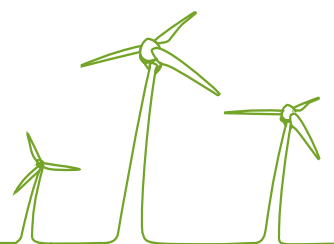


BILAGA 3

Skuggningsmodelleringar



Project:

Pörtom

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Calculated:

21.5.2013 20:57/2.8.579

SHADOW - Main Result

Calculation: Pörtom Vestas V126 x 23 x HH137 (real case)

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) [UMEA]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1,02	2,84	3,78	6,14	8,62	9,94	7,42	5,13	4,32	3,43	1,58	0,96

Operational hours are calculated from WTGs in calculation and wind distribution:

Pörtom mätmast

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
406	408	396	474	472	888	1583	1693	761	539	487	458	8566

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

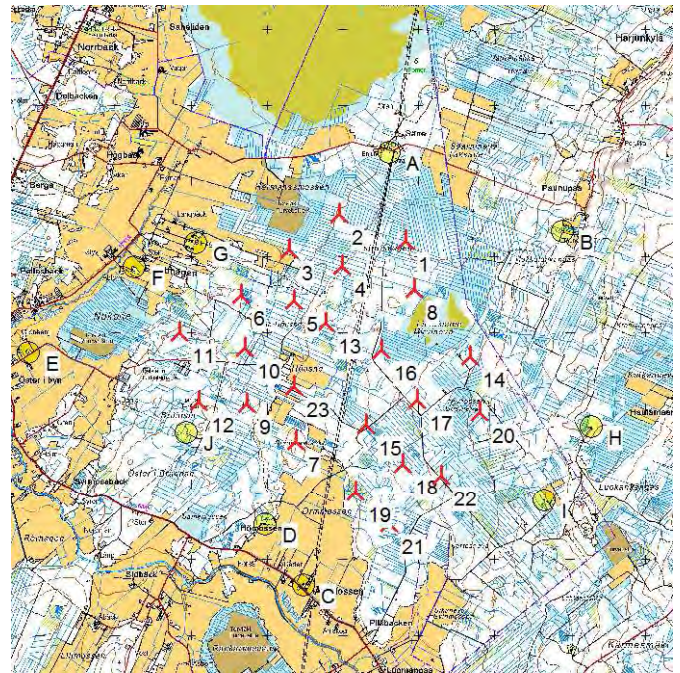
A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:

Height contours used: Korkeuskäyrät

Obstacles used in calculation

Eye height: 1,5 m

Grid resolution: 10,0 m



Scale 1:100 000

★ New WTG

● Shadow receptor

WTGs

ETRS 89 Zone: 35

East North

Z

Row

data/Description

WTG type

Valid Manufact.

Type-generator

Power, rated

[kW]

Rotor diameter

[m]

Hub height

[m]

Shadow data

Calculation RPM

distance

[m] [RPM]

1	230 832	6 966 209	49,2	1	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
2	229 955	6 966 564	40,7	2	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
3	229 294	6 966 095	35,8	3	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
4	229 994	6 965 875	44,5	4	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
5	229 351	6 965 422	38,7	5	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
6	228 661	6 965 499	40,0	6	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
7	229 379	6 963 565	51,7	7	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
8	230 940	6 965 579	54,7	8	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
9	228 727	6 964 062	46,1	9	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
10	228 712	6 964 799	42,5	10	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
11	227 846	6 965 006	41,1	11	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
12	228 094	6 964 087	48,6	14	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
13	229 773	6 965 133	45,0	15	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
14	231 676	6 964 690	58,6	16	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
15	230 303	6 963 780	50,9	17	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
16	230 514	6 964 772	52,5	18	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
17	230 977	6 964 114	56,3	19	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
18	230 795	6 963 261	52,4	20	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
19	230 172	6 962 898	45,2	21	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
20	231 803	6 963 951	61,9	22	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
21	230 613	6 962 469	47,5	23	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
22	231 300	6 963 106	55,2	24	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
23	229 356	6 964 293	41,8	25	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5

Project:

Pörtom

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Calculated:

21.5.2013 20:57/2.8.579

SHADOW - Main Result

Calculation: Pörtom Vestas V126 x 23 x HH137 (real case)

Shadow receptor-Input

ETRS 89 Zone: 35

No.	Name	East	North	Z	Width	Height	Height a.g.l.	Degrees from south cw	Slope of window	Direction mode
				[m]	[m]	[m]	[m]	[°]	[°]	
A	Fast bostad	230 620	6 967 377	42,2	1,0	1,0	1,0	-180,0	90,0	"Green house mode"
B	Fast bostad	232 901	6 966 343	70,1	1,0	1,0	1,0	-180,0	90,0	"Green house mode"
C	Fast bostad	229 481	6 961 667	42,5	1,0	1,0	1,0	-180,0	90,0	"Green house mode"
D	Fast bostad	228 970	6 962 466	44,4	1,0	1,0	1,0	-180,0	90,0	"Green house mode"
E	Fast bostad	225 850	6 964 736	30,4	1,0	1,0	1,0	-180,0	90,0	"Green house mode"
F	Fast bostad	227 246	6 965 867	31,8	1,0	1,0	1,0	-180,0	90,0	"Green house mode"
G	Fast bostad	228 054	6 966 189	35,0	1,0	1,0	1,0	-180,0	90,0	"Green house mode"
H	Fritidsbostad	233 279	6 963 752	80,0	1,0	1,0	1,0	-180,0	90,0	"Green house mode"
I	Fritidsbostad	232 661	6 962 785	69,7	1,0	1,0	1,0	-180,0	90,0	"Green house mode"
J	Fritidsbostad	227 936	6 963 688	47,5	1,0	1,0	1,0	-180,0	90,0	"Green house mode"

Calculation Results

Shadow receptor

Shadow, expected values

No.	Name	Shadow hours per year [h/year]
A	Fast bostad	7:20
B	Fast bostad	0:00
C	Fast bostad	6:04
D	Fast bostad	3:54
E	Fast bostad	0:00
F	Fast bostad	4:14
G	Fast bostad	11:40
H	Fritidsbostad	1:06
I	Fritidsbostad	3:07
J	Fritidsbostad	14:28

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

No.	Name	Worst case [h/year]	Expected [h/year]
1	1	18:54	2:35
2	2	16:40	3:05
3	3	9:24	1:50
4	4	12:19	1:37
5	5	6:21	1:14
6	6	24:35	4:52
7	7	6:54	1:19
8	8	0:00	0:00
9	9	45:28	12:00
10	10	9:36	1:25
11	11	38:33	6:14
12	14	0:00	0:00
13	15	0:00	0:00
14	16	0:00	0:00
15	17	0:00	0:00
16	18	0:00	0:00
17	19	0:00	0:00
18	20	0:00	0:00
19	21	12:39	2:52
20	22	11:07	2:49
21	23	27:02	7:06
22	24	7:16	1:26
23	25	8:19	1:57

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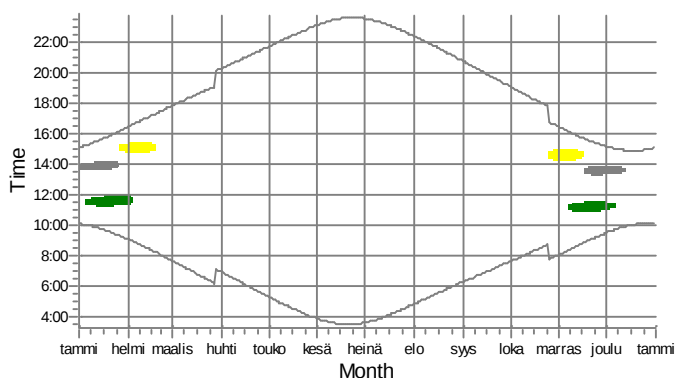
Calculated:

21.5.2013 20:57/2.8.579

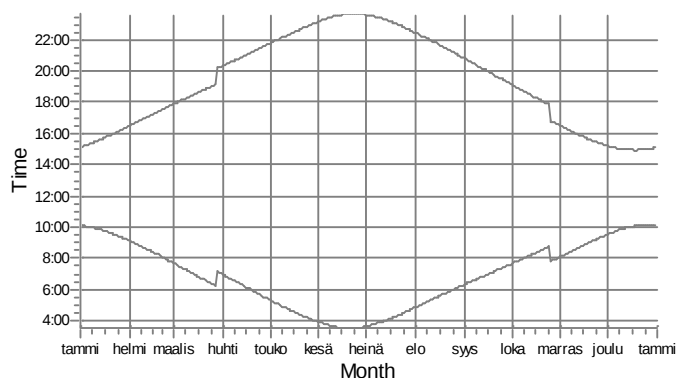
SHADOW - Calendar, graphical

Calculation: Pörtom Vestas V126 x 23 x HH137 (real case)

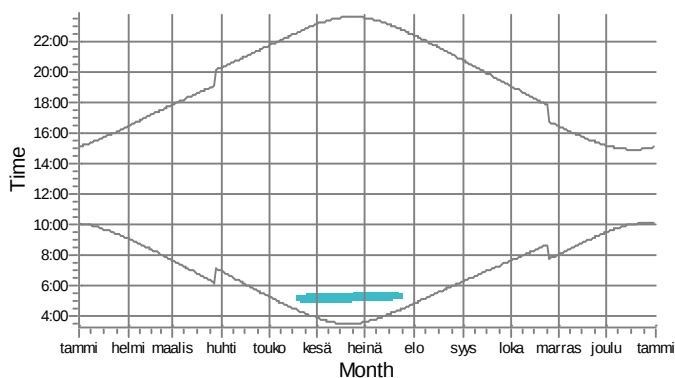
A: Fast bostad



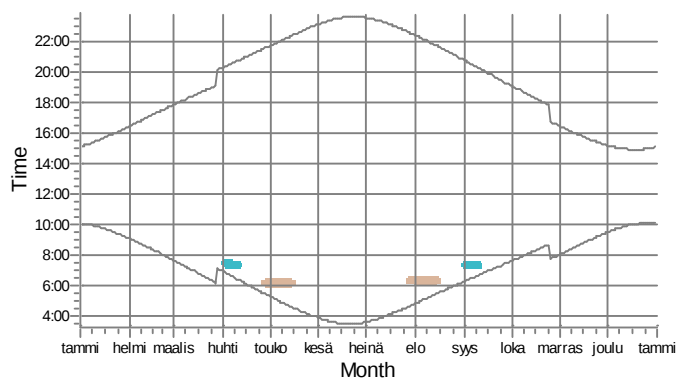
B: Fast bostad



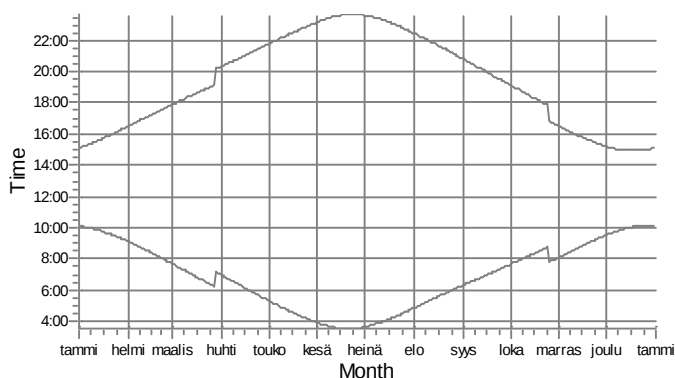
C: Fast bostad



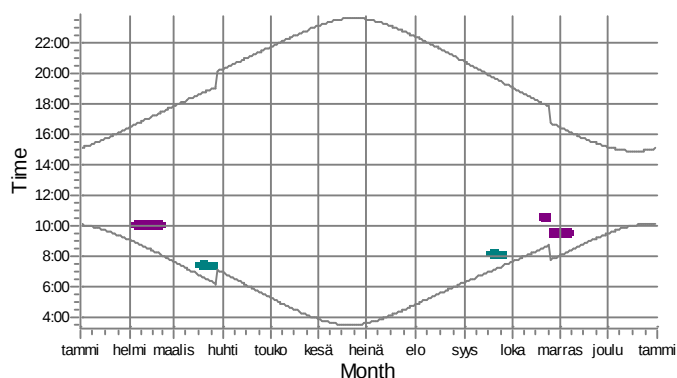
D: Fast bostad



E: Fast bostad



F: Fast bostad



WTGs



1: 1

2: 2



4: 4

6: 6



11: 11

19: 21



21: 23

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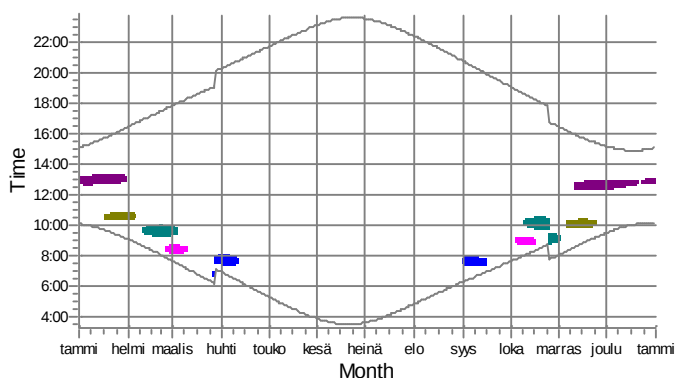
Calculated:

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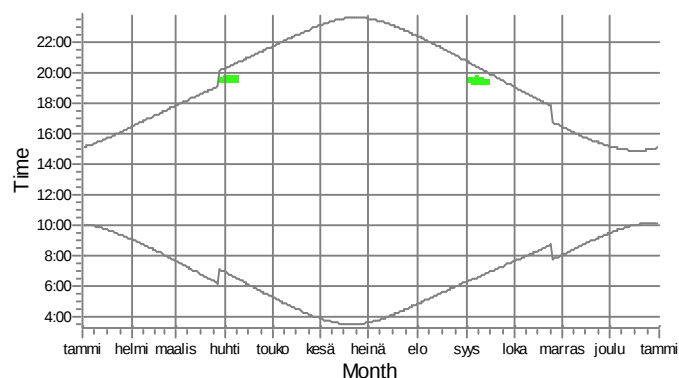
SHADOW - Calendar, graphical

Calculation: Pörtom Vestas V126 x 23 x HH137 (real case)

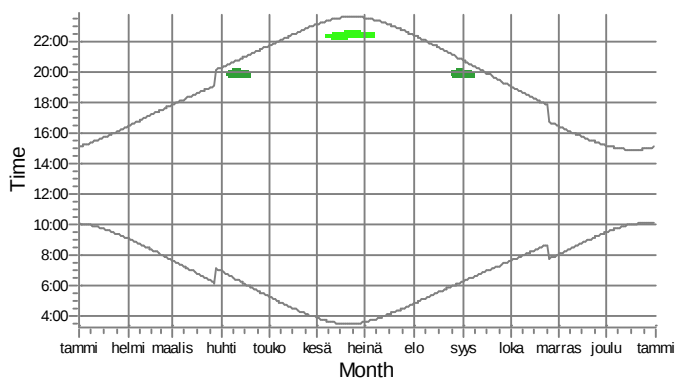
G: Fast bostad



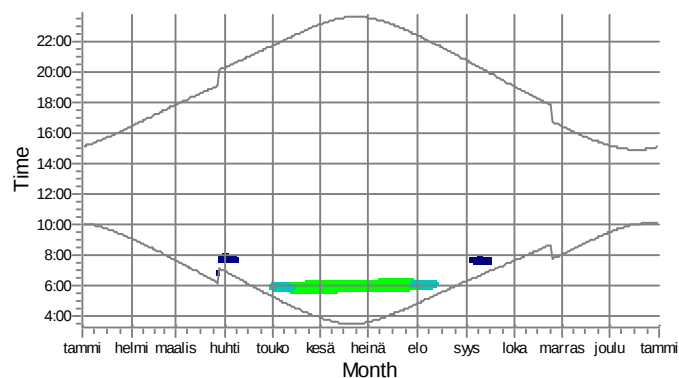
H: Fritidsbostad



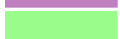
I: Fritidsbostad



J: Fritidsbostad



WTGs

	3: 3		6: 6		9: 9		11: 11		22: 24
	5: 5		7: 7		10: 10		20: 22		23: 25

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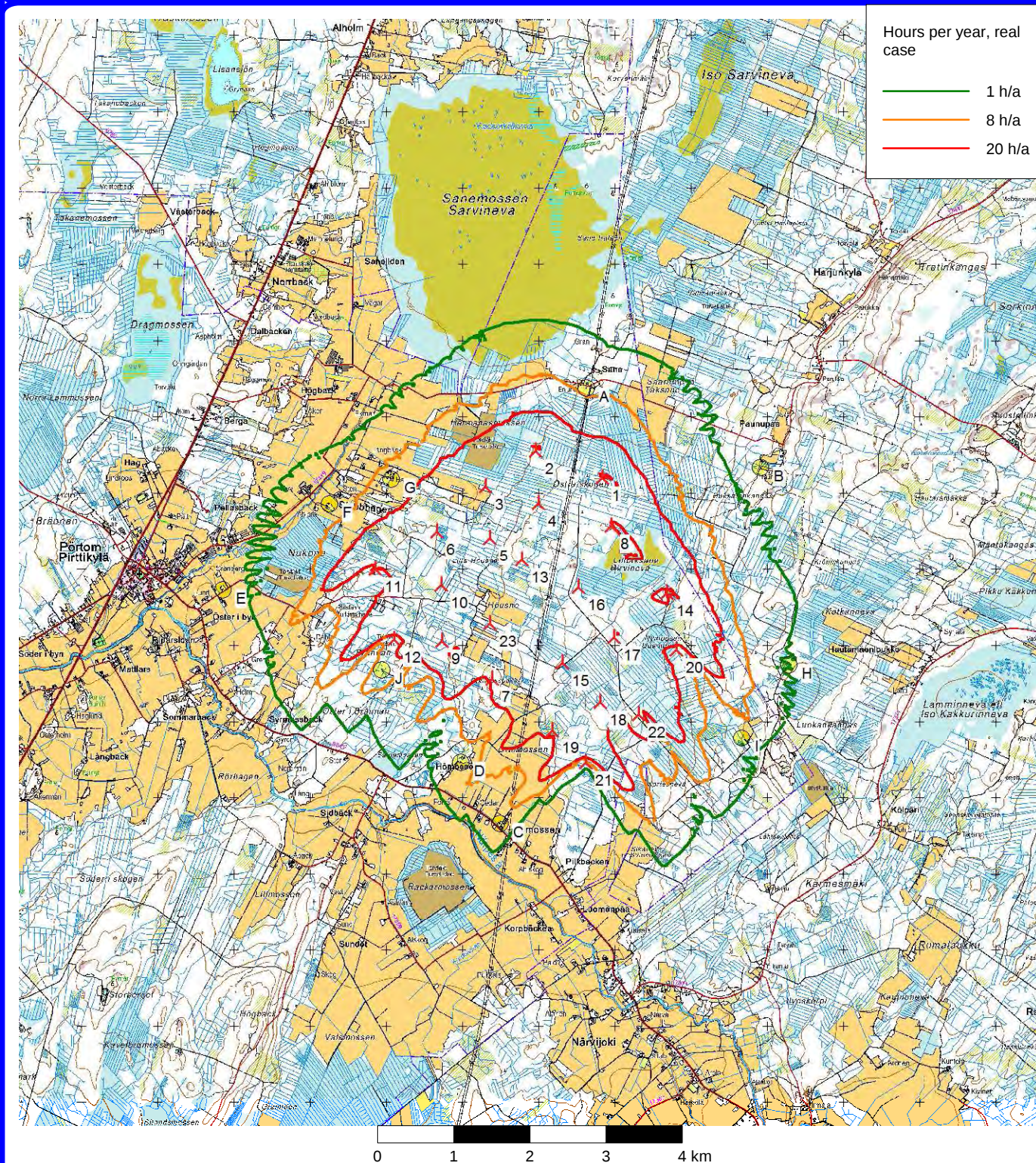
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Calculated:

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SHADOW - Map

Calculation: Pörtom Vestas V126 x 23 x HH137 (real case)



New WTG

Shadow receptor

Flicker map level: Korkeuskäyrät

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Calculated:

1.8.2013 8:58/2.8.579

SHADOW - Main Result

Calculation: Pörtom Vestas V126 x 12 x HH137 (real case)

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) [UMEA]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1,02	2,84	3,78	6,14	8,62	9,94	7,42	5,13	4,32	3,43	1,58	0,96

Operational hours are calculated from WTGs in calculation and wind distribution:

Pörtom mätmast

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
406	408	396	474	472	888	1583	1693	761	539	487	458	8566

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

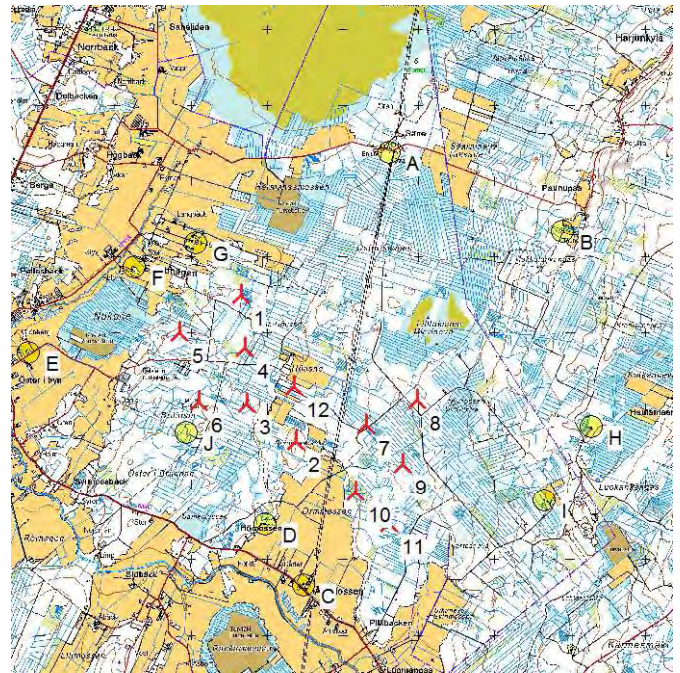
A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:

Height contours used: Korkeuskäyrät

Obstacles used in calculation

Eye height: 1,5 m

Grid resolution: 10,0 m



Scale 1:100 000

✚ New WTG

● Shadow receptor

WTGs

ETRS 89 Zone: 35				WTG type				Shadow data			
East	North	Z	Row	Valid	Manuf.	Type-generator	Power, rated	Rotor diameter	Hub height	Calculation	RPM
data/Description								distance			
[m]								[m] [RPM]			
1	228 661	6 965 499	40,0 4	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
2	229 379	6 963 565	51,7 12	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
3	228 727	6 964 062	46,1 11	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
4	228 712	6 964 799	42,5 8	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
5	227 846	6 965 006	41,1 9	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
6	228 094	6 964 087	48,6 10	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
7	230 303	6 963 780	50,9 17	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
8	230 977	6 964 114	56,3 18	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
9	230 795	6 963 261	52,4 16	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
10	230 172	6 962 898	45,2 13	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
11	230 613	6 962 469	47,5 14	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
12	229 356	6 964 293	41,8 7	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5

Shadow receptor-Input

ETRS 89 Zone: 35											
No.	Name	East	North	Z	Width	Height	Height a.g.l.	Degrees from south cw	Slope of window	Direction mode	
				[m]	[m]	[m]	[m]	[°]	[°]		
A	Fast bostad	230 620	6 967 377	42,2	1,0	1,0	1,0	-180,0	90,0	"Green house mode"	
B	Fast bostad	232 901	6 966 343	70,1	1,0	1,0	1,0	-180,0	90,0	"Green house mode"	
C	Fast bostad	229 481	6 961 667	42,5	1,0	1,0	1,0	-180,0	90,0	"Green house mode"	
D	Fast bostad	228 970	6 962 466	44,4	1,0	1,0	1,0	-180,0	90,0	"Green house mode"	
E	Fast bostad	225 850	6 964 736	30,4	1,0	1,0	1,0	-180,0	90,0	"Green house mode"	
F	Fast bostad	227 246	6 965 867	31,8	1,0	1,0	1,0	-180,0	90,0	"Green house mode"	
G	Fast bostad	228 054	6 966 189	35,0	1,0	1,0	1,0	-180,0	90,0	"Green house mode"	
H	Fritidsbostad	233 279	6 963 752	80,0	1,0	1,0	1,0	-180,0	90,0	"Green house mode"	
I	Fritidsbostad	232 661	6 962 785	69,7	1,0	1,0	1,0	-180,0	90,0	"Green house mode"	
J	Fritidsbostad	227 936	6 963 688	47,5	1,0	1,0	1,0	-180,0	90,0	"Green house mode"	

Project:

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Calculated:

1.8.2013 8:58/2.8.579



SHADOW - Main Result

Calculation: Pörtom Vestas V126 x 12 x HH137 (real case)

Calculation Results

Shadow receptor

Shadow, expected values

No.	Name	Shadow hours per year [h/year]
A	Fast bostad	0:00
B	Fast bostad	0:00
C	Fast bostad	6:04
D	Fast bostad	3:54
E	Fast bostad	0:00
F	Fast bostad	4:14
G	Fast bostad	8:27
H	Fritidsbostad	0:00
I	Fritidsbostad	0:00
J	Fritidsbostad	14:28

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

No.	Name	Worst case [h/year]	Expected [h/year]
1	4	24:35	4:53
2	12	6:54	1:19
3	11	45:28	12:00
4	8	9:36	1:25
5	9	38:33	6:14
6	10	0:00	0:00
7	17	0:00	0:00
8	18	0:00	0:00
9	16	0:00	0:00
10	13	12:39	2:52
11	14	27:02	7:06
12	7	8:19	1:57

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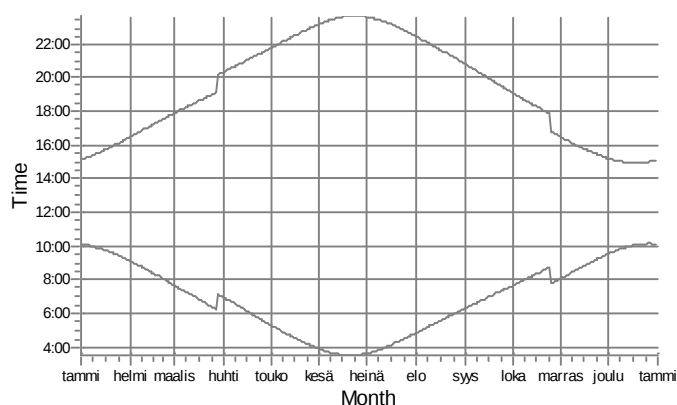
Calculated:

1.8.2013 8:58/2.8.579

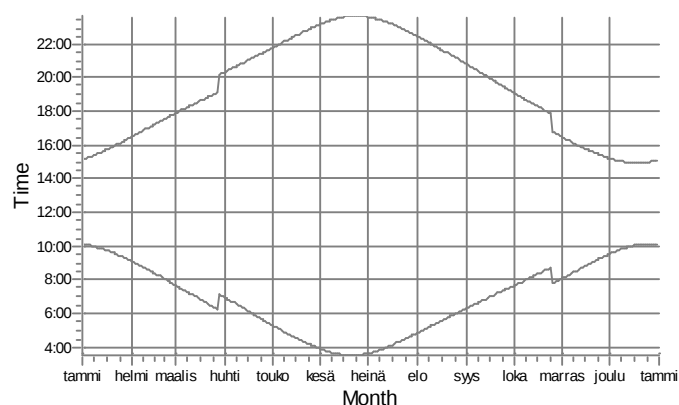
SHADOW - Calendar, graphical

Calculation: Pörtom Vestas V126 x 12 x HH137 (real case)

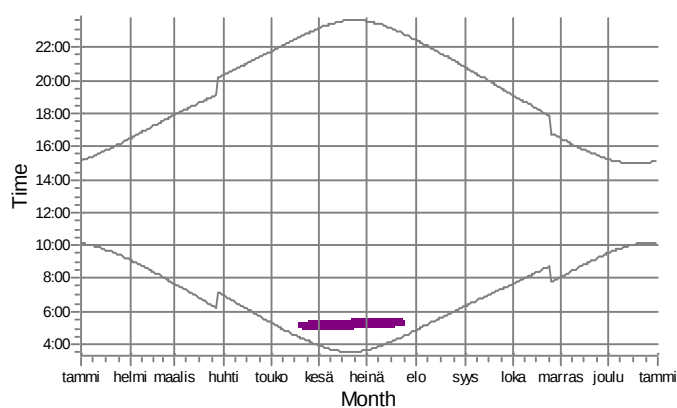
A: Fast bostad



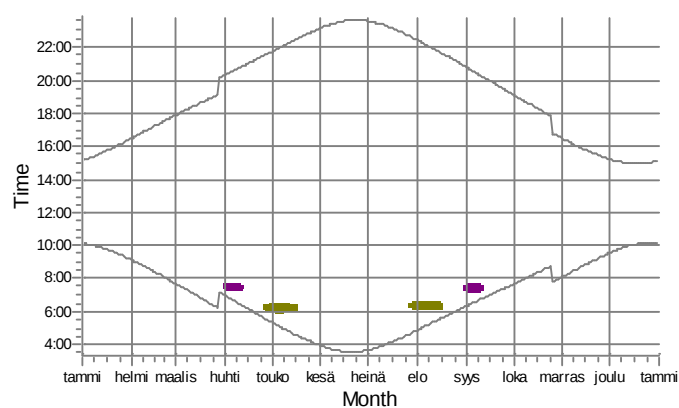
B: Fast bostad



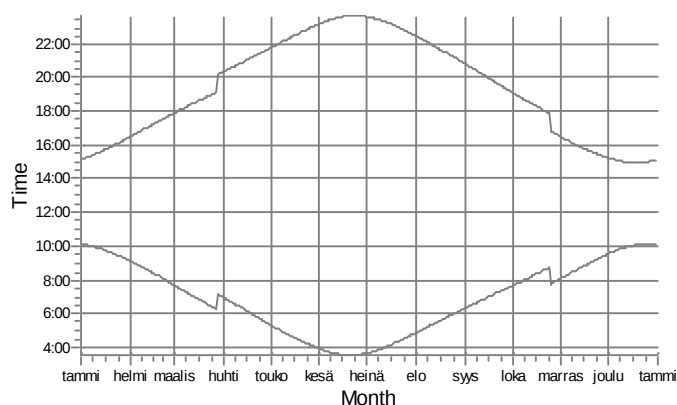
C: Fast bostad



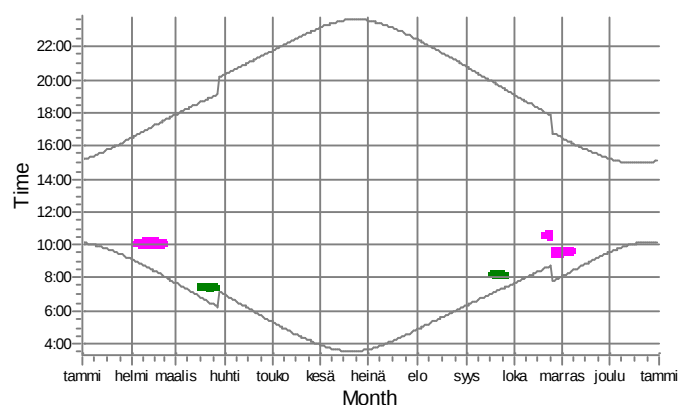
D: Fast bostad



E: Fast bostad



F: Fast bostad



WTGs



1: 4



5: 9



10: 13



11: 14

Project:

Pörtom

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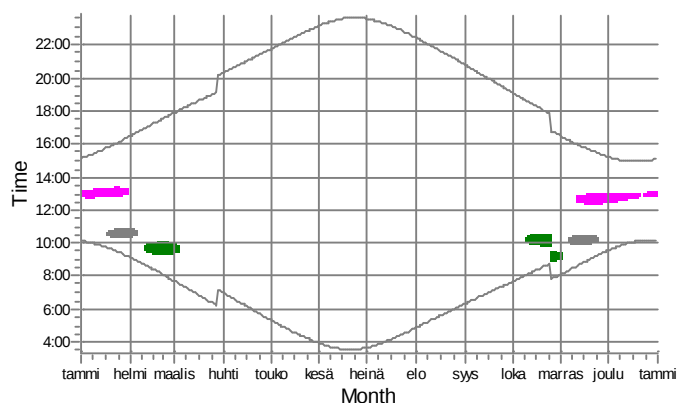
Calculated:

1.8.2013 8:58/2.8.579

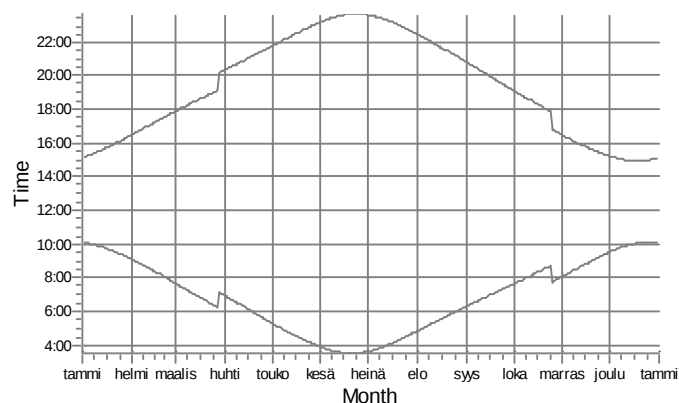
SHADOW - Calendar, graphical

Calculation: Pörtom Vestas V126 x 12 x HH137 (real case)

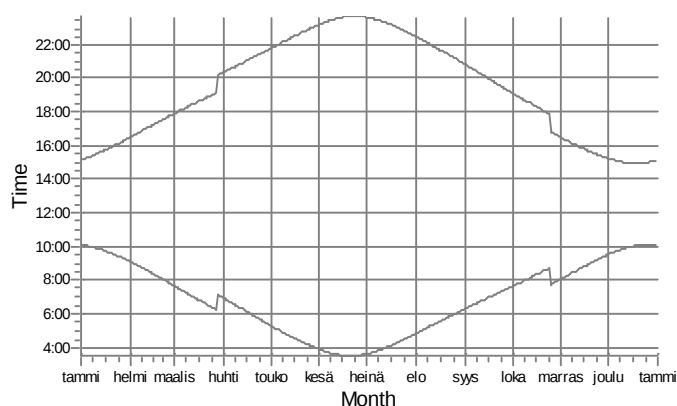
G: Fast bostad



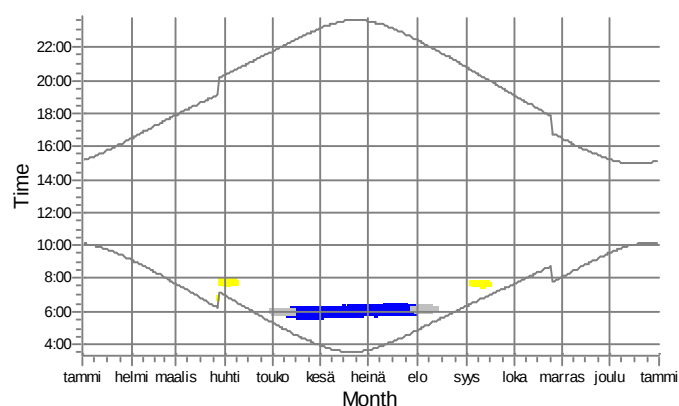
H: Fritidsbostad



I: Fritidsbostad



J: Fritidsbostad



WTGs



1: 4

2: 12



3: 11

4: 8



5: 9

12: 7

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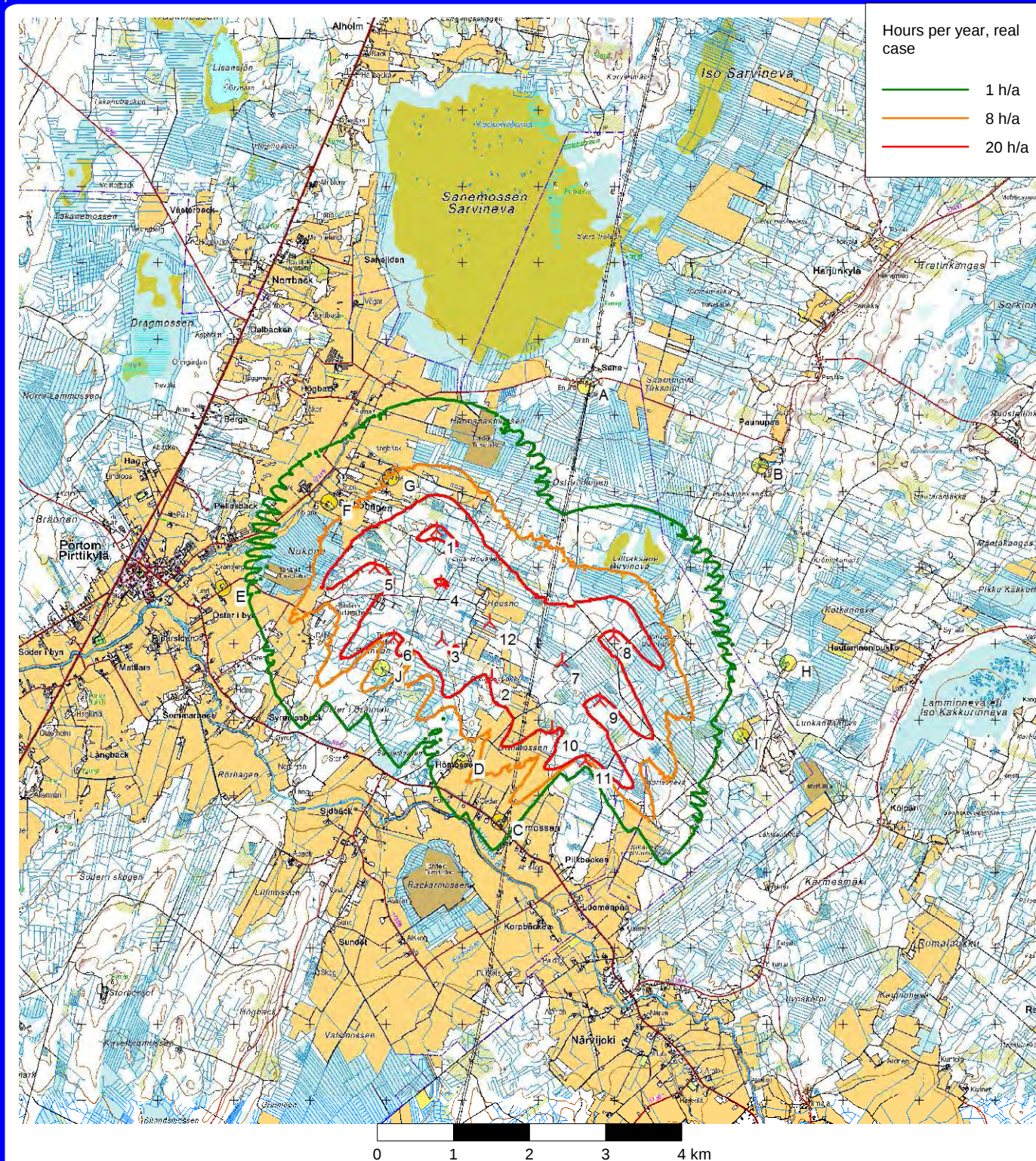
Janne Märsylä / janne.marsyla@fcg.fi

Calculated:

1.8.2013 8:58/2.8.579

SHADOW - Map

Calculation: Pörtom Vestas V126 x 12 x HH137 (real case)



New WTG

Shadow receptor

Flicker map level: Korkeuskäyrät

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Calculated:

9.10.2013 10:52/2.8.579

SHADOW - Main Result

Calculation: Pörtom Vestas V126 x 23 x HH137 (worst case)

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

The calculated times are "worst case" given by the following assumptions:

The sun is shining all the day, from sunrise to sunset

The rotor plane is always perpendicular to the line from the WTG to the sun

The WTG is always operating

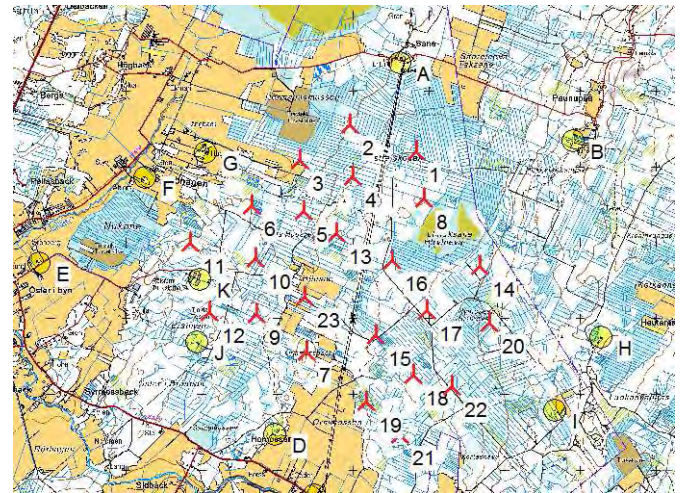
A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:

Height contours used: Korkeuskäyrät

Obstacles used in calculation

Eye height: 1,5 m

Grid resolution: 10,0 m



Scale 1:100 000

▲ New WTG

● Shadow receptor

WTGs

ETRS 89 Zone: 35				WTG type						Shadow data		
East	North	Z	Row	Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Calculation	RPM	
			data/Description							distance		
			[m]				[kW]	[m]	[m]	[m]	[RPM]	
1	230 832	6 966 209	49,2 WTG 23	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5	
2	229 955	6 966 564	40,7 WTG 1	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5	
3	229 294	6 966 095	35,8 WTG 2	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5	
4	229 994	6 965 875	44,5 WTG 3	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5	
5	229 351	6 965 422	38,7 WTG 5	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5	
6	228 661	6 965 499	40,0 WTG 4	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5	
7	229 379	6 963 565	51,7 WTG 12	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5	
8	230 940	6 965 579	54,7 WTG 22	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5	
9	228 727	6 964 062	46,1 WTG 11	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5	
10	228 712	6 964 799	42,5 WTG 8	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5	
11	227 846	6 965 006	41,1 WTG 9	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5	
12	228 094	6 964 087	48,6 WTG 10	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5	
13	229 773	6 965 133	45,0 WTG 6	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5	
14	231 676	6 964 690	58,6 WTG 20	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5	
15	230 303	6 963 780	50,9 WTG 17	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5	
16	230 514	6 964 772	52,5 WTG 21	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5	
17	230 977	6 964 114	56,3 WTG 18	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5	
18	230 795	6 963 261	52,4 WTG 16	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5	
19	230 172	6 962 898	45,2 WTG 13	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5	
20	231 803	6 963 951	61,9 WTG 19	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5	
21	230 613	6 962 469	47,5 WTG 14	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5	
22	231 300	6 963 106	55,2 WTG 15	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5	
23	229 356	6 964 293	41,8 WTG 7	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5	

Shadow receptor-Input

ETRS 89 Zone: 35											
No.	Name	East	North	Z	Width	Height	Height	Degrees from	Slope of	Direction mode	
							a.g.l.	south cw	window		
				[m]	[m]	[m]	[m]	[°]	[°]		
A	Fast bostad	230 620	6 967 377	42,2	1,0	1,0	1,0	-180,0	90,0	"Green house mode"	
B	Fast bostad	232 901	6 966 343	70,1	1,0	1,0	1,0	-180,0	90,0	"Green house mode"	
C	Fast bostad	229 481	6 961 667	42,5	1,0	1,0	1,0	-180,0	90,0	"Green house mode"	
D	Fast bostad	228 970	6 962 466	44,4	1,0	1,0	1,0	-180,0	90,0	"Green house mode"	
E	Fast bostad	225 850	6 964 736	30,4	1,0	1,0	1,0	-180,0	90,0	"Green house mode"	
F	Fast bostad	227 246	6 965 867	31,8	1,0	1,0	1,0	-180,0	90,0	"Green house mode"	
G	Fast bostad	228 054	6 966 189	35,0	1,0	1,0	1,0	-180,0	90,0	"Green house mode"	

To be continued on next page...

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9.10.2013 10:52/2.8.579



SHADOW - Main Result

Calculation: Pörtom Vestas V126 x 23 x HH137 (worst case)

...continued from previous page

ETRS 89 Zone: 35

No.	Name	East	North	Z	Width	Height	Height a.g.l.	Degrees from south cw	Slope of window	Direction mode
				[m]	[m]	[m]	[m]	[°]	[°]	
H	Fritidsbostad	233 279	6 963 752	80,0	1,0	1,0	1,0	-180,0	90,0	"Green house mode"
I	Fritidsbostad	232 661	6 962 785	69,7	1,0	1,0	1,0	-180,0	90,0	"Green house mode"
J	Fritidsbostad	227 936	6 963 688	47,5	1,0	1,0	1,0	-180,0	90,0	"Green house mode"
K	Pälsfarm	227 972	6 964 523	47,5	1,0	1,0	1,0	-180,0	90,0	"Green house mode"

Calculation Results

Shadow receptor

Shadow, worst case

No.	Name	Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]
A	Fast bostad	47:53	96	0:44
B	Fast bostad	0:00	0	0:00
C	Fast bostad	21:51	65	0:23
D	Fast bostad	17:50	65	0:24
E	Fast bostad	0:00	0	0:00
F	Fast bostad	21:46	67	0:29
G	Fast bostad	66:43	173	0:42
H	Fritidsbostad	5:36	24	0:19
I	Fritidsbostad	12:48	58	0:21
J	Fritidsbostad	57:26	132	0:36
K	Pälsfarm	158:08	220	1:26

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

No.	Name	Worst case [h/year]	Expected [h/year]
1	WTG 23	18:54	
2	WTG 1	16:40	
3	WTG 2	9:24	
4	WTG 3	12:19	
5	WTG 5	17:03	
6	WTG 4	24:35	
7	WTG 12	11:50	
8	WTG 22	0:00	
9	WTG 11	63:13	
10	WTG 8	61:34	
11	WTG 9	38:33	
12	WTG 10	66:55	
13	WTG 6	0:00	
14	WTG 20	0:00	
15	WTG 17	0:00	
16	WTG 21	0:00	
17	WTG 18	0:00	
18	WTG 16	0:00	
19	WTG 13	12:39	
20	WTG 19	11:07	
21	WTG 14	27:02	
22	WTG 15	7:16	
23	WTG 7	15:20	

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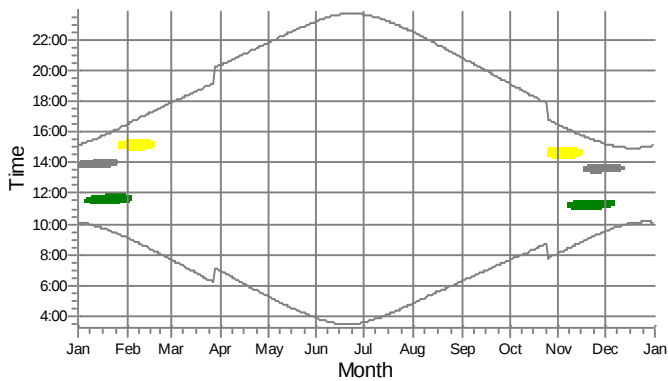
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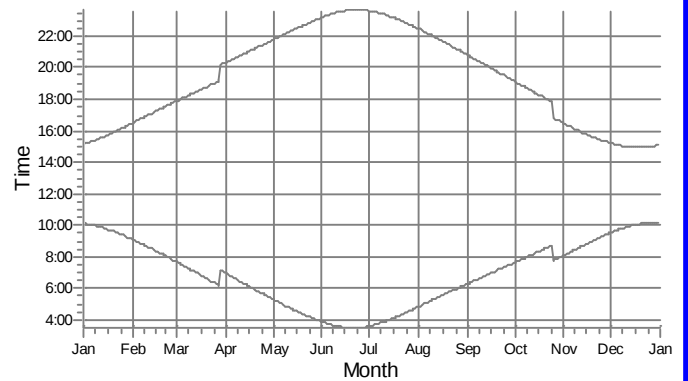
SHADOW - Calendar, graphical

Calculation: Pörtom Vestas V126 x 23 x HH137 (worst case)

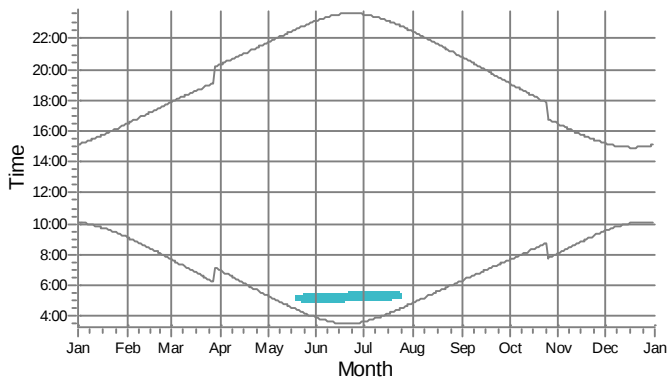
A: Fast bostad



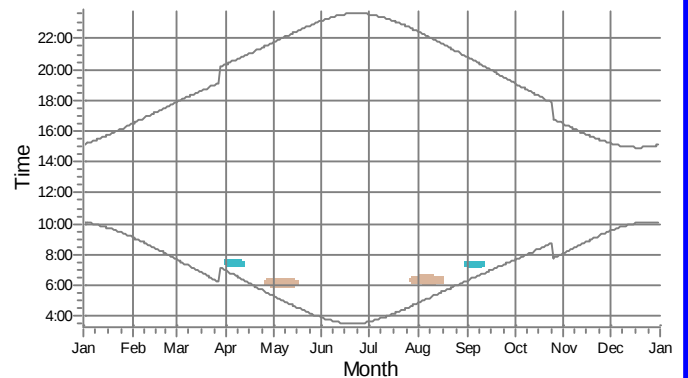
B: Fast bostad



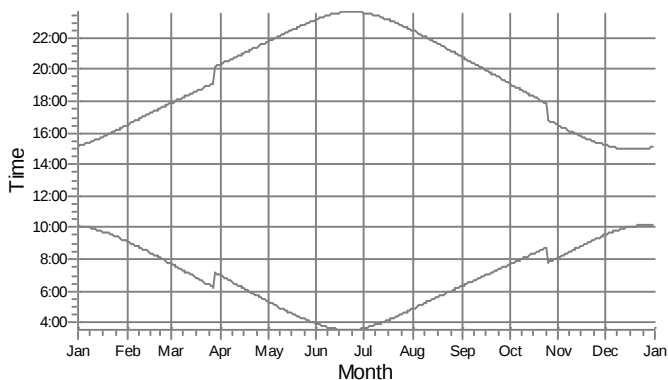
C: Fast bostad



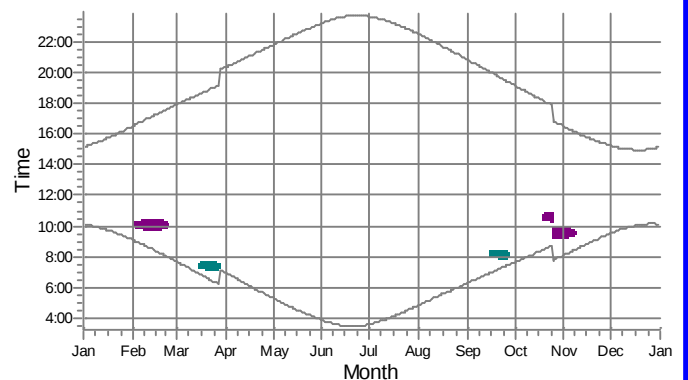
D: Fast bostad



E: Fast bostad



F: Fast bostad



WTGs



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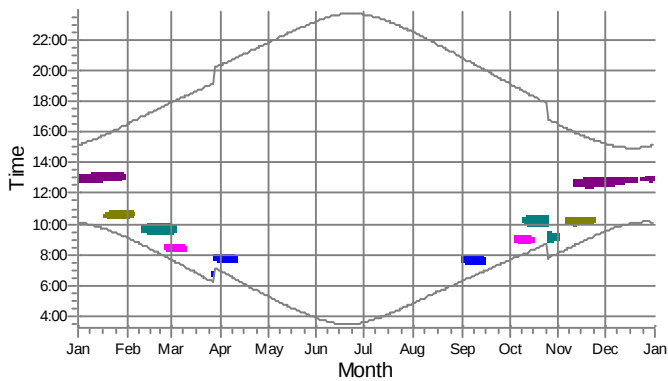
Calculated:

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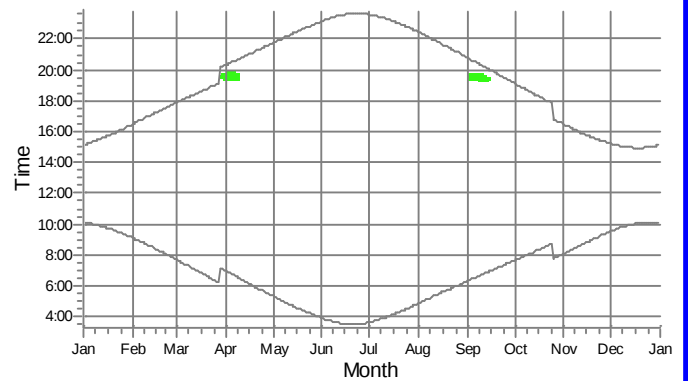
SHADOW - Calendar, graphical

Calculation: Pörtom Vestas V126 x 23 x HH137 (worst case)

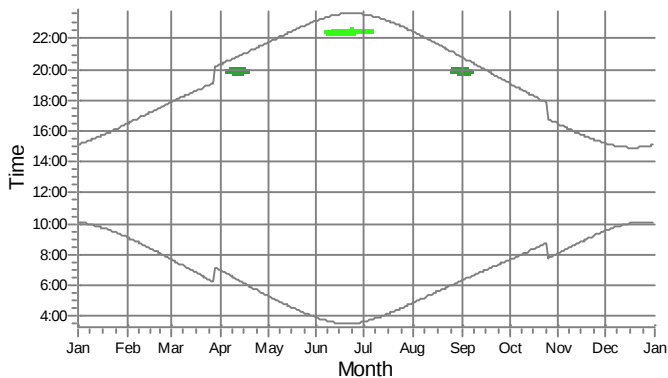
G: Fast bostad



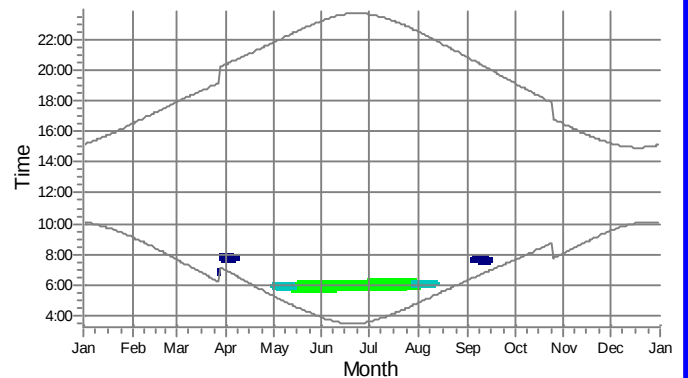
H: Fritidsbostad



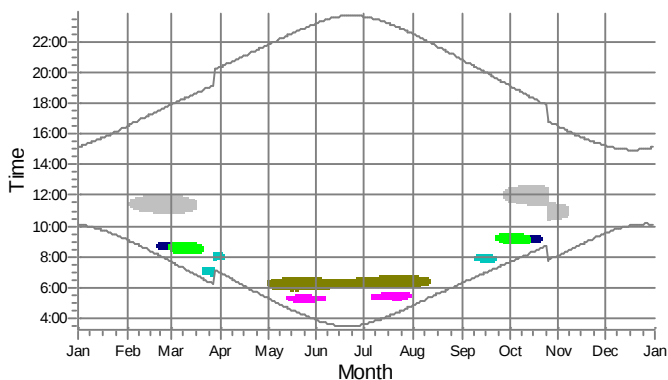
I: Fritidsbostad



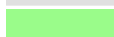
J: Fritidsbostad



K: Pälsfarm



WTGs

	3: WTG 2		7: WTG 12		11: WTG 9		22: WTG 15
	5: WTG 5		9: WTG 11		12: WTG 10		23: WTG 7
	6: WTG 4		10: WTG 8		20: WTG 19		

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SHADOW - Map

Calculation: Pörtom Vestas V126 x 23 x HH137 (worst case)



New WTG

Shadow receptor

Flicker map level: Korkeuskäyrät

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SHADOW - Main Result

Calculation: Pörtom Vestas V126 x 12 x HH137 (worst case)

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

The calculated times are "worst case" given by the following assumptions:

The sun is shining all the day, from sunrise to sunset

The rotor plane is always perpendicular to the line from the WTG to the sun

The WTG is always operating

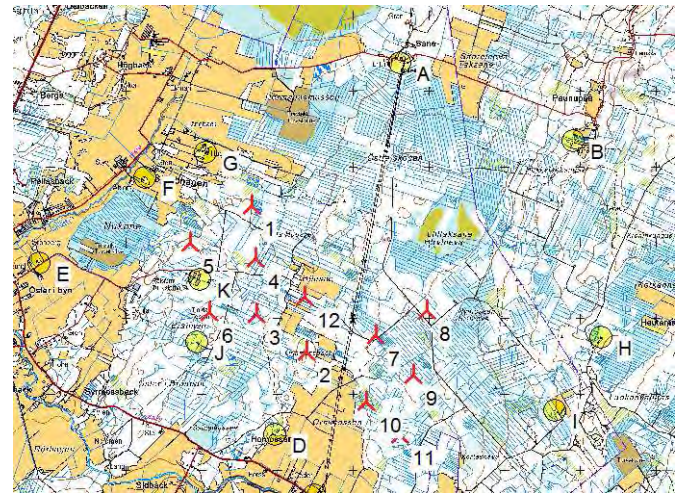
A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:

Height contours used: Korkeuskäyrät

Obstacles used in calculation

Eye height: 1,5 m

Grid resolution: 10,0 m



Scale 1:100 000

▲ New WTG

● Shadow receptor

WTGs

ETRS 89 Zone: 35				WTG type						Shadow data		
East	North	Z	Row	Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Calculation	RPM	
			data/Description							distance		
			[m]				[kW]	[m]	[m]	[m]	[RPM]	
1	228 661	6 965 499	40,0 4	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5	
2	229 379	6 963 565	51,7 12	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5	
3	228 727	6 964 062	46,1 11	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5	
4	228 712	6 964 799	42,5 8	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5	
5	227 846	6 965 006	41,1 9	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5	
6	228 094	6 964 087	48,6 10	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5	
7	230 303	6 963 780	50,9 17	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5	
8	230 977	6 964 114	56,3 18	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5	
9	230 795	6 963 261	52,4 16	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5	
10	230 172	6 962 898	45,2 13	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5	
11	230 613	6 962 469	47,5 14	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5	
12	229 356	6 964 293	41,8 7	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5	

Shadow receptor-Input

ETRS 89 Zone: 35											
No.	Name	East	North	Z	Width	Height	Height	Degrees from	Slope of	Direction mode	
							a.g.l.	south cw	window		
				[m]	[m]	[m]	[m]	[°]	[°]		
A	Fast bostad	230 620	6 967 377	42,2	1,0	1,0	1,0	-180,0	90,0	"Green house mode"	
B	Fast bostad	232 901	6 966 343	70,1	1,0	1,0	1,0	-180,0	90,0	"Green house mode"	
C	Fast bostad	229 481	6 961 667	42,5	1,0	1,0	1,0	-180,0	90,0	"Green house mode"	
D	Fast bostad	228 970	6 962 466	44,4	1,0	1,0	1,0	-180,0	90,0	"Green house mode"	
E	Fast bostad	225 850	6 964 736	30,4	1,0	1,0	1,0	-180,0	90,0	"Green house mode"	
F	Fast bostad	227 246	6 965 867	31,8	1,0	1,0	1,0	-180,0	90,0	"Green house mode"	
G	Fast bostad	228 054	6 966 189	35,0	1,0	1,0	1,0	-180,0	90,0	"Green house mode"	
H	Fritidsbostad	233 279	6 963 752	80,0	1,0	1,0	1,0	-180,0	90,0	"Green house mode"	
I	Fritidsbostad	232 661	6 962 785	69,7	1,0	1,0	1,0	-180,0	90,0	"Green house mode"	
J	Fritidsbostad	227 936	6 963 688	47,5	1,0	1,0	1,0	-180,0	90,0	"Green house mode"	
K	Pälsfarm	227 972	6 964 523	47,5	1,0	1,0	1,0	-180,0	90,0	"Green house mode"	

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SHADOW - Main Result

Calculation: Pörtom Vestas V126 x 12 x HH137 (worst case)

Calculation Results

Shadow receptor

Shadow, worst case

No.	Name	Shadow hours	Shadow days	Max shadow
		per year [h/year]	per year [days/year]	hours per day [h/day]
A	Fast bostad	0:00	0	0:00
B	Fast bostad	0:00	0	0:00
C	Fast bostad	21:51	65	0:23
D	Fast bostad	17:50	65	0:24
E	Fast bostad	0:00	0	0:00
F	Fast bostad	21:46	67	0:29
G	Fast bostad	50:58	132	0:42
H	Fritidsbostad	0:00	0	0:00
I	Fritidsbostad	0:00	0	0:00
J	Fritidsbostad	57:26	132	0:36
K	Pälsfarm	147:25	220	1:26

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

No.	Name	Worst case	Expected
		[h/year]	[h/year]
1	4	24:35	
2	12	11:50	
3	11	63:13	
4	8	61:34	
5	9	38:33	
6	10	66:55	
7	17	0:00	
8	18	0:00	
9	16	0:00	
10	13	12:39	
11	14	27:02	
12	7	15:20	

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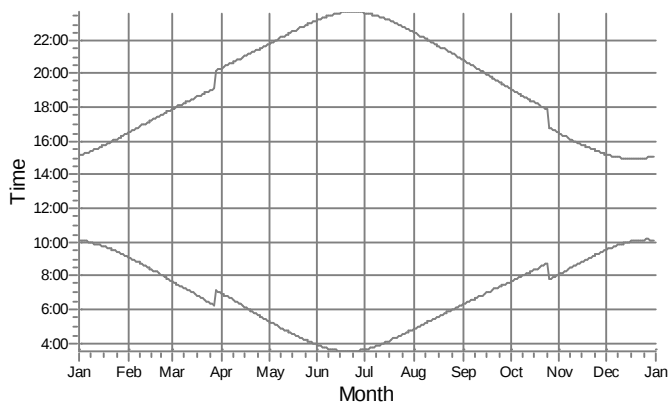
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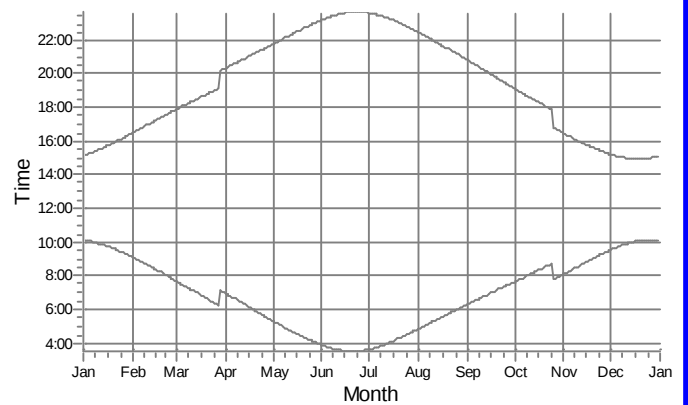
9.10.2013 11:12/2.8.579

SHADOW - Calendar, graphical**Calculation:** Pörtom Vestas V126 x 12 x HH137 (worst case)

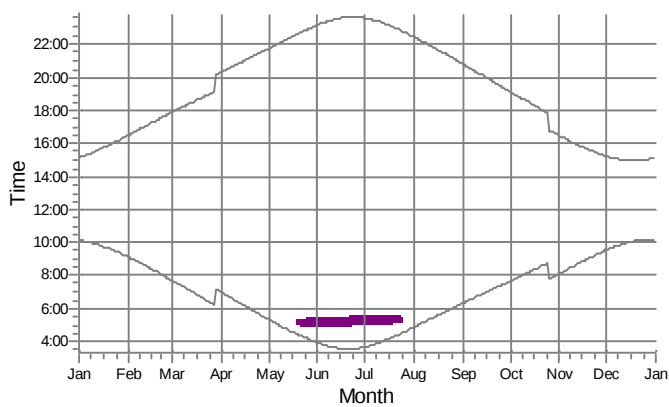
A: Fast bostad



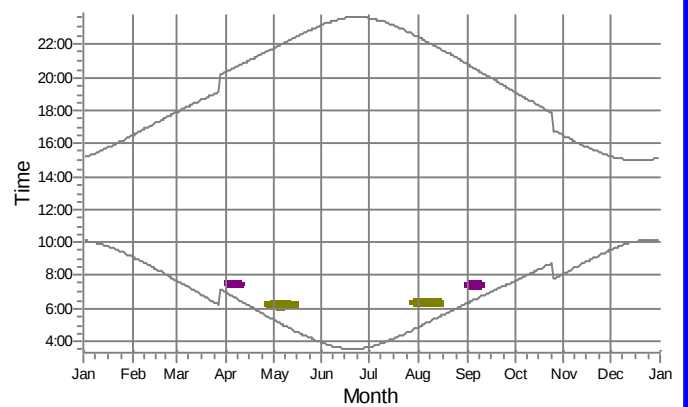
B: Fast bostad



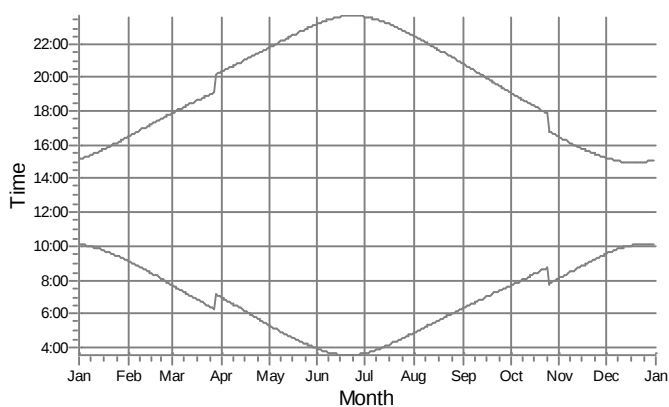
C: Fast bostad



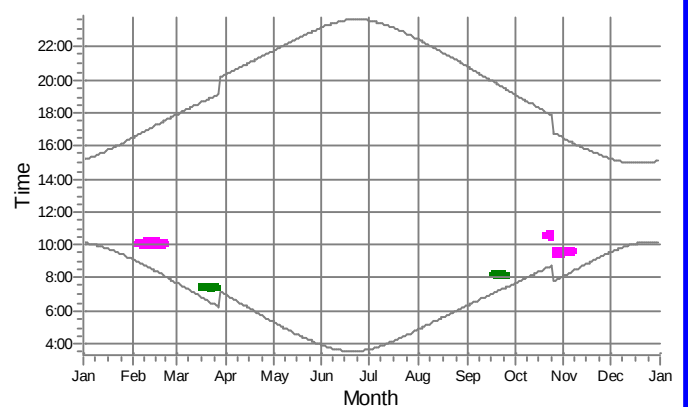
D: Fast bostad



E: Fast bostad



F: Fast bostad



WTGs



1: 4



5: 9



10: 13



11: 14

Project:

Pörtom

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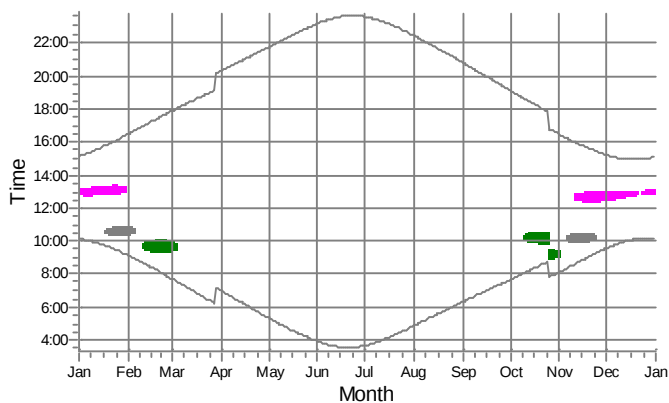
Janne Märsylä / janne.marsyla@fcg.fi

Calculated:

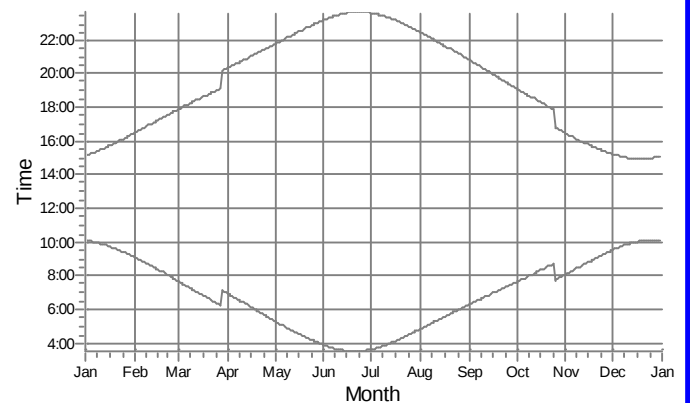
9.10.2013 11:12/2.8.579

SHADOW - Calendar, graphical**Calculation:** Pörtom Vestas V126 x 12 x HH137 (worst case)

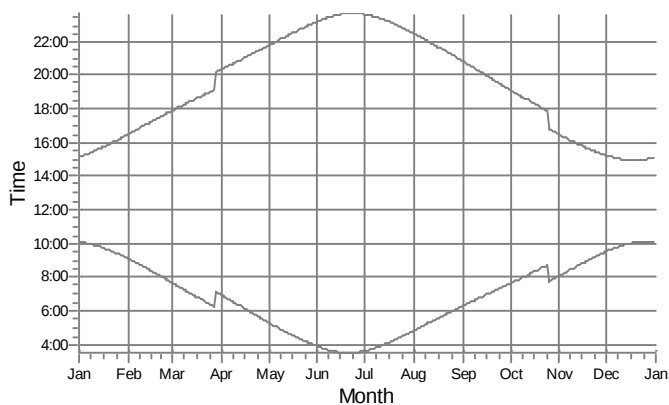
G: Fast bostad



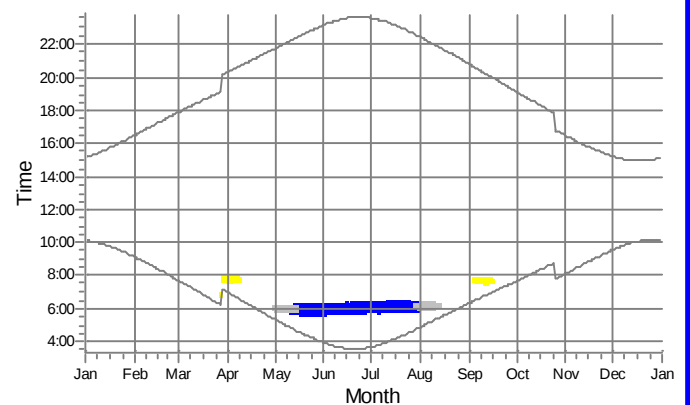
H: Fritidsbostad



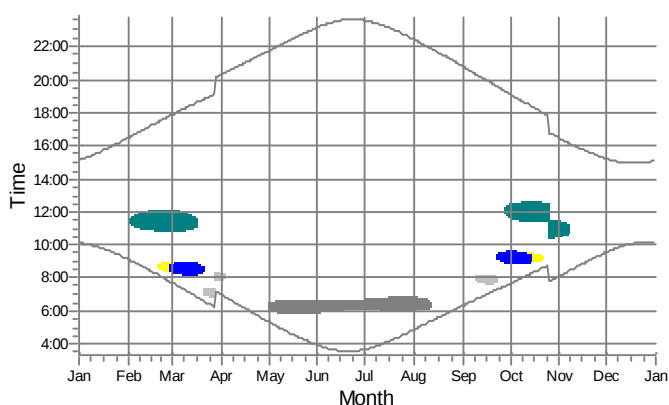
I: Fritidsbostad



J: Fritidsbostad



K: Pälsfarm



WTGs



Project:

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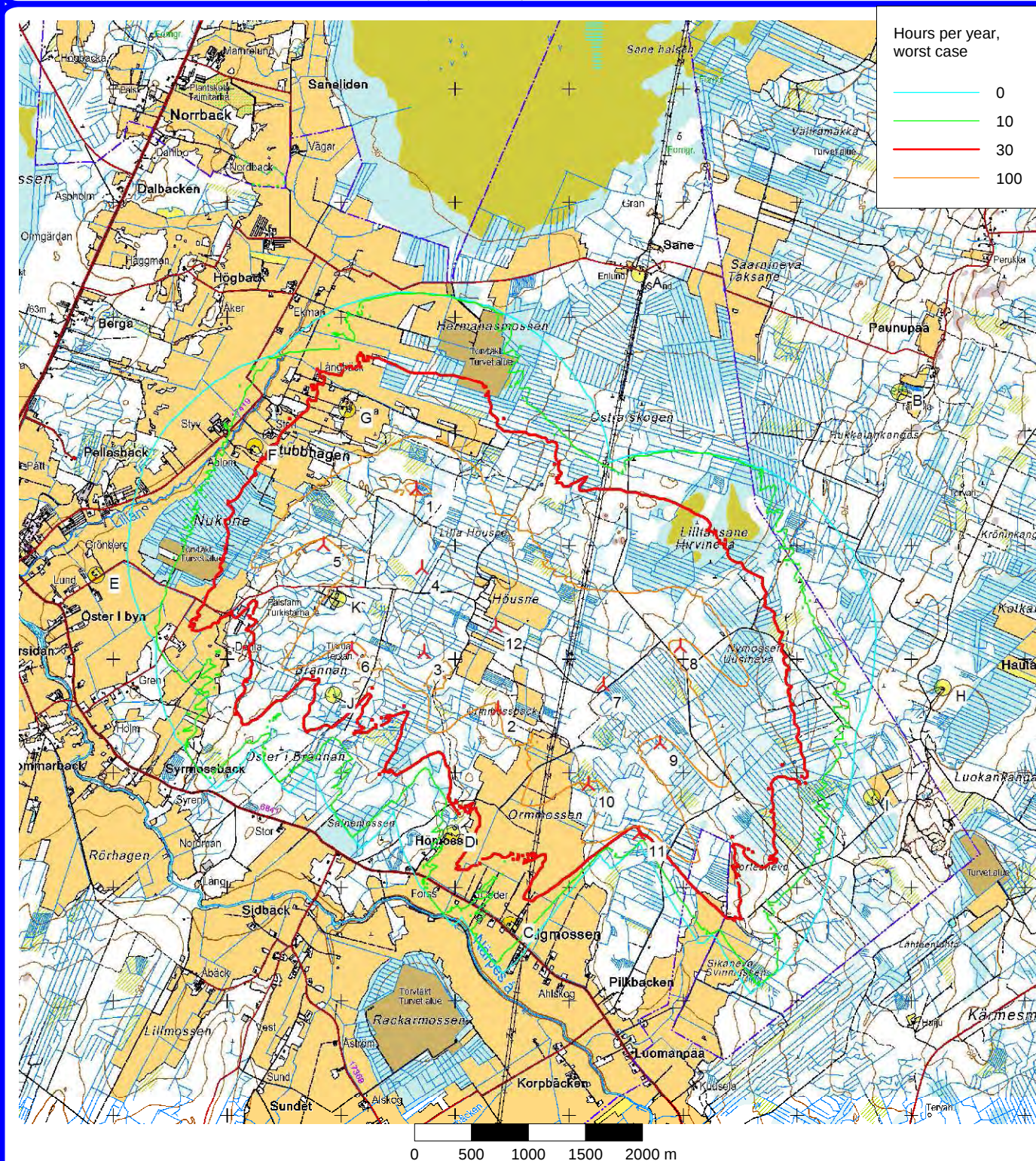
Janne Märsylä / janne.marsyla@fcg.fi

Calculated:

9.10.2013 11:12/2.8.579

SHADOW - Map

Calculation: Pörtom Vestas V126 x 12 x HH137 (worst case)



New WTG

Shadow receptor

Flicker map level: Korkeuskäyrät

BILAGA 4

Synlighetsanalys (ZVI)

