S Barnes Road Solar Project

Sound Impact Assessment

April 2024

Prepared For:

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1.0 Introduction

RPIL Solar 10, LLC is proposing to construct the S Barnes Road Solar Project (the Project) located in Kane County, Illinois. The Project consists of approximately 40 acres (Project Area), and currently zoned as Farming District (Zone F). The Project entails a ground mounted photovoltaic (PV) solar array totaling approximately 4.99 MW. There are commercial, religious, residential, and agricultural uses within the area. The Project's southern boundary is bounded by a railroad right-of-way.

2.0 Concepts of Environmental Sound

Sounds are generated by a variety of sources (e.g., a musical instrument, a voice speaking, or an airplane that passes overhead). Energy is required to produce sound and this sound energy is transmitted through the air in the form of sound waves – tiny, quick oscillations of pressure just above and just below atmospheric pressure. These oscillations, or sound pressures, impinge on the ear, creating the sound we hear. The range of sound pressures that can be detected by a person with normal hearing is very wide, ranging from about 20 micro-pascals (µPa) for very faint sounds at the threshold of hearing to nearly 10 million µPa for extremely loud sounds, such as a jet during take-off at a distance of 300 feet. Because the range of human hearing is so wide, sound levels are reported using "sound pressure levels", which are expressed in terms of decibels. The sound pressure level in decibels is the logarithm of the ratio of the sound pressure of the source to the reference sound pressure of 20 µPa, multiplied by 20.

Table 2-1 provides some examples of common sources of sound and their sound pressure levels. All sound levels in this assessment are provided in A-weighted decibels, abbreviated "dB(A)" or "dBA." The A-weighted sound level reflects how the human ear responds to sound, by deemphasizing sounds that occur in frequencies at which the human ear is least sensitive to sound (at frequencies below about 100 hertz and above 10,000 hertz) and emphasizing sounds that occur in frequencies at which the human ear is most sensitive to sound (in the mid-frequency range from about 200 to 8,000 hertz). In the context of environmental sound, noise is defined as "unwanted sound."

Table 2-1 Examples of Common Sound Pressure Levels

Sound Level dB(A)	Common Indoor Sounds	Common Outdoor Sounds
110	Rock Band	Jet Takeoff at 1000 feet
100	Inside NYC Subway Train	Chain Saw at 3 feet
90	Food Blender at 3 feet	Impact Hammer (Hoe Ram) at 50 feet
80	Garbage Disposal at 3 feet	Diesel Truck at 50 feet
70	Vacuum Cleaner at 10 feet	Lawn Mower at 100 feet
60	Normal Speech at 3 feet	Auto (40 mph) at 100 feet
50	Dishwasher in Next Room	Busy Suburban Area at night
40	Empty Conference Room	Quiet Suburban Area at night
25	Empty Concert Hall	Rural Area at night

Sound pressure levels are typically presented in community noise assessments utilizing the noise metrics described below and expressed in terms of A-weighted decibels.

- "L_{10}" is the sound level that is exceeded for 10 percent of the time. This metric is a measure of the intrusiveness of relatively short-duration noise events that occurred during the measurement period;
- "L_{50}" is the sound level that is exceeded for 50 percent of the measurement period;
- "L_{90}" is the sound level that is exceeded for 90 percent of the time and is a measure of the background or residual sound levels in the absence of recurring noise events;
- "L_{EQ}" is the is the constant sound level which would contain the same acoustic energy as the varying sound levels during the time period and is representative of the average noise exposure level for that time period; and
- "L_{MAX}" is the instantaneous maximum sound level for the time period.

It is often necessary to combine the sound pressure levels from one or more sources. Because decibels are logarithmic quantities, it is not possible to simply add the values of the sound pressure levels together. For example, if two sound sources each produce 70 dB and they are operated together, their combined impact is 73 dB – not 140 dB as might be expected. Four equal 70 dB sources operating simultaneously result in a total sound pressure level of 76 dB. In fact, for every doubling of the number of equal sources, the sound pressure level goes up another three decibels. A tenfold increase in the number of sources makes the sound pressure level increase by 10 dB, while a hundredfold increase makes the level increase by 20 dB. The logarithmic combination of *n* different sound levels is calculated by the following equation:

$$L_{total}=10*\log_{10}\left(10^{\frac{L_1}{10}} + 10^{\frac{L_2}{10}} +\ldots+10^{\frac{L_n}{10}}\right)$$

Perceived changes in sound level can be slightly more subjective; the average person will not notice a change of 1-2 dB, a 3 dB increase is just barely perceptible, while a 5 dB change is clearly noticeable.

3.0 Applicable Noise Standards and Regulations

The Kane County Code of Ordinances contains noise regulations specifically pertaining to commercial solar energy facilities. This ordinance requires that solar facility noise levels "shall be in compliance with applicable Illinois Pollution Control Board (IPCB) regulations."

IPCB regulations for noise are listed in Part 901: Sound Emission Standards and Limitations for Property Line-Noise-Sources and are based on the land use of the facility and the receiving property. The Project is located on Class C land and surrounding properties include both LBCS Class C (agricultural) and Class A land (residences and religious institutions). Noise thresholds are most restrictive for receiving lands in Class A, so those are the thresholds used for comparison in this Study. The regulations include other non-applicable thresholds for highly impulsive sounds and prominent discrete tones that will not be generated by the proposed Project.

Table 3-1 and Table 3-2 below list the octave band sound pressure level thresholds for sound emitted to class A land from Class C land.

Table 3-1 IPCB Daytime Noise Thresholds for Receiving Class A Land from Class C Land

Octave Band Center Frequency (Hertz)	Allowable Octave Band Sound Pressure Levels (dB)
31.5	75
63	74
125	69
250	64
500	58
1000	52
2000	47
4000	43
8000	40

Table 3-2 IPCB Nighttime Noise Thresholds for Receiving Class A Land from Class C Land

Octave Band Center Frequency (Hertz)	Allowable Octave Band Sound Pressure Levels (dB)
31.5	69
63	67
125	62
250	54
500	47
1000	41
2000	36
4000	32
8000	32

Kane County code also states that applicants "shall submit manufacturer's sound power level characteristics and other relevant data regarding noise characteristics necessary for a competent noise analysis." These specifications are described in Section 4.1.1 and included in Appendix A.

4.0 Predictive Modeling of Sound Impacts During Operation

This section describes the methods, assumptions, and results of the Cadna-A® noise modeling used to predict future sound levels resulting from the operation of the proposed Project at the property line and nearby receptors.

4.1 Noise Model

The Cadna-A® computer noise model was used to predict future sound pressure levels from the operation of the proposed equipment in the Project Area, including at the outer wall of the dwellings located at adjacent properties. An industry standard, Cadna-A® was developed by DataKustik GmbH to provide an estimate of sound levels at distances from specific noise sources. This model takes into account:

- Sound power levels from stationary and mobile sources;
- The effects of terrain features including relative elevations of noise sources;
- Intervening objects including buildings and sound barrier walls; and
- Ground effects due to areas of pavement and unpaved ground.

Cadna-A® accounts for shielding and reflections due to intervening buildings or other structures in the propagation path, as well as diffracted paths around and over structures, which tend to reduce computed noise levels. The shielding effects due to intervening terrain are included in the model. The shielding effects due to the proposed electrical equipment and existing off-site buildings and ground vegetation were excluded from the model to provide a level of conservatism to the analysis.

For ground effects, the reflectivity of the surface is described by a “ground factor” variable (G), which ranges from 0 for ‘hard’ ground (paved surfaces, concrete, etc.) and 1 for “porous” ground (grassland and other vegetated areas). The model used a ground absorption factor (G) of 0.8 for to conservatively represent typical ground conditions under the solar panels, which will primarily remain vegetated. Existing and proposed above-ground vegetation (trees, shrubs, etc.) is not included in the model for conservatism but may provide additional sound mitigation depending on height and density of foliage.

The International Standards Organization current standard for outdoor sound propagation (ISO 9613 Part 2 – “Attenuation of sound during propagation outdoors”) was used within Cadna-A®. This standard provides a method for calculating environmental noise in communities from a variety of sources with known emission levels. The method contained within the standard calculates the attenuation over the entire sound path under weather conditions that are favorable for sound propagation, such as for downwind propagation or “under a well-developed moderate ground-based temperature inversion.” Application of conditions that are favorable for sound propagation yields conservative estimates of operational noise levels in the surrounding area.

4.1.1 Modeling Inputs

Based on the proposed site design of the Project, the major noise-producing sources during operation will be the power inverters and transformers. A total of 48 inverters are proposed throughout the site, with 2 transformers in the central portion of the site on dedicated equipment pads. The location of these sources is shown on Figure 1.

The source model inputs were based on proposed or generic electrical equipment specifications. The sound level for the proposed inverters is based on manufacturer sound pressure level data (see Appendix A) of 56.9 dBA at 1m (sound power level of 67.9 dBA) based on the "Left Side Measurement" from the Sungrow SG125HV Noise Level Test Report. The transformer sound level of 62 dBA is based on the value obtained from NEMA Standards Publication TR 1-2013 (R2019): Transformers, Step Voltage Regulators and Reactors for a 2,500 kVA pad mounted transformer (Primary BIL of 95 kV, ONAN cooling class).

Since the sound-producing equipment were assumed to be continuously operating, the L_{90} (background level) and L_{EQ} (equivalent constant level) of the proposed equipment are the same for the purposes of this assessment.

Table 4-1 Noise Source Inputs to the Cadna-A Model

Equipment Name	Source Height*	Octave Band Sound Power Levels (dB)									Total (dBA)
		31.5	63	125	250	500	1000	2000	4000	8000	
125kW Inverter (48)	1m	61.6	60.6	62.6	61.6	65.6	56.6	55.6	63.6	56.6	67.9
2500kVA Transformer (2)	1m	63.6	56.3	66.1	68.2	59.3	51.6	38.9	29.9	25.1	62.0

** Heights based on component dimensions and mounting orientation, assumed pad-mounted equipment.*

The conceptual site layout and existing topography were used to create a terrain model that represents the topography during operation of the proposed facility. Figure 1 shows the proposed topography within the site. The inputs to the model are 1-meter contours, based on USGS 3DEP topographic data. The model conservatively assumed continuous and simultaneous operation of all sound-producing equipment. A search radius of 1 mile from each receptor was used in the model to ensure that all noise sources contributing to the predicted facility noise level were modeled at every noise-sensitive receptor.

4.1.2 Sound Level Results

Cadna-A® allows the user to place receptors at selected locations and predicts sound levels at those specific receptor locations. For this analysis, receptors were placed along the property line of the proposed facility.

Table 4.2 presents the predicted sound levels resulting solely from the operation of the proposed equipment. The model also calculated sound levels for the surrounding area, using a 5-foot receptor grid, with a receptor height of 5.1 feet (representative of average ear height). This data is displayed in the isopleths on Figure 1, which show lines of equal sound level at the Project and the surrounding area.

Table 4-2 Cadna-A Modeling Result Sound Levels

Site ID	Modeled Sound Level (dBA)
PL-1	17.8
PL-2	21.0
PL-3	22.9
PL-4	22.4
PL-5	28.1
PL-6	21.5
PL-7	20.6
PL-8	18.7
PL-9	21.9
PL-10	30.5

For comparison to IPCB octave band standards, the maximum (unweighted) octave band sound pressure level at the property line is shown in Table 4-3 below.

Table 4-3 Cadna-A Modeling Result Octave Band Sound Levels

Octave Band Center Frequency (Hertz)	Maximum Modeled at Property Line	IPCB Threshold (Day)	IPCB Threshold (Night)
31.5	23.6	75	69
63	22.4	74	67
125	17.9	69	62
250	7.8	64	54
500	12.0	58	47
1000	11.2	52	41
2000	10.5	47	36
4000	12.4	43	32
8000	<0.1	40	32

5.0 Conclusion

The results of this Noise Impact Assessment conducted for the proposed Project demonstrate that the predicted sound levels from the proposed facility will be a maximum of 30.5 dBA at the property line. Sound levels at receiving properties beyond the property line will be even lower. This sound level will not be perceptible over ambient noise during daytime or nighttime conditions. When added to a relatively quiet ambient sound level of 30 dBA, this would create a 3.3 dBA increase, which is barely perceptible, and would not be perceptible over typical daytime ambient noise levels of 35+ dBA. Octave band sound pressure levels are well below the thresholds established by IPCB. As such, the predicted sound generated by the Project is compliant with Kane County's and IPCB's guidelines.

6.0 References

IPCB, 2018. SOUND EMISSION STANDARDS AND LIMITATIONS FOR PROPERTY LINE-NOISE SOURCES. Accessed April 2024 at https://pcb.illinois.gov/documents/dsweb/Get/Document-12261/

Kane County, 2023. Code of Ordinances. 25-5-4-9: COMMERCIAL SOLAR ENERGY FACILITIES Accessed April 2024 at

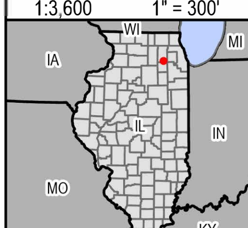
NEMA, 2019. Transformers, Regulators and Reactors. NEMA TR 1-2013 (R2019) Accessed April 2024 at https://www.nema.org/standards/view/transformers-regulators-and-reactors

MONITORING LOCATION
TRANSFORMER LOCATION
INVERTER LOCATION
SOLAR MODULES
SITE BOUNDARY
TOPOGRAPHIC CONTOURS (1M)

BASEMAP ACQUIRED FROM ESRI/USGS "WORLD_IMAGERY_HYBRID" ONLINE SERVICE
LAYER AERIAL DATE: 3/22/2022

N

0 150 300
FEET
1:3,600 1" = 300'



RPIL SOLAR 10, LLC
KANE COUNTY, IL

TITLE:
S BARNES ROAD SOLAR
NOISE ASSESSMENT

DRAWN BY:	M. ERNSTING	PROJ. NO.:	567363
CHECKED BY:	M. FEINBLATT	**FIGURE 1** **SITE LAYOUT**	
APPROVED BY:	A. ROWLEY		
DATE:	APRIL 2024		

TRC
404 WYMAN STREET
SUITE 375
WALTHAM, MA
02451

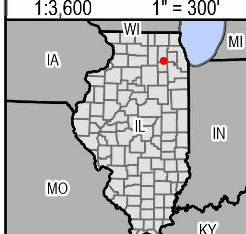
FILE: 567363_SBARNESROADSOLAR_NOISE

COORDINATE SYSTEM: NAD 1983 2011 STATEPLANE ILLINOIS EAST FIPS 1201 FT US; MAP ROTATION: 0
-- SAVED BY: MERNSTING ON 4/12/2024, 11:21:39 AM; FILE PATH: K:\567363 RENEWABLE PROPERTIES S BARNES ROAD SOLAR NOISE\04 GRAPHICS\GIS\APRX\567363_SBARNESROADSOLAR_NOISE.APRX; LAYOUT NAME: 567363_SITELAYOUT

MONITORING LOCATION	SOUND LEVEL (DBA)
INVERTER LOCATION	< 20
TRANSFORMER LOCATION	20 - 29
SOLAR MODULES	30 - 39
SITE BOUNDARY	40 - 49
	≥ 50

BASEMAP ACQUIRED FROM ESRI/USGS "WORLD_IMAGERY_HYBRID" ONLINE SERVICE
LAYER AERIAL DATE: 3/22/2022

0 150 300
FEET
1:3,600 1" = 300'



RPIL SOLAR 10, LLC
KANE COUNTY, IL

TITLE:
S BARNES ROAD SOLAR NOISE ASSESSMENT

DRAWN BY:	M. ERNSTING	PROJ. NO.:	567363
CHECKED BY:	M. FEINBLATT		
APPROVED BY:	A. ROWLEY		
DATE:	APRIL 2024		

FIGURE 2
MODELING RESULTS

TRC
404 WYMAN STREET
SUITE 375
WALTHAM, MA
02451

FILE: 567363_SBARNESROADSOLAR_NOISE

COORDINATE SYSTEM: NAD 1983 2011 STATEPLANE ILLINOIS EAST FIPS 1201 FT US; MAP ROTATION: 0
-- SAVED BY: MERNSTING ON 4/12/2024, 11:21:39 AM; FILE PATH: K:\567363 RENEWABLE PROPERTIES S BARNES ROAD SOLAR NOISE\04 GRAPHICS\GIS\APRX\567363_SBARNESROADSOLAR_NOISE.APRX; LAYOUT NAME: 567363_NOISERESULTS

APPENDIX A EQUIPMENT SPECIFICATIONS

SG125HV Noise Level Test Report

Version	Date	Author	Approved by
V10	2017,May, 28	Bale, Yang	Chen W

1.Introduction

This document describes the noise level test for SG125HV.The test is conducted in the Sungrow Testing Center, which is a WMT testing lab (Witnessed Manufacturer's Testing) accredited by TUV, CSA and UL.

The test procedures are in accordance with the standard ISO3746 and the sound pressure level fulfills the requirements in the IEC62109-1 standard.

2.Noise Level Test

The noise test was completed in the shielding room using the test platform shown below:

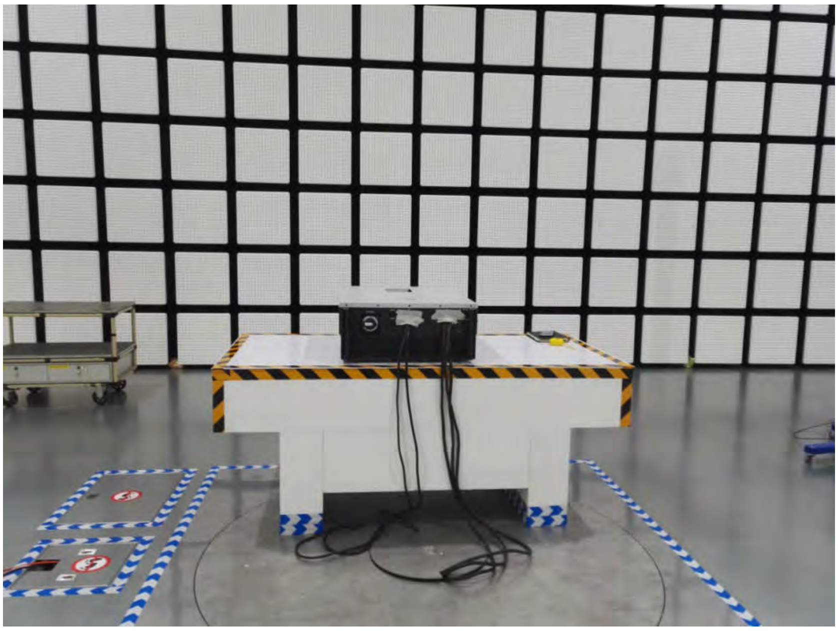


Fig-1 Noise Test Platform

During the test, the noise test instrument is located at a distance of 1m from the inverter, the inverter's operating DC voltage is 1050V and its output power is 125kW.The test data for the four directions and background noise are as follows:

Direction	**Test Data**
Bottom	61.6dB
Left Side	56.9dB
Top	53.7dB
Right Side	53.2dB
Background Noise	31.1dB

Appendix: Testing Pictures

Fig-2 Background Noise

Fig-3 Bottom Side

Fig-4 Left Side

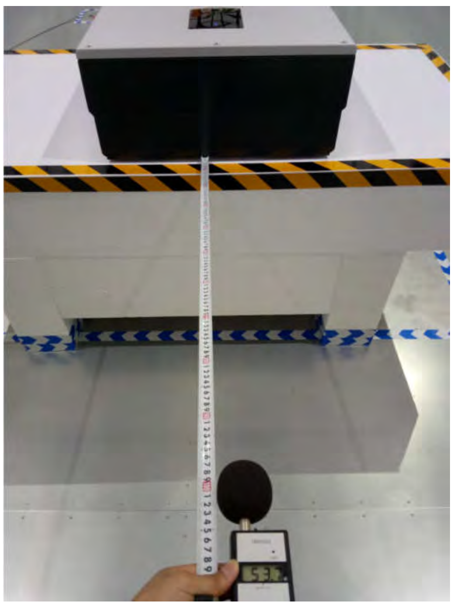


Fig-5Top Side

Fig-6Right Side

Table 1
Audible Sound Levels for Oil-Immersed Power Transformers

Average Sound Level tt. Decibels	Equivalent Two-Winding Rating*																	
	350 kV BIL and Below			450, 550, 650 kV BIL			750 and 825 kV BIL			900 and 1050 kV BIL			1175 kV BIL			1300 kV BIL. and Above		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
57	700																	
58	1000																	
59				700														
60	1500			1000														
61	2000																	
62	2500			1500														
63	3000			2000														
64	4000			2500														
65	5000			3000														
66	6000			4000			3000											
67	7500	6250▲▲		5000	3750▲▲		4000	3125▲▲										
68	10000	7500		6000	5000		5000	3750										
69	12500	9375		7500	6250		6000	5000										
70	15000	12500		10000	7500		7500	6250										
71	20000	16667		12500	9375		10000	7500										
72	25000	20000	20800	15000	12500		12500	9375										
73	30000	26667	25000	20000	16667		15000	12500		12500								
74	40000	33333	33333	25000	20000	20800	20000	16667		15000			12500					
75	50000	40000	41687	30000	26667	25000	25000	20000	20800	20000	16667		15000			12500		
76	60000	53333	50000	40000	33333	33333	30000	26667	25000	25000	20000	20800	20000	16667		15000		
77	80000	66687	66667	50000	40000	41667	40000	33333	33333	30000	26667	25000	25000	20000	20800	20000	16667	
78	100000	80000	83333	60000	53333	50000	50000	40000	41667	40000	33333	33333	30000	26667	25000	25000	20000	20800
79		106667	100000	80000	66667	66667	60000	53333	50000	50000	40000	41667	40000	33333	33333	30000	26667	25000
80		133333	133333	100000	60000	83333	80000	66667	66667	60000	53333	50000	50000	40000	41667	40000	33333	33333
81			166667		106667	100000	100000	80000	83333	80000	66667	66667	60000	53333	50000	50000	40000	41667
82			200000		133333	133333		106867	100000	100000	80000	83333	80000	66667	66667	60000	53333	50000
83			250000			166667		133333	133333		10686	100000	100000	80000	83333	80000	66667	68667
84			300000			200000			166667		13333	133333		106667	100000	100000	80000	83333
85			400000			250000			200000			166667		133333	133333		106667	100000
86						300000			250000			200000			166667		133333	133333
87						400000			300000			250000			200000			168667
88									400000			300000			250000			200000
89												400000			300000			250000
90															400000			300000
91																		400000

Column 1 • Class*ONAN. ONWN and OFWF Rating*
Column 2 • Class* ONAF and ODAF First stage Auxiliary Cooling"t
Column 3 • Straight OFAF Ratings, ONAF * and ODAF * Second stage Auxiliary Cooling"t'
Classes of cooling, see section 5.1 IEEE Std. C57.12-2010

"First- and second stage auxiliary cooling, see section 4 Table 1 of IEEE Std. C57-12-2010
f For column 2 and 3 ratings, the sound levels are with the auxiliary cooling equipment in operation.
tf For intermediate kVA ratings, use the average sound level of the next larger kVA rating.
▲The equivalent two-winding 55ºC or 65ºC rating is defined as one-half the sum of the kVA rating of all windings
▲▲ Sixtv-seven decibels for all kVA ratings equal to this or smaller.

Table 2
Audible Sound Levels for Liquid-Immersed Network Transformers and Step-Voltage Regulators

Equivalent Two-Winding kVA	Average Sound Level Decibels
0-50	48
51-100	51
101-300	55
301-500	56
501-750	57
751-1000	58
1001-1500	60
1501-2000	61
2001-2500	62
2501-3000	63