

Project:

Tuomiperä

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Hans Vadback / hans.vadback@fcg.fi

Calculated:

30.9.2013 10:47/2.8.579

SHADOW - Main Result

Calculation: N117-3000 x 9 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) [LULEA]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0,60	2,61	4,18	6,47	8,80	10,60	9,50	6,88	4,22	2,77	1,22	0,17

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

MERRA_basic_E24.668_N64.000

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
589	431	431	457	612	863	999	1083	969	797	682	705	8618

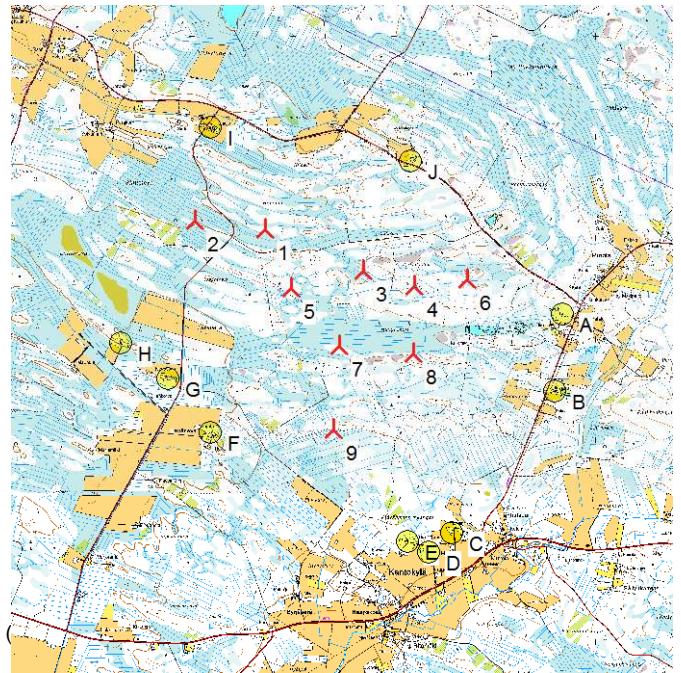
Idle start wind speed: Cut in wind speed from power curve

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: Tuomiperä height contour lines.wpo

Obstacles used in calculation

Eye height: 1,5 m

Grid resolution: 10,0 m



Scale 1:75 000
New WTG Shadow receptor

WTGs

	Finish TM ETRS-TM35FIN-ETRS89			Row data/Description	WTG type			Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Shadow data	
	East	North	Z		Valid	Manufact.	Type-generator				Calculation distance [m]	RPM [RPM]
1	392 723	7 111 083	82,5	YP2-T1	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	14,1
2	392 032	7 111 173	80,0	YP2-T2	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	14,1
3	393 701	7 110 679	85,0	YP2-T3	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	14,1
4	394 202	7 110 527	88,4	YP2-T4	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	14,1
5	392 983	7 110 506	83,5	YP2-T5	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	14,1
6	394 729	7 110 594	89,7	YP2-T6	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	14,1
7	393 458	7 109 936	83,8	YP2-T7	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	14,1
8	394 188	7 109 857	85,0	YP2-T8	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	14,1
9	393 403	7 109 108	84,1	YP2-T9	Yes	NORDEX	N117/3000-3 000	3 000	116,8	140,6	1 486	14,1

Shadow receptor-Input

No.	Name	Finish TM ETRS-TM35FIN-ETRS89			Width [m]	Height [m]	Height a.g.l. [m]	Degrees from south cw [°]	Slope of window [°]	Direction mode
		East	North	Z						
A	Asuinrakennus (Pinolantie 266)	395 675	7 110 246	87,5	1,0	1,0	1,0	0,0	0,0	"Green house mode"
B	Höitokoti (Pinolantie 189)	395 590	7 109 486	85,0	1,0	1,0	1,0	0,0	0,0	"Green house mode"
C	Asuinrakennus (Männikkötie 33)	394 575	7 108 070	83,0	1,0	1,0	1,0	0,0	0,0	"Green house mode"
D	Kantokylän kylätalo (Vanhakouluntie 36)	394 348	7 107 888	81,9	1,0	1,0	1,0	0,0	0,0	"Green house mode"
E	Asuinrakennus (Vanhakouluntie 65)	394 131	7 107 990	82,8	1,0	1,0	1,0	0,0	0,0	"Green house mode"
F	Asuinrakennus (Levänevantie 227)	392 179	7 109 070	80,0	1,0	1,0	1,0	0,0	0,0	"Green house mode"
G	Asuinrakennus (Levänevantie 286)	391 760	7 109 605	80,0	1,0	1,0	1,0	0,0	0,0	"Green house mode"
H	Asuinrakennus (Kivinevantie 75)	391 299	7 109 963	80,0	1,0	1,0	1,0	0,0	0,0	"Green house mode"
I	Asuinrakennus (Levänevantie 441)	392 180	7 112 098	80,0	1,0	1,0	1,0	0,0	0,0	"Green house mode"
J	Asuinrakennus (Tuomiperäntie 656)	394 165	7 111 764	85,8	1,0	1,0	1,0	0,0	0,0	"Green house mode"

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SHADOW - Main Result

Calculation: N117-3000 x 9 x HH141

Calculation Results

Shadow receptor

No.	Name	Shadow, expected values	
		Shadow hours	per year [h/year]
A	Asuinrakennus (Pinolantie 266)		4:16
B	Hoitokoti (Pinolantie 189)		3:15
C	Asuinrakennus (Männikkötie 33)		0:00
D	Kantokylän kylätalo (Vanhakouluntie 36)		0:00
E	Asuinrakennus (Vanhakouluntie 65)		0:00
F	Asuinrakennus (Levänevantie 227)		2:01
G	Asuinrakennus (Levänevantie 286)		0:00
H	Asuinrakennus (Kivinevantie 75)		0:00
I	Asuinrakennus (Levänevantie 441)		4:22
J	Asuinrakennus (Tuomiperäntie 656)		4:18

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

No.	Name	Worst case [h/year]	Expected [h/year]
1	YP2-T1	11:48	1:52
2	YP2-T2	19:59	2:29
3	YP2-T3	12:55	1:34
4	YP2-T4	13:58	1:22
5	YP2-T5	0:00	0:00
6	YP2-T6	30:47	7:14
7	YP2-T7	0:00	0:00
8	YP2-T8	6:32	1:39
9	YP2-T9	8:28	2:01

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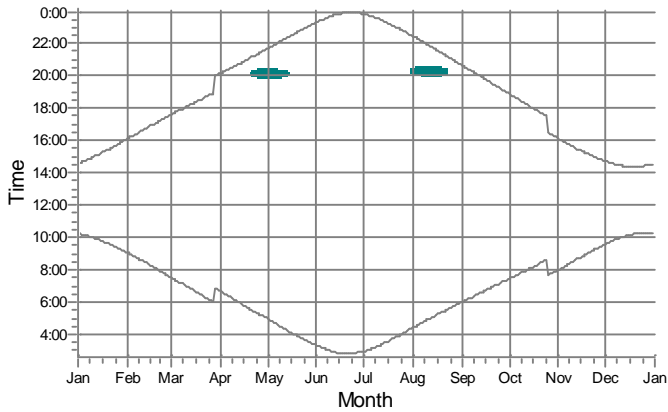


SUUNNITTELU JA TEKNIikka

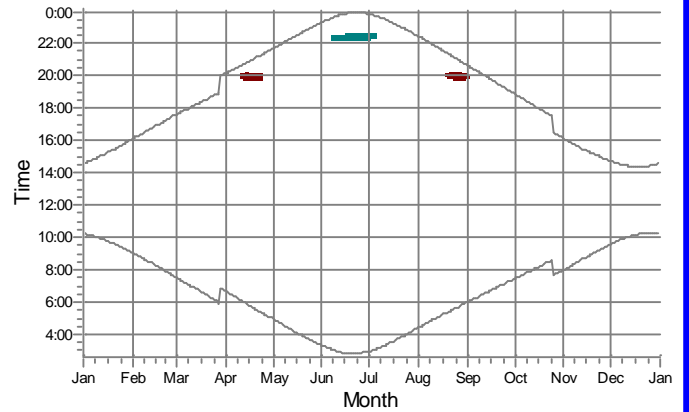
SHADOW - Calendar, graphical

Calculation: N117-3000 x 9 x HH141

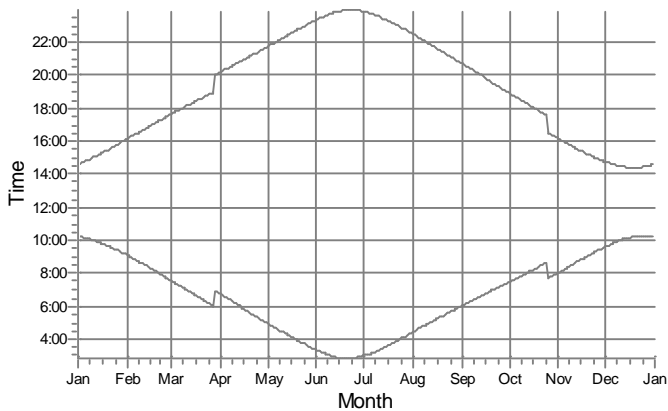
A: Asuinrakennus (Pinolantie 266)



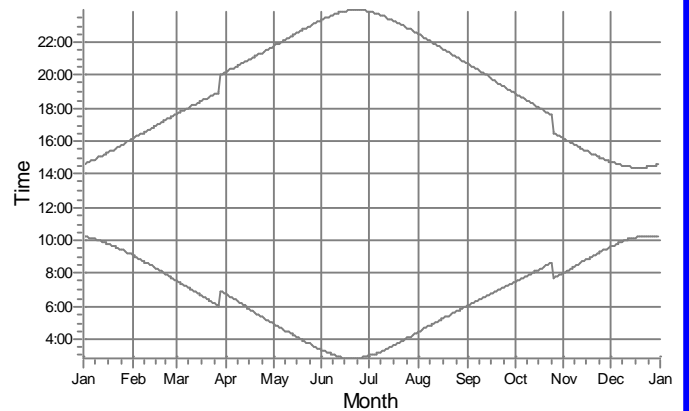
B: Hoitokoti (Pinolantie 189)



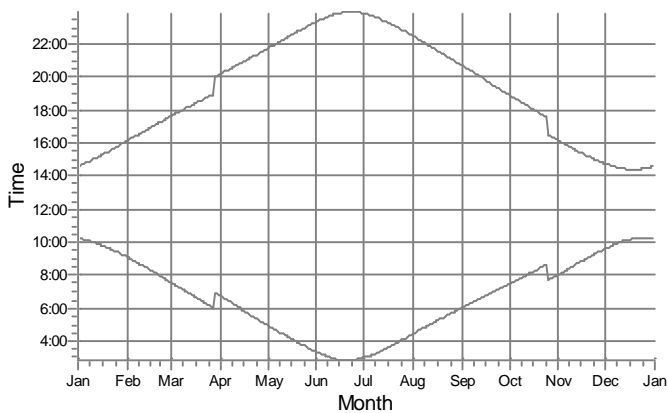
C: Asuinrakennus (Männikkötie 33)



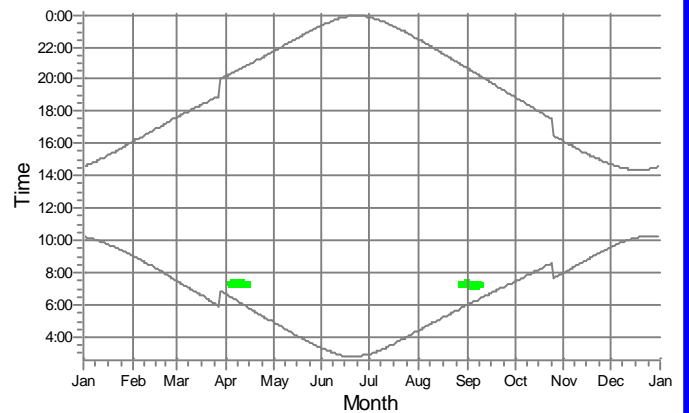
D: Kantokylän kylätalo (Vanhakoulutie 36)



E: Asuinrakennus (Vanhakoulutie 65)



F: Asuinrakennus (Levänevantie 227)



WTGs

6: YP2-T6 8: YP2-T8 9: YP2-T9

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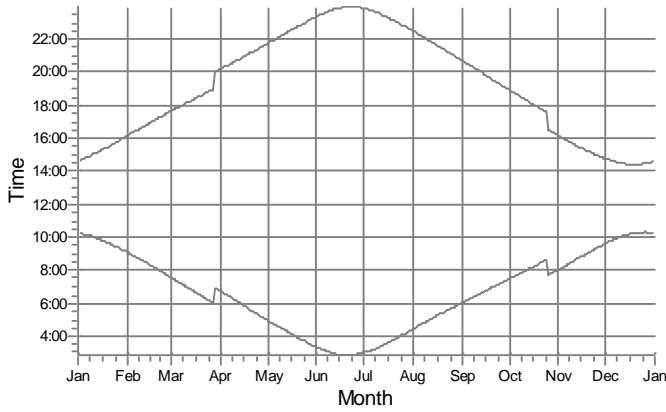


SUUNNITTELU JA TEKNIikka

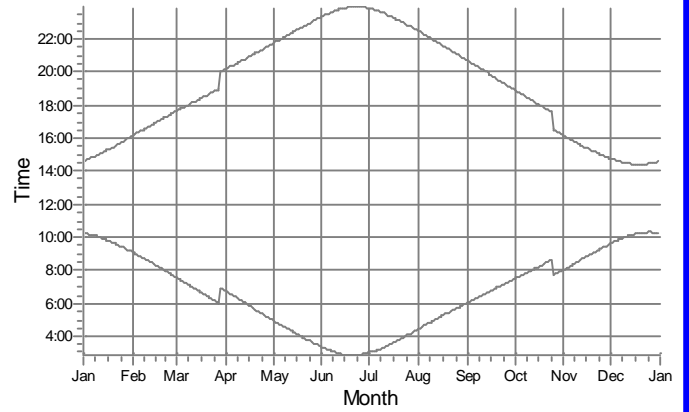
SHADOW - Calendar, graphical

Calculation: N117-3000 x 9 x HH141

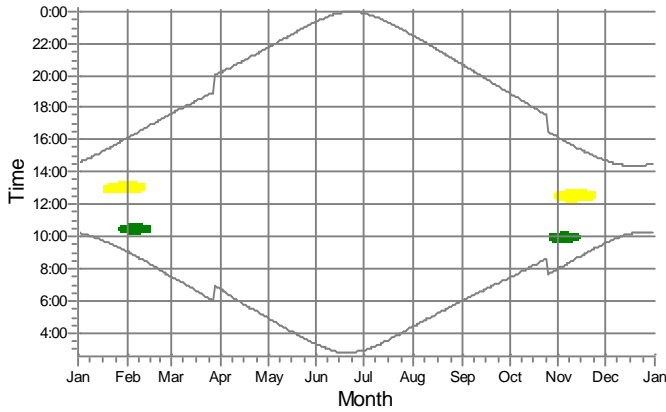
G: Asuinrakennus (Levänevantie 286)



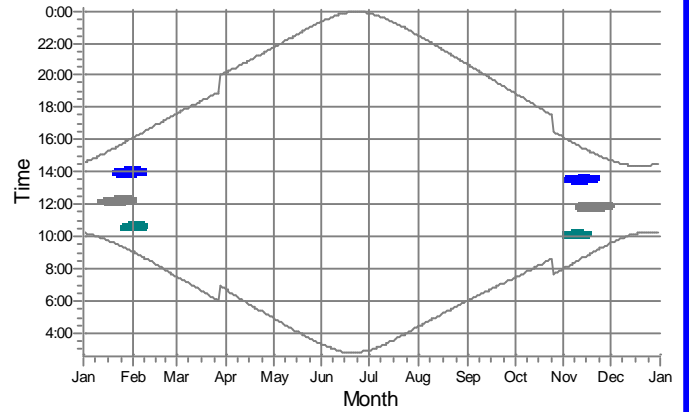
H: Asuinrakennus (Kivinevantie 75)



I: Asuinrakennus (Levänevantie 441)



J: Asuinrakennus (Tuomiperäntie 656)



WTGs

- 1: YP2-T1
- 2: YP2-T2
- 3: YP2-T3
- 4: YP2-T4
- 6: YP2-T6

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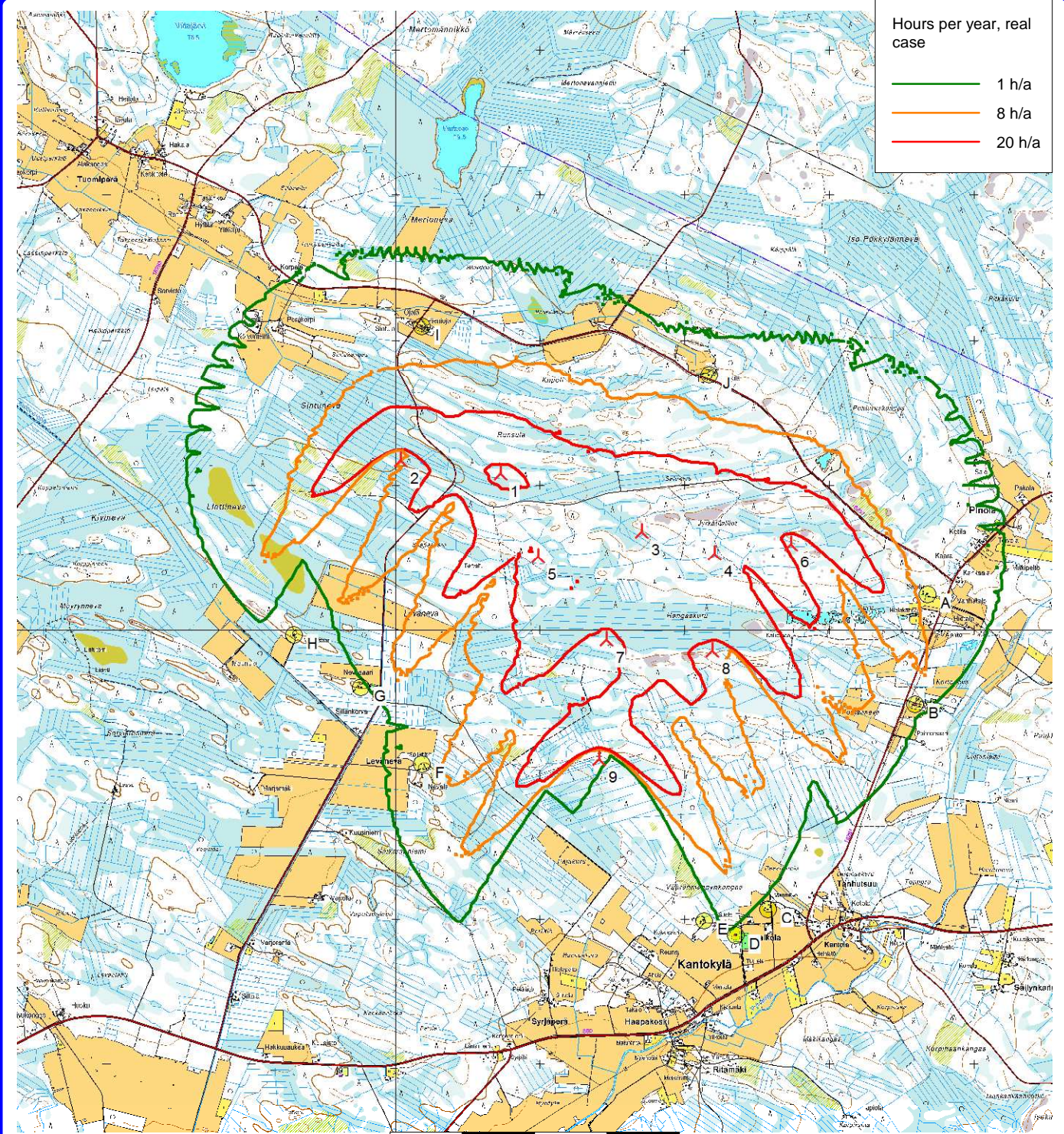
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SHADOW - Map

Calculation: N117-3000 x 9 x HH141



Hours per year, real case

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

Map: Peruskartat , Print scale 1:40 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 392 960 North: 7 110 400

New WTG Shadow receptor

Flicker map level: Height Contours: Tuomiperä height contour lines.wpo (1)

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Calculated:

30.9.2013 10:53/2.8.579



SUUNNITTELU JA TEKNIikka

SHADOW - Main Result

Calculation: V126-3300 x 9 x HH137

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) [LULEA]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0,60	2,61	4,18	6,47	8,80	10,60	9,50	6,88	4,22	2,77	1,22	0,17

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

MERRA_basic_E24.668_N64.000

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
588	431	431	456	611	862	998	1081	968	796	681	704	8608

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

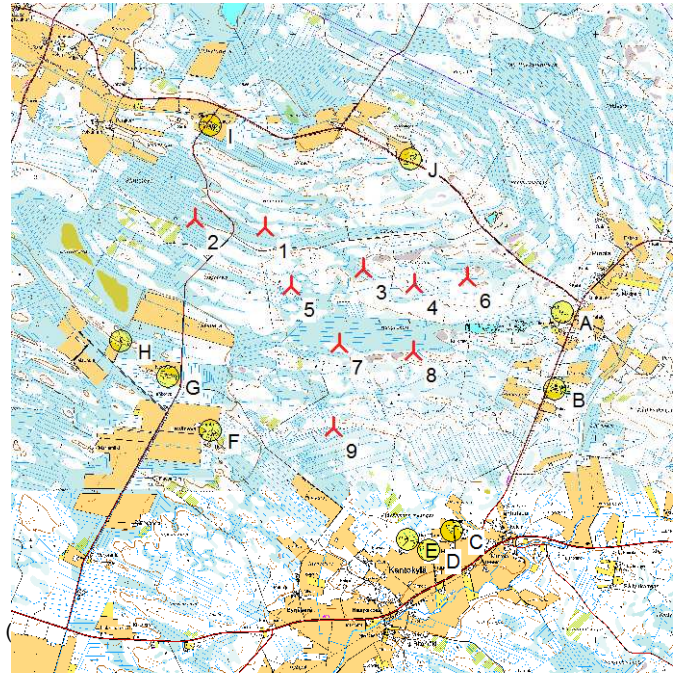
A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:

Height contours used: Height Contours: Tuomiperä height contour lines.wpo

Obstacles used in calculation

Eye height: 1,5 m

Grid resolution: 10,0 m



Scale 1:75 000

▲ New WTG

● Shadow receptor

WTGs

	Finish TM ETRS-TM35FIN-ETRS89			Row data/Description	WTG type			Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Shadow data	
	East	North	Z [m]		Valid	Manufact.	Type-generator				Calculation distance [m]	RPM [RPM]
1	392 723	7 111 083	82,5	YP2-T1	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
2	392 032	7 111 173	80,0	YP2-T2	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
3	393 701	7 110 679	85,0	YP2-T3	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
4	394 202	7 110 527	88,4	YP2-T4	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
5	392 983	7 110 506	83,5	YP2-T5	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
6	394 729	7 110 594	89,7	YP2-T6	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
7	393 458	7 109 936	83,8	YP2-T7	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
8	394 188	7 109 857	85,0	YP2-T8	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5
9	393 403	7 109 108	84,1	YP2-T9	Yes	VESTAS	V126-3 300	3 300	126,0	137,0	1 708	16,5

Shadow receptor-Input

No.	Name	Finish TM ETRS-TM35FIN-ETRS89			Width [m]	Height [m]	Height a.g.l. [m]	Degrees from south cw [°]	Slope of window [°]	Direction mode
		East	North	Z [m]						
A	Asuinrakennus (Pinolantie 266)	395 675	7 110 246	87,5	1,0	1,0	1,0	0,0	0,0	"Green house mode"
B	Höitokoti (Pinolantie 189)	395 590	7 109 486	85,0	1,0	1,0	1,0	0,0	0,0	"Green house mode"
C	Asuinrakennus (Männikkötie 33)	394 575	7 108 070	83,0	1,0	1,0	1,0	0,0	0,0	"Green house mode"
D	Kantokylän kylätalo (Vanhakouluntie 36)	394 348	7 107 888	81,9	1,0	1,0	1,0	0,0	0,0	"Green house mode"
E	Asuinrakennus (Vanhakouluntie 65)	394 131	7 107 990	82,8	1,0	1,0	1,0	0,0	0,0	"Green house mode"
F	Asuinrakennus (Levänevantie 227)	392 179	7 109 070	80,0	1,0	1,0	1,0	0,0	0,0	"Green house mode"
G	Asuinrakennus (Levänevantie 286)	391 760	7 109 605	80,0	1,0	1,0	1,0	0,0	0,0	"Green house mode"
H	Asuinrakennus (Kivinevantie 75)	391 299	7 109 963	80,0	1,0	1,0	1,0	0,0	0,0	"Green house mode"
I	Asuinrakennus (Levänevantie 441)	392 180	7 112 098	80,0	1,0	1,0	1,0	0,0	0,0	"Green house mode"
J	Asuinrakennus (Tuomiperäntie 656)	394 165	7 111 764	85,8	1,0	1,0	1,0	0,0	0,0	"Green house mode"

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SHADOW - Main Result

Calculation: V126-3300 x 9 x HH137

Calculation Results

Shadow receptor

No.	Name	Shadow, expected values	
		Shadow hours	per year [h/year]
A	Asuinrakennus (Pinolantie 266)		7:39
B	Hoitokoti (Pinolantie 189)		4:22
C	Asuinrakennus (Männikkötie 33)		4:19
D	Kantokylän kylätalo (Vanhakouluntie 36)		2:55
E	Asuinrakennus (Vanhakouluntie 65)		0:00
F	Asuinrakennus (Levänevantie 227)		5:44
G	Asuinrakennus (Levänevantie 286)		4:16
H	Asuinrakennus (Kivinevantie 75)		0:00
I	Asuinrakennus (Levänevantie 441)		5:04
J	Asuinrakennus (Tuomiperäntie 656)		6:01

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

No.	Name	Worst case [h/year]	Expected [h/year]
1	YP2-T1	19:07	3:08
2	YP2-T2	24:03	2:56
3	YP2-T3	15:18	1:49
4	YP2-T4	23:32	3:12
5	YP2-T5	14:26	4:16
6	YP2-T6	37:58	9:01
7	YP2-T7	11:37	3:24
8	YP2-T8	13:06	2:58
9	YP2-T9	33:00	9:35

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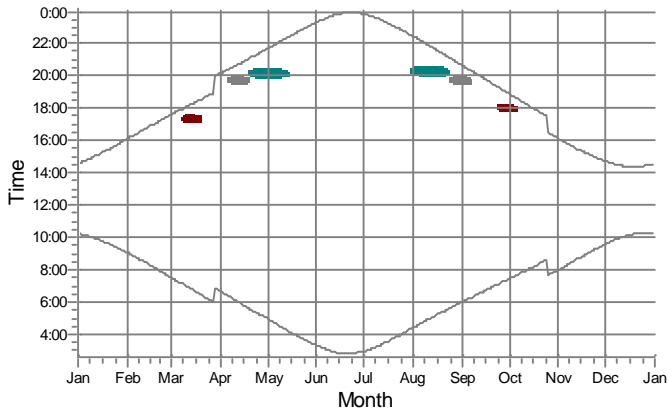
Hans Vadbäck / hans.vadbäck@fcg.fi
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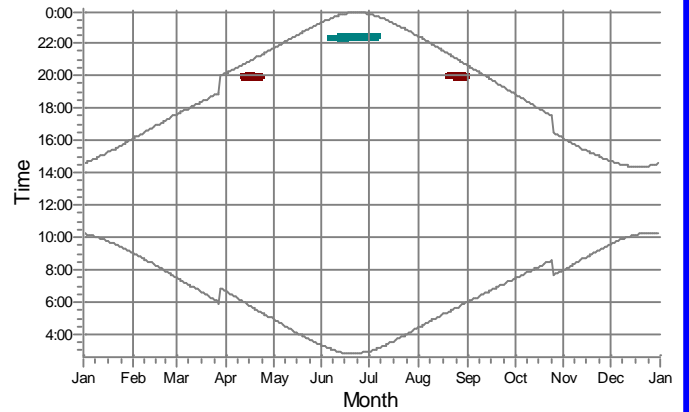
SHADOW - Calendar, graphical

Calculation: V126-3300 x 9 x HH137

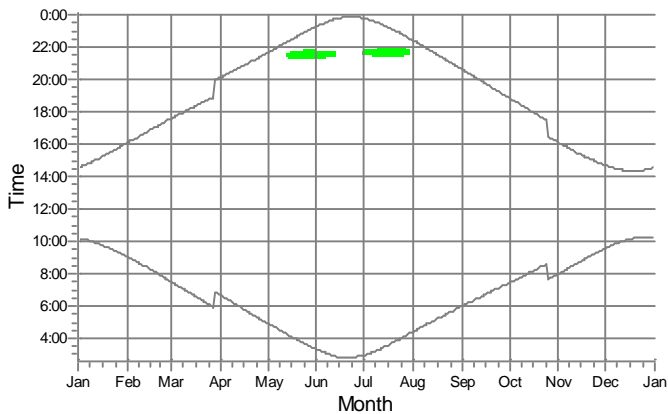
A: Asuinrakennus (Pinolantie 266)



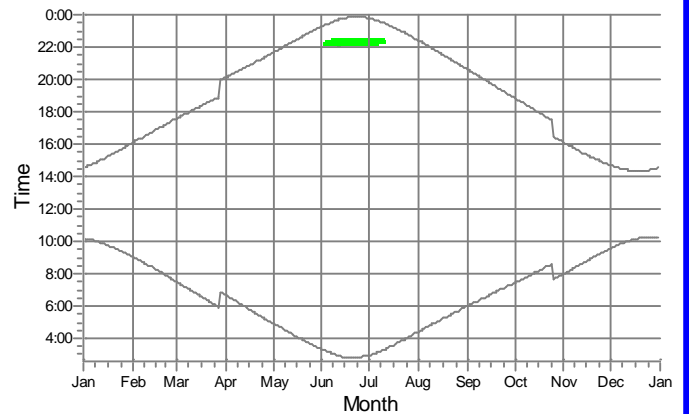
B: Hoitokoti (Pinolantie 189)



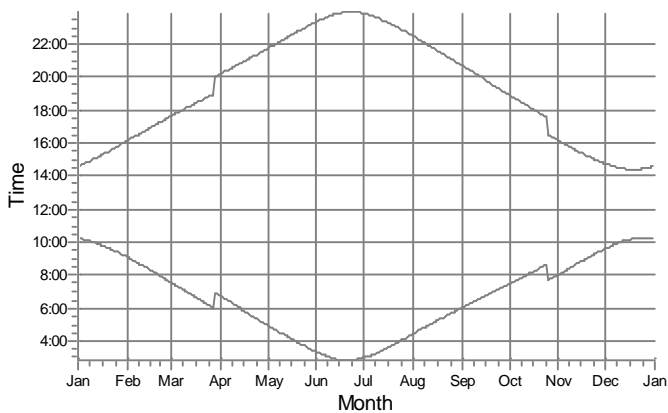
C: Asuinrakennus (Männikkötie 33)



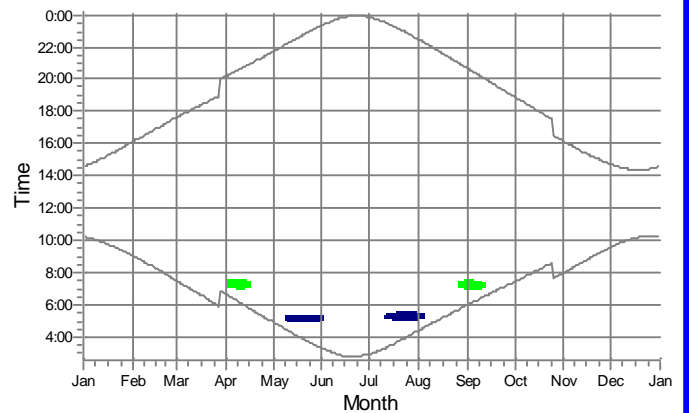
D: Kantokylän kylätalo (Vanhakouluntie 36)



E: Asuinrakennus (Vanhakouluntie 65)



F: Asuinrakennus (Levänevantie 227)



WTGs

- 4: YP2-T4
- 6: YP2-T6
- 7: YP2-T7
- 8: YP2-T8
- 9: YP2-T9

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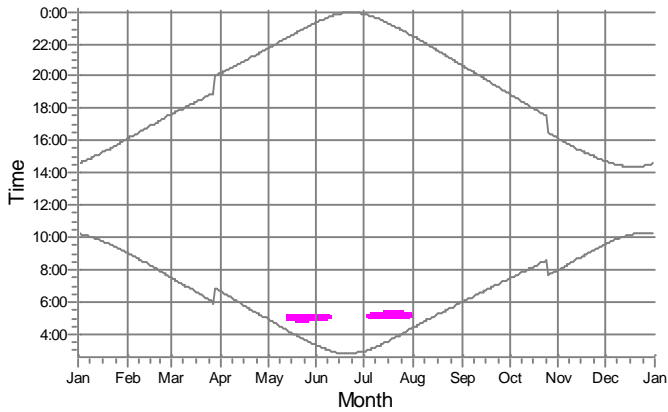


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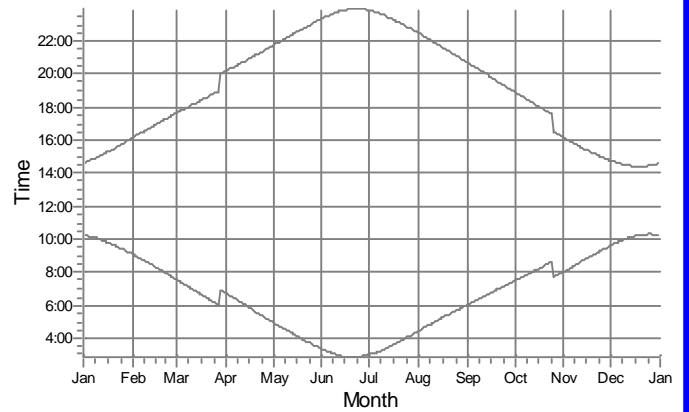
SHADOW - Calendar, graphical

Calculation: V126-3300 x 9 x HH137

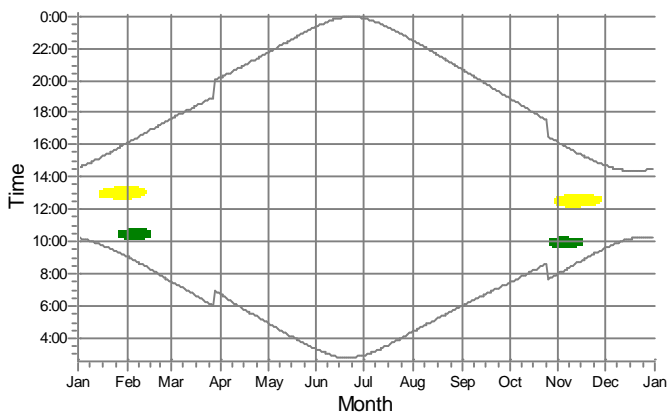
G: Asuinrakennus (Levänevantie 286)



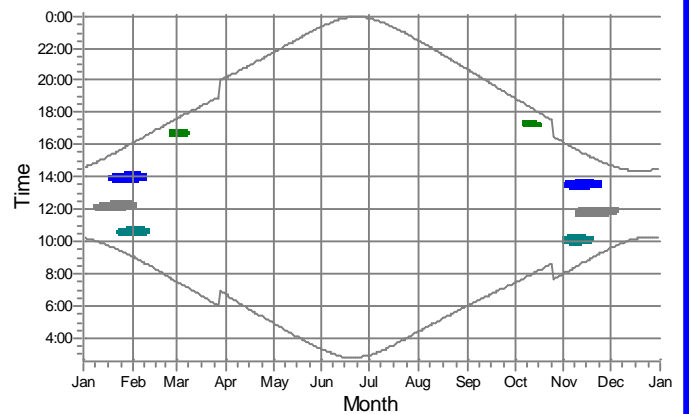
H: Asuinrakennus (Kivinevantie 75)









I: Asuinrakennus (Levänevantie 441)



J: Asuinrakennus (Tuomiperäntie 656)



WTGs

- | | | | | | |
|---|-----------|---|-----------|---|-----------|
|  | 1: YP2-T1 |  | 3: YP2-T3 |  | 5: YP2-T5 |
|  | 2: YP2-T2 |  | 4: YP2-T4 |  | 6: YP2-T6 |

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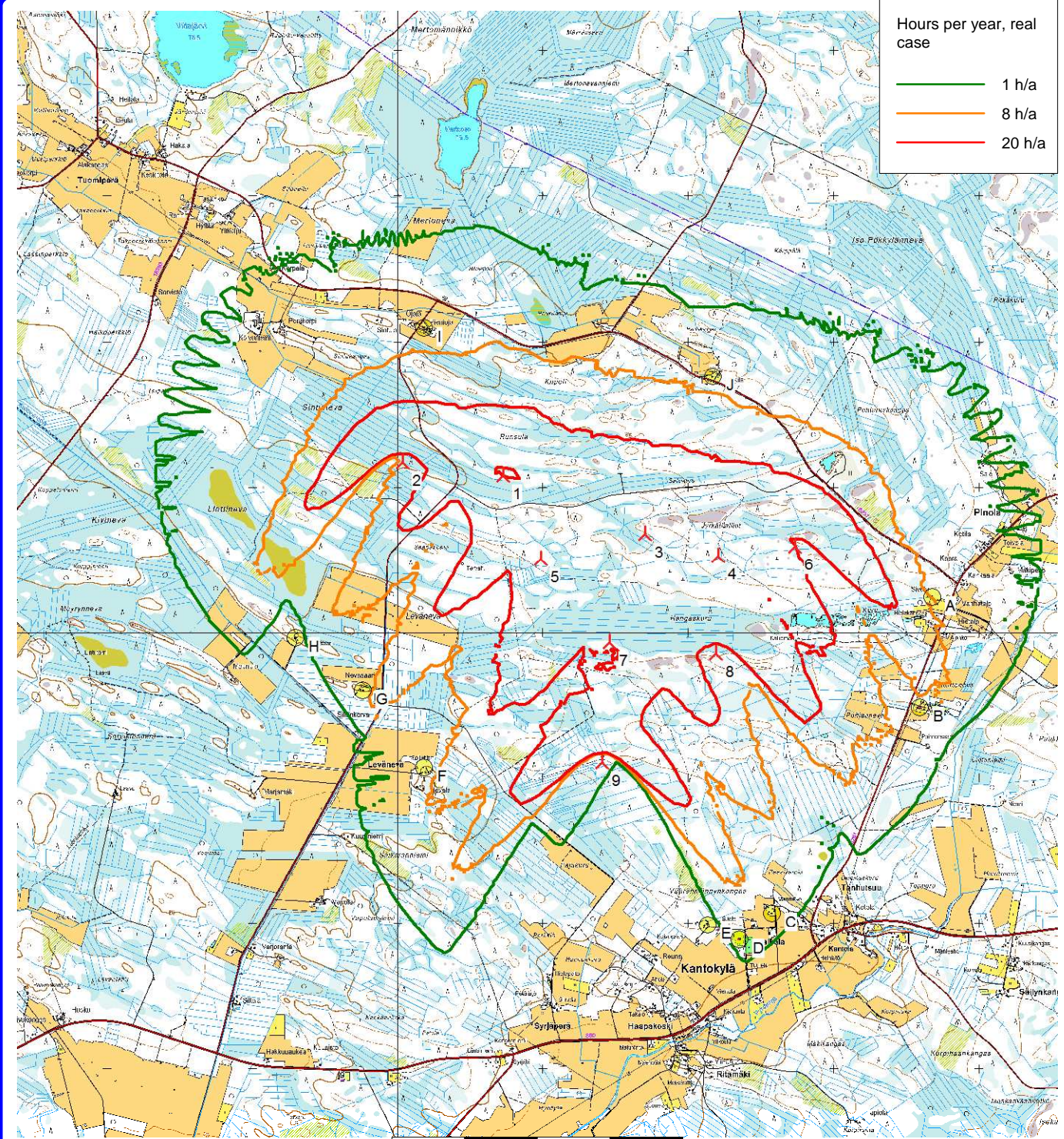
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Hans Vadback / hans.vadback@fcg.fi
Calculated:
30.9.2013 10:53/2.8.579

SHADOW - Map

Calculation: V126-3300 x 9 x HH137



Hours per year, real case

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

0 500 1000 1500 2000 m

Map: Peruskartat , Print scale 1:40 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 392 960 North: 7 110 400

New WTG Shadow receptor

Flicker map level: Height Contours: Tuomiperä height contour lines.wpo (1)