

## SHADOW - Main Result

**Calculation:** 2024-03-15\_Urakkaneva\_Shadow\_9x V162-6.4\_HH169\_with forest

### 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) []  
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
0.77 2.30 4.42 6.93 8.90 9.87 9.23 6.84 4.43 2.25 0.93 0.26

Operational hours are calculated from WTGs in calculation and wind distribution:  
WM Nivala

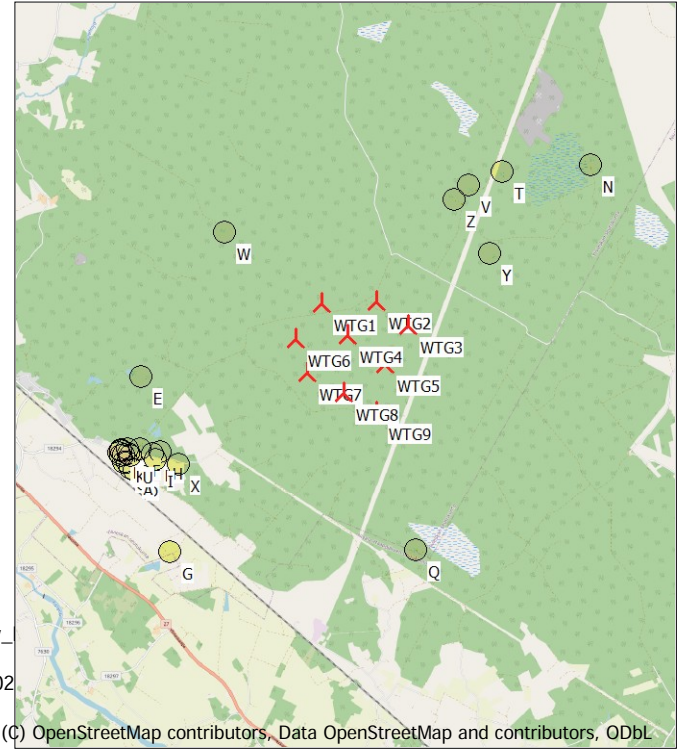
Operational time  
N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
623 467 405 424 521 792 1'036 1'068 1'018 893 697 647 8'593

Idle start wind speed: Cut in wind speed from power curve  
A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:  
Height contours used: Height Contours: 2020-12-22\_Urakkaneva\_Orography\_  
Area object(s) used in calculation:  
Area object (Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): 202  
Receptor grid resolution: 1.0 m

All coordinates are in  
UTM (north)-ETRS89 Zone: 35

### WTGs

	Easting	Northing	Z	Row data/Description	WTG type			Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Shadow data	
					Valid	Manufact.	Type-generator				Calculation distance [m]	RPM [RPM]
WTG1	396'211	7'101'094	94.2	VESTAS V162-6.4 6400 162.0 !-! ...Yes	VESTAS	V162-6.4-6'400	6'400	162.0	169.0	2'030	12.1	
WTG2	397'111	7'101'106	95.5	VESTAS V162-6.4 6400 162.0 !-! ...Yes	VESTAS	V162-6.4-6'400	6'400	162.0	169.0	2'030	12.1	
WTG3	397'634	7'100'697	99.0	VESTAS V162-6.4 6400 162.0 !-! ...Yes	VESTAS	V162-6.4-6'400	6'400	162.0	169.0	2'030	12.1	
WTG4	396'621	7'100'560	95.9	VESTAS V162-6.4 6400 162.0 !-! ...Yes	VESTAS	V162-6.4-6'400	6'400	162.0	169.0	2'030	12.1	
WTG5	397'234	7'100'072	97.3	VESTAS V162-6.4 6400 162.0 !-! ...Yes	VESTAS	V162-6.4-6'400	6'400	162.0	169.0	2'030	12.1	
WTG6	395'776	7'100'518	94.5	VESTAS V162-6.4 6400 162.0 !-! ...Yes	VESTAS	V162-6.4-6'400	6'400	162.0	169.0	2'030	12.1	
WTG7	395'945	7'099'964	95.0	VESTAS V162-6.4 6400 162.0 !-! ...Yes	VESTAS	V162-6.4-6'400	6'400	162.0	169.0	2'030	12.1	
WTG8	396'528	7'099'617	95.3	VESTAS V162-6.4 6400 162.0 !-! ...Yes	VESTAS	V162-6.4-6'400	6'400	162.0	169.0	2'030	12.1	
WTG9	397'062	7'099'281	96.6	VESTAS V162-6.4 6400 162.0 !-! ...Yes	VESTAS	V162-6.4-6'400	6'400	162.0	169.0	2'030	12.1	



### Shadow receptor-Input

No.	Easting	Northing	Z	Width	Height	Elevation a.g.l.	Slope of window	Direction mode	Eye height (ZVI) a.g.l.
	[m]	[m]	[m]	[m]	[m]	[m]	[°]		[m]
A	392'954	7'098'494	80.0	1.0	1.0	1.0	90.0	"Green house mode"	2.0
B	392'893	7'098'598	81.8	1.0	1.0	1.0	90.0	"Green house mode"	2.0
C	392'838	7'098'600	81.3	1.0	1.0	1.0	90.0	"Green house mode"	2.0
D	392'910	7'098'814	85.6	1.0	1.0	1.0	90.0	"Green house mode"	2.0
E	393'183	7'099'997	90.0	1.0	1.0	1.0	90.0	"Green house mode"	2.0
F	393'127	7'098'800	85.0	1.0	1.0	1.0	90.0	"Green house mode"	2.0
G	393'552	7'097'057	73.2	1.0	1.0	1.0	90.0	"Green house mode"	2.0
H	393'465	7'098'732	85.0	1.0	1.0	1.0	90.0	"Green house mode"	2.0
I	393'379	7'098'610	82.3	1.0	1.0	1.0	90.0	"Green house mode"	2.0
J	392'813	7'098'803	85.1	1.0	1.0	1.0	90.0	"Green house mode"	2.0
K	392'834	7'098'708	84.4	1.0	1.0	1.0	90.0	"Green house mode"	2.0
L	393'324	7'098'709	85.0	1.0	1.0	1.0	90.0	"Green house mode"	2.0
M	392'772	7'098'738	84.2	1.0	1.0	1.0	90.0	"Green house mode"	2.0
N	400'743	7'103'242	104.3	1.0	1.0	1.0	90.0	"Green house mode"	2.0
O	393'011	7'098'445	80.0	1.0	1.0	1.0	90.0	"Green house mode"	2.0

To be continued on next page...

## SHADOW - Main Result

**Calculation:** 2024-03-15\_Urakkaneva\_Shadow\_9x V162-6.4\_HH169\_with forest

...continued from previous page

No.	Easting	Northing	Z	Width	Height	Elevation a.g.l.	Slope of window	Direction mode	Eye height (ZVI) a.g.l.
			[m]	[m]	[m]	[m]	[°]		[m]
P	392'807	7'098'774	85.0	1.0	1.0	1.0	90.0	"Green house mode"	2.0
Q	397'641	7'096'959	99.3	1.0	1.0	1.0	90.0	"Green house mode"	2.0
R	392'797	7'098'697	83.5	1.0	1.0	1.0	90.0	"Green house mode"	2.0
S	392'924	7'098'727	84.8	1.0	1.0	1.0	90.0	"Green house mode"	2.0
T	399'277	7'103'184	100.0	1.0	1.0	1.0	90.0	"Green house mode"	2.0
U	392'955	7'098'698	84.1	1.0	1.0	1.0	90.0	"Green house mode"	2.0
V	398'726	7'102'979	100.0	1.0	1.0	1.0	90.0	"Green house mode"	2.0
W	394'643	7'102'346	90.5	1.0	1.0	1.0	90.0	"Green house mode"	2.0
X	393'762	7'098'534	81.3	1.0	1.0	1.0	90.0	"Green house mode"	2.0
Y	399'043	7'101'843	101.3	1.0	1.0	1.0	90.0	"Green house mode"	2.0
Z	398'461	7'102'746	100.0	1.0	1.0	1.0	90.0	"Green house mode"	2.0

## Calculation Results

Shadow receptor

### Shadow, expected values

No. Shadow hours

per year

[h/year]

A	0:00
B	0:00
C	0:00
D	0:00
E	0:00
F	0:00
G	0:00
H	0:00
I	0:00
J	0:00
K	0:00
L	0:00
M	0:00
N	0:00
O	0:00
P	0:00
Q	0:00
R	0:00
S	0:00
T	0:00
U	0:00
V	0:00
W	0:00
X	0:00
Y	0:00
Z	0:00

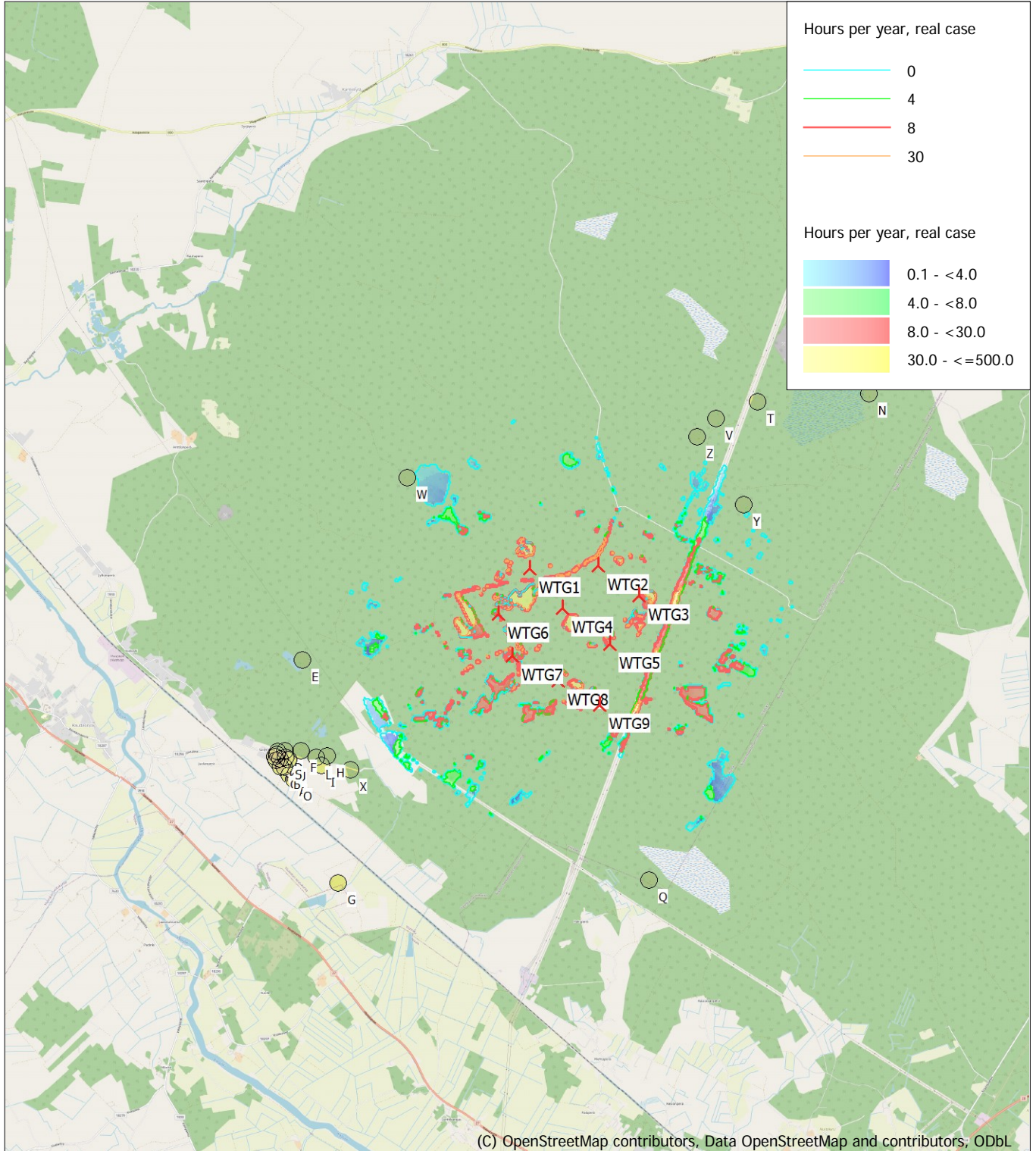
Total amount of flickering on the shadow receptors caused by each WTG

No.	Name	Expected [h/year]
WTG1	VESTAS V162-6.4 6400 162.0 !-! hub: 169.0 m (TOT: 250.0 m) (764)	0:00
WTG2	VESTAS V162-6.4 6400 162.0 !-! hub: 169.0 m (TOT: 250.0 m) (765)	0:00
WTG3	VESTAS V162-6.4 6400 162.0 !-! hub: 169.0 m (TOT: 250.0 m) (766)	0:00
WTG4	VESTAS V162-6.4 6400 162.0 !-! hub: 169.0 m (TOT: 250.0 m) (767)	0:00
WTG5	VESTAS V162-6.4 6400 162.0 !-! hub: 169.0 m (TOT: 250.0 m) (768)	0:00
WTG6	VESTAS V162-6.4 6400 162.0 !-! hub: 169.0 m (TOT: 250.0 m) (769)	0:00
WTG7	VESTAS V162-6.4 6400 162.0 !-! hub: 169.0 m (TOT: 250.0 m) (770)	0:00
WTG8	VESTAS V162-6.4 6400 162.0 !-! hub: 169.0 m (TOT: 250.0 m) (771)	0:00
WTG9	VESTAS V162-6.4 6400 162.0 !-! hub: 169.0 m (TOT: 250.0 m) (772)	0:00

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

## SHADOW - Map

Calculation: 2024-03-15\_Urakkaneva\_Shadow\_9x V162-6.4\_HH169\_with forest



Map: EMD OpenStreetMap , Print scale 1:75'000, Map center UTM (north)-ETRS89 Zone: 35 East: 396'280 North: 7'101'240  
New WTG  
Shadow receptor  
Flicker map level: Height Contours: 2020-12-22\_Urakkaneva\_Orography\_NLS 10m\_coarse.wpo (3)  
Time step: 3 minutes, Day step: 7 days, Map resolution: 20 m, Visibility resolution: 10 m, Eye height: 2.0 m