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Noise impact assessment for a planned repowering project at the wind farm near Ellhöft, Germany

Introduction:

Grenzstrom Bürgerwind GmbH & Co. KG (the “customer”) is developing the Ellhöft Wind Farm in the region of North Frisia, Schleswig-Holstein, Germany with eight planned turbines. The turbines are planned as Nordex N133/4.8 MW with a hub height of 110,0 m. In context with this Project, seven currently existing turbines will be repowered. The customer has requested GL Garrad Hassan Deutschland GmbH (DNV) to carry out the noise impact assessment for this configuration. The results of this work are summarized in this technical letter.

Details of the methodology and procedures used for the noise impact calculation can be found within the report 10264887-A-3-A “Schallimmissionsberechnung für die Umgebung des geplanten Windenergieparks Ellhöft” issued by DNV at 2022-08-26.

Wind turbines taken into account:

The following turbine configuration given by the customer is considering 39 existing and additional planned wind turbine generator systems (WTGs) in total as well as one new turbines planned by the customer. The additional windfarm project with six WTGs, planned/realized on Danish territory by the Tønder Kommune is also respected as preload. Table 1 shows detailed information of the preload WTGs, table 2 shows the detailed information of the planned WTGs in question.

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Table 1: Existing and additional planned preload WTGs, technical data and sound power level

WTG No.	Manufacturer Type	Hub height in m	Rated power P _w in kW	Sound power level L _{WA} in dB(A)	Impulsivity penalty K _i in dB(A) ¹	Tonality penalty K _t in dB(A) ²	Sound power level L _{WA} in dB(A) (noise reduced mode for the night-time)
Preload							
S_01, S_02 sowie S_04 bis S_08, S_11, S_12	Siemens SWT 3.0-113	92,5	3.000	105,5 ³	0 ³	0 ³	
S_09	Siemens SWT 3.0-113	92,5	3.000	105,5 ³	0 ³	0 ³	100,5 ⁵
S_10	Siemens SWT 3.0-113	92,5	3.000	105,5 ³	0 ³	0 ³	99,5 ⁵
S_03	Siemens SWT 3.0-101	79,5	3.000	107,0 ³	0 ³	0 ³	
SV_28	Siemens SWT 2.3-93	93	2.300	106,0 ³	0 ³	0 ³	103,0 ⁵
SV_29	Siemens SWT 2.3-93	93	2.300	106,0 ³	0 ³	0 ³	104,0 ⁷
SV_31	Siemens SWT 2.3-93	93	2.300	106,0 ³	0 ³	0 ³	105,0 ⁵
SV_32	REpower 6M	100	6.000	107,0 ³	0 ³	0 ³	105,0 ⁵
SV_33 und SV_34	REpower 6M	100	6.000	107,0 ³	0 ³	0 ³	105,0 ⁶
SV_35	Enercon E-101	99	3.050	106,6 ⁴	0 ⁴	0 ⁴	
01 bis 03	Vestas V112/3.3 MW	94	3.300	104,4 ³	0 ³	0 ³	
G14, G18, G19	Siemens SWT 3.2 MW-113	92,5	3.200	105,0 ¹¹	0 ¹⁰	0 ¹⁰	100,0 ¹¹
G15	Siemens SWT 3.2 MW-113	115,5	3.200	105,0 ¹¹	0 ¹⁰	0 ¹⁰	
G16	Nordex N133/4.8	106,2	4.800	106,2 ¹⁴	0 ¹⁴	0 ¹⁴	
G17	Siemens SWT-DD-130	110,0	4.300	107,5 ¹³	0 ¹²	0 ¹²	101,5 ¹³
S21	Nordex N117/3,6 MW STE	91,0	3.600	103,5 ¹⁵	0 ¹⁵	0 ¹⁵	101,1 ¹⁶
S22	Nordex N117/3,6 MW STE	91,0	3.600	103,5 ¹⁵	0 ¹⁵	0 ¹⁵	101,3 ¹⁷
S23	Nordex N117/3,6 MW STE	91,0	3.600	103,5 ¹⁵	0 ¹⁵	0 ¹⁵	98,0 ¹⁸
S24	Nordex N117/3,6 MW STE	91,0	3.600	103,5 ¹⁵	0 ¹⁵	0 ¹⁵	
S25	Nordex N117/3,6 MW STE	91,0	3.600	103,5 ¹⁵	0 ¹⁵	0 ¹⁵	103,0 ¹⁹
Tønder Kommune, DK (Preload)							
DK01 bis DK03	Vestas V126-3.45MW HTq	87	3.450	103,0 ⁸	0 ⁷	0 ⁷	
DK04	Vestas V126-3.45MW HTq	87	3.450	104,4 ⁹	0 ⁸	0 ⁸	
DK05 und K06	Vestas V126-3.45MW HTq	87	3.450	104,9 ¹⁰	0 ⁹	0 ⁹	

¹ According to DIN 45645 T1

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- 2 Recommendation from the working group on „wind turbine noise“ /3/
- 3 Permitted sound power level during the day-time hours
- 4 Permitted sound power level during the night-time hours (used for calculations), $L_{WA} = 105,0$ dB(A) acc. To Report 214220-01.01 „Zusammenfassung aus mehreren Einzelmessungen“, Kötter Consulting Engineers
- 5 Permitted sound power level during the night-time hours
- 6 Abandonment of operation with the permitted sound power level through reduced night-time operation in favor of new planning
- 7 Manufacturer’s guarantee for the power optimized mode “S01”
- 8 Manufacturer’s guarantee for the power optimized mode “0”
- 9 Manufacturer’s guarantee for the power optimized mode “P01”
- 10 Manufacturer’s guarantee 105,0 dB(A) for the power optimized mode „Mode 1“ (Siemens Doc.: SGRE ON NE&ME TE SAS DE&UK-40-0000-085AA5F-01 / 25.01.2019)
- 11 Manufacturer’s guarantee 100 dB(A) for the noise optimized mode „Mode 6“ (Siemens Doc.: SGRE ON NE&ME TE SAS DE&UK-40-0000-085AA5F-01 / 25.01.2019)
- 12 Manufacturer’s guarantee 106 dB(A) for the power optimized mode „Mode 1“ (Siemens Doc.: SRGE ON NE&ME TE SAS DE&UK-40-0000-085AA5E-00 / 25.01.2019)
- 13 Manufacturer’s guarantee 102 dB(A) for the noise optimized mode „Mode 6“ (Siemens Doc.: SRGE ON NE&ME TE SAS DE&UK-40-0000-085AA5E-00 / 25.01.2019)
- 14 Manufacturer’s specification 104.5 dB(A) according to Nordex document F008 272 A19 IN Rev.5 of 2022-01-13 /13/ for the power-optimised operating mode “Mode 0” plus 1.7 dB of additional manufacturer’s uncertainty.
- 15 Manufacturer’s specification for the power-optimised operating mode “Mode 0”: 103.5 dB(A) acc. to Nordex Doc.: F008_256_A19_IN Rev. 01 of 2020-01-24
- 16 Manufacturer’s specification for noise-reduced mode of operation in “Mode 5”: 99.0 dB(A) acc. to Nordex Doc: F008_256_A19_IN Rev. 01 of 2020-01-24 plus a turbine-specific emission surcharge of 2.1 dB.
- 17 Manufacturer’s specification for noise-reduced mode of operation in “Mode 5”: 99.0 dB(A) acc. to Nordex Doc.: F008_256_A19_IN Rev. 01 of 2020-01-24 plus a turbine-specific emission surcharge of 2.3 dB.
- 18 Manufacturer’s specification for noise-reduced mode of operation in “Mode 7”: 98.0 dB(A) acc. to Nordex Doc.: F008_256_A19_IN Rev. 01 of 2020-01-24 without system-specific emission surcharge.
- 19 Manufacturer’s specification for noise-reduced mode of operation in “Mode 1”: 103.0 dB(A) acc. to Nordex Doc: F008_256_A19_IN Rev. 01 of 2020-01-24 without system-specific emission surcharge

Table 2: Planned WTGs, technical data and sound power level

WTG No.	Manufacturer Type	Hub height in m	Rated power P_w in kW	Sound power level L_{WA} in dB(A)	Impulsivity penalty K_i in dB(A) ¹	Tonality penalty K_t in dB(A) ²	Sound power level L_{WA} in dB(A) (noise reduced mode for the night-time)
Planned WTGs (Additional load)							
GBW20	Nordex N133/4.8	110,0	4.800	106,2 ³	0 ³	0 ³	100,7 ⁴
GBW27	Nordex N133/4.8	110,0	4.800	106,2 ³	0 ³	0 ³	100,7 ⁴
GBW28	Nordex N133/4.8	110,0	4.800	106,2 ³	0 ³	0 ³	102,7 ⁵
GBW29	Nordex N133/4.8	110,0	4.800	106,2 ³	0 ³	0 ³	102,7 ⁵
GBW30	Nordex N133/4.8	110,0	4.800	106,2 ³	0 ³	0 ³	100,2 ⁶
GBW31	Nordex N133/4.8	110,0	4.800	106,2 ⁵	0 ³	0 ³	100,7 ⁴
GBW32	Nordex N133/4.8	110,0	4.800	106,2 ⁵	0 ³	0 ³	100,7 ⁴
GBW33	Nordex N133/4.8	110,0	4.800	106,2 ³	0 ³	0 ³	100,2 ⁶

- 1 According to DIN 45645 T1
- 2 Recommendation from the working group on „wind turbine noise“ /3/
- 3 Manufacturer’s specification 104.5 dB(A) acc. to Nordex document F008 272 A19 IN Rev.5 of 2022-01-13 /13/ for the power-optimised operating mode “Mode 0” plus 1.7 dB additional manufacturer’s uncertainty
- 4 Manufacturer’s specification 99,0 dB(A) acc. to Nordex document F008 272 A19 IN Rev.5 of 2022-01-13 /13/ for the power-optimised operating mode “Mode 8” plus 1.7 dB additional manufacturer’s uncertainty
- 5 Manufacturer’s specification 101,0 dB(A) acc. to Nordex document F008 272 A19 IN Rev.5 of 2022-01-13 /13/ for the power-optimised operating mode “Mode 7” plus 1.7 dB additional manufacturer’s uncertainty
- 6 Manufacturer’s specification 98,5 dB(A) acc. to Nordex document F008 272 A19 IN Rev.5 of 2022-01-13 /13/ for the power-optimised operating mode “Mode 9” plus 1.7 dB additional manufacturer’s uncertainty

Chosen points of impact and results

The points of noise impact chosen for the calculation are the most relevant residences within the area of noise impact of the planned wind turbines. For the area in question these points of impact are given in table 3 together with the calculation results for the night-time period between 22:00 h and 06:00 h.

The coordinates of the listed points of impact can be found within Annex 9.10 of Noise Impact Report 10264887-A-3-A. Detailed results for every single noise impact level of each single turbine at the points of impact can be found within Annex 9.11 (daytime) and Annex 9.12 (night-time) of the above mentioned report.

Table 3: Chosen relevant points of impact and results for night-time preload additional load and total load

point of immission	permissible noise level, night-time dB(A)	noise rating level, night-time in dB(A)			meets the max. permissible noise level?
		preload	additional load	total load	
IO 01 Struxbüller Weg 1, Eilhöft	45	45	)	45	Yes
IO 02 Böglumer Straße 1, Eilhöft	45	45	)	45	Yes
IO 03 Böglumer Straße 6, Eilhöft	45	47	)	47	No
IO 04 Uhlenberg, Fassade süd EG	45	41	34	42	Yes
IO 04 Uhlenberg, Fassade süd OG	45	41	34	42	Yes
IO 04 Uhlenberg, Fassade nord EG	45	45	37	45	Yes
IO 04 Uhlenberg, Fassade nord OG	45	45	37	45	Yes
IO 04 Uhlenberg, Fassade ost EG	45	42	39	43	Yes
IO 04 Uhlenberg, Fassade ost OG	45	42	39	43	Yes
IO 04 Uhlenberg, Fassade west OG	45	45	)	45	Yes
IO 05 Böglumer Straße 7, Eilhöft	45	44	39	45	Yes
IO 06 Dorfstraße 10 (Gulum), Eilhöft	45	43	40	44	Yes
IO 07 Dorfstraße 29, Eilhöft	45	40	41	44	Yes
IO 08 Dorfstraße 21-25, Eilhöft	45	40	41	43	Yes
IO 09 Dorfstraße 4, Eilhöft	45	40	41	44	Yes
IO 10 Dorfstraße 9, Eilhöft	45	41	42	45	Yes
IO 11 Dorfstraße 2a, EG nord	45	42	43	45	Yes
IO 11 Dorfstraße 2a, EG ost	45	40	40	43	Yes
IO 11 Dorfstraße 2a, OG ost	45	40	40	43	Yes
IO 11 Dorfstraße 2a, EG süd	45	)	)	)	Yes
IO 11 Dorfstraße 2a, EG west	45	37	40	42	Yes
IO 11 Dorfstraße 2a, OG west	45	38	39	41	Yes
IO 12 Grenzstraße 6, EG nord	45	43	)	43	Yes
IO 12 Grenzstraße 6, OG nord	45	43	)	43	Yes
IO 12 Grenzstraße 6, EG ost	45	38	)	38	Yes
IO 12 Grenzstraße 6, OG ost	45	38	)	38	Yes
IO 12 Grenzstraße 6, EG süd	45	38	)	38	Yes
IO 12 Grenzstraße 6, OG süd	45	39	)	39	Yes
IO 13 Grenzstraße 4, EG nord	45	44	)	44	Yes
IO 13 Grenzstraße 4, OG nord	45	44	)	44	Yes
IO 13 Grenzstraße 4, EG süd	45	45	)	45	Yes
IO 13 Grenzstraße 4, OG süd	45	45	)	45	Yes
IO 13 Grenzstraße 4, EG west	45	45	)	45	Yes
IO 13 Grenzstraße 4, OG west	45	45	)	45	Yes
IO 14 Grenzstraße 2, EG nord	45	39	)	39	Yes
IO 14 Grenzstraße 2, EG ost	45	44	)	44	Yes
IO 14 Grenzstraße 2, EG süd	45	39	)	39	Yes
IO 14 Grenzstraße 2, EG west	45	35	)	35	Yes
IO 15 Grenzstraße 3, EG ost	45	44	)	44	Yes
IO 15 Grenzstraße 3, OG ost	45	44	)	44	Yes
IO 15 Grenzstraße 3, EG süd	45	40	)	40	Yes
IO 15 Grenzstraße 3, OG süd	45	40	)	40	Yes
IO 15 Grenzstraße 3, EG west	45	41	)	41	Yes
IO 15 Grenzstraße 3, OG west	45	41	)	41	Yes
IO 16 Grenzstraße 8, Süderlügum	45	45	)	45	Yes
IO 17 Grenzstrasse 12, Eilhöft	45	40	41	44	Yes

point of immission	permissible noise level, night-time dB(A)	noise rating level, night-time in dB(A)			meets the max. permissible noise level?
		preload	additional load	total load	
IO 18 Grenzstraße 14, Ellhöft	45	41	40	43	Yes
IO 19 Am Wald 1, Ellhöft	45	34	)	34	Yes
IO 20 Beyersweg 15 A-C, Westre	45	45	)	45	Yes
IO 21 Beyersweg 13, Westre	45	45	)	45	Yes
IO 22 Schwarze Berge 1, Westre	45	40	)	40	Yes
IO 23 Grenzstraße 3 (Engholm), Westre	45	34	)	34	Yes
IO 24 Grenzstraße 4, Westre	45	36	)	36	Yes
IO 25 Berbekssand 2, Westre	45	36	)	36	Yes
IO 26 Berbekssand 3, Westre	45	38	)	38	Yes
IO 27 Saedholm 1 (DK)	45	42	)	42	Yes
IO 28 Karlsminde (DK)	45	34	)	34	Yes
IO 29 Karlsmindevej 1 (DK)	45	)	)	)	Yes
IO 30 Lydersholmvej 13 (DK)	45	)	)	)	Yes
IO 31 Vindvedvej (DK)	45	)	)	)	Yes
IO 32 Hovmosevej 1 (DK)	45	)	)	)	Yes
IO 33 Hovmosevej 15 (DK)	45	33	)	33	Yes

) The single noise level caused by each of the WTGs is at least 12 dB(A) below the permitted noise level and they are not respected within the calculation of the total noise level (according to /4/). Therefore, no value can be ascertained.

Assessment of results

In the opinion of the author and with respect to the TA-Lärm /1/ and the policies from /5/ and /6/ inducted per decree /4/ for the region of Schleswig-Holstein, the possibility of the surrounding residents being unduly affected by the planned WTGs can be ruled out for the given configuration, as long as the emission levels given for the turbines are not exceeded.

With reference to /7/ and taking into account the actual planned configuration for the Ellhöft wind farm as well as the repowering of seven current existing turbines, it can also be assumed that the valid Danish regulations regarding noise impact are still fulfilled.

Bibliography

- /1/ Technical Guidelines on Wind Turbine Generators, Part 1: Determination of Noise Emission Values, Revision 18, (FGW Guideline), German Association for the Advancement of Wind Energy (*Technische Richtlinie für Windenergieanlagen, Teil 1: Bestimmung der Schallemissionswerte, Revision 18, (FGW-Richtlinie)*), Fördergesellschaft Windenergie e. V., 1998-10.
- /2/ 6th general administrative regulation associated with the federal law on noise control "A Technical Guide to Noise Control" (*Sechste Allgemeine Verwaltungsvorschrift zum Bundes-Immissionsschutzgesetz, „Technische Anleitung zum Schutz gegen Lärm TA – Lärm“*), 1998-08-28.
- /3/ Noise control as part of the approval process for new wind turbine generator systems, Recommendation from the working group on "wind turbine noise" made up of environmental protection agencies and measurement institutes. (*Schallimmissionsschutz im Genehmigungsverfahren von Windenergieanlagen, Empfehlung des Arbeitskreis „Geräusche von Windenergieanlagen“ der Immissionsschutzbehörden und Messinstitute*), 1999-10.



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- /4/ Ministerium für Energiewende, Landwirtschaft, Umwelt, Natur und Digitalisierung des Landes Schleswig-Holstein, „Einführung der aktuellen LAI-Hinweise zum Schallimmissionsschutz bei Windenergieanlagen in Schleswig-Holstein“, 2018-01-31
- /5/ Dokumentation zur Schallausbreitung: Interimsverfahren zur Prognose der Geräuschimmissionen von Windkraftanlagen, Fassung 2015-05.1
- /6/ Hinweise zum Schallimmissionsschutz bei Windenergieanlagen (WKA), Überarbeiteter Entwurf vom 2016-03-17 mit Änderungen PhysE vom 2016-06-23, Stand 2016-06-30
- /7/ Vindmøller ved Vindved, Miljørapport med VVM-redegørelse og Miljøvurdering (April 2017), Bilag 5, (calculated 2017-01-27)

Sincerely

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