Project:
EFFECTEN SLAGSCHADUW HERENTALS GEPLANDE WINDTURBINES HERENTALS

EDF Luminus
Markiesstraat 1
1000 Brussel

Licensed user:
COGEN Energy BVBA
Boelare 52
BE-9900 EEKLO

Frederik De Smet / fds@cogen-energy.be
Calculated:
25-10-2017 17:20/3.1.617

SHADOW - Main Result

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) [UCCLE]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1,73	3,04	3,77	5,42	6,72	6,47	6,55	6,53	5,25	3,96	2,43	1,56

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
261	393	465	559	645	475	572	869	1.140	1.059	606	326	7.370

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

A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values.
A WTG will be visible if it is visible from any part of the receiver window.
The ZVI calculation is based on the following assumptions:
Height contours used: Height Contours: CONTOURLINE_ONLINEDATA_19.wpo
Obstacles used in calculation
Eye height: 1,5 m
Grid resolution: 10,0 m
Topographic shadow included in calculation

All coordinates are in
Belgian Lambert72-BD72 (BE 2001 <±1m)

Scale 1:20.000

New WTG Shadow receptor

WTGs

	X	Y	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	181.978	205.416	10,0	Siemens SWT-2.3-120 2300 120.0 !O!...	Yes	Siemens	SWT-2.3-120-2.300	2.300	120,0	92,0	1.633	13,0
2	182.369	205.299	10,0	Siemens SWT-2.3-120 2300 120.0 !O!...	Yes	Siemens	SWT-2.3-120-2.300	2.300	120,0	92,0	1.633	13,0
3	184.217	205.481	13,7	ENERCON E-92 2,3 MW 2300 92.0 !-! ...	No	ENERCON	E-92 2,3 MW-2.300	2.300	92,0	108,4	1.516	16,0
4	184.563	205.378	20,0	ENERCON E-92 2,3 MW 2300 92.0 !-! ...	No	ENERCON	E-92 2,3 MW-2.300	2.300	92,0	108,4	1.516	16,0

Shadow receptor-Input

No.	X	Y	Z	Width	Height	Height a.g.l.	Degrees from south cw	Slope of window	Direction mode
			[m]	[m]	[m]	[m]	[°]	[°]	
A	182.446	204.982	10,0	5,0	2,0	1,0	0,0	90,0	"Green house mode"
B	182.697	205.374	12,1	5,0	2,0	1,0	0,0	90,0	"Green house mode"
C	181.588	205.659	14,9	5,0	2,0	1,0	0,0	90,0	"Green house mode"
D	181.639	204.876	10,0	5,0	2,0	1,0	0,0	90,0	"Green house mode"
E	182.214	204.865	10,0	5,0	2,0	1,0	0,0	90,0	"Green house mode"
F	181.541	205.149	10,0	5,0	2,0	1,0	0,0	90,0	"Green house mode"
G	181.864	205.714	10,4	5,0	2,0	1,0	0,0	90,0	"Green house mode"
H	181.963	205.747	10,7	5,0	2,0	1,0	0,0	90,0	"Green house mode"
I	182.058	205.724	12,3	5,0	2,0	1,0	0,0	90,0	"Green house mode"
J	182.190	205.699	12,4	5,0	2,0	1,0	0,0	90,0	"Green house mode"
K	182.346	205.800	13,9	5,0	2,0	1,0	0,0	90,0	"Green house mode"
L	182.561	205.609	15,7	5,0	2,0	1,0	0,0	90,0	"Green house mode"
M	181.389	205.512	18,0	5,0	2,0	1,0	0,0	90,0	"Green house mode"
N	182.040	204.744	10,0	5,0	2,0	1,0	0,0	90,0	"Green house mode"
O	181.711	205.689	12,9	5,0	2,0	1,0	0,0	90,0	"Green house mode"
P	182.878	205.185	15,7	5,0	2,0	1,0	0,0	90,0	"Green house mode"

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SHADOW - Main Result

Calculation Results

Shadow receptor

No.	Shadow, worst case: Shadow hours per year [h/year]	Shadow, worst case: Shadow days per year [days/year]	Shadow, worst case: Max shadow hours per day [h/day]	Shadow, expected values: Shadow hours per year [h/year]
A	0:00	0	0:00	0:00
B	139:55	108	1:56	31:40
C	82:31	88	1:24	13:39
D	36:49	74	0:37	9:01
E	0:00	0	0:00	0:00
F	64:36	113	0:52	15:46
G	212:37	120	2:13	24:49
H	206:04	101	2:19	22:39
I	236:41	112	2:33	27:26
J	245:55	137	2:21	32:22
K	103:04	114	1:13	13:49
L	180:09	181	1:22	27:12
M	37:21	69	0:48	7:27
N	0:00	0	0:00	0:00
O	166:06	144	1:54	21:22
P	75:03	100	1:03	17:10

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

No.	Name	Worst case [h/year]	Expected [h/year]
1	Siemens SWT-2.3-120 2300 120.0 !O! hub: 92,0 m (TOT: 152,0 m) (1)	970:08	139:53
2	Siemens SWT-2.3-120 2300 120.0 !O! hub: 92,0 m (TOT: 152,0 m) (2)	676:06	110:12
3	ENERCON E-92 2,3 MW 2300 92.0 !-! hub: 108,4 m (TOT: 154,4 m) (10)	4:31	1:06
4	ENERCON E-92 2,3 MW 2300 92.0 !-! hub: 108,4 m (TOT: 154,4 m) (11)	0:00	0:00

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

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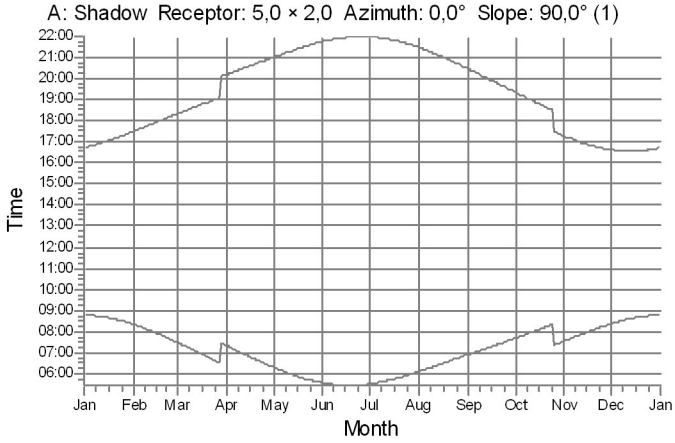
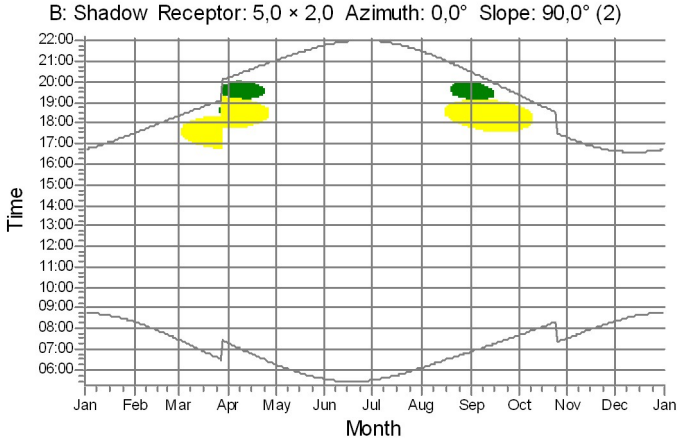
SHADOW - Calendar, graphical

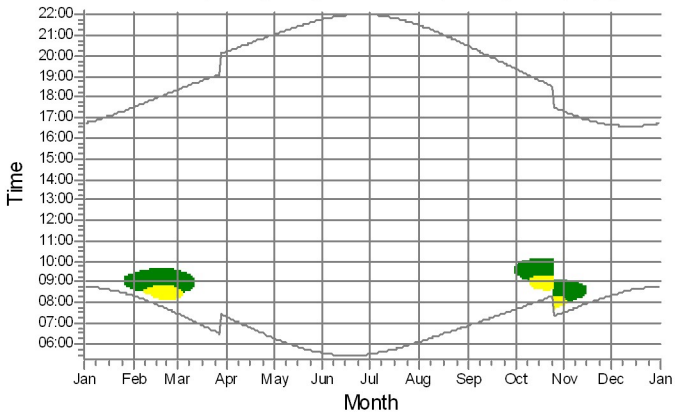
A: Shadow Receptor: 5,0 × 2,0 Azimuth: 0,0° Slope: 90,0° (1)



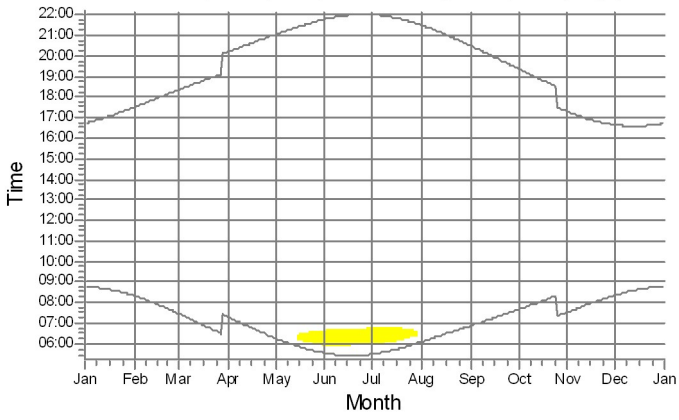
B: Shadow Receptor: 5,0 × 2,0 Azimuth: 0,0° Slope: 90,0° (2)



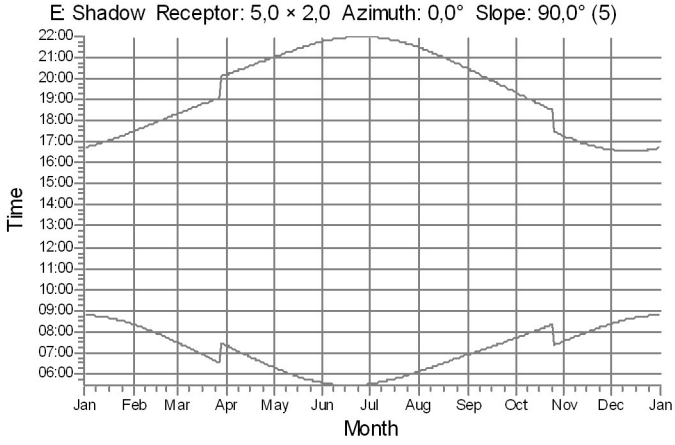
C: Shadow Receptor: 5,0 × 2,0 Azimuth: 0,0° Slope: 90,0° (3)



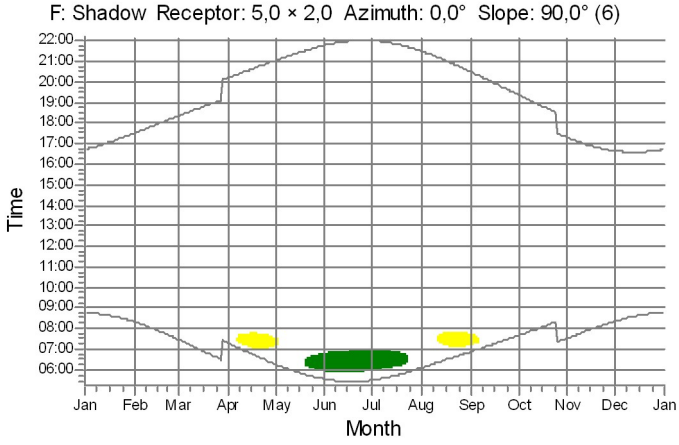
D: Shadow Receptor: 5,0 × 2,0 Azimuth: 0,0° Slope: 90,0° (4)



E: Shadow Receptor: 5,0 × 2,0 Azimuth: 0,0° Slope: 90,0° (5)



F: Shadow Receptor: 5,0 × 2,0 Azimuth: 0,0° Slope: 90,0° (6)



WTGs

1: Siemens SWT-2.3-120 2300 120.0 !O! hub: 92,0 m (TOT: 152,0 m) (1)

2: Siemens SWT-2.3-120 2300 120.0 !O! hub: 92,0 m (TOT: 152,0 m) (2)

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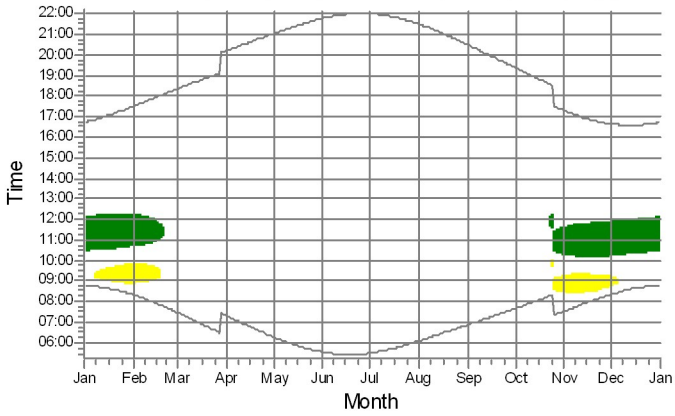
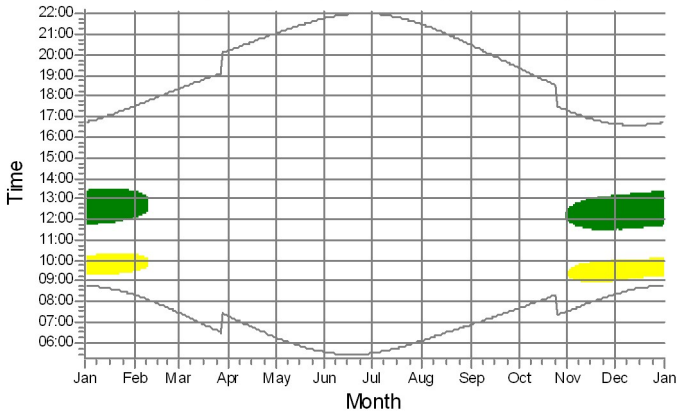
SHADOW - Calendar, graphical

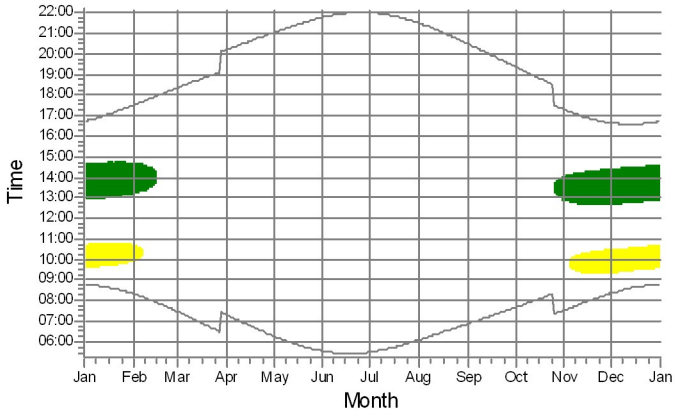
G: Shadow Receptor: 5,0 × 2,0 Azimuth: 0,0° Slope: 90,0° (7)



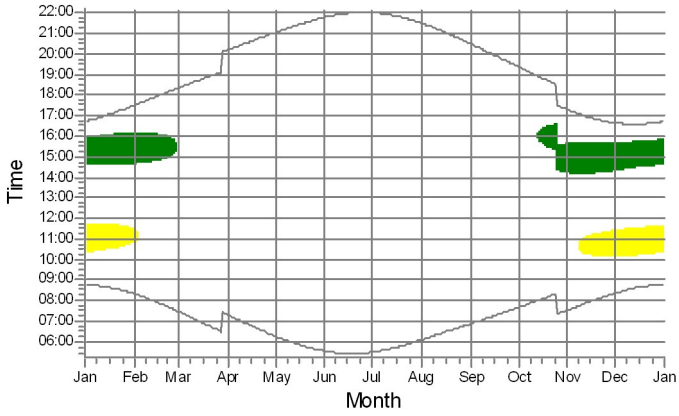
H: Shadow Receptor: 5,0 × 2,0 Azimuth: 0,0° Slope: 90,0° (8)



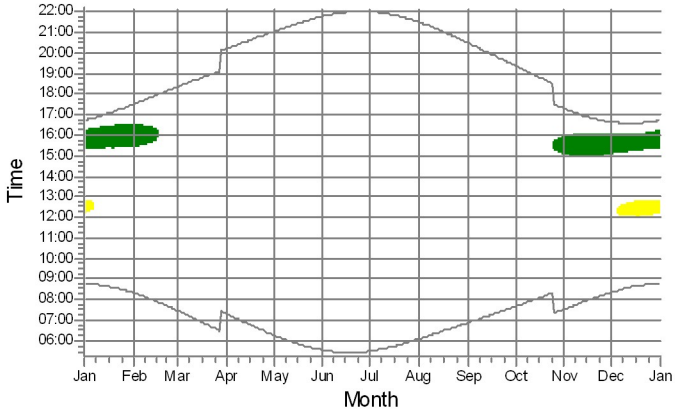
I: Shadow Receptor: 5,0 × 2,0 Azimuth: 0,0° Slope: 90,0° (9)



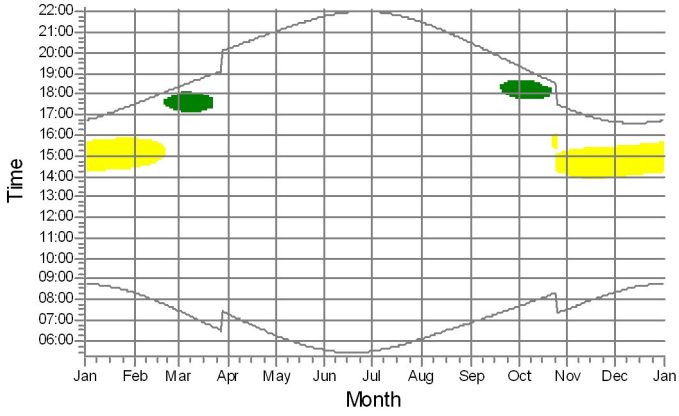
J: Shadow Receptor: 5,0 × 2,0 Azimuth: 0,0° Slope: 90,0° (10)



K: Shadow Receptor: 5,0 × 2,0 Azimuth: 0,0° Slope: 90,0° (11)



L: Shadow Receptor: 5,0 × 2,0 Azimuth: 0,0° Slope: 90,0° (12)



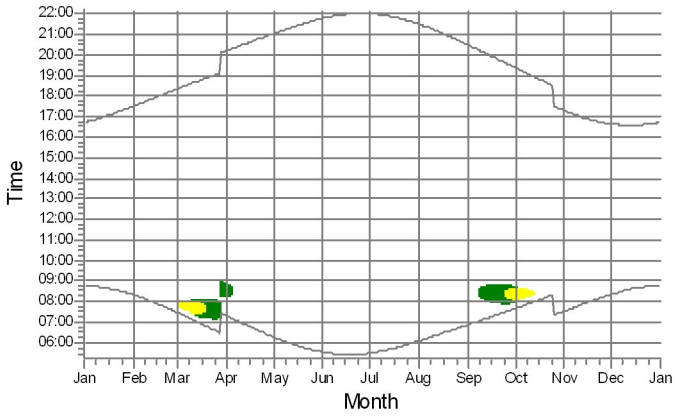
WTGs

1: Siemens SWT-2.3-120 2300 120.0 !O! hub: 92,0 m (TOT: 152,0 m) (1)

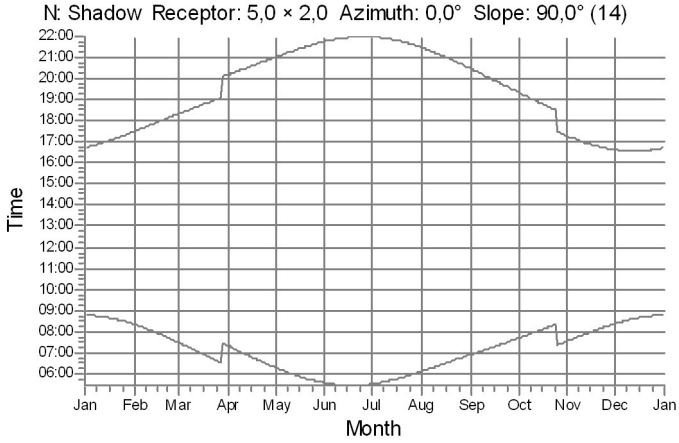
2: Siemens SWT-2.3-120 2300 120.0 !O! hub: 92,0 m (TOT: 152,0 m) (2)

SHADOW - Calendar, graphical

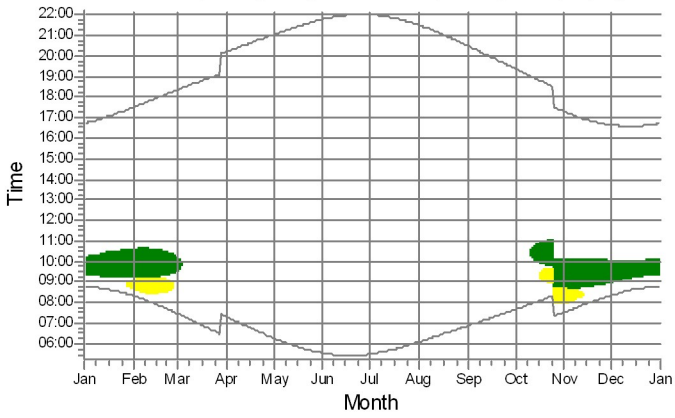
M: Shadow Receptor: 5,0 × 2,0 Azimuth: 0,0° Slope: 90,0° (13)



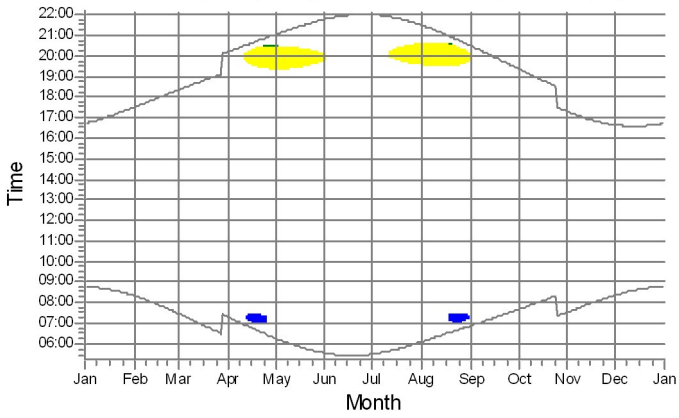
N: Shadow Receptor: 5,0 × 2,0 Azimuth: 0,0° Slope: 90,0° (14)



O: Shadow Receptor: 5,0 × 2,0 Azimuth: 0,0° Slope: 90,0° (15)



P: Shadow Receptor: 5,0 × 2,0 Azimuth: 0,0° Slope: 90,0° (17)

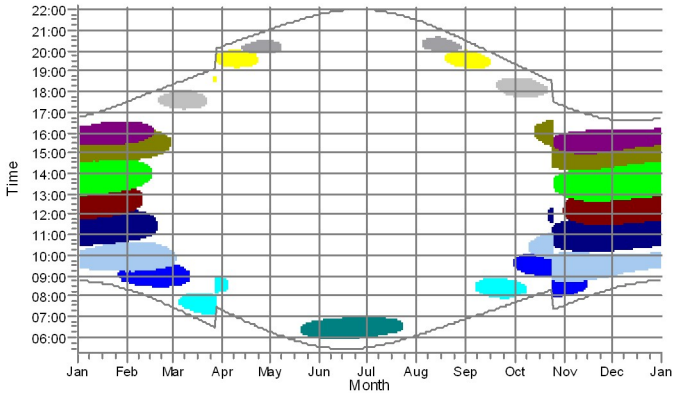


WTGs

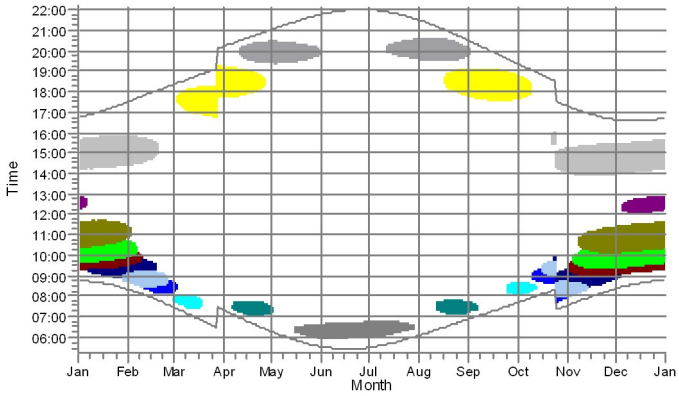
1: Siemens SWT-2.3-120 2300 120.0 !O! hub: 92,0 m (TOT: 152,0 m) (1)
2: Siemens SWT-2.3-120 2300 120.0 !O! hub: 92,0 m (TOT: 152,0 m) (2)
3: ENERCON E-92 2,3 MW 2300 92.0 !-! hub: 108,4 m (TOT: 154,4 m) (10)

SHADOW - Calendar per WTG, graphical

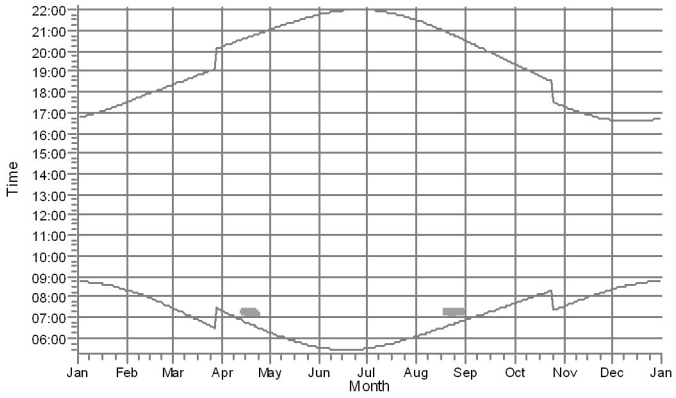
1: Siemens SWT-2.3-120 2300 120.0 !O! hub: 92,0 m (TOT: 152,0 m) (1)



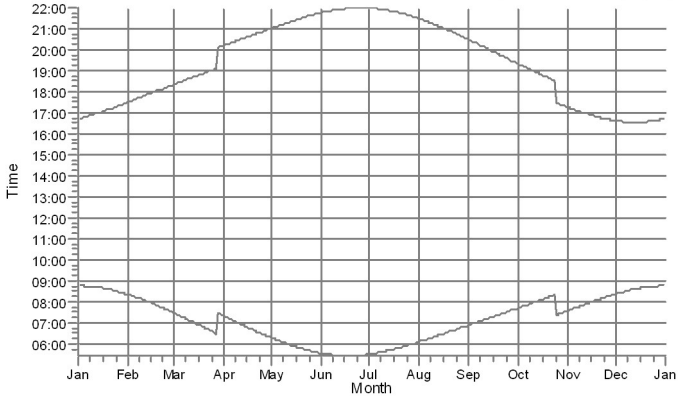
2: Siemens SWT-2.3-120 2300 120.0 !O! hub: 92,0 m (TOT: 152,0 m) (2)



3: ENERCON E-92 2,3 MW 2300 92.0 !-! hub: 108,4 m (TOT: 154,4 m) (10)



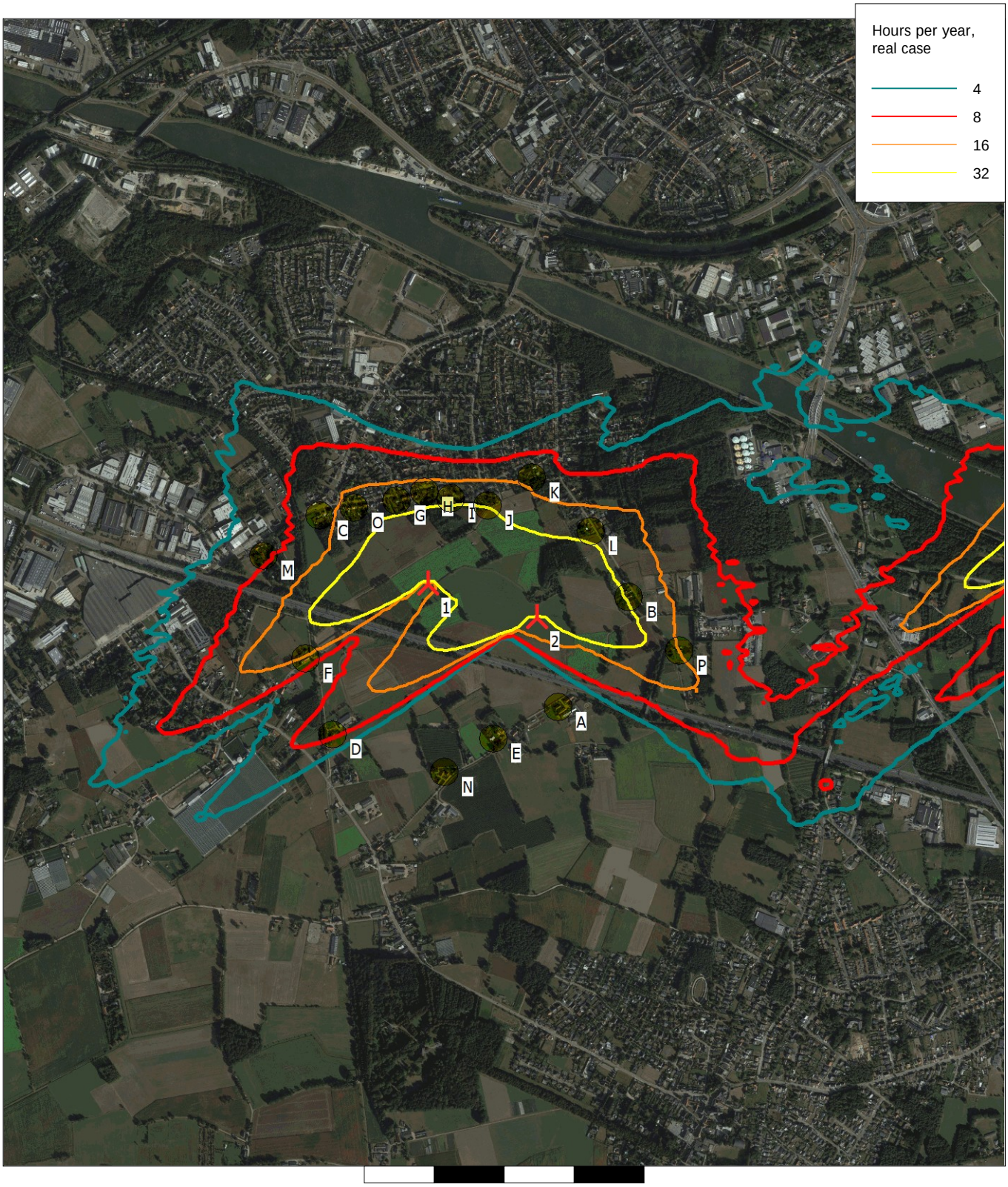
4: ENERCON E-92 2,3 MW 2300 92.0 !-! hub: 108,4 m (TOT: 154,4 m) (11)



Shadow receptors

- B: Shadow Receptor: 5,0 × 2,0 Azimuth: 0,0° Slope: 90,0° (2)
- C: Shadow Receptor: 5,0 × 2,0 Azimuth: 0,0° Slope: 90,0° (3)
- D: Shadow Receptor: 5,0 × 2,0 Azimuth: 0,0° Slope: 90,0° (4)
- F: Shadow Receptor: 5,0 × 2,0 Azimuth: 0,0° Slope: 90,0° (6)
- G: Shadow Receptor: 5,0 × 2,0 Azimuth: 0,0° Slope: 90,0° (7)
- H: Shadow Receptor: 5,0 × 2,0 Azimuth: 0,0° Slope: 90,0° (8)
- I: Shadow Receptor: 5,0 × 2,0 Azimuth: 0,0° Slope: 90,0° (9)
- J: Shadow Receptor: 5,0 × 2,0 Azimuth: 0,0° Slope: 90,0° (10)
- K: Shadow Receptor: 5,0 × 2,0 Azimuth: 0,0° Slope: 90,0° (11)
- L: Shadow Receptor: 5,0 × 2,0 Azimuth: 0,0° Slope: 90,0° (12)
- M: Shadow Receptor: 5,0 × 2,0 Azimuth: 0,0° Slope: 90,0° (13)
- O: Shadow Receptor: 5,0 × 2,0 Azimuth: 0,0° Slope: 90,0° (15)
- P: Shadow Receptor: 5,0 × 2,0 Azimuth: 0,0° Slope: 90,0° (17)

SHADOW - Map



Map: HERENTALS2 , Print scale 1:20.000, Map center Belgian Lambert72-BD72 (BE 2001 <±1m) East: 182.195 North: 205.344

New WTG Shadow receptor

Flicker map level: Height Contours: CONTOURLINE_ONLINEDATA_19.wpo (1)