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Shadow flicker 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 and a rotor diameter of 133 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 shadow flicker assessment for this changed configuration. The results of this work are summarized in this technical letter.

Details of the methodology and procedures used for the shadow flicker calculation can be found within the report 10264887-A-4-A “Schattenwurfberechnung 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 the eight 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 and the planned WTGs in question.

Table 1: Planned and existing turbines and technical data

WTG No.	Manufacturer Type	Hub height (m)	Rotor diameter (m)	Ground reflection coefficient R_0
Existing WTGs (preload)				
S_01, S_02 and S_04 to S_08 to S_12	Siemens SWT 3.0-113	92,5	113,0	0
S_03	Siemens SWT 3.0-101	79,5	101,0	0
SV_28, SV_29 and SV_31	Siemens SWT 2.3-93	93	92,6	0
SV_32 to SV_34	REpower 6M	100	126,0	0
SV_35	Enercon E-101	99	101,0	0
01 to 03	Vestas V112/3.3 MW	94	112,0	0
G14, G15, G18, G19	Siemens SWT 3.2 MW-113	92,5	113,0	0
G16	Nordex N133/4.8 MW	110	133,0	0
G17	Siemens SWT-DD-130	115	130,0	0
S21 to S25	Nordex N117/3,6 MW STE	91,0	116,8	0
Additional planning Tønder Kommune, DK (preload)				
DK01 und K06	Vestas V126-3.45MW HTq	87	126,0	0
Planned WTGs (additional load)				
GBW20 and GBW27 to GBW33	Nordex N133/4.8 MW	110,0	133,0	0

Chosen points of impact and results

The points of shadow flicker impact chosen for the calculation are representative residences within the area of shadow flicker impact of the planned wind turbines. For the area in question detailed information for these points of impact are given in report 10264887-A-4-A.

Table 2: Chosen relevant points of impact and results for preload additional shadow flicker and total impact

point of immission	Preload		Shadow flicker additional impact		total impact	
	h/year	h/day	h/year	h/day	h/year	h/day
IO 001 Struxbüller Weg 1	209:57	02:30	0:00	00:00	209:57	02:30
IO 002 Böglumer Straße 1	264:12	01:56	0:00	00:00	264:12	01:56
IO 003 Böglumer Str 2 u. 3	249:25	01:45	3:49	00:17	253:14	01:45
IO 004 Böglumer Straße 6	174:57	01:17	16:43	00:23	186:49	01:17
IO 005 Uhlenberg 1	49:51	00:33	128:38	00:52	171:04	01:04
IO 006 Böglumer Straße 7	50:02	00:56	50:59	00:38	97:25	01:12
IO 007 Dorfstraße 10 (Gulum)	65:27	00:42	59:04	00:44	121:14	01:04
IO 008 Dorfstraße 29	43:34	00:35	68:31	00:36	108:18	00:49
IO 009 Dorfstraße 27	48:40	00:33	46:55	00:32	92:02	00:49

point of immission	Preload		Shadow flicker additional impact		total impact	
	h/year	h/day	h/year	h/day	h/year	h/day
IO 010 Dorfstraße 21-25	56:44	00:29	66:25	00:36	116:34	00:58
IO 011 Dorfstraße 4	56:44	00:30	74:36	00:38	124:04	01:01
IO 012 Dorfstraße 9	26:17	00:35	70:39	00:39	87:09	00:54
IO 013 Dorfstraße 2a	46:23	00:25	117:32	00:54	152:29	01:14
IO 014 Grenzstraße 3	74:11	00:50	0:00	00:00	74:11	00:50
IO 015 Grenzstraße 2	131:19	01:29	0:00	00:00	131:19	01:29
IO 016 Grenzstraße 4	111:23	01:58	8:10	00:18	119:33	01:58
IO 017 Grenzstraße 6	99:40	01:05	30:52	00:25	130:32	01:05
IO 018 Grenzstraße 8	141:40	01:28	2:46	00:08	144:26	01:28
IO 019 Grenzstraße 12, Osterhof (Schwarze Berge)	30:12	00:33	46:08	00:45	70:39	00:56
IO 020 Am Wald 1, Ellhöft	34:54	00:33	16:26	00:32	50:08	00:46
IO 021 Schwarze Berge 1	15:19	00:28	0:00	00:00	15:19	00:28
IO 022 Grenzstraße 1	52:01	00:46	236:33	01:45	280:21	02:14
IO 023 Schwarze Berge 18	15:17	00:28	0:00	00:00	15:17	00:28
IO 024 Beierskrovej 15 a-c, Westre	56:57	00:44	36:55	00:51	93:52	00:55
IO 025 Beierskrovej 13, Westre	35:21	00:41	52:37	00:45	87:58	00:45
IO 026 Grenzstraße 3 (Engholm), Westre	2:30	00:09	0:00	00:00	2:30	00:09
IO 027 Grenzstraße 4, Westre	03:06	00:09	0:00	00:00	3:06	00:09
IO 028 Berbekssand 2, Westre	0:00	00:00	0:00	00:00	0:00	00:00
IO 029 Berbekssand 3, Westre	0:00	00:00	0:00	00:00	0:00	00:00
IO 030 Saedholm 1 (DK)	69:10	00:58	0:00	00:00	69:10	00:58
IO 031 Karlsminde (DK)	13:01	00:26	0:00	00:00	13:01	00:26
IO 032 Karlsmindevej 1 (DK)	2:22	00:14	0:00	00:00	2:22	00:14
IO 033 Lydersholmvej 13 (DK)	0:00	00:00	0:00	00:00	0:00	00:00
IO 034 Vindvedvej 3 (DK)	13:16	00:23	0:00	00:00	13:16	00:23
IO 035 Hovmsvej 1 (DK)	9:28	00:18	0:00	00:00	9:28	00:18
IO 036 Hovmosevej 17 (DK)	11:02	00:17	0:00	00:00	11:02	00:17
IO 037 Hovmosevej 15 (DK)	12:02	00:24	0:00	00:00	12:02	00:24

Assessment of results

In summary, the exceedance of the permitted shadow flicker limits is already affected by the existing turbines. The additional impact caused by the planned turbines is increasing this exceeding.

Overlooking the results for the points of impact at the danish territory (I0 30 to IO 37), the possibility of the surrounding residents being unduly affected, caused by the planned WTGs of the Grenzstrom Bürgerwind GmbH & Co. KG, can be excluded for the given configuration. Independent from the calculated results, a suitable configured shadow flicker protection system can ensure that the surrounding residential areas are not unduly affected by the existing and/or planned turbines.

Sincerely

for GL Garrad Hassan Deutschland GmbH

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