

Project:

**Merkkikallio**

Printed/Page

23.10.2014 12:39 / 1

Licensed user:

**FCG Suunnittelu ja tekniikka Oy**

Osmontie 34, PO Box 950

FI-00601 Helsinki

+358104095666

Paulina Kaivo-oja / paulina.kaivo-oja@fcg.fi

Calculated:

23.10.2014 12:31/2.9.269

## SHADOW - Main Result

Calculation: G132 x 20 x HH149

### 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:

MERRA\_basic\_E22.002\_N63.000

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
726	630	499	458	549	715	903	1292	934	794	585	572	8659

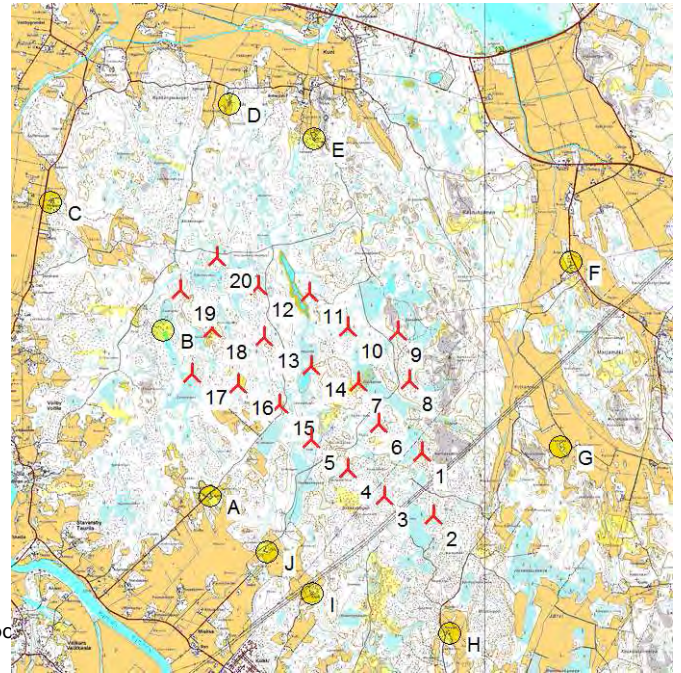
Idle start wind speed: Cut in wind speed from power curve

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: Merkkikallio\_height contour lines.wpc

Obstacles used in calculation

Eye height: 1,5 m

Grid resolution: 10,0 m



▲ New WTG

● Shadow receptor

### WTGs

Finish TM ETRS-TM35FIN-ETRS89	ETRS-TM35FIN-ETRS89			Row data/Description	WTG type				Shadow data			
	East	North	Z		Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Calculation distance	RPM
			[m]				[kW]	[m]	[m]	[m]	[m]	[RPM]
1	247 179	7 007 678	23,1	24	Yes	GAMESA	G132-5 000	5 000	132,0	149,0	2 500	12,0
2	247 326	7 006 839	30,0	4	Yes	GAMESA	G132-5 000	5 000	132,0	149,0	2 500	12,0
3	246 686	7 007 088	29,0	5	Yes	GAMESA	G132-5 000	5 000	132,0	149,0	2 500	12,0
4	246 193	7 007 452	25,0	6	Yes	GAMESA	G132-5 000	5 000	132,0	149,0	2 500	12,0
5	245 719	7 007 851	15,0	7	Yes	GAMESA	G132-5 000	5 000	132,0	149,0	2 500	12,0
6	246 599	7 008 050	20,0	8	Yes	GAMESA	G132-5 000	5 000	132,0	149,0	2 500	12,0
7	246 333	7 008 602	20,0	9	Yes	GAMESA	G132-5 000	5 000	132,0	149,0	2 500	12,0
8	247 005	7 008 619	23,7	10	Yes	GAMESA	G132-5 000	5 000	132,0	149,0	2 500	12,0
9	246 857	7 009 262	20,4	11	Yes	GAMESA	G132-5 000	5 000	132,0	149,0	2 500	12,0
10	246 197	7 009 318	20,0	12	Yes	GAMESA	G132-5 000	5 000	132,0	149,0	2 500	12,0
11	245 695	7 009 777	15,6	13	Yes	GAMESA	G132-5 000	5 000	132,0	149,0	2 500	12,0
12	245 020	7 009 865	15,0	14	Yes	GAMESA	G132-5 000	5 000	132,0	149,0	2 500	12,0
13	245 102	7 009 197	18,4	15	Yes	GAMESA	G132-5 000	5 000	132,0	149,0	2 500	12,0
14	245 718	7 008 815	15,0	16	Yes	GAMESA	G132-5 000	5 000	132,0	149,0	2 500	12,0
15	245 303	7 008 303	15,0	17	Yes	GAMESA	G132-5 000	5 000	132,0	149,0	2 500	12,0
16	244 750	7 008 566	15,0	18	Yes	GAMESA	G132-5 000	5 000	132,0	149,0	2 500	12,0
17	244 153	7 008 706	12,9	19	Yes	GAMESA	G132-5 000	5 000	132,0	149,0	2 500	12,0
18	244 411	7 009 302	20,0	20	Yes	GAMESA	G132-5 000	5 000	132,0	149,0	2 500	12,0
19	243 995	7 009 816	14,3	21	Yes	GAMESA	G132-5 000	5 000	132,0	149,0	2 500	12,0
20	244 472	7 010 240	16,7	22	Yes	GAMESA	G132-5 000	5 000	132,0	149,0	2 500	12,0

### Shadow receptor-Input

No.	Name	Finish TM ETRS-TM35FIN-ETRS89							Slope of window	Direction mode
		East	North	Z	Width	Height	Height a.g.l.	Degrees from south		
				[m]	[m]	[m]	[m]	[°]	[°]	
A	Asuinrakennus (Langkujavägen 200)	244 392	7 007 085	10,0	5,0	5,0	1,0	0,0	0,0	"Green house mode"

To be continued on next page...

Project:

Merkkikallio

Printed/Page

23.10.2014 12:39 / 2

Licensed user:

FCG Suunnittelu ja tekniikka Oy

Osmontie 34, PO Box 950

FI-00601 Helsinki

+358104095666

Paulina Kaivo-oja / paulina.kaivo-oja@fcg.fi

Calculated:

23.10.2014 12:31/2.9.269

**SHADOW - Main Result**

Calculation: G132 x 20 x HH149

...continued from previous page

**Finish TM ETRS-TM35FIN-ETRS89**

No.	Name	East	North	Z	Width	Height	Height a.g.l.	Degrees from south	Slope of window	Direction mode
B	Lomarakennus (Voitby Långträsket)	243 772	7 009 284	12,8	5,0	5,0	1,0	0,0	0,0	"Green house mode"
C	Asuinrakennus (Voitbyntie 480)	242 293	7 010 963	5,0	5,0	5,0	1,0	0,0	0,0	"Green house mode"
D	Asuinrakennus (Kunintie 289)	244 642	7 012 253	5,0	5,0	5,0	1,0	0,0	0,0	"Green house mode"
E	Asuinrakennus (Sandhedsvägen 65)	245 754	7 011 805	10,0	5,0	5,0	1,0	0,0	0,0	"Green house mode"
F	Asuinrakennus (Mullontie 128)	249 130	7 010 173	7,5	5,0	5,0	1,0	0,0	0,0	"Green house mode"
G	Lomarakennus/Partiomaja (Korpilahdenkuja 134)	248 995	7 007 749	10,0	5,0	5,0	1,0	0,0	0,0	"Green house mode"
H	Asuinrakennus (Kotkannevantie 269)	247 537	7 005 291	18,5	5,0	5,0	1,0	0,0	0,0	"Green house mode"
I	Asuinrakennus (Klumpintie 171)	245 733	7 005 809	12,5	5,0	5,0	1,0	0,0	0,0	"Green house mode"
J	Asuinrakennus (Klumpvägen 170)	245 136	7 006 355	10,0	5,0	5,0	1,0	0,0	0,0	"Green house mode"

**Calculation Results**

Shadow receptor

**Shadow, expected values**

No.	Name	Shadow hours per year [h/year]
A	Asuinrakennus (Langkujavägen 200)	8:09
B	Lomarakennus (Voitby Långträsket)	30:23
C	Asuinrakennus (Voitbyntie 480)	1:12
D	Asuinrakennus (Kunintie 289)	2:37
E	Asuinrakennus (Sandhedsvägen 65)	3:37
F	Asuinrakennus (Mullontie 128)	0:27
G	Lomarakennus/Partiomaja (Korpilahdenkuja 134)	3:40
H	Asuinrakennus (Kotkannevantie 269)	0:00
I	Asuinrakennus (Klumpintie 171)	2:50
J	Asuinrakennus (Klumpvägen 170)	4:17

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

No.	Name	Worst case [h/year]	Expected [h/year]
1	24	9:08	2:06
2	4	18:30	4:36
3	5	14:20	3:29
4	6	5:37	1:12
5	7	16:46	4:28
6	8	5:22	1:14
7	9	5:38	1:33
8	10	3:40	0:45
9	11	2:13	0:27
10	12	2:11	0:28
11	13	17:48	2:41
12	14	30:00	5:44
13	15	9:19	2:00
14	16	3:36	0:40
15	17	4:51	0:59
16	18	11:11	2:18
17	19	34:45	7:12
18	20	50:58	11:51
19	21	3:42	0:44
20	22	21:21	3:02

Project:

**Merkkikallio**

Printed/Page

23.10.2014 12:39 / 3

Licensed user:

**FCG Suunnittelu ja tekniikka Oy**

Osmontie 34, PO Box 950

FI-00601 Helsinki

+358104095666

Paulina Kaivo-oja / paulina.kaivo-oja@fcg.fi

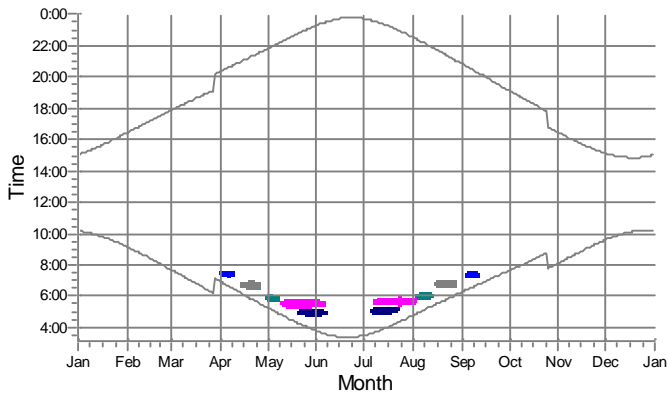
Calculated:

23.10.2014 12:31/2.9.269

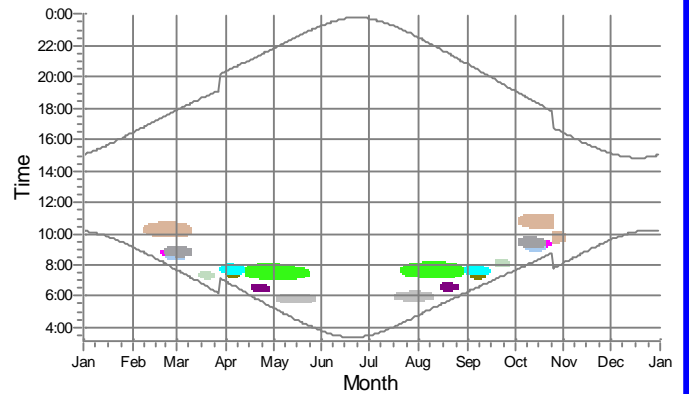
**SHADOW - Calendar, graphical**

Calculation: G132 x 20 x HH149

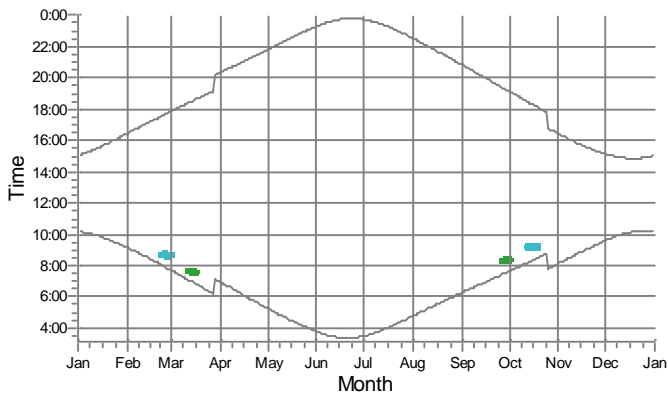
A: Asuinrakennus (Langkujavägen 200)



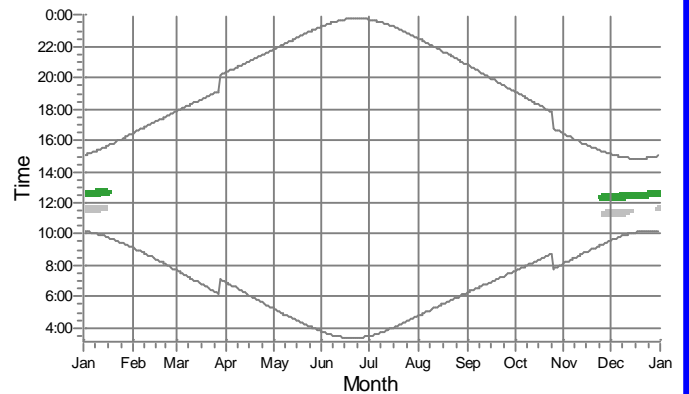
B: Lomarakennus (Voitby Långträsket)



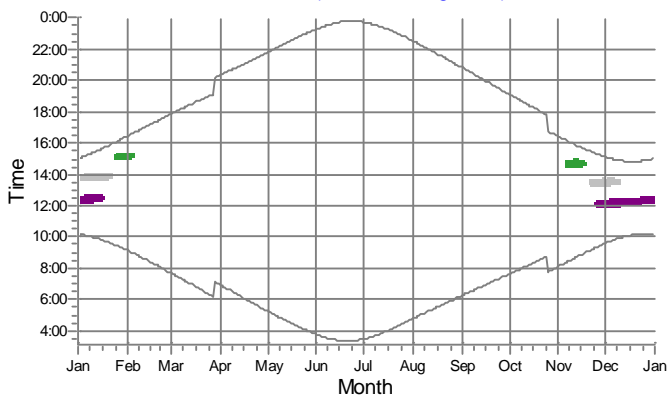
C: Asuinrakennus (Voitbyntie 480)



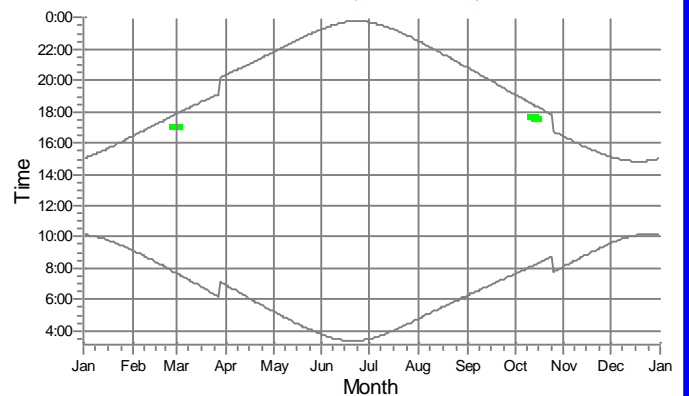
D: Asuinrakennus (Kunintie 289)


















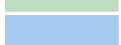

E: Asuinrakennus (Sandhedsvägen 65)



F: Asuinrakennus (Mullontie 128)



**WTGs**

	3: 5		7: 9		12: 14		16: 18		20: 22
	4: 6		9: 11		13: 15		17: 19		
	5: 7		10: 12		14: 16		18: 20		
	6: 8		11: 13		15: 17		19: 21		

Project:

**Merkkikallio**

Printed/Page

23.10.2014 12:39 / 4

Licensed user:

**FCG Suunnittelu ja tekniikka Oy**

Osmontie 34, PO Box 950

FI-00601 Helsinki

+358104095666

Paulina Kaivo-oja / paulina.kaivo-oja@fcg.fi

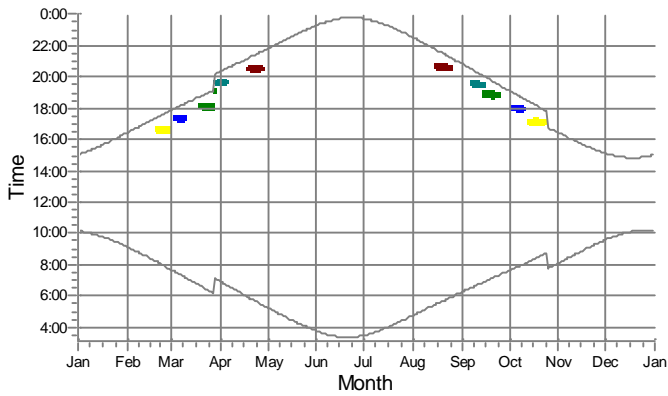
Calculated:

23.10.2014 12:31/2.9.269

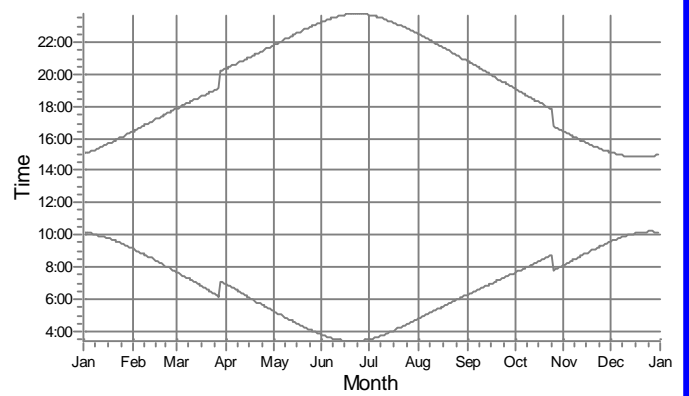
### SHADOW - Calendar, graphical

Calculation: G132 x 20 x HH149

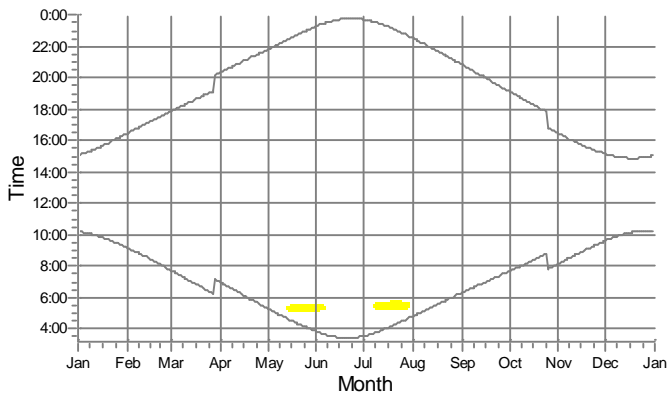
G: Lomarakenus/Partiomaja (Korpilahdenkuja 134)



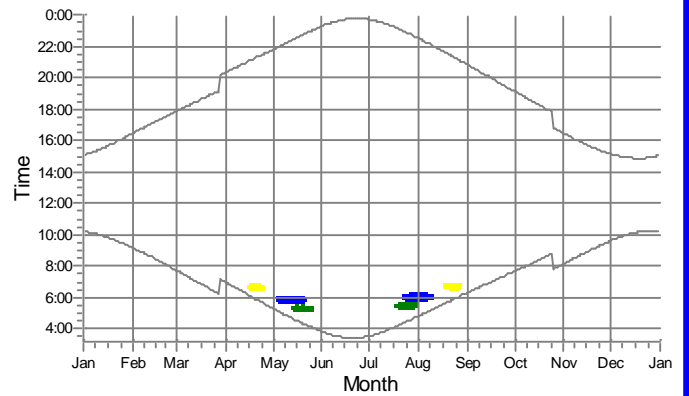
H: Asuinrakennus (Kotkannevantie 269)



I: Asuinrakennus (Klumpintie 171)



J: Asuinrakennus (Klumpvägen 170)



WTGs



1: 24



2: 4



3: 5



6: 8



8: 10



Project:

**Merkkikallio**

Printed/Page

23.10.2014 12:39 / 5

Licensed user:

**FCG Suunnittelu ja tekniikka Oy**

Osmontie 34, PO Box 950

FI-00601 Helsinki

+358104095666

Paulina Kaivo-oja / paulina.kaivo-oja@fcg.fi

Calculated:

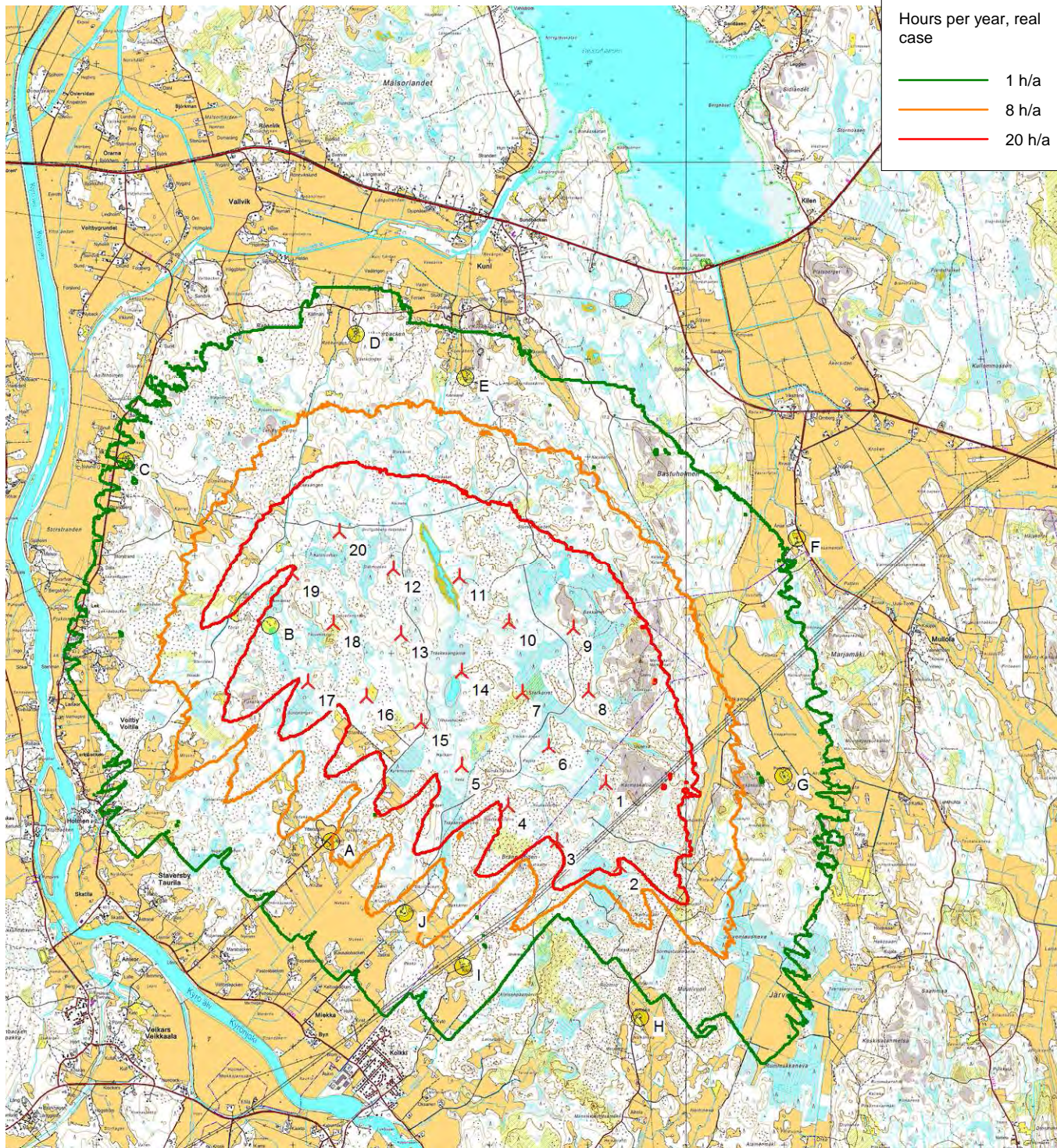
23.10.2014 12:31/2.9.269

## SHADOW - Map

Calculation: G132 x 20 x HH149

Hours per year, real case

- 1 h/a
- 8 h/a
- 20 h/a



Map: Peruskarttarasteri , Print scale 1:60 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 245 880 North: 7 009 300

New WTG

Shadow receptor

Flicker map level: Height Contours: Merkkikallio\_height contour lines.wpo (1)



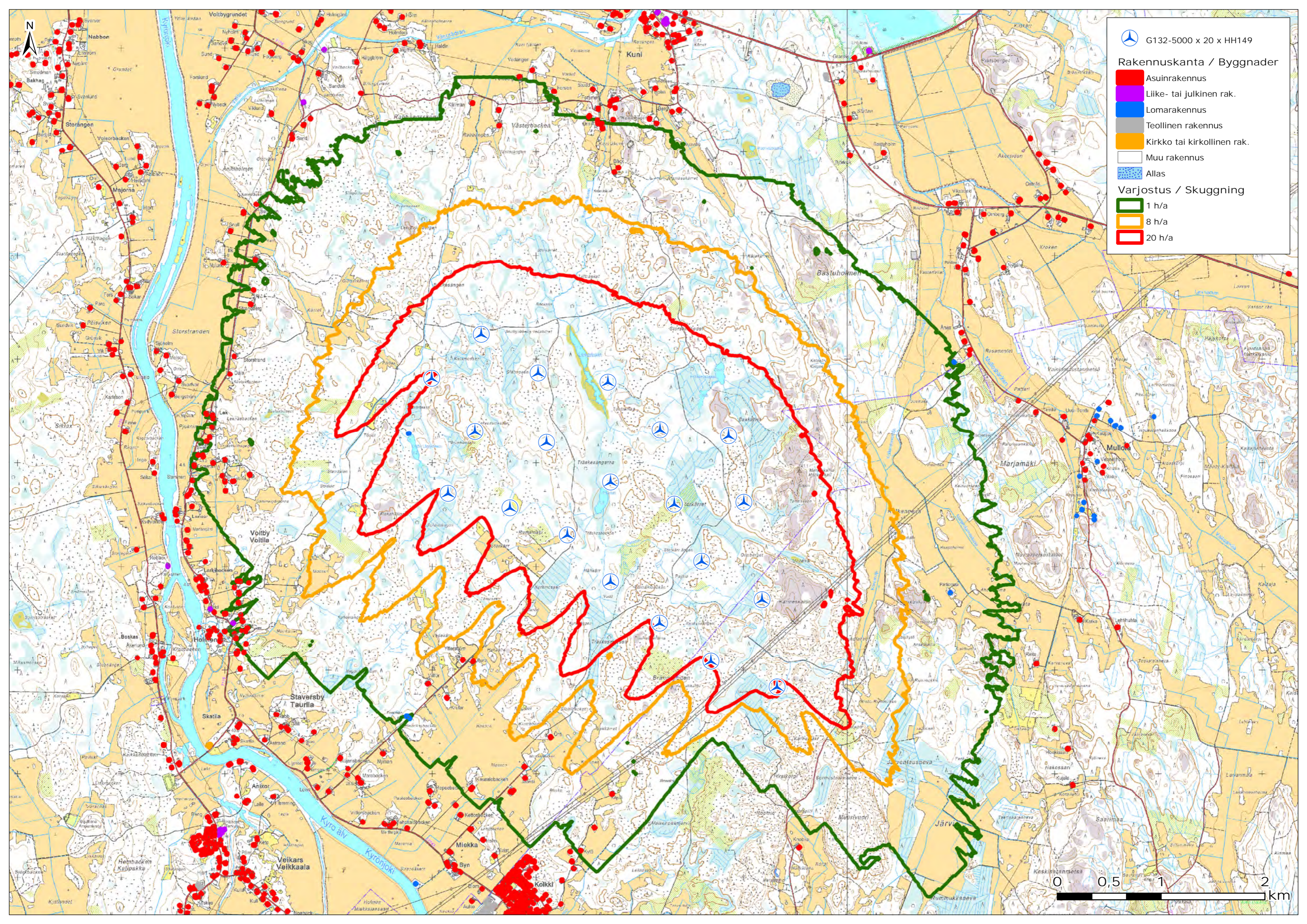
G132-5000 x 20 x HH149

### Rakennuskanta / Byggnader

- Asuinrakennus
- Liike- tai julkinen rak.
- Lomarakennus
- Teollinen rakennus
- Kirkko tai kirkollinen rak.
- Muu rakennus
- Allas

### Varjostus / Skuggning

- 1 h/a
- 8 h/a
- 20 h/a



0 0,5 1 2 km



Project:

**Merkkikallio**

Printed/Page

10.11.2014 13:10 / 1

Licensed user:

**FCG Suunnittelu ja tekniikka Oy**

Osmontie 34, PO Box 950

FI-00601 Helsinki

+358104095666

Paulina Kaivo-oja / paulina.kaivo-oja@fcg.fi

Calculated:

10.11.2014 13:09/2.9.269

## SHADOW - Main Result

Calculation: N131 x 22 x HH144

### 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:

MERRA\_basic\_E22.002\_N63.000

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
726	629	499	458	549	714	902	1291	933	793	584	572	8650

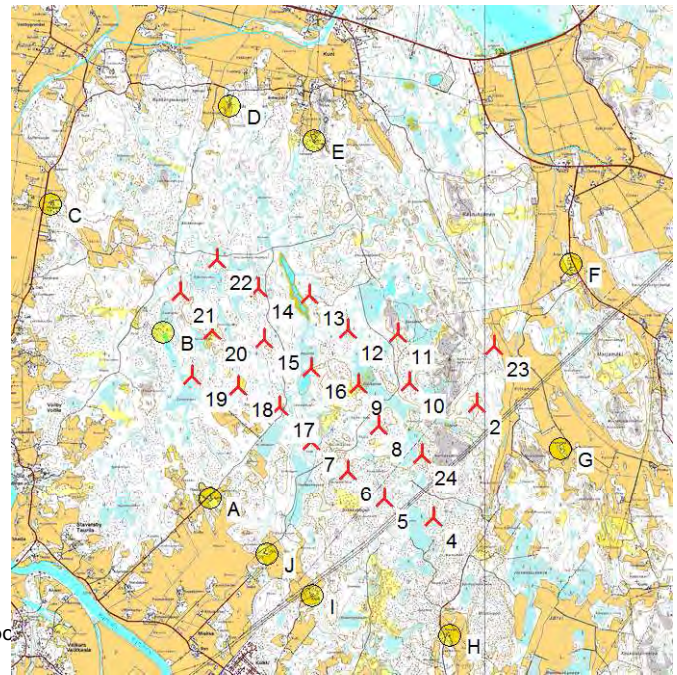
Idle start wind speed: Cut in wind speed from power curve

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: Merkkikallio\_height contour lines.wpc

Obstacles used in calculation

Eye height: 1,5 m

Grid resolution: 10,0 m



Scale 1:100 000

▲ New WTG

● Shadow receptor

### WTGs

	Finish TM ETRS-TM35FIN-ETRS89			Row data/Description	WTG type			Shadow data				
	East	North	Z		Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Calculation distance	RPM
	[m]						[kW]	[m]	[m]	[m]	[RPM]	
1	248 124	7 009 098	11,2	23	Yes	NORDEX	N131/3000-3 000	3 000	131,0	144,0	1 721	10,3
2	247 891	7 008 346	20,0	2	Yes	NORDEX	N131/3000-3 000	3 000	131,0	144,0	1 721	10,3
3	247 179	7 007 678	23,1	24	Yes	NORDEX	N131/3000-3 000	3 000	131,0	144,0	1 721	10,3
4	247 326	7 006 839	30,0	4	Yes	NORDEX	N131/3000-3 000	3 000	131,0	144,0	1 721	10,3
5	246 686	7 007 088	29,0	5	Yes	NORDEX	N131/3000-3 000	3 000	131,0	144,0	1 721	10,3
6	246 193	7 007 452	25,0	6	Yes	NORDEX	N131/3000-3 000	3 000	131,0	144,0	1 721	10,3
7	245 719	7 007 851	15,0	7	Yes	NORDEX	N131/3000-3 000	3 000	131,0	144,0	1 721	10,3
8	246 599	7 008 050	20,0	8	Yes	NORDEX	N131/3000-3 000	3 000	131,0	144,0	1 721	10,3
9	246 333	7 008 602	20,0	9	Yes	NORDEX	N131/3000-3 000	3 000	131,0	144,0	1 721	10,3
10	247 005	7 008 619	23,7	10	Yes	NORDEX	N131/3000-3 000	3 000	131,0	144,0	1 721	10,3
11	246 857	7 009 262	20,4	11	Yes	NORDEX	N131/3000-3 000	3 000	131,0	144,0	1 721	10,3
12	246 197	7 009 318	20,0	12	Yes	NORDEX	N131/3000-3 000	3 000	131,0	144,0	1 721	10,3
13	245 695	7 009 777	15,6	13	Yes	NORDEX	N131/3000-3 000	3 000	131,0	144,0	1 721	10,3
14	245 020	7 009 865	15,0	14	Yes	NORDEX	N131/3000-3 000	3 000	131,0	144,0	1 721	10,3
15	245 102	7 009 197	18,4	15	Yes	NORDEX	N131/3000-3 000	3 000	131,0	144,0	1 721	10,3
16	245 718	7 008 815	15,0	16	Yes	NORDEX	N131/3000-3 000	3 000	131,0	144,0	1 721	10,3
17	245 303	7 008 303	15,0	17	Yes	NORDEX	N131/3000-3 000	3 000	131,0	144,0	1 721	10,3
18	244 750	7 008 566	15,0	18	Yes	NORDEX	N131/3000-3 000	3 000	131,0	144,0	1 721	10,3
19	244 153	7 008 706	12,9	19	Yes	NORDEX	N131/3000-3 000	3 000	131,0	144,0	1 721	10,3
20	244 411	7 009 302	20,0	20	Yes	NORDEX	N131/3000-3 000	3 000	131,0	144,0	1 721	10,3
21	243 995	7 009 816	14,3	21	Yes	NORDEX	N131/3000-3 000	3 000	131,0	144,0	1 721	10,3
22	244 472	7 010 240	16,7	22	Yes	NORDEX	N131/3000-3 000	3 000	131,0	144,0	1 721	10,3

Project:

Merkkikallio

Printed/Page

10.11.2014 13:10 / 2

Licensed user:

FCG Suunnittelu ja tekniikka Oy

Osmontie 34, PO Box 950

FI-00601 Helsinki

+358104095666

Paulina Kaivo-oja / paulina.kaivo-oja@fcg.fi

Calculated:

10.11.2014 13:09/2.9.269

**SHADOW - Main Result**

Calculation: N131 x 22 x HH144

**Shadow receptor-Input**

No.	Name	Finish TM ETRS-TM35FIN-ETRS89						Height a.g.l.	Degrees from south	Slope of window	Direction mode
		East	North	Z	Width	Height	Height				
				[m]	[m]	[m]	[m]				
								cw			
								[°]	[°]		
A	Asuinrakennus (Langkujavägen 200)	244 392	7 007 085	10,0	5,0	5,0	1,0	0,0	0,0	0,0	"Green house mode"
B	Lomarakennus (Voitby Långträsket)	243 772	7 009 284	12,8	5,0	5,0	1,0	0,0	0,0	0,0	"Green house mode"
C	Asuinrakennus (Voitbyntie 480)	242 293	7 010 963	5,0	5,0	5,0	1,0	0,0	0,0	0,0	"Green house mode"
D	Asuinrakennus (Kunintie 289)	244 642	7 012 253	5,0	5,0	5,0	1,0	0,0	0,0	0,0	"Green house mode"
E	Asuinrakennus (Sandhedsvägen 65)	245 754	7 011 805	10,0	5,0	5,0	1,0	0,0	0,0	0,0	"Green house mode"
F	Asuinrakennus (Mullontie 128)	249 130	7 010 173	7,5	5,0	5,0	1,0	0,0	0,0	0,0	"Green house mode"
G	Lomarakennus/Partiomaja (Korpilahdenkuja 134)	248 995	7 007 749	10,0	5,0	5,0	1,0	0,0	0,0	0,0	"Green house mode"
H	Asuinrakennus (Kotkannevantie 269)	247 537	7 005 291	18,5	5,0	5,0	1,0	0,0	0,0	0,0	"Green house mode"
I	Asuinrakennus (Klumpintie 171)	245 733	7 005 809	12,5	5,0	5,0	1,0	0,0	0,0	0,0	"Green house mode"
J	Asuinrakennus (Klumpvägen 170)	245 136	7 006 355	10,0	5,0	5,0	1,0	0,0	0,0	0,0	"Green house mode"

**Calculation Results**

Shadow receptor

No.	Name	Shadow, expected values	
		Shadow hours	per year [h/year]
A	Asuinrakennus (Langkujavägen 200)	3:51	
B	Lomarakennus (Voitby Långträsket)	26:27	
C	Asuinrakennus (Voitbyntie 480)	0:00	
D	Asuinrakennus (Kunintie 289)	0:00	
E	Asuinrakennus (Sandhedsvägen 65)	0:00	
F	Asuinrakennus (Mullontie 128)	1:48	
G	Lomarakennus/Partiomaja (Korpilahdenkuja 134)	3:33	
H	Asuinrakennus (Kotkannevantie 269)	0:00	
I	Asuinrakennus (Klumpintie 171)	0:00	
J	Asuinrakennus (Klumpvägen 170)	2:16	

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

No.	Name	Worst case [h/year]	Expected [h/year]
1	23	9:29	1:48
2	2	15:09	3:33
3	24	0:00	0:00
4	4	0:00	0:00
5	5	8:44	2:16
6	6	0:00	0:00
7	7	14:06	3:51
8	8	0:00	0:00
9	9	0:00	0:00
10	10	0:00	0:00
11	11	0:00	0:00
12	12	0:00	0:00
13	13	0:00	0:00
14	14	14:17	3:38
15	15	9:18	1:59
16	16	0:00	0:00
17	17	0:00	0:00
18	18	11:05	2:17
19	19	34:37	7:10
20	20	49:19	11:21
21	21	0:00	0:00
22	22	0:00	0:00



Project:

**Merkkikallio**

Printed/Page

10.11.2014 13:10 / 3

Licensed user:

**FCG Suunnittelu ja tekniikka Oy**

Osmontie 34, PO Box 950

FI-00601 Helsinki

+358104095666

Paulina Kaivo-oja / paulina.kaivo-oja@fcg.fi

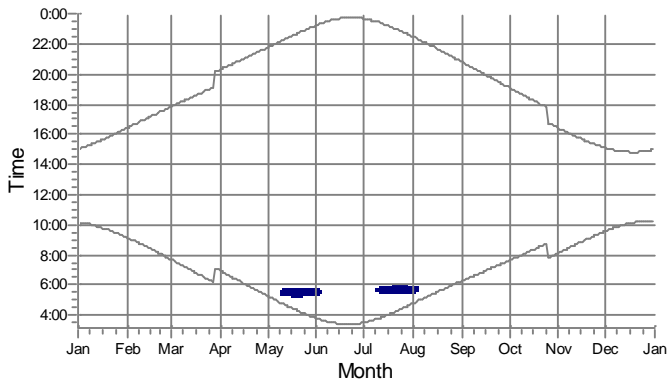
Calculated:

10.11.2014 13:09/2.9.269

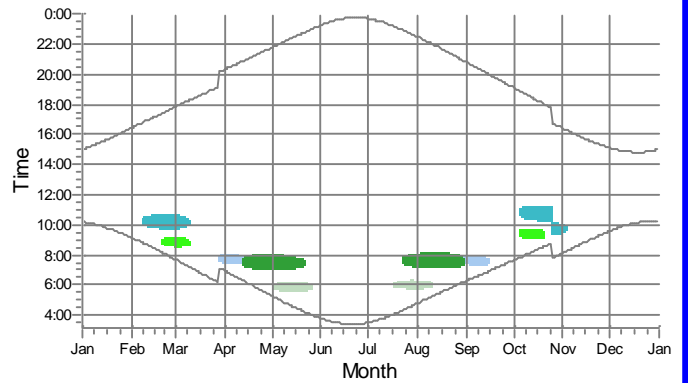
**SHADOW - Calendar, graphical**

Calculation: N131 x 22 x HH144

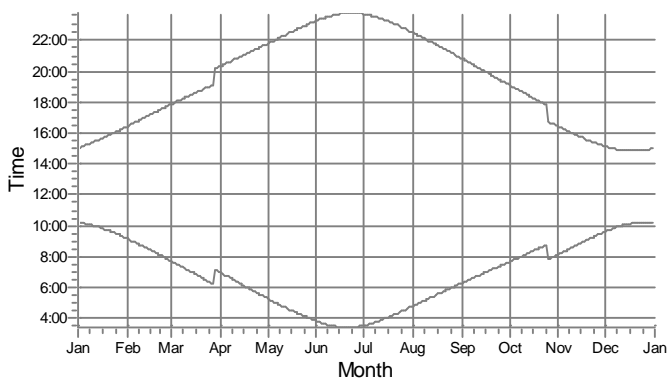
A: Asuinrakennus (Langkujavägen 200)



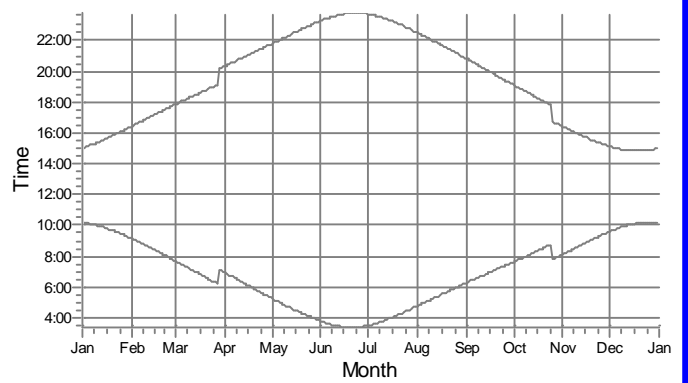
B: Lomarakennus (Voitby Långträsket)



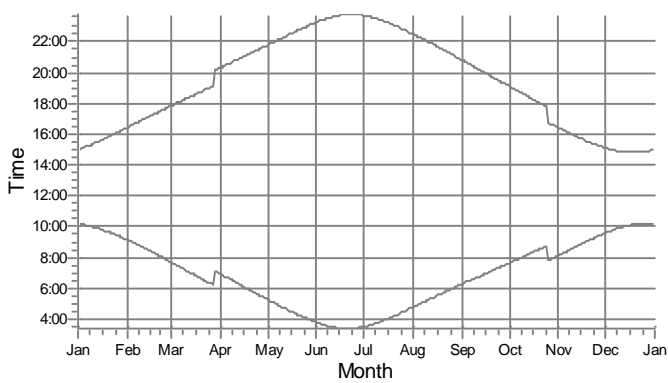
C: Asuinrakennus (Voitbyntie 480)



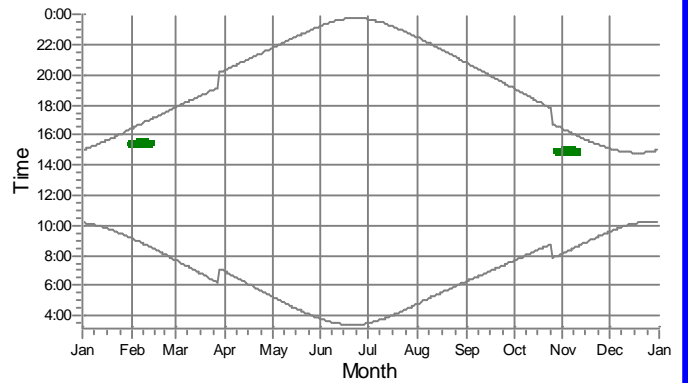
D: Asuinrakennus (Kunintie 289)



E: Asuinrakennus (Sandhedsvägen 65)



F: Asuinrakennus (Mullontie 128)



WTGs

	1: 23		14: 14		18: 18		20: 20
	7: 7		15: 15		19: 19		



Project:

**Merkkikallio**

Printed/Page

10.11.2014 13:10 / 4

Licensed user:

**FCG Suunnittelu ja tekniikka Oy**

Osmontie 34, PO Box 950

FI-00601 Helsinki

+358104095666

Paulina Kaivo-oja / paulina.kaivo-oja@fcg.fi

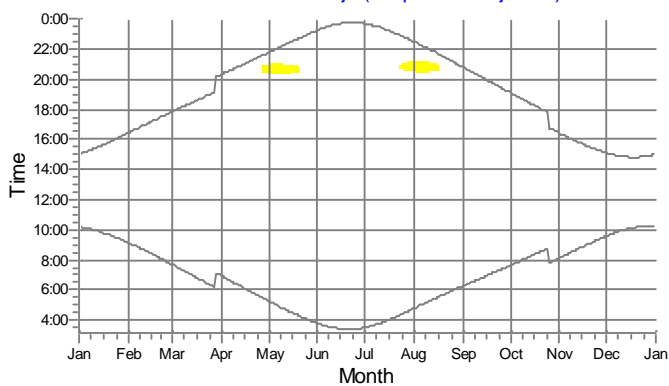
Calculated:

10.11.2014 13:09/2.9.269

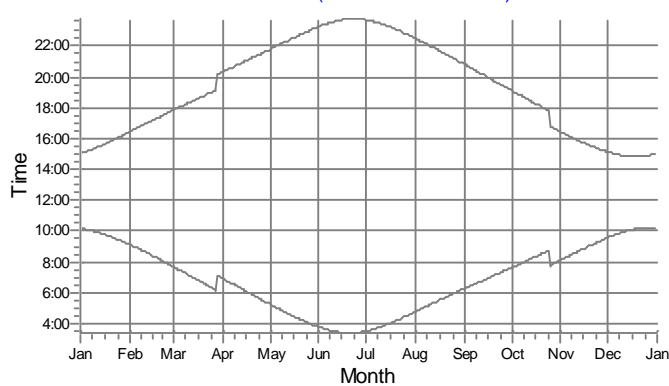
## SHADOW - Calendar, graphical

Calculation: N131 x 22 x HH144

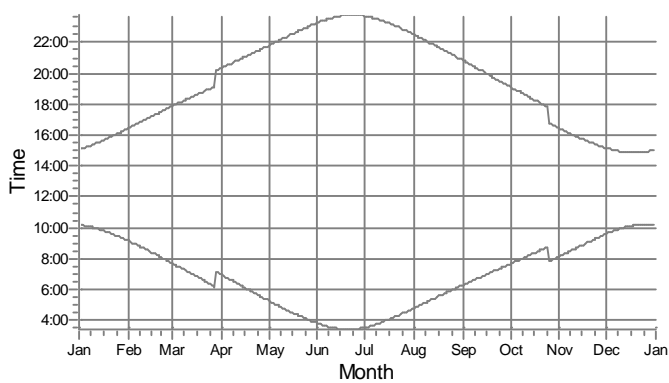
G: Lomarakenus/Partiomaja (Korpilahdenkuja 134)



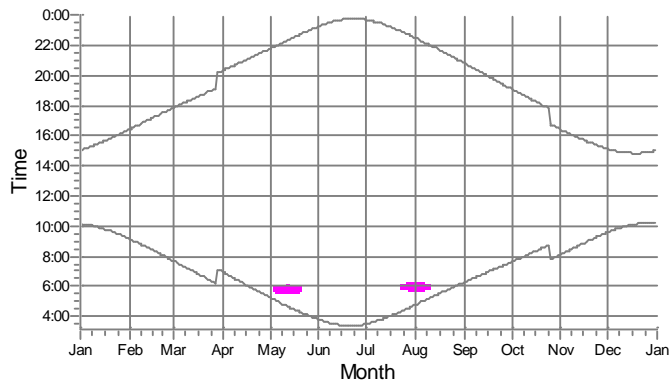
H: Asuinrakennus (Kotkannevantie 269)



I: Asuinrakennus (Klumpintie 171)



J: Asuinrakennus (Klumpvägen 170)



WTGs



2: 2



5: 5



Project:

**Merkkikallio**

Printed/Page

10.11.2014 13:10 / 5

Licensed user:

**FCG Suunnittelu ja tekniikka Oy**

Osmontie 34, PO Box 950

FI-00601 Helsinki

+358104095666

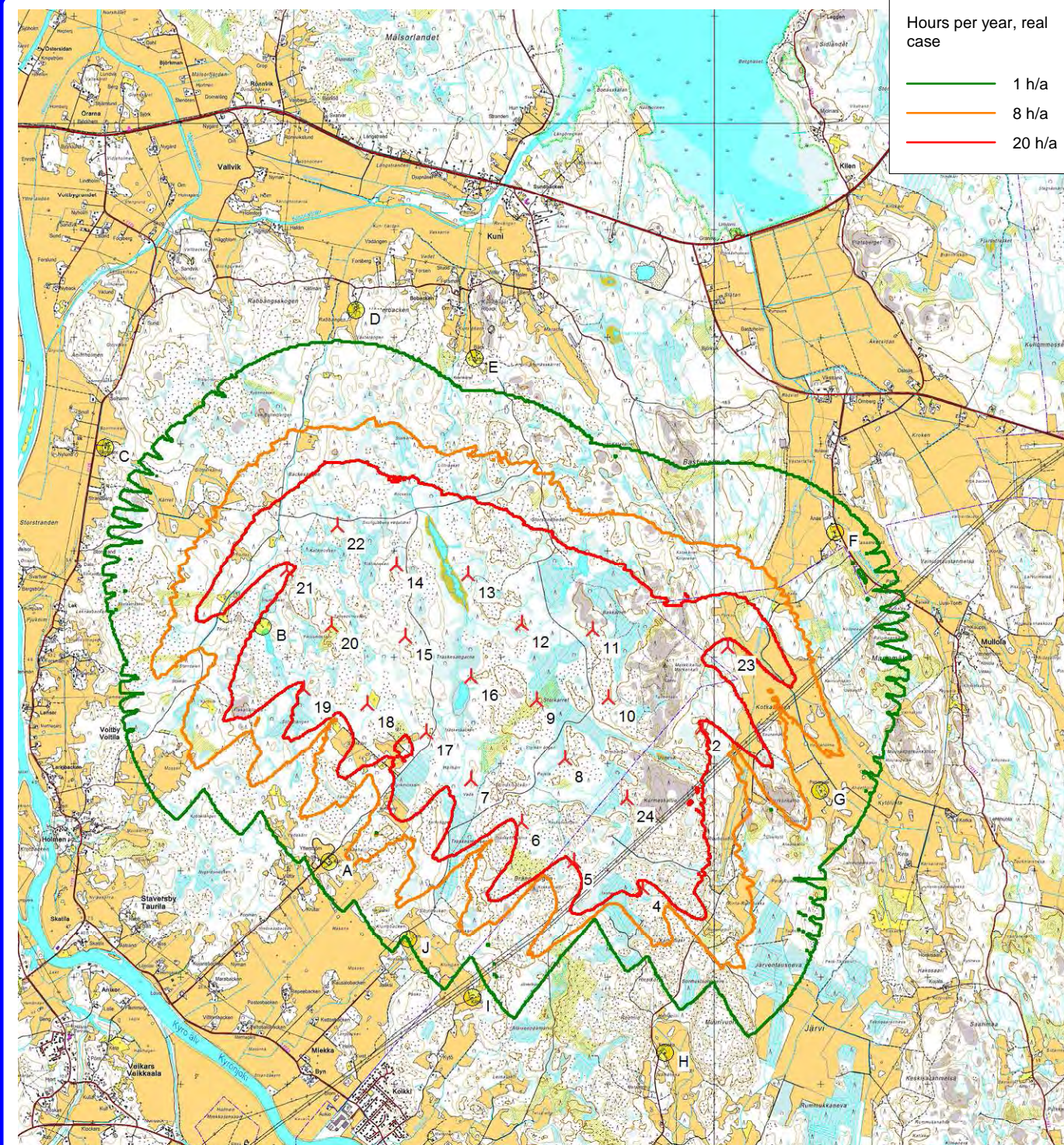
Paulina Kaivo-oja / paulina.kaivo-oja@fcg.fi

Calculated:

10.11.2014 13:09/2.9.269

## SHADOW - Map

Calculation: N131 x 22 x HH144



Hours per year, real case

- 1 h/a
- 8 h/a
- 20 h/a

0 1 2 3 4 km

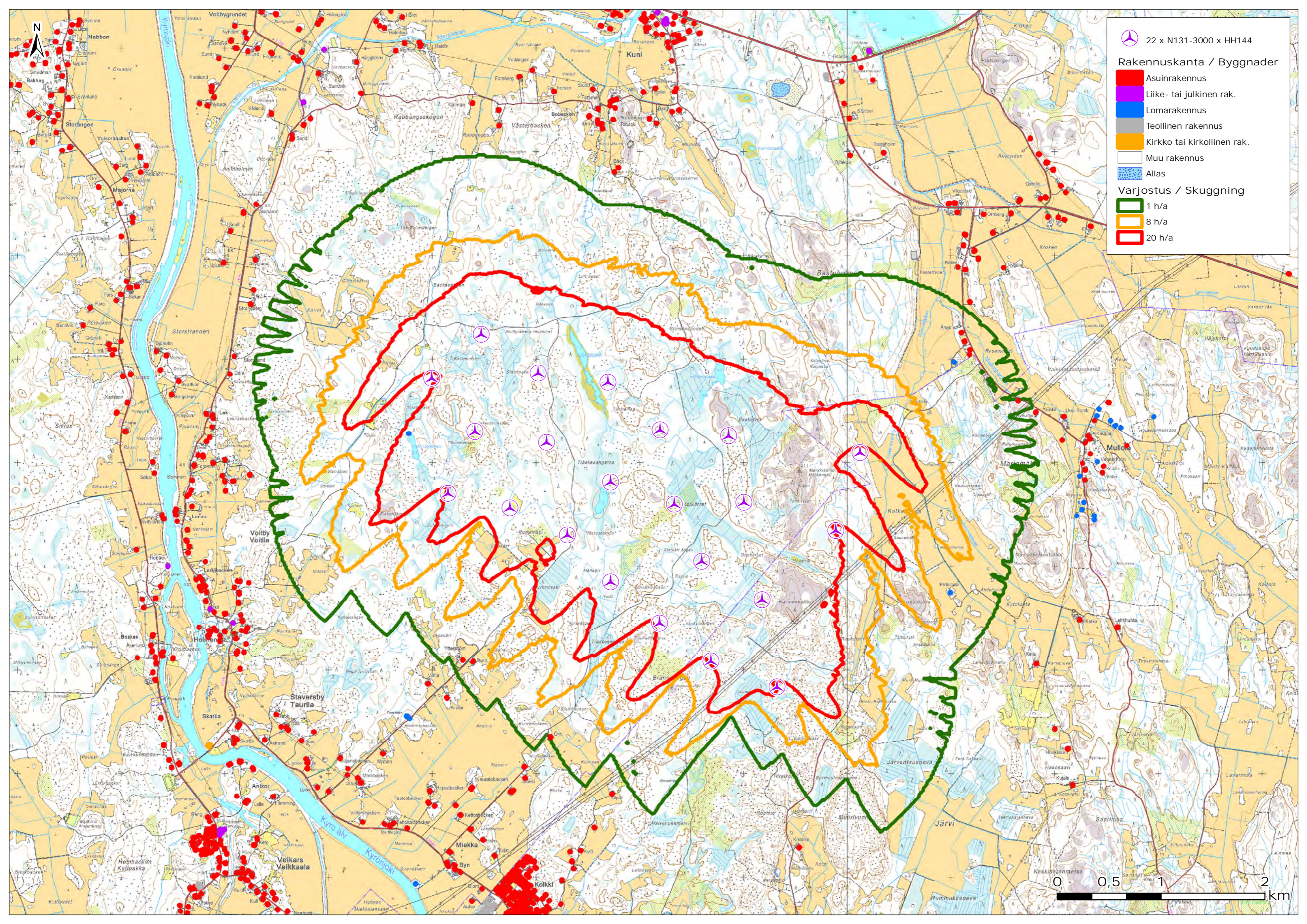
Map: Peruskarttarasteri , Print scale 1:55 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 245 880 North: 7 009 300

New WTG

Shadow receptor

Flicker map level: Height Contours: Merkkikallio\_height contour lines.wpo (1)





22 x N131-3000 x HH144

**Rakennuskanta / Byggnader**

- Asuinrakennus
- Liike- tai julkinen rak.
- Lomarakennus
- Teollinen rakennus
- Kirkko tai kirkollinen rak.
- Muu rakennus
- Allas

**Varjostus / Skuggning**

- 1 h/a
- 8 h/a
- 20 h/a





Project:

**Merkkikallio**

Printed/Page

23.10.2014 13:59 / 1

Licensed user:

**FCG Suunnittelu ja tekniikka Oy**

Osmontie 34, PO Box 950

FI-00601 Helsinki

+358104095666

Paulina Kaivo-oja / paulina.kaivo-oja@fcg.fi

Calculated:

23.10.2014 13:55/2.9.269

## SHADOW - Main Result

Calculation: N117 x 30 x HH141

### 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:

MERRA\_basic\_E22.002\_N63.000

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
725	628	498	457	548	713	902	1290	932	793	584	571	8642

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

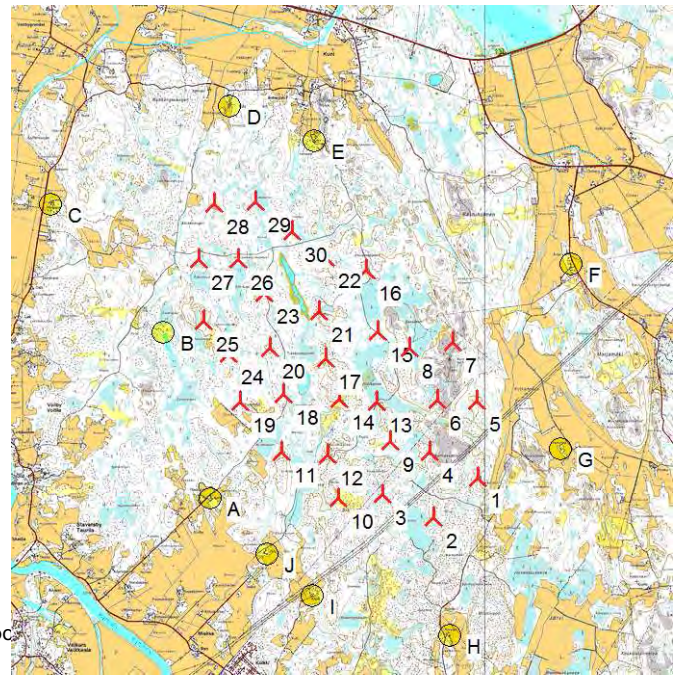
A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:

Height contours used: Height Contours: Merkkikallio\_height contour lines.wpc

Obstacles used in calculation

Eye height: 1,5 m

Grid resolution: 10,0 m



Scale 1:100 000  
 ▲ New WTG      ● Shadow receptor

### WTGs

	Finish TM ETRS-TM35FIN-ETRS89				WTG type				Shadow data			
	East	North	Z	Row data/Description	Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Calculation distance [m]	RPM [RPM]
	[m]											
1	247 904	7 007 365	27,5	NORDEX N117/3000 3000 116.... Yes	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	12,6
2	247 326	7 006 838	30,0	NORDEX N117/3000 3000 116.... Yes	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	12,6
3	246 653	7 007 146	30,0	NORDEX N117/3000 3000 116.... Yes	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	12,6
4	247 273	7 007 706	30,0	NORDEX N117/3000 3000 116.... Yes	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	12,6
5	247 892	7 008 386	20,0	NORDEX N117/3000 3000 116.... Yes	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	12,6
6	247 378	7 008 398	26,0	NORDEX N117/3000 3000 116.... Yes	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	12,6
7	247 581	7 009 156	27,5	NORDEX N117/3000 3000 116.... Yes	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	12,6
8	247 015	7 009 079	20,4	NORDEX N117/3000 3000 116.... Yes	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	12,6
9	246 761	7 007 851	20,0	NORDEX N117/3000 3000 116.... Yes	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	12,6
10	246 068	7 007 085	30,0	NORDEX N117/3000 3000 116.... Yes	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	12,6
11	245 321	7 007 713	20,0	NORDEX N117/3000 3000 116.... Yes	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	12,6
12	245 933	7 007 667	20,0	NORDEX N117/3000 3000 116.... Yes	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	12,6
13	246 583	7 008 373	20,0	NORDEX N117/3000 3000 116.... Yes	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	12,6
14	246 082	7 008 407	25,0	NORDEX N117/3000 3000 116.... Yes	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	12,6
15	246 594	7 009 288	18,6	NORDEX N117/3000 3000 116.... Yes	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	12,6
16	246 437	7 010 102	20,0	NORDEX N117/3000 3000 116.... Yes	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	12,6
17	245 903	7 008 944	19,5	NORDEX N117/3000 3000 116.... Yes	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	12,6
18	245 349	7 008 468	14,8	NORDEX N117/3000 3000 116.... Yes	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	12,6
19	244 782	7 008 372	15,0	NORDEX N117/3000 3000 116.... Yes	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	12,6
20	245 172	7 009 082	20,0	NORDEX N117/3000 3000 116.... Yes	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	12,6
21	245 818	7 009 556	20,0	NORDEX N117/3000 3000 116.... Yes	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	12,6
22	245 907	7 010 264	21,1	NORDEX N117/3000 3000 116.... Yes	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	12,6
23	245 097	7 009 800	15,0	NORDEX N117/3000 3000 116.... Yes	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	12,6
24	244 631	7 009 006	17,5	NORDEX N117/3000 3000 116.... Yes	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	12,6
25	244 302	7 009 432	20,0	NORDEX N117/3000 3000 116.... Yes	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	12,6
26	244 759	7 010 242	13,8	NORDEX N117/3000 3000 116.... Yes	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	12,6
27	244 242	7 010 245	14,3	NORDEX N117/3000 3000 116.... Yes	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	12,6
28	244 435	7 010 971	19,2	NORDEX N117/3000 3000 116.... Yes	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	12,6
29	244 977	7 011 001	12,5	NORDEX N117/3000 3000 116.... Yes	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	12,6
30	245 464	7 010 613	14,7	NORDEX N117/3000 3000 116.... Yes	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	12,6



Project:

Merkkikallio

Printed/Page

23.10.2014 13:59 / 2

Licensed user:

FCG Suunnittelu ja tekniikka Oy

Osmontie 34, PO Box 950

FI-00601 Helsinki

+358104095666

Paulina Kaivo-oja / paulina.kaivo-oja@fcg.fi

Calculated:

23.10.2014 13:55/2.9.269

**SHADOW - Main Result**

Calculation: N117 x 30 x HH141

**Shadow receptor-Input**

No.	Name	Finish TM ETRS-TM35FIN-ETRS89						Height a.g.l.	Degrees from south	Slope of window	Direction mode
		East	North	Z	Width	Height	Height				
				[m]	[m]	[m]	[m]				
									cw [°]	[°]	
A	Asuinrakennus (Langkujavägen 200)	244 392	7 007 085	10,0	5,0	5,0	1,0	0,0	0,0	0,0	"Green house mode"
B	Lomarakennus (Voitby Långträsket)	243 772	7 009 284	12,8	5,0	5,0	1,0	0,0	0,0	0,0	"Green house mode"
C	Asuinrakennus (Voitbyntie 480)	242 293	7 010 963	5,0	5,0	5,0	1,0	0,0	0,0	0,0	"Green house mode"
D	Asuinrakennus (Kunintie 289)	244 642	7 012 253	5,0	5,0	5,0	1,0	0,0	0,0	0,0	"Green house mode"
E	Asuinrakennus (Sandhedsvägen 65)	245 754	7 011 805	10,0	5,0	5,0	1,0	0,0	0,0	0,0	"Green house mode"
F	Asuinrakennus (Mullontie 128)	249 130	7 010 173	7,5	5,0	5,0	1,0	0,0	0,0	0,0	"Green house mode"
G	Lomarakennus/Partiomaja (Korpilahdenkuja 134)	248 995	7 007 749	10,0	5,0	5,0	1,0	0,0	0,0	0,0	"Green house mode"
H	Asuinrakennus (Kotkannevantie 269)	247 537	7 005 291	18,5	5,0	5,0	1,0	0,0	0,0	0,0	"Green house mode"
I	Asuinrakennus (Klumpintie 171)	245 733	7 005 809	12,5	5,0	5,0	1,0	0,0	0,0	0,0	"Green house mode"
J	Asuinrakennus (Klumpvägen 170)	245 136	7 006 355	10,0	5,0	5,0	1,0	0,0	0,0	0,0	"Green house mode"

**Calculation Results**

Shadow receptor

No.	Name	Shadow, expected values	
		Shadow hours per year [h/year]	
A	Asuinrakennus (Langkujavägen 200)	6:49	
B	Lomarakennus (Voitby Långträsket)	28:45	
C	Asuinrakennus (Voitbyntie 480)	0:00	
D	Asuinrakennus (Kunintie 289)	3:46	
E	Asuinrakennus (Sandhedsvägen 65)	4:43	
F	Asuinrakennus (Mullontie 128)	0:00	
G	Lomarakennus/Partiomaja (Korpilahdenkuja 134)	4:47	
H	Asuinrakennus (Kotkannevantie 269)	0:00	
I	Asuinrakennus (Klumpintie 171)	0:00	
J	Asuinrakennus (Klumpvägen 170)	3:22	

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

No.	Name	Worst case [h/year]	Expected [h/year]
2	NORDEX N117/3000 3000 116.8 !O! hub: 140,6 m (TOT: 199,0 m) (2)	0:00	0:00
3	NORDEX N117/3000 3000 116.8 !O! hub: 140,6 m (TOT: 199,0 m) (3)	0:00	0:00
4	NORDEX N117/3000 3000 116.8 !O! hub: 140,6 m (TOT: 199,0 m) (4)	0:00	0:00
5	NORDEX N117/3000 3000 116.8 !O! hub: 140,6 m (TOT: 199,0 m) (5)	12:02	2:53
6	NORDEX N117/3000 3000 116.8 !O! hub: 140,6 m (TOT: 199,0 m) (6)	0:00	0:00
7	NORDEX N117/3000 3000 116.8 !O! hub: 140,6 m (TOT: 199,0 m) (7)	0:00	0:00
8	NORDEX N117/3000 3000 116.8 !O! hub: 140,6 m (TOT: 199,0 m) (8)	0:00	0:00
9	NORDEX N117/3000 3000 116.8 !O! hub: 140,6 m (TOT: 199,0 m) (9)	0:00	0:00
10	NORDEX N117/3000 3000 116.8 !O! hub: 140,6 m (TOT: 199,0 m) (10)	11:16	3:22
11	NORDEX N117/3000 3000 116.8 !O! hub: 140,6 m (TOT: 199,0 m) (12)	23:26	6:49
12	NORDEX N117/3000 3000 116.8 !O! hub: 140,6 m (TOT: 199,0 m) (13)	0:00	0:00
13	NORDEX N117/3000 3000 116.8 !O! hub: 140,6 m (TOT: 199,0 m) (14)	0:00	0:00
14	NORDEX N117/3000 3000 116.8 !O! hub: 140,6 m (TOT: 199,0 m) (15)	0:00	0:00
15	NORDEX N117/3000 3000 116.8 !O! hub: 140,6 m (TOT: 199,0 m) (16)	0:00	0:00
16	NORDEX N117/3000 3000 116.8 !O! hub: 140,6 m (TOT: 199,0 m) (17)	0:00	0:00
17	NORDEX N117/3000 3000 116.8 !O! hub: 140,6 m (TOT: 199,0 m) (18)	0:00	0:00
18	NORDEX N117/3000 3000 116.8 !O! hub: 140,6 m (TOT: 199,0 m) (19)	0:00	0:00
19	NORDEX N117/3000 3000 116.8 !O! hub: 140,6 m (TOT: 199,0 m) (20)	7:27	1:30
20	NORDEX N117/3000 3000 116.8 !O! hub: 140,6 m (TOT: 199,0 m) (21)	6:19	1:13
21	NORDEX N117/3000 3000 116.8 !O! hub: 140,6 m (TOT: 199,0 m) (22)	0:00	0:00
22	NORDEX N117/3000 3000 116.8 !O! hub: 140,6 m (TOT: 199,0 m) (23)	0:00	0:00
23	NORDEX N117/3000 3000 116.8 !O! hub: 140,6 m (TOT: 199,0 m) (24)	9:11	2:14
24	NORDEX N117/3000 3000 116.8 !O! hub: 140,6 m (TOT: 199,0 m) (25)	15:14	2:53
25	NORDEX N117/3000 3000 116.8 !O! hub: 140,6 m (TOT: 199,0 m) (26)	72:37	19:38

To be continued on next page...



Project:

Merkkikallio

Printed/Page

23.10.2014 13:59 / 3

Licensed user:

**FCG Suunnittelu ja tekniikka Oy**

Osmontie 34, PO Box 950

FI-00601 Helsinki

+358104095666

Paulina Kaivo-oja / paulina.kaivo-oja@fcg.fi

Calculated:

23.10.2014 13:55/2.9.269

**SHADOW - Main Result****Calculation:** N117 x 30 x HH141

...continued from previous page

No.	Name	Worst case [h/year]	Expected [h/year]
26	NORDEX N117/3000 3000 116.8 !O! hub: 140,6 m (TOT: 199,0 m) (27)	4:28	1:19
27	NORDEX N117/3000 3000 116.8 !O! hub: 140,6 m (TOT: 199,0 m) (28)	0:00	0:00
28	NORDEX N117/3000 3000 116.8 !O! hub: 140,6 m (TOT: 199,0 m) (29)	14:59	2:00
29	NORDEX N117/3000 3000 116.8 !O! hub: 140,6 m (TOT: 199,0 m) (30)	24:44	4:16
30	NORDEX N117/3000 3000 116.8 !O! hub: 140,6 m (TOT: 199,0 m) (31)	16:17	2:12



Project:

**Merkkikallio**

Printed/Page

23.10.2014 13:59 / 4

Licensed user:

**FCG Suunnittelu ja tekniikka Oy**

Osmontie 34, PO Box 950

FI-00601 Helsinki

+358104095666

Paulina Kaivo-oja / paulina.kaivo-oja@fcg.fi

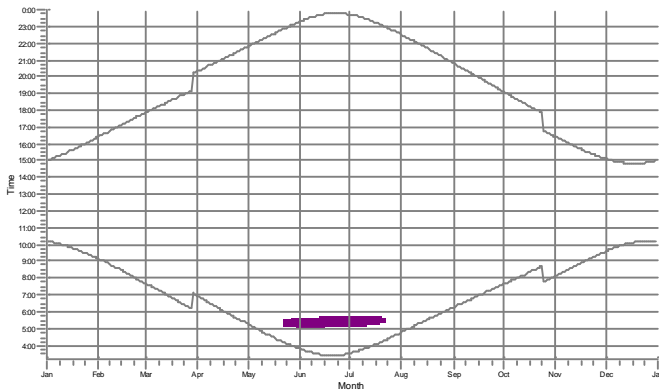
Calculated:

23.10.2014 13:55/2.9.269

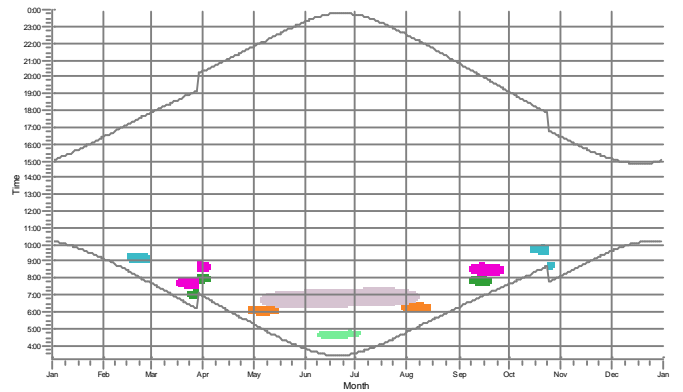
**SHADOW - Calendar, graphical**

Calculation: N117 x 30 x HH141

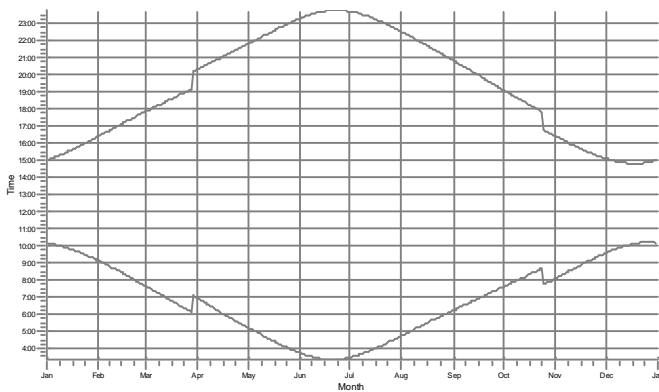
A: Asuinrakennus (Langkujavägen 200)



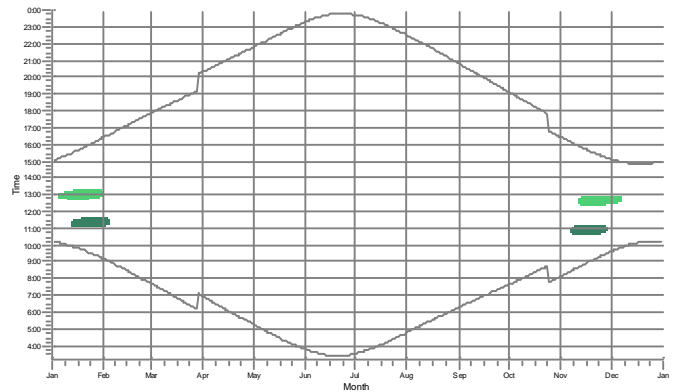
B: Lomarakennus (Voitby Långträsket)



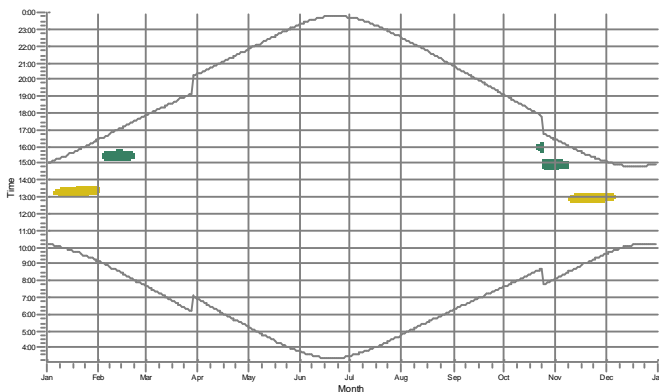
C: Asuinrakennus (Voitbyntie 480)



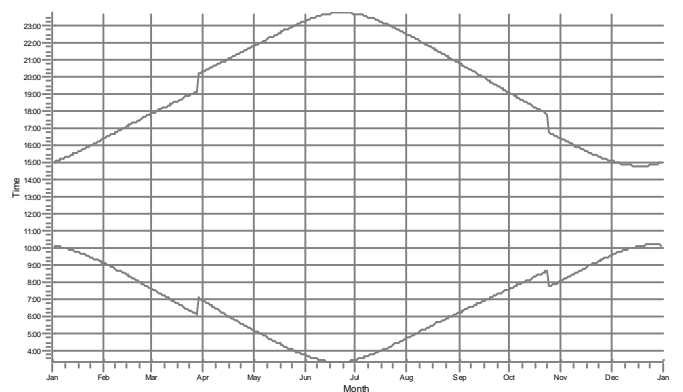
D: Asuinrakennus (Kuntantie 289)













E: Asuinrakennus (Sandhedsvägen 65)



F: Asuinrakennus (Mullontie 128)



WTGs

- |  |  |  |
|--|--|--|
|  11: NORDEX N117/3000 3000 116.8 IO! hub: 140.6 m (TOT: 199.0 m) (12) |  24: NORDEX N117/3000 3000 116.8 IO! hub: 140.6 m (TOT: 199.0 m) (25) |  29: NORDEX N117/3000 3000 116.8 IO! hub: 140.6 m (TOT: 199.0 m) (30) |
|  19: NORDEX N117/3000 3000 116.8 IO! hub: 140.6 m (TOT: 199.0 m) (20) |  25: NORDEX N117/3000 3000 116.8 IO! hub: 140.6 m (TOT: 199.0 m) (26) |  30: NORDEX N117/3000 3000 116.8 IO! hub: 140.6 m (TOT: 199.0 m) (31) |
|  20: NORDEX N117/3000 3000 116.8 IO! hub: 140.6 m (TOT: 199.0 m) (21) |  26: NORDEX N117/3000 3000 116.8 IO! hub: 140.6 m (TOT: 199.0 m) (27) |  |
|  23: NORDEX N117/3000 3000 116.8 IO! hub: 140.6 m (TOT: 199.0 m) (24) |  28: NORDEX N117/3000 3000 116.8 IO! hub: 140.6 m (TOT: 199.0 m) (29) |  |

Project:

**Merkkikallio**

Printed/Page

23.10.2014 13:59 / 5

Licensed user:

**FCG Suunnittelu ja tekniikka Oy**

Osmontie 34, PO Box 950

FI-00601 Helsinki

+358104095666

Paulina Kaivo-oja / paulina.kaivo-oja@fcg.fi

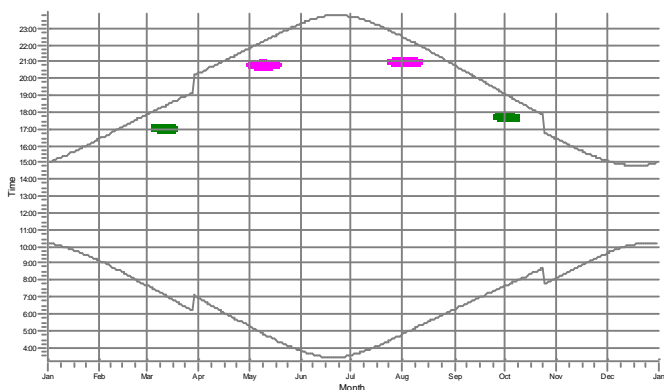
Calculated:

23.10.2014 13:55/2.9.269

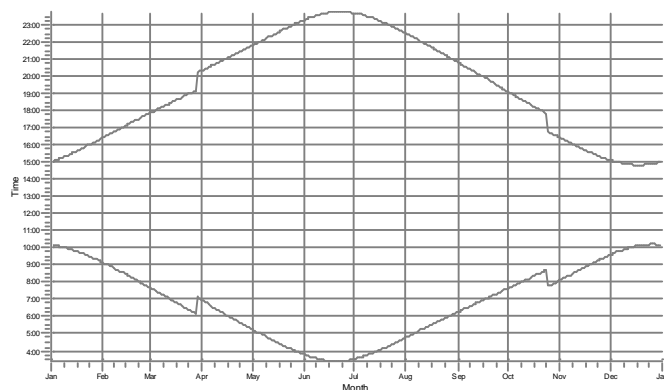
## SHADOW - Calendar, graphical

Calculation: N117 x 30 x HH141

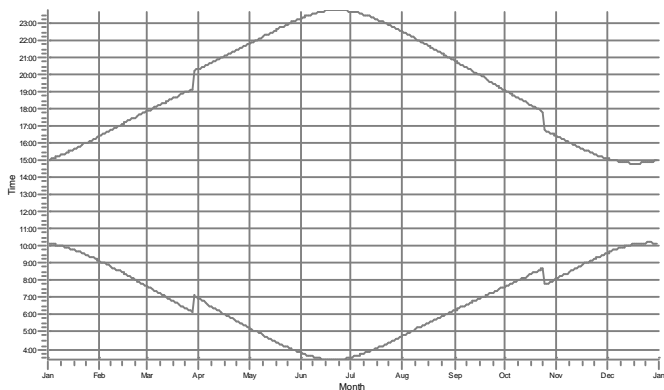
G: Lomarakennus/Partiomaja (Korpilahdenkuja 134)



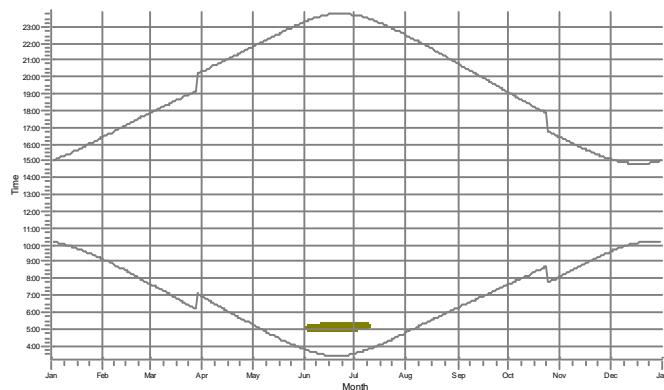
H: Asuinrakennus (Kotkannevantie 269)



I: Asuinrakennus (Klumpintie 171)



J: Asuinrakennus (Klumpvägen 170)



WTGs

1: NORDEX N117/3000 3000 116.8 IO! hub: 140,6 m (TOT: 199,0 m) (1)

5: NORDEX N117/3000 3000 116.8 IO! hub: 140,6 m (TOT: 199,0 m) (5)

10: NORDEX N117/3000 3000 116.8 IO! hub: 140,6 m (TOT: 199,0 m) (10)



Project:

**Merkkikallio**

Printed/Page

23.10.2014 13:59 / 6

Licensed user:

**FCG Suunnittelu ja tekniikka Oy**

Osmontie 34, PO Box 950

FI-00601 Helsinki

+358104095666

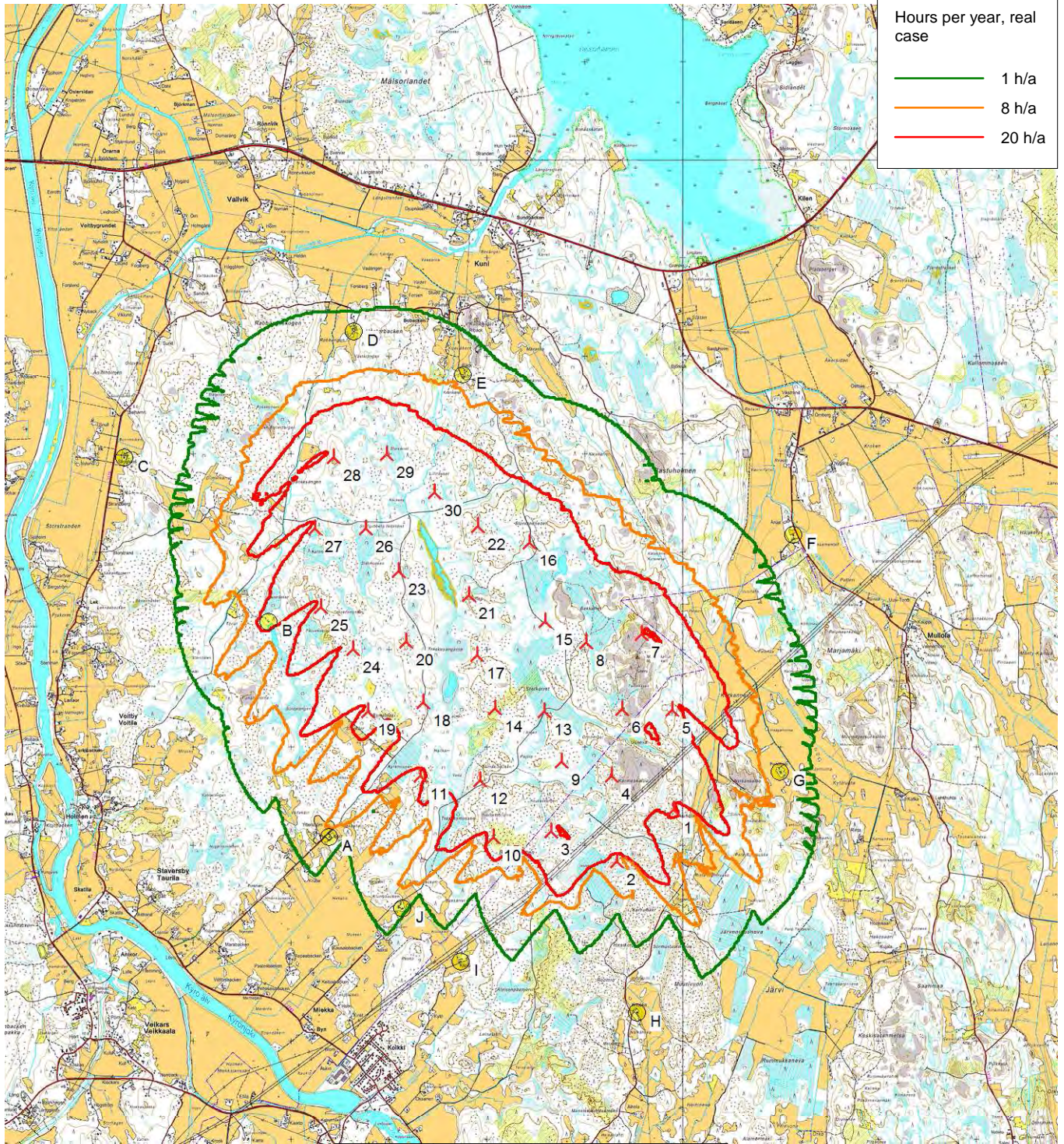
Paulina Kaivo-oja / paulina.kaivo-oja@fcg.fi

Calculated:

23.10.2014 13:55/2.9.269

### SHADOW - Map

Calculation: N117 x 30 x HH141



Map: Peruskarttarasteri , Print scale 1:60 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 245 880 North: 7 009 300

New WTG

Shadow receptor

Flicker map level: Height Contours: Merkkikallio\_height contour lines.wpo (1)