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**Subject**            **Acoustical Model of the Alcazar Energy Storage Project**

**Attention**        Shabari Basu/Alcazar ESS, LLC, a subsidiary of Terra-Gen Power, LLC

**From**              Mark Bastasch, P.E. (OR), INCE Bd. Cert./Jacobs

**Date**              April 2, 2025

## 1. Introduction

Jacobs has developed an acoustical model to document predicted sound levels from the Alcazar Energy Storage Project (Project) proposed for development by Alcazar ESS, LLC (Applicant), a subsidiary of Terra-Gen Power, LLC, at 430 Hurley Avenue in the Town of Ulster, New York. The model compares Project sound levels to the Town of Ulster’s acoustical requirements.

### 1.1 Project Description

The Applicant proposes to construct, own, and operate the Project, a lithium-ion battery energy storage facility capable of delivering up to 250 megawatts of energy storage capacity and associated ancillary services into the New York electric grid. The Project will include lithium-ion battery modules installed in racks housed in outdoor battery energy storage system enclosures, associated equipment, a Project-specific substation, and a generation tie-line connecting the Project to the adjacent existing Central Hudson Gas & Electric 345-kilovolt Hurley Substation.

### 1.2 Fundamentals of Acoustics

Acoustics is the study of sound, and noise is defined industrywide as unwanted sound. Airborne sound is a rapid fluctuation or oscillation of air pressure above and below atmospheric pressure creating a sound wave. Acoustical terms used in this section are summarized in Table 1.

**Table 1. Definitions of Acoustical Terms**

Term	Definition
Ambient Noise Level	The composite of noise from all sources near and far. The normal or existing level of environmental noise or sound at a given location. The ambient noise level is typically defined by the $L_{eq}$ level.
Background Noise Level	The underlying ever-present lower level noise that remains in the absence of intrusive or intermittent sounds. Distant sources, such as traffic, typically make up the background. The background level is generally defined by the $L_{90}$ percentile noise level.
Intrusive	Noise that intrudes over and above the existing ambient noise level at a given location. The relative intrusiveness of a sound depends upon its

**Table 1. Definitions of Acoustical Terms**

Term	Definition
	amplitude, duration, frequency, time of occurrence, tonal content, the prevailing ambient noise level as well as the sensitivity of the receiver. The intrusive level is generally defined by the L <sub>10</sub> percentile noise level.
Sound Pressure (Noise) Level Decibel (dB)	A unit describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure, which is 20 micropascals (20 micronewtons per square meter).
A-Weighted Sound Pressure (Noise) Level (dBA)	The sound level in decibels as measured on a sound level meter using the A-weighted filter network. The A-weighted filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise. All sound (noise) levels in this report are A-weighted.
Equivalent Noise Level (L <sub>eq</sub> )	The average A-weighted noise level, on an equal energy basis, during the measurement period.
Percentile Noise Level (L <sub>n</sub> )	The noise level exceeded during n percent of the measurement period, where n is a number between 0 and 100 (for example, L <sub>90</sub> )

The most common metric is the overall A-weighted sound level measurement adopted by regulatory bodies worldwide. The A-weighting network measures sound to the way in which a person perceives or hears sound. There is consensus that A-weighting is appropriate for estimating the hazard of noise-induced hearing loss. With respect to other effects, such as annoyance, A-weighting is acceptable if largely middle-and high-frequency noise is present; however, if the noise is unusually high, at low frequencies, or contains prominent low-frequency tones, the A-weighting may not give a valid measure.

A-weighted sound levels are typically measured or presented as equivalent noise level (L<sub>eq</sub>), which is defined as the average noise level, on an equal energy basis for a stated period of time, and is commonly used to measure steady-state sound or noise that is usually dominant. Statistical methods are used to capture the dynamics of a changing acoustical environment. Statistical measurements are typically denoted by L<sub>xx</sub>, where xx represents the percentile of time the sound level is exceeded. The L<sub>90</sub> measurement represents the noise level that is exceeded during 90 percent of the measurement period. Similarly, L<sub>10</sub> represents the noise level exceeded for 10 percent of the measurement period.

Table 2 shows the relative A-weighted noise levels of common sounds measured in the environment and in industry for various sound levels.

**Table 2. Typical A-weighted Sound Levels**

Common Outdoor Activities	Noise Level (dBA)	Common Indoor Activities
Jet fly-over at 1,000 feet	— 110 —	Rock band
Gas lawn mower at 3 feet	— 100 —	
Diesel truck at 50 feet at 50 mph	— 90 —	Food blender at 3 feet
Noisy urban area, daytime	— 80 —	Garbage disposal at 3 feet
Gas lawn mower, 100 feet	— 70 —	Vacuum cleaner at 10 feet
Commercial area		Normal speech at 3 feet
Heavy traffic at 300 feet	— 60 —	
Quiet urban daytime	— 50 —	Large business office Dishwasher next room
Quiet urban nighttime	— 40 —	Theater, large conference room (background)
Quiet suburban nighttime	— 30 —	Library
Quiet rural nighttime	— 20 —	Bedroom at night, concert hall (background)
	— 10 —	Broadcast/recording studio
Lowest threshold of human hearing	— 0 —	Lowest threshold of human hearing

Source: Caltrans 2013.

## 2. Regulatory and Environmental Setting

The *Code of the Town of Ulster* (Town Code) (Town of Ulster 2024) contains general legislation intended to limit sound levels and prevent excessive sound that may jeopardize the health, welfare, or safety of the citizens or degrade the quality of life; and to control sound originating from stationary sources within the limits of the Town of Ulster. The maximum permissible sound levels by receiving property category are established in Chapter 117 of the Town Code and are reproduced in Table 3.

**Table 3. Maximum Permissible Sound Levels by Receiving Property Category**

Sound Source Property Category	Receiving Property Category			
	Residential		Nonresidential	
	7:00 a.m. to 10:00 p.m.	10:00 p.m. to 7:00 a.m.	7:00 a.m. to 10:00 p.m.	10:00 p.m. to 7:00 a.m.
Residential	72 dBA	66 dBA	72 dBA	66 dBA
Nonresidential	72 dBA	66 dBA	72 dBA	66 dBA

Table I, Town of Ulster 2024 (p. 11703)

Construction is exempt from the sound level limits in Table 3, provided all motorized equipment used in construction is equipped with functioning mufflers (Town Code 2024, p. 11703).

The Project is predicted to be in compliance with the applicable Town Code requirements.

### 3. Methods and Results

Battery energy storage systems consist of a battery charging and discharging system. Inverters convert the direct current from and to the battery energy storage enclosure to alternating current for transmission from and to the step-up transformers. The step-up transformers in turn modify the voltage to be consistent with electrical grid requirements.

An acoustical model of the proposed Project was developed using source input levels derived from data supplied by manufacturers, the Applicant, or information found in the technical literature. The sound levels presented represent the anticipated steady-state level from the Project with essentially all equipment operating during the day or night.

Standard acoustical engineering methods were used in the noise analysis. The acoustical model, CadnaA by DataKustik GmbH of Munich, Germany (DataKustik 2025), is a sophisticated tool that enables one to fully model complex industrial plants. The sound propagation factors used in the model have been adopted from International Organization for Standardization (ISO) 9613-2 *Acoustics—Sound Attenuation During Propagation Outdoors* (ISO 2024). Atmospheric absorption was estimated for conditions of 10 degrees Celsius and 70 percent relative humidity (conditions that favor propagation) and computed in accordance with ISO 9613-1 (ISO 1993). The model divides the proposed Project into a list of individual sound sources representing each piece of sound-emitting equipment. The sound power levels representing the standard performance of each of these components are assigned based on data supplied by manufacturers or information found in the technical literature. Using these sound power levels as a basis, the model calculates the sound pressure level that would occur at each receptor from each source after losses from distance, air absorption, and other factors are considered. The sum of all these individual levels is the total Project level at the modeling point.

The ISO 9613-2 method is based on an omnidirectional downwind condition. That is, the sound prediction algorithms assume every point at which sound level is calculated is downwind of all sound-emitting equipment simultaneously. In essence, the prediction assumes each receiver or prediction point is a “black hole” and the wind is blowing from each source and into this black hole. While this is physically impossible, the ISO 9613-2 model has been widely and successfully used to develop acoustical models for power facilities. Numerous agencies and regulatory bodies rely on properly conducted ISO 9613-2 modeling. The ISO 9613-2 parameters used in this assessment are a receptor height of 1.5 meters, a hard ground factor of  $G=0.0$  for the site, and a mixed ground factor of  $G=0.5$  elsewhere (where  $G$  may vary between 0 for hard pavement or water and 1 for acoustically absorptive ground such as plowed earth).

While final equipment selection will occur as design progresses, a representative acoustical model was developed based on 248 battery energy storage enclosures, 62 inverters, and 2 step-up transformers. As is typical at this stage of a project design, the model is subject to revision and detailed vendor specifications will ultimately be developed to ensure the Project complies with the applicable requirements.

Modeled sound pressure level contours based on the preliminary equipment layout are presented on Figure 1. The predicted Project sound levels at the Project boundary with all equipment operating comply with the daytime noise limit of 72 dBA and the nighttime noise limit of 66 dBA. As is typical at this stage of a project, final detailed design information is still under development. Therefore, these results are

indicative, based on an early layout developed to support Project permitting. Noise generated during the testing and commissioning phase of the Project is not expected to substantially differ from that produced during normal full-load operation. Operational traffic is anticipated to be minimal, primarily pickup trucks used by a small operation and maintenance staff for periodic maintenance.

#### 4. Conclusion

The results of the acoustical modeling conducted for the proposed Project and depicted on Figure 1 demonstrate that the predicted operational sound levels are expected to comply with the Town of Ulster's daytime noise limit of 72 dBA and nighttime noise limit of 66 dBA.

#### 5. References

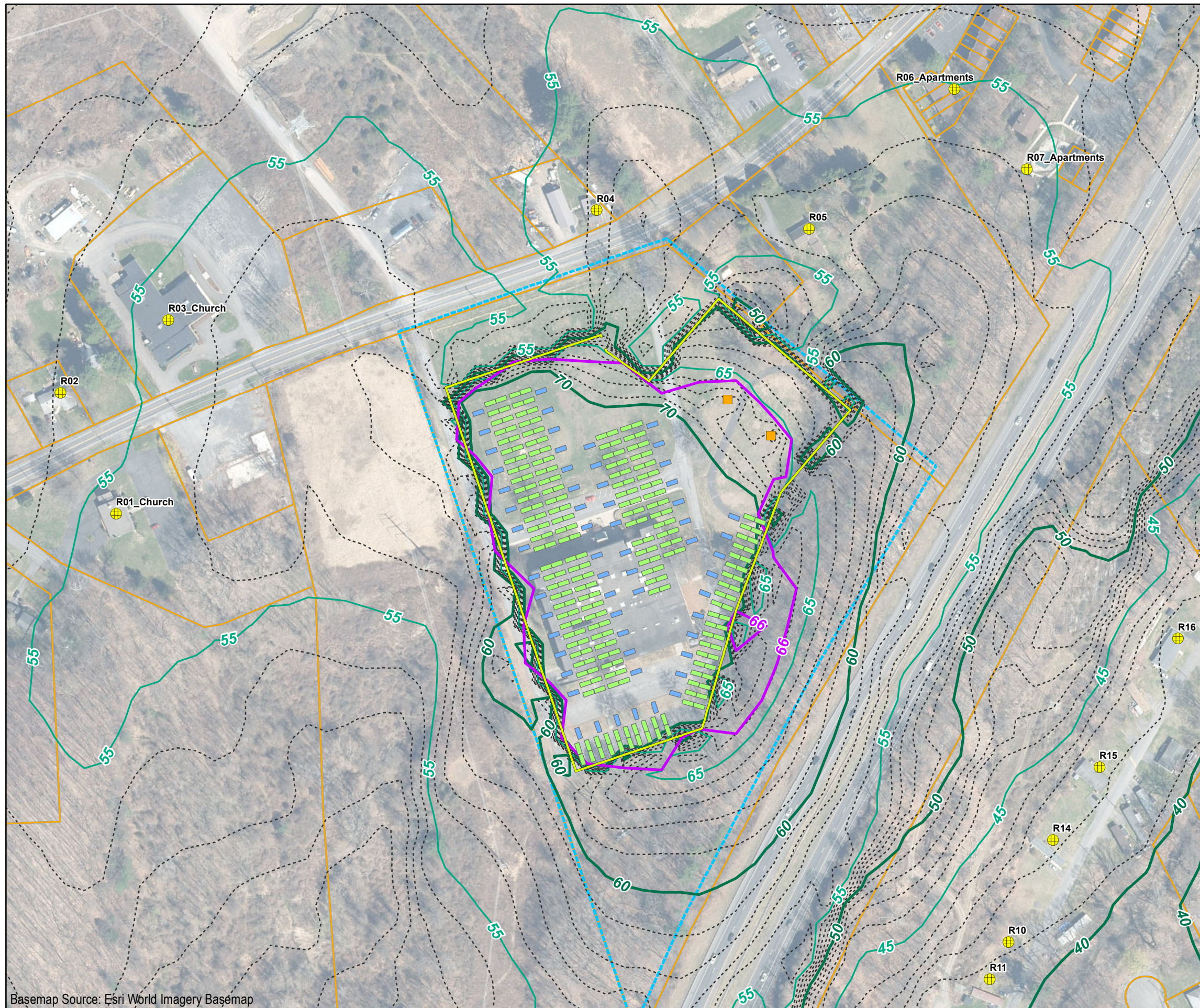
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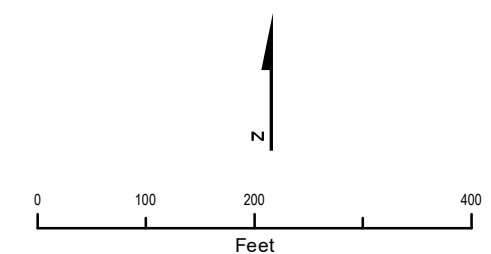
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**LEGEND**

**Predicted Sound Level Contours (dBA, Leq)**

- 10 dBA Contour
- 5 dBA Contour
- - - 1 dBA Contour
- Maximum Permissible Nighttime Sound Level (66 dBA, Leq) at Residential Receiving Property (10 p.m. to 7 a.m.)
- Sensitive Receptor
- Sound Barrier (4 m)
- Batteries
- Inverters
- Substation Transformers
- Project Boundary



**Figure 1**  
**Predicted Sound Level Contours (dBA, Leq)**  
 4 m Tall Sound Barrier  
 Terra-Gen Alcazar  
 Ulster County, New York