



PROKON Wind Energy Finland Oy

## Kattiharjun tuulivoimapuiston laajennus, Laihia Välkemallinnus

8.2.2024

## Sisällysluettelo

1. Lähtötiedot ja menetelmät .....	- 3 -
2. Välkemallinnuksen tulokset .....	- 5 -
2.1. Laskentatulokset, ilman puustoa .....	- 5 -
2.3.2 Laskentatulokset, puusto huomioitu .....	- 10 -
Liitteet .....	- 15 -

## 1. Lähtötiedot ja menetelmät

Tässä raportissa esitetään Kattiharjun tuulivoimapuiston laajennuksen välkemallinnus. Välkemallinnus on tehty WindPRO:n SHADOW-moduulilla ja laskennassa on käytetty WindPRO versiota 3.6.361. Puuston korkeustiedot perustuvat Luonnonvarakeskuksen (Luke) vuoden 2021 tietoihin. Välkemallinnuksen on laatinut Prokon Wind Energy Finland Oy.

Kattiharjun tuulivoimapuiston laajennuksen välkemallinnus on laadittu käyttämällä teoreettista voimalatyyppiä Generic 200, jonka roottorin halkaisija on 200 m, voimalan napakorkeus 159 m ja kokonaiskorkeus 259 m.

Mallinuksissa on huomioitu Kattiharjun tuulivoimapuiston tuulivoimalat. Kattiharjun tuulivoimapuiston välkemallinnus on laadittu käyttämällä voimalatyyppinä Nordex N163 6.X voimalaa, jonka roottorin halkaisija on 163 m. Voimalan numero 6 napakorkeus on 148,5 m, voimaloiden numero 2, 7 ja 8 napakorkeus on 149,5 m ja voimaloiden numero 1, 3, 4, 5, 9, 10, 11, 12, 13 ja 14 napakorkeus 150,5 m. Voimaloiden napakorkeus vaihtelee, koska osaan voimaloista suunnitellaan rakennettavan korotettu perustus. Voimaloiden kokonaiskorkeus on näin ollen 230-232 metriä.

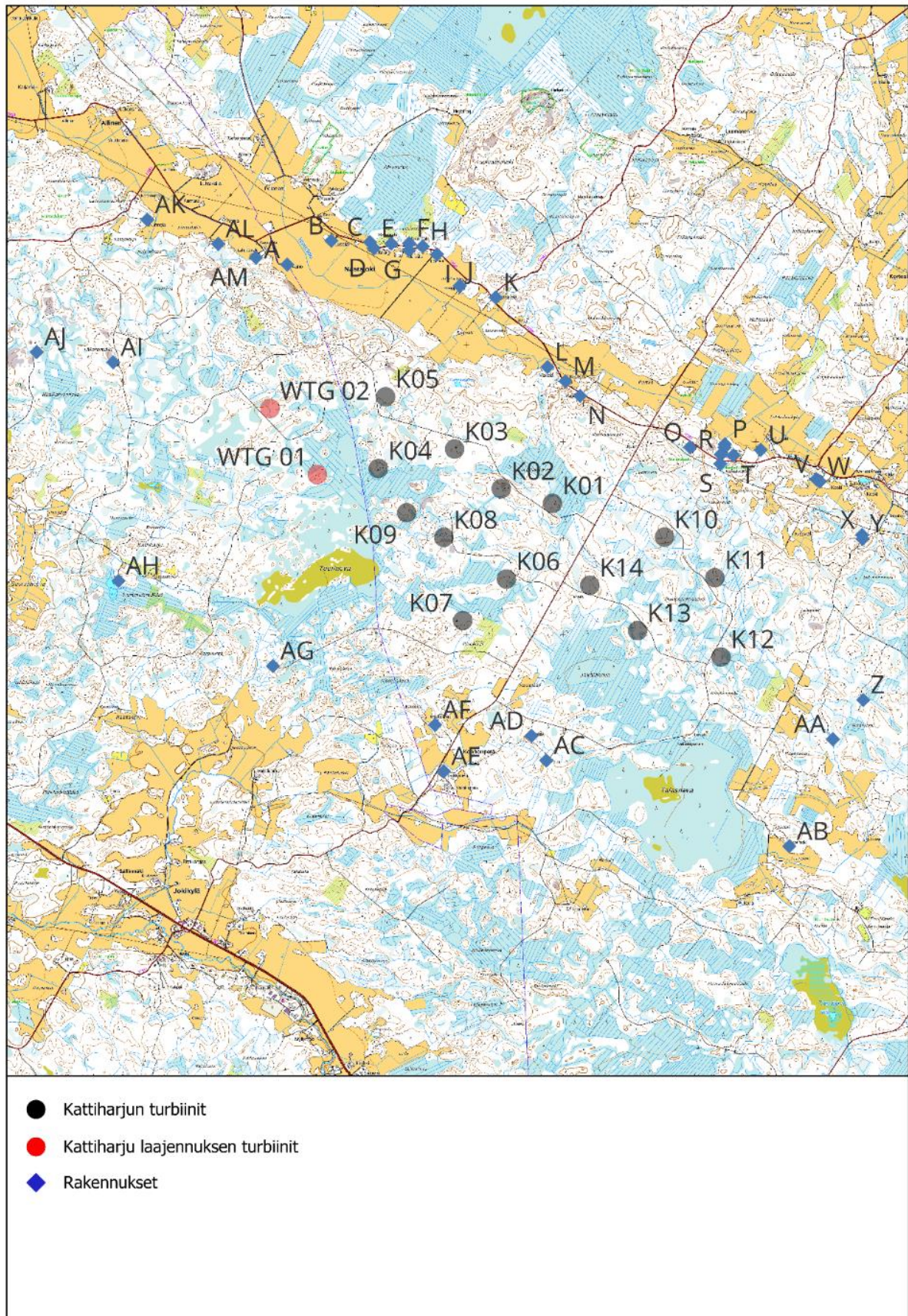
Taulukossa 1 on esitetty välkemallinnuksessa käytettyjen voimaloiden perustiedot.

*Taulukko 1. Välkemallinnuksessa käytettyjen voimaloiden perustiedot.*

	Voimala malli	Voimaloiden lukumäärä (kpl)	Nimellisteho (MW)	Roottorin halkaisija (m)	Napa-korkeus (m)	Kokonaiskorkeus (m)
<b>Kattiharjun laajennus</b>	Generic 200	2	7,2	200	159	259
<b>Kattiharju</b>	N163	14	6,8	163	148,5-150,5	230-232

Kuvassa 1 on esitetty Kattiharjun tuulivoimapuiston laajennuksen voimalat (WTG 01 ja WTG 02), Kattiharjun tuulivoimapuiston voimalat (K01-K14) ja lähellä olevien rakennusten (A-AM) sijainnit.





Kuva 1. Tuulivoimaloiden ja lähellä olevien rakennusten sijainnit



## 2. Välkemallinnuksen tulokset

### 2.1. Laskentatulokset, ilman puustoa

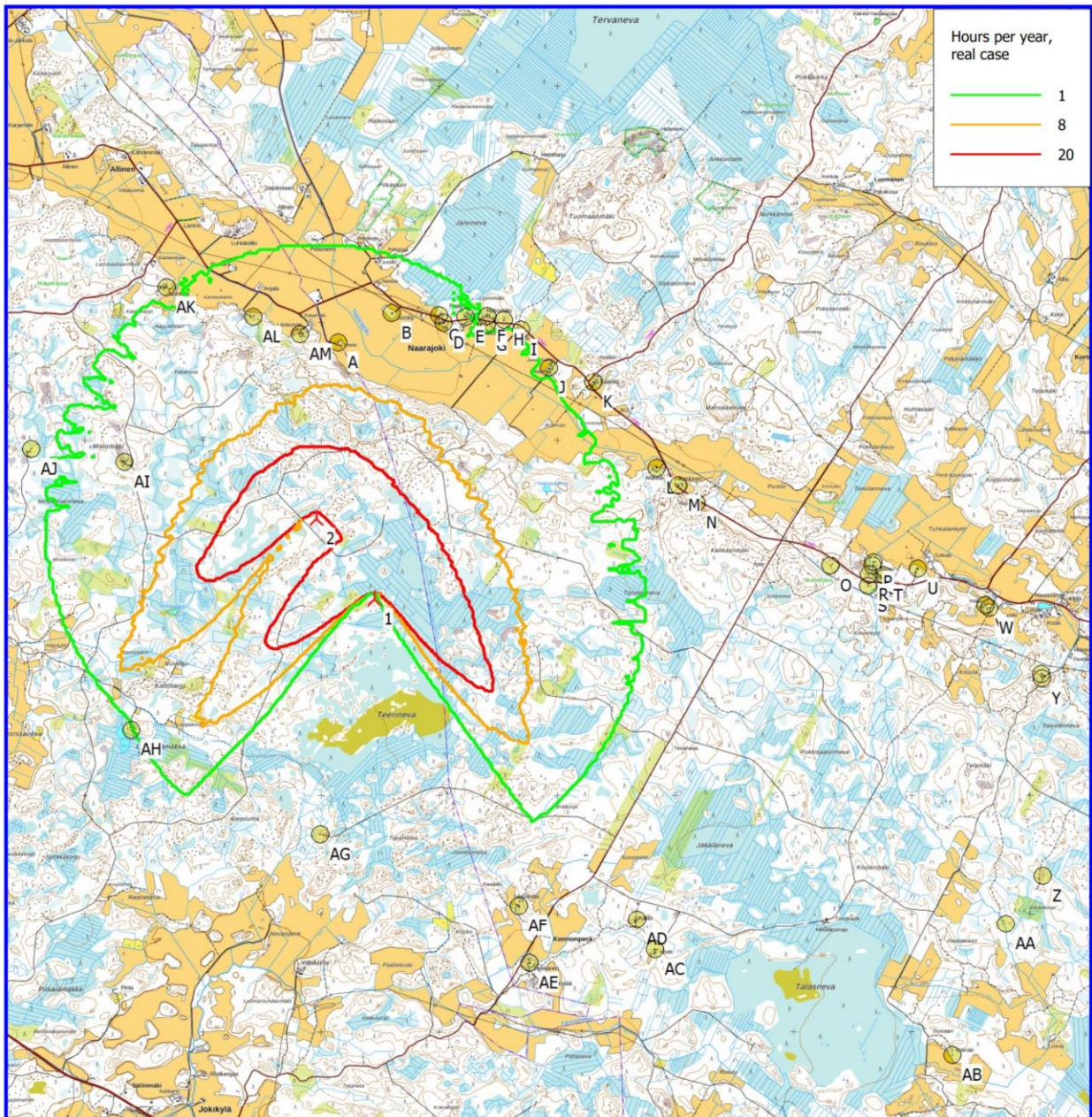
Rakennusten A-AM mallinnetut keskimääräiset vuosittaiset välketunnit Kattiharjun tuulivoimapuiston laajennukselle on esitetty taulukossa 2 (tuntia vuodessa) tilanteessa, jossa puuston suojaavaa vaikutusta ei ole huomioitu. Kuvassa 3 on esitetty Kattiharjun laajennuksen välkemallinnuksen tulos kartalla. Mallinnuksen perusteella yhdenkään rakennuksen pihapiirissä välke ei ylitä suositeltua arvoa 8 h/vuodessa.

Taulukossa 2 on lisäksi esitetty mallinnustulos Kattiharjun tuulivoimapuistolle sekä yhteismallinnus, jossa on huomioitu Kattiharjun tuulivoimapuisto ja tuulivoimapuiston laajennus. Kattiharjun tuulivoimapuiston mallinnustuloksen perusteella 7 rakennuksen (L, M, N, O, R, S, T) pihapiirissä välke ylittää 8 h/vuosi. Kattiharjun tuulivoimapuiston ja tuulivoimapuiston laajennuksen mallinnustuloksen perusteella 7 rakennuksen (L, M, N, O, R, S, T) pihapiirissä välke ylittää 8 h/vuosi. Kuvassa 4 on esitetty Kattiharjun tuulivoimapuiston välkemallinnuksen tulos kartalla ja kuvassa 5 on esitetty Kattiharjun tuulivoimapuiston ja tuulivoimapuiston laajennuksen välkemallinnuksen tulos kartalla.

*Taulukko 2. Keskimääräiset välketunnit vuodessa). Arvot, jotka ylittävät suositellun rajan (8 h vuodessa), on merkitty punaisella. Puuston suojaavaa vaikutusta ei ole huomioitu.*

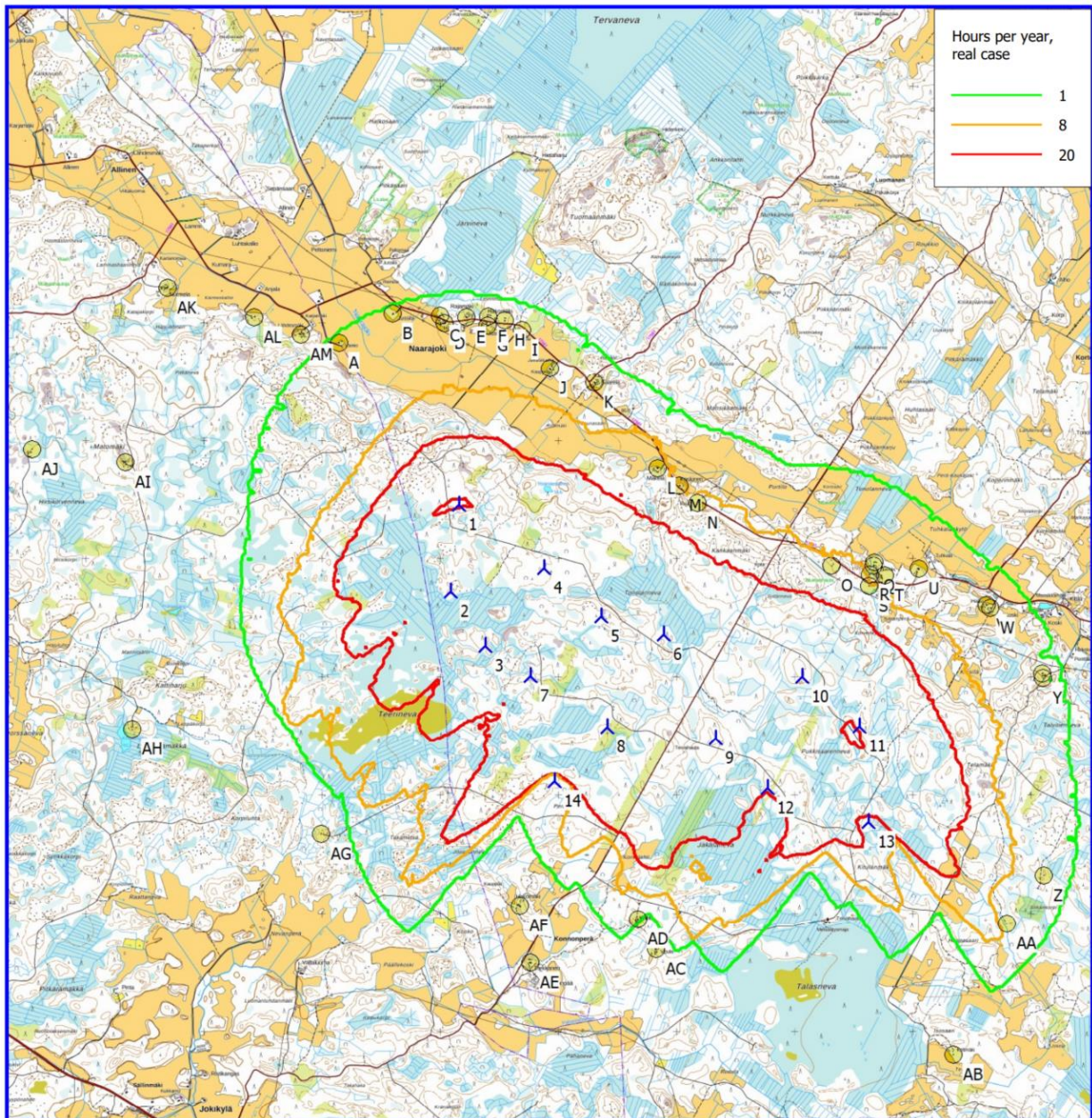
Rakennus	Kattiharjun tuulivoimapuiston laajennus	Kattiharjun tuulivoimapuisto	Kattiharjun tuulivoimapuisto ja tuulivoimapuiston laajennus
	Välketunnit vuodessa, puuston suojaavaa vaikutusta ei huomioitu (h/vuosi)	Välketunnit vuodessa, puuston suojaavaa vaikutusta ei huomioitu (h/vuosi)	Välketunnit vuodessa, puuston suojaavaa vaikutusta ei huomioitu (h/vuosi)
A	5:57	1:44	7:54
B	2:20	1:44	4:07
C	1:37	2:33	4:12
D	1:40	2:43	4:25
E	1:22	2:44	4:08
F	1:10	2:41	3:52
G	1:17	2:50	4:10
H	1:06	2:38	3:46
I	0:00	2:16	2:15
J	0:00	5:07	5:05
K	0:00	4:46	4:44
L	0:00	10:55	10:50
M	0:00	9:36	9:31
N	0:00	11:29	11:24
O	0:00	12:04	11:59
P	0:00	7:18	7:15
Q	0:00	7:39	7:36
R	0:00	8:42	8:38
S	0:00	11:28	11:23
T	0:00	8:06	8:02
U	0:00	5:38	5:35

V	0:00	3:52	3:50
W	0:00	3:44	3:42
X	0:00	1:38	1:37
Y	0:00	1:39	1:38
Z	0:00	2:29	2:28
AA	0:00	6:07	6:04
AB	0:00	0:00	0:00
AC	0:00	0:00	0:00
AD	0:00	2:00	1:59
AE	0:00	0:00	0:00
AF	0:00	0:00	0:00
AG	0:00	0:00	0:00
AH	0:00	0:00	0:00
AI	2:11	0:00	2:03
AJ	0:00	0:00	0:00
AK	0:00	0:00	0:00
AL	2:14	0:00	2:17
AM	3:37	0:00	3:44



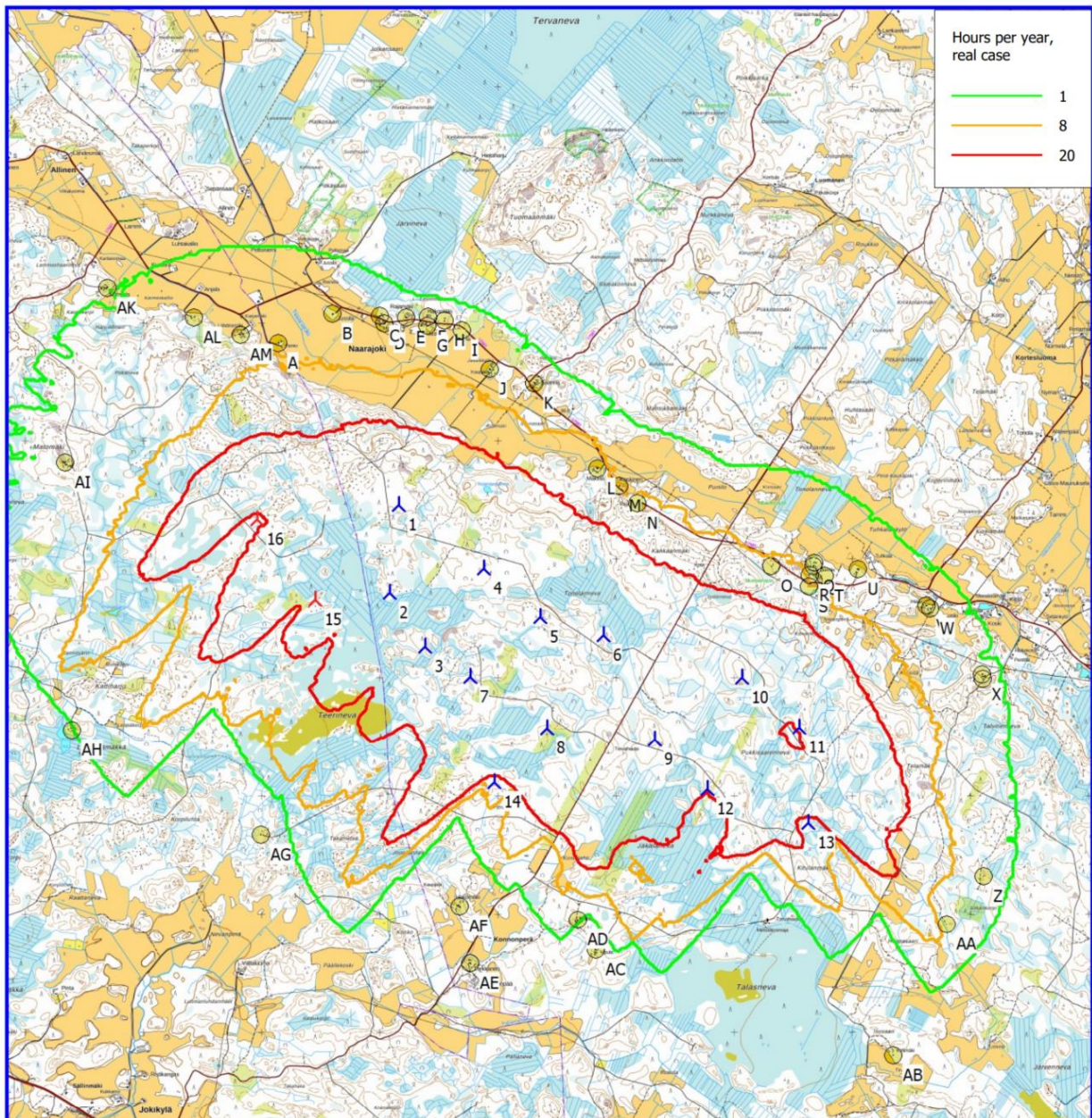
Kuva 3. Välikemallinnuksen tulos ilman puuston suojaavaa vaikutusta. Kattiharjun tuulivoimapaiston laajennus.





Kuva 4. Välikemallinnuksen tulos ilman puuston suojaavaa vaikutusta. Kattiharjun tulivoima-alue.





Kuva 5. Välikmallinnuksen tulos ilman puuston suojaavaa vaikutusta. Kattiharjun tulivoimapuisto ja tulivoimapuiston laajennus.

## 2.3.2 Laskentatulos, puusto huomioitu

Rakennusten A-AM mallinnetut keskimääräiset vuosittaiset väketunnit Kattiharjun tuulivoimapuiston laajenukselle on esitetty taulukossa 3 (tuntia vuodessa) tilanteessa, jossa puuston suojaava vaikutus on huomioitu. Kuvassa 6 on esitetty väkemanninnuksen tulos kartalla. Mallinnusten perusteella yhdenkään rakennuksen pihapiirissä väke ei ylitä suositeltua arvoa 8 h/vuodessa.

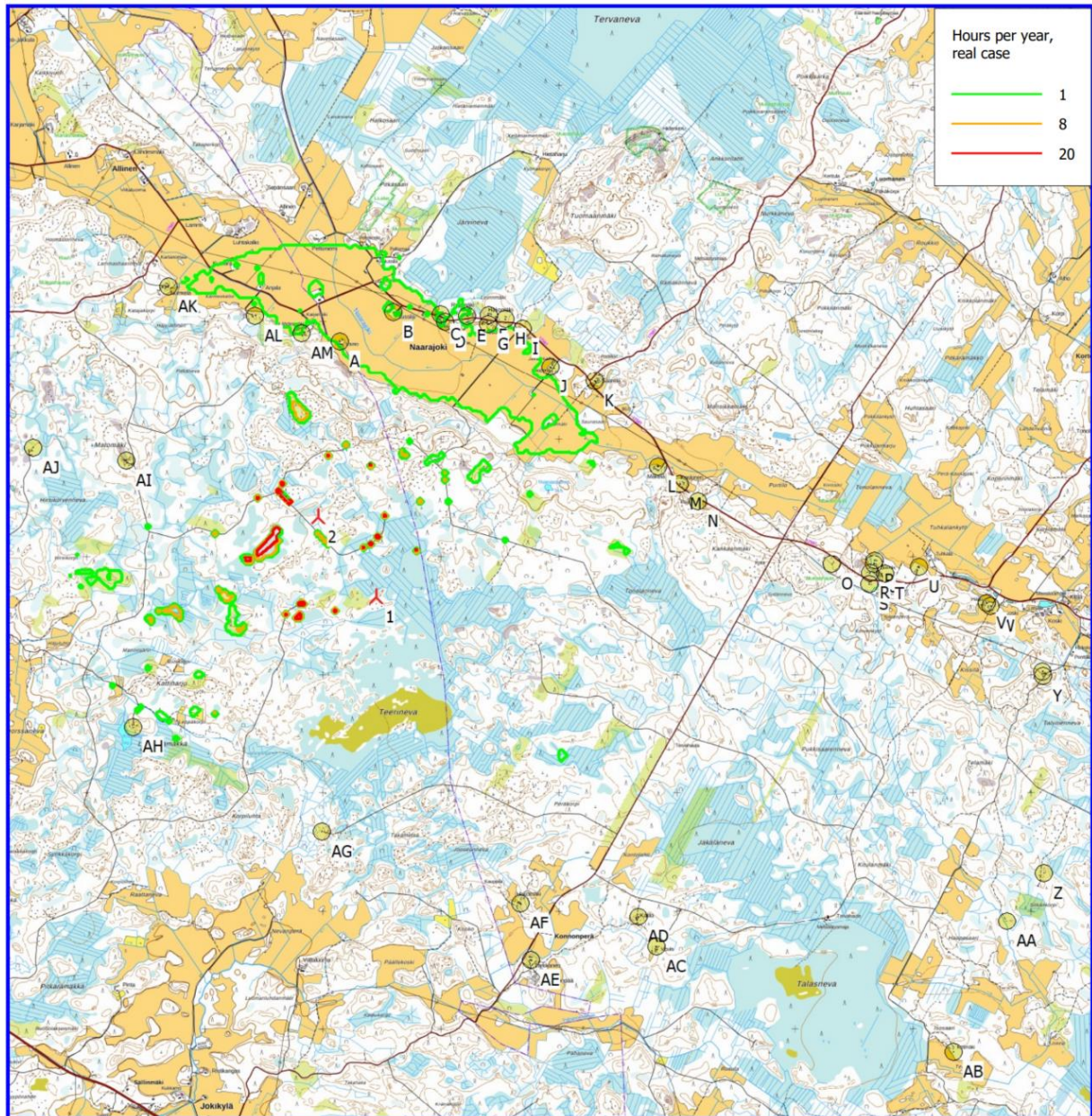
Taulukossa 3 on lisäksi esitetty mallinnustulos Kattiharjun tuulivoimapuistolle sekä yhteismallinnus, jossa on huomioitu Kattiharjun tuulivoimapuisto ja tuulivoimapuiston laajennus. Kattiharjun tuulivoimapuiston mallinnustuloksen perusteella 2 rakennuksen (L, T) pihapiirissä väke ylittää 8 h/vuosi. Kattiharjun tuulivoimapuiston ja tuulivoimapuiston laajennuksen mallinnustuloksen perusteella 2 rakennuksen (L, T) pihapiirissä väke ylittää 8 h/vuosi. Kuvassa 7 on esitetty Kattiharjun tuulivoimapuiston väkemanninnuksen tulos kartalla ja kuvassa 8 on esitetty Kattiharjun tuulivoimapuiston ja tuulivoimapuiston laajennuksen väkemanninnuksen tulos kartalla.

*Taulukko 3. Keskimääräiset väketunnit vuodessa). Arvot, jotka ylittävät suositellun rajan (8 h vuodessa), on merkitty punaisella. Laskelmissa on huomioitu puuston suojaava vaikutus.*

Rakennus	Kattiharjun tuulivoimapuiston laajennus	Kattiharjun tuulivoimapuisto	Kattiharjun tuulivoimapuisto ja tuulivoimapuiston laajennus
	Väketunnit vuodessa, puuston suojaava vaikutus on huomioitu (h/vuosi)	Väketunnit vuodessa, puuston suojaava vaikutus on huomioitu (h/vuosi)	Väketunnit vuodessa, puuston suojaava vaikutus on huomioitu (h/vuosi)
A	5:57	1:44	7:54
B	2:20	1:44	4:07
C	1:37	2:33	4:12
D	1:40	2:43	4:25
E	1:22	0:00	1:24
F	1:10	2:41	3:52
G	1:17	2:50	4:10
H	1:06	0:00	1:08
I	0:00	2:16	2:15
J	0:00	5:07	5:05
K	0:00	4:46	4:44
L	0:00	10:55	10:50
M	0:00	6:34	6:31
N	0:00	7:33	7:30
O	0:00	0:00	0:00
P	0:00	7:18	7:15
Q	0:00	7:39	7:36
R	0:00	0:00	0:00
S	0:00	0:00	0:00
T	0:00	8:06	8:02
U	0:00	5:38	5:35
V	0:00	3:52	3:50

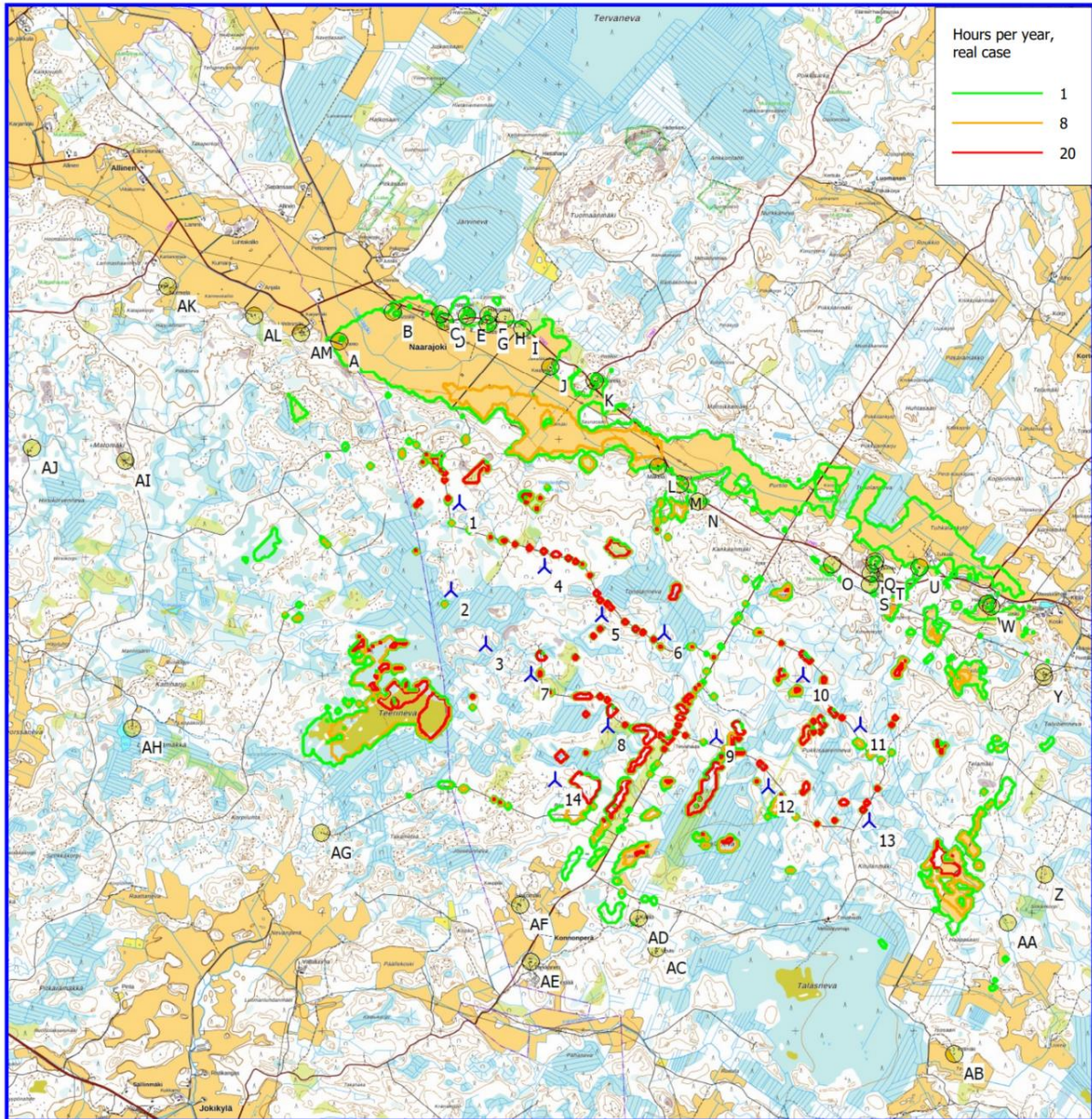


W	0:00	2:14	2:13
X	0:00	0:00	0:00
Y	0:00	0:00	0:00
Z	0:00	0:00	0:00
AA	0:00	0:00	0:00
AB	0:00	0:00	0:00
AC	0:00	0:00	0:00
AD	0:00	0:00	0:00
AE	0:00	0:00	0:00
AF	0:00	0:00	0:00
AG	0:00	0:00	0:00
AH	0:00	0:00	0:00
AI	0:00	0:00	0:00
AJ	0:00	0:00	0:00
AK	0:00	0:00	0:00
AL	0:00	0:00	0:00
AM	3:37	0:00	3:44



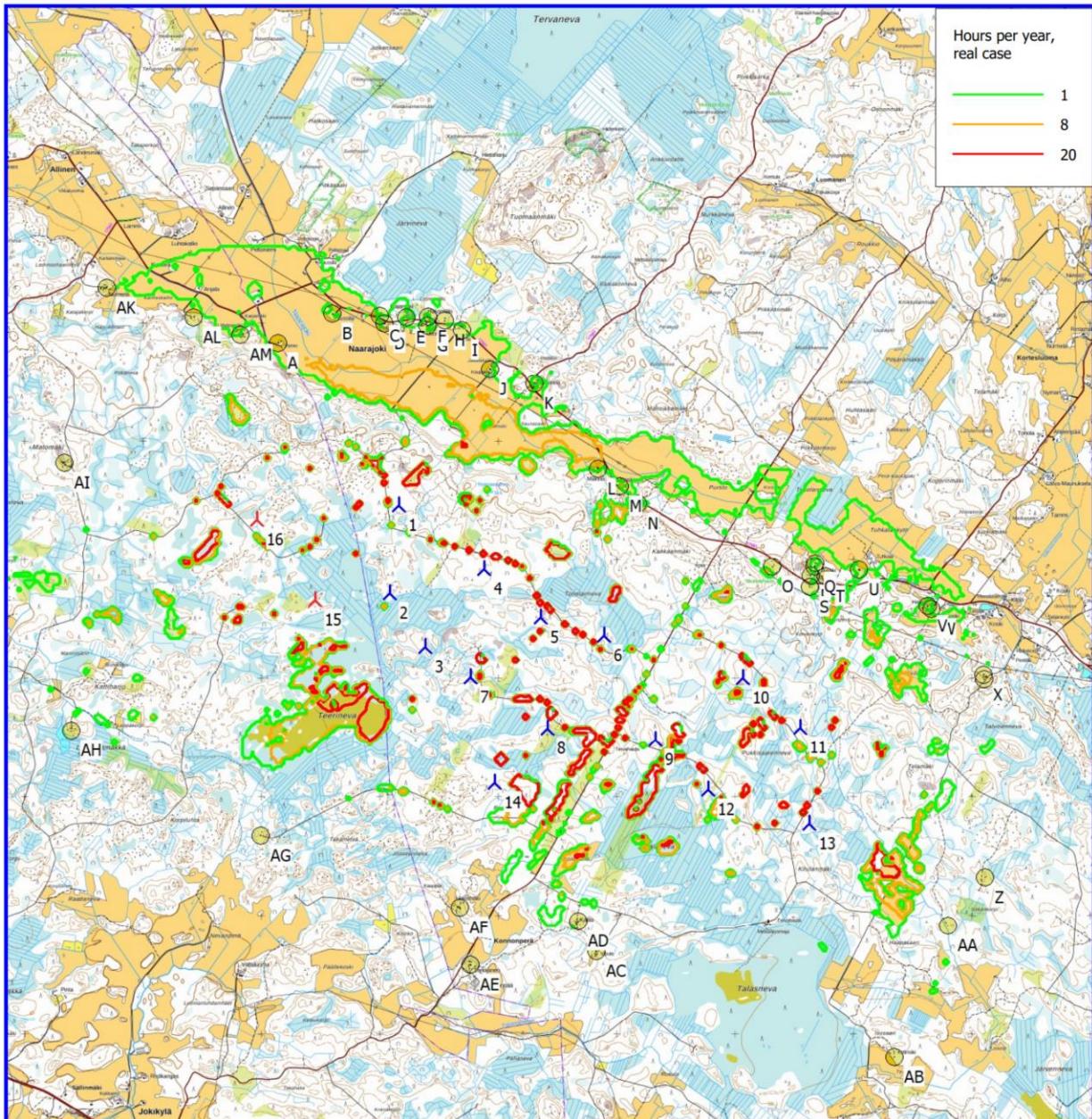
Kuva 6. Väikemallinnuksen tulos, kun puuston suojaava vaikutus on huomioitu. Kattiharjun tuulivoimapuiston laajennus.





Kuva 7. Välkemallinnuksen tulos, kun puuston suojaava vaikutus on huomioitu. Kattiharjun tuulivoimapuisto.





Kuva 8. Väikemallinnuksen tulos, kun puuston suojaava vaikutus on huomioitu. Kattiharjun tulivoimapuisto ja tulivoimapuiston laajennus.

## Liitteet

Liite 1. Välkemallinnuksen tulokset, ilman puustoa (Kattiharjun laajennus)

Liite 2. Välkemallinnuksen tulokset, ilman puustoa (Kattiharju)

Liite 3. Välkemallinnuksen tulokset, ilman puustoa (Kattiharju ja Kattiharjun laajennus)

Liite 4. Välkemallinnuksen tulokset, puusto huomioitu (Kattiharjun laajennus)

Liite 5. Välkemallinnuksen tulokset, puusto huomioitu (Kattiharju)

Liite 6. Välkemallinnuksen tulokset, puusto huomioitu (Kattiharju ja Kattiharjun laajennus)



Project:

20220502 Kattiharju extension

Licensed user:

PROKON Regenerative Energien eG  
 Kirchhoffstraße 3  
 DE-25524 Itzehoe  
 +49 4821 6855 100  
 Kristiina Isohella / k.isoehella@prokon.net  
 Calculated:  
 30/01/2024 12.40/3.6.361

## SHADOW - Main Result

Calculation: 2 x Generik 200-159 rev04

### Assumptions for shadow calculations

Maximum distance for influence  
 Calculate only when more than 20 % of sun is covered by the blade  
 Please look in WTG table

Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S (Average daily sunshine hours) []  
 Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 1,00 2,82 4,23 6,60 8,77 9,10 8,87 6,81 4,67 2,52 1,17 0,58

Operational hours are calculated from WTGs in calculation and wind distribution:  
 EMD-WRF Europe+ (ERA5) [SAMPLE]\_N62,897697\_E022,215485 (29)

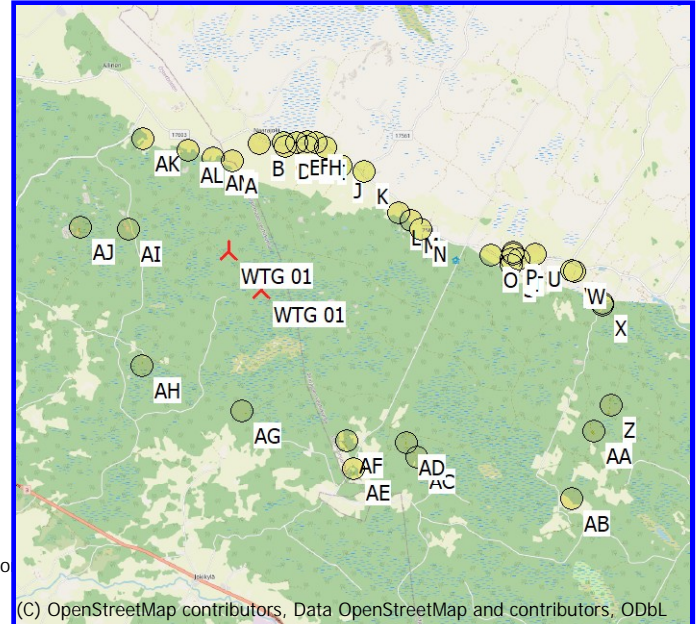
Operational time  
 N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 667 307 312 351 501 982 940 1 370 1 108 781 544 495 8 359  
 Idle start wind speed: Cut in wind speed from power curve

A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:  
 Height contours used: Height Contours: CONTOURLINE\_20220502 Kattiharju extension  
 Receptor grid resolution: 1,0 m

All coordinates are in  
 Finish TM ETRS-TM35FIN-ETRS89

### WTGs

	East	North	Z	Row data/Description	WTG type			Shadow data				
					Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Calculation distance [m]	RPM [RPM]
WTG 01	255 965,3	6 985 341,4	50,6	Generic Generic 200-200 10000 20...	Yes	Generic	Generic 200-200-10 000	10 000	200,0	159,0	2 315	8,0
WTG 01	256 455,1	6 984 657,8	50,0	Generic Generic 200-200 10000 20...	Yes	Generic	Generic 200-200-10 000	10 000	200,0	159,0	2 315	8,0



### Shadow receptor-Input

No.	East	North	Z	Width	Height	Elevation	Slope of	Direction mode	Eye height
						a.g.l.	window		(ZVI) a.g.l.
			[m]	[m]	[m]	[m]	[°]		[m]
A	256 144,0	6 986 832,0	25,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
B	256 601,0	6 987 078,0	25,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
C	257 002,0	6 987 064,0	26,3	5,0	5,0	2,0	90,0	"Green house mode"	7,0
D	257 041,8	6 986 999,5	27,5	5,0	5,0	2,0	90,0	"Green house mode"	7,0
E	257 223,0	6 987 049,0	27,5	5,0	5,0	2,0	90,0	"Green house mode"	7,0
F	257 407,0	6 987 052,0	30,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
G	257 405,0	6 986 981,0	28,2	5,0	5,0	2,0	90,0	"Green house mode"	7,0
H	257 547,0	6 987 020,0	30,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
I	257 695,0	6 986 937,0	27,5	5,0	5,0	2,0	90,0	"Green house mode"	7,0
J	257 931,0	6 986 612,0	27,5	5,0	5,0	2,0	90,0	"Green house mode"	7,0
K	258 304,0	6 986 491,0	29,8	5,0	5,0	2,0	90,0	"Green house mode"	7,0
L	258 840,0	6 985 771,0	30,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
M	259 027,0	6 985 623,0	32,1	5,0	5,0	2,0	90,0	"Green house mode"	7,0
N	259 178,0	6 985 472,0	37,2	5,0	5,0	2,0	90,0	"Green house mode"	7,0
O	260 316,0	6 984 939,0	44,6	5,0	5,0	2,0	90,0	"Green house mode"	7,0
P	260 677,0	6 984 970,0	33,3	5,0	5,0	2,0	90,0	"Green house mode"	7,0
Q	260 673,0	6 984 939,0	34,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
R	260 636,0	6 984 866,0	34,8	5,0	5,0	2,0	90,0	"Green house mode"	7,0
S	260 630,0	6 984 769,0	35,9	5,0	5,0	2,0	90,0	"Green house mode"	7,0
T	260 766,0	6 984 856,0	35,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
U	261 049,0	6 984 913,0	35,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
V	261 624,0	6 984 609,0	37,2	5,0	5,0	2,0	90,0	"Green house mode"	7,0
W	261 660,0	6 984 585,0	36,9	5,0	5,0	2,0	90,0	"Green house mode"	7,0
X	262 099,0	6 984 032,0	39,6	5,0	5,0	2,0	90,0	"Green house mode"	7,0

To be continued on next page...



Project:

20220502 Kattiharju extension

Licensed user:

PROKON Regenerative Energien eG

Kirchhoffstraße 3

DE-25524 Itzehoe

+49 4821 6855 100

Kristiina Isohella / k.isohella@prokon.net

Calculated:

30/01/2024 12.40/3.6.361

## SHADOW - Main Result

Calculation: 2 x Generik 200-159 rev04

...continued from previous page

No.	East	North	Z	Width	Height	Elevation a.g.l.	Slope of window	Direction mode	Eye height (ZVI) a.g.l.
			[m]	[m]	[m]	[m]	[°]		[m]
Y	262 104,0	6 983 991,0	41,3	5,0	5,0	2,0	90,0	"Green house mode"	7,0
Z	262 110,0	6 982 324,0	50,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AA	261 796,0	6 981 916,0	47,5	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AB	261 344,0	6 980 808,0	48,3	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AC	258 828,0	6 981 696,0	50,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AD	258 674,0	6 981 951,0	52,2	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AE	257 766,0	6 981 583,0	50,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AF	257 676,0	6 982 065,0	49,8	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AG	255 996,0	6 982 675,0	45,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AH	254 396,7	6 983 556,8	46,7	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AI	254 341,0	6 985 820,4	55,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AJ	253 549,6	6 985 926,4	45,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AK	254 694,4	6 987 295,9	28,5	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AL	255 429,2	6 987 046,3	30,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AM	255 820,0	6 986 903,4	28,1	5,0	5,0	2,0	90,0	"Green house mode"	7,0

## Calculation Results

Shadow receptor

Shadow, expected values

No. Shadow hours

per year

[h/year]

A	5:57
B	2:20
C	1:37
D	1:40
E	1:22
F	1:10
G	1:17
H	1:06
I	0:00
J	0:00
K	0:00
L	0:00
M	0:00
N	0:00
O	0:00
P	0:00
Q	0:00
R	0:00
S	0:00
T	0:00
U	0:00
V	0:00
W	0:00
X	0:00
Y	0:00
Z	0:00
AA	0:00
AB	0:00
AC	0:00
AD	0:00
AE	0:00
AF	0:00
AG	0:00
AH	0:00
AI	2:11
AJ	0:00
AK	0:00
AL	2:14
AM	3:37

Project:

20220502 Kattiharju extension

Licensed user:

PROKON Regenerative Energien eG  
Kirchhoffstraße 3  
DE-25524 Itzehoe  
+49 4821 6855 100  
Kristiina Isohella / k.isohella@prokon.net  
Calculated:  
30/01/2024 12.40/3.6.361

## SHADOW - Main Result

Calculation: 2 x Generik 200-159 rev04

Total amount of flickering on the shadow receptors caused by each WTG

No.	Name	Expected [h/year]
WTG 01	Generic Generic 200-200 10000 200.0 !-! hub: 159,0 m (TOT: 259,0 m) (76)	19:22
WTG 01	Generic Generic 200-200 10000 200.0 !-! hub: 159,0 m (TOT: 259,0 m) (75)	1:56

Total times in Receptor wise and WTG wise tables can differ, as a WTG can lead to flicker at 2 or more receptors simultaneously and/or receptors may receive flicker from 2 or more WTGs simultaneously.

The calculation of the total expected values for a given receptor assumes a weighted average directional reduction for all WTGs contributing to shadow flicker within the same day. In the case where shadow flicker from different WTGs is not concurrent within the day, the total expected time at a given receptor may deviate marginally from the individual flicker time caused by each turbine separately.

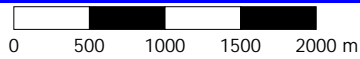
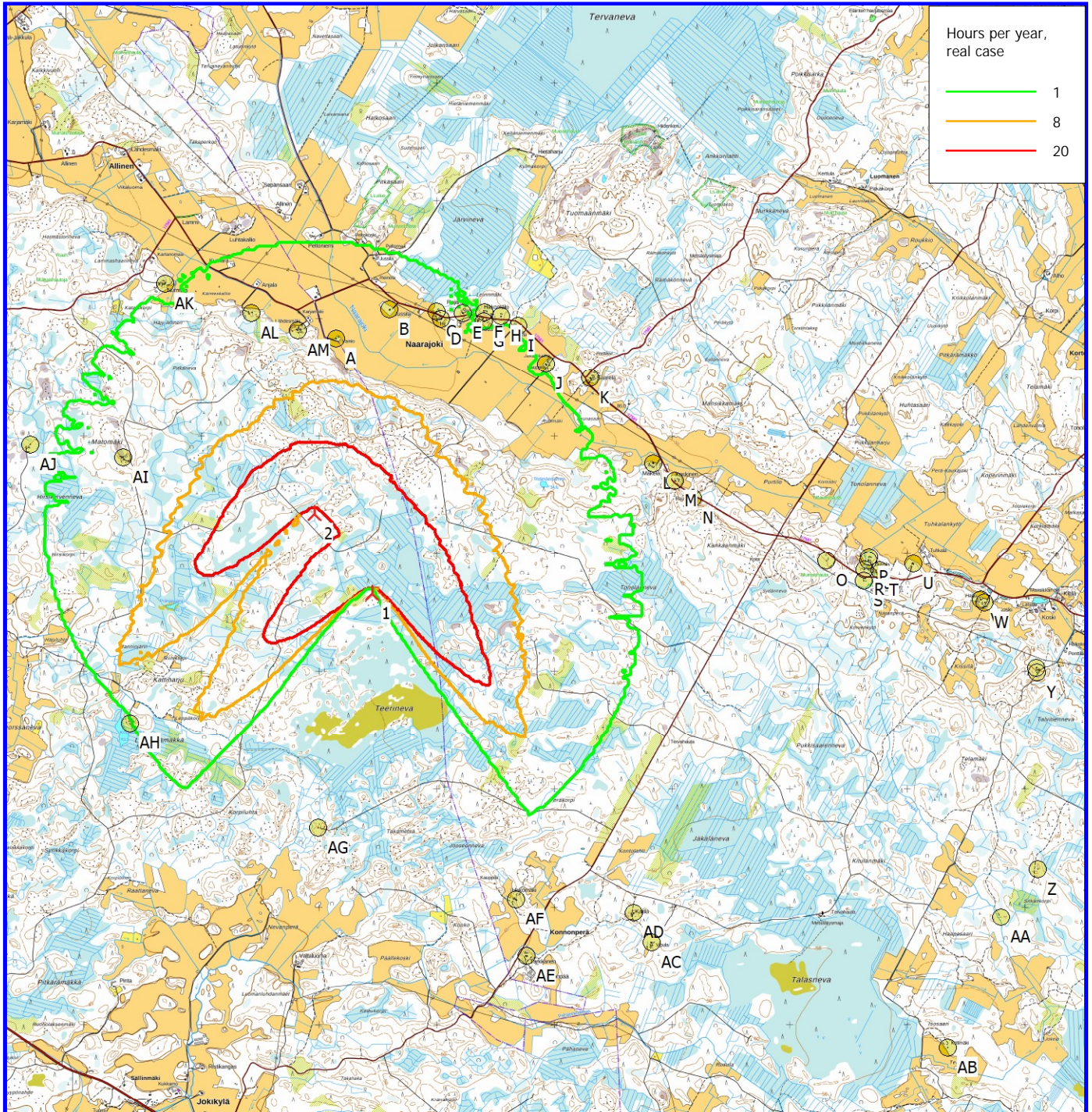


Project:  
20220502 Kattiharju extension

Licensed user:  
PROKON Regenerative Energien eG  
Kirchhoffstraße 3  
DE-25524 Itzehoe  
+49 4821 6855 100  
Kristiina Isohella / k.isoehella@prokon.net  
Calculated:  
30/01/2024 12.40/3.6.361

### SHADOW - Map

Calculation: 2 x Generik 200-159 rev04



Map: Peruskartta 5/2023 , Print scale 1:50 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 257 460,0 North: 6 984 562,7

▲ New WTG      📍 Shadow receptor

Flicker map level: Height Contours: CONTOURLINE\_20220502 Kattiharju extension\_1.wpo (2)

Time step: 4 minutes. Day step: 14 days. Map resolution: 30 m. Visibility resolution: 15 m. Eye height: 1,5 m



Project:

20220502 Kattiharju extension

Licensed user:

PROKON Regenerative Energien eG  
Kirchhoffstraße 3  
DE-25524 Itzehoe  
+49 4821 6855 100  
Kristiina Isohella / k.isohella@prokon.net  
Calculated:  
30/01/2024 9.45/3.6.361

## SHADOW - Main Result

Calculation: 14 x Nordex N163 Kattiharju 2

### Assumptions for shadow calculations

Maximum distance for influence  
Calculate only when more than 20 % of sun is covered by the blade  
Please look in WTG table

Minimum sun height over horizon for influence 3 °  
Day step for calculation 1 days  
Time step for calculation 1 minutes

Sunshine probability S (Average daily sunshine hours) []  
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
1,00 2,82 4,23 6,60 8,77 9,10 8,87 6,81 4,67 2,52 1,17 0,58

Operational hours are calculated from WTGs in calculation and wind distribution:  
MERRA-2\_N63,00\_E021,875

Operational time  
N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
749 665 443 381 493 730 1048 1340 814 670 549 537 8418  
Idle start wind speed: Cut in wind speed from power curve

A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:  
Height contours used: Height Contours: CONTOURLINE\_20220502 Kattiharju extension  
Receptor grid resolution: 1,0 m

All coordinates are in  
Finish TM ETRS-TM35FIN-ETRS89

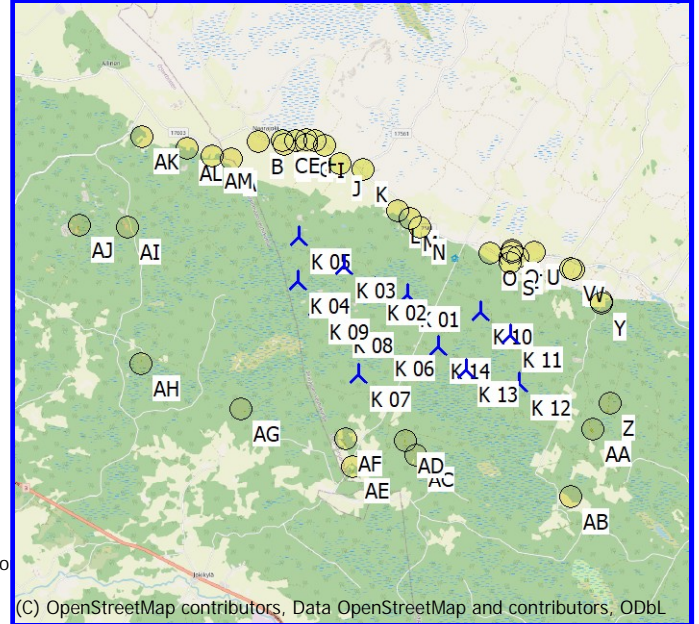
### WTGs

	East	North	Z	Row data/Description	WTG type			Shadow data				
					Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Calculation distance [m]	RPM [RPM]
K 01	258 892,0	6 984 359,0	47,0	NORDEX N163/6.X-6800 6800 163,0 !-! h... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0
K 02	258 361,0	6 984 512,0	53,0	NORDEX N163/6.X-6800 6800 163,0 !-! h... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0
K 03	257 878,0	6 984 922,0	50,3	NORDEX N163/6.X-6800 6800 163,0 !-! h... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0
K 04	257 087,0	6 984 720,0	52,0	NORDEX N163/6.X-6800 6800 163,0 !-! h... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0
K 05	257 163,0	6 985 462,0	51,2	NORDEX N163/6.X-6800 6800 163,0 !-! h... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0
K 06	258 414,0	6 983 575,0	52,5	NORDEX N163/6.X-6800 6800 163,0 !-! h... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0
K 07	257 971,0	6 983 115,0	54,9	NORDEX N163/6.X-6800 6800 163,0 !-! h... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0
K 08	257 766,0	6 984 007,5	53,5	NORDEX N163/6.X-6800 6800 163,0 !-! h... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0
K 09	257 382,0	6 984 262,0	52,0	NORDEX N163/6.X-6800 6800 163,0 !-! h... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0
K 10	260 067,0	6 984 002,0	51,9	NORDEX N163/6.X-6800 6800 163,0 !-! h... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0
K 11	260 550,0	6 983 585,0	47,0	NORDEX N163/6.X-6800 6800 163,0 !-! h... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0
K 12	260 625,0	6 982 771,0	49,5	NORDEX N163/6.X-6800 6800 163,0 !-! h... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0
K 13	259 770,0	6 983 060,0	52,8	NORDEX N163/6.X-6800 6800 163,0 !-! h... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0
K 14	259 329,0	6 983 480,0	54,5	NORDEX N163/6.X-6800 6800 163,0 !-! h... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0

### Shadow receptor-Input

No.	East	North	Z	Width	Height	Elevation	Slope of	Direction mode	Eye height
			[m]	[m]	[m]	a.g.l. [m]	window [°]		(ZVI) a.g.l. [m]
A	256 144,0	6 986 832,0	25,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
B	256 601,0	6 987 078,0	25,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
C	257 002,0	6 987 064,0	26,3	5,0	5,0	2,0	90,0	"Green house mode"	7,0
D	257 041,8	6 986 999,5	27,5	5,0	5,0	2,0	90,0	"Green house mode"	7,0
E	257 223,0	6 987 049,0	27,5	5,0	5,0	2,0	90,0	"Green house mode"	7,0
F	257 407,0	6 987 052,0	30,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
G	257 405,0	6 986 981,0	28,2	5,0	5,0	2,0	90,0	"Green house mode"	7,0
H	257 547,0	6 987 020,0	30,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
I	257 695,0	6 986 937,0	27,5	5,0	5,0	2,0	90,0	"Green house mode"	7,0
J	257 931,0	6 986 612,0	27,5	5,0	5,0	2,0	90,0	"Green house mode"	7,0
K	258 304,0	6 986 491,0	29,8	5,0	5,0	2,0	90,0	"Green house mode"	7,0
L	258 840,0	6 985 771,0	30,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
M	259 027,0	6 985 623,0	32,1	5,0	5,0	2,0	90,0	"Green house mode"	7,0

To be continued on next page...



Project:

20220502 Kattiharju extension

Licensed user:

PROKON Regenerative Energien eG  
 Kirchhoffstraße 3  
 DE-25524 Itzehoe  
 +49 4821 6855 100  
 Kristiina Isohella / k.isohella@prokon.net  
 Calculated:  
 30/01/2024 9.45/3.6.361

## SHADOW - Main Result

Calculation: 14 x Nordex N163 Kattiharju 2

...continued from previous page

No.	East	North	Z	Width	Height	Elevation a.g.l.	Slope of window	Direction mode	Eye height (ZVI) a.g.l.
			[m]	[m]	[m]	[m]	[°]		[m]
N	259 178,0	6 985 472,0	37,2	5,0	5,0	2,0	90,0	"Green house mode"	7,0
O	260 316,0	6 984 939,0	44,6	5,0	5,0	2,0	90,0	"Green house mode"	7,0
P	260 677,0	6 984 970,0	33,3	5,0	5,0	2,0	90,0	"Green house mode"	7,0
Q	260 673,0	6 984 939,0	34,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
R	260 636,0	6 984 866,0	34,8	5,0	5,0	2,0	90,0	"Green house mode"	7,0
S	260 630,0	6 984 769,0	35,9	5,0	5,0	2,0	90,0	"Green house mode"	7,0
T	260 766,0	6 984 856,0	35,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
U	261 049,0	6 984 913,0	35,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
V	261 624,0	6 984 609,0	37,2	5,0	5,0	2,0	90,0	"Green house mode"	7,0
W	261 660,0	6 984 585,0	36,9	5,0	5,0	2,0	90,0	"Green house mode"	7,0
X	262 099,0	6 984 032,0	39,6	5,0	5,0	2,0	90,0	"Green house mode"	7,0
Y	262 104,0	6 983 991,0	41,3	5,0	5,0	2,0	90,0	"Green house mode"	7,0
Z	262 110,0	6 982 324,0	50,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AA	261 796,0	6 981 916,0	47,5	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AB	261 344,0	6 980 808,0	48,3	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AC	258 828,0	6 981 696,0	50,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AD	258 674,0	6 981 951,0	52,2	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AE	257 766,0	6 981 583,0	50,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AF	257 676,0	6 982 065,0	49,8	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AG	255 996,0	6 982 675,0	45,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AH	254 396,7	6 983 556,8	46,7	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AI	254 341,0	6 985 820,4	55,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AJ	253 549,6	6 985 926,4	45,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AK	254 694,4	6 987 295,9	28,5	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AL	255 429,2	6 987 046,3	30,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AM	255 820,0	6 986 903,4	28,1	5,0	5,0	2,0	90,0	"Green house mode"	7,0

## Calculation Results

Shadow receptor

Shadow, expected values

No. Shadow hours

per year

[h/year]

A	1:44
B	1:44
C	2:33
D	2:43
E	2:44
F	2:41
G	2:50
H	2:38
I	2:16
J	5:07
K	4:46
L	10:55
M	9:36
N	11:29
O	12:04
P	7:18
Q	7:39
R	8:42
S	11:28
T	8:06
U	5:38
V	3:52
W	3:44
X	1:38
Y	1:39
Z	2:29
AA	6:07
AB	0:00
AC	0:00
AD	2:00

To be continued on next page...

Project:

20220502 Kattiharju extension

Licensed user:

PROKON Regenerative Energien eG  
Kirchhoffstraße 3  
DE-25524 Itzehoe  
+49 4821 6855 100  
Kristiina Isohella / k.isohella@prokon.net  
Calculated:  
30/01/2024 9.45/3.6.361

## SHADOW - Main Result

Calculation: 14 x Nordex N163 Kattiharju 2

...continued from previous page  
Shadow, expected values

No.	Shadow hours per year [h/year]
AE	0:00
AF	0:00
AG	0:00
AH	0:00
AI	0:00
AJ	0:00
AK	0:00
AL	0:00
AM	0:00

Total amount of flickering on the shadow receptors caused by each WTG

No.	Name	Expected [h/year]
K 01	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (6)	14:26
K 02	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (5)	9:11
K 03	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (4)	12:53
K 04	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (2)	0:00
K 05	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (1)	23:30
K 06	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (8)	0:00
K 07	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (67)	0:00
K 08	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (7)	0:00
K 09	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (3)	0:00
K 10	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (63)	21:04
K 11	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (64)	18:47
K 12	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (66)	8:36
K 13	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (65)	2:00
K 14	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (62)	1:26

Total times in Receptor wise and WTG wise tables can differ, as a WTG can lead to flicker at 2 or more receptors simultaneously and/or receptors may receive flicker from 2 or more WTGs simultaneously.

The calculation of the total expected values for a given receptor assumes a weighted average directional reduction for all WTGs contributing to shadow flicker within the same day. In the case where shadow flicker from different WTGs is not concurrent within the day, the total expected time at a given receptor may deviate marginally from the individual flicker time caused by each turbine separately.

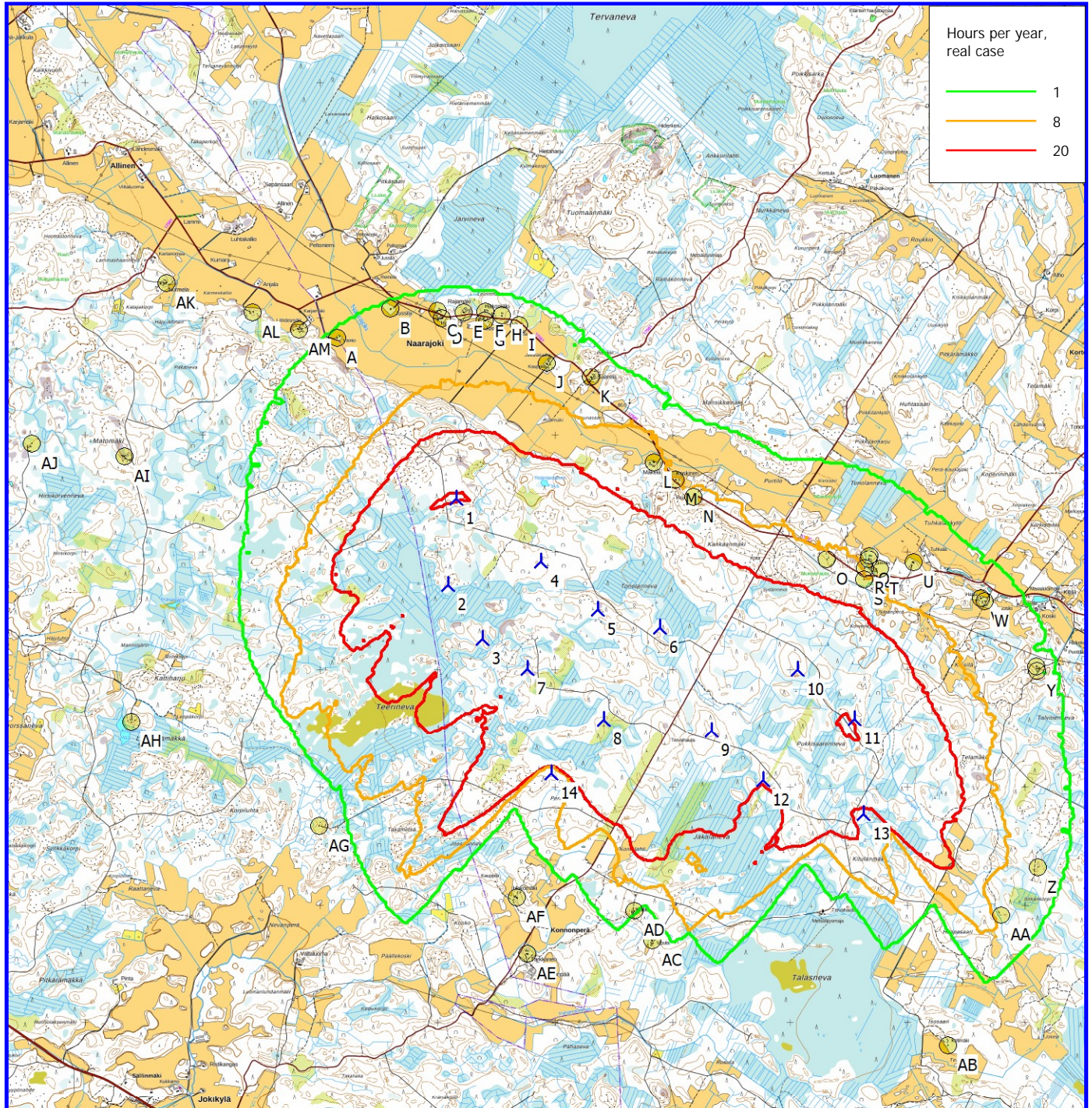


Project:  
20220502 Kattiharju extension

Licensed user:  
PROKON Regenerative Energien eG  
Kirchhoffstraße 3  
DE-25524 Itzehoe  
+49 4821 6855 100  
Kristiina Isohella / k.isohella@prokon.net  
Calculated:  
30/01/2024 9.45/3.6.361

### SHADOW - Map

Calculation: 14 x Nordex N163 Kattiharju 2



0 500 1000 1500 2000 m

Map: Peruskartta 5/2023 , Print scale 1:50 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 257 460,0 North: 6 984 562,7

▲ New WTG      📍 Shadow receptor

Flicker map level: Height Contours: CONTOURLINE\_20220502 Kattiharju extension\_1.wpo (2)

Time step: 4 minutes. Day step: 14 days. Map resolution: 30 m. Visibility resolution: 15 m. Eye height: 1,5 m



Project:

20220502 Kattiharju extension

Licensed user:

PROKON Regenerative Energien eG  
 Kirchhoffstraße 3  
 DE-25524 Itzehoe  
 +49 4821 6855 100  
 Kristiina Isohella / k.isohella@prokon.net  
 Calculated:  
 30/01/2024 10.42/3.6.361

## SHADOW - Main Result

Calculation: 2 x Generic 200-159 rev04 + Kattiharju receptors 2

### Assumptions for shadow calculations

Maximum distance for influence

Calculate only when more than 20 % of sun is covered by the blade

Please look in WTG table

Minimum sun height over horizon for influence 3 °

Day step for calculation 1 days

Time step for calculation 1 minutes

Sunshine probability S (Average daily sunshine hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1,00	2,82	4,23	6,60	8,77	9,10	8,87	6,81	4,67	2,52	1,17	0,58

Operational hours are calculated from WTGs in calculation and wind distribution:  
 MERRA-2\_N63,00\_E021,875

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
743	660	439	378	490	724	1040	1330	807	665	545	533	8355

Idle start wind speed: Cut in wind speed from power curve

A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:

Height contours used: Height Contours: CONTOURLINE\_20220502 Kattiharju extension  
 Receptor grid resolution: 1,0 m

All coordinates are in

Finish TM ETRS-TM35FIN-ETRS89

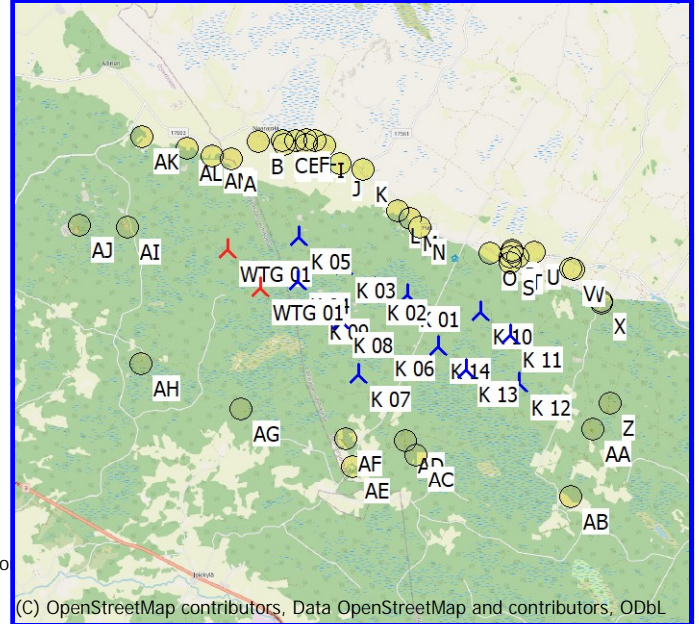
### WTGs

	East	North	Z	Row data/Description	WTG type			Shadow data				
					Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Calculation distance [m]	RPM [RPM]
K 01	258 892,0	6 984 359,0	47,0	NORDEX N163/6.X-6800 6800 163.... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0
K 02	258 361,0	6 984 512,0	53,0	NORDEX N163/6.X-6800 6800 163.... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0
K 03	257 878,0	6 984 922,0	50,3	NORDEX N163/6.X-6800 6800 163.... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0
K 04	257 087,0	6 984 720,0	52,0	NORDEX N163/6.X-6800 6800 163.... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0
K 05	257 163,0	6 985 462,0	51,2	NORDEX N163/6.X-6800 6800 163.... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0
K 06	258 414,0	6 983 575,0	52,5	NORDEX N163/6.X-6800 6800 163.... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0
K 07	257 971,0	6 983 115,0	54,9	NORDEX N163/6.X-6800 6800 163.... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0
K 08	257 766,0	6 984 007,5	53,5	NORDEX N163/6.X-6800 6800 163.... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0
K 09	257 382,0	6 984 262,0	52,0	NORDEX N163/6.X-6800 6800 163.... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0
K 10	260 067,0	6 984 002,0	51,9	NORDEX N163/6.X-6800 6800 163.... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0
K 11	260 550,0	6 983 585,0	47,0	NORDEX N163/6.X-6800 6800 163.... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0
K 12	260 625,0	6 982 771,0	49,5	NORDEX N163/6.X-6800 6800 163.... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0
K 13	259 770,0	6 983 060,0	52,8	NORDEX N163/6.X-6800 6800 163.... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0
K 14	259 329,0	6 983 480,0	54,5	NORDEX N163/6.X-6800 6800 163.... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0
WTG 01	255 965,3	6 985 341,4	50,6	Generic Generic 200-200 10000 20... Yes	Yes	Generic	Generic 200-200-10 000	10 000	200,0	159,0	2 315	8,0
WTG 01	256 455,1	6 984 657,8	50,0	Generic Generic 200-200 10000 20... Yes	Yes	Generic	Generic 200-200-10 000	10 000	200,0	159,0	2 315	8,0

### Shadow receptor-Input

No.	East	North	Z	Width	Height	Elevation a.g.l.	Slope of window	Direction mode	Eye height (ZVI) a.g.l.
	[m]	[m]	[m]	[m]	[m]	[m]	[°]		[m]
A	256 144,0	6 986 832,0	25,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
B	256 601,0	6 987 078,0	25,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
C	257 002,0	6 987 064,0	26,3	5,0	5,0	2,0	90,0	"Green house mode"	7,0
D	257 041,8	6 986 999,5	27,5	5,0	5,0	2,0	90,0	"Green house mode"	7,0
E	257 223,0	6 987 049,0	27,5	5,0	5,0	2,0	90,0	"Green house mode"	7,0
F	257 407,0	6 987 052,0	30,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
G	257 405,0	6 986 981,0	28,2	5,0	5,0	2,0	90,0	"Green house mode"	7,0
H	257 547,0	6 987 020,0	30,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
I	257 695,0	6 986 937,0	27,5	5,0	5,0	2,0	90,0	"Green house mode"	7,0
J	257 931,0	6 986 612,0	27,5	5,0	5,0	2,0	90,0	"Green house mode"	7,0
K	258 304,0	6 986 491,0	29,8	5,0	5,0	2,0	90,0	"Green house mode"	7,0

To be continued on next page...



Scale 1:125 000  
 ▲ New WTG      ● Shadow receptor



Project:

20220502 Kattiharju extension

Licensed user:

PROKON Regenerative Energien eG  
 Kirchhoffstraße 3  
 DE-25524 Itzehoe  
 +49 4821 6855 100  
 Kristiina Isohella / k.isohella@prokon.net  
 Calculated:  
 30/01/2024 10.42/3.6.361

## SHADOW - Main Result

Calculation: 2 x Generic 200-159 rev04 + Kattiharju receptors 2

...continued from previous page

No.	East	North	Z	Width	Height	Elevation a.g.l.	Slope of window	Direction mode	Eye height (ZVI) a.g.l.
			[m]	[m]	[m]	[m]	[°]		[m]
L	258 840,0	6 985 771,0	30,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
M	259 027,0	6 985 623,0	32,1	5,0	5,0	2,0	90,0	"Green house mode"	7,0
N	259 178,0	6 985 472,0	37,2	5,0	5,0	2,0	90,0	"Green house mode"	7,0
O	260 316,0	6 984 939,0	44,6	5,0	5,0	2,0	90,0	"Green house mode"	7,0
P	260 677,0	6 984 970,0	33,3	5,0	5,0	2,0	90,0	"Green house mode"	7,0
Q	260 673,0	6 984 939,0	34,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
R	260 636,0	6 984 866,0	34,8	5,0	5,0	2,0	90,0	"Green house mode"	7,0
S	260 630,0	6 984 769,0	35,9	5,0	5,0	2,0	90,0	"Green house mode"	7,0
T	260 766,0	6 984 856,0	35,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
U	261 049,0	6 984 913,0	35,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
V	261 624,0	6 984 609,0	37,2	5,0	5,0	2,0	90,0	"Green house mode"	7,0
W	261 660,0	6 984 585,0	36,9	5,0	5,0	2,0	90,0	"Green house mode"	7,0
X	262 099,0	6 984 032,0	39,6	5,0	5,0	2,0	90,0	"Green house mode"	7,0
Y	262 104,0	6 983 991,0	41,3	5,0	5,0	2,0	90,0	"Green house mode"	7,0
Z	262 110,0	6 982 324,0	50,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AA	261 796,0	6 981 916,0	47,5	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AB	261 344,0	6 980 808,0	48,3	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AC	258 828,0	6 981 696,0	50,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AD	258 674,0	6 981 951,0	52,2	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AE	257 766,0	6 981 583,0	50,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AF	257 676,0	6 982 065,0	49,8	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AG	255 996,0	6 982 675,0	45,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AH	254 396,7	6 983 556,8	46,7	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AI	254 341,0	6 985 820,4	55,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AJ	253 549,6	6 985 926,4	45,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AK	254 694,4	6 987 295,9	28,5	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AL	255 429,2	6 987 046,3	30,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AM	255 820,0	6 986 903,4	28,1	5,0	5,0	2,0	90,0	"Green house mode"	7,0

## Calculation Results

Shadow receptor

Shadow, expected values

No. Shadow hours

per year  
[h/year]

A	7:54
B	4:07
C	4:12
D	4:25
E	4:08
F	3:52
G	4:10
H	3:46
I	2:15
J	5:05
K	4:44
L	10:50
M	9:31
N	11:24
O	11:59
P	7:15
Q	7:36
R	8:38
S	11:23
T	8:02
U	5:35
V	3:50
W	3:42
X	1:37
Y	1:38
Z	2:28
AA	6:04
AB	0:00

To be continued on next page...

Project:

20220502 Kattiharju extension

Licensed user:

PROKON Regenerative Energien eG  
Kirchhoffstraße 3  
DE-25524 Itzehoe  
+49 4821 6855 100  
Kristiina Isohella / k.isohella@prokon.net  
Calculated:  
30/01/2024 10.42/3.6.361

## SHADOW - Main Result

Calculation: 2 x Generic 200-159 rev04 + Kattiharju receptors 2

...continued from previous page  
Shadow, expected values

No.	Shadow hours per year [h/year]
AC	0:00
AD	1:59
AE	0:00
AF	0:00
AG	0:00
AH	0:00
AI	2:03
AJ	0:00
AK	0:00
AL	2:17
AM	3:44

Total amount of flickering on the shadow receptors caused by each WTG

No.	Name	Expected [h/year]
K 01	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (6)	14:20
K 02	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (5)	9:07
K 03	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (4)	12:48
K 04	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (2)	0:00
K 05	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (1)	23:19
K 06	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (8)	0:00
K 07	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (67)	0:00
K 08	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (7)	0:00
K 09	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (3)	0:00
K 10	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (63)	20:54
K 11	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (64)	18:38
K 12	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (66)	8:32
K 13	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (65)	1:59
K 14	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (62)	1:25
WTG 01	Generic Generic 200-200 10000 200.0 !-! hub: 159,0 m (TOT: 259,0 m) (76)	19:43
WTG 01	Generic Generic 200-200 10000 200.0 !-! hub: 159,0 m (TOT: 259,0 m) (75)	2:00

Total times in Receptor wise and WTG wise tables can differ, as a WTG can lead to flicker at 2 or more receptors simultaneously and/or receptors may receive flicker from 2 or more WTGs simultaneously.

The calculation of the total expected values for a given receptor assumes a weighted average directional reduction for all WTGs contributing to shadow flicker within the same day. In the case where shadow flicker from different WTGs is not concurrent within the day, the total expected time at a given receptor may deviate marginally from the individual flicker time caused by each turbine separately.

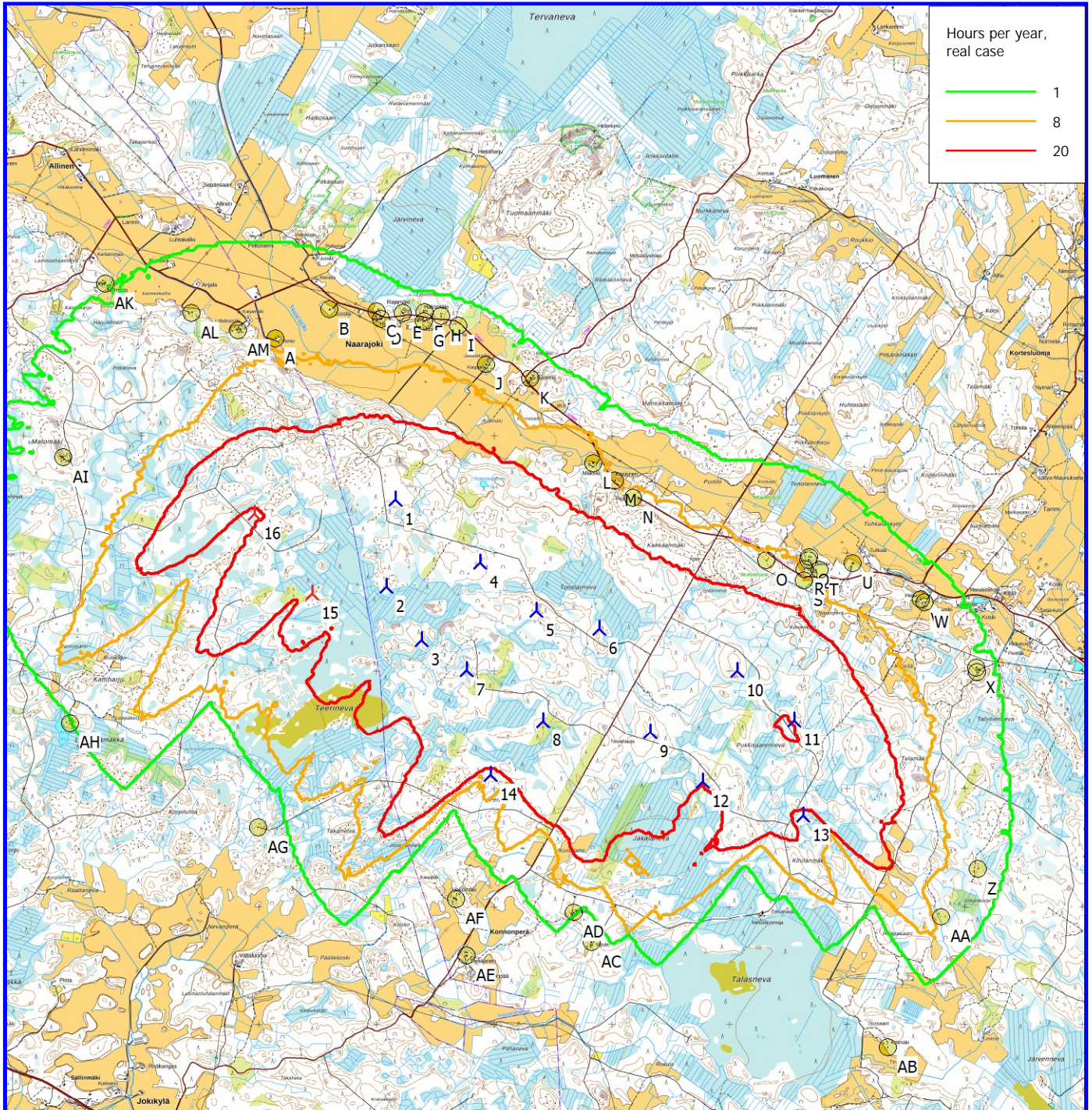


Project:  
20220502 Kattiharju extension

Licensed user:  
PROKON Regenerative Energien eG  
Kirchhoffstraße 3  
DE-25524 Itzehoe  
+49 4821 6855 100  
Kristiina Isohella / k.isohella@prokon.net  
Calculated:  
30/01/2024 10.42/3.6.361

### SHADOW - Map

Calculation: 2 x Generic 200-159 rev04 + Kattiharju receptors 2



0 500 1000 1500 2000 m

Map: Peruskartta 5/2023 , Print scale 1:50 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 257 970,0 North: 6 984 562,7

▲ New WTG      📍 Shadow receptor

Flicker map level: Height Contours: CONTOURLINE\_20220502 Kattiharju extension\_1.wpo (2)

Time step: 4 minutes. Day step: 14 days. Map resolution: 30 m. Visibility resolution: 15 m. Eye height: 1,5 m



Project:  
20220502 Kattiharju extension

Licensed user:  
PROKON Regenerative Energien eG  
Kirchhoffstraße 3  
DE-25524 Itzehoe  
+49 4821 6855 100  
Kristiina Isohella / k.isoehella@prokon.net  
Calculated:  
30/01/2024 13.52/3.6.361

## SHADOW - Main Result

Calculation: 2 x Generik 200-159 rev04 + Forest

### Assumptions for shadow calculations

Maximum distance for influence  
Calculate only when more than 20 % of sun is covered by the blade  
Please look in WTG table

Minimum sun height over horizon for influence 3 °  
Day step for calculation 1 days  
Time step for calculation 1 minutes

Sunshine probability S (Average daily sunshine hours) []  
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
1,00 2,82 4,23 6,60 8,77 9,10 8,87 6,81 4,67 2,52 1,17 0,58

Operational hours are calculated from WTGs in calculation and wind distribution:  
EMD-WRF Europe+ (ERA5) [SAMPLE]\_N62,897697\_E022,215485 (29)

Operational time  
N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
667 307 312 351 501 982 940 1 370 1 108 781 544 495 8 359  
Idle start wind speed: Cut in wind speed from power curve

A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:  
Height contours used: Height Contours: CONTOURLINE\_20220502 Kattiharju extension  
Area object(s) used in calculation:  
Area object (Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REGIONS\_2  
Receptor grid resolution: 1,0 m

All coordinates are in  
Finish TM ETRS-TM35FIN-ETRS89

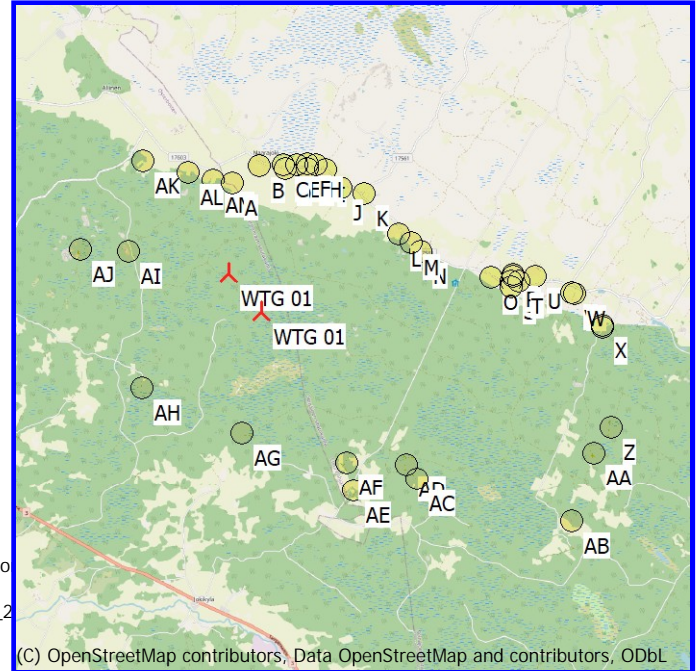
### WTGs

	East	North	Z	Row data/Description	WTG type			Shadow data				
					Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Calculation distance [m]	RPM
WTG 01	255 965,3	6 985 341,4	50,6	Generic Generic 200-200 10000 20...	Yes	Generic	Generic 200-200-10 000	10 000	200,0	159,0	2 315	8,0
WTG 01	256 455,1	6 984 657,8	50,0	Generic Generic 200-200 10000 20...	Yes	Generic	Generic 200-200-10 000	10 000	200,0	159,0	2 315	8,0

### Shadow receptor-Input

No.	East	North	Z	Width	Height	Elevation	Slope of	Direction mode	Eye height
			[m]	[m]	[m]	a.g.l.	window		(ZVI) a.g.l.
			[m]	[m]	[m]	[m]	[°]		[m]
A	256 144,0	6 986 832,0	25,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
B	256 601,0	6 987 078,0	25,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
C	257 002,0	6 987 064,0	26,3	5,0	5,0	2,0	90,0	"Green house mode"	7,0
D	257 041,8	6 986 999,5	27,5	5,0	5,0	2,0	90,0	"Green house mode"	7,0
E	257 223,0	6 987 049,0	27,5	5,0	5,0	2,0	90,0	"Green house mode"	7,0
F	257 407,0	6 987 052,0	30,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
G	257 405,0	6 986 981,0	28,2	5,0	5,0	2,0	90,0	"Green house mode"	7,0
H	257 547,0	6 987 020,0	30,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
I	257 695,0	6 986 937,0	27,5	5,0	5,0	2,0	90,0	"Green house mode"	7,0
J	257 931,0	6 986 612,0	27,5	5,0	5,0	2,0	90,0	"Green house mode"	7,0
K	258 304,0	6 986 491,0	29,8	5,0	5,0	2,0	90,0	"Green house mode"	7,0
L	258 840,0	6 985 771,0	30,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
M	259 027,0	6 985 623,0	32,1	5,0	5,0	2,0	90,0	"Green house mode"	7,0
N	259 178,0	6 985 472,0	37,2	5,0	5,0	2,0	90,0	"Green house mode"	7,0
O	260 316,0	6 984 939,0	44,6	5,0	5,0	2,0	90,0	"Green house mode"	7,0
P	260 677,0	6 984 970,0	33,3	5,0	5,0	2,0	90,0	"Green house mode"	7,0
Q	260 673,0	6 984 939,0	34,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
R	260 636,0	6 984 866,0	34,8	5,0	5,0	2,0	90,0	"Green house mode"	7,0
S	260 630,0	6 984 769,0	35,9	5,0	5,0	2,0	90,0	"Green house mode"	7,0
T	260 766,0	6 984 856,0	35,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
U	261 049,0	6 984 913,0	35,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
V	261 624,0	6 984 609,0	37,2	5,0	5,0	2,0	90,0	"Green house mode"	7,0

To be continued on next page...



(C) OpenStreetMap contributors, Data OpenStreetMap and contributors, ODbL  
Scale 1:125 000  
New WTG  
Shadow receptor



Project:

20220502 Kattiharju extension

Licensed user:

PROKON Regenerative Energien eG

Kirchhoffstraße 3

DE-25524 Itzehoe

+49 4821 6855 100

Kristiina Isohella / k.isohella@prokon.net

Calculated:

30/01/2024 13.52/3.6.361

## SHADOW - Main Result

Calculation: 2 x Generik 200-159 rev04 + Forest

...continued from previous page

No.	East	North	Z	Width	Height	Elevation a.g.l.	Slope of window	Direction mode	Eye height (ZVI) a.g.l.
			[m]	[m]	[m]	[m]	[°]		[m]
W	261 660,0	6 984 585,0	36,9	5,0	5,0	2,0	90,0	"Green house mode"	7,0
X	262 099,0	6 984 032,0	39,6	5,0	5,0	2,0	90,0	"Green house mode"	7,0
Y	262 104,0	6 983 991,0	41,3	5,0	5,0	2,0	90,0	"Green house mode"	7,0
Z	262 110,0	6 982 324,0	50,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AA	261 796,0	6 981 916,0	47,5	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AB	261 344,0	6 980 808,0	48,3	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AC	258 828,0	6 981 696,0	50,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AD	258 674,0	6 981 951,0	52,2	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AE	257 766,0	6 981 583,0	50,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AF	257 676,0	6 982 065,0	49,8	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AG	255 996,0	6 982 675,0	45,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AH	254 396,7	6 983 556,8	46,7	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AI	254 341,0	6 985 820,4	55,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AJ	253 549,6	6 985 926,4	45,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AK	254 694,4	6 987 295,9	28,5	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AL	255 429,2	6 987 046,3	30,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AM	255 820,0	6 986 903,4	28,1	5,0	5,0	2,0	90,0	"Green house mode"	7,0

## Calculation Results

Shadow receptor

Shadow, expected values

No. Shadow hours

per year

[h/year]

A	5:57
B	2:20
C	1:37
D	1:40
E	1:22
F	1:10
G	1:17
H	1:06
I	0:00
J	0:00
K	0:00
L	0:00
M	0:00
N	0:00
O	0:00
P	0:00
Q	0:00
R	0:00
S	0:00
T	0:00
U	0:00
V	0:00
W	0:00
X	0:00
Y	0:00
Z	0:00
AA	0:00
AB	0:00
AC	0:00
AD	0:00
AE	0:00
AF	0:00
AG	0:00
AH	0:00
AI	0:00
AJ	0:00
AK	0:00
AL	0:00
AM	3:37

Project:

20220502 Kattiharju extension

Licensed user:

PROKON Regenerative Energien eG  
Kirchhoffstraße 3  
DE-25524 Itzehoe  
+49 4821 6855 100  
Kristiina Isohella / k.isohella@prokon.net  
Calculated:  
30/01/2024 13.52/3.6.361

## SHADOW - Main Result

Calculation: 2 x Generik 200-159 rev04 + Forest

Total amount of flickering on the shadow receptors caused by each WTG

No.	Name	Expected [h/year]
WTG 01	Generic Generic 200-200 10000 200.0 !-! hub: 159,0 m (TOT: 259,0 m) (76)	14:56
WTG 01	Generic Generic 200-200 10000 200.0 !-! hub: 159,0 m (TOT: 259,0 m) (75)	1:56

Total times in Receptor wise and WTG wise tables can differ, as a WTG can lead to flicker at 2 or more receptors simultaneously and/or receptors may receive flicker from 2 or more WTGs simultaneously.

The calculation of the total expected values for a given receptor assumes a weighted average directional reduction for all WTGs contributing to shadow flicker within the same day. In the case where shadow flicker from different WTGs is not concurrent within the day, the total expected time at a given receptor may deviate marginally from the individual flicker time caused by each turbine separately.

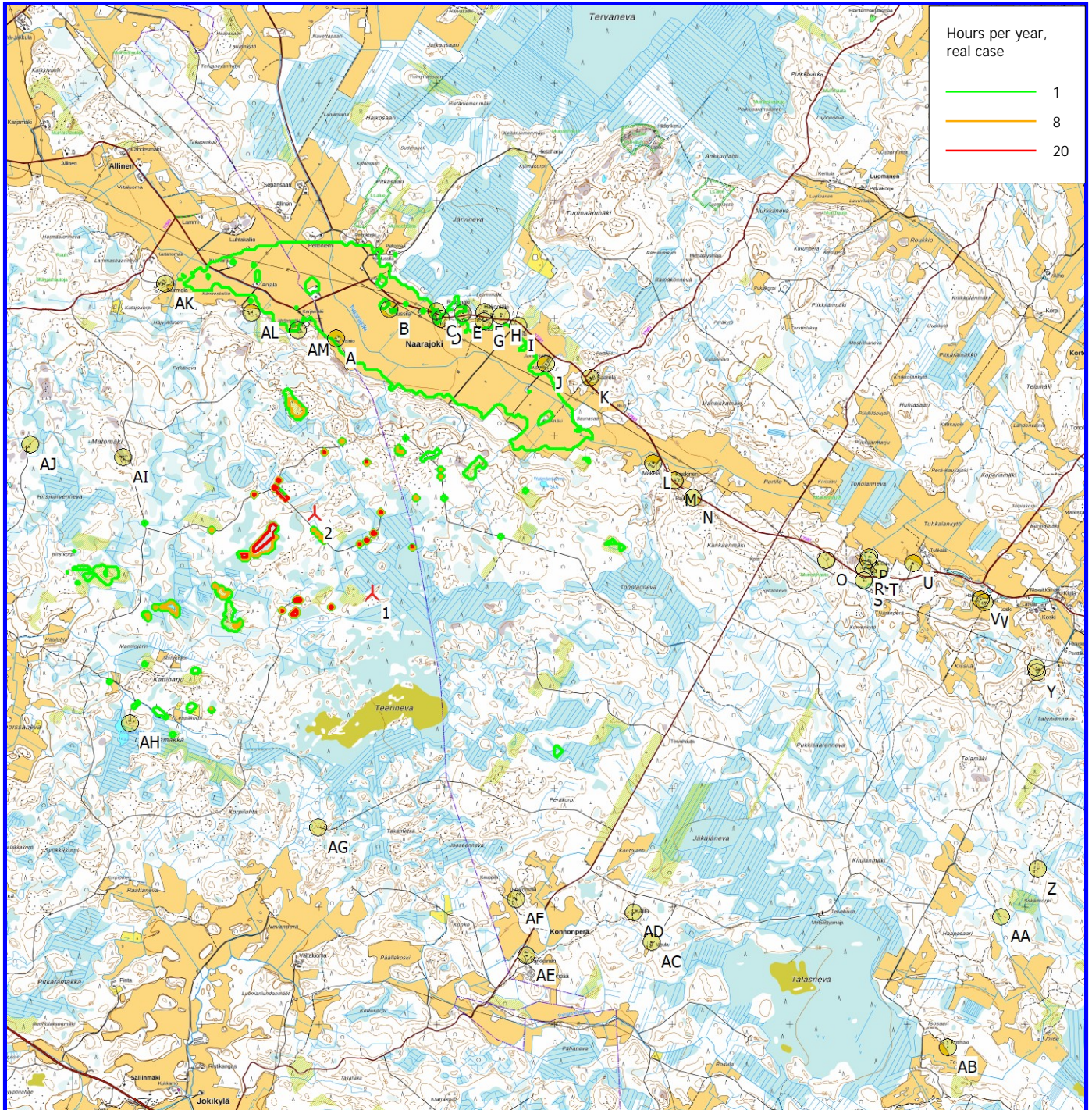


Project:  
20220502 Kattiharju extension

Licensed user:  
PROKON Regenerative Energien eG  
Kirchhoffstraße 3  
DE-25524 Itzehoe  
+49 4821 6855 100  
Kristiina Isohella / k.isohella@prokon.net  
Calculated:  
30/01/2024 13.52/3.6.361

### SHADOW - Map

Calculation: 2 x Generik 200-159 rev04 + Forest



0 500 1000 1500 2000 m

Map: Peruskartta 5/2023 , Print scale 1:50 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 257 460,0 North: 6 984 562,7

🚧 New WTG      🌑 Shadow receptor

Flicker map level: Height Contours: CONTOURLINE\_20220502 Kattiharju extension\_1.wpo (2)

Time step: 4 minutes. Day step: 14 days. Map resolution: 30 m. Visibility resolution: 15 m. Eye height: 1,5 m



Project:

20220502 Kattiharju extension

Licensed user:

PROKON Regenerative Energien eG  
Kirchhoffstraße 3  
DE-25524 Itzehoe  
+49 4821 6855 100  
Kristiina Isohella / k.isoehella@prokon.net  
Calculated:  
30/01/2024 10.32/3.6.361

## SHADOW - Main Result

Calculation: 14 x Nordex N163 Kattiharju receptor 2 +forest

### Assumptions for shadow calculations

Maximum distance for influence  
Calculate only when more than 20 % of sun is covered by the blade  
Please look in WTG table

Minimum sun height over horizon for influence 3 °  
Day step for calculation 1 days  
Time step for calculation 1 minutes

Sunshine probability S (Average daily sunshine hours) []  
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
1,00 2,82 4,23 6,60 8,77 9,10 8,87 6,81 4,67 2,52 1,17 0,58

Operational hours are calculated from WTGs in calculation and wind distribution:  
MERRA-2\_N63,00\_E021,875

Operational time  
N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
749 665 443 381 493 730 1048 1340 814 670 549 537 8418  
Idle start wind speed: Cut in wind speed from power curve

A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:  
Height contours used: Height Contours: CONTOURLINE\_20220502 Kattiharju extension  
Area object(s) used in calculation:  
Area object (Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REGIONS\_2  
Receptor grid resolution: 1,0 m

All coordinates are in  
Finish TM ETRS-TM35FIN-ETRS89

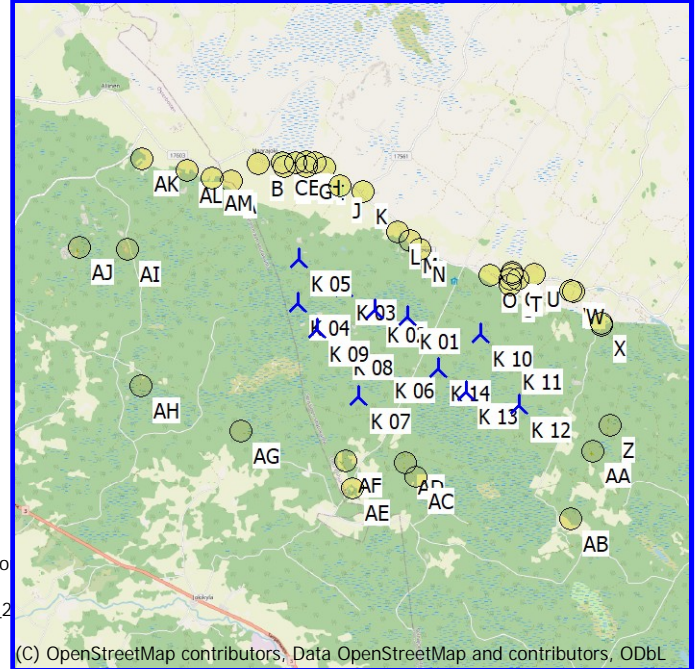
### WTGs

	East	North	Z	Row data/Description	WTG type			Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Shadow data	
					Valid	Manufact.	Type-generator				Calculation distance [m]	RPM
			[m]									
K 01	258 892,0	6 984 359,0	47,0	NORDEX N163/6.X-6800 6800 163,0 !-! h... Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0	
K 02	258 361,0	6 984 512,0	53,0	NORDEX N163/6.X-6800 6800 163,0 !-! h... Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0	
K 03	257 878,0	6 984 922,0	50,3	NORDEX N163/6.X-6800 6800 163,0 !-! h... Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0	
K 04	257 087,0	6 984 720,0	52,0	NORDEX N163/6.X-6800 6800 163,0 !-! h... Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0	
K 05	257 163,0	6 985 462,0	51,2	NORDEX N163/6.X-6800 6800 163,0 !-! h... Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0	
K 06	258 414,0	6 983 575,0	52,5	NORDEX N163/6.X-6800 6800 163,0 !-! h... Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0	
K 07	257 971,0	6 983 115,0	54,9	NORDEX N163/6.X-6800 6800 163,0 !-! h... Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0	
K 08	257 766,0	6 984 007,5	53,5	NORDEX N163/6.X-6800 6800 163,0 !-! h... Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0	
K 09	257 382,0	6 984 262,0	52,0	NORDEX N163/6.X-6800 6800 163,0 !-! h... Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0	
K 10	260 067,0	6 984 002,0	51,9	NORDEX N163/6.X-6800 6800 163,0 !-! h... Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0	
K 11	260 550,0	6 983 585,0	47,0	NORDEX N163/6.X-6800 6800 163,0 !-! h... Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0	
K 12	260 625,0	6 982 771,0	49,5	NORDEX N163/6.X-6800 6800 163,0 !-! h... Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0	
K 13	259 770,0	6 983 060,0	52,8	NORDEX N163/6.X-6800 6800 163,0 !-! h... Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0	
K 14	259 329,0	6 983 480,0	54,5	NORDEX N163/6.X-6800 6800 163,0 !-! h... Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0	

### Shadow receptor-Input

No.	East	North	Z	Width	Height	Elevation a.g.l.	Slope of window	Direction mode	Eye height (ZVI) a.g.l.
			[m]	[m]	[m]	[m]	[°]		[m]
A	256 144,0	6 986 832,0	25,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
B	256 601,0	6 987 078,0	25,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
C	257 002,0	6 987 064,0	26,3	5,0	5,0	2,0	90,0	"Green house mode"	7,0
D	257 041,8	6 986 999,5	27,5	5,0	5,0	2,0	90,0	"Green house mode"	7,0
E	257 223,0	6 987 049,0	27,5	5,0	5,0	2,0	90,0	"Green house mode"	7,0
F	257 407,0	6 987 052,0	30,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
G	257 405,0	6 986 981,0	28,2	5,0	5,0	2,0	90,0	"Green house mode"	7,0
H	257 547,0	6 987 020,0	30,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
I	257 695,0	6 986 937,0	27,5	5,0	5,0	2,0	90,0	"Green house mode"	7,0
J	257 931,0	6 986 612,0	27,5	5,0	5,0	2,0	90,0	"Green house mode"	7,0
K	258 304,0	6 986 491,0	29,8	5,0	5,0	2,0	90,0	"Green house mode"	7,0

To be continued on next page...



Scale 1:125 000  
New WTG Shadow receptor

Project:

20220502 Kattiharju extension

Licensed user:

PROKON Regenerative Energien eG  
 Kirchhoffstraße 3  
 DE-25524 Itzehoe  
 +49 4821 6855 100  
 Kristiina Isohella / k.isohella@prokon.net  
 Calculated:  
 30/01/2024 10.32/3.6.361

## SHADOW - Main Result

Calculation: 14 x Nordex N163 Kattiharju receptor 2 +forest

...continued from previous page

No.	East	North	Z	Width	Height	Elevation a.g.l.	Slope of window	Direction mode	Eye height (ZVI) a.g.l.
	[m]	[m]	[m]	[m]	[m]	[m]	[°]		[m]
L	258 840,0	6 985 771,0	30,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
M	259 027,0	6 985 623,0	32,1	5,0	5,0	2,0	90,0	"Green house mode"	7,0
N	259 178,0	6 985 472,0	37,2	5,0	5,0	2,0	90,0	"Green house mode"	7,0
O	260 316,0	6 984 939,0	44,6	5,0	5,0	2,0	90,0	"Green house mode"	7,0
P	260 677,0	6 984 970,0	33,3	5,0	5,0	2,0	90,0	"Green house mode"	7,0
Q	260 673,0	6 984 939,0	34,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
R	260 636,0	6 984 866,0	34,8	5,0	5,0	2,0	90,0	"Green house mode"	7,0
S	260 630,0	6 984 769,0	35,9	5,0	5,0	2,0	90,0	"Green house mode"	7,0
T	260 766,0	6 984 856,0	35,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
U	261 049,0	6 984 913,0	35,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
V	261 624,0	6 984 609,0	37,2	5,0	5,0	2,0	90,0	"Green house mode"	7,0
W	261 660,0	6 984 585,0	36,9	5,0	5,0	2,0	90,0	"Green house mode"	7,0
X	262 099,0	6 984 032,0	39,6	5,0	5,0	2,0	90,0	"Green house mode"	7,0
Y	262 104,0	6 983 991,0	41,3	5,0	5,0	2,0	90,0	"Green house mode"	7,0
Z	262 110,0	6 982 324,0	50,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AA	261 796,0	6 981 916,0	47,5	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AB	261 344,0	6 980 808,0	48,3	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AC	258 828,0	6 981 696,0	50,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AD	258 674,0	6 981 951,0	52,2	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AE	257 766,0	6 981 583,0	50,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AF	257 676,0	6 982 065,0	49,8	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AG	255 996,0	6 982 675,0	45,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AH	254 396,7	6 983 556,8	46,7	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AI	254 341,0	6 985 820,4	55,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AJ	253 549,6	6 985 926,4	45,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AK	254 694,4	6 987 295,9	28,5	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AL	255 429,2	6 987 046,3	30,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AM	255 820,0	6 986 903,4	28,1	5,0	5,0	2,0	90,0	"Green house mode"	7,0

## Calculation Results

Shadow receptor

Shadow, expected values

No. Shadow hours

per year  
[h/year]

A	1:44
B	1:44
C	2:33
D	2:43
E	0:00
F	2:41
G	2:50
H	0:00
I	2:16
J	5:07
K	4:46
L	10:55
M	6:34
N	7:33
O	0:00
P	7:18
Q	7:39
R	0:00
S	0:00
T	8:06
U	5:38
V	3:52
W	2:14
X	0:00
Y	0:00
Z	0:00
AA	0:00
AB	0:00

To be continued on next page...

Project:

20220502 Kattiharju extension

Licensed user:

PROKON Regenerative Energien eG  
Kirchhoffstraße 3  
DE-25524 Itzehoe  
+49 4821 6855 100  
Kristiina Isohella / k.isohella@prokon.net  
Calculated:  
30/01/2024 10.32/3.6.361

## SHADOW - Main Result

Calculation: 14 x Nordex N163 Kattiharju receptor 2 +forest

...continued from previous page  
Shadow, expected values

No.	Shadow hours per year [h/year]
AC	0:00
AD	0:00
AE	0:00
AF	0:00
AG	0:00
AH	0:00
AI	0:00
AJ	0:00
AK	0:00
AL	0:00
AM	0:00

Total amount of flickering on the shadow receptors caused by each WTG

No.	Name	Expected [h/year]
K 01	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (6)	11:20
K 02	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (5)	6:09
K 03	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (4)	10:37
K 04	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (2)	0:00
K 05	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (1)	18:28
K 06	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (8)	0:00
K 07	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (67)	0:00
K 08	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (7)	0:00
K 09	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (3)	0:00
K 10	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (63)	12:16
K 11	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (64)	12:03
K 12	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (66)	0:00
K 13	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (65)	0:00
K 14	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (62)	0:00

Total times in Receptor wise and WTG wise tables can differ, as a WTG can lead to flicker at 2 or more receptors simultaneously and/or receptors may receive flicker from 2 or more WTGs simultaneously.

The calculation of the total expected values for a given receptor assumes a weighted average directional reduction for all WTGs contributing to shadow flicker within the same day. In the case where shadow flicker from different WTGs is not concurrent within the day, the total expected time at a given receptor may deviate marginally from the individual flicker time caused by each turbine separately.

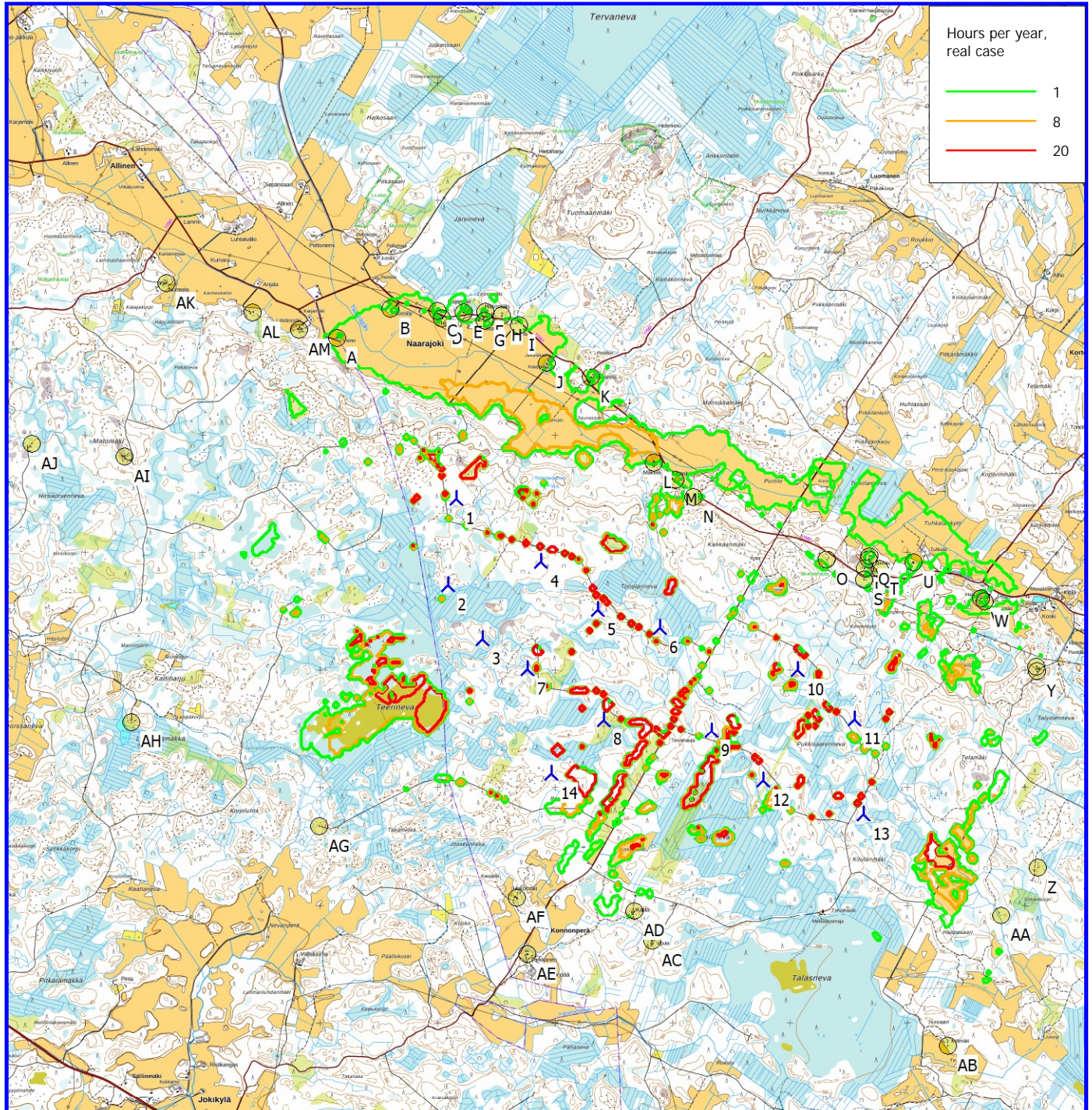


Project:  
20220502 Kattiharju extension

Licensed user:  
PROKON Regenerative Energien eG  
Kirchhoffstraße 3  
DE-25524 Itzehoe  
+49 4821 6855 100  
Kristiina Isohella / k.isohella@prokon.net  
Calculated:  
30/01/2024 10.32/3.6.361

### SHADOW - Map

Calculation: 14 x Nordex N163 Kattiharju receptor 2 +forest



0 500 1000 1500 2000 m

Map: Peruskartta 5/2023 , Print scale 1:50 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 257 460,0 North: 6 984 562,7

New WTG Shadow receptor

Flicker map level: Height Contours: CONTOURLINE\_20220502 Kattiharju extension\_1.wpo (2)

Time step: 4 minutes. Day step: 14 days. Map resolution: 30 m. Visibility resolution: 15 m. Eye height: 1,5 m



Project:

20220502 Kattiharju extension

Licensed user:

PROKON Regenerative Energien eG  
 Kirchhoffstraße 3  
 DE-25524 Itzehoe  
 +49 4821 6855 100  
 Kristiina Isohella / k.isohella@prokon.net  
 Calculated:  
 30/01/2024 10.13/3.6.361

## SHADOW - Main Result

Calculation: 2 x Generic 200-159 rev04 + Kattiharju receptors 2 + Forest

### Assumptions for shadow calculations

Maximum distance for influence  
 Calculate only when more than 20 % of sun is covered by the blade  
 Please look in WTG table

Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S (Average daily sunshine hours) []  
 Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 1,00 2,82 4,23 6,60 8,77 9,10 8,87 6,81 4,67 2,52 1,17 0,58

Operational hours are calculated from WTGs in calculation and wind distribution:  
 MERRA-2\_N63,00\_E021,875

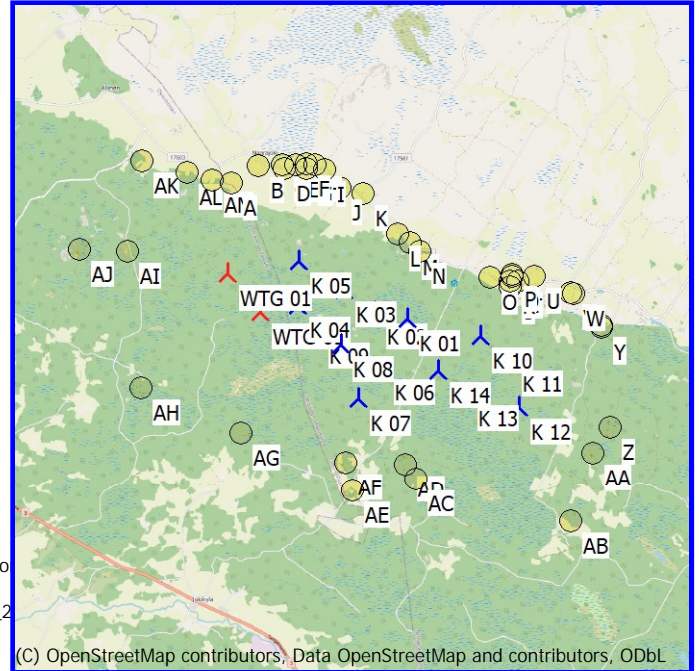
Operational time  
 N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 743 660 439 378 490 724 1040 1330 807 665 545 533 8355  
 Idle start wind speed: Cut in wind speed from power curve

A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:  
 Height contours used: Height Contours: CONTOURLINE\_20220502 Kattiharju extension  
 Area object(s) used in calculation:  
 Area object (Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REGIONS\_2  
 Receptor grid resolution: 1,0 m

All coordinates are in  
 Finish TM ETRS-TM35FIN-ETRS89

### WTGs

	East	North	Z	Row data/Description	WTG type			Shadow data					
					Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Calculation distance [m]	RPM	
			[m]										
K 01	258 892,0	6 984 359,0	47,0	NORDEX N163/6.X-6800 6800 163.... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0	
K 02	258 361,0	6 984 512,0	53,0	NORDEX N163/6.X-6800 6800 163.... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0	
K 03	257 878,0	6 984 922,0	50,3	NORDEX N163/6.X-6800 6800 163.... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0	
K 04	257 087,0	6 984 720,0	52,0	NORDEX N163/6.X-6800 6800 163.... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0	
K 05	257 163,0	6 985 462,0	51,2	NORDEX N163/6.X-6800 6800 163.... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0	
K 06	258 414,0	6 983 575,0	52,5	NORDEX N163/6.X-6800 6800 163.... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0	
K 07	257 971,0	6 983 115,0	54,9	NORDEX N163/6.X-6800 6800 163.... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0	
K 08	257 766,0	6 984 007,5	53,5	NORDEX N163/6.X-6800 6800 163.... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0	
K 09	257 382,0	6 984 262,0	52,0	NORDEX N163/6.X-6800 6800 163.... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0	
K 10	260 067,0	6 984 002,0	51,9	NORDEX N163/6.X-6800 6800 163.... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0	
K 11	260 550,0	6 983 585,0	47,0	NORDEX N163/6.X-6800 6800 163.... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0	
K 12	260 625,0	6 982 771,0	49,5	NORDEX N163/6.X-6800 6800 163.... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0	
K 13	259 770,0	6 983 060,0	52,8	NORDEX N163/6.X-6800 6800 163.... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0	
K 14	259 329,0	6 983 480,0	54,5	NORDEX N163/6.X-6800 6800 163.... Yes	Yes	NORDEX	N163/6.X-6800-6 800	6 800	163,0	148,5	1 786	10,0	
WTG 01	255 965,3	6 985 341,4	50,6	Generic Generic 200-200 10000 20... Yes	Yes	Generic	Generic 200-200-10 000	10 000	200,0	159,0	2 315	8,0	
WTG 01	256 455,1	6 984 657,8	50,0	Generic Generic 200-200 10000 20... Yes	Yes	Generic	Generic 200-200-10 000	10 000	200,0	159,0	2 315	8,0	



(C) OpenStreetMap contributors, Data OpenStreetMap and contributors, ODbL  
 Scale 1:125 000  
 ▲ New WTG      ● Shadow receptor

### Shadow receptor-Input

No.	East	North	Z	Width	Height	Elevation a.g.l.	Slope of window	Direction mode	Eye height (ZVI) a.g.l.
	[m]	[m]	[m]	[m]	[m]	[m]	[°]		[m]
A	256 144,0	6 986 832,0	25,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
B	256 601,0	6 987 078,0	25,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
C	257 002,0	6 987 064,0	26,3	5,0	5,0	2,0	90,0	"Green house mode"	7,0
D	257 041,8	6 986 999,5	27,5	5,0	5,0	2,0	90,0	"Green house mode"	7,0
E	257 223,0	6 987 049,0	27,5	5,0	5,0	2,0	90,0	"Green house mode"	7,0
F	257 407,0	6 987 052,0	30,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
G	257 405,0	6 986 981,0	28,2	5,0	5,0	2,0	90,0	"Green house mode"	7,0
H	257 547,0	6 987 020,0	30,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
I	257 695,0	6 986 937,0	27,5	5,0	5,0	2,0	90,0	"Green house mode"	7,0

To be continued on next page...



Project:

20220502 Kattiharju extension

Licensed user:

PROKON Regenerative Energien eG  
 Kirchhoffstraße 3  
 DE-25524 Itzehoe  
 +49 4821 6855 100  
 Kristiina Isohella / k.isohella@prokon.net  
 Calculated:  
 30/01/2024 10.13/3.6.361

## SHADOW - Main Result

Calculation: 2 x Generic 200-159 rev04 + Kattiharju receptors 2 + Forest

...continued from previous page

No.	East	North	Z	Width	Height	Elevation a.g.l.	Slope of window	Direction mode	Eye height (ZVI) a.g.l.
	[m]	[m]	[m]	[m]	[m]	[m]	[°]		[m]
J	257 931,0	6 986 612,0	27,5	5,0	5,0	2,0	90,0	"Green house mode"	7,0
K	258 304,0	6 986 491,0	29,8	5,0	5,0	2,0	90,0	"Green house mode"	7,0
L	258 840,0	6 985 771,0	30,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
M	259 027,0	6 985 623,0	32,1	5,0	5,0	2,0	90,0	"Green house mode"	7,0
N	259 178,0	6 985 472,0	37,2	5,0	5,0	2,0	90,0	"Green house mode"	7,0
O	260 316,0	6 984 939,0	44,6	5,0	5,0	2,0	90,0	"Green house mode"	7,0
P	260 677,0	6 984 970,0	33,3	5,0	5,0	2,0	90,0	"Green house mode"	7,0
Q	260 673,0	6 984 939,0	34,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
R	260 636,0	6 984 866,0	34,8	5,0	5,0	2,0	90,0	"Green house mode"	7,0
S	260 630,0	6 984 769,0	35,9	5,0	5,0	2,0	90,0	"Green house mode"	7,0
T	260 766,0	6 984 856,0	35,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
U	261 049,0	6 984 913,0	35,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
V	261 624,0	6 984 609,0	37,2	5,0	5,0	2,0	90,0	"Green house mode"	7,0
W	261 660,0	6 984 585,0	36,9	5,0	5,0	2,0	90,0	"Green house mode"	7,0
X	262 099,0	6 984 032,0	39,6	5,0	5,0	2,0	90,0	"Green house mode"	7,0
Y	262 104,0	6 983 991,0	41,3	5,0	5,0	2,0	90,0	"Green house mode"	7,0
Z	262 110,0	6 982 324,0	50,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AA	261 796,0	6 981 916,0	47,5	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AB	261 344,0	6 980 808,0	48,3	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AC	258 828,0	6 981 696,0	50,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AD	258 674,0	6 981 951,0	52,2	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AE	257 766,0	6 981 583,0	50,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AF	257 676,0	6 982 065,0	49,8	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AG	255 996,0	6 982 675,0	45,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AH	254 396,7	6 983 556,8	46,7	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AI	254 341,0	6 985 820,4	55,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AJ	253 549,6	6 985 926,4	45,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AK	254 694,4	6 987 295,9	28,5	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AL	255 429,2	6 987 046,3	30,0	5,0	5,0	2,0	90,0	"Green house mode"	7,0
AM	255 820,0	6 986 903,4	28,1	5,0	5,0	2,0	90,0	"Green house mode"	7,0

## Calculation Results

Shadow receptor

Shadow, expected values

No. Shadow hours

per year

[h/year]

A	7:54
B	4:07
C	4:12
D	4:25
E	1:24
F	3:52
G	4:10
H	1:08
I	2:15
J	5:05
K	4:44
L	10:50
M	6:31
N	7:30
O	0:00
P	7:15
Q	7:36
R	0:00
S	0:00
T	8:02
U	5:35
V	3:50
W	2:13
X	0:00
Y	0:00
Z	0:00

To be continued on next page...

Project:

20220502 Kattiharju extension

Licensed user:

PROKON Regenerative Energien eG  
 Kirchhoffstraße 3  
 DE-25524 Itzehoe  
 +49 4821 6855 100  
 Kristiina Isohella / k.isohella@prokon.net  
 Calculated:  
 30/01/2024 10.13/3.6.361

## SHADOW - Main Result

Calculation: 2 x Generic 200-159 rev04 + Kattiharju receptors 2 + Forest

...continued from previous page  
 Shadow, expected values

No.	Shadow hours per year [h/year]
AA	0:00
AB	0:00
AC	0:00
AD	0:00
AE	0:00
AF	0:00
AG	0:00
AH	0:00
AI	0:00
AJ	0:00
AK	0:00
AL	0:00
AM	3:44

Total amount of flickering on the shadow receptors caused by each WTG

No.	Name	Expected [h/year]
K 01	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (6)	11:15
K 02	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (5)	6:06
K 03	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (4)	10:32
K 04	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (2)	0:00
K 05	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (1)	18:20
K 06	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (8)	0:00
K 07	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (67)	0:00
K 08	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (7)	0:00
K 09	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (3)	0:00
K 10	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (63)	12:10
K 11	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (64)	11:57
K 12	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (66)	0:00
K 13	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (65)	0:00
K 14	NORDEX N163/6.X-6800 6800 163.0 !-! hub: 148,5 m (TOT: 230,0 m) (62)	0:00
WTG 01	Generic Generic 200-200 10000 200.0 !-! hub: 159,0 m (TOT: 259,0 m) (76)	15:21
WTG 01	Generic Generic 200-200 10000 200.0 !-! hub: 159,0 m (TOT: 259,0 m) (75)	2:00

Total times in Receptor wise and WTG wise tables can differ, as a WTG can lead to flicker at 2 or more receptors simultaneously and/or receptors may receive flicker from 2 or more WTGs simultaneously.

The calculation of the total expected values for a given receptor assumes a weighted average directional reduction for all WTGs contributing to shadow flicker within the same day. In the case where shadow flicker from different WTGs is not concurrent within the day, the total expected time at a given receptor may deviate marginally from the individual flicker time caused by each turbine separately.

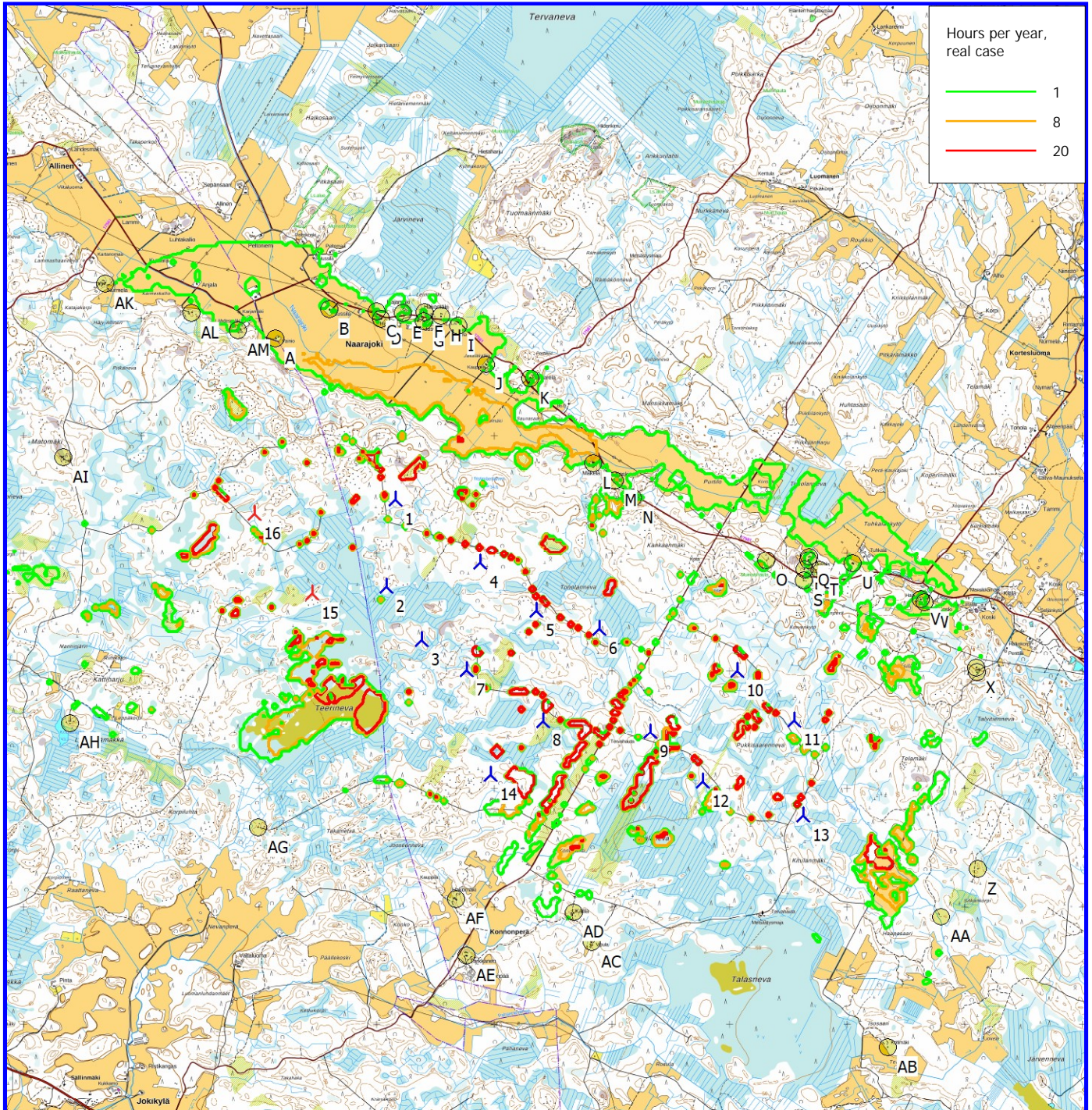


Project:  
20220502 Kattiharju extension

Licensed user:  
PROKON Regenerative Energien eG  
Kirchhoffstraße 3  
DE-25524 Itzehoe  
+49 4821 6855 100  
Kristiina Isohella / k.isoehella@prokon.net  
Calculated:  
30/01/2024 10.13/3.6.361

### SHADOW - Map

Calculation: 2 x Generic 200-159 rev04 + Kattiharju receptors 2 + Forest



0 500 1000 1500 2000 m

Map: Peruskartta 5/2023 , Print scale 1:50 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 257 970,0 North: 6 984 562,7

▲ New WTG      📍 Shadow receptor

Flicker map level: Height Contours: CONTOURLINE\_20220502 Kattiharju extension\_1.wpo (2)

Time step: 4 minutes. Day step: 14 days. Map resolution: 30 m. Visibility resolution: 15 m. Eye height: 1,5 m