

Bilaga 3B - Skuggor

Layout B

16 st Gamesa G128, 4,5 MW

Totalhöjd 150 meter

Project:

Grönhult

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VATTENFALL AB IT

Företagsenhet 1002

SE-962 80 Jokkmokk

Jenny Longworth / jenny.longworth@vattenfall.com

Calculated:

2014-05-27 23:16/2.9.269

SHADOW - Main Result

Calculation: 140421 G128 16vkv 86HH

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) [VAXJO /KRONOBER G]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.36	1.52	2.62	6.08	8.82	7.64	6.65	5.42	4.02	2.68	1.38	0.88

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

Grönhult_MKBKkompl

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
409	396	494	582	612	612	634	921	1,286	1,399	702	455	8,502

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: 120531_GH2mCont_2mScan_5mTop

Obstacles not used in calculation

Eye height: 1.5 m

Grid resolution: 10.0 m

WTGs

	Swedish RT90 2.5gonV 0:-15-RT90 (SE)				WTG type			Shadow data				
	East	North	Z	Row data/Description	Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Calculation distance [m]	RPM [RPM]
1	1,357,844	6,363,917	266.9	GAMESA G128 4500 128.0 !O! ...	Yes	GAMESA	G128-4,500	4,500	128.0	86.0	2,500	12.0
2	1,358,458	6,364,142	260.0	GAMESA G128 4500 128.0 !O! ...	Yes	GAMESA	G128-4,500	4,500	128.0	86.0	2,500	12.0
3	1,361,178	6,364,684	275.9	GAMESA G128 4500 128.0 !O! ...	Yes	GAMESA	G128-4,500	4,500	128.0	86.0	2,500	12.0
4	1,360,224	6,364,520	282.0	GAMESA G128 4500 128.0 !O! ...	Yes	GAMESA	G128-4,500	4,500	128.0	86.0	2,500	12.0
5	1,361,225	6,365,680	270.0	GAMESA G128 4500 128.0 !O! ...	Yes	GAMESA	G128-4,500	4,500	128.0	86.0	2,500	12.0
6	1,360,781	6,365,123	268.8	GAMESA G128 4500 128.0 !O! ...	Yes	GAMESA	G128-4,500	4,500	128.0	86.0	2,500	12.0
7	1,357,824	6,364,337	295.1	GAMESA G128 4500 128.0 !O! ...	Yes	GAMESA	G128-4,500	4,500	128.0	86.0	2,500	12.0
8	1,360,623	6,366,042	270.0	GAMESA G128 4500 128.0 !O! ...	Yes	GAMESA	G128-4,500	4,500	128.0	86.0	2,500	12.0
9	1,358,252	6,364,777	306.3	GAMESA G128 4500 128.0 !O! ...	Yes	GAMESA	G128-4,500	4,500	128.0	86.0	2,500	12.0
10	1,361,528	6,364,353	281.5	GAMESA G128 4500 128.0 !O! ...	Yes	GAMESA	G128-4,500	4,500	128.0	86.0	2,500	12.0
11	1,358,871	6,364,586	282.3	GAMESA G128 4500 128.0 !O! ...	Yes	GAMESA	G128-4,500	4,500	128.0	86.0	2,500	12.0
12	1,360,036	6,365,555	270.0	GAMESA G128 4500 128.0 !O! ...	Yes	GAMESA	G128-4,500	4,500	128.0	86.0	2,500	12.0
13	1,361,929	6,364,826	277.9	GAMESA G128 4500 128.0 !O! ...	Yes	GAMESA	G128-4,500	4,500	128.0	86.0	2,500	12.0
14	1,361,607	6,365,395	271.0	GAMESA G128 4500 128.0 !O! ...	Yes	GAMESA	G128-4,500	4,500	128.0	86.0	2,500	12.0
15	1,358,386	6,365,230	293.4	GAMESA G128 4500 128.0 !O! ...	Yes	GAMESA	G128-4,500	4,500	128.0	86.0	2,500	12.0
16	1,359,246	6,364,152	278.0	GAMESA G128 4500 128.0 !O! ...	Yes	GAMESA	G128-4,500	4,500	128.0	86.0	2,500	12.0

Shadow receptor-Input

No.	Name	Swedish RT90 2.5gonV 0:-15-RT90 (SE)				Height a.g.l. [m]	Degrees from south cw [°]	Slope of window [°]	Direction mode
		East	North	Z	Width [m]				
A 1	1,354,439	6,365,935	231.9	5.0	5.0	2.0	0.0	0.0	"Green house mode"
B 2	1,354,303	6,365,863	228.0	5.0	5.0	2.0	0.0	0.0	"Green house mode"
C 3	1,355,719	6,366,777	230.0	5.0	5.0	2.0	0.0	0.0	"Green house mode"
D 4	1,355,823	6,366,785	228.0	5.0	5.0	2.0	0.0	0.0	"Green house mode"
E 5	1,356,247	6,366,773	220.8	5.0	5.0	2.0	0.0	0.0	"Green house mode"
F 6	1,356,082	6,365,087	238.0	5.0	5.0	2.0	0.0	0.0	"Green house mode"

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SHADOW - Main Result

Calculation: 140421 G128 16vkv 86HH

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Swedish RT90 2.5gonV 0:-15-RT90 (SE)

No.	Name	East	North	Z	Width	Height	Height a.g.l.	Degrees from south cw	Slope of window	Direction mode
				[m]	[m]	[m]	[m]	[°]	[°]	
G 7		1,356,579	6,366,515	237.5	5.0	5.0	2.0	0.0	0.0	"Green house mode"
H 8		1,356,602	6,365,151	223.5	5.0	5.0	2.0	0.0	0.0	"Green house mode"
I 9		1,355,989	6,364,921	223.7	5.0	5.0	2.0	0.0	0.0	"Green house mode"
J 10		1,355,455	6,364,908	260.8	5.0	5.0	2.0	0.0	0.0	"Green house mode"
K 11		1,356,610	6,364,688	204.8	5.0	5.0	2.0	0.0	0.0	"Green house mode"
L 12		1,357,661	6,365,318	239.4	5.0	5.0	2.0	0.0	0.0	"Green house mode"
M 13		1,358,186	6,366,173	238.8	5.0	5.0	2.0	0.0	0.0	"Green house mode"
N 14		1,359,151	6,365,788	250.8	5.0	5.0	2.0	0.0	0.0	"Green house mode"
O 18		1,358,766	6,363,488	243.7	5.0	5.0	2.0	0.0	0.0	"Green house mode"
P 19		1,358,001	6,363,183	217.1	5.0	5.0	2.0	0.0	0.0	"Green house mode"
Q 20		1,357,381	6,363,228	204.0	5.0	5.0	2.0	0.0	0.0	"Green house mode"
R 21		1,357,226	6,363,318	206.2	5.0	5.0	2.0	0.0	0.0	"Green house mode"
S 23		1,360,701	6,363,648	259.7	5.0	5.0	2.0	0.0	0.0	"Green house mode"
T 24		1,361,391	6,363,808	280.0	5.0	5.0	2.0	0.0	0.0	"Green house mode"
U 26		1,362,356	6,365,303	284.8	5.0	5.0	2.0	0.0	0.0	"Green house mode"
V 27		1,362,521	6,365,953	278.0	5.0	5.0	2.0	0.0	0.0	"Green house mode"
W 28		1,361,906	6,366,738	260.8	5.0	5.0	2.0	0.0	0.0	"Green house mode"
X 29		1,360,812	6,366,711	272.4	5.0	5.0	2.0	0.0	0.0	"Green house mode"
Y 30		1,360,247	6,366,836	262.8	5.0	5.0	2.0	0.0	0.0	"Green house mode"
Z 31		1,359,762	6,366,416	259.0	5.0	5.0	2.0	0.0	0.0	"Green house mode"
AA 32		1,359,427	6,365,846	262.2	5.0	5.0	2.0	0.0	0.0	"Green house mode"
AB 33		1,353,748	6,365,145	228.1	5.0	5.0	2.0	0.0	0.0	"Green house mode"
AC 35		1,362,402	6,364,363	270.8	5.0	5.0	2.0	0.0	0.0	"Green house mode"
AD 38		1,358,924	6,363,405	248.0	5.0	5.0	2.0	0.0	0.0	"Green house mode"
AE 37		1,362,749	6,365,140	286.0	5.0	5.0	2.0	0.0	0.0	"Green house mode"
AF 36		1,362,389	6,365,360	289.1	5.0	5.0	2.0	0.0	0.0	"Green house mode"
AG 17		1,355,333	6,364,842	245.5	5.0	5.0	2.0	0.0	0.0	"Green house mode"
AH 15		1,359,233	6,363,491	249.6	5.0	5.0	2.0	0.0	0.0	"Green house mode"

Calculation Results

Shadow receptor

No.	Name	Shadow, worst case			Shadow, expected values	
		Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow hours per year [h/year]	
A 1		0:00	0	0:00	0:00	
B 2		0:00	0	0:00	0:00	
C 3		0:00	0	0:00	0:00	
D 4		0:00	0	0:00	0:00	
E 5		0:00	0	0:00	0:00	
F 6		10:35	66	0:16	1:43	
G 7		5:46	37	0:14	0:36	
H 8		27:14	112	0:34	3:59	
I 9		11:17	68	0:16	1:54	
J 10		1:04	11	0:09	0:10	
K 11		34:17	134	0:24	6:25	
L 12		81:01	164	0:41	11:24	
M 13		39:09	89	0:53	3:24	
N 14		72:23	182	0:46	10:28	
O 18		41:21	112	0:33	11:16	
P 19		6:53	32	0:16	1:58	
Q 20		5:38	30	0:16	1:45	
R 21		29:22	82	0:35	8:34	
S 23		2:08	22	0:08	0:36	
T 24		10:05	48	0:22	2:43	
U 26		91:22	202	0:50	14:51	
V 27		29:14	123	0:30	3:43	
W 28		29:03	86	0:32	3:06	

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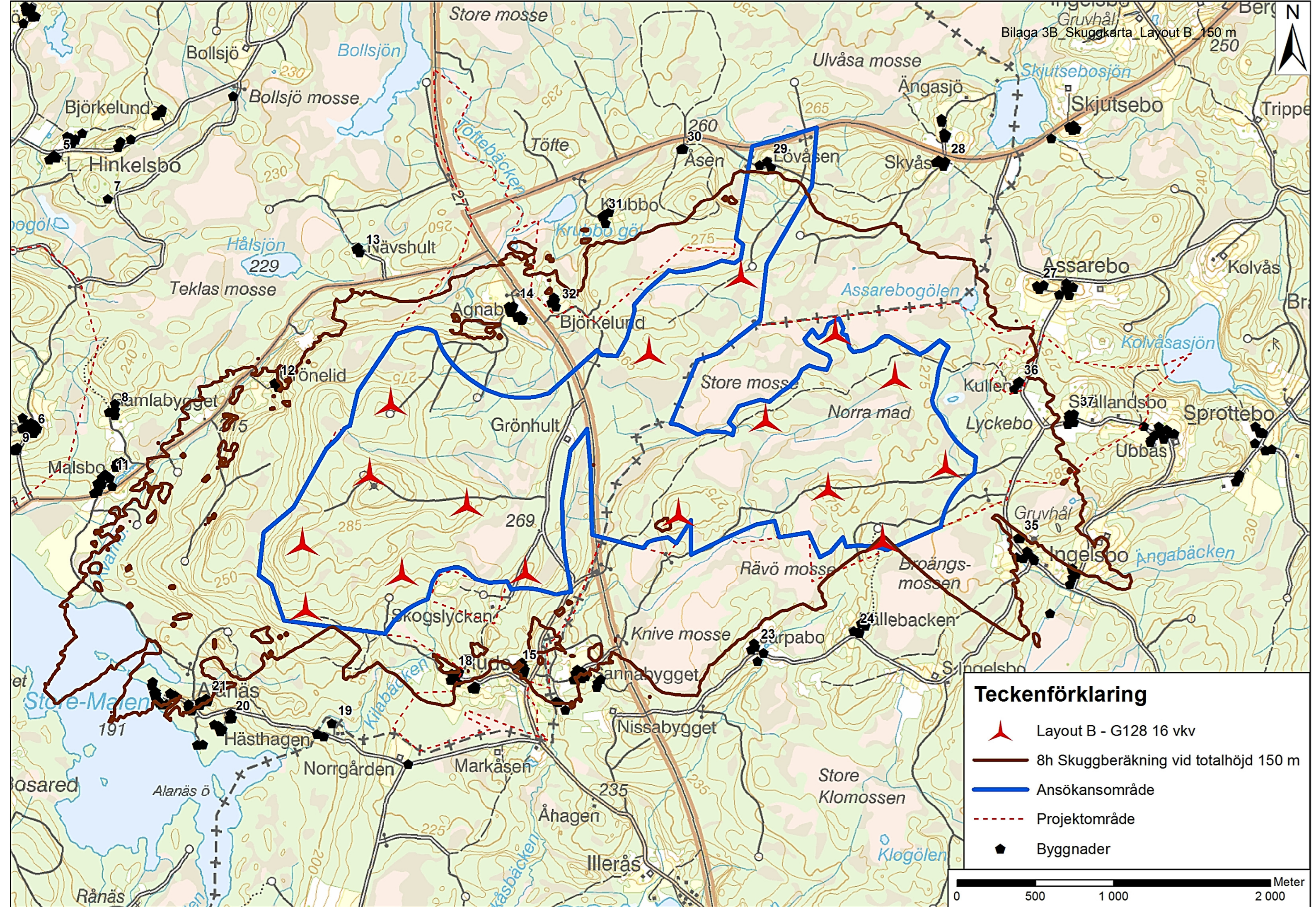
SHADOW - Main Result**Calculation:** 140421 G128 16vkv 86HH

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No.	Name	Shadow, worst case		Max shadow hours per day	Shadow, expected values
		Shadow hours per year [h/year]	Shadow days per year [days/year]		Shadow hours per year [h/year]
X 29		80:07	62	1:53	7:04
Y 30		49:59	80	0:46	4:26
Z 31		59:42	138	0:44	6:14
AA 32		86:21	220	0:45	11:58
AB 33		0:00	0	0:00	0:00
AC 35		35:05	119	0:43	7:53
AD 38		27:49	92	0:27	7:03
AE 37		31:27	118	0:43	5:40
AF 36		77:51	216	0:46	12:03
AG 17		0:00	0	0:00	0:00
AH 15		40:20	128	0:32	10:13

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

No.	Name	Worst case [h/year]	Expected [h/year]
1	GAMESA G128 4500 128.0 !O! hub: 86.0 m (TOT: 150.0 m) (517)	47:01	9:40
2	GAMESA G128 4500 128.0 !O! hub: 86.0 m (TOT: 150.0 m) (518)	46:05	11:28
3	GAMESA G128 4500 128.0 !O! hub: 86.0 m (TOT: 150.0 m) (519)	24:13	4:33
4	GAMESA G128 4500 128.0 !O! hub: 86.0 m (TOT: 150.0 m) (520)	48:40	8:53
5	GAMESA G128 4500 128.0 !O! hub: 86.0 m (TOT: 150.0 m) (521)	62:18	8:07
6	GAMESA G128 4500 128.0 !O! hub: 86.0 m (TOT: 150.0 m) (522)	27:05	3:38
7	GAMESA G128 4500 128.0 !O! hub: 86.0 m (TOT: 150.0 m) (523)	83:22	12:46
8	GAMESA G128 4500 128.0 !O! hub: 86.0 m (TOT: 150.0 m) (524)	114:03	13:17
9	GAMESA G128 4500 128.0 !O! hub: 86.0 m (TOT: 150.0 m) (525)	68:53	9:15
10	GAMESA G128 4500 128.0 !O! hub: 86.0 m (TOT: 150.0 m) (526)	40:54	7:05
11	GAMESA G128 4500 128.0 !O! hub: 86.0 m (TOT: 150.0 m) (527)	18:02	3:15
12	GAMESA G128 4500 128.0 !O! hub: 86.0 m (TOT: 150.0 m) (528)	94:31	11:24
13	GAMESA G128 4500 128.0 !O! hub: 86.0 m (TOT: 150.0 m) (529)	89:14	11:17
14	GAMESA G128 4500 128.0 !O! hub: 86.0 m (TOT: 150.0 m) (530)	62:57	11:22
15	GAMESA G128 4500 128.0 !O! hub: 86.0 m (TOT: 150.0 m) (531)	110:10	17:25
16	GAMESA G128 4500 128.0 !O! hub: 86.0 m (TOT: 150.0 m) (532)	17:51	5:08



Teckenförklaring

-  Layout B - G128 16 kv
-  8h Skuggberäkning vid totalhöjd 150 m
-  Ansökansområde
-  Projektområde
-  Byggnader

0 500 1000 2000 Meter

Bilaga 3B - Skuggor

Layout B

16 st Gamesa G128, 4,5 MW

Totalhöjd 200 meter

Project:

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SHADOW - Main Result

Calculation: 140421 G128 16vkv 136HH

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) [VAXJO /KRONOBER G]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.36	1.52	2.62	6.08	8.82	7.64	6.65	5.42	4.02	2.68	1.38	0.88

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

140330_GrönhultMast_LT_7.14_ERA

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
416	404	503	593	623	623	645	938	1,309	1,424	715	463	8,656

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: 120531_GH2mCont_2mScan_5mTop

Obstacles not used in calculation

Eye height: 1.5 m

Grid resolution: 10.0 m

WTGs

	Swedish RT90 2.5gonV 0:-15-RT90 (SE)				WTG type			Shadow data				
	East	North	Z	Row data/Description	Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Calculation distance [m]	RPM [RPM]
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Swedish RT90 2.5gonV 0:-15-RT90 (SE)

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		[m]	[m]	[m]	[m]	[m]	[m]	[°]	[°]	
G 7		1,356,579	6,366,515	237.5	5.0	5.0	2.0	0.0	0.0	"Green house mode"
H 8		1,356,602	6,365,151	223.5	5.0	5.0	2.0	0.0	0.0	"Green house mode"
I 9		1,355,989	6,364,921	223.7	5.0	5.0	2.0	0.0	0.0	"Green house mode"
J 10		1,355,455	6,364,908	260.8	5.0	5.0	2.0	0.0	0.0	"Green house mode"
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M 13		1,358,186	6,366,173	238.8	5.0	5.0	2.0	0.0	0.0	"Green house mode"
N 14		1,359,151	6,365,788	250.8	5.0	5.0	2.0	0.0	0.0	"Green house mode"
O 18		1,358,766	6,363,488	243.7	5.0	5.0	2.0	0.0	0.0	"Green house mode"
P 19		1,358,001	6,363,183	217.1	5.0	5.0	2.0	0.0	0.0	"Green house mode"
Q 20		1,357,381	6,363,228	204.0	5.0	5.0	2.0	0.0	0.0	"Green house mode"
R 21		1,357,226	6,363,318	206.2	5.0	5.0	2.0	0.0	0.0	"Green house mode"
S 23		1,360,701	6,363,648	259.7	5.0	5.0	2.0	0.0	0.0	"Green house mode"
T 24		1,361,391	6,363,808	280.0	5.0	5.0	2.0	0.0	0.0	"Green house mode"
U 26		1,362,356	6,365,303	284.8	5.0	5.0	2.0	0.0	0.0	"Green house mode"
V 27		1,362,521	6,365,953	278.0	5.0	5.0	2.0	0.0	0.0	"Green house mode"
W 28		1,361,906	6,366,738	260.8	5.0	5.0	2.0	0.0	0.0	"Green house mode"
X 29		1,360,812	6,366,711	272.4	5.0	5.0	2.0	0.0	0.0	"Green house mode"
Y 30		1,360,247	6,366,836	262.8	5.0	5.0	2.0	0.0	0.0	"Green house mode"
Z 31		1,359,762	6,366,416	259.0	5.0	5.0	2.0	0.0	0.0	"Green house mode"
AA 32		1,359,427	6,365,846	262.2	5.0	5.0	2.0	0.0	0.0	"Green house mode"
AB 33		1,353,748	6,365,145	228.1	5.0	5.0	2.0	0.0	0.0	"Green house mode"
AC 35		1,362,402	6,364,363	270.8	5.0	5.0	2.0	0.0	0.0	"Green house mode"
AD 38		1,358,924	6,363,405	248.0	5.0	5.0	2.0	0.0	0.0	"Green house mode"
AE 37		1,362,749	6,365,140	286.0	5.0	5.0	2.0	0.0	0.0	"Green house mode"
AF 36		1,362,389	6,365,360	289.1	5.0	5.0	2.0	0.0	0.0	"Green house mode"
AG 17		1,355,333	6,364,842	245.5	5.0	5.0	2.0	0.0	0.0	"Green house mode"
AH 15		1,359,233	6,363,491	249.6	5.0	5.0	2.0	0.0	0.0	"Green house mode"

Calculation Results

Shadow receptor

No.	Name	Shadow, worst case			Shadow, expected values	
		Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow hours per year [h/year]	
A 1		0:00	0	0:00	0:00	
B 2		0:00	0	0:00	0:00	
C 3		0:00	0	0:00	0:00	
D 4		0:00	0	0:00	0:00	
E 5		0:00	0	0:00	0:00	
F 6		14:03	73	0:16	2:22	
G 7		7:31	42	0:14	0:49	
H 8		30:15	111	0:36	4:30	
I 9		13:45	76	0:16	2:28	
J 10		2:14	15	0:13	0:21	
K 11		35:47	136	0:27	7:06	
L 12		104:05	184	0:55	14:43	
M 13		78:07	120	1:20	7:07	
N 14		106:20	221	0:45	14:46	
O 18		42:12	96	0:34	11:48	
P 19		0:00	0	0:00	0:00	
Q 20		6:54	35	0:16	2:12	
R 21		14:31	63	0:19	4:21	
S 23		8:07	30	0:21	2:03	
T 24		20:45	79	0:24	5:33	
U 26		118:05	204	1:06	21:43	
V 27		65:53	172	0:44	8:24	
W 28		44:27	117	0:35	5:03	

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Project:

Grönhult

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Licensed user:

VATTENFALL AB IT

Företagsenhet 1002

SE-962 80 Jokkmokk

Jenny Longworth / jenny.longworth@vattenfall.com

Calculated:

2014-05-27 21:55/2.9.269

SHADOW - Main Result

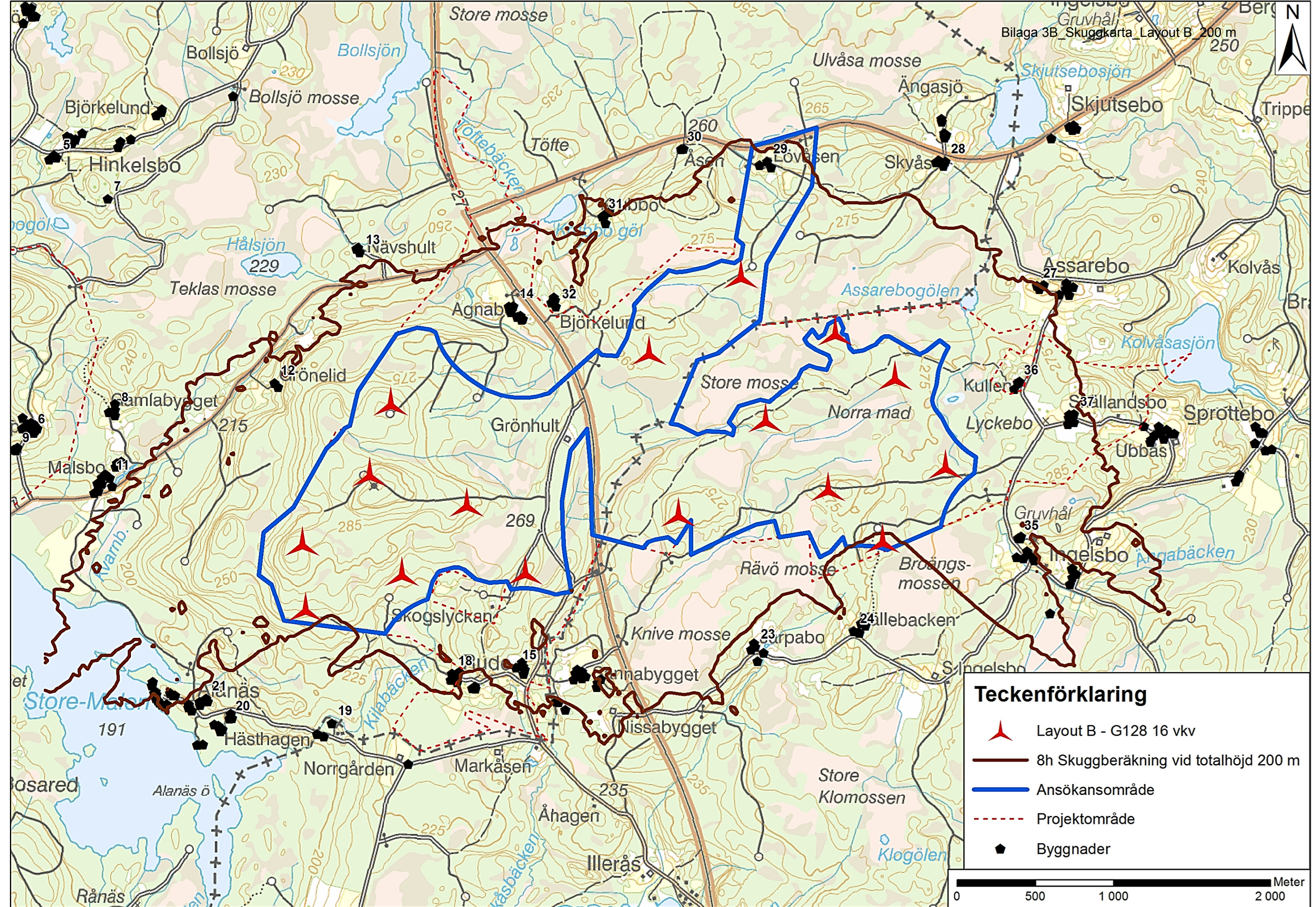
Calculation: 140421 G128 16vkv 136HH

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No.	Name	Shadow, worst case		Max shadow hours per day	Shadow, expected values
		Shadow hours per year [h/year]	Shadow days per year [days/year]		Shadow hours per year [h/year]
X 29		132:02	92	2:00	12:34
Y 30		62:48	92	1:18	5:57
Z 31		89:23	165	1:12	9:40
AA 32		124:54	236	0:57	17:29
AB 33		0:00	0	0:00	0:00
AC 35		41:03	115	0:46	10:05
AD 38		19:45	67	0:27	5:30
AE 37		54:12	138	0:51	10:33
AF 36		104:02	199	0:57	18:29
AG 17		0:00	0	0:00	0:00
AH 15		36:03	115	0:35	9:48

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

No.	Name	Worst case [h/year]	Expected [h/year]
1	GAMESA G128 4500 128.0 !O! hub: 136.0 m (TOT: 200.0 m) (400)	80:48	15:44
2	GAMESA G128 4500 128.0 !O! hub: 136.0 m (TOT: 200.0 m) (401)	40:44	6:54
3	GAMESA G128 4500 128.0 !O! hub: 136.0 m (TOT: 200.0 m) (403)	50:38	9:05
4	GAMESA G128 4500 128.0 !O! hub: 136.0 m (TOT: 200.0 m) (404)	61:51	11:46
5	GAMESA G128 4500 128.0 !O! hub: 136.0 m (TOT: 200.0 m) (405)	105:28	14:54
6	GAMESA G128 4500 128.0 !O! hub: 136.0 m (TOT: 200.0 m) (406)	52:08	7:38
7	GAMESA G128 4500 128.0 !O! hub: 136.0 m (TOT: 200.0 m) (407)	89:37	12:45
8	GAMESA G128 4500 128.0 !O! hub: 136.0 m (TOT: 200.0 m) (408)	155:44	20:07
9	GAMESA G128 4500 128.0 !O! hub: 136.0 m (TOT: 200.0 m) (410)	82:17	10:44
10	GAMESA G128 4500 128.0 !O! hub: 136.0 m (TOT: 200.0 m) (411)	59:51	9:57
11	GAMESA G128 4500 128.0 !O! hub: 136.0 m (TOT: 200.0 m) (412)	52:01	5:10
12	GAMESA G128 4500 128.0 !O! hub: 136.0 m (TOT: 200.0 m) (512)	124:03	15:32
13	GAMESA G128 4500 128.0 !O! hub: 136.0 m (TOT: 200.0 m) (513)	101:35	12:47
14	GAMESA G128 4500 128.0 !O! hub: 136.0 m (TOT: 200.0 m) (514)	100:05	18:42
15	GAMESA G128 4500 128.0 !O! hub: 136.0 m (TOT: 200.0 m) (515)	122:24	20:26
16	GAMESA G128 4500 128.0 !O! hub: 136.0 m (TOT: 200.0 m) (516)	29:28	6:55



Teckenförklaring

-  Layout B - G128 16 kv
-  8h Skuggberäkning vid totalhöjd 200 m
-  Ansökansområde
-  Projektområde
-  Byggnader

0 500 1000 2000 Meter