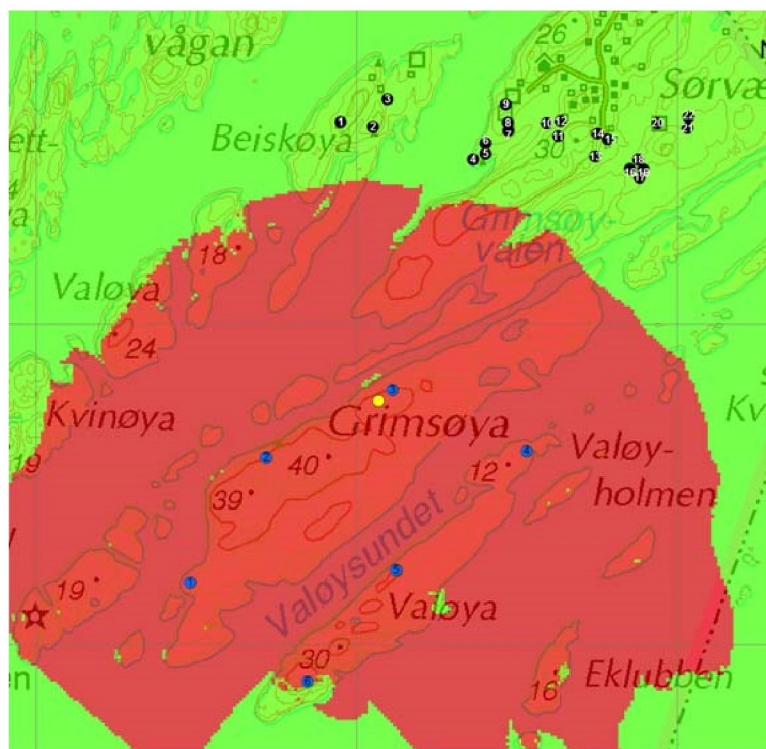




Helligvær, Bodø Kommune, Nordland

Beregninger av skyggekast

Rapport: KVT/RK/2013/R060



Rapportnummer KVT/RK/2013/R60	Dato 14.08.2013
Rapporttittel Helligvær, Bodø kommune, Nordland Beregninger av skyggekast	Klassifisering Begrenset til kunde Utgave nummer 0
Kunde Ecofact	Antall sider 12 + vedlegg
Kundens referanse Toralf Tysse	Status Endelig
Sammendrag Det er utført beregninger for skyggekast for den planlagte vindparken på Helligvær bestående av 6 Nordex N100 2.5 MW turbiner. Det er utført beregninger for 22 kartlagte bygninger. Kartleggingen er basert på flyfoto. Bruksområdet til bygningene er ikke kjent. Beregningene er basert på N50 kart, flyfoto, vindturbindata, vinddata fra produksjonsrapport og skydekke data fra den meteorologiske stasjonen ved Bodø flyplass. Det finnes ingen krav eller retningslinjer for skyggekast fra vindparker i Norge. Retningslinjene for Danmark er derfor lagt til grunn for vurdering av resultatet. Øvre grense for forventet årlig skyggekast (10 t/år) blir ikke oversteget for noen bygninger. "Worst case" beregninger gjøres uten å ta hensyn til skydekke og vindretning. "Worst case" grense for tid med skyggekast i løpet av året (30 t/år) blir oversteget for 14 bygninger og "worst case" grensen for skyggekast per dag (30 min/dag) blir oversteget for 21 bygninger.	
Forbehold Selv om det i arbeidet med denne rapporten, så langt vi kjenner til, er benyttet oppdaterte analysemetoder, og vi i vårt arbeid forsøker å gi et så godt resultat som mulig, kan Kjeller vindteknikk AS ikke holdes ansvarlig for resultatene i rapporten eller for framtidig bruk av denne, og heller ikke for eventuelle direkte eller indirekte tap som skyldes eventuelle feil i rapporten.	

Revisjonshistorie				
Utgave	Dato	Antall eksemplarer	Kommentar	Distribusjon
0	14.08.2013	Elektronisk	Endelig	

	Navn	Dato	Signatur
Utført av	Reiar Kravik	14/08/2013	<i>Reiar Kravik</i>
Kontrollert av	Anne Line Løvholm	14.08.2013	<i>Anne Line Løvholm</i>
Godkjent av	Lars Tallhaug	14/8-2013	<i>Lars Tallhaug</i>

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1 Innledning

Det er gjort skyggekastberegninger for den planlagte vindparken på Helligvær. Den planlagte vindparken består av 6 turbiner, koordinatene er gitt i Appendiks A. Det er utført beregninger for turbiner av typen Nordex N100 2.5 MW med navhøyde 100 m.

Det er ikke mottatt koordinater for bygninger på Helligvær fra Ecofact. Koordinatene for skyggemottakerene er basert på flyfoto. Bruksområdet til disse bygningene er ikke kjent. Koordinater for mottakerne er gitt i Appendiks A. Den planlagte vindparken og de aktuelle bygningene er vist i kartet i Figur 1.



2 Skyggekast

2.1 Skyggekast fra vindturbiner

Når en vindpark er i drift vil vindturbinene gi roterende skygger. Dette kan være sjenerende, spesielt når de faller på lysåpninger som vinduer. Den roterende skyggen vil da for de som sitter innendørs gi en blinkende effekt, gjerne kaldt stroboskopeffekten. Skyggekast kan også være sjenerende når man oppholder seg utendørs. Skyggen av en stillestående turbin vil normalt oppleves som uproblematisk.

Hvor og når skyggekast oppstår avhenger av mottakers lokalisering i forhold til vindparken, lokal topografi, solens posisjon på himmelen, skydekke og vindforhold. Man får mest skyggekast når solen står lavt, slik at skyggene blir lange. Effekten av skyggene avtar med avstanden fra vindturbinene, dette fordi turbinbladene da vil dekke en mindre del av solskiven slik at skyggen blir mer diffus.

2.2 Kunnskapsnivå angående effekt av skyggekast

Kunnskapsnivået rundt effektene av skyggekast er forholdsvis begrenset. I Tyskland er det imidlertid gjennomført en feltstudie i 1999 og et laboratorieforsøk i 2000. I feltstudien (Pohl, Faul og Mausfeld 1999) oppga deltakerne at skyggekast var en belastning. I laboratorieforsøket (Pohl, Faul og Mausfeld 2000) ble det påvist stressymptomer hos de som ble utsatt for skyggekast. Yngre personer viste seg å takle belastningen av skyggekast bedre enn eldre personer. Stressymptomene som ble funnet var moderate, men det påpekes at langtidsvirkninger kan være større.

2.3 Grenseverdier

Det finnes i dag ingen norske retningslinjer for grenseverdier for hva som aksepteres av skyggekast. For Sverige (Boverket u.d.) og Danmark (Danmark Vindmølleforening 2009) er det utarbeidet retningslinjer som også benyttes for norske vindparker. Ved beregning av skyggekasttid beregnes to tilfeller, "worst case" og faktisk forventet skyggetid. "Worst case" beregningen gir antall skyggetimer turbinene kan forårsake for en mottaker gitt at avstandene mellom turbinene og mottaker er tilstrekkelig korte, og solen er oppe. For faktisk forventet tid med skyggekast tar man hensyn til sannsynligheten for sol, driftstid for vindturbinen og vindretningen. De danske retningslinjene gir følgende grenseverdier.

- Teoretisk skyggetid ("worst case") < 30 timer/år
- Faktisk forventet skyggetid < 10 timer/år
- Faktisk forventet skyggetid < 30 minutter/dag

Disse retningslinjene er benyttet for vurdering av beregningsresultatene i denne analysen.

2.4 Refleksblink fra vindturbiner

Refleksblink forekommer når solen reflekteres i blanke flater på turbinbladene. Turbinbladenes roterende bevegelse vil da gjøre at refleksjonen oppfattes som blink. Refleksblink er mer komplisert å beregne enn skyggekast fordi omfanget av refleksblink også vil avhenge av turbinbladenes utforming og vridning (pitch). Problemet kan imidlertid minimeres ved å velge overflatebehandlinger med meget lave glanstall (Danske Energistyrelsen 2002). Dersom det tas tilstrekkelig hensyn ved fargevalg og overflatebehandling av turbinbladene vil belastningen av refleksblink være liten.

2.5 Datagrunnlag

Basert på flyfoto fra området er totalt 22 skyggemottakere kartlagt, koordinatene til skyggekastmottakerne er gitt i Vedlegg A Koordinater. Bruksområdet til bygningene er ukjent.

Data for turbinene er hentet fra EMD sin database (EMD 2012). For beskrivelse av topografi er det benyttet høydekoter med ekvidistanse på 5 m. Det er beregnet skyggekast for turbiner av typen Nordex N100 2.5 MW med navhøyde på 100 m og rotordiameter på 100 m. Den planlagte vindparken består av 6 turbiner og koordinatene er gitt i Vedlegg A Koordinater. Driftstiden for vindturbinen er beregnet ut fra at turbinen roterer kun mellom hastighetene på 4 m/s og 25 m/s, som er det hastighetsintervallet hvor turbinen generer kraft.

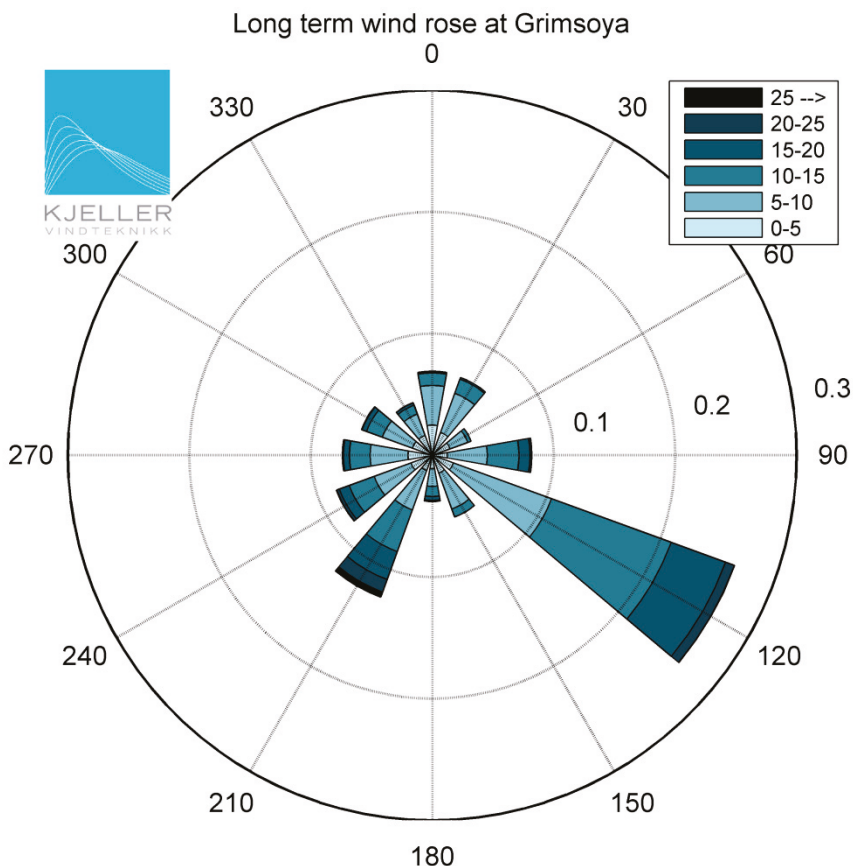
Solstatistikk er beregnet fra observasjoner av midlere skydekke fra juli 1983 til juni 2013 ved Bodø Lufthavn. Dataene er hentet fra www.eklima.no som driftes av Meteorologisk institutt. Stasjonen er valgt på grunn av den nære beliggenheten til den planlagte vindparken. Ut fra månedlig midlere skydekke er månedlig solsannsynlighet beregnet, denne er gitt Tabell 1. Det er knyttet usikkerhet til beregning og bruk av solsannsynlighet, dette er diskutert senere i rapporten. Solsannsynlighet angir sannsynligheten for solskinn når solen er oppe.

Beregningene tar hensyn til kortere dager om vinteren og lengre dager om sommeren. Daglengden (maksimal antall soltimer) beregnes for hver dag gjennom hele året basert på breddegrad.

Tabell 1: Beregnet solsannsynlighet for Bodø.

Måned	1	2	3	4	5	6	7	8	9	10	11	12
Solsannsynlighet	0,27	0,30	0,30	0,30	0,29	0,29	0,25	0,27	0,25	0,25	0,29	0,28

Vindforholdene er hentet fra langtidskorrigerte vindforhold gitt i (Lundén 2012). Posisjonen til masten er vist i Figur 1 (UTM33 E 452069 N 7475760) og er hentet fra (Karlsson 2010). Vindrose basert på den forventede langtidsvinden er vist i Figur 2. Som man kan se fra vindrosen er hovedvindretningen fra øst-sørøst.



Figur 2: Forventet vindrose på Helligvær.

2.6 Metodikk

Beregningen av skyggekast er utført i WindPRO versjon 2.9 (EMD 2012). Ved beregning av skyggekast fra vindturbiner er det gjort antagelser og forenklinger, basert på tidligere erfaring og metodikk fra andre land.

Dersom turbinen står stille vil den ikke gi sjenerende skygger. Timer med stillestående turbiner inkluderes derfor ikke i antall timer med skyggekast. Skyggen elimineres helt eller delvis dersom solen er dekket av skyer. Dersom vindretningen ikke er den samme som solens innfallsvinkel vil omfanget av skyggekast bli mindre. Dette er fordi vindturbinene dreier med vindretningen for å oppnå høyest mulig energiproduksjon.

Situasjoner hvor bebyggelsen er plassert mer enn 2 km fra nærmeste turbin, solen står lavere enn 3° over horisonten eller rotorbladene dekker mindre enn 20 % av solskiven er ikke inkludert i beregningene. Det er antatt at skyggeeffekten i disse situasjonene er så diffuse at de er neglisjerbare. Dette er basert på tyske retningslinjer (EMD 2012). Det er i tillegg gjort beregning av ZVI (Zones of Visual Influence). Det vil si å beregne om en turbin er synlig fra bygningen. Om den ikke er synlig, vil den ikke bidra til skyggekast. Det er også tatt hensyn til topografisk skygge i beregningen, som tar hensyn til topografi og solens plassering.

Det er plassert skyggemottakerobjekt på bygninger lokalisert nær vindparken. Det er antatt at bygningene har vinduer på alle sider, dermed vil det alltid være vinduer rettet mot vindparken.

Vinduene er antatt å være 2 m * 2 m og plassert 1 m over bakkenivå. Vinduene er plassert 90° (vertikalt) med bakkenivået.

Det er også beregnet et skyggekastkart for området rundt vindparken (Figur 3). Oppløsningen i det beregnede kartet er på 10 m * 10 m. Det er avvik mellom verdiene i tabellen og verdiene i kartet. Dette skyldes at kartet viser skyggekast for et punkt på bakken mens antall skyggetimer beregnet for bygningene, gitt i Tabell 3, er for vertikale vinduer med størrelse 2 m * 2 m plassert 1 m over bakken. Kartet vil derfor kun være en indikasjon på forventet skyggekast for en mottaker. Man kan derfor ikke benytte kartet til å finne verdiene for bygninger siden dette avhenger av bygningens og vinduenes størrelse. Tiden man opplever skyggekast vil være lik eller lengre enn det kartet viser.

2.7 Resultat

Turbinenes beregnede driftstid for hver sektor er spesifisert i Tabell 2. Den totale driftstiden til den planlagte vindturbinen er beregnet til å være 8394 timer per år. I samsvar med vindrosen i Figur 2 er det størst antall driftstimer for vind fra øst-sørøstlig retning.

Tabell 2: Beregnet årlig driftstid per sektor for planlagt vindpark på Helligvær.

Sektor	N	NNØ	ØNØ	Ø	ØSØ	SSØ	S	SSV	VSV	V	VNV	NNV	Totalt
Driftstid [t]	568	563	330	771	2096	484	346	1015	719	613	506	386	8394

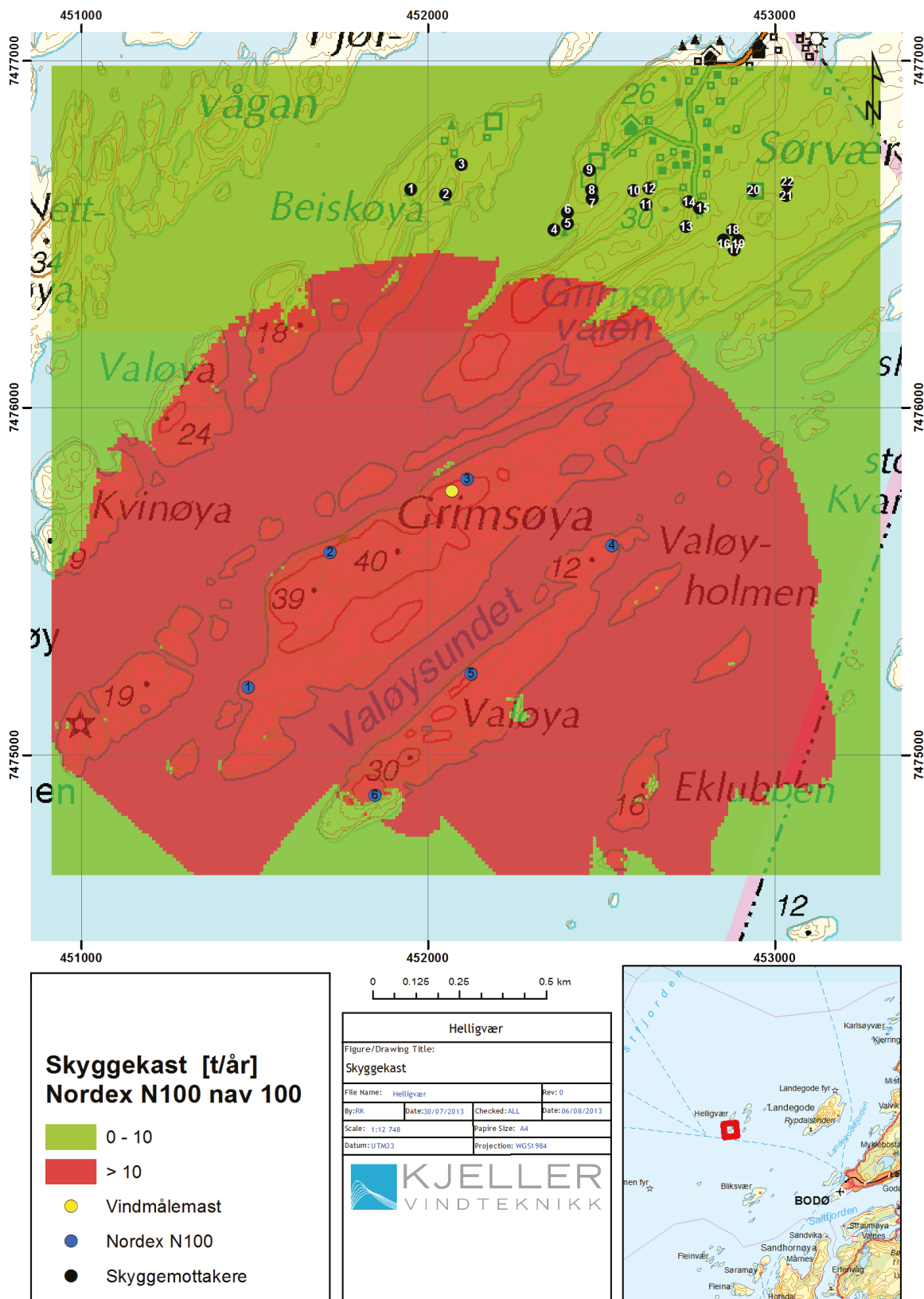
Tid med skyggekast for de 22 bygningene er gitt i Tabell 3. De danske retningslinjene for forventet antall timer med skyggekast per år blir ikke oversteget for noen bygninger. Den maksimale grensen for skyggekast for timer per år ("worst case") er oversteget for 14 bygninger. Den maksimale grensen for skyggekast for timer per dag ("worst case") er oversteget for 21 bygninger. De bygningene som har oversteget grenseverdien er merket med lyserød bakgrunn i Tabell 3.

Tabell 3: Beregnet skyggekast for mottakerne rundt Helligvær. De felter der kriteriet er oversteget er merket med lyserød bakgrunn.

Bygning	Skyggekast			Forventingsverdier
	"Worst case"			
	[timer/år]	[dager/år]	[timer/dag]	[timer/år]
1	41:16	50	1:11	6:30
2	41:34	52	1:22	6:35
3	33:16	48	1:09	5:17
4	26:35	44	0:53	4:04
5	26:10	42	0:51	4:06
6	44:46	60	1:05	6:59
7	38:59	59	0:53	6:07
8	37:05	56	0:53	5:49
9	33:02	51	0:53	5:10
10	33:55	60	0:44	5:23
11	33:32	62	0:44	5:21
12	31:32	60	0:41	5:01
13	33:54	70	0:43	5:25
14	11:12	34	0:24	1:39
15	30:28	66	0:41	4:51
16	32:25	71	0:43	5:19
17	31:45	69	0:44	5:16
18	29:53	67	0:42	4:55
19	30:00	68	0:42	4:59
20	23:10	59	0:37	3:49
21	20:11	55	0:36	3:25
22	19:14	53	0:35	3:15

Perioder av året og tid på døgnet de ulike skyggemottakerne er utsatt for skyggekast fremstilt grafisk i WindPRO utskriftene i Appendiks B. Av oversikten kan en se at det er skyggekast på mottakerne i månedene januar, februar, oktober og november.

Kart med beregnet forventet tid med skyggekast er vist i Figur 3. Resultatutskrift fra WindPRO er gitt i Vedlegg B WindPRO utskrifter.



Figur 3: Kart over Helligvær med forventet skyggetimer per år, berørte bygninger og turbiner. Kartet er beregnet for punkt på bakken og er kun en indikasjon på skyggekast for en bygning. Kartet kan derfor ikke brukes for å finne forventet skyggetid for mottakerne. Skyggetiden for en bygning vil være lik eller lengre enn det kartet viser.

3 Vurderinger

3.1 Feilkilder og usikkerhet

Det er knyttet usikkerhet til observasjonene av sol og skydekke, som er utført på Bodø flyplass som ligger ved kysten sammenlignet med vindparken som ligger lengre ute i åpent farvann. Skyggekast fra vindturbinene for andre lokaliteter enn de som er representert med de 22 kartlagte bygningene er ikke vurdert i denne analysen.

Mottakerenes plassering for beregningene er basert på flyfoto. Beregningene er sensitive med hensyn til plassering av mottakerne. Små endringer i angitt posisjon kan endre resultatet med hensyn til skygge. Den antatte vindusflaten på 2 m * 2 m er også en usikkerhetskilde.

På bakgrunn av de ulike mulige feilkildene er det derfor usikkerhet knyttet til beregningsresultatene. Denne usikkerheten er ikke estimert i denne analysen.

3.2 Avbøtende tiltak

For skyggekast vil avbøtende tiltak være avstenging av turbiner i gitte perioder og for gitte sektorer. Alternativt kan beplantning også redusere skyggekastproblematikken.

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Pohl, J., F. Faul, og R. Mausfeld. *Belästigung durch periodischen Schattenwurf von Windenergieanlagen - Laborpilotstudie*. Staatliches Umweltamt Schleswig, 2000.

Vedlegg A Koordinater

Tabell 4: Koordinater for turbinene på Helligvær i UTM sone 33 koordinater.

Turbin	E	N
1	451482	7475194
2	451718	7475585
3	452113	7475795
4	452531	7475604
5	452124	7475233
6	451847	7474885

Tabell 5: Koordinater for bygninger ved Helligvær i UTM sone 33 koordinater.

Bygning	Øst	Nord
1	451951	7476630
2	452051	7476616
3	452097	7476702
4	452364	7476514
5	452403	7476532
6	452402	7476564
7	452474	7476602
8	452472	7476628
9	452465	7476685
10	452594	7476626
11	452630	7476587
12	452638	7476633
13	452744	7476523
14	452753	7476594
15	452783	7476576
16	452853	7476485
17	452883	7476457
18	452879	7476513
19	452895	7476483
20	452939	7476627
21	453033	7476612
22	453036	7476647

Vedlegg B WindPRO utskrifter

Project:

Helligvaer

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30.07.2013 13:17 / 2

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Calculated:

30.07.2013 12:52/2.9.250

SHADOW - Main Result

Calculation: helligvaer

...continued from previous page

UTM (north)-WGS84 Zone: 33

No.	East	North	Z	Width	Height	Height a.g.l.	Degrees from south cw	Slope of window	Direction mode
			[m]	[m]	[m]	[m]	[°]	[°]	
16	452 853	7 476 485	5.0	2.0	2.0	1.0	0.0	90.0	"Green house mode"
17	452 883	7 476 457	5.4	2.0	2.0	1.0	0.0	90.0	"Green house mode"
18	452 879	7 476 513	7.1	2.0	2.0	1.0	0.0	90.0	"Green house mode"
19	452 895	7 476 483	7.1	2.0	2.0	1.0	0.0	90.0	"Green house mode"
20	452 939	7 476 627	7.6	2.0	2.0	1.0	0.0	90.0	"Green house mode"
21	453 033	7 476 612	10.0	2.0	2.0	1.0	0.0	90.0	"Green house mode"
22	453 036	7 476 647	9.7	2.0	2.0	1.0	0.0	90.0	"Green house mode"

Calculation Results

Shadow receptor

No.	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]	
1	41:16	50	1:11	6:30	
2	41:34	52	1:22	6:35	
3	33:16	48	1:09	5:17	
4	26:35	44	0:53	4:04	
5	26:10	42	0:51	4:06	
6	44:46	60	1:05	6:59	
7	38:59	59	0:53	6:07	
8	37:05	56	0:53	5:49	
9	33:02	51	0:53	5:10	
10	33:55	60	0:44	5:23	
11	33:32	62	0:44	5:21	
12	31:32	60	0:41	5:01	
13	33:54	70	0:43	5:25	
14	11:12	34	0:24	1:39	
15	30:28	66	0:41	4:51	
16	32:25	71	0:43	5:19	
17	31:45	69	0:44	5:16	
18	29:53	67	0:42	4:55	
19	30:00	68	0:42	4:59	
20	23:10	59	0:37	3:49	
21	20:11	55	0:36	3:25	
22	19:14	53	0:35	3:15	

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

No.	Name	Worst case [h/year]	Expected [h/year]
1	NORDEX N100 2500 99.8 !O! hub: 100.0 m (TOT: 149.9 m) (1)	9:12	1:26
2	NORDEX N100 2500 99.8 !O! hub: 100.0 m (TOT: 149.9 m) (2)	55:39	8:55
3	NORDEX N100 2500 99.8 !O! hub: 100.0 m (TOT: 149.9 m) (3)	123:48	19:51
4	NORDEX N100 2500 99.8 !O! hub: 100.0 m (TOT: 149.9 m) (4)	102:24	15:57
5	NORDEX N100 2500 99.8 !O! hub: 100.0 m (TOT: 149.9 m) (5)	45:31	7:03
6	NORDEX N100 2500 99.8 !O! hub: 100.0 m (TOT: 149.9 m) (6)	0:00	0:00

Project:

Helligvaer

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Calculated:

30.07.2013 12:52/2.9.250

SHADOW - Calendar

Calculation: helligvaerShadow receptor: 1 - Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (30)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.27	0.30	0.30	0.30	0.29	0.29	0.25	0.27	0.25	0.25	0.29	0.28

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
568	563	330	771	2 096	484	346	1 015	719	613	506	386	8 394

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

	January		February		March		April		May		June		July		August		September		October		November		December	
1	11:24		09:19		11:15 (3)	07:26	06:20	04:13							03:26	05:31	07:14				08:07		09:32 (4)	10:19
	12:53		15:19	69	13:35 (1)	17:11	20:01	21:55							22:53	20:37	18:34				15:29	57	12:42 (2)	13:28
2	11:20		09:15		10:18 (4)	07:22	06:15	04:08							03:31	05:34	07:17				08:11		09:31 (4)	10:24
	12:58		15:24	62	13:32 (1)	17:14	20:04	21:59							22:48	20:33	18:30				15:25	64	12:44 (2)	13:24
3	11:16		09:11		10:13 (4)	07:18	06:11	04:04							03:35	05:38	07:21				08:15		09:31 (4)	10:28
	13:03		15:28	57	13:17 (2)	17:18	20:08	22:03							22:44	20:29	18:26				15:21	67	12:45 (2)	13:20
4	11:12		09:07		10:07 (4)	07:14	06:07	04:00							03:40	05:41	07:24				08:19		09:31 (4)	10:33
	13:08		15:32	63	13:17 (2)	17:22	20:12	22:07							22:39	20:25	18:22				15:17	69	12:46 (2)	13:16
5	11:08		09:03		10:01 (4)	07:10	06:03	03:55							03:44	05:45	07:28				08:23		09:30 (4)	10:38
	13:13		15:36	70	13:17 (2)	17:25	20:15	22:12							22:34	20:21	18:18				15:13	70	12:46 (2)	13:12
6	11:04		08:59		10:01 (4)	07:06	05:59	03:51							03:49	05:48	07:31				08:27		09:32 (4)	10:43
	13:18		15:41	70	13:17 (2)	17:29	20:19	22:16							22:30	20:17	18:14				15:09	70	12:47 (2)	13:08
7	11:00		08:55		10:01 (4)	07:02	05:55	03:46							03:53	05:52	07:35				08:32		09:38 (4)	10:48
	13:23		15:45	69	13:16 (2)	17:33	20:22	22:21							22:25	20:13	18:10				15:05	63	12:47 (2)	13:04
8	10:55		08:51		10:01 (4)	06:58	05:51	03:42							03:57	05:55	07:38				08:36		09:44 (4)	10:53
	13:28		15:49	66	13:15 (2)	17:36	20:26	22:25							22:21	20:08	18:06				15:01	60	12:48 (2)	13:00
9	10:51		08:47		10:02 (4)	06:54	05:46	03:37							04:02	05:59	07:42				08:40		10:46 (3)	10:58
	13:33		15:53	62	13:14 (2)	17:40	20:30	22:30							22:16	20:04	18:02				14:57	63	13:04 (1)	12:56
10	10:47		08:43		10:02 (4)	06:50	05:42	03:32							04:06	06:02	07:45				08:44		10:46 (3)	11:03
	13:38		15:57	57	13:12 (2)	17:43	20:33	22:34							22:12	20:00	17:58				14:53	66	13:05 (1)	12:52
11	10:43		08:39		10:03 (4)	06:45	05:38	03:28							04:10	06:06	07:49				08:48		10:47 (3)	11:08
	13:43		16:01	45	13:08 (2)	17:47	20:37	22:39							22:07	19:56	17:54				14:49	70	13:07 (1)	12:48
12	10:39		08:35		10:04 (4)	06:41	05:34	03:23							04:14	06:09	07:52				08:53		10:48 (3)	11:13
	13:47		16:05	38	11:40 (3)	17:50	20:41	22:44							22:03	19:52	17:50				14:45	70	13:08 (1)	12:44
13	10:35		08:31		10:06 (4)	06:37	05:30	03:18							04:18	06:13	07:56				08:57		10:49 (3)	11:18
	13:52		16:09	32	11:39 (3)	17:54	20:44	22:48							21:58	19:48	17:46				14:41	70	13:08 (1)	12:40
14	10:31		08:27		11:20 (3)	06:33	05:26	03:13							04:22	06:16	07:59				09:01		10:50 (3)	11:23
	13:57		16:13	19	11:39 (3)	17:58	20:48	22:53							21:54	19:44	17:41				14:37	68	13:09 (1)	12:36
15	10:27		08:23		11:21 (3)	06:29	05:21	03:08				01:45			04:26	06:19	08:03				09:06		10:52 (3)	11:28
	14:02		16:17	16	11:37 (3)	18:01	20:52	22:58				00:37			21:50	19:40	17:37				14:33	59	13:03 (1)	12:31
16	10:23		08:19		11:24 (3)	06:25	05:17	03:04				01:56			04:30	06:23	08:07				09:10		10:55 (3)	11:33
	14:07		16:21	9	11:33 (3)	18:05	20:55	23:03				00:27			21:45	19:35	17:33				14:28	44	12:55 (1)	12:27
17	10:19		08:14			06:21	05:13	02:59				02:05			04:34	06:26	08:10				09:14		11:07 (5)	11:38
	14:11		16:25			18:08	20:59	23:09				00:18			21:41	19:31	17:29				14:24	29	12:43 (2)	12:23
18	10:15		08:10			06:17	05:09	02:53				02:05			04:38	06:30	08:14				09:19		11:07 (5)	11:43
	14:16		16:29			18:12	21:03	23:14				00:10			21:37	19:27	17:25				14:20	16	11:23 (5)	12:19
19	10:11		08:06			06:13	05:05	02:48				02:13			04:42	06:33	08:18				09:23		11:22 (5)	11:49
	14:21		16:33			18:15	21:07	23:19				00:03			21:32	19:23	17:21				14:16	1	11:23 (5)	12:14
20	10:07		08:02			06:09	05:00	02:43				02:20			04:46	06:36	08:21				09:28			11:55
	14:25		16:37			18:19	21:11	23:25				23:57			21:28	19:19	17:17				14:12			12:09
21	10:03		07:58			06:05	04:56	02:37				02:26			04:50	06:40	08:25				09:32			11:34
	14:30		16:41			18:22	21:14	23:31				23:51			21:24	19:15	17:13				14:08			11:26
22	09:59		07:54			06:01	04:52	02:32				02:33			04:54	06:43	08:29				09:37			
	14:35		16:44			18:26	21:18	23:37				23:45			21:20	19:11	17:09				14:04			
23	09:55		11:48 (5)	07:50		05:57	04:48	02:26				02:39			04:58	06:47	08:32				09:41			
	14:39	1	11:49 (5)	16:48		18:29	21:22	23:43				23:39			21:15	19:07	17:05				14:00			
24	09:51		11:33 (5)	07:46		05:52	04:43	02:20				02:45			05:01	06:50	08:36				09:46			
	14:44	17	11:50 (5)	16:52		18:33	21:26	23:49				23:33			21:11	19:03	17:01				13:56			
25	09:47		11:33 (5)	07:42		05:48	04:39	02:14				02:50			05:05	06:53	07:40				09:51			11:55
	14:48	30	13:10 (2)	16:56		18:36	21:30	23:56				23:28			21:07	18:59	15:57				13:52			12:15
26	09:43		11:21 (3)	07:38		05:44	04:35	02:07				02:56			05:09	06:57	07:44				10:53 (3)	09:55		11:50
	14:53	45	13:22 (1)	17:00		18:40	21:34	00:04				23:23			21:03	18:55	15:53				11:04 (3)	13:48		12:21
27	09:39		11:19 (3)	07:34		05:40	04:30	02:00				03:01			05:12	07:00	07:48				10:50 (3)	10:00		11:46
	14:57	59	13:31 (1)	17:03		18:43	21:38	00:12				23:18			20:58	18:50	15:49				16	11:06 (3)	13:44	12:26
28	09:35		11:18 (3)	07:30		05:36	04:26	01:42				03:06			05:16	07:04	07:52				09:39 (4)	10:05		11:41
	15:02	68	13:36 (1)	17:07		18:47	21:42	00:22				23:13			20:54	18:46	15:45				23	11:08 (3)	13:40	12:31
29	09:31		11:17 (3)			06:32	04:22	01:31				03:11			05:20	07:07	07:55				09:36 (4)	10:09		11:37
	15:06	69	13:36 (1)			19:50	21:46	00:34				23:08			20:50	18:42	15:41				32	11:09 (3)	13:36	12:36
30	09:27		11:16 (3)			06:28	04:17	01:07				03:16			05:23	07:10	07:59				09:34 (4)	10:14		11:33
	15:11	71	13:36 (1)			19:54	21:51	00:57				23:03			20:46	18:38	15:37				38	11:10 (3)	13:32	12:42
31	09:23		11:15 (3)			06:24						03:21			05:27		08:03				09:33 (4)			11:29
	15:15	69	13:35 (1)			19:57						22:58			20:42		15:33				47	12:39 (2)		12:47
Potential sun hours	115		219			361		468		627		720		694		536		398		292		161		64
Total, worst case		429		804																167		1076		
Sun reduction		0.27		0.30																0.25		0.29		
Oper. time red.		0.96		0.96																0.96		0.96		

Project:

Helligvaer

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30.07.2013 13:11 / 2

Licensed user:

Kjeller Vindteknikk AS

Gunnar Randres vei 12

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reiar.k / reiar.kravik@vindteknikk.no

Calculated:

30.07.2013 12:52/2.9.250

SHADOW - Calendar

Calculation: helligvaerShadow receptor: 2 - Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (29)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.27	0.30	0.30	0.30	0.29	0.29	0.25	0.27	0.25	0.25	0.29	0.28

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
568	563	330	771	2 096	484	346	1 015	719	613	506	386	8 394

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

	[January	[February	[March	[April	[May	[June	[July	[August	[September	[October	[November	[December	
1	11:24	09:19	10:25 (4)	07:26	06:20	04:13		03:26	05:31	07:14	08:07	09:49 (4) 10:19	
	12:53	15:19	72	13:52 (1)	17:11	20:01	21:55	22:53	20:37	18:34	15:29	64	13:07 (2) 13:28
2	11:20	09:15		10:18 (4)	07:22	06:15	04:08	03:31	05:34	07:17	08:11		09:48 (4) 10:24
	12:58	15:24	80	13:51 (1)	17:14	20:04	21:59	22:48	20:33	18:30	15:25	68	13:07 (2) 13:24
3	11:16	09:11		10:18 (4)	07:18	06:11	04:04	03:35	05:38	07:21	08:15		09:47 (4) 10:28
	13:03	15:28	82	13:51 (1)	17:18	20:08	22:03	22:44	20:29	18:26	15:21	71	13:08 (2) 13:20
4	11:12	09:07		10:17 (4)	07:14	06:07	04:00	03:40	05:41	07:24	08:19		09:48 (4) 10:33
	13:08	15:32	78	13:48 (1)	17:22	20:12	22:07	22:39	20:25	18:22	15:17	73	13:09 (2) 13:16
5	11:08	09:03		10:17 (4)	07:10	06:03	03:55	03:44	05:45	07:28	08:23		09:47 (4) 10:38
	13:13	15:36	74	13:39 (2)	17:25	20:15	22:12	22:34	20:21	18:18	15:13	74	13:09 (2) 13:12
6	11:04	08:59		10:18 (4)	07:06	05:59	03:51	03:49	05:48	07:31	08:27		09:47 (4) 10:43
	13:18	15:41	72	13:39 (2)	17:29	20:19	22:16	22:30	20:17	18:14	15:09	73	13:09 (2) 13:08
7	11:00	08:55		10:18 (4)	07:02	05:55	03:46	03:53	05:52	07:35	08:32		09:48 (4) 10:48
	13:23	15:45	72	13:39 (2)	17:33	20:22	22:21	22:25	20:13	18:10	15:05	78	13:19 (1) 13:04
8	10:55	08:51		10:18 (4)	06:58	05:51	03:42	03:57	05:55	07:38	08:36		09:48 (4) 10:53
	13:28	15:49	71	13:39 (2)	17:36	20:26	22:25	22:21	20:08	18:06	15:01	82	13:21 (1) 13:00
9	10:51	08:47		10:19 (4)	06:54	05:46	03:37	04:02	05:59	07:42	08:40		09:50 (4) 10:58
	13:33	15:53	67	13:38 (2)	17:40	20:30	22:30	22:16	20:04	18:02	14:57	80	13:22 (1) 12:56
10	10:47	08:43		10:19 (4)	06:50	05:42	03:32	04:06	06:02	07:45	08:44		09:56 (4) 11:03
	13:38	15:57	64	13:37 (2)	17:43	20:33	22:34	22:12	20:00	17:58	14:53	73	13:23 (1) 12:52
11	10:43	08:39		10:20 (4)	06:45	05:38	03:28	04:10	06:06	07:49	08:48		10:03 (4) 11:08
	13:43	16:01	58	13:35 (2)	17:47	20:37	22:39	22:07	19:56	17:54	14:49	64	13:23 (1) 12:48
12	10:39	08:35		10:22 (4)	06:41	05:34	03:23	04:14	06:09	07:52	08:53		11:15 (3) 11:13
	13:47	16:05	50	13:34 (2)	17:50	20:41	22:44	22:03	19:52	17:50	14:45	58	13:24 (1) 12:44
13	10:35	08:31		10:26 (4)	06:37	05:30	03:18	04:18	06:13	07:56	08:57		11:16 (3) 11:18
	13:52	16:09	32	13:30 (2)	17:54	20:44	22:48	21:58	19:48	17:46	14:41	50	13:19 (1) 12:40
14	10:31	08:27		11:46 (3)	06:33	05:26	03:13	04:22	06:16	07:59	09:01		11:18 (3) 11:23
	13:57	16:13	21	12:07 (3)	17:58	20:48	22:53	21:54	19:44	17:41	14:37	39	13:12 (1) 12:36
15	10:27	08:23		11:47 (3)	06:29	05:21	03:08	04:26	06:19	08:03	09:06		11:19 (3) 11:28
	14:02	16:17	19	12:06 (3)	18:01	20:52	22:58	00:37	21:50	19:40	14:32	30	13:03 (2) 12:31
16	10:23	08:19		11:49 (3)	06:25	05:17	03:04	01:56	04:30	06:23	08:07		11:22 (3) 11:33
	14:07	16:21	14	12:03 (3)	18:05	20:55	23:03	00:27	21:45	19:35	14:28	19	11:41 (5) 12:27
17	10:19	08:14		11:54 (3)	06:21	05:13	02:59	02:05	04:34	06:26	08:10		11:24 (5) 11:38
	14:11	16:25	4	11:58 (3)	18:08	20:59	23:09	00:18	21:41	19:31	14:24	17	11:41 (5) 12:23
18	10:15	08:10			06:17	05:09	02:53	02:05	04:38	06:30	08:14		11:24 (5) 11:43
	14:16	16:29			18:12	21:03	23:14	00:10	21:37	19:27	17:25	16	11:40 (5) 12:19
19	10:11	08:06			06:13	05:05	02:48	02:13	04:42	06:33	08:18		11:24 (5) 11:49
	14:21	16:33			18:15	21:07	23:19	00:03	21:32	19:23	17:21	16	11:40 (5) 12:14
20	10:07	08:02			06:09	05:00	02:43	02:20	04:46	06:36	08:21		11:55
	14:25	16:37			18:19	21:11	23:25	23:57	21:28	19:19	17:17		12:09
21	10:03	07:58			06:05	04:56	02:37	02:26	04:50	06:40	08:25		11:55
	14:30	16:41			18:22	21:14	23:31	23:51	21:24	19:15	17:13		11:43
22	09:59	07:54			06:01	04:52	02:32	02:33	04:54	06:43	08:29		
	14:35	16:44			18:26	21:18	23:37	23:45	21:20	19:11	17:09		
23	09:55	11:50 (5)	07:50		05:57	04:48	02:26	02:39	04:58	06:47	08:32		
	14:39	16:46	16		18:29	21:22	23:43	23:39	21:15	19:07	17:05		
24	09:51	11:50 (5)	07:46		05:52	04:43	02:20	02:45	05:01	06:50	08:36		
	14:44	16:52	17		18:33	21:26	23:49	23:33	21:11	19:03	17:01		
25	09:47	11:50 (5)	07:42		05:48	04:39	02:14	02:50	05:05	06:53	07:40		
	14:48	16:56	17		18:36	21:30	23:56	23:28	21:07	18:59	15:57	8	11:30 (3) 13:52
26	09:43	11:49 (3)	07:38		05:44	04:35	02:07	02:56	05:09	06:57	07:44		
	14:53	17:00	19		18:40	21:34	00:04	23:23	21:03	18:55	15:53	15	11:34 (3) 13:48
27	09:39	11:46 (3)	07:34		05:40	04:30	02:00	03:01	05:12	07:00	07:48		
	14:57	17:03	31		18:43	21:38	00:12	23:18	20:58	18:50	15:49	19	11:35 (3) 13:44
28	09:35	11:45 (3)	07:30		05:36	04:26	01:42	03:06	05:16	07:04	07:52		
	15:02	17:07	39		18:47	21:42	00:22	23:13	20:54	18:46	15:45	22	11:37 (3) 13:40
29	09:31	11:44 (3)			06:32	04:22	01:31	03:11	05:20	07:07	07:55		
	15:06	13:48 (1)			19:50	21:46	00:34	23:08	20:50	18:42	15:41	36	13:01 (2) 13:36
30	09:27	11:44 (3)			06:28	04:17	01:07	03:16	05:23	07:10	07:59		
	15:11	13:52 (1)	57		19:54	21:50	00:57	23:03	20:46	18:38	15:37	50	13:04 (2) 13:32
31	09:23	10:31 (4)			06:24			03:21	05:27		08:03		
	15:15	13:52 (1)	63		19:57			22:58	20:42		15:33	59	13:06 (2) 12:47
Potential sun hours	115	219		361	468	627	720	694	536	398	292	161	64
Total, worst case	310	930									209	1045	
Sun reduction	0.27	0.30									0.25	0.29	
Oper. time red.	0.96	0.96									0.96	0.96	
Wind dir. red.	0.57	0.58									0.58	0.57	
Total reduction	0.15	0.17									0.14	0.16	
Total, real	45	155									29	167	

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

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

Helligvaer

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30.07.2013 13:11 / 3

Licensed user:

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Calculated:

30.07.2013 12:52/2.9.250

SHADOW - Calendar

Calculation: helligvaerShadow receptor: 3 - Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (31)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.27	0.30	0.30	0.30	0.29	0.29	0.25	0.27	0.25	0.25	0.29	0.28

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
568	563	330	771	2 096	484	346	1 015	719	613	506	386	8 394

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

	January		February		March		April		May		June		July		August		September		October		November		December	
1	11:24		09:19		10:33 (4)	07:26	06:20	04:13							03:26	05:31	07:14				08:07		10:08 (4)	10:19
	12:53		15:19	62	13:40 (2)	17:11	20:01	21:55							22:53	20:37	18:34				15:29	53	13:09 (2)	13:28
2	11:20		09:15		10:32 (4)	07:22	06:15	04:08							03:31	05:34	07:17				08:11		10:06 (4)	10:24
	12:58		15:24	65	13:40 (2)	17:14	20:04	21:59							22:48	20:33	18:30				15:25	58	13:10 (2)	13:24
3	11:16		09:11		10:33 (4)	07:18	06:11	04:04							03:35	05:38	07:21				08:15		10:05 (4)	10:28
	13:03		15:28	68	13:42 (2)	17:18	20:08	22:03							22:44	20:29	18:26				15:21	62	13:10 (2)	13:20
4	11:12		09:07		10:33 (4)	07:14	06:07	04:00							03:40	05:41	07:24				08:19		10:05 (4)	10:33
	13:08		15:32	69	13:42 (2)	17:22	20:12	22:07							22:39	20:25	18:22				15:17	64	13:11 (2)	13:16
5	11:08		09:03		10:33 (4)	07:10	06:03	03:55							03:44	05:45	07:28				08:23		10:04 (4)	10:38
	13:13		15:36	68	13:41 (2)	17:25	20:15	22:12							22:34	20:21	18:18				15:13	65	13:11 (2)	13:12
6	11:04		08:59		10:34 (4)	07:06	05:59	03:51							03:49	05:48	07:31				08:27		10:04 (4)	10:43
	13:18		15:41	66	13:42 (2)	17:29	20:19	22:16							22:30	20:17	18:14				15:09	68	13:12 (2)	13:08
7	11:00		08:55		10:34 (4)	07:02	05:55	03:46							03:53	05:52	07:35				08:32		10:04 (4)	10:48
	13:23		15:45	66	13:41 (2)	17:33	20:22	22:21							22:25	20:13	18:10				15:05	66	13:12 (2)	13:04
8	10:55		08:51		10:36 (4)	06:58	05:51	03:42							03:57	05:55	07:38				08:36		10:04 (4)	10:53
	13:28		15:49	61	13:41 (2)	17:36	20:26	22:25							22:21	20:08	18:06				15:01	66	13:12 (2)	13:00
9	10:51		08:47		10:37 (4)	06:54	05:46	03:37							04:02	05:59	07:42				08:40		10:04 (4)	10:58
	13:33		15:53	58	13:41 (2)	17:40	20:30	22:30							22:16	20:04	18:02				14:57	64	13:11 (2)	12:56
10	10:47		08:43		10:38 (4)	06:50	05:42	03:32							04:06	06:02	07:45				08:44		10:04 (4)	11:03
	13:38		15:57	50	13:39 (2)	17:43	20:33	22:34							22:12	20:00	17:58				14:53	63	13:11 (2)	12:52
11	10:43		08:39		10:41 (4)	06:45	05:38	03:28							04:10	06:06	07:49				08:48		10:05 (4)	11:08
	13:43		16:01	40	13:37 (2)	17:47	20:37	22:39							22:07	19:56	17:54				14:49	58	13:10 (2)	12:48
12	10:39		08:35		11:59 (3)	06:41	05:34	03:23							04:14	06:09	07:52				08:53		10:10 (4)	11:13
	13:47		16:05	28	13:35 (2)	17:50	20:41	22:44							22:03	19:52	17:50				14:45	50	13:10 (2)	12:44
13	10:35		08:31		12:01 (3)	06:37	05:30	03:18							04:18	06:13	07:56				08:57		10:17 (4)	11:18
	13:52		16:09	17	12:18 (3)	17:54	20:44	22:48							21:58	19:48	17:46				14:41	38	13:08 (2)	12:40
14	10:31		08:27		12:03 (3)	06:33	05:26	03:13							04:22	06:16	07:59				09:01		11:32 (3)	11:23
	13:57		16:13	14	12:17 (3)	17:58	20:48	22:53							21:54	19:44	17:41				14:37	27	13:07 (2)	12:36
15	10:27		08:23		12:07 (3)	06:29	05:21	03:08					01:45		04:26	06:19	08:03				09:06		11:31 (5)	11:28
	14:02		16:17	7	12:14 (3)	18:01	20:52	22:58					00:37		21:50	19:40	17:37				14:32	19	13:03 (2)	12:31
16	10:23		08:19			06:25	05:17	03:04					01:56		04:30	06:23	08:07				09:10		11:32 (5)	11:33
	14:07		16:21			18:05	20:55	23:03					00:27		21:45	19:35	17:33				14:28	17	11:49 (5)	12:27
17	10:19		08:14			06:21	05:13	02:58					02:05		04:34	06:26	08:10				09:14		11:32 (5)	11:38
	14:11		16:25			18:08	20:59	23:09					00:18		21:41	19:31	17:29				14:24	17	11:49 (5)	12:23
18	10:15		08:10			06:17	05:09	02:53					02:05		04:38	06:30	08:14				09:19		11:32 (5)	11:44
	14:16		16:29			18:12	21:03	23:14					00:10		21:37	19:27	17:25				14:20	16	11:48 (5)	12:19
19	10:11		08:06			06:13	05:05	02:48					02:13		04:42	06:33	08:18				09:23		11:33 (5)	11:49
	14:21		16:33			18:15	21:07	23:19					00:03		21:32	19:23	17:21				14:16	15	11:48 (5)	12:14
20	10:07		08:02			06:09	05:00	02:43					02:20		04:46	06:36	08:21				09:28			11:55
	14:25		16:37			18:19	21:11	23:25					23:57		21:28	19:19	17:17				14:12			12:09
21	10:03		07:58			06:05	04:56	02:37					02:26		04:50	06:40	08:25				09:32			11:38
	14:30		16:41			18:22	21:14	23:31					23:51		21:24	19:15	17:13				14:08			11:51
22	09:59		07:54			06:01	04:52	02:32					02:33		04:54	06:43	08:29				09:37			
	14:35		16:44			18:26	21:18	23:37					23:45		21:20	19:11	17:09				14:04			
23	09:55		11:59 (5)	07:50		05:57	04:48	02:26					02:39		04:58	06:47	08:32				09:41			
	14:39	15	12:14 (5)	16:48		18:29	21:22	23:43					23:39		21:15	19:07	17:05				14:00			
24	09:51		11:59 (5)	07:46		05:52	04:43	02:20					02:45		05:01	06:50	08:36				09:46			
	14:44	15	12:14 (5)	16:52		18:33	21:26	23:49					23:33		21:11	19:03	17:01				13:56			
25	09:47		11:58 (5)	07:42		05:48	04:39	02:14					02:50		05:05	06:53	07:40				09:51			11:55
	14:48	17	12:15 (5)	16:56		18:36	21:30	23:56					23:28		21:07	18:59	15:57				13:52			12:15
26	09:43		11:59 (5)	07:38		05:44	04:35	02:07					02:56		05:09	06:57	07:44				09:55			11:50
	14:53	16	12:15 (5)	17:00		18:40	21:34	00:04					23:23		21:03	18:55	15:53				13:48			12:21
27	09:39		11:59 (5)	07:34		05:40	04:30	01:51					03:01		05:12	07:00	07:48				11:34 (3)	10:00		11:46
	14:57	18	13:30 (2)	17:03		18:43	21:38	00:12					23:18		20:58	18:50	15:49	10			11:44 (3)	13:44		12:26
28	09:35		11:59 (3)	07:30		05:36	04:26	01:42					03:06		05:16	07:04	07:52				11:32 (3)	10:05		11:41
	15:02	26	13:34 (2)	17:07		18:47	21:42	00:22					23:13		20:54	18:46	15:45	15			11:47 (3)	13:40		12:31
29	09:31		10:45 (4)			06:32	04:22	01:30					03:11		05:20	07:07	07:55				11:30 (3)	10:09		11:37
	15:06	38	13:37 (2)			19:50	21:46	00:34					23:08		20:50	18:42	15:41	19			11:49 (3)	13:36		12:36
30	09:27		10:38 (4)			06:28	04:17	01:07					03:16		05:23	07:10	07:59				11:29 (3)	10:14		11:33
	15:11	50	13:38 (2)			19:54	21:51	00:57					23:03		20:46	18:38	15:37	30			13:06 (2)	13:32		12:42
31	09:23		10:33 (4)			06:24							03:21		05:27		08:03				10:10 (4)			11:29
	15:15	59	13:39 (2)			19:57							22:58		20:42		15:33	43			13:08 (2)			12:47
Potential sun hours	115		219			361	468	627			720		694		536	398	292				161			41
Total, worst case		254		739																117		886		
Sun reduction		0.27		0.30																0.25		0.29		
Oper. time red.		0.96		0.96																0.96		0.96		
Wind dir. red.		0.57																						

Project:

Helligvaer

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30.07.2013 13:11 / 4

Licensed user:

Kjeller Vindteknikk AS

Gunnar Randres vei 12

NO-2007 Kjeller

(+47) 480 50 480

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Calculated:

30.07.2013 12:52/2.9.250

SHADOW - Calendar

Calculation: helligvaerShadow receptor: 4 - Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (24)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.27	0.30	0.30	0.30	0.29	0.29	0.25	0.27	0.25	0.25	0.29	0.28

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
568	563	330	771	2 096	484	346	1 015	719	613	506	386	8 394

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

	January	February	March	April	May	June	July	August	September	October	November	December		
1	11:24	09:19	07:26	06:20	04:13			03:26	05:31	07:14	08:07	12:48 (3)	10:19	
	12:53	15:19	17:11	20:01	21:55			22:53	20:37	18:34	15:29	43	14:13 (2)	13:28
2	11:20	09:15	07:22	06:15	04:08			03:31	05:34	07:17	08:11	12:48 (3)	10:24	
	12:58	15:24	17:14	20:04	21:59			22:48	20:33	18:30	15:25	39	14:12 (2)	13:24
3	11:16	09:11	07:18	06:11	04:04			03:35	05:38	07:21	08:15	12:49 (3)	10:28	
	13:03	15:28	17:18	20:08	22:03			22:44	20:29	18:26	15:21	32	14:09 (2)	13:20
4	11:12	09:07	13:26 (3)	07:14	06:07	04:00		03:40	05:41	07:24	08:19	12:51 (3)	10:33	
	13:08	15:32	11	13:37 (3)	17:22	20:12	22:07	22:39	20:25	18:22	15:17	22	13:13 (3)	13:16
5	11:08	09:03	13:24 (3)	07:10	06:03	03:55		03:44	05:45	07:28	08:23	12:52 (3)	10:38	
	13:13	15:36	16	13:40 (3)	17:25	20:15	22:12	22:34	20:21	18:18	15:13	19	13:11 (3)	13:12
6	11:03	08:59	13:21 (3)	07:06	05:59	03:51		03:49	05:48	07:31	08:27	12:54 (3)	10:43	
	13:18	15:41	20	13:41 (3)	17:29	20:19	22:16	22:30	20:17	18:14	15:09	16	13:10 (3)	13:08
7	10:59	08:55	13:20 (3)	07:02	05:55	03:46		03:53	05:52	07:35	08:32	12:57 (3)	10:48	
	13:23	15:45	23	13:43 (3)	17:33	20:22	22:21	22:25	20:12	18:10	15:05	10	13:07 (3)	13:04
8	10:55	08:51	13:20 (3)	06:58	05:51	03:42		03:57	05:55	07:38	08:36		10:53	
	13:28	15:49	33	14:40 (2)	17:36	20:26	22:25	22:21	20:08	18:06	15:01		13:00	
9	10:51	08:47	13:19 (3)	06:54	05:46	03:37		04:02	05:59	07:42	08:40		10:58	
	13:33	15:53	40	14:43 (2)	17:40	20:30	22:30	22:16	20:04	18:02	14:57		12:56	
10	10:47	08:43	13:18 (3)	06:49	05:42	03:32		04:06	06:02	07:45	08:44		11:03	
	13:38	15:57	44	14:44 (2)	17:43	20:33	22:34	22:12	20:00	17:58	14:53		12:52	
11	10:43	08:39	13:17 (3)	06:45	05:38	03:28		04:10	06:06	07:49	08:48		11:08	
	13:43	16:01	47	14:45 (2)	17:47	20:37	22:39	22:07	19:56	17:54	14:49		12:48	
12	10:39	08:35	13:17 (3)	06:41	05:34	03:23		04:14	06:09	07:52	08:53		11:13	
	13:47	16:05	50	14:46 (2)	17:50	20:41	22:44	22:03	19:52	17:50	14:45		12:44	
13	10:35	08:31	13:16 (3)	06:37	05:30	03:18		04:18	06:12	07:56	08:57		11:18	
	13:52	16:09	51	14:46 (2)	17:54	20:44	22:48	21:58	19:48	17:45	14:41		12:40	
14	10:31	08:27	13:17 (3)	06:33	05:26	03:13		04:22	06:16	07:59	09:01		11:23	
	13:57	16:13	52	14:47 (2)	17:57	20:48	22:53	21:54	19:44	17:41	14:36		12:36	
15	10:27	08:23	13:17 (3)	06:29	05:21	03:08	01:45	04:26	06:19	08:03	09:05		11:28	
	14:02	16:17	52	14:47 (2)	18:01	20:52	22:58	00:37	21:50	19:40	14:32		12:32	
16	10:23	08:18	13:17 (3)	06:25	05:17	03:04	01:56	04:30	06:23	08:07	09:10		11:33	
	14:07	16:21	52	14:47 (2)	18:05	20:55	23:03	00:27	21:45	19:35	14:28		12:27	
17	10:19	08:14	13:17 (3)	06:21	05:13	02:59	02:05	04:34	06:26	08:10	13:57 (3)	09:14	11:38	
	14:11	16:25	50	14:46 (2)	18:08	20:59	23:08	00:18	21:41	19:31	17:29	12	14:09 (3)	14:24
18	10:15	08:10	13:17 (3)	06:17	05:09	02:53	02:05	04:38	06:30	08:14	13:54 (3)	09:19	11:43	
	14:16	16:29	49	14:45 (2)	18:12	21:03	23:14	00:10	21:37	19:27	17:25	18	14:12 (3)	14:20
19	10:11	08:06	13:18 (3)	06:13	05:05	02:48	02:13	04:42	06:33	08:18	13:52 (3)	09:23	11:49	
	14:21	16:33	47	14:45 (2)	18:15	21:07	23:19	00:03	21:32	19:23	17:21	21	14:13 (3)	14:16
20	10:07	08:02	13:18 (3)	06:09	05:00	02:43	02:20	04:46	06:36	08:21	13:50 (3)	09:28	11:55	
	14:25	16:37	44	14:44 (2)	18:19	21:11	23:25	23:57	21:28	19:19	17:17	33	15:11 (2)	14:12
21	10:03	07:58	13:19 (3)	06:05	04:56	02:37	02:26	04:50	06:40	08:25	13:50 (3)	09:32	11:39	
	14:30	16:41	39	14:43 (2)	18:22	21:14	23:31	23:51	21:24	19:15	17:13	40	15:14 (2)	14:08
22	09:59	07:54	13:20 (3)	06:01	04:52	02:32	02:33	04:54	06:43	08:29	13:48 (3)	09:37	11:55	
	14:35	16:44	31	14:40 (2)	18:26	21:18	23:37	23:45	21:20	19:11	17:09	45	15:15 (2)	14:04
23	09:55	07:50	13:22 (3)	05:57	04:48	02:26	02:39	04:58	06:47	08:32	13:47 (3)	09:41		
	14:39	16:48	20	13:42 (3)	18:29	21:22	23:43	23:39	21:15	19:07	17:05	47	15:15 (2)	14:00
24	09:51	07:46	13:24 (3)	05:52	04:43	02:20	02:45	05:01	06:50	08:36	13:47 (3)	09:46		
	14:44	16:52	16	13:40 (3)	18:33	21:26	23:49	23:33	21:11	19:03	17:01	49	15:16 (2)	13:56
25	09:47	07:42	13:28 (3)	05:48	04:39	02:14	02:50	05:05	06:53	07:40	12:46 (3)	09:50	11:54	
	14:48	16:56	8	13:36 (3)	18:36	21:30	23:56	23:28	21:07	18:59	15:57	51	14:16 (2)	13:52
26	09:43	07:38		05:44	04:35	02:07	02:56	05:09	06:57	07:44	12:46 (3)	09:55	11:50	
	14:53	17:00		18:40	21:34	00:04	23:23	21:03	18:55	15:53	14:17 (2)	13:48	12:21	
27	09:39	07:34		05:40	04:30	02:00	03:01	05:12	07:00	07:48	12:46 (3)	10:00	11:45	
	14:57	17:03		18:43	21:38	00:12	23:18	20:58	18:50	15:49	14:16 (2)	13:44	12:26	
28	09:35	07:30		05:36	04:26	01:42	03:06	05:16	07:04	07:51	12:46 (3)	10:04	11:41	
	15:02	17:07		18:47	21:42	00:22	23:12	20:54	18:46	15:45	14:16 (2)	13:40	12:31	
29	09:31			06:32	04:22	01:31	03:11	05:20	07:07	07:55	12:46 (3)	10:09	11:37	
	15:06			19:50	21:46	00:33	23:07	20:50	18:42	15:41	14:16 (2)	13:36	12:37	
30	09:27			06:28	04:17	01:08	03:16	05:23	07:10	07:59	12:47 (3)	10:14	11:33	
	15:10			19:54	21:50	00:56	23:03	20:46	18:38	15:37	14:15 (2)	13:32	12:42	
31	09:23			06:24		23:14	03:21	05:27		08:03	12:47 (3)		11:29	
	15:15			19:57	02:54		22:58	20:42		15:33	14:15 (2)	47	12:47	12:47
Potential sun hours	115	219	361	468	607	720	694	536	398	292	161		41	
Total, worst case		795									619	181		
Sun reduction		0.30									0.25	0.29		
Oper. time red.		0.96									0.96	0.96		
Wind dir. red.		0.57									0.57	0.56		
Total reduction		0.16									0.14	0.16		
Total, real		131									85	28		

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	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker
			(WTG causing flicker last time)

Project:

Helligvaer

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30.07.2013 13:11 / 5

Licensed user:

Kjeller Vindteknikk AS

Gunnar Randres vei 12

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Calculated:

30.07.2013 12:52/2.9.250

SHADOW - Calendar

Calculation: helligvaerShadow receptor: 5 - Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (22)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.27	0.30	0.30	0.30	0.29	0.29	0.25	0.27	0.25	0.25	0.29	0.28

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
568	563	330	771	2 096	484	346	1 015	719	613	506	386	8 394

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

	January	February	March	April	May	June	July	August	September	October	November	December		
1	11:24	09:19	07:26	06:20	04:13			03:26	05:31	07:14	08:07	12:57 (3)	10:19	
	12:53	15:19	17:11	20:01	21:55			22:53	20:37	18:34	15:29	44	14:18 (2)	13:28
2	11:20	09:15	07:22	06:15	04:08			03:31	05:34	07:17	08:11		12:58 (3)	10:24
	12:58	15:24	17:14	20:04	21:59			22:48	20:33	18:30	15:25	42	14:16 (2)	13:24
3	11:16	09:11	07:18	06:11	04:04			03:35	05:38	07:21	08:15		12:58 (3)	10:28
	13:03	15:28	17:18	20:08	22:03			22:44	20:29	18:26	15:21	40	14:14 (1)	13:20
4	11:12	09:07	13:35 (3)	07:14	06:07	04:00		03:40	05:41	07:24	08:19		13:00 (3)	10:33
	13:08	15:32	12	13:47 (3)	17:22	20:12		22:39	20:25	18:22	15:17	37	14:15 (1)	13:16
5	11:08	09:03	13:32 (3)	07:10	06:03	03:55		03:44	05:45	07:28	08:23		13:01 (3)	10:38
	13:13	15:36	21	14:34 (1)	17:25	20:15		22:34	20:21	18:18	15:13	28	14:09 (1)	13:12
6	11:03	08:59	13:30 (3)	07:06	05:59	03:51		03:49	05:48	07:31	08:27		13:03 (3)	10:43
	13:18	15:41	30	14:39 (1)	17:29	20:19		22:30	20:17	18:14	15:09	19	14:03 (1)	13:08
7	10:59	08:55	13:30 (3)	07:02	05:55	03:46		03:53	05:52	07:35	08:32		13:06 (3)	10:48
	13:23	15:45	37	14:45 (1)	17:33	20:22		22:25	20:12	18:10	15:05	11	13:17 (3)	13:04
8	10:55	08:51	13:29 (3)	06:58	05:51	03:42		03:57	05:55	07:38	08:36			10:53
	13:28	15:49	40	14:45 (1)	17:36	20:26		22:21	20:08	18:06	15:01			13:00
9	10:51	08:47	13:28 (3)	06:54	05:46	03:37		04:02	05:59	07:42	08:40			10:58
	13:33	15:53	43	14:47 (2)	17:40	20:30		22:16	20:04	18:02	14:57			12:56
10	10:47	08:43	13:27 (3)	06:49	05:42	03:32		04:06	06:02	07:45	08:44			11:03
	13:38	15:57	45	14:48 (2)	17:43	20:33		22:12	20:00	17:58	14:53			12:52
11	10:43	08:39	13:27 (3)	06:45	05:38	03:28		04:10	06:06	07:49	08:48			11:08
	13:43	16:01	45	14:49 (2)	17:47	20:37		22:07	19:56	17:54	14:49			12:48
12	10:39	08:35	13:26 (3)	06:41	05:34	03:23		04:14	06:09	07:52	08:53			11:13
	13:47	16:05	49	14:50 (2)	17:50	20:41		22:03	19:52	17:50	14:45			12:44
13	10:35	08:31	13:26 (3)	06:37	05:30	03:18		04:18	06:12	07:56	08:57			11:18
	13:52	16:09	50	14:50 (2)	17:54	20:44		21:58	19:48	17:45	14:41			12:40
14	10:31	08:27	13:27 (3)	06:33	05:26	03:13		04:22	06:16	07:59	09:01			11:23
	13:57	16:13	50	14:51 (2)	17:57	20:48		21:54	19:44	17:41	14:36			12:36
15	10:27	08:23	13:27 (3)	06:29	05:21	03:08	01:45	04:26	06:19	08:03	09:05			11:28
	14:02	16:17	49	14:51 (2)	18:01	20:52	00:37	21:50	19:39	17:37	14:32			12:32
16	10:23	08:18	13:26 (3)	06:25	05:17	03:04	01:56	04:30	06:23	08:07	09:10			11:33
	14:07	16:21	50	14:51 (2)	18:05	20:55	00:27	21:45	19:35	17:33	14:28			12:27
17	10:19	08:14	13:26 (3)	06:21	05:13	02:58	02:05	04:34	06:26	08:10	09:14			11:38
	14:11	16:25	48	14:50 (2)	18:08	20:59	00:18	21:41	19:31	17:29	14:24			12:23
18	10:15	08:10	13:27 (3)	06:17	05:09	02:53	02:05	04:38	06:30	08:14	14:06 (3)	09:19		11:43
	14:16	16:29	46	14:49 (2)	18:12	21:03	00:10	21:37	19:27	17:25	12	14:18 (3)	14:20	12:19
19	10:11	08:06	13:28 (3)	06:13	05:05	02:48	02:13	04:42	06:33	08:18	14:03 (3)	09:23		11:49
	14:21	16:33	44	14:49 (2)	18:15	21:07	00:03	21:32	19:23	17:21	18	14:21 (3)	14:16	12:14
20	10:07	08:02	13:28 (3)	06:09	05:00	02:43	02:20	04:46	06:36	08:21	14:01 (3)	09:28		11:55
	14:25	16:37	40	14:48 (2)	18:19	21:11	23:57	21:28	19:19	17:17	27	15:14 (2)	14:12	12:09
21	10:03	07:58	13:30 (3)	06:05	04:56	02:37	02:26	04:50	06:40	08:25	14:00 (3)	09:32		12:14
	14:30	16:41	34	14:46 (2)	18:22	21:14	23:51	21:24	19:15	17:13	37	15:18 (2)	14:08	10:48
22	09:59	07:54	13:31 (3)	06:01	04:52	02:32	02:33	04:54	06:43	08:29	13:59 (3)	09:37		
	14:35	16:44	21	14:41 (2)	18:26	21:18	23:45	21:20	19:11	17:09	41	15:19 (2)	14:04	
23	09:55	07:50	13:33 (3)	05:57	04:48	02:26	02:39	04:58	06:47	08:32	13:57 (3)	09:41		
	14:39	16:48	16	13:49 (3)	18:29	21:22	23:39	21:15	19:07	17:05	45	15:19 (2)	14:00	
24	09:51	07:46	13:36 (3)	05:52	04:43	02:20	02:45	05:01	06:50	08:36	13:57 (3)	09:46		
	14:44	16:52	9	13:45 (3)	18:33	21:26	23:33	21:11	19:03	17:01	48	15:20 (2)	13:56	
25	09:47	07:42		05:48	04:39	02:14	02:50	05:05	06:53	07:40	12:56 (3)	09:50		11:54
	14:48	16:56		18:36	21:30	23:56	23:28	21:07	18:59	15:57	49	14:20 (2)	13:52	12:15
26	09:43	07:38		05:44	04:35	02:07	02:56	05:09	06:57	07:44	12:56 (3)	09:55		11:50
	14:53	17:00		18:40	21:34	00:04	23:23	21:03	18:54	15:53	51	14:21 (2)	13:48	12:21
27	09:39	07:34		05:40	04:30	02:00	03:01	05:12	07:00	07:48	12:55 (3)	10:00		11:45
	14:57	17:03		18:43	21:38	00:12	23:18	20:58	18:50	15:49	50	14:20 (2)	13:44	12:26
28	09:35	07:30		05:36	04:26	01:42	03:06	05:16	07:04	07:51	12:56 (3)	10:04		11:41
	15:02	17:07		18:47	21:42	00:22	23:12	20:54	18:46	15:45	50	14:20 (2)	13:40	12:31
29	09:31			06:32	04:22	01:31	03:11	05:20	07:07	07:55	12:56 (3)	10:09		11:37
	15:06			19:50	21:46	00:33	23:07	20:50	18:42	15:41	49	14:20 (2)	13:36	12:36
30	09:27			06:28	04:17	01:08	03:16	05:23	07:10	07:59	12:56 (3)	10:14		11:33
	15:10			19:54	21:50	00:56	23:03	20:46	18:38	15:37	48	14:20 (2)	13:32	12:42
31	09:23			06:24		23:12	03:21	05:27		08:03	12:57 (3)			11:29
	15:15			19:57	02:55		22:58	20:42		15:33	45	14:19 (2)		12:47
Potential sun hours	115	219	361	468	607	720	694	536	398	292	161		63	
Total, worst case														
Sun reduction		779									570	221		
Oper. time red.		0.30									0.25	0.29		
Wind dir. red.		0.96									0.96	0.96		
Total reduction		0.58									0.58	0.58		
Total, real		0.17									0.14	0.16		
		131									80	36		

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	(WTG causing flicker first time)
	Sun set (hh:mm)	Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:

Helligvaer

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30.07.2013 13:11 / 6

Licensed user:

Kjeller Vindteknikk AS

Gunnar Randres vei 12

NO-2007 Kjeller

(+47) 480 50 480

reiar.kr / reiar.kravik@vindteknikk.no

Calculated:

30.07.2013 12:52/2.9.250

SHADOW - Calendar

Calculation: helligvaerShadow receptor: 6 - Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (21)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.27	0.30	0.30	0.30	0.29	0.29	0.25	0.27	0.25	0.25	0.29	0.28

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
568	563	330	771	2 096	484	346	1 015	719	613	506	386	8 394

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

	January	February	March	April	May	June	July	August	September	October	November	December
1	11:24	09:19	11:29 (4)	07:26	06:20	04:13		03:26	05:31	07:14	08:07	11:04 (4) 10:19
	12:53	15:19	42 13:11 (5)	17:11	20:01	21:55		22:53	20:37	18:34	15:29	61 14:15 (2) 13:28
2	11:20	09:15	11:28 (4)	07:22	06:15	04:08		03:31	05:34	07:17	08:11	11:02 (4) 10:24
	12:58	15:24	50 13:41 (3)	17:14	20:04	21:59		22:48	20:33	18:30	15:25	62 14:14 (2) 13:24
3	11:16	09:11	11:28 (4)	07:18	06:11	04:04		03:35	05:38	07:21	08:15	11:01 (4) 10:28
	13:03	15:28	55 13:44 (3)	17:18	20:08	22:03		22:44	20:29	18:26	15:21	63 14:13 (2) 13:20
4	11:12	09:07	11:30 (4)	07:14	06:07	04:00		03:40	05:41	07:24	08:19	11:01 (4) 10:33
	13:08	15:32	56 13:47 (3)	17:22	20:12	22:07		22:39	20:25	18:22	15:17	60 14:12 (1) 13:16
5	11:08	09:03	11:30 (4)	07:10	06:03	03:55		03:44	05:45	07:28	08:23	11:00 (4) 10:38
	13:13	15:36	63 14:34 (1)	17:25	20:15	22:12		22:34	20:21	18:18	15:13	65 14:09 (1) 13:12
6	11:03	08:59	11:30 (4)	07:06	05:59	03:51		03:49	05:48	07:31	08:27	11:00 (4) 10:43
	13:18	15:41	63 14:39 (1)	17:29	20:19	22:16		22:30	20:17	18:14	15:09	60 14:03 (1) 13:08
7	10:59	08:55	11:31 (4)	07:02	05:55	03:46		03:53	05:52	07:35	08:32	11:00 (4) 10:48
	13:23	15:45	61 14:42 (1)	17:33	20:22	22:21		22:25	20:12	18:10	15:05	56 13:17 (3) 13:04
8	10:55	08:51	11:32 (4)	06:58	05:51	03:42		03:57	05:55	07:38	08:36	11:00 (4) 10:53
	13:28	15:49	62 14:44 (2)	17:36	20:26	22:25		22:21	20:08	18:06	15:01	54 13:15 (3) 13:00
9	10:51	08:47	11:33 (4)	06:54	05:46	03:37		04:02	05:59	07:42	08:40	11:00 (4) 10:58
	13:33	15:53	62 14:45 (2)	17:40	20:30	22:30		22:16	20:04	18:02	14:57	50 13:12 (3) 12:56
10	10:47	08:43	11:34 (4)	06:49	05:42	03:32		04:06	06:02	07:45	08:44	10:59 (4) 11:03
	13:38	15:57	61 14:46 (2)	17:43	20:33	22:34		22:12	20:00	17:58	14:53	43 12:42 (5) 12:52
11	10:43	08:39	11:37 (4)	06:45	05:38	03:28		04:10	06:06	07:49	08:48	11:00 (4) 11:08
	13:43	16:01	57 14:46 (2)	17:47	20:37	22:39		22:07	19:56	17:54	14:49	43 12:43 (5) 12:48
12	10:39	08:35	13:23 (3)	06:41	05:34	03:23		04:14	06:09	07:52	08:53	11:01 (4) 11:13
	13:47	16:05	49 14:47 (2)	17:50	20:41	22:44		22:03	19:52	17:50	14:45	42 12:43 (5) 12:44
13	10:35	08:31	13:23 (3)	06:37	05:30	03:18		04:18	06:12	07:56	08:57	11:01 (4) 11:18
	13:52	16:09	49 14:47 (2)	17:54	20:44	22:48		21:58	19:48	17:45	14:41	40 12:42 (5) 12:40
14	10:31	08:27	13:24 (3)	06:33	05:26	03:13		04:22	06:16	07:59	09:01	11:02 (4) 11:23
	13:57	16:13	49 14:48 (2)	17:57	20:48	22:53		21:54	19:44	17:41	14:36	40 12:43 (5) 12:36
15	10:27	08:23	13:24 (3)	06:29	05:21	03:08	01:45	04:26	06:19	08:03	09:05	11:02 (4) 11:28
	14:02	16:17	48 14:47 (2)	18:01	20:52	22:58	00:37	21:50	19:39	17:37	14:32	38 12:42 (5) 12:31
16	10:23	08:18	13:24 (3)	06:25	05:17	03:04	01:56	04:30	06:23	08:07	09:10	11:03 (4) 11:33
	14:07	16:21	47 14:47 (2)	18:05	20:55	23:03	00:27	21:45	19:35	17:33	14:28	35 12:42 (5) 12:27
17	10:19	08:14	13:25 (3)	06:21	05:13	02:58	02:05	04:34	06:26	08:10	09:14	11:05 (4) 11:38
	14:11	16:25	44 14:46 (2)	18:08	20:59	23:08	00:18	21:41	19:31	17:29	14:24	32 12:42 (5) 12:23
18	10:15	08:10	13:25 (3)	06:17	05:09	02:53	02:05	04:38	06:30	08:14	09:19	11:06 (4) 11:43
	14:16	16:29	41 14:45 (2)	18:12	21:03	23:14	00:10	21:37	19:27	17:25	14:20	19 12:33 (5) 12:19
19	10:11	08:06	13:27 (3)	06:13	05:05	02:48	02:13	04:42	06:33	08:18	09:23	11:49
	14:21	16:33	36 14:44 (2)	18:15	21:07	23:19	00:03	21:32	19:23	17:21	14:16	12:14
20	10:07	08:02	13:28 (3)	06:09	05:00	02:43	02:20	04:46	06:36	08:21	09:28	11:55
	14:25	16:37	28 14:41 (2)	18:19	21:11	23:25	23:57	21:28	19:19	17:17	13 14:15 (3) 14:12	12:09
21	10:03	07:58	13:30 (3)	06:05	04:56	02:37	02:26	04:50	06:40	08:25	14:00 (3)	09:32
	14:30	16:41	16 13:46 (3)	18:22	21:14	23:31	23:51	21:24	19:15	17:13	18 14:18 (3) 14:08	12:14
22	09:59	07:54	13:33 (3)	06:01	04:52	02:32	02:33	04:54	06:43	08:29	13:58 (3)	09:37
	14:35	16:44	10 13:43 (3)	18:26	21:18	23:37	23:45	21:20	19:11	17:09	31 15:13 (2) 14:04	
23	09:55	07:50		05:57	04:48	02:26	02:39	04:58	06:47	08:32	13:56 (3)	09:41
	14:39	16:48		18:29	21:22	23:43	23:39	21:15	19:07	17:05	38 15:14 (2) 14:00	
24	09:51	11:32 (4)	07:46	05:52	04:43	02:20	02:45	05:01	06:50	08:36	13:56 (3)	09:46
	14:44	20 12:59 (5)	16:52	18:33	21:26	23:49	23:33	21:11	19:03	17:01	42 15:16 (2) 13:56	
25	09:47	11:31 (4)	07:42	05:48	04:39	02:14	02:50	05:05	06:53	07:40	12:54 (3)	09:50
	14:48	32 13:08 (5)	16:56	18:36	21:30	23:56	23:28	21:07	18:59	15:57	45 14:16 (2) 13:52	11:54
26	09:43	11:30 (4)	07:38	05:44	04:35	02:07	02:56	05:09	06:57	07:44	12:54 (3)	09:55
	14:53	35 13:09 (5)	17:00	18:40	21:34	00:04	23:23	21:03	18:54	15:53	47 14:17 (2) 13:48	12:21
27	09:39	11:29 (4)	07:34	05:40	04:30	02:00	03:01	05:12	07:00	07:48	12:53 (3)	10:00
	14:57	37 13:09 (5)	17:03	18:43	21:38	00:12	23:18	20:58	18:50	15:49	47 14:16 (2) 13:44	12:26
28	09:35	11:29 (4)	07:30	05:36	04:26	01:42	03:06	05:16	07:04	07:51	12:53 (3)	10:04
	15:02	39 13:10 (5)	17:07	18:47	21:42	00:22	23:12	20:54	18:46	15:45	49 14:17 (2) 13:40	12:31
29	09:31	11:29 (4)		06:32	04:22	01:31	03:11	05:20	07:07	07:55	12:53 (3)	10:09
	15:06	41 13:11 (5)		19:50	21:46	00:34	23:08	20:50	18:42	15:41	49 14:17 (2) 13:36	12:36
30	09:27	11:29 (4)		06:28	04:17	01:08	03:16	05:23	07:10	07:59	12:53 (3)	10:14
	15:10	42 13:11 (5)		19:54	21:50	00:57	23:03	20:46	18:38	15:37	49 14:17 (2) 13:32	12:42
31	09:23	11:29 (4)		06:24			03:21	05:27		08:03	11:06 (4)	12:29
	15:15	42 13:11 (5)		19:57			22:58	20:42		15:33	58 14:16 (2)	12:47
Potential sun hours	115	219	361	468	627	720	694	536	398	292	161	64
Total, worst case	288	1049								486	863	
Sun reduction	0.27	0.30								0.25	0.29	
Oper. time red.	0.96	0.96								0.96	0.96	
Wind dir. red.	0.56	0.58								0.58	0.57	
Total reduction	0.15	0.17								0.14	0.16	
Total, real	42	174								68	136	

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	(WTG causing flicker first time)
	Sun set (hh:mm)	Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:

Helligvaer

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30.07.2013 13:11 / 7

Licensed user:

Kjeller Vindteknikk AS

Gunnar Randres vei 12

NO-2007 Kjeller

(+47) 480 50 480

reiar.k / reiar.kravik@vindteknikk.no

Calculated:

30.07.2013 12:52/2.9.250

SHADOW - Calendar

Calculation: helligvaerShadow receptor: 7 - Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (19)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.27	0.30	0.30	0.30	0.29	0.29	0.25	0.27	0.25	0.25	0.29	0.28

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
568	563	330	771	2 096	484	346	1 015	719	613	506	386	8 394

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

	January		February		March		April		May		June		July		August		September		October		November		December	
1	11:24		09:19		11:48 (4)	07:26	06:20	04:13							03:26	05:31	07:14				08:07		13:09 (3)	10:19
	12:53		15:19	41	13:22 (5)	17:11	20:01	21:55							22:53	20:37	18:34				15:29	43	14:22 (2)	13:28
2	11:20		09:15		11:47 (4)	07:22	06:15	04:08							03:31	05:34	07:17				08:11		11:25 (4)	10:24
	12:58		15:24	50	13:57 (3)	17:14	20:04	21:59							22:48	20:33	18:30				15:25	50	14:21 (2)	13:24
3	11:16		09:11		11:47 (4)	07:18	06:11	04:04							03:35	05:38	07:21				08:15		11:22 (4)	10:28
	13:03		15:28	53	13:59 (3)	17:18	20:08	22:03							22:44	20:29	18:26				15:21	52	14:19 (2)	13:20
4	11:12		09:07		11:49 (4)	07:14	06:07	04:00							03:40	05:41	07:24				08:19		11:21 (4)	10:33
	13:08		15:32	52	14:02 (3)	17:22	20:12	22:07							22:39	20:25	18:22				15:17	47	14:15 (2)	13:16
5	11:08		09:03		11:49 (4)	07:10	06:03	03:55							03:44	05:45	07:28				08:23		11:20 (4)	10:38
	13:13		15:36	49	14:03 (3)	17:25	20:15	22:12							22:34	20:21	18:18				15:13	42	13:33 (3)	13:12
6	11:03		08:59		11:50 (4)	07:06	05:59	03:51							03:49	05:48	07:31				08:27		11:19 (4)	10:43
	13:18		15:41	42	14:03 (3)	17:29	20:19	22:16							22:30	20:17	18:14				15:09	51	13:33 (3)	13:08
7	10:59		08:55		11:51 (4)	07:02	05:55	03:46							03:53	05:52	07:35				08:32		11:19 (4)	10:48
	13:23		15:45	47	14:45 (2)	17:33	20:22	22:21							22:25	20:12	18:10				15:05	53	13:32 (3)	13:04
8	10:55		08:51		11:54 (4)	06:58	05:51	03:42							03:57	05:55	07:38				08:36		11:19 (4)	10:53
	13:28		15:49	51	14:51 (2)	17:36	20:26	22:25							22:21	20:08	18:06				15:01	52	13:30 (3)	13:00
9	10:51		08:47		11:57 (4)	06:54	05:46	03:37							04:02	05:59	07:42				08:40		11:18 (4)	10:58
	13:33		15:53	49	14:52 (2)	17:40	20:30	22:30							22:16	20:04	18:02				14:57	51	13:28 (3)	12:56
10	10:47		08:43		13:39 (3)	06:49	05:42	03:32							04:06	06:02	07:45				08:44		11:18 (4)	11:03
	13:38		15:57	43	14:52 (2)	17:43	20:33	22:34							22:12	20:00	17:58				14:53	40	12:52 (5)	12:52
11	10:43		08:39		13:39 (3)	06:45	05:38	03:28							04:10	06:06	07:49				08:48		11:18 (4)	11:08
	13:43		16:01	45	14:53 (2)	17:47	20:37	22:39							22:07	19:56	17:54				14:49	42	12:53 (5)	12:48
12	10:39		08:35		13:39 (3)	06:41	05:34	03:23							04:14	06:09	07:52				08:53		11:19 (4)	11:13
	13:47		16:05	45	14:53 (2)	17:50	20:41	22:44							22:03	19:52	17:50				14:45	41	12:53 (5)	12:44
13	10:35		08:31		13:39 (3)	06:37	05:30	03:18							04:18	06:12	07:56				08:57		11:19 (4)	11:18
	13:52		16:09	46	14:54 (2)	17:54	20:44	22:48							21:58	19:48	17:45				14:40	41	12:53 (5)	12:40
14	10:31		08:27		13:40 (3)	06:33	05:26	03:13							04:22	06:16	07:59				09:01		11:19 (4)	11:23
	13:57		16:13	44	14:54 (2)	17:57	20:48	22:53							21:54	19:44	17:41				14:36	41	12:53 (5)	12:36
15	10:27		08:23		13:40 (3)	06:29	05:21	03:08						01:45	04:26	06:19	08:03				09:05		11:19 (4)	11:28
	14:02		16:17	44	14:54 (2)	18:01	20:52	22:58						00:37	21:50	19:39	17:37				14:32	40	12:53 (5)	12:31
16	10:23		08:18		13:41 (3)	06:25	05:17	03:03						01:56	04:30	06:23	08:07				09:10		11:20 (4)	11:33
	14:07		16:21	41	14:53 (2)	18:05	20:55	23:03						00:27	21:45	19:35	17:33				14:28	37	12:52 (5)	12:27
17	10:19		08:14		13:41 (3)	06:21	05:13	02:58						02:05	04:34	06:26	08:10				09:14		11:21 (4)	11:38
	14:11		16:25	39	14:52 (2)	18:08	20:59	23:08						00:18	21:41	19:31	17:29				14:24	28	12:45 (5)	12:23
18	10:15		08:10		13:42 (3)	06:17	05:09	02:53						02:05	04:38	06:30	08:14				09:19		11:22 (4)	11:43
	14:16		16:29	34	14:51 (2)	18:12	21:03	23:14						00:10	21:37	19:27	17:25				14:20	19	11:41 (4)	12:19
19	10:11		08:06		13:44 (3)	06:13	05:05	02:48						02:13	04:42	06:33	08:18				09:23		11:23 (4)	11:49
	14:21		16:33	26	14:49 (2)	18:15	21:07	23:19						00:03	21:32	19:23	17:21				14:16	17	11:40 (4)	12:14
20	10:07		08:02		13:46 (3)	06:09	05:00	02:43						02:20	04:46	06:36	08:21				09:28			11:55
	14:25		16:37	12	13:58 (3)	18:19	21:11	23:25						23:57	21:28	19:19	17:17				14:12			12:09
21	10:03		07:58			06:05	04:56	02:37						02:26	04:50	06:40	08:25							11:55
	14:30		16:41			18:22	21:14	23:31						23:51	21:24	19:15	17:13			7	14:27 (3)			11:44
22	09:59		07:54			06:01	04:52	02:32						02:33	04:54	06:43	08:29							
	14:35		16:44			18:26	21:18	23:37						23:45	21:20	19:11	17:09			18	15:17 (2)			
23	09:55			11:49 (4)	07:50		05:57	04:47	02:26					02:39	04:58	06:47	08:32							
	14:39	17		12:06 (4)	16:48		18:29	21:22	23:43					23:39	21:15	19:07	17:05			28	15:20 (2)			
24	09:51			11:48 (4)	07:46		05:52	04:43	02:20					02:45	05:01	06:50	08:36							
	14:44	19		12:07 (4)	16:52		18:33	21:26	23:49					23:33	21:11	19:03	17:01			34	15:22 (2)			
25	09:47			11:47 (4)	07:42		05:48	04:39	02:14					02:50	05:05	06:53	07:40							11:54
	14:48	28		13:11 (5)	16:56		18:36	21:30	23:56					23:28	21:07	18:59	15:57			39	14:22 (2)			12:15
26	09:43			11:47 (4)	07:38		05:44	04:35	02:07					02:56	05:09	06:57	07:44							11:50
	14:53	37		13:19 (5)	16:59		18:40	21:34	00:04					23:23	21:03	18:54	15:53			42	14:23 (2)			12:21
27	09:39			11:47 (4)	07:34		05:40	04:30	01:51					03:01	05:12	07:00	07:48							11:45
	14:57	39		13:20 (5)	17:03		18:43	21:38	00:12					23:18	20:58	18:50	15:49			45	14:23 (2)			12:26
28	09:35			11:46 (4)	07:30		05:36	04:26	01:42					03:06	05:16	07:04	07:51							11:41
	15:02	42		13:21 (5)	17:07		18:47	21:42	00:22					23:12	20:54	18:46	15:45			45	14:23 (2)			12:31
29	09:31			11:47 (4)			06:32	04:22	01:30					03:11	05:20	07:07	07:55							11:37
	15:06	41		13:21 (5)			19:50	21:46	00:34					23:08	20:50	18:42	15:41			45	14:23 (2)			12:36
30	09:27			11:47 (4)			06:28	04:17	01:07					03:16	05:23	07:10	07:59							11:33
	15:10	42		13:22 (5)			19:54	21:50	00:57					23:03	20:46	18:38	15:37			45	14:23 (2)			12:42
31	09:23			11:47 (4)			06:24							03:21	05:27		08:03							11:29
	15:15	41		13:21 (5)			19:57							22:58	20:42		15:33			45	14:23 (2)			12:47
Potential sun hours	115		219			361		468	627		720		694		536		398				161			64
Total, worst case		306			853															393		787		
Sun reduction		0.27			0.30															0.25		0.29		
Oper. time red.		0.96			0.96															0.96		0.96		
Wind dir. red.		0.56																						

Project:

Helligvaer

Printed/Page

30.07.2013 13:11 / 8

Licensed user:

Kjeller Vindteknikk AS

Gunnar Randres vei 12

NO-2007 Kjeller

(+47) 480 50 480

reiar.k / reiar.kravik@vindteknikk.no

Calculated:

30.07.2013 12:52/2.9.250

SHADOW - Calendar

Calculation: helligvaerShadow receptor: 8 - Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (20)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.27	0.30	0.30	0.30	0.29	0.29	0.25	0.27	0.25	0.25	0.29	0.28

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
568	563	330	771	2 096	484	346	1 015	719	613	506	386	8 394

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

	January		February		March		April		May		June		July		August		September		October		November		December	
1	11:24		09:19		11:48 (4)	07:26	06:20	04:13							03:26	05:31	07:14			08:07		13:06 (3)	10:19	
	12:53		15:19	51	13:55 (3)	17:11	20:01	21:55							22:53	20:37	18:34			15:29	44	14:20 (2)	13:28	
2	11:20		09:15		11:47 (4)	07:22	06:15	04:08							03:31	05:34	07:17			08:11		13:06 (3)	10:24	
	12:58		15:24	53	13:56 (3)	17:14	20:04	21:59							22:48	20:33	18:30			15:25	42	14:19 (2)	13:24	
3	11:16		09:11		11:48 (4)	07:18	06:11	04:04							03:35	05:38	07:21			08:15		11:24 (4)	10:28	
	13:03		15:28	53	13:58 (3)	17:18	20:08	22:03							22:44	20:29	18:26			15:21	50	14:18 (2)	13:20	
4	11:12		09:07		11:49 (4)	07:14	06:07	04:00							03:40	05:41	07:24			08:19		11:23 (4)	10:33	
	13:08		15:32	51	14:00 (3)	17:22	20:12	22:07							22:39	20:25	18:22			15:17	49	14:15 (2)	13:16	
5	11:08		09:03		11:50 (4)	07:10	06:03	03:55							03:44	05:45	07:28			08:23		11:21 (4)	10:38	
	13:13		15:36	41	14:00 (3)	17:25	20:15	22:12							22:34	20:21	18:18			15:13	43	14:09 (2)	13:12	
6	11:04		08:59		11:51 (4)	07:06	05:59	03:51							03:49	05:48	07:31			08:27		11:20 (4)	10:43	
	13:18		15:41	44	14:39 (2)	17:29	20:19	22:16							22:30	20:17	18:14			15:09	44	13:31 (3)	13:08	
7	10:59		08:55		11:53 (4)	07:02	05:55	03:46							03:53	05:52	07:35			08:32		11:20 (4)	10:48	
	13:23		15:45	49	14:45 (2)	17:33	20:22	22:21							22:25	20:12	18:10			15:05	51	13:30 (3)	13:04	
8	10:55		08:51		11:56 (4)	06:58	05:51	03:42							03:57	05:55	07:38			08:36		11:19 (4)	10:53	
	13:28		15:49	50	14:49 (2)	17:36	20:26	22:25							22:21	20:08	18:06			15:01	52	13:29 (3)	13:00	
9	10:51		08:47		13:37 (3)	06:54	05:46	03:37							04:02	05:59	07:42			08:40		11:19 (4)	10:58	
	13:33		15:53	42	14:50 (2)	17:40	20:30	22:30							22:16	20:04	18:02			14:57	52	13:27 (3)	12:56	
10	10:47		08:43		13:36 (3)	06:49	05:42	03:32							04:06	06:02	07:45			08:44		11:18 (4)	11:03	
	13:38		15:57	44	14:50 (2)	17:43	20:33	22:34							22:12	20:00	17:58			14:53	50	13:25 (3)	12:52	
11	10:43		08:39		13:36 (3)	06:45	05:38	03:28							04:10	06:06	07:49			08:48		11:18 (4)	11:08	
	13:43		16:01	44	14:50 (2)	17:47	20:37	22:39							22:07	19:56	17:54			14:49	43	13:21 (3)	12:48	
12	10:39		08:35		13:36 (3)	06:41	05:34	03:23							04:14	06:09	07:52			08:53		11:19 (4)	11:13	
	13:47		16:05	45	14:51 (2)	17:50	20:41	22:44							22:03	19:52	17:50			14:45	39	12:51 (5)	12:44	
13	10:35		08:31		13:37 (3)	06:37	05:30	03:18							04:18	06:12	07:56			08:57		11:18 (4)	11:18	
	13:52		16:09	43	14:50 (2)	17:54	20:44	22:48							21:58	19:48	17:45			14:40	41	12:51 (5)	12:40	
14	10:31		08:27		13:38 (3)	06:33	05:26	03:13							04:22	06:16	07:59			09:01		11:19 (4)	11:23	
	13:57		16:13	42	14:51 (2)	17:57	20:48	22:53							21:54	19:44	17:41			14:36	40	12:52 (5)	12:36	
15	10:27		08:23		13:38 (3)	06:29	05:21	03:08				01:45			04:26	06:19	08:03			09:05		11:19 (4)	11:28	
	14:02		16:17	41	14:50 (2)	18:01	20:52	22:58				00:37			21:50	19:39	17:37			14:32	39	12:51 (5)	12:31	
16	10:23		08:18		13:39 (3)	06:25	05:17	03:03				01:56			04:30	06:23	08:07			09:10		11:19 (4)	11:33	
	14:07		16:21	36	14:49 (2)	18:05	20:55	23:03				00:27			21:45	19:35	17:33			14:28	38	12:51 (5)	12:27	
17	10:19		08:14		13:40 (3)	06:21	05:13	02:58				02:05			04:34	06:26	08:10			09:14		11:21 (4)	11:38	
	14:11		16:25	32	14:48 (2)	18:08	20:59	23:08				00:18			21:41	19:31	17:29			14:24	30	12:45 (5)	12:23	
18	10:15		08:10		13:41 (3)	06:17	05:09	02:53				02:05			04:38	06:30	08:14			09:19		11:21 (4)	11:43	
	14:16		16:29	26	14:46 (2)	18:12	21:03	23:14				00:10			21:37	19:27	17:25			14:20	20	11:41 (4)	12:19	
19	10:11		08:06		13:45 (3)	06:13	05:05	02:48				02:13			04:42	06:33	08:18			09:23		11:22 (4)	11:49	
	14:21		16:33	10	13:55 (3)	18:15	21:07	23:19				00:03			21:32	19:23	17:21			14:16	18	11:40 (4)	12:14	
20	10:07		08:02			06:09	05:00	02:43				02:20			04:46	06:36	08:21			09:28			11:55	
	14:25		16:37			18:19	21:11	23:25				23:57			21:28	19:19	17:17			14:12			12:09	
21	10:03		07:58			06:05	04:56	02:37				02:26			04:50	06:40	08:25			09:32			13:04	
	14:30		16:41			18:22	21:14	23:31				23:51			21:24	19:15	17:13			14:08			13:31	
22	09:59		07:54			06:01	04:52	02:32				02:33			04:54	06:43	08:29			09:37				
	14:35		16:44			18:26	21:18	23:37				23:45			21:20	19:11	17:09			14:04				
23	09:55		11:48 (4)	07:50		05:57	04:47	02:26				02:39			04:58	06:47	08:32				14:14 (3)	09:41		
	14:39	19	12:07 (4)	16:48		18:29	21:22	23:43				23:39			21:15	19:07	17:05			14	15:13 (2)	14:00		
24	09:51		11:47 (4)	07:46		05:52	04:43	02:20				02:45			05:01	06:50	08:36				14:12 (3)	09:46		
	14:44	20	12:07 (4)	16:52		18:33	21:26	23:49				23:33			21:11	19:03	17:01			26	15:17 (2)	13:56		
25	09:47		11:47 (4)	07:42		05:48	04:39	02:14				02:50			05:05	06:53	07:40				13:09 (3)	09:50	11:55	
	14:48	30	13:11 (5)	16:56		18:36	21:30	23:56				23:28			21:07	18:59	15:57			34	14:18 (2)	13:52	12:15	
26	09:43		11:47 (4)	07:38		05:44	04:35	02:07				02:56			05:09	06:57	07:44				13:09 (3)	09:55	11:50	
	14:53	38	13:18 (5)	16:59		18:40	21:34	00:04				23:23			21:03	18:54	15:53			37	14:19 (2)	13:48	12:21	
27	09:39		11:46 (4)	07:34		05:40	04:30	01:51				03:01			05:12	07:00	07:48				13:07 (3)	10:00	11:45	
	14:57	40	13:19 (5)	17:03		18:43	21:38	00:12				23:18			20:58	18:50	15:49			41	14:19 (2)	13:44	12:26	
28	09:35		11:46 (4)	07:30		05:36	04:26	01:42				03:06			05:16	07:04	07:51				13:07 (3)	10:04	11:41	
	15:02	41	13:19 (5)	17:07		18:47	21:42	00:22				23:12			20:54	18:46	15:45			42	14:20 (2)	13:40	12:31	
29	09:31		11:47 (4)			06:32	04:22	01:30				03:11			05:20	07:07	07:55				13:06 (3)	10:09	11:37	
	15:06	41	13:20 (5)			19:50	21:46	00:34				23:08			20:50	18:42	15:41			44	14:20 (2)	13:36	12:36	
30	09:27		11:47 (4)			06:28	04:17	01:07				03:16			05:23	07:10	07:59				13:06 (3)	10:14	11:33	
	15:10	41	13:20 (5)			19:54	21:50	00:57				23:03			20:46	18:38	15:37			45	14:21 (2)	13:32	12:42	
31	09:23		11:47 (4)			06:24						03:21			05:27		08:03				13:06 (3)		11:29	
	15:15	45	13:50 (3)			19:57						22:58			20:42		15:33			45	14:20 (2)		12:47	
Potential sun hours	115		219			361	468	627			720	694			536	398	292			161			62	
Total, worst case		315		797														328		785				
Sun reduction		0.27		0.30														0.25		0.29				
Oper. time red.		0.96		0.96														0.96		0.96				
Wind dir. red.		0.56		0.58														0.59		0.57				
Total reduction		0.14		0.17														0.14		0.16				
Total, real		46		133														47		124				

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	(WTG causing flicker first time)
	Sun set (hh:mm)	Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:

Helligvaer

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30.07.2013 13:11 / 9

Licensed user:

Kjeller Vindteknikk AS

Gunnar Randres vei 12

NO-2007 Kjeller

(+47) 480 50 480

reiar.k / reiar.kravik@vindteknikk.no

Calculated:

30.07.2013 12:52/2.9.250

SHADOW - Calendar

Calculation: helligvaerShadow receptor: 9 - Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (25)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.27	0.30	0.30	0.30	0.29	0.29	0.25	0.27	0.25	0.25	0.29	0.28

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
568	563	330	771	2 096	484	346	1 015	719	613	506	386	8 394

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

	January	February	March	April	May	June	July	August	September	October	November	December
1	11:24	09:19	11:48 (4)	07:26	06:20	04:13		03:26	05:31	07:14	08:07	13:00 (3)
	12:53	15:19	52	13:51 (3)	17:11	20:01	21:55	22:53	20:37	18:34	15:29	43
2	11:20	09:15		11:48 (4)	07:22	06:15	04:08	03:31	05:34	07:17	08:11	13:00 (3)
	12:58	15:24	51	13:52 (3)	17:14	20:04	21:59	22:48	20:33	18:30	15:25	42
3	11:16	09:11		11:49 (4)	07:18	06:11	04:04	03:35	05:38	07:21	08:15	13:00 (3)
	13:03	15:28	47	13:53 (3)	17:18	20:08	22:03	22:44	20:29	18:26	15:21	42
4	11:12	09:07		11:51 (4)	07:14	06:07	04:00	03:40	05:41	07:24	08:19	13:00 (3)
	13:08	15:32	39	13:54 (3)	17:22	20:12	22:07	22:39	20:25	18:22	15:17	41
5	11:08	09:03		11:52 (4)	07:10	06:03	03:55	03:44	05:45	07:28	08:23	11:23 (4)
	13:13	15:36	43	14:34 (2)	17:25	20:15	22:12	22:34	20:21	18:18	15:13	48
6	11:04	08:59		11:54 (4)	07:06	05:59	03:51	03:49	05:48	07:31	08:27	11:22 (4)
	13:18	15:40	45	14:39 (2)	17:29	20:19	22:16	22:30	20:17	18:14	15:09	42
7	10:59	08:55		13:30 (3)	07:02	05:55	03:46	03:53	05:52	07:35	08:32	11:21 (4)
	13:23	15:45	41	14:43 (2)	17:32	20:22	22:21	22:25	20:12	18:10	15:05	40
8	10:55	08:51		13:30 (3)	06:58	05:51	03:42	03:57	05:55	07:38	08:36	11:20 (4)
	13:28	15:49	43	14:44 (2)	17:36	20:26	22:25	22:21	20:08	18:06	15:01	48
9	10:51	08:47		13:31 (3)	06:54	05:46	03:37	04:02	05:59	07:42	08:40	11:19 (4)
	13:33	15:53	42	14:44 (2)	17:40	20:30	22:30	22:16	20:04	18:02	14:57	51
10	10:47	08:43		13:30 (3)	06:49	05:42	03:32	04:06	06:02	07:45	08:44	11:18 (4)
	13:38	15:57	43	14:44 (2)	17:43	20:33	22:34	22:12	20:00	17:58	14:53	53
11	10:43	08:39		13:31 (3)	06:45	05:38	03:28	04:10	06:06	07:49	08:48	11:18 (4)
	13:43	16:01	41	14:44 (2)	17:47	20:37	22:39	22:07	19:56	17:54	14:49	53
12	10:39	08:35		13:31 (3)	06:41	05:34	03:23	04:14	06:09	07:52	08:53	11:18 (4)
	13:47	16:05	40	14:43 (2)	17:50	20:41	22:44	22:03	19:52	17:50	14:45	51
13	10:35	08:31		13:32 (3)	06:37	05:30	03:18	04:18	06:12	07:56	08:57	11:18 (4)
	13:52	16:09	38	14:43 (2)	17:54	20:44	22:48	21:58	19:48	17:45	14:40	45
14	10:31	08:27		13:34 (3)	06:33	05:26	03:13	04:22	06:16	07:59	09:01	11:18 (4)
	13:57	16:13	34	14:43 (2)	17:57	20:48	22:53	21:54	19:44	17:41	14:36	39
15	10:27	08:23		13:35 (3)	06:29	05:21	03:08	04:26	06:19	08:03	09:05	11:18 (4)
	14:02	16:17	29	14:42 (2)	18:01	20:52	22:58	00:37	21:50	19:39	14:32	39
16	10:23	08:18		13:37 (3)	06:25	05:17	03:03	01:56	04:30	06:23	08:07	11:19 (4)
	14:07	16:21	21	14:40 (2)	18:05	20:55	23:03	00:27	21:45	19:35	14:28	38
17	10:19	08:14		16:21	05:13	02:58		02:05	04:34	06:26	08:10	11:20 (4)
	14:11	16:25		18:08	20:59	23:09		00:18	21:41	19:31	17:29	33
18	10:15	08:10		16:17	05:09	02:53		02:05	04:38	06:30	08:14	11:20 (4)
	14:16	16:29		18:12	21:03	23:14		00:10	21:37	19:27	17:25	20
19	10:11	08:06		16:13	05:05	02:48		02:12	04:42	06:33	08:18	11:22 (4)
	14:21	16:33		18:15	21:07	23:19		00:03	21:32	19:23	17:21	18
20	10:07	08:02		16:09	05:00	02:43		02:20	04:46	06:36	08:21	11:55
	14:25	16:37		18:19	21:11	23:25		23:57	21:28	19:19	17:17	12:09
21	10:03	07:58		16:05	04:56	02:37		02:26	04:50	06:40	08:25	11:41
	14:30	16:41		18:22	21:14	23:31		23:51	21:24	19:15	17:13	11:55
22	09:59	07:54		16:01	04:52	02:32		02:33	04:54	06:43	08:29	
	14:35	16:44		18:26	21:18	23:37		23:45	21:20	19:11	17:09	
23	09:55	11:48 (4)	07:50	05:57	04:47	02:26		02:39	04:57	06:47	08:32	
	14:39	12:06 (4)	16:48	18:29	21:22	23:43		23:39	21:15	19:07	17:05	
24	09:51	11:46 (4)	07:46	05:52	04:43	02:20		02:45	05:01	06:50	08:36	
	14:44	12:07 (4)	16:52	18:33	21:26	23:49		23:33	21:11	19:03	17:01	
25	09:47	11:46 (4)	07:42	05:48	04:39	02:13		02:50	05:05	06:53	07:40	
	14:48	13:11 (5)	16:56	18:36	21:30	23:56		23:28	21:07	18:59	15:57	6
26	09:43	11:46 (4)	07:38	05:44	04:35	02:07		02:56	05:09	06:57	07:44	13:06 (3)
	14:53	13:15 (5)	16:59	18:40	21:34	00:04		23:23	21:03	18:54	15:53	23
27	09:39	11:46 (4)	07:34	05:40	04:30	01:51		03:01	05:12	07:00	07:48	13:04 (3)
	14:57	13:15 (5)	17:03	18:43	21:38	00:12		23:18	20:58	18:50	15:49	30
28	09:35	11:46 (4)	07:30	05:36	04:26	01:42		03:06	05:16	07:04	07:51	13:03 (3)
	15:02	13:16 (5)	17:07	18:47	21:42	00:22		23:13	20:54	18:46	15:45	34
29	09:31	11:47 (4)		06:32	04:22	01:30		03:11	05:20	07:07	07:55	13:02 (3)
	15:06	13:45 (3)		19:50	21:46	00:34		23:08	20:50	18:42	15:41	38
30	09:27	11:47 (4)		06:28	04:17	01:07		03:16	05:23	07:10	07:59	13:01 (3)
	15:10	13:48 (3)		19:54	21:50	00:57		23:03	20:46	18:38	15:37	40
31	09:23	11:47 (4)		06:24				03:21	05:27		08:03	13:01 (3)
	15:15	13:50 (3)		19:57				22:58	20:42		15:33	42
Potential sun hours	115	219	361	468	627	720	694	536	398	292	161	786
Total, worst case	334	649									213	0.29
Sun reduction	0.27	0.30									0.25	0.96
Oper. time red.	0.96	0.96									0.59	0.16
Wind dir. red.	0.56	0.58									0.14	124
Total reduction	0.15	0.17									30	
Total, real	48	108										

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	(WTG causing flicker first time)
	Sun set (hh:mm)	Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:

Helligvaer

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30.07.2013 13:11 / 10

Licensed user:

Kjeller Vindteknikk AS

Gunnar Randres vei 12

NO-2007 Kjeller

(+47) 480 50 480

reiar.k / reiar.kravik@vindteknikk.no

Calculated:

30.07.2013 12:52/2.9.250

SHADOW - Calendar

Calculation: helligvaerShadow receptor: 10 - Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (17)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.27	0.30	0.30	0.30	0.29	0.29	0.25	0.27	0.25	0.25	0.29	0.28

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
568	563	330	771	2 096	484	346	1 015	719	613	506	386	8 394

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

	[January	[February	[March	[April	[May	[June	[July	[August	[September	[October	[November	[December							
1	11:24	09:19	12:16 (4)	07:26	06:20	04:13		03:26	05:31	07:14	08:07	13:35 (3)	10:19						
	12:53	15:19	40	13:39 (5)	17:11	20:01	21:55	22:53	20:37	18:34	15:29	31	14:30 (2)	13:28					
2	11:20	09:15		12:16 (4)	07:22	06:15	04:08	03:31	05:34	07:17	08:11		13:35 (3)	10:24					
	12:58	15:23	38	13:38 (5)	17:14	20:04	21:59	22:48	20:33	18:30	15:25	24	14:25 (2)	13:24					
3	11:16	09:11		12:16 (4)	07:18	06:11	04:04	03:35	05:38	07:21	08:15		11:52 (4)	10:28					
	13:03	15:28	37	13:38 (5)	17:18	20:08	22:03	22:44	20:29	18:26	15:21	32	13:57 (3)	13:20					
4	11:12	09:07		12:18 (4)	07:14	06:07	04:00	03:40	05:41	07:24	08:19		11:51 (4)	10:33					
	13:08	15:32	41	14:20 (3)	17:22	20:12	22:07	22:39	20:25	18:22	15:17	34	13:56 (3)	13:16					
5	11:08	09:03		12:18 (4)	07:10	06:03	03:55	03:44	05:45	07:28	08:23		11:49 (4)	10:38					
	13:13	15:36	44	14:23 (3)	17:25	20:15	22:12	22:34	20:21	18:18	15:13	40	13:54 (3)	13:12					
6	11:03	08:59		12:19 (4)	07:06	05:59	03:51	03:49	05:48	07:31	08:27		11:49 (4)	10:43					
	13:18	15:40	38	14:24 (3)	17:29	20:19	22:16	22:30	20:17	18:14	15:09	42	13:53 (3)	13:08					
7	10:59	08:55		12:21 (4)	07:02	05:55	03:46	03:53	05:52	07:35	08:31		11:48 (4)	10:48					
	13:23	15:45	34	14:26 (3)	17:32	20:22	22:21	22:25	20:12	18:10	15:05	40	13:50 (3)	13:04					
8	10:55	08:51		12:24 (4)	06:58	05:51	03:41	03:57	05:55	07:38	08:36		11:47 (4)	10:53					
	13:28	15:49	31	14:28 (3)	17:36	20:26	22:25	22:21	20:08	18:06	15:01	36	13:08 (5)	13:00					
9	10:51	08:47		14:06 (3)	06:54	05:46	03:37	04:02	05:59	07:42	08:40		11:47 (4)	10:58					
	13:33	15:53	25	14:57 (2)	17:40	20:30	22:30	22:16	20:04	18:02	14:57	39	13:10 (5)	12:56					
10	10:47	08:43		14:05 (3)	06:49	05:42	03:32	04:06	06:02	07:45	08:44		11:47 (4)	11:03					
	13:38	15:57	32	15:01 (2)	17:43	20:33	22:34	22:12	20:00	17:58	14:53	39	13:10 (5)	12:52					
11	10:43	08:39		14:05 (3)	06:45	05:38	03:28	04:10	06:06	07:49	08:48		11:47 (4)	11:08					
	13:43	16:01	38	15:05 (2)	17:47	20:37	22:39	22:07	19:56	17:54	14:49	41	13:11 (5)	12:48					
12	10:39	08:35		14:04 (3)	06:41	05:34	03:23	04:14	06:09	07:52	08:53		11:47 (4)	11:13					
	13:47	16:05	41	15:06 (2)	17:50	20:41	22:44	22:03	19:52	17:50	14:45	41	13:11 (5)	12:44					
13	10:35	08:31		14:04 (3)	06:37	05:30	03:18	04:18	06:12	07:56	08:57		11:47 (4)	11:18					
	13:52	16:09	42	15:07 (2)	17:54	20:44	22:48	21:58	19:48	17:45	14:40	40	13:10 (5)	12:40					
14	10:31	08:27		14:05 (3)	06:33	05:26	03:13	04:22	06:16	07:59	09:01		11:48 (4)	11:23					
	13:57	16:13	43	15:08 (2)	17:57	20:48	22:53	21:54	19:44	17:41	14:36	38	13:10 (5)	12:36					
15	10:27	08:23		14:05 (3)	06:29	05:21	03:08	04:26	06:19	08:03	09:05		11:48 (4)	11:28					
	14:02	16:17	42	15:08 (2)	18:01	20:52	22:58	00:37	21:50	19:39	14:32	30	13:03 (5)	12:31					
16	10:23	08:18		14:05 (3)	06:25	05:17	03:03	01:56	04:30	06:23	08:07		11:48 (4)	11:33					
	14:07	16:21	41	15:07 (2)	18:05	20:55	23:03	00:27	21:45	19:35	14:28	22	12:10 (4)	12:27					
17	10:19	08:14		14:06 (3)	06:21	05:13	02:58	02:05	04:34	06:26	08:10		11:49 (4)	11:38					
	14:11	16:25	38	15:06 (2)	18:08	20:59	23:08	00:18	21:41	19:31	14:24	21	12:10 (4)	12:23					
18	10:15	08:10		14:06 (3)	06:17	05:09	02:53	02:05	04:38	06:30	08:14		11:50 (4)	11:43					
	14:16	16:29	35	15:05 (2)	18:12	21:03	23:14	00:10	21:37	19:27	14:20	19	12:09 (4)	12:19					
19	10:11	08:06		14:08 (3)	06:13	05:04	02:48	02:13	04:42	06:33	08:17		11:51 (4)	11:49					
	14:21	16:33	31	15:05 (2)	18:15	21:07	23:19	00:03	21:32	19:23	14:16	18	12:09 (4)	12:14					
20	10:07	08:02		14:09 (3)	06:09	05:00	02:43	02:20	04:46	06:36	08:21			11:55					
	14:25	16:37	23	15:02 (2)	18:19	21:11	23:25	23:57	21:28	19:19	14:12			12:09					
21	10:03	07:58		14:13 (3)	06:05	04:56	02:37	02:26	04:50	06:40	08:25		14:42 (3)	09:32					
	14:30	16:41	9	14:22 (3)	18:22	21:14	23:31	23:51	21:24	19:15	17:13	15	15:31 (2)	14:08					
22	09:59	07:54			06:01	04:52	02:32	02:33	04:54	06:43	08:29		14:39 (3)	09:37					
	14:35	16:44			18:26	21:18	23:37	23:45	21:20	19:11	17:09	26	15:34 (2)	14:04					
23	09:55				05:57	04:47	02:26	02:39	04:57	06:47	08:32		14:37 (3)	09:41					
	14:39	18	12:17 (4)	07:50		18:29	21:22	23:39	21:15	19:07	17:05	32	15:35 (2)	14:00					
24	09:51		12:16 (4)	07:46		05:52	04:43	02:20	05:01	06:50	08:36		14:37 (3)	09:46					
	14:44	19	12:35 (4)	16:52		18:33	21:26	23:49	23:33	21:11	19:03	36	15:36 (2)	13:56					
25	09:47		12:15 (4)	07:42		05:48	04:39	02:13	02:50	05:05	06:53		13:35 (3)	09:50					
	14:48	21	12:36 (4)	16:56		18:36	21:30	23:56	23:28	21:07	18:59	39	14:36 (2)	13:52					
26	09:43		12:15 (4)	07:38		05:44	04:35	02:07	02:56	05:09	06:57		13:35 (3)	09:55					
	14:53	22	12:37 (4)	16:59		18:40	21:34	00:04	23:23	21:03	18:54	41	14:37 (2)	13:48					
27	09:39		12:15 (4)	07:34		05:40	04:30	01:51	03:01	05:12	07:00		13:34 (3)	10:00					
	14:57	32	13:31 (5)	17:03		18:43	21:38	00:12	23:18	20:58	18:50	41	14:36 (2)	13:44					
28	09:35		12:15 (4)	07:30		05:36	04:26	01:42	03:06	05:16	07:04		13:34 (3)	10:04					
	15:02	39	13:38 (5)	17:07		18:47	21:42	00:22	23:12	20:54	18:46	43	14:37 (2)	13:40					
29	09:31		12:15 (4)			06:32	04:22	01:30	03:11	05:20	07:07		13:34 (3)	10:09					
	15:06	41	13:39 (5)			19:50	21:46	00:34	23:07	20:50	18:42	41	14:36 (2)	13:36					
30	09:27		12:16 (4)			06:28	04:17	01:07	03:16	05:23	07:10		13:34 (3)	10:14					
	15:10	39	13:39 (5)			19:54	21:50	00:57	23:03	20:46	18:38	41	14:36 (2)	13:32					
31	09:23		12:15 (4)			06:24			03:21	05:27	08:03		13:35 (3)						
	15:15	41	13:39 (5)			19:57			03:21	05:27	08:03		13:35 (3)						
Potential sun hours	115		219		361	468	627	720	694	536	398	292	15:33	38	14:35 (2)	161		627	62
Total, worst case		272		743									393					627	
Sun reduction		0.27		0.30									0.25					0.29	
Oper. time red.		0.96		0.96									0.96					0.96	
Wind dir. red.		0.56		0.60									0.61					0.57	
Total reduction		0.14		0.17									0.15					0.16	
Total, real		39		127									58					99	

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

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

Helligvaer

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30.07.2013 13:11 / 11

Licensed user:

Kjeller Vindteknikk AS

Gunnar Randres vei 12

NO-2007 Kjeller

(+47) 480 50 480

reiar.k / reiar.kravik@vindteknikk.no

Calculated:

30.07.2013 12:52/2.9.250

SHADOW - Calendar

Calculation: helligvaerShadow receptor: 11 - Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (16)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.27	0.30	0.30	0.30	0.29	0.29	0.25	0.27	0.25	0.25	0.29	0.28

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
568	563	330	771	2 096	484	346	1 015	719	613	506	386	8 394

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

	[January	[February	[March	[April	[May	[June	[July	[August	[September	[October	[November	[December		
1	11:24	09:19	12:25 (4)	07:26	06:20	04:13		03:26	05:31	07:14	08:07	13:48 (3)	10:19	
	12:53	15:19	40	13:47 (5)	17:11	20:01	21:55	22:53	20:37	18:34	15:29	23	14:11 (3)	13:28
2	11:20	09:15		12:25 (4)	07:22	06:15	04:08	03:31	05:34	07:17	08:11		13:48 (3)	10:24
	12:58	15:23	38	13:46 (5)	17:14	20:04	21:59	22:48	20:33	18:30	15:25	22	14:10 (3)	13:24
3	11:16	09:11		12:26 (4)	07:18	06:11	04:04	03:35	05:38	07:21	08:15		12:03 (4)	10:28
	13:03	15:28	37	13:46 (5)	17:18	20:08	22:03	22:44	20:29	18:26	15:21	28	14:09 (3)	13:20
4	11:12	09:07		12:27 (4)	07:14	06:07	04:00	03:40	05:41	07:24	08:19		12:01 (4)	10:33
	13:08	15:32	34	13:46 (5)	17:22	20:12	22:07	22:39	20:25	18:22	15:17	31	14:08 (3)	13:16
5	11:08	09:03		12:28 (4)	07:10	06:03	03:55	03:44	05:45	07:28	08:23		11:59 (4)	10:38
	13:13	15:36	40	14:34 (3)	17:25	20:15	22:12	22:34	20:21	18:18	15:13	37	14:06 (3)	13:12
6	11:03	08:59		12:29 (4)	07:06	05:59	03:51	03:49	05:48	07:31	08:27		11:58 (4)	10:43
	13:18	15:40	37	14:36 (3)	17:29	20:19	22:16	22:30	20:17	18:14	15:09	38	14:03 (3)	13:08
7	10:59	08:55		12:31 (4)	07:02	05:55	03:46	03:53	05:52	07:35	08:31		11:58 (4)	10:48
	13:23	15:45	31	14:38 (3)	17:32	20:22	22:21	22:25	20:12	18:10	15:05	35	13:17 (5)	13:04
8	10:55	08:51		12:35 (4)	06:58	05:51	03:41	03:57	05:55	07:38	08:36		11:56 (4)	10:53
	13:28	15:49	26	14:40 (3)	17:36	20:26	22:25	22:21	20:08	18:06	15:01	36	13:16 (5)	13:00
9	10:51	08:47		14:19 (3)	06:54	05:46	03:37	04:02	05:59	07:42	08:40		11:56 (4)	10:58
	13:33	15:53	22	14:41 (3)	17:40	20:30	22:30	22:16	20:04	18:02	14:57	40	13:18 (5)	12:56
10	10:47	08:43		14:18 (3)	06:49	05:42	03:32	04:06	06:02	07:45	08:44		11:56 (4)	11:03
	13:38	15:57	23	14:41 (3)	17:43	20:33	22:34	22:12	20:00	17:58	14:53	41	13:18 (5)	12:52
11	10:43	08:39		14:17 (3)	06:45	05:38	03:28	04:10	06:06	07:49	08:48		11:56 (4)	11:08
	13:43	16:01	30	15:06 (2)	17:47	20:37	22:39	22:07	19:56	17:54	14:49	42	13:19 (5)	12:48
12	10:39	08:35		14:17 (3)	06:41	05:34	03:23	04:14	06:09	07:52	08:53		11:56 (4)	11:13
	13:47	16:05	36	15:11 (2)	17:50	20:41	22:44	22:03	19:52	17:50	14:45	42	13:19 (5)	12:44
13	10:35	08:31		14:17 (3)	06:37	05:30	03:18	04:18	06:12	07:56	08:57		11:56 (4)	11:18
	13:52	16:09	42	15:16 (2)	17:54	20:44	22:48	21:58	19:48	17:45	14:40	41	13:18 (5)	12:40
14	10:31	08:27		14:18 (3)	06:33	05:26	03:13	04:22	06:16	07:59	09:01		11:56 (4)	11:23
	13:57	16:13	42	15:17 (2)	17:57	20:48	22:53	21:54	19:44	17:41	14:36	35	13:12 (5)	12:36
15	10:27	08:22		14:18 (3)	06:29	05:21	03:08	04:26	06:19	08:03	09:05		11:56 (4)	11:28
	14:02	16:17	43	15:17 (2)	18:01	20:52	22:58	00:37	21:50	19:39	14:32	25	12:21 (4)	12:31
16	10:23	08:18		14:18 (3)	06:25	05:17	03:03	01:56	04:30	06:23	08:07		11:56 (4)	11:33
	14:07	16:21	42	15:17 (2)	18:05	20:55	23:03	00:27	21:45	19:35	14:28	24	12:20 (4)	12:27
17	10:19	08:14		14:18 (3)	06:21	05:13	02:58	02:05	04:34	06:26	08:10		11:58 (4)	11:38
	14:11	16:25	40	15:16 (2)	18:08	20:59	23:08	00:18	21:41	19:31	14:24	23	12:21 (4)	12:23
18	10:15	08:10		14:18 (3)	06:17	05:09	02:53	02:05	04:38	06:30	08:14		11:58 (4)	11:43
	14:16	16:29	38	15:15 (2)	18:12	21:03	23:14	00:10	21:37	19:27	14:20	22	12:20 (4)	12:19
19	10:11	08:06		14:20 (3)	06:13	05:04	02:48	02:13	04:42	06:33	08:17		11:59 (4)	11:49
	14:21	16:33	34	15:15 (2)	18:15	21:07	23:19	00:03	21:32	19:23	14:16	17	12:16 (4)	12:14
20	10:07	08:02		14:21 (3)	06:09	05:00	02:43	02:20	04:46	06:36	08:21		14:55 (3)	09:28
	14:25	16:37	28	15:13 (2)	18:19	21:11	23:25	23:57	21:28	19:19	14:12	10	15:05 (3)	14:12
21	10:03	07:58		14:23 (3)	06:05	04:56	02:37	02:26	04:50	06:40	08:25		14:53 (3)	09:32
	14:30	16:41	20	15:11 (2)	18:22	21:14	23:31	23:51	21:24	19:15	14:08	24	15:43 (2)	14:08
22	09:59	07:54		14:26 (3)	06:01	04:52	02:32	02:33	04:54	06:43	08:29		14:51 (3)	09:37
	14:35	16:44	7	14:33 (3)	18:26	21:18	23:36	23:45	21:20	19:11	14:04	30	15:44 (2)	14:04
23	09:55		12:25 (4)	07:50	05:56	04:47	02:26	02:39	04:57	06:47	08:32		14:49 (3)	09:41
	14:39	17	12:42 (4)	16:48	18:29	21:22	23:43	23:39	21:15	19:07	17:05	36	15:45 (2)	14:00
24	09:51		12:24 (4)	07:46	05:52	04:43	02:20	02:45	05:01	06:50	08:36		14:49 (3)	09:46
	14:44	22	12:46 (4)	16:52	18:33	21:26	23:49	23:33	21:11	19:03	17:01	38	15:46 (2)	13:56
25	09:47		12:24 (4)	07:42	05:48	04:39	02:14	02:50	05:05	06:53	07:40		13:47 (3)	09:50
	14:48	23	12:47 (4)	16:56	18:36	21:30	23:56	23:28	21:07	18:59	15:57	41	14:46 (2)	13:52
26	09:43		12:24 (4)	07:38	05:44	04:35	02:07	02:56	05:09	06:57	07:44		13:47 (3)	09:55
	14:53	23	12:47 (4)	16:59	18:40	21:34	00:04	23:23	21:03	18:54	15:53	42	14:46 (2)	13:48
27	09:39		12:24 (4)	07:34	05:40	04:30	01:51	03:01	05:12	07:00	07:48		13:46 (3)	10:00
	14:57	25	13:31 (5)	17:03	18:43	21:38	00:12	23:18	20:58	18:50	15:49	44	14:46 (2)	13:44
28	09:35		12:24 (4)	07:30	05:36	04:26	01:42	03:06	05:16	07:04	07:51		13:47 (3)	10:04
	15:02	34	13:40 (5)	17:07	18:47	21:42	00:22	23:12	20:54	18:46	15:45	42	14:46 (2)	13:40
29	09:31		12:24 (4)		06:32	04:22	01:30	03:11	05:20	07:07	07:55		13:47 (3)	10:09
	15:06	42	13:47 (5)		19:50	21:46	00:34	23:07	20:50	18:42	15:41	41	14:45 (2)	13:36
30	09:27		12:25 (4)		06:28	04:17	01:08	03:16	05:23	07:10	07:59		13:47 (3)	10:14
	15:10	41	13:47 (5)		19:54	21:50	00:57	23:03	20:46	18:38	15:37	35	14:40 (2)	13:32
31	09:23		12:25 (4)		06:24			03:21	05:27		08:03		13:47 (3)	
	15:15	41	13:47 (5)		19:57			22:58	20:42		15:33	29	14:35 (2)	
Potential sun hours	115		219		361	468	627	720	694	536	398	292	161	64
Total, worst case	268		730									412	602	
Sun reduction	0.27		0.30									0.25	0.29	
Oper. time red.	0.96		0.96									0.96	0.96	
Wind dir. red.	0.56		0.60									0.62	0.57	
Total reduction	0.14		0.17									0.15	0.16	
Total, real	39		126									61	95	

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

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

Helligvaer

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30.07.2013 13:11 / 12

Licensed user:

Kjeller Vindteknikk AS

Gunnar Randres vei 12

NO-2007 Kjeller

(+47) 480 50 480

reiar.k / reiar.kravik@vindteknikk.no

Calculated:

30.07.2013 12:52/2.9.250

SHADOW - Calendar

Calculation: helligvaerShadow receptor: 12 - Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (18)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.27	0.30	0.30	0.30	0.29	0.29	0.25	0.27	0.25	0.25	0.29	0.28

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
568	563	330	771	2 096	484	346	1 015	719	613	506	386	8 394

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

	January	February	March	April	May	June	July	August	September	October	November	December
1	11:24	09:19	12:27 (4)	07:26	06:20	04:13		03:26	05:31	07:14	08:07	13:44 (3)
	12:53	15:19	39	13:46 (5)	17:11	20:01	21:55	22:53	20:37	18:34	15:29	24
2	11:20	09:15		12:26 (4)	07:22	06:15	04:08	03:30	05:34	07:17	08:11	13:44 (3)
	12:58	15:23	38	13:45 (5)	17:14	20:04	21:59	22:48	20:33	18:30	15:25	22
3	11:16	09:11		12:27 (4)	07:18	06:11	04:04	03:35	05:38	07:21	08:15	12:06 (4)
	13:03	15:28	35	13:44 (5)	17:18	20:08	22:03	22:44	20:29	18:26	15:21	24
4	11:12	09:07		12:29 (4)	07:14	06:07	04:00	03:40	05:41	07:24	08:19	12:03 (4)
	13:08	15:32	37	14:28 (3)	17:22	20:12	22:07	22:39	20:25	18:22	15:17	29
5	11:08	09:03		12:29 (4)	07:10	06:03	03:55	03:44	05:45	07:28	08:23	12:01 (4)
	13:13	15:36	40	14:31 (3)	17:25	20:15	22:12	22:34	20:21	18:18	15:13	35
6	11:03	08:59		12:30 (4)	07:06	05:59	03:51	03:49	05:48	07:31	08:27	12:00 (4)
	13:18	15:40	33	14:33 (3)	17:29	20:19	22:16	22:30	20:17	18:14	15:09	39
7	10:59	08:55		12:33 (4)	07:02	05:55	03:46	03:53	05:52	07:35	08:31	11:59 (4)
	13:23	15:45	29	14:34 (3)	17:32	20:22	22:21	22:25	20:12	18:10	15:05	38
8	10:55	08:51		14:15 (3)	06:58	05:51	03:41	03:57	05:55	07:38	08:36	11:57 (4)
	13:28	15:49	21	14:36 (3)	17:36	20:26	22:25	22:21	20:08	18:06	15:01	37
9	10:51	08:47		14:15 (3)	06:54	05:46	03:37	04:02	05:59	07:42	08:40	11:58 (4)
	13:33	15:53	22	14:37 (3)	17:40	20:30	22:30	22:16	20:04	18:02	14:57	37
10	10:47	08:43		14:14 (3)	06:49	05:42	03:32	04:06	06:02	07:45	08:44	11:57 (4)
	13:38	15:57	26	15:01 (2)	17:43	20:33	22:34	22:12	20:00	17:58	14:53	39
11	10:43	08:39		14:13 (3)	06:45	05:38	03:28	04:10	06:06	07:49	08:48	11:57 (4)
	13:43	16:01	34	15:06 (2)	17:47	20:37	22:39	22:07	19:56	17:54	14:49	41
12	10:39	08:35		14:13 (3)	06:41	05:34	03:23	04:14	06:09	07:52	08:53	11:57 (4)
	13:47	16:05	39	15:11 (2)	17:50	20:41	22:44	22:03	19:52	17:50	14:45	40
13	10:35	08:31		14:13 (3)	06:37	05:30	03:18	04:18	06:12	07:56	08:57	11:57 (4)
	13:52	16:09	40	15:11 (2)	17:54	20:44	22:48	21:58	19:48	17:45	14:40	40
14	10:31	08:27		14:14 (3)	06:33	05:26	03:13	04:22	06:16	07:59	09:01	11:58 (4)
	13:57	16:13	41	15:13 (2)	17:57	20:48	22:53	21:54	19:44	17:41	14:36	34
15	10:27	08:22		14:14 (3)	06:29	05:21	03:08	04:26	06:19	08:03	09:05	11:58 (4)
	14:02	16:17	40	15:12 (2)	18:01	20:52	22:58	00:37	21:50	19:39	14:32	25
16	10:23	08:18		14:14 (3)	06:25	05:17	03:03	01:56	04:30	06:23	08:07	11:58 (4)
	14:07	16:21	40	15:12 (2)	18:05	20:55	23:03	00:27	21:45	19:35	14:28	22
17	10:19	08:14		14:15 (3)	06:21	05:13	02:58	02:05	04:34	06:26	08:10	11:59 (4)
	14:11	16:25	37	15:11 (2)	18:08	20:59	23:08	00:18	21:41	19:31	14:24	22
18	10:15	08:10		14:15 (3)	06:17	05:09	02:53	02:05	04:38	06:30	08:14	11:59 (4)
	14:16	16:29	34	15:10 (2)	18:12	21:03	23:14	00:10	21:37	19:27	14:20	21
19	10:11	08:06		14:17 (3)	06:13	05:04	02:48	02:12	04:42	06:33	08:17	12:00 (4)
	14:21	16:33	29	15:10 (2)	18:15	21:07	23:19	00:03	21:32	19:23	14:16	16
20	10:07	08:02		14:19 (3)	06:09	05:00	02:43	02:20	04:46	06:36	08:21	11:55
	14:25	16:37	21	15:07 (2)	18:19	21:11	23:25	23:57	21:28	19:19	14:12	12:09
21	10:03	07:58		14:23 (3)	06:05	04:56	02:37	02:26	04:50	06:40	08:25	12:24
	14:30	16:41	6	14:29 (3)	18:22	21:14	23:31	23:51	21:24	19:15	14:08	13:41
22	09:59	07:54		18:26	21:18	23:37	23:45	02:33	04:54	06:43	08:29	
	14:35	16:44		18:26	21:18	23:37	23:45	02:33	04:54	06:43	08:29	
23	09:55	16:44		18:26	21:18	23:37	23:45	02:33	04:54	06:43	08:29	
	14:39	16:48		18:29	21:22	23:43	23:39	02:39	04:57	06:47	08:32	
24	09:51	16:46		18:32	21:26	23:49	23:33	02:45	05:01	06:50	08:36	
	14:44	16:52		18:33	21:26	23:49	23:33	02:45	05:01	06:50	08:36	
25	09:47	16:42		18:36	21:30	23:56	23:28	02:50	05:05	06:53	07:40	11:55
	14:48	16:56		18:36	21:30	23:56	23:28	02:50	05:05	06:53	07:40	
26	09:43	16:38		18:40	21:34	00:04	02:56	02:56	05:09	06:57	07:44	11:50
	14:53	16:59		18:40	21:34	00:04	02:56	02:56	05:09	06:57	07:44	
27	09:39	16:34		18:40	21:34	00:04	02:56	02:56	05:09	06:57	07:44	11:50
	14:57	16:59		18:40	21:34	00:04	02:56	02:56	05:09	06:57	07:44	
28	09:35	16:30		18:40	21:34	00:04	02:56	02:56	05:09	06:57	07:44	11:50
	15:02	17:07		18:40	21:34	00:04	02:56	02:56	05:09	06:57	07:44	
29	09:31	16:26		18:40	21:34	00:04	02:56	02:56	05:09	06:57	07:44	11:50
	15:06	16:26		18:40	21:34	00:04	02:56	02:56	05:09	06:57	07:44	
30	09:27	16:22		18:40	21:34	00:04	02:56	02:56	05:09	06:57	07:44	11:50
	15:10	16:22		18:40	21:34	00:04	02:56	02:56	05:09	06:57	07:44	
31	09:23	16:18		18:40	21:34	00:04	02:56	02:56	05:09	06:57	07:44	11:50
	15:15	16:18		18:40	21:34	00:04	02:56	02:56	05:09	06:57	07:44	
Potential sun hours	115	219	361	468	627	720	694	536	398	292	161	42
Total, worst case	258	681								368		
Sun reduction	0.27	0.30								0.25		
Oper. time red.	0.96	0.96								0.96		
Wind dir. red.	0.56	0.60								0.62		
Total reduction	0.14	0.17								0.15		
Total, real	37	118								55		

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	(WTG causing flicker first time)
	Sun set (hh:mm)	Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:

Helligvaer

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Licensed user:

Kjeller Vindteknikk AS

Gunnar Randres vei 12

NO-2007 Kjeller

(+47) 480 50 480

reiar.k / reiar.kravik@vindteknikk.no

Calculated:

30.07.2013 12:52/2.9.250

SHADOW - Calendar

Calculation: helligvaerShadow receptor: 13 - Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (12)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.27	0.30	0.30	0.30	0.29	0.29	0.25	0.27	0.25	0.25	0.29	0.28

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
568	563	330	771	2 096	484	346	1 015	719	613	506	386	8 394

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

	January		February		March		April		May		June		July		August		September		October		November		December		
1	11:24		09:19	12:55 (4)	07:26	06:20	04:13								03:26	05:31	07:14			08:07		12:30 (4)	10:19		
	12:53		15:19	42	14:09 (5)	17:11	20:01	21:55							22:53	20:37	18:34			15:29	16	12:46 (4)	13:28		
2	11:20		09:15	12:54 (4)	07:22	06:15	04:08								03:31	05:34	07:17			08:11		12:28 (4)	10:23		
	12:58		15:23	43	14:08 (5)	17:14	20:04	21:59							22:48	20:33	18:30			15:25	28	13:35 (5)	13:24		
3	11:16		09:11	12:54 (4)	07:18	06:11	04:04								03:35	05:38	07:21			08:15		12:27 (4)	10:28		
	13:03		15:28	43	14:08 (5)	17:18	20:08	22:03							22:43	20:29	18:26			15:21	33	13:36 (5)	13:20		
4	11:12		09:07	12:55 (4)	07:14	06:07	04:00								03:40	05:41	07:24			08:19		12:27 (4)	10:33		
	13:08		15:32	43	14:09 (5)	17:22	20:12	22:07							22:39	20:25	18:22			15:17	36	13:38 (5)	13:16		
5	11:07		09:03	12:55 (4)	07:10	06:03	03:55								03:44	05:45	07:28			08:23		12:26 (4)	10:38		
	13:13		15:36	42	14:09 (5)	17:25	20:15	22:12							22:34	20:21	18:18			15:13	39	13:38 (5)	13:12		
6	11:03		08:59	12:56 (4)	07:06	05:59	03:51								03:49	05:48	07:31			08:27		12:26 (4)	10:43		
	13:18		15:40	39	14:08 (5)	17:29	20:19	22:16							22:30	20:17	18:14			15:09	40	13:39 (5)	13:08		
7	10:59		08:55	12:57 (4)	07:02	05:55	03:46								03:53	05:52	07:35			08:31		12:25 (4)	10:48		
	13:23		15:45	36	14:08 (5)	17:32	20:22	22:21							22:25	20:12	18:10			15:05	41	13:38 (5)	13:04		
8	10:55		08:51	12:58 (4)	06:58	05:51	03:41								03:57	05:55	07:38			08:36		12:25 (4)	10:53		
	13:28		15:49	33	14:07 (5)	17:36	20:26	22:25							22:21	20:08	18:06			15:01	42	13:39 (5)	13:00		
9	10:51		08:47	12:58 (4)	06:54	05:46	03:37								04:02	05:59	07:42			08:40		12:25 (4)	10:58		
	13:33		15:53	26	14:04 (5)	17:40	20:30	22:30							22:16	20:04	18:02			14:57	43	13:40 (5)	12:56		
10	10:47		08:43	13:00 (4)	06:49	05:42	03:32								04:06	06:02	07:45			08:44		12:25 (4)	11:03		
	13:38		15:57	15	13:15 (4)	17:43	20:33	22:34							22:12	20:00	17:58			14:53	42	13:39 (5)	12:52		
11	10:43		08:39	13:03 (4)	06:45	05:38	03:28								04:10	06:06	07:49			08:48		12:26 (4)	11:08		
	13:43		16:01	17	15:03 (3)	17:47	20:37	22:39							22:07	19:56	17:54			14:49	34	13:33 (5)	12:48		
12	10:39		08:35	14:53 (3)	06:41	05:34	03:23								04:14	06:09	07:52			08:52		12:26 (4)	11:13		
	13:47		16:05	14	15:07 (3)	17:50	20:41	22:44							22:03	19:52	17:49			14:45	28	13:27 (5)	12:44		
13	10:35		08:31	14:51 (3)	06:37	05:30	03:18								04:18	06:12	07:56			08:57		12:26 (4)	11:18		
	13:52		16:09	17	15:08 (3)	17:54	20:44	22:48							21:58	19:48	17:45			14:40	25	12:51 (4)	12:40		
14	10:31		08:27	14:50 (3)	06:33	05:26	03:13								04:22	06:16	07:59			09:01		12:27 (4)	11:23		
	13:57		16:13	19	15:09 (3)	17:57	20:48	22:53							21:54	19:44	17:41			14:36	23	12:50 (4)	12:36		
15	10:27		08:22	14:50 (3)	06:29	05:21	03:08						01:45		04:26	06:19	08:03			15:26 (3)	09:05		12:27 (4)	11:28	
	14:02		16:17	25	15:27 (2)	18:01	20:52	22:58					00:37		21:50	19:39	17:37			12	15:38 (3)	14:32	23	12:50 (4)	12:31
16	10:23		08:18	14:49 (3)	06:25	05:17	03:03						01:56		04:30	06:23	08:07			15:24 (3)	09:10		12:28 (4)	11:33	
	14:07		16:21	32	15:31 (2)	18:05	20:55	23:03					00:27		21:45	19:35	17:33			16	15:40 (3)	14:28	21	12:49 (4)	12:27
17	10:19		08:14	14:48 (3)	06:21	05:13	02:58						02:05		04:34	06:26	08:10			15:22 (3)	09:14		12:30 (4)	11:38	
	14:11		16:25	39	15:35 (2)	18:08	20:59	23:08					00:18		21:41	19:31	17:29			28	16:04 (2)	14:24	15	12:45 (4)	12:23
18	10:15		08:10	14:48 (3)	06:17	05:09	02:53						02:05		04:38	06:30	08:14			15:21 (3)	09:19		12:31 (4)	11:43	
	14:16		16:29	41	15:36 (2)	18:12	21:03	23:14					00:10		21:37	19:27	17:25			33	16:05 (2)	14:20	2	12:33 (4)	12:19
19	10:11		08:06	14:48 (3)	06:13	05:04	02:48						02:13		04:42	06:33	08:17			15:19 (3)	09:23			11:49	
	14:21		16:33	42	15:37 (2)	18:15	21:07	23:19					00:03		21:32	19:23	17:21			38	16:06 (2)	14:16			12:14
20	10:07		08:02	14:48 (3)	06:09	05:00	02:43						02:20		04:46	06:36	08:21			15:19 (3)	09:28			11:55	
	14:25		16:37	41	15:36 (2)	18:19	21:11	23:25					23:57		21:28	19:19	17:17			39	16:06 (2)	14:12			12:09
21	10:03		07:58	14:48 (3)	06:05	04:56	02:37						02:26		04:50	06:40	08:25			15:19 (3)	09:32			12:20	
	14:30		16:41	41	15:37 (2)	18:22	21:14	23:31					23:51		21:24	19:15	17:13			41	16:07 (2)	14:08			11:35
22	09:59		07:54	14:48 (3)	06:01	04:52	02:32						02:33		04:54	06:43	08:29			15:18 (3)	09:37				
	14:35		16:44	40	15:36 (2)	18:26	21:18	23:36					23:45		21:20	19:11	17:09			42	16:07 (2)	14:04			
23	09:55		07:50	14:48 (3)	05:56	04:47	02:26						02:39		04:57	06:47	08:32			15:18 (3)	09:41				
	14:39		16:48	36	15:34 (2)	18:29	21:22	23:43					23:39		21:15	19:07	17:05			41	16:06 (2)	14:00			
24	09:51	2	12:57 (4)	07:46	14:49 (3)	05:52	04:43	02:20					02:45		05:01	06:50	08:36			15:18 (3)	09:46				
	14:44		12:59 (4)	16:52	15:33 (2)	18:33	21:26	23:49					23:33		21:11	19:03	17:01			41	16:06 (2)	13:56			
25	09:47		12:56 (4)	07:42	14:51 (3)	05:48	04:39	02:14					02:50		05:05	06:53	07:40			14:18 (3)	09:50			11:54	
	14:48	15	13:11 (4)	16:56	24	15:31 (2)	18:36	21:30					23:28		21:07	18:59	15:57			38	15:04 (2)	13:52			12:15
26	09:43		12:55 (4)	07:38	14:52 (3)	05:44	04:35	02:07					02:56		05:09	06:57	07:44			14:19 (3)	09:55			11:50	
	14:53	21	13:16 (4)	16:59	15	15:07 (3)	18:40	21:34					23:23		21:03	18:54	15:53			30	15:00 (2)	13:48			12:21
27	09:39		12:55 (4)	07:34	14:55 (3)	05:40	04:30	01:51					03:01		05:12	07:00	07:48			14:19 (3)	10:00			11:45	
	14:57	22	13:17 (4)	17:03	9	15:04 (3)	18:43	21:38					23:18		20:58	18:50	15:49			22	14:54 (2)	13:44			12:26
28	09:35		12:54 (4)	07:30		05:36	04:26	01:42					03:06		05:16	07:04	07:51			14:20 (3)	10:04			11:41	
	15:02	24	13:18 (4)	17:07		18:47	21:42	00:21					23:12		20:54	18:46	15:45			19	14:39 (3)	13:40			12:31
29	09:31		12:55 (4)			06:32	04:22	01:31					03:11		05:20	07:07	07:55			14:22 (3)	10:09			11:37	
	15:06	24	13:19 (4)			19:50	21:46	00:33					23:07		20:50	18:42	15:41			16	14:38 (3)	13:36			12:36
30	09:27		12:55 (4)			06:28	04:17	01:08					03:16		05:23	07:10	07:59			14:24 (3)	10:14			11:33	
	15:10	28	13:56 (5)			19:54	21:50	00:56					23:03		20:46	18:38			12	14:36 (3)	13:32			12:42	
31	09:23		12:54 (4)			06:24		23:11					03:21		05:27		08:03				12:32 (4)			11:29	
	15:15	36	14:02 (5)			19:57		02:54					22:58		20:42		15:33			17	14:32 (3)			12:47	
Potential sun hours	115		219			361	468	607		720		694		536		398	292			161			64		
Total, worst case		172		846										</											

Project:

Helligvaer

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30.07.2013 13:11 / 14

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Calculated:

30.07.2013 12:52/2.9.250

SHADOW - Calendar

Calculation: helligvaerShadow receptor: 14 - Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (14)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.27	0.30	0.30	0.30	0.29	0.29	0.25	0.27	0.25	0.25	0.29	0.28

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
568	563	330	771	2 096	484	346	1 015	719	613	506	386	8 394

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

	January	February	March	April	May	June	July	August	September	October	November	December
1	11:24	09:19	12:54 (4)	07:26	06:20	04:13		03:26	05:31	07:14	08:07	10:19
	12:53	15:19	24 13:18 (4)	17:11	20:01	21:55		22:53	20:37	18:34	15:29	13:28
2	11:20	09:15	12:53 (4)	07:22	06:15	04:08		03:30	05:34	07:17	08:11	10:23
	12:58	15:23	24 13:17 (4)	17:14	20:04	21:59		22:48	20:33	18:30	15:25	12:42 (4) 13:24
3	11:16	09:11	12:54 (4)	07:18	06:11	04:04		03:35	05:38	07:21	08:15	10:28
	13:03	15:28	23 13:17 (4)	17:18	20:08	22:03		22:43	20:29	18:26	15:21	12:43 (4) 13:20
4	11:12	09:07	12:55 (4)	07:14	06:07	04:00		03:40	05:41	07:24	08:19	10:33
	13:08	15:32	23 13:18 (4)	17:22	20:12	22:07		22:39	20:25	18:22	15:17	12:45 (4) 13:16
5	11:08	09:03	12:56 (4)	07:10	06:03	03:55		03:44	05:45	07:28	08:23	10:38
	13:13	15:36	21 13:17 (4)	17:25	20:15	22:12		22:34	20:21	18:18	15:13	12:46 (4) 13:12
6	11:03	08:59	12:56 (4)	07:06	05:59	03:51		03:49	05:48	07:31	08:27	10:43
	13:18	15:40	20 13:16 (4)	17:29	20:19	22:16		22:30	20:17	18:14	15:09	12:47 (4) 13:08
7	10:59	08:55	12:58 (4)	07:02	05:55	03:46		03:53	05:52	07:35	08:31	10:48
	13:23	15:45	17 13:15 (4)	17:32	20:22	22:21		22:25	20:12	18:10	15:05	12:47 (4) 13:04
8	10:55	08:51	12:59 (4)	06:58	05:51	03:41		03:57	05:55	07:38	08:36	10:53
	13:28	15:49	15 13:14 (4)	17:36	20:26	22:25		22:21	20:08	18:06	15:01	12:47 (4) 13:00
9	10:51	08:47	13:02 (4)	06:54	05:46	03:37		04:02	05:59	07:42	08:40	10:58
	13:33	15:53	10 13:12 (4)	17:40	20:30	22:30		22:16	20:04	18:02	14:57	12:56
10	10:47	08:43		06:49	05:42	03:32		04:06	06:02	07:45	08:44	11:03
	13:38	15:57		17:43	20:33	22:34		22:12	20:00	17:58	14:53	12:52
11	10:43	08:39		06:45	05:38	03:28		04:10	06:06	07:49	08:48	11:08
	13:43	16:01		17:47	20:37	22:39		22:07	19:56	17:54	14:49	12:48
12	10:39	08:35		06:41	05:34	03:23		04:14	06:09	07:52	08:52	11:13
	13:47	16:05		17:50	20:41	22:44		22:03	19:52	17:49	14:44	12:44
13	10:35	08:31		06:37	05:30	03:18		04:18	06:12	07:56	08:57	11:18
	13:52	16:09		17:54	20:44	22:48		21:58	19:48	17:45	14:40	12:49 (4) 12:40
14	10:31	08:27		06:33	05:26	03:13		04:22	06:16	07:59	09:01	11:23
	13:57	16:13		17:57	20:48	22:53		21:54	19:44	17:41	14:36	12:49 (4) 12:36
15	10:27	08:22		06:29	05:21	03:08	01:45	04:26	06:19	08:03	09:05	11:28
	14:02	16:17		18:01	20:52	22:58	00:37	21:50	19:39	17:37	14:32	12:48 (4) 12:31
16	10:23	08:18		06:25	05:17	03:03	01:56	04:30	06:23	08:07	09:10	11:33
	14:07	16:21		18:05	20:55	23:03	00:27	21:45	19:35	17:33	14:28	12:47 (4) 12:27
17	10:19	08:14		06:21	05:13	02:58	02:05	04:34	06:26	08:10	09:14	11:38
	14:11	16:25		18:08	20:59	23:08	00:18	21:41	19:31	17:29	14:24	12:45 (4) 12:23
18	10:15	08:10		06:17	05:09	02:53	02:05	04:38	06:30	08:14	09:19	11:43
	14:16	16:29		18:12	21:03	23:14	00:10	21:37	19:27	17:25	14:20	12:33 (4) 12:19
19	10:11	08:06		06:13	05:04	02:48	02:12	04:42	06:33	08:17	09:23	11:49
	14:21	16:33		18:15	21:07	23:19	00:03	21:32	19:23	17:21	14:16	12:14
20	10:07	08:02		06:09	05:00	02:43	02:20	04:46	06:36	08:21	09:28	11:55
	14:25	16:37		18:19	21:11	23:25	23:57	21:28	19:19	17:17	14:12	12:09
21	10:03	07:58		06:05	04:56	02:37	02:26	04:50	06:40	08:25	09:32	11:55
	14:30	16:41		18:22	21:14	23:31	23:51	21:24	19:15	17:13	14:08	11:44
22	09:59	07:54		06:01	04:52	02:32	02:33	04:54	06:43	08:29	09:37	
	14:35	16:44		18:26	21:18	23:36	23:45	21:20	19:11	17:09	14:04	
23	09:55	07:50		05:56	04:47	02:26	02:39	04:57	06:47	08:32	09:41	
	14:39	16:48		18:29	21:22	23:43	23:39	21:15	19:07	17:05	14:00	
24	09:51	12:55 (4)	07:46	05:52	04:43	02:20	02:45	05:01	06:50	08:36	09:46	
	14:44	4 12:59 (4)	16:52	18:33	21:26	23:49	23:33	21:11	19:03	17:01	13:56	
25	09:47	12:54 (4)	07:42	05:48	04:39	02:13	02:50	05:05	06:53	07:40	09:50	11:54
	14:48	17 13:11 (4)	16:56	18:36	21:30	23:56	23:28	21:07	18:59	15:57	13:52	12:15
26	09:43	12:54 (4)	07:38	05:44	04:35	02:07	02:56	05:09	06:57	07:44	09:55	11:50
	14:53	21 13:15 (4)	16:59	18:40	21:34	00:04	23:23	21:03	18:54	15:53	13:48	12:21
27	09:39	12:53 (4)	07:34	05:40	04:30	01:51	03:01	05:12	07:00	07:48	10:00	11:45
	14:57	22 13:15 (4)	17:03	18:43	21:38	00:12	23:18	20:58	18:50	15:49	13:44	12:26
28	09:35	12:53 (4)	07:30	05:36	04:26	01:42	03:06	05:16	07:04	07:51	10:04	11:41
	15:02	23 13:16 (4)	17:07	18:47	21:42	00:22	23:12	20:54	18:46	15:45	13:40	12:31
29	09:31	12:54 (4)		06:32	04:22	01:30	03:11	05:20	07:07	07:55	10:09	11:37
	15:06	23 13:17 (4)		19:50	21:46	00:34	23:07	20:50	18:42	15:41	13:36	12:36
30	09:27	12:54 (4)		06:28	04:17	01:07	03:16	05:23	07:10	07:59	10:14	11:33
	15:10	23 13:17 (4)		19:54	21:50	00:57	23:03	20:46	18:38	15:37	13:32	12:42
31	09:23	12:53 (4)		06:24			03:21	05:27		08:03		11:29
	15:15	24 13:17 (4)		19:57			22:58	20:42		15:33		12:47
Potential sun hours	115	219	361	468	627	720	694	536	398	292	161	64
Total, worst case	157	177										338
Sun reduction	0.27	0.30										0.29
Oper. time red.	0.96	0.96										0.96
Wind dir. red.	0.53	0.53										0.53
Total reduction	0.14	0.15										0.15
Total, real	22	27									50	

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

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

Helligvaer

Printed/Page

30.07.2013 13:11 / 15

Licensed user:

Kjeller Vindteknikk AS

Gunnar Randres vei 12

NO-2007 Kjeller

(+47) 480 50 480

reiar.k / reiar.kravik@vindteknikk.no

Calculated:

30.07.2013 12:52/2.9.250

SHADOW - Calendar

Calculation: helligvaerShadow receptor: 15 - Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (13)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.27	0.30	0.30	0.30	0.29	0.29	0.25	0.27	0.25	0.25	0.29	0.28

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
568	563	330	771	2 096	484	346	1 015	719	613	506	386	8 394

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

	January	February	March	April	May	June	July	August	September	October	November	December
1	11:24	09:19	13:02 (4)	07:26	06:20	04:13		03:26	05:30	07:14	08:07	12:37 (4)
	12:53	15:19	38 14:09 (5)	17:11	20:01	21:55		22:53	20:37	18:34	15:29	14 12:51 (4)
2	11:20	09:15	13:01 (4)	07:22	06:15	04:08		03:30	05:34	07:17	08:11	12:35 (4)
	12:58	15:23	40 14:10 (5)	17:14	20:04	21:59		22:48	20:33	18:30	15:25	26 13:36 (5)
3	11:16	09:11	13:01 (4)	07:18	06:11	04:04		03:35	05:38	07:21	08:15	12:34 (4)
	13:03	15:28	40 14:10 (5)	17:18	20:08	22:03		22:43	20:29	18:26	15:21	31 13:38 (5)
4	11:12	09:07	13:02 (4)	07:14	06:07	04:00		03:40	05:41	07:24	08:19	12:34 (4)
	13:08	15:32	40 14:11 (5)	17:22	20:12	22:07		22:39	20:25	18:22	15:17	35 13:40 (5)
5	11:07	09:03	13:02 (4)	07:10	06:03	03:55		03:44	05:45	07:28	08:23	12:33 (4)
	13:13	15:36	39 14:10 (5)	17:25	20:15	22:12		22:34	20:21	18:18	15:13	37 13:40 (5)
6	11:03	08:59	13:02 (4)	07:06	05:59	03:51		03:49	05:48	07:31	08:27	12:33 (4)
	13:18	15:40	38 14:10 (5)	17:29	20:19	22:16		22:30	20:17	18:14	15:09	39 13:41 (5)
7	10:59	08:55	13:04 (4)	07:02	05:55	03:46		03:53	05:52	07:35	08:31	12:32 (4)
	13:23	15:45	34 14:09 (5)	17:32	20:22	22:21		22:25	20:12	18:10	15:05	39 13:40 (5)
8	10:55	08:51	13:05 (4)	06:58	05:51	03:41		03:57	05:55	07:38	08:36	12:32 (4)
	13:28	15:49	31 14:09 (5)	17:36	20:26	22:25		22:21	20:08	18:06	15:01	40 13:40 (5)
9	10:51	08:47	13:06 (4)	06:54	05:46	03:37		04:02	05:59	07:42	08:40	12:32 (4)
	13:33	15:53	24 14:07 (5)	17:40	20:30	22:30		22:16	20:04	18:02	14:57	41 13:41 (5)
10	10:47	08:43	13:07 (4)	06:49	05:42	03:32		04:06	06:02	07:45	08:44	12:32 (4)
	13:38	15:57	14 13:21 (4)	17:43	20:33	22:34		22:12	20:00	17:58	14:53	38 13:39 (5)
11	10:43	08:39	13:10 (4)	06:45	05:38	03:28		04:10	06:06	07:49	08:48	12:33 (4)
	13:43	16:01	15 15:02 (3)	17:47	20:37	22:39		22:07	19:56	17:54	14:49	31 13:33 (5)
12	10:39	08:35	14:52 (3)	06:41	05:34	03:23		04:14	06:09	07:52	08:52	12:33 (4)
	13:47	16:05	13 15:05 (3)	17:50	20:41	22:44		22:03	19:52	17:49	14:44	23 12:56 (4)
13	10:35	08:31	14:51 (3)	06:37	05:30	03:18		04:18	06:12	07:56	08:57	12:34 (4)
	13:52	16:09	16 15:07 (3)	17:54	20:44	22:48		21:58	19:48	17:45	14:40	22 12:56 (4)
14	10:31	08:27	14:49 (3)	06:33	05:26	03:13		04:22	06:16	07:59	09:01	12:34 (4)
	13:57	16:13	19 15:08 (3)	17:57	20:48	22:53		21:54	19:44	17:41	14:36	22 12:56 (4)
15	10:27	08:22	14:49 (3)	06:29	05:21	03:08	01:45	04:26	06:19	08:03	09:05	12:35 (4)
	14:02	16:17	27 15:27 (2)	18:01	20:52	22:58	00:37	21:50	19:39	17:37	14:32	20 12:55 (4)
16	10:23	08:18	14:49 (3)	06:25	05:17	03:03	01:56	04:30	06:23	08:07		12:36 (4)
	14:07	16:21	32 15:31 (2)	18:05	20:55	23:03	00:27	21:45	19:35	17:33	11 15:25 (3)	18 12:54 (4)
17	10:19	08:14	14:48 (3)	06:21	05:13	02:58	02:05	04:34	06:26	08:10	15:23 (3)	12:38 (4)
	14:11	16:25	37 15:34 (2)	18:08	20:59	23:08	00:18	21:41	19:31	17:29	18 15:59 (2)	7 12:45 (4)
18	10:15	08:10	14:47 (3)	06:17	05:09	02:53	02:05	04:38	06:30	08:14	15:21 (3)	
	14:16	16:29	39 15:34 (2)	18:12	21:03	23:14	00:10	21:37	19:27	17:25	28 16:02 (2)	12:19
19	10:11	08:06	14:48 (3)	06:13	05:04	02:48	02:13	04:42	06:33	08:17	15:20 (3)	11:49
	14:21	16:33	39 15:34 (2)	18:15	21:07	23:19	00:03	21:32	19:23	17:21	33 16:03 (2)	12:14
20	10:07	08:02	14:47 (3)	06:09	05:00	02:43	02:20	04:46	06:36	08:21	15:19 (3)	11:55
	14:25	16:37	39 15:34 (2)	18:19	21:11	23:25	23:57	21:28	19:19	17:17	36 16:04 (2)	12:09
21	10:03	07:58	14:48 (3)	06:05	04:56	02:37	02:26	04:50	06:40	08:25	15:19 (3)	11:38
	14:30	16:41	37 15:34 (2)	18:22	21:14	23:31	23:51	21:24	19:15	17:13	38 16:05 (2)	12:41
22	09:59	07:54	14:48 (3)	06:01	04:52	02:32	02:33	04:54	06:43	08:29	15:18 (3)	
	14:35	16:44	35 15:33 (2)	18:26	21:18	23:36	23:45	21:20	19:11	17:09	40 16:05 (2)	
23	09:55	07:50	14:49 (3)	05:56	04:47	02:26	02:39	04:57	06:47	08:32	15:17 (3)	
	14:39	16:48	31 15:31 (2)	18:29	21:22	23:43	23:39	21:15	19:07	17:05	40 16:04 (2)	
24	09:51	07:46	14:50 (3)	05:52	04:43	02:20	02:45	05:01	06:50	08:36	15:18 (3)	
	14:44	16:52	26 15:30 (2)	18:33	21:26	23:49	23:33	21:11	19:03	17:01	38 16:04 (2)	
25	09:47	13:04 (4)	07:42	14:52 (3)	05:48	04:39	02:50	05:05	06:53	07:40	14:18 (3)	11:54
	14:48	7 13:11 (4)	16:56	15:06 (3)	18:36	21:30	23:28	21:07	18:59	15:57	37 15:03 (2)	12:15
26	09:43	13:03 (4)	07:38	14:54 (3)	05:44	04:35	02:56	05:09	06:57	07:44	14:19 (3)	11:50
	14:53	18 13:21 (4)	16:59	9 15:03 (3)	18:40	21:34	23:23	21:03	18:54	15:53	31 15:00 (2)	12:21
27	09:39	13:02 (4)	07:34		05:40	04:30	03:01	05:12	07:00	07:48	14:18 (3)	11:45
	14:57	20 13:22 (4)	17:03		18:43	21:38	23:18	20:58	18:50	15:49	25 14:54 (2)	12:26
28	09:35	13:02 (4)	07:30		05:36	04:26	03:06	05:16	07:04	07:51	14:20 (3)	11:41
	15:02	21 13:23 (4)	17:07		18:47	21:42	23:12	20:54	18:46	15:45	18 14:38 (3)	12:31
29	09:31	13:02 (4)			06:32	04:22	03:11	05:20	07:07	07:55	14:21 (3)	11:37
	15:06	22 13:24 (4)			19:50	21:46	23:07	20:50	18:42	15:41	16 14:37 (3)	12:36
30	09:27	13:02 (4)			06:28	04:17	03:16	05:23	07:10	07:59	14:23 (3)	11:33
	15:10	24 13:56 (5)			19:54	21:50	23:03	20:46	18:38	15:37	12 14:35 (3)	12:42
31	09:23	13:01 (4)			06:24		03:21	05:27		08:03	12:40 (4)	11:29
	15:15	31 14:02 (5)			19:57		22:58	20:42		15:33	15 14:32 (3)	12:47
Potential sun hours	115	219	361	468	627	720	694	536	398	292	161	483
Total, worst case	143		766							436		0.29
Sun reduction	0.27		0.30							0.25		0.96
Oper. time red.	0.96		0.96							0.96		0.64
Wind dir. red.	0.53		0.60							0.64		0.15
Total reduction	0.14		0.17							0.15		0.73
Total, real	20		132							67		

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

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

Helligvaer

Printed/Page

30.07.2013 13:11 / 16

Licensed user:

Kjeller Vindteknikk AS

Gunnar Randres vei 12

NO-2007 Kjeller

(+47) 480 50 480

reiar.k / reiar.kravik@vindteknikk.no

Calculated:

30.07.2013 12:52/2.9.250

SHADOW - Calendar

Calculation: helligvaerShadow receptor: 16 - Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (9)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.27	0.30	0.30	0.30	0.29	0.29	0.25	0.27	0.25	0.25	0.29	0.28

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
568	563	330	771	2 096	484	346	1 015	719	613	506	386	8 394

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

	January	February	March	April	May	June	July	August	September	October	November	December						
1	11:24 12:53	09:19 15:19	13:25 (4) 13:48 (4)	07:26 17:11	15:14 (3) 15:32 (3)	06:20 20:01	04:13 21:55		03:26 22:53	05:30 20:37	07:14 18:34	08:07 15:29	12:55 (4) 13:56 (5)	10:19 13:28				
2	11:20 12:58	09:15 15:23	13:24 (4) 14:15 (5)	07:22 17:14	15:14 (3) 15:30 (3)	06:15 20:04	04:08 21:59		03:30 22:48	05:34 20:33	07:17 18:30	08:11 15:25	12:54 (4) 13:57 (5)	10:23 13:24				
3	11:16 13:03	09:11 15:28	13:23 (4) 14:21 (5)	07:18 17:18	15:17 (3) 15:27 (3)	06:11 20:08	04:04 22:03		03:35 22:43	05:38 20:29	07:21 18:26	08:15 15:21	12:53 (4) 13:57 (5)	10:28 13:20				
4	11:11 13:08	09:07 15:32	13:24 (4) 14:27 (5)	07:14 17:22		06:07 20:11	04:00 22:07		03:40 22:39	05:41 20:25	07:24 18:22	08:19 15:17	12:54 (4) 13:58 (5)	10:33 13:16				
5	11:07 13:13	09:03 15:36	13:24 (4) 14:27 (5)	07:10 17:25		06:03 20:15	03:55 22:12		03:44 22:34	05:45 20:21	07:28 18:18	08:23 15:13	12:54 (4) 13:57 (5)	10:38 13:12				
6	11:03 13:18	08:59 15:40	13:23 (4) 14:27 (5)	07:06 17:29		05:59 20:19	03:51 22:16		03:49 22:30	05:48 20:17	07:31 18:14	08:27 15:09	12:54 (4) 13:57 (5)	10:43 13:08				
7	10:59 13:23	08:55 15:45	13:24 (4) 14:27 (5)	07:02 17:32		05:55 20:22	03:46 22:20		03:53 22:25	05:52 20:12	07:35 18:10	08:31 15:05	12:53 (4) 13:56 (5)	10:48 13:04				
8	10:55 13:28	08:51 15:49	13:24 (4) 14:28 (5)	06:58 17:36		05:51 20:26	03:41 22:25		03:57 22:21	05:55 20:08	07:38 18:06	08:36 15:01	12:54 (4) 13:51 (5)	10:53 13:00				
9	10:51 13:33	08:47 15:53	13:24 (4) 14:26 (5)	06:54 17:40		05:46 20:30	03:37 22:30		04:02 22:16	05:59 20:04	07:42 18:02	08:40 14:57	12:55 (4) 13:46 (5)	10:58 12:56				
10	10:47 13:38	08:43 15:57	13:25 (4) 14:26 (5)	06:49 17:43		05:42 20:33	03:32 22:34		04:06 22:12	06:02 20:00	07:45 17:58	15:54 (3) 15:59 (3)	08:44 14:53	11:03 12:52				
11	10:43 13:43	08:39 16:01	13:25 (4) 14:25 (5)	06:45 17:47		05:38 20:37	03:28 22:39		04:10 22:07	06:06 19:56	07:49 17:54	15:50 (3) 16:03 (3)	08:48 14:49	11:08 12:48				
12	10:39 13:47	08:35 16:05	13:26 (4) 14:23 (5)	06:41 17:50		05:34 20:40	03:23 22:44		04:14 22:03	06:09 19:52	07:52 17:49	15:48 (3) 16:04 (3)	08:52 14:44	11:13 12:44				
13	10:35 13:52	08:31 16:09	13:28 (4) 13:46 (4)	06:37 17:54		05:30 20:44	03:18 22:48		04:18 21:58	06:12 19:48	07:56 17:45	15:46 (3) 16:18 (2)	08:57 14:40	11:18 12:40				
14	10:31 13:57	08:26 16:13	13:29 (4) 13:44 (4)	06:33 17:57		05:26 20:48	03:13 22:53		04:22 21:54	19:48 19:44	17:45 17:41	15:45 (3) 16:21 (2)	09:01 14:36	11:23 12:36				
15	10:27 14:02	08:22 16:17	13:33 (4) 13:42 (4)	06:29 18:01		05:21 20:52	03:08 22:58	01:45	04:26 21:50	06:19 19:39	08:03 17:37	15:44 (3) 16:22 (2)	09:05 14:32	11:28 12:31				
16	10:23 14:07	08:18 16:21		06:25 18:05		05:17 20:55	03:03 23:03	01:56	04:30 21:45	06:23 19:35	08:07 17:33	15:44 (3) 16:22 (2)	09:10 14:28	11:33 12:27				
17	10:19 14:11	08:14 16:25	15:19 (3) 15:28 (3)	06:21 18:08		05:13 20:59	02:58 23:08	02:05	04:34 21:41	06:26 19:31	08:10 17:29	15:43 (3) 16:23 (2)	09:14 14:24	11:38 12:23				
18	10:15 14:16	08:10 16:29	15:16 (3) 15:30 (3)	06:17 18:12		05:09 21:03	02:53 23:14	02:05	04:38 21:37	06:30 19:27	08:14 17:25	15:43 (3) 16:23 (2)	09:19 14:20	11:43 12:19				
19	10:11 14:21	08:06 16:33	15:15 (3) 15:45 (2)	06:13 18:15		05:04 21:07	02:48 23:19	02:13	04:42 21:32	06:33 19:23	08:17 17:21	15:43 (3) 16:22 (2)	09:23 14:16	11:49 12:14				
20	10:07 14:25	08:02 16:37	15:14 (3) 15:49 (2)	06:09 18:19		05:00 21:11	02:43 23:25	02:20	04:46 21:28	06:36 19:19	08:21 17:17	15:43 (3) 16:22 (2)	09:28 14:12	11:55 12:09				
21	10:03 14:30	07:58 16:41	15:13 (3) 15:51 (2)	06:05 18:22		04:56 21:14	02:37 23:30	02:26	04:50 21:24	06:40 19:15	08:25 17:13	15:44 (3) 16:22 (2)	09:32 14:08	11:45 11:54				
22	09:59 14:35	07:54 16:44	15:12 (3) 15:51 (2)	06:01 18:26		04:52 21:18	02:32 23:36	02:33	04:54 21:20	06:43 19:11	08:29 17:09	15:44 (3) 16:18 (2)	09:37 14:04					
23	09:55 14:39	07:50 16:48	15:11 (3) 15:51 (2)	05:56 18:29		04:47 21:22	02:26 23:43	02:39	04:57 21:15	06:47 19:07	08:32 17:05	15:45 (3) 16:13 (2)	09:41 14:00					
24	09:51 14:44	07:46 16:52	15:12 (3) 15:51 (2)	05:52 18:33		04:43 21:26	02:20 23:49	02:45	05:01 21:11	06:50 19:03	08:36 17:01	15:47 (3) 16:01 (3)	09:46 13:56					
25	09:47 14:48	07:42 16:56	15:12 (3) 15:51 (2)	05:48 18:36		04:39 21:30	02:14 23:56	02:50	05:05 21:07	06:53 18:59	07:40 15:57	14:49 (3) 14:57 (3)	09:50 13:52	11:54 12:15				
26	09:43 14:53	07:38 16:59	15:12 (3) 15:50 (2)	05:44 18:40		04:35 21:34	02:07 00:04	02:56	05:09 23:23	06:57 21:03	07:44 18:54	09:55 15:53	13:56 13:48	11:50 12:21				
27	09:39 14:57	13:30 (4) 1 13:31 (4)	07:34 17:03	15:12 (3) 15:49 (2)	05:40 18:43	04:30 21:38	02:00 00:12	03:01	05:12 23:17	07:00 20:58	07:48 18:50	13:01 (4) 13:12 (4)	10:00 13:44	11:45 12:26				
28	09:35 15:02	13:28 (4) 12 13:40 (4)	07:30 17:07	15:12 (3) 15:46 (2)	05:36 18:47	04:26 21:42	01:42 00:21	03:06	05:16 23:12	07:04 20:54	07:51 18:47	12:59 (4) 13:14 (4)	10:04 13:40	11:41 12:31				
29	09:31 15:06	13:27 (4) 17 13:44 (4)		06:32 19:50		04:22 21:46	01:31 00:33	03:11	05:20 23:07	07:07 20:50	07:55 18:42	12:57 (4) 13:50 (5)	10:09 13:36	11:37 12:36				
30	09:27 15:10	13:26 (4) 20 13:46 (4)		06:28 19:54		04:17 21:50	01:08 00:56	03:16	05:23 23:03	07:10 20:46	07:59 18:38	12:56 (4) 13:57 (3)	10:14 13:32	11:33 12:42				
31	09:23 15:15	13:25 (4) 21 13:46 (4)		06:24 19:57		23:16 03:07	05:27 00:07	03:21	05:27 22:58	05:27 20:42	08:03 20:42	12:55 (4) 13:55 (5)	10:14 12:47	11:29 12:47				
Potential sun hours	115		219		361		468		607	720	694	536	398	292		161		41
Total, worst case	71		848		44										541		441	
Sun reduction	0.27		0.30		0.30										0.25		0.29	
Oper. time red.	0.96		0.96		0.96										0.96		0.96	
Wind dir. red.	0.56		0.61		0.65										0.64		0.57	
Total reduction	0.14		0.17		0.19										0.15		0.16	
Total, real	10		148		8										83		70	

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

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

Project:

Helligvaer

Printed/Page

30.07.2013 13:11 / 17

Licensed user:

Kjeller Vindteknikk AS

Gunnar Randres vei 12

NO-2007 Kjeller

(+47) 480 50 480

reiar.k / reiar.kravik@vindteknikk.no

Calculated:

30.07.2013 12:52/2.9.250

SHADOW - Calendar

Calculation: helligvaerShadow receptor: 17 - Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (8)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.27	0.30	0.30	0.30	0.29	0.29	0.25	0.27	0.25	0.25	0.29	0.28

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
568	563	330	771	2 096	484	346	1 015	719	613	506	386	8 394

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

	January	February	March	April	May	June	July	August	September	October	November	December		
1	11:24 12:53	09:19 15:19	13:35 (4) 13:56 (4)	07:26 17:11	15:21 (3) 15:53 (2)	06:20 20:01	04:13 21:55	03:26 22:53	05:30 20:37	07:14 18:34	08:07 15:29	13:04 (4) 14:03 (5)	10:19 13:28	
2	11:20 12:58	09:15 15:23	13:34 (4) 13:57 (4)	07:22 17:14	15:21 (3) 15:41 (3)	06:15 20:04	04:08 21:59	03:31 22:48	05:34 20:33	07:17 18:30	08:11 15:25	13:03 (4) 14:04 (5)	10:23 13:24	
3	11:16 13:03	09:11 15:28	13:34 (4) 14:21 (5)	07:18 17:18	15:23 (3) 15:40 (3)	06:11 20:08	04:04 22:03	03:35 22:43	05:38 20:29	07:21 18:26	08:15 15:21	13:03 (4) 14:03 (5)	10:28 13:20	
4	11:11 13:08	09:07 15:32	13:34 (4) 14:28 (5)	07:14 17:22	15:25 (3) 15:38 (3)	06:07 20:11	04:00 22:07	03:40 22:39	05:41 20:25	07:24 18:22	08:19 15:17	13:03 (4) 14:04 (5)	10:33 13:16	
5	11:07 13:13	09:03 15:36	13:33 (4) 14:33 (5)	07:10 17:25	15:27 (3) 15:34 (3)	06:03 20:15	03:55 22:12	03:44 22:34	05:45 20:21	07:28 18:18	08:23 15:13	13:03 (4) 14:03 (5)	10:38 13:12	
6	11:03 13:18	08:59 15:40	13:33 (4) 14:33 (5)	07:06 17:29	15:59 20:19	03:51 22:16	03:51 22:16	03:49 22:30	05:48 20:17	07:31 18:14	08:27 15:09	13:04 (4) 14:03 (5)	10:43 13:08	
7	10:59 13:23	08:55 15:45	13:33 (4) 14:34 (5)	07:02 17:32	15:55 20:22	03:46 22:20	03:46 22:20	03:53 22:25	05:52 20:12	07:35 18:10	08:31 15:05	13:03 (4) 13:57 (5)	10:48 13:04	
8	10:55 13:28	08:51 15:49	13:34 (4) 14:34 (5)	06:58 17:36	15:51 20:26	03:41 22:25	03:41 22:25	03:57 22:21	05:55 20:08	07:38 18:06	08:36 15:01	13:04 (4) 13:51 (5)	10:53 13:00	
9	10:51 13:33	08:47 15:53	13:33 (4) 14:33 (5)	06:54 17:40	15:46 20:30	03:37 22:30	03:37 22:30	04:02 22:16	05:59 20:04	07:42 18:02	16:00 (3) 16:11 (3)	10:40 14:57	10:58 12:56	
10	10:47 13:38	08:43 15:57	13:34 (4) 14:33 (5)	06:49 17:43	15:42 20:33	03:32 22:34	03:32 22:34	04:06 22:12	06:02 20:00	07:45 17:58	15:58 (3) 16:13 (3)	10:44 14:53	11:03 12:52	
11	10:43 13:43	08:39 16:01	13:34 (4) 14:33 (5)	06:45 17:47	15:38 20:37	06:45 22:39	06:45 22:39	04:10 22:07	06:06 19:56	07:49 17:54	15:56 (3) 16:14 (3)	10:48 14:49	11:08 12:48	
12	10:39 13:47	08:35 16:05	13:35 (4) 14:32 (5)	06:41 17:50	15:34 20:40	06:41 22:44	06:41 22:44	04:14 22:03	06:09 19:52	07:52 17:49	15:55 (3) 16:25 (2)	10:52 14:44	11:13 12:44	
13	10:35 13:52	08:31 16:09	13:36 (4) 14:30 (5)	06:37 17:54	15:30 20:44	06:37 22:48	06:37 22:48	04:18 21:58	06:12 19:48	07:56 17:45	15:54 (3) 16:25 (2)	10:57 14:40	11:18 12:40	
14	10:31 13:57	08:26 16:13	13:37 (4) 13:56 (4)	06:33 17:57	15:26 20:48	06:33 22:53	06:33 22:53	04:22 21:54	06:16 19:44	07:59 17:41	15:53 (3) 16:28 (2)	09:01 14:36	11:23 12:36	
15	10:27 14:02	08:22 16:17	13:39 (4) 13:55 (4)	06:29 18:01	15:21 20:52	03:08 22:58	03:08 22:58	01:45 00:37	04:26 21:50	06:19 19:39	15:53 (3) 16:29 (2)	09:05 14:32	11:28 12:32	
16	10:23 14:07	08:18 16:21	13:41 (4) 13:52 (4)	06:25 18:05	15:17 20:55	03:03 23:03	03:03 23:03	01:56 00:27	04:30 21:45	06:23 19:35	15:53 (3) 16:29 (2)	09:10 14:28	11:33 12:27	
17	10:19 14:11	08:14 16:25		16:21	15:13 20:59	02:58 23:08	02:58 23:08	02:05 00:18	04:34 21:41	06:26 19:31	15:53 (3) 16:29 (2)	09:14 14:24	11:38 12:23	
18	10:15 14:16	08:10 16:29		16:17	15:09 21:03	13:53 23:14	13:53 23:14	02:05 00:10	04:38 21:37	06:30 19:27	15:53 (3) 16:29 (2)	09:19 14:20	11:43 12:19	
19	10:11 14:21	08:06 16:33	15:27 (3) 15:38 (3)	16:13 18:15	15:04 21:07	02:48 23:19	02:48 23:19	02:13 00:03	04:42 21:32	06:33 19:23	15:53 (3) 16:28 (2)	09:23 14:16	11:49 12:15	
20	10:07 14:25	08:02 16:37	15:25 (3) 15:49 (2)	16:09 18:19	15:00 21:11	02:43 23:25	02:43 23:25	02:20 23:57	04:46 21:28	06:36 19:19	15:53 (3) 16:27 (2)	09:28 14:12	11:55 12:10	
21	10:03 14:30	07:58 16:41	15:24 (3) 15:54 (2)	16:05 18:22	14:56 21:14	02:37 23:30	02:37 23:30	02:26 23:51	04:50 21:24	06:40 19:15	15:55 (3) 16:23 (2)	09:32 14:08	09:43 12:19	
22	09:59 14:35	07:54 16:44	15:22 (3) 15:57 (2)	16:01 18:26	14:52 21:18	02:32 23:36	02:32 23:36	02:33 23:45	04:54 21:20	06:43 19:11	15:56 (3) 16:18 (2)	09:37 14:04		
23	09:55 14:39	07:50 16:48	15:21 (3) 15:57 (2)	16:56 18:29	14:47 21:22	02:26 23:43	02:26 23:43	02:39 23:39	04:57 21:15	06:47 19:07	15:58 (3) 16:07 (3)	09:41 14:00		
24	09:51 14:44	07:46 16:52	15:21 (3) 15:57 (2)	16:52 18:33	14:43 21:26	02:20 23:49	02:20 23:49	02:45 23:33	05:01 21:11	06:50 19:03	15:56 (3) 17:01	09:37 13:56		
25	09:47 14:48	07:42 16:56	15:20 (3) 15:57 (2)	16:48 18:36	14:39 21:30	02:14 23:56	02:14 23:56	02:50 23:28	05:05 21:07	06:53 18:59	15:53 (3) 16:29 (2)	09:50 13:52	11:54 12:15	
26	09:43 14:53	07:38 16:59	15:20 (3) 15:57 (2)	16:44 18:40	14:35 21:34	02:07 23:40	02:07 23:40	02:56 23:23	05:09 21:03	06:57 18:54	15:53 (3) 16:28 (2)	09:55 13:48	11:50 12:21	
27	09:39 14:57	07:34 17:03	15:21 (3) 15:56 (2)	16:40 18:43	14:30 21:38	02:00 23:50	02:00 23:50	03:01 23:17	05:12 20:58	07:00 18:50	15:49 13:06 (4)	10:00 10:04	11:45 12:26	
28	09:35 15:02	07:30 17:07	15:20 (3) 15:55 (2)	16:36 18:47	14:26 21:42	01:42 20:21	01:42 20:21	03:06 23:12	06:16 20:54	07:04 18:46	15:45 15:45	10:04 13:40	11:41 12:31	
29	09:31 15:06	13:39 (4) 9 13:48 (4)		16:32 19:50	14:22 21:46	01:31 20:33	01:31 20:33	03:11 23:07	05:20 20:50	07:07 18:42	13:05 (4) 15:41	10:09 13:36	11:37 12:36	
30	09:27 15:10	13:37 (4) 17 13:54 (4)		16:28 19:54	14:17 21:50	13:47 20:56	13:47 20:56	03:16 23:03	05:23 20:46	07:10 18:38	13:05 (4) 14:02 (5)	10:14 13:32	11:33 12:42	
31	09:23 15:15	13:36 (4) 19 13:55 (4)		16:24 19:57	23:04 14:27			03:21 22:58	05:27 20:42	07:07 18:03	13:04 (4) 14:03 (5)		11:29 12:47	
Potential sun hours	115	219	361	468	608	720	694	536	398	292	161	43		
Total, worst case	45	813	87	0.30							562	398		
Sun reduction	0.27	0.30	0.30								0.25	0.29		
Oper. time red.	0.96	0.96	0.96								0.96	0.96		
Wind dir. red.	0.57	0.61	0.66								0.64	0.58		
Total reduction	0.15	0.18	0.19								0.15	0.16		
Total, real	7	143	17								86	64		

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

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

Helligvaer

Printed/Page

30.07.2013 13:11 / 18

Licensed user:

Kjeller Vindteknikk AS

Gunnar Randres vei 12

NO-2007 Kjeller

(+47) 480 50 480

reiar.k / reiar.kravik@vindteknikk.no

Calculated:

30.07.2013 12:52/2.9.250

SHADOW - Calendar

Calculation: helligvaerShadow receptor: 18 - Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (11)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.27	0.30	0.30	0.30	0.29	0.29	0.25	0.27	0.25	0.25	0.29	0.28

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
568	563	330	771	2 096	484	346	1 015	719	613	506	386	8 394

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

	January	February	March	April	May	June	July	August	September	October	November	December		
1	11:24 12:53	09:19 15:19	13:29 (4) 13:51 (4)	07:26 17:11	15:15 (3) 15:30 (3)	06:20 20:01	04:13 21:55		03:26 22:53	05:30 20:37	07:14 18:34	08:07 15:29	12:59 (4) 13:57 (5)	10:19 13:28
2	11:20 12:58	09:15 15:23	13:28 (4) 14:15 (5)	07:22 17:14	15:17 (3) 15:26 (3)	06:15 20:04	04:08 21:59		03:30 22:48	05:34 20:33	07:17 18:30	08:11 15:25	12:59 (4) 13:58 (5)	10:23 13:24
3	11:16 13:03	09:11 15:28	13:27 (4) 14:21 (5)	07:18 17:18		06:11 20:08	04:04 22:03		03:35 22:43	05:38 20:29	07:21 18:26	08:15 15:21	12:58 (4) 13:58 (5)	10:28 13:20
4	11:12 13:08	09:07 15:32	13:28 (4) 14:28 (5)	07:14 17:22		06:07 20:11	04:00 22:07		03:40 22:39	05:41 20:25	07:24 18:22	08:19 15:17	12:58 (4) 13:59 (5)	10:33 13:16
5	11:07 13:13	09:03 15:36	13:28 (4) 14:28 (5)	07:10 17:25		06:03 20:15	03:55 22:12		03:44 22:34	05:45 20:21	07:28 18:18	08:23 15:13	12:58 (4) 13:58 (5)	10:38 13:12
6	11:03 13:18	08:59 15:40	13:27 (4) 14:28 (5)	07:06 17:29		05:59 20:19	03:51 22:16		03:49 22:30	05:48 20:17	07:31 18:14	08:27 15:09	12:58 (4) 13:59 (5)	10:43 13:08
7	10:59 13:23	08:55 15:45	13:28 (4) 14:29 (5)	07:02 17:32		05:55 20:22	03:46 22:21		03:53 22:25	05:52 20:12	07:35 18:10	08:31 15:05	12:57 (4) 13:57 (5)	10:48 13:04
8	10:55 13:28	08:51 15:49	13:29 (4) 14:29 (5)	06:58 17:36		05:51 20:26	03:41 22:25		03:57 22:21	05:55 20:08	07:38 18:06	08:36 15:01	12:58 (4) 13:51 (5)	10:53 13:00
9	10:51 13:33	08:47 15:53	13:29 (4) 14:27 (5)	06:54 17:40		05:46 20:30	03:37 22:30		04:02 22:16	05:59 20:04	07:42 18:02	08:40 14:57	12:59 (4) 13:46 (5)	10:58 12:56
10	10:47 13:38	08:43 15:57	13:29 (4) 14:27 (5)	06:49 17:43		05:42 20:33	03:32 22:34		04:06 22:12	06:02 20:00	07:45 17:58	08:44 14:53	12:59 (4) 13:42 (4)	11:03 12:52
11	10:43 13:43	08:39 16:01	13:30 (4) 14:26 (5)	06:45 17:47		05:38 20:37	03:28 22:39		04:10 22:07	06:06 19:56	07:49 17:54	15:56 (3) 15:57 (3)	13:00 (4) 14:49	11:08 12:48
12	10:39 13:47	08:35 16:05	13:32 (4) 14:23 (5)	06:41 17:50		05:34 20:40	03:23 22:44		04:14 22:03	06:09 19:52	07:52 17:49	15:50 (3) 16:02 (3)	13:08 14:44	11:13 12:44
13	10:35 13:52	08:31 16:09	13:33 (4) 14:48 (4)	06:37 17:54		05:30 20:44	03:18 22:48		04:18 21:58	06:12 19:48	07:56 17:45	15:48 (3) 16:04 (3)	13:02 (4) 14:40	11:18 12:40
14	10:31 13:57	08:26 16:13	13:36 (4) 13:45 (4)	06:33 17:57		05:26 20:48	03:13 22:53		04:22 21:54	06:16 19:44	07:59 17:41	15:46 (3) 16:18 (2)	13:04 (4) 14:36	11:23 12:36
15	10:27 14:02	08:22 16:17	13:37 (4) 15:20 (3)	06:29 18:05		05:21 20:52	03:08 22:58	01:45	04:26 21:50	06:19 19:39	08:03 17:37	15:45 (3) 16:20 (2)	13:05 14:32	11:28 12:31
16	10:23 14:07	08:18 16:21	15:20 (3) 15:28 (3)	06:25 18:05		05:17 20:55	03:03 23:03	01:56	04:30 21:45	06:23 19:35	08:07 17:33	15:44 (3) 16:21 (2)	13:30 14:28	11:33 12:27
17	10:19 14:11	08:14 16:25	15:17 (3) 15:30 (3)	06:21 18:08		05:13 20:59	02:58 23:08	02:05	04:34 21:41	06:26 19:31	08:10 17:29	15:44 (3) 16:22 (2)	13:14 14:24	11:38 12:23
18	10:15 14:16	08:10 16:29	15:15 (3) 15:40 (2)	06:17 18:12		05:09 21:03	02:53 23:14	02:05	04:38 21:37	06:30 19:27	08:14 17:25	15:43 (3) 16:22 (2)	13:19 14:20	11:43 12:19
19	10:11 14:21	08:06 16:33	15:14 (3) 15:45 (2)	06:13 18:15		05:04 21:07	02:48 23:19	02:13	04:42 21:32	06:33 19:23	08:17 17:21	15:43 (3) 16:21 (2)	13:23 14:16	11:49 12:14
20	10:07 14:25	08:02 16:37	15:13 (3) 15:49 (2)	06:09 18:19		05:00 21:11	02:43 23:25	02:20	04:46 21:28	06:36 19:19	08:21 17:17	15:43 (3) 16:21 (2)	13:28 14:12	11:55 12:09
21	10:03 14:30	07:58 16:41	15:13 (3) 15:51 (2)	06:05 18:22		04:56 21:14	02:37 23:30	02:26	04:50 21:24	06:40 19:15	08:25 17:13	15:44 (3) 16:21 (2)	13:32 14:08	11:51
22	09:59 14:35	07:54 16:44	15:12 (3) 15:50 (2)	06:01 18:26		04:52 21:18	02:32 23:36	02:33	04:54 21:20	06:43 19:11	08:29 17:09	15:44 (3) 16:18 (2)	13:37 14:04	
23	09:55 14:39	07:50 16:48	15:11 (3) 15:50 (2)	05:56 18:29		04:47 21:22	02:26 23:43	02:39	04:57 21:15	06:47 19:07	08:32 17:05	15:44 (3) 16:13 (2)	13:41 14:00	
24	09:51 14:44	07:46 16:52	15:12 (3) 15:50 (2)	05:52 18:33		04:43 21:26	02:20 23:49	02:45	05:01 21:11	06:50 19:03	08:36 17:01	15:46 (3) 16:02 (3)	13:46 13:56	
25	09:47 14:48	07:42 16:56	15:12 (3) 15:50 (2)	05:48 18:36		04:39 21:30	02:14 23:56	02:50	05:05 21:07	06:53 18:59	07:40 15:57	14:47 (3) 14:59 (3)	13:50 13:52	11:54 12:15
26	09:43 14:53	07:38 16:59	15:12 (3) 15:48 (2)	05:44 18:40		04:35 21:34	02:07 00:04	02:56	05:09 21:03	06:57 18:54	07:44 15:53	14:50 (3) 14:56 (3)	13:55 13:48	11:50 12:21
27	09:39 14:57	07:34 17:03	15:13 (3) 15:47 (2)	05:40 18:43		04:30 21:38	01:51 00:12	03:01	05:12 20:58	07:00 18:50	07:48 15:49	15:00 15:49	13:44 13:44	11:45 12:26
28	09:35 15:02	13:31 (4) 13:40 (4)	15:14 (3) 15:31 (3)	05:36 18:47		04:26 21:42	01:42 00:21	03:06	05:16 20:54	07:04 18:46	07:51 15:45	13:05 (4) 13:16 (4)	10:04 13:40	11:41 12:31
29	09:31 15:06	13:31 (4) 13:48 (4)	15:32 (3) 15:48 (4)	05:32 18:50		04:22 21:46	01:31 00:33	03:11	05:20 20:50	07:07 18:42	07:55 15:41	13:03 (4) 13:18 (4)	10:09 13:36	11:37 12:36
30	09:27 15:10	13:27 (4) 13:49 (4)	15:33 (3) 15:49 (4)	05:28 19:54		04:17 21:50	01:08 00:56	03:16	05:23 23:03	07:10 20:46	07:59 18:38	13:01 (4) 13:54 (5)	13:36 13:32	11:33 12:42
31	09:23 15:15	13:29 (4) 13:50 (4)	15:34 (3) 15:30 (4)	05:24 19:57		23:12 02:53	03:21	03:21	05:27 22:58	08:03 20:42	18:00 (4) 15:33	13:00 (4) 13:56 (5)	11:29 12:47	
Potential sun hours	115	219	361	468	607	720	694	536	398	292	161	276		
Total, worst case	66	798	24								482	423		
Sun reduction	0.27	0.30	0.30								0.25	0.29		
Oper. time red.	0.96	0.96	0.96								0.96	0.96		
Wind dir. red.	0.56	0.61	0.65								0.64	0.57		
Total reduction	0.15	0.18	0.19								0.15	0.16		
Total, real	10	140	4								74	67		

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

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

Project:

Helligvaer

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Kjeller Vindteknikk AS

Gunnar Randres vei 12

NO-2007 Kjeller

(+47) 480 50 480

reiar.k / reiar.kravik@vindteknikk.no

Calculated:

30.07.2013 12:52/2.9.250

SHADOW - Calendar

Calculation: helligvaerShadow receptor: 19 - Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (10)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.27	0.30	0.30	0.30	0.29	0.29	0.25	0.27	0.25	0.25	0.29	0.28

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
568	563	330	771	2 096	484	346	1 015	719	613	506	386	8 394

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

	January	February	March	April	May	June	July	August	September	October	November	December
1	11:24	09:19	13:36 (4)	07:26	15:20 (3)	06:20	04:13		03:26	05:30	07:14	08:07
	12:53	15:19	13:57 (4)	17:11	19	15:39 (3)	20:01	21:55	22:53	20:37	18:34	15:29
2	11:20	09:15	13:34 (4)	07:22	15:21 (3)	06:15	04:08		03:30	05:34	07:17	08:11
	12:58	15:23	13:57 (4)	17:14	16	15:37 (3)	20:04	21:59	22:48	20:33	18:30	15:25
3	11:16	09:11	13:34 (4)	07:18	15:23 (3)	06:11	04:04		03:35	05:38	07:21	08:15
	13:03	15:28	14:21 (5)	17:18	12	15:35 (3)	20:08	22:03	22:43	20:29	18:26	15:21
4	11:11	09:07	13:34 (4)	07:14	15:28 (3)	06:07	04:00		03:40	05:41	07:24	08:19
	13:08	15:32	14:28 (5)	17:22	3	15:31 (3)	20:11	22:07	22:39	20:25	18:22	15:17
5	11:07	09:03	13:34 (4)	07:10		06:03	03:55		03:44	05:45	07:28	08:23
	13:13	15:36	14:33 (5)	17:25		20:15	22:12		22:34	20:21	18:18	15:13
6	11:03	08:59	13:34 (4)	07:06		05:59	03:51		03:49	05:48	07:31	08:27
	13:18	15:40	14:33 (5)	17:29		20:19	22:16		22:30	20:17	18:14	15:09
7	10:59	08:55	13:34 (4)	07:02		05:55	03:46		03:53	05:52	07:35	08:31
	13:23	15:45	14:33 (5)	17:32		20:22	22:20		22:25	20:12	18:10	15:05
8	10:55	08:51	13:35 (4)	06:58		05:51	03:41		03:57	05:55	07:38	08:36
	13:28	15:49	14:34 (5)	17:36		20:26	22:25		22:21	20:08	18:06	15:01
9	10:51	08:47	13:34 (4)	06:54		05:46	03:37		04:02	05:59	07:42	08:40
	13:33	15:53	14:33 (5)	17:40		20:30	22:30		22:16	20:04	18:02	14:57
10	10:47	08:43	13:35 (4)	06:49		05:42	03:32		04:06	06:02	07:45	08:44
	13:38	15:57	14:32 (5)	17:43		20:33	22:34		22:12	20:00	17:58	8
11	10:43	08:39	13:35 (4)	06:45		05:38	03:28		04:10	06:06	07:49	15:59 (3)
	13:43	16:01	14:32 (5)	17:47		20:37	22:39		22:07	19:56	17:54	14
12	10:39	08:35	13:36 (4)	06:41		05:34	03:23		04:14	06:09	07:52	15:54 (3)
	13:47	16:05	14:30 (5)	17:50		20:40	22:44		22:03	19:52	17:49	17
13	10:35	08:31	13:37 (4)	06:37		05:30	03:18		04:18	06:12	07:56	15:53 (3)
	13:52	16:09	14:27 (5)	17:54		20:44	22:48		21:58	19:48	17:45	25
14	10:31	08:26	13:39 (4)	06:33		05:26	03:13		04:22	06:16	07:59	15:52 (3)
	13:57	16:13	13:54 (4)	17:57		20:48	22:53		21:54	19:44	17:41	32
15	10:27	08:22	13:42 (4)	06:29		05:21	03:08		04:26	06:19	08:03	15:51 (3)
	14:02	16:17	13:53 (4)	18:01		20:52	22:58		00:37	21:50	19:39	35
16	10:23	08:18		06:25		05:17	03:03		01:56	04:30	06:23	15:51 (3)
	14:07	16:21		18:05		20:55	23:03		00:27	21:45	19:35	36
17	10:19	08:14		06:21		05:13	02:58		02:05	04:34	06:26	15:50 (3)
	14:11	16:25		18:08		20:59	23:08		00:18	21:41	19:31	37
18	10:15	08:10	15:24 (3)	06:17		05:09	02:53		02:05	04:38	06:30	15:50 (3)
	14:16	16:29	11	15:35 (3)	18:12	21:03	23:14		00:10	21:37	19:27	37
19	10:11	08:06	15:23 (3)	06:13		05:04	02:48		02:13	04:42	06:33	15:50 (3)
	14:21	16:33	16	15:45 (2)	18:15	21:07	23:19		00:03	21:32	19:23	36
20	10:07	08:02	15:21 (3)	06:09		05:00	02:43		02:20	04:46	06:36	15:50 (3)
	14:25	16:37	25	15:49 (2)	18:19	21:11	23:25		23:57	21:28	19:19	35
21	10:03	07:58	15:21 (3)	06:05		04:56	02:37		02:26	04:50	06:40	15:52 (3)
	14:30	16:41	33	15:54 (2)	18:22	21:14	23:30		23:51	21:24	19:15	30
22	09:59	07:54	15:20 (3)	06:01		04:52	02:32		02:33	04:54	06:43	15:52 (3)
	14:35	16:44	35	15:55 (2)	18:26	21:18	23:36		23:45	21:20	19:11	22
23	09:55	07:50	15:19 (3)	05:56		04:47	02:26		02:39	04:57	06:47	15:53 (3)
	14:39	16:48	36	15:55 (2)	18:29	21:22	23:43		23:39	21:15	19:07	14
24	09:51	07:46	15:19 (3)	05:52		04:43	02:20		02:45	05:01	06:50	15:56 (3)
	14:44	16:52	36	15:55 (2)	18:33	21:26	23:49		23:33	21:11	19:03	9
25	09:47	07:42	15:18 (3)	05:48		04:39	02:14		02:50	05:05	06:53	15:57
	14:48	16:56	36	15:54 (2)	18:36	21:30	23:56		23:28	21:07	18:59	1
26	09:43	07:38	15:18 (3)	05:44		04:35	02:07		02:56	05:09	06:57	13:17 (4)
	14:53	16:59	36	15:54 (2)	18:40	21:34	00:04		23:23	21:03	18:54	15:53
27	09:39	07:34	15:19 (3)	05:40		04:30	01:51		03:01	05:12	07:00	13:10 (4)
	14:57	17:03	35	15:54 (2)	18:43	21:38	00:12		23:17	20:58	18:50	15:49
28	09:35	13:39 (4)	07:30	15:19 (3)	05:36	04:26	01:42		03:06	05:16	07:04	13:08 (4)
	15:02	1	13:40 (4)	17:07	29	15:51 (2)	18:47		23:12	20:54	18:46	15:45
29	09:31	13:38 (4)		06:32		04:22	01:31		03:11	05:20	07:07	13:25 (4)
	15:06	10	13:48 (4)		19:50	21:46	00:33		23:07	20:50	18:42	25
30	09:27	13:37 (4)		06:28		04:17	01:08		03:16	05:23	07:10	13:06 (4)
	15:10	18	13:55 (4)		19:54	21:50	00:56		23:03	20:46	18:38	31
31	09:23	13:36 (4)		06:24			23:16		03:21	05:27		13:05 (4)
	15:15	20	13:56 (4)		19:57		03:08		22:58	20:42		15:33
Potential sun hours	115	219	361	468	607	720	694	536	398	292	161	41
Total, worst case	49	794	50							510	397	
Sun reduction	0.27	0.30	0.30							0.25	0.29	
Oper. time red.	0.96	0.96	0.96							0.96	0.96	
Wind dir. red.	0.57	0.61	0.66							0.64	0.58	
Total reduction	0.15	0.18	0.19							0.15	0.16	
Total, real	7	140	9							78	64	

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	(WTG causing flicker first time)
	Sun set (hh:mm)	Last time (hh:mm) with flicker	(WTG causing flicker last time)
	Minutes with flicker		

Project:

Helligvaer

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Calculated:

30.07.2013 12:52/2.9.250

SHADOW - Calendar

Calculation: helligvaerShadow receptor: 20 - Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (15)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.27	0.30	0.30	0.30	0.29	0.29	0.25	0.27	0.25	0.25	0.29	0.28

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
568	563	330	771	2 096	484	346	1 015	719	613	506	386	8 394

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

	[January	[February	[March	[April	[May	[June	[July	[August	[September	[October		[November	[December		
1	11:24	09:19	13:33 (4)	07:26	06:20	04:13		03:26	05:30	07:14		08:07	13:06 (4)	10:19	
	12:53	15:19	21	13:54 (4)	17:11	20:01	21:55	22:53	20:37	18:34		15:29	24	13:54 (5)	13:28
2	11:20	09:15		13:32 (4)	07:22	06:15	04:08	03:30	05:34	07:17		08:11		13:05 (4)	10:23
	12:58	15:23	25	14:15 (5)	17:14	20:04	21:59	22:48	20:33	18:30		15:25	29	13:55 (5)	13:24
3	11:16	09:11		13:32 (4)	07:18	06:11	04:04	03:35	05:38	07:21		08:15		13:04 (4)	10:28
	13:03	15:28	31	14:21 (5)	17:18	20:08	22:03	22:43	20:29	18:26		15:21	32	13:56 (5)	13:20
4	11:12	09:07		13:33 (4)	07:14	06:07	04:00	03:40	05:41	07:24		08:19		13:04 (4)	10:33
	13:08	15:32	36	14:27 (5)	17:22	20:11	22:07	22:39	20:25	18:22		15:17	34	13:57 (5)	13:16
5	11:08	09:03		13:33 (4)	07:10	06:03	03:55	03:44	05:45	07:28		08:23		13:03 (4)	10:38
	13:13	15:36	37	14:27 (5)	17:25	20:15	22:12	22:34	20:21	18:18		15:13	36	13:57 (5)	13:12
6	11:03	08:59		13:33 (4)	07:06	05:59	03:51	03:49	05:48	07:31		08:27		13:03 (4)	10:43
	13:18	15:40	36	14:27 (5)	17:29	20:19	22:16	22:30	20:17	18:14		15:09	37	13:57 (5)	13:08
7	10:59	08:55		13:34 (4)	07:02	05:55	03:46	03:53	05:52	07:35		08:31		13:02 (4)	10:48
	13:23	15:45	34	14:27 (5)	17:32	20:22	22:21	22:25	20:12	18:10		15:05	37	13:57 (5)	13:04
8	10:55	08:51		13:35 (4)	06:58	05:51	03:41	03:57	05:55	07:38		08:36		13:03 (4)	10:53
	13:28	15:49	32	14:27 (5)	17:36	20:26	22:25	22:21	20:08	18:06		15:01	31	13:51 (5)	13:00
9	10:51	08:47		13:35 (4)	06:54	05:46	03:37	04:02	05:59	07:42		08:40		13:04 (4)	10:58
	13:33	15:53	28	14:25 (5)	17:40	20:30	22:30	22:16	20:04	18:02		14:57	23	13:46 (5)	12:56
10	10:47	08:43		13:37 (4)	06:49	05:42	03:32	04:06	06:02	07:45		08:44		13:04 (4)	11:03
	13:38	15:57	22	14:24 (5)	17:43	20:33	22:34	22:12	20:00	17:58		14:53	21	13:25 (4)	12:52
11	10:43	08:39		13:39 (4)	06:45	05:38	03:28	04:10	06:06	07:49		08:48		13:04 (4)	11:08
	13:43	16:01	10	13:49 (4)	17:47	20:37	22:39	22:07	19:56	17:54		14:48	21	13:25 (4)	12:48
12	10:39	08:35			06:41	05:34	03:23	04:14	06:09	07:52		08:52		13:05 (4)	11:13
	13:47	16:05			17:50	20:40	22:44	22:03	19:52	17:49		14:44	19	13:24 (4)	12:44
13	10:35	08:31		15:14 (3)	06:37	05:30	03:18	04:18	06:12	07:56		08:57		13:06 (4)	11:18
	13:52	16:09	2	15:16 (3)	17:54	20:44	22:48	21:58	19:48	17:45		14:40	13	13:19 (4)	12:40
14	10:31	08:27		15:10 (3)	06:33	05:26	03:13	04:22	06:16	07:59		09:01		13:07 (4)	11:23
	13:57	16:13	11	15:21 (3)	17:57	20:48	22:53	21:54	19:44	17:41		14:36	5	13:12 (4)	12:35
15	10:27	08:22		15:09 (3)	06:29	05:21	03:08	01:45	04:26	06:19	08:03		15:47 (3)	09:05	11:28
	14:02	16:17	15	15:24 (3)	18:01	20:52	22:58	00:37	21:50	19:39	17:37	3	15:50 (3)	14:32	12:31
16	10:23	08:18		15:08 (3)	06:25	05:17	03:03	01:56	04:30	06:23	08:07		15:42 (3)	09:10	11:33
	14:07	16:21	17	15:25 (3)	18:05	20:55	23:03	00:27	21:45	19:35	17:33	11	15:53 (3)	14:28	12:27
17	10:19	08:14		15:07 (3)	06:21	05:13	02:58	02:05	04:34	06:26	08:10		15:40 (3)	09:14	11:38
	14:11	16:25	23	15:35 (2)	18:08	20:59	23:08	00:18	21:41	19:31	17:29	22	16:11 (2)	14:24	12:23
18	10:15	08:10		15:06 (3)	06:17	05:09	02:53	02:05	04:38	06:30	08:14		15:39 (3)	09:19	11:43
	14:16	16:29	31	15:40 (2)	18:12	21:03	23:14	00:10	21:37	19:27	17:25	28	16:13 (2)	14:20	12:19
19	10:11	08:06		15:06 (3)	06:13	05:04	02:48	02:12	04:42	06:33	08:17		15:38 (3)	09:23	11:49
	14:21	16:33	34	15:43 (2)	18:15	21:07	23:19	00:03	21:32	19:23	17:21	31	16:13 (2)	14:16	12:14
20	10:07	08:02		15:06 (3)	06:09	05:00	02:43	02:20	04:46	06:36	08:21		15:37 (3)	09:28	11:55
	14:25	16:37	35	15:43 (2)	18:19	21:11	23:25	23:57	21:28	19:19	17:17	33	16:13 (2)	14:12	12:09
21	10:03	07:58		15:06 (3)	06:05	04:56	02:37	02:26	04:50	06:40	08:25		15:37 (3)	09:32	12:24
	14:30	16:41	35	15:44 (2)	18:22	21:14	23:31	23:51	21:24	19:15	17:13	34	16:14 (2)	14:08	13:59
22	09:59	07:54		15:06 (3)	06:01	04:52	02:32	02:33	04:54	06:43	08:29		15:36 (3)	09:37	
	14:35	16:44	34	15:43 (2)	18:26	21:18	23:36	23:45	21:20	19:11	17:09	36	16:14 (2)	14:04	
23	09:55	07:50		15:06 (3)	05:56	04:47	02:26	02:39	04:57	06:47	08:32		15:36 (3)	09:41	
	14:39	16:48	30	15:41 (2)	18:29	21:22	23:43	23:39	21:15	19:07	17:05	34	16:13 (2)	14:00	
24	09:51	07:46		15:08 (3)	05:52	04:43	02:20	02:45	05:01	06:50	08:36		15:37 (3)	09:46	
	14:44	16:52	26	15:41 (2)	18:33	21:26	23:49	23:33	21:11	19:03	17:01	28	16:09 (2)	13:56	
25	09:47	07:42		15:09 (3)	05:48	04:39	02:13	02:50	05:05	06:53	07:40		14:37 (3)	09:50	11:55
	14:48	16:56	18	15:38 (2)	18:36	21:30	23:56	23:28	21:07	18:59	15:57	22	15:04 (2)	13:52	12:15
26	09:43	07:38		15:11 (3)	05:44	04:35	02:07	02:56	05:09	06:57	07:44		14:38 (3)	09:55	11:50
	14:53	16:59	9	15:20 (3)	18:40	21:34	00:04	23:23	21:03	18:54	15:53	16	14:54 (3)	13:48	12:21
27	09:39	07:34			05:40	04:30	01:51	03:01	05:12	07:00	07:48		14:39 (3)	10:00	11:45
	14:57	17:03			18:43	21:38	00:12	23:18	20:58	18:50	15:49	13	14:52 (3)	13:44	12:26
28	09:35		13:34 (4)	07:30		05:36	04:26	03:06	05:16	07:04	07:51		14:41 (3)	10:04	11:41
	15:02	6	13:40 (4)	17:07		18:47	21:42	23:12	20:54	18:46	15:45	9	14:50 (3)	13:40	12:31
29	09:31		13:34 (4)			06:32	04:22	03:11	05:20	07:07	07:55		15:36 (3)	10:09	11:37
	15:06	14	13:48 (4)			19:50	21:46	23:07	20:50	18:42	15:41		16:14 (2)	14:04	12:36
30	09:27		13:34 (4)			06:28	04:17	03:16	05:23	07:10	07:59		13:12 (4)	10:14	11:33
	15:10	19	13:53 (4)			19:54	21:50	23:03	20:46	18:38	15:37	5	13:17 (4)	13:32	12:41
31	09:23		13:33 (4)			06:24		03:21	05:27	08:03			13:08 (4)		11:29
	15:15	20	13:53 (4)			19:57		22:58	20:42		15:33	12	13:20 (4)		12:47
Potential sun hours	115	219		361	468	627	720	694	536	398	292	161		42	
Total, worst case	59	632									337	362			
Sun reduction	0.27	0.30									0.25	0.29			
Oper. time red.	0.96	0.96									0.96	0.96			
Wind dir. red.	0.56	0.61									0.64	0.58			
Total reduction	0.15	0.18									0.15	0.16			
Total, real	9	111									52	58			

Project:

Helligvaer

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Kjeller Vindteknikk AS

Gunnar Randres vei 12

NO-2007 Kjeller

(+47) 480 50 480

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Calculated:

30.07.2013 12:52/2.9.250

SHADOW - Calendar

Calculation: helligvaerShadow receptor: 21 - Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (28)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.27	0.30	0.30	0.30	0.29	0.29	0.25	0.27	0.25	0.25	0.29	0.28

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
568	563	330	771	2 096	484	346	1 015	719	613	506	386	8 394

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

	January	February	March	April	May	June	July	August	September	October	November	December
1	11:24	09:19	13:54 (4)	07:26	06:20	04:13		03:26	05:30	07:14	08:07	13:24 (4)
	12:53	15:19	15	14:09 (4)	17:11	20:01	21:55	22:53	20:37	18:34	15:29	30
2	11:20	09:15	13:53 (4)	07:22	06:15	04:08		03:30	05:34	07:17	08:11	13:24 (4)
	12:58	15:23	20	14:13 (4)	17:14	20:04	21:59	22:48	20:33	18:30	15:25	32
3	11:16	09:11	13:52 (4)	07:18	06:11	04:04		03:35	05:38	07:21	08:15	13:23 (4)
	13:03	15:28	21	14:13 (4)	17:18	20:08	22:03	22:43	20:29	18:26	15:21	34
4	11:12	09:07	13:53 (4)	07:14	06:07	04:00		03:40	05:41	07:24	08:19	13:23 (4)
	13:08	15:32	23	14:28 (5)	17:22	20:11	22:07	22:39	20:25	18:22	15:17	36
5	11:07	09:03	13:53 (4)	07:10	06:03	03:55		03:44	05:45	07:28	08:23	13:23 (4)
	13:13	15:36	30	14:34 (5)	17:25	20:15	22:12	22:34	20:21	18:18	15:13	35
6	11:03	08:59	13:52 (4)	07:06	05:59	03:51		03:49	05:48	07:31	08:27	13:23 (4)
	13:18	15:40	36	14:39 (5)	17:29	20:19	22:16	22:30	20:17	18:14	15:09	28
7	10:59	08:55	13:53 (4)	07:02	05:55	03:46		03:53	05:52	07:35	08:31	13:22 (4)
	13:23	15:45	36	14:40 (5)	17:32	20:22	22:20	22:25	20:12	18:10	15:05	24
8	10:55	08:51	13:54 (4)	06:58	05:51	03:41		03:57	05:55	07:38	08:36	13:23 (4)
	13:28	15:49	34	14:40 (5)	17:36	20:26	22:25	22:21	20:08	18:06	15:01	20
9	10:51	08:47	13:54 (4)	06:53	05:46	03:37		04:02	05:59	07:42	08:40	13:24 (4)
	13:33	15:53	32	14:39 (5)	17:40	20:30	22:30	22:16	20:04	18:02	14:57	20
10	10:47	08:43	13:55 (4)	06:49	05:42	03:32		04:06	06:02	07:45	08:44	13:24 (4)
	13:38	15:57	28	14:38 (5)	17:43	20:33	22:34	22:12	20:00	17:58	14:53	15
11	10:43	08:39	13:56 (4)	06:45	05:38	03:28		04:10	06:06	07:49	08:48	13:26 (4)
	13:43	16:01	24	14:37 (5)	17:47	20:37	22:39	22:07	19:56	17:54	14:48	7
12	10:39	08:35	13:57 (4)	06:41	05:34	03:23		04:14	06:09	07:52	08:52	
	13:47	16:05	15	14:34 (5)	17:50	20:40	22:44	22:03	19:52	17:49	14:44	
13	10:35	08:31	14:00 (4)	06:37	05:30	03:18		04:18	06:12	07:56	08:57	
	13:52	16:09	7	14:07 (4)	17:54	20:44	22:48	21:58	19:48	17:45	14:40	
14	10:31	08:26		06:33	05:26	03:13		04:22	06:16	07:59		
	13:57	16:13		17:57	20:48	22:53		21:54	19:44	17:41	8	
15	10:27	08:22		06:29	05:21	03:08	01:45	04:26	06:19	08:03	15:56 (3)	
	14:02	16:17		18:01	20:52	22:58	00:37	21:50	19:39	17:37	13	
16	10:23	08:18	15:26 (3)	06:25	05:17	03:03	01:56	04:30	06:23	08:07	15:55 (3)	
	14:07	16:21	5	15:31 (3)	18:04	20:55	00:27	21:45	19:35	17:33	23	
17	10:19	08:14	15:24 (3)	06:21	05:13	02:58	02:05	04:34	06:26	08:10	15:53 (3)	
	14:11	16:25	11	15:35 (3)	18:08	20:59	00:18	21:41	19:31	17:29	29	
18	10:15	08:10	15:22 (3)	06:17	05:09	02:53	02:05	04:38	06:29	08:14	15:52 (3)	
	14:16	16:29	16	15:38 (3)	18:12	21:03	00:10	21:37	19:27	17:25	32	
19	10:11	08:06	15:22 (3)	06:13	05:04	02:48	02:12	04:42	06:33	08:17	15:52 (3)	
	14:21	16:33	23	15:45 (2)	18:15	21:07	00:03	21:32	19:23	17:21	32	
20	10:07	08:02	15:21 (3)	06:09	05:00	02:43	02:20	04:46	06:36	08:21	15:51 (3)	
	14:25	16:37	28	15:49 (2)	18:19	21:11	23:57	21:28	19:19	17:17	33	
21	10:03	07:58	15:21 (3)	06:05	04:56	02:37	02:26	04:50	06:40	08:25	15:52 (3)	
	14:30	16:41	32	15:53 (2)	18:22	21:14	23:51	21:24	19:15	17:13	31	
22	09:59	07:54	15:21 (3)	06:01	04:52	02:32	02:33	04:54	06:43	08:29	15:52 (3)	
	14:35	16:44	32	15:53 (2)	18:26	21:18	23:45	21:20	19:11	17:09	26	
23	09:55	07:50	15:20 (3)	05:56	04:47	02:26	02:39	04:57	06:46	08:32	15:52 (3)	
	14:39	16:48	32	15:52 (2)	18:29	21:22	23:39	21:15	19:07	17:05	20	
24	09:51	07:46	15:21 (3)	05:52	04:43	02:20	02:45	05:01	06:50	08:36	15:53 (3)	
	14:44	16:52	31	15:52 (2)	18:33	21:26	23:33	21:11	19:03	17:01	16	
25	09:47	07:42	15:21 (3)	05:48	04:39	02:13	02:50	05:05	06:53	07:40	14:54 (3)	
	14:48	16:56	27	15:50 (2)	18:36	21:30	23:28	21:07	18:59	15:57	10	
26	09:43	07:38	15:23 (3)	05:44	04:35	02:07	02:56	05:09	06:57	07:44	14:57 (3)	
	14:53	16:59	20	15:48 (2)	18:40	21:34	23:23	21:03	18:54	15:53	3	
27	09:39	07:34	15:25 (3)	05:40	04:30	01:51	03:01	05:12	07:00	07:48	15:00 (3)	
	14:57	17:03	11	15:36 (3)	18:43	21:38	23:18	20:58	18:50	15:49		
28	09:35	07:30	15:28 (3)	05:36	04:26	01:42	03:06	05:16	07:04	07:51		
	15:02	17:07	4	15:32 (3)	18:47	21:42	23:12	20:54	18:46	15:45		
29	09:31			06:32	04:22	01:30	03:11	05:20	07:07	07:55		
	15:06			19:50	21:46	00:34	23:07	20:50	18:42	15:41	9	
30	09:27	13:55 (4)		06:28	04:17	01:07	03:16	05:23	07:10	07:59		
	15:10	1		19:54	21:50	00:57		23:03	20:46	18:38	18	
31	09:23	13:54 (4)		06:24				03:21	05:27	08:03	14:05 (5)	
	15:15	8		19:57				22:58	20:42	15:33	25	
Potential sun hours	115			361	468	627	720	694	536	398	292	
Total, worst case	9			593							328	
Sun reduction	0.27			0.30							0.25	
Oper. time red.	0.96			0.96							0.96	
Wind dir. red.	0.59			0.62							0.65	
Total reduction	0.15			0.18							0.16	
Total, real	1			107							51	

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	(WTG causing flicker first time)
	Sun set (hh:mm)	Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:

Helligvaer

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30.07.2013 13:11 / 22

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Kjeller Vindteknikk AS

Gunnar Randres vei 12

NO-2007 Kjeller

(+47) 480 50 480

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Calculated:

30.07.2013 12:52/2.9.250

SHADOW - Calendar

Calculation: helligvaerShadow receptor: 22 - Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (27)

Assumptions for shadow calculations

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.27	0.30	0.30	0.30	0.29	0.29	0.25	0.27	0.25	0.25	0.29	0.28

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
568	563	330	771	2 096	484	346	1 015	719	613	506	386	8 394

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

	January	February	March	April	May	June	July	August	September	October	November	December
1	11:24	09:19	13:51 (4)	07:26	06:20	04:13		03:26	05:30	07:14	08:07	13:23 (4)
	12:53	15:19	18	14:09 (4)	17:11	20:01	21:55	22:53	20:37	18:34	15:29	26
2	11:20	09:15	13:50 (4)	07:22	06:15	04:08		03:30	05:34	07:17	08:11	13:22 (4)
	12:58	15:23	20	14:10 (4)	17:14	20:04	21:59	22:48	20:33	18:30	15:25	30
3	11:16	09:11	13:50 (4)	07:18	06:11	04:04		03:35	05:38	07:21	08:15	13:21 (4)
	13:03	15:28	21	14:11 (4)	17:18	20:08	22:03	22:43	20:29	18:26	15:21	33
4	11:12	09:07	13:51 (4)	07:14	06:07	04:00		03:40	05:41	07:24	08:19	13:21 (4)
	13:08	15:32	25	14:28 (5)	17:22	20:11	22:07	22:39	20:25	18:22	15:17	35
5	11:08	09:03	13:50 (4)	07:10	06:03	03:55		03:44	05:45	07:28	08:23	13:20 (4)
	13:13	15:36	32	14:34 (5)	17:25	20:15	22:12	22:34	20:21	18:18	15:13	35
6	11:03	08:59	13:50 (4)	07:06	05:59	03:51		03:49	05:48	07:31	08:27	13:21 (4)
	13:18	15:40	35	14:37 (5)	17:29	20:19	22:16	22:30	20:17	18:14	15:09	31
7	10:59	08:55	13:51 (4)	07:02	05:55	03:46		03:53	05:52	07:35	08:31	13:20 (4)
	13:23	15:45	34	14:37 (5)	17:32	20:22	22:21	22:25	20:12	18:10	15:05	25
8	10:55	08:51	13:52 (4)	06:58	05:51	03:41		03:57	05:55	07:38	08:36	13:20 (4)
	13:28	15:49	32	14:37 (5)	17:36	20:26	22:25	22:21	20:08	18:06	15:01	21
9	10:51	08:47	13:52 (4)	06:53	05:46	03:37		04:02	05:59	07:42	08:40	13:22 (4)
	13:33	15:53	30	14:36 (5)	17:40	20:30	22:30	22:16	20:04	18:02	14:57	19
10	10:47	08:43	13:53 (4)	06:49	05:42	03:32		04:06	06:02	07:45	08:44	13:22 (4)
	13:38	15:57	26	14:35 (5)	17:43	20:33	22:34	22:12	20:00	17:58	14:53	17
11	10:43	08:39	13:55 (4)	06:45	05:38	03:28		04:10	06:06	07:49	08:48	13:23 (4)
	13:43	16:01	18	14:33 (5)	17:47	20:37	22:39	22:07	19:56	17:54	14:48	10
12	10:39	08:35	13:57 (4)	06:41	05:34	03:23		04:14	06:09	07:52	08:52	13:24 (4)
	13:47	16:05	8	14:05 (4)	17:50	20:40	22:44	22:03	19:52	17:49	14:44	3
13	10:35	08:31		06:37	05:30	03:18		04:18	06:12	07:56	08:57	
	13:52	16:09		17:54	20:44	22:48		21:58	19:48	17:45	14:40	
14	10:31	08:26		06:33	05:26	03:13		04:22	06:16	07:59	09:01	
	13:57	16:13		17:57	20:48	22:53		21:54	19:44	17:41	14:36	
15	10:27	08:22		15:22 (3)	06:29	05:21	03:08	04:26	06:19	08:03	15:55 (3)	
	14:02	16:17	4	15:26 (3)	18:01	20:52	22:58	00:37	21:50	19:39	17:37	7
16	10:23	08:18		15:20 (3)	06:25	05:17	03:03	04:30	06:23	08:07	15:52 (3)	
	14:07	16:21	11	15:31 (3)	18:04	20:55	23:03	00:27	21:45	19:35	17:33	12
17	10:19	08:14		15:19 (3)	06:21	05:13	02:58	04:34	06:26	08:10	15:50 (3)	
	14:11	16:25	15	15:34 (3)	18:08	20:59	23:08	00:18	21:41	19:31	17:29	23
18	10:15	08:10		15:18 (3)	06:17	05:09	02:53	04:38	06:29	08:14	15:49 (3)	
	14:16	16:29	20	15:40 (2)	18:12	21:03	23:14	00:10	21:37	19:27	17:25	28
19	10:11	08:06		15:18 (3)	06:13	05:04	02:48	04:42	06:33	08:17	15:48 (3)	
	14:21	16:33	26	15:45 (2)	18:15	21:07	23:19	00:03	21:32	19:23	17:21	31
20	10:07	08:02		15:17 (3)	06:09	05:00	02:43	04:46	06:36	08:21	15:47 (3)	
	14:25	16:37	32	15:49 (2)	18:19	21:11	23:25	23:57	21:28	19:19	17:17	33
21	10:03	07:58		15:17 (3)	06:05	04:56	02:37	04:50	06:40	08:25	15:48 (3)	
	14:30	16:41	33	15:50 (2)	18:22	21:14	23:31	23:51	21:24	19:15	17:13	33
22	09:59	07:54		15:17 (3)	06:01	04:52	02:32	04:54	06:43	08:29	15:48 (3)	
	14:35	16:44	31	15:49 (2)	18:26	21:18	23:36	23:45	21:20	19:11	17:09	30
23	09:55	07:50		15:17 (3)	05:56	04:47	02:26	04:57	06:46	08:32	15:47 (3)	
	14:39	16:48	29	15:48 (2)	18:29	21:22	23:43	23:39	21:15	19:07	17:05	25
24	09:51	07:46		15:18 (3)	05:52	04:43	02:20	05:01	06:50	08:36	15:48 (3)	
	14:44	16:52	27	15:48 (2)	18:33	21:26	23:49	23:33	21:11	19:03	17:01	18
25	09:47	07:42		15:19 (3)	05:48	04:39	02:13	05:05	06:53	07:40	14:49 (3)	
	14:48	16:56	20	15:45 (2)	18:36	21:30	23:56	23:28	21:07	18:59	15:57	15
26	09:43	07:38		15:21 (3)	05:44	04:35	02:07	05:09	06:57	07:44	14:50 (3)	
	14:53	16:59	10	15:31 (3)	18:40	21:34	00:04	23:23	21:03	18:54	15:53	10
27	09:39	07:34			05:40	04:30	01:51	03:01	05:12	07:00	07:48	
	14:57	17:03			18:43	21:38	00:12	23:18	20:58	18:50	15:49	2
28	09:35	07:30			05:36	04:26	01:42	03:06	05:16	07:04	07:51	
	15:02	17:07			18:47	21:42	00:22	23:12	20:54	18:46	15:45	
29	09:31				06:32	04:22	01:30	03:11	05:20	07:07	07:55	
	15:06				19:50	21:46	00:34	23:07	20:50	18:42	15:41	
30	09:27	13:52 (4)			06:28	04:17	01:07	03:16	05:23	07:10	07:59	
	15:10	4			19:54	21:50	00:57	23:03	20:46	18:38	15:37	9
31	09:23	13:51 (4)			06:24			03:21	05:27		08:03	
	15:15	11			19:57			22:58	20:42		15:33	21
Potential sun hours	115		219		361	468	627	720	694	536	398	292
Total, worst case		15			557							297
Sun reduction		0.27			0.30							0.25
Oper. time red.		0.96			0.96							0.96
Wind dir. red.		0.58			0.62							0.65
Total reduction		0.15			0.18							0.16
Total, real		2			100							46

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

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

Helligvaer

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31.07.2013 11:14 / 1

Licensed user:

Kjeller Vindteknikk AS

Gunnar Randres vei 12

NO-2007 Kjeller

(+47) 480 50 480

reiar.k / reiar.kravik@vindteknikk.no

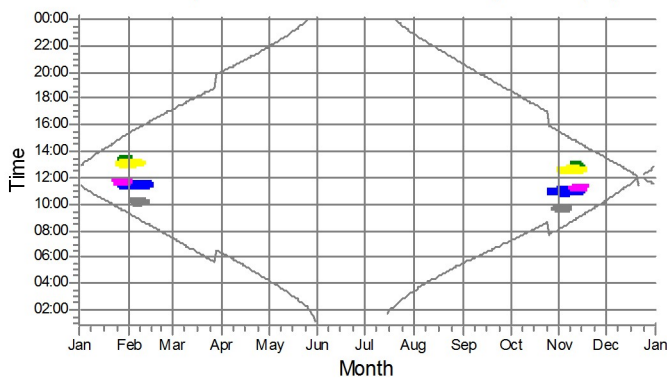
Calculated:

30.07.2013 12:52/2.9.250

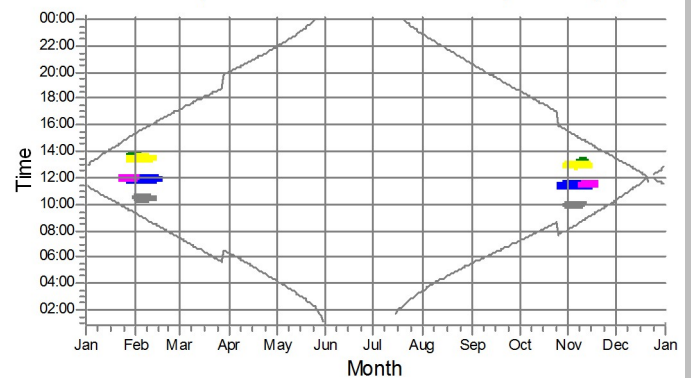
SHADOW - Calendar, graphical

Calculation: helligvaer

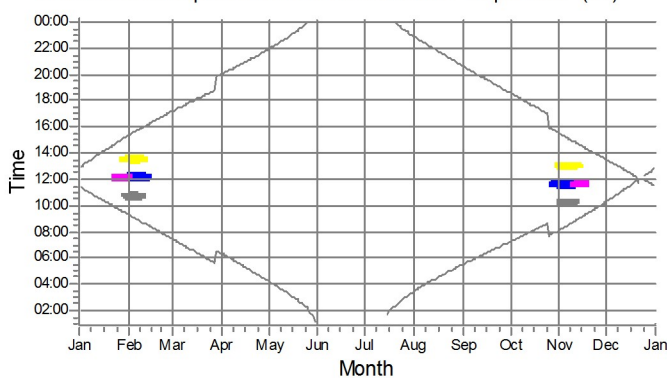
1: Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (30)



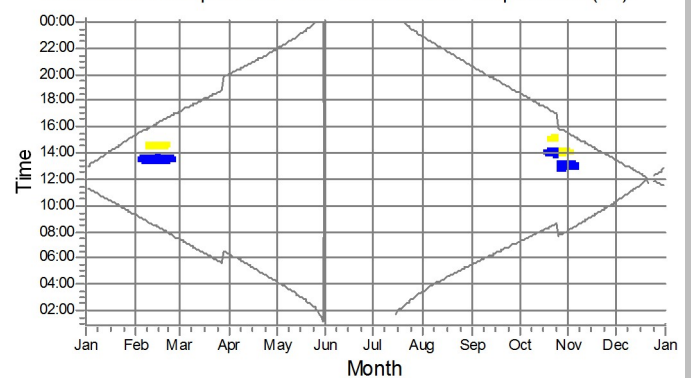
2: Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (29)



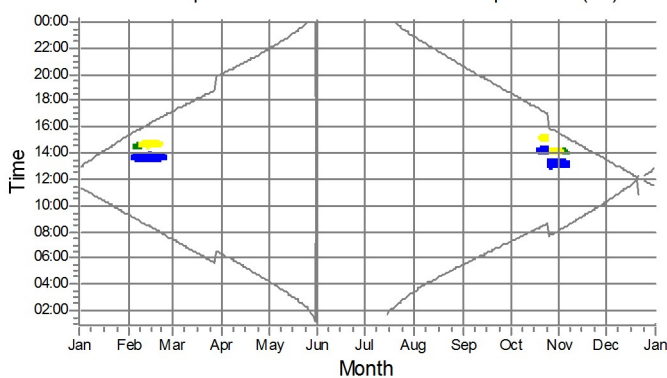
3: Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (31)



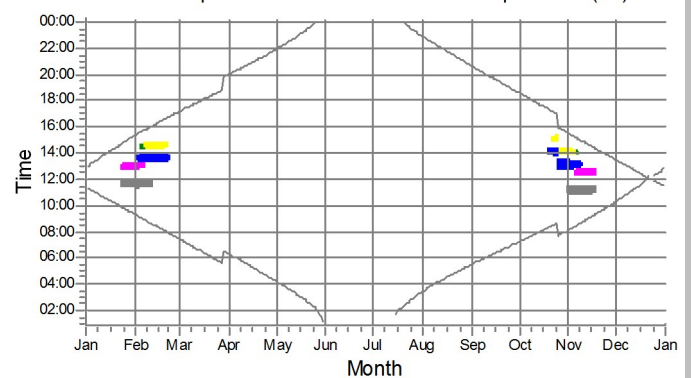
4: Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (24)



5: Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (22)



6: Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (21)



WTGs

- 1: NORDEX N100 2500 99.8 !O! hub: 100.0 m (TOT: 149.9 m) (1)
- 2: NORDEX N100 2500 99.8 !O! hub: 100.0 m (TOT: 149.9 m) (2)
- 3: NORDEX N100 2500 99.8 !O! hub: 100.0 m (TOT: 149.9 m) (3)
- 4: NORDEX N100 2500 99.8 !O! hub: 100.0 m (TOT: 149.9 m) (4)
- 5: NORDEX N100 2500 99.8 !O! hub: 100.0 m (TOT: 149.9 m) (5)

Project:

Helligvaer

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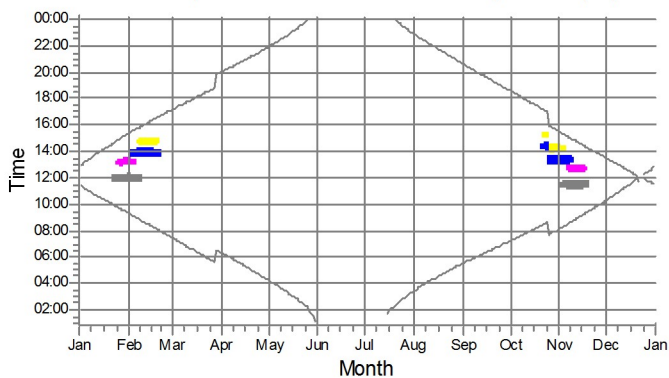
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30.07.2013 12:52/2.9.250

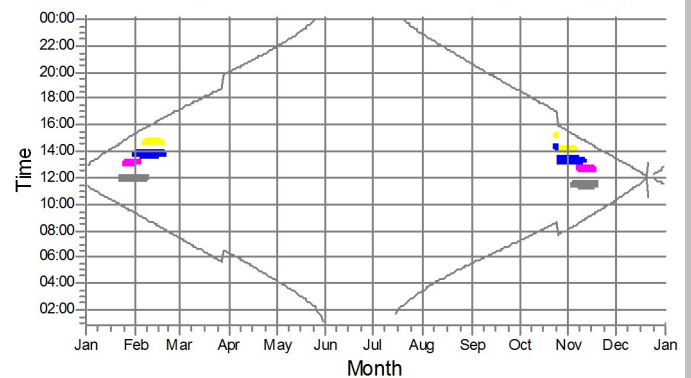
SHADOW - Calendar, graphical

Calculation: helligvaer

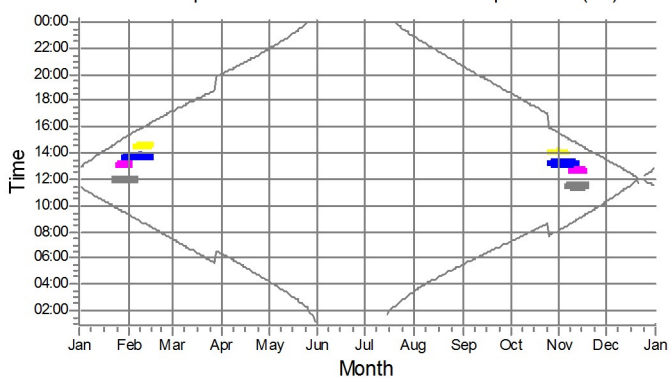
7: Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (19)



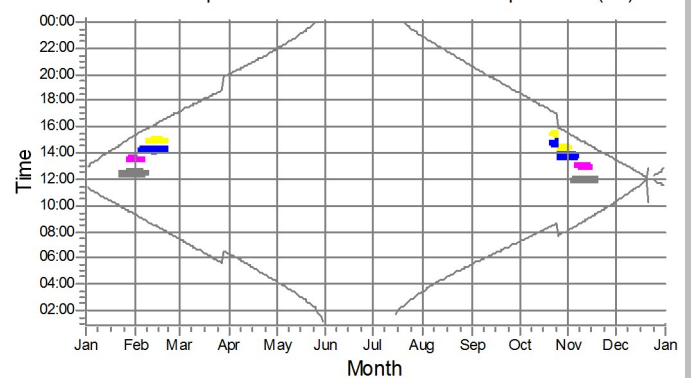
8: Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (20)



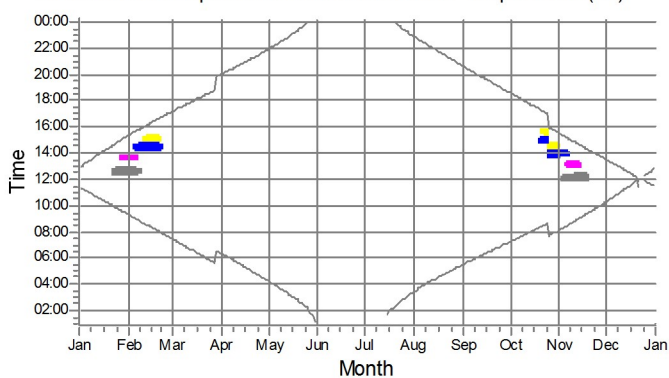
9: Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (25)



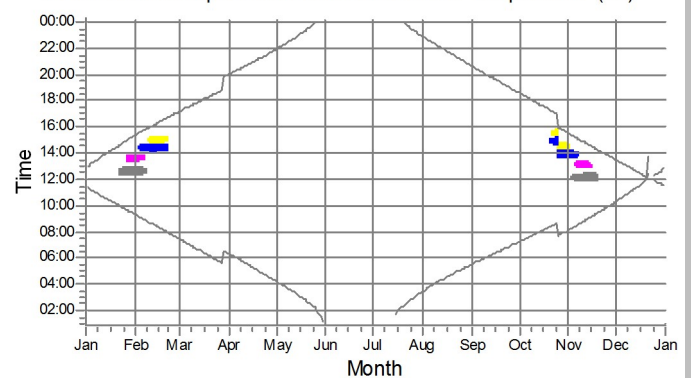
10: Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (17)



11: Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (16)



12: Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (18)



WTGs

- 2: NORDEX N100 2500 99.8 !O! hub: 100.0 m (TOT: 149.9 m) (2)
- 3: NORDEX N100 2500 99.8 !O! hub: 100.0 m (TOT: 149.9 m) (3)
- 4: NORDEX N100 2500 99.8 !O! hub: 100.0 m (TOT: 149.9 m) (4)
- 5: NORDEX N100 2500 99.8 !O! hub: 100.0 m (TOT: 149.9 m) (5)

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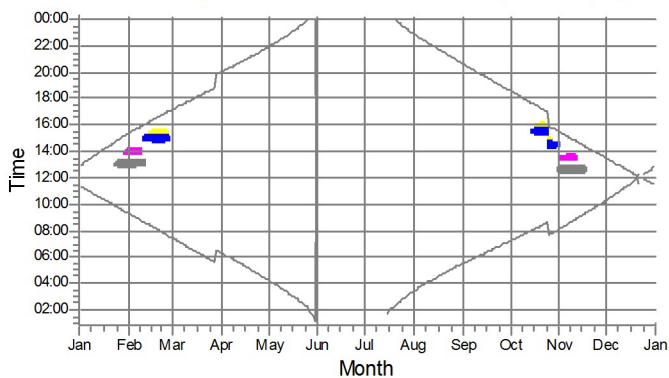
Calculated:

30.07.2013 12:52/2.9.250

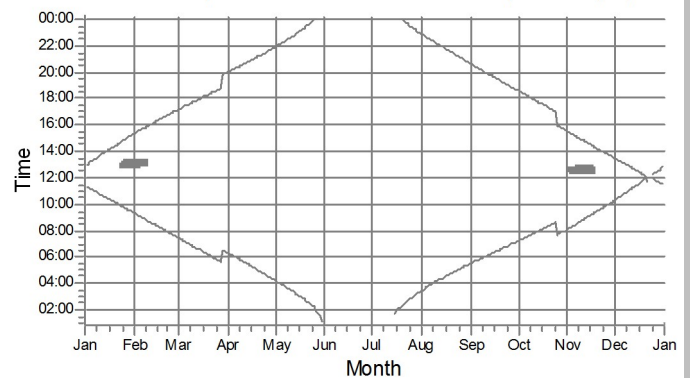
SHADOW - Calendar, graphical

Calculation: helligvaer

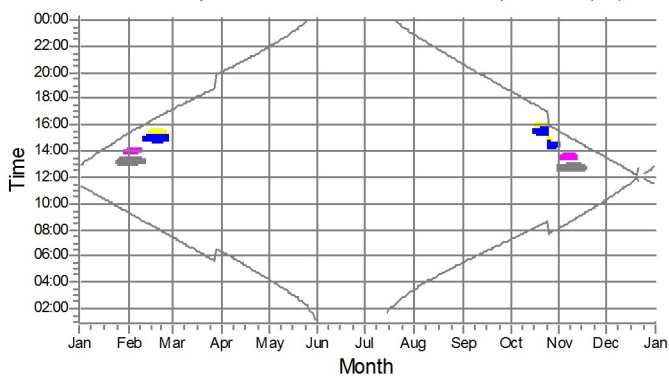
13: Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (12)



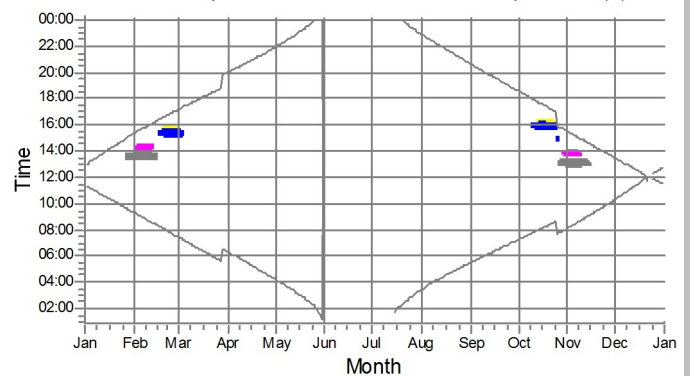
14: Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (14)



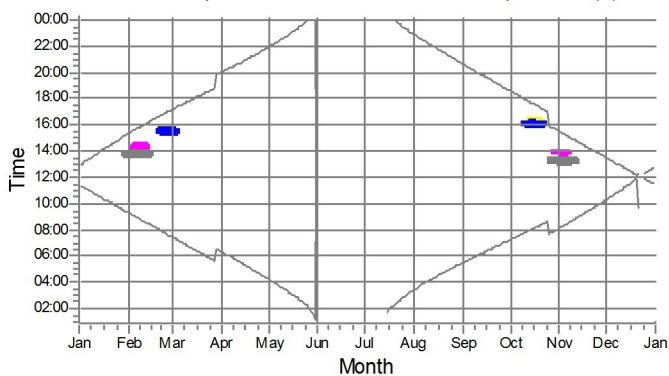
15: Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (13)



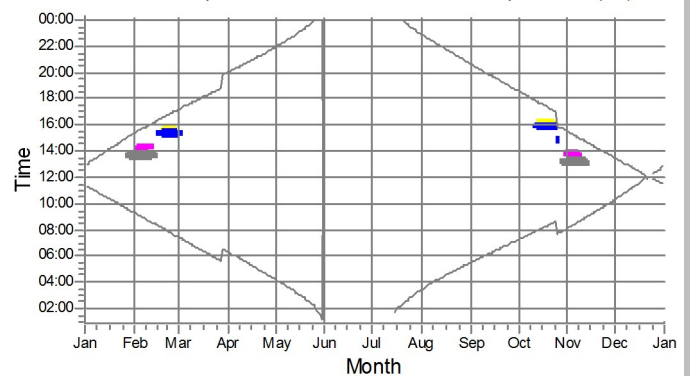
16: Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (9)



17: Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (8)



18: Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (11)



WTGs

- 2: NORDEX N100 2500 99.8 !O! hub: 100.0 m (TOT: 149.9 m) (2)
- 3: NORDEX N100 2500 99.8 !O! hub: 100.0 m (TOT: 149.9 m) (3)
- 4: NORDEX N100 2500 99.8 !O! hub: 100.0 m (TOT: 149.9 m) (4)
- 5: NORDEX N100 2500 99.8 !O! hub: 100.0 m (TOT: 149.9 m) (5)

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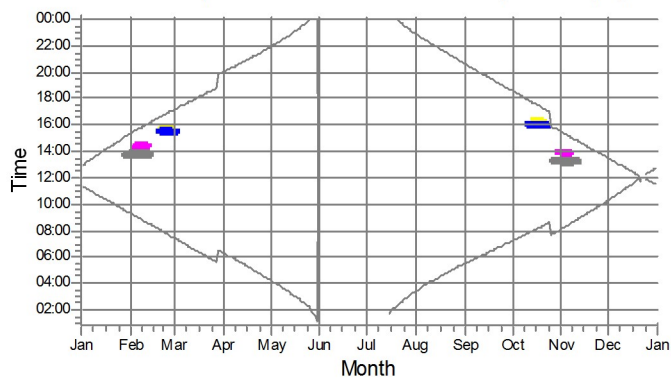
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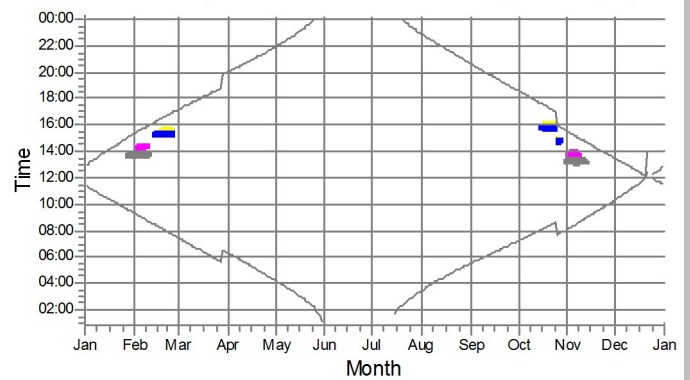
SHADOW - Calendar, graphical

Calculation: helligvaer

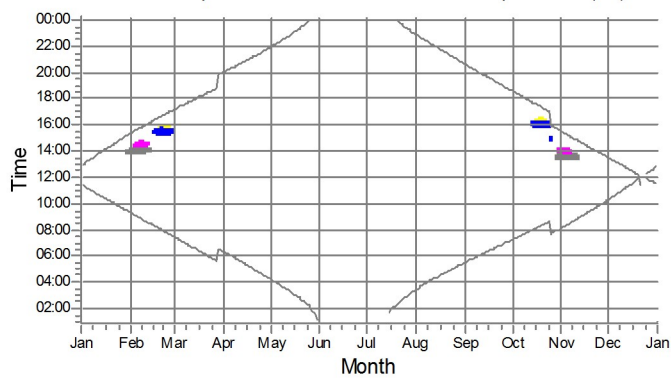
19: Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (10)



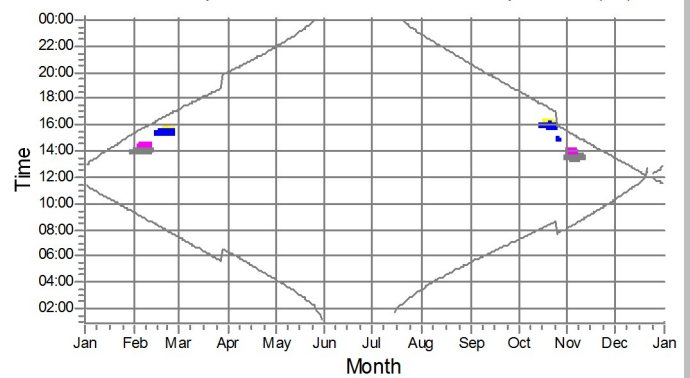
20: Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (15)



21: Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (28)



22: Shadow Receptor: 2.0 × 2.0 Azimuth: 0.0° Slope: 90.0° (27)



WTGs

- 2: NORDEX N100 2500 99.8 !O! hub: 100.0 m (TOT: 149.9 m) (2)
- 3: NORDEX N100 2500 99.8 !O! hub: 100.0 m (TOT: 149.9 m) (3)
- 4: NORDEX N100 2500 99.8 !O! hub: 100.0 m (TOT: 149.9 m) (4)
- 5: NORDEX N100 2500 99.8 !O! hub: 100.0 m (TOT: 149.9 m) (5)

