
PROGETTO PER LA REALIZZAZIONE DI UN IMPIANTO PER LA PRODUZIONE DI ENERGIA
MEDIANTE LO SFRUTTAMENTO DEL VENTO NEI TERRITORI COMUNALI
DI CANINO E MONTALTO DI CASTRO (VT) LOC. SUGARELLA
POTENZA NOMINALE 93,6 MW

PROGETTO DEFINITIVO - SIA

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**ES.6 Analisi dell'evoluzione dell'ombra indotta
dagli aereogeneratori - Shadow flickering**

REV. DATA DESCRIZIONE

REV.	DATA	DESCRIZIONE



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1. INTRODUZIONE

Il presente elaborato ha lo scopo di valutare in maniera tecnica l'eventuale impatto generato dall'evoluzione dell'ombra derivante dalla futura installazione di un impianto di produzione di energia da fonte eolica in territorio extra urbano dei Comuni di Canino e Montalto di Castro (VT). Il progetto è composto da n°13 aerogeneratori del tipo IEC S - 150, con potenza unitaria pari a 7.2 MW, altezza al mozzo pari a 150 e diametro rotorico pari a 172.

In particolare, la posizione degli aerogeneratori è la seguente:

WTG	Coordinate WGS84 fuso 32N	
	Est	Nord
CA01	722.669,64	4.697.611,39
CA08	724.214,63	4.696.400,41
CA09	724.320,33	4.697.510,83
CA12	725.972,02	4.698.916,22
CA11	726.298,46	4.699.724,37
CA03	725.778,17	4.700.010,10
CA10	724.864,00	4.699.318,86
CA06	723.818,21	4.694.906,84
CA07	723.785,70	4.695.657,74
CA05	722.877,17	4.695.220,22
CA04	722.609,19	4.695.859,70
CA02	722.191,93	4.697.051,99
MC01	720.066,80	4.696.714,80

Tab. 1 – Coordinate aerogeneratori



Figura 1: Planimetria dell'impianto



Lo Shadow-Flickering è l'espressione comunemente impiegata in ambito specialistico per descrivere l'effetto stroboscopico delle ombre proiettate dalle pale rotanti degli aerogeneratori eolici quando sussistono le condizioni meteorologiche opportune; infatti la possibilità e la durata di tali effetti dipendono da una serie di condizioni ambientali, tra cui: la posizione del sole, l'ora del giorno, il giorno dell'anno, le condizioni atmosferiche ambientali e la posizione della turbina eolica rispetto ad un recettore sensibile. La valutazione tecnica è eseguita con l'ausilio di un software di simulazione specifico per la progettazione degli impianti eolici WIND PRO®, costituito da un insieme di moduli di elaborazione orientati alla simulazione di una serie di aspetti che caratterizzano le diverse fasi progettuali. Il modulo SHADOW è quello specifico per la valutazione dell'evoluzione dell'ombra e del flickering. In tale report è riportata:

- *La descrizione del caso studio con le posizioni delle turbine e loro caratteristiche tecniche*
- *Una breve descrizione tecnica del fenomeno di shadow flickering*
- *La descrizione dei recettori soggetti al fenomeno per i quali è stata richiesta questa analisi*
- *Sintesi della metodologia di analisi seguita per lo studio*
- *Sintesi dei risultati ottenuti, con allegati grafici ed analitici di dettaglio che descrivono il fenomeno su ognuno dei recettori e da parte di ognuna delle turbine per tutto l'anno solare.*



2. STUDIO DELL'EVOLUZIONE DELL'OMBRA GIORNALIERA GENERATA DAGLI AEROGENERATORI

Le turbine eoliche, come altre strutture fortemente sviluppate in altezza, proiettano un'ombra sulle aree adiacenti in presenza della luce solare diretta. Per chi vive in tali zone prossime all'insediamento eolico può essere molto fastidioso il cosiddetto fenomeno del "flicker" che consiste in un effetto di lampeggiamento che si verifica quando le pale del rotore in movimento "tagliano" la luce solare in maniera intermittente. Una progettazione attenta a questa problematica permette di evitare questo spiacevole fenomeno semplicemente prevedendo il luogo di incidenza dell'ombra e disponendo le turbine in maniera tale che l'ombra sulle zone sensibili non superi un certo numero di ore all'anno. Il grafico in Figura 2 riporta l'evoluzione annuale dell'ombra di una turbina considerando il caso peggiore di pale sempre in rotazione intorno al mozzo, e orientate sempre ortogonalmente al sole durante la sua evoluzione giornaliera.

Come è evidente dal grafico e dalla legenda le ore annue di ombra sono sempre minori con l'aumentare della distanza dal pilone secondo una particolare geometria dettata dalla posizione geografica; da osservare che l'ombra arriva a proiettarsi anche sino ad una distanza di 1 km, anche se solo per pochi minuti all'anno.

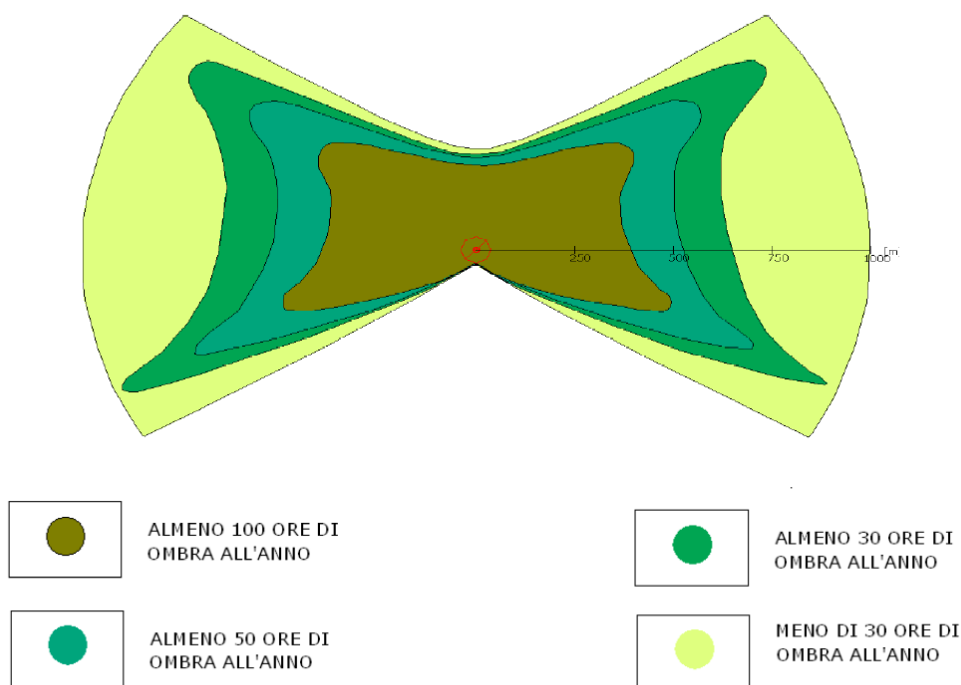


Figura 2: Evoluzione annuale tipo dell'ombra di una pala

Considerati i pochi precedenti esistenti (Germania) e le ipotesi così penalizzanti con cui è stato calcolato tale grafico si è ritenuto opportuno effettuare una sovrapposizione sull'impianto della parte più interna del grafico ovvero dell'area **che supera le 100 ore all'anno di ombra dei punti di installazione, intendendo questo come limite da non superarsi.**

In Italia, così come nella maggior parte dei paesi Europei ed extraeuropei non esiste una normativa specifica relativa al disturbo generato dal fenomeno di Shadow – Flickering. Esistono delle regolamentazioni locali ma quasi mai comprendono limiti numerici specifici, quanto piuttosto delle raccomandazioni tese a sottolineare che il fenomeno non sia "unreasonable" o "significant".



3. INDIVIDUAZIONE DEI RECETTORI ED IPOTESI DI CALCOLO

3.1 INDIVIDUAZIONE DEI RICETTORI

Il progetto in esame nei comuni di Canino e Montalto di Castro prevede l'installazione di 13 aerogeneratori.

L'analisi di shadow-flickering di cui al presente studio è scaturita da una attività di censimento nell'area del parco eolico in progetto così come descritto nell'elaborato ES.8.1 Individuazione recettori.

Da tale studio ne è derivato che l'unico recettore (A) da considerare effettivamente sensibile è esterno all'intorno di 500 m (distanza pari a 2,5 volte l'altezza complessiva) dall'asse di ciascun aerogeneratore. Ad ogni modo si è ritenuto opportuno procedere con l'analisi per detto recettore, individuato nello stralcio planimetrico che segue, per il quale è stata stabilita l'abitabilità.

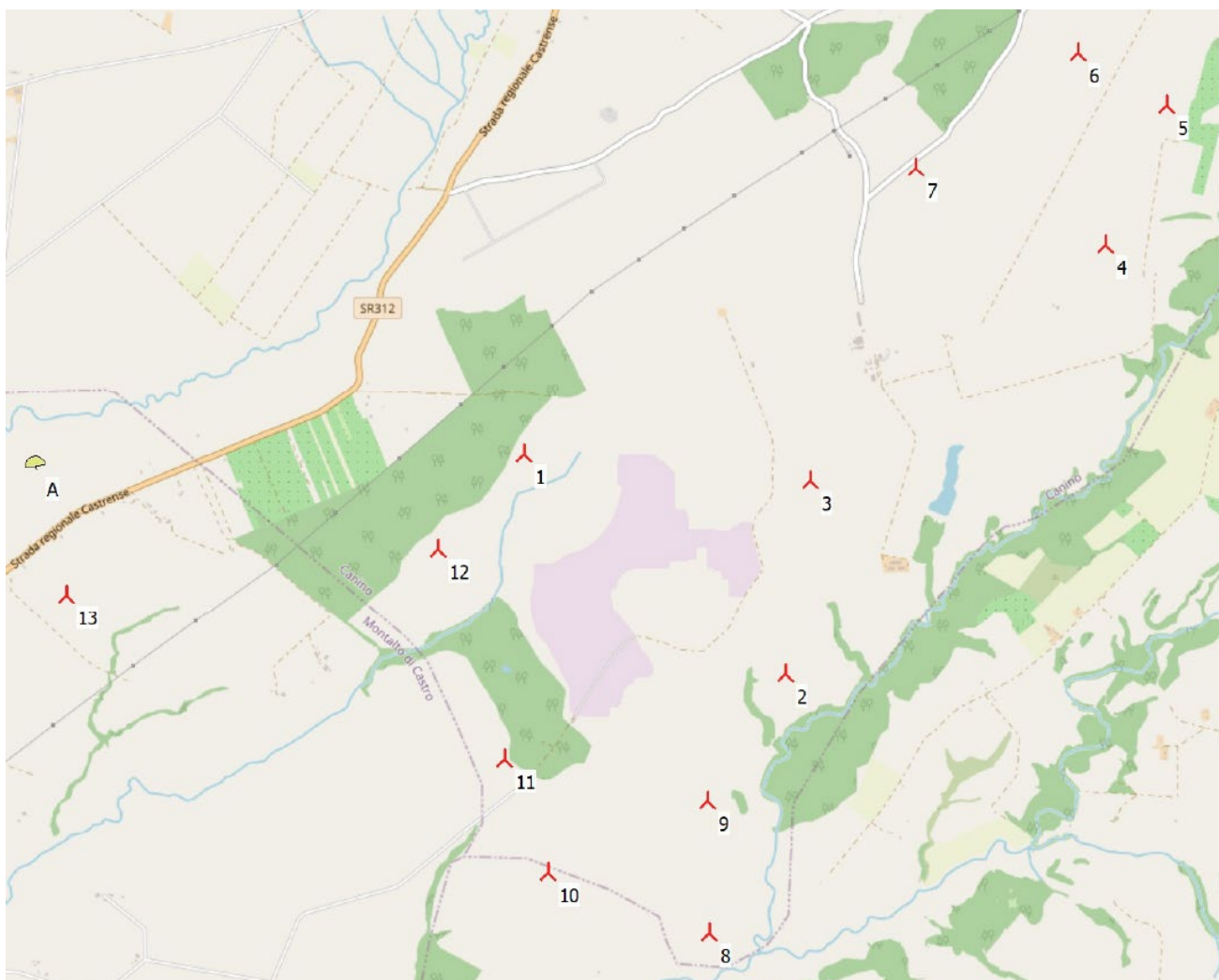


Figura 3 -Indicazione dei recettori

La distanza intercorrente tra il recettore A in oggetto e l'aerogeneratore più prossimo è pari a circa 760 m.

In relazione a ciò, si fa presente che già in fase di scelta delle aree sulle quali ubicare l'impianto si è cercato di allontanarsi il più possibile dall'area urbana e dalle abitazioni ed edifici ritenuti sensibili.

Tale fascia è stata definita in fase di progetto al fine di garantire il rispetto dei limiti in merito non solo all'ombreggiamento ma anche agli impatti acustici, elettromagnetici e in termini di calcolo della gittata.



Lo studio, i cui risultati in dettaglio sono riportati di seguito, è stato condotto con uno specifico software (WindPRO).

Nello studio ci si è posti nella condizione più sfavorevole possibile, in quanto si è considerato che:

- il sole risplende per tutta la giornata dall'alba al tramonto (cioè si è sempre in assenza di copertura nuvolosa);
- il piano di rotazione delle pale è sempre perpendicolare alla linea che passa per il sole e per l'aerogeneratore (l'aerogeneratore "insegue" il sole);
- l'aerogeneratore è sempre operativo.

Allo stesso tempo, si è trascurata la presenza degli alberi e di altri ostacoli che bordano le strade "intercettando" l'ombra degli aerogeneratori riducendo il fastidio del flickering.

Ciò significa che i risultati ai quali si perverrà sono ampiamente cautelativi.

3.2 BASE DATI E PARAMETRI DI CALCOLO

In base alla metodologia descritta nei paragrafi precedenti, sono stati utilizzati i seguenti dati di input per impostare il modello di simulazione per la valutazione del fenomeno di Shadow-Flickering degli aerogeneratori di progetto:

- Il DTM o Modello del terreno digitale** per caratterizzare l'orografia è stato estrapolato dal grid disponibile in download dal SIT della Regione Puglia, georeferenziato, sovrapposto, confrontato e adeguato con le curve di livello presenti sulla cartografia ufficiale CTR 1:5.000 con uno step di 5 m. Il modello digitale ottenuto copre un'area sufficiente ad inglobare l'area del parco eolico di progetto e trova un buon riscontro con l'andamento orografico verificato in sito.
- Posizioni geografiche di recettori con dettaglio dimensionale delle aree più esposte.** Sono i ricettori individuati dallo studio acustico e classificati secondo la loro abitabilità e destinazione d'uso. Per tutti i ricettori si è ritenuto opportuno usare l'ipotesi di cautela della modalità "green house mode". Questa scelta è stata operata poiché in talune circostanze anche lo spazio antistante le strutture può essere considerato o adibito a luogo di riposo e relax. La scelta di una singola finestra o di una facciata in alcune condizioni potrebbe risultare riduttiva allo scopo di una vera valutazione d'impatto.
- Posizioni geografiche delle turbine eoliche e loro caratteristiche dimensionali**
Gli aerogeneratori di progetto con le loro caratteristiche dimensionali e tecnologiche
- Nessun ostacolo naturale o artificiale è stato modellato.**



4. RISULTATI DEL CALCOLO DELL'EVOLUZIONE DELL'OMBRA

Nella procedura "Worst case" il fenomeno di shadow/flickering viene calcolato non tenendo conto delle condizioni di soleggiamento del sito e del vento, dati che allo stato dell'arte per il sito in questione non sono disponibili. Invece se avessimo di dati di cui sopra potremmo calcolare il fenomeno di shadow/flickering con la metodologia ("real case"), che secondo altri casi simili comporterebbe la riduzione del fenomeno ad 1/3 dei valori, il quale seppur più realistico, è comunque sovrastimato poiché non tiene conto della presenza di nubi e di vegetazione ad alto fusto. Dalle simulazioni effettuate, si evince che gli aerogeneratori di progetto generano maggiormente il fenomeno di shadow/flickering sul recettore "k" individuato nell'analisi che, nelle ipotesi di "Worst case", subisce il fenomeno per un periodo che si avvicina o supera di poco le 100 ore/anno, per tutti gli altri rimanenti recettori considerati invece, l'effetto calcolato è più modesto e/o comunque meno rilevante fino a divenire irrilevante e in alcuni casi nullo.

Con le considerazioni di cui sopra, ovvero prevedendo la riduzione ad 1/3 si avranno valori sicuramente più ridotti per i ricettori con k= 33 ore/anno e comunque sono abitati meno di 4 ore giorno e quindi la probabilità di accadimento si riduce quasi al nulla.

È stato elaborato un calendario dell'ombra riportato in appendice (rif. Appendice Calendar), che riporta in maniera grafica giorno per giorno, per tutto l'anno, la durata giornaliera del fenomeno, l'orario di inizio e di fine del fenomeno, nelle condizioni di caso reale. Dalla lettura del "Calendar" si legge che il fenomeno dell'ombreggiamento, si esplica sui recettori con intensità maggiore nel periodo compreso tra Gennaio, Marzo, Aprile, Settembre, Novembre e Dicembre nelle prime ore della giornata, oppure al primo pomeriggio. Nella figura che segue è riportato a titolo di esempio il grafico "calendar" di un recettore: le macchie individuano i momenti di shadow, la posizione nel grafico individua tempo e durata del fenomeno, il colore della macchia individua la turbina che causa il fenomeno.

L'allegato 2 riporta il dettaglio analitico di quanto espresso dal grafico precedente con gli specifici orari di inizio e di fine del fenomeno. A seguire è altresì riportata la sintesi grafica annuale (come mostra l'immagine precedente) dell'apporto di ombreggiamento a carico di ogni recettore ed il/gli aerogeneratore/i responsabile/i del fenomeno.

E' stata inoltre elaborata una mappa (report Map, Allegato 3) in cui vengono riportate, con diverse gradazioni di colore, le zone soggette ad una determinata durata del fenomeno dell'ombreggiamento oltre all'estensione areale nella quale il fenomeno risulta significativo.

Il fenomeno dell'ombreggiamento interessa marginalmente tratti di strade comunali e/o private per un numero di ore all'anno del tutto irrilevanti e cioè pari ad un massimo di 30 ore/anno, ma solo in alcuni tratti. Preme tuttavia evidenziare che nelle simulazioni non si è tenuto conto della possibile presenza di vegetazione capace di offrire un effetto "barriera" ai recettori e/o alle strade limitrofe. Inoltre, la percezione dell'impianto dalla strada risulterebbe essere "in movimento" e quindi legata alla breve permanenza delle automobili in transito, per cui il fastidio indotto sarebbe temporalmente limitato. A questo si aggiunge che le simulazioni sono state effettuate assumendo le "condizioni peggiori", sovrastimando pertanto l'effetto di flickering.



5. CONCLUSIONI E RACCOMANDAZIONI

In conclusione, si può affermare che i risultati ottenuti dell'elaborazione evidenziano, pur considerando le condizioni più sfavorevoli, che le turbine di progetto generano effetti di shadow flickering **i cui impatti risultano essere sostanzialmente nulli.**

In ogni caso è comunque da rimarcare l'effetto di sovrastima dovuto al grado di cautela utilizzato per la simulazione che non tiene in conto di tutte le possibili fonti di attenuazione dell'effetto cui ogni recettore è (o può essere) soggetto quali presenza di alberi, ostacoli, siepi e quant'altro possa attenuare il fenomeno dell'evoluzione giornaliera dell'ombra.

6. ELENCO ALLEGATI

1. Main result: quadro sintetico dei risultati di calcolo;
2. Calendar: analisi giornaliera dell'effetto "flickering" ricevuto da ogni recettore;
3. Calendar, graphical: grafico dell'analisi giornaliera dell'effetto "flickering" ricevuto da ogni recettore;
4. Calendar per WTG: analisi giornaliera dell'effetto "flickering" indotto da ogni aerogeneratore sui recettori;
5. Calendar per WTG, graphical: grafico dell'analisi giornaliera dell'effetto "flickering" indotto da ogni aerogeneratore sui recettori;
6. Map: mappa dei recettori.



SHADOW - Main Result

Calculation: WON016_ShadowFlickering
Assumptions for shadow calculations

Maximum distance for influence
Calculate only when more than 20 % of sun is covered by the blade
Please look in WTG table

Minimum sun height over horizon for influence 3 °
Day step for calculation 1 days
Time step for calculation 1 minutes
The calculated times are "worst case" given by the following assumptions:
The sun is shining all the day, from sunrise to sunset
The rotor plane is always perpendicular to the line from the WTG to the sun
The WTG is always operating

A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:
Height contours used: Elevation Grid Data Object: WON016_luglio_EMDGrid_...
Receptor grid resolution: 1.0 m

All coordinates are in
UTM (north)-WGS84 Zone: 32

WTGs

	Easting	Northing	Z	Row data/Description	WTG type			Shadow data				
					Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Calculation distance [m]	RPM [RPM]
1	722,670	4,697,611	87.7	VESTAS V172-7.2 7200 172.0 !O! ... Yes	Yes	VESTAS	V172-7.2-7,200	7,200	172.0	150.0	2,039	12.1
2	724,215	4,696,400	86.0	VESTAS V172-7.2 7200 172.0 !O! ... Yes	Yes	VESTAS	V172-7.2-7,200	7,200	172.0	150.0	2,039	12.1
3	724,320	4,697,511	115.6	VESTAS V172-7.2 7200 172.0 !O! ... Yes	Yes	VESTAS	V172-7.2-7,200	7,200	172.0	150.0	2,039	12.1
4	725,972	4,698,916	116.7	VESTAS V172-7.2 7200 172.0 !O! ... Yes	Yes	VESTAS	V172-7.2-7,200	7,200	172.0	150.0	2,039	12.1
5	726,298	4,699,724	124.6	VESTAS V172-7.2 7200 172.0 !O! ... Yes	Yes	VESTAS	V172-7.2-7,200	7,200	172.0	150.0	2,039	12.1
6	725,778	4,700,010	126.8	VESTAS V172-7.2 7200 172.0 !O! ... Yes	Yes	VESTAS	V172-7.2-7,200	7,200	172.0	150.0	2,039	12.1
7	724,864	4,699,319	120.0	VESTAS V172-7.2 7200 172.0 !O! ... Yes	Yes	VESTAS	V172-7.2-7,200	7,200	172.0	150.0	2,039	12.1
8	723,818	4,694,907	56.0	VESTAS V172-7.2 7200 172.0 !O! ... Yes	Yes	VESTAS	V172-7.2-7,200	7,200	172.0	150.0	2,039	12.1
9	723,786	4,695,658	78.8	VESTAS V172-7.2 7200 172.0 !O! ... Yes	Yes	VESTAS	V172-7.2-7,200	7,200	172.0	150.0	2,039	12.1
10	722,877	4,695,220	86.6	VESTAS V172-7.2 7200 172.0 !O! ... Yes	Yes	VESTAS	V172-7.2-7,200	7,200	172.0	150.0	2,039	12.1
11	722,609	4,695,860	85.0	VESTAS V172-7.2 7200 172.0 !O! ... Yes	Yes	VESTAS	V172-7.2-7,200	7,200	172.0	150.0	2,039	12.1
12	722,192	4,697,052	88.8	VESTAS V172-7.2 7200 172.0 !O! ... Yes	Yes	VESTAS	V172-7.2-7,200	7,200	172.0	150.0	2,039	12.1
13	720,067	4,696,715	64.8	VESTAS V172-7.2 7200 172.0 !O! ... Yes	Yes	VESTAS	V172-7.2-7,200	7,200	172.0	150.0	2,039	12.1

Shadow receptor-Input

No.	Easting	Northing	Z	Width	Height	Elevation	Degrees from	Slope of	Direction mode	Eye height
			[m]	[m]	[m]	a.g.l. [m]	south cw [°]	window [°]		(ZVI) a.g.l. [m]
A	719,867	4,697,450	62.3	1.0	1.0	1.0	-10.0	90.0	Fixed direction	2.0

Calculation Results

Shadow receptor

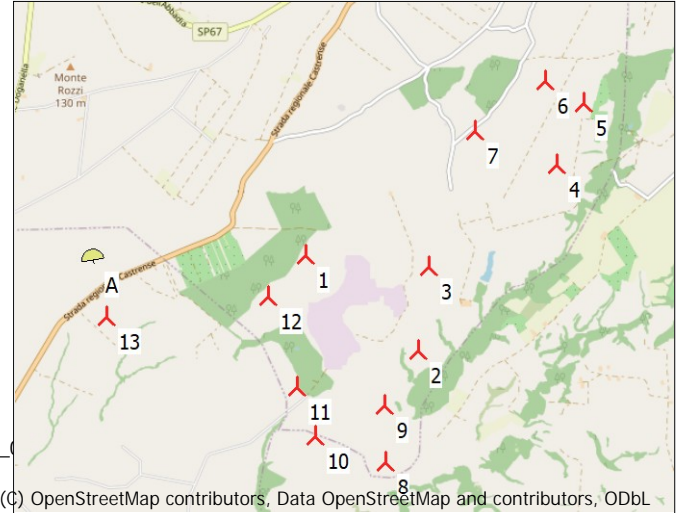
Shadow, worst case

No.	Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]
A	0:00	0	0:00

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

No.	Name	Worst case [h/year]
1	VESTAS V172-7.2 7200 172.0 !O! hub: 150.0 m (TOT: 236.0 m) (1)	0:00
2	VESTAS V172-7.2 7200 172.0 !O! hub: 150.0 m (TOT: 236.0 m) (2)	0:00
3	VESTAS V172-7.2 7200 172.0 !O! hub: 150.0 m (TOT: 236.0 m) (3)	0:00
4	VESTAS V172-7.2 7200 172.0 !O! hub: 150.0 m (TOT: 236.0 m) (4)	0:00
5	VESTAS V172-7.2 7200 172.0 !O! hub: 150.0 m (TOT: 236.0 m) (5)	0:00

To be continued on next page...



(C) OpenStreetMap contributors, Data OpenStreetMap and contributors, ODbL

Scale 1:100,000
New WTG (red icon)
Shadow receptor (yellow icon)

Project:

WON016_luglio

Licensed user:

Iron solar s.r.l.

via Lanzone, 31

IT-20122 Milano

+393487125089

Fabio Paccapelo / francesca.saccarola@hopegroup.it

Calculated:

03/08/2023 07:10/3.6.361

SHADOW - Main Result

Calculation: WON016_ShadowFlickering

...continued from previous page

No.	Name	Worst case [h/year]
6	VESTAS V172-7.2 7200 172.0 !O! hub: 150.0 m (TOT: 236.0 m) (6)	0:00
7	VESTAS V172-7.2 7200 172.0 !O! hub: 150.0 m (TOT: 236.0 m) (7)	0:00
8	VESTAS V172-7.2 7200 172.0 !O! hub: 150.0 m (TOT: 236.0 m) (8)	0:00
9	VESTAS V172-7.2 7200 172.0 !O! hub: 150.0 m (TOT: 236.0 m) (9)	0:00
10	VESTAS V172-7.2 7200 172.0 !O! hub: 150.0 m (TOT: 236.0 m) (10)	0:00
11	VESTAS V172-7.2 7200 172.0 !O! hub: 150.0 m (TOT: 236.0 m) (11)	0:00
12	VESTAS V172-7.2 7200 172.0 !O! hub: 150.0 m (TOT: 236.0 m) (12)	0:00
13	VESTAS V172-7.2 7200 172.0 !O! hub: 150.0 m (TOT: 236.0 m) (13)	0:00

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

SHADOW - Calendar

Calculation: WON016_ShadowFlickering Shadow receptor: A - Shadow Receptor: 1.0 × 1.0 Azimuth: -10.0° Slope: 90.0° (1)
Assumptions for shadow calculations

The calculated times are "worst case" given by the following assumptions:

- The sun is shining all the day, from sunrise to sunset
- The rotor plane is always perpendicular to the line from the WTG to the sun
- The WTG is always operating

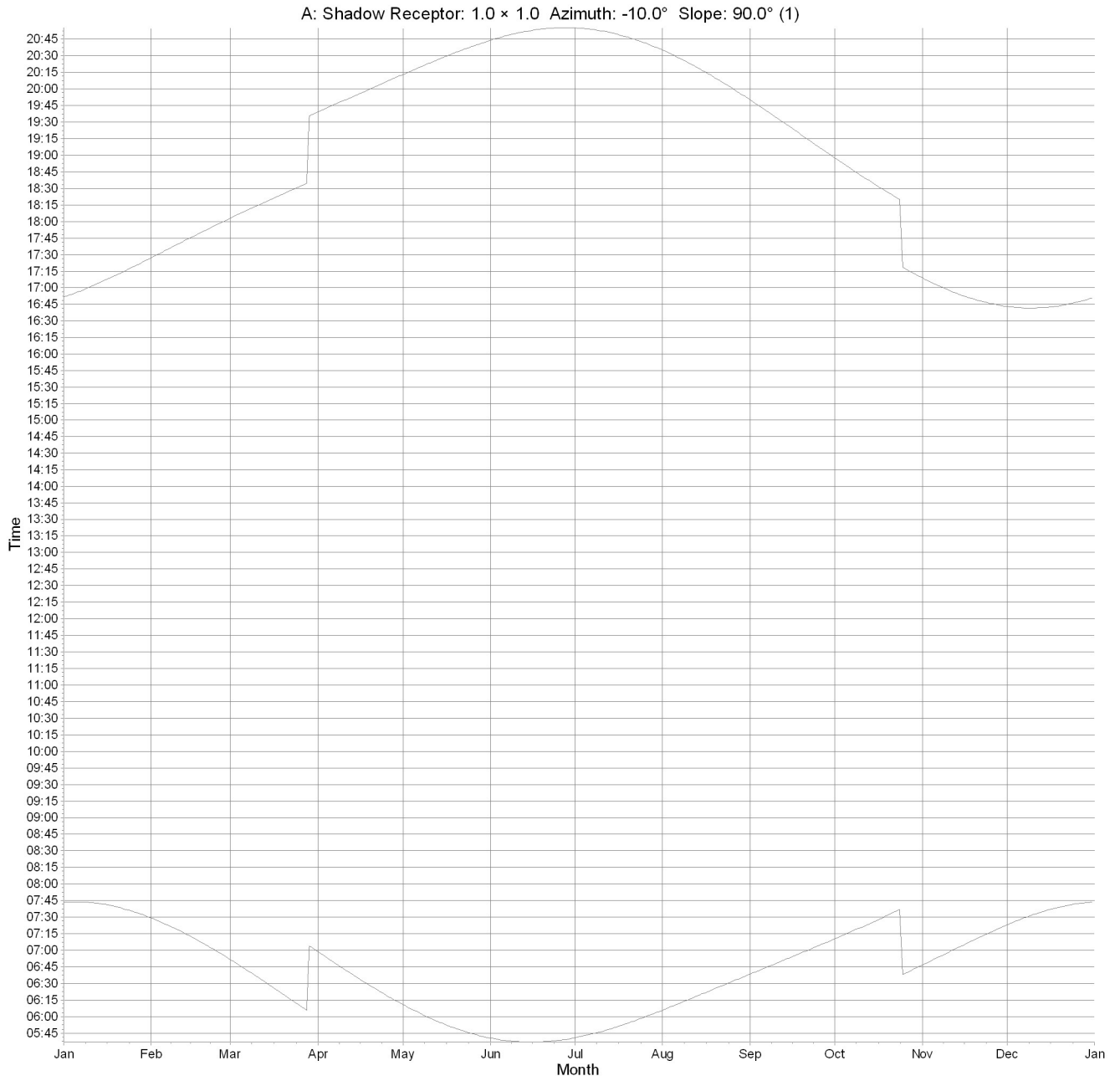
	January	February	March	April	May	June	July	August	September	October	November	December
1	07:43 16:51	07:29 17:27	06:51 18:03	06:58 19:39	06:10 20:12	05:40 20:44	05:40 20:55	06:05 20:35	06:38 19:50	07:10 18:57	06:46 17:08	07:22 16:42
2	07:43 16:52	07:28 17:28	06:49 18:04	06:56 19:40	06:09 20:14	05:39 20:44	05:41 20:55	06:06 20:33	06:39 19:48	07:11 18:55	06:47 17:07	07:24 16:42
3	07:43 16:53	07:27 17:29	06:48 18:05	06:55 19:41	06:08 20:15	05:39 20:45	05:41 20:54	06:07 20:32	06:40 19:46	07:12 18:54	06:49 17:06	07:25 16:42
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31	07:30 17:25		07:00 19:38		05:40 20:43		06:04 20:36	06:37 19:51		06:45 17:10		07:43 16:50
Potential sun hours Total, worst case	293	295	369	400	452	457	463	431	376	344	295	283

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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SHADOW - Calendar, graphical

Calculation: WON016_ShadowFlickering Shadow receptor: A - Shadow Receptor: 1.0 × 1.0 Azimuth: -10.0° Slope: 90.0° (1)



SHADOW - Calendar per WTG

Calculation: WON016_ShadowFlickering WTG: 1 - VESTAS V172-7.2 7200 172.0 IO! hub: 150.0 m (TOT: 236.0 m) (1)
Assumptions for shadow calculations

The calculated times are "worst case" given by the following assumptions:

- The sun is shining all the day, from sunrise to sunset
- The rotor plane is always perpendicular to the line from the WTG to the sun
- The WTG is always operating

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:43 16:51	07:28 17:27	06:51 18:02	06:58 19:39	06:10 20:12	05:40 20:43	05:40 20:55	06:05 20:34	06:38 19:49	07:10 18:57	06:46 17:08	07:22 16:42
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31	07:29 17:25		07:00 19:37		05:40 20:43		06:04 20:36	06:37 19:51		07:43 17:10		07:43 16:50
Potential sun hours	293	295	369	400	452	457	463	431	376	344	295	283
Sum of minutes with flicker	0	0	0	0	0	0	0	0	0	0	0	0

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

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

SHADOW - Calendar per WTG

Calculation: WON016_ShadowFlickering WTG: 2 - VESTAS V172-7.2 7200 172.0 IO! hub: 150.0 m (TOT: 236.0 m) (2)
Assumptions for shadow calculations

The calculated times are "worst case" given by the following assumptions:

- The sun is shining all the day, from sunrise to sunset
- The rotor plane is always perpendicular to the line from the WTG to the sun
- The WTG is always operating

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:43 16:51	07:28 17:26	06:51 18:02	06:58 19:38	06:10 20:12	05:40 20:43	05:40 20:54	06:05 20:34	06:38 19:49	07:10 18:57	06:46 17:08	07:22 16:42
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27	07:33 17:20	06:54 18:00	06:07 18:33	06:16 20:08	05:43 20:39	05:38 20:55	06:00 20:40	06:32 19:58	07:05 19:04	07:39 17:15	07:18 16:44	07:42 16:47
28	07:32 17:21	06:52 18:01	06:05 18:34	06:14 20:09	05:42 20:40	05:39 20:55	06:01 20:39	06:33 19:56	07:06 19:02	07:40 17:14	07:19 16:43	07:42 16:48
29	07:31 17:23		07:03 19:35	06:13 20:10	05:41 20:41	05:39 20:55	06:02 20:38	06:34 19:54	07:07 19:00	07:41 17:12	07:20 16:43	07:42 16:48
30	07:30 17:24		07:01 19:36	06:12 20:11	05:41 20:42	05:39 20:55	06:03 20:37	06:36 19:53	07:08 18:59	07:42 17:11	07:21 16:43	07:43 16:49
31	07:29 17:25		07:00 19:37		05:40 20:42		06:04 20:35	06:37 19:51		06:45 17:09		07:43 16:50
Potential sun hours	294	295	369	400	452	457	463	431	376	344	295	283
Sum of minutes with flicker	0	0	0	0	0	0	0	0	0	0	0	0

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

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

SHADOW - Calendar per WTG

Calculation: WON016_ShadowFlickering WTG: 3 - VESTAS V172-7.2 7200 172.0 IO! hub: 150.0 m (TOT: 236.0 m) (3)
Assumptions for shadow calculations

The calculated times are "worst case" given by the following assumptions:

- The sun is shining all the day, from sunrise to sunset
- The rotor plane is always perpendicular to the line from the WTG to the sun
- The WTG is always operating

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:43 16:51	07:28 17:26	06:51 18:02	06:58 19:38	06:10 20:12	05:40 20:43	05:40 20:55	06:05 20:34	06:38 19:49	07:10 18:57	06:46 17:08	07:22 16:42
2	07:43 16:52	07:27 17:28	06:49 18:04	06:56 19:40	06:09 20:13	05:39 20:44	05:40 20:54	06:06 20:33	06:39 19:48	07:11 18:55	06:47 17:07	07:23 16:42
3	07:43 16:53	07:26 17:29	06:47 18:05	06:54 19:41	06:07 20:14	05:39 20:45	05:41 20:54	06:07 20:32	06:40 19:46	07:12 18:53	06:48 17:06	07:24 16:42
4	07:43 16:54	07:25 17:30	06:46 18:06	06:53 19:42	06:06 20:16	05:38 20:46	05:41 20:54	06:08 20:31	06:41 19:44	07:13 18:52	06:50 17:04	07:25 16:41
5	07:43 16:55	07:24 17:32	06:44 18:07	06:51 19:43	06:05 20:17	05:38 20:46	05:42 20:54	06:09 20:30	06:42 19:43	07:14 18:50	06:51 17:03	07:26 16:41
6	07:43 16:56	07:23 17:33	06:43 18:08	06:49 19:44	06:04 20:18	05:38 20:47	05:43 20:53	06:10 20:28	06:43 19:41	07:15 18:48	06:52 17:02	07:27 16:41
7	07:43 16:56	07:22 17:34	06:41 18:10	06:48 19:45	06:02 20:19	05:37 20:48	05:43 20:53	06:11 20:27	06:44 19:39	07:16 18:46	06:53 17:01	07:28 16:41
8	07:43 16:58	07:21 17:36	06:39 18:11	06:46 19:46	06:01 20:20	05:37 20:48	05:44 20:53	06:12 20:26	06:45 19:37	07:17 18:45	06:55 17:00	07:29 16:41
9	07:43 16:59	07:19 17:37	06:38 18:12	06:44 19:47	06:00 20:21	05:37 20:49	05:45 20:52	06:13 20:24	06:46 19:36	07:18 18:43	06:56 16:59	07:30 16:41
10	07:43 17:00	07:18 17:38	06:36 18:13	06:43 19:49	05:59 20:22	05:37 20:49	05:45 20:52	06:14 20:23	06:47 19:34	07:20 18:41	06:57 16:57	07:31 16:41
11	07:42 17:01	07:17 17:40	06:34 18:14	06:41 19:50	05:57 20:23	05:36 20:50	05:46 20:52	06:15 20:22	06:48 19:32	07:21 18:40	06:58 16:56	07:32 16:41
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31	07:29 17:25		07:00 19:37		05:40 20:42		06:04 20:35	06:37 19:51		06:45 17:09		07:43 16:50
Potential sun hours	293	295	369	400	452	457	463	431	376	344	295	283
Sum of minutes with flicker	0	0	0	0	0	0	0	0	0	0	0	0

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

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

SHADOW - Calendar per WTG

Calculation: WON016_ShadowFlickering WTG: 4 - VESTAS V172-7.2 7200 172.0 IO! hub: 150.0 m (TOT: 236.0 m) (4)
Assumptions for shadow calculations

The calculated times are "worst case" given by the following assumptions:

- The sun is shining all the day, from sunrise to sunset
- The rotor plane is always perpendicular to the line from the WTG to the sun
- The WTG is always operating

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:43 16:51	07:28 17:26	06:51 18:02	06:58 19:38	06:10 20:12	05:40 20:43	05:40 20:54	06:05 20:34	06:38 19:49	07:10 18:57	06:46 17:08	07:22 16:42
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31	07:29 17:25		06:59 19:37		05:40 20:42		06:04 20:35	06:36 19:51		06:45 17:09		07:43 16:50
Potential sun hours	293	295	369	400	452	457	463	431	376	344	295	283
Sum of minutes with flicker	0	0	0	0	0	0	0	0	0	0	0	0

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

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

SHADOW - Calendar per WTG

Calculation: WON016_ShadowFlickering WTG: 5 - VESTAS V172-7.2 7200 172.0 IO! hub: 150.0 m (TOT: 236.0 m) (5)
Assumptions for shadow calculations

The calculated times are "worst case" given by the following assumptions:

- The sun is shining all the day, from sunrise to sunset
- The rotor plane is always perpendicular to the line from the WTG to the sun
- The WTG is always operating

	January	February	March	April	May	June	July	August	September	October	November	December
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16	07:40 17:06	07:10 17:46	06:26 18:20	06:33 19:55	05:52 20:28	05:36 20:52	05:50 20:49	06:21 20:15	06:53 19:23	07:26 18:31	07:05 16:51	07:36 16:42
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31	07:29 17:25		06:59 19:37		05:40 20:42		06:04 20:35	06:36 19:51		06:45 17:09		07:43 16:50
Potential sun hours	293	295	369	400	452	457	463	431	376	344	295	283
Sum of minutes with flicker	0	0	0	0	0	0	0	0	0	0	0	0

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

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

SHADOW - Calendar per WTG

Calculation: WON016_ShadowFlickering WTG: 6 - VESTAS V172-7.2 7200 172.0 IO! hub: 150.0 m (TOT: 236.0 m) (6)
Assumptions for shadow calculations

The calculated times are "worst case" given by the following assumptions:

- The sun is shining all the day, from sunrise to sunset
- The rotor plane is always perpendicular to the line from the WTG to the sun
- The WTG is always operating

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:43 16:51	07:28 17:26	06:51 18:02	06:58 19:38	06:10 20:12	05:40 20:43	05:40 20:55	06:05 20:34	06:38 19:49	07:10 18:57	06:46 17:08	07:22 16:42
2	07:43 16:52	07:27 17:28	06:49 18:03	06:56 19:40	06:09 20:13	05:39 20:44	05:40 20:54	06:06 20:33	06:39 19:48	07:11 18:55	06:47 17:07	07:23 16:42
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31	07:29 17:25		06:59 19:37		05:40 20:42		06:04 20:35	06:36 19:51		06:45 17:09		07:43 16:50
Potential sun hours	293	295	369	400	452	457	463	431	376	344	295	283
Sum of minutes with flicker	0	0	0	0	0	0	0	0	0	0	0	0

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

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

SHADOW - Calendar per WTG

Calculation: WON016_ShadowFlickering WTG: 7 - VESTAS V172-7.2 7200 172.0 IO! hub: 150.0 m (TOT: 236.0 m) (7)
Assumptions for shadow calculations

The calculated times are "worst case" given by the following assumptions:

- The sun is shining all the day, from sunrise to sunset
- The rotor plane is always perpendicular to the line from the WTG to the sun
- The WTG is always operating

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:43 16:51	07:28 17:26	06:51 18:02	06:58 19:38	06:10 20:12	05:40 20:43	05:40 20:55	06:05 20:34	06:38 19:49	07:10 18:57	06:46 17:08	07:22 16:42
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Potential sun hours	293	295	369	400	452	457	463	431	376	344	295	283
Sum of minutes with flicker	0	0	0	0	0	0	0	0	0	0	0	0

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

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

SHADOW - Calendar per WTG

Calculation: WON016_ShadowFlickering WTG: 8 - VESTAS V172-7.2 7200 172.0 IO! hub: 150.0 m (TOT: 236.0 m) (8)
Assumptions for shadow calculations

The calculated times are "worst case" given by the following assumptions:

- The sun is shining all the day, from sunrise to sunset
- The rotor plane is always perpendicular to the line from the WTG to the sun
- The WTG is always operating

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:43 16:51	07:28 17:27	06:51 18:02	06:58 19:38	06:10 20:12	05:40 20:43	05:40 20:54	06:05 20:34	06:38 19:49	07:10 18:57	06:46 17:08	07:22 16:42
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Potential sun hours	294	295	369	400	452	457	463	430	376	344	295	283
Sum of minutes with flicker	0	0	0	0	0	0	0	0	0	0	0	0

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

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

SHADOW - Calendar per WTG

Calculation: WON016_ShadowFlickering WTG: 9 - VESTAS V172-7.2 7200 172.0 IO! hub: 150.0 m (TOT: 236.0 m) (9)
Assumptions for shadow calculations

The calculated times are "worst case" given by the following assumptions:

- The sun is shining all the day, from sunrise to sunset
- The rotor plane is always perpendicular to the line from the WTG to the sun
- The WTG is always operating

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:43 16:51	07:28 17:27	06:51 18:02	06:58 19:38	06:10 20:12	05:40 20:43	05:40 20:54	06:05 20:34	06:38 19:49	07:10 18:57	06:46 17:08	07:22 16:42
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Potential sun hours	294	295	369	400	452	457	463	431	376	344	295	283
Sum of minutes with flicker	0	0	0	0	0	0	0	0	0	0	0	0

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

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

SHADOW - Calendar per WTG

Calculation: WON016_ShadowFlickering WTG: 10 - VESTAS V172-7.2 7200 172.0 !O! hub: 150.0 m (TOT: 236.0 m) (10)
Assumptions for shadow calculations

The calculated times are "worst case" given by the following assumptions:

- The sun is shining all the day, from sunrise to sunset
- The rotor plane is always perpendicular to the line from the WTG to the sun
- The WTG is always operating

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:43 16:51	07:28 17:27	06:51 18:02	06:58 19:39	06:10 20:12	05:40 20:43	05:40 20:55	06:05 20:34	06:38 19:49	07:10 18:57	06:46 17:08	07:22 16:42
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28	07:32 17:21	06:52 18:01	06:05 18:34	06:14 20:09	05:42 20:40	05:39 20:55	06:01 20:39	06:33 19:56	07:06 19:02	07:40 17:14	07:19 16:44	07:42 16:48
29	07:31 17:23		07:03 19:35	06:13 20:10	05:42 20:41	05:39 20:55	06:02 20:38	06:35 19:54	07:07 19:00	07:41 17:12	07:20 16:43	07:42 16:48
30	07:30 17:24		07:01 19:36	06:12 20:11	05:41 20:42	05:40 20:55	06:03 20:37	06:36 19:53	07:09 18:59	07:42 17:11	07:21 16:43	07:43 16:49
31	07:29 17:25		07:00 19:37		05:40 20:43		06:04 20:35	06:37 19:51		06:45 17:10		07:43 16:50
Potential sun hours	294	295	369	400	452	457	463	431	376	344	295	283
Sum of minutes with flicker	0	0	0	0	0	0	0	0	0	0	0	0

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

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

SHADOW - Calendar per WTG

Calculation: WON016_ShadowFlickering WTG: 11 - VESTAS V172-7.2 7200 172.0 !O! hub: 150.0 m (TOT: 236.0 m) (11)
Assumptions for shadow calculations

The calculated times are "worst case" given by the following assumptions:

- The sun is shining all the day, from sunrise to sunset
- The rotor plane is always perpendicular to the line from the WTG to the sun
- The WTG is always operating

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:43 16:51	07:28 17:27	06:51 18:02	06:58 19:39	06:10 20:12	05:40 20:43	05:40 20:55	06:05 20:34	06:38 19:49	07:10 18:57	06:46 17:08	07:22 16:42
2	07:43 16:52	07:27 17:28	06:49 18:04	06:56 19:40	06:09 20:13	05:39 20:44	05:41 20:54	06:06 20:33	06:39 19:48	07:11 18:55	06:47 17:07	07:23 16:42
3	07:43 16:53	07:26 17:29	06:48 18:05	06:55 19:41	06:08 20:15	05:39 20:45	05:41 20:54	06:07 20:32	06:40 19:46	07:12 18:53	06:48 17:06	07:24 16:42
4	07:43 16:54	07:25 17:31	06:46 18:06	06:53 19:42	06:06 20:16	05:38 20:46	05:42 20:54	06:08 20:31	06:41 19:44	07:13 18:52	06:50 17:04	07:25 16:42
5	07:43 16:55	07:24 17:32	06:44 18:07	06:51 19:43	06:05 20:17	05:38 20:46	05:42 20:54	06:09 20:30	06:42 19:43	07:14 18:50	06:51 17:03	07:26 16:41
6	07:43 16:56	07:23 17:33	06:43 18:08	06:49 19:44	06:04 20:18	05:38 20:47	05:43 20:54	06:10 20:28	06:43 19:41	07:15 18:48	06:52 17:02	07:27 16:41
7	07:43 16:57	07:22 17:34	06:41 18:10	06:48 19:45	06:02 20:19	05:37 20:48	05:43 20:53	06:11 20:27	06:44 19:39	07:16 18:47	06:53 17:01	07:28 16:41
8	07:43 16:58	07:21 17:36	06:39 18:11	06:46 19:46	06:01 20:20	05:37 20:48	05:44 20:53	06:12 20:26	06:45 19:37	07:17 18:45	06:55 17:00	07:29 16:41
9	07:43 16:59	07:19 17:37	06:38 18:12	06:44 19:48	06:00 20:21	05:37 20:49	05:45 20:52	06:13 20:25	06:46 19:36	07:19 18:43	06:56 16:59	07:30 16:41
10	07:43 17:00	07:18 17:38	06:36 18:13	06:43 19:49	05:59 20:22	05:37 20:50	05:45 20:52	06:14 20:23	06:47 19:34	07:20 18:42	06:57 16:58	07:31 16:41
11	07:42 17:01	07:17 17:40	06:34 18:14	06:41 19:50	05:58 20:23	05:36 20:50	05:46 20:52	06:15 20:22	06:48 19:32	07:21 18:40	06:58 16:56	07:32 16:41
12	07:42 17:02	07:16 17:41	06:33 18:16	06:39 19:51	05:56 20:24	05:36 20:51	05:47 20:51	06:17 20:20	06:49 19:30	07:22 18:38	07:00 16:55	07:33 16:41
13	07:42 17:03	07:14 17:42	06:31 18:17	06:38 19:52	05:55 20:25	05:36 20:51	05:48 20:51	06:18 20:19	06:50 19:29	07:23 18:37	07:01 16:54	07:34 16:41
14	07:41 17:04	07:13 17:44	06:29 18:18	06:36 19:53	05:54 20:26	05:36 20:52	05:48 20:50	06:19 20:18	06:51 19:27	07:24 18:35	07:02 16:53	07:35 16:41
15	07:41 17:05	07:12 17:45	06:27 18:19	06:34 19:54	05:53 20:28	05:36 20:52	05:49 20:49	06:20 20:16	06:53 19:25	07:25 18:33	07:03 16:53	07:35 16:42
16	07:40 17:06	07:10 17:46	06:26 18:20	06:33 19:55	05:52 20:29	05:36 20:52	05:50 20:49	06:21 20:15	06:54 19:23	07:27 18:32	07:05 16:52	07:36 16:42
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22	07:37 17:14	07:02 17:54	06:15 18:27	06:23 20:02	05:47 20:35	05:37 20:54	05:55 20:44	06:27 20:06	07:00 19:13	07:34 18:22	07:12 16:47	07:40 16:44
23	07:36 17:15	07:00 17:55	06:14 18:28	06:22 20:03	05:46 20:35	05:37 20:54	05:56 20:43	06:28 20:04	07:01 19:11	07:35 18:21	07:13 16:46	07:40 16:45
24	07:36 17:16	06:59 17:56	06:12 18:29	06:20 20:04	05:45 20:36	05:37 20:55	05:57 20:43	06:29 20:03	07:02 19:09	07:36 18:19	07:14 16:46	07:41 16:45
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27	07:33 17:20	06:54 18:00	06:07 18:33	06:16 20:08	05:43 20:39	05:38 20:55	06:00 20:40	06:32 19:58	07:05 19:04	07:39 17:15	07:18 16:44	07:42 16:47
28	07:32 17:21	06:52 18:01	06:05 18:34	06:14 20:09	05:42 20:40	05:39 20:55	06:01 20:39	06:33 19:56	07:06 19:02	07:40 17:14	07:19 16:44	07:42 16:48
29	07:31 17:23		07:03 19:35	06:13 20:10	05:42 20:41	05:39 20:55	06:02 20:38	06:35 19:54	07:07 19:00	07:41 17:12	07:20 16:43	07:42 16:48
30	07:30 17:24		07:01 19:36	06:12 20:11	05:41 20:42	05:40 20:55	06:03 20:37	06:36 19:53	07:09 18:59	07:42 17:11	07:21 16:43	07:43 16:49
31	07:29 17:25		07:00 19:37		05:40 20:43		06:04 20:36	06:37 19:51		06:45 17:10		07:43 16:50
Potential sun hours	294	295	369	400	452	457	463	431	376	344	295	283
Sum of minutes with flicker	0	0	0	0	0	0	0	0	0	0	0	0

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

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

SHADOW - Calendar per WTG

Calculation: WON016_ShadowFlickering WTG: 12 - VESTAS V172-7.2 7200 172.0 !O! hub: 150.0 m (TOT: 236.0 m) (12)
Assumptions for shadow calculations

The calculated times are "worst case" given by the following assumptions:

- The sun is shining all the day, from sunrise to sunset
- The rotor plane is always perpendicular to the line from the WTG to the sun
- The WTG is always operating

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:43 16:51	07:28 17:27	06:51 18:02	06:58 19:39	06:10 20:12	05:40 20:43	05:40 20:55	06:05 20:34	06:38 19:49	07:10 18:57	06:46 17:08	07:22 16:42
2	07:43 16:52	07:27 17:28	06:49 18:04	06:56 19:40	06:09 20:13	05:39 20:44	05:40 20:54	06:06 20:33	06:39 19:48	07:11 18:55	06:47 17:07	07:23 16:42
3	07:43 16:53	07:26 17:29	06:48 18:05	06:55 19:41	06:08 20:15	05:39 20:45	05:41 20:54	06:07 20:32	06:40 19:46	07:12 18:53	06:48 17:06	07:24 16:42
4	07:43 16:54	07:25 17:31	06:46 18:06	06:53 19:42	06:06 20:16	05:38 20:46	05:42 20:54	06:08 20:31	06:41 19:44	07:13 18:52	06:50 17:04	07:26 16:42
5	07:43 16:55	07:24 17:32	06:44 18:07	06:51 19:43	06:05 20:17	05:38 20:46	05:42 20:54	06:09 20:30	06:42 19:43	07:14 18:50	06:51 17:03	07:27 16:41
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23	07:36 17:15	07:00 17:55	06:14 18:28	06:22 20:03	05:46 20:36	05:37 20:54	05:56 20:43	06:28 20:04	07:01 19:11	07:35 18:21	07:13 16:46	07:40 16:45
24	07:36 17:16	06:59 17:56	06:12 18:29	06:20 20:04	05:45 20:36	05:37 20:55	05:57 20:43	06:29 20:03	07:02 19:09	07:36 18:19	07:14 16:46	07:41 16:45
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30	07:30 17:24		07:01 19:36	06:12 20:11	05:41 20:42	05:40 20:55	06:03 20:37	06:36 19:53	07:09 18:59	07:42 17:11	07:21 16:43	07:43 16:49
31	07:29 17:25		07:00 19:37		05:40 20:43		06:04 20:36	06:37 19:51		06:45 17:10		07:43 16:50
Potential sun hours	293	295	369	400	452	457	463	431	376	344	295	283
Sum of minutes with flicker	0	0	0	0	0	0	0	0	0	0	0	0

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

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

SHADOW - Calendar per WTG

Calculation: WON016_ShadowFlickering WTG: 13 - VESTAS V172-7.2 7200 172.0 !O! hub: 150.0 m (TOT: 236.0 m) (13)
Assumptions for shadow calculations

The calculated times are "worst case" given by the following assumptions:

- The sun is shining all the day, from sunrise to sunset
- The rotor plane is always perpendicular to the line from the WTG to the sun
- The WTG is always operating

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:43 16:51	07:29 17:27	06:51 18:03	06:58 19:39	06:10 20:12	05:40 20:43	05:40 20:55	06:05 20:35	06:38 19:50	07:10 18:57	06:46 17:08	07:22 16:42
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13	07:42 17:03	07:14 17:42	06:31 18:17	06:38 19:52	05:55 20:26	05:36 20:51	05:48 20:51	06:18 20:19	06:51 19:29	07:23 18:37	07:01 16:55	07:34 16:41
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15	07:41 17:05	07:12 17:45	06:28 18:19	06:35 19:54	05:53 20:28	05:36 20:52	05:49 20:50	06:20 20:16	06:53 19:25	07:26 18:33	07:04 16:53	07:35 16:42
16	07:41 17:07	07:10 17:46	06:26 18:20	06:33 19:56	05:52 20:29	05:36 20:53	05:50 20:49	06:21 20:15	06:54 19:24	07:27 18:32	07:05 16:52	07:36 16:42
17	07:40 17:08	07:09 17:48	06:24 18:22	06:31 19:57	05:51 20:30	05:36 20:53	05:51 20:48	06:22 20:13	06:55 19:22	07:28 18:30	07:06 16:51	07:37 16:42
18	07:40 17:09	07:08 17:49	06:22 18:23	06:30 19:58	05:50 20:31	05:36 20:53	05:52 20:48	06:23 20:12	06:56 19:20	07:29 18:29	07:07 16:50	07:38 16:43
19	07:39 17:10	07:06 17:50	06:21 18:24	06:28 19:59	05:49 20:32	05:36 20:54	05:53 20:47	06:24 20:10	06:57 19:18	07:30 18:27	07:08 16:49	07:38 16:43
20	07:38 17:11	07:05 17:51	06:19 18:25	06:27 20:00	05:48 20:33	05:37 20:54	05:54 20:46	06:25 20:09	06:58 19:16	07:31 18:26	07:10 16:48	07:39 16:43
21	07:38 17:13	07:03 17:53	06:17 18:26	06:25 20:01	05:48 20:34	05:37 20:54	05:55 20:45	06:26 20:07	06:59 19:15	07:33 18:24	07:11 16:48	07:39 16:44
22	07:37 17:14	07:02 17:54	06:15 18:27	06:23 20:02	05:47 20:35	05:37 20:54	05:55 20:44	06:27 20:06	07:00 19:13	07:34 18:22	07:12 16:47	07:40 16:44
23	07:36 17:15	07:00 17:55	06:14 18:28	06:22 20:03	05:46 20:36	05:37 20:55	05:56 20:44	06:28 20:04	07:01 19:11	07:35 18:21	07:13 16:46	07:40 16:45
24	07:36 17:16	06:59 17:56	06:12 18:30	06:20 20:05	05:45 20:37	05:37 20:55	05:57 20:43	06:29 20:03	07:02 19:09	07:36 18:20	07:14 16:46	07:41 16:45
25	07:35 17:18	06:57 17:58	06:10 18:31	06:19 20:06	05:44 20:37	05:38 20:55	05:58 20:42	06:30 20:01	07:03 19:08	07:37 17:18	07:16 16:45	07:41 16:46
26	07:34 17:19	06:56 17:59	06:08 18:32	06:17 20:07	05:44 20:38	05:38 20:55	05:59 20:41	06:31 19:59	07:04 19:06	07:38 17:17	07:17 16:45	07:42 16:46
27	07:33 17:20	06:54 18:00	06:07 18:33	06:16 20:08	05:43 20:39	05:38 20:55	06:00 20:40	06:33 19:58	07:05 19:04	07:39 17:15	07:18 16:44	07:42 16:47
28	07:32 17:21	06:52 18:01	06:05 18:34	06:15 20:09	05:42 20:40	05:39 20:55	06:01 20:39	06:34 19:56	07:07 19:02	07:40 17:14	07:19 16:44	07:42 16:48
29	07:31 17:23		07:03 19:35	06:13 20:10	05:42 20:41	05:39 20:55	06:02 20:38	06:35 19:55	07:08 19:01	07:41 17:12	07:20 16:43	07:43 16:49
30	07:31 17:24		07:02 19:36	06:12 20:11	05:41 20:42	05:40 20:55	06:03 20:37	06:36 19:53	07:09 18:59	07:42 17:11	07:21 16:43	07:43 16:49
31	07:30 17:25		07:00 19:38		05:40 20:43		06:04 20:36	06:37 19:51		06:45 17:10		07:43 16:50
Potential sun hours	294	295	369	400	452	457	463	431	376	344	295	283
Sum of minutes with flicker	0	0	0	0	0	0	0	0	0	0	0	0

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

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

Project:

WON016_luglio

Licensed user:

Iron solar s.r.l.

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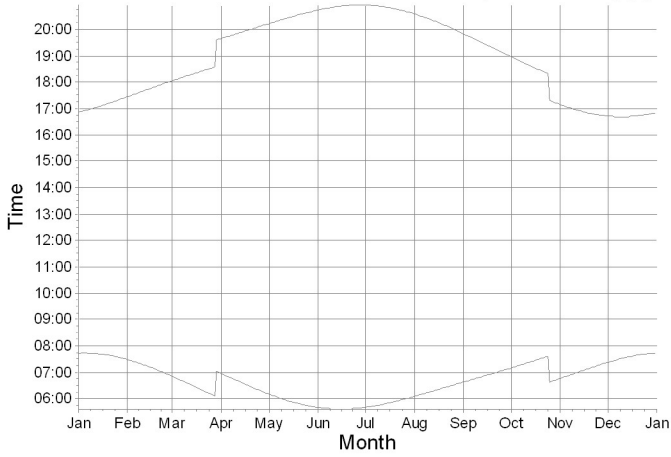
Calculated:

03/08/2023 07:10/3.6.361

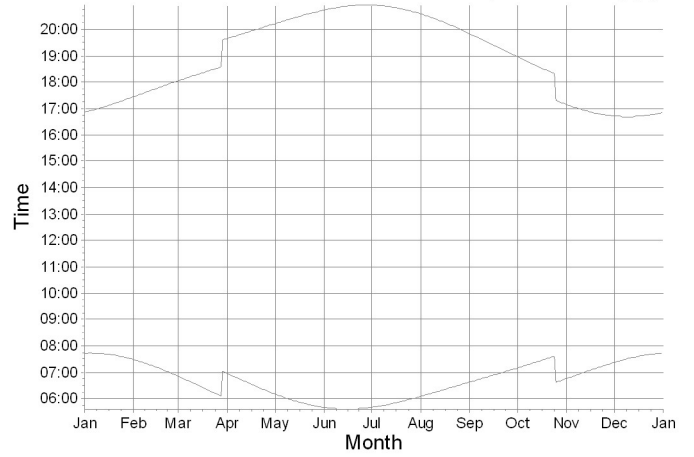
SHADOW - Calendar per WTG, graphical

Calculation: WON016_ShadowFlickering

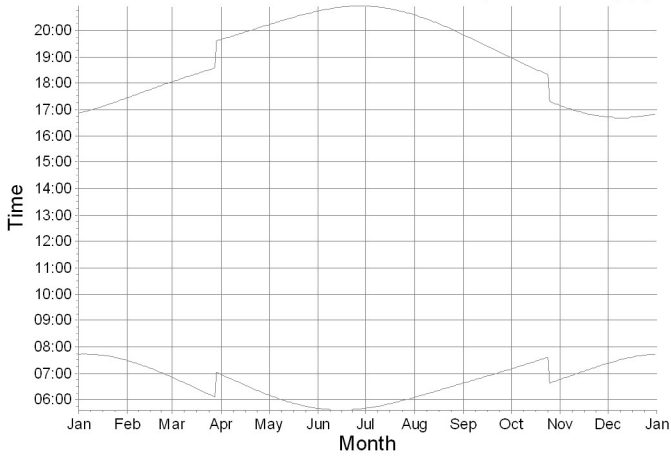
1: VESTAS V172-7.2 7200 172.0 !O! hub: 150.0 m (TOT: 236.0 m) (1)



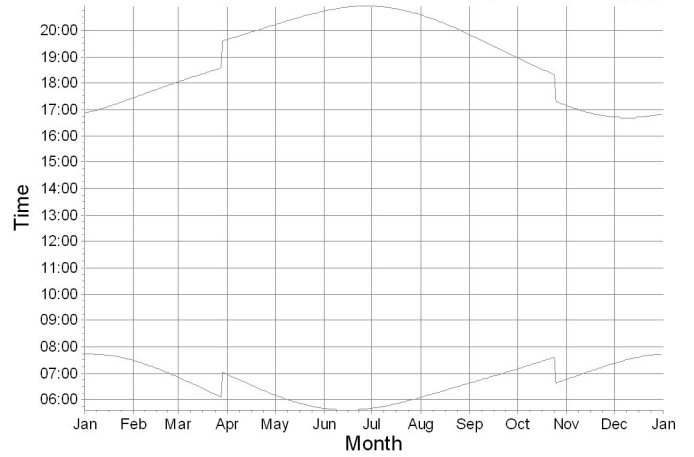
2: VESTAS V172-7.2 7200 172.0 !O! hub: 150.0 m (TOT: 236.0 m) (2)



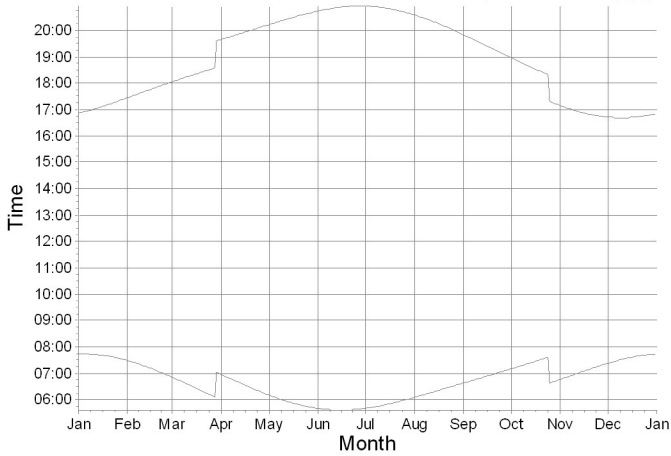
3: VESTAS V172-7.2 7200 172.0 !O! hub: 150.0 m (TOT: 236.0 m) (3)



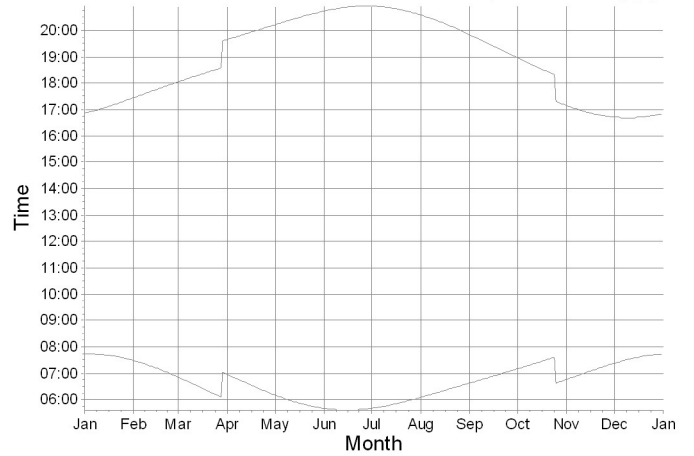
4: VESTAS V172-7.2 7200 172.0 !O! hub: 150.0 m (TOT: 236.0 m) (4)



5: VESTAS V172-7.2 7200 172.0 !O! hub: 150.0 m (TOT: 236.0 m) (5)



6: VESTAS V172-7.2 7200 172.0 !O! hub: 150.0 m (TOT: 236.0 m) (6)



Shadow receptors

Project:

WON016_luglio

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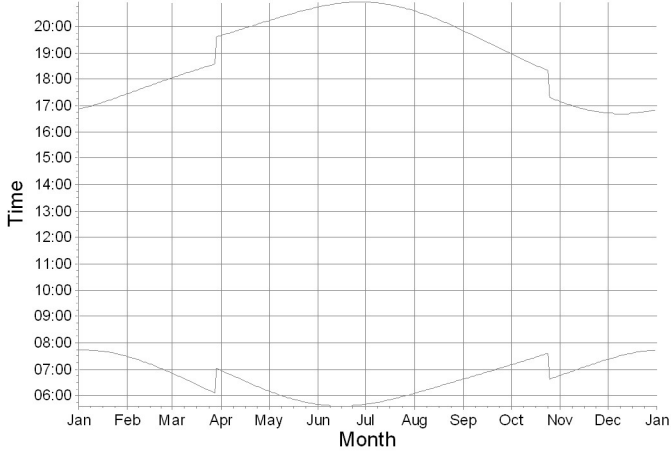
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03/08/2023 07:10/3.6.361

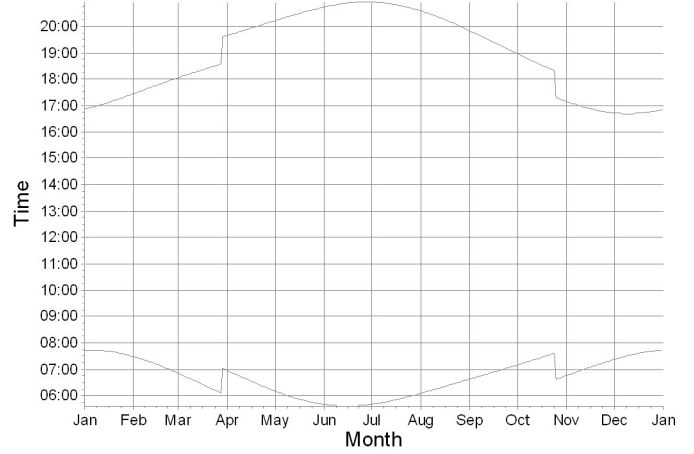
SHADOW - Calendar per WTG, graphical

Calculation: WON016_ShadowFlickering

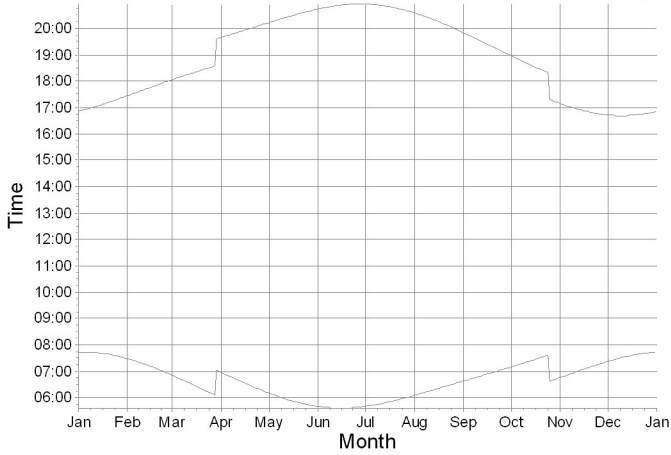
7: VESTAS V172-7.2 7200 172.0 !O! hub: 150.0 m (TOT: 236.0 m) (7)



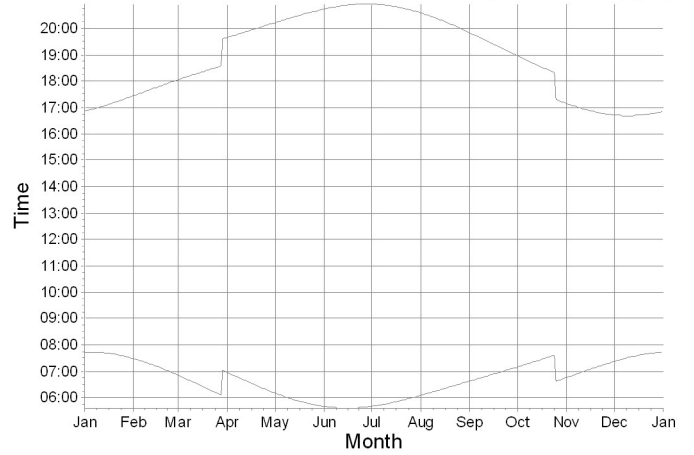
8: VESTAS V172-7.2 7200 172.0 !O! hub: 150.0 m (TOT: 236.0 m) (8)



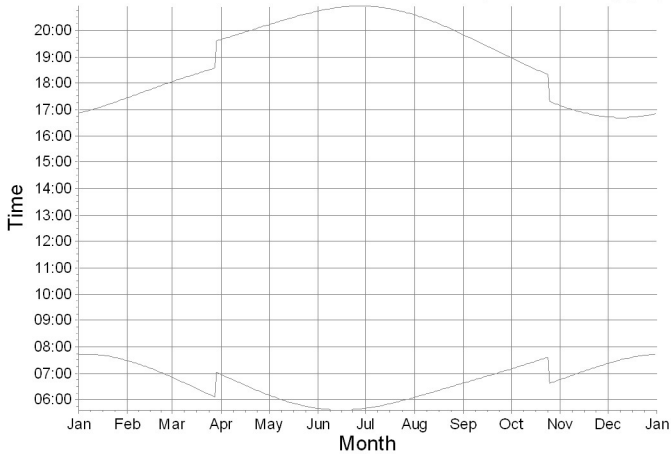
9: VESTAS V172-7.2 7200 172.0 !O! hub: 150.0 m (TOT: 236.0 m) (9)



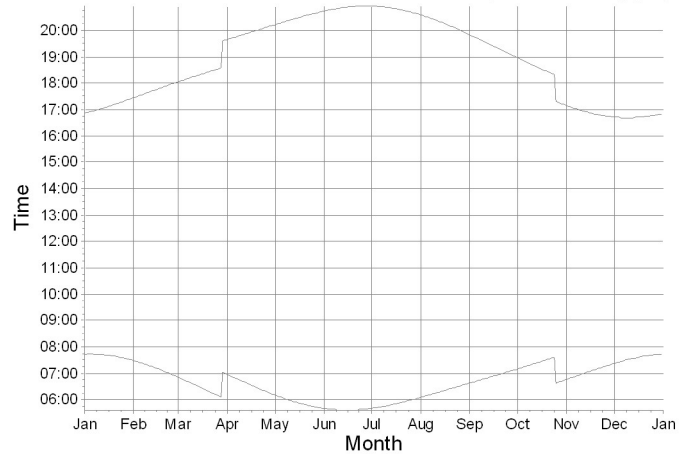
10: VESTAS V172-7.2 7200 172.0 !O! hub: 150.0 m (TOT: 236.0 m) (10)



11: VESTAS V172-7.2 7200 172.0 !O! hub: 150.0 m (TOT: 236.0 m) (11)



12: VESTAS V172-7.2 7200 172.0 !O! hub: 150.0 m (TOT: 236.0 m) (12)



Shadow receptors

Project:

WON016_luglio

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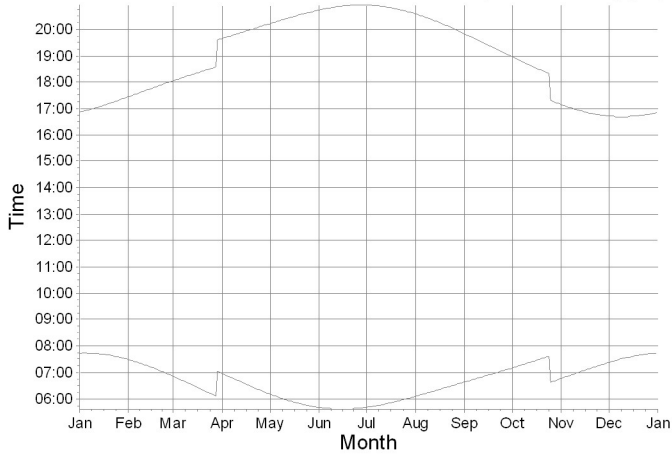
Calculated:

03/08/2023 07:10/3.6.361

SHADOW - Calendar per WTG, graphical

Calculation: WON016_ShadowFlickering

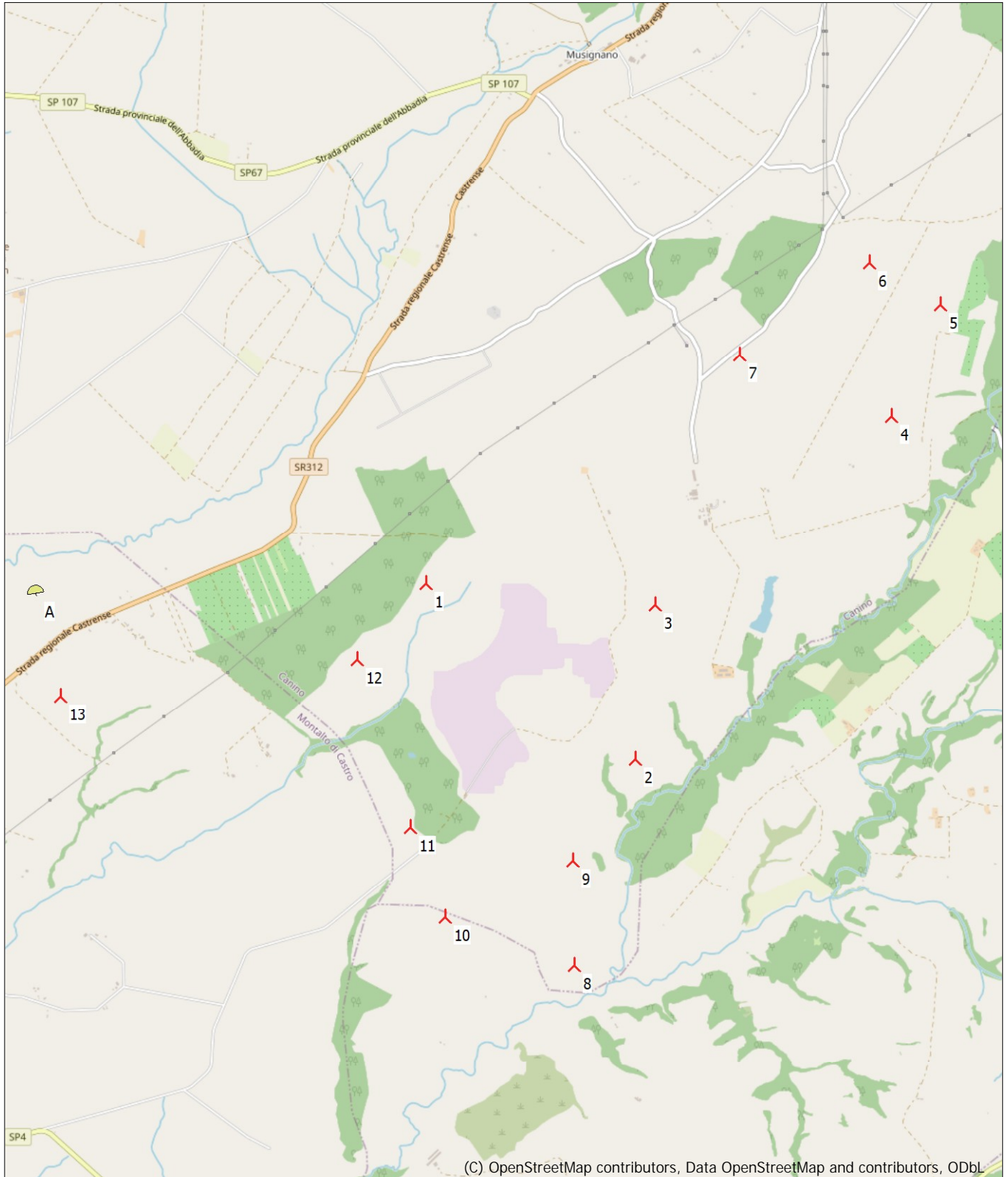
13: VESTAS V172-7.2 7200 172.0 !O! hub: 150.0 m (TOT: 236.0 m) (13)



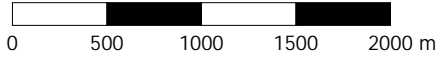
Shadow receptors

SHADOW - Map

Calculation: WON016_ShadowFlickering



(C) OpenStreetMap contributors, Data OpenStreetMap and contributors, ODbL



Map: EMD OpenStreetMap , Print scale 1:40,000, Map center UTM (north)-WGS84 Zone: 32 East: 723,083 North: 4,697,458

New WTG Shadow receptor

Flicker map level: Elevation Grid Data Object: WON016_luglio_EMDGrid_0.wpg (1)