Vastaanottaja
Prokon Wind Energy Finland Oy

Asiakirjatyyppi
Raportti

Päivämäärä
17.10.2022

Viite
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VARSAVAARAN TUULIVOIMAHANKE

VÄLKEMALLINNUS

RAMBOLL

TUULIVOIMAHANKE
VÄLKEMALLINNUS

Päivämäärä	17.10.2022
Laatija	Ville Virtanen
Tarkastaja	Jari Hosiokangas

Sisältää Maanmittauslaitoksen Maastotietokannan 12/2019 aineistoa.

Viite 1510064983-004

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1. YLEISTÄ

Prokon Wind Energy Finland Oy suunnittelee tuulivoima-alueen rakentamista Varsavaaran alueelle Paltamoon. Tässä selvityksessä tutkittiin Varsavaaran kahden vaihtoehdon tuulivoimalaitosten aiheuttamat välkevaikutukset, sekä yhteisvaikutukset yhdessä Hietavaaran ja Hukkalansalon tuulivoima-alueiden kanssa ympäristössä ympäristönvaikutusten arviointia varten. Ympäristöministeriön Tuulivoimarakentamisen suunnittelu (Ympäristöhallinnon ohjeita 5/2016) oppaan mukaisesti liikkuvasta varjosta puhutaan välkkeenä.

Työ on tehty Prokon Wind Energy Finland Oy:n toimeksiannosta. Välkeselvityksestä ja välkevaikutusten arvioinnista on vastannut ins.(AMK) Ville Virtanen.

2. VERTAILUARVOT

Tuulivoimaloista aiheutuvalle välkkeelle ei ole määritelty Suomessa raja- tai ohjearvoja. Ympäristöministeriön julkistamassa Tuulivoimarakentamisen suunnittelu (Ympäristöhallinnon ohjeita 5/2016) oppaassa suositellaan käyttämään apuna muiden maiden suosituksia välkkeen rajoittamisesta. [1]

Eri maissa on annettu suunnitteluarvoja tai raja-arvoja välkkeen määrälle asutukselle tai muille altistuville kohteille. Saksassa on annettu ohjeistus (WEA-Schattenwurf-Hinweise) mallintamiseen sekä raja-arvot maksimivälketilanteessa sekä todellisessa tilanteessa [2]. Ruotsalaisessa suunnitteluohjeistuksessa viitataan saksalaiseen ohjeistukseen ja suositukset perustuvat pitkälti saksalaiseen ohjeistukseen [3]. Tanskassa on ohjeistuksena annettu, että vuotuinen todellinen välkemäärä tulee rajoittaa kymmeneen tuntiin vuodessa [4].

Taulukko 1. Esimerkkejä muiden maiden suosituksista ja raja-arvoista välkkeen esiintymisen osalta

Maa	Real Case	Worst Case
Saksa	8 tuntia/vuosi	30 tuntia/vuosi 30 min/päivä
Ruotsi	8 tuntia/vuosi 30 min/päivä	-
Tanska	10 tuntia/vuosi	-

3. VAIKUTUSMEKANISMIT

Toiminnassa olevat tuulivoimalat voivat aiheuttaa liikkuvaa varjoa eli välkettä ympäristöönsä, kun auringon säteet suuntautuvat tuulivoimalan lapojen takaa tiettyyn katselupisteeseen. Tällöin roottorin lapojen pyöriminen aiheuttaa liikkuvan varjon ja varjojen liikkumisnopeus riippuu roottorin pyörimisnopeudesta.

Välkevaikutus syntyy sääolojen, vuodenajan ja vuorokauden ajan mukaan, joten välkettä on havaittavissa tietyssä katselupisteessä vain tiettyjen valaistusolosuhteiden täyttyessä ja tiettyinä aikoina vuorokaudesta ja vuodesta. Välkettä ei esiinny, kun aurinko on pilvessä tai kun tuulivoimala ei ole käynnissä, tai auringon asema on välkkeen muodostumiselle epäedullinen. Myös tuulen suunnalla on vaikutusta varjon muodostukselle. Poikittain aurinkoon oleva voimala aiheuttaa erilaisen varjon kuin kohtisuoraan aurinkoon suuntautunut voimala.

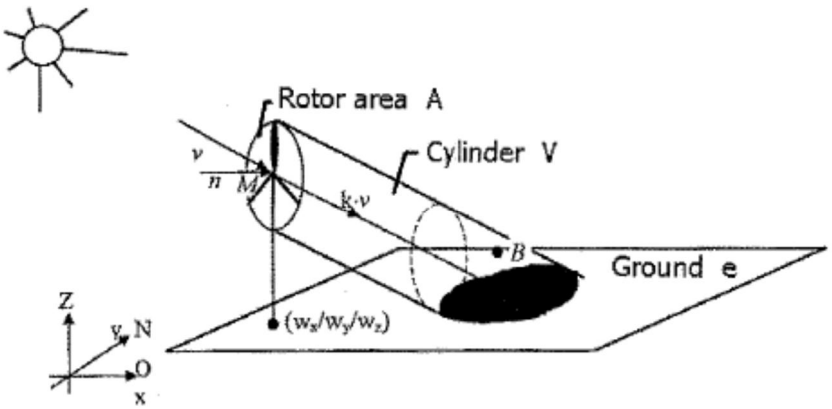
Laajimmalle varjo ulottuu, kun aurinko on matalalla. Toisaalta kun aurinko laskee riittävän matalalle, yhtenäistä varjoa ei enää muodostu. Tällöin valonsäteet joutuvat kulkemaan pitemmän matkan ilmakehän läpi, jolloin säteily hajaantuu. Vaikutusalueen koko riippuu tuulivoimalamallin dimensioista ja lavan muodosta sekä alueellisista sääolosuhteista sekä maasto-olosuhteista (metsä, mäki jne.).

4. MALLINNUSMENETELMÄ JA LÄHTÖTIEDOT

4.1 Mallinnusohjelma ja laskentamalli

Tuulivoimaloiden aiheuttaman välkkeen esiintymisalue ja esiintymistiheys laskettiin EMD WindPRO 3.4 -ohjelman Shadow -moduulilla, joka laskee kuinka usein ja minkälaisina jaksoina tietty kohde on tuulivoimaloiden luoman liikkuvan varjon alaisena. Ohjelma on yleisesti käytössä tuulivoimaloiden aiheuttaman välkkeen mallinnuksessa. Lisätietoja ohjelmasta ja laskentamallin kuvauksen saa internet-osoitteesta *http://www.emd.dk/* löytyvästä ohjelman käyttöohjeesta [5].

Ohjelmalla voidaan tehdä kahdentyyppisiä laskentoja, ns. Pahin tilanne (*Worst Case)*- ja Todellinen tilanne (*Real Case)* -laskelmia. Välkevyöhykekartan lisäksi ohjelmalla voidaan laskea yksittäisiin reseptoripisteisiin kohdistuvaa välkevaikutusta.



Kuva 1. Tuulivoimalan aiheuttaman liikkuvan varjon alue [5]

4.2 Välkelaskenta

Laskentapisteiden väliseksi etäisyydeksi määritettiin 20 metriä. Laskennan tarkastelukorkeutena käytettiin 1,5 metriä, eli noin ihmisen silmänkorkeutta. Laskennassa käytetyn saksalaisen ohjeistuksen (joka on yleisesti käytössä oleva laskentatapa) mukaan välkevaikutusta laskettaessa auringonpaistekulman raja horisontista on kolme astetta, jonka alle menevää auringon säteilyä ei oteta huomioon ja laskennassa roottorin lavan tulee peittää vähintään 20 % auringosta [2].

Mallinnuksissa ei huomioida puuston ja rakennusten aiheuttamaa peittovaikutusta, jotka voivat rajoittaa merkittävästi välkkeen esiintyvyyttä maanpinnan tasolla.

Worst Case –laskenta antaa teoreettisen maksimivälkemäärän. Laskenta olettaa auringon paistavan koko ajan (auringonnoususta auringonlaskuun) ja tuulivoimaloiden oletetaan käyvän koko ajan sekä tuulen suunnan seuraavan aurinkoa siten, että välkettä syntyy tarkastelupisteeseen aina maksimaalinen määrä. Worst Case -laskennan vuosiarvot eivät siten vastaa tulevaa todellista vuosittaista välkevaikutusta tuulivoimaloiden ympäristössä.

Real Case -laskennoissa huomioidaan alueen tuulisuus- ja auringonpaistetiedot. Worst case -tuloksista tehdään vähennykset auringonpaistetietoihin ja käyttötuntitietoihin (tuulensuunta sektoreittain) perustuen, josta saadaan Real case -tulos. Auringonpaisteisuustietona käytettiin Ilmatieteen laitoksen Oulun lentoaseman Oulunsalon sääaseman keskiarvoisia auringonpaisteisuustietoja ilmastolliselta vertailukaudelta 1981–2010 [6]. Tuulivoimaloiden vuotuiseksi toiminta-ajaksi määritettiin Suomen Tuuliatlaksen tiedoista 96 %. Toiminta-ajat laskettiin 12 suuntasektorille olettaen, että tuulivoimalat toimivat tuulennopeuden ollessa napakorkeudella yli 3 m/s.

Taulukko 2 Real Case -laskennassa käytetyt keskimääräiset auringonpaisteisuustunnit eri kuukausina (tuntia päivässä)

Tam	Hel	Maa	Huh	Tou	Kes	Hei	Elo	Syy	Lok	Mar	Jou
0,77	2,46	4,42	6,93	8,81	9,87	9,13	6,84	4,43	2,23	0,93	0,26

Taulukko 3. Real Case -laskennassa käytetty vuotuinen toiminnallinen aika (tuntia vuodessa) tuulensuuntasektoreittain

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
505	346	395	547	622	672	916	1097	1009	967	708	648	8432

Real Case -välkevyöhykelaskennan lisäksi laskentoja tehtiin myös yksittäisiin reseptoripisteisiin hankealueen ympäristössä.

4.3 Maastomalli

Maastomalli on laadittu Maanmittauslaitoksen maastotietokannan aineistosta. Maastomallissa ei huomioitu puustoa tai rakennuksia.

4.4 Tuulivoimalatiedot

Laskennoissa huomioitiin Varsavaaran osalta 21 tuulivoimalaa vaihtoehdossa VE 1 ja 7 voimalaa vaihtoehdossa VE2 taulukon 4 mukaisilla sijainneilla.

Mallinnus tehtiin käyttäen napakorkeutta 200 mpy ja roottorin halkaisijaa 200 metriä. Roottorikoon ja napakorkeuden lisäksi myös lavan muoto ja leveys vaikuttavat maksimivälke-etäisyyteen, joka mallinnusohjelman mukaan on tälle laitosmallille noin 2240 metriä. Lavan leveystiedot ekstrapoloitiin 200 m roottorin halkaisijan pohjalta:

- Max blade width = 4,50 m
- Blade width for 90 % radius = 2,1 m

Taulukko 4. Tuulivoimalaitosten koordinaatit (ETRS-TM35FIN)

Tunnus	X	Y	Napakorkeus	Kok.-korkeus	Vaihtoehto
VV01	541971	7160969	200	300	VE1/VE2
VV02	543249	7160670	200	300	VE1/VE2
VV03	543865	7160308	200	300	VE1
VV04	544525	7159955	200	300	VE1
VV05	541467	7160508	200	300	VE1/VE2
VV06	542585	7160341	200	300	VE1/VE2
VV07	543049	7159835	200	300	VE1/VE2
VV08	541169	7159837	200	300	VE1/VE2
VV09	541941	7159916	200	300	VE1/VE2
VV10	540703	7158502	200	300	VE1
VV11	541423	7158417	200	300	VE1
VV12	542175	7158498	200	300	VE1
VV13	543529	7158779	200	300	VE1
VV14	539316	7156847	200	300	VE1
VV15	540144	7157334	200	300	VE1
VV16	539898	7155824	200	300	VE1
VV17	540656	7156069	200	300	VE1
VV18	540500	7155359	200	300	VE1
VV19	541617	7154933	200	300	VE1
VV20	541169	7159837	200	300	VE1
VV21	541635	7153995	200	300	VE1

4.5 Laskentojen epävarmuus

Koska Worst Case -laskenta perustuu auringon asemaan suhteessa tuulivoimalaitokseen ja tarkastelupisteeseen, voidaan laskennan tarkkuutta pitää hyvinkin luotettavana, kun määritetään välkkeen mahdollisia esiintymisajankohtia. Kun tarkoituksena on ennustaa todellista välkkeen esiintyvyyttä alueella vuoden aikana, ei Worst Case -mallinnus vastaa todellisuutta.

Real Case –mallinnuksessa käytetään keskimääräisiä auringonpaisteisuustietoja ja Tuuliatlaksen mukaan määritettyjä tuulen suuntien toiminnallisia aikoja. Mallinnuksen mukainen Real case -tulos kuvaa tavanomaisen vuoden tilannetta. Välkevaikutusten todellinen tilanne siis vaihtelee eri vuosina, koska välkkeen esiintyminen tietyssä katselupisteessä tietyllä hetkellä edellyttää, että

- aurinko paistaa tuulivoimalaitosten roottorin takaa tarkastelupisteeseen
- tuulivoimala pyörii ja tuulivoimalan roottorin asento mahdollistaa liikkuvan varjon syntymisen takana olevaan tarkastelupisteeseen
- ilman kirkkaus mahdollistaa varjon syntymisen

Real Case -mallinnuksessa tuotetaan paras mahdollinen ennuste tulevasta välketilanteesta alueella. Mallissa ei kuitenkaan huomioida rakennusten ja puuston peitevaikutusta. Jos tuulivoimalat eivät ole nähtävissä, eivät ne myöskään aiheuta välkevaikutuksia.

5. MALLINNUSTULOKSET

Varsavaaran tuulivoimahankkeen välkkeen esiintymiskartat on esitetty liitteessä 1. Välkevyöhykelaskennan lisäksi tehtiin laskentoja 29 reseptoripisteeseen, joiden sijainnit on esitetty liitteenä olevissa välkekartoissa ja tulokset taulukossa 5.

Vuotuinen välketuntien määrä ylittää vaihtoehdossa VE1 8 h (rajana Saksassa ja Ruotsissa) kuuden reseptoripisteen kohdalla ja vaihtoehdossa VE2 yhden reseptoripisteen kohdalla. Puusto huomioituna 8 h ylittyy vaihtoehdossa VE1 yhden reseptoripisteen kohdalla, vaihtoehdossa VE2 8 h ei ylity yhdenkään reseptoripisteen osalta.

Taulukko 5. Reseptoripistelaskentojen tulokset ilman puustoa ja puusto huomioituna

Reseptori	Varsavaara VE1	Varsavaara VE1, puusto	Varsavaara VE2	Varsavaara VE2, puusto	Muut
	Real Case, h/a*	Real Case, h/a*	Real Case, h/a*	Real Case, h/a*	Real Case, h/a*
1	3:22	0:00	3:22	0:00	27:49
2	0:00	0:00	0:00	0:00	26:23
3	0:00	0:00	0:00	0:00	4:07
4	4:04	1:37	2:27	0:00	6:54
5	6:10	2:26	2:26	2:26	0:00
6	6:21	2:38	0:00	0:00	0:00
7	7:43	0:00	0:00	0:00	0:00
8	0:00	0:00	0:00	0:00	0:00
9	4:07	0:00	0:00	0:00	0:00
10	5:13	0:00	0:00	0:00	0:00
11	7:20	0:00	0:00	0:00	0:00
12	6:46	0:00	0:00	0:00	0:00
13	7:04	0:00	0:00	0:00	0:00
14	2:58	0:00	0:00	0:00	0:00
15	6:41	6:41	0:00	0:00	0:00
16	8:18	0:00	0:00	0:00	0:00
17	8:14	3:28	0:00	0:00	0:00
18	8:37	0:00	0:00	0:00	0:00
19	4:51	0:00	0:00	0:00	0:00
20	6:09	0:00	0:00	0:00	0:00
21	7:38	0:00	0:00	0:00	0:00
22	6:48	0:00	0:00	0:00	0:00
23	56:56	30:26	4:38	0:00	0:00
24	2:41	0:00	0:00	0:00	0:00
25	3:55	0:00	0:00	0:00	0:00
26	7:56	5:20	2:36	0:00	0:00
27	17:00	3:21	14:46	3:21	13:46
28	6:04	1:36	4:53	1:36	13:25
29	52:35	6:03	0:00	0:00	0:00

*tuntia vuodessa

Yhteisvaikutusten osalta 8 h ylittyy useiden loma- ja asuinrakennusten kohdalla. Puusto huomioituna 8 h ylittyy vaihtoehdossa VE1 kahden reseptoripisteen osalta ja vaihtoehdossa VE2 yhden reseptoripisteen kohdalla.

Taulukko 6. Reseptoripistelaskentojen tulokset ilman puustoa ja puusto huomioituna yhteismallinnuksissa

Reseptori	Yhteismallinnus VE1	Yhteismallinnus VE1, puusto	Yhteismallinnus VE2	Yhteismallinnus VE2, puusto
	Real Case, h/a*	Real Case, h/a*	Real Case, h/a*	Real Case, h/a*
1	30:47	5:00	30:47	5:00
2	26:23	6:50	26:23	6:50
3	4:07	0:00	4:07	0:00
4	10:57	1:37	9:21	0:00
5	6:10	2:26	2:26	2:26
6	6:21	2:38	0:00	0:00
7	7:43	0:00	0:00	0:00
8	0:00	0:00	0:00	0:00
9	4:07	0:00	0:00	0:00
10	5:13	0:00	0:00	0:00
11	7:20	0:00	0:00	0:00
12	6:46	0:00	0:00	0:00
13	7:04	0:00	0:00	0:00
14	2:58	0:00	0:00	0:00
15	6:41	6:41	0:00	0:00
16	8:18	0:00	0:00	0:00
17	8:14	3:28	0:00	0:00
18	8:37	0:00	0:00	0:00
19	4:51	0:00	0:00	0:00
20	6:09	0:00	0:00	0:00
21	7:38	0:00	0:00	0:00
22	6:48	0:00	0:00	0:00
23	56:56	30:26	4:38	0:00
24	2:41	0:00	0:00	0:00
25	3:55	0:00	0:00	0:00
26	7:56	5:20	2:36	0:00
27	30:49	3:21	28:35	3:21
28	19:31	15:01	18:22	15:01
29	52:35	6:03	0:00	0:00

Potentiaaliset välkkeen esiintymisajankohdat reseptoreissa on esitetty liitteessä 2.

6. YHTEENVETO JA JOHTOPÄÄTÖKSET

Mallinnuksella tarkasteltiin Varsavaaran alueelle Paltamoon suunniteltujen tuulivoimaloiden välkevaikutuksia tuulivoimaloiden ympäristössä. Mallinnus tehtiin kahdessa vaihtoehdossa yksin ja yhdessä lähimpien tuulivoima-alueiden kanssa ympäristönvaikutusten arviointia varten ilman puustoa ja puusto huomioituna.

Suomen säädöksissä ei ole määritetty sitovia ohje- tai raja-arvoja tuulivoimaloiden aiheuttamalle välkkeelle. Mallinnuksen mukaan vuotuinen välketuntien määrä ylittää vaihtoehdossa VE1 8 h (rajana Saksassa ja Ruotsissa) kuuden reseptoripisteen kohdalla ja vaihtoehdossa VE2 yhden reseptoripisteen kohdalla. Puusto huomioituna 8 h ylittyy vaihtoehdossa VE1 yhden reseptoripisteen kohdalla, vaihtoehdossa VE2 8 h ei ylity yhdenkään reseptoripisteen osalta.

Yhteisvaikutusten osalta 8 h ylittyy useiden loma- ja asuinrakennusten kohdalla. Ylitykset aiheutuvat pääasiassa Hietavaaran ja Hukkalansalon tuulivoimaloista. Reseptoripisteen 4 osalta 8 h ei ylity ainoastaan Varsavaaran taikka alueen muiden voimaloiden takia, vaan ylitys ilmenee vasta yhteisvaikutus huomioituna molemmassa Varsavaaran vaihtoehdossa. Puusto huomioituna 8 h

ylittyy vaihtoehdossa VE1 kahden reseptoripisteen osalta ja vaihtoehdossa VE2 yhden reseptoripisteen kohdalla.

Mallinnus antaa laskennallisen tuloksen ympäristöön kohdistuvasta välkevaikutuksesta. Vuosittaiseen todelliseen välkevaikutukseen vaikuttaa, kuinka tarkkaan vuosittainen tuulivoimaloiden toiminta ja sääolosuhteet vastaavat mallinnuksessa käytettyjä arvoja, sekä lisäksi muun muassa voimaloiden näkyminen tai näkymisen estyminen esimerkiksi puuston tai rakennusten vuoksi. Puustoa tai ympäristön asuin- ja lomarakennuksia ei ole huomioitu mallissa. Puuston on kuitenkin oltava riittävän tiheää ja korkeata sekä suojata altistuvaa kohdetta kattavasti. Myös vuodenajan vaihtelut on huomioitava puuston kyvyssä rajoittaa tuulivoimaloiden näkyvyyttä. Jos tuulivoimalat eivät näy häiriintyvään kohteeseen, ei myöskään välkettä aiheudu.

Välkkeen syntyyn voidaan vaikuttaa tuulivoimalaan liitettävällä teknisellä ohjauksella, jolla tuulivoimala pysäytetään tarvittaessa. Järjestelmän avulla välkkeen muodostumista tietyssä kohteessa monitoroidaan voimalan nasellin päälle tai runkoon asennettavilla valosensoreilla, jotka laskevat muodostumisen mahdollisuutta tietyssä suunnassa valoisuuden ja roottorin asennon mukaan.

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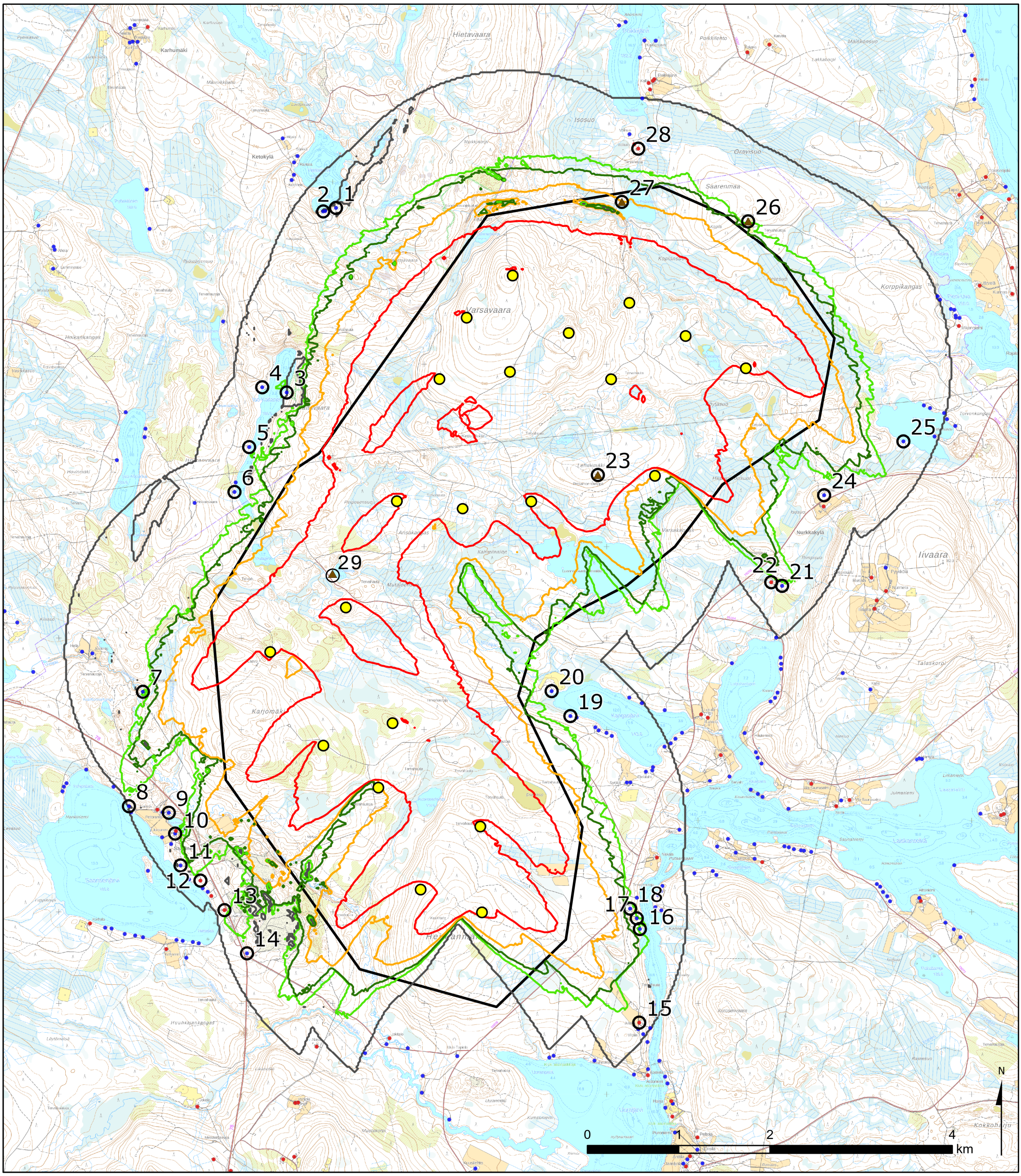
7. Suomen Tuuliatlas

LIITTEET

Liite 1 Real Case -laskennan välkevyöhykkeet ilman puustoa ja puusto huomioituna
Liite 2 Kalenterit välkkeen mahdollisen esiintymisen ajankohdista reseptoripisteissä



RAMBOLL

PROKON Wind Energy Finland Oy
Varsavaaran tuulivoimapuisto

Välkemallinnus (WindPro)

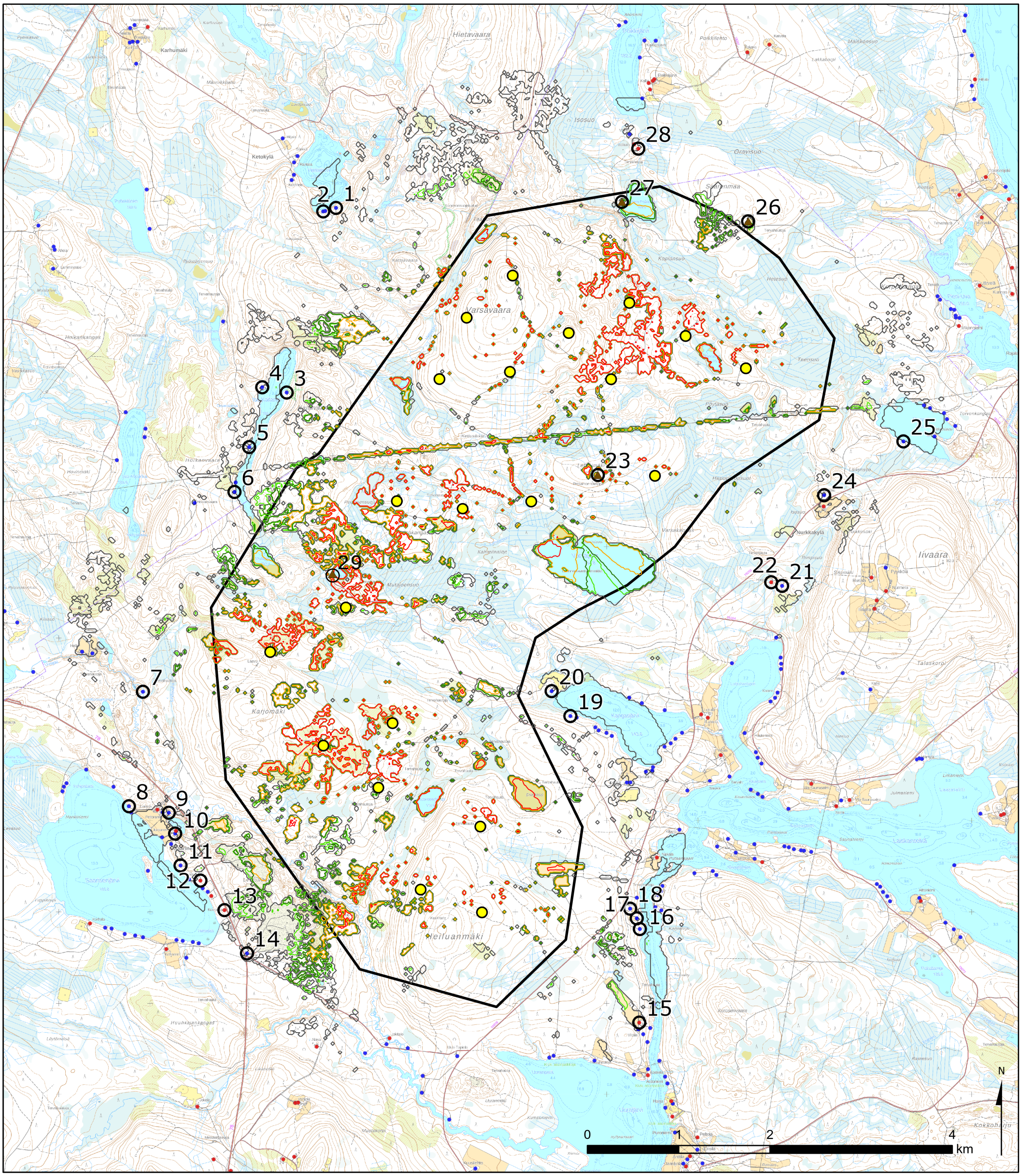
Varsavaara VE1

13.10.2022

Real Case
välkevyöhykkeet
tuntia vuodessa

- 0
- 8
- 10
- 15
- 30

- Tuulivoimala, Varsavaara
- Asuinrakennus
- Lomarakennus
- Kiinteistöjen käyttötarkoitus selvitetään kaavoituksen yhteydessä
- Reseptorit
- Varsavaaran hankealue



RAMBOLL

PROKON Wind Energy Finland Oy
Varsavaaran tuulivoimapuisto

Välkemallinnus (WindPro)
Puusto huomioitu

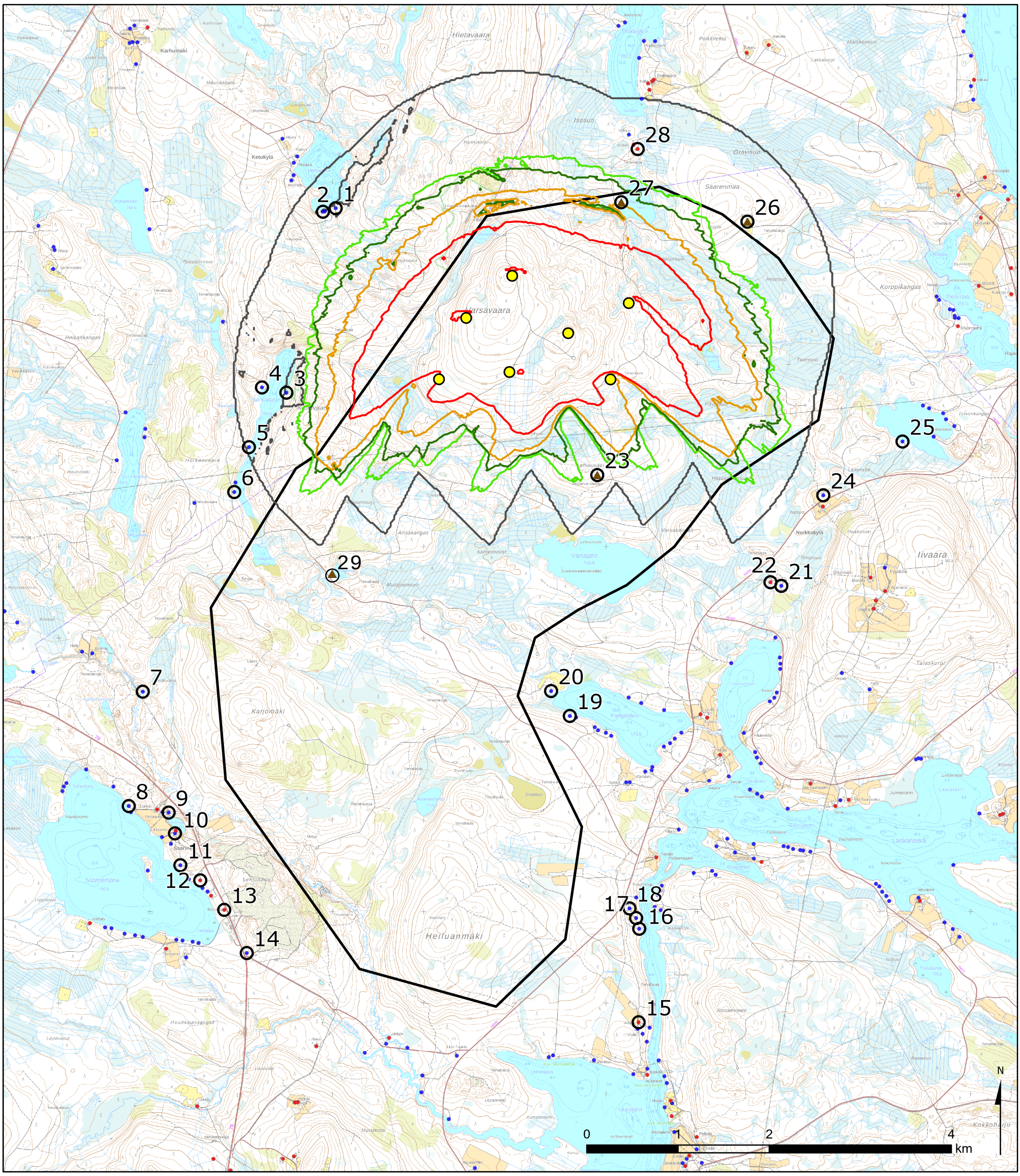
Varsavaara VE1

20.10.2022

Real Case
välkevyöhykkeet
tuntia vuodessa

- 0
- 8
- 10
- 15
- 30

- Tuulivoimala, Varsavaara
- Asuinrakennus
- Lomarakennus
- Kiinteistöjen käyttötarkoitus selvitetään kaavoituksen yhteydessä
- Reseptorit
- Varsavaaran hankealue



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PROKON Wind Energy Finland Oy
Varsavaaran tuulivoimapuisto

Välkemallinnus (WindPro)

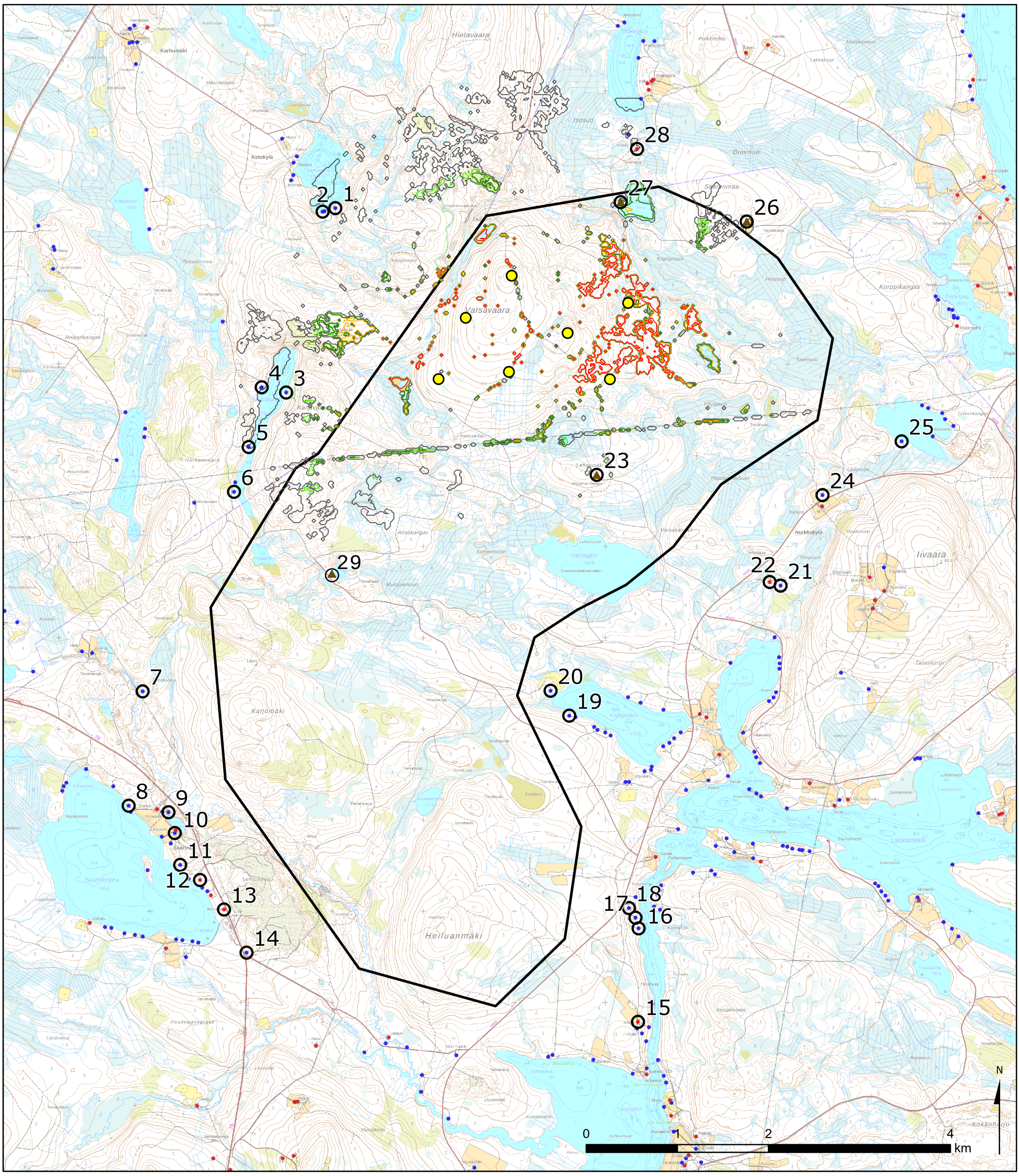
Varsavaara VE2

13.10.2022

Real Case
välkevyöhykkeet
tuntia vuodessa

- 0
- 8
- 10
- 15
- 30

- Tuulivoimala, Varsavaara VE2
- Asuinrakennus
- Lomarakennus
- Kiinteistöjen käyttötarkoitus selvitetään kaavoituksen yhteydessä
- Reseptorit
- Varsavaaran hankealue



RAMBOLL

PROKON Wind Energy Finland Oy
Varsavaaran tuulivoimapuisto

Välkemallinnus (WindPro)
Puusto huomioitu

Varsavaara VE2

20.10.2022

Real Case
välkevyöhykkeet
tuntia vuodessa

- 0
- 8
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- Tuulivoimala, Varsavaara VE2
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- Reseptorit
- Varsavaaran hankealue

RAMBOLL

PROKON Wind Energy Finland Oy
Varsavaaran tuulivoimapuisto

Yhteisvälkemallinnus (WindPro)

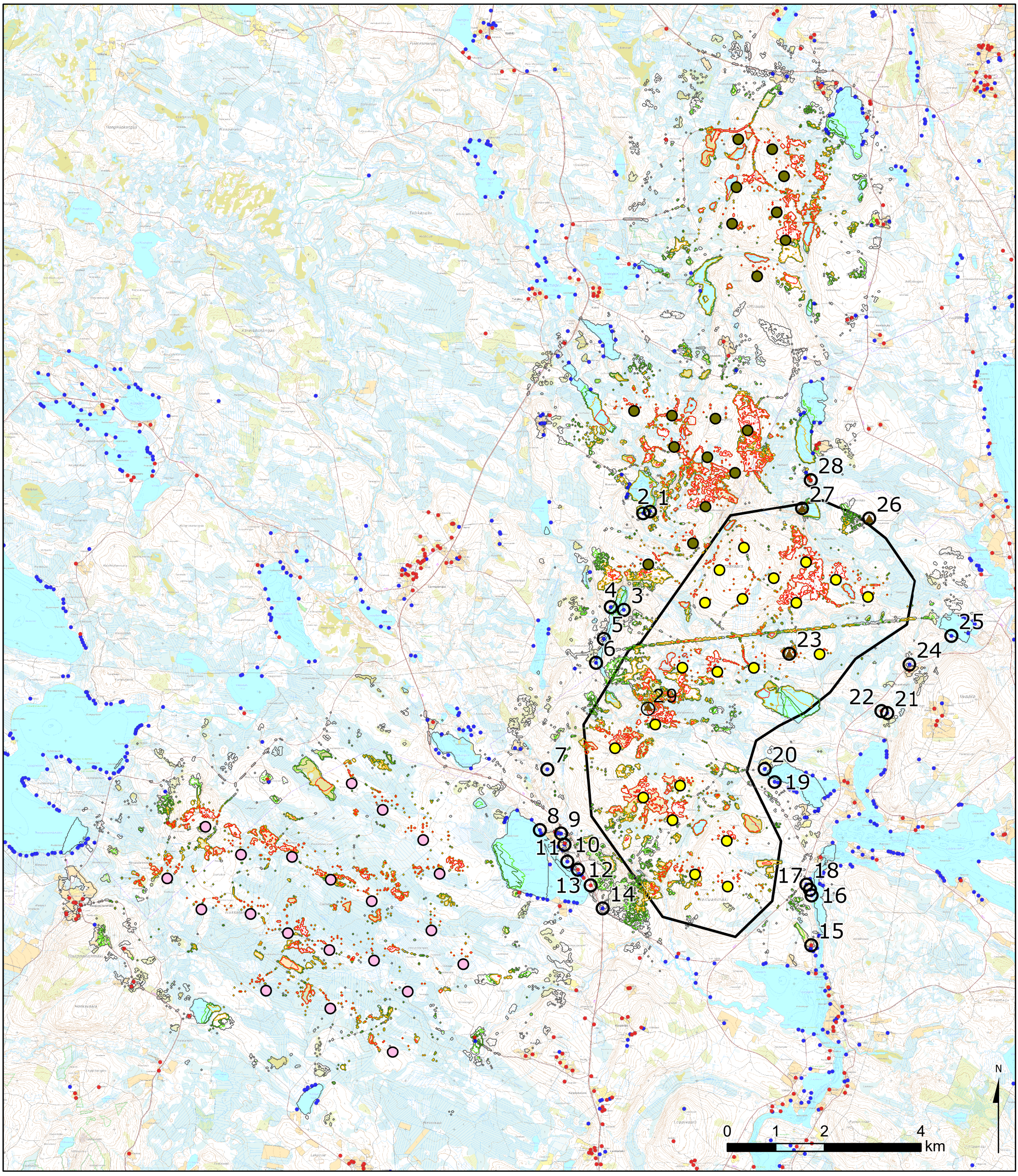
Varsavaaran VE1, Hietavaaran ja Hukkalansalon tuulivoimalat

13.10.2022

Real Case
välkevyöhykkeet
tuntia vuodessa

- 0
- 8
- 10
- 15
- 30

- Tuulivoimala, Varsavaara
- Tuulivoimala, Hietavaara
- Tuulivoimala, Hukkalansalo
- Asuinrakennus
- Lomarakennus
- Kiinteistöjen käyttötarkoitus selvitetään kaavoituksen yhteydessä
- Reseptorit
- Varsavaaran hankealue



RAMBOLL

PROKON Wind Energy Finland Oy
Varsavaaran tuulivoimapuisto

Yhteisvälkemallinnus (WindPro)
Puusto huomioitu

Varsavaaran VE1, Hietavaaran ja Hukkalansalon tuulivoimalat

20.10.2022

Real Case
välkevyöhykkeet
tuntia vuodessa

- 0
- 8
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- 30

- Tuulivoimala, Varsavaara
- Tuulivoimala, Hietavaara
- Tuulivoimala, Hukkalansalo
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- Kiinteistöjen käyttötarkoitus selvitetään kaavoituksen yhteydessä
- Reseptorit
- Varsavaaran hankealue

RAMBOLL

PROKON Wind Energy Finland Oy
Varsavaaran tuulivoimapuisto

Yhteisvälkemallinnus (WindPro)

Varsavaaran VE2, Hietavaaran ja Hukkalansalon tuulivoimalat

13.10.2022

Real Case
välkevyöhykkeet
tuntia vuodessa

- 0
- 8
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- Tuulivoimala, Varsavaara VE2
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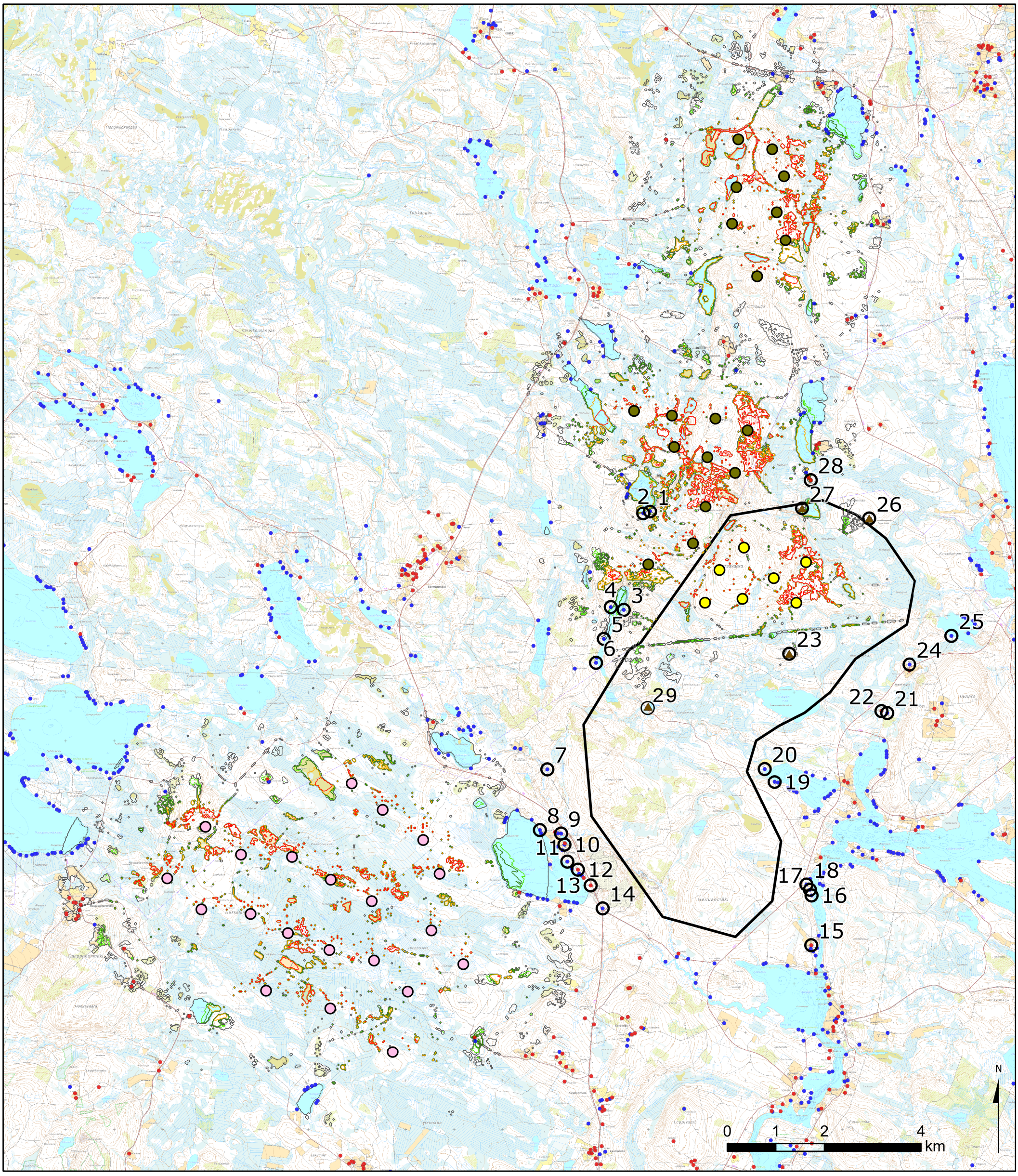
- Tuulivoimala, Hukkalansalo
- Asuinrakennus
- Lomarakennus
- Kiinteistöjen käyttötarkoitus selvitetään kaavoituksen yhteydessä
- Reseptorit
- Varsavaaran hankealue



RAMBOLL

PROKON Wind Energy Finland Oy
Varsavaaran tuulivoimapuisto

Yhteisvälkemallinnus (WindPro)
Puusto huomioitu

Varsavaaran VE2, Hietavaaran ja Hukkalansalon tuulivoimalat

20.10.2022

Real Case
välkevyöhykkeet
tuntia vuodessa

- 0
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- 10
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- 30

- Tuulivoimala, Varsavaara VE2
- Tuulivoimala, Hietavaara
- Tuulivoimala, Hukkalansalo
- Asuinrakennus
- Lomarakennus
- Kiinteistöjen käyttötarkoitus selvitetään kaavoituksen yhteydessä
- Reseptorit
- Varsavaaran hankealue

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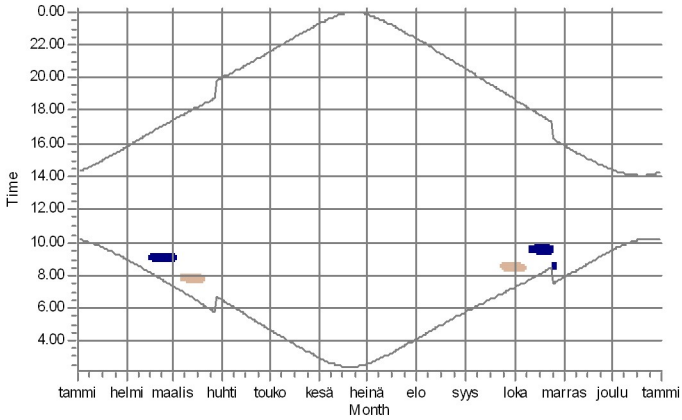
Ville Virtanen / ville.virtanen@ramboll.fi
Calculated:
14/10/2022 13.36/3.4.388

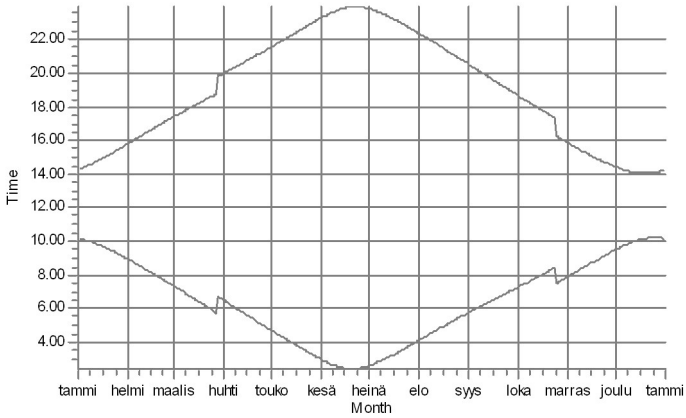
SHADOW - Calendar, graphical

Calculation: Varsavaara_H200_D200

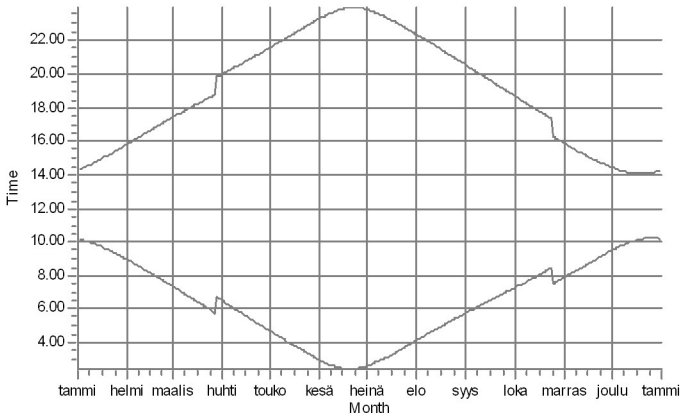
1: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (16)



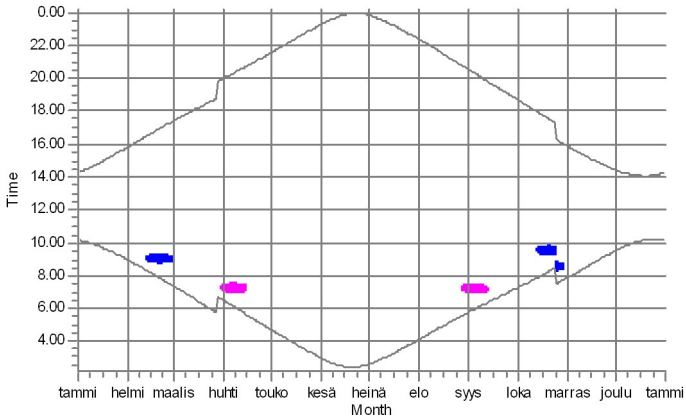
2: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (17)



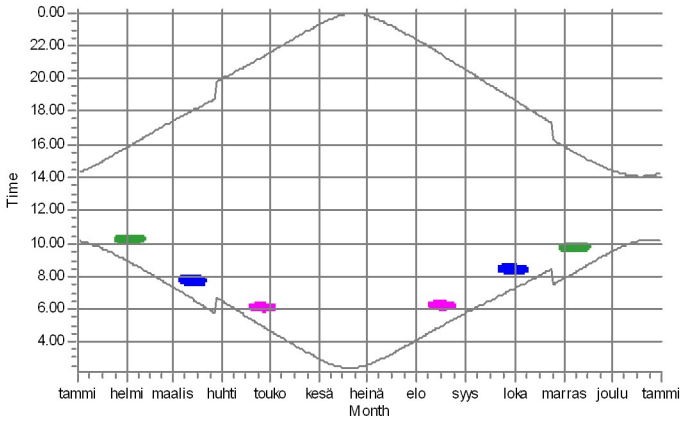
3: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (19)



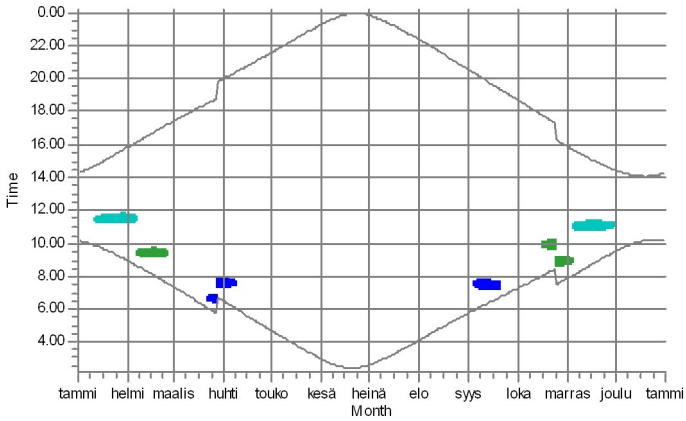
4: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (20)



5: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (18)



6: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (21)



WTGs

- 3: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 5: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 7: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 17: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 20: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 21: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0

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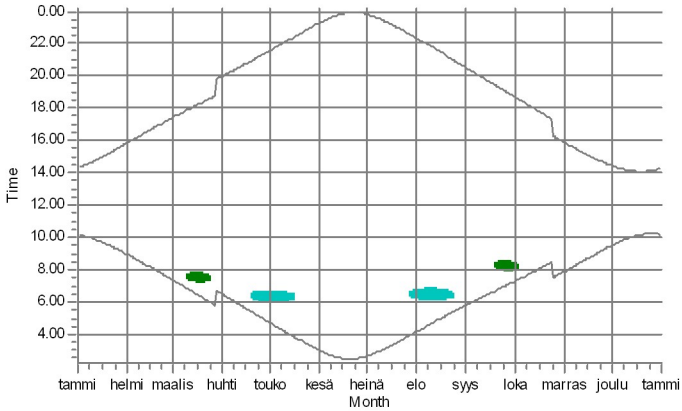
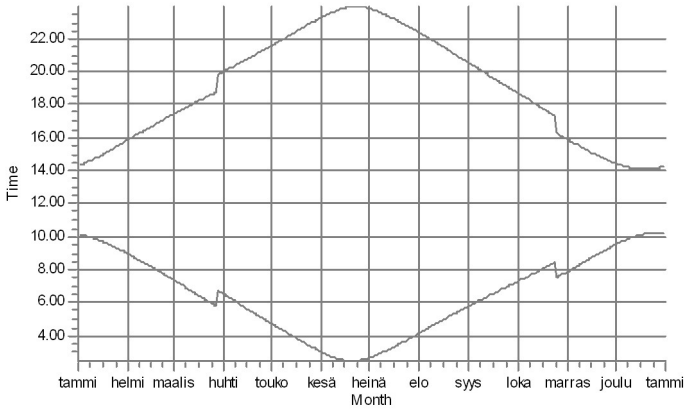
SHADOW - Calendar, graphical

Calculation: Varsavaara_H200_D200

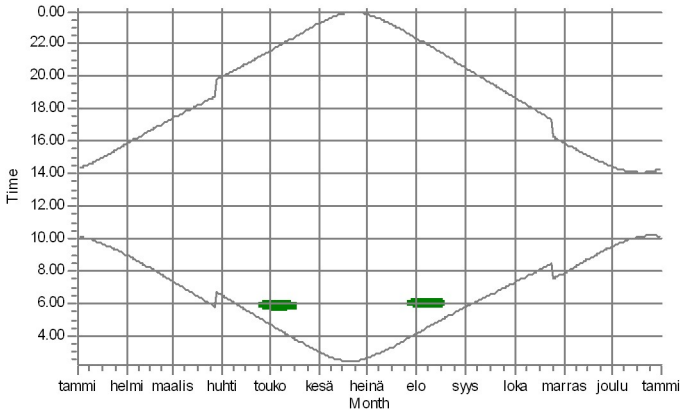
7: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (7)



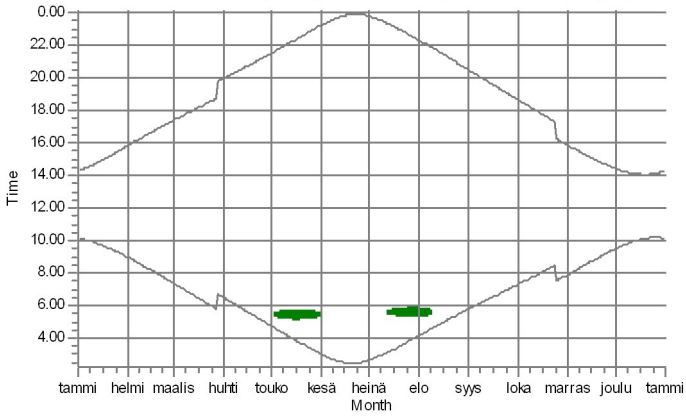
8: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (9)



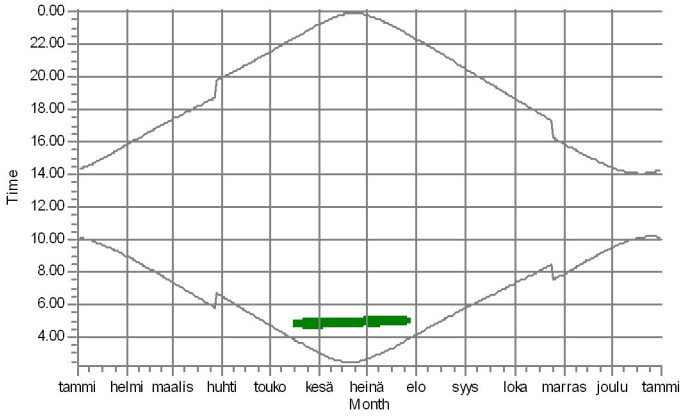
9: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (8)



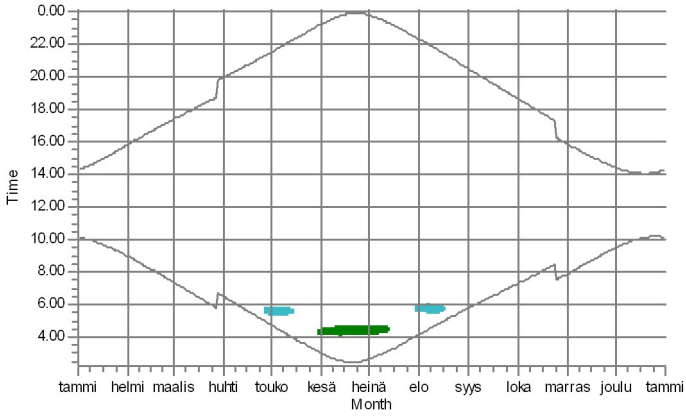
10: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (10)



11: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (11)



12: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (24)



WTGs

1: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
19: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
21: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0

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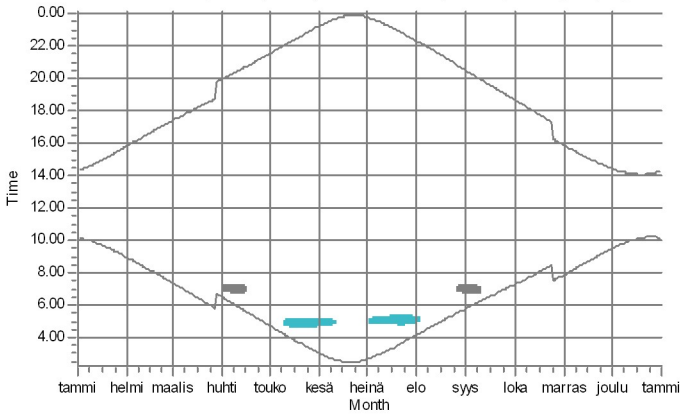
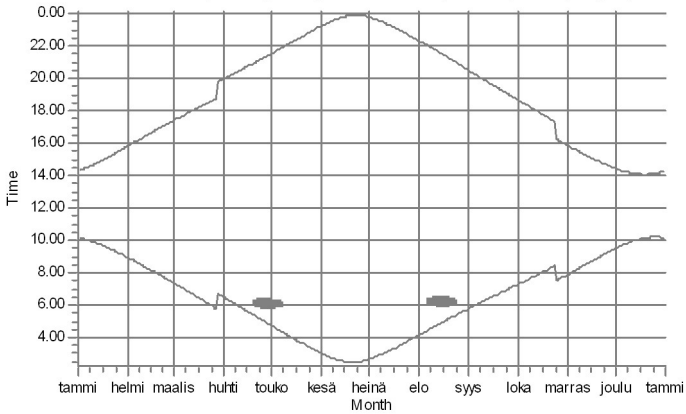
SHADOW - Calendar, graphical

Calculation: Varsavaara_H200_D200

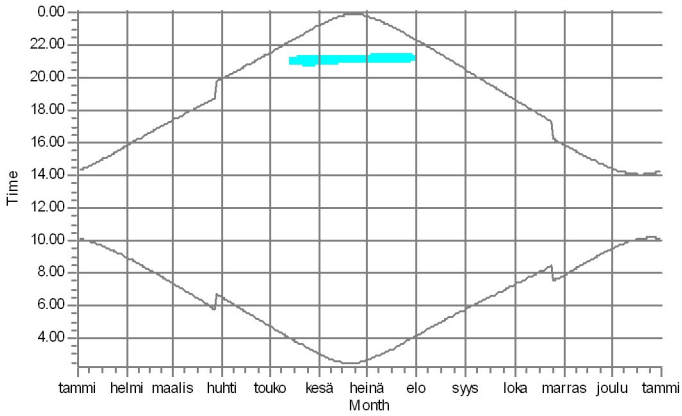
13: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (25)



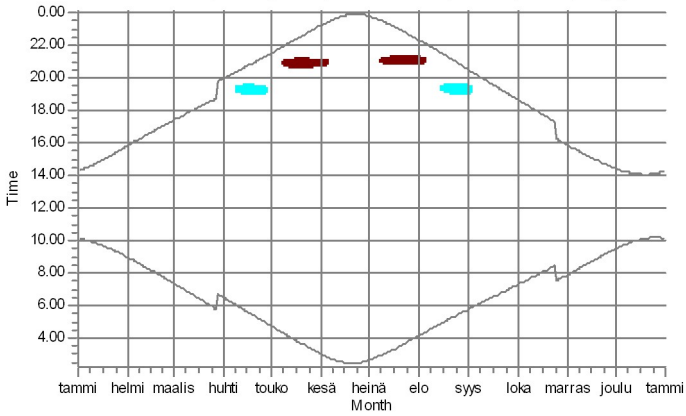
14: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (12)



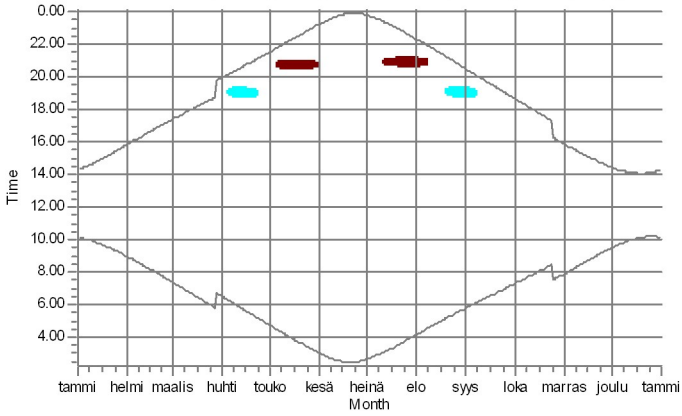
15: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (26)



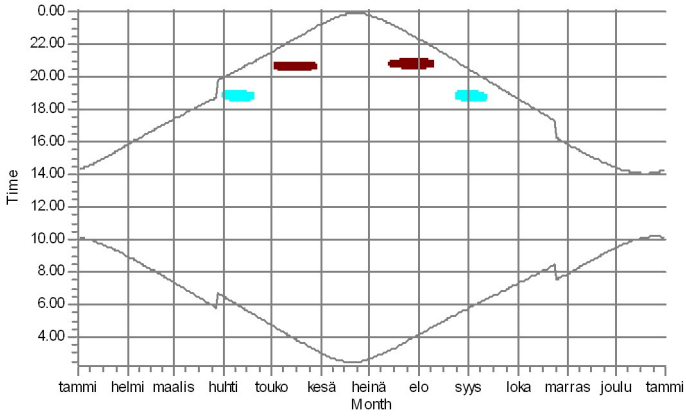
16: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (6)



17: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (5)



18: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (4)



WTGs

4: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
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13: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
19: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0

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Calculated:
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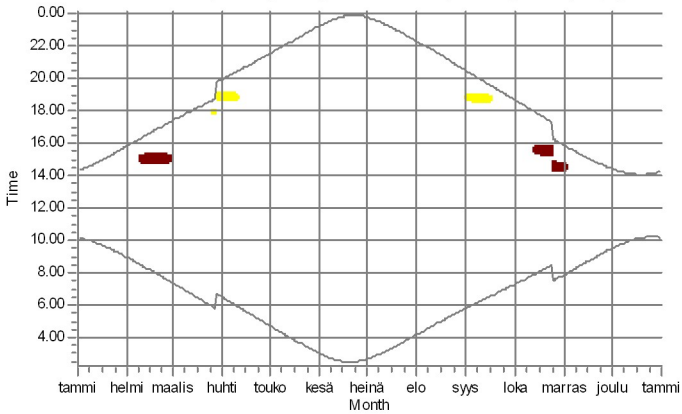
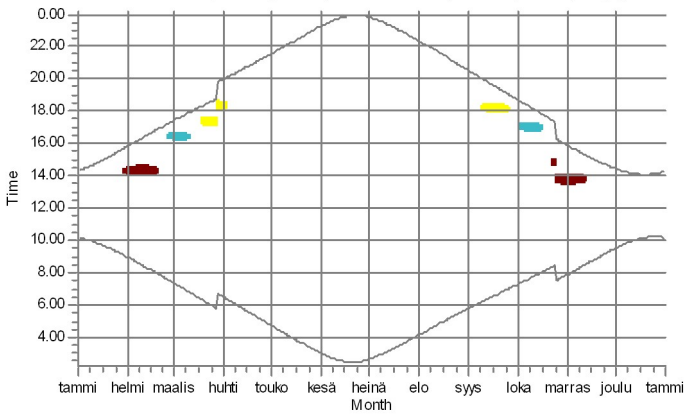
SHADOW - Calendar, graphical

Calculation: Varsavaara_H200_D200

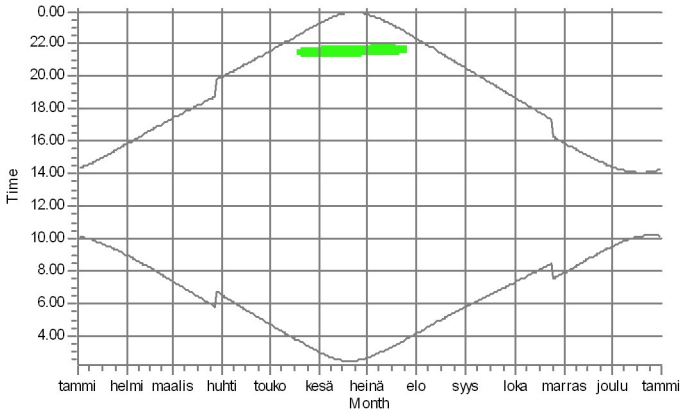
19: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (3)



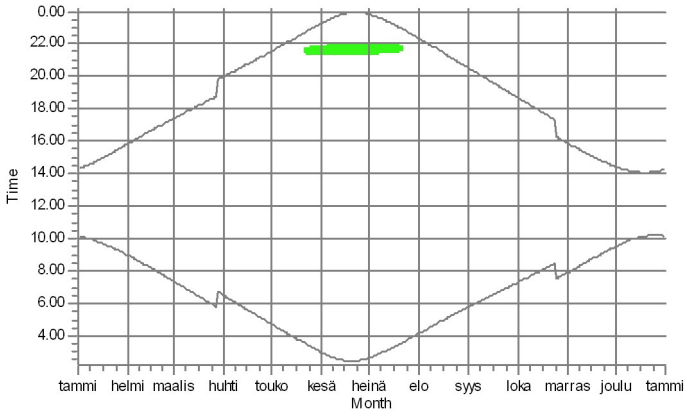
20: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (2)



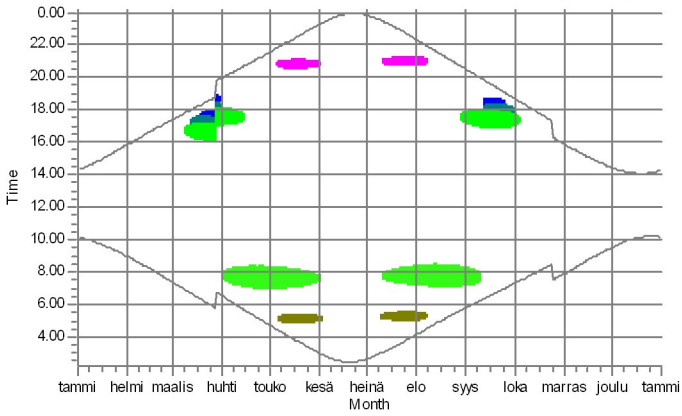
21: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (1)



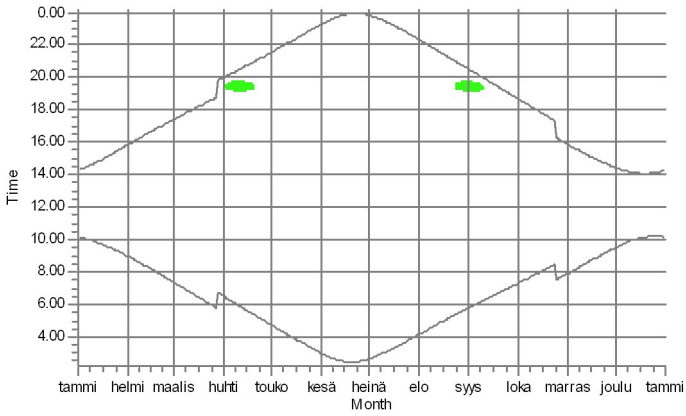
22: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (23)



23: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (22)



24: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (15)



WTGs

- 2: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 3: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 5: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 6: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 8: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 9: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 10: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
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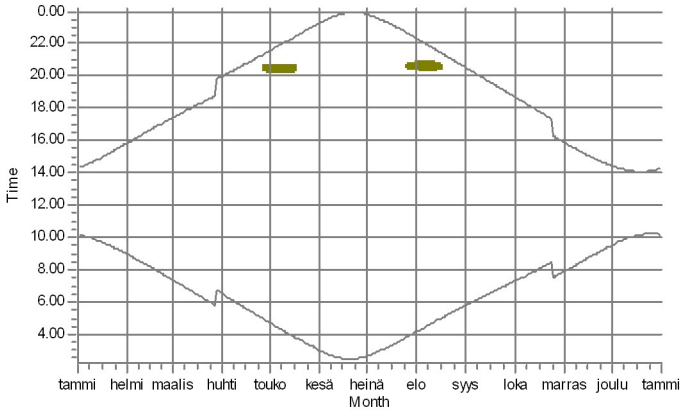
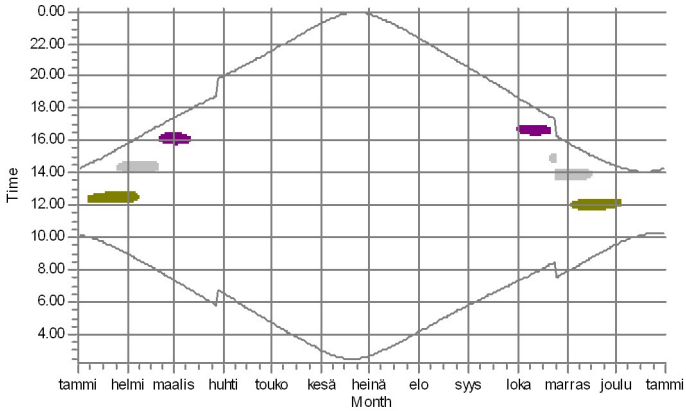
SHADOW - Calendar, graphical

Calculation: Varsavaara_H200_D200

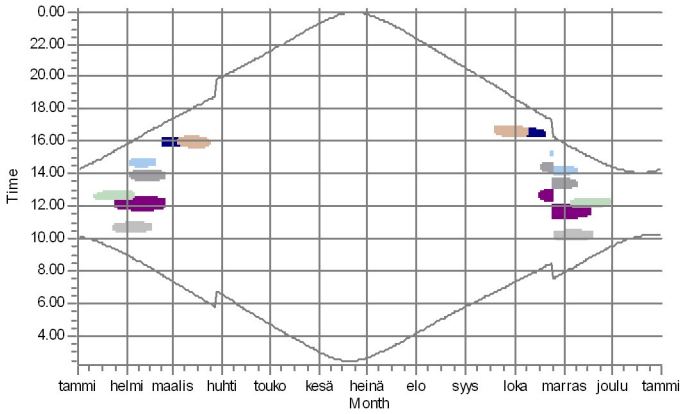
25: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (14)



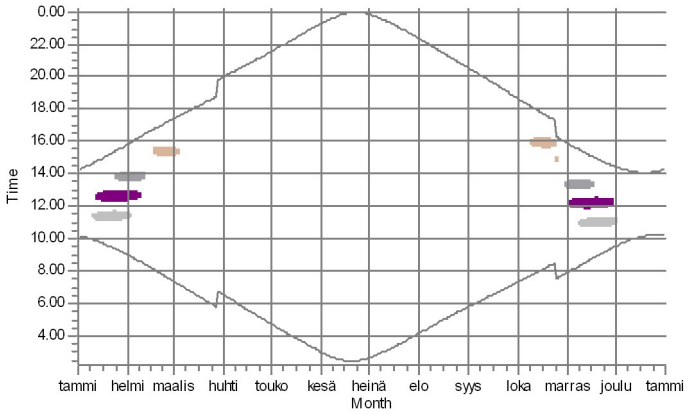
26: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (13)



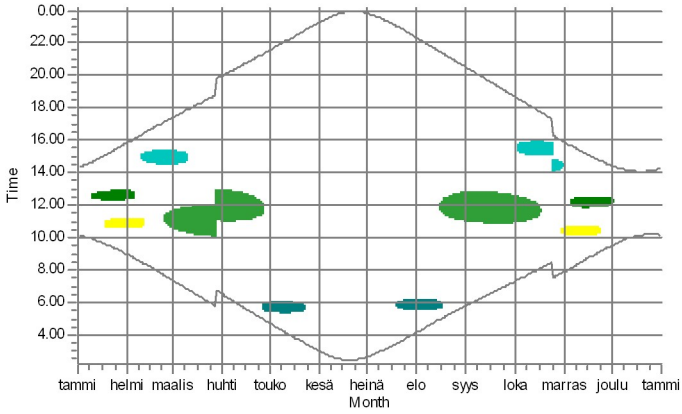
27: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (28)



28: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (27)



29: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (38)



WTGs

- 1: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 2: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 6: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 7: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 10: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 11: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 12: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 14: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 15: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 16: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 17: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 20: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 21: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0

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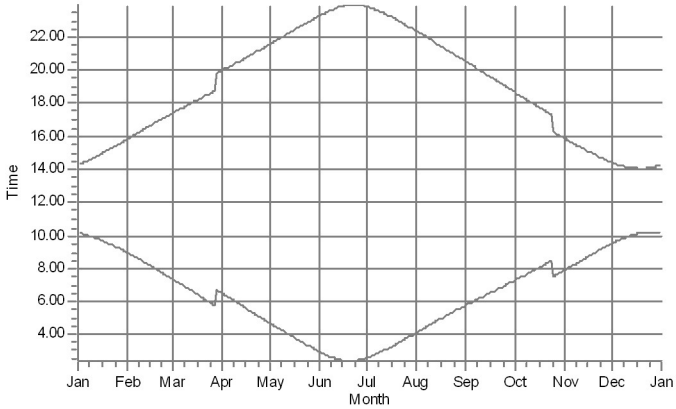
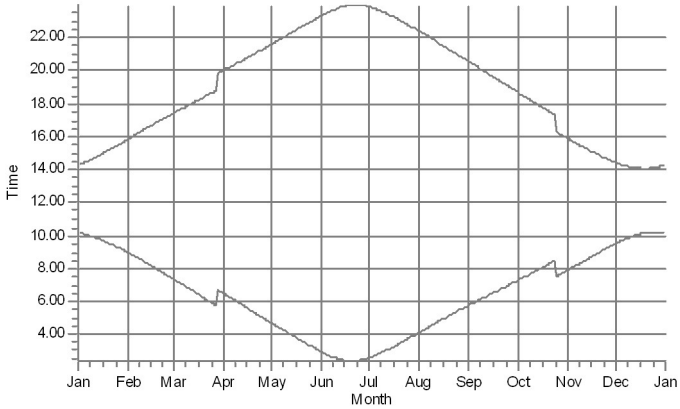
SHADOW - Calendar, graphical

Calculation: PUUSTO Varsavaara_H200_D200

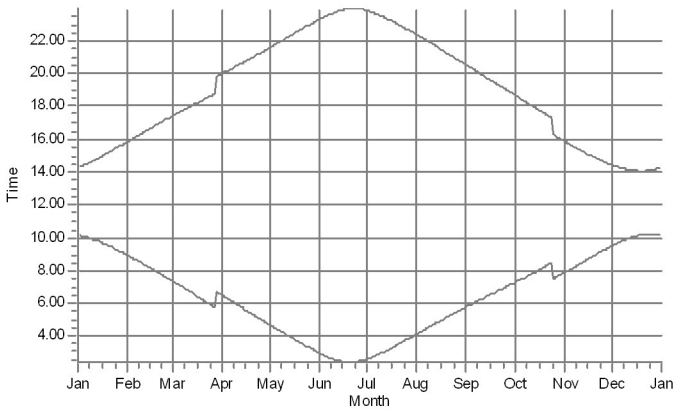
1: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (16)



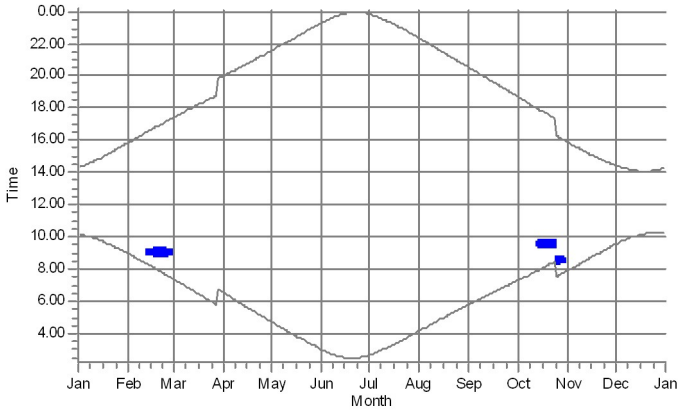
2: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (17)



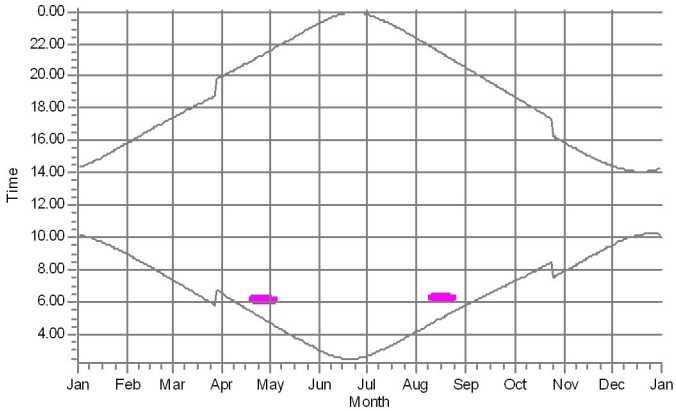
3: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (19)



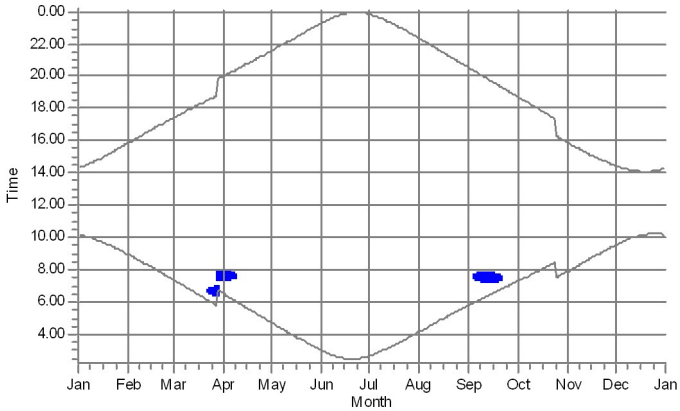
4: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (20)



5: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (18)



6: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (21)



WTGs

3: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0

5: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0

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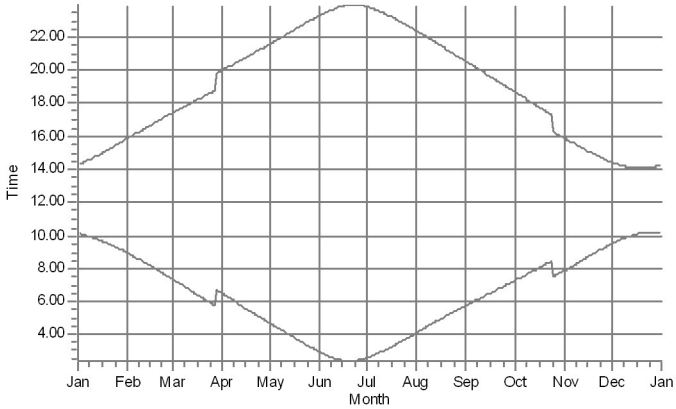
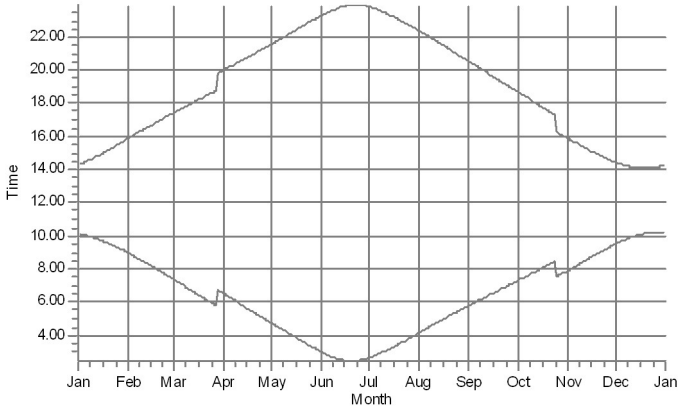
SHADOW - Calendar, graphical

Calculation: PUUSTO Varsavaara_H200_D200

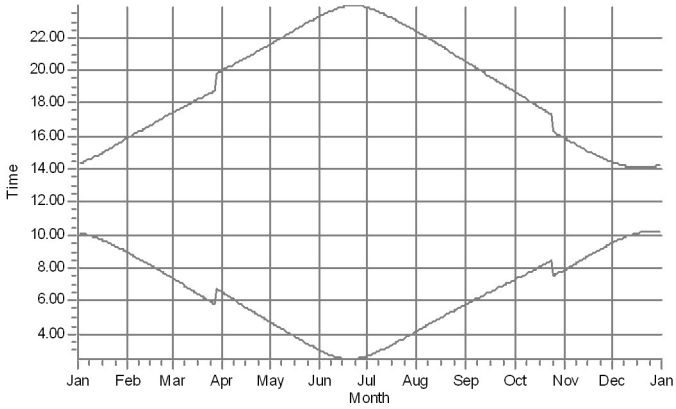
7: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (7)



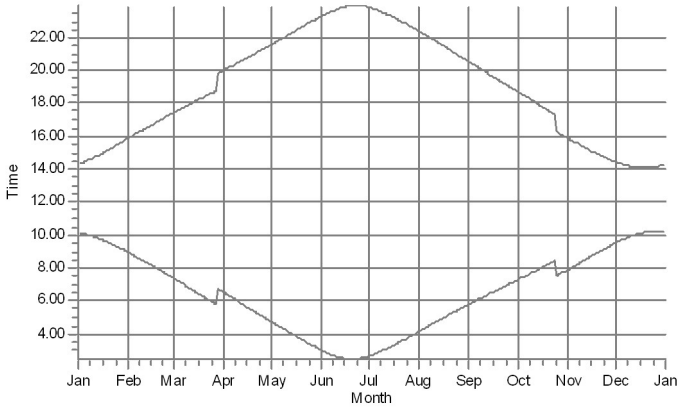
8: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (9)



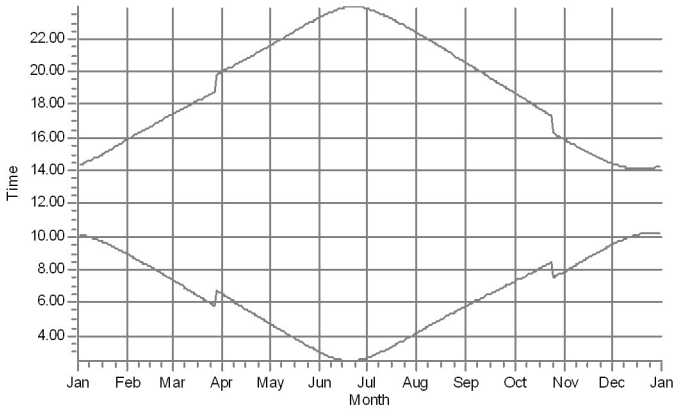
9: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (8)



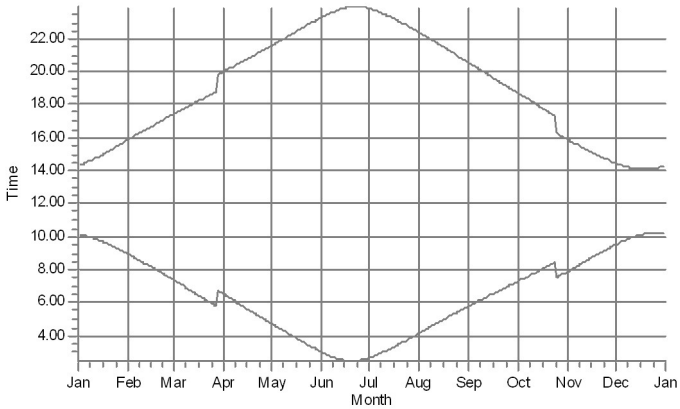
10: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (10)



11: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (11)



12: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (24)



WTGs

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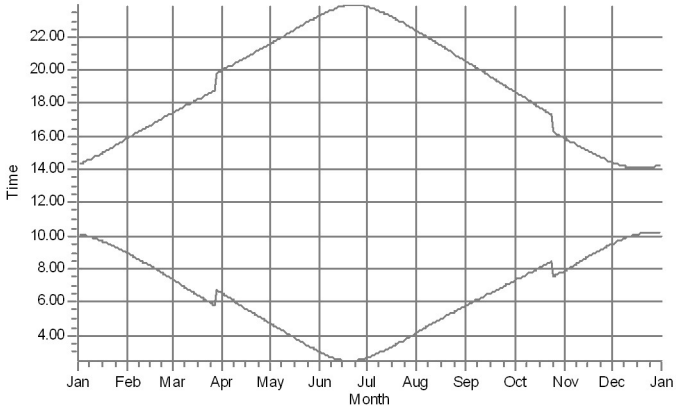
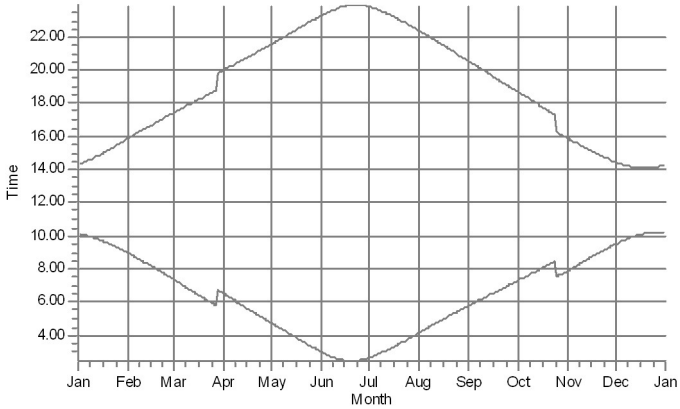
SHADOW - Calendar, graphical

Calculation: PUUSTO Varsavaara_H200_D200

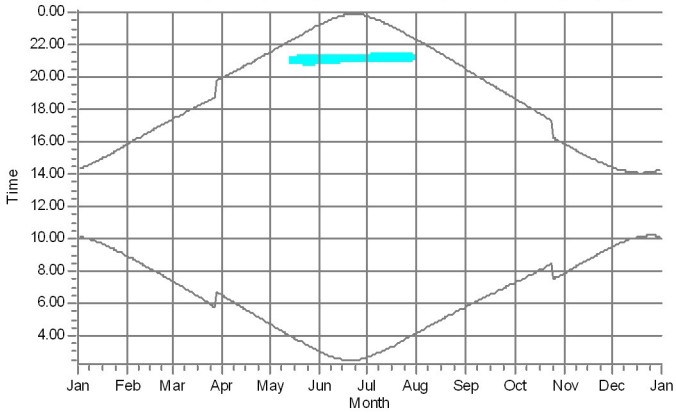
13: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (25)



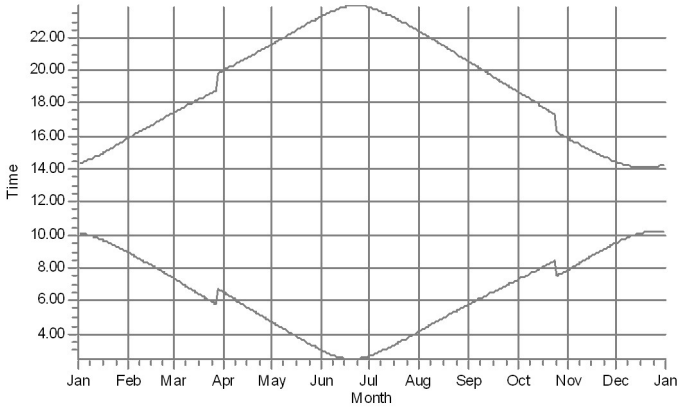
14: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (12)



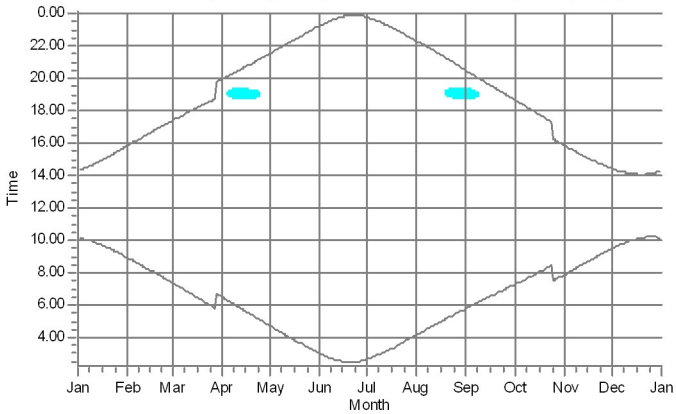
15: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (26)



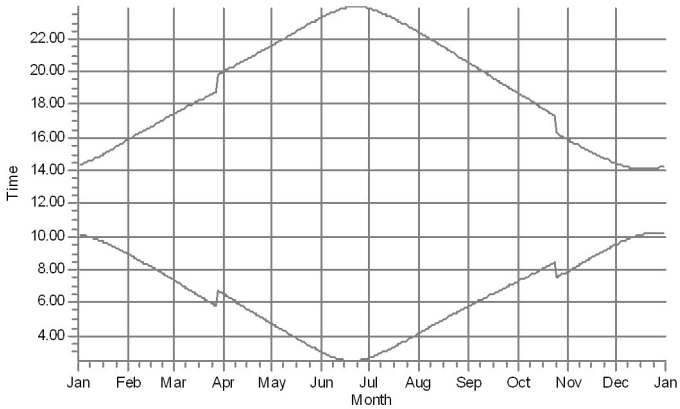
16: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (6)



17: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (5)



18: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (4)



WTGs

13: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0

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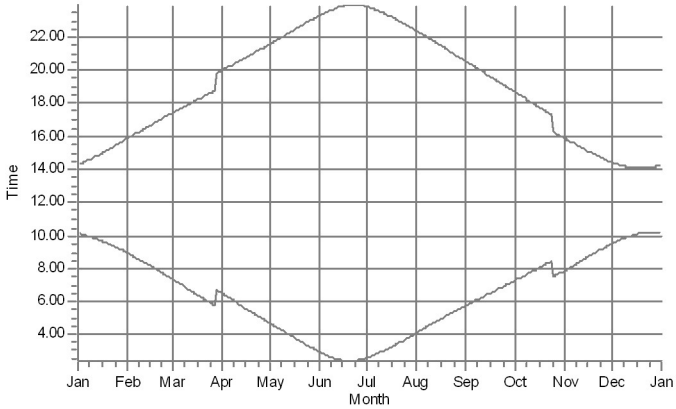
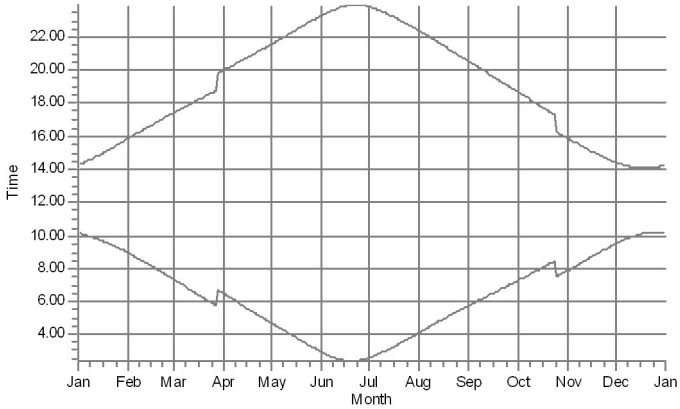
SHADOW - Calendar, graphical

Calculation: PUUSTO Varsavaara_H200_D200

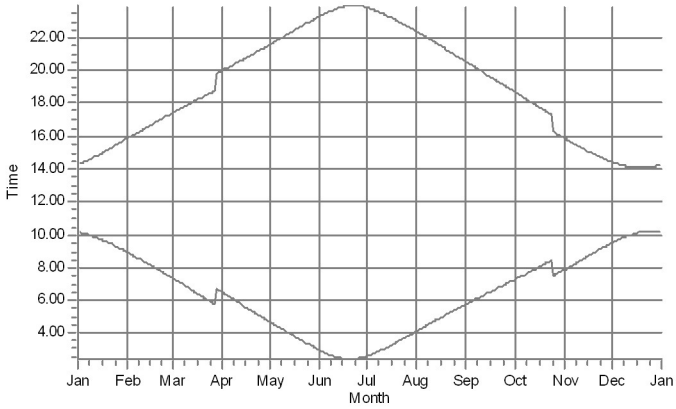
19: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (3)



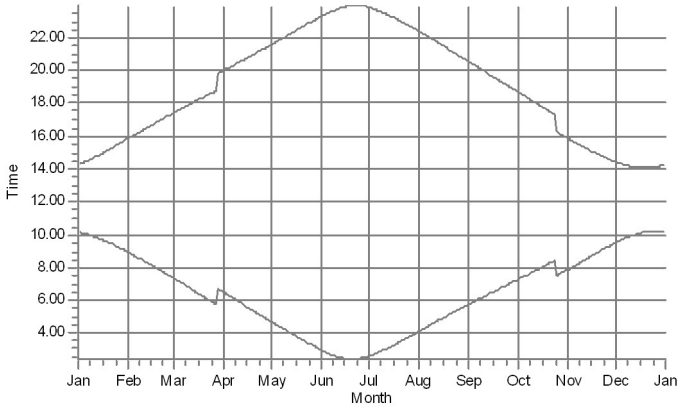
20: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (2)



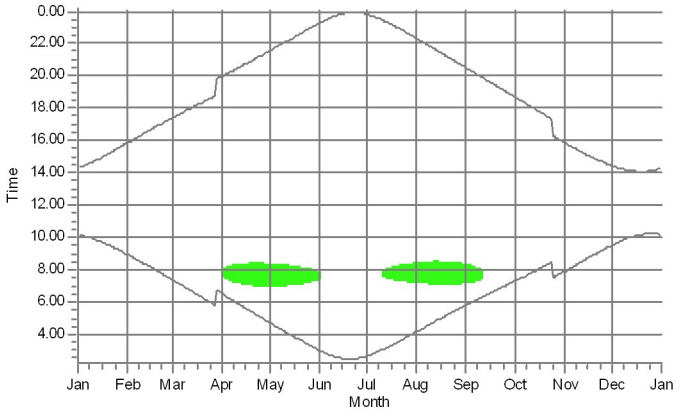
21: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (1)



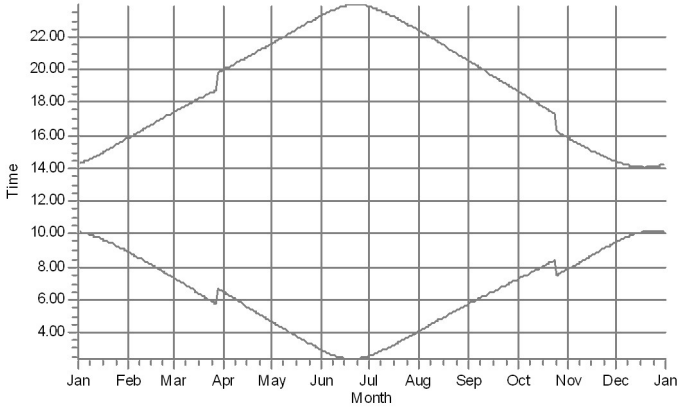
22: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (23)



23: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (22)



24: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (15)



WTGs

18: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0

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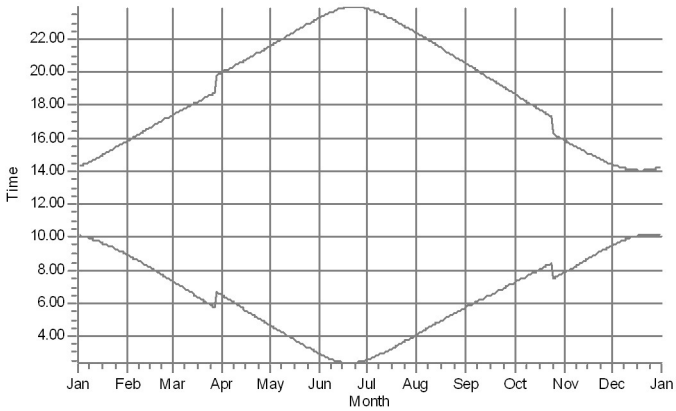
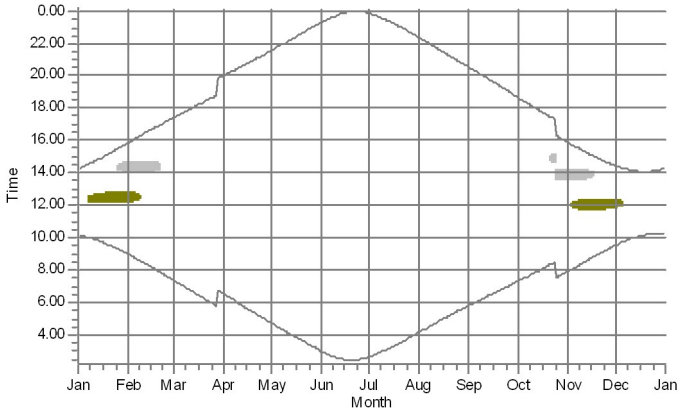
SHADOW - Calendar, graphical

Calculation: PUUSTO Varsavaara_H200_D200

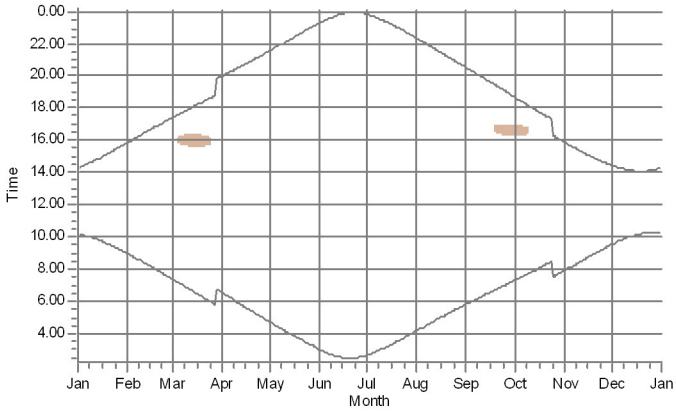
25: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (14)



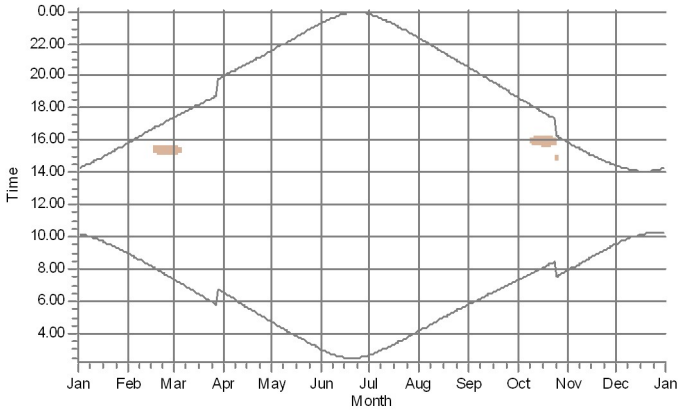
26: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (13)



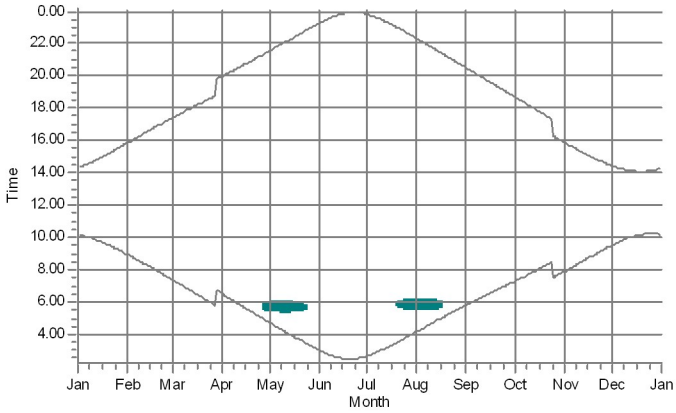
27: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (28)



28: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (27)



29: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (38)



WTGs

- 6: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 10: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 12: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 17: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0

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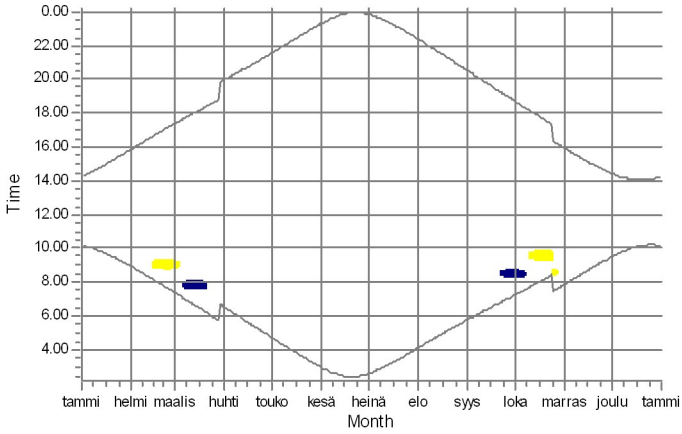
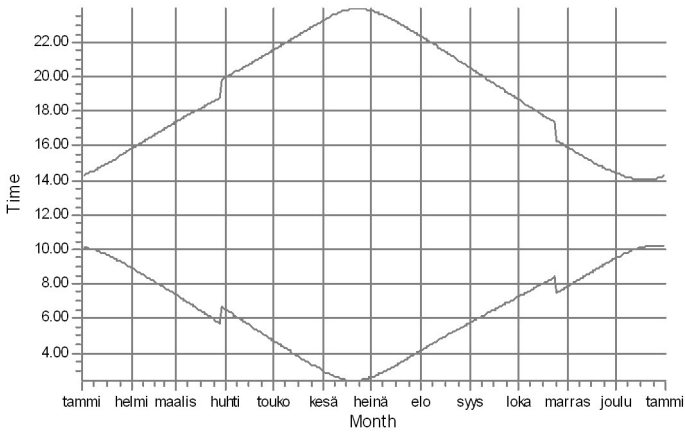
SHADOW - Calendar, graphical

Calculation: V2 Varsavaara_H200_D200

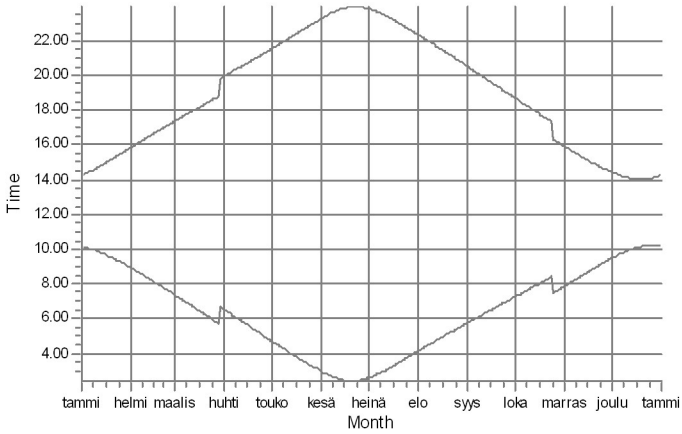
1: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (16)



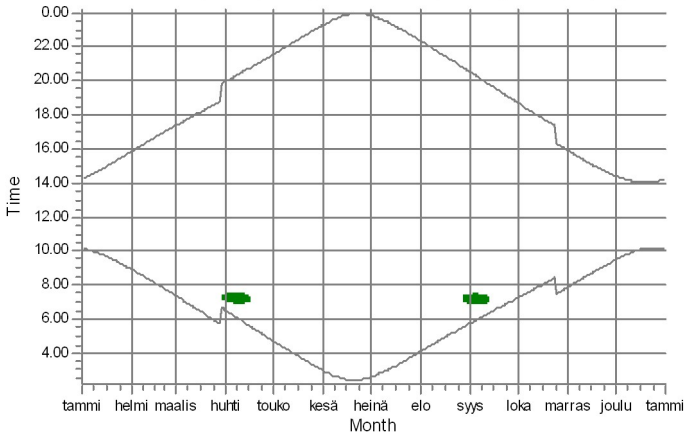
2: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (17)



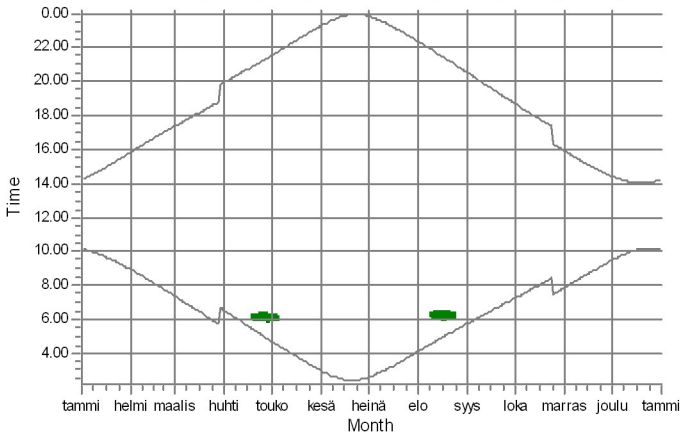
3: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (19)



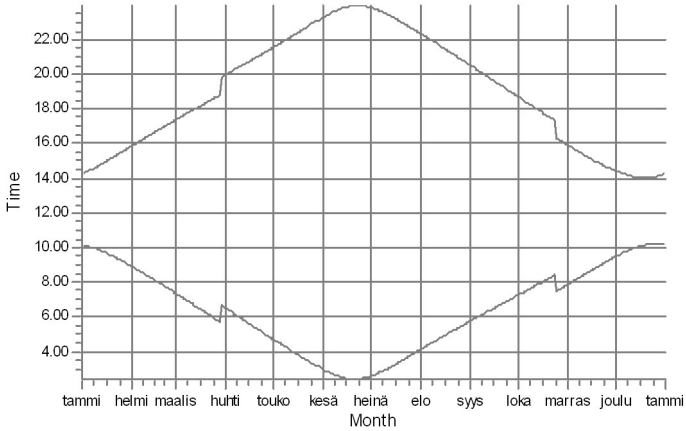
4: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (20)



5: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (18)



6: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (21)



WTGs

- 1: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 2: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 7: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0

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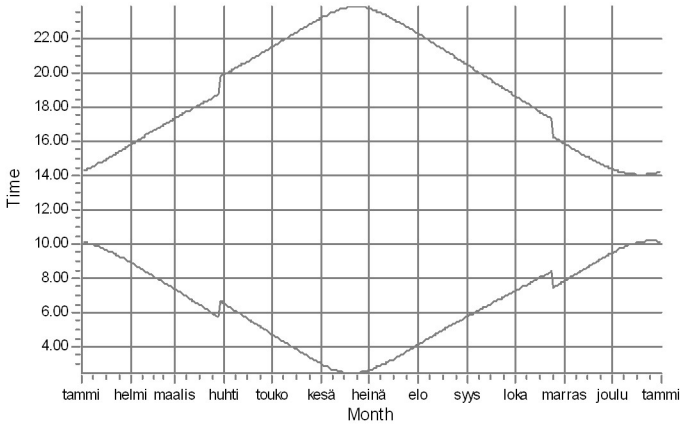
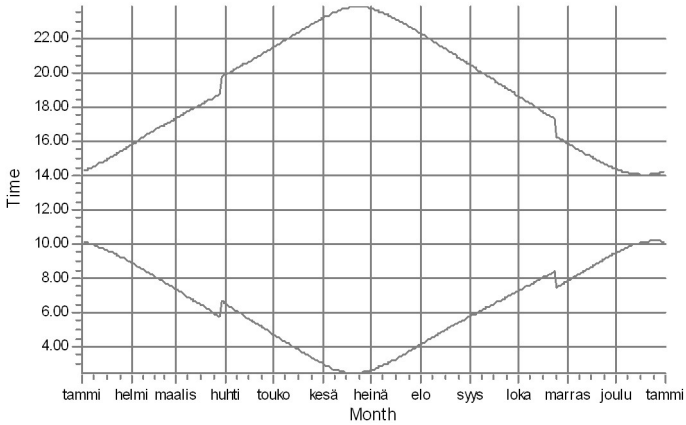
SHADOW - Calendar, graphical

Calculation: V2 Varsavaara_H200_D200

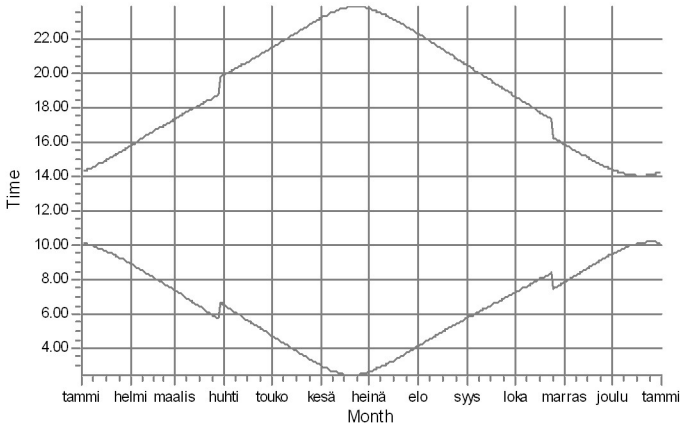
7: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (7)



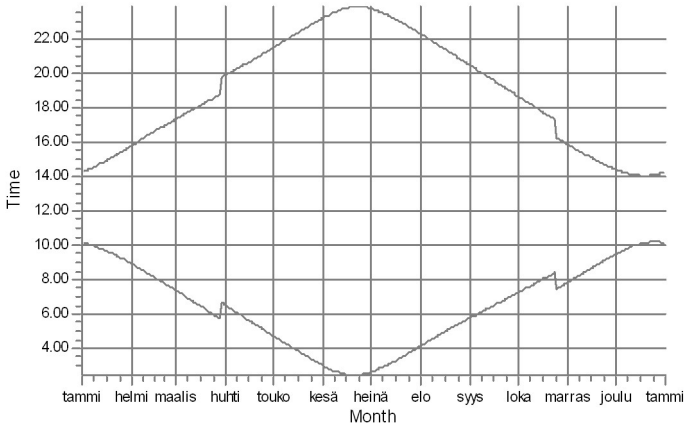
8: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (9)



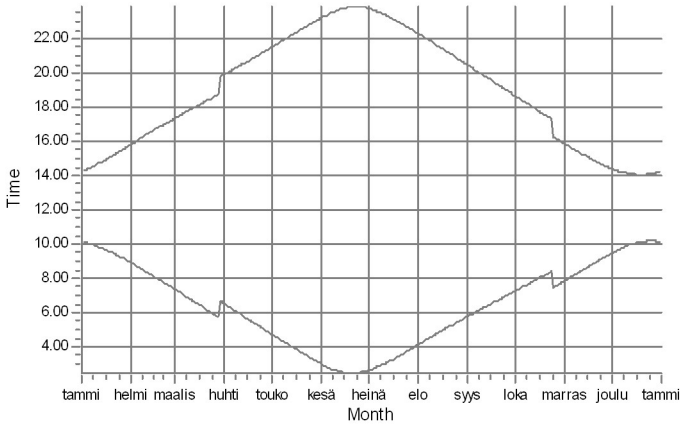
9: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (8)



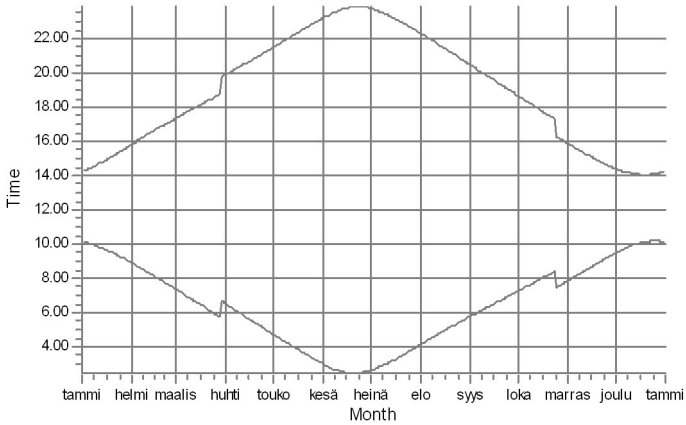
10: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (10)



11: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (11)



12: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (24)



WTGs

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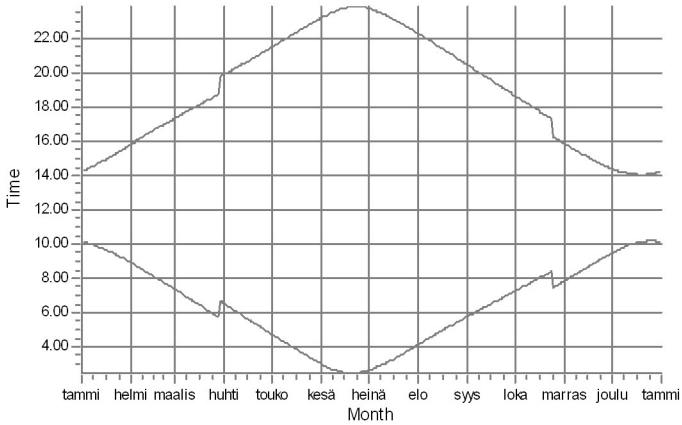
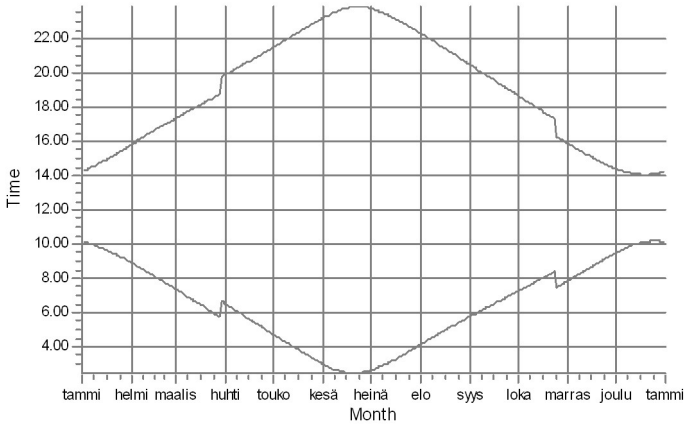
SHADOW - Calendar, graphical

Calculation: V2 Varsavaara_H200_D200

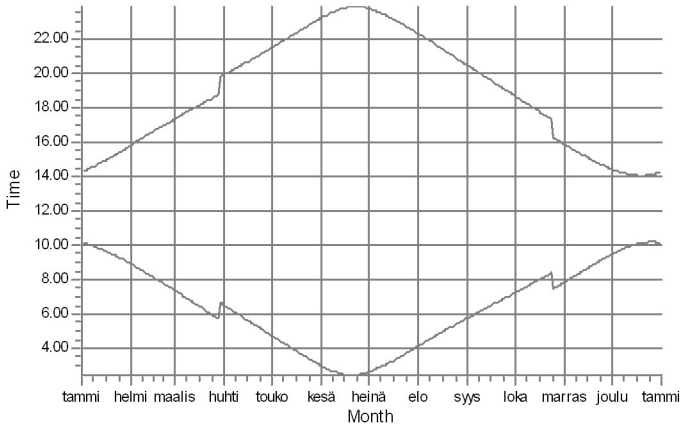
13: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (25)



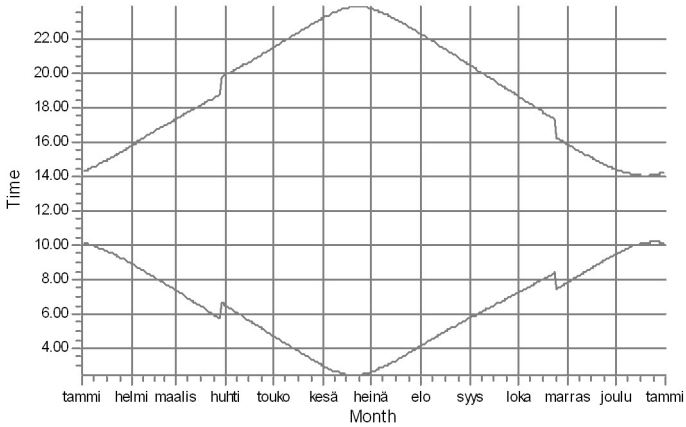
14: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (12)



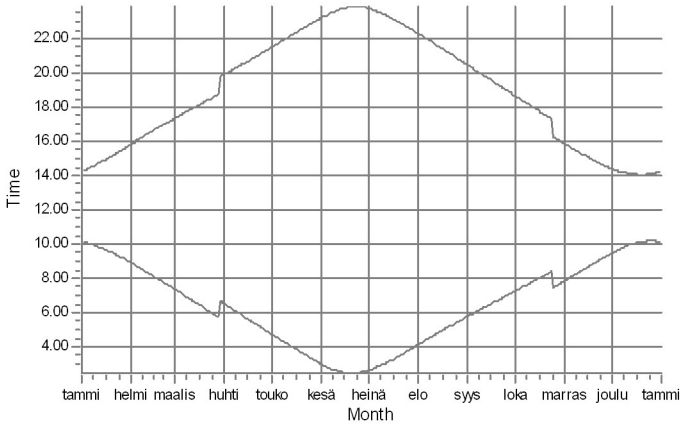
15: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (26)



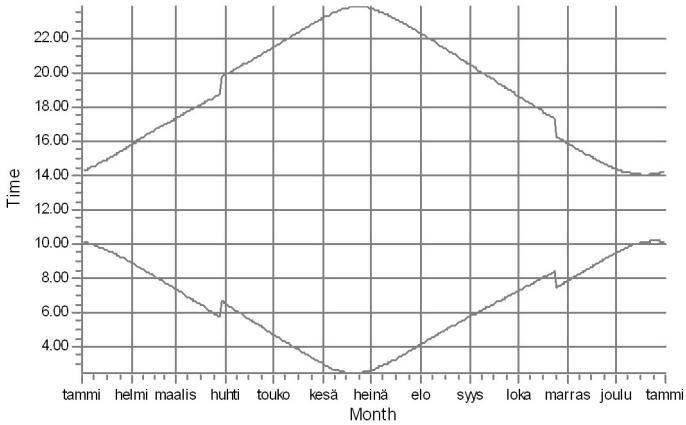
16: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (6)



17: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (5)



18: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (4)



WTGs

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Calculated:
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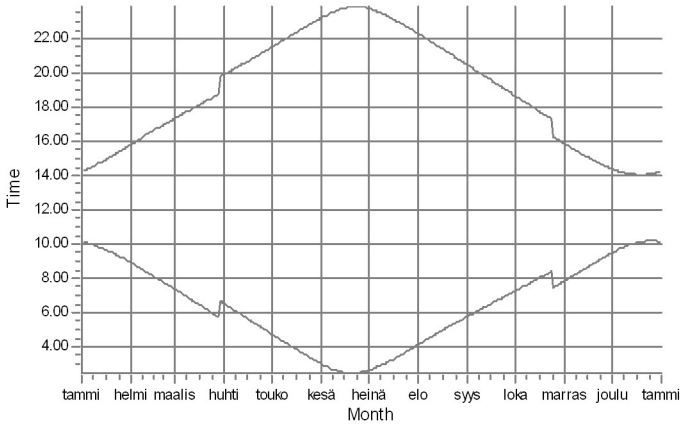
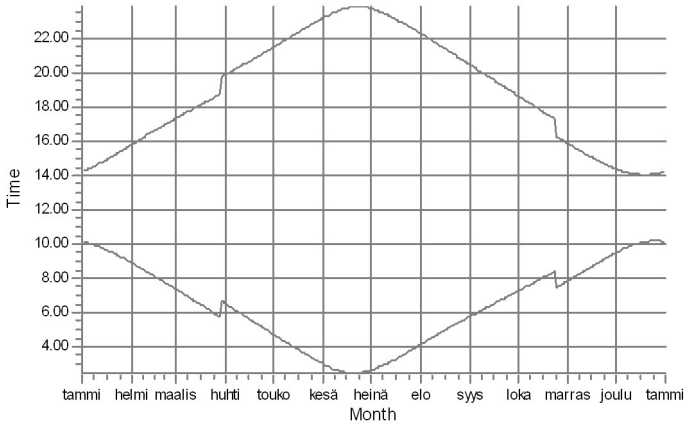
SHADOW - Calendar, graphical

Calculation: V2 Varsavaara_H200_D200

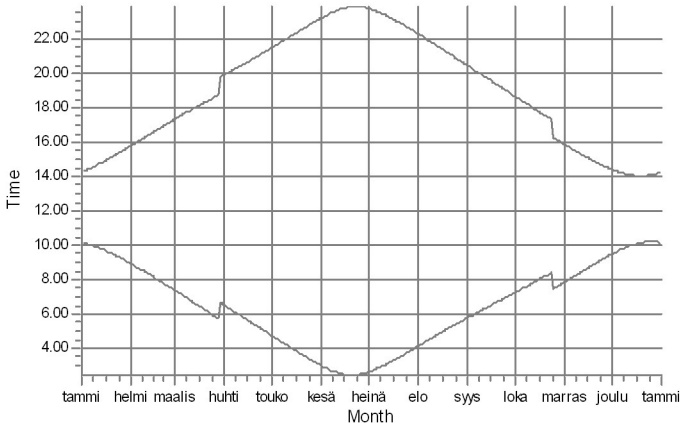
19: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (3)



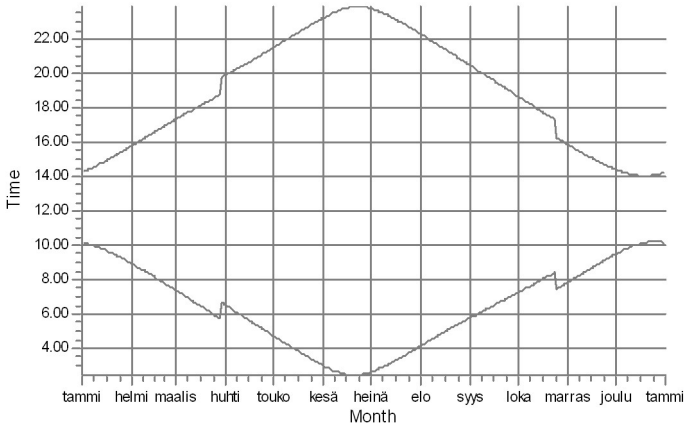
20: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (2)



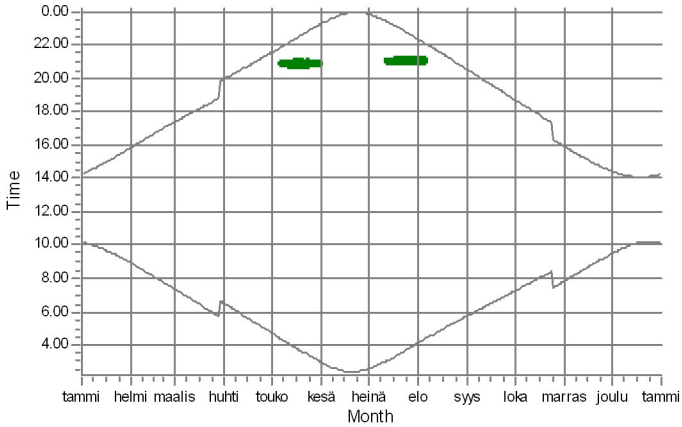
21: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (1)



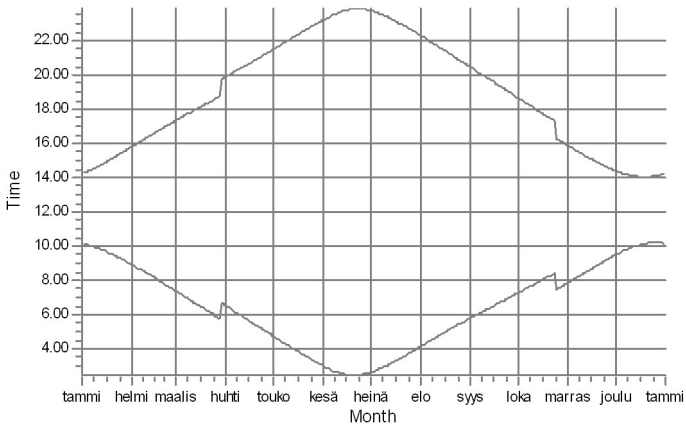
22: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (23)



23: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (22)



24: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (15)



WTGs

1: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0

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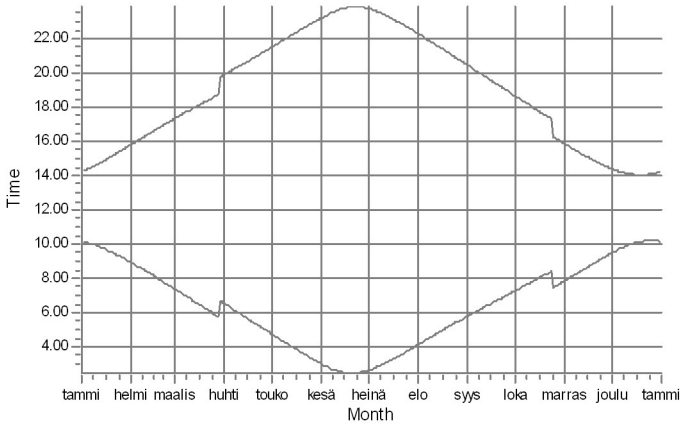
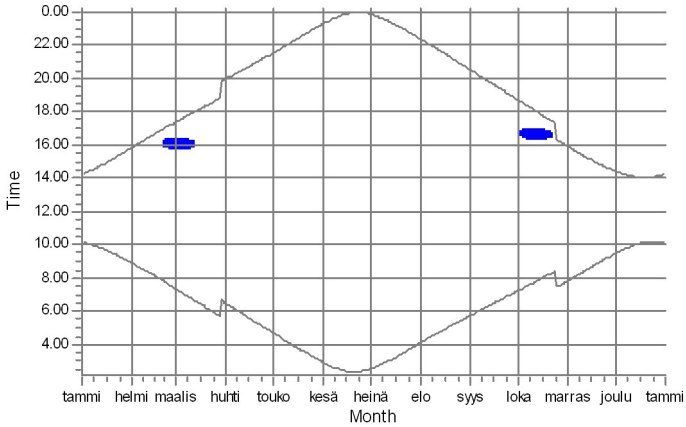
SHADOW - Calendar, graphical

Calculation: V2 Varsavaara_H200_D200

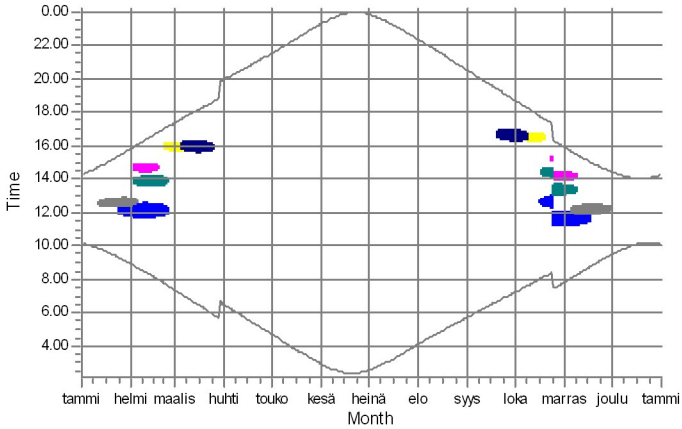
25: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (14)



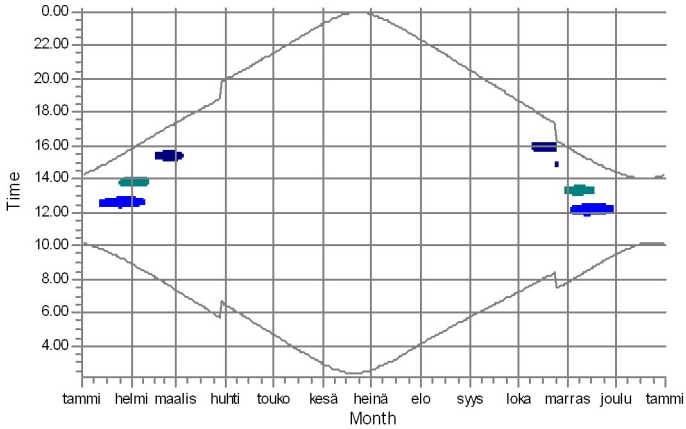
26: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (13)



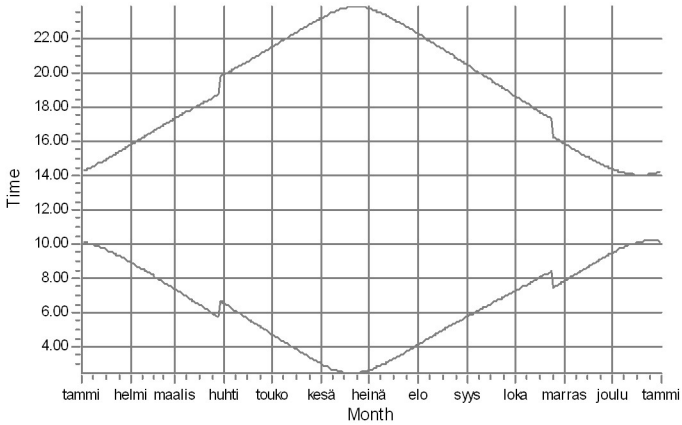
27: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (28)



28: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (27)



29: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (38)



WTGs

- 2: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 3: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 4: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 5: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 6: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 7: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0

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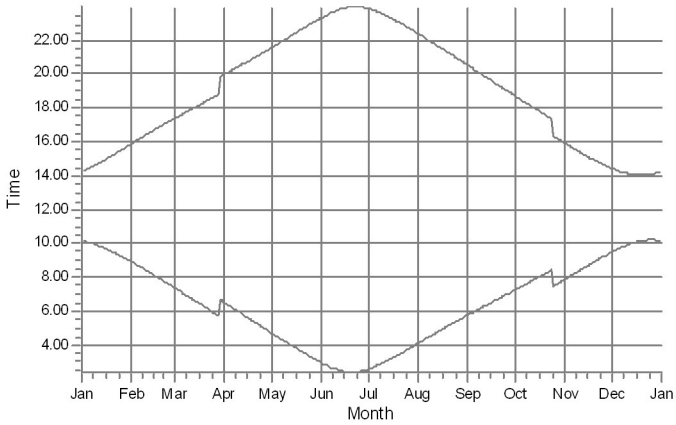
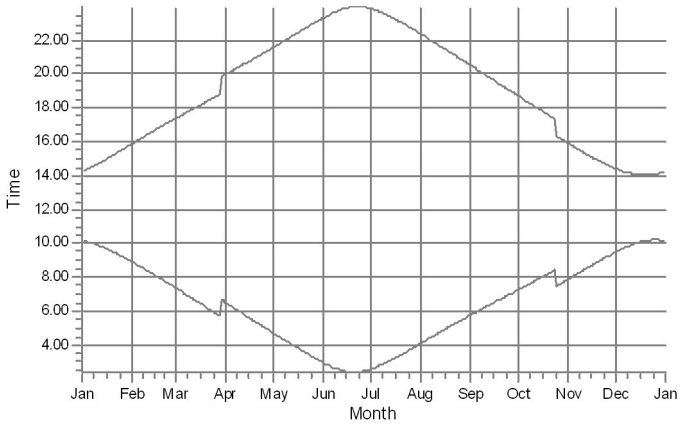
SHADOW - Calendar, graphical

Calculation: PUUSTO V2 Varsavaara_H200_D200

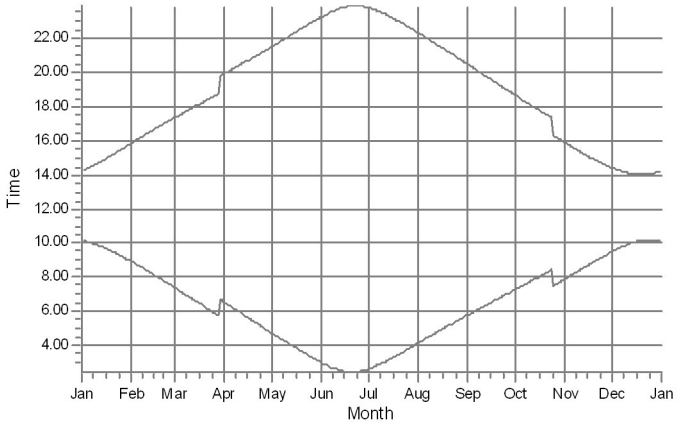
1: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (16)



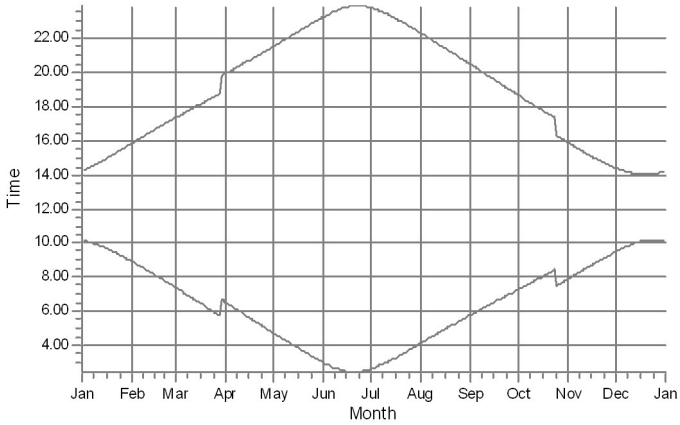
2: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (17)



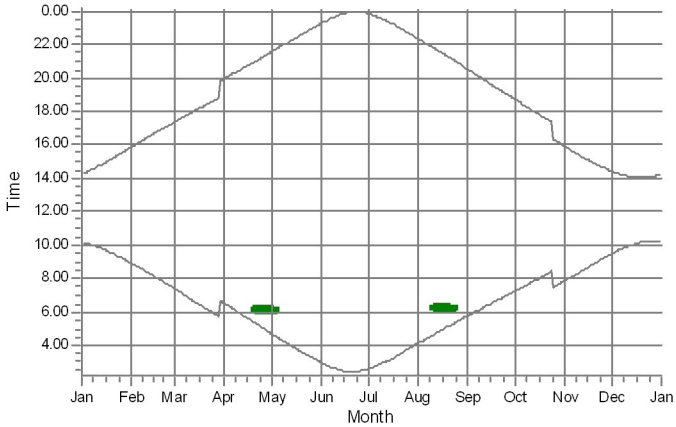
3: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (19)



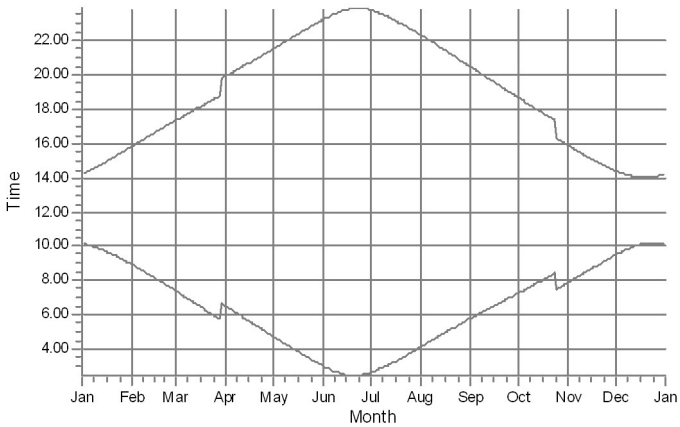
4: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (20)



5: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (18)



6: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (21)



WTGs

1: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0

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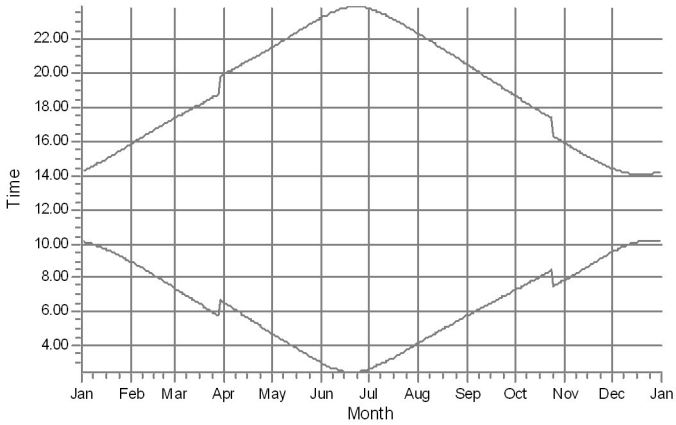
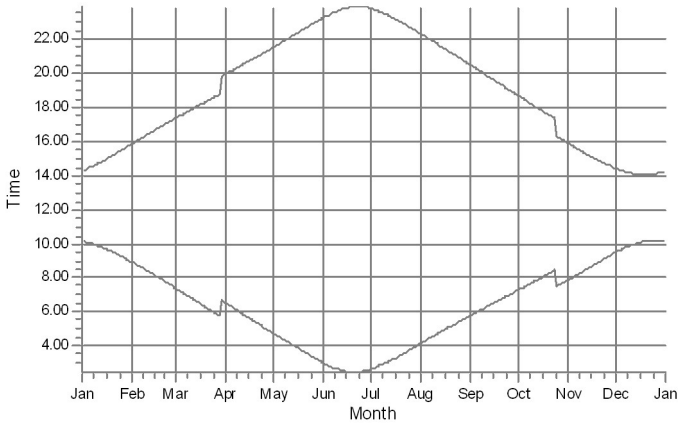
SHADOW - Calendar, graphical

Calculation: PUUSTO V2 Varsavaara_H200_D200

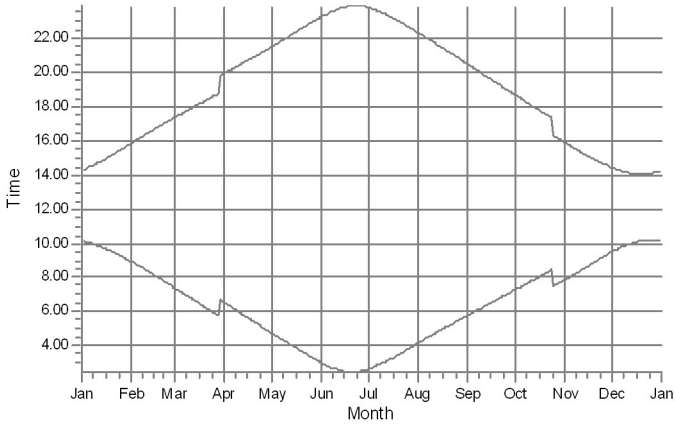
7: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (7)



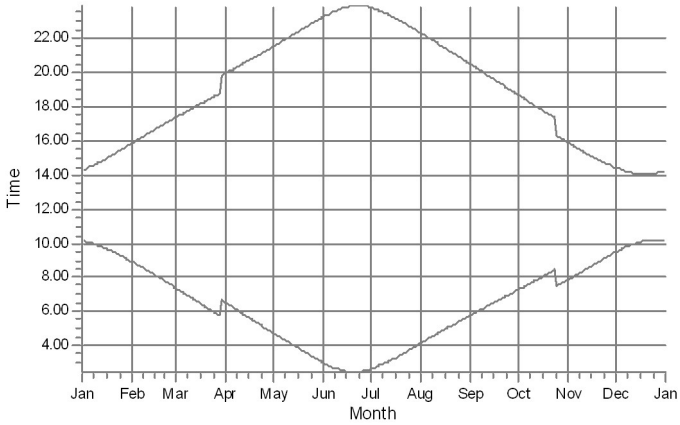
8: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (9)



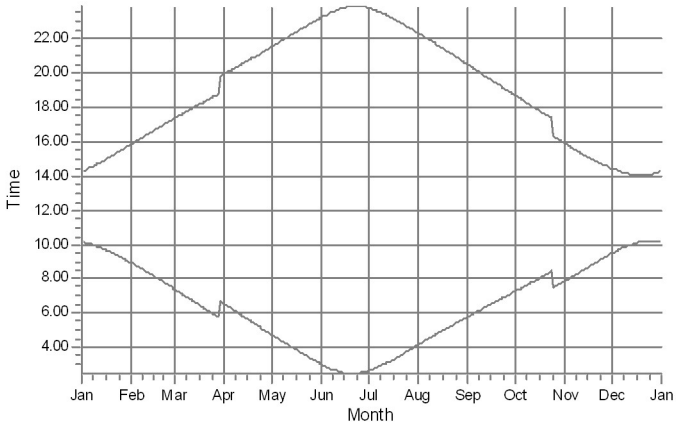
9: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (8)



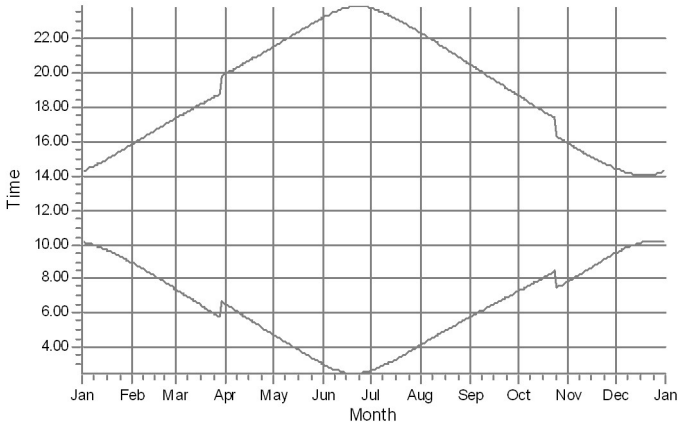
10: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (10)



11: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (11)



12: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (24)



WTGs

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Ville Virtanen / ville.virtanen@ramboll.fi
Calculated:
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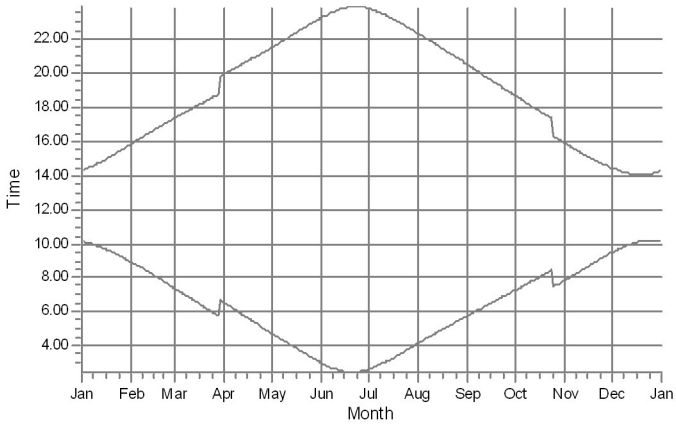
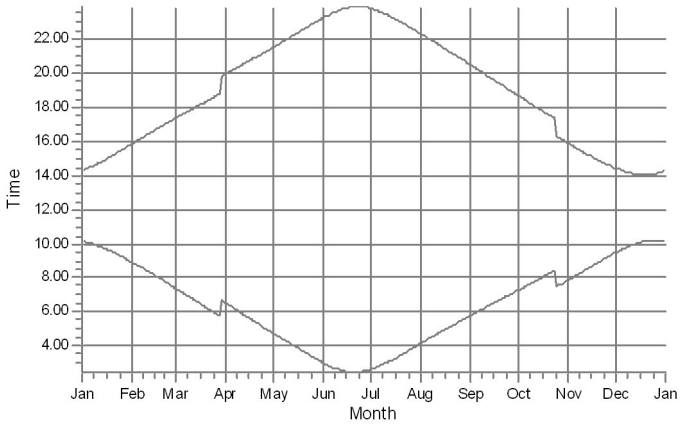
SHADOW - Calendar, graphical

Calculation: PUUSTO V2 Varsavaara_H200_D200

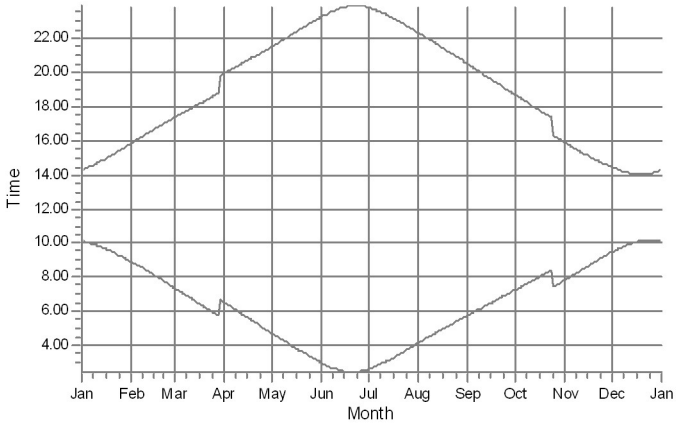
13: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (25)



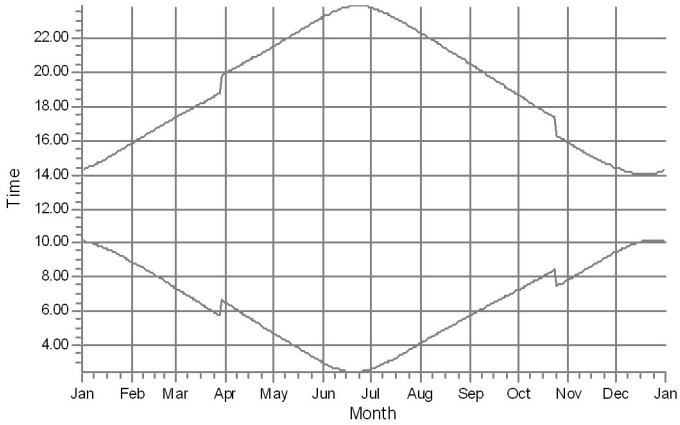
14: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (12)



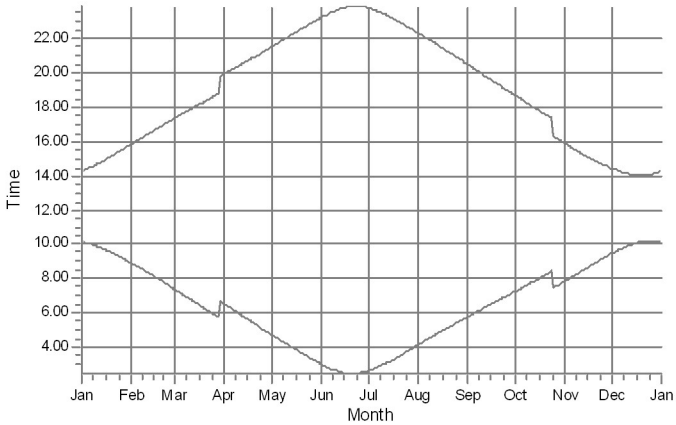
15: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (26)



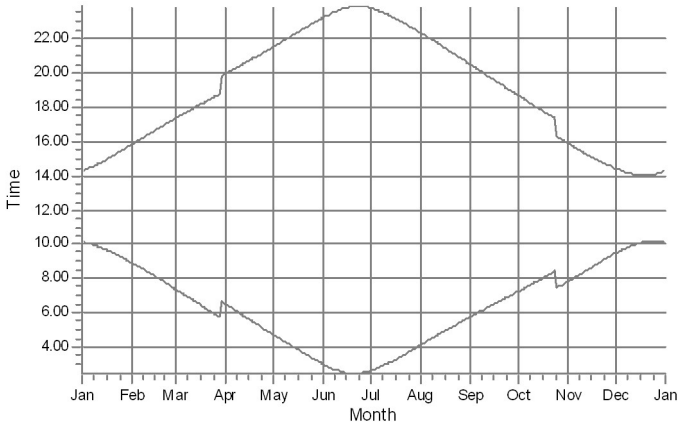
16: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (6)



17: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (5)



18: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (4)



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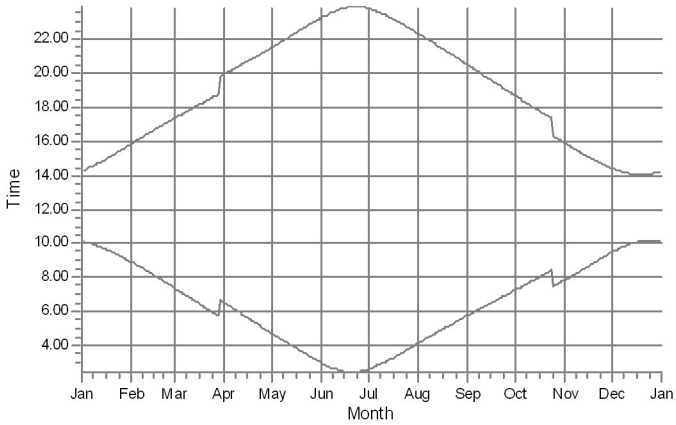
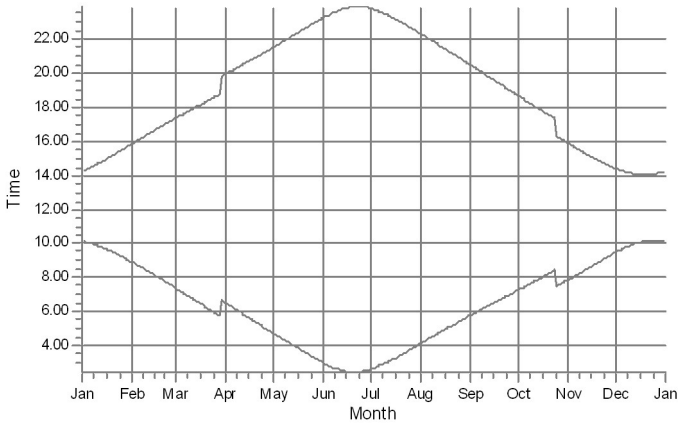
SHADOW - Calendar, graphical

Calculation: PUUSTO V2 Varsavaara_H200_D200

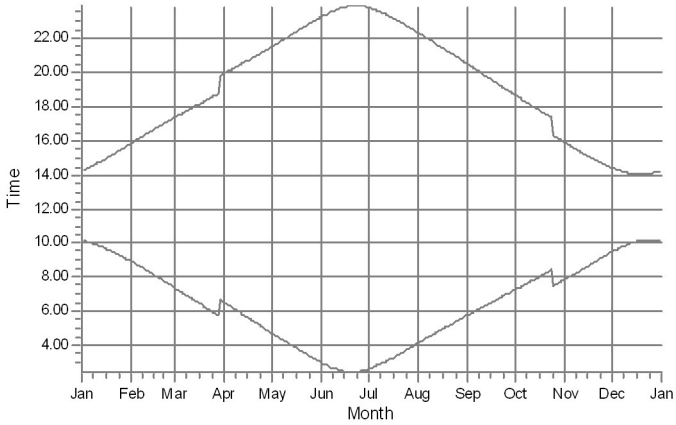
19: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (3)



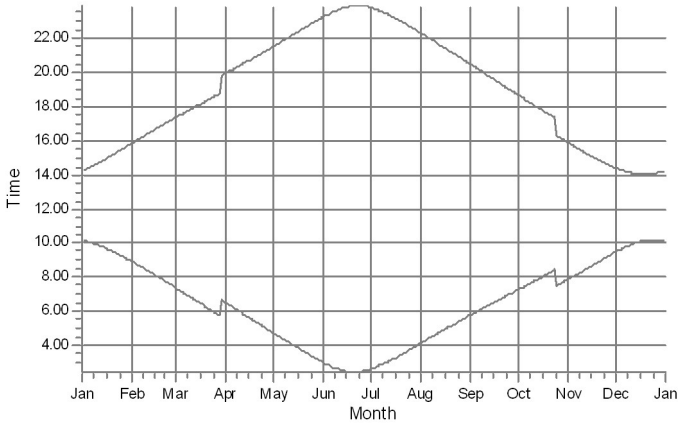
20: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (2)



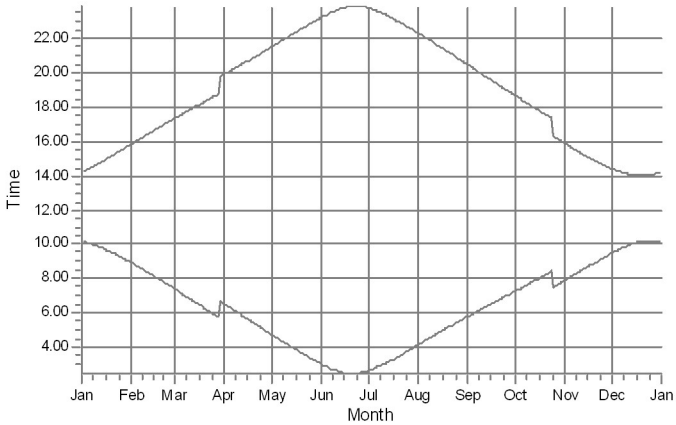
21: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (1)



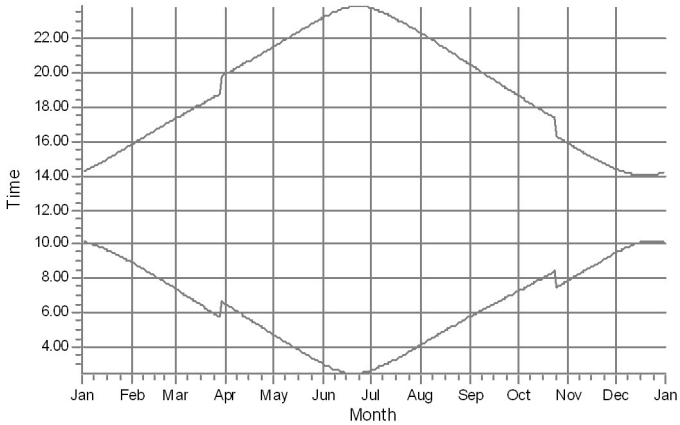
22: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (23)



23: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (22)



24: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (15)



WTGs

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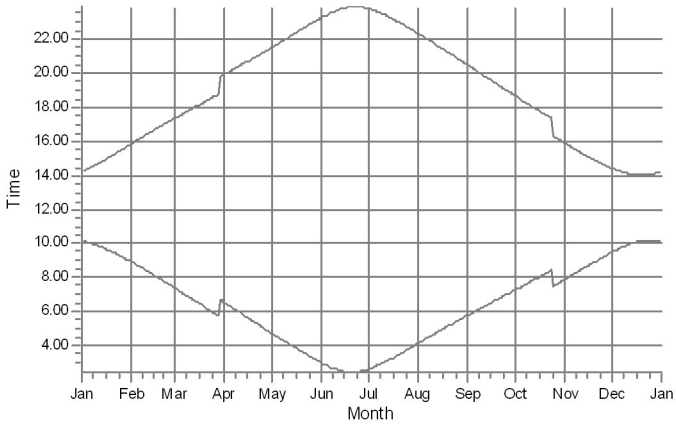
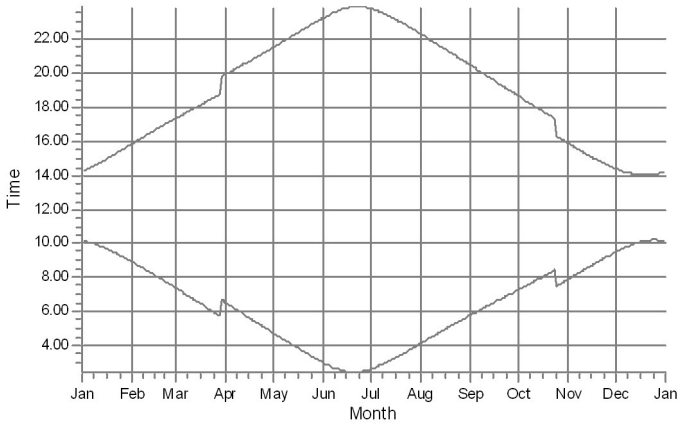
SHADOW - Calendar, graphical

Calculation: PUUSTO V2 Varsavaara_H200_D200

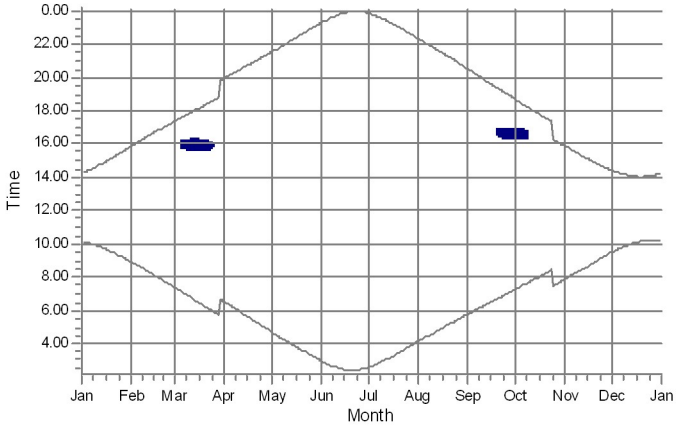
25: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (14)



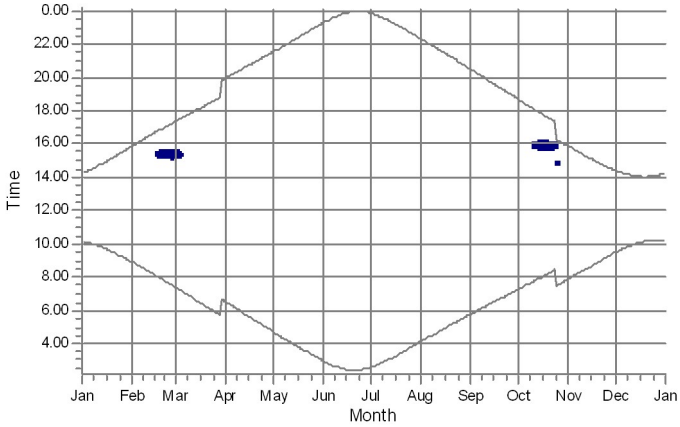
26: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (13)



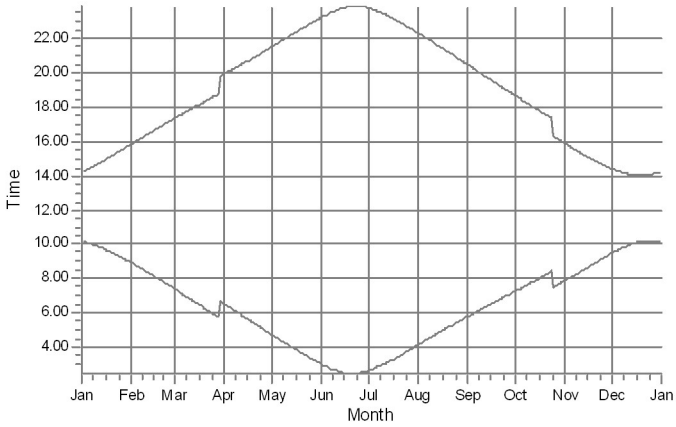
27: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (28)



28: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (27)



29: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (38)



WTGs

7: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0

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Calculated:
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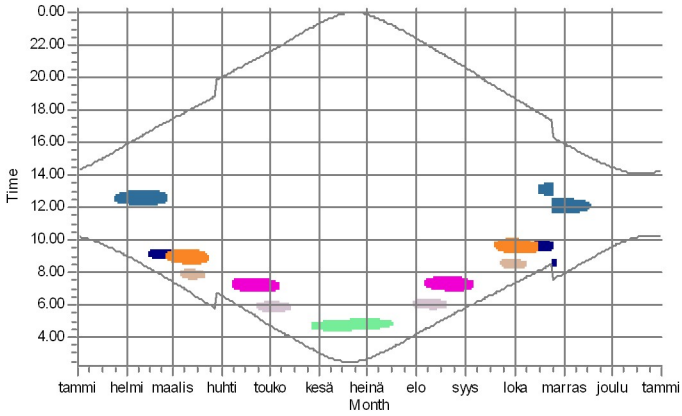
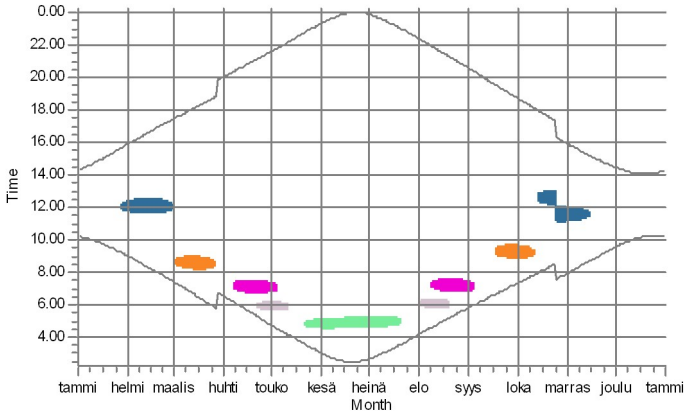
SHADOW - Calendar, graphical

Calculation: Varsavaara+Hietavaara+Hukkalansalo_H200_D200

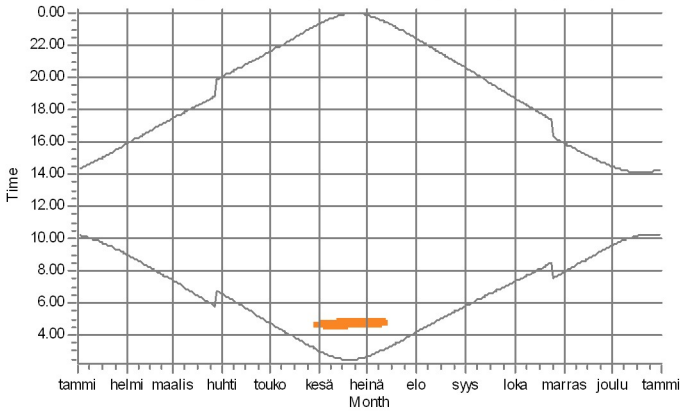
1: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (16)



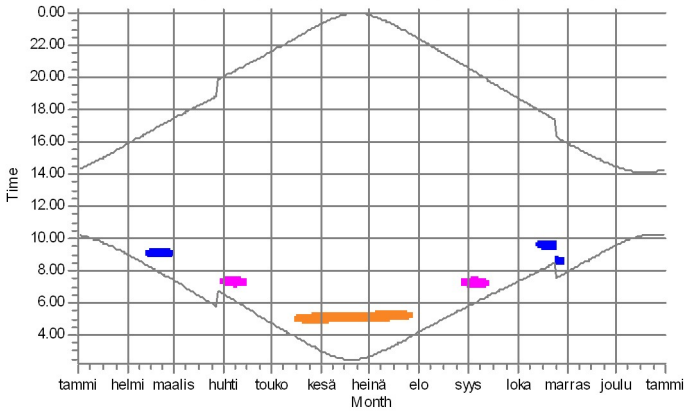
2: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (17)



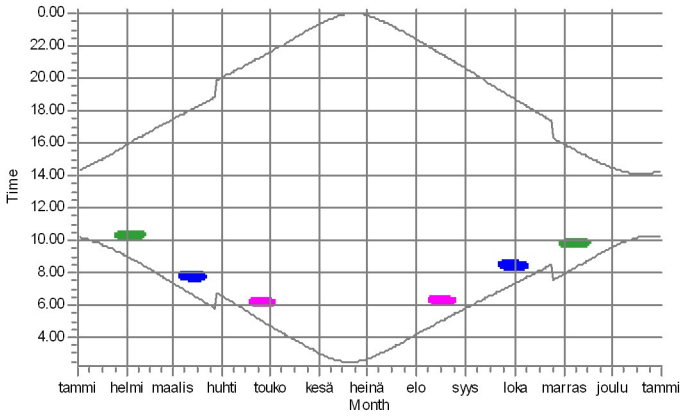
3: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (19)



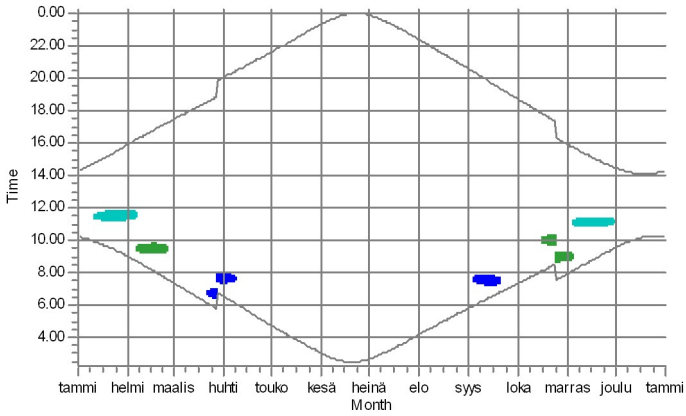
4: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (20)



5: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (18)



6: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (21)



WTGs

3: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
5: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
7: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
17: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
20: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
21: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
22: NORDEX N163/6.X 6800 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (1)
23: NORDEX N163/6.X 6800 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (2)
24: NORDEX N163/6.X 6800 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (3)
25: NORDEX N163/6.X 6800 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (4)
26: NORDEX N163/6.X 6800 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (5)

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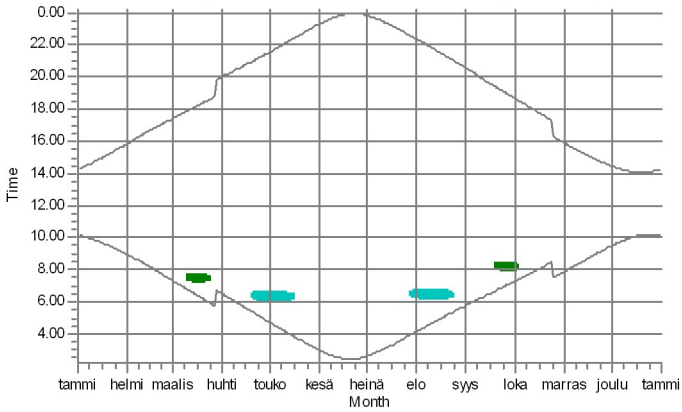
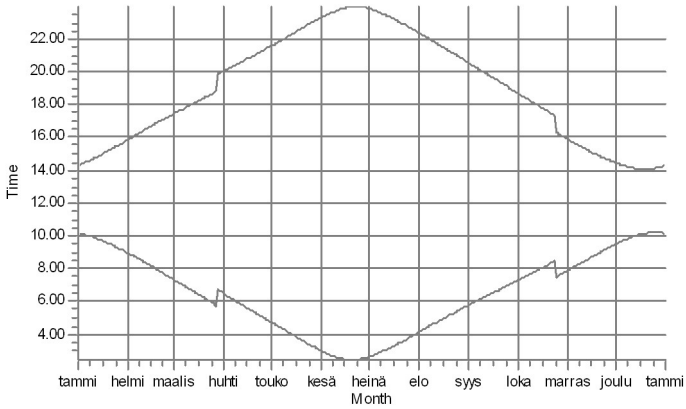
SHADOW - Calendar, graphical

Calculation: Varsavaara+Hietavaara+Hukkalansalo_H200_D200

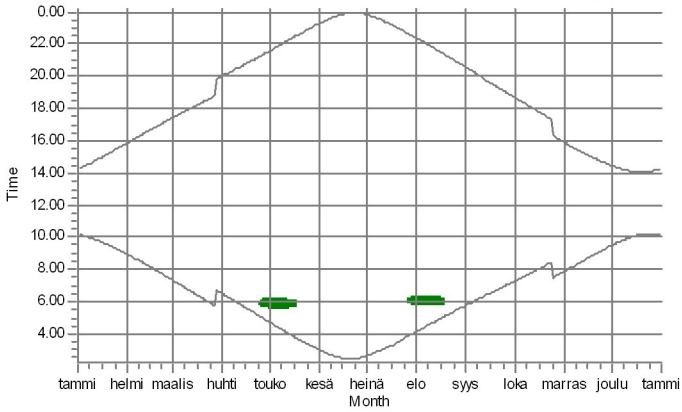
7: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (7)



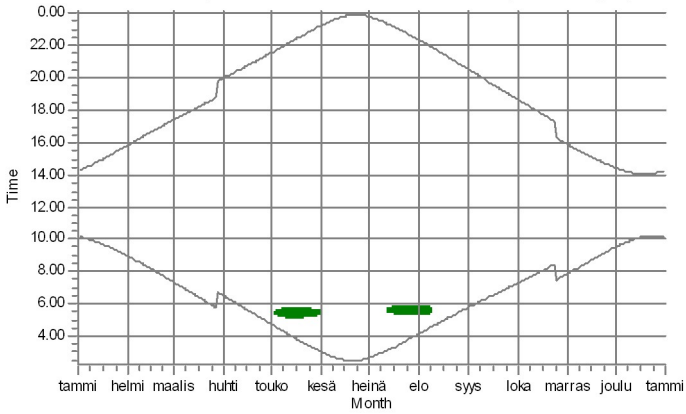
8: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (9)



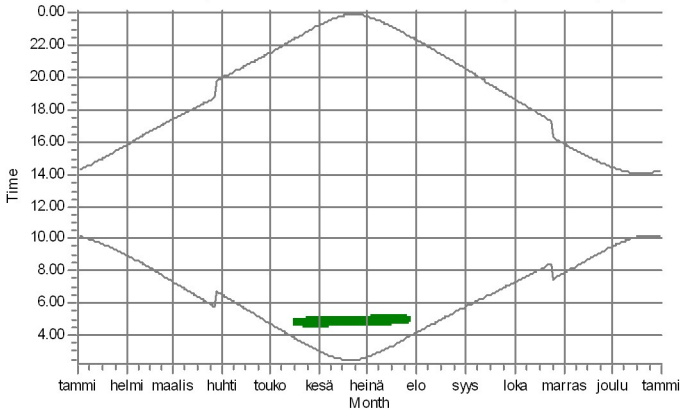
9: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (8)



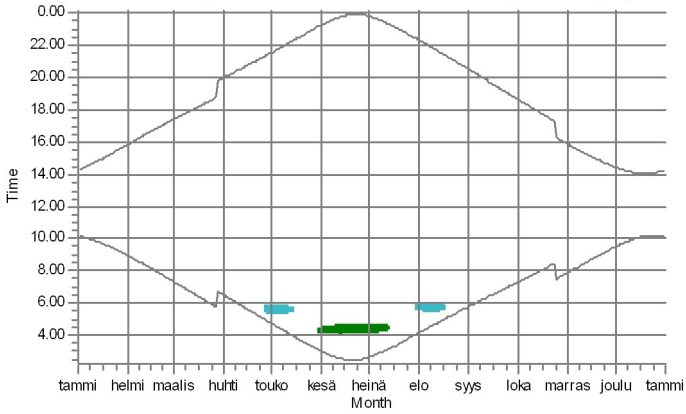
10: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (10)



11: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (11)



12: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (24)



WTGs

1: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0

19: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0

21: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0

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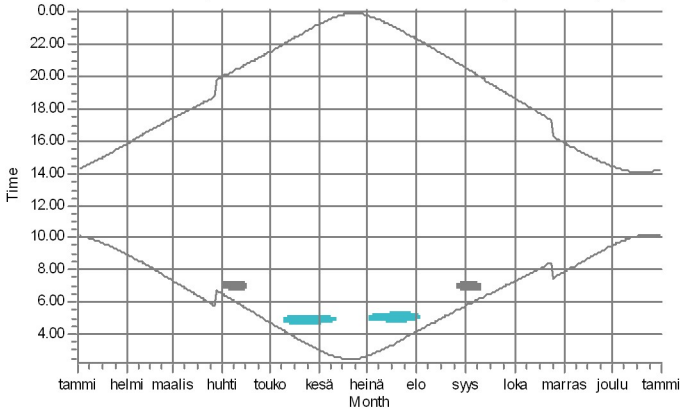
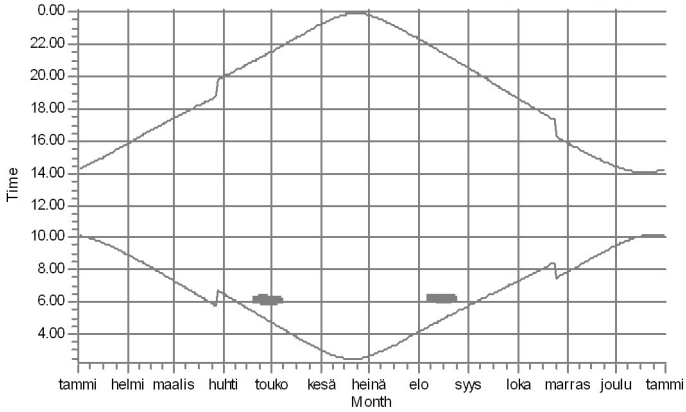
SHADOW - Calendar, graphical

Calculation: Varsavaara+Hietavaara+Hukkalansalo_H200_D200

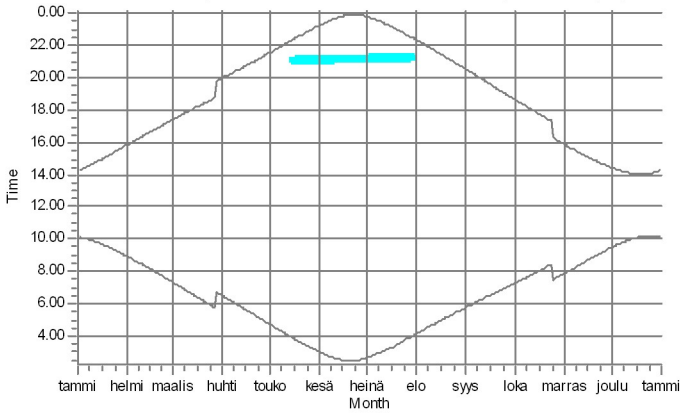
13: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (25)



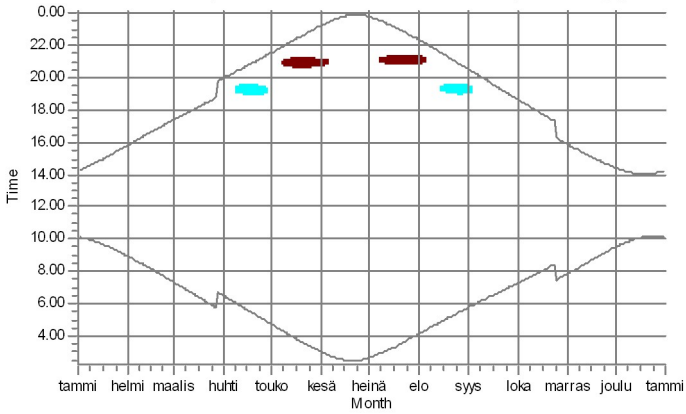
14: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (12)



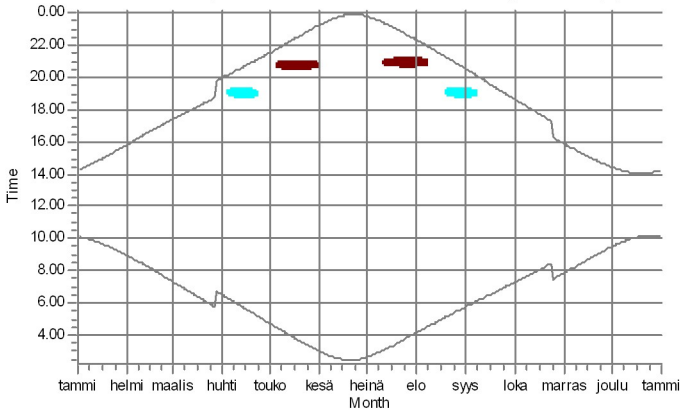
15: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (26)



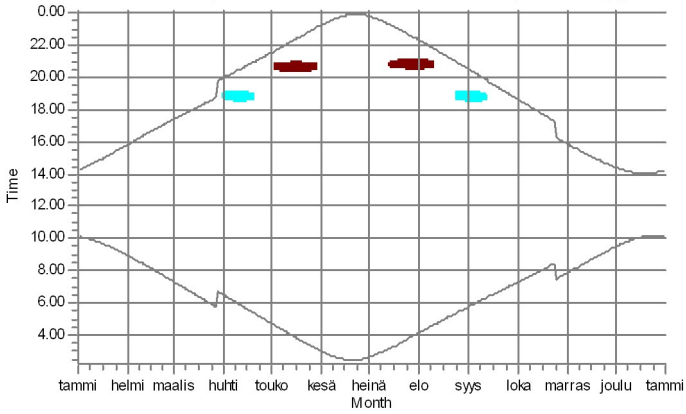
16: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (6)



17: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (5)



18: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (4)



WTGs

4: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
8: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
13: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
19: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0

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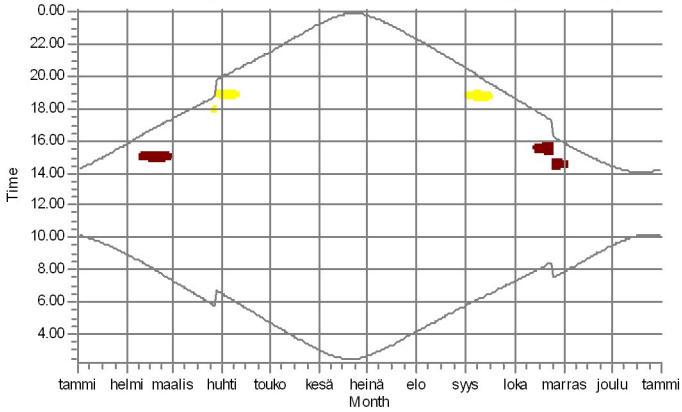
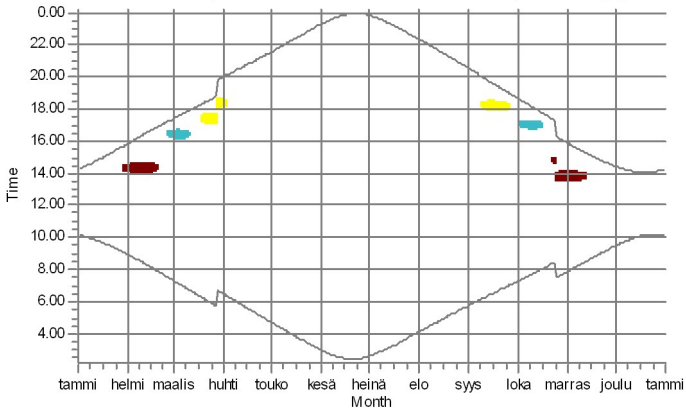
SHADOW - Calendar, graphical

Calculation: Varsavaara+Hietavaara+Hukkalansalo_H200_D200

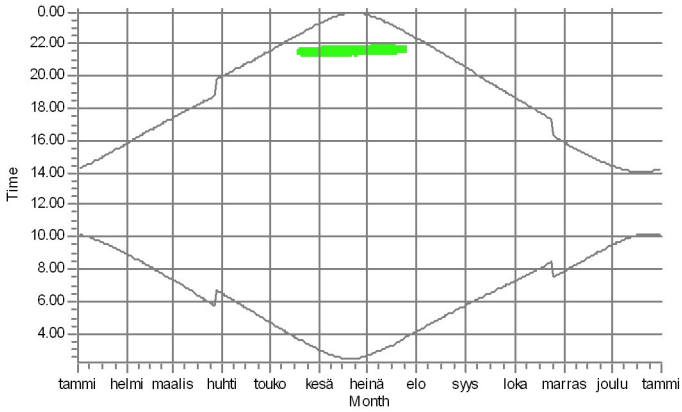
19: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (3)



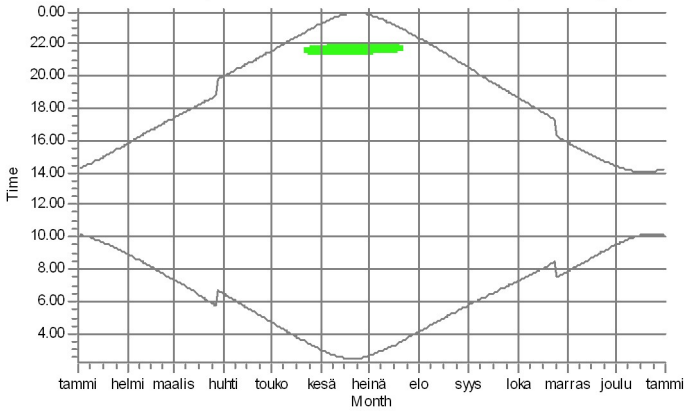
20: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (2)



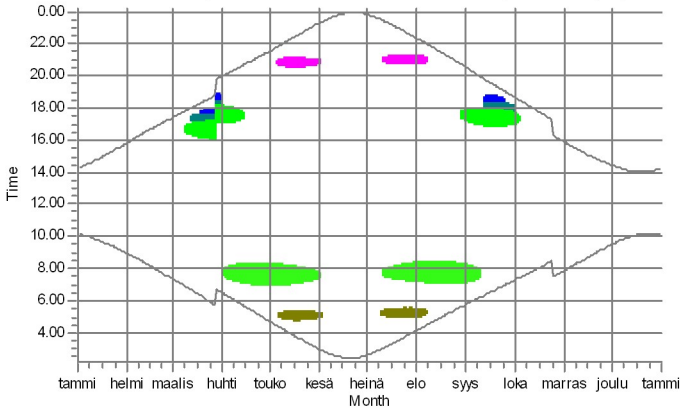
21: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (1)



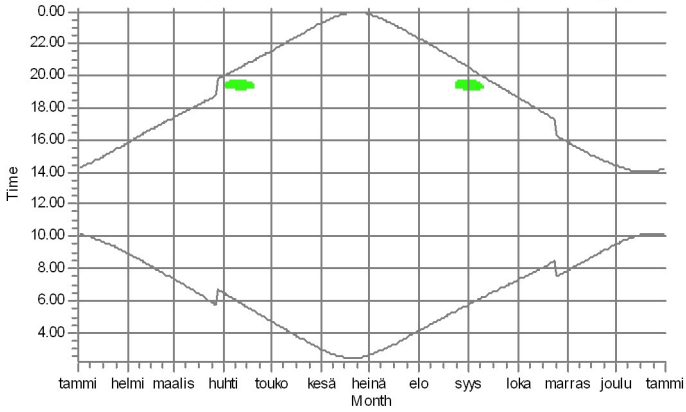
22: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (23)



23: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (22)



24: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (15)



WTGs

2: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
3: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
5: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
6: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
8: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
9: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
10: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
18: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
19: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0

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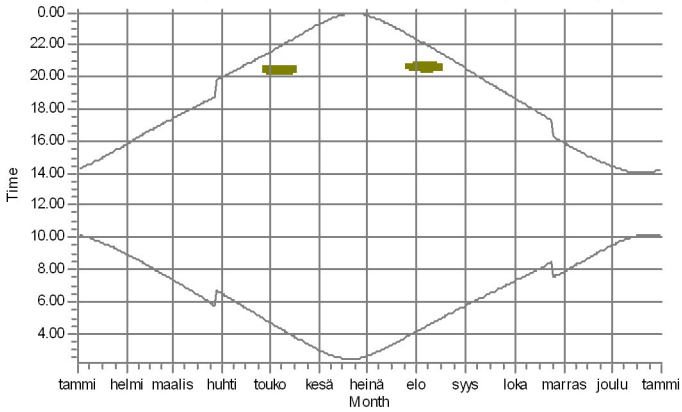
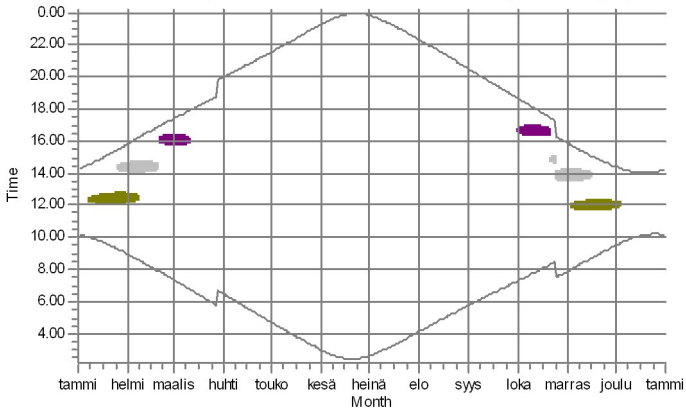
SHADOW - Calendar, graphical

Calculation: Varsavaara+Hietavaara+Hukkalansalo_H200_D200

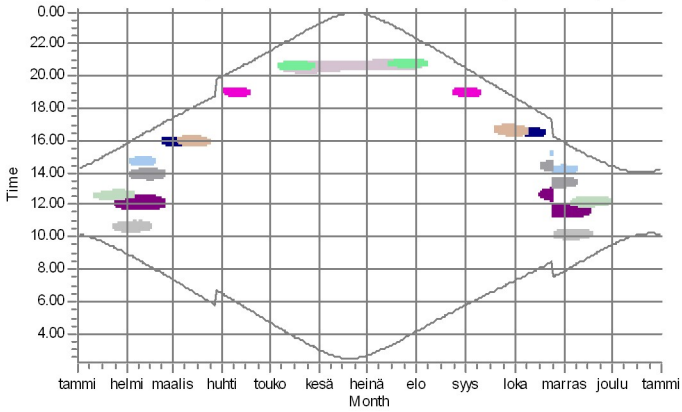
25: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (14)



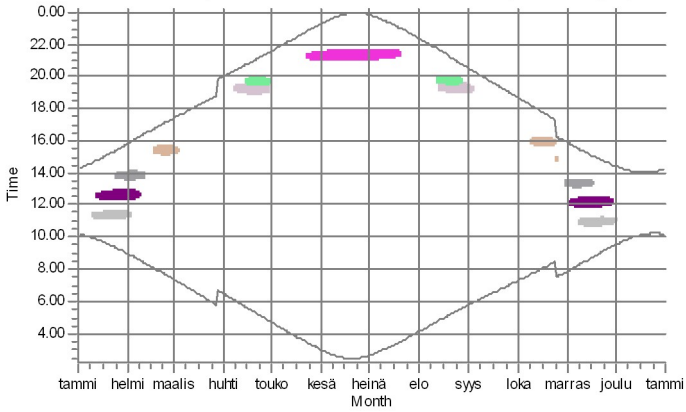
26: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (13)



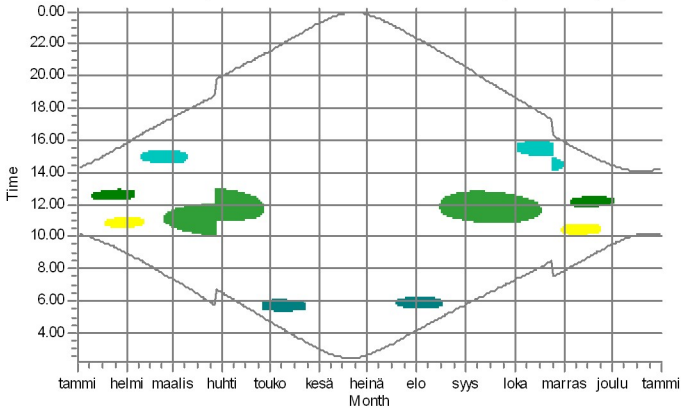
27: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (28)



28: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (27)



29: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (38)



WTGs

1: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
2: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
6: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
7: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
10: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
11: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
12: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
14: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
15: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
16: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
17: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
20: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
21: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
24: NORDEX N163/6.X 6800 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (3)
25: NORDEX N163/6.X 6800 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (4)
26: NORDEX N163/6.X 6800 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (5)
31: NORDEX N163/6.X 6800 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (10)

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Calculated:
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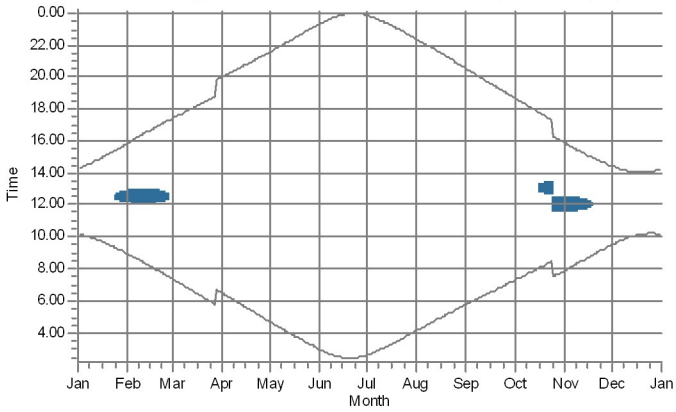
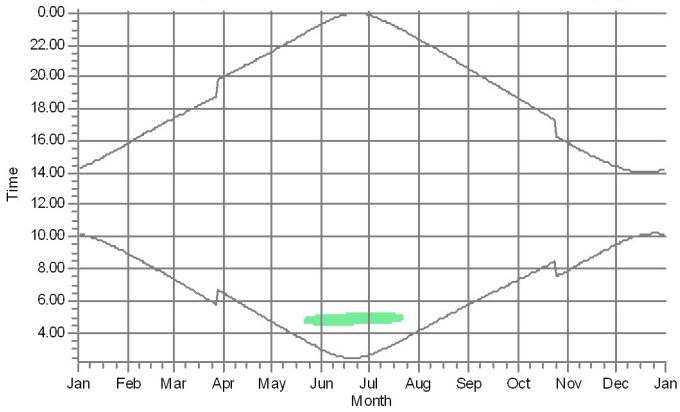
SHADOW - Calendar, graphical

Calculation: PUUSTO Varsavaara+Hietavaara+Hukkalansalo_H200_D200

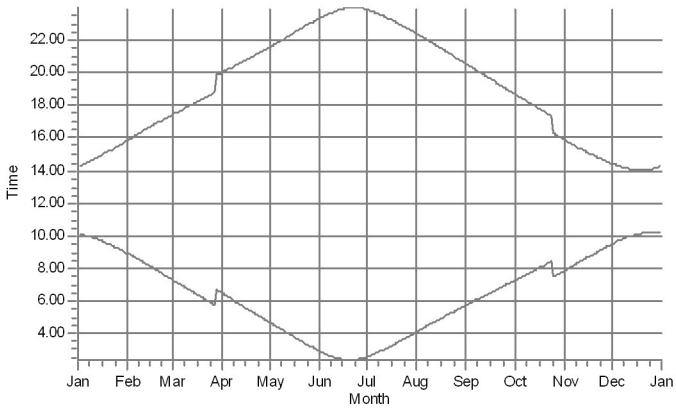
1: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (16)



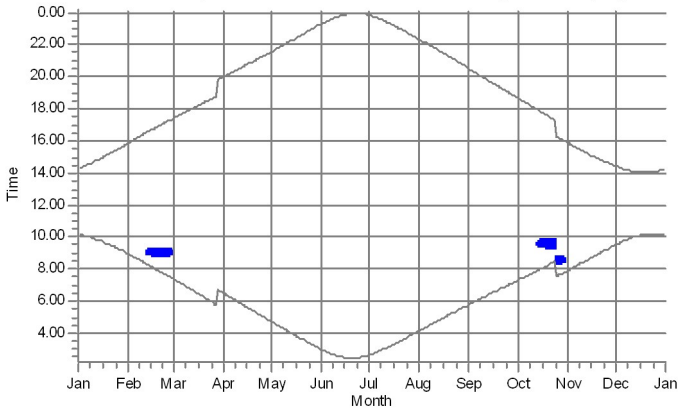
2: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (17)



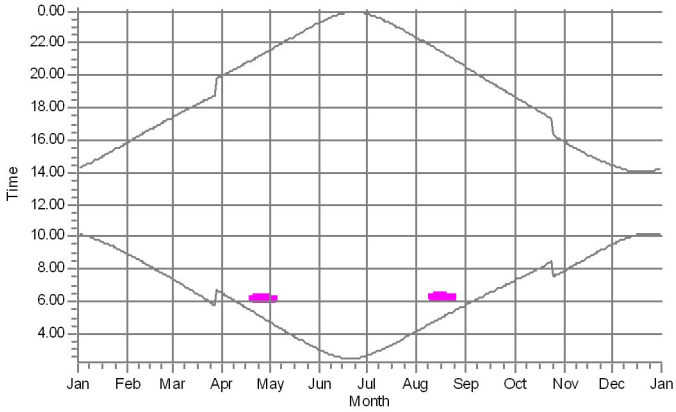
3: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (19)



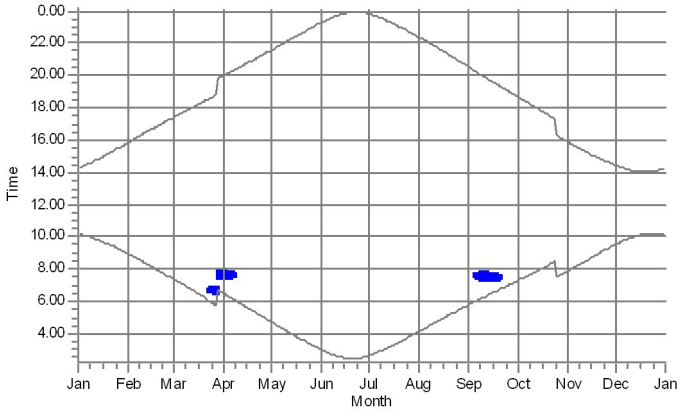
4: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (20)



5: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (18)



6: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (21)



WTGs

3: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
5: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
22: NORDEX N163/6.X 6800 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (1)
26: NORDEX N163/6.X 6800 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (5)

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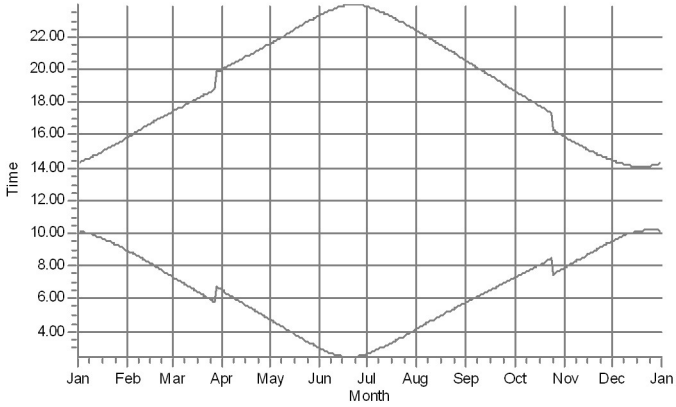
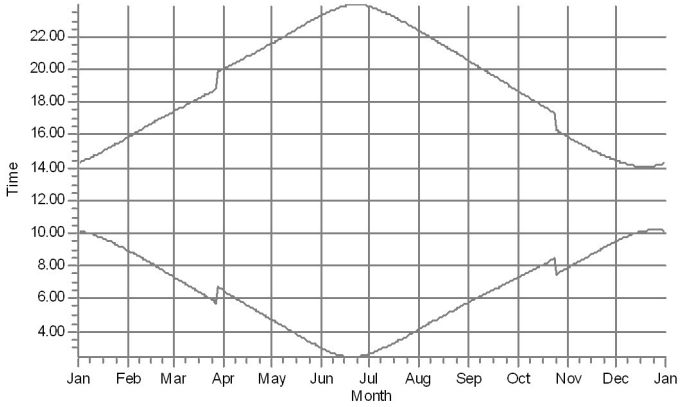
SHADOW - Calendar, graphical

Calculation: PUUSTO Varsavaara+Hietavaara+Hukkalansalo_H200_D200

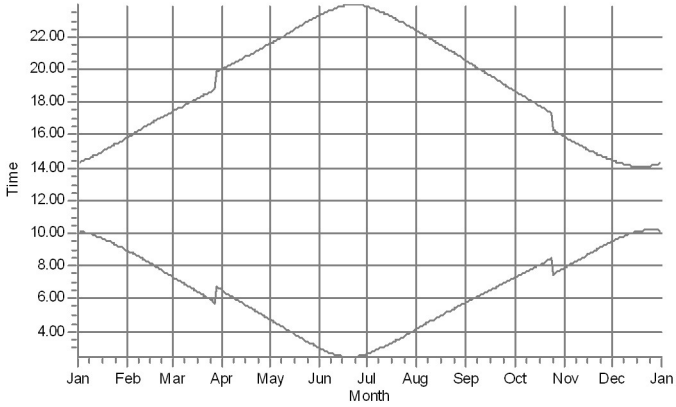
7: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (7)



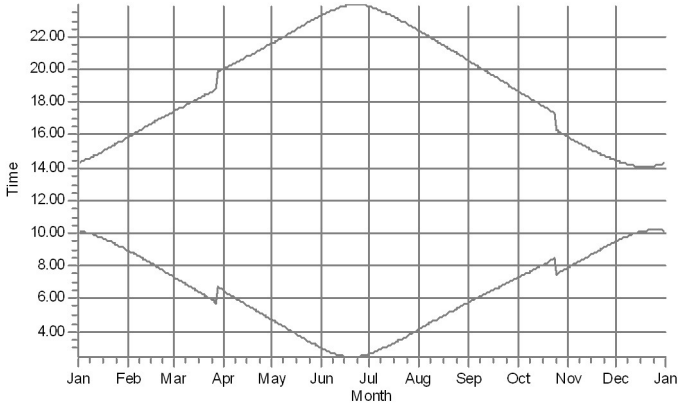
8: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (9)



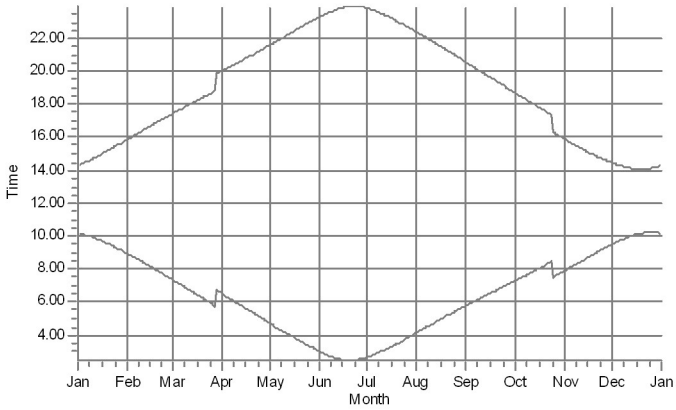
9: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (8)



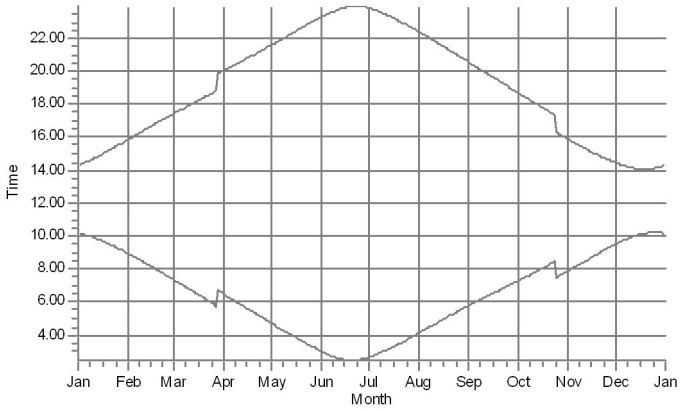
10: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (10)



11: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (11)



12: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (24)



WTGs

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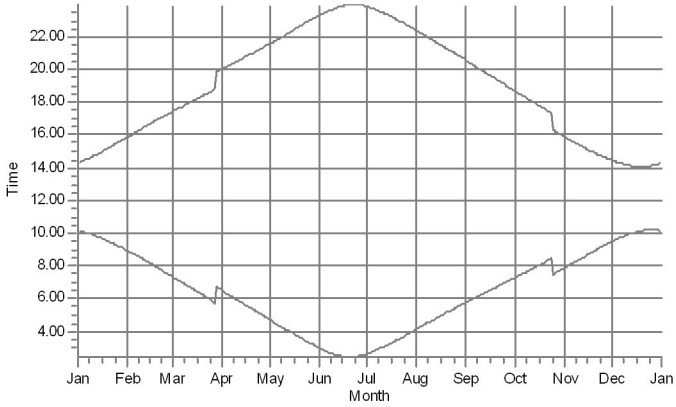
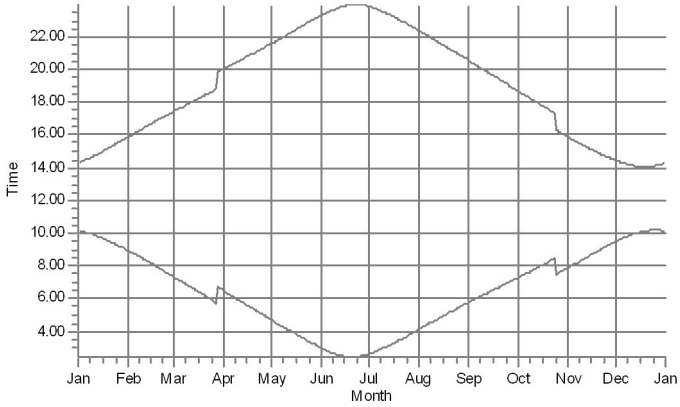
SHADOW - Calendar, graphical

Calculation: PUUSTO Varsavaara+Hietavaara+Hukkalansalo_H200_D200

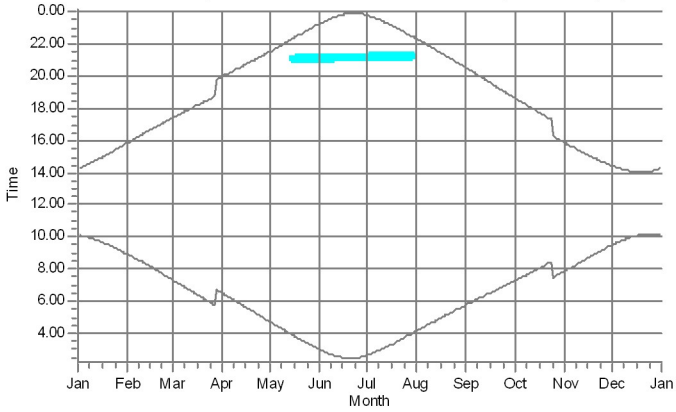
13: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (25)



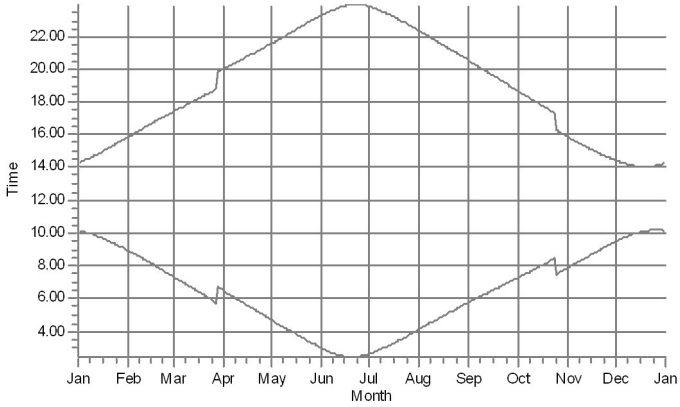
14: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (12)



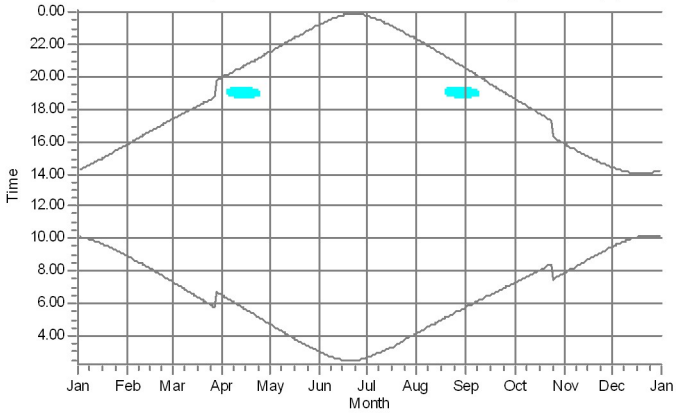
15: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (26)



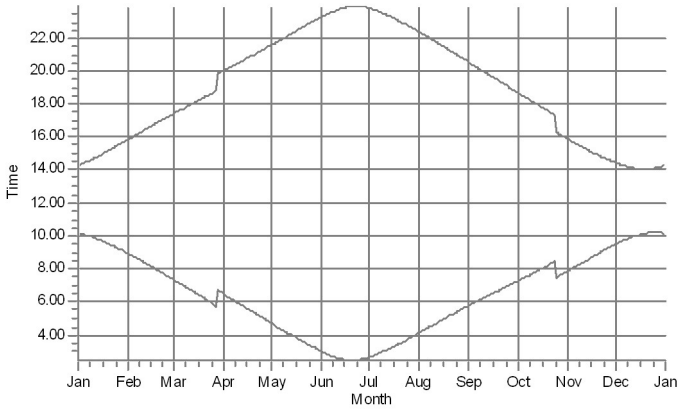
16: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (6)



17: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (5)



18: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (4)



WTGs

13: Generic Generic 200-200 10000 200.0 l-l hub: 200,0 m (TOT: 300,0

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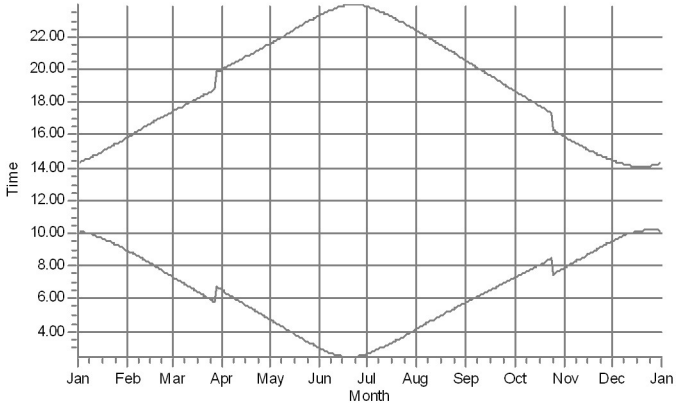
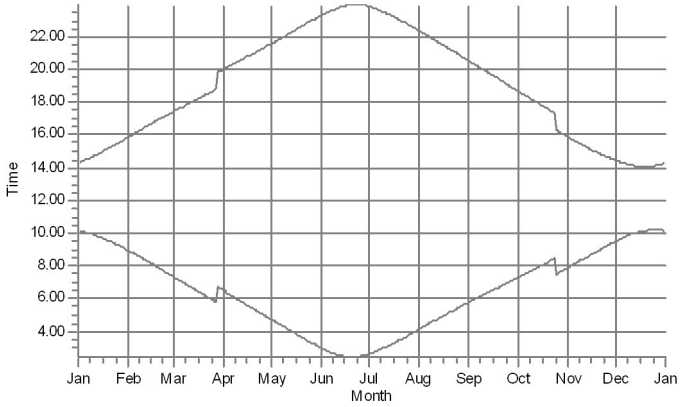
SHADOW - Calendar, graphical

Calculation: PUUSTO Varsavaara+Hietavaara+Hukkalansalo_H200_D200

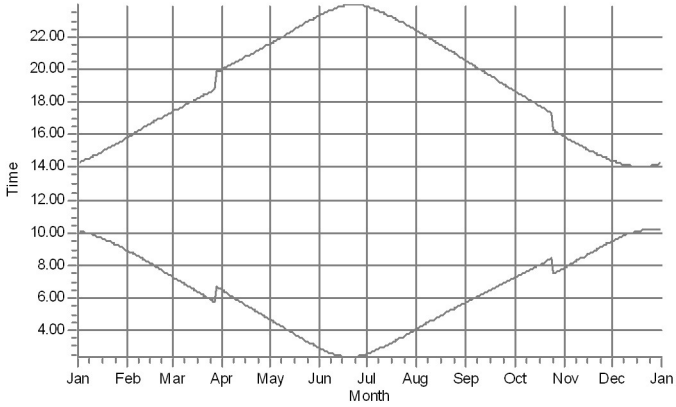
19: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (3)



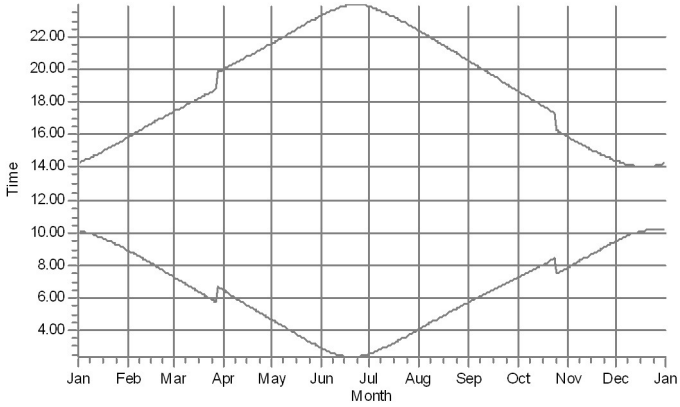
20: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (2)



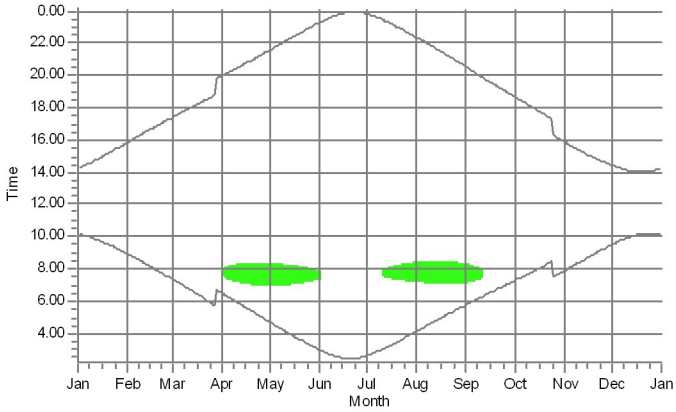
21: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (1)



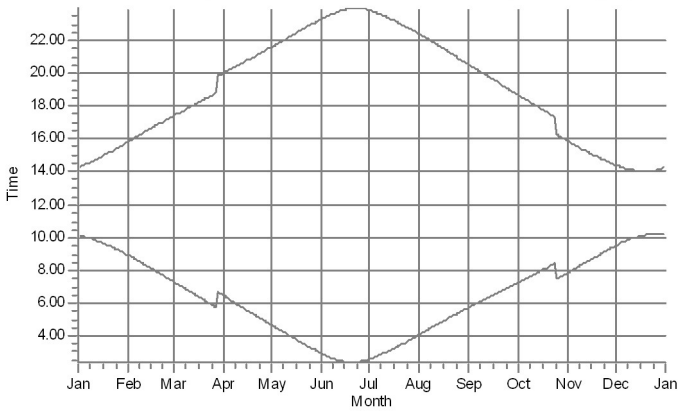
22: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (23)



23: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (22)



24: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (15)



WTGs

18: Generic Generic 200-200 10000 200.0 l-l hub: 200,0 m (TOT: 300,0

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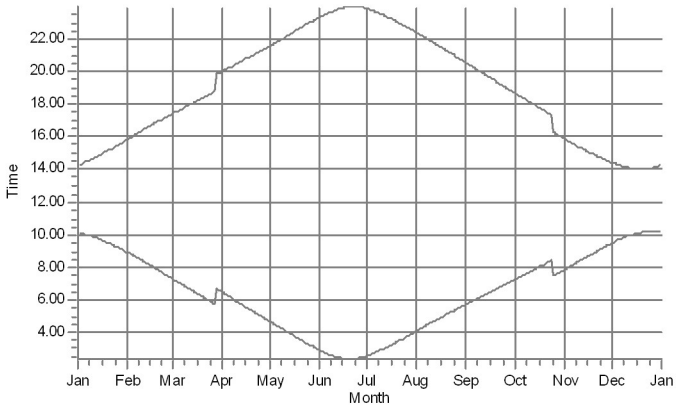
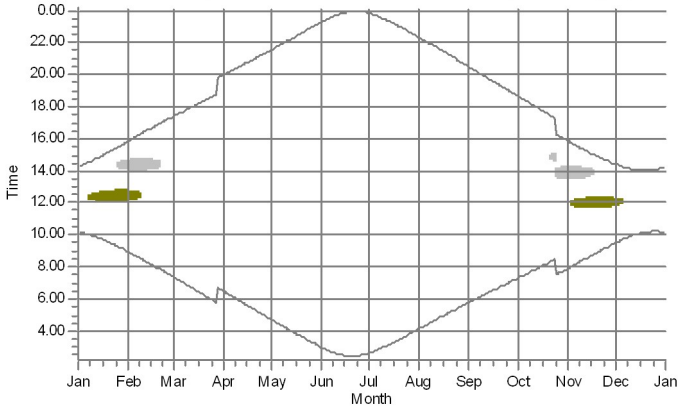
SHADOW - Calendar, graphical

Calculation: PUUSTO Varsavaara+Hietavaara+Hukkalansalo_H200_D200

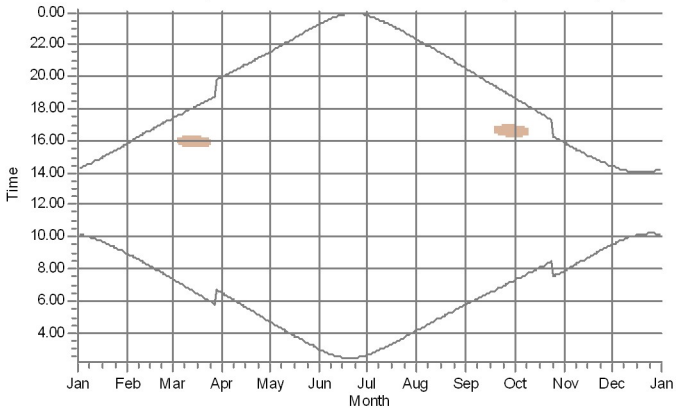
25: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (14)



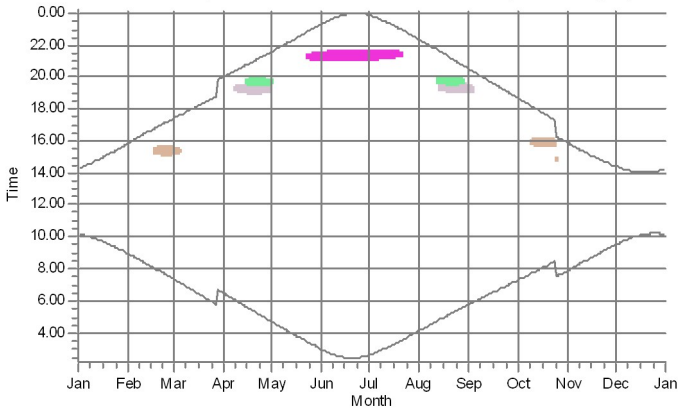
26: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (13)



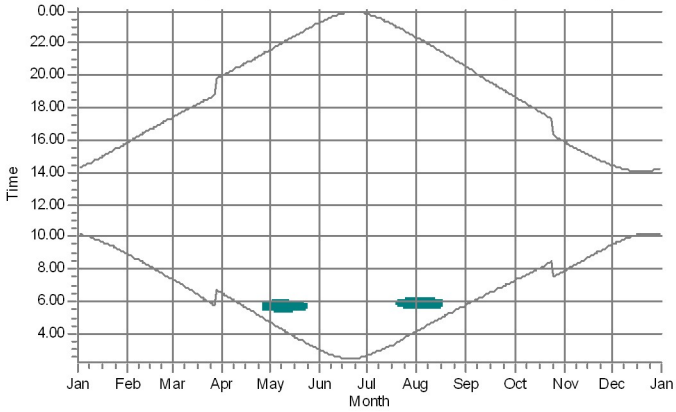
27: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (28)



28: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (27)



29: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (38)



WTGs

6: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
10: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
12: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
17: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
25: NORDEX N163/6.X 6800 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (4)
26: NORDEX N163/6.X 6800 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (5)
31: NORDEX N163/6.X 6800 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (10)

Project:
WindPro_Varsavaara_Pieni-Paljakka

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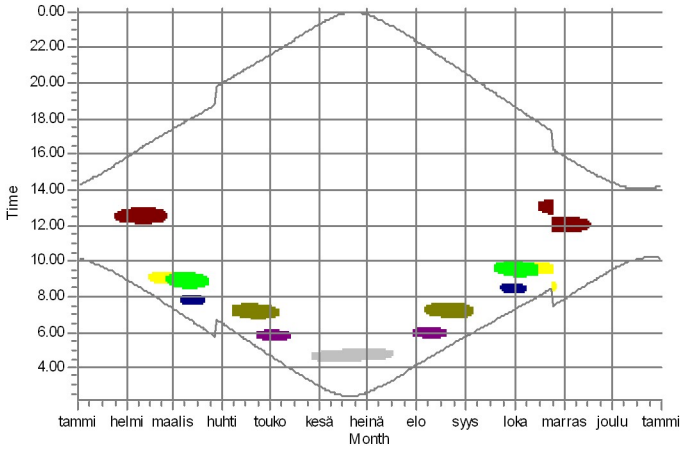
Calculated:
14/10/2022 15.04/3.4.388

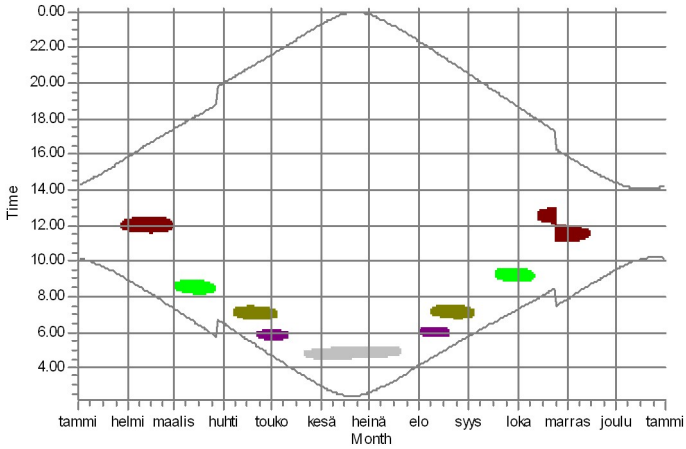
SHADOW - Calendar, graphical

Calculation: V2 Varsavaara+Hietavaara+Hukkalansalo_H200_D200

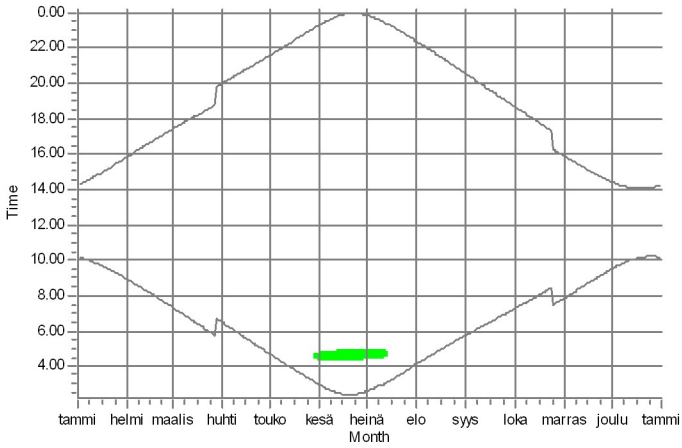
1: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (16)



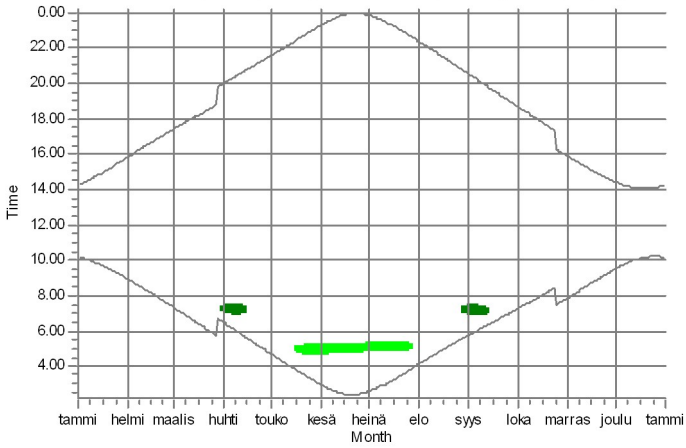
2: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (17)



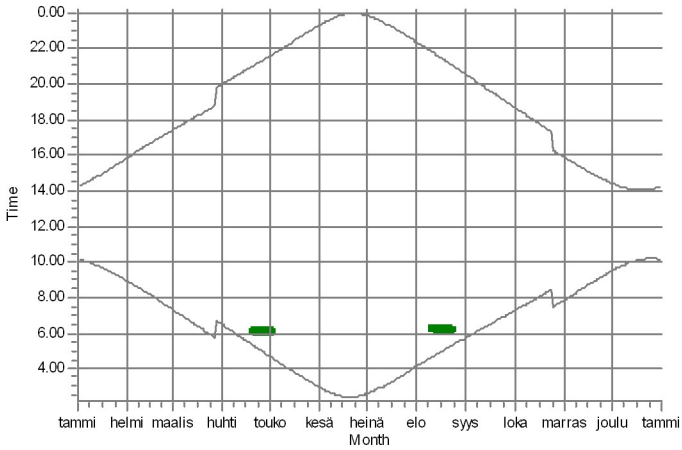
3: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (19)



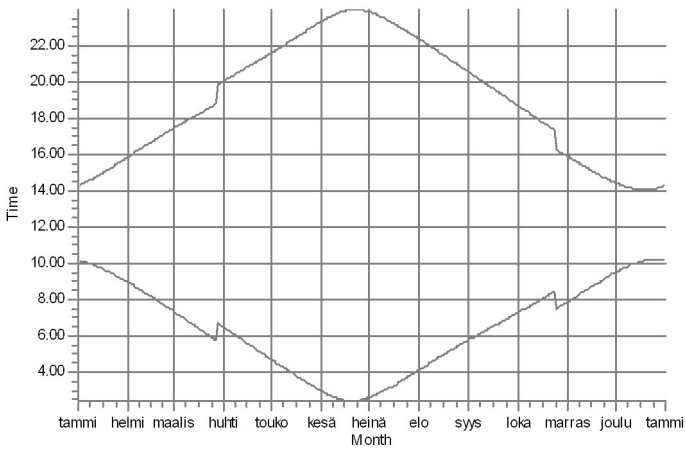
4: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (20)



5: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (18)



6: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (21)



WTGs

1: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
2: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
7: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
8: NORDEX N163/6.X 6800 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (1)
9: NORDEX N163/6.X 6800 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (2)
10: NORDEX N163/6.X 6800 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (3)
11: NORDEX N163/6.X 6800 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (4)
12: NORDEX N163/6.X 6800 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (5)

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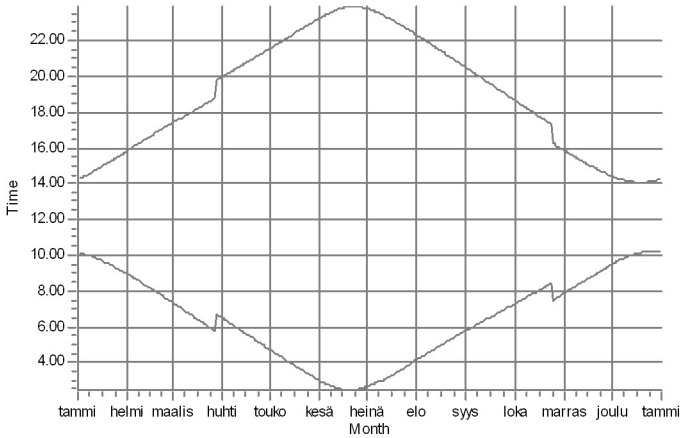
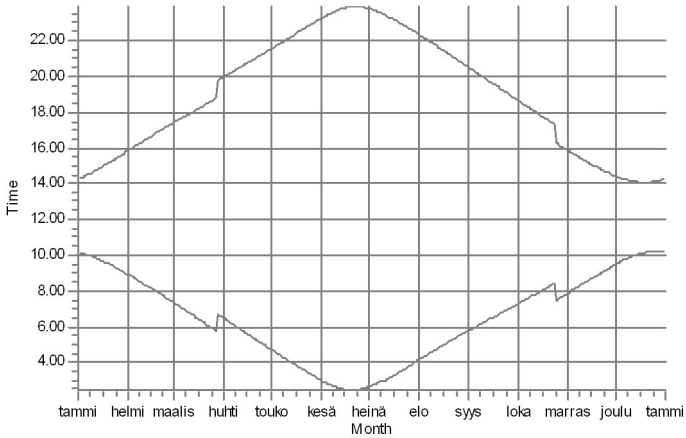
SHADOW - Calendar, graphical

Calculation: V2 Varsavaara+Hietavaara+Hukkalansalo_H200_D200

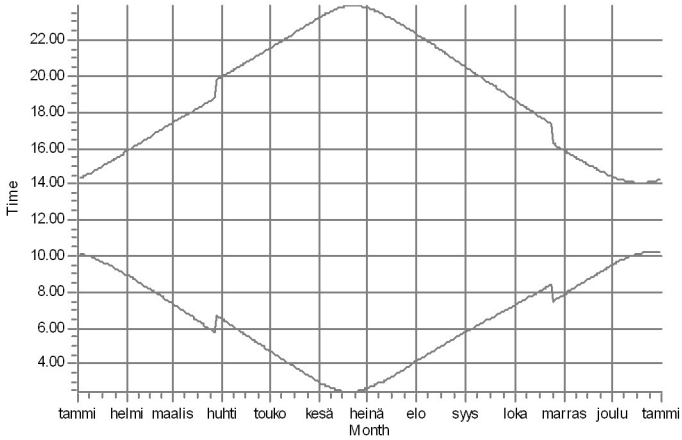
7: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (7)



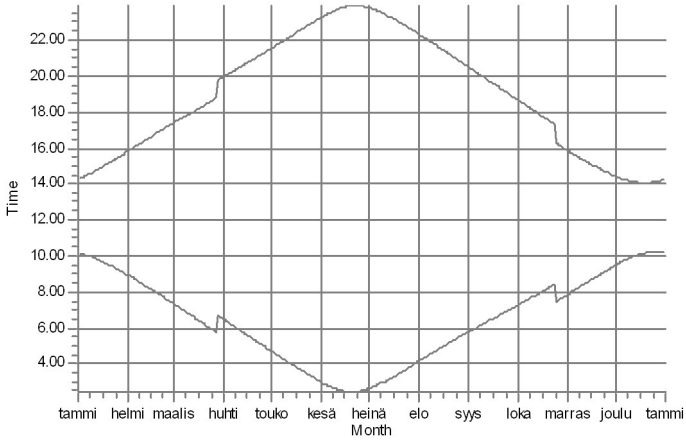
8: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (9)



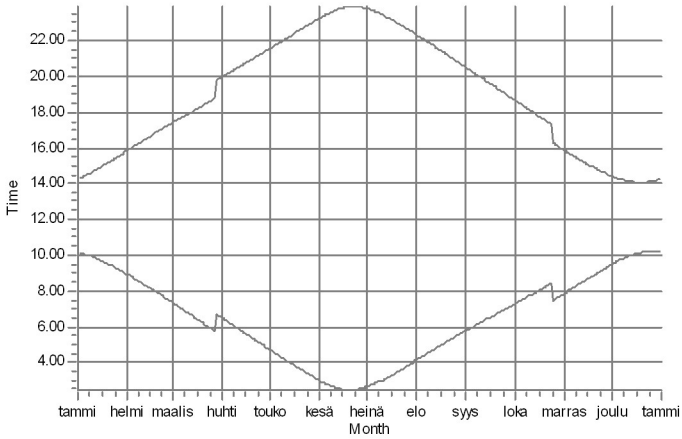
9: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (8)



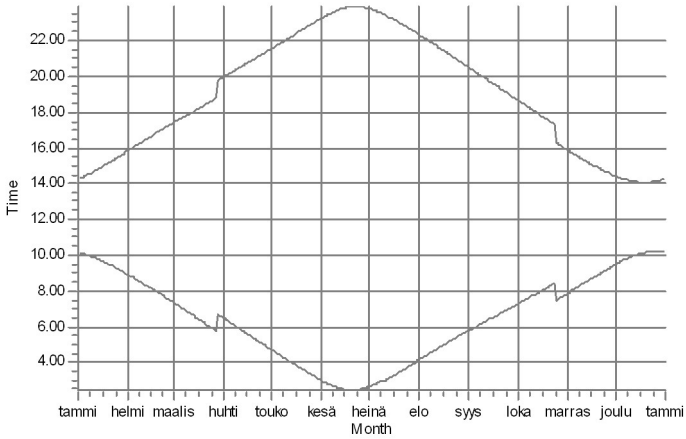
10: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (10)



11: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (11)



12: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (24)



WTGs

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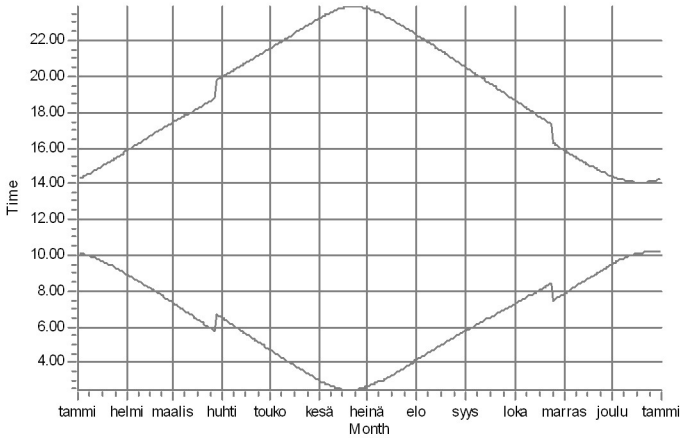
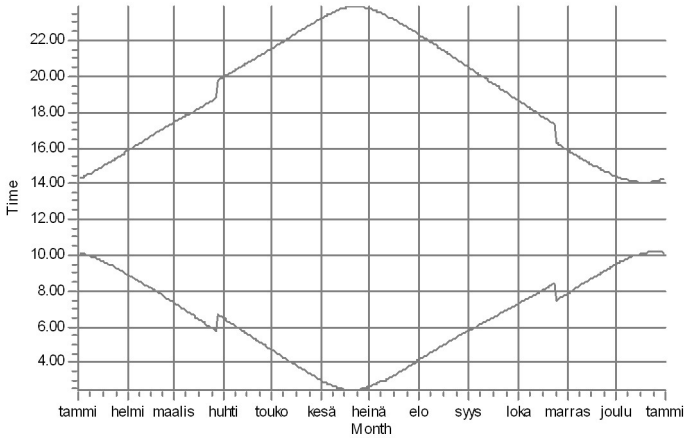
SHADOW - Calendar, graphical

Calculation: V2 Varsavaara+Hietavaara+Hukkalansalo_H200_D200

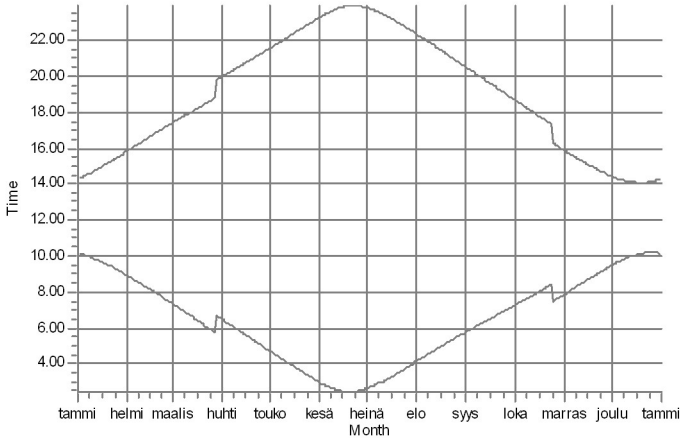
13: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (25)



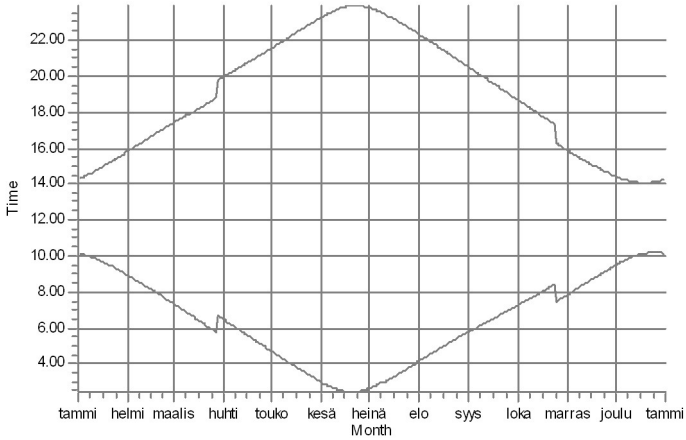
14: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (12)



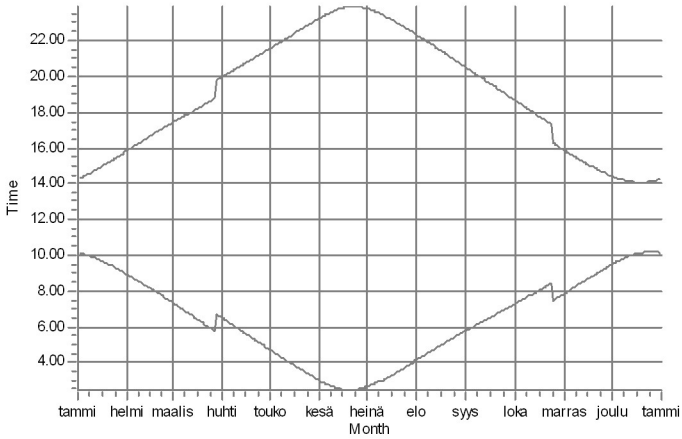
15: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (26)



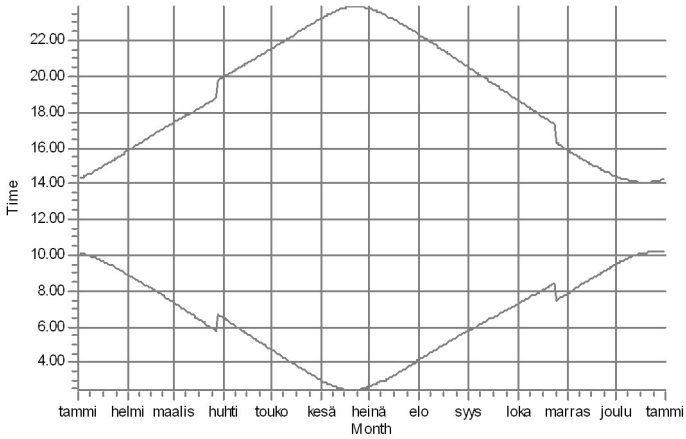
16: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (6)



17: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (5)



18: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (4)



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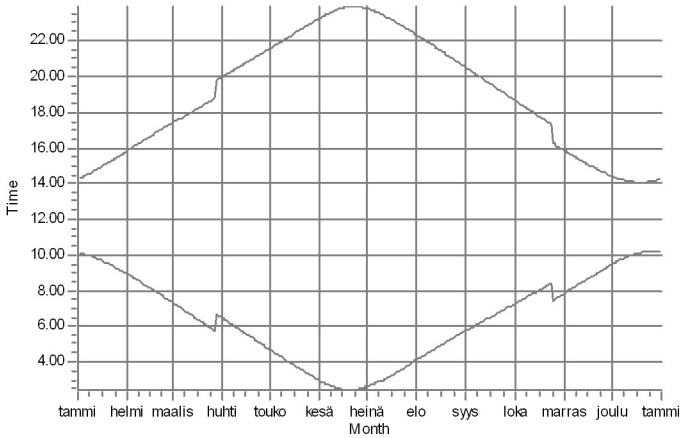
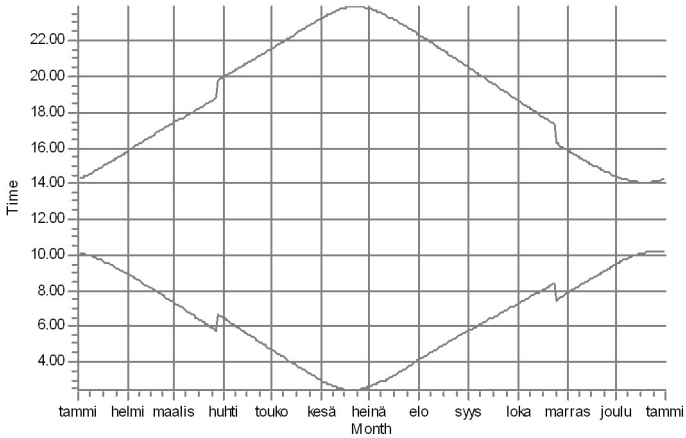
SHADOW - Calendar, graphical

Calculation: V2 Varsavaara+Hietavaara+Hukkalansalo_H200_D200

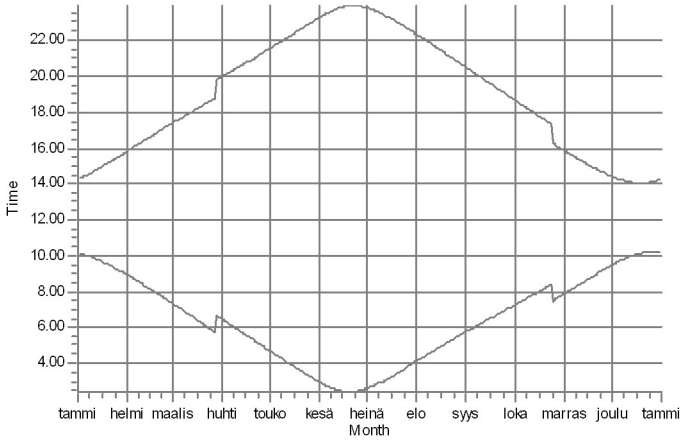
19: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (3)



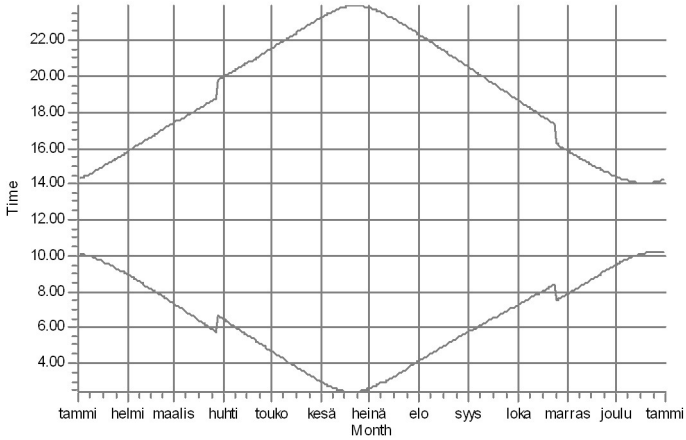
20: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (2)



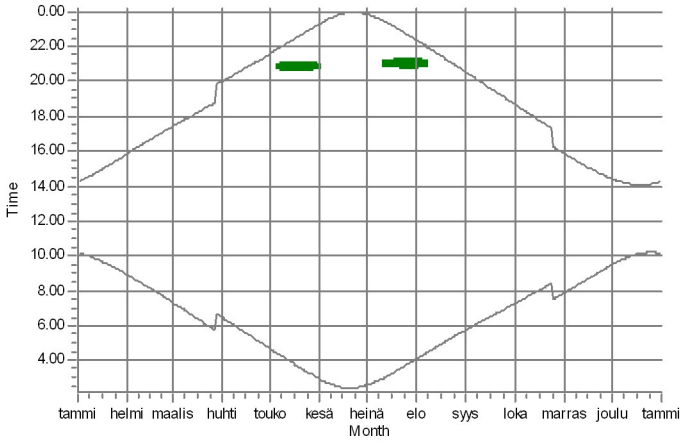
21: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (1)



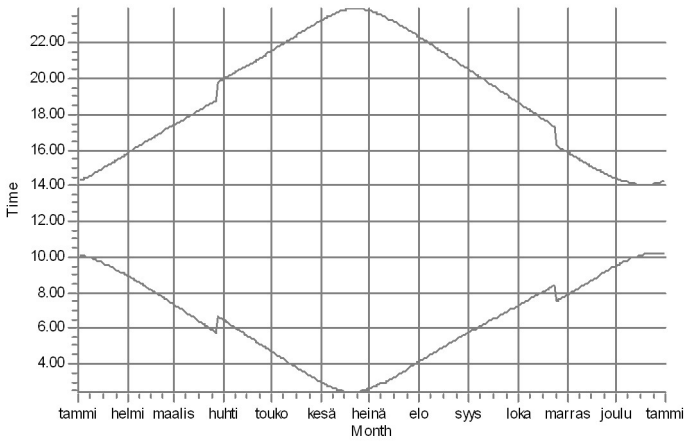
22: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (23)



23: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (22)



24: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (15)



WTGs

1: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0

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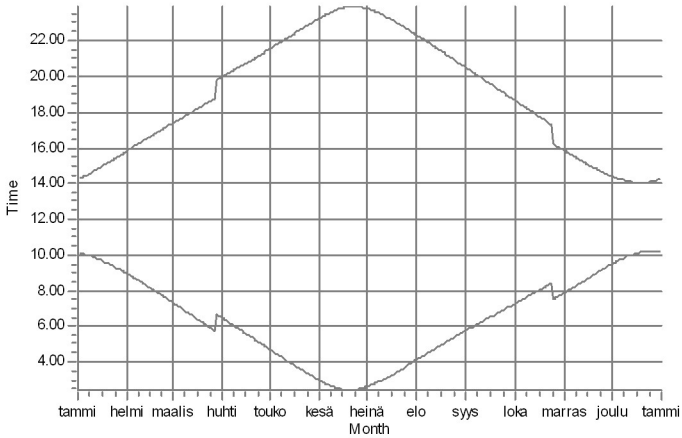
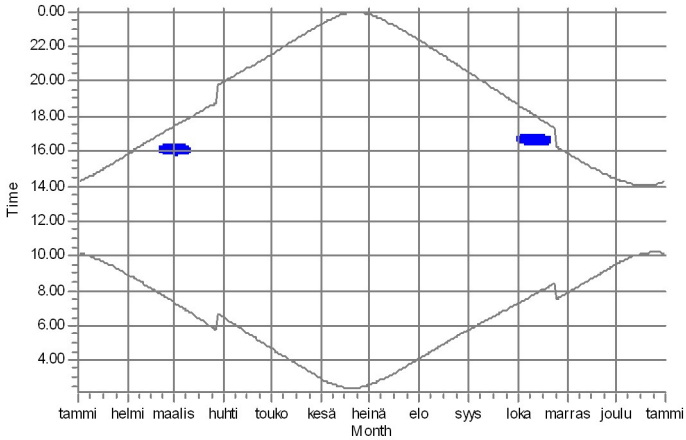
SHADOW - Calendar, graphical

Calculation: V2 Varsavaara+Hietavaara+Hukkalansalo_H200_D200

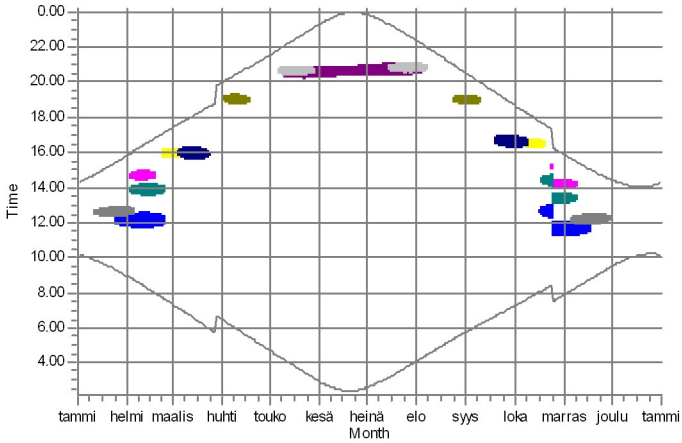
25: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (14)



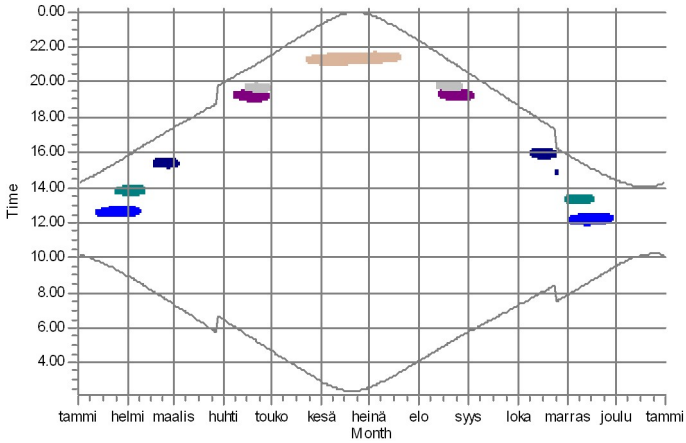
26: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (13)



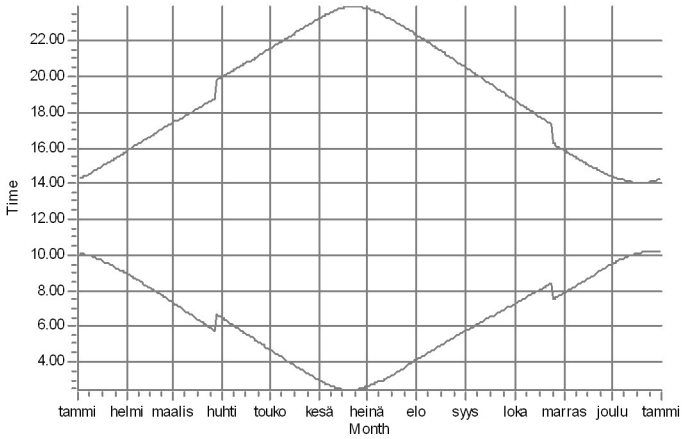
27: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (28)



28: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (27)



29: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (38)



WTGs

- 2: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 3: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 4: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 5: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 6: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 7: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 10: NORDEX N163/6.X 6800 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (3)
- 11: NORDEX N163/6.X 6800 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (4)
- 12: NORDEX N163/6.X 6800 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (5)
- 17: NORDEX N163/6.X 6800 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (10)

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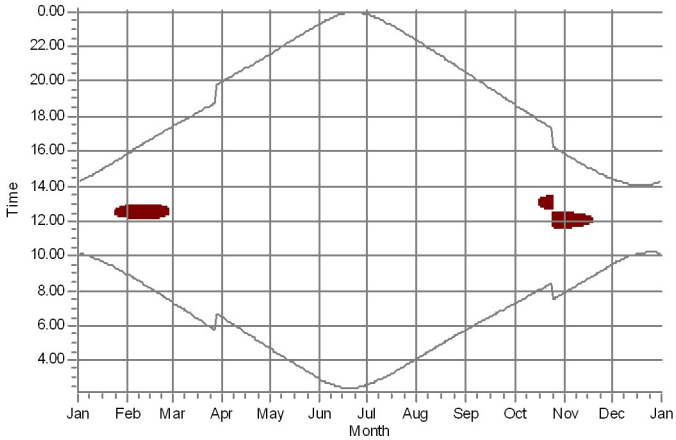
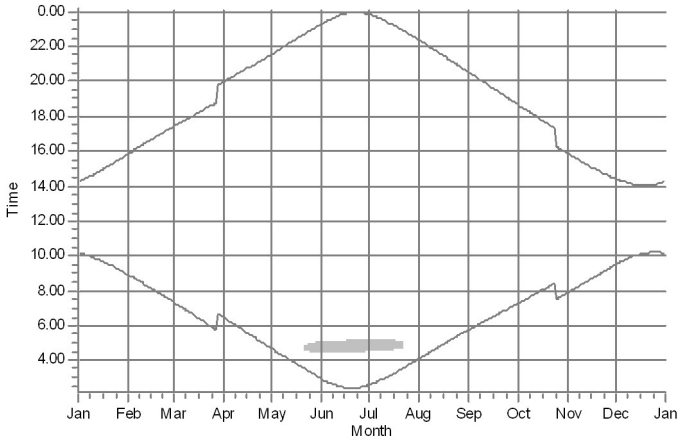
SHADOW - Calendar, graphical

Calculation: PUUSTO V2 Varsavaara+Hietavaara+Hukkalansalo_H200_D200

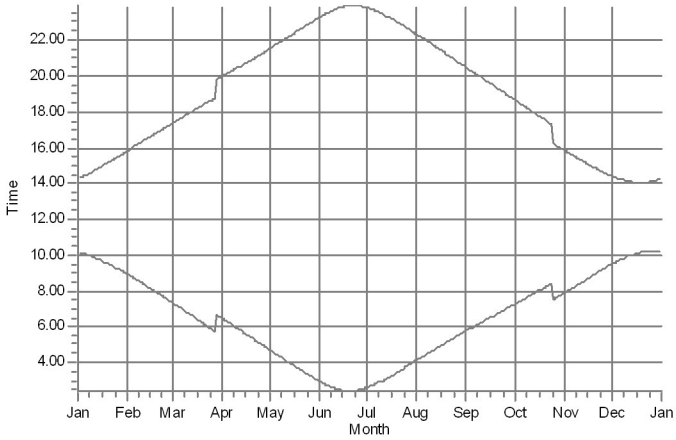
1: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (16)



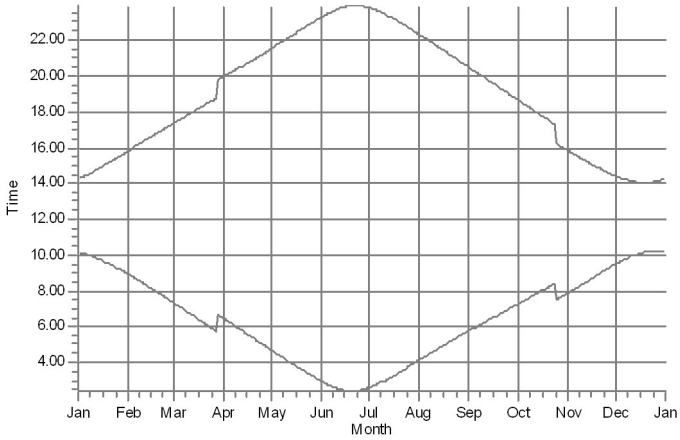
2: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (17)



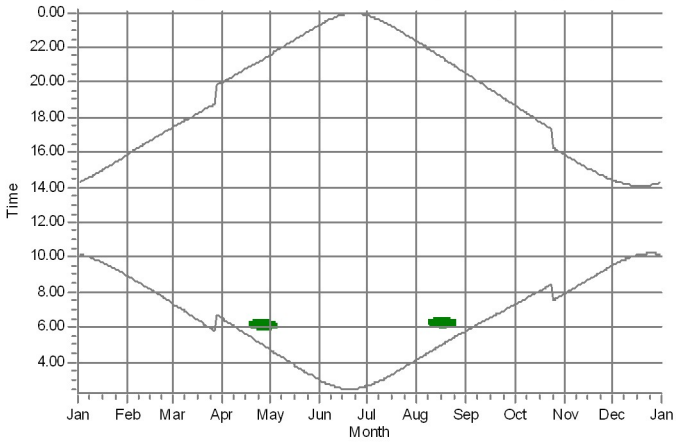
3: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (19)



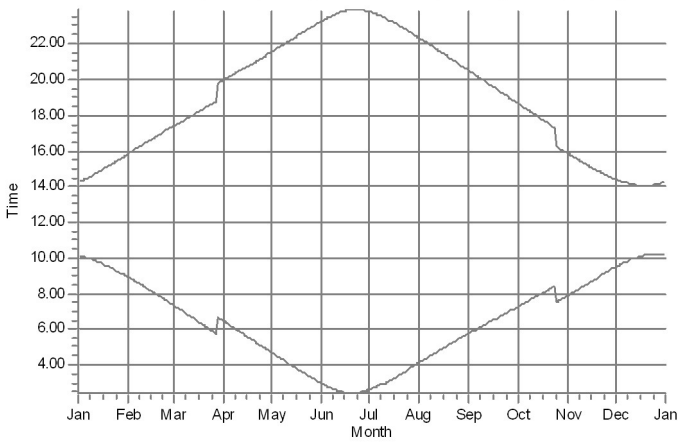
4: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (20)



5: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (18)



6: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (21)



WTGs

1: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0

8: NORDEX N163/6.X 6800 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (1)

12: NORDEX N163/6.X 6800 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (5)

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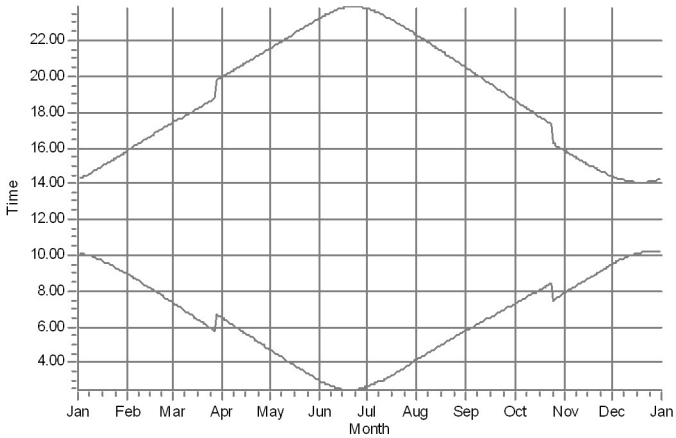
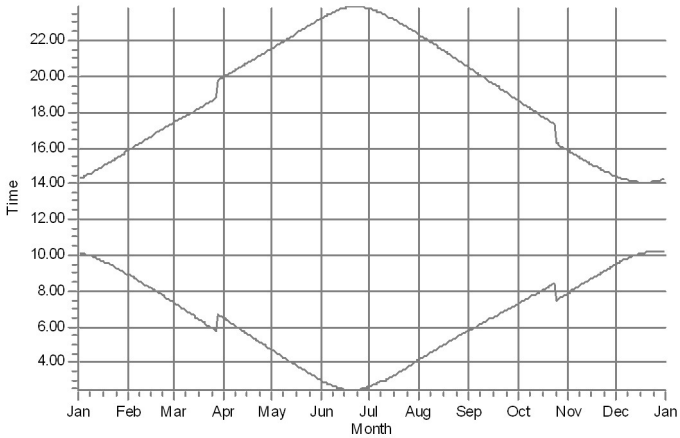
SHADOW - Calendar, graphical

Calculation: PUUSTO V2 Varsavaara+Hietavaara+Hukkalansalo_H200_D200

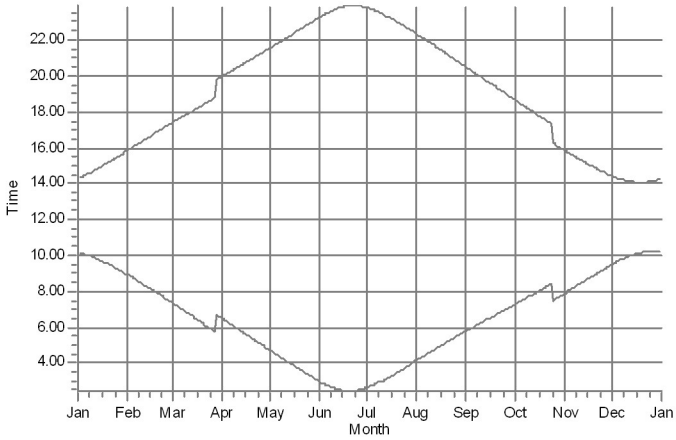
7: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (7)



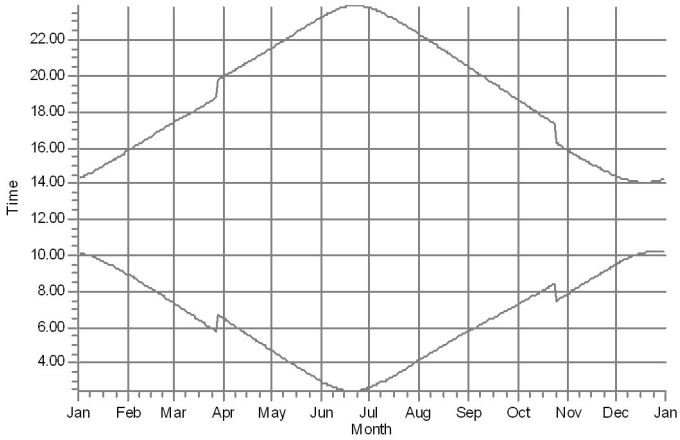
8: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (9)



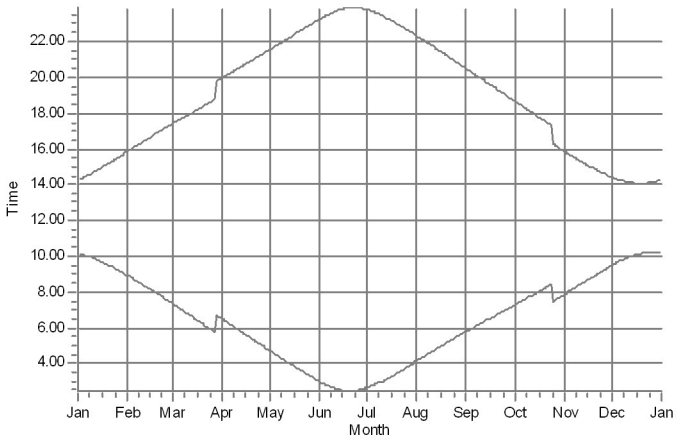
9: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (8)



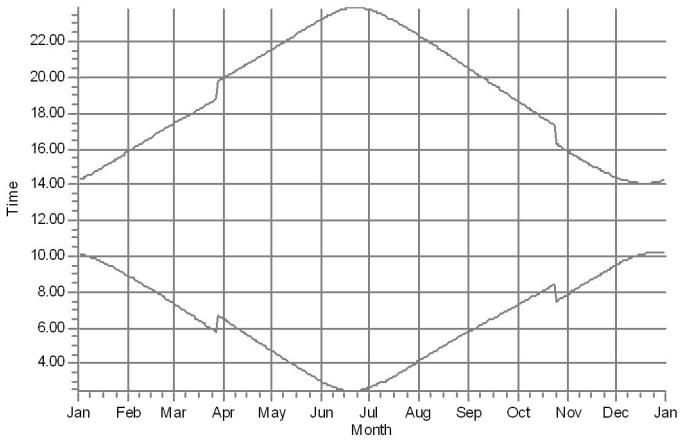
10: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (10)



11: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (11)



12: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (24)



WTGs

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Calculated:
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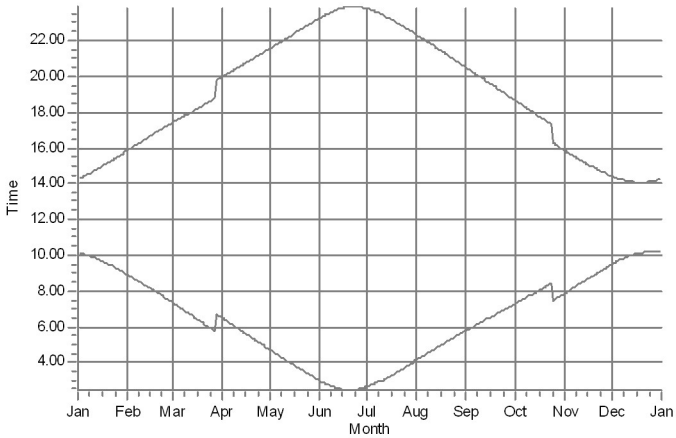
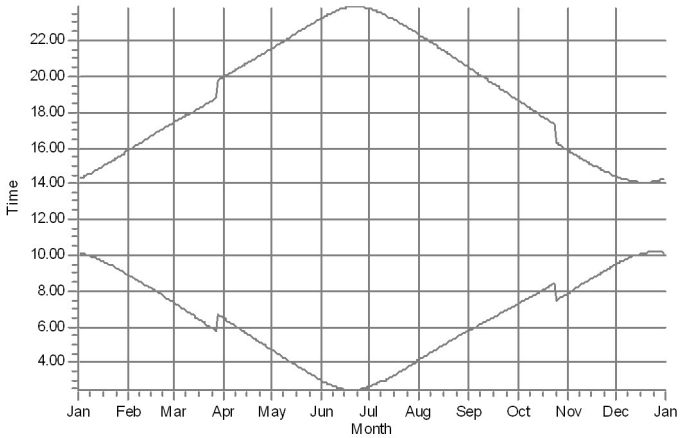
SHADOW - Calendar, graphical

Calculation: PUUSTO V2 Varsavaara+Hietavaara+Hukkalansalo_H200_D200

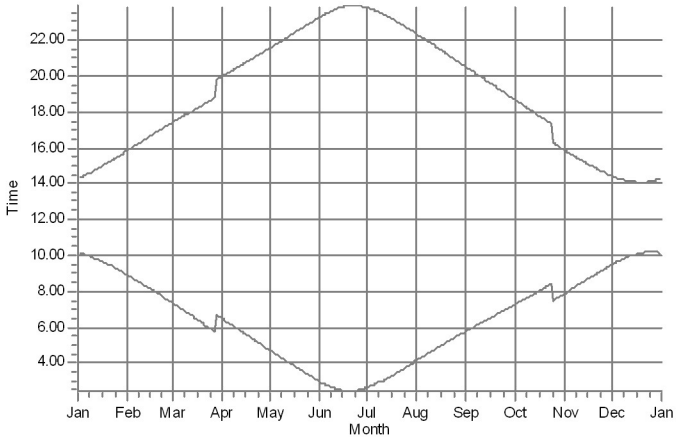
13: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (25)



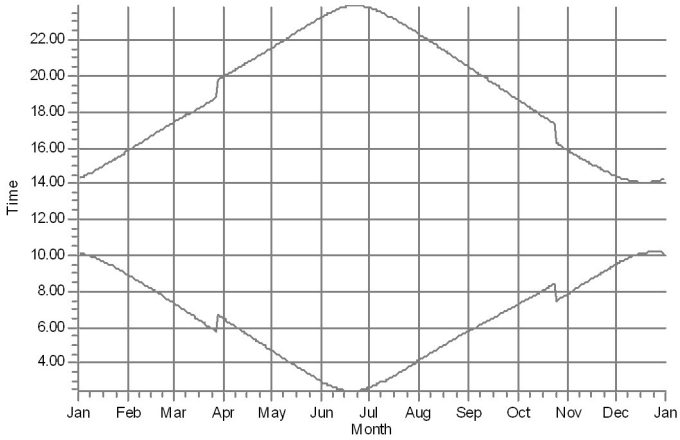
14: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (12)



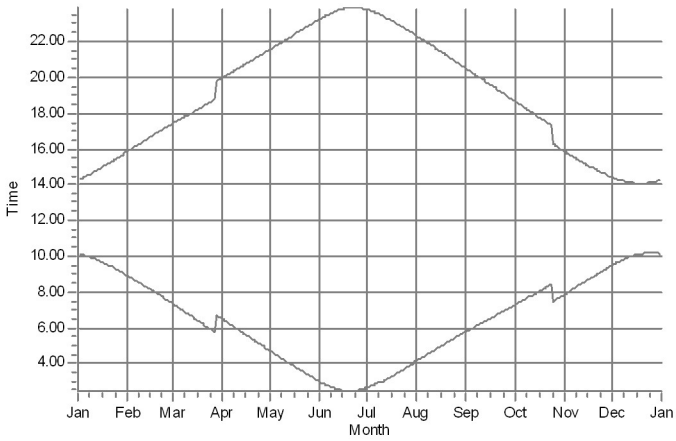
15: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (26)



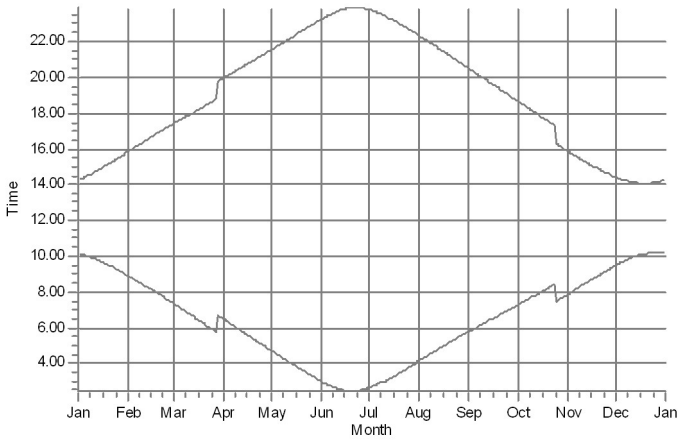
16: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (6)



17: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (5)



18: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (4)



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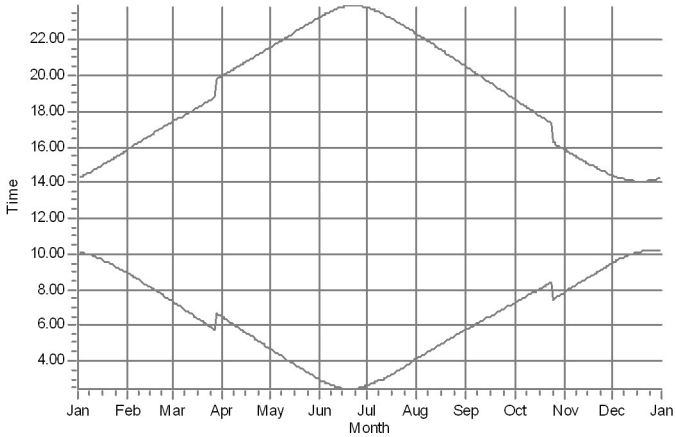
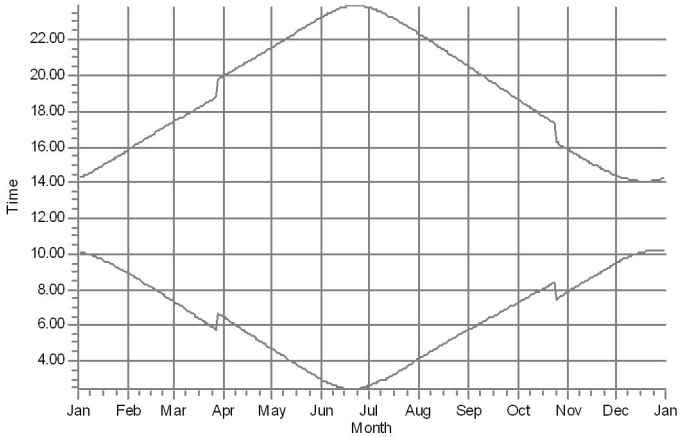
SHADOW - Calendar, graphical

Calculation: PUUSTO V2 Varsavaara+Hietavaara+Hukkalansalo_H200_D200

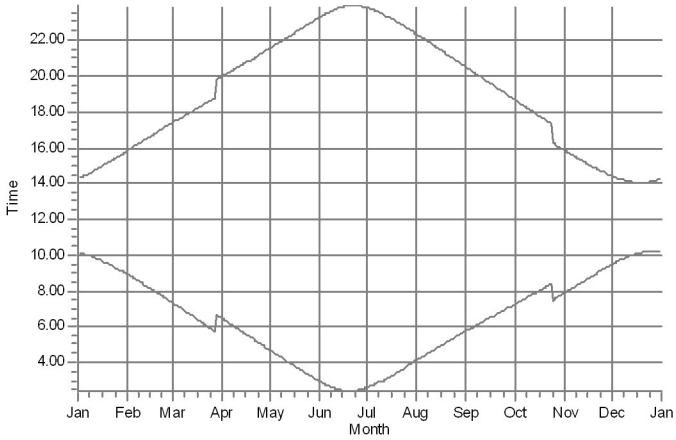
19: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (3)



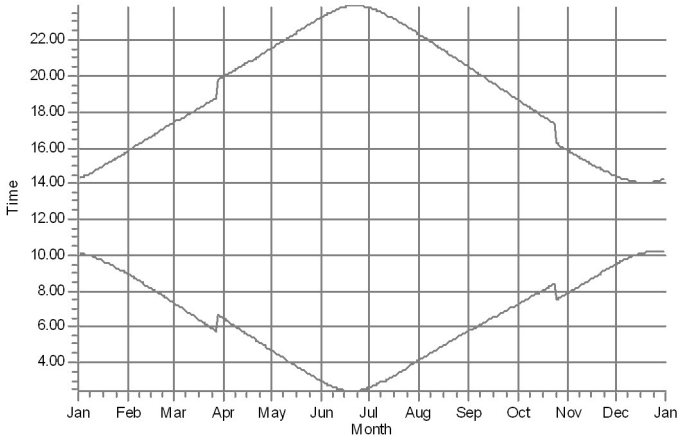
20: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (2)



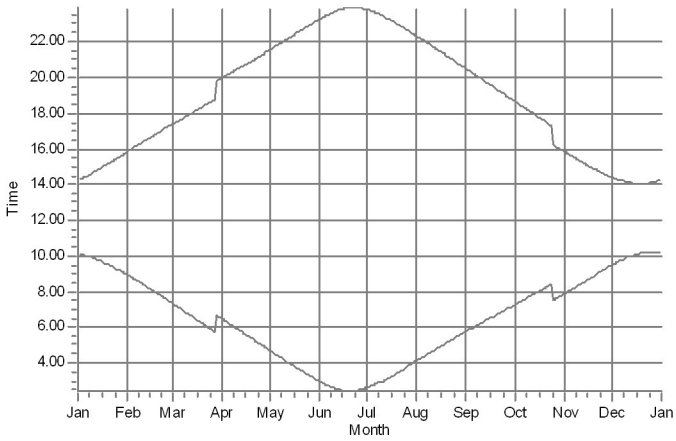
21: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (1)



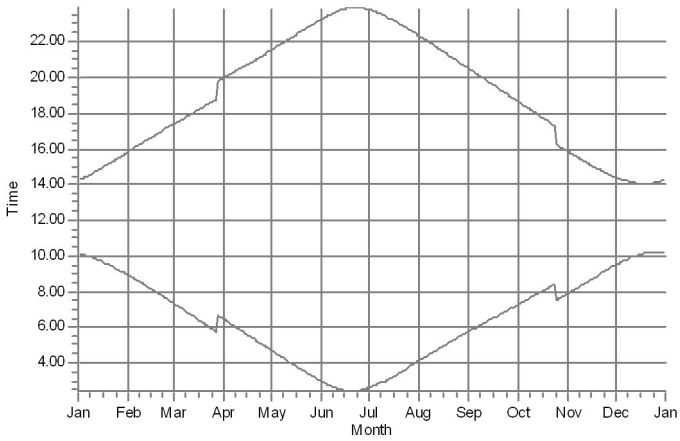
22: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (23)



23: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (22)



24: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (15)



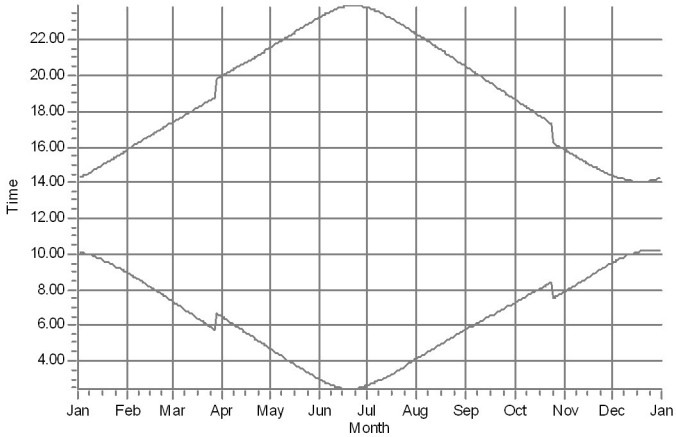
WTGs

Licensed user:
Ramboll Deutschland GmbH
Elisabeth-Consbruch-Straße 3
DE-34131 Kassel
-
Ville Virtanen / ville.virtanen@ramboll.fi
Calculated:
20/10/2022 13.00/3.5.587

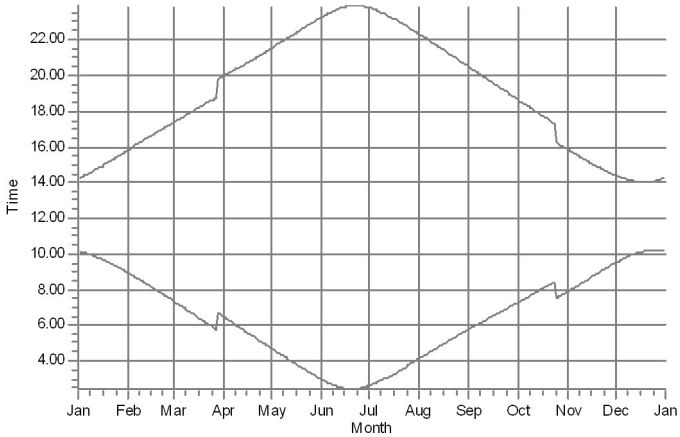
SHADOW - Calendar, graphical

Calculation: PUUSTO V2 Varsavaara+Hietavaara+Hukkalansalo_H200_D200

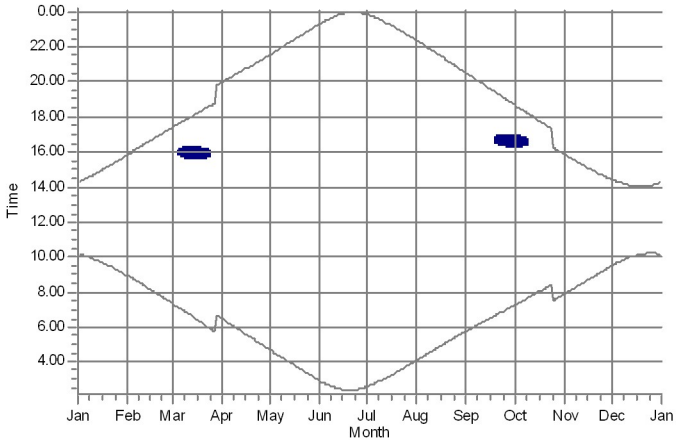
25: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (14)



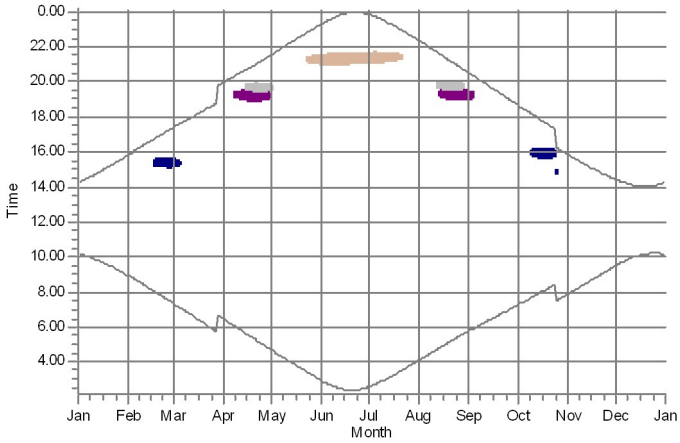
26: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (13)



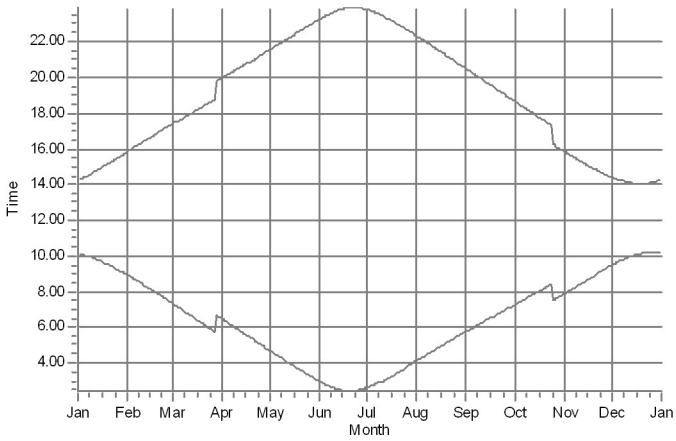
27: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (28)



28: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (27)



29: Shadow Receptor: 1,0 × 1,0 Azimuth: 0,0° Slope: 90,0° (38)



WTGs

- 7: Generic Generic 200-200 10000 200.0 !-! hub: 200,0 m (TOT: 300,0
- 11: NORDEX N163/6.X 6800 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (4)
- 12: NORDEX N163/6.X 6800 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (5)
- 17: NORDEX N163/6.X 6800 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (10)