey dwelling located south of the Project; modelled as a point receptor sensitive to glare in any direction.
	R02	323314	5634324	1.5	Occupied one-storey dwelling located south of the Project; modelled as a point receptor sensitive to glare in any direction.
	R03	324551	5634112	1.5	Occupied one-storey dwelling located south of the Project; modelled as a point receptor sensitive to glare in any direction.
	R04	321319	5634523	1.5 and 4.5	Occupied two-storey dwelling located southwest of the Project; modelled as a point receptor sensitive to glare in any direction; modelled at two different heights to characterize potential effects to the first and second storey.
	R05	321282	5634418	1.5	Occupied one-storey dwelling located southwest of the Project; modelled as a point receptor sensitive to glare in any direction.
Roadway	Cargill Access Road	n/a[(a)]	n/a[(a)]	1.08, 1.80, and 2.30[(b)]	Roadway located northwest of the Project; modelled using a line receptor with a 25° azimuthal viewing angle in both travel directions; modelled at three different heights in accordance with draft guidance from Alberta Transportation (2021).
	McKinnon Drive	n/a[(a)]	n/a[(a)]	1.08, 1.80, and 2.30[(b)]	Roadway located northeast of the Project; modelled using a line receptor with a 25° azimuthal viewing angle in both travel directions; modelled at three different heights in accordance with draft guidance from Alberta Transportation (2021).
	Pioneer Access Road	n/a[(a)]	n/a[(a)]	1.08, 1.80, and 2.30[(b)]	Roadway located north of the Project; modelled using a line receptor with a 25° azimuthal viewing angle in both travel directions; modelled at three different heights in accordance with draft guidance from Alberta Transportation (2021).
	Railway Avenue	n/a[(a)]	n/a[(a)]	1.08, 1.80, and 2.30[(b)]	Roadway located northeast of the Project; modelled using a line receptor with a 25° azimuthal viewing angle in both travel directions; modelled at three different heights in accordance with draft guidance from Alberta Transportation (2021).
	Stella-Jones Access Road	n/a[(a)]	n/a[(a)]	1.08, 1.80, and 2.30[(b)]	Roadway located north of the Project; modelled using a line receptor with a 25[c] azimuthal viewing angle in both travel directions; modelled at three different heights in accordance with draft guidance from Alberta Transportation (2021).

Table 2: Glare Receptors

Receptor Type	Receptor Name	Universal Transverse Mercator Coordinates [Zone 12]		Receptor Height(s) [m]	Description / Comment
		Easting [m]	Northing [m]		
	Highway 24	n/a[(a)]	n/a[(a)]	1.08, 1.80, and 2.30[(b)]	Roadway located north of the Project; modelled using a line receptor with a 25° azimuthal viewing angle in both travel directions; modelled at three different heights in accordance with draft guidance from Alberta Transportation (2021).
	Range Road 261	n/a[(a)]	n/a[(a)]	1.08, 1.80, and 2.30[(b)]	Roadway located east of the Project; modelled using a line receptor with a 25° azimuthal viewing angle in both travel directions; modelled at three different heights in accordance with draft guidance from Alberta Transportation (2021).
	Range Road 262	n/a[(a)]	n/a[(a)]	1.08, 1.80, and 2.30[(b)]	Roadway located south of the Project; modelled using a line receptor with a 25° azimuthal viewing angle in both travel directions; modelled at three different heights in accordance with draft guidance from Alberta Transportation (2021).
	Range Road 263	n/a[(a)]	n/a[(a)]	1.08, 1.80, and 2.30[(b)]	Roadway located west of the Project; modelled using a line receptor with a 25° azimuthal viewing angle in both travel directions; modelled at three different heights in accordance with draft guidance from Alberta Transportation (2021).
	Township Road 220	n/a[(a)]	n/a[(a)]	1.08, 1.80, and 2.30[(b)]	Roadway located south of the Project; modelled using a line receptor with a 25° azimuthal viewing angle in both travel directions; modelled at three different heights in accordance with draft guidance from Alberta Transportation (2021).
	Township Road 221	n/a[(a)]	n/a[(a)]	1.08, 1.80, and 2.30[(b)]	Roadway located northwest of the Project; modelled using a line receptor with a 25° azimuthal viewing angle in both travel directions; modelled at three different heights in accordance with draft guidance from Alberta Transportation (2021).
Railway	Main Line	n/a[(a)]	n/a[(a)]	3.0	Railway main line located north of the Project; modelled using a line receptor with a 25° azimuthal viewing angle in both travel directions.
	Cargill Siding	n/a[(a)]	n/a[(a)]	3.0	Railway siding located northwest of the Project; modelled using a line receptor with a 25° azimuthal viewing angle in both travel directions.
	Pioneer Siding	n/a[(a)]	n/a[(a)]	3.0	Railway siding located north of the Project; modelled using a line receptor with a 25° azimuthal viewing angle in both travel directions.

(a) Roadways and railways were modelled as line receptors (see Figure 2).
(b) In accordance with draft guidance from Alberta Transportation (2021), roadway receptors were modelled at three different heights above ground: 1.08 m (passenger vehicle), 1.80 m (single unit truck or bus), 2.30 m (large truck and trailer combination).

3.0 ASSESSMENT RESULTS

Table 3 presents glare predictions for each of the receptors considered in the Project glare assessment. As indicated in Table 3, the SGHAT model developed for the Project predicts there will be no glare at any of the 19 receptors considered in the assessment.

Table 3: Glare Assessment Results

Receptor Type	Receptor Name	Duration of Project Glare [minutes per year]			Comment
		Green Glare	Yellow Glare	Red Glare	
Occupied Dwelling	R01	0	0	0	No glare effect from the Project
	R02	0	0	0	No glare effect from the Project
	R03	0	0	0	No glare effect from the Project
	R04	0	0	0	No glare effect from the Project
	R05	0	0	0	No glare effect from the Project
Roadway	Cargill Access Road	0	0	0	No glare effect from the Project
	McKinnon Drive	0	0	0	No glare effect from the Project
	Pioneer Access Road	0	0	0	No glare effect from the Project
	Railway Avenue	0	0	0	No glare effect from the Project
	Stella-Jones Access Road	0	0	0	No glare effect from the Project
	Highway 24	0	0	0	No glare effect from the Project
	Range Road 261	0	0	0	No glare effect from the Project
	Range Road 262	0	0	0	No glare effect from the Project
	Range Road 263	0	0	0	No glare effect from the Project
	Township Road 220	0	0	0	No glare effect from the Project
	Township Road 221	0	0	0	No glare effect from the Project
Railway	Main Line	0	0	0	No glare effect from the Project
	Cargill Siding	0	0	0	No glare effect from the Project
	Pioneer Siding	0	0	0	No glare effect from the Project

4.0 CONCLUSION

The Proponent is proposing to develop the Nova Solar Project in Wheatland County. The Project design incorporates features that will minimize potential glare effects. Project solar panels will have anti-reflective coating. Project solar panels will be mounted on a tracking system that adjusts their inclination as the sun moves across the sky. Both these design features will increase the absorption of incoming sunlight and reduce the amount of sunlight that is reflected towards receptors in the environment.

In accordance with AUC requirements (AUC 2021), a glare assessment was prepared for the Project. The glare assessment made use of a widely accepted SGHAT to predict Project glare levels and assess potential glare effects at 19 receptors in the Project area (i.e., five occupied dwellings, 11 roadways, and three railways).

The SGHAT predicts there will be no Project glare at any of the 19 receptors considered in the glare assessment. As such, the glare assessment concludes there are no potential glare effects associated with the Project.

Signature Page

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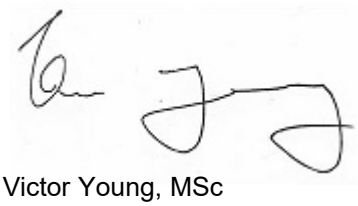

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https://golderassociates.sharepoint.com/sites/143101/project files/6 deliverables/09. glare assessment/21458999 res nova glare report_rev0_20220211.docx

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