galbo mariano
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GMT+02:00

"PARCO EOLICO SENNORI (SS)"

Progetto per la realizzazione di un parco eolico con potenza pari a 42 MW sito nel Comune di Sennori (SS) con opere di connessione alla RTN nel Comune di Tergu (SS)

COMMITTENTE

EDISON
Edison Rinnovabili S.p.A.

PROGETTAZIONE

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TITOLO ELABORATO

STUDIO SUGLI EFFETTI DELLO SHADOW FLICKERING

SCALA	
COMMESSA	**SVIL- 1000190562**
CODIFICA DOCUMENTO	SEN-SA-R07_00

REV.	DESCRIZIONE	DATA	REDATTO	VERIFICATO	APPROVATO
4					
3					
2					
1					
0	PRIMA EMISSIONE	Luglio 2024	EG	GL	MG

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

ISO A4

INDICE

1 PREMESSA

La società Hydro Engineering s.s. è stata incaricata di redigere il progetto definitivo dell'impianto eolico denominato "Sennori" composto da n. 6 aerogeneratori, ciascuno di potenza nominale pari a 7 MW, per una potenza complessiva di 42 MW, proposto dalla società Edison Rinnovabili S.p.A., facente parte del Gruppo Edison, con sede legale in Milano via Foro Buonaparte 31, 20121.

Il modello tipo di aerogeneratore scelto avrà potenza nominale di 7 MW, con diametro del rotore fino a 163 m e altezza massima al top della pala fino a 180 m per l'aerogeneratore SEN-01 e fino a 200 m per gli aerogeneratori SEN-02, SEN-03, SEN-04, SEN-05 e SEN-06. Questa tipologia di aerogeneratore è allo stato attuale quella ritenuta più idonea per il sito di progetto dell'impianto.

Il presente elaborato riguarda l'analisi del fenomeno denominato "shadow flickering" (letteralmente ombreggiamento intermittente) ovvero l'espressione comunemente impiegata per descrivere l'effetto stroboscopico delle ombre proiettate dalle pale rotanti degli aerogeneratori eolici allorquando il sole si trova alle loro spalle. Il fenomeno si traduce in una variazione alternata di intensità luminosa che, a lungo andare, può provocare fastidio agli occupanti delle abitazioni le cui finestre risultano esposte al fenomeno stesso.

L'analisi condotta è finalizzata ad ottenere le mappe di ombreggiamento nella condizione real case, ovvero tenendo conto dell'eliofania locale e della distribuzione di frequenza di velocità e direzione del vento.

2 IL SITO

2.1 RIFERIMENTI CARTOGRAFICI

Le aree interessate dal posizionamento degli aerogeneratori ricadono integralmente in territorio del Comune di Sennori. Di seguito fogli di mappa cartografici interessati dalle opere:

1 IGM 25 K:

- ✓ 441_II_ Sorso;
- ✓ 442_III_Sèdini;
- ✓ 459_I_ Sassari;
- ✓ 460_IV_Osilo;

2 CTRN 10K WGS84:

- ✓ 442090;
- ✓ 442130;
- ✓ 441160;
- ✓ 459040;
- ✓ 460010.

3 Fogli di mappa catastali

- ✓ Comune di Sennori - Fogli 24,21,15,14,9,8,5 e 4;
- ✓ Comune di Osilo -Fogli 29, 21, 5, 21;
- ✓ Comune di Tergu (B)— Fogli 2;
- ✓ Comune di Tergu (C) - Fogli 5,3,2,1.

Di seguito le coordinate assolute nel sistema UTM 32 WGS84 degli aerogeneratori:

NOME	EST	NORD	Riferimenti catastali
SEN-01	467572	4514323	Sennori-Foglio 24, p.lla: 39-38
SEN-02	468077	4514587	Sennori-Foglio 24, p.lla: 34
SEN-03	468245	4515046	Sennori-Foglio 21, p.lla: 39
SEN-04	468583	4515434	Sennori-Foglio 21, p.lle: 33
SEN-05	468479	4516040	Sennori-Foglio 21, p.lla: 75
SEN-06	468528	4516546	Sennori-Foglio 21, p.lla: 14
Edifico Consegna	468439	4516796	Sennori-Foglio 14, p.lla: 105

Tabella 2-1 - Coordinate aerogeneratori nel sistema UTM 32 WGS84

Figura 2-1 - Ubicazione area di impianto da satellite

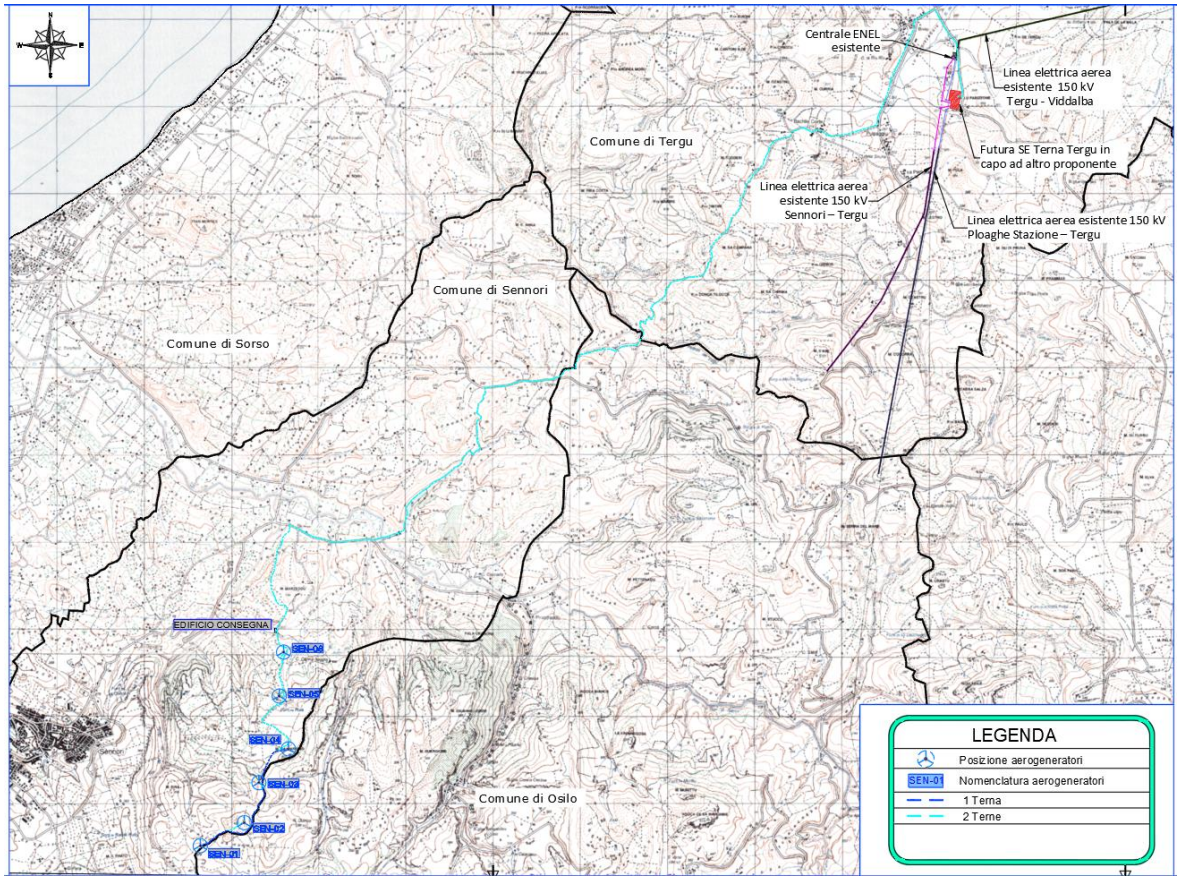


Figura 2-2: - Inquadramento impianto su IGM 1:25.000

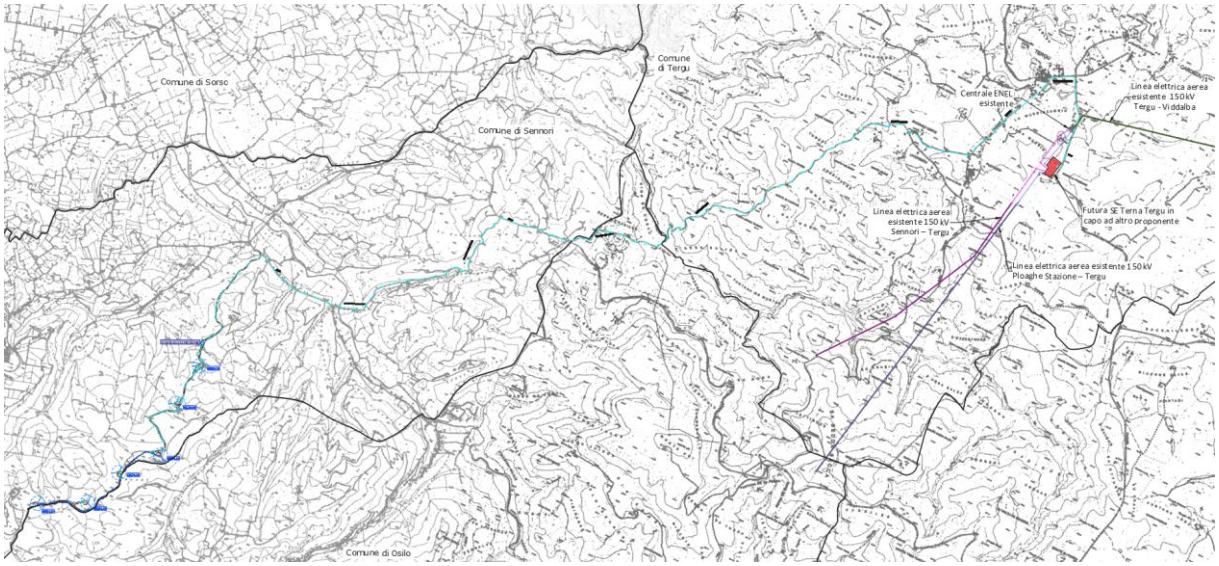


Figura 2-3: Inquadramento impianto su CTR 1:10.000

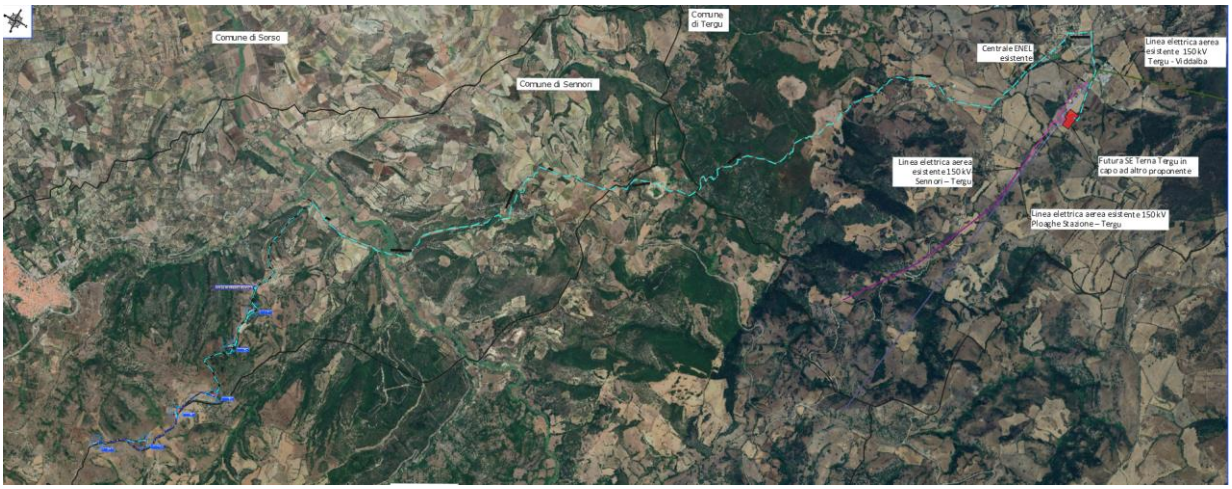


Figura 2-4: - Inquadramento impianto su ortofoto

3 L'IMPIANTO EOLICO

3.1 GENERALITA'

L'impianto eolico è composto da aerogeneratori indipendenti, dotati di generatori asincroni trifase. Ogni generatore è topograficamente, strutturalmente ed elettricamente indipendente dagli altri anche dal punto di vista delle funzioni di controllo e protezione.
Gli aerogeneratori sono interconnessi da un cavo 36kV e a loro volta connessi alla rete (SE TERNA) tramite un cavidotto interrato. Nella stessa stazione sarà ubicato il sistema di monitoraggio, comando, misura e supervisione (MCM) dell'impianto eolico che consente di valutare in remoto il funzionamento complessivo e le prestazioni dell'impianto ai fini della sua gestione. Non saranno necessarie cabine elettriche prefabbricate a base torre, in quanto le apparecchiature saranno direttamente installate all'interno della navicella della torre di sostegno dell'aerogeneratore. Questo comporterà un minore impatto dell'impianto con il paesaggio circostante.
L'impianto Eolico sarà costituito da n° 6 aerogeneratori, ciascuno di potenza massima da 7,0 MW, corrispondenti ad una potenza installata massima di 42,00 MW.

3.2 AEROGENERATORI

L'aerogeneratore è una macchina che sfrutta l'energia cinetica posseduta del vento, per la produzione di energia elettrica, rappresentata nell'elaborato "SEN-PD-D25-00_Modello Aerogeneratore".
Sul mercato esistono diverse tipologie di aerogeneratori, ad asse orizzontale e verticale, con rotore mono, bi o tripala, posto sopra o sottovento. Il tipo di aerogeneratore previsto per l'impianto in oggetto è un aerogeneratore ad asse orizzontale con rotore tripala e una potenza massima di 7,0 MW, le cui caratteristiche principali sono di seguito riportate:

- ✓ rotore tripala a passo variabile, di diametro massimo 163 m, posto sopravento al sostegno, in resina epossidica rinforzata con fibra di vetro, con mozzo rigido in acciaio;
- ✓ navicella in carpenteria metallica con carenatura in vetroresina e lamiera, in cui sono collocati il generatore elettrico e le apparecchiature idrauliche ed elettriche di comando e controllo;
- ✓ sostegno tubolare troncoconico in acciaio, avente altezza fino all'asse del rotore in conseguenza della tipologia di aerogeneratore che sarà scelto.
- ✓ L'altezza complessiva prevista (calcolata come l'altezza al mozzo più la lunghezza della pala) è pari a 200 m e a 180 m (in quanto sono previsti due tipologie di aerogeneratori con altezze al mozzo diverse).

I tronchi di torre sono realizzati da lastre in acciaio laminate, saldate per formare una struttura tubolare troncoconica. Si tratta di aerogeneratori di tipologia già impiegata estesamente in altri parchi italiani/UE, che consentono il miglior sfruttamento della risorsa vento e che presentano garanzie specifiche dal punto di vista della sicurezza (così come si dimostrerà in vari altri documenti: piano di produzione, studio di gittata etc.);

La turbina verrà equipaggiata, in accordo alle disposizioni dell'ENAC (Ente Nazionale per l'Aviazione Civile), con un sistema di segnalazione notturna per la segnalazione aerea.

La segnalazione notturna consiste nell'utilizzo di una luce rossa da installare sull'estradosso della navicella dell'aerogeneratore nonché ulteriore luci lungo il sostegno di acciaio (se richieste dall'Ente).

Le turbine di inizio e fine tratto avranno una segnalazione diurna consistente nella verniciatura della parte estrema della pala con tre bande di colore rosso ciascuna di 6 m per un totale di 18 m.

In ogni caso la definizione della segnaletica diurna/notturna rispetterà le prescrizioni Enac.

La navicella è dotata di un sistema antincendio, che consiste di rilevatori di fumo e CO, i quali rivelano gli incendi e attivano un sistema di spegnimento ad acqua atomizzata ad alta pressione nel caso di incendi dei componenti meccanici e a gas inerte (azoto) nel caso di incendi dei componenti elettrici (cabine elettriche e trasformatore). In aggiunta a ciò, il rivestimento della navicella contiene materiali autoestinguenti.

L'aerogeneratore è dotato di un completo sistema antifulmine, in grado di proteggere da danni diretti ed indiretti sia alla struttura (interna ed esterna) che alle persone. Il fulmine viene "catturato" per mezzo di un sistema di conduttori integrati nelle pale del rotore, disposti ogni 5 metri per tutta la lunghezza della pala. Da questi, la corrente del fulmine è incanalata attraverso un sistema di conduttori a bassa impedenza fino al sistema di messa a terra. La corrente di un eventuale fulmine è scaricata dal rotore e dalla navicella alla torre tramite collettori ad anelli e scaricatori di sovratensioni. La corrente del fulmine è infine scaricata a terra tramite un dispersore di terra. I dispositivi antifulmine previsti sono conformi agli standard della più elevata classe di protezione (Classe I), secondo lo standard internazionale IEC 61024-1.

Generalmente, una moderna turbina eolica entra in funzione a velocità del vento di circa 3-5 m/s e raggiunge la sua potenza nominale a velocità di circa 10-14 m/s. A velocità del vento superiori, il sistema di controllo del passo inizia a funzionare in maniera da limitare la potenza della macchina e da prevenire sovraccarichi al generatore ed agli altri componenti elettromeccanici. A velocità di circa 22-25 m/s il sistema di controllo orienta le pale in maniera tale da mandare in stallo il rotore e da evitare forti sollecitazioni e danni meccanici e strutturali. L'obiettivo è quello di far funzionare il rotore con il massimo rendimento possibile con velocità del vento comprese tra quella di avviamento e quella nominale, di

mantenere costante la potenza nominale all'albero di trasmissione quando la velocità del vento aumenta e di bloccare la macchina in caso di venti estremi Il moderno sistema di controllo del passo degli aerogeneratori permette di ruotare singolarmente le pale intorno al loro asse principale; questo sistema, in combinazione con i generatori a velocità variabile, ha portato ad un significativo miglioramento del funzionamento e del rendimento degli aerogeneratori.

La frenatura è effettuata regolando l'inclinazione delle pale del rotore ad un angolo di 91°. Ciascuno dei tre dispositivi di regolazione dell'angolo delle pale del rotore è completamente indipendente. In caso di un guasto del sistema di alimentazione, i motori a corrente continua sono alimentati da accumulatori che ruotano con il rotore. L'impiego di motori a corrente continua permette, in caso di emergenza, la connessione in continua degli accumulatori, senza necessità di impiego di inverter. Ciò costituisce un importante fattore di sicurezza, se confrontato con i sistemi pitch, progettati in corrente alternata. La torsione di una sola pala è sufficiente per portare la turbina in un range di velocità nel quale la turbina non può subire danni. Ciò costituisce un triplice sistema ridondante di sicurezza. Nel caso in cui uno dei sistemi primari di sicurezza si guasti, si attiva un disco meccanico di frenatura che arresta il rotore congiuntamente al sistema di registrazione della pala.

I sistemi frenanti sono progettati per una funzione "fail-safe"; ciò significa che, se un qualunque componente del sistema frenante non funziona correttamente o è guasto, immediatamente l'aerogeneratore si porta in condizioni di sicurezza.

Gli aerogeneratori hanno una vita utile di circa 30 anni, al termine dei quali è necessario provvedere al loro smantellamento ed eventualmente alla loro sostituzione con nuovi aerogeneratori.

La fase di decomissioning avverrà con modalità analoghe a quanto descritto per la fase di installazione.

Le componenti elettriche (trasformatore, quadri elettrici, ecc) verranno quindi smaltite, in accordo con la direttiva europea (WEEE - Waste of Electrical and Electronic Equipment); le parti in metallo (acciaio e rame) e in plastica rinforzata (GPR) potranno invece essere riciclate.

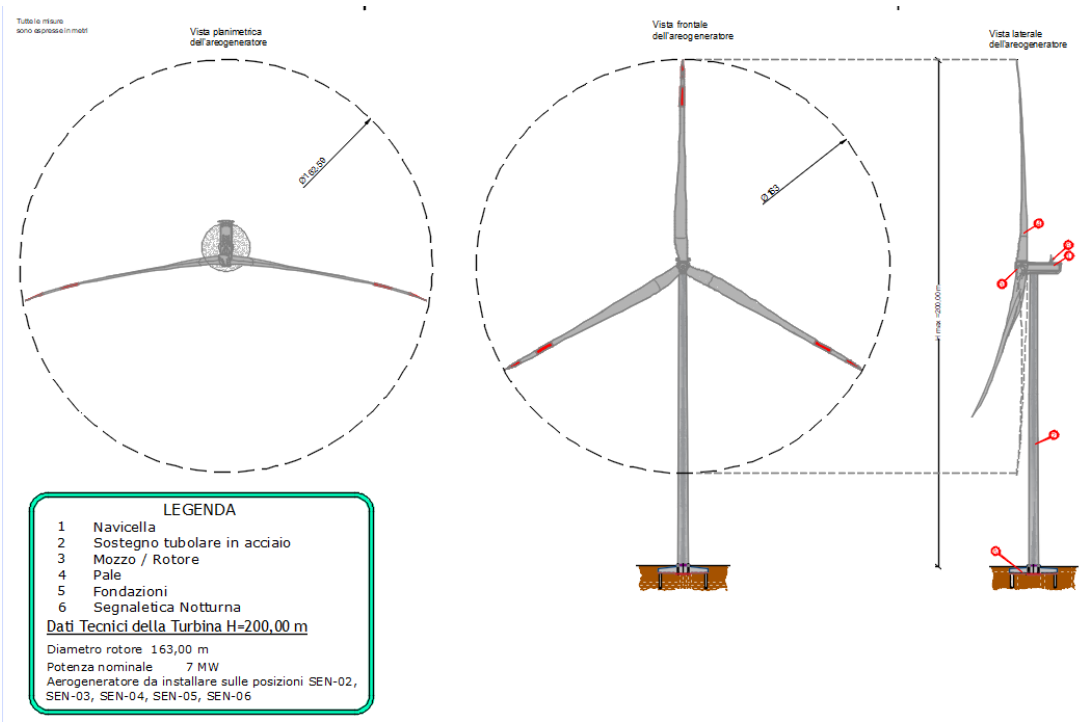


Figura 3-1 - Schema aerogeneratore H totale 200 m, diametro rotore fino a 1663,0 m

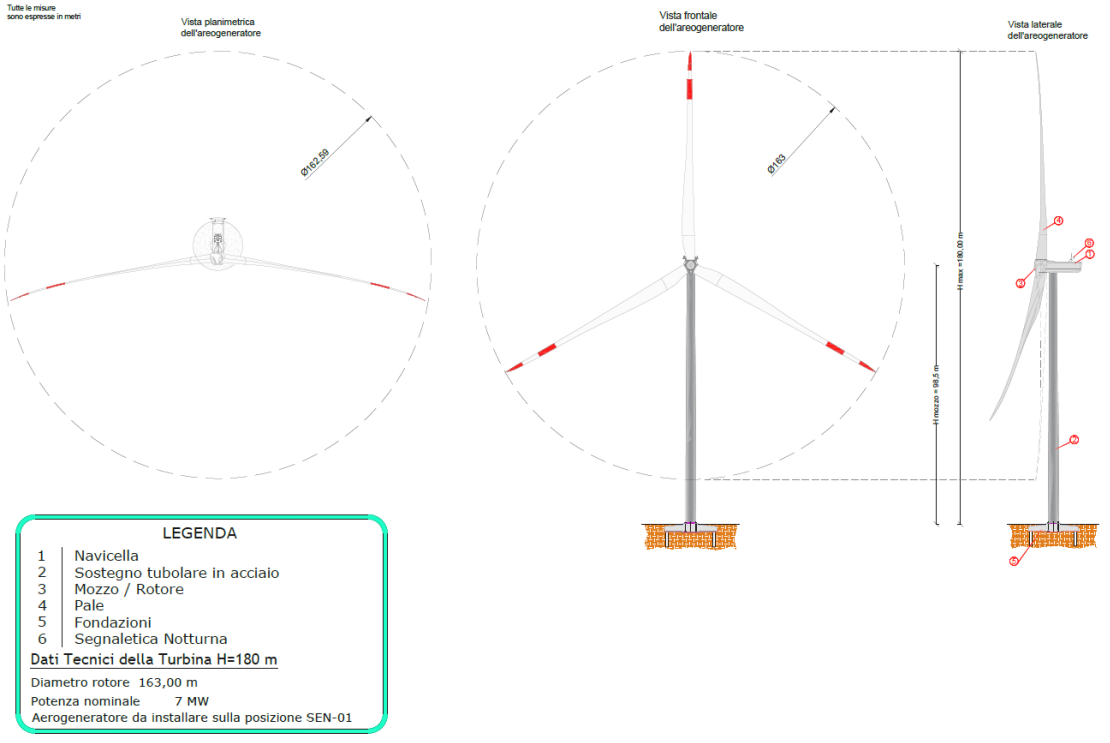


Figura 3-2 - Schema aerogeneratore H totale 180 m, diametro rotore fino a 163,0 m

4 SHADOW FLICKERING

Lo shadow flickering consiste in una variazione periodica dell'intensità luminosa osservata causata dalla proiezione, su una superficie, dell'ombra indotta da oggetti in movimento. Per un impianto eolico tale fenomeno è generato dalla proiezione, al suolo o su un ricettore, dell'ombra prodotta dalle pale degli aerogeneratori in rotazione. Dal punto di vista dell'oggetto/soggetto recettore, lo shadow flickering si manifesta in una variazione ciclica dell'intensità luminosa: in presenza di luce solare diretta, un recettore localizzato nella zona d'ombra indotta dal rotore, sarà investito da un continuo alternarsi di luce diretta ed ombra, causato dalla proiezione delle ombre dalle pale in movimento. Tale fenomeno se vissuto dal recettore per periodi di tempo non trascurabili può generare un disturbo, quando:

- ✓ si sia in presenza di un livello sufficiente di intensità luminosa, ossia in condizioni di cielo sereno sgombro da nubi ed in assenza di nebbia e con sole alto rispetto all'orizzonte;
- ✓ la linea recettore-aerogeneratore non incontri ostacoli: in presenza di vegetazione o edifici interposti: l'ombra generata da questi ultimi annullerebbe il fenomeno.
- ✓ Pertanto, ad esempio, qualora il recettore sia una abitazione, perché il fenomeno di "shadow flickering" diventi consistente, le finestre dovrebbero essere orientate perpendicolarmente alla linea recettore-aerogeneratore e non affacciarsi su ostacoli;
- ✓ la turbina sia orientata in modo che il rotore risulti perpendicolare alla linea sole-ricettore: come mostrato nelle figure seguenti, quando il piano del rotore è perpendicolare alla linea sole-recettore, l'ombra proiettata dalle pale risulta muoversi all'interno di un "cerchio" che riferisce alla circonferenza del rotore inducendo uno shadow flickering non trascurabile (per situazioni in cui, dal punto di vista del recettore, il piano del rotore risulti essere in linea con il sole ed il recettore, l'ombra proiettata è sottile, di bassa intensità ed è caratterizzata da un rapido movimento, risultando pertanto lo shadow flickering di entità trascurabile);
- ✓ la posizione del sole sia tale da indurre una luminosità sufficiente. Ciò si traduce, in riferimento alla latitudine di progetto, in un'altezza del sole pari ad almeno 5° sull'orizzonte;
- ✓ le pale sono in movimento;
- ✓ turbina e ricettore siano vicini: le ombre proiettate in prossimità dell'aerogeneratore risultano di maggiore intensità e nitidezza rispetto a quelle proiettate lontano. Quando una turbina è posizionata sufficientemente vicino al ricettore, così che una porzione ampia di pala copra il sole, l'intensità del flicker risulta maggiore. All'aumentare della distanza tra turbina e recettore, le pale coprono una porzione sempre più piccola del sole, inducendo un flicker di minore entità. Inoltre, il fenomeno risulta di bassa entità

quando l'ombra proiettata sul recettore è indotta dall'estremità delle pale; raggiunge il massimo dell'intensità in corrispondenza dell'attacco di pala all'hub.

Rilevamenti sul campo hanno evidenziato che per distanze tra aerogeneratore di altezza paragonabile a quella delle macchine di progetto) e recettori superiori a 700 m il fenomeno è da rilevarsi solamente all'alba e al tramonto, momenti in cui la radiazione diretta è di minore intensità. Pertanto, in riferimento a quanto sin qui esposto, si può concludere che durata ed entità dello shadow flickering sono condizionate:

- ✓ dalla distanza tra aerogeneratore e recettore;
- ✓ dalla direzione ed intensità del vento;
- ✓ dall'orientamento del recettore;
- ✓ dalla presenza o meno di ostacoli lungo la linea di vista del recettore/aerogeneratore/sole;
- ✓ dalle condizioni metereologiche;
- ✓ dall'altezza del sole.

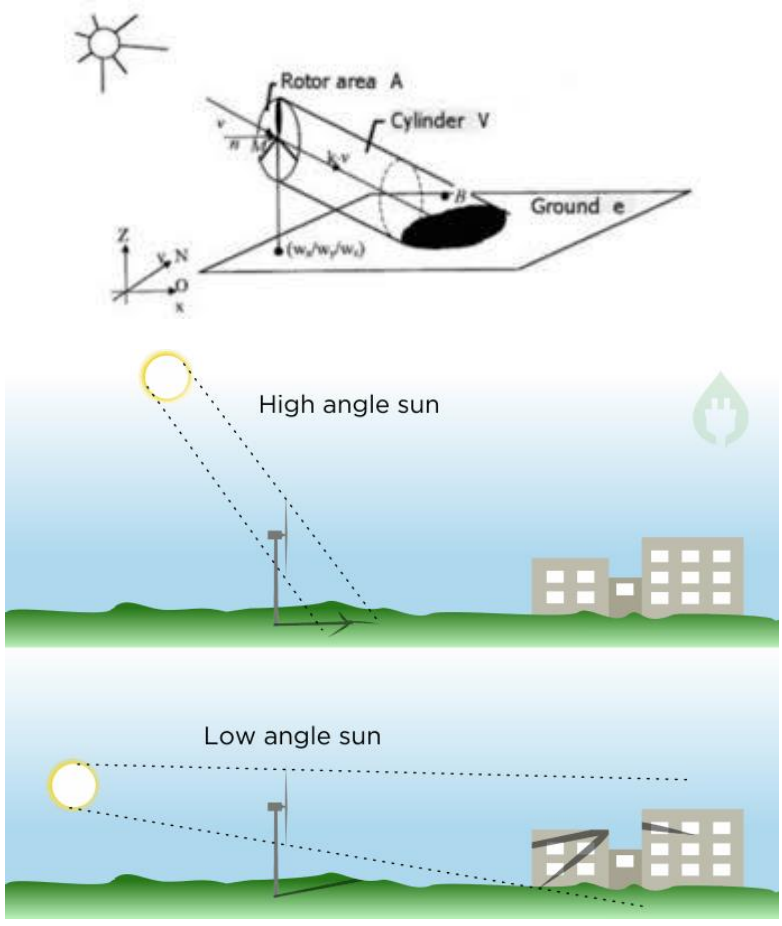


Figura 4-1 – Immagini esplicative del fenomeno oggetto della presente relazione specialistica

5 ANALISI DEL FENOMENO MEDIANTE SOFTWARE WINDPRO

Le simulazioni condotte in queste sede sono state effettuate mediante software dedicato – WINDPRO – Modulo Shadow.

Mediante tale applicativo è possibile effettuare delle valutazioni di ombreggiamento sia su recettori puntuali individuati mediante censimento catastale sia su aree generiche nel caso di agglomerati abitati.

La simulazione è effettuata tenendo conto della completa rotazione annua del sole.

Nel caso specifico, al fine di verificare la sussistenza del fenomeno dello shadow flickering indotto dalle opere in progetto, sono state effettuate simulazioni in considerazione:

- ✓ della altezza della macchina (h_{mozzo} più altezza pala pari a 200,0 m SEN-02; SEN-03, SEN-04, SEN-05 e SEN-06 e 180,0 m SEN-01);
- ✓ orientamento del rotore rispetto al ricettore in funzione di dati statistici di vento;
- ✓ proiezione dell'ombra rispetto ai recettori;
- ✓ posizione dei possibili recettori.

Il software, grazie all'implementazione del modello tridimensionale del terreno, permette di tenere in considerazione anche le potenziali visibilità dei recettori dai singoli aerogeneratori: la schermatura dovuta ad effetti topografici risulta spesso fortemente significativa.

La simulazione annua, che tiene conto di una inoperatività degli aerogeneratori di progetto di circa il 10% delle ore annue (Valutazione a vantaggio di sicurezza), comprende pertanto le simulazioni peggiorative di:

- ✓ stagione estiva, all'interno della quale ricadono le 24 ore del solstizio d'estate 21-06 (massimo valore di declinazione positiva del sole);
- ✓ stagione invernale, all'interno della quale ricadono le 24 ore del solstizio d'inverno 21-12 (massimo valore di declinazione negativa del sole) e le 24 ore del perielio d'inverno 04-01, giorno durante il quale sole e terra si trovano alla minima distanza e le ombre più lunghe;
- ✓ Le valutazioni sul fenomeno di shadow flickering, nelle condizioni sopra riportate, andranno valutate alla luce di quanto segue:
- ✓ il fenomeno di flickering risulta tanto più rilevante quanto maggiore è l'intensità della luce del sole (21 giugno);
- ✓ dal punto di vista dell'individuazione dei possibili osservatori, la condizione più sfavorevole si ha nel periodo dell'anno, in determinate ore del giorno, in cui le ombre

indotte dagli aerogeneratori risultano più lunghe.

In particolare:

- ✓ il 4 gennaio il sole ha un'altezza maggiore di 20° sull'orizzonte nell'intervallo compreso tra le 9:30 e le 15:00;
- ✓ il 21 giugno il sole ha un'altezza maggiore di 20° sull'orizzonte nell'intervallo compreso tra le 6:45 e le 17:45.

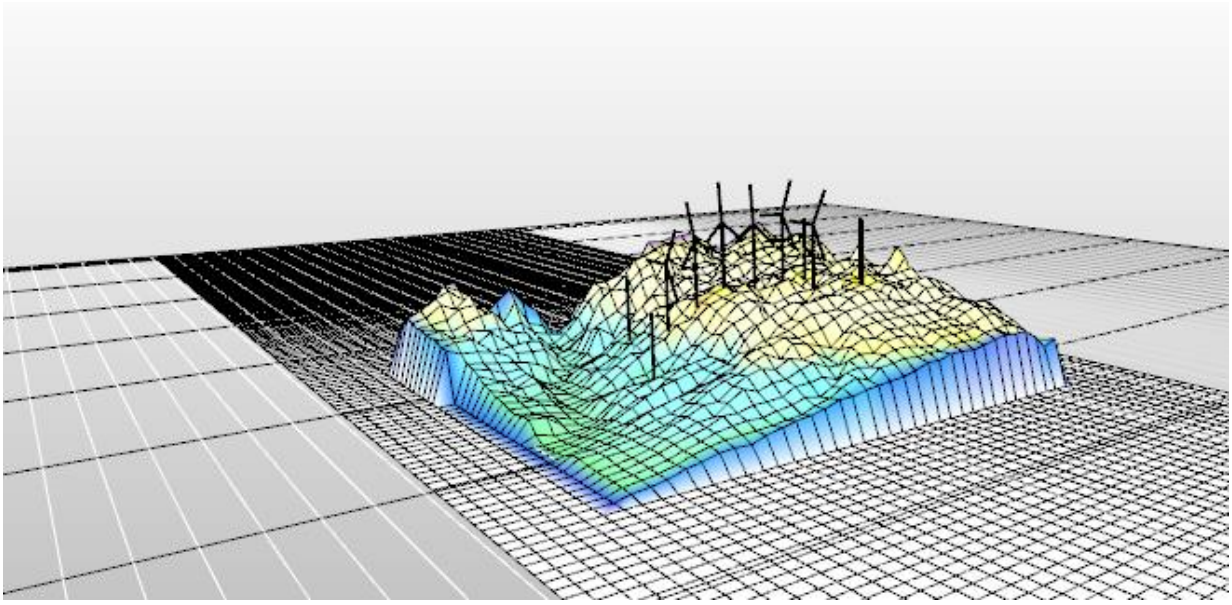
La simulazione effettuata tiene conto di alcuni dati di input:

- ✓ condizioni metereologiche (statistiche annue) provenienti dalla stazione metereologica di Alghero;
- ✓ fenomeno valutabile a partire da una altezza del sole sull'orizzonte pari a 5° (simulazione a vantaggio di sicurezza);
- ✓ inoperatività delle turbine pari a circa il 10% delle ore annue (assunzione a vantaggio di sicurezza);
- ✓ distribuzione statistica della ventosità in base a cui è resa proporzionale la prevalenza del fenomeno di shading; il numero di ore annue è stato distribuito lungo 12 direzioni (N-NNE-ENE-E-ESE-SSE-S-SSW-WSW-W-WNW-NNW) in modo proporzionale come da allegato 8.

La simulazione e le valutazioni sono dunque effettuate anche nelle condizioni di "worst case" nonostante quelle su cui concentrare le valutazioni dovranno essere quelle del "realistic case", tenendo conto delle ore di sole statistiche annue (Stazione metereologica Alghero)

A seguire un'estrapolazione dell'interfaccia della modellazione delle turbine su DTM implementata su software WINPRO in cui al fine di valutare eventuali ostacoli "topografici" al fenomeno in analisi.

Modello 3D di Simulazione:



Dati di input – Assunzioni per shadow calculation da software:

Project:
Sennori

Licensed user:
Hydro Engineering s.s.
via Rossotti, 39
IT-91011 Alcamo

Ettore / egalbo@hydroeng.it
Calculated:
02/08/2024 19:53/4.0.424

SHADOW - Main Result

Assumptions for shadow calculations

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

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

Sunshine probability S (Average daily sunshine hours) [ALGHERO]

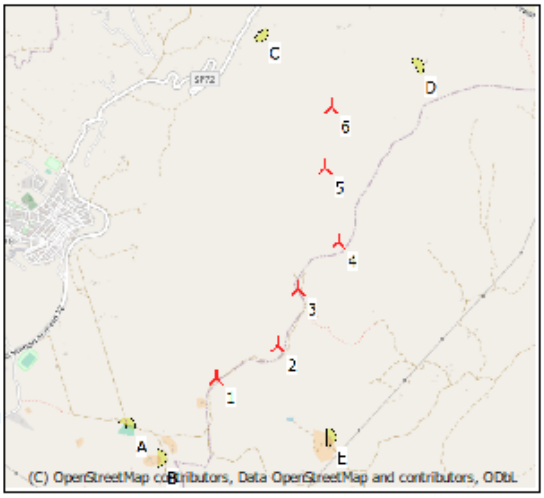
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3,85	4,78	5,80	6,92	8,25	9,91	10,91	9,92	8,15	6,40	4,83	3,92

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
79	158	315	946	315	158	237	237	631	552	3.154	1.104	7.886

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: Sennori_EMDGrid_1.wpg
Receptor grid resolution: 1,0 m
Topographic shadow included in calculation

All coordinates are in
Geo [deg]-WGS84



Scale 1:50.000
New WTG
Shadow receptor

6 VALUTAZIONI DEL FENOMENO NEL PARCO EOLICO SENNORI

Lo studio condotto in questa sede, ha permesso di valutare l'effetto dell'ombreggiamento indotto dagli aerogeneratori di progetto, su potenziali recettori in un intorno di 1000 m dagli stessi. I recettori selezionati sono solamente quelli classificati con categoria catastale relativa ad abitazioni di varia natura (categoria A) o altre categorie in cui è prevista costante ed assidua presenza di persone. Nella fattispecie le valutazioni sono state condotte su immobili di categoria:

- ✓ A03 – Abitazioni di tipo economico;
- ✓ A04 – Abitazioni di tipo popolare;

Gli altri immobili, che non sono soggetti a presenza assidua di persone (magazzini, stalle, fabbricati i natura industriale, o fabbricati rurali/diruti) non sono valutati come "recettori".

I recettori individuati su cui è stata condotta l'analisi sono i seguenti:

ID Recettore (Simulazione Windpro)	Ccordinate WGS84		Foglio di mappa		Particelle	Categoria
	Latitudine	Longitudine	Comune	Numero		
1	40,775669°	8,606926°	Sennori	28	51	A03
2	40,773319°	8,609973°	Sennori	28	55	A03
3	40,804711°	8,619926°	Sennori	14	269	A03
4	40,802229°	8,635138°	Sennori	15	173	A03
5	40,774860°	8,626472°	Osilo	29	41	A04

L'ombreggiamento è stato valutato a partire dalle 6 nuove turbine di progetto implementate nel software sulla base delle coordinate nel sistema cartografico WGS84:

WTGs

	Longitude	Latitude	Z [m]	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]
1	8,615698° E	40,779239° N	381,7	SEN-01	Yes	NORDEX	N163/6.X-7.000	7.000	163,0	98,0
2	8,621669° E	40,781637° N	409,7	SEN-02	Yes	NORDEX	N163/6.X-7.000	7.000	163,0	118,0
3	8,623625° E	40,785778° N	379,3	SEN-03	Yes	NORDEX	N163/6.X-7.000	7.000	163,0	118,0
4	8,627623° E	40,789296° N	397,5	SEN-04	Yes	NORDEX	N163/6.X-7.000	7.000	163,0	118,0
5	8,626348° E	40,794751° N	307,0	SEN-05	Yes	NORDEX	N163/6.X-7.000	7.000	163,0	118,0
6	8,626915° E	40,799302° N	256,0	SEN-06	Yes	NORDEX	N163/6.X-7.000	7.000	163,0	118,0

I risultati della simulazione ha portato ai risultati di seguito sintetizzati:

Calculation Results

Shadow receptor

No.	Name	Shadow, worst case: Shadow hours per year [h/year]	Shadow, worst case: Shadow days per year [days/year]	Shadow, worst case: Max shadow hours per day [h/day]	Shadow, expected values: Shadow hours per year [h/year]
A	Sennori n.28 - p.lla 51 (A03)	0:00	0	0:00	0:00
B	Sennori n.28 - p.lla 55 (A03)	0:00	0	0:00	0:00
C	Sennori n.14 - p.lla 269 (A03)	0:00	0	0:00	0:00
D	Sennori n.15 - p.lla 173 (A03)	66:59	120	0:48	19:04
E	Osilo n.29 - p.lla 41 (A04)	21:35	62	0:28	10:23

SHADOW - Main Result

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

No.	Name	Worst case [h/year]	Expected [h/year]
1	SEN-01	21:35	10:23
2	SEN-02	0:00	0:00
3	SEN-03	0:00	0:00
4	SEN-04	0:00	0:00
5	SEN-05	26:37	5:34
6	SEN-06	40:22	13:44

Il risultato di cui sopra mostra come l'ombreggiamento annuo sui primi tre recettori sia nullo, mentre invece si verificherà un ombreggiamento pari a circa 19 ore (expected values) sul recettore D e 10:23 ore (expected values) sul recettore E: i valori ottenuti sono al di sotto della soglia delle 30 ore annue prese in considerazione dalla normativa tecnica di settore tedesca (DIN) usata ad oggi come riferimento legislativo (valori soglia).

In nessuna delle simulazioni effettuate, l'ombreggiamento si verifica su viabilità pubblica di tipo Provinciale o Statale: la più prossima agli aerogeneratori di progetto è la SP72 che dista circa 950,00 m dalla SEN-06. In tutte le mappe risultano "coinvolti" nel fenomeno anche altri immobili di categoria:

- ✓ D/1 - Opifici
- ✓ D/10 – Fabbricati per funzioni produttive connesse alle attività agricole
- ✓ C/2 – Magazzini e locali di deposito;
- ✓ C/6 – Stalle, scuderie, rimesse, autorimesse
- ✓ F/3 – Unità in corso di costruzione
- ✓ F/6 – Fabbricato in attesa di dichiarazione (circolare 1/2009)
- ✓ Fabb. Diruto
- ✓ Fabb. rurale

su questi, proprio per effetto della presenza non continuativa di persone o della natura delle attività svolte, non sono state approfondite le valutazioni. Sugli immobili di categoria catastale A03/A04 sopra riportati sono invece state valutate le ore e le condizioni di irraggiamento annuo come più esplicitamente riportato negli output e nei report allegati alla presente relazione specialistica.

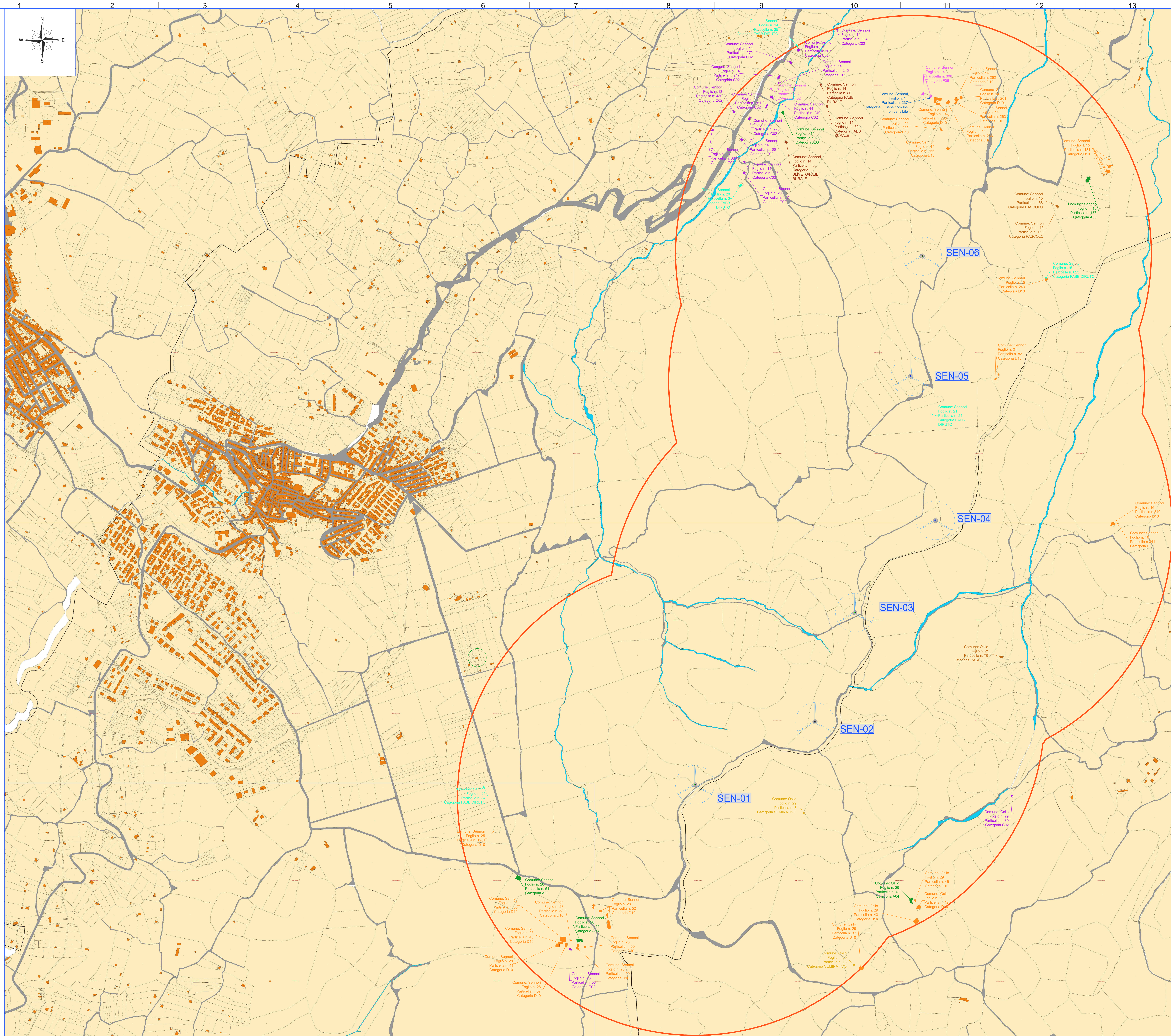
7 VALUTAZIONI TEORICHE SULLO SHADOW FLICKERING

Lo "shadow flickering" è ritenuto "pericoloso" in quanto dimostrato che l'effetto visivo, dovuto alla intermittenza dell'ombra creata dal moto delle pale in rotazione sia causa di possibili danni alla salute umana. Si ritiene più precisamente che il fenomeno sia strettamente connesso con i problemi di epilessia. Tuttavia, le frequenze che possono provocare un senso di fastidio sono comprese tra i 2.5 Hz e i 20 Hz (Verkuijlen and Westra, 1984) e l'effetto sugli individui è simile a quello che si sperimenterebbe in seguito alle variazioni di intensità luminosa sulla quale siano manifesti problemi di alimentazione elettrica.
Questo tipo di aerogeneratore da 7,0 MW (con D163 m) ha in genere un numero di giri per minuti legato alla velocità di cut-off (26 m/s) mai superiore ai 12,0 rpm. Una semplice conversione in termini di unità di misura dimostra che 60 rpm sono pari all'incirca ad 1 Hz. Considerando le macchine da 3 pale e moltiplicando pertanto la frequenza di tale rotazione, si arriva a dimostrare come l'effetto di disturbo massimo generabile per effetto del fenomeno di shadow flickering dovuto al moto delle pale è pari a poco più di 0,5 Hz.

Si è pertanto, anche in condizioni di esercizio nelle condizioni peggiorative, ben al di sotto delle soglie che possono essere definibili pericolose in termini medici.

Si dovrebbe inoltre considerare un ulteriore fattore legato proprio alla durata dei periodi nei quali le condizioni atmosferiche siano tali da permettere che il fenomeno arrivi ad avere tale intensità massima; di solito ciò si verifica quando il cielo è terso e luminoso e non quando è nuvoloso o anche solo parzialmente nuvoloso ed in assenza di alcun tipo di ostacolo fisico e topografico.
Quanto sopra detto, porta a definire ininfluente il fenomeno dello shadow flickering ad opera del progetto del Parco Eolico di Sennori (SS).

8 ALLEGATO 1 – INDIVIDUAZIONE PLANIMETRICA DEGLI IMMOBILI CENSITI NEL BUFFER DI 1000 M DA CIASCUN AEROGENERATORE



LEGENDA

Verifica delle distanze di cui all'Allegato e) della DGR 59/90 della Regione Sardegna

Distanza dai fabbricati

- Buffer di 1.000 m
- Censimento fabbricati accatastati

Aree campite con l'ausilio degli shapefile disponibili sul geoportale della Regione Sardegna.

- Posizione e nomenclatura aerogeneratore di progetto

"PARCO EOLICO SENNORI (SS)"

Progetto per la realizzazione di un parco eolico con potenza pari a 42 MW sito nel Comune di Sennori (SS) con opere di connessione alla RTN nel Comune di Tergu (SS)

COMMITTENTE

Edison Rinnovabili S.p.A.

PROGETTAZIONE

Hydro Engineering s.s.
di Damiano e Mariano Galbo
via Rossotti, 39
91011 Alcamo (TP) Italy

ORDINE DEGLI INGEGNERI PROV. TRAPANI — Ing. Mariano Galbo N. 724

TITOLO ELABORATO

ALLEGATO 1
STUDIO SUGLI EFFETTI DELLO SHADOW FLICKERING

SCALA	
COMMESSA	**SVIL- 1000190562**
CODIFICA DOCUMENTO	SEN-SA-R07_00

REV.	DESCRIZIONE	DATA	REDATTO	VERIFICATO	APPROVATO
4					
3					
2					
1					
0	PRIMA EMISSIONE	Luglio 2024	EG	GL	MG

ISO A0

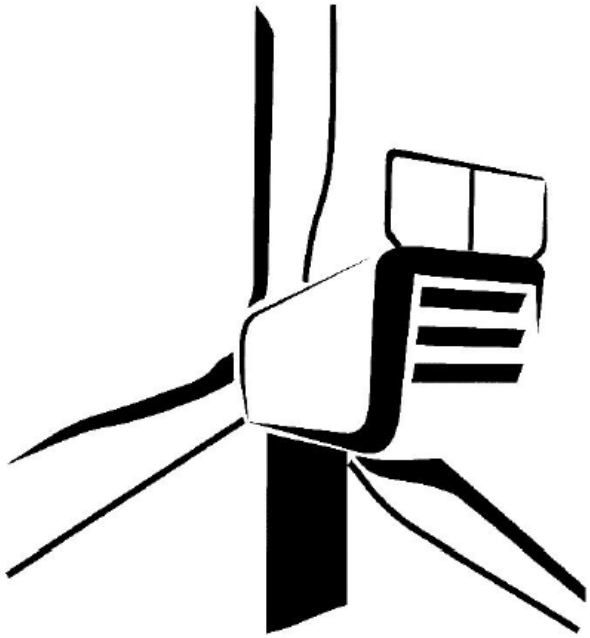
9 ALLEGATO 2 – CENSIMENTO RECETTORI NEL BUFFER DEI 1000 m DAGLI AEROGENERATORI DI PROGETTO

Comune	Foglio	Particella	Sub	Categoria	Note	Buffer (m)
Sennori	14	237		-	BENE COMUNE NON CESNSIBILE	1000
Sennori	**28**	**51**		**A03**	**Abitazioni di tipo economico**	**1000**
Sennori	**28**	**55**		**A03**	**Abitazioni di tipo economico**	**1000**
Sennori	**14**	**269**		**A03**	**Abitazioni di tipo economico**	**1000**
Sennori	**15**	**173**		**A03**	**Abitazioni di tipo economico**	**1000**
Osilo	**29**	**41**		**A04-D10**	**Abitazioni di tipo popolare**	**1000**
Sennori	25	1172		C02	Magazzini e locali di deposito	1000
Sennori	23	185		C02	Magazzini e locali di deposito	1000
Sennori	23	182		C02	Magazzini e locali di deposito	1000
Sennori	23	183		C02	Magazzini e locali di deposito	1000
Sennori	23	164		C02	Magazzini e locali di deposito	1000
Sennori	13	376		C02	Magazzini e locali di deposito	1000
Sennori	13	380		C02	Magazzini e locali di deposito	1000
Sennori	13	430		C02	Magazzini e locali di deposito	1000
Sennori	13	446		C02	Magazzini e locali di deposito	1000
Sennori	13	378		C02	Magazzini e locali di deposito	1000
Sennori	20	117		C02	Magazzini e locali di deposito	1000
Sennori	14	286		C02	Magazzini e locali di deposito	1000
Sennori	14	166		C02	Magazzini e locali di deposito	1000
Sennori	14	276		C02	Magazzini e locali di deposito	1000
Sennori	14	251		C02	Magazzini e locali di deposito	1000
Sennori	14	249		C02	Magazzini e locali di deposito	1000
Sennori	14	245		C02	Magazzini e locali di deposito	1000
Sennori	14	247		C02	Magazzini e locali di deposito	1000
Sennori	14	272		C02	Magazzini e locali di deposito	1000
Sennori	14	267		C02	Magazzini e locali di deposito	1000
Sennori	14	284		C02	Magazzini e locali di deposito	1000
Sennori	14	304		C02	Magazzini e locali di deposito	1000
Sennori	14	319		C02	Magazzini e locali di deposito	1000
Sennori	15	109		C02	Magazzini e locali di deposito	1000
Osilo	29	39		C02	Magazzini e locali di deposito	1000
Sennori	14	307		C02-F03	F03 UNITA' IN CORSO DI COSTRUZIONE	1000
Sennori	28	53		C06	Stalle, scuderie, rimesse, autorimesse (senza fine di lucro)	1000
Sennori	25	1201		D01	MINI-EOLICO	1000
Sennori	28	56		D10	Fabbricati per funzioni produttive connesse alle attività agricole	1000
Sennori	28	40		D10	Fabbricati per funzioni produttive connesse alle attività agricole	1000
Sennori	28	41		D10	Fabbricati per funzioni produttive connesse alle attività agricole	1000
Sennori	28	58		D10	Fabbricati per funzioni produttive connesse alle attività agricole	1000
Sennori	28	57		D10	Fabbricati per funzioni produttive connesse alle attività agricole	1000
Sennori	28	59		D10	Fabbricati per funzioni produttive connesse alle attività agricole	1000
Sennori	28	60		D10	Fabbricati per funzioni produttive connesse alle attività agricole	1000
Sennori	28	52	1	D10	Fabbricati per funzioni produttive connesse alle attività agricole	1000
Sennori	28	52	2	D10	Fabbricati per funzioni produttive connesse alle attività agricole	1000
Sennori	28	52	3	D10	Fabbricati per funzioni produttive connesse alle attività agricole	1000
Sennori	28	52	4	D10	Fabbricati per funzioni produttive connesse alle attività agricole	1000
Sennori	23	147		D10	Fabbricati per funzioni produttive connesse alle attività agricole	1000
Sennori	14	233		D10	Fabbricati per funzioni produttive connesse alle attività agricole	1000
Sennori	14	236		D10	Fabbricati per funzioni produttive connesse alle attività agricole	1000
Sennori	14	263		D10	Fabbricati per funzioni produttive connesse alle attività agricole	1000
Sennori	14	262		D10	Fabbricati per funzioni produttive connesse alle attività agricole	1000
Sennori	14	261		D10	Fabbricati per funzioni produttive connesse alle attività agricole	1000
Sennori	14	265		D10	Fabbricati per funzioni produttive connesse alle attività agricole	1000
Sennori	14	266		D10	Fabbricati per funzioni produttive connesse alle attività agricole	1000
Sennori	15	181	1	D10	Fabbricati per funzioni produttive connesse alle attività agricole	1000
Sennori	15	181	2	D10	Fabbricati per funzioni produttive connesse alle attività agricole	1000
Sennori	15	181	3	D10	Fabbricati per funzioni produttive connesse alle attività agricole	1000
Sennori	15	181	4	D10	Fabbricati per funzioni produttive connesse alle attività agricole	1000
Sennori	15	181	5	D10	Fabbricati per funzioni produttive connesse alle attività agricole	1000
Sennori	15	181	6	D10	Fabbricati per funzioni produttive connesse alle attività agricole	1000

Comune	Foglio	Particella	Sub	Categoria	Note	Buffer (m)
Sennori	15	243		D10	Fabbricati per funzioni produttive connesse alle attività agricole	1000
Sennori	21	82	1	D10	Fabbricati per funzioni produttive connesse alle attività agricole	1000
Sennori	21	82	2	D10	Fabbricati per funzioni produttive connesse alle attività agricole	1000
Osilo	29	43		D10	Fabbricati per funzioni produttive connesse alle attività agricole	1000
Osilo	29	42		D10	Fabbricati per funzioni produttive connesse alle attività agricole	1000
Osilo	29	46		D10	Fabbricati per funzioni produttive connesse alle attività agricole	1000
Osilo	16	340		D10	Fabbricati per funzioni produttive connesse alle attività agricole	1000
Osilo	16	341		D10	Fabbricati per funzioni produttive connesse alle attività agricole	1000
Osilo	29	37		D10		1000
Sennori	14	291		F02	UNITA' COLLABENTE	1000
Sennori	15	178		F02	UNITA' COLLABENTE	1000
Sennori	14	306	1	F06	FABBRICATO IN ATTESA DI DICHIARAZIONE	1000
Sennori	14	306	2	F06	FABBRICATO IN ATTESA DI DICHIARAZIONE	1000
Sennori	25	34		FABB DIRUTO		1000
Sennori	20	3		FABB DIRUTO		1000
Sennori	14	35		FABB DIRUTO		1000
Sennori	15	62		FABB DIRUTO		1000
Sennori	23	38		FABB RURALE		1000
Sennori	13	36		FABB RURALE		1000
Sennori	13	28		FABB RURALE		1000
Sennori	14	81		FABB RURALE		1000
Sennori	14	80		FABB RURALE		1000
Sennori	15	169		PASCOLO		1000
Osilo	21	79		PASCOLO		1000
Sennori	15	168		PASCOLO - PASCOLO ARB		1000
Sennori	21	24		PASCOLO ARB - FABB DIRUTO		1000
Osilo	29	13		SEMINATIVO		1000
Osilo	29	3		SEMINATIVO - PASCOLO		1000
Sennori	14	96		ULIVETO-FABB RURALE		1000

10 ALLEGATO 3 – SPECIFICHE TECNICHE AEROGENERATORI DI PROGETTO

NORDEX acciona Windpower	GENERAL DOCUMENTATION	Doc.: **2014649EN** Rev.: **06**
TECHNICAL DESCRIPTION Delta4000 - N163/6.X		Page: **1 / 20**



- Translation of the original document (2014649DE, rev. 06) -
This is a translation from German. In case of doubt, the German text shall prevail.

Language: EN - English
Department: Engineering/ CPS

Author	Reviewer	Approver
SBS 27-09-2023	A.G.L. 11-10-2023	JIL 12-10-2023

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Validity

Turbine generation	Product series	Product
Delta	Delta4000	N163/6.X

1. Structure

The Nordex N163/6.X wind turbine (WT) is a speed-variable wind turbine with a rotor diameter of 163 m and a nominal power of 7000 kW, which can be adapted dependent on location. The wind turbine is designed for class S in accordance with IEC 61400-1 or wind zone S in accordance with DIBt 2012 and is available in 50 Hz and 60 Hz variants.

A Nordex N163/6.X wind turbine consists of the following main components:

- Rotor with rotor hub, three rotor blades and the pitch system
- Nacelle with rotor shaft and bearing, gearbox, generator, Yaw system, medium voltage transformer and converter
- Tubular steel tower or hybrid tower with medium-voltage switchgear.

1.1 Tower

The wind turbine N163/6.X can be erected on a steel tower or on a hybrid tower. The tubular steel tower consists of several conical or cylindrical sections. This tower is bolted to the anchor cage embedded in the foundation. The bottom part of the hybrid tower consists of a concrete tower and the top part of a tubular steel tower with two sections.

A climbing assistance, e. g a service lift or a step ladder, the vertical ladder with fall protection system as well as resting and working platforms inside the tower allow for a weather-protected ascent to the nacelle.

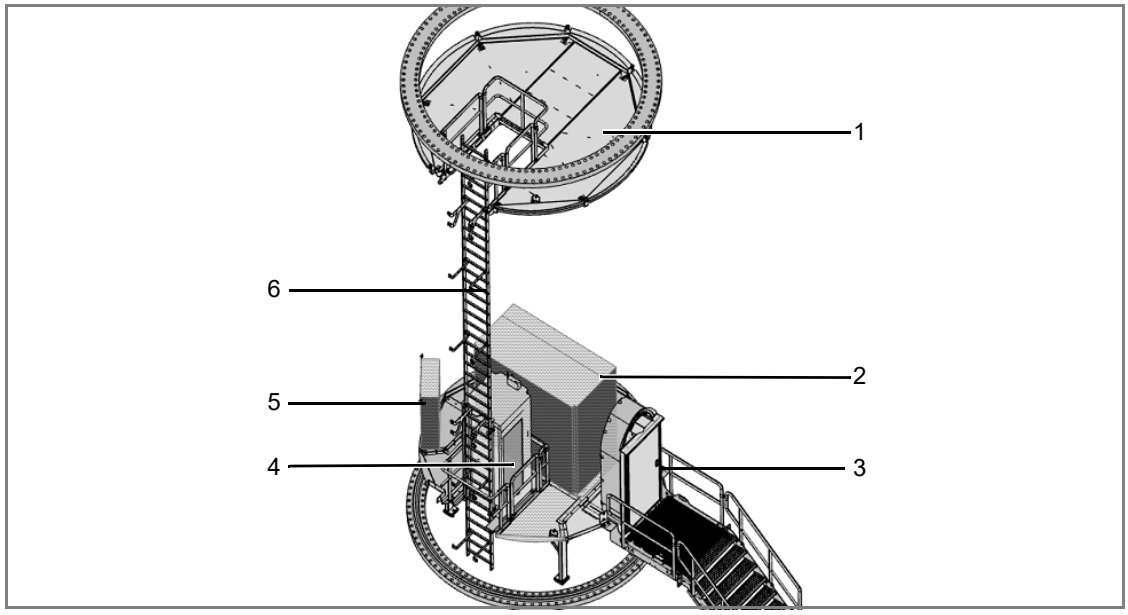

Fig. 1: Overview of installations in the bottom section of the steel tube tower with a vertical ladder (in case of a step ladder different image)

1 Flange platform
2 MV switchgear
3 Tower access
4 Tower service lift
5 Control cabinet
6 Ladder path

The foundation structure of all towers depends on the soil conditions at the intended location.

1.2 Rotor

The rotor consists of the rotor hub with three slewing bearings, the pitch system for blade adjustment and three rotor blades.

The **rotor hub** consists of a base element with support system and spinner. The base element consists of a stiff cast structure, on which the pitch bearings and the rotor blades are assembled. The rotor hub is covered with the spinner which enables the direct access from the nacelle into the rotor hub.

The **rotor blades** are made from high quality fiber glass- and carbon-fiber reinforced plastic. The rotor blade is tested statically and dynamically in accordance with the guidelines IEC 61400-23 and DNVGL-ST-0376.

The **pitch system** serves to adjust the pitch angle of the rotor blades set by the control system. For each individual rotor blade the pitch system comprises an electromechanical drive with rotary current motor, planetary gear and drive pinion, as well as a control unit with frequency converter and emergency power supply. Power supply and signal transfer are realized through a slip ring in the nacelle.

1.3 Nacelle

The nacelle contains essential mechanical and electric components of the wind turbine.

The **rotor shaft** transmits the rotary motion of the rotor to the gearbox and is mounted in the **rotor bearing** in the nacelle. A rotor lock is integrated in the rotor bearing housing, with which the rotor can be reliably locked in place mechanically.

With the mechanical **rotor brake** the rotor is locked during maintenance work. For this, a sufficient oil pressure is generated by the hydraulic pump.

The **gearbox** increases the rotor speed until it reaches the speed required for the generator. The bearings and gearings are continuously lubricated with oil. A combination filter element with coarse, fine and ultrafine filter retains solid particles. The control system monitors the contamination of the filter element. The gear oil used for lubrication also cools the gearbox. The temperatures of the gearbox bearings and the oil are continuously monitored. If the optimum operating temperature is not yet reached, a thermal bypass directs the gear oil directly back to the gearbox. Only when the gear oil temperature reaches a predetermined value is the transmission oil cooled by an oil / water cooler, which is located directly on the gearbox. As a result, the gear oil temperature is kept in a narrow temperature range during operation.

The **coupling** acts as force-transmitting connection between the gearbox and the generator.

The **generator** is a 6-pole doubly-fed induction machine. The generator has a built-on air-water heat exchanger and is connected to the cooling circuit.

The **converter** connects the electrical grid to the generator which means the generator can be operated with variable rotational speeds.

The **transformer** converts the low voltage of the generator-converter system into medium voltage of the wind farm grid. The transformer is cooled by the connection to the cooling circuit.

In the **switch cabinet**, all electrical components required for the control and supply of the turbine are located.

The cooling water is re-cooled by a **passive cooler** on the nacelle roof.

The **yaw drives** optimally rotate the nacelle into the wind. The yaw drives are located on the machine frame in the nacelle. A yaw drive consists of an electric motor, multi-stage planetary gear, and a drive pinion. The drive pinions mesh with the external teeth of the yaw bearing. In the aligned position the nacelle is held with the yaw drives.

All nacelle assemblies are protected against wind and weather conditions by means of a **nacelle housing**.

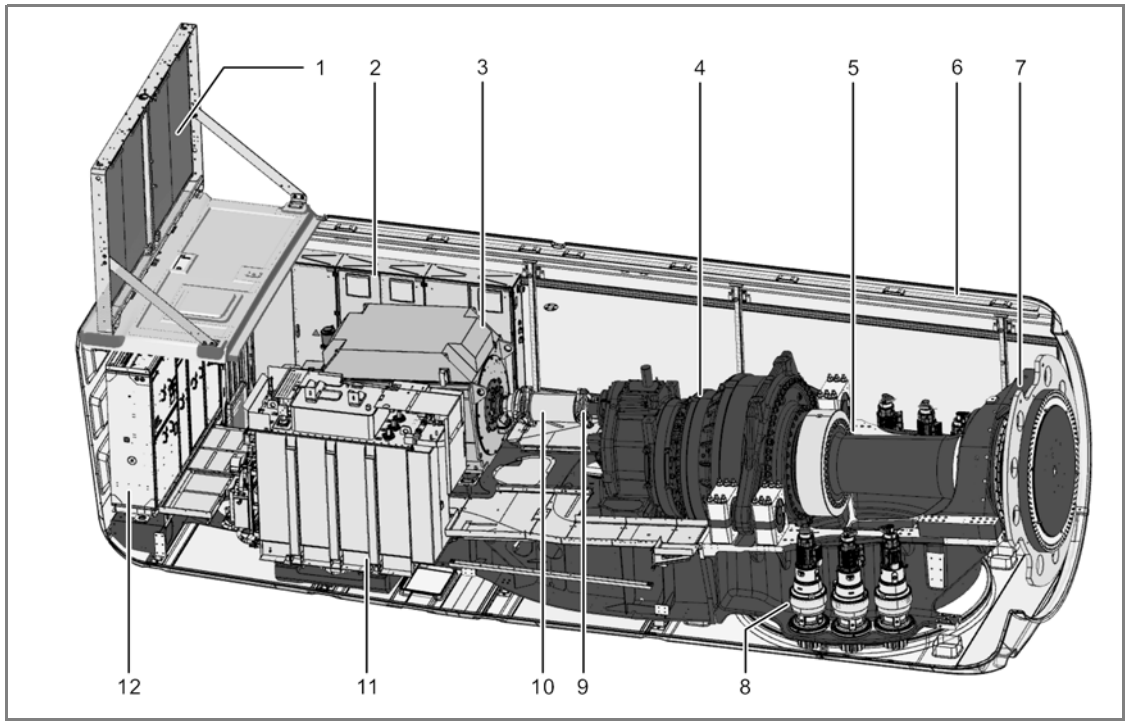

Fig. 2: Schematic diagram of the nacelle

1 Passive cooler
2 Cabinet
3 Generator
4 Gearbox
5 Rotor shaft
6 Nacelle housing
7 Rotor bearing
8 Yaw drives
9 Rotor brake
10 Coupling
11 Transformer
12 Converter

1.4 Auxiliary systems

1.4.1 Automatic lubrication system

Generator bearing, gearing of the pitch bearings, rotor bearing and gearing of the yaw bearing are each equipped with an **automatic lubrication system**.

1.4.2 Heaters

Gearbox, generator, cooling circuit and all relevant switch cabinets are equipped with **heaters**.

1.4.3 E-chain hoist and crossbeam

An electric **chain hoist** is installed in the nacelle which is used for lifting tools, components and other work materials from the ground into the nacelle.

A crossbeam including a sliding trolley is prepared for the use of a manual chain hoist to move the materials within the nacelle.

1.4.4 Cooling system

Two separate cooling circuits ensure cooling of the large components. Converter and gearbox are cooled in one cooling circuit and generator and transformer in the other.

Both cooling circuits are connected to passive coolers on the nacelle roof, in which the water is recooled.

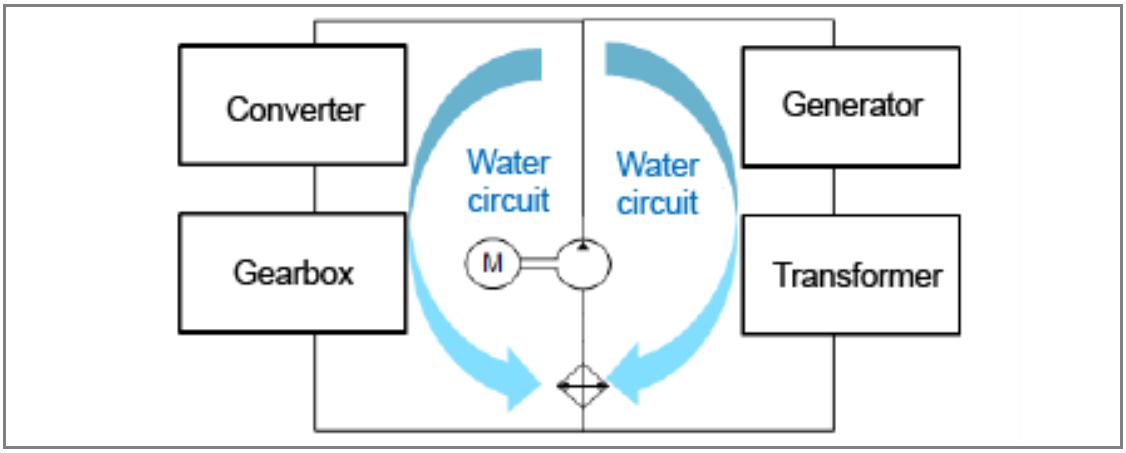

Fig. 3: Schematic representation of the cooling circuit

2. Control and electrical system

The WT operates automatically. A programmable logic controller (PLC) continuously monitors the operating parameters using various sensors, compares the actual values with the corresponding setpoints and issues the required control signals to the WT components. The operating parameters are specified by Nordex and are adapted to the individual location. The controller is located in a control cabinet in the tower base.

When there is no wind the WT remains in idle mode. Only various auxiliary systems are operational or activated as required: e.g., heaters, gear lubrication or PLC, which monitors the data from the wind measuring system. All other systems are switched off and do not use any energy. The rotor idles. When the cut-in wind speed is reached, the WT changes to the "ready for operation" condition. Now all systems are tested, the nacelle turns into the wind and the rotor blades turn into the wind. When a certain speed is reached, the generator is connected to the grid and the WT produces electrical energy.

At low wind speeds the WT operates at part load. The rotor blade remain turned into wind to the maximum extent. The power produced by the WT depends on the wind speed.

When the nominal wind speed is reached, the WT switches over to the nominal load range. If the wind speed continues to increase, the speed control changes the rotor blade angle so that the rotor speed and thus the power output of the WT remain constant.

The yaw system ensures that the nacelle is always optimally aligned to the wind. To this end two separate wind measuring systems on the nacelle measure the wind direction. Only one wind measuring system is used for the control system, while the second system monitors the first and takes over in case the first system fails. If the wind direction measured deviates too much from the nacelle alignment, the nacelle is yawed into the wind.

The wind energy absorbed from the rotor is converted into electrical energy using a doubly-fed induction machine with slip ring rotor. Its stator is connected directly, and the rotor via a specially controlled frequency converter, to the MV transformer which connects the turbine to the grid. Only part of the power needs to be routed via the converter, permitting low electrical system losses.

2.1 Safety systems

Nordex wind turbines are equipped with technical equipment and devices that protect people and systems and ensure permanent operation. The entire turbine is designed in accordance with the Machinery Directive 2006/42/EC and certified as per IEC 61400.

Safety-relevant parameters in the system control are monitored continuously. Here, the sensor data of the safe sensors are transmitted via a safe bus system to the safe controller for evaluation. If specified parameters are exceeded, the system is stopped via actuators and set to a safe state.

Depending on the cut-out cause, different brake programs are triggered. In event of external causes, such as excessive wind speeds or below operating temperatures, the wind turbine is gently braked by means of rotor blade adjustment. Other safety functions are used to stop drives safely for maintenance work.

2.2 Lightning / overvoltage protection, electromagnetic compatibility (EMC)

The lightning/surge protection of the wind turbine is based on the EMC-compliant lightning protection zone concept, which comprises the implementation of internal and external lightning/surge protection measures under consideration of the standard IEC 61400-24. The wind turbine is designed according to lightning protection class I.

The wind turbine with the electrical equipment, consumers, the measurement, control, protection, information and telecommunication technology meets the EMC requirements according to IEC 61400-1.

2.3 Medium-voltage system

The medium voltage components are used to connect a WT to the wind farm medium-voltage grid or the local grid operator. The tower base contains the **MV switchgear**. It consists of a transformer field with circuit breakers and at least one ring cable field as default and up to three ring cable fields as an option (dependent on the wind farm configuration). The transformer panel consists of a vacuum circuit breaker and the disconnector with ground switch. The ring cable panel consist of a switch disconnector with a ground switch. The entire MV switchgear is assembled on a support/adapter frame.

Further characteristics of the MV switchgear:

- Routine tests of each switchgear in compliance with IEC 62271-200
- Type tested, SF6 insulation
- Internal switchgear for self-contained electrical systems (min. IP2X)
- SF-6 tank: metal-clad, metal-enclosed (min. IP65), independent of environmental influences
- Switch positions shown "On - Off - Grounded"
- Test terminal strip for secondary test
- Low-maintenance in accordance with class E2 (IEC 62271-100)

In case of technical availability Nordex can as an alternative to traditional SF6 insulated switchgear also supply SF6-free switchgear. This option is to be agreed upon with Nordex in advance.

The system protection of the MV switchgear is achieved by the following items:

- Improved personal safety and system protection in case of arcing by type testing in compliance with IEC 62271-200
- Protection device supplied with converter current and stabilized for inrush current as DMT protection relay (independent maximum current protection)
- Actuating openings for switchgear are interlocked to preclude operation of more than one simultaneously, and can be locked as an option
- Corrosion protection of the switchgear cells through hot-dip galvanization and painted surfaces
- Pressure relief by pressure absorber duct in case of arcing. Alternatively, for the USA, an arc suppressor can be installed in the tank and in the cable connection compartment.

Transformer and **converter** are located in the nacelle. The transformer has been specified in accordance with IEC 60076-16.

The steel components at the transformer are dimensioned for corrosion protection class C3 (H). Additional protection measures:

- Grounded tank (Ester transformer)
- Overtemperature protection with temperature sensor and relay
- Hermetic protection (leakage) and overpressure protection for ester transformer

2.4 Low-voltage grid types

The **950 V low voltage grid** is the primary wind turbine low voltage energy system. It is insulated from the ground as an IT grid and three phase AC network. The elements of the electrical operating and measuring devices of this network are grounded directly or via separate protective equipotential bonding cables. A central insulation monitor has been installed as another protective measure for personal and turbine safety in the 950-V-IT system.

The **400 V/230 V low voltage grid** is the auxiliary wind turbine low voltage system. It has its neutral point grounded directly in the supplying grid transformers as a TN system and three-phase system. The equipment grounding conductor PE and the neutral conductor are available separately. The bodies of electrical equipment and consumers, including the additional protective equipotential bonding, are connected directly, through protective earthing conductor connections, straight to the neutral points of the supply grid transformers.

2.5 Auxiliary power of the wind turbine

The auxiliary low voltage required by the wind turbine in stand-by mode and feed-in mode is requested by the following consumers:

- System control including main converter control
- 400 V/230 V auxiliary power of the main converter
- 230 V AC UPS supply including 24 V DC supply
- Yaw system
- Pitch system
- Auxiliary drives such as pumps, fans and lubrication units
- Heating and lighting
- Auxiliary systems such as service lift, obstacle lights

Long-term measurements show that the average annual base load of the low-voltage auxiliary power plant in WT feed-in operation is approx. 15 kW in the average 10 min mean value and the maximum 10-min average value can reach up to 25 kW/32kVA. These values are already included in the power curves. For locations with an average annual wind speed of 6.5 m/s approx. 10 MWh auxiliary consumption arise, however, this value is greatly dependent on location.

Auxiliary consumption is defined as the energy consumption of the WT from the grid for a period during which the WT does not supply current to the grid.

3. Options

Various options are available upon request as additional equipment for Nordex wind turbines.

The option of optional equipment must be coordinated with Nordex in advance.

4. Technical data

4.1 Technical design

Technical design	
Survival temperature	-40 °C to +50 °C
Operating temperature range of the Normal Climate Version	-20 °C to +40 °C[1)]
Operating temperature range of the Cold Climate Version	-30 °C to +40 °C[1)]
Stop	Standard: -20 °C, restart at -18 °C CCV: -30 °C, restart at -28 °C
Max. height above MSL	2000 m1[)]
Certificate	In accordance with IEC 61400-22 and DIBt 2012
Type	3-blade rotor with horizontal axis Up-wind turbine
Output control	Active single blade adjustment
Nominal power	up to 7000 kW[1)]
Rated power at wind speed (at an air density of 1.225 kg/m^3)	Approx. 13.5 m/s
Operating speed range of the rotor	6.0 min^{-1} to 11.6 min^{-1}
Nominal speed	approx. 10.0 min^{-1}
Cut-in wind speed	3 m/s
Cut-out wind speed	26 m/s[2)]
Cut-back-in wind speed	25.5 m/s[2)]
Calculated service life	≥ 25 years

[1)] Nominal output is achieved depending on the power factor and the installation altitude up to defined temperature ranges.

[2)] Depending on the project, the cut-out wind speed can be decreased to safeguard the structural stability.

4.2 Towers

Towers	TS98-01	TS113-00	TS118-03	TS138	TS148-01	TS159-01	TCS164B-03
Hub height*	98.5 m	113.0 m	118.0 m	138.0 m	148.0 m	158.5 m	164.0 m
Tower type	Tubular steel tower						Hybrid tower
Wind class	IEC S	IEC S	IEC S DIBt S	IEC S	IEC S	IEC S	IEC S DIBt S
Surface finish	Color system coating						**

* Includes foundation height above ground level

** Steel section: Color system coating; Concrete part: Fair-faced concrete

4.3 Rotor and rotor blades

Rotor	
Rotor diameter	163.0 m
Swept area	20867 m2
Nominal power/area	326 W/m2
Rotor shaft inclination angle	5 °
Blade cone angle	5.5 °

Rotor blade	
Material	fiber glass and carbon fiber reinforced plastic
Total length	79.7 m

Rotor hub	
Material of the rotor hub body	Casting
Material spinner	glass-fiber reinforced plastic

4.4 Nacelle

Nacelle	
Support structure	welded steel structure
Cladding	glass-fiber reinforced plastic
Machine frame	Casting
Generator frame	welded steel construction

4.4.1 Rotor shaft

Rotor shaft / rotor bearing	
Type	Forged hollow shaft
Material	42CrMo4 or 34CrNiMo6
Bearing type	Spherical roller bearing
Lubrication	Regularly using lubricating grease

4.4.2 Brake and gearbox

Mechanical brake	
Type	Actively actuated disk brake
Location	On the high-speed shaft
Number of brake calipers	1
Brake pad material	Organic pad material

Gearbox	
Type	Multi-stage planetary gear + spur gear stage
Gear ratio	50 Hz: i = 122.4 60 Hz: i = 146.9
Lubrication	Forced-feed lubrication
Oil quantity including cooling circuit	max. 800 l
Oil type	VG 320
Max. oil temperature	Approx. 77 °C
Oil change	Change, if required

4.4.3 E-chain hoist and crossbeam

E-chain hoist and lifting beam	
Electrical chain hoist max load	 Min. 850 kg
Crossbeam max load	Sliding trolley to accommodate a manual chain hoist 1000 kg

4.5 Electrical system

Electrical system *	
Nominal power P_{nG}	7000
Nominal voltage	3 x AC 950 V ± 10 % (specific to grid code)
Nominal current during full reactive current feed-in I_{nG} at S_{nG}	4727 A
Nominal apparent power S_{nG} at P_{nG}	7778 kVA
Frequency	50 and 60 Hz

*) All data are maximum values. The values may deviate depending on the rated voltage, rated apparent power and WT active power.

4.5.1 Transformer

Transformer*	**50 Hz**	**60 Hz**
Total weight	approx. 10 t	
Insulation medium	Ester	
Rated voltage OV, U_r	950 V	
Maximum rated voltage OS, dependent on MV grid, U_r	20 kV/30 kV/34 kV	
Taps, overvoltage side	20 kV and 30 kV: + 4 x 2.5 % 34 kV: + 4 x 0.5 kV	
Grid voltage OS	20; 20.5; 21; 21.5; 22 kV 30; 30.75; 31.5; 32.25; 33 kV 34; 34.5; 35; 35.5; 36 kV	
Rated frequency, f_r	50 Hz	60 Hz
Vector group	Dy5	
Installation altitude (above MSL)	Up to 2000 m	
Rated apparent power, S_r	7800 kVA	
Impedance voltage, U_z	9 % ± 10 % tolerance	
Minimum peak efficiency index, η, (EU) 2019/1783, 548/2014	99.590%	–
Inrush current	≤ 5.5 x I_N (peak value)	
Power loss[1)] No-load losses Short circuit losses	 3050 W 80000 W	 4300 W 80700 W

*) The values are, if not specified otherwise, maximum values. The values may deviate depending on the rated voltage, rated apparent power and WT active power.

1) Guide values

4.5.2 Medium-voltage switchgear

Medium-voltage switchgear	
Rated voltage (dependent on MV grid)	24; 36; 38 or 40.5 kV
Rated current	50 Hz: 630 A 60 Hz: 600 A
Rated short-circuit duration	1 s
Rated short circuit current	24 kV: 16 kA (20 kA optional) 36/38/40.5 kV: 20 kA (25 kA optional)
Minimum/maximum ambient temperature during operation	NCV: -25 °C to +40 °C
	CCV: -30 °C to +40 °C
Connection type	External cone type C according to EN 50181 USA: External cone type E according to IEEE 386
Circuit breaker	
Number of switching cycles with rated current	E2
Number of switching cycles with short-circuit breaking current	E2
Number of mechanical switching cycles	M1
Switching of capacitive currents	Min. C1 - low
Switch disconnector	
Number of switching cycles with rated current	E3
Number of switching cycles with short-circuit breaking current	E3
Number of mechanical switching cycles	M1
Disconnector	
Number of mechanical switching cycles	M0
Ground switch	
Switching number with rated short-circuit inrush current	E2
Number of mechanical switching cycles	≥ 1000

4.5.3 Generator

Generator	
Type	6-pole doubly-fed induction machine
Degree of protection	IP 54 (slip ring box IP 23)
Nominal voltage	950 V
Frequency	50 and 60 Hz
Speed range	50 Hz: 650 to 1500 min^{-1} 60 Hz: 780 to 1800 min^{-1}
Poles	6
Weight	approx. 13.5 t

4.6 Cooling system

Cooling system	
Gearbox	
Type	Oil circuit with oil/water heat exchanger and thermal bypass
Filters	Coarse filter 50 µm / fine filter 10 µm / ultrafine filter <5 µm
Generator	
Type	Water circuit with water/air heat exchanger and thermal bypass
Coolant	Water/glycol-based coolant
Converter	
Type	Water circuit with water/air heat exchanger and thermal bypass
Coolant	Water/glycol-based coolant
Transformer	
Coolant	Water/glycol-based coolant
Cooling circuit	Ester circuit with ester/water heat exchanger

4.7 Pitch system

Pitch system	
Pitch bearing	Double-row four-point contact bearing
Gearing/raceway lubrication	Regular lubrication with grease
Drive	Electric motors incl. spring-loaded brake and multi-stage planetary gear
Emergency power supply	Batteries

4.8 Yaw system

Yaw system	
Yaw bearing	Double-row four-point contact bearing
Gearing/raceway lubrication	Regular lubrication with grease
Drive	Electric motors incl. spring-loaded brake and four-stage planetary gear
Number of drives	5-6
Yaw speed	Approx. 0.4 °/s

4.9 Corrosion protection

Corrosion protection*	Inside	Outside
Nacelle	C3	C4
Hub, including material spinner	C3	C4
Tower Steel sections Concrete components	C3 Color system coating Fair-faced concrete	C4 Color system coating Fair-faced concrete

* Categories of corrosion protection according to ISO 12944-2

4.10 Automation systems

Automation system	
Field bus system	Profinet
Safe fieldbus system	Profisafe via Profinet
Turbine control	Profinet system control
Safety control	Integrated safety control

11 ALLEGATO 4 – MAIN RESULTS SIMULAZIONE

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SHADOW - Main Result

Assumptions for shadow calculations

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

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

Sunshine probability S (Average daily sunshine hours) [ALGHERO]

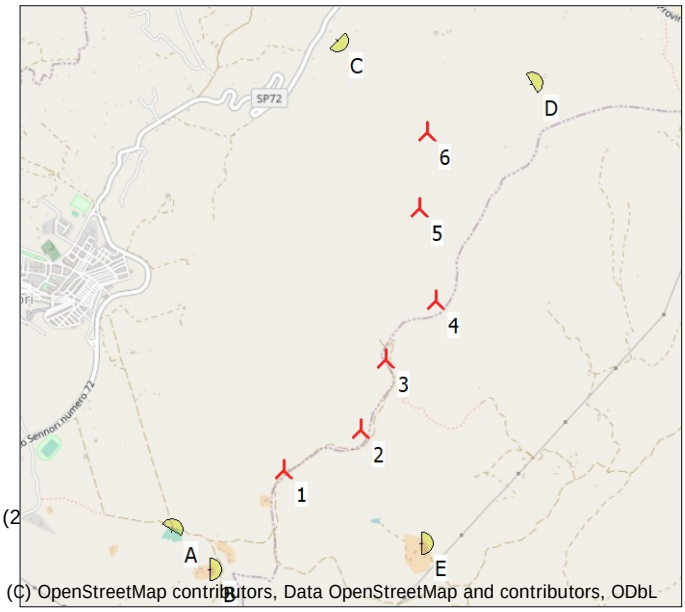
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3,85	4,78	5,80	6,92	8,25	9,91	10,91	9,92	8,15	6,40	4,83	3,92

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
79	158	315	946	315	158	237	237	631	552	3.154	1.104	7.886

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: Sennori_EMDGrid_1.wpg (2
Receptor grid resolution: 1,0 m
Topographic shadow included in calculation

All coordinates are in
Geo [deg]-WGS84



Scale 1:50.000
New WTG
Shadow receptor

WTGs

	Longitude	Latitude	Z	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Shadow data Calculation distance	RPM
			[m]					[kW]	[m]	[m]	[m]	[RPM]
1	8,615698° E	40,779239° N	381,7	SEN-01	Yes	NORDEX	N163/6.X-7.000	7.000	163,0	98,0	1.789	10,7
2	8,621669° E	40,781637° N	409,7	SEN-02	Yes	NORDEX	N163/6.X-7.000	7.000	163,0	118,0	1.788	10,7
3	8,623625° E	40,785778° N	379,3	SEN-03	Yes	NORDEX	N163/6.X-7.000	7.000	163,0	118,0	1.788	10,7
4	8,627623° E	40,789296° N	397,5	SEN-04	Yes	NORDEX	N163/6.X-7.000	7.000	163,0	118,0	1.788	10,7
5	8,626348° E	40,794751° N	307,0	SEN-05	Yes	NORDEX	N163/6.X-7.000	7.000	163,0	118,0	1.788	10,7
6	8,626915° E	40,799302° N	256,0	SEN-06	Yes	NORDEX	N163/6.X-7.000	7.000	163,0	118,0	1.788	10,7

Shadow receptor-Input

No.	Name	Longitude	Latitude	Z	Width	Height	Elevation a.g.l.	Degrees from south cw	Slope of window	Direction mode	Eye height (ZVI) a.g.l.
				[m]	[m]	[m]	[m]	[°]	[°]		[m]
A	Sennori n.28 - p.lla 51 (A03)	8,606926° E	40,775669° N	412,7	1,0	1,5	1,0	30,0	90,0	Fixed direction	2,5
B	Sennori n.28 - p.lla 55 (A03)	8,609973° E	40,773319° N	394,5	1,0	1,5	1,0	90,0	90,0	Fixed direction	2,5
C	Sennori n.14 - p.lla 269 (A03)	8,619926° E	40,804711° N	78,8	1,0	1,5	1,0	135,0	90,0	Fixed direction	2,5
D	Sennori n.15 - p.lla 173 (A03)	8,635138° E	40,802229° N	185,5	1,0	1,5	1,0	60,0	90,0	Fixed direction	2,5
E	Osilo n.29 - p.lla 41 (A04)	8,626472° E	40,774860° N	380,4	1,0	1,5	1,0	90,0	90,0	Fixed direction	2,5

Calculation Results

Shadow receptor

No.	Name	Shadow, worst case Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow, expected values Shadow hours per year [h/year]
A	Sennori n.28 - p.lla 51 (A03)	0:00	0	0:00	0:00
B	Sennori n.28 - p.lla 55 (A03)	0:00	0	0:00	0:00
C	Sennori n.14 - p.lla 269 (A03)	0:00	0	0:00	0:00
D	Sennori n.15 - p.lla 173 (A03)	66:59	120	0:48	19:04
E	Osilo n.29 - p.lla 41 (A04)	21:35	62	0:28	10:23

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SHADOW - Main Result

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

No.	Name	Worst case [h/year]	Expected [h/year]
1	SEN-01	21:35	10:23
2	SEN-02	0:00	0:00
3	SEN-03	0:00	0:00
4	SEN-04	0:00	0:00
5	SEN-05	26:37	5:34
6	SEN-06	40:22	13:44

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.

12 ALLEGATO 5 – CALENDARIO OMBREGGIAMENTO

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SHADOW - Calendar

Shadow receptor: A - Sennori n.28 - p.lla 51 (A03)

Assumptions for shadow calculations

Sunshine probability S (Average daily sunshine hours) [ALGHERO]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3,85	4,78	5,80	6,92	8,25	9,91	10,91	9,92	8,15	6,40	4,83	3,92

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
79	158	315	946	315	158	237	237	631	552	3.154	1.104	7.886

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:50	07:37	07:02	07:11	06:26	05:57	05:58	06:22	06:52	07:22	06:55	07:30
	17:09	17:43	18:16	19:50	20:21	20:51	21:01	20:43	20:00	19:10	17:24	16:59
2	07:50	07:36	07:00	07:10	06:25	05:57	05:58	06:23	06:53	07:23	06:57	07:31
	17:09	17:44	18:17	19:51	20:22	20:51	21:01	20:42	19:58	19:08	17:22	16:59
3	07:51	07:35	06:59	07:08	06:23	05:56	05:59	06:24	06:54	07:24	06:58	07:32
	17:10	17:45	18:19	19:52	20:23	20:52	21:01	20:41	19:57	19:06	17:21	16:59
4	07:51	07:34	06:57	07:06	06:22	05:56	05:59	06:24	06:55	07:25	06:59	07:33
	17:11	17:46	18:20	19:53	20:25	20:53	21:01	20:39	19:55	19:05	17:20	16:59
5	07:51	07:33	06:55	07:05	06:21	05:56	06:00	06:25	06:56	07:26	07:00	07:34
	17:12	17:48	18:21	19:54	20:26	20:53	21:01	20:38	19:53	19:03	17:19	16:59
6	07:51	07:32	06:54	07:03	06:20	05:55	06:01	06:26	06:57	07:27	07:01	07:35
	17:13	17:49	18:22	19:55	20:27	20:54	21:01	20:37	19:52	19:02	17:18	16:58
7	07:51	07:31	06:52	07:01	06:18	05:55	06:01	06:27	06:58	07:28	07:02	07:36
	17:14	17:50	18:23	19:56	20:28	20:55	21:00	20:36	19:50	19:00	17:17	16:58
8	07:50	07:30	06:51	07:00	06:17	05:55	06:02	06:28	06:59	07:29	07:04	07:37
	17:15	17:51	18:24	19:57	20:29	20:55	21:00	20:35	19:49	18:58	17:15	16:58
9	07:50	07:29	06:49	06:58	06:16	05:55	06:02	06:29	07:00	07:30	07:05	07:38
	17:16	17:52	18:25	19:58	20:30	20:56	21:00	20:33	19:47	18:57	17:14	16:58
10	07:50	07:28	06:48	06:57	06:15	05:54	06:03	06:30	07:01	07:31	07:06	07:39
	17:17	17:54	18:26	19:59	20:31	20:56	20:59	20:32	19:45	18:55	17:13	16:58
11	07:50	07:26	06:46	06:55	06:14	05:54	06:04	06:31	07:02	07:32	07:07	07:39
	17:18	17:55	18:27	20:00	20:32	20:57	20:59	20:31	19:44	18:54	17:12	16:58
12	07:50	07:25	06:44	06:54	06:13	05:54	06:05	06:32	07:03	07:33	07:08	07:40
	17:19	17:56	18:29	20:01	20:33	20:57	20:58	20:30	19:42	18:52	17:11	16:59
13	07:49	07:24	06:43	06:52	06:12	05:54	06:05	06:33	07:04	07:34	07:10	07:41
	17:20	17:57	18:30	20:03	20:34	20:58	20:58	20:28	19:40	18:50	17:11	16:59
14	07:49	07:23	06:41	06:50	06:11	05:54	06:06	06:34	07:05	07:35	07:11	07:42
	17:21	17:59	18:31	20:04	20:35	20:58	20:57	20:27	19:38	18:49	17:10	16:59
15	07:49	07:21	06:39	06:49	06:10	05:54	06:07	06:35	07:06	07:36	07:12	07:43
	17:22	18:00	18:32	20:05	20:36	20:59	20:57	20:26	19:37	18:47	17:09	16:59
16	07:48	07:20	06:38	06:47	06:09	05:54	06:08	06:36	07:07	07:37	07:13	07:43
	17:23	18:01	18:33	20:06	20:37	20:59	20:56	20:24	19:35	18:46	17:08	16:59
17	07:48	07:19	06:36	06:46	06:08	05:54	06:08	06:37	07:08	07:38	07:14	07:44
	17:25	18:02	18:34	20:07	20:38	21:00	20:56	20:23	19:33	18:44	17:07	17:00
18	07:47	07:17	06:34	06:44	06:07	05:54	06:09	06:38	07:09	07:40	07:15	07:45
	17:26	18:03	18:35	20:08	20:39	21:00	20:55	20:21	19:32	18:43	17:06	17:00
19	07:47	07:16	06:33	06:43	06:06	05:54	06:10	06:39	07:10	07:41	07:17	07:45
	17:27	18:05	18:36	20:09	20:39	21:00	20:54	20:20	19:30	18:41	17:06	17:00
20	07:46	07:15	06:31	06:41	06:05	05:54	06:11	06:40	07:11	07:42	07:18	07:46
	17:28	18:06	18:37	20:10	20:40	21:01	20:54	20:18	19:28	18:40	17:05	17:01
21	07:46	07:13	06:30	06:40	06:04	05:55	06:12	06:41	07:12	07:43	07:19	07:46
	17:29	18:07	18:38	20:11	20:41	21:01	20:53	20:17	19:27	18:38	17:04	17:01
22	07:45	07:12	06:28	06:38	06:04	05:55	06:12	06:42	07:13	07:44	07:20	07:47
	17:30	18:08	18:39	20:12	20:42	21:01	20:52	20:15	19:25	18:37	17:04	17:02
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	17:32	18:09	18:40	20:13	20:43	21:01	20:51	20:14	19:23	18:35	17:03	17:02
24	07:44	07:09	06:25	06:35	06:02	05:55	06:14	06:44	07:15	07:46	07:22	07:48
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	17:34	18:12	18:43	20:15	20:45	21:01	20:50	20:11	19:20	17:33	17:02	17:03
26	07:42	07:06	06:21	06:33	06:01	05:56	06:16	06:46	07:17	06:48	07:25	07:49
	17:35	18:13	18:44	20:16	20:46	21:02	20:49	20:09	19:18	17:31	17:01	17:04
27	07:42	07:05	06:20	06:31	06:00	05:56	06:17	06:47	07:18	06:50	07:26	07:49
	17:36	18:14	18:45	20:17	20:47	21:02	20:48	20:08	19:16	17:30	17:01	17:05
28	07:41	07:03	06:18	06:30	05:59	05:57	06:18	06:48	07:19	06:51	07:27	07:49
	17:38	18:15	18:46	20:18	20:47	21:02	20:47	20:06	19:15	17:29	17:01	17:05
29	07:40		07:16	06:29	05:59	05:57	06:19	06:49	07:20	06:52	07:28	07:50
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30	07:39		07:15	06:27	05:58	05:57	06:20	06:50	07:21	06:53	07:29	07:50
	17:40		19:48	20:20	20:49	21:02	20:45	20:03	19:11	17:26	17:00	17:07
31	07:38		07:13		05:58		06:21	06:51		06:54		07:50
	17:41		19:49		20:50		20:44	20:02		17:25		17:08
Potential sun hours	298	298	370	398	448	451	458	427	375	346	299	289
Total, worst case												
Sun reduction												
Oper. time red.												
Wind dir. red.												
Total reduction												
Total, real												

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)

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Calculated:
02/08/2024 19:53/4.0.424

SHADOW - Calendar

Shadow receptor: B - Sennori n.28 - p.lla 55 (A03)

Assumptions for shadow calculations

Sunshine probability S (Average daily sunshine hours) [ALGHERO]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3,85	4,78	5,80	6,92	8,25	9,91	10,91	9,92	8,15	6,40	4,83	3,92

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
79	158	315	946	315	158	237	237	631	552	3.154	1.104	7.886

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:50	07:37	07:02	07:11	06:26	05:57	05:58	06:22	06:52	07:22	06:55	07:30
	17:09	17:43	18:16	19:50	20:21	20:51	21:01	20:43	20:00	19:10	17:24	16:59
2	07:50	07:36	07:00	07:10	06:25	05:57	05:58	06:23	06:53	07:23	06:57	07:31
	17:09	17:44	18:17	19:51	20:22	20:51	21:01	20:42	19:58	19:08	17:22	16:59
3	07:51	07:35	06:59	07:08	06:23	05:56	05:59	06:23	06:54	07:24	06:58	07:32
	17:10	17:45	18:19	19:52	20:23	20:52	21:01	20:41	19:57	19:06	17:21	16:59
4	07:51	07:34	06:57	07:06	06:22	05:56	05:59	06:24	06:55	07:25	06:59	07:33
	17:11	17:46	18:20	19:53	20:24	20:53	21:01	20:39	19:55	19:05	17:20	16:59
5	07:51	07:33	06:55	07:05	06:21	05:56	06:00	06:25	06:56	07:26	07:00	07:34
	17:12	17:47	18:21	19:54	20:26	20:53	21:01	20:38	19:53	19:03	17:19	16:59
6	07:51	07:32	06:54	07:03	06:20	05:55	06:01	06:26	06:57	07:27	07:01	07:35
	17:13	17:49	18:22	19:55	20:27	20:54	21:01	20:37	19:52	19:02	17:18	16:58
7	07:51	07:31	06:52	07:01	06:18	05:55	06:01	06:27	06:58	07:28	07:02	07:36
	17:14	17:50	18:23	19:56	20:28	20:55	21:00	20:36	19:50	19:00	17:17	16:58
8	07:50	07:30	06:51	07:00	06:17	05:55	06:02	06:28	06:59	07:29	07:04	07:37
	17:15	17:51	18:24	19:57	20:29	20:55	21:00	20:35	19:49	18:58	17:15	16:58
9	07:50	07:29	06:49	06:58	06:16	05:55	06:02	06:29	07:00	07:30	07:05	07:38
	17:16	17:52	18:25	19:58	20:30	20:56	21:00	20:33	19:47	18:57	17:14	16:58
10	07:50	07:28	06:48	06:57	06:15	05:54	06:03	06:30	07:01	07:31	07:06	07:39
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	17:18	17:55	18:27	20:00	20:32	20:57	20:59	20:31	19:43	18:54	17:12	16:58
12	07:50	07:25	06:44	06:54	06:13	05:54	06:05	06:32	07:03	07:33	07:08	07:40
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13	07:49	07:24	06:43	06:52	06:12	05:54	06:05	06:33	07:04	07:34	07:10	07:41
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14	07:49	07:23	06:41	06:50	06:11	05:54	06:06	06:34	07:05	07:35	07:11	07:42
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15	07:49	07:21	06:39	06:49	06:10	05:54	06:07	06:35	07:06	07:36	07:12	07:43
	17:22	18:00	18:32	20:05	20:36	20:59	20:57	20:25	19:37	18:47	17:09	16:59
16	07:48	07:20	06:38	06:47	06:09	05:54	06:08	06:36	07:07	07:37	07:13	07:43
	17:23	18:01	18:33	20:06	20:37	20:59	20:56	20:24	19:35	18:46	17:08	16:59
17	07:48	07:19	06:36	06:46	06:08	05:54	06:08	06:37	07:08	07:38	07:14	07:44
	17:25	18:02	18:34	20:07	20:38	21:00	20:56	20:23	19:33	18:44	17:07	17:00
18	07:47	07:17	06:34	06:44	06:07	05:54	06:09	06:38	07:09	07:40	07:15	07:45
	17:26	18:03	18:35	20:08	20:39	21:00	20:55	20:21	19:32	18:43	17:06	17:00
19	07:47	07:16	06:33	06:43	06:06	05:54	06:10	06:39	07:10	07:41	07:17	07:45
	17:27	18:05	18:36	20:09	20:39	21:00	20:54	20:20	19:30	18:41	17:06	17:00
20	07:46	07:15	06:31	06:41	06:05	05:54	06:11	06:40	07:11	07:42	07:18	07:46
	17:28	18:06	18:37	20:10	20:40	21:01	20:53	20:18	19:28	18:40	17:05	17:01
21	07:46	07:13	06:30	06:40	06:04	05:55	06:12	06:41	07:12	07:43	07:19	07:46
	17:29	18:07	18:38	20:11	20:41	21:01	20:53	20:17	19:27	18:38	17:04	17:01
22	07:45	07:12	06:28	06:38	06:04	05:55	06:12	06:42	07:13	07:44	07:20	07:47
	17:30	18:08	18:39	20:12	20:42	21:01	20:52	20:15	19:25	18:37	17:04	17:02
23	07:44	07:11	06:26	06:37	06:03	05:55	06:13	06:43	07:14	07:45	07:21	07:47
	17:32	18:09	18:40	20:13	20:43	21:01	20:51	20:14	19:23	18:35	17:03	17:02
24	07:44	07:09	06:25	06:35	06:02	05:55	06:14	06:44	07:15	07:46	07:22	07:48
	17:33	18:10	18:41	20:14	20:44	21:01	20:50	20:12	19:22	18:34	17:02	17:03
25	07:43	07:08	06:23	06:34	06:01	05:56	06:15	06:45	07:16	06:47	07:23	07:48
	17:34	18:12	18:43	20:15	20:45	21:01	20:49	20:11	19:20	17:33	17:02	17:03
26	07:42	07:06	06:21	06:33	06:01	05:56	06:16	06:46	07:17	06:48	07:25	07:49
	17:35	18:13	18:44	20:16	20:46	21:01	20:49	20:09	19:18	17:31	17:01	17:04
27	07:42	07:05	06:20	06:31	06:00	05:56	06:17	06:47	07:18	06:50	07:26	07:49
	17:36	18:14	18:45	20:17	20:47	21:02	20:48	20:08	19:16	17:30	17:01	17:05
28	07:41	07:03	06:18	06:30	05:59	05:57	06:18	06:48	07:19	06:51	07:27	07:49
	17:38	18:15	18:46	20:18	20:47	21:02	20:47	20:06	19:15	17:29	17:01	17:05
29	07:40		07:16	06:29	05:59	05:57	06:19	06:49	07:20	06:52	07:28	07:50
	17:39		19:47	20:19	20:48	21:02	20:46	20:05	19:13	17:27	17:00	17:06
30	07:39		07:15	06:27	05:58	05:57	06:20	06:50	07:21	06:53	07:29	07:50
	17:40		19:48	20:20	20:49	21:02	20:45	20:03	19:11	17:26	17:00	17:07
31	07:38		07:13		05:58		06:21	06:51		06:54		07:50
	17:41		19:49		20:50		20:44	20:02		17:25		17:08
Potential sun hours	298	298	370	398	448	451	458	427	375	346	299	289
Total, worst case												
Sun reduction												
Oper. time red.												
Wind dir. red.												
Total reduction												
Total, real												

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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Calculated:
02/08/2024 19:53/4.0.424

SHADOW - Calendar

Shadow receptor: C - Sennori n.14 - p.lla 269 (A03)

Assumptions for shadow calculations

Sunshine probability S (Average daily sunshine hours) [ALGHERO]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3,85	4,78	5,80	6,92	8,25	9,91	10,91	9,92	8,15	6,40	4,83	3,92

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
79	158	315	946	315	158	237	237	631	552	3.154	1.104	7.886

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:50	07:37	07:02	07:11	06:26	05:57	05:58	06:21	06:52	07:22	06:55	07:30
	17:08	17:42	18:16	19:50	20:21	20:51	21:01	20:43	20:00	19:10	17:23	16:59
2	07:51	07:36	07:00	07:10	06:24	05:57	05:58	06:22	06:53	07:23	06:57	07:31
	17:09	17:44	18:17	19:51	20:22	20:51	21:01	20:42	19:58	19:08	17:22	16:59
3	07:51	07:35	06:59	07:08	06:23	05:56	05:59	06:23	06:54	07:24	06:58	07:32
	17:10	17:45	18:18	19:52	20:23	20:52	21:01	20:41	19:57	19:06	17:21	16:59
4	07:51	07:34	06:57	07:06	06:22	05:56	05:59	06:24	06:55	07:25	06:59	07:33
	17:11	17:46	18:20	19:53	20:25	20:53	21:01	20:39	19:55	19:05	17:20	16:59
5	07:51	07:33	06:55	07:05	06:21	05:56	06:00	06:25	06:56	07:26	07:00	07:34
	17:12	17:47	18:21	19:54	20:26	20:53	21:01	20:38	19:53	19:03	17:19	16:58
6	07:51	07:32	06:54	07:03	06:20	05:55	06:00	06:26	06:57	07:27	07:01	07:35
	17:13	17:49	18:22	19:55	20:27	20:54	21:01	20:37	19:52	19:01	17:18	16:58
7	07:51	07:31	06:52	07:01	06:18	05:55	06:01	06:27	06:58	07:28	07:02	07:36
	17:14	17:50	18:23	19:56	20:28	20:55	21:00	20:36	19:50	19:00	17:16	16:58
8	07:50	07:30	06:51	07:00	06:17	05:55	06:02	06:28	06:59	07:29	07:04	07:37
	17:15	17:51	18:24	19:57	20:29	20:55	21:00	20:35	19:48	18:58	17:15	16:58
9	07:50	07:29	06:49	06:58	06:16	05:55	06:02	06:29	07:00	07:30	07:05	07:38
	17:16	17:52	18:25	19:58	20:30	20:56	21:00	20:33	19:47	18:57	17:14	16:58
10	07:50	07:28	06:48	06:57	06:15	05:54	06:03	06:30	07:01	07:31	07:06	07:39
	17:17	17:54	18:26	19:59	20:31	20:56	20:59	20:32	19:45	18:55	17:13	16:58
11	07:50	07:26	06:46	06:55	06:14	05:54	06:04	06:31	07:02	07:32	07:07	07:39
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13	07:49	07:24	06:43	06:52	06:12	05:54	06:05	06:33	07:04	07:34	07:10	07:41
	17:20	17:57	18:30	20:02	20:34	20:58	20:58	20:28	19:40	18:50	17:10	16:59
14	07:49	07:23	06:41	06:50	06:11	05:54	06:06	06:34	07:05	07:35	07:11	07:42
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	17:22	18:00	18:32	20:05	20:36	20:59	20:57	20:26	19:37	18:47	17:09	16:59
16	07:48	07:20	06:38	06:47	06:09	05:54	06:07	06:36	07:07	07:37	07:13	07:43
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17	07:48	07:19	06:36	06:46	06:08	05:54	06:08	06:37	07:08	07:38	07:14	07:44
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	17:27	18:04	18:36	20:09	20:39	21:00	20:54	20:20	19:30	18:41	17:06	17:00
20	07:46	07:15	06:31	06:41	06:05	05:54	06:11	06:40	07:11	07:42	07:18	07:46
	17:28	18:06	18:37	20:10	20:40	21:01	20:54	20:18	19:28	18:40	17:05	17:01
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	17:35	18:13	18:44	20:16	20:46	21:02	20:49	20:09	19:18	17:31	17:01	17:04
27	07:42	07:05	06:19	06:31	06:00	05:56	06:17	06:47	07:18	06:50	07:26	07:49
	17:36	18:14	18:45	20:17	20:47	21:02	20:48	20:08	19:16	17:30	17:01	17:04
28	07:41	07:03	06:18	06:30	05:59	05:56	06:18	06:48	07:19	06:51	07:27	07:49
	17:37	18:15	18:46	20:18	20:47	21:02	20:47	20:06	19:15	17:29	17:00	17:05
29	07:40		07:16	06:28	05:59	05:57	06:19	06:49	07:20	06:52	07:28	07:50
	17:39		19:47	20:19	20:48	21:02	20:46	20:05	19:13	17:27	17:00	17:06
30	07:39		07:15	06:27	05:58	05:57	06:20	06:50	07:21	06:53	07:29	07:50
	17:40		19:48	20:20	20:49	21:02	20:45	20:03	19:11	17:26	17:00	17:07
31	07:38		07:13		05:58		06:21	06:51		06:54		07:50
	17:41		19:49		20:50		20:44	20:02		17:25		17:07
Potential sun hours	298	298	370	398	448	451	458	427	375	345	298	289
Total, worst case												
Sun reduction												
Oper. time red.												
Wind dir. red.												
Total reduction												
Total, real												

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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Calculated:
02/08/2024 19:53/4.0.424

SHADOW - Calendar

Shadow receptor: D - Sennori n.15 - p.lla 173 (A03)
Assumptions for shadow calculations

Sunshine probability S (Average daily sunshine hours) [ALGHERO]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3,85	4,78	5,80	6,92	8,25	9,91	10,91	9,92	8,15	6,40	4,83	3,92

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
79	158	315	946	315	158	237	237	631	552	3.154	1.104	7.886

	January			February			March			April		May	June
1	07:50		15:15 (5)	07:37			07:02		16:27 (6)	07:11		06:26	05:57
	17:08	33	15:48 (5)	17:42			18:16	46	17:13 (6)	19:50		20:21	20:51
2	07:50		15:15 (5)	07:36			07:00		16:28 (6)	07:10		06:24	05:57
	17:09	33	15:48 (5)	17:44			18:17	45	17:13 (6)	19:51		20:22	20:51
3	07:51		15:16 (5)	07:35			06:58		16:28 (6)	07:08		06:23	05:56
	17:10	32	15:48 (5)	17:45			18:18	43	17:11 (6)	19:52		20:23	20:52
4	07:51		15:17 (5)	07:34			06:57		16:29 (6)	07:06		06:22	05:56
	17:11	32	15:49 (5)	17:46			18:20	42	17:11 (6)	19:53		20:24	20:53
5	07:51		15:18 (5)	07:33			06:55		16:29 (6)	07:05		06:21	05:56
	17:12	31	15:49 (5)	17:47			18:21	41	17:10 (6)	19:54		20:25	20:53
6	07:51		15:18 (5)	07:32			06:54		16:31 (6)	07:03		06:19	05:55
	17:13	31	15:49 (5)	17:49			18:22	38	17:09 (6)	19:55		20:27	20:54
7	07:51		15:18 (5)	07:31			06:52		16:32 (6)	07:01		06:18	05:55
	17:14	30	15:48 (5)	17:50			18:23	35	17:07 (6)	19:56		20:28	20:55
8	07:50		15:19 (5)	07:30			06:51		16:32 (6)	07:00		06:17	05:55
	17:15	30	15:49 (5)	17:51			18:24	33	17:05 (6)	19:57		20:29	20:55
9	07:50		15:20 (5)	07:29		16:43 (6)	06:49		16:35 (6)	06:58		06:16	05:54
	17:16	29	15:49 (5)	17:52	15	16:58 (6)	18:25	29	17:04 (6)	19:58		20:30	20:56
10	07:50		15:22 (5)	07:28		16:40 (6)	06:47		16:36 (6)	06:57		06:15	05:54
	17:17	27	15:49 (5)	17:54	22	17:02 (6)	18:26	25	17:01 (6)	19:59		20:31	20:56
11	07:50		15:22 (5)	07:26		16:38 (6)	06:46		16:40 (6)	06:55		06:14	05:54
	17:18	26	15:48 (5)	17:55	26	17:04 (6)	18:27	19	16:59 (6)	20:00		20:32	20:57
12	07:50		15:23 (5)	07:25		16:36 (6)	06:44		16:44 (6)	06:53		06:13	05:54
	17:19	25	15:48 (5)	17:56	31	17:07 (6)	18:28	10	16:54 (6)	20:01		20:33	20:57
13	07:49		15:25 (5)	07:24		16:34 (6)	06:43			06:52		06:12	05:54
	17:20	23	15:48 (5)	17:57	33	17:07 (6)	18:30			20:02		20:34	20:58
14	07:49		15:26 (5)	07:23		16:33 (6)	06:41			06:50		06:11	05:54
	17:21	21	15:47 (5)	17:58	36	17:09 (6)	18:31			20:03		20:35	20:58
15	07:49		15:28 (5)	07:21		16:32 (6)	06:39			06:49		06:10	05:54
	17:22	19	15:47 (5)	18:00	39	17:11 (6)	18:32			20:05		20:36	20:59
16	07:48		15:29 (5)	07:20		16:30 (6)	06:38			06:47		06:09	05:54
	17:23	16	15:45 (5)	18:01	41	17:11 (6)	18:33			20:06		20:37	20:59
17	07:48		15:32 (5)	07:19		16:30 (6)	06:36			06:46		06:08	05:54
	17:24	12	15:44 (5)	18:02	42	17:12 (6)	18:34			20:07		20:38	21:00
18	07:47		15:35 (5)	07:17		16:30 (6)	06:34			06:44		06:07	05:54
	17:26	6	15:41 (5)	18:03	43	17:13 (6)	18:35			20:08		20:38	21:00
19	07:47			07:16		16:28 (6)	06:33			06:43		06:06	05:54
	17:27			18:04	45	17:13 (6)	18:36			20:09		20:39	21:00
20	07:46			07:15		16:28 (6)	06:31			06:41		06:05	05:54
	17:28			18:06	46	17:14 (6)	18:37			20:10		20:40	21:00
21	07:46			07:13		16:27 (6)	06:29			06:40		06:04	05:54
	17:29			18:07	47	17:14 (6)	18:38			20:11		20:41	21:01
22	07:45			07:12		16:27 (6)	06:28			06:38		06:03	05:55
	17:30			18:08	47	17:14 (6)	18:39			20:12		20:42	21:01
23	07:44			07:10		16:27 (6)	06:26			06:37		06:03	05:55
	17:31			18:09	48	17:15 (6)	18:40			20:13		20:43	21:01
24	07:44			07:09		16:27 (6)	06:24			06:35		06:02	05:55
	17:33			18:10	48	17:15 (6)	18:41			20:14		20:44	21:01
25	07:43			07:08		16:27 (6)	06:23			06:34		06:01	05:55
	17:34			18:12	48	17:15 (6)	18:42			20:15		20:45	21:01
26	07:42			07:06		16:27 (6)	06:21			06:32		06:01	05:56
	17:35			18:13	47	17:14 (6)	18:43			20:16		20:46	21:01
27	07:42			07:05		16:27 (6)	06:19			06:31		06:00	05:56
	17:36			18:14	48	17:15 (6)	18:45			20:17		20:47	21:02
28	07:41			07:03		16:27 (6)	06:18			06:30		05:59	05:56
	17:37			18:15	47	17:14 (6)	18:46			20:18		20:47	21:02
29	07:40						07:16			06:28		05:59	05:57
	17:39						19:47			20:19		20:48	21:02
30	07:39						07:14			06:27		05:58	05:57
	17:40						19:48			20:20		20:49	21:02
31	07:38						07:13					05:58	
	17:41						19:49					20:50	
Potential sun hours	298			298			370			398		448	451
Total, worst case		456			799			406					
Sun reduction		0,40			0,45			0,49					
Oper. time red.		0,90			0,90			0,90					
Wind dir. red.		0,55			0,73			0,73					
Total reduction		0,20			0,29			0,32					
Total, real		90			234			128					

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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Ettore / egalbo@hydroeng.it
Calculated:
02/08/2024 19:53/4.0.424

SHADOW - Calendar

Shadow receptor: D - Sennori n.15 - p.lla 173 (A03)

Assumptions for shadow calculations

Sunshine probability S (Average daily sunshine hours) [ALGHERO]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3,85	4,78	5,80	6,92	8,25	9,91	10,91	9,92	8,15	6,40	4,83	3,92

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
79	158	315	946	315	158	237	237	631	552	3.154	1.104	7.886

	July		August		September		October			November			December		
1	05:58		06:21		06:52		07:21			06:55		16:10 (6)	07:30		15:04 (5)
	21:01		20:43		20:00		19:10			17:23	21	16:31 (6)	16:59	26	15:30 (5)
2	05:58		06:22		06:53		07:23		17:19 (6)	06:57		16:13 (6)	07:31		15:04 (5)
	21:01		20:42		19:58		19:08	16	17:35 (6)	17:22	14	16:27 (6)	16:59	27	15:31 (5)
3	05:59		06:23		06:54		07:24		17:16 (6)	06:58			07:32		15:05 (5)
	21:01		20:40		19:57		19:06	23	17:39 (6)	17:21			16:59	28	15:33 (5)
4	05:59		06:24		06:55		07:25		17:13 (6)	06:59			07:33		15:04 (5)
	21:01		20:39		19:55		19:05	28	17:41 (6)	17:20			16:59	30	15:34 (5)
5	06:00		06:25		06:56		07:26		17:11 (6)	07:00			07:34		15:04 (5)
	21:01		20:38		19:53		19:03	31	17:42 (6)	17:19			16:58	30	15:34 (5)
6	06:00		06:26		06:57		07:27		17:09 (6)	07:01			07:35		15:03 (5)
	21:01		20:37		19:52		19:01	34	17:43 (6)	17:18			16:58	31	15:34 (5)
7	06:01		06:27		06:58		07:28		17:07 (6)	07:02			07:36		15:04 (5)
	21:00		20:36		19:50		19:00	37	17:44 (6)	17:16			16:58	31	15:35 (5)
8	06:02		06:28		06:59		07:29		17:06 (6)	07:04			07:37		15:04 (5)
	21:00		20:35		19:48		18:58	39	17:45 (6)	17:15			16:58	32	15:36 (5)
9	06:02		06:29		07:00		07:30		17:04 (6)	07:05			07:38		15:04 (5)
	21:00		20:33		19:47		18:57	41	17:45 (6)	17:14			16:58	32	15:36 (5)
10	06:03		06:30		07:01		07:31		17:03 (6)	07:06			07:39		15:04 (5)
	20:59		20:32		19:45		18:55	43	17:46 (6)	17:13			16:58	33	15:37 (5)
11	06:04		06:31		07:02		07:32		17:02 (6)	07:07			07:39		15:05 (5)
	20:59		20:31		19:43		18:53	44	17:46 (6)	17:12			16:58	33	15:38 (5)
12	06:04		06:32		07:03		07:33		17:01 (6)	07:08			07:40		15:05 (5)
	20:58		20:29		19:42		18:52	45	17:46 (6)	17:11			16:58	34	15:39 (5)
13	06:05		06:33		07:04		07:34		17:00 (6)	07:10			07:41		15:06 (5)
	20:58		20:28		19:40		18:50	46	17:46 (6)	17:10			16:59	34	15:40 (5)
14	06:06		06:34		07:05		07:35		16:59 (6)	07:11			07:42		15:05 (5)
	20:57		20:27		19:38		18:49	47	17:46 (6)	17:09			16:59	34	15:39 (5)
15	06:07		06:35		07:06		07:36		16:59 (6)	07:12			07:43		15:06 (5)
	20:57		20:25		19:37		18:47	47	17:46 (6)	17:09			16:59	34	15:40 (5)
16	06:07		06:36		07:07		07:37		16:59 (6)	07:13			07:43		15:07 (5)
	20:56		20:24		19:35		18:46	48	17:47 (6)	17:08			16:59	34	15:41 (5)
17	06:08		06:37		07:08		07:38		16:59 (6)	07:14			07:44		15:07 (5)
	20:56		20:23		19:33		18:44	47	17:46 (6)	17:07			16:59	34	15:41 (5)
18	06:09		06:38		07:09		07:39		16:58 (6)	07:15			07:45		15:07 (5)
	20:55		20:21		19:32		18:43	48	17:46 (6)	17:06			17:00	35	15:42 (5)
19	06:10		06:39		07:09		07:41		16:58 (6)	07:17			07:45		15:07 (5)
	20:54		20:20		19:30		18:41	48	17:46 (6)	17:05			17:00	35	15:42 (5)
20	06:11		06:40		07:10		07:42		16:58 (6)	07:18			07:46		15:08 (5)
	20:53		20:18		19:28		18:40	47	17:45 (6)	17:05			17:01	35	15:43 (5)
21	06:11		06:41		07:11		07:43		16:58 (6)	07:19			07:46		15:09 (5)
	20:53		20:17		19:27		18:38	46	17:44 (6)	17:04			17:01	35	15:44 (5)
22	06:12		06:42		07:12		07:44		16:59 (6)	07:20			07:47		15:09 (5)
	20:52		20:15		19:25		18:37	45	17:44 (6)	17:03			17:02	35	15:44 (5)
23	06:13		06:43		07:13		07:45		16:59 (6)	07:21			07:47		15:09 (5)
	20:51		20:14		19:23		18:35	45	17:44 (6)	17:03			17:02	35	15:44 (5)
24	06:14		06:44		07:14		07:46		16:59 (6)	07:22		15:14 (5)	07:48		15:10 (5)
	20:50		20:12		19:21		18:34	44	17:43 (6)	17:02	5	15:19 (5)	17:03	35	15:45 (5)
25	06:15		06:45		07:15		06:47		16:00 (6)	07:23		15:10 (5)	07:48		15:10 (5)
	20:49		20:11		19:20		17:33	41	16:41 (6)	17:02	12	15:22 (5)	17:03	35	15:45 (5)
26	06:16		06:46		07:16		06:48		16:00 (6)	07:25		15:08 (5)	07:49		15:11 (5)
	20:49		20:09		19:18		17:31	40	16:40 (6)	17:01	16	15:24 (5)	17:04	35	15:46 (5)
27	06:17		06:47		07:17		06:50		16:02 (6)	07:26		15:07 (5)	07:49		15:12 (5)
	20:48		20:08		19:16		17:30	38	16:40 (6)	17:01	19	15:26 (5)	17:04	34	15:46 (5)
28	06:18		06:48		07:18		06:51		16:03 (6)	07:27		15:06 (5)	07:49		15:12 (5)
	20:47		20:06		19:15		17:28	35	16:38 (6)	17:00	21	15:27 (5)	17:05	34	15:46 (5)
29	06:19		06:49		07:19		06:52		16:04 (6)	07:28		15:05 (5)	07:50		15:12 (5)
	20:46		20:05		19:13		17:27	33	16:37 (6)	17:00	23	15:28 (5)	17:06	34	15:46 (5)
30	06:20		06:50		07:20		06:53		16:05 (6)	07:29		15:05 (5)	07:50		15:13 (5)
	20:45		20:03		19:11		17:26	30	16:35 (6)	17:00	24	15:29 (5)	17:07	33	15:46 (5)
31	06:20		06:51				06:54		16:08 (6)				07:50		15:14 (5)
	20:44		20:01				17:25	26	16:34 (6)				17:07	34	15:48 (5)
Potential sun hours	458		427		375		345			299			289		
Total, worst case								1182			155			1021	
Sun reduction								0,57			0,49			0,42	
Oper. time red.								0,90			0,90			0,90	
Wind dir. red.								0,73			0,59			0,55	
Total reduction								0,37			0,26			0,21	
Total, real								441			40			212	

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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Ettore / egalbo@hydroeng.it
Calculated:
02/08/2024 19:53/4.0.424

SHADOW - Calendar

Shadow receptor: E - Osilo n.29 - p.lla 41 (A04)

Assumptions for shadow calculations

Sunshine probability S (Average daily sunshine hours) [ALGHERO]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3,85	4,78	5,80	6,92	8,25	9,91	10,91	9,92	8,15	6,40	4,83	3,92

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
79	158	315	946	315	158	237	237	631	552	3.154	1.104	7.886

	January	February	March	April	May		June		July		August	September	October	November	December
1	07:50	07:37	07:02	07:11	06:26		05:57		20:07 (1)	05:58	20:09 (1)	06:22	06:52	07:22	06:55	07:30
	17:08	17:42	18:16	19:50	20:21		20:50	19	20:26 (1)	21:01	20:36 (1)	20:43	20:00	19:10	17:23	16:59
2	07:50	07:36	07:00	07:10	06:25		05:57		20:06 (1)	05:58	20:10 (1)	06:22	06:53	07:23	06:57	07:31
	17:09	17:44	18:17	19:51	20:22		20:51	20	20:26 (1)	21:01	20:36 (1)	20:42	19:58	19:08	17:22	16:59
3	07:50	07:35	06:59	07:08	06:23		05:56		20:06 (1)	05:59	20:10 (1)	06:23	06:54	07:24	06:58	07:32
	17:10	17:45	18:18	19:52	20:23		20:52	21	20:27 (1)	21:01	20:36 (1)	20:40	19:57	19:06	17:21	16:59
4	07:51	07:34	06:57	07:06	06:22		05:56		20:06 (1)	05:59	20:11 (1)	06:24	06:55	07:25	06:59	07:33
	17:11	17:46	18:20	19:53	20:24		20:53	22	20:28 (1)	21:01	20:36 (1)	20:39	19:55	19:05	17:20	16:59
5	07:51	07:33	06:55	07:05	06:21		05:56		20:05 (1)	06:00	20:11 (1)	06:25	06:56	07:26	07:00	07:34
	17:12	17:47	18:21	19:54	20:25		20:53	23	20:28 (1)	21:01	20:35 (1)	20:38	19:53	19:03	17:19	16:59
6	07:51	07:32	06:54	07:03	06:20		05:55		20:05 (1)	06:01	20:11 (1)	06:26	06:57	07:27	07:01	07:35
	17:13	17:49	18:22	19:55	20:26		20:54	24	20:29 (1)	21:00	20:35 (1)	20:37	19:52	19:01	17:18	16:58
7	07:50	07:31	06:52	07:01	06:18		05:55		20:06 (1)	06:01	20:12 (1)	06:27	06:58	07:28	07:02	07:36
	17:14	17:50	18:23	19:56	20:28		20:55	24	20:30 (1)	21:00	20:35 (1)	20:36	19:50	19:00	17:16	16:58
8	07:50	07:30	06:51	07:00	06:17		05:55		20:06 (1)	06:02	20:12 (1)	06:28	06:59	07:29	07:04	07:37
	17:15	17:51	18:24	19:57	20:29		20:55	25	20:31 (1)	21:00	20:35 (1)	20:35	19:48	18:58	17:15	16:58
9	07:50	07:29	06:49	06:58	06:16		05:55		20:05 (1)	06:02	20:13 (1)	06:29	07:00	07:30	07:05	07:38
	17:16	17:52	18:25	19:58	20:30		20:56	25	20:30 (1)	21:00	20:35 (1)	20:33	19:47	18:57	17:14	16:58
10	07:50	07:28	06:47	06:57	06:15		05:54		20:05 (1)	06:03	20:13 (1)	06:30	07:01	07:31	07:06	07:38
	17:17	17:54	18:26	19:59	20:31		20:56	26	20:31 (1)	20:59	20:34 (1)	20:32	19:45	18:55	17:13	16:58
11	07:50	07:26	06:46	06:55	06:14		05:54		20:05 (1)	06:04	20:14 (1)	06:31	07:02	07:32	07:07	07:39
	17:18	17:55	18:27	20:00	20:32		20:57	27	20:32 (1)	20:59	20:34 (1)	20:31	19:43	18:53	17:12	16:58
12	07:50	07:25	06:44	06:53	06:13		05:54		20:06 (1)	06:04	20:14 (1)	06:32	07:03	07:33	07:08	07:40
	17:19	17:56	18:29	20:01	20:33		20:57	26	20:32 (1)	20:58	20:33 (1)	20:29	19:42	18:52	17:11	16:58
13	07:49	07:24	06:43	06:52	06:12		05:54		20:06 (1)	06:05	20:15 (1)	06:33	07:04	07:34	07:10	07:41
	17:20	17:57	18:30	20:02	20:34		20:58	27	20:33 (1)	20:58	20:33 (1)	20:28	19:40	18:50	17:10	16:59
14	07:49	07:23	06:41	06:50	06:11		05:54		20:06 (1)	06:06	20:15 (1)	06:34	07:05	07:35	07:11	07:42
	17:21	17:58	18:31	20:03	20:35		20:58	27	20:33 (1)	20:57	20:32 (1)	20:27	19:38	18:49	17:10	16:59
15	07:49	07:21	06:39	06:49	06:10		05:54		20:06 (1)	06:07	20:16 (1)	06:35	07:06	07:36	07:12	07:42
	17:22	18:00	18:32	20:05	20:36		20:59	27	20:33 (1)	20:57	20:32 (1)	20:25	19:37	18:47	17:09	16:59
16	07:48	07:20	06:38	06:47	06:09		05:54		20:06 (1)	06:07	20:17 (1)	06:36	07:07	07:37	07:13	07:43
	17:23	18:01	18:33	20:06	20:37		20:59	28	20:34 (1)	20:56	20:32 (1)	20:24	19:35	18:46	17:08	16:59
17	07:48	07:19	06:36	06:46	06:08		05:54		20:06 (1)	06:08	20:19 (1)	06:37	07:08	07:38	07:14	07:44
	17:24	18:02	18:34	20:07	20:37		21:00	28	20:34 (1)	20:55	20:31 (1)	20:23	19:33	18:44	17:07	17:00
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	17:27	18:05	18:36	20:09	20:39		21:00	28	20:34 (1)	20:54	20:29 (1)	20:20	19:30	18:41	17:06	17:00
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	17:28	18:06	18:37	20:10	20:40		21:00	28	20:35 (1)	20:53	20:29 (1)	20:18	19:28	18:40	17:05	17:01
21	07:46	07:13	06:29	06:40	06:04		05:55		20:07 (1)	06:12	20:24 (1)	06:41	07:12	07:43	07:19	07:46
	17:29	18:07	18:38	20:11	20:41		21:01	28	20:35 (1)	20:53	20:29 (1)	20:17	19:27	18:38	17:04	17:01
22	07:45	07:12	06:28	06:38	06:04	20:14 (1)	05:55		20:07 (1)	06:12	20:26 (1)	06:42	07:12	07:44	07:20	07:47
	17:30	18:08	18:39	20:12	20:42	4 20:18 (1)	21:01	28	20:35 (1)	20:52	2 20:28 (1)	20:15	19:25	18:37	17:04	17:02
23	07:44	07:10	06:26	06:37	06:03	20:12 (1)	05:55		20:07 (1)	06:13		06:43	07:13	07:45	07:21	07:47
	17:31	18:09	18:40	20:13	20:43	6 20:18 (1)	21:01	28	20:35 (1)	20:51		20:14	19:23	18:35	17:03	17:02
24	07:44	07:09	06:24	06:35	06:02	20:11 (1)	05:55		20:08 (1)	06:14		06:44	07:14	07:46	07:22	07:48
	17:33	18:10	18:41	20:14	20:44	9 20:20 (1)	21:01	28	20:36 (1)	20:50		20:12	19:21	18:34	17:02	17:03
25	07:43	07:08	06:23	06:34	06:01	20:10 (1)	05:55		20:08 (1)	06:15		06:45	07:15	06:47	07:23	07:48
	17:34	18:12	18:42	20:15	20:45	10 20:20 (1)	21:01	28	20:36 (1)	20:49		20:11	19:20	17:33	17:02	17:03
26	07:42	07:06	06:21	06:33	06:01	20:10 (1)	05:56		20:08 (1)	06:16		06:46	07:16	06:48	07:25	07:49
	17:35	18:13	18:44	20:16	20:46	12 20:22 (1)	21:01	28	20:36 (1)	20:49		20:09	19:18	17:31	17:01	17:04
27	07:41	07:05	06:19	06:31	06:00	20:08 (1)	05:56		20:09 (1)	06:17		06:47	07:17	06:50	07:26	07:49
	17:36	18:14	18:45	20:17	20:47	14 20:22 (1)	21:01	28	20:37 (1)	20:48		20:08	19:16	17:30	17:01	17:05
28	07:41	07:03	06:18	06:30	05:59	20:07 (1)	05:57		20:09 (1)	06:18		06:48	07:18	06:51	07:27	07:49
	17:38	18:15	18:46	20:18	20:47	15 20:22 (1)	21:02	27	20:36 (1)	20:47		20:06	19:15	17:29	17:00	17:05
29	07:40		07:16	06:28	05:59	20:07 (1)	05:57		20:09 (1)	06:19		06:49	07:19	06:52	07:28	07:50
	17:39		19:47	20:19	20:48	17 20:24 (1)	21:01	27	20:36 (1)	20:46		20:05	19:13	17:27	17:00	17:06
30	07:39		07:15	06:27	05:58	20:06 (1)	05:57		20:10 (1)	06:20		06:50	07:21	06:53	07:29	07:50
	17:40		19:48	20:20	20:49	18 20:24 (1)	21:01	26	20:36 (1)	20:45		20:03	19:11	17:26	17:00	17:07
31	07:38		07:13		05:58	20:06 (1)				06:21		06:51		06:54		07:50
	17:41		19:49		20:50	19 20:25 (1)				20:44		20:01		17:25		17:07
Potential sun hours	298	298	370	398	448		451			458		427	375	346	299	289
Total, worst case						124		779		392						
Sun reduction						0,57		0,66		0,74						
Oper. time red.						0,90		0,90		0,90						
Wind dir. red.						0,79		0,79		0,79						
Total reduction						0,41		0,47		0,53						
Total, real						51		366		207						

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)

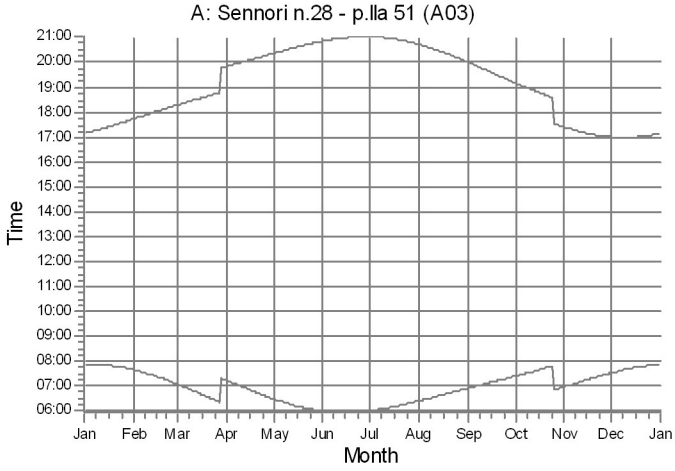
13 ALLEGATO 6 – CALENDARIO GRAFICO OMBREGGIAMENTO

Licensed user:
Hydro Engineering s.s.
via Rossotti, 39
IT-91011 Alcamo

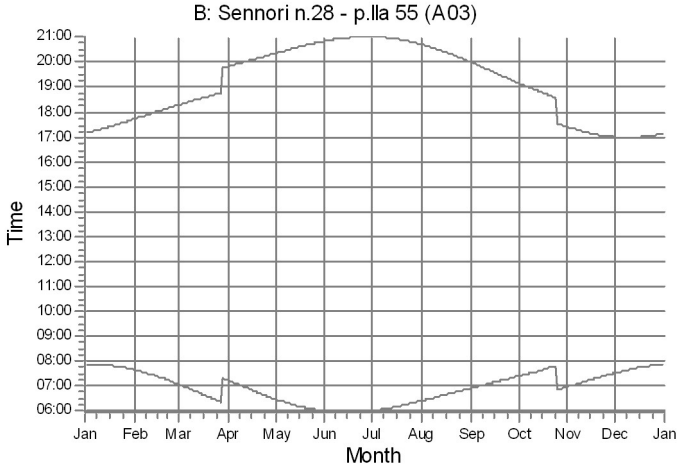
Ettore / egalbo@hydroeng.it
Calculated:
02/08/2024 19:53/4.0.424

SHADOW - Calendar, graphical

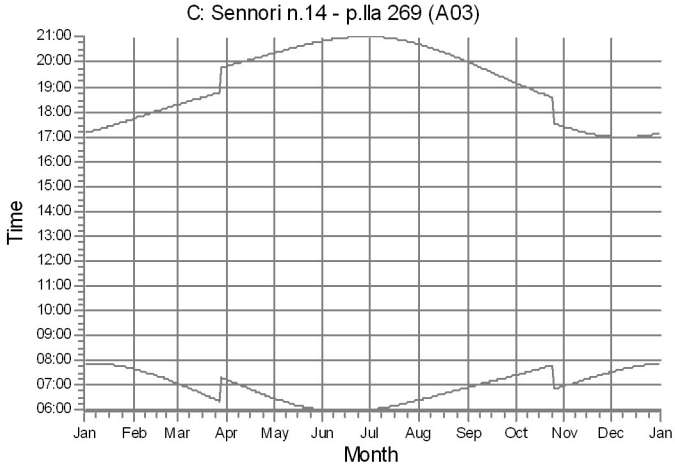
A: Sennori n.28 - p.lla 51 (A03)



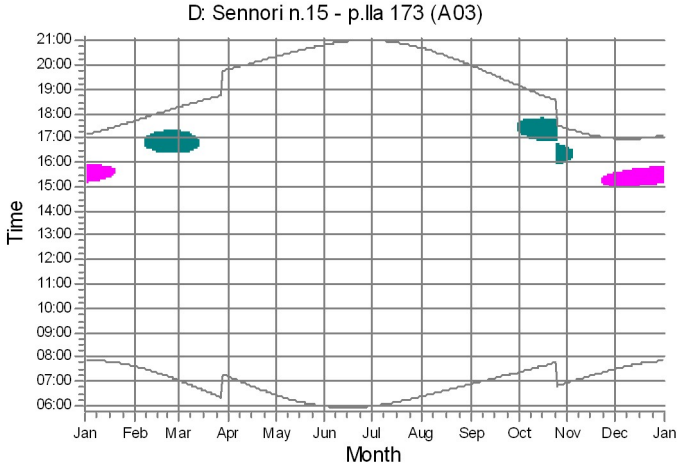
B: Sennori n.28 - p.lla 55 (A03)



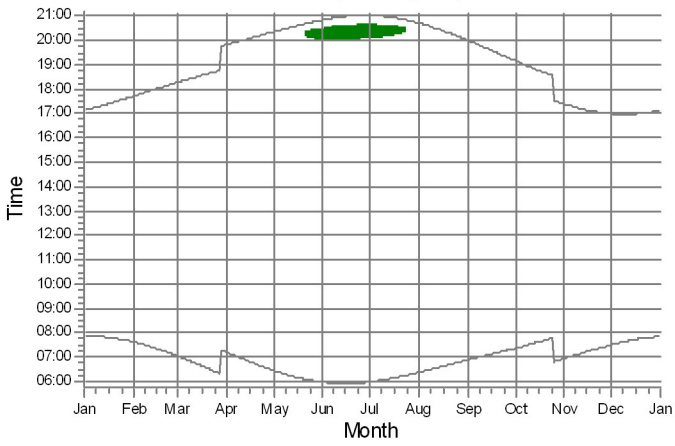
C: Sennori n.14 - p.lla 269 (A03)



D: Sennori n.15 - p.lla 173 (A03)



E: Osilo n.29 - p.lla 41 (A04)



WTGs

1: SEN-01 5: SEN-05 6: SEN-06

14 ALLEGATO 7 – CALENDARIO PER WTG

Licensed user:
Hydro Engineering s.s.
via Rossotti, 39
IT-91011 Alcamo

Ettore / egalbo@hydroeng.it
Calculated:
02/08/2024 19:53/4.0.424

SHADOW - Calendar per WTG

WTG: 1 - SEN-01

Assumptions for shadow calculations

Sunshine probability S (Average daily sunshine hours) [ALGHERO]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3,85	4,78	5,80	6,92	8,25	9,91	10,91	9,92	8,15	6,40	4,83	3,92

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
79	158	315	946	315	158	237	237	631	552	3.154	1.104	7.886

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:50	07:37	07:02	07:11	06:26	05:57 20:07-20:26/19	05:58 20:09-20:36/27	06:22	06:52	07:22	06:55	07:30
	17:09	17:43	18:16	19:50	20:21	20:51	21:01	20:43	20:00	19:10	17:23	16:59
2	07:50	07:36	07:00	07:10	06:25	05:57 20:06-20:26/20	05:58 20:10-20:36/26	06:23	06:53	07:23	06:57	07:31
	17:09	17:44	18:17	19:51	20:22	20:51	21:01	20:42	19:58	19:08	17:22	16:59
3	07:51	07:35	06:59	07:08	06:23	05:56 20:06-20:27/21	05:59 20:10-20:36/26	06:23	06:54	07:24	06:58	07:32
	17:10	17:45	18:19	19:52	20:23	20:52	21:01	20:40	19:57	19:06	17:21	16:59
4	07:51	07:34	06:57	07:06	06:22	05:56 20:06-20:28/22	05:59 20:11-20:36/25	06:24	06:55	07:25	06:59	07:33
	17:11	17:46	18:20	19:53	20:24	20:53	21:01	20:39	19:55	19:05	17:20	16:59
5	07:51	07:33	06:55	07:05	06:21	05:56 20:05-20:28/23	06:00 20:11-20:35/24	06:25	06:56	07:26	07:00	07:34
	17:12	17:47	18:21	19:54	20:26	20:53	21:01	20:38	19:53	19:03	17:19	16:59
6	07:51	07:32	06:54	07:03	06:20	05:55 20:05-20:29/24	06:01 20:11-20:35/24	06:26	06:57	07:27	07:01	07:35
	17:13	17:49	18:22	19:55	20:27	20:54	21:01	20:37	19:52	19:02	17:18	16:58
7	07:51	07:31	06:52	07:01	06:18	05:55 20:06-20:30/24	06:01 20:12-20:35/23	06:27	06:58	07:28	07:02	07:36
	17:14	17:50	18:23	19:56	20:28	20:55	21:00	20:36	19:50	19:00	17:17	16:58
8	07:50	07:30	06:51	07:00	06:17	05:55 20:06-20:31/25	06:02 20:12-20:35/23	06:28	06:59	07:29	07:04	07:37
	17:15	17:51	18:24	19:57	20:29	20:55	21:00	20:35	19:48	18:58	17:15	16:58
9	07:50	07:29	06:49	06:58	06:16	05:55 20:05-20:30/25	06:02 20:13-20:35/22	06:29	07:00	07:30	07:05	07:38
	17:16	17:52	18:25	19:58	20:30	20:56	21:00	20:33	19:47	18:57	17:14	16:58
10	07:50	07:28	06:48	06:57	06:15	05:54 20:05-20:31/26	06:03 20:13-20:34/21	06:30	07:01	07:31	07:06	07:39
	17:17	17:54	18:26	19:59	20:31	20:56	20:59	20:32	19:45	18:55	17:13	16:58
11	07:50	07:26	06:46	06:55	06:14	05:54 20:05-20:32/27	06:04 20:14-20:34/20	06:31	07:02	07:32	07:07	07:39
	17:18	17:55	18:27	20:00	20:32	20:57	20:59	20:31	19:43	18:53	17:12	16:58
12	07:50	07:25	06:44	06:53	06:13	05:54 20:06-20:32/26	06:04 20:14-20:33/19	06:32	07:03	07:33	07:08	07:40
	17:19	17:56	18:29	20:01	20:33	20:57	20:58	20:30	19:42	18:52	17:11	16:59
13	07:49	07:24	06:43	06:52	06:12	05:54 20:06-20:33/27	06:05 20:15-20:33/18	06:33	07:04	07:34	07:10	07:41
	17:20	17:57	18:30	20:02	20:34	20:58	20:58	20:28	19:40	18:50	17:11	16:59
14	07:49	07:23	06:41	06:50	06:11	05:54 20:06-20:33/27	06:06 20:15-20:32/17	06:34	07:05	07:35	07:11	07:42
	17:21	17:59	18:31	20:04	20:35	20:58	20:57	20:27	19:38	18:49	17:10	16:59
15	07:49	07:21	06:39	06:49	06:10	05:54 20:06-20:33/27	06:07 20:16-20:32/16	06:35	07:06	07:36	07:12	07:43
	17:22	18:00	18:32	20:05	20:36	20:59	20:57	20:25	19:37	18:47	17:09	16:59
16	07:48	07:20	06:38	06:47	06:09	05:54 20:06-20:34/28	06:07 20:17-20:32/15	06:36	07:07	07:37	07:13	07:43
	17:23	18:01	18:33	20:06	20:37	20:59	20:56	20:24	19:35	18:46	17:08	16:59
17	07:48	07:19	06:36	06:46	06:08	05:54 20:06-20:34/28	06:08 20:19-20:31/12	06:37	07:08	07:38	07:14	07:44
	17:24	18:02	18:34	20:07	20:38	21:00	20:56	20:23	19:33	18:44	17:07	17:00
18	07:47	07:17	06:34	06:44	06:07	05:54 20:06-20:34/28	06:09 20:19-20:30/11	06:38	07:09	07:39	07:15	07:45
	17:26	18:03	18:35	20:08	20:38	21:00	20:55	20:21	19:32	18:43	17:06	17:00
19	07:47	07:16	06:33	06:43	06:06	05:54 20:06-20:34/28	06:10 20:20-20:29/9	06:39	07:10	07:41	07:17	07:45
	17:27	18:05	18:36	20:09	20:39	21:00	20:54	20:20	19:30	18:41	17:06	17:00
20	07:46	07:15	06:31	06:41	06:05	05:54 20:07-20:35/28	06:11 20:22-20:29/7	06:40	07:11	07:42	07:18	07:46
	17:28	18:06	18:37	20:10	20:40	21:00	20:53	20:18	19:28	18:40	17:05	17:01
21	07:46	07:13	06:29	06:40	06:04	05:55 20:07-20:35/28	06:12 20:24-20:29/5	06:41	07:12	07:43	07:19	07:46
	17:29	18:07	18:38	20:11	20:41	21:01	20:53	20:17	19:27	18:38	17:04	17:01
22	07:45	07:12	06:28	06:38	06:04 20:14-20:18/4	05:55 20:07-20:35/28	06:12 20:26-20:28/2	06:42	07:13	07:44	07:20	07:47
	17:30	18:08	18:39	20:12	20:42	21:01	20:52	20:15	19:25	18:37	17:04	17:02
23	07:44	07:10	06:26	06:37	06:03 20:12-20:18/6	05:55 20:07-20:35/28	06:13	06:43	07:14	07:45	07:21	07:47
	17:32	18:09	18:40	20:13	20:43	21:01	20:51	20:14	19:23	18:35	17:03	17:02
24	07:44	07:09	06:25	06:35	06:02 20:11-20:20/9	05:55 20:08-20:36/28	06:14	06:44	07:15	07:46	07:22	07:48
	17:33	18:10	18:41	20:14	20:44	21:01	20:50	20:12	19:22	18:34	17:02	17:03
25	07:43	07:08	06:23	06:34	06:01 20:10-20:20/10	05:56 20:08-20:36/28	06:15	06:45	07:16	06:47	07:23	07:48
	17:34	18:12	18:43	20:15	20:45	21:01	20:49	20:11	19:20	17:33	17:02	17:03
26	07:42	07:06	06:21	06:33	06:01 20:10-20:22/12	05:56 20:08-20:36/28	06:16	06:46	07:17	06:48	07:25	07:49
	17:35	18:13	18:44	20:16	20:46	21:01	20:49	20:09	19:18	17:31	17:01	17:04
27	07:42	07:05	06:20	06:31	06:00 20:08-20:22/14	05:56 20:09-20:37/28	06:17	06:47	07:18	06:50	07:26	07:49
	17:36	18:14	18:45	20:17	20:47	21:02	20:48	20:08	19:16	17:30	17:01	17:05
28	07:41	07:03	06:18	06:30	05:59 20:07-20:22/15	05:57 20:09-20:36/27	06:18	06:48	07:19	06:51	07:27	07:49
	17:38	18:15	18:46	20:18	20:47	21:02	20:47	20:06	19:15	17:29	17:00	17:05
29	07:40		07:16	06:28	05:59 20:07-20:24/17	05:57 20:09-20:36/27	06:19	06:49	07:20	06:52	07:28	07:50
	17:39		19:47	20:19	20:48	21:02	20:46	20:05	19:13	17:27	17:00	17:06
30	07:39		07:15	06:27	05:58 20:06-20:24/18	05:57 20:10-20:36/26	06:20	06:50	07:21	06:53	07:29	07:50
	17:40		19:48	20:20	20:49	21:02	20:45	20:03	19:11	17:26	17:00	17:07
31	07:38		07:13		05:58 20:06-20:25/19		06:21	06:51		06:54		07:50
	17:41		19:49		20:50		20:44	20:02		17:25		17:07
Potential sun hours	298	298	370	398	448	451	458	427	375	346	299	289
Sum of minutes with flicker	0	0	0	0	124	779	392	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

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Calculated:
02/08/2024 19:53/4.0.424

SHADOW - Calendar per WTG

WTG: 2 - SEN-02

Assumptions for shadow calculations

Sunshine probability S (Average daily sunshine hours) [ALGHERO]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3,85	4,78	5,80	6,92	8,25	9,91	10,91	9,92	8,15	6,40	4,83	3,92

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
79	158	315	946	315	158	237	237	631	552	3.154	1.104	7.886

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:50	07:37	07:02	07:11	06:26	05:57	05:58	06:22	06:52	07:22	06:55	07:30
	17:08	17:42	18:16	19:50	20:21	20:51	21:01	20:43	20:00	19:10	17:23	16:59
2	07:50	07:36	07:00	07:10	06:25	05:57	05:58	06:22	06:53	07:23	06:57	07:31
	17:09	17:44	18:17	19:51	20:22	20:51	21:01	20:42	19:58	19:08	17:22	16:59
3	07:51	07:35	06:59	07:08	06:23	05:56	05:59	06:23	06:54	07:24	06:58	07:32
	17:10	17:45	18:18	19:52	20:23	20:52	21:01	20:40	19:57	19:06	17:21	16:59
4	07:51	07:34	06:57	07:06	06:22	05:56	05:59	06:24	06:55	07:25	06:59	07:33
	17:11	17:46	18:20	19:53	20:24	20:53	21:01	20:39	19:55	19:05	17:20	16:59
5	07:51	07:33	06:55	07:05	06:21	05:56	06:00	06:25	06:56	07:26	07:00	07:34
	17:12	17:47	18:21	19:54	20:25	20:53	21:01	20:38	19:53	19:03	17:19	16:59
6	07:51	07:32	06:54	07:03	06:20	05:55	06:00	06:26	06:57	07:27	07:01	07:35
	17:13	17:49	18:22	19:55	20:27	20:54	21:01	20:37	19:52	19:01	17:18	16:58
7	07:51	07:31	06:52	07:01	06:18	05:55	06:01	06:27	06:58	07:28	07:02	07:36
	17:14	17:50	18:23	19:56	20:28	20:55	21:00	20:36	19:50	19:00	17:16	16:58
8	07:50	07:30	06:51	07:00	06:17	05:55	06:02	06:28	06:59	07:29	07:04	07:37
	17:15	17:51	18:24	19:57	20:29	20:55	21:00	20:35	19:48	18:58	17:15	16:58
9	07:50	07:29	06:49	06:58	06:16	05:55	06:02	06:29	07:00	07:30	07:05	07:38
	17:16	17:52	18:25	19:58	20:30	20:56	21:00	20:33	19:47	18:57	17:14	16:58
10	07:50	07:28	06:47	06:57	06:15	05:54	06:03	06:30	07:01	07:31	07:06	07:39
	17:17	17:54	18:26	19:59	20:31	20:56	20:59	20:32	19:45	18:55	17:13	16:58
11	07:50	07:26	06:46	06:55	06:14	05:54	06:04	06:31	07:02	07:32	07:07	07:39
	17:18	17:55	18:27	20:00	20:32	20:57	20:59	20:31	19:43	18:53	17:12	16:58
12	07:50	07:25	06:44	06:53	06:13	05:54	06:04	06:32	07:03	07:33	07:08	07:40
	17:19	17:56	18:29	20:01	20:33	20:57	20:58	20:29	19:42	18:52	17:11	16:58
13	07:49	07:24	06:43	06:52	06:12	05:54	06:05	06:33	07:04	07:34	07:10	07:41
	17:20	17:57	18:30	20:02	20:34	20:58	20:58	20:28	19:40	18:50	17:10	16:59
14	07:49	07:23	06:41	06:50	06:11	05:54	06:06	06:34	07:05	07:35	07:11	07:42
	17:21	17:58	18:31	20:04	20:35	20:58	20:57	20:27	19:38	18:49	17:10	16:59
15	07:49	07:21	06:39	06:49	06:10	05:54	06:07	06:35	07:06	07:36	07:12	07:42
	17:22	18:00	18:32	20:05	20:36	20:59	20:57	20:25	19:37	18:47	17:09	16:59
16	07:48	07:20	06:38	06:47	06:09	05:54	06:07	06:36	07:07	07:37	07:13	07:43
	17:23	18:01	18:33	20:06	20:37	20:59	20:56	20:24	19:35	18:46	17:08	16:59
17	07:48	07:19	06:36	06:46	06:08	05:54	06:08	06:37	07:08	07:38	07:14	07:44
	17:24	18:02	18:34	20:07	20:38	21:00	20:56	20:23	19:33	18:44	17:07	17:00
18	07:47	07:17	06:34	06:44	06:07	05:54	06:09	06:38	07:09	07:39	07:15	07:45
	17:26	18:03	18:35	20:08	20:38	21:00	20:55	20:21	19:32	18:43	17:06	17:00
19	07:47	07:16	06:33	06:43	06:06	05:54	06:10	06:39	07:10	07:41	07:17	07:45
	17:27	18:05	18:36	20:09	20:39	21:00	20:54	20:20	19:30	18:41	17:06	17:00
20	07:46	07:15	06:31	06:41	06:05	05:54	06:11	06:40	07:11	07:42	07:18	07:46
	17:28	18:06	18:37	20:10	20:40	21:00	20:53	20:18	19:28	18:40	17:05	17:01
21	07:46	07:13	06:29	06:40	06:04	05:54	06:12	06:41	07:12	07:43	07:19	07:46
	17:29	18:07	18:38	20:11	20:41	21:01	20:53	20:17	19:27	18:38	17:04	17:01
22	07:45	07:12	06:28	06:38	06:04	05:55	06:12	06:42	07:13	07:44	07:20	07:47
	17:30	18:08	18:39	20:12	20:42	21:01	20:52	20:15	19:25	18:37	17:04	17:02
23	07:44	07:10	06:26	06:37	06:03	05:55	06:13	06:43	07:14	07:45	07:21	07:47
	17:31	18:09	18:40	20:13	20:43	21:01	20:51	20:14	19:23	18:35	17:03	17:02
24	07:44	07:09	06:24	06:35	06:02	05:55	06:14	06:44	07:15	07:46	07:22	07:48
	17:33	18:10	18:41	20:14	20:44	21:01	20:50	20:12	19:21	18:34	17:02	17:03
25	07:43	07:08	06:23	06:34	06:01	05:55	06:15	06:45	07:15	06:47	07:23	07:48
	17:34	18:12	18:42	20:15	20:45	21:01	20:49	20:11	19:20	17:33	17:02	17:03
26	07:42	07:06	06:21	06:33	06:01	05:56	06:16	06:46	07:16	06:48	07:25	07:49
	17:35	18:13	18:44	20:16	20:46	21:01	20:49	20:09	19:18	17:31	17:01	17:04
27	07:42	07:05	06:19	06:31	06:00	05:56	06:17	06:47	07:18	06:50	07:26	07:49
	17:36	18:14	18:45	20:17	20:47	21:02	20:48	20:08	19:16	17:30	17:01	17:05
28	07:41	07:03	06:18	06:30	05:59	05:57	06:18	06:48	07:19	06:51	07:27	07:49
	17:38	18:15	18:46	20:18	20:47	21:02	20:47	20:06	19:15	17:29	17:00	17:05
29	07:40		07:16	06:28	05:59	05:57	06:19	06:49	07:20	06:52	07:28	07:50
	17:39		19:47	20:19	20:48	21:02	20:46	20:05	19:13	17:27	17:00	17:06
30	07:39		07:15	06:27	05:58	05:57	06:20	06:50	07:21	06:53	07:29	07:50
	17:40		19:48	20:20	20:49	21:01	20:45	20:03	19:11	17:26	17:00	17:07
31	07:38		07:13		05:58		06:21	06:51		06:54		07:50
	17:41		19:49		20:50		20:44	20:02		17:25		17:07
Potential sun hours	298	298	370	398	448	451	458	427	375	346	299	289
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

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Ettore / egalbo@hydroeng.it
Calculated:
02/08/2024 19:53/4.0.424

SHADOW - Calendar per WTG

WTG: 3 - SEN-03

Assumptions for shadow calculations

Sunshine probability S (Average daily sunshine hours) [ALGHERO]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3,85	4,78	5,80	6,92	8,25	9,91	10,91	9,92	8,15	6,40	4,83	3,92

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
79	158	315	946	315	158	237	237	631	552	3.154	1.104	7.886

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:50	07:37	07:02	07:11	06:26	05:57	05:58	06:22	06:52	07:22	06:55	07:30
	17:08	17:42	18:16	19:50	20:21	20:51	21:01	20:43	20:00	19:10	17:23	16:59
2	07:50	07:36	07:00	07:10	06:25	05:57	05:58	06:22	06:53	07:23	06:57	07:31
	17:09	17:44	18:17	19:51	20:22	20:51	21:01	20:42	19:58	19:08	17:22	16:59
3	07:51	07:35	06:59	07:08	06:23	05:56	05:59	06:23	06:54	07:24	06:58	07:32
	17:10	17:45	18:18	19:52	20:23	20:52	21:01	20:40	19:57	19:06	17:21	16:59
4	07:51	07:34	06:57	07:06	06:22	05:56	05:59	06:24	06:55	07:25	06:59	07:33
	17:11	17:46	18:20	19:53	20:24	20:53	21:01	20:39	19:55	19:05	17:20	16:59
5	07:51	07:33	06:55	07:05	06:21	05:56	06:00	06:25	06:56	07:26	07:00	07:34
	17:12	17:47	18:21	19:54	20:25	20:53	21:01	20:38	19:53	19:03	17:19	16:59
6	07:51	07:32	06:54	07:03	06:20	05:55	06:00	06:26	06:57	07:27	07:01	07:35
	17:13	17:49	18:22	19:55	20:27	20:54	21:01	20:37	19:52	19:01	17:18	16:58
7	07:51	07:31	06:52	07:01	06:18	05:55	06:01	06:27	06:58	07:28	07:02	07:36
	17:14	17:50	18:23	19:56	20:28	20:55	21:00	20:36	19:50	19:00	17:16	16:58
8	07:50	07:30	06:51	07:00	06:17	05:55	06:02	06:28	06:59	07:29	07:04	07:37
	17:15	17:51	18:24	19:57	20:29	20:55	21:00	20:35	19:48	18:58	17:15	16:58
9	07:50	07:29	06:49	06:58	06:16	05:55	06:02	06:29	07:00	07:30	07:05	07:38
	17:16	17:52	18:25	19:58	20:30	20:56	21:00	20:33	19:47	18:57	17:14	16:58
10	07:50	07:28	06:47	06:57	06:15	05:54	06:03	06:30	07:01	07:31	07:06	07:39
	17:17	17:54	18:26	19:59	20:31	20:56	20:59	20:32	19:45	18:55	17:13	16:58
11	07:50	07:26	06:46	06:55	06:14	05:54	06:04	06:31	07:02	07:32	07:07	07:39
	17:18	17:55	18:27	20:00	20:32	20:57	20:59	20:31	19:43	18:53	17:12	16:58
12	07:50	07:25	06:44	06:53	06:13	05:54	06:04	06:32	07:03	07:33	07:08	07:40
	17:19	17:56	18:29	20:01	20:33	20:57	20:58	20:29	19:42	18:52	17:11	16:58
13	07:49	07:24	06:43	06:52	06:12	05:54	06:05	06:33	07:04	07:34	07:10	07:41
	17:20	17:57	18:30	20:02	20:34	20:58	20:58	20:28	19:40	18:50	17:10	16:59
14	07:49	07:23	06:41	06:50	06:11	05:54	06:06	06:34	07:05	07:35	07:11	07:42
	17:21	17:58	18:31	20:04	20:35	20:58	20:57	20:27	19:38	18:49	17:10	16:59
15	07:49	07:21	06:39	06:49	06:10	05:54	06:07	06:35	07:06	07:36	07:12	07:43
	17:22	18:00	18:32	20:05	20:36	20:59	20:57	20:25	19:37	18:47	17:09	16:59
16	07:48	07:20	06:38	06:47	06:09	05:54	06:07	06:36	07:07	07:37	07:13	07:43
	17:23	18:01	18:33	20:06	20:37	20:59	20:56	20:24	19:35	18:46	17:08	16:59
17	07:48	07:19	06:36	06:46	06:08	05:54	06:08	06:37	07:08	07:38	07:14	07:44
	17:24	18:02	18:34	20:07	20:38	21:00	20:56	20:23	19:33	18:44	17:07	17:00
18	07:47	07:17	06:34	06:44	06:07	05:54	06:09	06:38	07:09	07:39	07:15	07:45
	17:26	18:03	18:35	20:08	20:38	21:00	20:55	20:21	19:32	18:43	17:06	17:00
19	07:47	07:16	06:33	06:43	06:06	05:54	06:10	06:39	07:10	07:41	07:17	07:45
	17:27	18:05	18:36	20:09	20:39	21:00	20:54	20:20	19:30	18:41	17:06	17:00
20	07:46	07:15	06:31	06:41	06:05	05:54	06:11	06:40	07:11	07:42	07:18	07:46
	17:28	18:06	18:37	20:10	20:40	21:00	20:53	20:18	19:28	18:40	17:05	17:01
21	07:46	07:13	06:29	06:40	06:04	05:54	06:12	06:41	07:12	07:43	07:19	07:46
	17:29	18:07	18:38	20:11	20:41	21:01	20:53	20:17	19:27	18:38	17:04	17:01
22	07:45	07:12	06:28	06:38	06:04	05:55	06:12	06:42	07:13	07:44	07:20	07:47
	17:30	18:08	18:39	20:12	20:42	21:01	20:52	20:15	19:25	18:37	17:04	17:02
23	07:44	07:10	06:26	06:37	06:03	05:55	06:13	06:43	07:13	07:45	07:21	07:47
	17:31	18:09	18:40	20:13	20:43	21:01	20:51	20:14	19:23	18:35	17:03	17:02
24	07:44	07:09	06:24	06:35	06:02	05:55	06:14	06:44	07:14	07:46	07:22	07:48
	17:33	18:10	18:41	20:14	20:44	21:01	20:50	20:12	19:21	18:34	17:02	17:03
25	07:43	07:08	06:23	06:34	06:01	05:55	06:15	06:45	07:15	06:47	07:23	07:48
	17:34	18:12	18:42	20:15	20:45	21:01	20:49	20:11	19:20	17:33	17:02	17:03
26	07:42	07:06	06:21	06:33	06:01	05:56	06:16	06:46	07:16	06:48	07:25	07:49
	17:35	18:13	18:44	20:16	20:46	21:01	20:49	20:09	19:18	17:31	17:01	17:04
27	07:42	07:05	06:19	06:31	06:00	05:56	06:17	06:47	07:17	06:50	07:26	07:49
	17:36	18:14	18:45	20:17	20:47	21:02	20:48	20:08	19:16	17:30	17:01	17:05
28	07:41	07:03	06:18	06:30	05:59	05:57	06:18	06:48	07:18	06:51	07:27	07:49
	17:38	18:15	18:46	20:18	20:47	21:02	20:47	20:06	19:15	17:29	17:00	17:05
29	07:40		07:16	06:28	05:59	05:57	06:19	06:49	07:20	06:52	07:28	07:50
	17:39		19:47	20:19	20:48	21:02	20:46	20:05	19:13	17:27	17:00	17:06
30	07:39		07:15	06:27	05:58	05:57	06:20	06:50	07:21	06:53	07:29	07:50
	17:40		19:48	20:20	20:49	21:01	20:45	20:03	19:11	17:26	17:00	17:07
31	07:38		07:13		05:58		06:21	06:51		06:54		07:50
	17:41		19:49		20:50		20:44	20:02		17:25		17:07
Potential sun hours	298	298	370	398	448	451	458	427	375	345	299	289
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

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Ettore / egalbo@hydroeng.it
Calculated:
02/08/2024 19:53/4.0.424

SHADOW - Calendar per WTG

WTG: 4 - SEN-04

Assumptions for shadow calculations

Sunshine probability S (Average daily sunshine hours) [ALGHERO]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3,85	4,78	5,80	6,92	8,25	9,91	10,91	9,92	8,15	6,40	4,83	3,92

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
79	158	315	946	315	158	237	237	631	552	3.154	1.104	7.886

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:50	07:37	07:02	07:11	06:26	05:57	05:58	06:21	06:52	07:22	06:55	07:30
	17:08	17:42	18:16	19:50	20:21	20:51	21:01	20:43	20:00	19:10	17:23	16:59
2	07:50	07:36	07:00	07:10	06:24	05:57	05:58	06:22	06:53	07:23	06:57	07:31
	17:09	17:44	18:17	19:51	20:22	20:51	21:01	20:42	19:58	19:08	17:22	16:59
3	07:51	07:35	06:59	07:08	06:23	05:56	05:59	06:23	06:54	07:24	06:58	07:32
	17:10	17:45	18:18	19:52	20:23	20:52	21:01	20:40	19:57	19:06	17:21	16:59
4	07:51	07:34	06:57	07:06	06:22	05:56	05:59	06:24	06:55	07:25	06:59	07:33
	17:11	17:46	18:20	19:53	20:24	20:53	21:01	20:39	19:55	19:05	17:20	16:59
5	07:51	07:33	06:55	07:05	06:21	05:56	06:00	06:25	06:56	07:26	07:00	07:34
	17:12	17:47	18:21	19:54	20:25	20:53	21:01	20:38	19:53	19:03	17:19	16:58
6	07:51	07:32	06:54	07:03	06:20	05:55	06:00	06:26	06:57	07:27	07:01	07:35
	17:13	17:49	18:22	19:55	20:27	20:54	21:01	20:37	19:52	19:01	17:18	16:58
7	07:51	07:31	06:52	07:01	06:18	05:55	06:01	06:27	06:58	07:28	07:02	07:36
	17:14	17:50	18:23	19:56	20:28	20:55	21:00	20:36	19:50	19:00	17:16	16:58
8	07:50	07:30	06:51	07:00	06:17	05:55	06:02	06:28	06:59	07:29	07:04	07:37
	17:15	17:51	18:24	19:57	20:29	20:55	21:00	20:35	19:48	18:58	17:15	16:58
9	07:50	07:29	06:49	06:58	06:16	05:55	06:02	06:29	07:00	07:30	07:05	07:38
	17:16	17:52	18:25	19:58	20:30	20:56	21:00	20:33	19:47	18:57	17:14	16:58
10	07:50	07:28	06:47	06:57	06:15	05:54	06:03	06:30	07:01	07:31	07:06	07:39
	17:17	17:54	18:26	19:59	20:31	20:56	20:59	20:32	19:45	18:55	17:13	16:58
11	07:50	07:26	06:46	06:55	06:14	05:54	06:04	06:31	07:02	07:32	07:07	07:39
	17:18	17:55	18:27	20:00	20:32	20:57	20:59	20:31	19:43	18:53	17:12	16:58
12	07:50	07:25	06:44	06:53	06:13	05:54	06:04	06:32	07:03	07:33	07:08	07:40
	17:19	17:56	18:29	20:01	20:33	20:57	20:58	20:29	19:42	18:52	17:11	16:58
13	07:49	07:24	06:43	06:52	06:12	05:54	06:05	06:33	07:04	07:34	07:10	07:41
	17:20	17:57	18:30	20:02	20:34	20:58	20:58	20:28	19:40	18:50	17:10	16:59
14	07:49	07:23	06:41	06:50	06:11	05:54	06:06	06:34	07:05	07:35	07:11	07:42
	17:21	17:58	18:31	20:03	20:35	20:58	20:57	20:27	19:38	18:49	17:10	16:59
15	07:49	07:21	06:39	06:49	06:10	05:54	06:07	06:35	07:06	07:36	07:12	07:42
	17:22	18:00	18:32	20:05	20:36	20:59	20:57	20:25	19:37	18:47	17:09	16:59
16	07:48	07:20	06:38	06:47	06:09	05:54	06:07	06:36	07:07	07:37	07:13	07:43
	17:23	18:01	18:33	20:06	20:37	20:59	20:56	20:24	19:35	18:46	17:08	16:59
17	07:48	07:19	06:36	06:46	06:08	05:54	06:08	06:37	07:08	07:38	07:14	07:44
	17:24	18:02	18:34	20:07	20:38	21:00	20:56	20:23	19:33	18:44	17:07	17:00
18	07:47	07:17	06:34	06:44	06:07	05:54	06:09	06:38	07:09	07:39	07:15	07:45
	17:26	18:03	18:35	20:08	20:38	21:00	20:55	20:21	19:32	18:43	17:06	17:00
19	07:47	07:16	06:33	06:43	06:06	05:54	06:10	06:39	07:10	07:41	07:17	07:45
	17:27	18:04	18:36	20:09	20:39	21:00	20:54	20:20	19:30	18:41	17:06	17:00
20	07:46	07:15	06:31	06:41	06:05	05:54	06:11	06:40	07:11	07:42	07:18	07:46
	17:28	18:06	18:37	20:10	20:40	21:00	20:53	20:18	19:28	18:40	17:05	17:01
21	07:46	07:13	06:29	06:40	06:04	05:54	06:11	06:41	07:12	07:43	07:19	07:46
	17:29	18:07	18:38	20:11	20:41	21:01	20:53	20:17	19:27	18:38	17:04	17:01
22	07:45	07:12	06:28	06:38	06:04	05:55	06:12	06:42	07:12	07:44	07:20	07:47
	17:30	18:08	18:39	20:12	20:42	21:01	20:52	20:15	19:25	18:37	17:03	17:02
23	07:44	07:10	06:26	06:37	06:03	05:55	06:13	06:43	07:13	07:45	07:21	07:47
	17:31	18:09	18:40	20:13	20:43	21:01	20:51	20:14	19:23	18:35	17:03	17:02
24	07:44	07:09	06:24	06:35	06:02	05:55	06:14	06:44	07:14	07:46	07:22	07:48
	17:33	18:10	18:41	20:14	20:44	21:01	20:50	20:12	19:21	18:34	17:02	17:03
25	07:43	07:08	06:23	06:34	06:01	05:55	06:15	06:45	07:15	06:47	07:23	07:48
	17:34	18:12	18:42	20:15	20:45	21:01	20:49	20:11	19:20	17:33	17:02	17:03
26	07:42	07:06	06:21	06:33	06:01	05:56	06:16	06:46	07:16	06:48	07:25	07:49
	17:35	18:13	18:44	20:16	20:46	21:01	20:49	20:09	19:18	17:31	17:01	17:04
27	07:42	07:05	06:19	06:31	06:00	05:56	06:17	06:47	07:17	06:50	07:26	07:49
	17:36	18:14	18:45	20:17	20:47	21:02	20:48	20:08	19:16	17:30	17:01	17:04
28	07:41	07:03	06:18	06:30	05:59	05:56	06:18	06:48	07:18	06:51	07:27	07:49
	17:38	18:15	18:46	20:18	20:47	21:02	20:47	20:06	19:15	17:29	17:00	17:05
29	07:40		07:16	06:28	05:59	05:57	06:19	06:49	07:19	06:52	07:28	07:50
	17:39		19:47	20:19	20:48	21:02	20:46	20:05	19:13	17:27	17:00	17:06
30	07:39		07:14	06:27	05:58	05:57	06:20	06:50	07:21	06:53	07:29	07:50
	17:40		19:48	20:20	20:49	21:01	20:45	20:03	19:11	17:26	17:00	17:07
31	07:38		07:13		05:58		06:21	06:51		06:54		07:50
	17:41		19:49		20:50		20:44	20:01		17:25		17:07
Potential sun hours	298	298	370	398	448	451	458	427	375	345	299	289
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

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Hydro Engineering s.s.
via Rossotti, 39
IT-91011 Alcamo

Ettore / egalbo@hydroeng.it
Calculated:
02/08/2024 19:53/4.0.424

SHADOW - Calendar per WTG

WTG: 5 - SEN-05

Assumptions for shadow calculations

Sunshine probability S (Average daily sunshine hours) [ALGHERO]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3,85	4,78	5,80	6,92	8,25	9,91	10,91	9,92	8,15	6,40	4,83	3,92

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
79	158	315	946	315	158	237	237	631	552	3.154	1.104	7.886

	January		February	March	April	May	June	July	August	September	October	November		December	
1	07:50	15:15-15:48/33	07:37	07:02	07:11	06:26	05:57	05:58	06:21	06:52	07:22	06:55		07:30	15:04-15:30/26
	17:08		17:42	18:16	19:50	20:21	20:51	21:01	20:43	20:00	19:10	17:23		16:59	
2	07:50	15:15-15:48/33	07:36	07:00	07:10	06:24	05:57	05:58	06:22	06:53	07:23	06:57		07:31	15:04-15:31/27
	17:09		17:44	18:17	19:51	20:22	20:51	21:01	20:42	19:58	19:08	17:22		16:59	
3	07:51	15:16-15:48/32	07:35	06:59	07:08	06:23	05:56	05:59	06:23	06:54	07:24	06:58		07:32	15:05-15:33/28
	17:10		17:45	18:18	19:52	20:23	20:52	21:01	20:40	19:57	19:06	17:21		16:59	
4	07:51	15:17-15:49/32	07:34	06:57	07:06	06:22	05:56	05:59	06:24	06:55	07:25	06:59		07:33	15:04-15:34/30
	17:11		17:46	18:20	19:53	20:24	20:53	21:01	20:39	19:55	19:05	17:20		16:59	
5	07:51	15:18-15:49/31	07:33	06:55	07:05	06:21	05:56	06:00	06:25	06:56	07:26	07:00		07:34	15:04-15:34/30
	17:12		17:47	18:21	19:54	20:26	20:53	21:01	20:38	19:53	19:03	17:19		16:58	
6	07:51	15:18-15:49/31	07:32	06:54	07:03	06:20	05:55	06:00	06:26	06:57	07:27	07:01		07:35	15:03-15:34/31
	17:13		17:49	18:22	19:55	20:27	20:54	21:01	20:37	19:52	19:01	17:18		16:58	
7	07:51	15:18-15:48/30	07:31	06:52	07:01	06:18	05:55	06:01	06:27	06:58	07:28	07:02		07:36	15:04-15:35/31
	17:14		17:50	18:23	19:56	20:28	20:55	21:00	20:36	19:50	19:00	17:16		16:58	
8	07:50	15:19-15:49/30	07:30	06:51	07:00	06:17	05:55	06:02	06:28	06:59	07:29	07:04		07:37	15:04-15:36/32
	17:15		17:51	18:24	19:57	20:29	20:55	21:00	20:35	19:48	18:58	17:15		16:58	
9	07:50	15:20-15:49/29	07:29	06:49	06:58	06:16	05:55	06:02	06:29	07:00	07:30	07:05		07:38	15:04-15:36/32
	17:16		17:52	18:25	19:58	20:30	20:56	21:00	20:33	19:47	18:57	17:14		16:58	
10	07:50	15:22-15:49/27	07:28	06:47	06:57	06:15	05:54	06:03	06:30	07:01	07:31	07:06		07:39	15:04-15:37/33
	17:17		17:54	18:26	19:59	20:31	20:56	20:59	20:32	19:45	18:55	17:13		16:58	
11	07:50	15:22-15:48/26	07:26	06:46	06:55	06:14	05:54	06:04	06:31	07:02	07:32	07:07		07:39	15:05-15:38/33
	17:18		17:55	18:27	20:00	20:32	20:57	20:59	20:31	19:43	18:53	17:12		16:58	
12	07:50	15:23-15:48/25	07:25	06:44	06:53	06:13	05:54	06:04	06:32	07:03	07:33	07:08		07:40	15:05-15:39/34
	17:19		17:56	18:29	20:01	20:33	20:57	20:58	20:30	19:42	18:52	17:11		16:58	
13	07:49	15:25-15:48/23	07:24	06:43	06:52	06:12	05:54	06:05	06:33	07:04	07:34	07:10		07:41	15:06-15:40/34
	17:20		17:57	18:30	20:02	20:34	20:58	20:58	20:28	19:40	18:50	17:10		16:59	
14	07:49	15:26-15:47/21	07:23	06:41	06:50	06:11	05:54	06:06	06:34	07:05	07:35	07:11		07:42	15:05-15:39/34
	17:21		17:58	18:31	20:04	20:35	20:58	20:57	20:27	19:38	18:49	17:10		16:59	
15	07:49	15:28-15:47/19	07:21	06:39	06:49	06:10	05:54	06:07	06:35	07:06	07:36	07:12		07:43	15:06-15:40/34
	17:22		18:00	18:32	20:05	20:36	20:59	20:57	20:25	19:37	18:47	17:09		16:59	
16	07:48	15:29-15:45/16	07:20	06:38	06:47	06:09	05:54	06:07	06:36	07:07	07:37	07:13		07:43	15:07-15:41/34
	17:23		18:01	18:33	20:06	20:37	20:59	20:56	20:24	19:35	18:46	17:08		16:59	
17	07:48	15:32-15:44/12	07:19	06:36	06:46	06:08	05:54	06:08	06:37	07:08	07:38	07:14		07:44	15:07-15:41/34
	17:24		18:02	18:34	20:07	20:38	21:00	20:56	20:23	19:33	18:44	17:07		17:00	
18	07:47	15:35-15:41/6	07:17	06:34	06:44	06:07	05:54	06:09	06:38	07:09	07:39	07:15		07:45	15:07-15:42/35
	17:26		18:03	18:35	20:08	20:38	21:00	20:55	20:21	19:32	18:43	17:06		17:00	
19	07:47		07:16	06:33	06:43	06:06	05:54	06:10	06:39	07:10	07:41	07:17		07:45	15:07-15:42/35
	17:27		18:04	18:36	20:09	20:39	21:00	20:54	20:20	19:30	18:41	17:06		17:00	
20	07:46		07:15	06:31	06:41	06:05	05:54	06:11	06:40	07:11	07:42	07:18		07:46	15:08-15:43/35
	17:28		18:06	18:37	20:10	20:40	21:01	20:53	20:18	19:28	18:40	17:05		17:01	
21	07:46		07:13	06:29	06:40	06:04	05:54	06:11	06:41	07:12	07:43	07:19		07:46	15:09-15:44/35
	17:29		18:07	18:38	20:11	20:41	21:01	20:53	20:17	19:27	18:38	17:04		17:01	
22	07:45		07:12	06:28	06:38	06:04	05:55	06:12	06:42	07:12	07:44	07:20		07:47	15:09-15:44/35
	17:30		18:08	18:39	20:12	20:42	21:01	20:52	20:15	19:25	18:37	17:03		17:02	
23	07:44		07:10	06:26	06:37	06:03	05:55	06:13	06:43	07:13	07:45	07:21		07:47	15:09-15:44/35
	17:31		18:09	18:40	20:13	20:43	21:01	20:51	20:14	19:23	18:35	17:03		17:02	
24	07:44		07:09	06:24	06:35	06:02	05:55	06:14	06:44	07:14	07:46	07:22	15:14-15:19/5	07:48	15:10-15:45/35
	17:33		18:10	18:41	20:14	20:44	21:01	20:50	20:12	19:21	18:34	17:02		17:03	
25	07:43		07:08	06:23	06:34	06:01	05:55	06:15	06:45	07:15	06:47	07:23	15:10-15:22/12	07:48	15:10-15:45/35
	17:34		18:12	18:42	20:15	20:45	21:01	20:49	20:11	19:20	17:33	17:02		17:03	
26	07:42		07:06	06:21	06:33	06:01	05:56	06:16	06:46	07:16	06:48	07:25	15:08-15:24/16	07:49	15:11-15:46/35
	17:35		18:13	18:44	20:16	20:46	21:02	20:49	20:09	19:18	17:31	17:01		17:04	
27	07:42		07:05	06:19	06:31	06:00	05:56	06:17	06:47	07:17	06:50	07:26	15:07-15:26/19	07:49	15:12-15:46/34
	17:36		18:14	18:45	20:17	20:47	21:02	20:48	20:08	19:16	17:30	17:01		17:04	
28	07:41		07:03	06:18	06:30	05:59	05:56	06:18	06:48	07:18	06:51	07:27	15:06-15:27/21	07:49	15:12-15:46/34
	17:37		18:15	18:46	20:18	20:47	21:02	20:47	20:06	19:15	17:29	17:00		17:05	
29	07:40			07:16	06:28	05:59	05:57	06:19	06:49	07:20	06:52	07:28	15:05-15:28/23	07:50	15:12-15:46/34
	17:39			19:47	20:19	20:48	21:02	20:46	20:05	19:13	17:27	17:00		17:06	
30	07:39			07:14	06:27	05:58	05:57	06:20	06:50	07:21	06:53	07:29	15:05-15:29/24	07:50	15:13-15:46/33
	17:40			19:48	20:20	20:49	21:02	20:45	20:03	19:11	17:26	17:00		17:07	
31	07:38			07:13		05:58		06:21	06:51		06:54			07:50	15:14-15:48/34
	17:41			19:49		20:50		20:44	20:02		17:25			17:07	
Potential sun hours	298		298	370	398	448	451	458	427	375	345	299		289	
Sum of minutes with flicker	456		0	0	0	0	0	0	0	0	0	120		1021	

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

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Ettore / egalbo@hydroeng.it
Calculated:
02/08/2024 19:53/4.0.424

SHADOW - Calendar per WTG

WTG: 6 - SEN-06

Assumptions for shadow calculations

Sunshine probability S (Average daily sunshine hours) [ALGHERO]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3,85	4,78	5,80	6,92	8,25	9,91	10,91	9,92	8,15	6,40	4,83	3,92

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
79	158	315	946	315	158	237	237	631	552	3.154	1.104	7.886

	January	February	March	April	May	June	July	August	September	October	November	December
1	07:50	07:37	07:02 16:27-17:13/46	07:11	06:26	05:57	05:58	06:21	06:52	07:22	06:55 16:10-16:31/21	07:30
	17:08	17:42	18:16	19:50	20:21	20:51	21:01	20:43	20:00	19:10	17:23	16:59
2	07:50	07:36	07:00 16:28-17:13/45	07:10	06:24	05:57	05:58	06:22	06:53	07:23 17:19-17:35/16	06:57 16:13-16:27/14	07:31
	17:09	17:44	18:17	19:51	20:22	20:51	21:01	20:42	19:58	19:08	17:22	16:59
3	07:51	07:35	06:59 16:28-17:11/43	07:08	06:23	05:56	05:59	06:23	06:54	07:24 17:16-17:39/23	06:58	07:32
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	17:14	17:50	18:23	19:56	20:28	20:55	21:00	20:36	19:50	19:00	17:16	16:58
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27	07:42	07:05 16:27-17:15/48	06:19	06:31	06:00	05:56	06:17	06:47	07:17	06:50 16:02-16:40/38	07:26	07:49
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30	07:39		07:14	06:27	05:58	05:57	06:20	06:50	07:21	06:53 16:05-16:35/30	07:29	07:50
	17:40		19:48	20:20	20:49	21:02	20:45	20:03	19:11	17:26	17:00	17:07
31	07:38		07:13		05:58		06:21	06:51		06:54 16:08-16:34/26		07:50
	17:41		19:49		20:50		20:44	20:02		17:25		17:07
Potential sun hours	298	298	370	398	448	451	458	427	375	345	299	289
Sum of minutes with flicker	0	799	406	0	0	0	0	0	0	1182	35	0

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

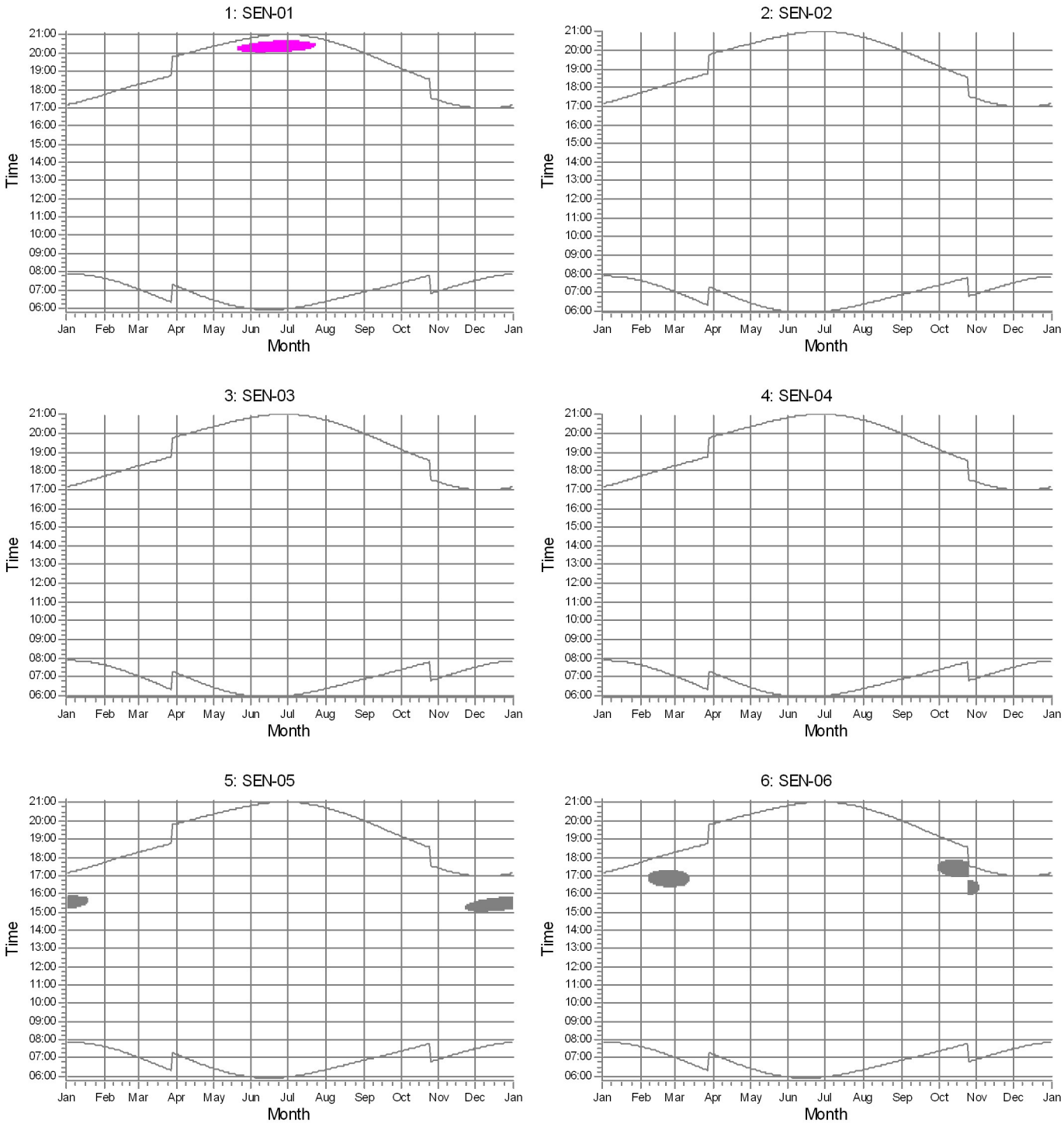
Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker
	Sun set (hh:mm)	First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker

15 ALLEGATO 8 – CALENDARIO GRAFICO PER WTG

Licensed user:
Hydro Engineering s.s.
via Rossotti, 39
IT-91011 Alcamo

Ettore / egalbo@hydroeng.it
Calculated:
03/08/2024 11:10/4.0.424

SHADOW - Calendar per WTG, graphical



Shadow receptors

D: Sennori n.15 - p.lla 173 (A03)

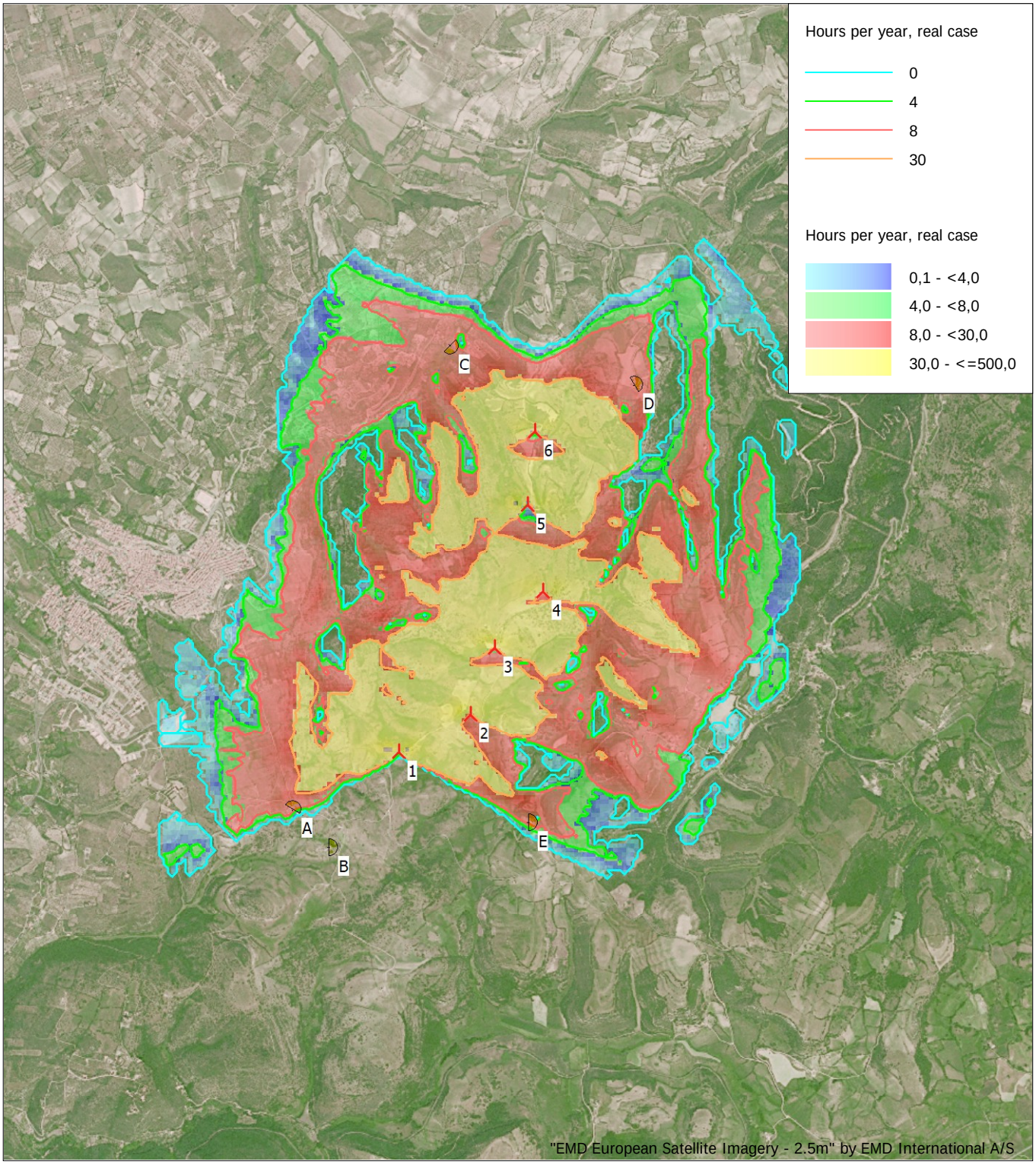
E: Osilo n.29 - p.lla 41 (A04)

16 ALLEGATO 9 – MAPPE DI OMBREGGIAMENTO

Licensed user:
Hydro Engineering s.s.
via Rossotti, 39
IT-91011 Alcamo

Ettore / egalbo@hydroeng.it
Calculated:
03/08/2024 11:10/4.0.424

SHADOW - Map



0 500 1000 1500 2000 m

Map: windPRO European Satellite Imagery - 2.5m , Print scale 1:40.000, Map center Geo WGS84 East: 8,625698° E North: 40,789970° N

New WTG Shadow receptor

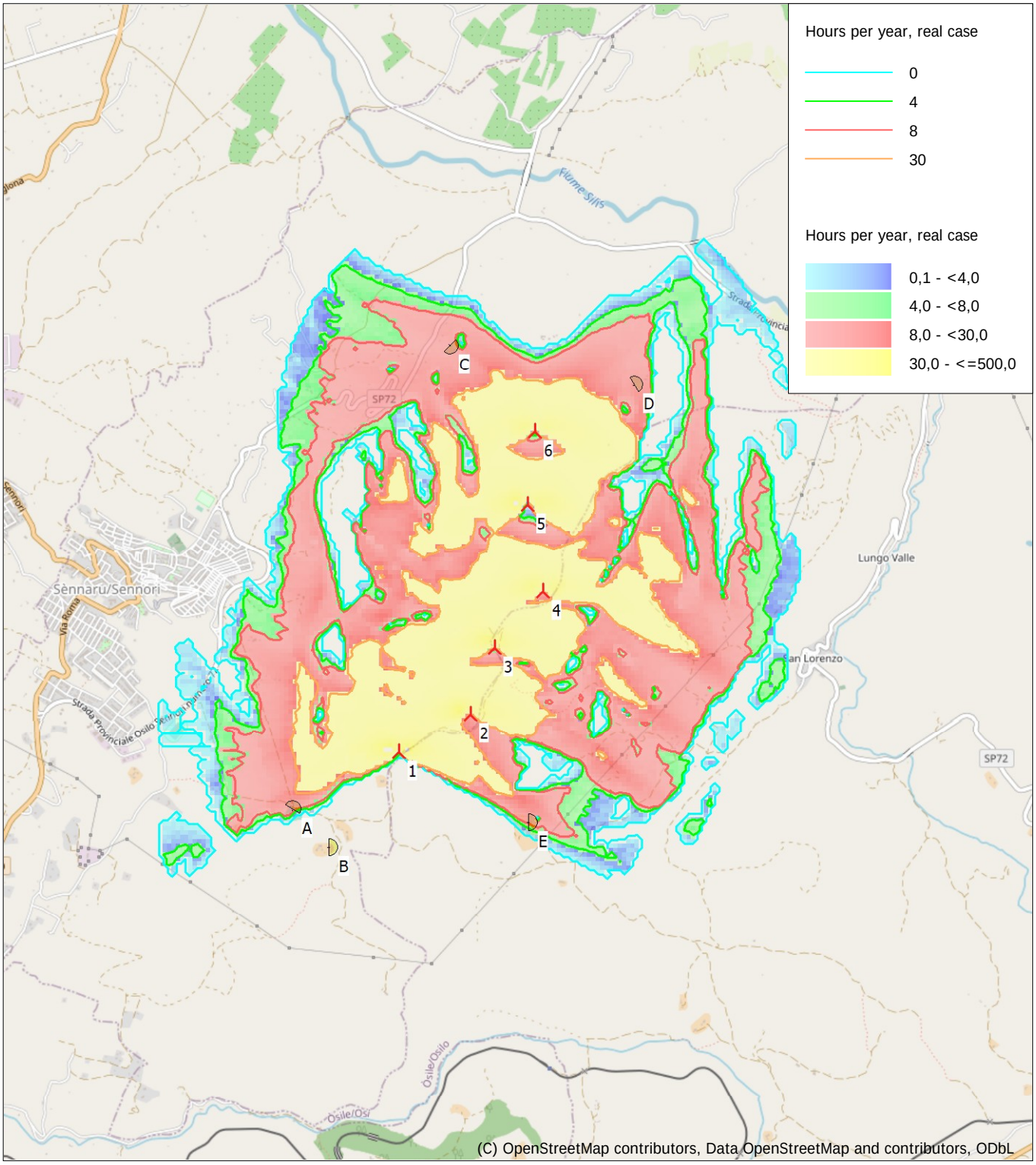
Flicker map level: Elevation Grid Data Object: Sennori_EMDGrid_1.wpg (2)

Time step: 4 minutes, Day step: 14 days, Map resolution: 30 m, Visibility resolution: 15 m, Eye height: 1,5 m

Licensed user:
Hydro Engineering s.s.
via Rossotti, 39
IT-91011 Alcamo

Ettore / egalbo@hydroeng.it
Calculated:
03/08/2024 11:10/4.0.424

SHADOW - Map



0 500 1000 1500 2000 m

Map: EMD OpenStreetMap , Print scale 1:40.000, Map center Geo WGS84 East: 8,625698° E North: 40,789970° N

New WTG Shadow receptor

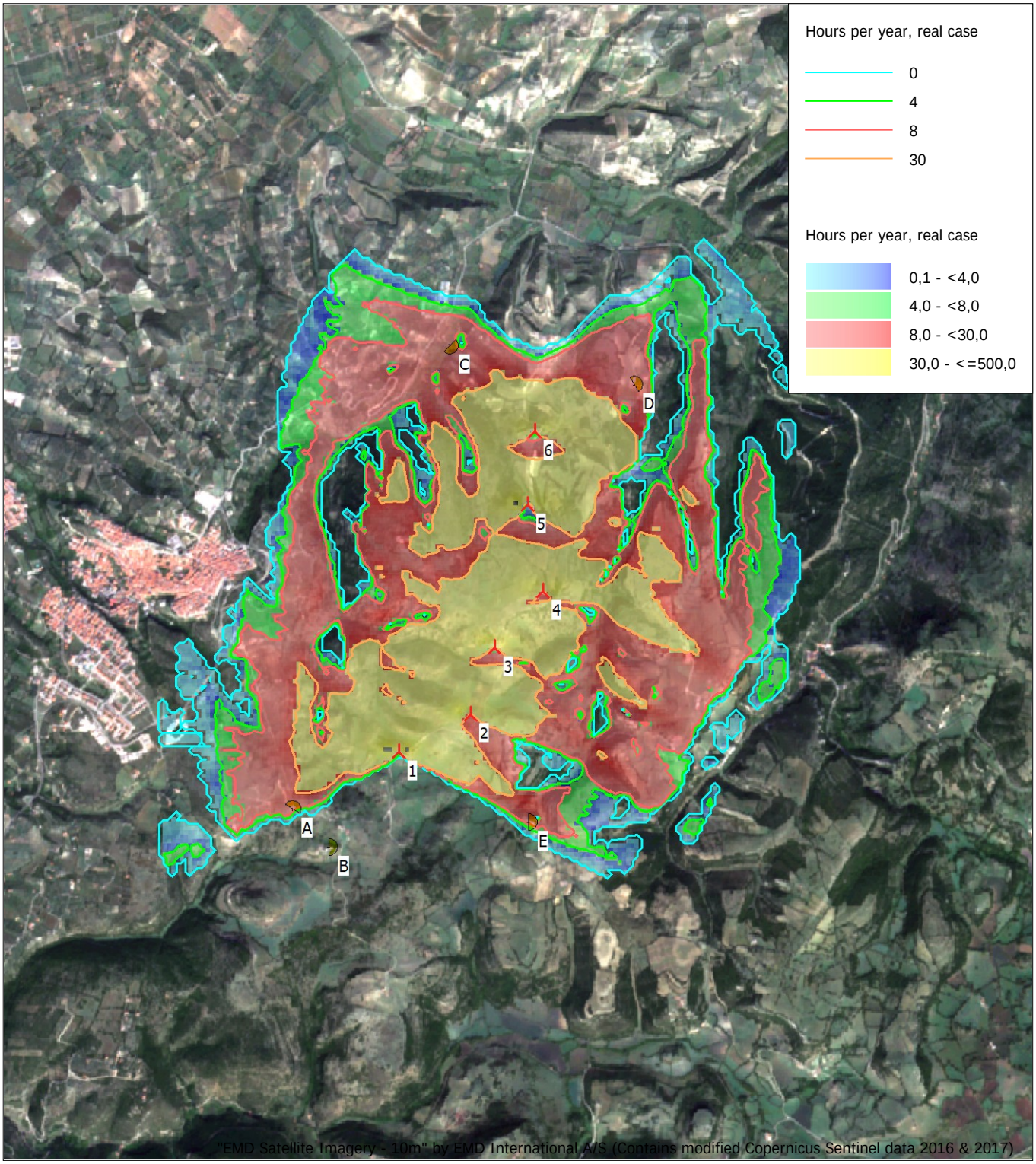
Flicker map level: Elevation Grid Data Object: Sennori_EMDGrid_1.wpg (2)

Time step: 4 minutes, Day step: 14 days, Map resolution: 30 m, Visibility resolution: 15 m, Eye height: 1,5 m

Licensed user:
Hydro Engineering s.s.
via Rossotti, 39
IT-91011 Alcamo

Ettore / egalbo@hydroeng.it
Calculated:
03/08/2024 11:10/4.0.424

SHADOW - Map



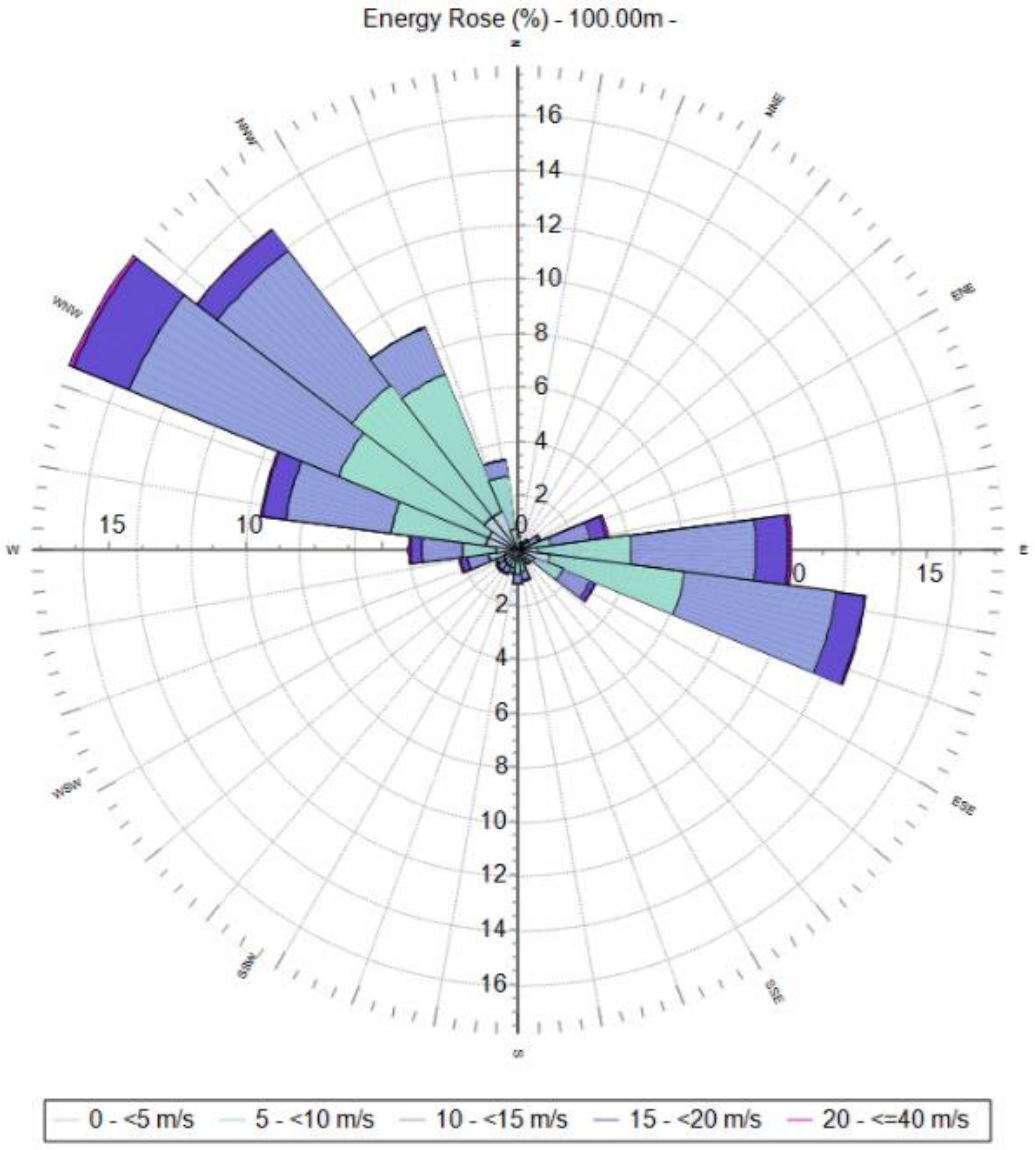
Map: windPRO Global Satellite Imagery - 10m (2022) , Print scale 1:40.000, Map center Geo WGS84 East: 8,625698° E North: 40,789970° N

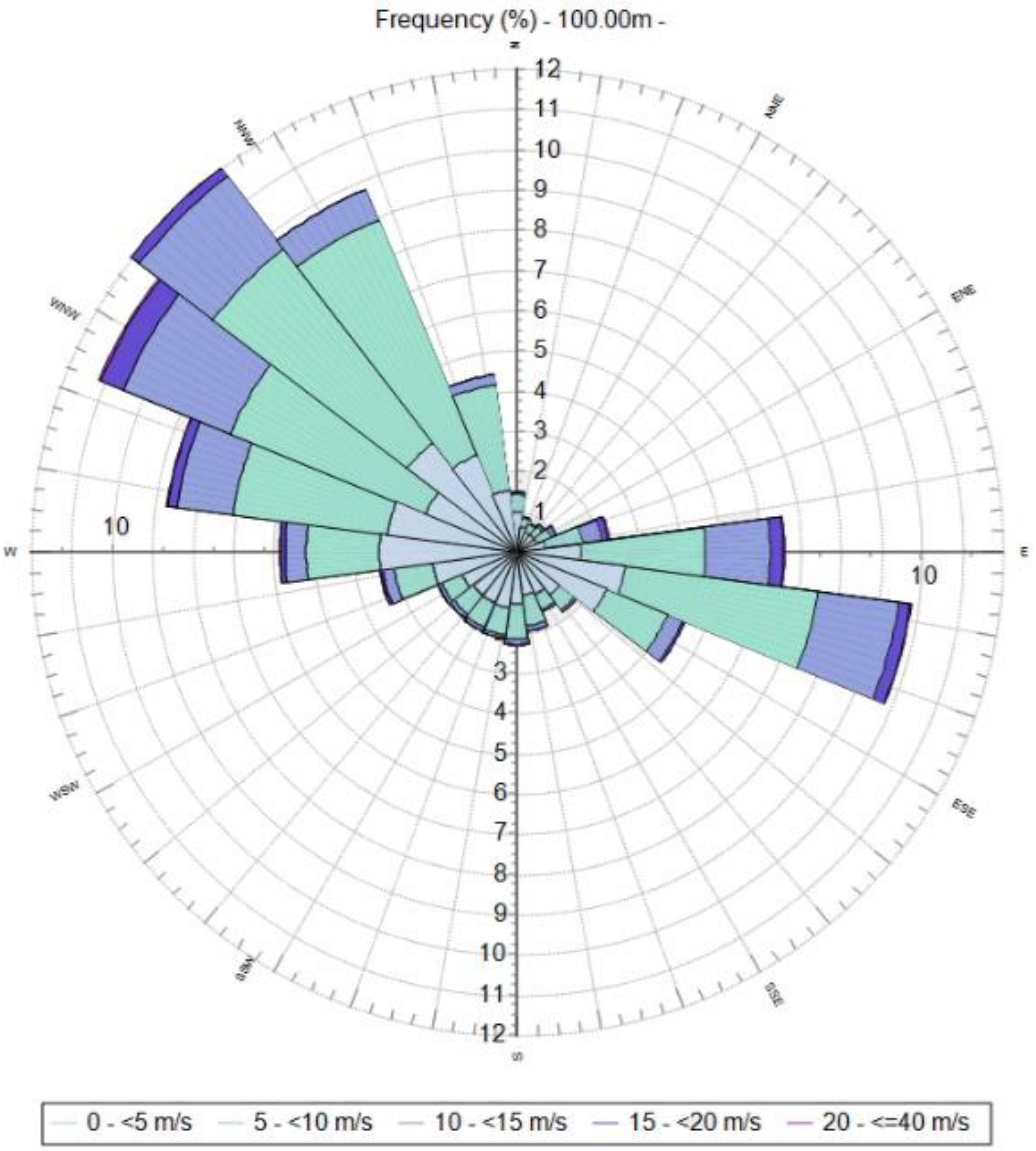
New WTG Shadow receptor

Flicker map level: Elevation Grid Data Object: Sennori_EMDGrid_1.wpg (2)

Time step: 4 minutes, Day step: 14 days, Map resolution: 30 m, Visibility resolution: 15 m, Eye height: 1,5 m

17 ALLEGATO 10 – ANALISI STAISTICA DEL VENTO




Frequency (%) - 100.00m -
N
NNE
ENE
E
ESE
SSE
S
SSW
WSW
W
WNW
NNW
12
11
10
9
8
7
6
5
4
3
2
1
10
10
0 - <5 m/s
5 - <10 m/s
10 - <15 m/s
15 - <20 m/s
20 - <=40 m/s