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Applying a general noise regulation on Wind Turbines: an administrative interpretation to a specific noise source

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Summary

In most cases, public policies management and environmental regulations development is hampered by government agendas and the interests of both, public and private sector, especially in countries that seek to foster the growth of the industry, also positioning itself in the development of non-conventional renewable energies.

In Chile, there is a general environmental noise regulation that applies for multiple noise sources, mainly productive activities, with a general procedure that can be used both for a night club or a wind farm. In this context, the possibilities of introducing a new regulation in a matter as specific as wind farms noise, are the lowest.

However, there are other ways to address the complexity of a technical problem that only seems to be solved introducing a new specific regulation. Drawing upon the legal and technical possibilities that the general noise regulation in the country presents, it was possible to introduce a path to solve in the short-term, most of the wind turbine noise technical issues that challenge the general regulation.

This paper presents an administrative interpretation of a general noise regulation to be applied on wind turbine noise through different action paths, involving the community, working with the assessment and supervising entities and establishing working groups with wind industries and other public entities, improving the regulation for wind turbine noise in Chile, without modifying the current environmental noise regulation. A comparison between the general procedure and the interpretation for wind farms noise is presented.

1. Introduction

Wind turbine noise (WTN) is a problem that has evolved around the world. It is known that currently there is no consensus among evaluation methodologies, which makes it difficult to design management strategies.

In Chile, every year more wind farms enter the System of Environmental Impact Assessment (SEIA) (2), which regulates compliance with environmental regulations in the country. Similarly, the number of people affected by WTN is increasing, as there are areas of the country with high wind potential but also have a sufficient number of communities to generate conflicts.

Given the complexity of the problem, the need arose to develop a strategy for WTN, which within its first objectives was to strengthen the regulatory framework. According to this, it was thought to elaborate a specific regulation, which led to a series of studies. However, administrative times could be very long, which would not make the regulation effective enough in relation to the large number of projects that enter year by year. This led to the definition of a dynamic strategy that would allow the establishment of WTN assessment criteria that do not avoid the technical and legal possibilities of the noise regulation in Chile. Along with an adequate follow-up to the revision of projects in the SEIA, training and dissemination of the problems associated with noise from wind farms, it has been possible to improve the assessment of WTN, through a general noise standard.

This document presents the aspects of the general noise regulation in Chile that could be interpreted to generate the specific assessment guidelines for WTN. Likewise, the key elements for the proper implementation of these criteria are mentioned, in the context of the wind farms noise strategy in Chile.

2. Noise regulation in Chile

The current noise regulation, applicable to wind farms, corresponds to the Supreme Decree N°38/11 of the Ministry of the Environment (DS 38) (4), which regulates noise from multiple sources. In this standard, wind farms are considered as elements of infrastructure, thus they must complain this regulation.

The DS 38 establishes differentiated limits, both rural and urban areas. In this case, since all the projects are located in rural areas, the maximum permissible levels are defined for each receiver, as shown in Table 1.

Table1: Noise limits for rural areas in the DS 38.

Day limit	Night limit
Background noise + 10 dB(A), maximum of 65 dB(A)	Background noise + 10 dB(A), maximum of 50 dB(A)

Limits for rural areas are directly related to the background noise of the site. Therefore, the adequate definition of background noise levels it is very important to quantify the acoustic impact on the receivers near the wind farm.

For the characterization of the emission of the source, a corrected sound pressure level is used. This value comes from the analysis of the descriptor L(A)eq 1 minute and the maximum level L(A)max recorded in the measurement period of 3 minutes. A comparison between both descriptors and the background noise level is necessary to finally define the final noise level that will characterize the noise from the source.

In relationship to the international regulation for wind farm noise, the limits of the DS 38 are located as one of the less strict, considering the night limit of the DS38. Usually the international regulation for wind farm noise is based on a standard of 45 dB(A) or less (1), with an specific measurement procedure.

2.1 Complexity for specific wind farm noise regulation

A new regulation for WTN could be part of a solution for this problem in Chile. However, the time of action is one of the most important issues to generate new regulations. Defining a specific regulation for a particular source in the Chilean regulatory framework is not easy. It will requires around 3 years of work according to the regulated procedure for making environmental regulations in Chile, which means that many projects will be unaffected by this new regulation.

On the other hand, there is an important lack of information in the public service and the private sector, regarding the noise generated by wind turbines, their causes and effects. Not knowing the phenomenon implies a low degree of depth in the noise studies presented to the SEIA. In Chile, there were no studies of noise emmission of wind farms focused on the improvement of the current noise regulation (DS 38) in this area.

It was identified that according to the massive growth of the wind industry in the country, it is necessary to generate an immediate intervention in the WTN assessment, particularly for new projects. This led to the conclusion that the definition of guidelines for the application of DS 38 is efficient in terms of time of action and technical possibilities. An adequate interpretation of DS 38 can address WTN, giving space to a more detailed analysis before the application, selecting the most representative samples according to the DS 38 requirements and possibilities.

3. Interpretation for wind turbine noise

The interpretation of the DS38 for WTN was mainly based on the following criteria that appear in the standard:

a. The measurement must be made in the most unfavorable condition for the receiver (worst case condition).
b. The background noise must be measured under the same measurement conditions of the noise source.
c. Predictions of noise levels can be made.

This led to orientate the application of DS38 for the following aspects of the regulation:

- Background noise measurement technique
- Wind farm noise prediction techniques
- Wind profile characterization
- Wind farm noise measurement technique
- Technical equipment

3.1 Background noise measurement technique

For the assessment of the background noise, which defines the maximum allowed noise level, a specific procedure has been agreed, meeting the general procedure established in the DS 38. This will require generating samples in three different wind speed ranges (6-8, 8-10 and 10-12 m/s) to assess wind farm noise and background noise at the wind farm. This also means that the assessment will require a continuous monitoring of background noise, selecting the lowest background noise average for each one of the three ranges, identifying the worst case condition. This data will be more representative of the noise immission levels but also could be stricter for the definition of maximum allowable levels. However, this will avoid that wind farms will be installed in a critical distance of the neighbourhoods.

3.2 Wind farm noise prediction techniques

To assess a new wind farm, the noise immission level must be predicted according to the following parameters:

Table 2: Specific methods and parameters for wind farm noise prediction

Method	Immission height	Humidity	Temperature	Wind direction	Ground factor	Wind speed noise map
ISO 9613-2	4 m	70 %	10 ° C	Downwind	0,5	8, 10 and 12 m/s at hub
NORD 2000	1,5 m	70 %	10 ° C	Downwind	D	8, 10 and 12 m/s at hub
CONCAWE	4 m	80 %	10 ° C	Downwind	0	8, 10 and 12 m/s at hub

These parameters have been adopted from the international regulation (3,6) and different studies in the Ministry of the Environment.

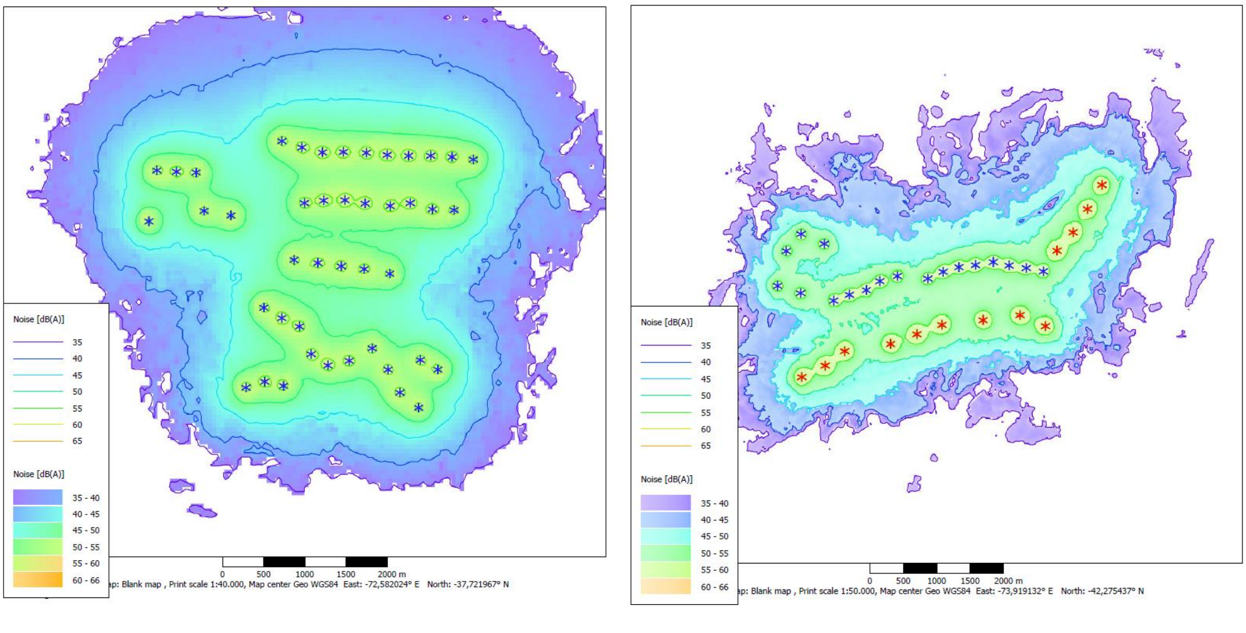

Fig. 1 – Wind farm noise maps generated with NORD 2000.

3.3 Wind profile characterization

Three methodologies for wind measurement are presented. The requirement is that all measurements must be correlated to the wind speed at hub height of wind turbines, thus identifying the worst case condition. Methodologies are the following:

1. Measuring tower with anemometer at hub height.
2. Measurement with SODAR or LIDAR system at hub height.
3. Measuring tower with anemometers or SODAR/LIDAR system.
4. SCADA monitoring system (installed wind farms).

3.4 Wind farm noise measurement technique

The noise measurement technique in the DS38 requires the definition of a receiver point, generating three noise measurements of one minute (LAeq 1 min), under the worst case condition criteria. It is clear that three arbitrary samples are not enough, due to the characteristics of the source (Fig. 2 and 3).

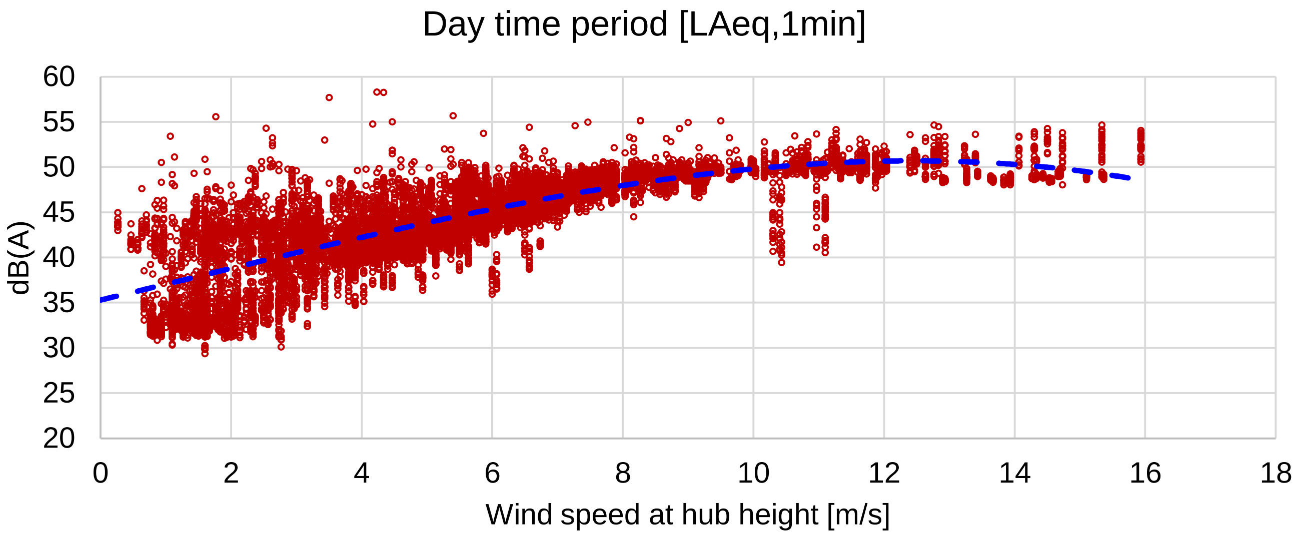

Fig. 2 – 14-day of wind farm noise monitoring 250 m away from nearest turbine (day time).

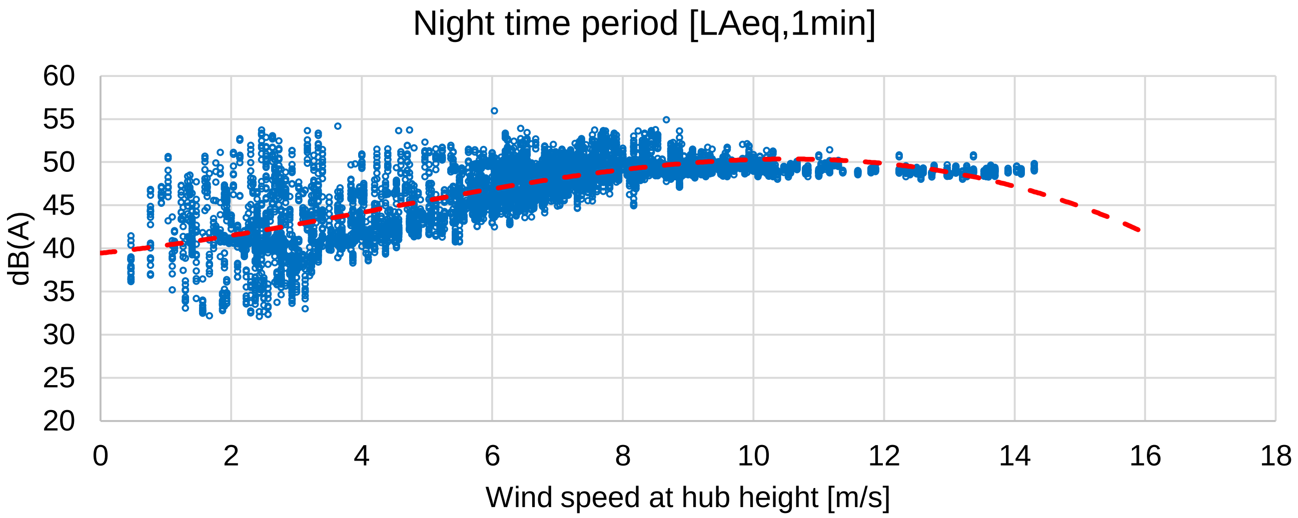

Fig. 3 – 14-day of wind farm noise monitoring 250 m away from nearest turbine (night time).

Previous figures shows a 14-day measurement at a wind farm. The receiver point was located 250 m away from the nearest turbine. Measurements were the most part of the time in downwind conditions.

Analyzing samples from 6 wind farms throughout the country, it was concluded that the maximum emission of the source is above 6 m/s, in accordance with the Danish regulation for WTN. Samples below 6 m/s show a high dispersion, not being representative. Due to the stabilization of samples over 12 m/s, the assessment will be made from 6 to 12 m/s. As the background noise, three different wind speed ranges (6-8, 8-10 and 10-12 m/s) will be studied to assess WTN.

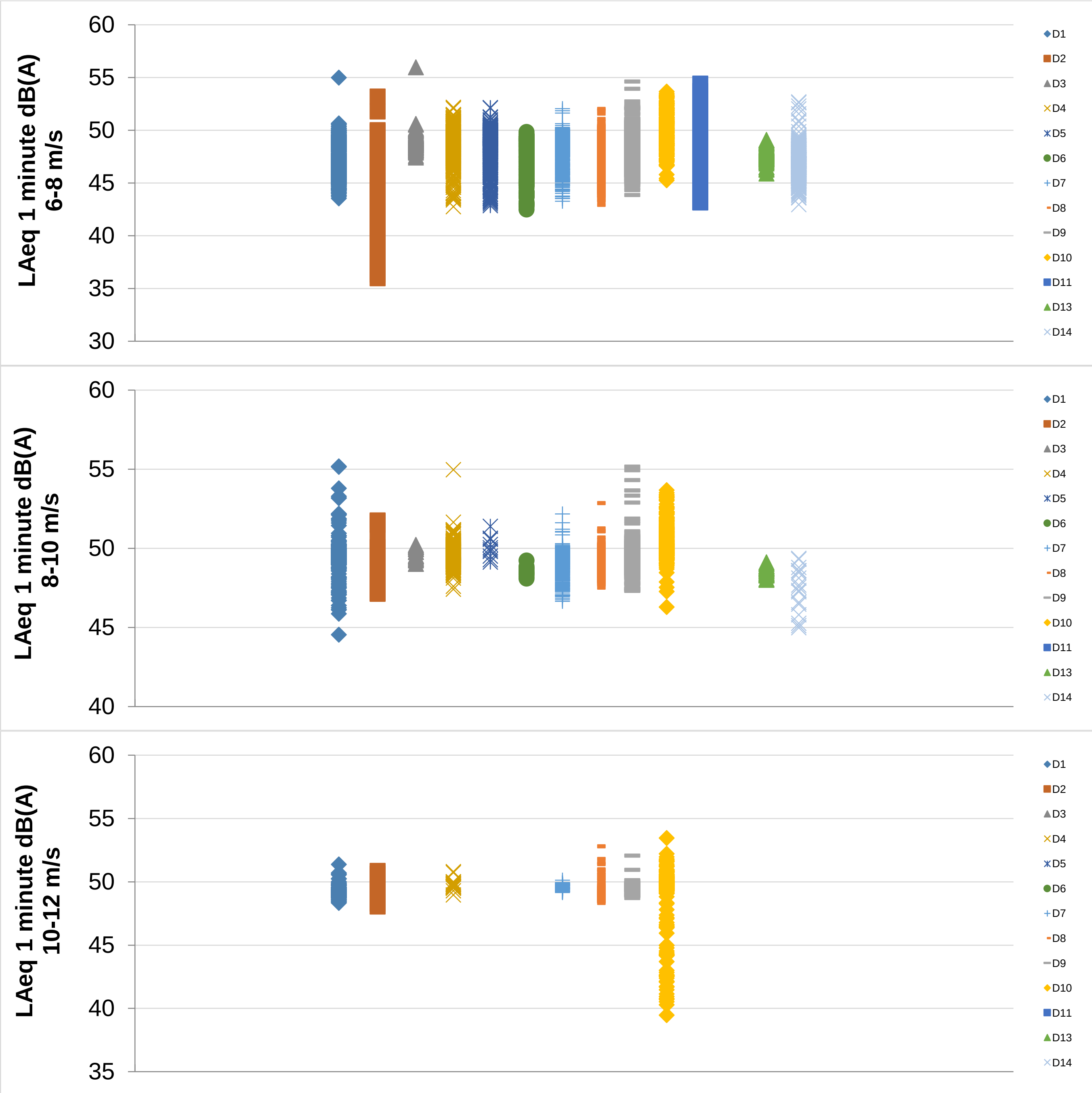

Fig. 4 – 14-day of wind farm noise monitoring 250 m away from nearest turbine (day and night time), separated by wind speed ranges.

The noise emission of the wind turbine has to be characterized with 3 samples for each wind speed range. In the figure before it is possible to notice that there are no samples for all of the days. Day 12 does not deliver any sample within the defined wind speeds, as also shown in Table. Day 9 presents all the data, for all the ranges. Through a continuous noise monitoring exercise it is possible to address these complexities, avoiding measuring on a day that is no representative for the source. This criteria is also in accordance with other international standards (3, 6).

The next step is to look for the maximum noise samples as shown in the Table, as long as they do not include occasional noises. Taking into account the lowest background noise emission for the same wind speeds, this will be representative of the worst case condition, according to the DS 38.

Table 3: Maximum samples on a 14-day of wind farm noise monitoring.

	Day time period (dB(A))			Night time period (dB(A))		
Day	**6 – 8 m/s**	**8 – 10 m/s**	**10 – 12 m/s**	**6 – 8 m/s**	**8 – 10 m/s**	**10 – 12 m/s**
1	49,9	50	**51,8**	51,1	50,4	49,8
2	49,4	-	-	50	50,1	**50**
3	-	-	-	50,2	50,2	-
4	**49,9**	**51,1**	50,8	51,3	50,6	-
5	47,9	-	-	51,3	**50,6**	-
6	45,9	-	-	49,9	49,2	-
7	**50,2**	**50,3**	-	50,6	50,3	**50,1**
8	49,9	50	**51,8**	50,5	50,4	49,6
9	**50,6**	51,1	50,1	**52,8**	**51,9**	49,8
10	-	**50,4**	**54,2**	**53,7**	**53,7**	**51,5**
11	49,9	-	-	**53,8**	-	-
12	-	-	-	-	-	-
13	-	-	-	49,1	49,1	-
14	48,6	-	-	49,9	49,4	-

Final step is to found the corrected sound pressure level. Considering the 3 maximum L(A)eq 1 minute samples for each one of the wind speed ranges, there will be a representative level for every wind speed range, for both day and night. Taking into account a minimum background noise of 35 dB(A), the maximum allowable level will be 45 dB(A).

Table 4: Selected samples for the DS38 application

Wind speed range	Day level dB(A)	Night level dB(A)	Maximum allowable level dB(A)
6-8 m/s	50	53	45
8-10 m/s	51	52	45
10-12 m/s	53	51	45

The analysis before shows that there is no compliance with the maximum allowable levels. This analysis has been implemented for new projects in the SEIA, avoiding critical distances between receivers and wind farms, therefore, reducing noise levels.

3.5 Technical equipment

Finally, the guidelines to asses WTN defines specific aspects that should be considered for the measurement of noise in relation to wind speeds. In particular, specific equipment is defined to perform measurements. With an adequate windshield, noise samples will be unaffected by wind gusts in measurement height, registering WTN with a higher degree of certainty.

Fig. 5 – Wind shield required for the application of the DS 38 in WTN.

All of these measures working together will promote an improvement of the DS38 for WTN, and the existence of an adequate distance between wind turbines and homes, avoiding the existence of any critical distance and, therefore, the acoustic impact on nearby communities will be reduced.

4. Wind turbine noise strategy

To support the presented guidelines in this work, the Wind Farms Noise Strategy in Chile integrates other action paths which are the awareness and training, information and coordination.

4.1 Awareness and training

In addition to strengthen noise regulation, the generation of training instances for environmental assessors, acoustic consultants and project developers is essential. Also, it is very important to interact with the community. It has been possible to identify that the community is very interested to be trained about WTN effects and being involved from the beginning, in the planning stage of the project. In the framework of the development of the Strategy has been possible to generate meetings with people who live near the wind farm. People wanted to be heard and involved, generating a close relationship with the wind farm owners. It has been proven that people with a constant interaction with the owners of the wind farm, does not present legal actions against the wind farm and they are willing to environmental noise management

4.2 Information of WTN

The information component is related to the studies that the state develops to assess WTN. Mainly seeks to characterize noise emission from wind farms throughout the country, perception of noise and its health effects on people. This information is the basis for interacting with the community and project developers.

4.3 Coordination

Finally, coordination with the different Government institutions it is essential to promote the development of the aforementioned components. The table 4 presents the attributions of different public and private institutions involved in the development of this Strategy.

Table 5: Involved institutions in the coordination

Action area	Institution
Environment	• Ministry of the Environment
Renewable Energies	• Ministry of Energy • Chilean Association of Renewable Energies
Projects assessment	• Service of Environmental Assessment • Project developers • Acoustic consultants
Land-use planning	• Ministry of Housing and Urban Construction • Livestock Agricultural Service
Acoustic isolation	• Ministry of Housing and Urban Construction
Perception and health effects	• Ministry of Health
Inspection	• Superintendence of the Environment
Community interaction	• City halls

5. Conclusions

The main objective of WTN noise regulation should not be the acoustic characterization of the source, but the definition of maximum allowable limits that consider reasonable exposure levels for nearby communities. In this context, it is considered that the interpretation of noise regulation in Chile for WTN is efficient.

Although, the measurement procedure and the acoustic descriptors used (L(A)eq 1 min), do not qualify in their entirety within the international standard usually seen for the analysis of WTN, through a public policy strategy the acoustic impact on nearby communities to wind projects has been reduced. This is considered a success since it has managed the system immediately, with the available tools.

From the technical point of view, it is not enough to take three noise samples arbitrarily. A proper analysis will require a noise monitoring of at least two weeks, either for the current descriptor or for a new noise descriptor. It is prudent to consider an extensive noise monitoring in order to identify the worst case condition.

The need for a specific regulation is not ruled out, defining new descriptors and more robust measurement procedures. However, this change should be gradual, keeping on mind the already defined guidelines for the assessment of WTN in Chile.

The solutions to an environmental noise problem are not always a specific regulation. A noise limit, a specific measurement procedure or the guidelines to assess an environmental noise problem responds mainly to a policy discussion. Technical decisions can influence the final decision, but they are not always the main factor that will determine that decision in a matter of public policy.

6. Acknowledgements

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