Project:
Ahlainen_Lammi

Licensed user:
Ramboll Deutschland GmbH
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DE-34131 Kassel
-
Maria Niemi / maria.niemi@ramboll.fi
Calculated:
27.2.2024 11.22/3.6.355

SHADOW - Main Result

Calculation: Lammi_Layout_23022024_HH160_RD180_TH250

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) []

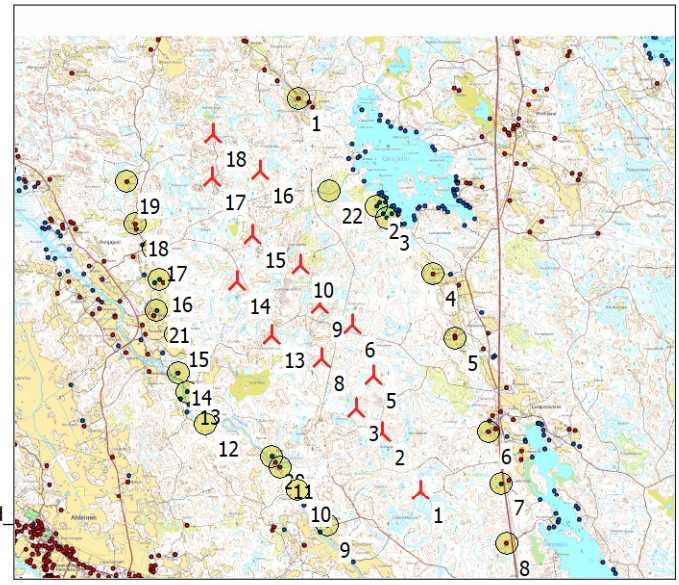
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.16	2.52	4.19	6.43	8.42	8.50	8.58	6.71	4.57	2.52	1.10	0.81

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
599	470	402	408	507	632	868	1 501	825	588	639	760	8 199

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: Elevation Grid Data Object: Ahlainen_Lammi_EMDGrid_
Receptor grid resolution: 10.0 m

All coordinates are in
Finish TM ETRS-TM35FIN-ETRS89



WTGs

	East	North	Z	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Shadow data Calculation distance	RPM
			[m]					[kW]	[m]	[m]	[m]	[RPM]
1	220 436	6 850 444	24.4	Siemens Gamesa SG 6.6 ...	Yes	Siemens Gamesa	SG 6.6 USER-6 600	6 600	180.0	160.0	2 209	8.8
2	219 924	6 851 213	23.7	Siemens Gamesa SG 6.6 ...	Yes	Siemens Gamesa	SG 6.6 USER-6 600	6 600	180.0	160.0	2 209	8.8
3	219 573	6 851 534	22.4	Siemens Gamesa SG 6.6 ...	Yes	Siemens Gamesa	SG 6.6 USER-6 600	6 600	180.0	160.0	2 209	8.8
5	219 804	6 851 964	33.8	Siemens Gamesa SG 6.6 ...	Yes	Siemens Gamesa	SG 6.6 USER-6 600	6 600	180.0	160.0	2 209	8.8
6	219 533	6 852 640	31.0	Siemens Gamesa SG 6.6 ...	Yes	Siemens Gamesa	SG 6.6 USER-6 600	6 600	180.0	160.0	2 209	8.8
8	219 120	6 852 190	22.0	Siemens Gamesa SG 6.6 ...	Yes	Siemens Gamesa	SG 6.6 USER-6 600	6 600	180.0	160.0	2 209	8.8
9	219 091	6 852 914	24.1	Siemens Gamesa SG 6.6 ...	Yes	Siemens Gamesa	SG 6.6 USER-6 600	6 600	180.0	160.0	2 209	8.8
10	218 836	6 853 425	27.5	Siemens Gamesa SG 6.6 ...	Yes	Siemens Gamesa	SG 6.6 USER-6 600	6 600	180.0	160.0	2 209	8.8
13	218 454	6 852 503	20.3	Siemens Gamesa SG 6.6 ...	Yes	Siemens Gamesa	SG 6.6 USER-6 600	6 600	180.0	160.0	2 209	8.8
14	218 006	6 853 217	15.1	Siemens Gamesa SG 6.6 ...	Yes	Siemens Gamesa	SG 6.6 USER-6 600	6 600	180.0	160.0	2 209	8.8
15	218 211	6 853 824	17.6	Siemens Gamesa SG 6.6 ...	Yes	Siemens Gamesa	SG 6.6 USER-6 600	6 600	180.0	160.0	2 209	8.8
16	218 307	6 854 670	28.6	Siemens Gamesa SG 6.6 ...	Yes	Siemens Gamesa	SG 6.6 USER-6 600	6 600	180.0	160.0	2 209	8.8
17	217 674	6 854 587	17.5	Siemens Gamesa SG 6.6 ...	Yes	Siemens Gamesa	SG 6.6 USER-6 600	6 600	180.0	160.0	2 209	8.8
18	217 682	6 855 162	26.3	Siemens Gamesa SG 6.6 ...	Yes	Siemens Gamesa	SG 6.6 USER-6 600	6 600	180.0	160.0	2 209	8.8

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]
1	218 818	6 855 624	22.4	1.0	1.0	1.0	90.0	"Green house mode"	2.0
2	219 852	6 854 205	29.8	1.0	1.0	1.0	90.0	"Green house mode"	2.0
3	219 986	6 854 053	29.8	1.0	1.0	1.0	90.0	"Green house mode"	2.0
4	220 596	6 853 312	30.2	1.0	1.0	1.0	90.0	"Green house mode"	2.0
5	220 888	6 852 464	35.2	1.0	1.0	1.0	90.0	"Green house mode"	2.0
6	221 330	6 851 230	35.2	1.0	1.0	1.0	90.0	"Green house mode"	2.0
7	221 499	6 850 540	28.3	1.0	1.0	1.0	90.0	"Green house mode"	2.0
8	221 569	6 849 742	29.7	1.0	1.0	1.0	90.0	"Green house mode"	2.0
9	219 198	6 849 978	16.1	1.0	1.0	1.0	90.0	"Green house mode"	2.0
10	218 803	6 850 449	17.4	1.0	1.0	1.0	90.0	"Green house mode"	2.0
11	218 569	6 850 756	14.0	1.0	1.0	1.0	90.0	"Green house mode"	2.0
12	217 584	6 851 326	11.0	1.0	1.0	1.0	90.0	"Green house mode"	2.0
13	217 344	6 851 756	6.8	1.0	1.0	1.0	90.0	"Green house mode"	2.0
14	217 221	6 852 002	10.8	1.0	1.0	1.0	90.0	"Green house mode"	2.0
15	217 183	6 852 513	6.7	1.0	1.0	1.0	90.0	"Green house mode"	2.0
16	216 974	6 853 239	8.8	1.0	1.0	1.0	90.0	"Green house mode"	2.0
17	216 902	6 853 651	12.6	1.0	1.0	1.0	90.0	"Green house mode"	2.0

To be continued on next page...

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SHADOW - Main Result

Calculation: Lammi_Layout_23022024_HH160_RD180_TH250

...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]
18	216 657	6 853 972	14.0	1.0	1.0	1.0	90.0	"Green house mode"	2.0
19	216 546	6 854 531	15.7	1.0	1.0	1.0	90.0	"Green house mode"	2.0
20	218 464	6 850 905	12.9	1.0	1.0	1.0	90.0	"Green house mode"	2.0
21	216 939	6 852 831	6.9	1.0	1.0	1.0	90.0	"Green house mode"	2.0
22	219 220	6 854 410	31.2	1.0	1.0	1.0	90.0	"Green house mode"	2.0

Calculation Results

Shadow receptor

	Shadow, worst case			Shadow, expected values
No.	Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow hours per year [h/year]
1	104:26	161	1:05	13:26
2	124:49	221	1:08	17:13
3	130:19	206	1:09	17:17
4	82:55	205	0:37	11:54
5	92:54	224	0:51	15:18
6	58:04	146	0:36	11:01
7	40:59	88	0:39	8:45
8	38:28	75	0:48	10:09
9	28:04	67	0:33	7:25
10	41:44	99	0:34	10:34
11	47:56	128	0:31	11:55
12	29:14	102	0:25	7:37
13	42:28	108	0:34	11:00
14	54:41	134	0:46	14:15
15	56:10	164	0:46	13:29
16	92:29	207	1:03	21:47
17	77:22	196	0:41	16:49
18	78:25	173	0:40	18:56
19	84:13	190	0:41	19:51
20	80:48	150	0:59	20:29
21	85:23	179	0:47	21:14
22	204:40	253	1:27	32:01

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

No.	Name	Worst case [h/year]	Expected [h/year]
1	Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (263)	142:17	29:28
2	Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (264)	133:26	28:44
3	Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (265)	105:44	23:58
5	Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (266)	85:06	14:34
6	Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (269)	119:56	15:16
8	Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (267)	97:34	17:46
9	Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (270)	142:11	24:12
10	Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (271)	161:18	27:27
13	Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (268)	141:13	28:57
14	Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (272)	138:20	29:10
15	Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (273)	155:52	32:15
16	Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (274)	131:17	27:31
17	Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (276)	94:14	21:39
18	Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (275)	72:01	17:09

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.

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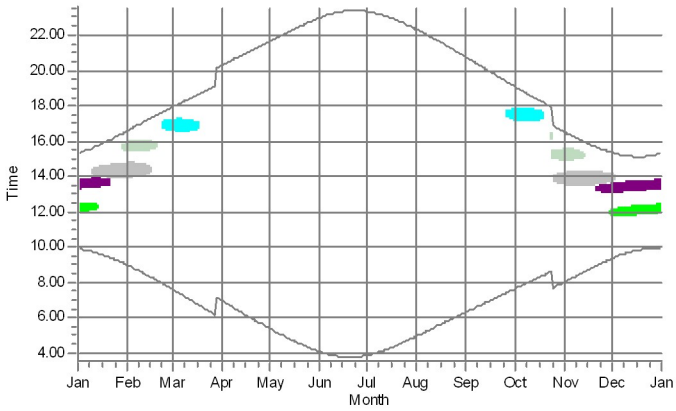
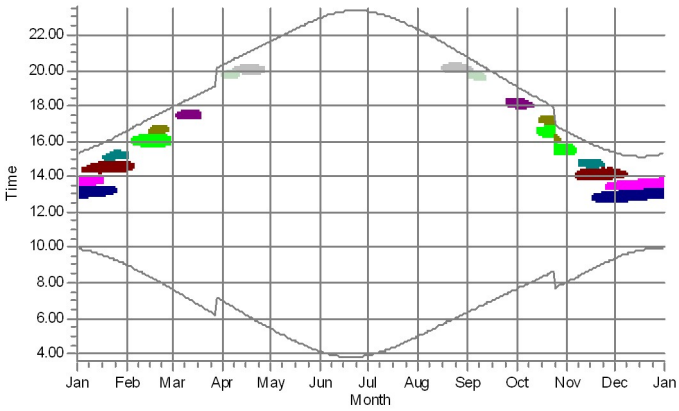
SHADOW - Calendar, graphical

Calculation: Lammi_Layout_23022024_HH160_RD180_TH250

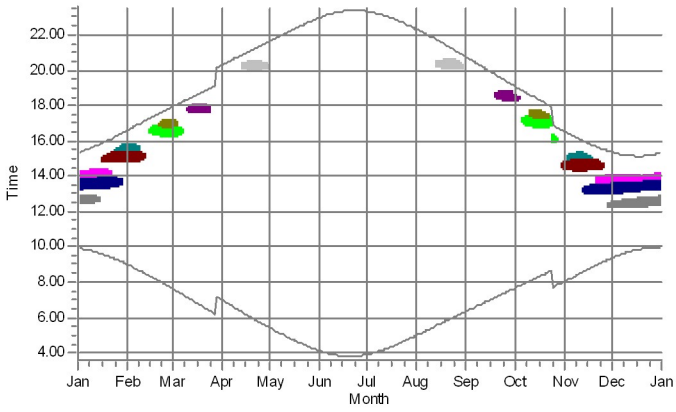
1: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (59)



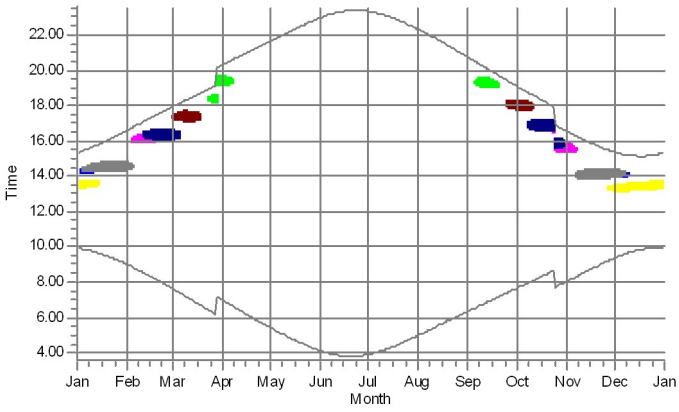
2: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (60)



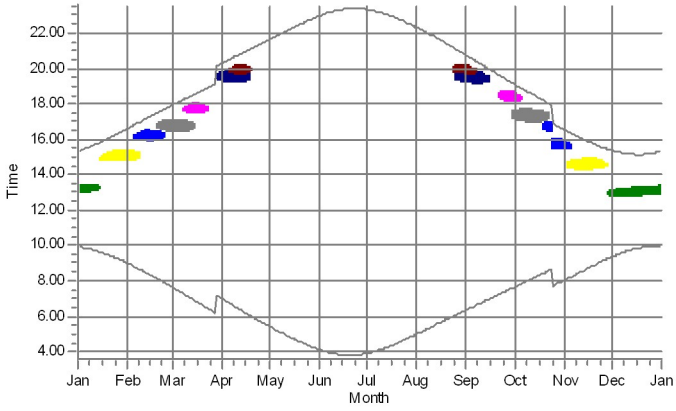
3: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (61)



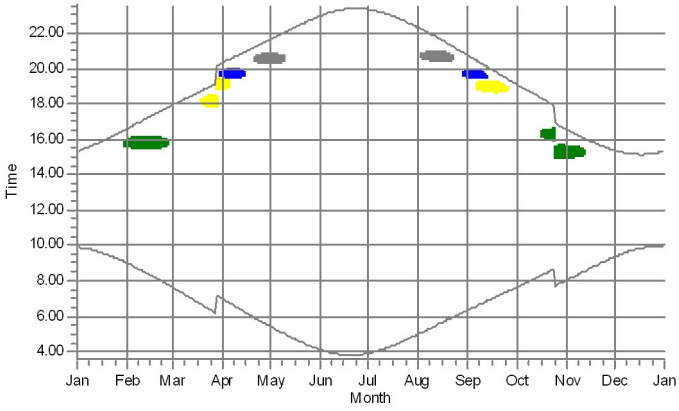
4: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (62)



5: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (63)



6: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (64)



WTGs

- 1: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (263)
- 2: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (264)
- 3: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (265)
- 5: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (266)
- 8: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (267)
- 13: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (268)
- 6: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (269)
- 9: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (270)
- 10: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (271)
- 14: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (272)
- 15: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (273)
- 16: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (274)
- 18: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (275)
- 17: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (276)

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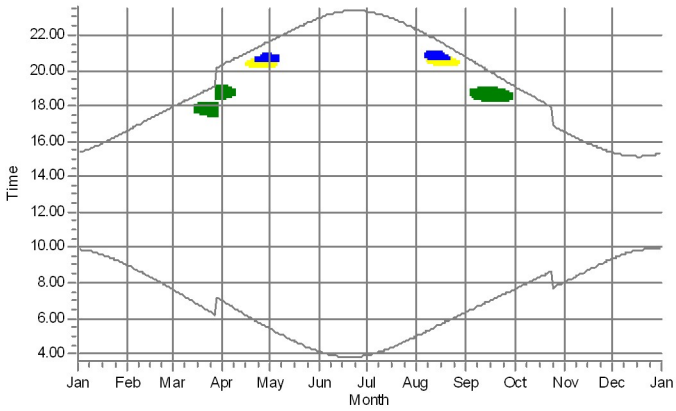
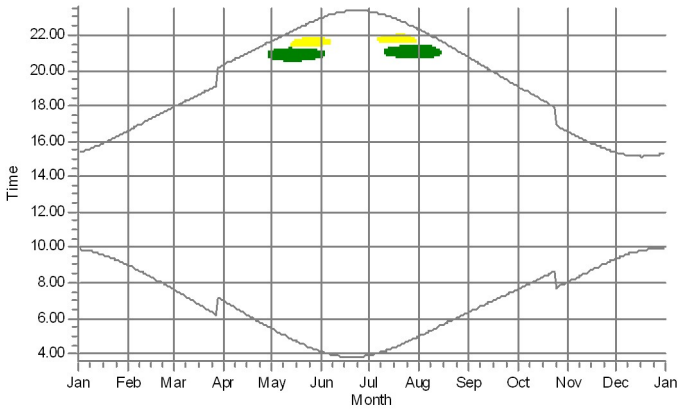
SHADOW - Calendar, graphical

Calculation: Lammi_Layout_23022024_HH160_RD180_TH250

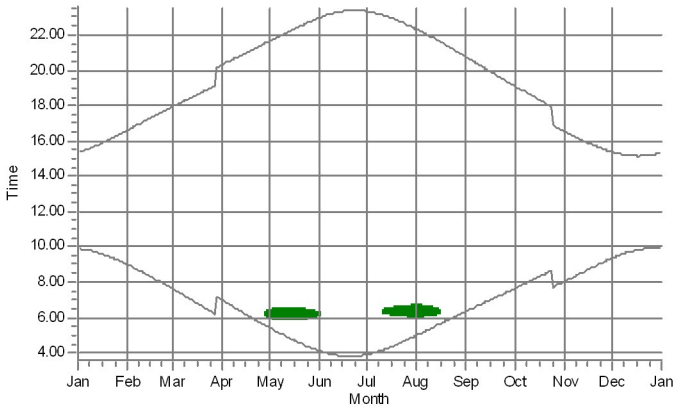
7: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (65)



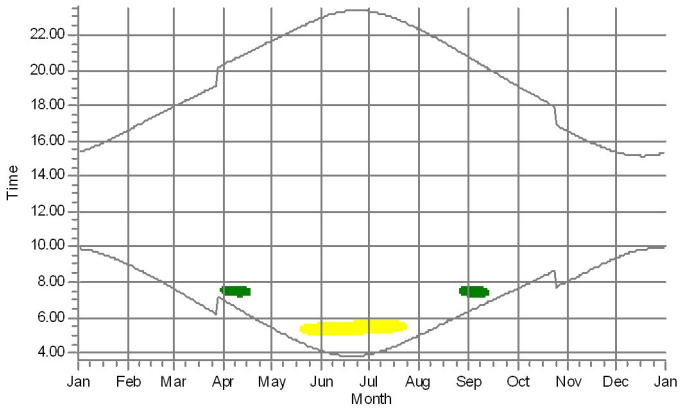
8: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (66)



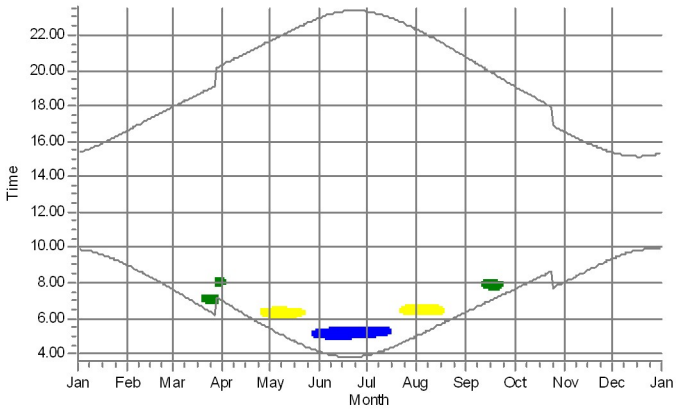
9: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (67)



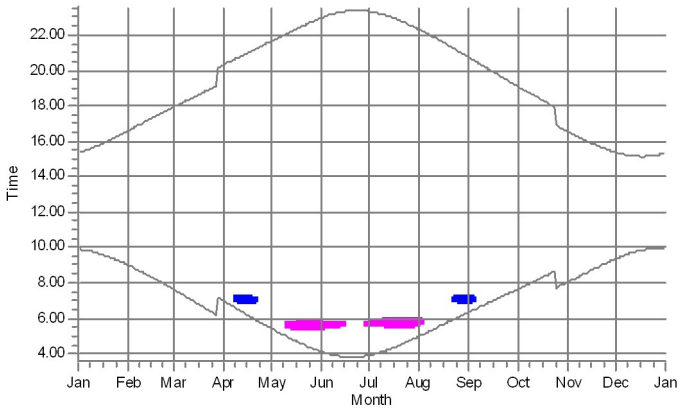
10: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (68)



11: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (69)



12: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (70)



WTGs

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2: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (264)
3: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (265)
8: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (267)

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SHADOW - Calendar, graphical

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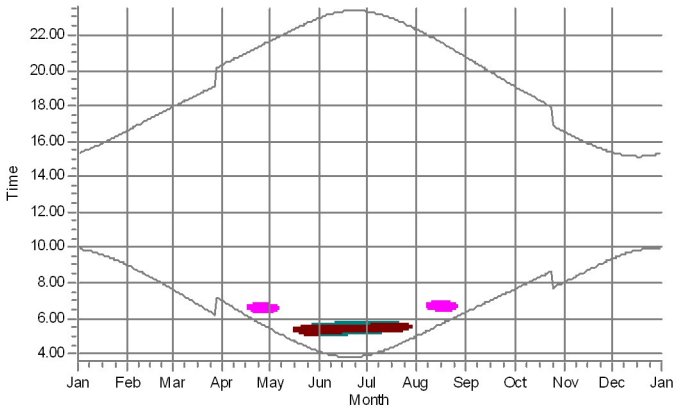
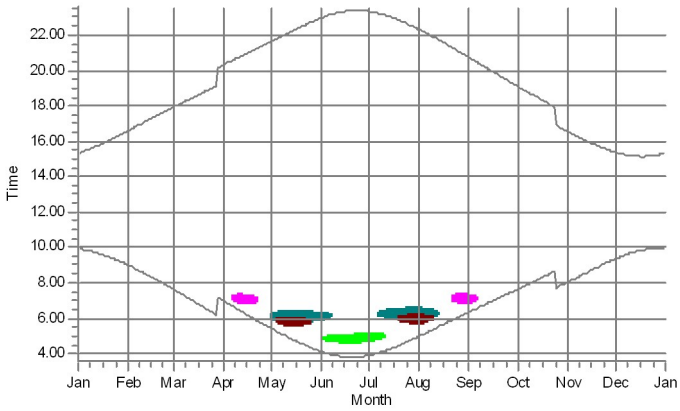
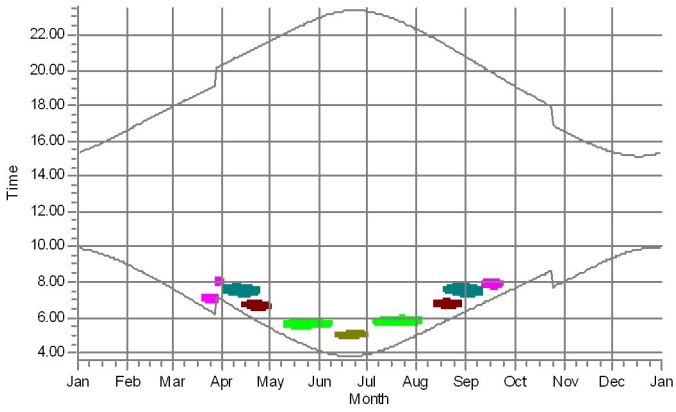
13: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (71)



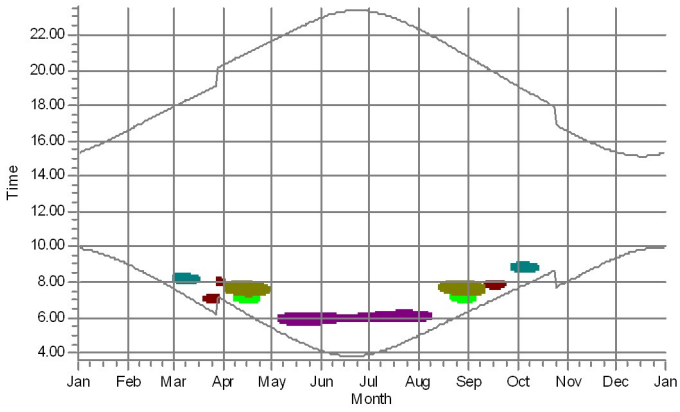
14: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (72)



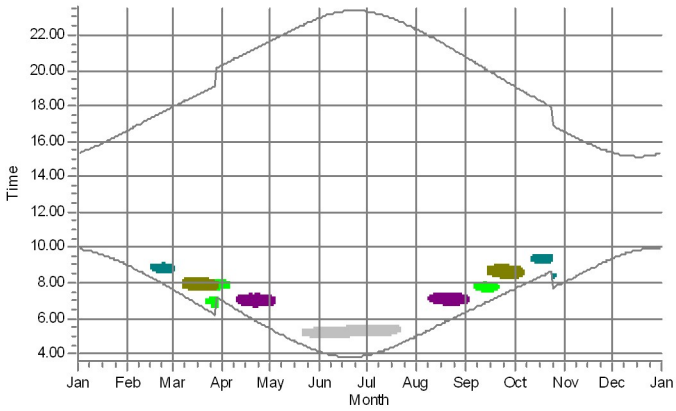
15: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (73)



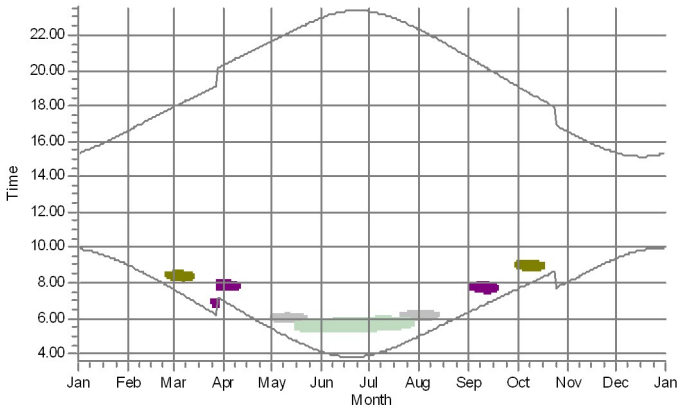
16: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (74)



17: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (75)



18: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (76)



WTGs

- 8: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (267)
- 13: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (268)
- 9: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (270)
- 10: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (271)
- 14: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (272)
- 15: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (273)
- 16: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (274)
- 17: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (276)

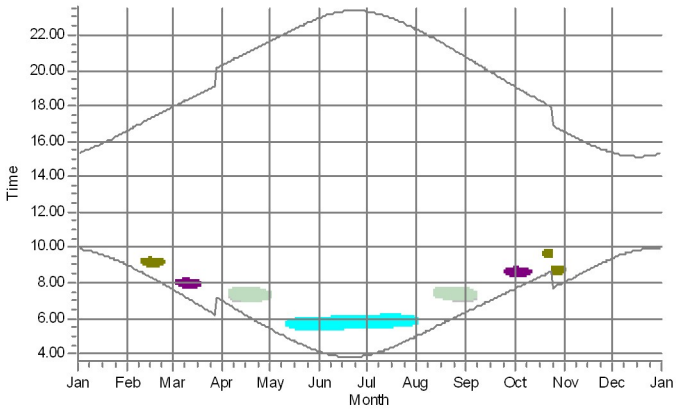
Project:
Ahlainen_Lammi

Licensed user:
Ramboll Deutschland GmbH
Elisabeth-Consbruch-Straße 3
DE-34131 Kassel
-
Maria Niemi / maria.niemi@ramboll.fi
Calculated:
27.2.2024 11.22/3.6.355

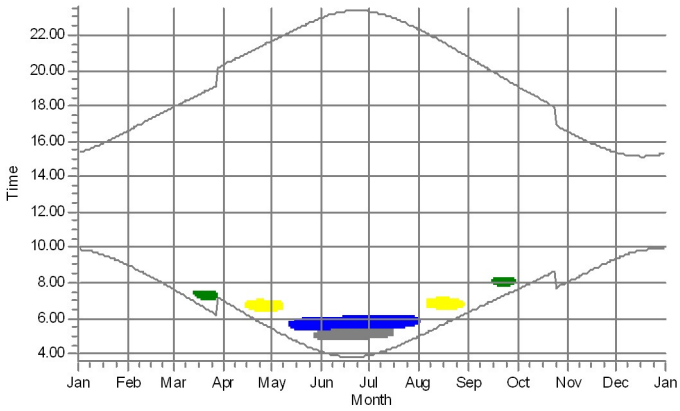
SHADOW - Calendar, graphical

Calculation: Lammi_Layout_23022024_HH160_RD180_TH250

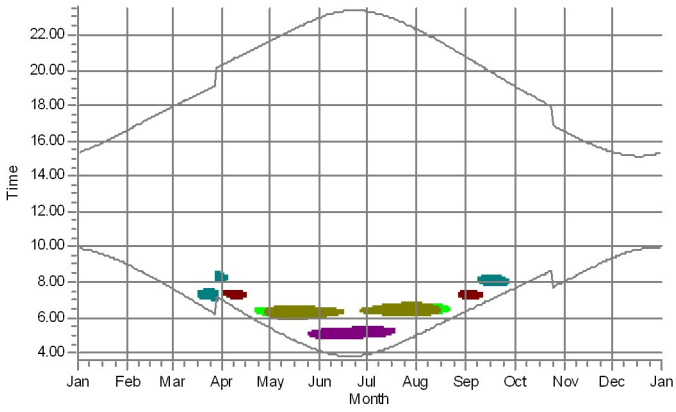
19: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (77)



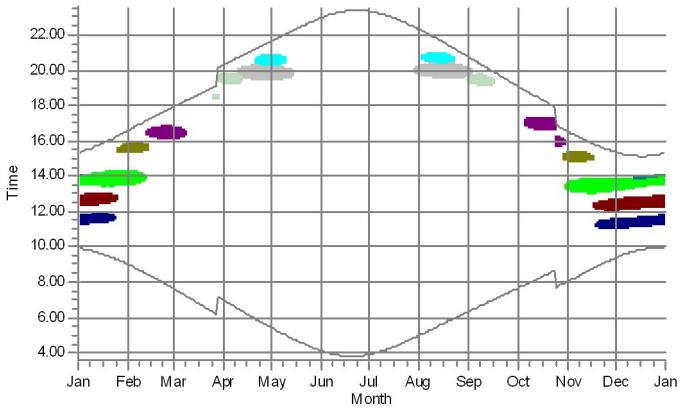
20: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (78)



21: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (79)

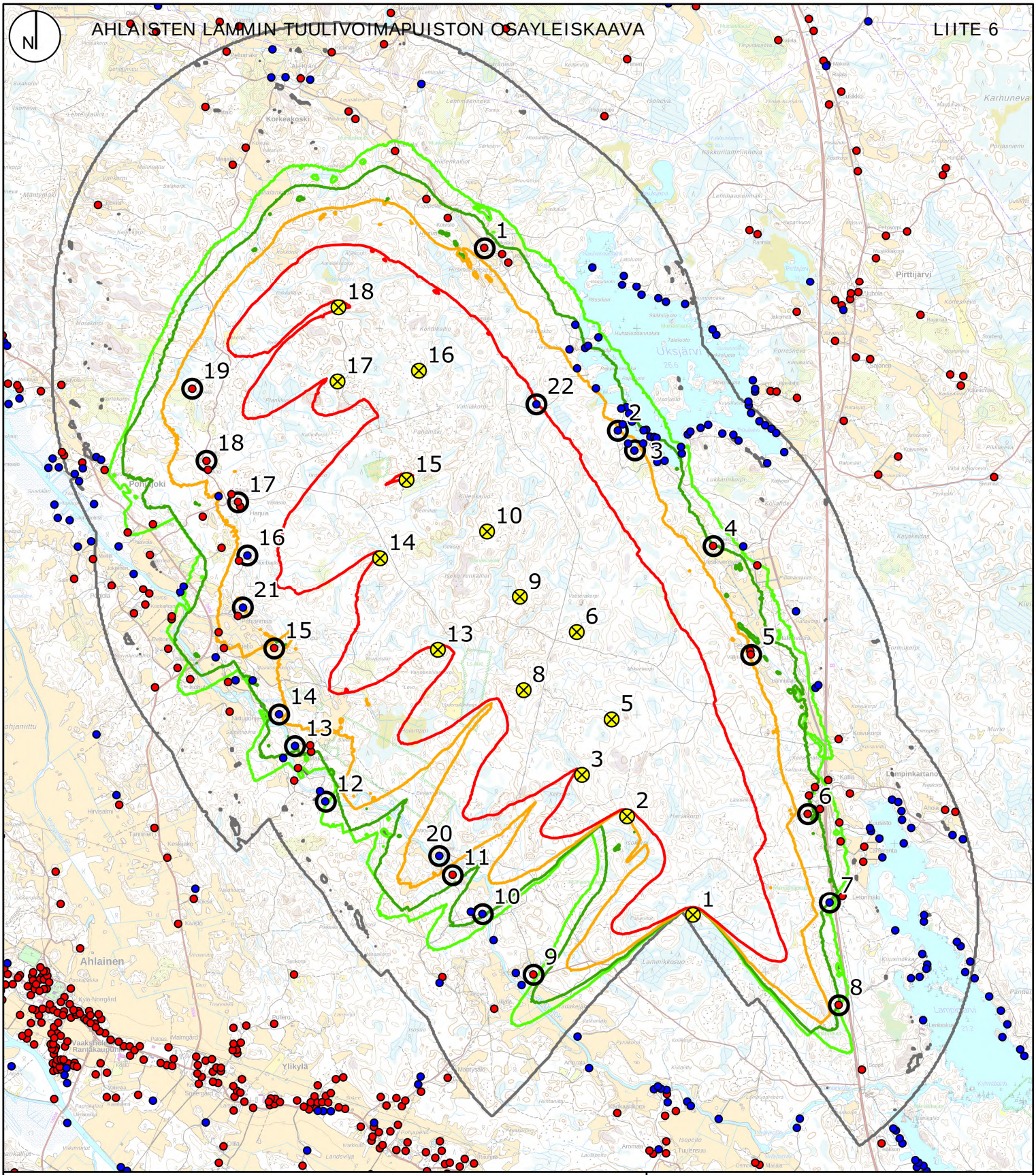


22: Shadow Receptor: 1.0 × 1.0 Azimuth: 0.0° Slope: 90.0° (80)



WTGs

- 1: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (263)
- 2: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (264)
- 3: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (265)
- 5: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (266)
- 13: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (268)
- 6: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (269)
- 9: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (270)
- 10: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (271)
- 14: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (272)
- 15: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (273)
- 16: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (274)
- 18: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (275)
- 17: Siemens Gamesa SG 6.6 USER 6600 180.0 !O! hub: 160.0 m (TOT: 250.0 m) (276)



RAMBØLL

Satawind Oy
Alhaisten Lammin tuulivoimahanke

Välkemallinnus
(WindPro 3.6)

Layout 14WTG
SG 6.6
Napakorkeus (HH) 160 m
Roottorin halkaisija (RD) 180 m
Kokonaiskorkeus (TH): 250 m

Välketuntia vuodessa
Real Case -mallinnus

- 0
- 8
- 10
- 15
- 30
- Tuulivoimala
- Reseptorit
- Asuinrakennus
- Lomarakennus

Mittakaava (A4): 1:40 000
0 0.5 1 2 km

27.2.2024 MN