

SHADOW

Calculation of Flickering from WTGs



WindPRO version 2.7.424 Beta Jan 2010

Project: Cronalaght demonstration - Module descriptions	Description: The project has been modified to demonstrate WindPRO functionalities.	Printed/Date: 06-01-2010 09:45 / 1
		Licensed user: EMD International A/S Niels Jernevej 10 DK-9220 Aalborg Ø +45 9635 4444 Thomas Sørensen, ts@emd.dk Calculated: 06-01-2010 09:42/2.7.424

SHADOW - Main Result

Calculation: Shadow demonstration calculation

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

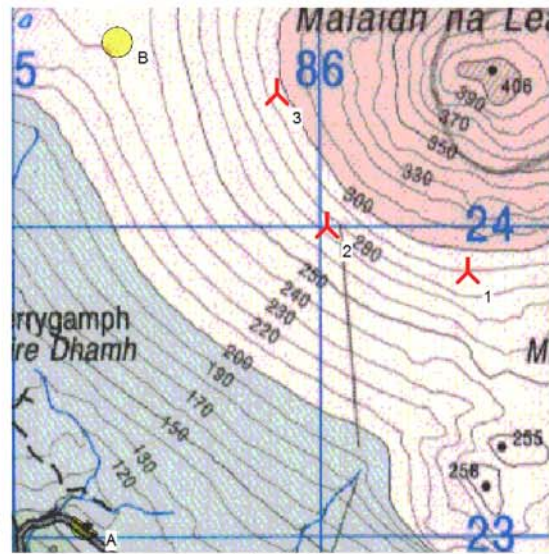
Minimum sun height over horizon for influence: 3 °
 Day step for calculation: 1 days
 Time step for calculation: 1 minutes

Sunshine probability S (Average daily sunshine hours) [MALIN HEAD C.]
 Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 1,15 2,00 2,55 4,69 6,02 5,13 4,45 3,83 3,52 2,48 1,46 0,85

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

Operational time
 N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum
 438 438 403 498 975 762 758 906 915 880 855 541 8.369

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: Heightcontours Cronalaght.wpo (1)
 Obstacles used in calculation
 Eye height: 1,5 m
 Grid resolution: 10 m

WTGs

IG	East	North	Z	Row data/Description	WTG type				Shadow data			
					Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Calculation distance [m]	RPM
1	186.487,9	423.847,0	289,0	VESTAS V90 3000 90.0 !O! hub: ...	Yes	VESTAS	V90-3.000	3.000	90,0	80,0	1.425	16,1
2	186.029,8	423.995,1	273,4	VESTAS V90 3000 90.0 !O! hub: ...	Yes	VESTAS	V90-3.000	3.000	90,0	80,0	1.425	16,1
3	185.865,6	424.429,3	295,1	VESTAS V90 3000 90.0 !O! hub: ...	Yes	VESTAS	V90-3.000	3.000	90,0	80,0	1.425	16,1

Shadow receptor-Input

No.	Name	East	North	Z	Width [m]	Height [m]	Height a.g.l. [m]	Degrees from south cw [°]	Slope of window [°]	Direction mode
A	Dwelling A	185.242,2	423.027,6	110,0	1,0	1,0	1,0	-146,3	90,0	Fixed direction
B	Hill cottage	185.346,8	424.594,0	235,2	1,0	1,0	1,0	-180,0	90,0	"Green house mode"

Calculation Results

No.	Name	Shadow, worst case			Shadow, expected values	
		Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow hours per year [h/year]	
A	Dwelling A	0:00	0	0:00	0:00	
B	Hill cottage	38:58	92	0:37	5:37	

Total amount of flickering on the shadow receptors caused by each WTG				
No.	Name	Worst case [h/year]	Expected [h/year]	
1	VESTAS V90 3000 90.0 !O! hub: 80,0 m (9.1)	4:41	0:37	
2	VESTAS V90 3000 90.0 !O! hub: 80,0 m (9.2)	11:32	1:21	

To be continued on next page...

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SHADOW - Main Result

Calculation: Shadow demonstration calculation

...continued from previous page

No.	Name	Worst case [h/year]	Expected [h/year]
3	VESTAS V90 3000 90.0 !O! hub: 80,0 m (9.3)	22:45	3:38

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SHADOW - Calendar

Calculation: Shadow demonstration calculation Shadow receptor: B - Hill cottage

Assumptions for shadow calculations

Maximum distance for influence 2.000 m
 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) [MALIN HEAD C.]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1,15	2,00	2,55	4,69	6,02	5,13	4,45	3,83	3,52	2,48	1,46	0,85

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
438	438	403	498	975	762	758	906	915	880	855	541	8.369

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

	January	February	March	April	May	June			
1	08:59	08:26	09:12 (2)	07:26	07:07	08:50 (3)	05:55	05:02	
	16:15	17:09	20 09:32 (2)	18:07	20:09	31 09:21 (3)	21:08	22:01	
2	08:59	08:24	09:11 (2)	07:23	07:05	08:51 (3)	05:53	05:01	
	16:16	17:11	21 09:32 (2)	18:09	20:11	28 09:19 (3)	21:09	22:02	
3	08:59	08:22	09:11 (2)	07:21	07:02	08:52 (3)	05:51	05:00	
	16:17	17:13	22 09:33 (2)	18:11	20:13	26 09:18 (3)	21:11	22:03	
4	08:58	08:21	09:11 (2)	07:18	07:00	08:53 (3)	05:49	05:00	
	16:18	17:15	23 09:34 (2)	18:13	20:15	22 09:15 (3)	21:13	22:04	
5	08:58	08:19	09:11 (2)	07:16	06:57	08:56 (3)	05:46	04:59	
	16:20	17:17	23 09:34 (2)	18:15	20:17	16 09:12 (3)	21:15	22:06	
6	08:57	08:17	09:11 (2)	07:13	06:55	08:59 (3)	05:44	04:58	
	16:21	17:19	23 09:34 (2)	18:18	20:19	8 09:07 (3)	21:17	22:07	
7	08:57	08:15	09:11 (2)	07:11	06:52		05:42	04:57	
	16:22	17:21	24 09:35 (2)	18:20	20:21		21:19	22:08	
8	08:56	08:13	08:46 (1)	07:08	06:50		05:40	04:57	
	16:24	17:23	33 09:35 (2)	18:22	20:23		21:21	22:09	
9	08:56	08:11	08:45 (1)	07:06	06:47		05:38	04:56	
	16:25	17:25	33 09:34 (2)	18:24	20:25		21:23	22:10	
10	08:55	08:09	08:43 (1)	07:03	06:45		05:36	04:55	
	16:27	17:28	35 09:33 (2)	18:26	20:27		21:25	22:11	
11	08:54	08:07	08:43 (1)	07:01	06:42		05:34	04:55	
	16:29	17:30	35 09:33 (2)	18:28	20:29		21:26	22:11	
12	08:53	08:05	08:43 (1)	06:58	06:40		05:33	04:54	
	16:30	17:32	33 09:32 (2)	18:30	20:30		21:28	22:12	
13	08:52	08:02	08:43 (1)	06:56	06:37		05:31	04:54	
	16:32	17:34	31 09:31 (2)	18:32	20:32		21:30	22:13	
14	08:51	08:00	08:42 (1)	06:53	06:35	08:10 (3)	05:29	04:54	
	16:34	17:36	26 09:27 (2)	18:34	3 08:13 (3)	20:34	21:32	22:14	
15	08:50	07:58	08:43 (1)	06:51	06:32	08:03 (3)	05:27	04:53	
	16:35	17:38	15 08:58 (1)	18:36	16 08:19 (3)	20:36	21:34	22:14	
16	08:49	07:56	08:44 (1)	06:48	06:30	08:01 (3)	05:25	04:53	
	16:37	17:40	13 08:57 (1)	18:38	21 08:22 (3)	20:38	21:36	22:15	
17	08:48	07:54	08:45 (1)	06:46	06:27	07:58 (3)	05:23	04:53	
	16:39	17:42	10 08:55 (1)	18:40	25 08:23 (3)	20:40	21:37	22:15	
18	08:47	07:51	08:47 (1)	06:43	06:25	07:57 (3)	05:22	04:53	
	16:41	17:44	6 08:53 (1)	18:42	28 08:25 (3)	20:42	21:39	22:16	
19	08:46	07:49		06:41	06:23	07:55 (3)	05:20	04:53	
	16:43	17:47		18:43	30 08:25 (3)	20:44	21:41	22:16	
20	08:45	07:47		06:38	06:20	07:54 (3)	05:18	04:53	
	16:45	17:49		18:45	33 08:27 (3)	20:46	21:42	22:17	
21	08:43	07:45		06:36	06:18	07:53 (3)	05:17	04:53	
	16:46	17:51		18:47	34 08:27 (3)	20:48	21:44	22:17	
22	08:42	07:42		06:33	06:16	07:51 (3)	05:15	04:53	
	16:48	17:53		18:49	35 08:26 (3)	20:50	21:46	22:17	
23	08:41	07:40		06:30	06:13	07:51 (3)	05:14	04:54	
	16:50	17:55		18:51	36 08:27 (3)	20:52	21:47	22:17	
24	08:39	07:38		06:28	06:11	07:50 (3)	05:12	04:54	
	16:52	17:57		18:53	37 08:27 (3)	20:54	21:49	22:17	
25	08:38	07:35		06:25	06:09	07:50 (3)	05:11	04:54	
	16:54	17:59		18:55	37 08:27 (3)	20:56	21:51	22:17	
26	08:36	07:33		06:23	06:06	07:49 (3)	05:10	04:55	
	16:56	18:01		18:57	37 08:26 (3)	20:58	21:52	22:17	
27	08:35	07:30		06:20	06:04	07:50 (3)	05:08	04:55	
	16:58	18:03		18:59	36 08:26 (3)	21:00	21:54	22:17	
28	08:33	07:28		06:18	06:02	07:49 (3)	05:07	04:55	
	17:00	9 09:17 (2)	18:05		19:01	36 08:25 (3)	21:02	21:55	22:17
29	08:31	09:15 (2)			07:15	08:49 (3)	05:06	04:56	
	17:02	13 09:28 (2)			20:03	35 09:24 (3)	21:04	21:57	22:17
30	08:30	09:13 (2)			07:12	08:49 (3)	05:05	04:57	
	17:04	16 09:29 (2)			20:05	34 09:23 (3)	21:06	21:58	22:16
31	08:28	09:12 (2)			07:10	08:49 (3)		05:04	
	17:07	19 09:31 (2)			20:07	33 09:22 (3)		21:59	
Potential sun hours	243	270	366	423	500	518			
Total, worst case	57	426	546	131					
Sun reduction	0,15	0,21	0,22	0,33					
Oper. time red.	0,96	0,96	0,96	0,96					
Wind dir. red.	0,65	0,65	0,65	0,65					
Total reduction	0,09	0,13	0,13	0,21					
Total, real	5	55	73	27					

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)

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SHADOW - Calendar

Calculation: Shadow demonstration calculation Shadow receptor: B - Hill cottage

Assumptions for shadow calculations

Maximum distance for influence 2.000 m
 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) [MALIN HEAD C.]

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 1,15 2,00 2,55 4,69 6,02 5,13 4,45 3,83 3,52 2,48 1,46 0,85

Operational time
 N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum
 438 438 403 498 975 762 758 906 915 880 855 541 8.369
 Idle start wind speed: Cut in wind speed from power curve

	July	August	September	October	November	December
1	04:58	05:40	06:38	07:34	07:36	08:13 (1) 08:34
	22:16	21:38	20:28	19:11	16:58	35 09:03 (2) 16:11
2	04:59	05:42	06:40	07:36	07:38	08:14 (1) 08:35
	22:16	21:36	20:26	19:09	16:56	33 09:03 (2) 16:10
3	04:59	05:44	06:42	07:38	07:40	08:16 (1) 08:37
	22:15	21:34	20:23	19:06	16:54	31 09:04 (2) 16:09
4	05:00	05:46	06:43	07:40	07:42	08:17 (2) 08:38
	22:15	21:32	20:21	19:04	16:52	23 09:04 (2) 16:08
5	05:01	05:47	06:45	07:42	07:44	08:18 (2) 08:40
	22:14	21:30	20:18	19:01	16:50	24 09:04 (2) 16:08
6	05:02	05:49	06:47	08:55 (3) 07:44	07:46	08:40 (2) 08:41
	22:13	21:28	20:16	8 09:03 (3) 18:59	16:48	24 09:04 (2) 16:07
7	05:03	05:51	06:49	08:51 (3) 07:46	07:48	08:41 (2) 08:43
	22:13	21:26	20:13	16 09:07 (3) 18:56	16:46	23 09:04 (2) 16:06
8	05:04	05:53	06:51	08:48 (3) 07:48	07:50	08:41 (2) 08:44
	22:12	21:24	20:11	22 09:10 (3) 18:54	16:44	23 09:04 (2) 16:06
9	05:05	05:55	06:53	08:46 (3) 07:50	07:52	08:42 (2) 08:45
	22:11	21:22	20:08	25 09:11 (3) 18:51	16:42	21 09:03 (2) 16:05
10	05:07	05:57	06:55	08:44 (3) 07:52	07:54	08:42 (2) 08:46
	22:10	21:20	20:05	28 09:12 (3) 18:49	16:40	20 09:02 (2) 16:05
11	05:08	05:58	06:57	08:43 (3) 07:53	07:56	08:44 (2) 08:48
	22:09	21:18	20:03	30 09:13 (3) 18:46	16:38	18 09:02 (2) 16:05
12	05:09	06:00	06:58	08:42 (3) 07:55	07:58	08:45 (2) 08:49
	22:08	21:16	20:00	32 09:14 (3) 18:44	16:36	16 09:01 (2) 16:05
13	05:10	06:02	07:00	08:41 (3) 07:57	08:00	08:47 (2) 08:50
	22:07	21:13	19:58	34 09:15 (3) 18:41	16:35	13 09:00 (2) 16:04
14	05:12	06:04	07:02	08:40 (3) 07:59	08:02	08:49 (2) 08:51
	22:06	21:11	19:55	35 09:15 (3) 18:39	16:33	9 08:58 (2) 16:04
15	05:13	06:06	07:04	08:38 (3) 08:01	08:04	08:52
	22:05	21:09	19:53	36 09:14 (3) 18:37	16:31	16:04
16	05:14	06:08	07:06	08:38 (3) 08:03	08:06	08:53
	22:04	21:07	19:50	37 09:15 (3) 18:34	16:30	16:04
17	05:16	06:10	07:08	08:38 (3) 08:05	08:08	08:54
	22:02	21:04	19:47	37 09:15 (3) 18:32	16:28	16:05
18	05:17	06:12	07:10	08:37 (3) 08:07	08:10	08:55
	22:01	21:02	19:45	37 09:14 (3) 18:29	16:26	16:05
19	05:19	06:13	07:12	08:37 (3) 08:09	08:12	08:55
	22:00	21:00	19:42	37 09:14 (3) 18:27	16:25	16:05
20	05:20	06:15	07:13	08:37 (3) 08:11	08:14	08:56
	21:58	20:57	19:40	37 09:14 (3) 18:25	16:23	16:05
21	05:22	06:17	07:15	08:37 (3) 08:13	08:16	08:57
	21:57	20:55	19:37	35 09:12 (3) 18:22	16:22	16:06
22	05:23	06:19	07:17	08:37 (3) 08:15	08:18	08:57
	21:55	20:53	19:35	34 09:11 (3) 18:20	16:21	16:06
23	05:25	06:21	07:19	08:37 (3) 08:17	08:20	08:58
	21:54	20:50	19:32	33 09:10 (3) 18:18	16:19	16:07
24	05:27	06:23	07:21	08:38 (3) 08:19	09:17 (1) 08:21	08:58
	21:52	20:48	19:29	31 09:09 (3) 18:15	7 09:24 (1) 16:18	16:07
25	05:28	06:25	07:23	08:39 (3) 07:21	08:15 (1) 08:23	08:58
	21:51	20:45	19:27	29 09:08 (3) 17:13	11 08:26 (1) 16:17	16:08
26	05:30	06:27	07:25	08:40 (3) 07:23	08:13 (1) 08:25	08:59
	21:49	20:43	19:24	26 09:06 (3) 17:11	14 08:27 (1) 16:16	16:09
27	05:32	06:28	07:27	08:42 (3) 07:25	08:12 (1) 08:27	08:59
	21:47	20:41	19:22	22 09:04 (3) 17:09	17 08:53 (2) 16:14	16:10
28	05:33	06:30	07:28	08:44 (3) 07:27	08:12 (1) 08:28	08:59
	21:45	20:38	19:19	18 09:02 (3) 17:06	27 08:58 (2) 16:13	16:10
29	05:35	06:32	07:30	08:48 (3) 07:29	08:12 (1) 08:30	08:59
	21:44	20:36	19:17	9 08:57 (3) 17:04	31 09:00 (2) 16:12	16:11
30	05:37	06:34	07:32	07:32	08:12 (1) 08:32	08:59
	21:42	20:33	19:14	17:02	35 09:02 (2) 16:11	16:12
31	05:38	06:36		07:34	08:12 (1)	08:59
	21:40	20:31		17:00	35 09:02 (2)	16:13
Potential sun hours	520	464	383	326	254	226
Total, worst case			688	177	313	
Sun reduction			0,28	0,24	0,17	
Oper. time red.			0,96	0,96	0,96	
Wind dir. red.			0,65	0,65	0,65	
Total reduction			0,17	0,15	0,11	
Total, real			118	26	33	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)

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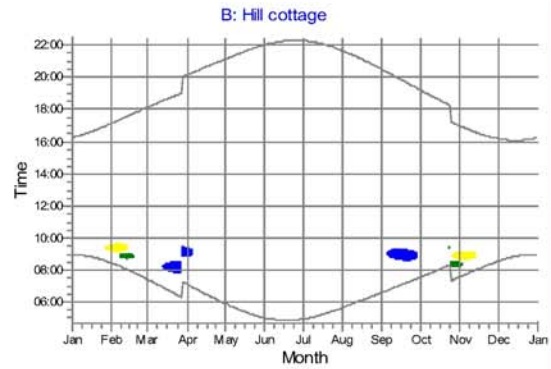
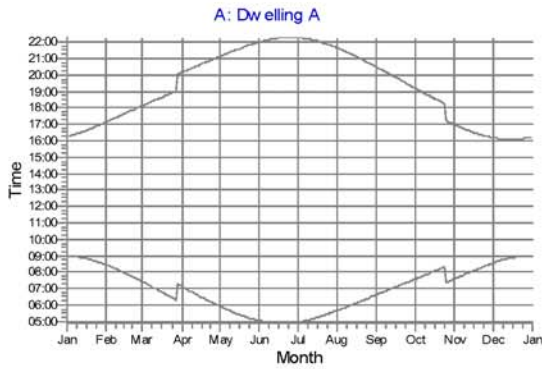
Project:
Cronalaght demonstration - Module descriptions

Description:
The project has been modified to demonstrate WindPRO functionalities.

Printed/Page:
06-01-2010 09:45 / 5
Licensed user:
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DK-9220 Aalborg Ø
+45 9635 4444
Thomas Sørensen, ts@emd.dk
Calculated:
06-01-2010 09:42/2.7.424

SHADOW - Calendar, graphical

Calculation: Shadow demonstration calculation



WTGs



1: VESTAS V90 3000 90.0 !O! hub: 80,0 m (9.1)
2: VESTAS V90 3000 90.0 !O! hub: 80,0 m (9.2)



3: VESTAS V90 3000 90.0 !O! hub: 80,0 m (9.3)

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		Calculated: 06-01-2010 09:42/2.7.424

SHADOW - Calendar per WTG

Calculation: Shadow demonstration calculation WTG: 3 - VESTAS V90 3000 90.0 !O! hub: 80,0 m (9.3)

Assumptions for shadow calculations

Maximum distance for influence: 2.000 m
 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) [MALIN HEAD C.]

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
 1,15 2,00 2,55 4,69 6,02 5,13 4,45 3,83 3,52 2,48 1,46 0,85

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
438	438	403	498	975	762	758	906	915	880	855	541	8.369

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

	January	February	March	April	May	June	July	August	September	October	November	December
1	08:59 16:15	08:26 17:09	07:26 18:07	07:07 20:09	08:50-09:21/31 21:07	05:55 22:01	05:02 22:16	04:58 21:38	05:40 20:28	06:38 19:11	07:34 16:58	07:36 16:10
2	08:59 16:16	08:24 17:11	07:23 18:09	07:05 20:11	08:51-09:19/28 21:09	05:53 22:02	05:01 22:16	04:59 21:36	05:42 20:26	06:40 19:09	07:36 16:56	07:38 16:10
3	08:58 16:17	08:22 17:13	07:21 18:11	07:02 20:13	08:52-09:18/26 21:11	05:51 22:03	05:00 22:15	04:59 21:34	05:44 20:23	06:42 19:06	07:38 16:54	07:40 16:09
4	08:58 16:18	08:21 17:15	07:18 18:13	07:00 20:15	08:53-09:15/22 21:13	05:49 22:04	05:00 22:15	05:00 21:32	05:46 20:21	06:43 19:04	07:40 16:51	07:42 16:08
5	08:58 16:20	08:19 17:17	07:16 18:15	06:57 20:17	08:56-09:12/16 21:15	05:46 22:05	05:01 22:14	05:47 21:30	06:45 20:18	07:42 19:01	07:44 16:49	08:40 16:07
6	08:57 16:21	08:17 17:19	07:13 18:17	06:55 20:19	08:59-09:07/8 21:17	05:44 22:07	05:02 22:13	05:49 21:28	06:47 20:16	07:44 18:59	07:46 16:48	08:41 16:07
7	08:57 16:22	08:15 17:21	07:11 18:20	06:52 20:21	06:52 22:19	05:42 22:08	05:03 22:13	05:51 21:26	06:49 20:13	07:46 18:56	07:48 16:46	08:43 16:06
8	08:56 16:24	08:13 17:23	07:08 18:22	06:50 20:23	06:50 22:21	05:40 22:09	05:04 22:12	05:53 21:24	06:51 20:11	07:48 18:54	07:50 16:44	08:44 16:06
9	08:56 16:25	08:11 17:25	07:06 18:24	06:47 20:25	06:47 22:23	05:38 22:10	05:05 22:11	05:55 21:22	06:53 20:08	07:50 18:51	07:52 16:42	08:45 16:05
10	08:55 16:27	08:09 17:28	07:03 18:26	06:45 20:27	06:45 22:25	05:36 22:11	05:07 22:10	05:57 21:20	06:55 20:05	07:44 18:49	07:51 16:40	08:46 16:05
11	08:54 16:29	08:07 17:30	07:01 18:28	06:42 20:28	06:42 22:26	05:34 22:11	05:08 22:09	05:58 21:18	06:57 20:03	07:53 18:46	07:56 16:38	08:48 16:05
12	08:53 16:30	08:04 17:32	06:58 18:30	06:40 20:30	06:40 22:28	05:32 22:12	05:09 22:08	06:00 21:16	06:58 20:00	07:55 18:44	07:58 16:36	08:49 16:05
13	08:52 16:32	08:02 17:34	06:56 18:32	06:37 20:32	06:37 22:30	05:31 22:13	05:10 22:07	06:02 21:13	07:00 19:58	08:41-09:15/34 18:41	07:57 16:35	08:00 16:04
14	08:51 16:34	08:00 17:36	06:53 18:34	06:35 20:34	06:35 22:32	05:29 22:14	05:12 22:06	06:04 21:11	07:02 19:55	08:40-09:15/35 18:39	07:59 16:33	08:02 16:04
15	08:50 16:35	07:58 17:38	06:51 18:36	06:30 20:36	06:30 22:34	05:27 22:14	05:13 22:05	06:06 21:09	07:04 19:53	08:38-09:14/36 18:36	08:01 16:31	08:52 16:04
16	08:49 16:37	07:56 17:40	06:48 18:38	06:30 20:38	06:30 22:36	05:25 22:15	05:14 22:04	06:08 21:07	07:06 19:50	08:38-09:15/37 18:34	08:03 16:29	08:53 16:04
17	08:48 16:39	07:54 17:42	06:46 18:40	06:27 20:40	06:27 22:37	05:23 22:15	05:16 22:02	06:10 21:04	07:08 19:47	08:38-09:15/37 18:32	08:05 16:28	08:54 16:05
18	08:47 16:41	07:51 17:44	06:43 18:41	06:25 20:42	06:25 22:39	05:22 22:16	05:17 22:01	06:12 21:02	07:10 19:45	08:37-09:14/37 18:29	08:07 16:26	08:10 16:05
19	08:46 16:43	07:49 17:47	06:41 18:43	06:23 20:44	06:23 22:41	05:20 22:16	05:19 22:00	06:13 21:00	07:11 19:42	08:37-09:14/37 18:27	08:09 16:25	08:12 16:05
20	08:45 16:45	07:47 17:49	06:38 18:45	06:20 20:46	06:20 22:42	05:18 22:17	05:20 21:58	06:15 20:57	07:13 19:40	08:37-09:14/37 18:25	08:11 16:23	08:14 16:05
21	08:43 16:46	07:45 17:51	06:35 18:47	06:18 20:48	06:18 22:44	05:17 22:17	05:22 21:57	06:17 20:55	07:15 19:37	08:37-09:12/35 18:22	08:13 16:22	08:57 16:06
22	08:42 16:48	07:42 17:53	06:33 18:49	06:15 20:50	06:15 22:46	05:15 22:17	05:23 21:55	06:19 20:53	07:17 19:35	08:37-09:11/34 18:20	08:15 16:21	08:57 16:06
23	08:41 16:50	07:40 17:55	06:30 18:51	06:13 20:52	06:13 22:47	05:14 22:17	05:25 21:54	06:21 20:50	07:19 19:32	08:37-09:10/33 18:18	08:17 16:19	08:58 16:07
24	08:39 16:52	07:38 17:57	06:28 18:53	06:11 20:54	06:11 22:49	05:12 22:17	05:27 21:52	06:23 20:48	07:21 19:29	08:38-09:09/31 18:15	08:19 16:18	08:58 16:07
25	08:38 16:54	07:35 17:59	06:25 18:55	06:09 20:56	06:09 22:51	05:11 22:17	05:28 21:50	06:25 20:45	07:23 19:27	08:39-09:08/29 18:13	08:21 16:17	08:58 16:08
26	08:36 16:56	07:33 18:01	06:23 18:57	06:06 20:58	06:06 22:52	05:10 22:17	05:30 21:49	06:27 20:43	07:25 19:24	08:40-09:06/26 18:11	08:13 16:16	08:59 16:09
27	08:35 16:58	07:30 18:03	06:20 18:59	06:06 21:00	06:06 22:54	05:08 22:17	05:32 21:47	06:28 20:41	07:27 19:22	08:42-09:04/22 18:09	08:25 16:14	08:27 16:10
28	08:33 17:00	07:28 18:05	06:18 19:01	06:02 21:02	06:02 22:55	05:07 22:17	05:33 21:45	06:30 20:38	07:28 19:19	08:44-09:02/18 18:06	08:27 16:13	08:59 16:10
29	08:31 17:02		07:15 19:01	06:59 21:04	06:59 22:56	05:06 22:17	05:35 21:44	06:32 20:36	07:30 19:17	08:48-08:57/9 18:04	08:30 16:12	08:59 16:11
30	08:30 17:04		07:12 19:05	06:57 21:06	06:57 22:58	05:05 22:16	05:37 21:42	06:34 20:33	07:32 19:14		08:32 16:11	08:59 16:12
31	08:28 17:07		07:10 19:07	06:55 21:07	06:55 22:59	05:04 22:17	05:38 21:40	06:36 20:31			08:34 16:10	08:59 16:13
Potential sun hours	243	270	366	423	500	518	520	464	383	688	326	226
Sum of minutes with flicker	0	0	546	131	0	0	0	0	0	688	0	0

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker
	Sun set (hh:mm)	First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker

WindPRO is developed by EMD International A/S, Niels Jernesvej 10, DK-9220 Aalborg Ø, Tlf. +45 96 35 44 44, Fax +45 96 35 44 46, e-mail: windpro@emd.dk

SHADOW

Calculation of Flickering from WTGs



WindPRO version 2.7.424 Beta Jan 2010

Project:
Cronalaght demonstration - Module descriptions

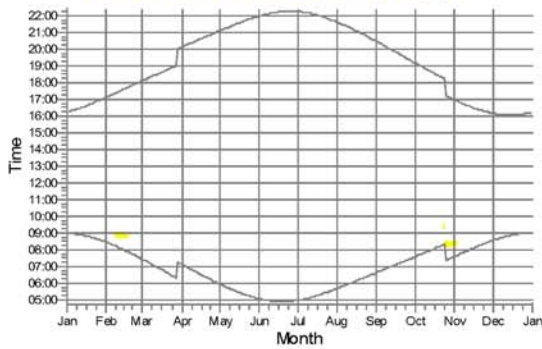
Description:
The project has been modified to demonstrate WindPRO functionalities.

Printed/Date:
06-01-2010 09:45 / 7
Licensed user:
EMD International A/S
Niels Jernesvej 10
DK-9220 Aalborg Ø
+45 9635 4444
Thomas Sørensen, ts@emd.dk
Calculated:
06-01-2010 09:42/2.7.424

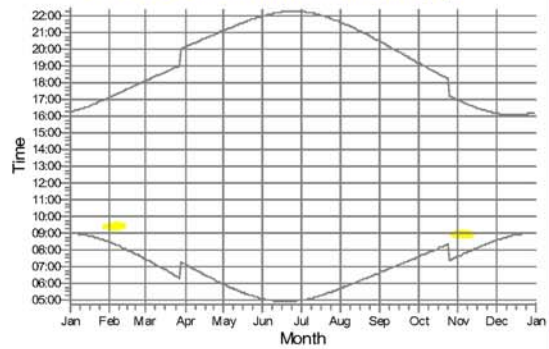
SHADOW - Calendar per WTG, graphical

Calculation: Shadow demonstration calculation

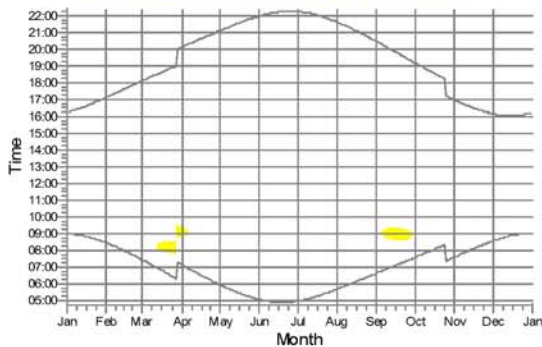
1: VESTAS V90 3000 90.0 !O! hub: 80,0 m (9.1)



2: VESTAS V90 3000 90.0 !O! hub: 80,0 m (9.2)



3: VESTAS V90 3000 90.0 !O! hub: 80,0 m (9.3)



WTGs

 B: Hill cottage

WindPRO is developed by EMD International A/S, Niels Jernesvej 10, DK-9220 Aalborg Ø. Tlf. +45 96 35 44 44, Fax +45 96 35 44 46, e-mail: windpro@emd.dk

SHADOW

Calculation of Flickering from WTGs



WindPRO version 2.7.424 Beta Jan 2010

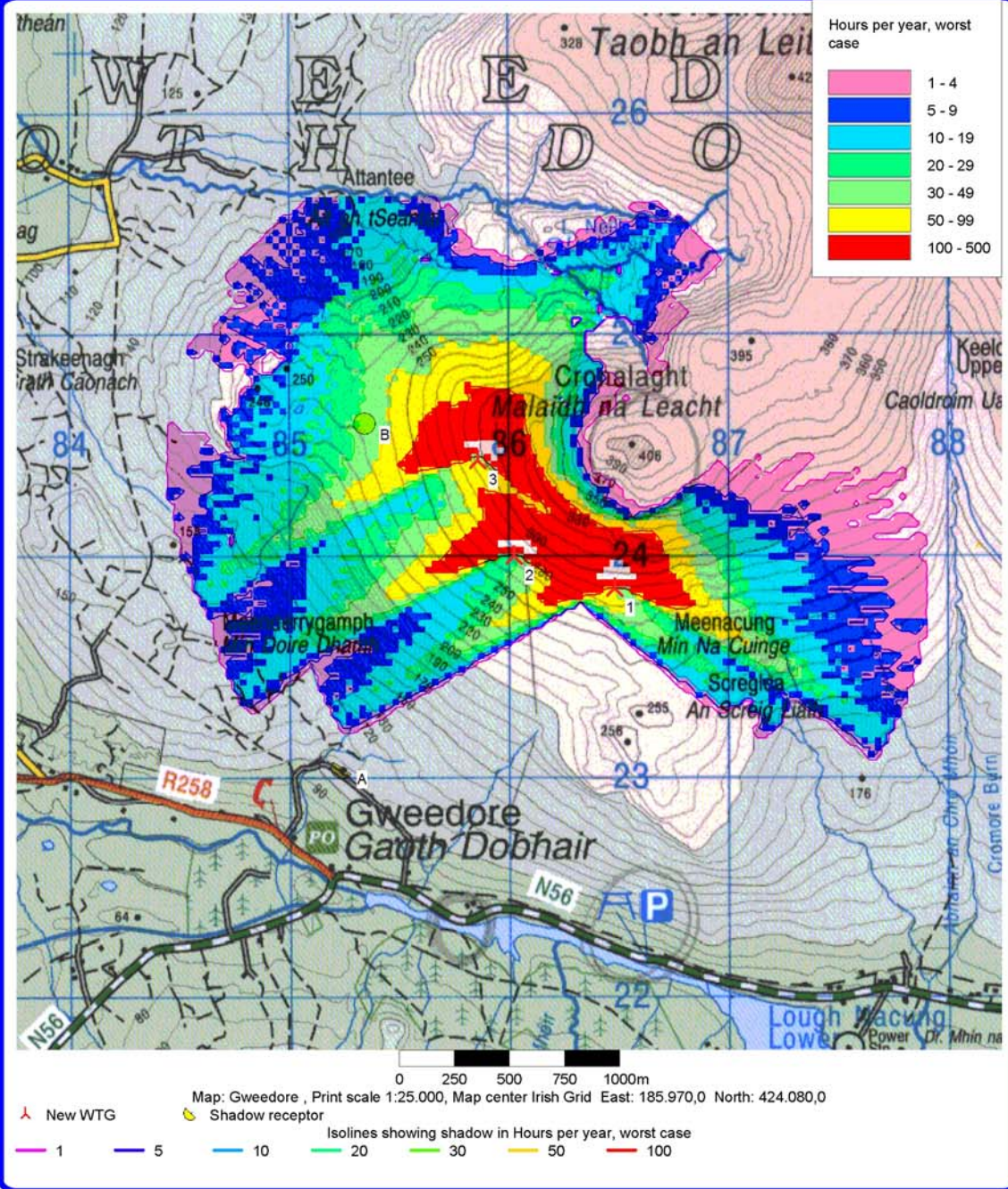
Project:
Cronalaght demonstration - Module descriptions

Description:
The project has been modified to demonstrate WindPRO functionalities.

Printed/Page:
06-01-2010 09:45 / 8
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DK-9220 Aalborg Ø
+45 9635 4444
Thomas Sørensen, ts@emd.dk
Calculated:
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SHADOW - Map

Calculation: Shadow demonstration calculation



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SHADOW

Calculation of Flickering from WTGs

