Noise Assessment for Southpoint Wind 30MW offshore Wind Farm Project in Lake Erie

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Introduction

Environmental noise/vibration impact studies for the proposed SouthPoint Wind 30 MW offshore wind farms in the western Lake Erie in Ontario Canada are conducted. The potential noise receptors have been identified for analyzing the noise reception level beyond the range of the setback distance of 1000m from the nearest wind turbines. WindPro software is used for noise modeling. The noise impact calculation by Windpro is based on the ISO 9613-2 general. Additionally, meteorological conditions including wind profile of the site and topography as well as acoustic emission data for the selected wind turbine brand have been coupled into the model. The detailed octva data at range of wind speed range of 6-11 m/s for each point of reception has been predicted. The results of the noise impact assessment for all identified receptors are demonstrated by noise level and noise contours for wind speeds of 6, 7, 8, 9, 10 and 11 m/s. Based on the siting location of the proposed three wind farms, the noise level on all receptors meet the criteria of Ministry of Environment Ontario for wind turbines in a rural area. The potential effects of airborne and underwater noise from the offshore wind energy project in Lake Erie is not discernible effects on the identified receptors are present. For the temporary short-term impact of noise produced by the construction and decommissioning phases can be mitigated properly through available best practice in world-wide offshore wind development and other costal engineering relevant industries.

Key Regulations related to this studies

Ministry of Environment Ontario (MOE) Requirements

The study presented in this report reflects the characteristic offshore wind profile including the air/water interface and meteorological features over the water body and the recommendations contained within the publication "Interpretation for Applying MOE NPC Publications to Wind Power Generation Facilities" released October, 2008 (herein referred to as the "MOE noise guidelines"), and the document referenced within this publication. The SouthPoint Wind bases on the MOE guidance documents and provides necessary information to apply for a Certificate of Approval (Air & Noise) under Section 9 of the Environmental Protection Act R.S.O. 1990. The noise guidelines in MOE publications NPC-232 as well as the wind generated noise levels were applied to set the noise limits. MOE publication NPC-232 entitled "Sound Level Limits for Stationary Sources in Class 3 Areas (Rural)," and international standards and best practice as well as industrial standards in the other industrialized countries.

World Health Organization (WHO) Community Noise Guidelines

The World Health Organization (WHO) provides recommendations for appropriate atmospheric noise levels in human dwellings and parklands in their publication: Guidelines for Community Noise[2]. This document states that noise levels for indoor living spaces should be kept below 35 dB LAeq (16 hour time base) during the day and evening to avoid speech intelligibility hindering and moderate annoyance. For outdoor living areas, such as balconies and terraces, sound levels from continuous sources should be kept below 55 dB LAeq (16 hour time base) to avoid serious annoyance, and 50 dB LAeq (16 hour time base) to avoid moderate annoyance during daytime and evening hours. The WHO further recommends that noise levels in bedrooms be kept below 30 dB LAeq (8 hour time base) for continuous sound and 45 dB LAmax for impulse events to avoid sleep disturbance. In addition, sound levels just outside living spaces should be kept below 45 dB LAeq (8 hour time base) and 60 dB LAmax so people may sleep uninterrupted with windows open. The limit that has been listed in an outdoor living area, such as around a dwelling, is 50 dBA for moderate annoyance.
In this assessment context, addition to the meet the criteria proposed by MOE and referring to WHO standards, the assessment also should consider the potential vulnerable group of people around the community. Vulnerable groups of people are considered by the World Heath Organizations (WHO) because they may be less able to cope with the adverse effects from noise. To date, by soliciting the comments from public, there are no comments have been proposed to claim the adverse effect might occur against their vulnerable situation related to the proposed SouthPoint wind 30 MW wind farm project.

Methods

General Process of noise assessment

In accordance with the MOE noise guidelines, the sound levels were calculated at 4.5 metres for two storey dwellings and vacant lots, and at the edge of a 30 metre boundary, at 1.5 metres above grade for single storey dwellings. The attenuation due to atmospheric absorption was based on the atmospheric attenuation coefficients for 10°C and 70% relative humidity; specific values provided in the MOE noise guidelines were used.
Related to the offshore wind site characteristics and the principle of noise guidelines of MOE, the consisted review by MOE process are as follows:
I) All wind farm applications must obtain a Certificate of Approval from MOE. If individual wind turbines have a capacity of 2 MW or more, the project must undergo an Environmental assessment review;
II) offshore wind farm need to detailed noise assessment despite all the points of reception are located beyond 1000m from the nearest wind turbines.
III) The noise limits are established based on the location of the receptors in Class 3 areas. Leamington and Kingsville region are considered as the class 3 areas based on the NPC 232.
IV) The sound power levels of the wind turbines are to be obtained from the standard procedures contained in IEC Standard 61400-11, by applying the wind speeds at 10 m height above ground[11].
V) The sound pressure levels at each receptor location are to be evaluated applying the procedures of ISO 9613-2. For ISO 9613, high elevation, and make the most noise in very high wind conditions these factors directly relate to how ground attenuation and meteorology are accounted for. ISO 9613-2, known as nonspectral ground attenuation, is for modeling A-weighted sound pressure level over absorptive or mostly absorptive ground.
VI) The noise impact is assessed by comparing the predicted noise levels at individual receptor location with the noise limits established in Step III. The noise impact is evaluated at each wind speed over the operating range of the wind turbine specifications.

Modeling Software

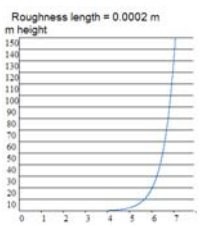
The WindPro Software

6.1.2 The WindPro Software

WindPro software, a world-wide popular professional wind energy design software include the all relevant environmental modeling modules, and has been used to extensively for the wind farm designs. Especially, the WindPro has verified and validated utilization for wind energy project. The relevant environmental calculations include the noise, visual impact and document all the environmental requirements of a project with WindPro, furthermore WindPro can print the necessary documentation for entire modeling inputs and assumptions. The WindPRO module DECIBEL for Noise Impact Calculation makes noise calculations an easy task. Both existing and new wind turbines are included, and it is possible to define Noise Sensitive Positions (spots) as well as areas described by polygons. These polygons can be drawn directly on the background map using the mouse. The program calculates based on the noise emission data (Lwa or octave data) the point on the polygon line with the highest noise impact and prints the coordinates and noise level for the point in the report. Differences in elevations between wind turbines and neighbors are included in the calculations since the coordinates for the wind turbines and the noise sensitive areas/positions all are given in 3D. The program can automatically calculate these elevations if digital maps are used. For each polygon/position, the maximum allowable noise level can be entered. In this way, it is possible to simultaneously carry out, for example, calculations relative to the nearest neighbor based on a 45 dB level and a nearby urban area at another distance based on a 40 dB level. Also it is possible to enter the initial background noise level without turbines if this is known and then calculate the additional noise inflicted by the wind turbines.
It is also possible to link a DECIBEL calculation to a project layout so a noise isoline map is automatically updated in the project window when changes are made so that the optimal layout may be determined with regards to noise impact. Noise-sensitive areas, One of the major advantages of WindPRO is, however, the possibility for graphic input of data concerning WTGs and noise-sensitive areas/points on a digital map directly on the screen. Criteria for noise assessment, there are two index of noise and sound level and finally output of the printed reports are produced.
This emission considers that WTG plus ambient noise is compared to ambient noise plus margin. In particular, with accordance to the guideline document, the specific time period are assessed respectively. This is the scenario where the noise level at the receptors is the background noise plus the noise contribution from the turbines. This sum is compared to a noise demand that consists of the background noise plus a margin. All values of noise level outputs include mean values (Lwa) and L90. The receptors are identified by the investigating and using aerial photograph.
All noise values are 90% exceedence values (L90): With this special settings all noise values are considered L90 values. That is, the noise that will be exceeded 90% of the time. Background noise must then be entered as L90 values. For the turbines the Lwa values will be used but deducted 2dB as a fair approximation of the L90 level.

The octave-band data are available the ISO 9613-2 code for the chosen wind turbine.

Wind shear and Wind Profile



Wind speed, m/s

Figure 1 Wind Profile of the Lake Erie in Summer

$$\alpha = \frac{\ln(V_2) - \ln(V_1)}{\ln(h_2) - \ln(h_1)}$$

Wind Shear Calculation formula is provided as above, the site specific data are applied to the wind shear calculation. The calculated wind shear for SouthPoint wind Porject in Western Lake Erie is equal to 0.158. Tthe wind shear profile for SouthPoint Wind site is demonstrated in Figure 1.

Modeling Results and Compliance

By using WindPro software and inputs of wind data the required, site conditions the noise contour of wind turbines are demonstrated in Figures 2 through 7. The results show that at highest average wind speed at winter time, away from 1000m distance, the noise level is mush lower than 39 bD. Which meet the requirements of MOE.

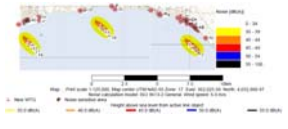


Figure 2 The Noise Contour Map at Wind Speed 6 m/s

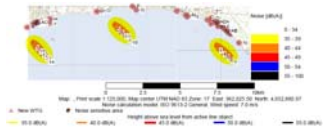


Figure 3 The Noise Contour Map at Wind Speed 7 m/s

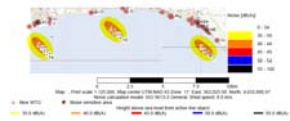


Figure 4 The Noise Contour Map at Wind Speed 8 m/s

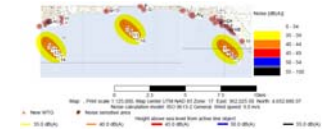


Figure 5 The Noise Contour Map at Wind Speed 8 m/s

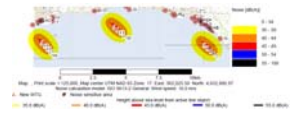


Figure 6 The Noise Contour Map at Wind Speed 10 m/s

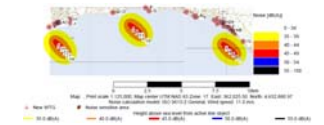


Figure 7 The Noise Contour Map at Wind Speed 11 m/s

Typical Mitigation Measures during Construction Phase

The typical mitigation measure including the follow.
Surround the pile with an air bubble curtain system or air-filled cofferdam.
Since the sound produced has a direct relationship to the force used to drive the pile, use of a smaller hammer should be used to reduce the sound pressures.
Use a hydraulic hammer if impact driving cannot be avoided. The force of the hammer blow can be controlled with hydraulic hammers; reducing the impact force will reduce the intensity of the resulting sound.
Drive piles when the current is reduced (i.e., centered around slack current) in areas of strong current to minimize the number of fish exposed to adverse levels of underwater sound.
When using an unconfined air bubble system in areas of strong currents, it is critical that the pile is fully contained within the bubble curtain. To accomplish this, adequate air flow and ring spacing both vertically and distance from the pile are factors that should be considered when designing the system.
The comprehensive survey for the published measurement results of infrasound from wind turbines indicates that wind turbines of contemporary design with an upwind rotor generate very faint infrasound with a level far below the threshold of perception even at a rather short distance. Furthermore, conclusively, when longer distances are considered, neither downwind nor upwind turbines are capable of violating assessment criteria for infrasound.

Conclusions

The detailed assessment of noise at receptor locations within 2000m shoreline in three wind farms have been undertaken. The major conclusions are drawn as follows.
At first, predicted sound pressure levels and measured background noise levels indicate that, for the majority of circumstances, at all receptor locations away from 1000m neighbouring the proposed site, wind turbine noise level will meet the Noise Criteria proposed by MOE. The noise produced by wind turbine generators may not discernible for the receptors along the shoreline areas because the ambient noise is masking the noise produced by wind turbine generators in offshore locations. Secondly, Mitigation Measures are taken during the construction phase and noise control can be managed through specifying working hours and equipment.
Thirdly, the location of the receptors is also significant. Upwind of a wind turbine there may be locations where no sound is heard. On the other hand sound may be propagated more easily downwind. Because of the prevailing wind direction in western Lake Erie is West-northing, the receptor along the northern shoreline in Leamington and Kingsville almost located at upwind direction, therefore, the less chance to hear the noise of wind turbines. Southpoint wind facilities have indiscernible impact for the local residents along the shoreline areas. Finally, the most notably conditions when there are strong wind, the sound level of the wind turbine generators are significant based on the modeling results. There are no greater than background sound level are present in 1km away regions.
Compared to the impact of noise travel on the potential points of reception in land, the offshore surrounding considerably decreases the noise travel distance because higher humidity over the water body; air/water interface effect for the sound propagation; and farther away setback distance of at least 5km.
Tremendous research and literature reviews on low frequency sound generator by up wind turbine is indiscernible according to physical acoustic investigations and medical observation and studies.

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