International Wind Turbine Noise Legislation Illustrated by a Cross Border Case Study

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Imagine the result.



Introduction

Research Objective

Comparison of wind turbine noise regulations in in Europe, North America and Australasia

Reasons for this Study

- Authorities interested in reference when developing new policy and regulations
- Developers interested in reference for limiting and judging noise complaints
- Concerned citizens refer to legislation or complaints in other countries



40 Jurisdictions Assessed in Study









Canada:

- Alberta
- Ontario
- Prince Edward Island





Michigan

Legislation and Regulations

- European and Australasian jurisdictions have specific wind turbine noise regulations, only Germany applies more general noise requirements
- USA nation policy defers to local state or county regulations
- 7 of 14 sampled US states have no specific wind turbine noise regulations
- Canada defers to provincial regulations





Wind Turbine Noise Metrics

Metric	# Juris- dictions	Weigh- ting	Assessment Period/ Parameter	Comment
L _{eq}	20	A	10 min., 1 h, day, night, 24 h, at 4/5/6/7/8/9/10 m/s, at 95% rated power	Mainly used for modelling based on sound power level measurements
L _r (D), L _r (G), L _{dn} , L _{den} , L _{night}	5	A	day, night, 24 h, year or at 6/8 m/s	Derived from L _{Aeq} metric, incl. penalty for times of day with increased sensitivity
L ₁₀ , L ₅₀ , L ₉₀	5	A	10 min., day, night, 1 h, 24 h	More suitable for direct compliance measurements
L _{pALF}	1	A	at 6/8 m/s	For low-frequency noise from 1 to 160 Hz
L _{eq} per (1/3) octave band	2	linear	day, night	Used to address low frequency noise



Comparison Between Countries with L_{Aeq} Noise Limit Values [Nighttime]





Overview L_{Aeq} Related Nighttime Noise Limit Values (indicative)



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A Cross Border Case Study







Noise Limits Within a 25 km Radius

The Netherlands

6.		人员主义			Residential	Rural		SZ / E	irkelenz	Grev
Belgium (Flanders)				47 dB		leins	Germany			
L _{Aeq} @95%RP	Residential	Rural		L _{night}	41 dE	3		L _r	Residential	Rural
Day	44 dB(A)*	48 dB(A)	- 1	[≈ 43 - rated p	45 dB(A) at 99 power]	5 %		Day	50 dB(A)/ 55 dB(A)	60 dB(A)
Evening/ Night	39 dB(A)*	43 dB(A)	<u>, </u>	laastri	cht Wind 1	arm	and the second	Night	35 dB(A)/ 40 dB(A)	45 dB(A)
* 4 dB(A) his 500 m from	gher, if less th industrial area	an a	trient		Heerie	Aa	and a second	NIE	Lanaken Nu	
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Google earth		L _{Aeq}		45 dB	(A)	· Link		No.		
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Request to Apply New Danish Legislation Low Frequency Noise

30 January 2012 Dagblad De Limburger Deens limiet op geluid windturbines

Over de geplande windturbines voor het Lanakerveld, is al veel gezegd. Maar nog niet dat in Denemarken vanaf dit jaar een strengere geluidslimiet van kracht is.



door Judith Houben

n Denemarken is het voortaan verboden om windturbines te plaatsen die een laag frequent geluid maken van meer dan 20 decibel (dB). Vestas - de Deense fabrikant die ook de vier Maas richtse turbines maakt (type Vestas V112-3 MW) heeft hierover in december een brief naar de Deense minister Karen Ellemann van milieu gestuurd die te vinden is op de site www.wind-watch.org. De firma maakt zich volgens de brief zorgen over deze nieuwe, screngere limiet. De meest economische turbines van Vestas (in de categorie 3 mega-

Danish Limit on Wind Turbine Noise





Danish Requirements Low Frequency Noise (since 1 January 2012)

Limit value: 20 dB L_{pALF} at a wind speed of 6 and 8 m/s

Definition L_{pALF} : Total A-weighted sound pressure level <u>indoors</u> in dwellings for the frequency range from 10 to 160 Hz one-third octave bands

Note:

Level difference outdoors-indoors is <u>defined</u> in the Statutory Order



Limit Values Proposed Wind Farm

The Netherlands

	And A CONTRACT OF A DESCRIPTION	Sector of the sector of the					
Belgium (Flanders)							
L _{Aeq} @95%RP	Residential	Rural					
Day	44 dB(A)*	48 dB(A)					
Evening/ Night	39 dB(A)*	43 dB(A)					

* 4 dB(A) higher, if less than 500 m from industrial area

	Residential	Rura				
L _{den}	47 dB					
L _{night}	41 dB					
[≈ 43 - 45 dB(A) at 95 % rated power]						

Maastricht Wind Farm

Heerlen

DenmarkResidentialRuralL_{pALF}20 dB at 6/8 m/s

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Google earth

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Simmerath

Greven

Erkelenz

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Assessment Cumulative Noise Levels

	NL	NL	B (FI)		a citos		and the second				
	L _{den} [dB]	L _{night} [dB]	L _{Aeq} night [dB(A)]		Lanaken			NL L _{den} [dB]	NL L _{night} [dB]	B (FI) L _{Aeq} night	DK L _{pALF} [dB]
Level	46	40	44	1						[dB(A)]	
Limit	47	41	43	N78a	630	Less L	evel	48	42	46	21
Gellik	and the	and the second	steenwes			Z- L	imit	47	41	55	20
Ni-gerdater	100	T.				6 a.			DK		
Tote	ostraat			X	3		L _{den} [dB]	L _{nig}	_{ht} L _{pA}] [dB	LF]	874
Googlerea	irth 🖪	78	5-16		~ P02	Level	45	39	19	3	1
rge († 2014 DigitalStok 2014 Google rge († 2014 Aerostik	e demotion of S				C Stine	Limit	47	41	20		
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Conclusions

- Wide range of noise regulations and on how stringent a jurisdiction is
- No common influence or application of metrics
- Depending on the noise metric used, the range in limit values could be a difference of 20 decibels or greater



Even when noise metrics and limit values are the same, there can be a difference in setback distance due to differences in assessment methods



Thank You for Your Attention!



Imagine the result

Bonus Slides



Noise Limits Wind Farms Netherlands and Belgium

Limit Values Netherlands (since 2011)

- 47 dB L_{den} (annual average)
- 41 dB L_{night} (annual average) [≈ 43 45 dB(A) at 95% rated power]

$$Lden = 10 \log \left(\frac{12 * 10^{\frac{Lday}{10}} + 4 * 10^{\frac{Levening+5}{10}} + 8 * 10^{\frac{Lnight+10}{10}}}{24} \right)$$

Target Values Belgium (Flanders Region) (since 2012)

		Day	Evening	Night
• Re	esidential areas	44 dB(A)*	39 dB(A)*	39 dB(A)*
• R	ural areas, residential areas	48 dB(A)*	43 dB(A)*	43 dB(A)*
<	500 m from industrial areas			
• In	dustrial areas	60 dB(A)*	55 dB(A)*	55 dB(A)*
• O	ther areas:	44-55 dB(A)*	39-50 dB(A)*	39-50 dB(A)*
* At 9	5% rated power			

In The Netherlands authorities can chose to take cumulative effects with neighbouring wind farms into account, but this is not obliged.

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Limit Values Denmark (since 2012)

General Noise Requirements

Limit Value	At Wind Speed 6 m/s	At Wind Speed 8 m/s
Near dwellings in country site	42 dB(A)	44 dB(A)
Residential areas	37 dB(A)	39 dB(A)

Requirements Low Frequency Noise (since 2012)

Limit value: 20 dB L_{pALF} at wind speed of both 6 and 8 m/s

Definition L_{pALF} : Total A-weighted sound pressure level <u>indoors</u> in dwellings for the frequency range from 10 to 160 Hz one-third octave bands

Note:

- Level difference outdoors-indoors is <u>defined</u> in the Statutory Order
- Insulation values are based on level difference which is exceeded for 67% of 26 measured rooms



Noise Limits Depending on Land Use or Background Noise Levels

Exceptions:

- Norway
- The Netherlands
- Belgian Region Wallonia
- Canadian province of Alberta
- A number of states and counties in the USA



Noise Limits Rural Areas vs. Residential Areas



- More stringent: France, Sweden, South Australia and New Zealand
- Less stringent: Belgian Region Flanders, Denmark and Germany

