



KOVASIN TUULIVOIMA OY

Kovasinkankaan tuulivoimahanke Ii

Melu- ja varjostusmallinnukset



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5.12.2022

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forest"

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Kovasinkankaan tuulivoimahanke II

1 MELU- JA VARJOSTUSMALLINNUKSEN TAVOITTEET

Iin kunnassa sijaitsevan Kovasinkankaan tuulivoimahankkeessa hankeomistaja Kovasin tuulivoima Oy suunnittelee 6 voimalan rakentamista. Voimaloiden Vestas 162-6.2MW melupäästö on 107,8 dB(A) ilman sahalaitoja. Voimalaitokseen on lisätty 2 dB(A) varmuusvaraa. Voimalavalmistaja Vestas ei kuitenkaan edellytä varmuusvaran lisäämistä, sillä voimalaitoksen V162 lähtömelutaso on takuuvaro. Voimaloiden roottorin halkaisija on 162 m (RD) ja voimalan napakorkeus 199 m (HH). Voimalan kokonaiskorkeus on 280 metriä.

Tuulivoimaloiden aiheuttamia melu ja varjostuksia on arvioitu laskentamallien avulla kaavan hyväksymisvaiheen voimalasijoittelulle. Yhteisvaikutuksia on mallinnettu hankealueen läheisyydessä sijaitsevan Ketunmaankankaan tuulivoimahankkeen kanssa. Ketunmaankankaan voimalaitokset ovat Vestaksen V126 -3.45MW voimaloita. Suunnitellaan 5 voimalaa, joiden napakorkeus on 137 metriä.

Melu- ja varjostusmallinnukset on laatinut FM Liisa Karhu FCG Finnish Consulting Group Oy:stä.

2 LÄHTÖTIEDOT JA MENETELMÄT

2.1 Melu

2.1.1 Melumallinnus

Tuulivoimaloiden aiheuttamat äänenpainetasot on mallinnettu WindPRO-laskentaohjelmalla ISO 9613-2 standardin mukaisesti. Ympäristöhallinnon tuulivoimaloiden melun mallintamista koskevan ohjeen 2/2014 mukaisesti tuulen nopeutena käytettiin 8 m/s, ilman lämpötilana 15 °C, ilmanpaineena 101,325 kPa, ilman suhteellisena kosteutena 70 %, maanpinnan kovuutena arvoa 0,4 ja järviens vesipinnan kovuutena arvoa 0,0. Laskenta on tehty 4,0 m maan pinnan tasosta. Laskennan pystysuora resoluutio on 1,0 m ja vaakasuora resoluutio on 1,0 m.

Melumallinnusten laskentatuloksia on havainnollistettu ns. keskiäänitasokarttojen avulla. Keskiäänitasokartoissa on melun keskiäänitaso- eli ekvivalenttiäänitasokäyrät (LAeq) 5 dB välein.

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Taulukko 1. Käytetyt mallinnusparametrit ISO 9613-2 laskelmissa sekä melulle altistuvat kohteet.

| MALLINNUSOHJELMA JA VERSIO: | | |
|---|---------------------|--|
| WindPRO version 3.4.388 | | Mallinnusmenetelmä: ISO 9613-2 |
| AKUSTISET TIEDOT/LASKENNAN LÄHTÖTIEDOT | | |
| Laskenta korkeus | | Laskentaruudun koko [m·m] |
| 4,0 m | | 25x25 m |
| Suhteellinen kosteus | | Lämpötila |
| 70 % | Muu, mikä ja miksi: | 15 C° |
| Maastomallin lähde ja tarkkuus | | |
| Maastomallin lähde: MML maastotietokanta | | Vaakaresoluutio:1,0 Pystyresoluutio:1,0 |
| Maan- ja vedenpinnan absorption ja heijastuksen huomioiminen, käytetyt kertoimet | | |
| Maa | 0,4 | HUOM |
| Vesistöt | 0,0 | |
| Ilmakehän stabiilius laskennassa/meteorologinen korjaus | | |
| Neutraali, (0): Neutraali | Muu, mikä ja miksi: | |
| Sääolosuhteiden huomiointi; laskennassa käytetty tuulen suunnat ja nopeus | | |
| Tuulen suunta: 0-360° | Tuulennopeus: 8 m/s | |
| Voimalan äänen suuntaavuus ja vaimentuminen | | |
| Vapaa avaruus: kyllä | Muu, mikä, miksi: | |

2.1.2 Matalataajuinen melu

Matalataajuinen melu laskettiin Ympäristöministeriön ohjeen 2/2014 mukaisin menetelmin käyttäen voimalavalmistajilta saatuja arvioita niiden äänitehotasoista.

Ohje 2/2014 antaa menetelmän matalataajuisen melun laskentaan rakennusten ulkopuolelle. Sosiaali- ja terveysministeriön Asumisterveysasetus 2015 antaa matalataajuiselle melulle toimenpiderajat asuinhuoneissa. Rakennusten sisälle kantautuva äänitaso arvioitiin Turun AMK:n (Keränen, Hakala ja Hongisto, 2018) julkistamien Anojanssi projektin tulosten mukaisten ääneneristyysarvoin ja tuloksia verrattiin toimenpiderajoihin.

Taulukko 2. Suomalaisen pientalon julkisivun äänitasoeron alalikiarvo Anojanssi projektin tulosten mukaisesti.

| f [Hz] | 20 | 25 | 31.5 | 40 | 50 | 63 | 80 | 100 | 125 | 160 | 200 |
|-------------|-----|-----|------|------|------|------|------|------|------|------|------|
| DLo [dB] | 7.6 | 8.3 | 9.2 | 10.3 | 11.5 | 13.0 | 14.8 | 16.8 | 18.8 | 21.1 | 22.8 |

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Tulokset on esitetty taajuuskohtaisena taulukkona hankealueen ympäröidyille asuin- ja lomarakennuksille.

2.2 Varjostusmallinnus

Tuulivoimaloiden varjostusvaikutuksia mallinnettiin WindPRO-ohjelman Shadow-moduulilla. Laskenkoissa varjot huomioidaan, jos aurinko on yli 3 astetta horisontin yläpuolella ja varjoksi lasketaan, kun siipi peittää vähintään 20 % auringosta.

Varjostusmallin laskennassa on huomioitu hankealueen korkeustiedot, tuulivoimaloiden sijainnit, tuulivoimalan napakorkeudet ja roottorin halkaisija ja hankealueen aikavyöhyke. Mallinnuksessa otettiin huomioon auringon asema horisontissa eri kelon- ja vuodenaikoina, pilvisyyys kuukausittain eli kuinka paljon aurinko paistaa ollessaan horisontin yläpuolella sekä tuulivoimalaitosten arvioitu vuotuinen käyntiaika.

Varjostuksen tarkastelukorkeutena lähialueen asuin- tai lomarakennusten pihapiirissä käytettiin 1,0 metriä ja laskenta-alueen kokoa 5,0 x 5,0 metriä. Laskentaikkunoiden suunnat asennettiin voimaloita kohti ns. "greenhouse mode".

Auringon keskimääräiset paistetunnit perustuvat Luulajan sääaseman pitkäaikaisiin mitattuihin säätietoihin 1981-2010, (Ilmatieteenlaitos raportti 2012:1). Laskentojen tuulen suunta ja nopeusjakaumana käytettiin NASA:n MERRA-dataa (Modern Era Retrospective-analysis for Research and Applications) hankealueen läheisyydeltä.

Varjostusmallinnuksen tuloksia on havainnollistettu kartan avulla. Kartalla esitetään varjostusvaikutuksen (1, 8 ja 20 tuntia vuodessa) laajuus. Sen lisäksi mallinnuksessa on laskettu vaikutus tuulivoimapuistoalueen ympäristössä oleviin herkkiin kohteisiin.

2.3 Paikkatietoaineisto

Korkeustiedot perustuvat Maanmittauslaitoksen (MML) maastotietokannan korkeuskäyrä aineistoon. Korkeusaseman intrapoloitimenetelmänä kohteille on käytetty WindPro TIN menetelmä.

Rakennusten käyttötarkoitus on arvoitu MML maastotietokannan asuin-, liike- tai julkisen-, loma-, teollisen-, kirkollisen, tai muun rakennuksen mukaisesti.

2.4 Voimalat

Tuulivoimaloiden melumallinnuksen lähtöarvoina on käytetty valmistajan ilmoittamia tuulivoimaloiden melupäästön arvoja.

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Taulukko 3. Kovasinkankaan hankkeen tuulivoimaloiden tyypitiedot ja äänitehotasot sekä melun erityispiirteet.

| TUULIVOIMALAN (TUULIVOIMALOIDEN TIEDOT) | | | | | | | | | | | |
|--|-------|-------------------------------|------|---|-----------------------------|-----------------|------|--|--|--|--|
| Tuulivoimalan valmistaja: Vestas | | | | Tyyppi: V162 – 6.2 MW | | Sarjanumero/t:- | | | | | |
| Nimellisteho: 6.2MW | | Napakorkeus: 199 m | | | Roottorin halkaisija: 162 m | | | | | | |
| Mahdollisuudet vaikuttaa tuulivoimalan melupäästöön käytön aikana ja sen vaikutus meluun | | | | | | | | | | | |
| Lapakulman säätö | | Pyörimisnopeus | | | Muu, mikä | | | | | | |
| Kyllä | - dB | Kyllä | - dB | Noise mode säätö: | | Mode 0 no STE | | | | | |
| Ei | | Ei | | Noise mode, lähtömelutaso | | 107,1 dB(A) | | | | | |
| AKUSTISET TIEDOT/LASKENNAN LÄHTÖTIEDOT | | | | | | | | | | | |
| Melupäästötiedot perustuvat dokumenttiin: " DMS no.: 0095-3732_00 Third octave noise emission, EnVentusTM V162-6.0 MW 50/60Hz | | | | | | | | | | | |
| Mallinnuksissa on lisätty voimalan äänitehotasoihin 2 dB ympäristöministeriön ohjeen 2/2014 mukaisesti. | | | | | | | | | | | |
| Oktaaveittain [Hz], dB(A) | | 1/3-oktaaveittain [Hz], dB(A) | | | | | | | | | |
| 31,5 | - | 20 | 63,6 | 200 | 97,1 | 2000 | 93,9 | | | | |
| 63 | 90,4 | 25 | 68,4 | 250 | 98,4 | 2500 | 91,6 | | | | |
| 125 | 98,4 | 31,5 | 73,1 | 315 | 99,4 | 3150 | 88,9 | | | | |
| 250 | 103,2 | 40 | 77,6 | 400 | 100 | 4000 | 85,7 | | | | |
| 500 | 104,9 | 50 | 81,3 | 500 | 100,2 | 5000 | 82,3 | | | | |
| 1000 | 103,5 | 63 | 84,9 | 630 | 100,1 | 6300 | 78,5 | | | | |
| 2000 | 98,9 | 80 | 88,2 | 800 | 99,6 | 8000 | 74,2 | | | | |
| 4000 | 91,2 | 100 | 90,9 | 1000 | 98,7 | 10000 | 69,8 | | | | |
| 8000 | 80,3 | 125 | 93,3 | 1250 | 97,5 | | | | | | |
| 109,6 dB(A) | | 160 | 95,5 | 1600 | 95,8 | | | | | | |
| Melun erityispiirteiden mittaus ja havainnot: | | | | | | | | | | | |
| Kapeakaistaisuus / Tonaalisuus | | Impulssimaisuus | | Merkityksellinen sykintä (amplitudimodulaatio) | | Muu, Mikä: | | | | | |
| Kyllä | Ei | Kyllä | ei | Kyllä | ei | Kyllä | ei | | | | |

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Taulukko 3. Ketunmaankankaan tuulivoimaloiden äänitehotasot sekä melun erityispiirteet.

| TUULIVOIMALAN (TUULIVOIMALOIDEN TIEDOT) | | | | | | | | | |
|--|-------------------------------|-----------------|------|---|-------------|---------------------------------|------|--|--|
| Tuulivoimalan valmistaja: Vestas | | | | Tyyppi: V126-3.45 MW | | Sarjanumero/t:- | | | |
| Nimellisteho:3,45 MW | Napakorkeus: 137 m | | | Roottorin halkaisija:126 | | Tornin tyyppi: teräs/hybridi | | | |
| Mahdollisuudet vaikuttaa tuulivoimalan melupäästöön käytön aikana ja sen vaikutus meluun | | | | | | | | | |
| Lapakulman säätö | Pyörimisnopeus | | | Muu, mikä | | | | | |
| Kyllä | Kyllä | - dB | | Noise mode säätö: | Mode 0 STE | | | | |
| Ei | Ei | | | Noise mode, lähtömelutaso | 106.2 dB(A) | | | | |
| AKUSTISET TIEDOT/LASKENNAN LÄHTÖTIEDOT | | | | | | | | | |
| Melupäästötiedot perustuvat dokumenttiin DMS no.: 0049-9517_01, V126-3.45MW-(IEC3A)-50/60Hz Third octave noise emission. Date 2015-02-23 | | | | | | | | | |
| Oktaaveittain [Hz],dB(A) | 1/3-oktaaveittain [Hz] LWA dB | | | | | | | | |
| | 20 | 65,1 | 200 | 90,1 | 1600 | 94,6 | | | |
| 63 | 88,2 | 25 | 70,1 | 250 | 91,3 | 2000 | 94,3 | | |
| 125 | 94,3 | 31,5 | 70,7 | 315 | 92,3 | 2500 | 91,8 | | |
| 250 | 96,1 | 40 | 75,1 | 400 | 92,6 | 3150 | 88,7 | | |
| 500 | 99,5 | 50 | 80,3 | 500 | 93,8 | 4000 | 87,2 | | |
| 1000 | 102,3 | 63 | 83,8 | 630 | 96,8 | 5000 | 80,5 | | |
| 2000 | 98,5 | 80 | 85,0 | 800 | 97,3 | 6300 | 76,6 | | |
| 4000 | 91,4 | 100 | 87,6 | 1000 | 97,8 | 8000 | 74,9 | | |
| 8000 | 80,2 | 125 | 91,2 | 1250 | 97,5 | | | | |
| 106,2 dB(A) | 160 | 89,1 | | | | | | | |
| Melun erityispiirteiden mittaus ja havainnot: | | | | | | | | | |
| Kapeakaistaisuus / Tonaalisuus | | Impulssimaisuus | | Merkityksellinen sykintä (amplitudimodulaatio) | | Muu, Mikä: | | | |
| Kyllä | ei | Kyllä | ei | Kyllä | ei | Kyllä | ei | | |

2.5 Raja- ja ohjearvot

2.5.1 Melu

Valtioneuvoston asetuksessa (1107/2015) tuulivoimaloille on määritelty ohjearvot päivä- ja yöajan keskiäänitasojen maksimiavolle. Jos tuulivoimalan melu sisältää tonaalisia, kapeakaistaisia tai impulssimaisia komponentteja, tai se on selvästi amplitudimoduloitunut, mallinnustuloksiin tulee ohjeen mukaan lisätä viisi desibeliä ennen ohjearvoon vertaamista. Koska ohjearvo sisältää jo tyyppisen tuulivoimamelun piirteet, edellä mainitut äänepiirteiden tulee olla tuulivoimalalle epätyypillisen voimakkaita, jotta mallinnustuloksissa täytyy huomioida viiden desibelin lisä äänenvoimakkuuteen.

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Taulukko 4. Valtioneuvoston asetuksen mukaiset tuulivoimaloiden melutaso-ohjeavrot (Valtioneuvoston asetus 1107/2015).

| Vaikutuskohde | Päivä (7-22) | Yö (22-7) |
|------------------|--------------|-----------|
| Pysyvä asutus | 45 dB | 40 dB |
| Loma-asutus | 45 dB | 40 dB |
| Hoitolaitokset | 45 dB | 40 dB |
| Oppilaitokset | 45 dB | — |
| Virkistysalueet | 45 dB | — |
| Leirintäalueet | 45 dB | 40 dB |
| Kansallispuistot | 40 dB | 40 dB |

Sosiaali- ja terveysministeriön asetuksessa (545/2015) on annettu matalataajuiselle melulle toimenpiderajoja. Toimenpiderajat koskevat asuinhuoneita ja ne on annettu taajuuspainottamattomina yhden tunnin keskiäänitasona tersseittäin. Toimenpiderajat koskevat yöaikaa ja päivällä sallitaan 5 dB suuremmat arvot.

Taulukko 5. Matalataajuisen sisämelun tunnin keskiäänitason toimenpiderajat nukkumiseen tarkoitetuissa tiloissa.

| Terssikaista Hz | 20 | 25 | 31,5 | 40 | 50 | 63 | 80 | 100 | 125 | 160 | 200 |
|--|----|----|------|----|----|----|----|-----|-----|-----|-----|
| Keskiäänitaso L _{Zeq,1h} , dB | 74 | 64 | 56 | 49 | 44 | 42 | 40 | 38 | 36 | 34 | 32 |
| Edellisestä laskettu keskiäänitaso A-painotettuna L _{Aeq,1h} , dB | 24 | 19 | 17 | 14 | 14 | 16 | 18 | 19 | 20 | 21 | 21 |

Lisäksi yöaikainen mahdollisesti unihäiriötä aiheuttava melu, joka erottuu selvästi taustamelusta, ei saa ylittää 25 dB yhden tunnin keskiäänitasona L_{Aeq,1h} mitattuna niissä tiloissa, jotka on tarkoitettu nukkumiseen.

2.5.2 Varjostus

Suomessa ei ole viranomaisten antamia yleisiä määräyksiä tuulivoimaloiden muodostaman varjostuksen enimmäiskestoista eikä varjonmuodostuksen arvointiperusteista. Ympäristöministeriön tuulivoimarakentamisen suunnitteluoheistuksessa esitetään käytettäväksi muiden maiden suosituksia välkkeen rajoittamisesta (Ympäristöministeriö 2012).

Useissa maissa on annettu raja-arvoja tai suosituksia hyväksyttävän välkevaikutuksen määrästä. Esimerkiksi Ruotsissa suositus on kahdeksan tuntia vuodessa ja 30 minuuttia päivässä.

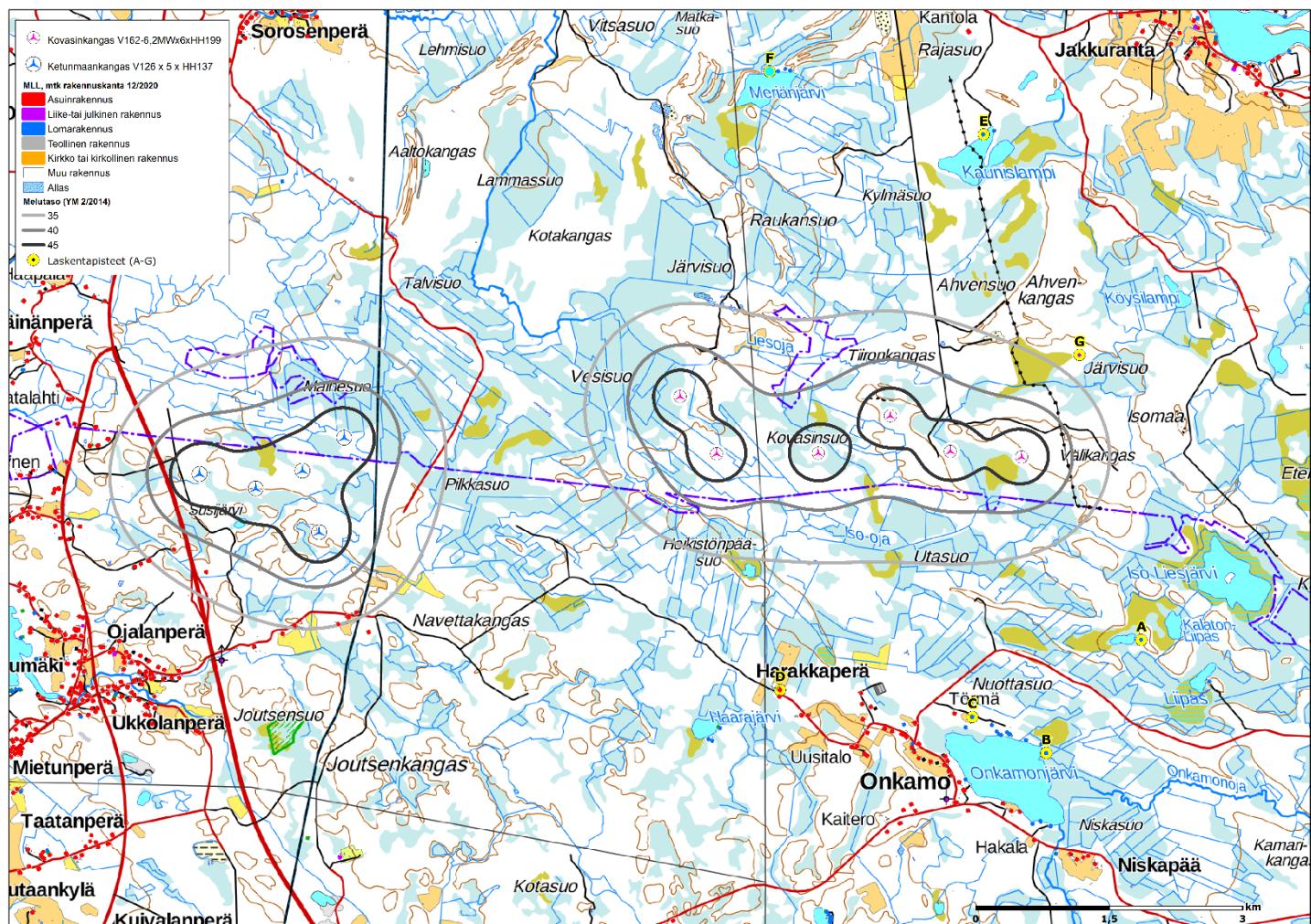
Arvioinnissa on tarkasteltu vaikutuksia alueella, jossa varjoja tai välkettä mallinnuksen mukaisessa todellisessa tilanteessa ("real case") esiintyy vähintään kahdeksan tuntia vuodessa.

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3 MELU- JA VARJOSTUSMALLINNUSTEN TULOKSET

3.1 Melun laskentatulokset ISO 9613-2

Tuulivoimapuistoa lähipien asuin- ja lomarakennusten pihapiirissä melutasot jäävät laskelmien mukaan alle 40 dB(A) (Liite 1).



Kuva 1. Laskennalliset melutasot standardin ISO 9613-2 mukaisesti.

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Taulukko 6. Laskennalliset melutasot lähtömelutason olleessa 104,0 dB(A).

| Laskentapiste | ETRS89-TM35 Itä | ETRS89-TM35 Pohjoinen | Kohteen korkeus- asema (m) | Laskenta-korkeus (m) | Melutaso dB(A) |
|---------------------------------------|-----------------|-----------------------|----------------------------|----------------------|----------------|
| Lomarakennus A (Kantolantie 285) | 435 168 | 7 235 667 | 40 | 4,0 | 30,3 |
| Lomarakennus B (Kantolantie 142) | 434 099 | 7 234 395 | 35 | 4,0 | 30,3 |
| Lomarakennus C (Kantolantie 42) | 433 269 | 7 234 801 | 35 | 4,0 | 31,7 |
| Asuinrakennus D (Onkamonkyläntie 280) | 431 108 | 7 235 103 | 32,5 | 4,0 | 28,9 |
| Lomarakennus E (Kaunislamenttie 153) | 433 395 | 7 241 348 | 37,5 | 4,0 | 28,1 |
| Lomarakennus F (Merijärvi) | 430 991 | 7 242 055 | 30 | 4,0 | 27,5 |
| Liikerakennus G (Impivaarantie kämpä) | 434 473 | 7 238 869 | 37,8 | 4,0 | 36,9 |

3.2 Matalataajuiset melutasot

Sisätilojen laskennallisia tuloksia on verrattu Sosiaali- ja terveysministeriön (STM) Asumisterveysasetuksessa (545/2015) annettuihin toimenpiderajoihin. Nämä ovat enimmäisarvoja, jotka on laadittu yöaikaiselle melulle nukkumiseen tarkoitettuihin tiloihin. Toimenpiderajaa on verrattu myös äänitasoon tarkasteltujen rakennusten ulkopuolella.

Mallinnettaessa voimalaitostyyppillä Vestas V162 6,2MW, matalataajuinen melu ei ylitä Sosiaali- ja terveysministeriön asumisterveysohjearvoa. Taulukoissa näkyy toimenpiderajan alitus (negatiivinen arvo) tai ylitys (positiivinen arvo).

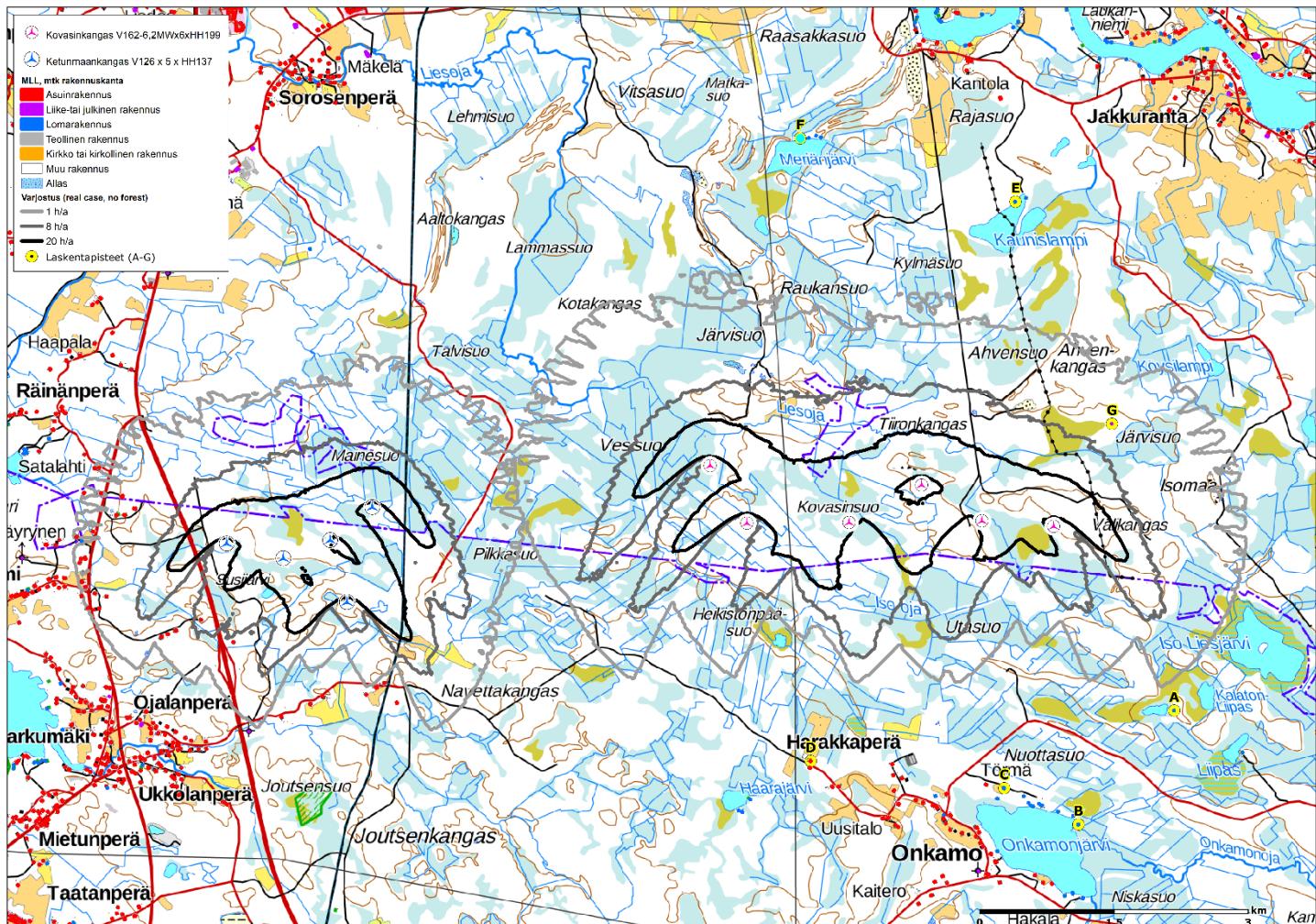
Taulukko 7. Matalataajuisen melun mallinnustulokset sekä vertailu verrattuna Sosiaali- ja terveysministeriön toimenpiderajaan. Myös suunnitteilla olevat Ketunmaankankaan tuulivoimalat on huomioitu.

| Rakennus | Äänitaso ulkona | | Äänitaso sisällä | |
|---------------------------------------|--|-----|--|----|
| | L eq,1h - Asumisterve ys- ohje sisällä | Hz | L eq,1h - Asumisterve ys- ohje sisällä | Hz |
| Lomarakennus A (Kantolantie 285) | -1,9 | 100 | -15,8 | 50 |
| Lomarakennus B (Kantolantie 142) | -3,1 | 100 | -16,8 | 50 |
| Lomarakennus C (Kantolantie 42) | -1,6 | 100 | -15,4 | 50 |
| Asuinrakennus D (Onkamonkyläntie 280) | -0,4 | 100 | -14,1 | 50 |
| Lomarakennus E (Kaunislamenttie 153) | -2,4 | 100 | -16,1 | 50 |
| Lomarakennus F (Merijärvi) | -3,1 | 100 | -16,5 | 50 |
| Liikerakennus G (Impivaarantie kämpä) | 3,2 | 200 | -11,6 | 50 |

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3.3 Varjostusmallinnuksen tulokset

Tuulivoimapuistoa lähiimpien asuin- ja lomarakennusten pihapiirissä varjostusvaikutus on mallinnuksen mukaan kaikissa laskentapisteissä alle 8 h/a, kun puiston suojaavaa vaikutusta ei ole huomioitu (Liite 3).



Kuva 2. Laskennalliset varjostusmallinnuksen tulokset "real case, no forest".

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**Taulukko 8. Laskennalliset varjostustunnit vuodessa lähialueen laskentapisteissä,
kun puiston suojaavaa vaikutusta ei ole huomioitu "real case, no forest".**

| Laskentapiste | ETRS89- -TM35 Itä | ETRS89- TM35 Pohjoinen | Koteen korkeus- asema (m) | Varjostus (h/a) |
|--|-------------------------|------------------------------|---------------------------------|--------------------|
| Lomarakennus A (Kantolantie 285) | 435 168 | 7 235 667 | 40,0 | 0:00 |
| Lomarakennus B (Kantolantie 142) | 434 099 | 7 234 395 | 35,0 | 0:00 |
| Lomarakennus C (Kantolantie 42) | 433 269 | 7 234 801 | 35,0 | 0:00 |
| Asuinrakennus D (Onkamonkyläntie 280) | 431 108 | 7 235 103 | 32,5 | 0:00 |
| Lomarakennus E (Kaunislamenttie 153) | 433 395 | 7 241 348 | 37,5 | 0:00 |
| Lomarakennus F (Merijärvi) | 430 991 | 7 242 055 | 30,0 | 0:00 |
| Liikerakennus G (Impivaarantie kämppä) | 434 473 | 7 238 869 | 37,8 | 4:42 |

Laatija

Tarkastaja

**Liite 1: Kovasinkankaan tuulivoimahanke - Melun levämismallinnuksen tulokset ISO 9613-2,
YM 2/2014**

DECIBEL - Main Result

Calculation: Kovasinkangas V162-6,2MW x 6 x HH199 + Ketunmaankangas V126-3.45MW x 5 x HH137_202221202

Noise calculation model:

ISO 9613-2 General

Wind speed (in 10 m height):

Highest noise value at receptor

Ground attenuation:

General, Ground factor: 0,4

Meteorological coefficient, CO:
0,0 dB

Type of demand in calculation:

1: WTG noise is compared to demand (DK, DE, SE, NL etc.)

Noise values in calculation:

All noise values are mean values (Lwa) (Normal)

Pure tones:

Fixed penalty added to source noise of WTGs with pure tones

Noise sensitive area

Height above ground level, when no value in NSA object:

4,0 m; Don't allow override of model height with height from NSA object

Uncertainty margin:

0,0 dB; Uncertainty margin in NSA has priority

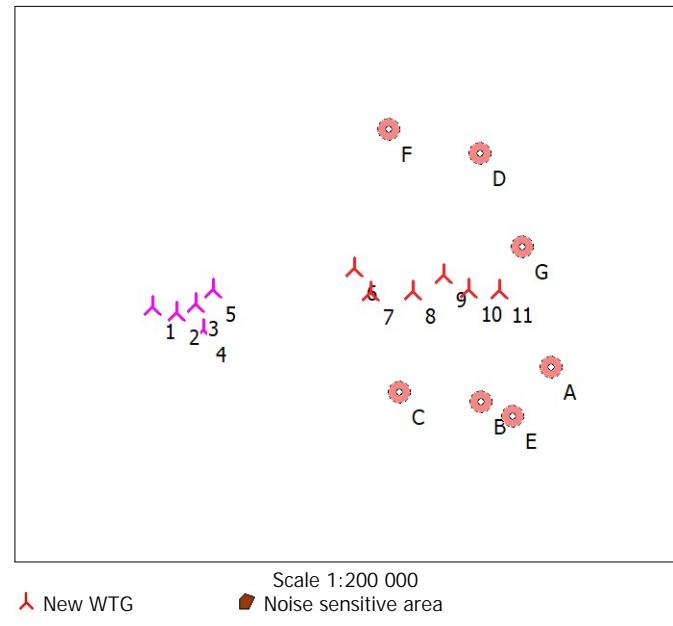
Deviation from "official" noise demands. Negative is more restrictive, positive is less restrictive.:
0,0 dB(A)

All coordinates are in

Finish TM ETRS-TM35FIN-ETRS89

WTGs

| East | North | Z | Row data/Description | WTG type Valid | Manufact. | Type-generator | Power, rated | Rotor diameter | Hub height | Noise data Creator | Name | First | LwaRef | Last | LwaRef |
|------|---------|-----------|---|-------------------|---------------------|----------------|-----------------|-------------------|---------------|--|------|-------|--------|-------|--------|
| | | | | | | | | | | | | [kW] | [m] | [m] | |
| 1 | 424 583 | 7 237 533 | 16,1 VESTAS V126-3.45 LTq 3450 12... Yes | VESTAS | V126-3.45 LTq-3 450 | 3 450 | 126,0 | 137,0 | USER | Level 0 - Calculated - Mode 0-0S - 2016-01 | 8,0 | 106,2 | 8,0 | 106,2 | |
| 2 | 425 215 | 7 237 368 | 20,0 VESTAS V126-3.45 LTq 3450 12... Yes | VESTAS | V126-3.45 LTq-3 450 | 3 450 | 126,0 | 137,0 | USER | Level 0 - Calculated - Mode 0-0S - 2016-01 | 8,0 | 106,2 | 8,0 | 106,2 | |
| 3 | 425 739 | 7 237 578 | 22,5 VESTAS V126-3.45 LTq 3450 12... Yes | VESTAS | V126-3.45 LTq-3 450 | 3 450 | 126,0 | 137,0 | USER | Level 0 - Calculated - Mode 0-0S - 2016-01 | 8,0 | 106,2 | 8,0 | 106,2 | |
| 4 | 425 926 | 7 236 878 | 21,5 VESTAS V126-3.45 LTq 3450 12... Yes | VESTAS | V126-3.45 LTq-3 450 | 3 450 | 126,0 | 137,0 | USER | Level 0 - Calculated - Mode 0-0S - 2016-01 | 8,0 | 106,2 | 8,0 | 106,2 | |
| 5 | 426 209 | 7 237 939 | 25,0 VESTAS V126-3.45 LTq 3450 12... Yes | VESTAS | V126-3.45 LTq-3 450 | 3 450 | 126,0 | 137,0 | USER | Level 0 - Calculated - Mode 0-0S - 2016-01 | 8,0 | 106,2 | 8,0 | 106,2 | |
| 6 | 429 984 | 7 238 403 | 28,3 VESTAS V162-6,2 6200 162,0 IO... Yes | VESTAS | V162-6,2-6 200 | 6 200 | 162,0 | 199,0 | USER | V162 - 6,2 MW Mode NO STE_+2dB - 12 20222 | 8,0 | 109,6 | 8,0 | 109,6 | |
| 7 | 430 394 | 7 237 760 | 31,7 VESTAS V162-6,2 6200 162,0 IO... Yes | VESTAS | V162-6,2-6 200 | 6 200 | 162,0 | 199,0 | USER | V162 - 6,2 MW Mode NO STE_+2dB - 12 20222 | 8,0 | 109,6 | 8,0 | 109,6 | |
| 8 | 431 537 | 7 237 767 | 35,0 VESTAS V162-6,2 6200 162,0 IO... Yes | VESTAS | V162-6,2-6 200 | 6 200 | 162,0 | 199,0 | USER | V162 - 6,2 MW Mode NO STE_+2dB - 12 20222 | 8,0 | 109,6 | 8,0 | 109,6 | |
| 9 | 432 345 | 7 238 184 | 41,0 VESTAS V162-6,2 6200 162,0 IO... Yes | VESTAS | V162-6,2-6 200 | 6 200 | 162,0 | 199,0 | USER | V162 - 6,2 MW Mode NO STE_+2dB - 12 20222 | 8,0 | 109,6 | 8,0 | 109,6 | |
| 10 | 433 021 | 7 237 786 | 40,0 VESTAS V162-6,2 6200 162,0 IO... Yes | VESTAS | V162-6,2-6 200 | 6 200 | 162,0 | 199,0 | USER | V162 - 6,2 MW Mode NO STE_+2dB - 12 20222 | 8,0 | 109,6 | 8,0 | 109,6 | |
| 11 | 433 822 | 7 237 725 | 38,7 VESTAS V162-6,2 6200 162,0 IO... Yes | VESTAS | V162-6,2-6 200 | 6 200 | 162,0 | 199,0 | USER | V162 - 6,2 MW Mode NO STE_+2dB - 12 20222 | 8,0 | 109,6 | 8,0 | 109,6 | |



Calculation Results

Sound level

Noise sensitive area

| No. | Name | East | North | Z | Immission height [m] | Demands Noise [dB(A)] | Sound level From WTGs [dB(A)] |
|-----|---|---------|-----------|------|-------------------------|-----------------------------|-------------------------------------|
| | | | | | | | |
| A | Lomarakennus A (Kantolantie 285) | 435 168 | 7 235 667 | 40,0 | 4,0 | 40,0 | 30,3 |
| B | Lomarakennus C (Kantolantie 42) | 433 269 | 7 234 801 | 35,0 | 4,0 | 40,0 | 30,3 |
| C | Asuinrakennus D (Onkamonykkyläntie 280) | 431 108 | 7 235 103 | 32,5 | 4,0 | 40,0 | 31,7 |
| D | Lomarakennus E (Kaunislammennitie 153) | 433 395 | 7 241 348 | 37,5 | 4,0 | 40,0 | 28,9 |
| E | Lomarakennus B (Kantolantie 142) | 434 099 | 7 234 395 | 35,0 | 4,0 | 40,0 | 28,1 |
| F | Lomarakennus F (Merijärvi) | 430 991 | 7 242 055 | 30,0 | 4,0 | 40,0 | 27,5 |
| G | Liikerakennus G (Impivaarantie kämpäpä) | 434 473 | 7 238 869 | 37,8 | 4,0 | 40,0 | 36,9 |

Distances (m)

| WTG | A | B | C | D | E | F | G |
|-----|-------|------|------|------|-------|------|------|
| 1 | 10748 | 9106 | 6962 | 9602 | 10020 | 7843 | 9980 |
| 2 | 10097 | 8453 | 6313 | 9097 | 9368 | 7439 | 9379 |
| 3 | 9619 | 8023 | 5908 | 8537 | 8943 | 6907 | 8830 |
| 4 | 9321 | 7631 | 5477 | 8704 | 8542 | 7243 | 8776 |
| 5 | 9243 | 7726 | 5660 | 7953 | 8650 | 6310 | 8316 |
| 6 | 5862 | 4875 | 3486 | 4506 | 5745 | 3789 | 4514 |
| 7 | 5212 | 4126 | 2751 | 4677 | 5005 | 4336 | 4227 |
| 8 | 4195 | 3435 | 2698 | 4034 | 4235 | 4322 | 3136 |
| 9 | 3783 | 3509 | 3322 | 3332 | 4177 | 4099 | 2235 |
| 10 | 3016 | 2996 | 3295 | 3581 | 3558 | 4727 | 1811 |
| 11 | 2458 | 2976 | 3774 | 3648 | 3341 | 5174 | 1316 |

Project:
Kovasinkangas_20191009

Description:
Kovasinkankaan tuulivoimapuisto, Ii

Licensed user:
FCG Finnish Consulting Group Oy
Osmontie 34, PO Box 950
FI-00601 Helsinki
+358104095666
Liisa KArhu / liisa.karhu@fcg.fi
Calculated:
2.12.2022 16.32/3.5.584

DECIBEL - Assumptions for noise calculation

Calculation: Kovasinkangas V162-6,2MW x 6 x HH199 + Ketunmaankangas V126-3.45MW x 5 x HH137_202221202

Noise calculation model:

ISO 9613-2 General

Wind speed (in 10 m height):

Highest noise value at receptor

Ground attenuation:

General, Ground factor: 0,4

Meteorological coefficient, CO:

0,0 dB

Type of demand in calculation:

1: WTG noise is compared to demand (DK, DE, SE, NL etc.)

Noise values in calculation:

All noise values are mean values (Lwa) (Normal)

Pure tones:

Fixed penalty added to source noise of WTGs with pure tones

Noise sensitive area

Height above ground level, when no value in NSA object:

4,0 m; Don't allow override of model height with height from NSA object

Uncertainty margin:

0,0 dB; Uncertainty margin in NSA has priority

Deviation from "official" noise demands. Negative is more restrictive, positive is less restrictive.:

0,0 dB(A)

Octave data required

Frequency dependent air absorption

| 63 | 125 | 250 | 500 | 1 000 | 2 000 | 4 000 | 8 000 |
|---------|---------|---------|---------|---------|---------|---------|---------|
| [dB/km] |
| 0,10 | 0,38 | 1,12 | 2,36 | 4,08 | 8,78 | 26,60 | 95,00 |

All coordinates are in

Finish TM ETRS-TM35FIN-ETRS89

WTG: VESTAS V126-3.45 LTq 3450 126.0 !O!

Noise: Level 0 - Calculated - Mode 0-0S - 2016-01

Source Source/Date Creator Edited
HH: Vestas; 10 m: calculated by EMD 8.1.2016 USER 11.9.2019 8.52

Document DMS 0053-3712.03.

Blades without serrated trailing edge.

Hub height wind speed noise data from Vestas. Wind speed at hub height is converted to 10 m height using the IEC 61400-11 wind profile (5 cm roughness). Noise levels are interpolated at integer wind speeds.

| Status | Hub height | Wind speed | LwA,ref | Pure tones | Octave data | | | | | | | |
|--------------|------------|------------|---------|------------|-------------|------|------|------|-------|------|------|------|
| | | | | | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
| From Windcat | 137,0 | 8,0 | 106,2 | No | 88,2 | 94,3 | 96,1 | 99,5 | 102,3 | 98,5 | 91,4 | 80,2 |

WTG: VESTAS V162-6.2 6200 162.0 !O!

Noise: V162 - 6.2 MW Mode NO STE_+2dB - 12 2022

Source Source/Date Creator Edited
Vestas 22.6.2021 USER 2.12.2022 16.32
DMS no.: 0105-5200_00

| Status | Hub height | Wind speed | LwA,ref | Pure tones | Octave data | | | | | | | |
|--------------|------------|------------|---------|------------|-------------|------|-------|-------|-------|------|------|------|
| | | | | | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
| From Windcat | 199,0 | 8,0 | 109,6 | No | 90,4 | 98,4 | 103,2 | 104,9 | 103,5 | 98,9 | 91,2 | 80,3 |

Noise sensitive area: A Lomarakennus A (Kantolantie 285)

Predefined calculation standard:

Immission height(a.g.l.): Use standard value from calculation model

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Project:
Kovasinkangas_20191009

Description:
Kovasinkankaan tuulivoimapuisto, II

Licensed user:
FCG Finnish Consulting Group Oy
Osmontie 34, PO Box 950
FI-00601 Helsinki
+358104095666
Liisa KArhu / liisa.karhu@fcg.fi
Calculated:
2.12.2022 16.32/3.5.584

DECIBEL - Assumptions for noise calculation

Calculation: Kovasinkangas V162-6,2MW x 6 x HH199 + Ketunmaankangas V126-3.45MW x 5 x HH137_202221202

Noise sensitive area: B Lomarakennus C (Kantolantie 42)

Predefined calculation standard:

Immission height(a.g.l.): Use standard value from calculation model

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)
No distance demand

Noise sensitive area: C Asuinrakennus D (Onkamonkyläntie 280)

Predefined calculation standard:

Immission height(a.g.l.): Use standard value from calculation model

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)
No distance demand

Noise sensitive area: D Lomarakennus E (Kaunislammmentie 153)

Predefined calculation standard:

Immission height(a.g.l.): Use standard value from calculation model

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)
No distance demand

Noise sensitive area: E Lomarakennus B (Kantolantie 142)

Predefined calculation standard:

Immission height(a.g.l.): Use standard value from calculation model

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)
No distance demand

Noise sensitive area: F Lomarakennus F (Merijärvi)

Predefined calculation standard:

Immission height(a.g.l.): Use standard value from calculation model

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)
No distance demand

Noise sensitive area: G Liikerakennus G (Impivaarantie kämpä)

Predefined calculation standard:

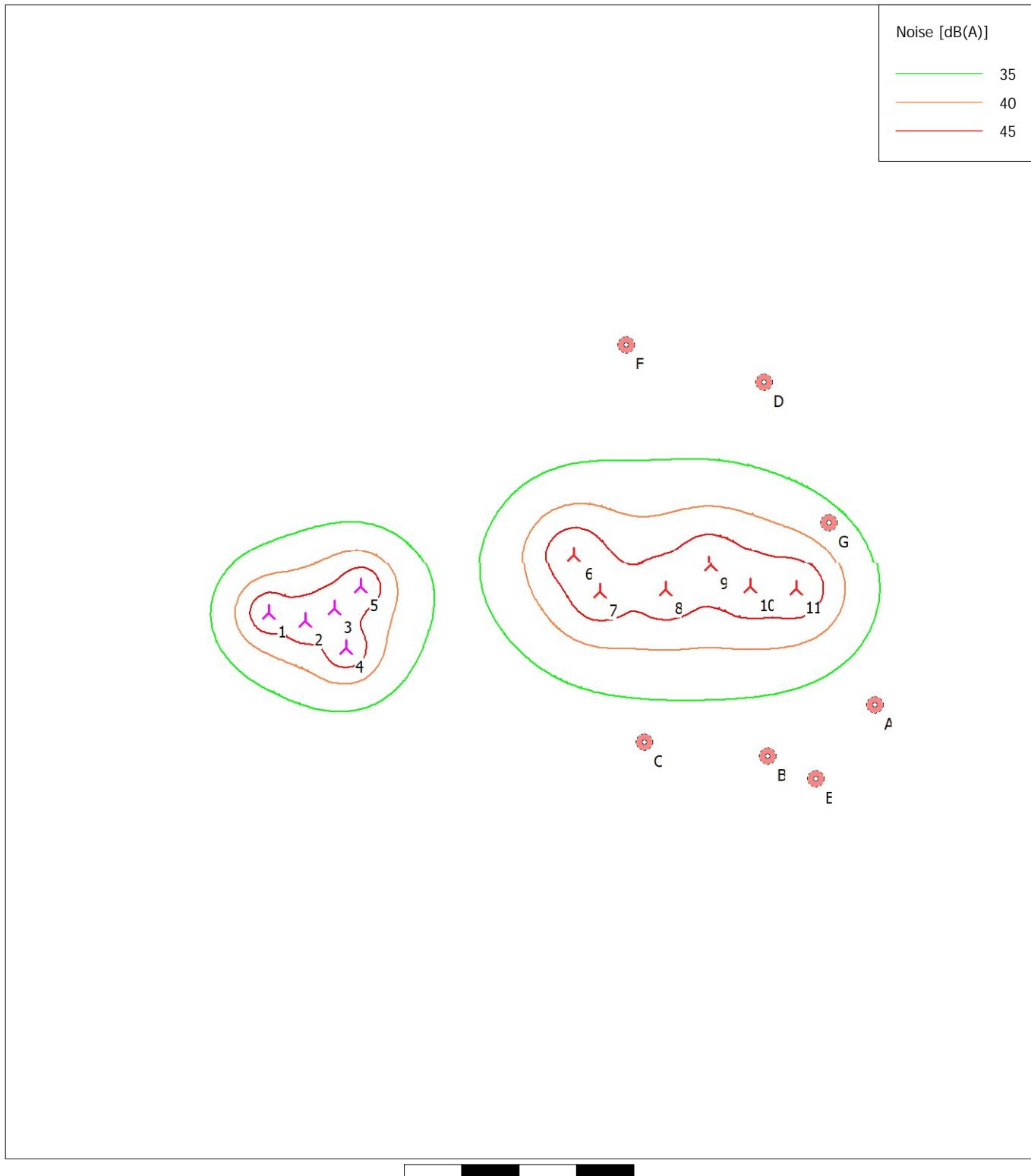
Immission height(a.g.l.): Use standard value from calculation model

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)
No distance demand

DECIBEL - Map Highest noise value at receptor

Calculation: Kovasinkangas V162-6,2MW x 6 x HH199 + Ketunmaankangas V126-3.45MW x 5 x HH137_202221202



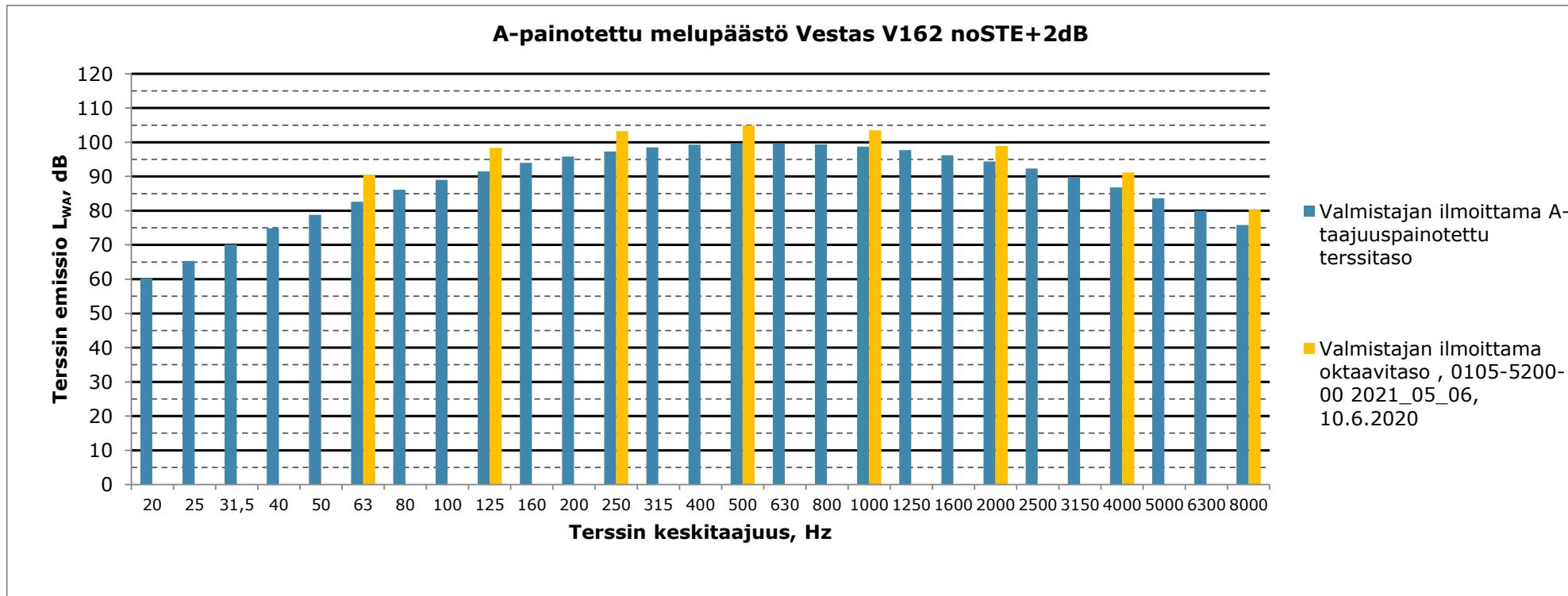
Map: Blank map , Print scale 1:100 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 429 203 North: 7 238 216

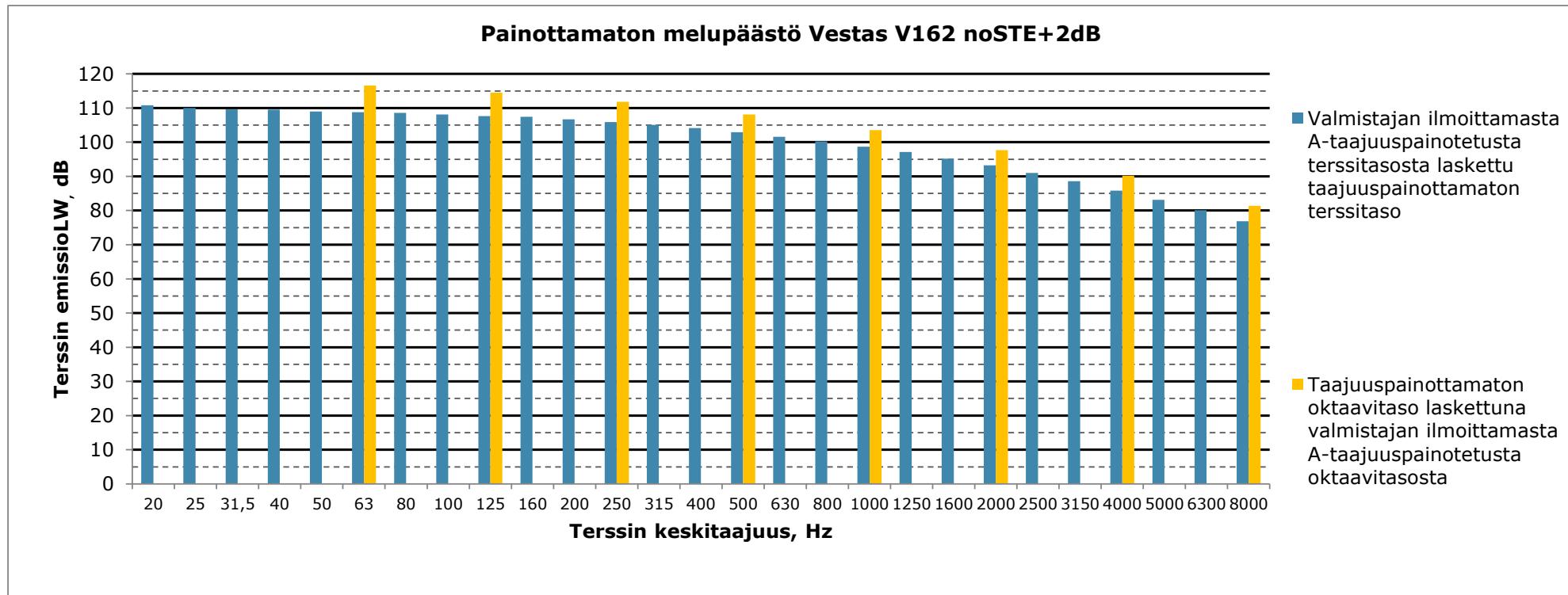
New WTG

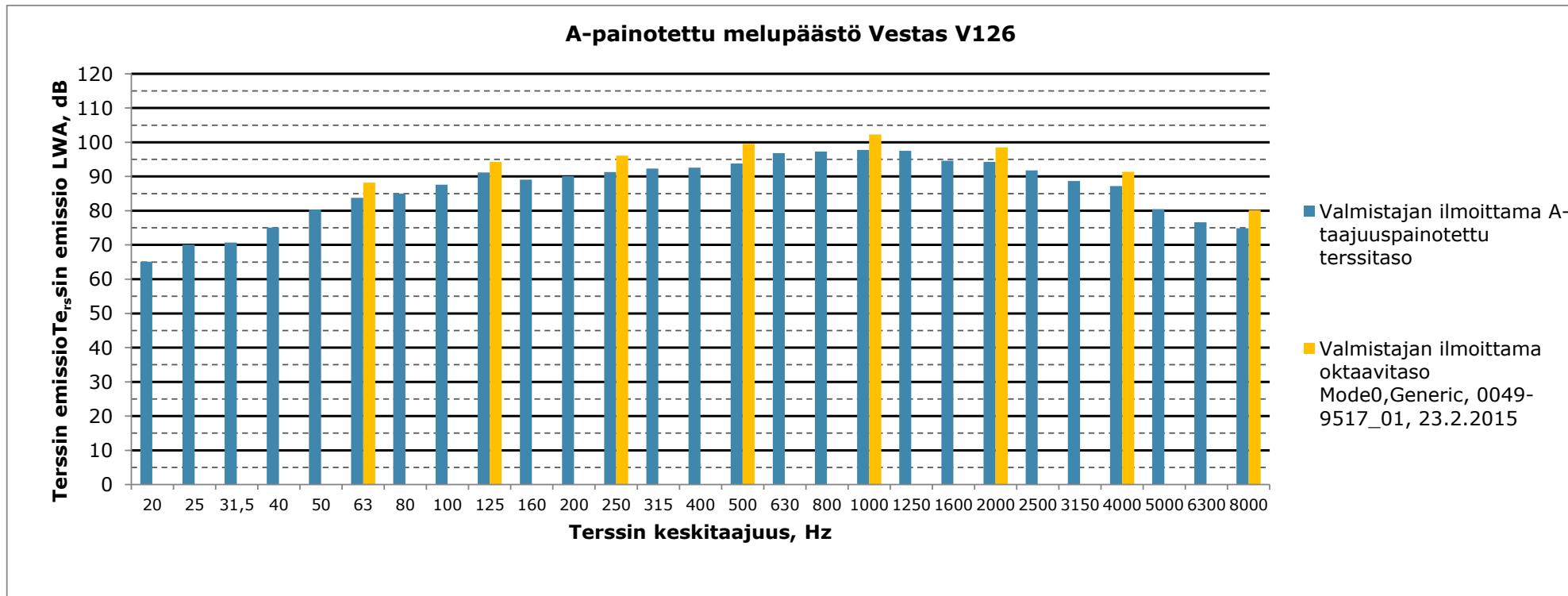
Noise sensitive area

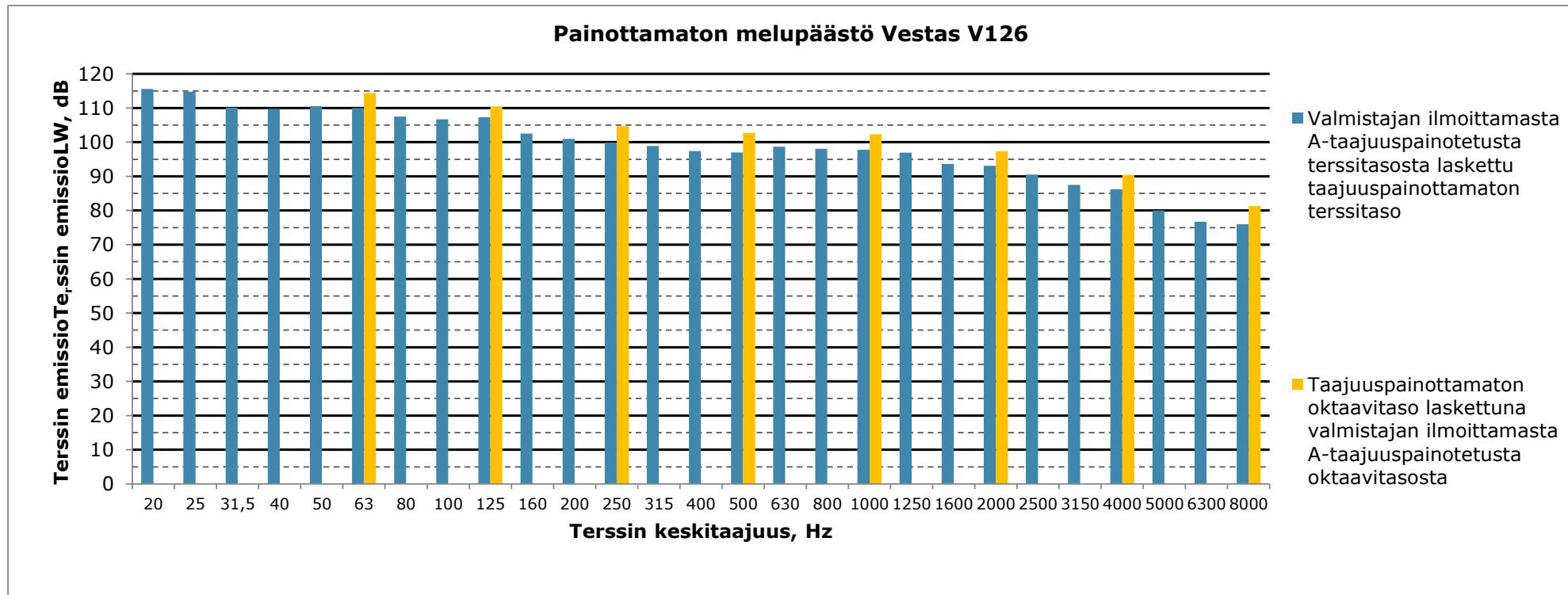
Noise calculation model: ISO 9613-2 General. Wind speed: Highest noise value at receptor
Height above sea level from active line object

Liite 2: Kovasinkankaan tuulivoimahanke - Matalataajuisen melun rakennuskohtaiset arvot

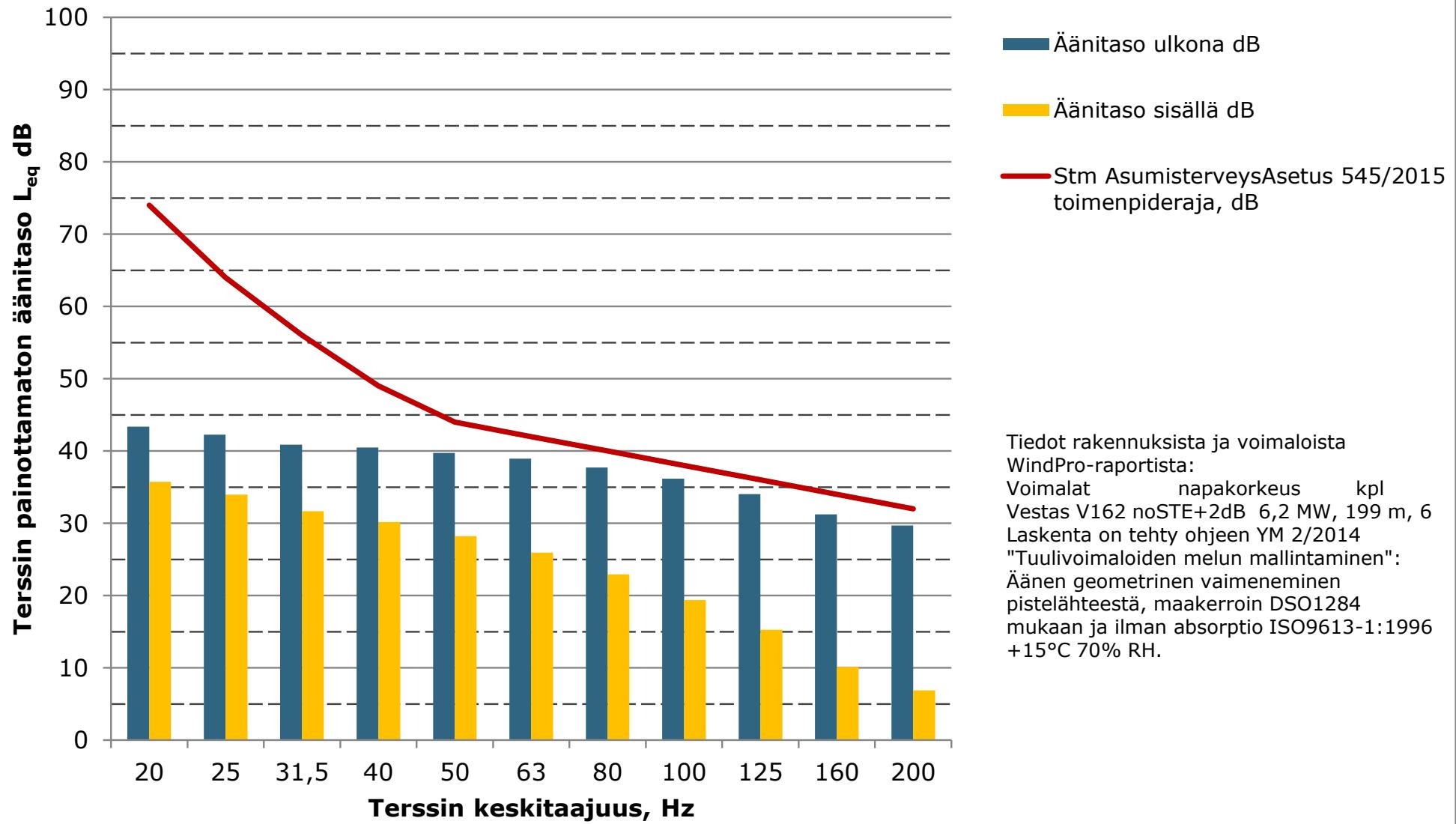




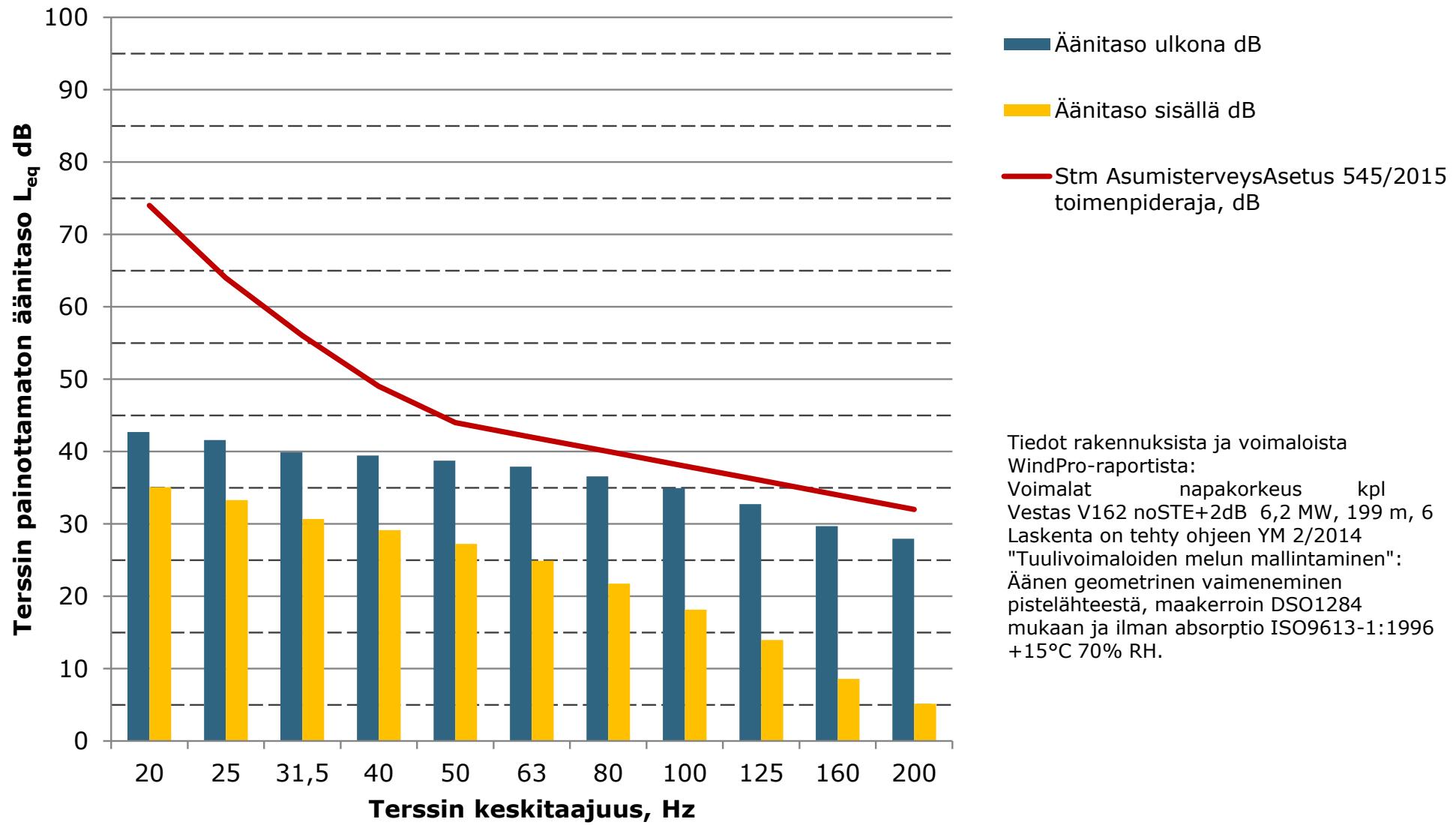




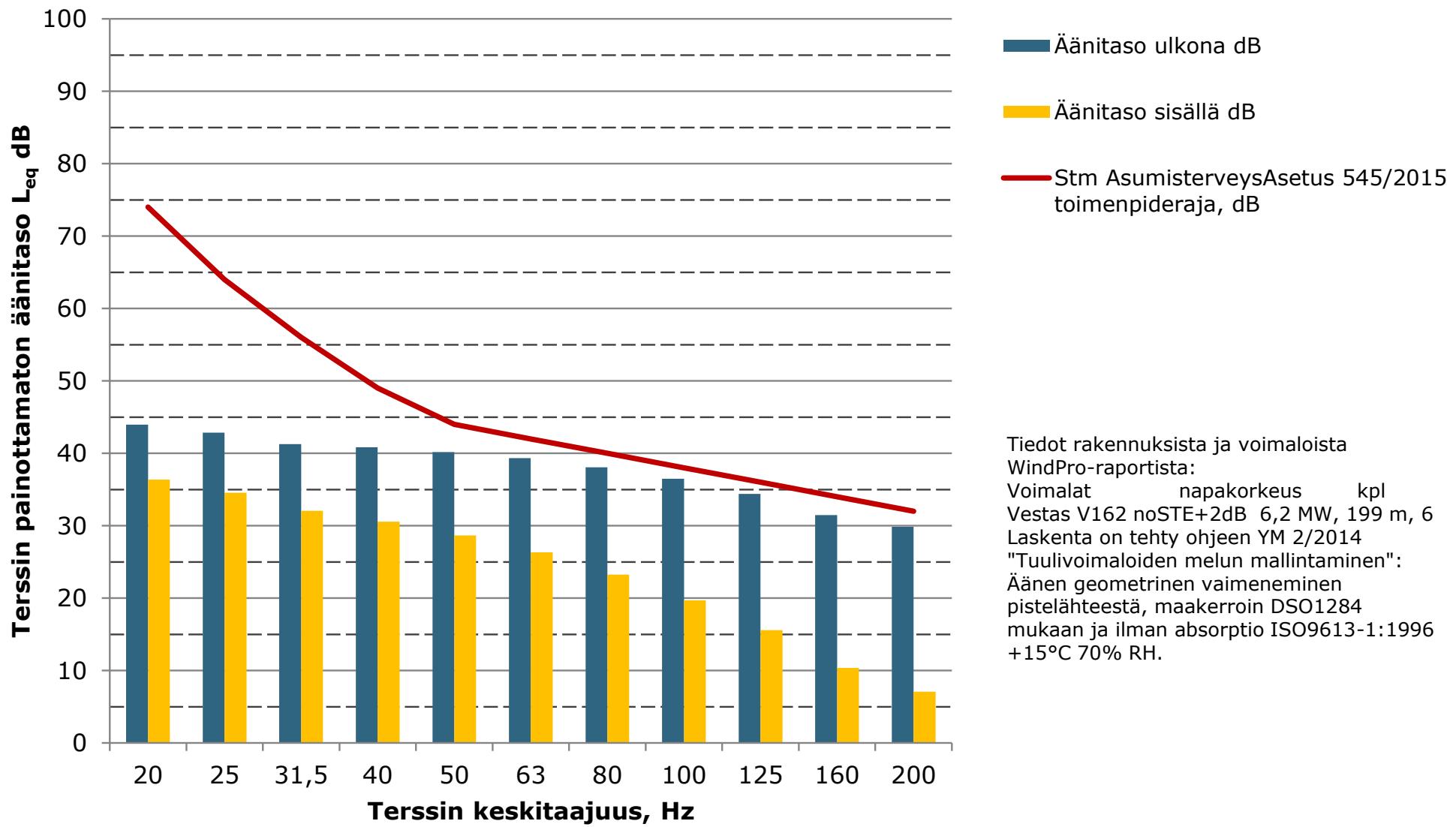
Matalien taajuuksien äänitasot ulkona ja sisällä, Lomarakennus A (Kantolantie 285), ääneneristyvyys Keränen, Hakala, Hongisto 2019, 84% persentiili mukaan



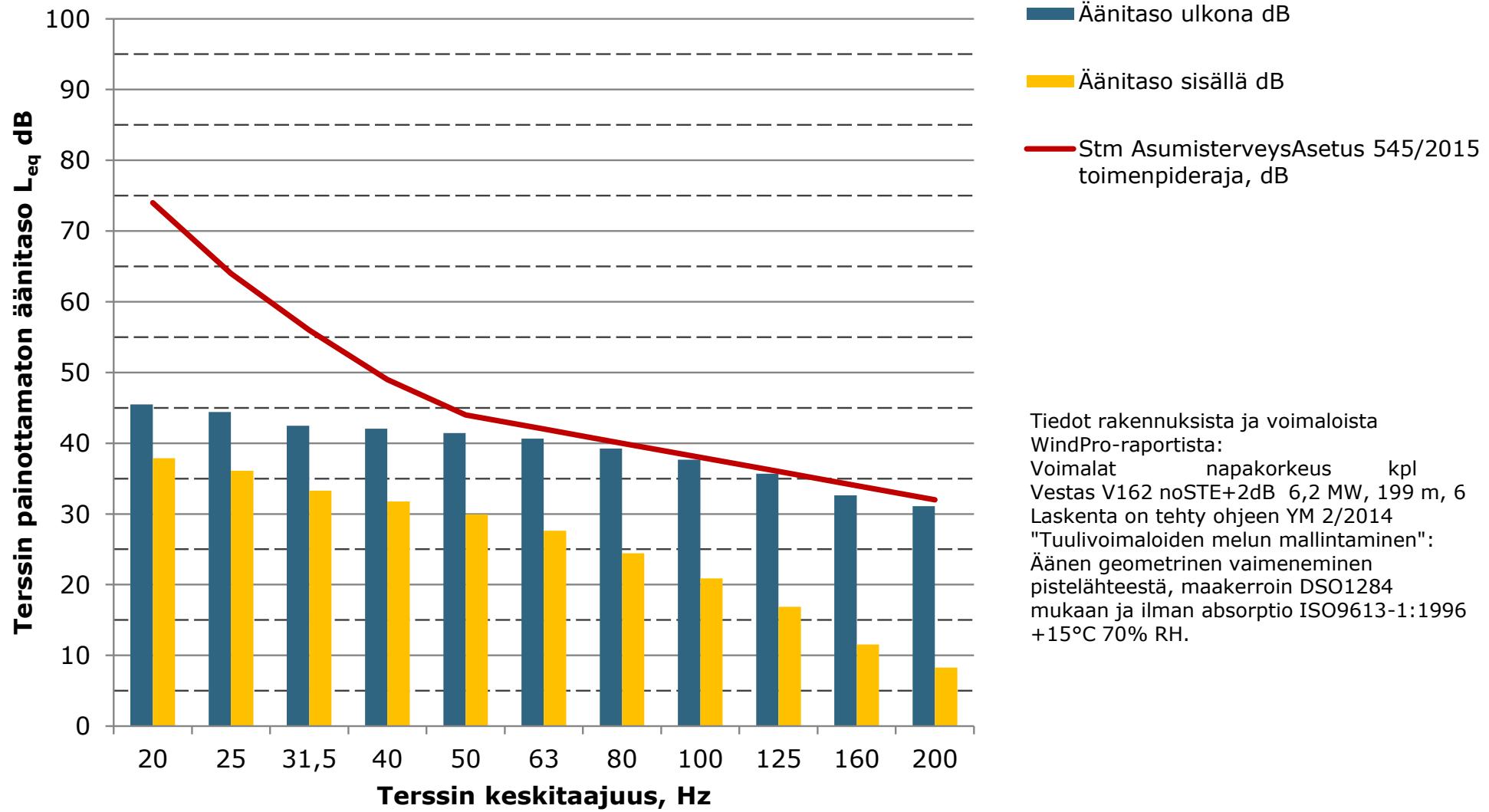
Matalien taajuuksien äänitasot ulkona ja sisällä, Lomarakennus B (Kantolantie 142), ääneneristyvyys Keränen, Hakala, Hongisto 2019, 84% persentiili mukaan



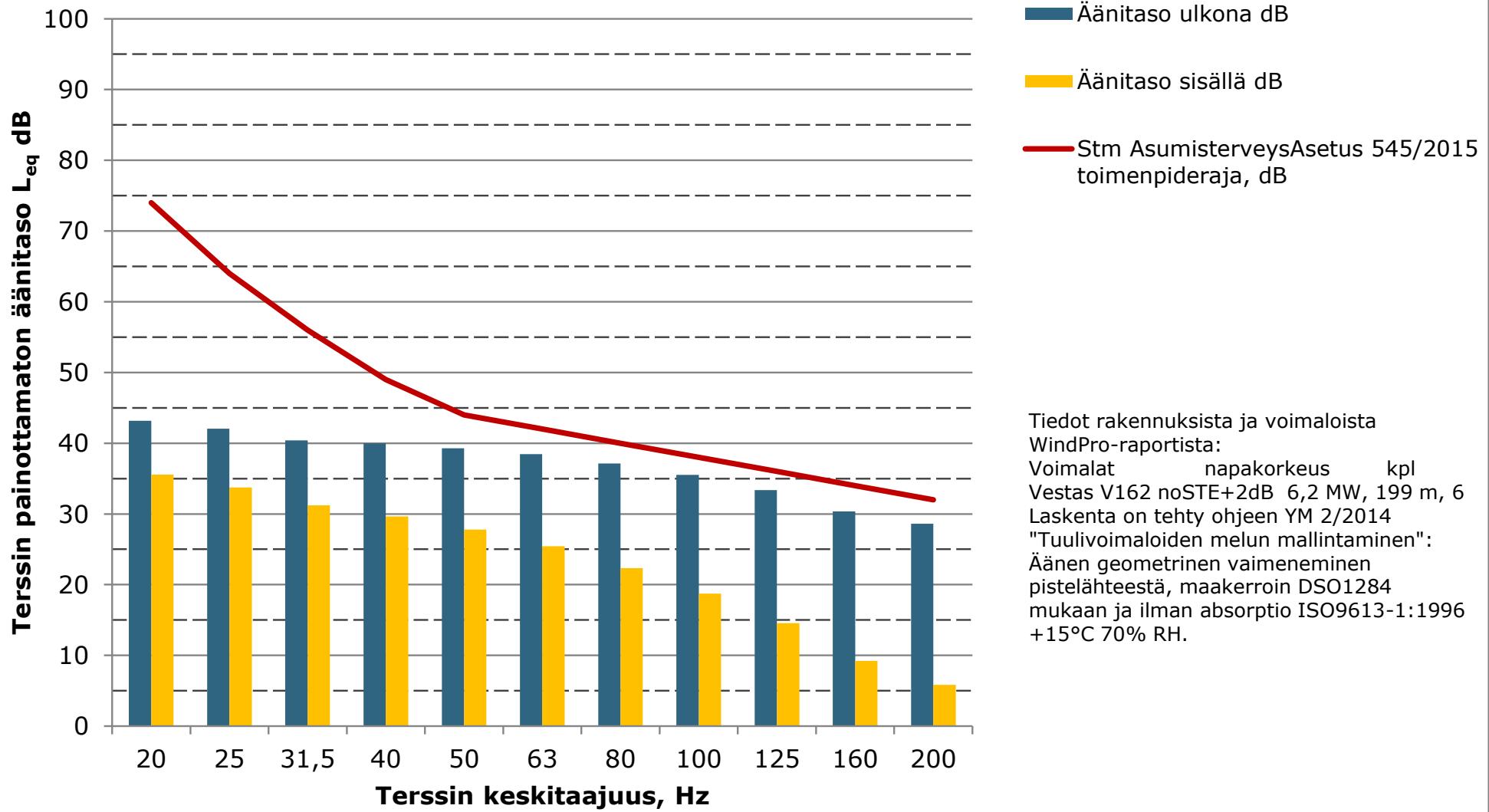
Matalien taajuuksien äänitasot ulkona ja sisällä, Lomarakennus C (Kantolantie 42), ääneneristyvys Keränen, Hakala, Hongisto 2019, 84% persentiili mukaan



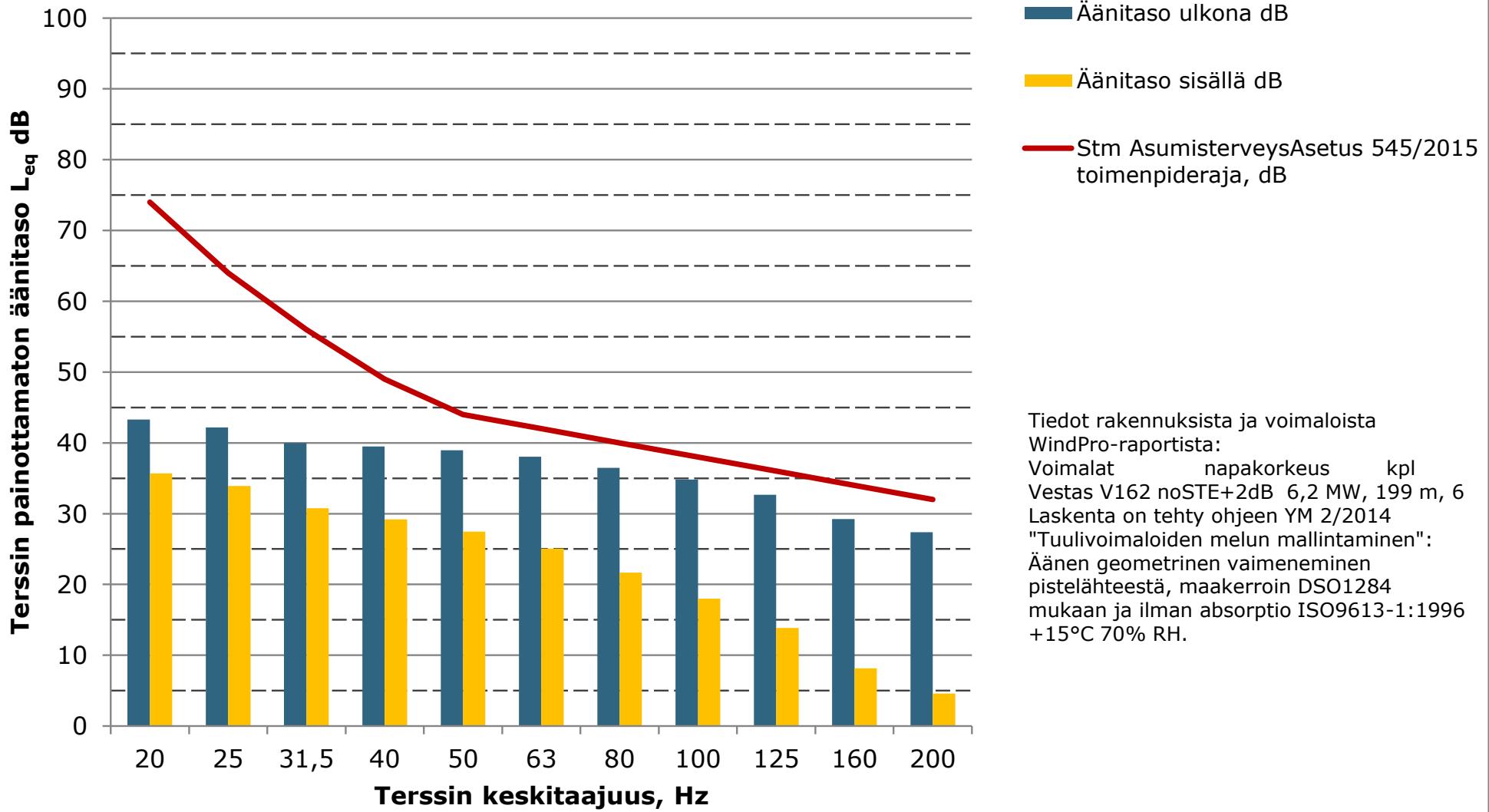
**Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus D
(Onkamonkyläntie 280), ääneneristyvys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**



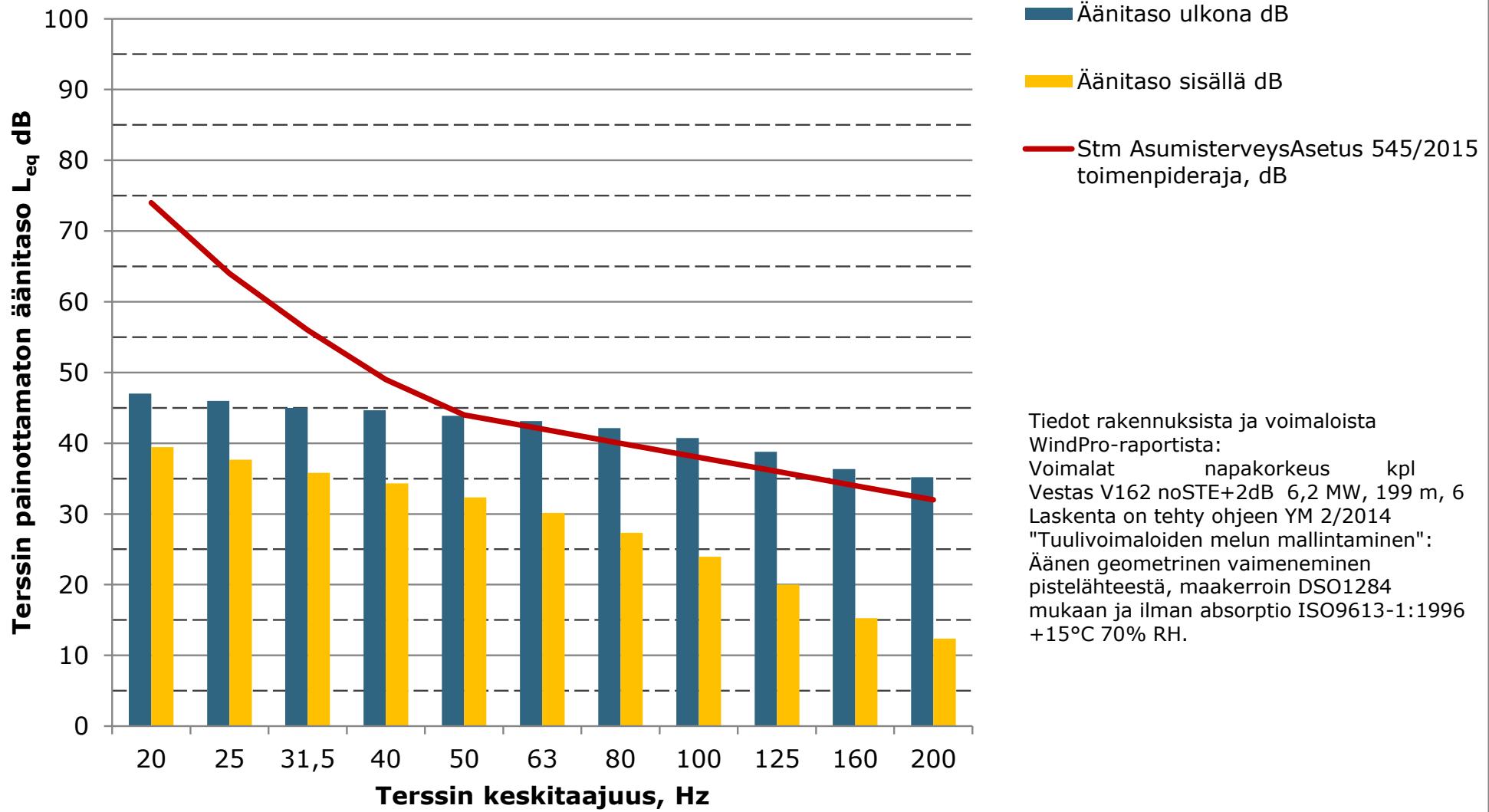
**Matalien taajuuksien äänitasot ulkona ja sisällä, Lomarakennus E
(Kaunislamenttie 153), ääneneristyvys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**



**Matalien taajuuksien äänitasot ulkona ja sisällä, Lomarakennus F
(Merijärvi), ääneneristyvyyss Keränen,Hakala,Hongisto 2019, 84% persentiili
mukaan**



**Matalien taajuuksien äänitasot ulkona ja sisällä, Liikerakennus G
(Impivaarantie kämppä), ääneneristyvys Keränen,Hakala,Hongisto 2019,
84% persentiili mukaan**



Liite 3: Kovasinkankaan tuulivoimahanke - Varjostusmallinnusten tulokset "real case, no forest"

SHADOW - Main Result

Calculation: Kovasinkangas V162-6,2MW x 6 x HH199 + Ketunmaankangas V126-3.45MW x 5 x HH137_no forest_20221202
 Assumptions for shadow calculations

Maximum distance for influence

Calculate only when more than 20 % of sun is covered by the blade

Please look in WTG table

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

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|------|------|------|------|------|-------|------|------|------|------|------|------|
| 0,60 | 2,61 | 4,18 | 6,47 | 8,80 | 10,60 | 9,50 | 6,88 | 4,22 | 2,77 | 1,22 | 0,17 |

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

Default Meteo data description (2)

Operational time

| N | NNE | ENE | E | ESE | SSE | S | SSW | WSW | W | WNW | NNW | Sum |
|-----|-----|-----|-----|-----|-----|-----|-------|-----|-----|-----|-----|-------|
| 619 | 605 | 559 | 627 | 758 | 839 | 939 | 1 102 | 916 | 649 | 504 | 548 | 8 664 |

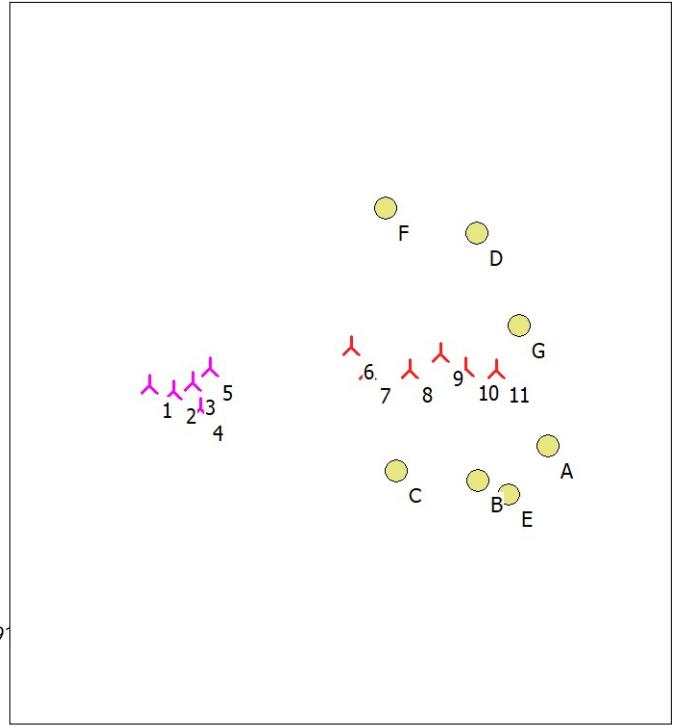
Idle start wind speed: Cut in wind speed from power curve

A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:

Height contours used: Height Contours: CONTOURLINE_Kovasinkangas_2019

Obstacles used in calculation

Receptor grid resolution: 10,0 m



All coordinates are in

Finish TM ETRS-TM35FIN-ETRS89

WTGs

| East | North | Z | Row data/Description | WTG type | | | Power, rated [kW] | Rotor diameter [m] | Hub height [m] | Shadow data Calculation distance [m] | RPM [RPM] |
|------|---------|-----------|--|----------|---------------------|----------------|-------------------|--------------------|----------------|--------------------------------------|-----------|
| | | | | Valid | Manufact. | Type-generator | | | | | |
| 1 | 424 583 | 7 237 533 | 16,1 VESTAS V126-3.45 LTq 3450 ... Yes | VESTAS | V126-3.45 LTq-3 450 | 3 450 | 126,0 | 137,0 | 1 718 | 13,4 | |
| 2 | 425 215 | 7 237 368 | 20,0 VESTAS V126-3.45 LTq 3450 ... Yes | VESTAS | V126-3.45 LTq-3 450 | 3 450 | 126,0 | 137,0 | 1 718 | 13,4 | |
| 3 | 425 739 | 7 237 570 | 22,5 VESTAS V126-3.45 LTq 3450 ... Yes | VESTAS | V126-3.45 LTq-3 450 | 3 450 | 126,0 | 137,0 | 1 718 | 13,4 | |
| 4 | 425 926 | 7 236 878 | 21,5 VESTAS V126-3.45 LTq 3450 ... Yes | VESTAS | V126-3.45 LTq-3 450 | 3 450 | 126,0 | 137,0 | 1 718 | 13,4 | |
| 5 | 426 209 | 7 237 939 | 25,0 VESTAS V126-3.45 LTq 3450 ... Yes | VESTAS | V126-3.45 LTq-3 450 | 3 450 | 126,0 | 137,0 | 1 718 | 13,4 | |
| 6 | 429 984 | 7 238 403 | 28,3 VESTAS V162-6.2 6200 162.0... Yes | VESTAS | V162-6.2-6 200 | 6 200 | 162,0 | 199,0 | 2 161 | 10,4 | |
| 7 | 430 394 | 7 237 760 | 31,7 VESTAS V162-6.2 6200 162.0... Yes | VESTAS | V162-6.2-6 200 | 6 200 | 162,0 | 199,0 | 2 161 | 10,4 | |
| 8 | 431 537 | 7 237 767 | 35,0 VESTAS V162-6.2 6200 162.0... Yes | VESTAS | V162-6.2-6 200 | 6 200 | 162,0 | 199,0 | 2 161 | 10,4 | |
| 9 | 432 345 | 7 238 186 | 41,0 VESTAS V162-6.2 6200 162.0... Yes | VESTAS | V162-6.2-6 200 | 6 200 | 162,0 | 199,0 | 2 161 | 10,4 | |
| 10 | 433 021 | 7 237 786 | 40,0 VESTAS V162-6.2 6200 162.0... Yes | VESTAS | V162-6.2-6 200 | 6 200 | 162,0 | 199,0 | 2 161 | 10,4 | |
| 11 | 433 822 | 7 237 725 | 38,7 VESTAS V162-6.2 6200 162.0... Yes | VESTAS | V162-6.2-6 200 | 6 200 | 162,0 | 199,0 | 2 161 | 10,4 | |

Shadow receptor-Input

| No. | Name | East | North | Z | Width | Height | Elevation a.g.l. | Slope of window [°] | Direction mode | Eye height (ZVI) a.g.l. [m] |
|-----|--|---------|-----------|------|-------|--------|------------------|---------------------|--------------------|-----------------------------|
| | | [m] | [m] | [m] | [m] | [m] | | | | |
| A | Lomarakennus A (Kantolantie 285) | 435 168 | 7 235 667 | 40,0 | 5,0 | 5,0 | 1,0 | 90,0 | "Green house mode" | 6,0 |
| B | Lomarakennus C (Kantolantie 42) | 433 269 | 7 234 801 | 35,0 | 5,0 | 5,0 | 1,0 | 90,0 | "Green house mode" | 6,0 |
| C | Asuinrakennus D (Onkamonkyläntie 280) | 431 108 | 7 235 103 | 32,5 | 5,0 | 5,0 | 1,0 | 90,0 | "Green house mode" | 6,0 |
| D | Lomarakennus E (Kaunislamenttie 153) | 433 395 | 7 241 348 | 37,5 | 5,0 | 5,0 | 1,0 | 90,0 | "Green house mode" | 6,0 |
| E | Lomarakennus B (Kantolantie 142) | 434 099 | 7 234 395 | 35,0 | 5,0 | 5,0 | 1,0 | 90,0 | "Green house mode" | 6,0 |
| F | Lomarakennus F (Merijärvi) | 430 991 | 7 242 055 | 30,0 | 5,0 | 5,0 | 1,0 | 90,0 | "Green house mode" | 6,0 |
| G | Liikerakennus G (Impivaarantie kämpää) | 434 473 | 7 238 869 | 37,8 | 5,0 | 5,0 | 1,0 | 90,0 | "Green house mode" | 6,0 |

SHADOW - Main Result

Calculation: Kovasinkangas V162-6,2MW x 6 x HH199 + Ketunmaankangas V126-3.45MW x 5 x HH137_no forest_20221202

Calculation Results

Shadow receptor

| No. | Name | Shadow, expected values Shadow hours per year [h/year] |
|-----|--|---|
| A | Lomarakennus A (Kantolantie 285) | 0:00 |
| B | Lomarakennus C (Kantolantie 42) | 0:00 |
| C | Asuinrakennus D (Onkamonkyläntie 280) | 0:00 |
| D | Lomarakennus E (Kaunislammmentie 153) | 0:00 |
| E | Lomarakennus B (Kantolantie 142) | 0:00 |
| F | Lomarakennus F (Merilänjärvi) | 0:00 |
| G | Liikerakennus G (Impivaarantie kämppä) | 4:42 |

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

| No. | Name | Expected [h/year] |
|-----|--|----------------------|
| 1 | VESTAS V126-3.45 LTq 3450 126.0 !O! hub: 137,0 m (TOT: 200,0 m) (13) | 0:00 |
| 2 | VESTAS V126-3.45 LTq 3450 126.0 !O! hub: 137,0 m (TOT: 200,0 m) (14) | 0:00 |
| 3 | VESTAS V126-3.45 LTq 3450 126.0 !O! hub: 137,0 m (TOT: 200,0 m) (15) | 0:00 |
| 4 | VESTAS V126-3.45 LTq 3450 126.0 !O! hub: 137,0 m (TOT: 200,0 m) (16) | 0:00 |
| 5 | VESTAS V126-3.45 LTq 3450 126.0 !O! hub: 137,0 m (TOT: 200,0 m) (17) | 0:00 |
| 6 | VESTAS V162-6.2 6200 162.0 !O! hub: 199,0 m (TOT: 280,0 m) (37) | 0:00 |
| 7 | VESTAS V162-6.2 6200 162.0 !O! hub: 199,0 m (TOT: 280,0 m) (38) | 0:00 |
| 8 | VESTAS V162-6.2 6200 162.0 !O! hub: 199,0 m (TOT: 280,0 m) (39) | 0:00 |
| 9 | VESTAS V162-6.2 6200 162.0 !O! hub: 199,0 m (TOT: 280,0 m) (40) | 0:00 |
| 10 | VESTAS V162-6.2 6200 162.0 !O! hub: 199,0 m (TOT: 280,0 m) (41) | 1:31 |
| 11 | VESTAS V162-6.2 6200 162.0 !O! hub: 199,0 m (TOT: 280,0 m) (42) | 3:10 |

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

The calculation of the total expected values for a given receptor assumes a weighted average directional reduction for all WTGs contributing to shadow flicker within the same day. In the case where shadow flicker from different WTGs is not concurrent within the day, the total expected time at a given receptor may deviate marginally from the individual flicker time caused by each turbine separately.

SHADOW - Calendar

Calculation: Kovasinkangas V162-6,2MW x 6 x HH199 + Ketunmaankangas V126-3.45MW x 5 x HH137_no forest_2022120Shadow receptor: A - Lomarakennus A (Kantolantie 285)
Assumptions for shadow calculations

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0,60 2,61 4,18 6,47 8,80 10,60 9,50 6,88 4,22 2,77 1,22 0,17

Operational time

| | N | NNE | ENE | E | ESE | SSE | S | SSW | WSW | W | WNW | NNW | Sum |
|--|-----|-----|-----|-----|-----|-----|-----|------|-----|-----|-----|-----|------|
| | 619 | 605 | 559 | 627 | 758 | 839 | 939 | 1102 | 916 | 649 | 504 | 548 | 8664 |

Idle start wind speed: Cut in wind speed from power curve

| | January | February | March | April | May | June | July | August | September | October | November | December |
|---------------------|---------|----------|-------|-------|-------|-------|-------|--------|-----------|---------|----------|----------|
| 1 | 10.30 | 09.11 | 07.32 | 06.38 | 04.46 | 02.51 | 02.24 | 04.09 | 05.53 | 07.25 | 08.05 | 09.49 |
| | 14.13 | 15.54 | 17.30 | 20.09 | 21.48 | 23.40 | 00.20 | 22.37 | 20.41 | 18.50 | 15.57 | 14.24 |
| 2 | 10.29 | 09.07 | 07.29 | 06.34 | 04.42 | 02.47 | 02.27 | 04.13 | 05.56 | 07.28 | 08.08 | 09.52 |
| | 14.15 | 15.57 | 17.34 | 20.12 | 21.51 | 23.44 | 00.17 | 22.33 | 20.38 | 18.46 | 15.54 | 14.22 |
| 3 | 10.28 | 09.04 | 07.25 | 06.30 | 04.38 | 02.44 | 02.30 | 04.16 | 05.59 | 07.31 | 08.12 | 09.55 |
| | 14.17 | 16.01 | 17.37 | 20.15 | 21.55 | 23.48 | 00.15 | 22.29 | 20.34 | 18.42 | 15.50 | 14.19 |
| 4 | 10.26 | 09.00 | 07.21 | 06.26 | 04.34 | 02.41 | 02.33 | 04.20 | 06.03 | 07.34 | 08.15 | 09.58 |
| | 14.20 | 16.05 | 17.40 | 20.18 | 21.58 | 23.51 | 00.12 | 22.26 | 20.30 | 18.38 | 15.47 | 14.17 |
| 5 | 10.24 | 08.57 | 07.18 | 06.23 | 04.31 | 02.38 | 02.36 | 04.24 | 06.06 | 07.37 | 08.19 | 10.01 |
| | 14.22 | 16.08 | 17.44 | 20.22 | 22.02 | 23.55 | 00.09 | 22.22 | 20.26 | 18.35 | 15.44 | 14.15 |
| 6 | 10.23 | 08.54 | 07.14 | 06.19 | 04.27 | 02.35 | 02.40 | 04.27 | 06.09 | 07.40 | 08.22 | 10.04 |
| | 14.25 | 16.12 | 17.47 | 20.25 | 22.05 | 23.58 | 00.06 | 22.18 | 20.23 | 18.31 | 15.40 | 14.13 |
| 7 | 10.21 | 08.50 | 07.10 | 06.15 | 04.23 | 02.32 | 02.43 | 04.31 | 06.12 | 07.43 | 08.26 | 10.07 |
| | 14.28 | 16.15 | 17.50 | 20.28 | 22.09 | 00.01 | 00.03 | 22.15 | 20.19 | 18.27 | 15.37 | 14.11 |
| 8 | 10.19 | 08.47 | 07.07 | 06.11 | 04.20 | 02.29 | 02.46 | 04.34 | 06.15 | 07.47 | 08.29 | 10.10 |
| | 14.31 | 16.19 | 17.53 | 20.31 | 22.12 | 00.05 | 00.00 | 22.11 | 20.15 | 18.24 | 15.33 | 14.09 |
| 9 | 10.17 | 08.43 | 07.03 | 06.08 | 04.16 | 02.26 | 02.50 | 04.38 | 06.18 | 07.50 | 08.33 | 10.13 |
| | 14.34 | 16.22 | 17.56 | 20.34 | 22.16 | 00.08 | 23.57 | 22.07 | 20.11 | 18.20 | 15.30 | 14.07 |
| 10 | 10.14 | 08.40 | 06.59 | 06.04 | 04.12 | 02.24 | 02.53 | 04.41 | 06.21 | 07.53 | 08.36 | 10.15 |
| | 14.37 | 16.26 | 18.00 | 20.37 | 22.20 | 00.11 | 23.54 | 22.04 | 20.08 | 18.16 | 15.27 | 14.06 |
| 11 | 10.12 | 08.37 | 06.56 | 06.00 | 04.09 | 02.21 | 02.57 | 04.44 | 06.24 | 07.56 | 08.40 | 10.17 |
| | 14.40 | 16.29 | 18.03 | 20.41 | 22.23 | 00.14 | 23.51 | 22.00 | 20.04 | 18.13 | 15.23 | 14.04 |
| 12 | 10.10 | 08.33 | 06.52 | 05.56 | 04.05 | 02.19 | 03.00 | 04.48 | 06.27 | 07.59 | 08.43 | 10.20 |
| | 14.43 | 16.33 | 18.06 | 20.44 | 22.27 | 00.16 | 23.47 | 21.56 | 20.00 | 18.09 | 15.20 | 14.03 |
| 13 | 10.07 | 08.30 | 06.48 | 05.53 | 04.01 | 02.17 | 03.00 | 04.51 | 06.30 | 08.02 | 08.47 | 10.22 |
| | 14.47 | 16.36 | 18.09 | 20.47 | 22.30 | 00.19 | 23.44 | 21.52 | 19.56 | 18.05 | 15.17 | 14.02 |
| 14 | 10.05 | 08.26 | 06.45 | 05.49 | 03.58 | 02.15 | 03.04 | 04.55 | 06.33 | 08.05 | 08.50 | 10.24 |
| | 14.50 | 16.40 | 18.12 | 20.50 | 22.34 | 00.22 | 23.41 | 21.49 | 19.53 | 18.02 | 15.14 | 14.01 |
| 15 | 10.02 | 08.22 | 06.41 | 05.45 | 03.54 | 02.13 | 03.08 | 04.58 | 06.36 | 08.09 | 08.54 | 10.26 |
| | 14.53 | 16.43 | 18.15 | 20.54 | 22.38 | 00.24 | 23.37 | 21.45 | 19.49 | 17.58 | 15.10 | 14.00 |
| 16 | 09.59 | 08.19 | 06.37 | 05.41 | 03.50 | 02.11 | 03.11 | 05.01 | 06.39 | 08.12 | 08.57 | 10.27 |
| | 14.57 | 16.47 | 18.19 | 20.57 | 22.41 | 00.26 | 23.34 | 21.41 | 19.45 | 17.54 | 15.07 | 13.59 |
| 17 | 09.57 | 08.15 | 06.33 | 05.38 | 03.47 | 02.10 | 03.15 | 05.05 | 06.42 | 08.15 | 09.01 | 10.29 |
| | 15.00 | 16.50 | 18.22 | 21.00 | 22.45 | 00.28 | 23.30 | 21.37 | 19.42 | 17.51 | 15.04 | 13.59 |
| 18 | 09.54 | 08.12 | 06.30 | 05.34 | 03.43 | 02.09 | 03.18 | 05.08 | 06.45 | 08.18 | 09.05 | 10.30 |
| | 15.04 | 16.54 | 18.25 | 21.04 | 22.49 | 00.29 | 23.27 | 21.34 | 19.38 | 17.47 | 15.01 | 13.58 |
| 19 | 09.51 | 08.08 | 06.26 | 05.30 | 03.39 | 02.08 | 03.22 | 05.11 | 06.48 | 08.21 | 09.08 | 10.31 |
| | 15.07 | 16.57 | 18.28 | 21.07 | 22.53 | 00.30 | 23.24 | 21.30 | 19.34 | 17.44 | 14.58 | 13.58 |
| 20 | 09.48 | 08.05 | 06.22 | 05.27 | 03.36 | 02.08 | 03.26 | 05.15 | 06.51 | 08.25 | 09.12 | 10.33 |
| | 15.11 | 17.00 | 18.31 | 21.10 | 22.56 | 00.31 | 23.20 | 21.26 | 19.30 | 17.40 | 14.55 | 13.58 |
| 21 | 09.45 | 08.01 | 06.19 | 05.23 | 03.32 | 02.08 | 03.29 | 05.18 | 06.54 | 08.28 | 09.15 | 10.33 |
| | 15.14 | 17.04 | 18.34 | 21.13 | 23.00 | 00.31 | 23.16 | 21.23 | 19.27 | 17.36 | 14.52 | 13.58 |
| 22 | 09.42 | 07.58 | 06.15 | 05.19 | 03.29 | 02.08 | 03.33 | 05.21 | 06.57 | 08.31 | 09.19 | 10.34 |
| | 15.18 | 17.07 | 18.37 | 21.17 | 23.04 | 00.32 | 23.13 | 21.19 | 19.23 | 17.33 | 14.49 | 13.59 |
| 23 | 09.39 | 07.54 | 06.11 | 05.15 | 03.25 | 02.09 | 03.37 | 05.24 | 07.01 | 08.35 | 09.22 | 10.34 |
| | 15.21 | 17.11 | 18.41 | 21.20 | 23.07 | 00.31 | 23.09 | 21.15 | 19.19 | 17.29 | 14.46 | 13.59 |
| 24 | 09.36 | 07.50 | 06.07 | 05.12 | 03.22 | 02.10 | 03.40 | 05.28 | 07.04 | 08.38 | 09.26 | 10.35 |
| | 15.25 | 17.14 | 18.44 | 21.24 | 23.11 | 00.31 | 23.06 | 21.11 | 19.15 | 17.26 | 14.43 | 14.00 |
| 25 | 09.33 | 07.47 | 06.04 | 05.08 | 03.18 | 02.11 | 03.44 | 05.31 | 07.07 | 07.41 | 09.29 | 10.35 |
| | 15.28 | 17.17 | 18.47 | 21.27 | 23.15 | 00.30 | 23.02 | 21.08 | 19.12 | 17.22 | 14.40 | 14.01 |
| 26 | 09.30 | 07.43 | 06.00 | 05.04 | 03.14 | 02.13 | 03.48 | 05.34 | 07.10 | 07.45 | 09.33 | 10.35 |
| | 15.32 | 17.21 | 18.50 | 21.30 | 23.19 | 00.29 | 22.59 | 21.04 | 19.08 | 16.19 | 14.37 | 14.02 |
| 27 | 09.27 | 07.39 | 05.56 | 05.00 | 03.11 | 02.15 | 03.51 | 05.37 | 07.13 | 07.48 | 09.36 | 10.34 |
| | 15.36 | 17.24 | 18.53 | 21.34 | 23.22 | 00.27 | 22.55 | 21.00 | 19.04 | 16.15 | 14.34 | 14.03 |
| 28 | 09.24 | 07.36 | 05.52 | 04.57 | 03.08 | 02.17 | 03.55 | 05.41 | 07.16 | 07.51 | 09.39 | 10.34 |
| | 15.39 | 17.27 | 18.56 | 21.37 | 23.26 | 00.26 | 22.51 | 20.56 | 19.01 | 16.11 | 14.32 | 14.05 |
| 29 | 09.20 | 06.49 | 04.53 | 03.04 | 02.19 | 03.59 | 05.44 | 07.19 | 07.55 | 09.43 | 10.33 | |
| | 15.43 | 19.59 | 21.41 | 23.30 | 00.24 | 22.48 | 20.53 | 18.57 | 16.08 | 14.29 | 14.06 | |
| 30 | 09.17 | 06.45 | 04.49 | 03.01 | 02.22 | 04.02 | 05.47 | 07.22 | 07.58 | 09.46 | 10.33 | |
| | 15.46 | 20.03 | 21.44 | 23.33 | 00.22 | 22.44 | 20.49 | 18.53 | 16.04 | 14.26 | 14.08 | |
| 31 | 09.14 | 06.41 | 02.54 | | | 04.06 | 05.50 | | 08.01 | | 10.32 | |
| | 15.50 | 20.06 | 23.37 | | | 22.40 | 20.45 | | 16.01 | | 14.10 | |
| Potential sun hours | 156 | 232 | 362 | 456 | 584 | 657 | 630 | 517 | 395 | 301 | 187 | 116 |
| Total, worst case | | | | | | | | | | | | |
| Sun reduction | | | | | | | | | | | | |
| Oper. time red. | | | | | | | | | | | | |
| Wind dir. red. | | | | | | | | | | | | |
| Total reduction | | | | | | | | | | | | |
| Total, real | | | | | | | | | | | | |

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

| Day in month | Sun rise (hh:mm) | Sun set (hh:mm) | Minutes with flicker | First time (hh:mm) with flicker | Last time (hh:mm) with flicker | (WTG causing flicker first time) | (WTG causing flicker last time) |
|--------------|------------------|-----------------|----------------------|---------------------------------|--------------------------------|----------------------------------|---------------------------------|
|--------------|------------------|-----------------|----------------------|---------------------------------|--------------------------------|----------------------------------|---------------------------------|

SHADOW - Calendar

Calculation: Kovasinkangas V162-6,2MW x 6 x HH199 + Ketunmaankangas V126-3.45MW x 5 x HH137_no forest_2022120Shadow receptor: B - Lomarakennus C (Kantolantie 42)
Assumptions for shadow calculations

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0,60 2,61 4,18 6,47 8,80 10,60 9,50 6,88 4,22 2,77 1,22 0,17

Operational time

| | N | NNE | ENE | E | ESE | SSE | S | SSW | WSW | W | WNW | NNW | Sum |
|-----|-----|-----|-----|-----|-----|-----|------|-----|-----|-----|-----|------|-----|
| 619 | 605 | 559 | 627 | 758 | 839 | 939 | 1102 | 916 | 649 | 504 | 548 | 8664 | |

Idle start wind speed: Cut in wind speed from power curve

| | January | February | March | April | May | June | July | August | September | October | November | December |
|---------------------|---------|----------|-------|-------|-------|-------|-------|--------|-----------|---------|----------|----------|
| 1 | 10.30 | 09.11 | 07.32 | 06.38 | 04.46 | 02.51 | 02.25 | 04.10 | 05.53 | 07.25 | 08.05 | 09.49 |
| | 14.13 | 15.54 | 17.31 | 20.09 | 21.48 | 23.40 | 00.19 | 22.37 | 20.42 | 18.50 | 15.58 | 14.24 |
| 2 | 10.29 | 09.07 | 07.29 | 06.34 | 04.42 | 02.48 | 02.28 | 04.13 | 05.56 | 07.28 | 08.08 | 09.52 |
| | 14.15 | 15.58 | 17.34 | 20.12 | 21.51 | 23.44 | 00.17 | 22.33 | 20.38 | 18.46 | 15.54 | 14.22 |
| 3 | 10.28 | 09.04 | 07.25 | 06.30 | 04.38 | 02.45 | 02.31 | 04.17 | 06.00 | 07.31 | 08.12 | 09.55 |
| | 14.18 | 16.01 | 17.37 | 20.15 | 21.55 | 23.48 | 00.14 | 22.29 | 20.34 | 18.42 | 15.51 | 14.20 |
| 4 | 10.26 | 09.01 | 07.21 | 06.27 | 04.35 | 02.41 | 02.34 | 04.20 | 06.03 | 07.34 | 08.15 | 09.58 |
| | 14.20 | 16.05 | 17.40 | 20.18 | 21.58 | 23.51 | 00.12 | 22.26 | 20.30 | 18.39 | 15.47 | 14.17 |
| 5 | 10.24 | 08.57 | 07.18 | 06.23 | 04.31 | 02.38 | 02.37 | 04.24 | 06.06 | 07.37 | 08.19 | 10.01 |
| | 14.23 | 16.08 | 17.44 | 20.22 | 22.02 | 23.55 | 00.09 | 22.22 | 20.27 | 18.35 | 15.44 | 14.15 |
| 6 | 10.23 | 08.54 | 07.14 | 06.19 | 04.27 | 02.35 | 02.40 | 04.27 | 06.09 | 07.40 | 08.22 | 10.04 |
| | 14.25 | 16.12 | 17.47 | 20.25 | 22.05 | 23.58 | 00.06 | 22.18 | 20.23 | 18.31 | 15.40 | 14.13 |
| 7 | 10.21 | 08.50 | 07.10 | 06.15 | 04.24 | 02.32 | 02.43 | 04.31 | 06.12 | 07.44 | 08.26 | 10.07 |
| | 14.28 | 16.15 | 17.50 | 20.28 | 22.09 | 00.01 | 00.03 | 22.15 | 20.19 | 18.28 | 15.37 | 14.11 |
| 8 | 10.19 | 08.47 | 07.07 | 06.12 | 04.20 | 02.30 | 02.47 | 04.34 | 06.15 | 07.47 | 08.29 | 10.10 |
| | 14.31 | 16.19 | 17.53 | 20.31 | 22.12 | 00.04 | 00.00 | 22.11 | 20.15 | 18.24 | 15.34 | 14.09 |
| 9 | 10.17 | 08.44 | 07.03 | 06.08 | 04.16 | 02.27 | 02.50 | 04.38 | 06.18 | 07.50 | 08.33 | 10.13 |
| | 14.34 | 16.23 | 17.57 | 20.34 | 22.16 | 00.08 | 23.57 | 22.07 | 20.12 | 18.20 | 15.30 | 14.08 |
| 10 | 10.14 | 08.40 | 06.59 | 06.04 | 04.12 | 02.24 | 02.54 | 04.41 | 06.21 | 07.53 | 08.36 | 10.15 |
| | 14.37 | 16.26 | 18.00 | 20.38 | 22.20 | 00.11 | 23.54 | 22.04 | 20.08 | 18.17 | 15.27 | 14.06 |
| 11 | 10.12 | 08.37 | 06.56 | 06.00 | 04.09 | 02.22 | 02.57 | 04.45 | 06.24 | 07.56 | 08.40 | 10.17 |
| | 14.40 | 16.30 | 18.03 | 20.41 | 22.23 | 00.14 | 23.51 | 22.00 | 20.04 | 18.13 | 15.24 | 14.05 |
| 12 | 10.10 | 08.33 | 06.52 | 05.57 | 04.05 | 02.19 | 03.01 | 04.48 | 06.27 | 07.59 | 08.43 | 10.20 |
| | 14.44 | 16.33 | 18.06 | 20.44 | 22.27 | 00.16 | 23.47 | 21.56 | 20.00 | 18.09 | 15.20 | 14.03 |
| 13 | 10.07 | 08.30 | 06.48 | 05.53 | 04.01 | 02.17 | 03.01 | 04.51 | 06.30 | 08.02 | 08.47 | 10.22 |
| | 14.47 | 16.37 | 18.09 | 20.47 | 22.31 | 00.19 | 23.44 | 21.52 | 19.57 | 18.06 | 15.17 | 14.02 |
| 14 | 10.05 | 08.26 | 06.45 | 05.49 | 03.58 | 02.15 | 03.04 | 04.55 | 06.33 | 08.06 | 08.50 | 10.24 |
| | 14.50 | 16.40 | 18.12 | 20.51 | 22.34 | 00.21 | 23.41 | 21.49 | 19.53 | 18.02 | 15.14 | 14.01 |
| 15 | 10.02 | 08.23 | 06.41 | 05.45 | 03.54 | 02.13 | 03.08 | 04.58 | 06.36 | 08.09 | 08.54 | 10.26 |
| | 14.53 | 16.44 | 18.16 | 20.54 | 22.38 | 00.24 | 23.37 | 21.45 | 19.49 | 17.58 | 15.11 | 14.00 |
| 16 | 09.59 | 08.19 | 06.37 | 05.42 | 03.51 | 02.12 | 03.11 | 05.02 | 06.39 | 08.12 | 08.58 | 10.27 |
| | 14.57 | 16.47 | 18.19 | 20.57 | 22.42 | 00.26 | 23.34 | 21.41 | 19.45 | 17.55 | 15.07 | 13.59 |
| 17 | 09.57 | 08.16 | 06.34 | 05.38 | 03.47 | 02.11 | 03.15 | 05.05 | 06.43 | 08.15 | 09.01 | 10.29 |
| | 15.00 | 16.50 | 18.22 | 21.00 | 22.45 | 00.27 | 23.30 | 21.38 | 19.42 | 17.51 | 15.04 | 13.59 |
| 18 | 09.54 | 08.12 | 06.30 | 05.34 | 03.43 | 02.10 | 03.19 | 05.08 | 06.46 | 08.18 | 09.05 | 10.30 |
| | 15.04 | 16.54 | 18.25 | 21.04 | 22.49 | 00.29 | 23.27 | 21.34 | 19.38 | 17.47 | 15.01 | 13.58 |
| 19 | 09.51 | 08.08 | 06.26 | 05.30 | 03.40 | 02.09 | 03.22 | 05.12 | 06.49 | 08.22 | 09.08 | 10.31 |
| | 15.07 | 16.57 | 18.28 | 21.07 | 22.53 | 00.30 | 23.24 | 21.30 | 19.34 | 17.44 | 14.58 | 13.58 |
| 20 | 09.48 | 08.05 | 06.22 | 05.27 | 03.36 | 02.09 | 03.26 | 05.15 | 06.52 | 08.25 | 09.12 | 10.32 |
| | 15.11 | 17.01 | 18.31 | 21.10 | 22.56 | 00.31 | 23.20 | 21.26 | 19.31 | 17.40 | 14.55 | 13.58 |
| 21 | 09.45 | 08.01 | 06.19 | 05.23 | 03.32 | 02.09 | 03.30 | 05.18 | 06.55 | 08.28 | 09.15 | 10.33 |
| | 15.14 | 17.04 | 18.34 | 21.14 | 23.00 | 00.31 | 23.16 | 21.23 | 19.27 | 17.37 | 14.52 | 13.58 |
| 22 | 09.42 | 07.58 | 06.15 | 05.19 | 03.29 | 02.09 | 03.33 | 05.21 | 06.58 | 08.31 | 09.19 | 10.34 |
| | 15.18 | 17.07 | 18.38 | 21.17 | 23.04 | 00.31 | 23.13 | 21.19 | 19.23 | 17.33 | 14.49 | 13.59 |
| 23 | 09.39 | 07.54 | 06.11 | 05.16 | 03.25 | 02.10 | 03.37 | 05.25 | 07.01 | 08.35 | 09.22 | 10.34 |
| | 15.21 | 17.11 | 18.41 | 21.20 | 23.07 | 00.31 | 23.09 | 21.15 | 19.19 | 17.29 | 14.46 | 13.59 |
| 24 | 09.36 | 07.50 | 06.08 | 05.12 | 03.22 | 02.11 | 03.41 | 05.28 | 07.04 | 08.38 | 09.26 | 10.35 |
| | 15.25 | 17.14 | 18.44 | 21.24 | 23.11 | 00.31 | 23.06 | 21.11 | 19.16 | 17.26 | 14.43 | 14.00 |
| 25 | 09.33 | 07.47 | 06.04 | 05.08 | 03.18 | 02.12 | 03.44 | 05.31 | 07.07 | 07.41 | 09.29 | 10.35 |
| | 15.29 | 17.17 | 18.47 | 21.27 | 23.15 | 00.30 | 23.02 | 21.08 | 19.12 | 17.22 | 14.40 | 14.01 |
| 26 | 09.30 | 07.43 | 06.00 | 05.04 | 03.15 | 02.13 | 03.48 | 05.34 | 07.10 | 07.45 | 09.33 | 10.35 |
| | 15.32 | 17.21 | 18.50 | 21.30 | 23.19 | 00.29 | 22.59 | 21.04 | 19.08 | 16.19 | 14.37 | 14.02 |
| 27 | 09.27 | 07.40 | 05.56 | 05.01 | 03.11 | 02.15 | 03.52 | 05.38 | 07.13 | 07.48 | 09.36 | 10.34 |
| | 15.36 | 17.24 | 18.53 | 21.34 | 23.22 | 00.27 | 22.55 | 21.00 | 19.05 | 16.15 | 14.35 | 14.03 |
| 28 | 09.24 | 07.36 | 05.53 | 04.57 | 03.08 | 02.17 | 03.55 | 05.41 | 07.16 | 07.51 | 09.39 | 10.34 |
| | 15.39 | 17.27 | 18.56 | 21.37 | 23.26 | 00.26 | 22.51 | 20.56 | 19.01 | 16.12 | 14.32 | 14.05 |
| 29 | 09.20 | 06.49 | 04.53 | 03.04 | 02.20 | 03.59 | 05.44 | 07.19 | 07.55 | 09.43 | 10.33 | |
| | 15.43 | 20.00 | 21.41 | 23.30 | 00.24 | 22.48 | 20.53 | 18.57 | 16.08 | 14.29 | 14.07 | |
| 30 | 09.17 | 06.45 | 04.49 | 03.01 | 02.22 | 04.02 | 05.47 | 07.22 | 07.58 | 09.46 | 10.33 | |
| | 15.47 | 20.03 | 21.44 | 23.33 | 00.22 | 22.44 | 20.49 | 18.53 | 16.05 | 14.27 | 14.08 | |
| 31 | 09.14 | 06.41 | 02.54 | | | 04.06 | 05.50 | | 08.02 | | 10.32 | |
| | 15.50 | 20.06 | 23.37 | | | 22.40 | 20.45 | | 16.01 | | 14.10 | |
| Potential sun hours | 156 | 232 | 362 | 456 | 584 | 657 | 630 | 517 | 395 | 301 | 187 | 116 |
| Total, worst case | | | | | | | | | | | | |
| Sun reduction | | | | | | | | | | | | |
| Oper. time red. | | | | | | | | | | | | |
| Wind dir. red. | | | | | | | | | | | | |
| Total reduction | | | | | | | | | | | | |
| Total, real | | | | | | | | | | | | |

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

| Day in month | Sun rise (hh:mm) | Sun set (hh:mm) | Minutes with flicker | First time (hh:mm) with flicker | Last time (hh:mm) with flicker | (WTG causing flicker first time) | (WTG causing flicker last time) |
|--------------|------------------|-----------------|----------------------|---------------------------------|--------------------------------|----------------------------------|---------------------------------|
|--------------|------------------|-----------------|----------------------|---------------------------------|--------------------------------|----------------------------------|---------------------------------|

SHADOW - Calendar

Calculation: Kovasinkangas V162-6,2MW x 6 x HH199 + Ketunmaankangas V126-3.45MW x 5 x HH137_no forest_20221202 Shadow receptor: C - Asuinrakennus D (Onkamonkyläntie 280) Sunshine probability S (Average daily sunshine hours) [LULEA]

Assumptions for shadow calculations

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0,60 2,61 4,18 6,47 8,80 10,60 9,50 6,88 4,22 2,77 1,22 0,17

Operational time

| N | NNE | ENE | E | ESE | SSE | S | SSW | WSW | W | WNW | NNW | Sum |
|-----|-----|-----|-----|-----|-----|-----|------|-----|-----|-----|-----|------|
| 619 | 605 | 559 | 627 | 758 | 839 | 939 | 1102 | 916 | 649 | 504 | 548 | 8664 |

Idle start wind speed: Cut in wind speed from power curve

| | January | February | March | April | May | June | July | August | September | October | November | December |
|---------------------|---------|----------|-------|-------|-------|-------|-------|--------|-----------|---------|----------|----------|
| 1 | 10.31 | 09.11 | 07.33 | 06.38 | 04.46 | 02.51 | 02.25 | 04.10 | 05.54 | 07.25 | 08.05 | 09.49 |
| | 14.13 | 15.54 | 17.31 | 20.09 | 21.48 | 23.41 | 00.20 | 22.37 | 20.42 | 18.50 | 15.58 | 14.24 |
| 2 | 10.29 | 09.07 | 07.29 | 06.34 | 04.42 | 02.48 | 02.28 | 04.13 | 05.57 | 07.28 | 08.09 | 09.53 |
| | 14.15 | 15.58 | 17.34 | 20.12 | 21.51 | 23.44 | 00.17 | 22.33 | 20.38 | 18.46 | 15.54 | 14.22 |
| 3 | 10.28 | 09.04 | 07.25 | 06.30 | 04.38 | 02.45 | 02.31 | 04.17 | 06.00 | 07.31 | 08.12 | 09.56 |
| | 14.18 | 16.01 | 17.37 | 20.15 | 21.55 | 23.48 | 00.15 | 22.30 | 20.34 | 18.42 | 15.51 | 14.20 |
| 4 | 10.26 | 09.01 | 07.22 | 06.27 | 04.35 | 02.42 | 02.34 | 04.20 | 06.03 | 07.34 | 08.16 | 09.59 |
| | 14.20 | 16.05 | 17.41 | 20.19 | 21.58 | 23.51 | 00.12 | 22.26 | 20.30 | 18.39 | 15.47 | 14.17 |
| 5 | 10.25 | 08.57 | 07.18 | 06.23 | 04.31 | 02.39 | 02.37 | 04.24 | 06.06 | 07.38 | 08.19 | 10.02 |
| | 14.23 | 16.09 | 17.44 | 20.22 | 22.02 | 23.55 | 00.09 | 22.22 | 20.27 | 18.35 | 15.44 | 14.15 |
| 6 | 10.23 | 08.54 | 07.14 | 06.19 | 04.27 | 02.36 | 02.40 | 04.27 | 06.09 | 07.41 | 08.22 | 10.05 |
| | 14.26 | 16.12 | 17.47 | 20.25 | 22.06 | 23.58 | 00.06 | 22.19 | 20.23 | 18.31 | 15.41 | 14.13 |
| 7 | 10.21 | 08.51 | 07.11 | 06.16 | 04.24 | 02.33 | 02.43 | 04.31 | 06.12 | 07.44 | 08.26 | 10.07 |
| | 14.28 | 16.16 | 17.50 | 20.28 | 22.09 | 00.01 | 00.03 | 22.15 | 20.19 | 18.28 | 15.37 | 14.11 |
| 8 | 10.19 | 08.47 | 07.07 | 06.12 | 04.20 | 02.30 | 02.47 | 04.34 | 06.15 | 07.47 | 08.29 | 10.10 |
| | 14.31 | 16.19 | 17.54 | 20.31 | 22.13 | 00.05 | 00.00 | 22.11 | 20.16 | 18.24 | 15.34 | 14.09 |
| 9 | 10.17 | 08.44 | 07.03 | 06.08 | 04.16 | 02.27 | 02.50 | 04.38 | 06.18 | 07.50 | 08.33 | 10.13 |
| | 14.34 | 16.23 | 17.57 | 20.35 | 22.16 | 00.08 | 23.57 | 22.08 | 20.12 | 18.20 | 15.30 | 14.08 |
| 10 | 10.15 | 08.40 | 07.00 | 06.04 | 04.13 | 02.24 | 02.54 | 04.41 | 06.21 | 07.53 | 08.37 | 10.15 |
| | 14.37 | 16.26 | 18.00 | 20.38 | 22.20 | 00.11 | 23.54 | 22.04 | 20.08 | 18.17 | 15.27 | 14.06 |
| 11 | 10.12 | 08.37 | 06.56 | 06.01 | 04.09 | 02.22 | 02.57 | 04.45 | 06.24 | 07.56 | 08.40 | 10.18 |
| | 14.41 | 16.30 | 18.03 | 20.41 | 22.23 | 00.14 | 23.51 | 22.00 | 20.04 | 18.13 | 15.24 | 14.05 |
| 12 | 10.10 | 08.33 | 06.52 | 05.57 | 04.05 | 02.20 | 03.01 | 04.48 | 06.28 | 07.59 | 08.44 | 10.20 |
| | 14.44 | 16.33 | 18.06 | 20.44 | 22.27 | 00.17 | 23.48 | 21.56 | 20.01 | 18.09 | 15.20 | 14.03 |
| 13 | 10.07 | 08.30 | 06.49 | 05.53 | 04.02 | 02.17 | 03.01 | 04.52 | 06.31 | 08.03 | 08.47 | 10.22 |
| | 14.47 | 16.37 | 18.09 | 20.48 | 22.31 | 00.19 | 23.44 | 21.53 | 19.57 | 18.06 | 15.17 | 14.02 |
| 14 | 10.05 | 08.26 | 06.45 | 05.49 | 03.58 | 02.15 | 03.04 | 04.55 | 06.34 | 08.06 | 08.51 | 10.24 |
| | 14.50 | 16.40 | 18.13 | 20.51 | 22.34 | 00.22 | 23.41 | 21.49 | 19.53 | 18.02 | 15.14 | 14.01 |
| 15 | 10.02 | 08.23 | 06.41 | 05.46 | 03.54 | 02.14 | 03.08 | 04.58 | 06.37 | 08.09 | 08.54 | 10.26 |
| | 14.54 | 16.44 | 18.16 | 20.54 | 22.38 | 00.24 | 23.38 | 21.45 | 19.49 | 17.58 | 15.11 | 14.00 |
| 16 | 10.00 | 08.19 | 06.37 | 05.42 | 03.51 | 02.12 | 03.12 | 05.02 | 06.40 | 08.12 | 08.58 | 10.28 |
| | 14.57 | 16.47 | 18.19 | 20.57 | 22.42 | 00.26 | 23.34 | 21.41 | 19.46 | 17.55 | 15.08 | 14.00 |
| 17 | 09.57 | 08.16 | 06.34 | 05.38 | 03.47 | 02.11 | 03.15 | 05.05 | 06.43 | 08.15 | 09.01 | 10.29 |
| | 15.00 | 16.51 | 18.22 | 21.01 | 22.45 | 00.28 | 23.31 | 21.38 | 19.42 | 17.51 | 15.04 | 13.59 |
| 18 | 09.54 | 08.12 | 06.30 | 05.34 | 03.43 | 02.10 | 03.19 | 05.08 | 06.46 | 08.19 | 09.05 | 10.31 |
| | 15.04 | 16.54 | 18.25 | 21.04 | 22.49 | 00.29 | 23.27 | 21.34 | 19.38 | 17.48 | 15.01 | 13.59 |
| 19 | 09.51 | 08.09 | 06.26 | 05.31 | 03.40 | 02.09 | 03.23 | 05.12 | 06.49 | 08.22 | 09.08 | 10.32 |
| | 15.07 | 16.57 | 18.28 | 21.07 | 22.53 | 00.30 | 23.24 | 21.30 | 19.34 | 17.44 | 14.58 | 13.58 |
| 20 | 09.48 | 08.05 | 06.23 | 05.27 | 03.36 | 02.09 | 03.26 | 05.15 | 06.52 | 08.25 | 09.12 | 10.33 |
| | 15.11 | 17.01 | 18.32 | 21.10 | 22.56 | 00.31 | 23.20 | 21.27 | 19.31 | 17.40 | 14.55 | 13.58 |
| 21 | 09.45 | 08.01 | 06.19 | 05.23 | 03.33 | 02.09 | 03.30 | 05.18 | 06.55 | 08.28 | 09.15 | 10.34 |
| | 15.15 | 17.04 | 18.35 | 21.14 | 23.00 | 00.31 | 23.17 | 21.23 | 19.27 | 17.37 | 14.52 | 13.59 |
| 22 | 09.42 | 07.58 | 06.15 | 05.19 | 03.29 | 02.09 | 03.34 | 05.22 | 06.58 | 08.32 | 09.19 | 10.34 |
| | 15.18 | 17.08 | 18.38 | 21.17 | 23.04 | 00.32 | 23.13 | 21.19 | 19.23 | 17.33 | 14.49 | 13.59 |
| 23 | 09.39 | 07.54 | 06.11 | 05.16 | 03.26 | 02.10 | 03.37 | 05.25 | 07.01 | 08.35 | 09.22 | 10.35 |
| | 15.22 | 17.11 | 18.41 | 21.21 | 23.08 | 00.31 | 23.10 | 21.15 | 19.20 | 17.30 | 14.46 | 14.00 |
| 24 | 09.36 | 07.51 | 06.08 | 05.12 | 03.22 | 02.11 | 03.41 | 05.28 | 07.04 | 08.38 | 09.26 | 10.35 |
| | 15.25 | 17.14 | 18.44 | 21.24 | 23.11 | 00.31 | 23.06 | 21.12 | 19.16 | 17.26 | 14.43 | 14.00 |
| 25 | 09.33 | 07.47 | 06.04 | 05.08 | 03.18 | 02.12 | 03.44 | 05.31 | 07.07 | 07.41 | 09.29 | 10.35 |
| | 15.29 | 17.18 | 18.47 | 21.27 | 23.15 | 00.30 | 23.02 | 21.08 | 19.12 | 17.22 | 14.40 | 14.01 |
| 26 | 09.30 | 07.43 | 06.00 | 05.05 | 03.15 | 02.13 | 03.48 | 05.34 | 07.10 | 07.45 | 09.33 | 10.35 |
| | 15.32 | 17.21 | 18.50 | 21.31 | 23.19 | 00.29 | 22.59 | 21.04 | 19.08 | 16.19 | 14.38 | 14.02 |
| 27 | 09.27 | 07.40 | 05.57 | 05.01 | 03.11 | 02.15 | 03.52 | 05.38 | 07.13 | 07.48 | 09.36 | 10.35 |
| | 15.36 | 17.24 | 18.53 | 21.34 | 23.22 | 00.28 | 22.55 | 21.00 | 19.05 | 16.15 | 14.35 | 14.04 |
| 28 | 09.24 | 07.36 | 05.53 | 04.57 | 03.08 | 02.17 | 03.55 | 05.41 | 07.16 | 07.52 | 09.40 | 10.34 |
| | 15.40 | 17.28 | 18.57 | 21.38 | 23.26 | 00.26 | 22.52 | 20.57 | 19.01 | 16.12 | 14.32 | 14.05 |
| 29 | 09.21 | 06.49 | 04.53 | 03.05 | 02.20 | 03.59 | 05.44 | 07.19 | 07.55 | 09.43 | 10.34 | |
| | 15.43 | 20.00 | 21.41 | 23.30 | 00.24 | 22.48 | 20.53 | 18.57 | 16.08 | 14.29 | 14.07 | |
| 30 | 09.17 | 06.45 | 04.50 | 03.01 | 02.22 | 04.03 | 05.47 | 07.22 | 07.58 | 09.46 | 10.33 | |
| | 15.47 | 20.03 | 21.44 | 23.33 | 00.22 | 22.44 | 20.49 | 18.54 | 16.05 | 14.27 | 14.08 | |
| 31 | 09.14 | 06.42 | 02.54 | | | 04.06 | 05.50 | | | 08.02 | | 10.32 |
| | 15.51 | 20.06 | 23.37 | | | 22.41 | 20.45 | | | 16.01 | | 14.10 |
| Potential sun hours | 156 | 232 | 362 | 456 | 584 | 657 | 630 | 517 | 395 | 301 | 187 | 116 |
| Total, worst case | | | | | | | | | | | | |
| Sun reduction | | | | | | | | | | | | |
| Oper. time red. | | | | | | | | | | | | |
| Wind dir. red. | | | | | | | | | | | | |
| Total reduction | | | | | | | | | | | | |
| Total, real | | | | | | | | | | | | |

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

| Day in month | Sun rise (hh:mm) | Sun set (hh:mm) | Minutes with flicker | First time (hh:mm) with flicker | Last time (hh:mm) with flicker | (WTG causing flicker first time) (WTG causing flicker last time) |
|--------------|------------------|-----------------|----------------------|---------------------------------|--------------------------------|---|
|--------------|------------------|-----------------|----------------------|---------------------------------|--------------------------------|---|

SHADOW - Calendar

Calculation: Kovasinkangas V162-6,2MW x 6 x HH199 + Ketunmaankangas V126-3.45MW x 5 x HH137_no forest_20221202 Shadow receptor: D - Lomarakennus E (Kaunislamenttie 153)
Assumptions for shadow calculations

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0,60 2,61 4,18 6,47 8,80 10,60 9,50 6,88 4,22 2,77 1,22 0,17

Operational time

| N | NNE | ENE | E | ESE | SSE | S | SSW | WSW | W | WNW | NNW | Sum |
|-----|-----|-----|-----|-----|-----|-----|------|-----|-----|-----|-----|------|
| 619 | 605 | 559 | 627 | 758 | 839 | 939 | 1102 | 916 | 649 | 504 | 548 | 8664 |

Idle start wind speed: Cut in wind speed from power curve

| | January | February | March | April | May | June | July | August | September | October | November | December |
|---------------------|---------|----------|-------|-------|-------|-------|-------|--------|-----------|---------|----------|----------|
| 1 | 10.32 | 09.11 | 07.33 | 06.38 | 04.45 | 02.50 | 02.23 | 04.09 | 05.53 | 07.25 | 08.05 | 09.50 |
| | 14.12 | 15.53 | 17.31 | 20.09 | 21.48 | 23.42 | 00.22 | 22.37 | 20.42 | 18.50 | 15.57 | 14.23 |
| 2 | 10.30 | 09.08 | 07.29 | 06.34 | 04.42 | 02.46 | 02.25 | 04.12 | 05.56 | 07.28 | 08.09 | 09.53 |
| | 14.14 | 15.57 | 17.34 | 20.12 | 21.52 | 23.46 | 00.19 | 22.34 | 20.38 | 18.46 | 15.54 | 14.21 |
| 3 | 10.29 | 09.04 | 07.25 | 06.30 | 04.38 | 02.43 | 02.28 | 04.16 | 05.59 | 07.31 | 08.12 | 09.56 |
| | 14.16 | 16.01 | 17.37 | 20.15 | 21.55 | 23.49 | 00.17 | 22.30 | 20.34 | 18.42 | 15.50 | 14.19 |
| 4 | 10.27 | 09.01 | 07.22 | 06.26 | 04.34 | 02.40 | 02.32 | 04.20 | 06.03 | 07.34 | 08.16 | 09.59 |
| | 14.19 | 16.04 | 17.40 | 20.19 | 21.59 | 23.53 | 00.14 | 22.26 | 20.30 | 18.39 | 15.47 | 14.16 |
| 5 | 10.25 | 08.58 | 07.18 | 06.23 | 04.30 | 02.37 | 02.35 | 04.23 | 06.06 | 07.37 | 08.19 | 10.02 |
| | 14.22 | 16.08 | 17.44 | 20.22 | 22.02 | 23.56 | 00.11 | 22.23 | 20.27 | 18.35 | 15.43 | 14.14 |
| 6 | 10.24 | 08.54 | 07.14 | 06.19 | 04.27 | 02.34 | 02.38 | 04.27 | 06.09 | 07.41 | 08.23 | 10.05 |
| | 14.24 | 16.11 | 17.47 | 20.25 | 22.06 | 00.00 | 00.08 | 22.19 | 20.23 | 18.31 | 15.40 | 14.12 |
| 7 | 10.22 | 08.51 | 07.11 | 06.15 | 04.23 | 02.31 | 02.42 | 04.30 | 06.12 | 07.44 | 08.26 | 10.08 |
| | 14.27 | 16.15 | 17.50 | 20.28 | 22.09 | 00.03 | 00.05 | 22.15 | 20.19 | 18.27 | 15.37 | 14.10 |
| 8 | 10.20 | 08.47 | 07.07 | 06.11 | 04.19 | 02.28 | 02.45 | 04.34 | 06.15 | 07.47 | 08.30 | 10.11 |
| | 14.30 | 16.19 | 17.53 | 20.31 | 22.13 | 00.06 | 00.02 | 22.12 | 20.15 | 18.24 | 15.33 | 14.08 |
| 9 | 10.18 | 08.44 | 07.03 | 06.08 | 04.16 | 02.25 | 02.49 | 04.37 | 06.18 | 07.50 | 08.33 | 10.14 |
| | 14.33 | 16.22 | 17.56 | 20.35 | 22.17 | 00.10 | 23.59 | 22.08 | 20.12 | 18.20 | 15.30 | 14.06 |
| 10 | 10.15 | 08.40 | 07.00 | 06.04 | 04.12 | 02.22 | 02.52 | 04.41 | 06.21 | 07.53 | 08.37 | 10.16 |
| | 14.36 | 16.26 | 18.00 | 20.38 | 22.20 | 00.13 | 23.55 | 22.04 | 20.08 | 18.16 | 15.26 | 14.05 |
| 11 | 10.13 | 08.37 | 06.56 | 06.00 | 04.08 | 02.20 | 02.56 | 04.44 | 06.24 | 07.56 | 08.40 | 10.19 |
| | 14.39 | 16.29 | 18.03 | 20.41 | 22.24 | 00.16 | 23.52 | 22.00 | 20.04 | 18.13 | 15.23 | 14.03 |
| 12 | 10.11 | 08.33 | 06.52 | 05.56 | 04.04 | 02.17 | 02.59 | 04.48 | 06.27 | 07.59 | 08.44 | 10.21 |
| | 14.43 | 16.33 | 18.06 | 20.44 | 22.28 | 00.19 | 23.49 | 21.57 | 20.00 | 18.09 | 15.20 | 14.02 |
| 13 | 10.08 | 08.30 | 06.48 | 05.53 | 04.01 | 02.15 | 03.03 | 04.51 | 06.30 | 08.03 | 08.47 | 10.23 |
| | 14.46 | 16.36 | 18.09 | 20.48 | 22.31 | 00.21 | 23.45 | 21.53 | 19.57 | 18.05 | 15.16 | 14.01 |
| 14 | 10.06 | 08.26 | 06.45 | 05.49 | 03.57 | 02.13 | 03.03 | 04.54 | 06.33 | 08.06 | 08.51 | 10.25 |
| | 14.49 | 16.40 | 18.12 | 20.51 | 22.35 | 00.24 | 23.42 | 21.49 | 19.53 | 18.02 | 15.13 | 14.00 |
| 15 | 10.03 | 08.23 | 06.41 | 05.45 | 03.53 | 02.11 | 03.07 | 04.58 | 06.36 | 08.09 | 08.55 | 10.27 |
| | 14.53 | 16.43 | 18.16 | 20.54 | 22.39 | 00.26 | 23.39 | 21.45 | 19.49 | 17.58 | 15.10 | 13.59 |
| 16 | 10.00 | 08.19 | 06.37 | 05.41 | 03.50 | 02.09 | 03.10 | 05.01 | 06.39 | 08.12 | 08.58 | 10.29 |
| | 14.56 | 16.47 | 18.19 | 20.57 | 22.42 | 00.28 | 23.35 | 21.42 | 19.46 | 17.54 | 15.07 | 13.58 |
| 17 | 09.57 | 08.16 | 06.34 | 05.38 | 03.46 | 02.08 | 03.14 | 05.04 | 06.42 | 08.15 | 09.02 | 10.30 |
| | 15.00 | 16.50 | 18.22 | 21.01 | 22.46 | 00.30 | 23.32 | 21.38 | 19.42 | 17.51 | 15.04 | 13.58 |
| 18 | 09.55 | 08.12 | 06.30 | 05.34 | 03.42 | 02.07 | 03.18 | 05.08 | 06.45 | 08.19 | 09.05 | 10.32 |
| | 15.03 | 16.54 | 18.25 | 21.04 | 22.50 | 00.32 | 23.28 | 21.34 | 19.38 | 17.47 | 15.00 | 13.57 |
| 19 | 09.52 | 08.09 | 06.26 | 05.30 | 03.39 | 02.06 | 03.21 | 05.11 | 06.49 | 08.22 | 09.09 | 10.33 |
| | 15.07 | 16.57 | 18.28 | 21.07 | 22.53 | 00.33 | 23.25 | 21.30 | 19.34 | 17.44 | 14.57 | 13.57 |
| 20 | 09.49 | 08.05 | 06.22 | 05.26 | 03.35 | 02.06 | 03.25 | 05.14 | 06.52 | 08.25 | 09.12 | 10.34 |
| | 15.10 | 17.00 | 18.31 | 21.11 | 22.57 | 00.34 | 23.21 | 21.27 | 19.31 | 17.40 | 14.54 | 13.57 |
| 21 | 09.46 | 08.02 | 06.19 | 05.23 | 03.32 | 02.06 | 03.29 | 05.18 | 06.55 | 08.28 | 09.16 | 10.35 |
| | 15.14 | 17.04 | 18.34 | 21.14 | 23.01 | 00.34 | 23.17 | 21.23 | 19.27 | 17.36 | 14.51 | 13.57 |
| 22 | 09.43 | 07.58 | 06.15 | 05.19 | 03.28 | 02.06 | 03.32 | 05.21 | 06.58 | 08.32 | 09.19 | 10.35 |
| | 15.17 | 17.07 | 18.38 | 21.17 | 23.05 | 00.34 | 23.14 | 21.19 | 19.23 | 17.33 | 14.48 | 13.58 |
| 23 | 09.40 | 07.54 | 06.11 | 05.15 | 03.24 | 02.07 | 03.36 | 05.24 | 07.01 | 08.35 | 09.23 | 10.36 |
| | 15.21 | 17.11 | 18.41 | 21.21 | 23.08 | 00.34 | 23.10 | 21.16 | 19.19 | 17.29 | 14.45 | 13.58 |
| 24 | 09.37 | 07.51 | 06.08 | 05.11 | 03.21 | 02.08 | 03.40 | 05.28 | 07.04 | 08.38 | 09.26 | 10.36 |
| | 15.24 | 17.14 | 18.44 | 21.24 | 23.12 | 00.33 | 23.07 | 21.12 | 19.16 | 17.26 | 14.42 | 13.59 |
| 25 | 09.34 | 07.47 | 06.04 | 05.08 | 03.17 | 02.09 | 03.43 | 05.31 | 07.07 | 07.42 | 09.30 | 10.36 |
| | 15.28 | 17.17 | 18.47 | 21.27 | 23.16 | 00.33 | 23.03 | 21.08 | 19.12 | 17.22 | 14.39 | 14.00 |
| 26 | 09.31 | 07.43 | 06.00 | 05.04 | 03.14 | 02.11 | 03.47 | 05.34 | 07.10 | 07.45 | 09.33 | 10.36 |
| | 15.32 | 17.21 | 18.50 | 21.31 | 23.20 | 00.31 | 22.59 | 21.04 | 19.08 | 16.18 | 14.37 | 14.01 |
| 27 | 09.27 | 07.40 | 05.56 | 05.00 | 03.10 | 02.13 | 03.51 | 05.37 | 07.13 | 07.48 | 09.37 | 10.36 |
| | 15.35 | 17.24 | 18.53 | 21.34 | 23.23 | 00.30 | 22.56 | 21.01 | 19.04 | 16.15 | 14.34 | 14.02 |
| 28 | 09.24 | 07.36 | 05.53 | 04.56 | 03.07 | 02.15 | 03.54 | 05.40 | 07.16 | 07.52 | 09.40 | 10.35 |
| | 15.39 | 17.27 | 18.56 | 21.38 | 23.27 | 00.28 | 22.52 | 20.57 | 19.01 | 16.11 | 14.31 | 14.04 |
| 29 | 09.21 | 06.49 | 04.53 | 03.03 | 02.17 | 03.58 | 05.44 | 07.19 | 07.55 | 09.44 | 10.35 | |
| | 15.43 | 20.00 | 21.41 | 23.31 | 00.26 | 22.48 | 20.53 | 18.57 | 16.08 | 14.28 | 14.05 | |
| 30 | 09.18 | 06.45 | 04.49 | 03.00 | 02.20 | 04.02 | 05.47 | 07.22 | 07.58 | 09.47 | 10.34 | |
| | 15.46 | 20.03 | 21.45 | 23.35 | 00.24 | 22.45 | 20.49 | 18.53 | 16.04 | 14.26 | 14.07 | |
| 31 | 09.14 | 06.41 | 02.53 | 23.38 | 22.41 | 20.45 | 04.05 | 05.50 | 08.02 | 16.01 | 14.09 | |
| | 15.50 | 20.06 | | | | | | | | | | |
| Potential sun hours | 155 | 232 | 362 | 456 | 585 | 660 | 631 | 517 | 395 | 301 | 187 | 115 |
| Total, worst case | | | | | | | | | | | | |
| Sun reduction | | | | | | | | | | | | |
| Oper. time red. | | | | | | | | | | | | |
| Wind dir. red. | | | | | | | | | | | | |
| Total reduction | | | | | | | | | | | | |
| Total, real | | | | | | | | | | | | |

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

| Day in month | Sun rise (hh:mm) | Sun set (hh:mm) | Minutes with flicker | First time (hh:mm) with flicker | Last time (hh:mm) with flicker | (WTG causing flicker first time) | (WTG causing flicker last time) |
|--------------|------------------|-----------------|----------------------|---------------------------------|--------------------------------|----------------------------------|---------------------------------|
|--------------|------------------|-----------------|----------------------|---------------------------------|--------------------------------|----------------------------------|---------------------------------|

SHADOW - Calendar

Calculation: Kovasinkangas V162-6,2MW x 6 x HH199 + Ketunmaankangas V126-3.45MW x 5 x HH137_no forest_2022120Shadow receptor: E - Lomarakennus B (Kantolantie 142)
Assumptions for shadow calculations

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0,60 2,61 4,18 6,47 8,80 10,60 9,50 6,88 4,22 2,77 1,22 0,17

Operational time

| | N | NNE | ENE | E | ESE | SSE | S | SSW | WSW | W | WNW | NNW | Sum |
|-----|-----|-----|-----|-----|-----|-----|------|-----|-----|-----|-----|------|-----|
| 619 | 605 | 559 | 627 | 758 | 839 | 939 | 1102 | 916 | 649 | 504 | 548 | 8664 | |

Idle start wind speed: Cut in wind speed from power curve

| | January | February | March | April | May | June | July | August | September | October | November | December |
|---------------------|---------|----------|-------|-------|-------|-------|-------|--------|-----------|---------|----------|----------|
| 1 | 10.30 | 09.10 | 07.32 | 06.38 | 04.46 | 02.51 | 02.25 | 04.10 | 05.53 | 07.25 | 08.05 | 09.49 |
| | 14.13 | 15.54 | 17.31 | 20.09 | 21.48 | 23.40 | 00.19 | 22.37 | 20.41 | 18.50 | 15.58 | 14.24 |
| 2 | 10.29 | 09.07 | 07.29 | 06.34 | 04.42 | 02.48 | 02.28 | 04.13 | 05.56 | 07.28 | 08.08 | 09.52 |
| | 14.15 | 15.58 | 17.34 | 20.12 | 21.51 | 23.44 | 00.17 | 22.33 | 20.38 | 18.46 | 15.54 | 14.22 |
| 3 | 10.27 | 09.04 | 07.25 | 06.30 | 04.38 | 02.45 | 02.31 | 04.17 | 06.00 | 07.31 | 08.12 | 09.55 |
| | 14.18 | 16.01 | 17.37 | 20.15 | 21.55 | 23.47 | 00.14 | 22.29 | 20.34 | 18.42 | 15.51 | 14.20 |
| 4 | 10.26 | 09.00 | 07.21 | 06.26 | 04.35 | 02.41 | 02.34 | 04.20 | 06.03 | 07.34 | 08.15 | 09.58 |
| | 14.20 | 16.05 | 17.40 | 20.18 | 21.58 | 23.51 | 00.12 | 22.26 | 20.30 | 18.39 | 15.47 | 14.17 |
| 5 | 10.24 | 08.57 | 07.18 | 06.23 | 04.31 | 02.38 | 02.37 | 04.24 | 06.06 | 07.37 | 08.19 | 10.01 |
| | 14.23 | 16.08 | 17.44 | 20.22 | 22.02 | 23.54 | 00.09 | 22.22 | 20.26 | 18.35 | 15.44 | 14.15 |
| 6 | 10.22 | 08.54 | 07.14 | 06.19 | 04.27 | 02.35 | 02.40 | 04.27 | 06.09 | 07.40 | 08.22 | 10.04 |
| | 14.25 | 16.12 | 17.47 | 20.25 | 22.05 | 23.58 | 00.06 | 22.18 | 20.23 | 18.31 | 15.40 | 14.13 |
| 7 | 10.21 | 08.50 | 07.10 | 06.15 | 04.23 | 02.32 | 02.43 | 04.31 | 06.12 | 07.43 | 08.26 | 10.07 |
| | 14.28 | 16.15 | 17.50 | 20.28 | 22.09 | 00.01 | 00.03 | 22.15 | 20.19 | 18.28 | 15.37 | 14.11 |
| 8 | 10.19 | 08.47 | 07.07 | 06.12 | 04.20 | 02.30 | 02.47 | 04.34 | 06.15 | 07.47 | 08.29 | 10.10 |
| | 14.31 | 16.19 | 17.53 | 20.31 | 22.12 | 00.04 | 00.00 | 22.11 | 20.15 | 18.24 | 15.34 | 14.09 |
| 9 | 10.16 | 08.43 | 07.03 | 06.08 | 04.16 | 02.27 | 02.50 | 04.38 | 06.18 | 07.50 | 08.33 | 10.12 |
| | 14.34 | 16.23 | 17.56 | 20.34 | 22.16 | 00.07 | 23.57 | 22.07 | 20.12 | 18.20 | 15.30 | 14.08 |
| 10 | 10.14 | 08.40 | 06.59 | 06.04 | 04.12 | 02.24 | 02.54 | 04.41 | 06.21 | 07.53 | 08.36 | 10.15 |
| | 14.37 | 16.26 | 18.00 | 20.38 | 22.20 | 00.10 | 23.54 | 22.03 | 20.08 | 18.16 | 15.27 | 14.06 |
| 11 | 10.12 | 08.37 | 06.56 | 06.00 | 04.09 | 02.22 | 02.57 | 04.45 | 06.24 | 07.56 | 08.40 | 10.17 |
| | 14.40 | 16.30 | 18.03 | 20.41 | 22.23 | 00.13 | 23.50 | 22.00 | 20.04 | 18.13 | 15.24 | 14.05 |
| 12 | 10.10 | 08.33 | 06.52 | 05.57 | 04.05 | 02.19 | 03.01 | 04.48 | 06.27 | 07.59 | 08.43 | 10.20 |
| | 14.44 | 16.33 | 18.06 | 20.44 | 22.27 | 00.16 | 23.47 | 21.56 | 20.00 | 18.09 | 15.20 | 14.03 |
| 13 | 10.07 | 08.30 | 06.48 | 05.53 | 04.01 | 02.17 | 03.01 | 04.51 | 06.30 | 08.02 | 08.47 | 10.22 |
| | 14.47 | 16.37 | 18.09 | 20.47 | 22.30 | 00.19 | 23.44 | 21.52 | 19.57 | 18.06 | 15.17 | 14.02 |
| 14 | 10.05 | 08.26 | 06.45 | 05.49 | 03.58 | 02.15 | 03.04 | 04.55 | 06.33 | 08.05 | 08.50 | 10.24 |
| | 14.50 | 16.40 | 18.12 | 20.50 | 22.34 | 00.21 | 23.41 | 21.49 | 19.53 | 18.02 | 15.14 | 14.01 |
| 15 | 10.02 | 08.23 | 06.41 | 05.45 | 03.54 | 02.14 | 03.08 | 04.58 | 06.36 | 08.09 | 08.54 | 10.26 |
| | 14.53 | 16.44 | 18.16 | 20.54 | 22.38 | 00.23 | 23.37 | 21.45 | 19.49 | 17.58 | 15.11 | 14.00 |
| 16 | 09.59 | 08.19 | 06.37 | 05.42 | 03.50 | 02.12 | 03.11 | 05.02 | 06.39 | 08.12 | 08.57 | 10.27 |
| | 14.57 | 16.47 | 18.19 | 20.57 | 22.41 | 00.25 | 23.34 | 21.41 | 19.45 | 17.55 | 15.07 | 13.59 |
| 17 | 09.57 | 08.15 | 06.33 | 05.38 | 03.47 | 02.11 | 03.15 | 05.05 | 06.42 | 08.15 | 09.01 | 10.29 |
| | 15.00 | 16.50 | 18.22 | 21.00 | 22.45 | 00.27 | 23.30 | 21.37 | 19.42 | 17.51 | 15.04 | 13.59 |
| 18 | 09.54 | 08.12 | 06.30 | 05.34 | 03.43 | 02.10 | 03.19 | 05.08 | 06.45 | 08.18 | 09.05 | 10.30 |
| | 15.04 | 16.54 | 18.25 | 21.04 | 22.49 | 00.28 | 23.27 | 21.34 | 19.38 | 17.47 | 15.01 | 13.58 |
| 19 | 09.51 | 08.08 | 06.26 | 05.30 | 03.40 | 02.09 | 03.22 | 05.12 | 06.49 | 08.21 | 09.08 | 10.31 |
| | 15.07 | 16.57 | 18.28 | 21.07 | 22.52 | 00.30 | 23.23 | 21.30 | 19.34 | 17.44 | 14.58 | 13.58 |
| 20 | 09.48 | 08.05 | 06.22 | 05.27 | 03.36 | 02.09 | 03.26 | 05.15 | 06.52 | 08.25 | 09.12 | 10.32 |
| | 15.11 | 17.01 | 18.31 | 21.10 | 22.56 | 00.30 | 23.20 | 21.26 | 19.30 | 17.40 | 14.55 | 13.58 |
| 21 | 09.45 | 08.01 | 06.19 | 05.23 | 03.32 | 02.09 | 03.30 | 05.18 | 06.55 | 08.28 | 09.15 | 10.33 |
| | 15.14 | 17.04 | 18.34 | 21.14 | 23.00 | 00.31 | 23.16 | 21.23 | 19.27 | 17.37 | 14.52 | 13.58 |
| 22 | 09.42 | 07.58 | 06.15 | 05.19 | 03.29 | 02.09 | 03.33 | 05.21 | 06.58 | 08.31 | 09.19 | 10.34 |
| | 15.18 | 17.07 | 18.38 | 21.17 | 23.04 | 00.31 | 23.13 | 21.19 | 19.23 | 17.33 | 14.49 | 13.59 |
| 23 | 09.39 | 07.54 | 06.11 | 05.15 | 03.25 | 02.10 | 03.37 | 05.25 | 07.01 | 08.35 | 09.22 | 10.34 |
| | 15.21 | 17.11 | 18.41 | 21.20 | 23.07 | 00.31 | 23.09 | 21.15 | 19.19 | 17.29 | 14.46 | 13.59 |
| 24 | 09.36 | 07.50 | 06.07 | 05.12 | 03.22 | 02.11 | 03.41 | 05.28 | 07.04 | 08.38 | 09.26 | 10.35 |
| | 15.25 | 17.14 | 18.44 | 21.24 | 23.11 | 00.30 | 23.06 | 21.11 | 19.16 | 17.26 | 14.43 | 14.00 |
| 25 | 09.33 | 07.47 | 06.04 | 05.08 | 03.18 | 02.12 | 03.44 | 05.31 | 07.07 | 07.41 | 09.29 | 10.35 |
| | 15.29 | 17.17 | 18.47 | 21.27 | 23.15 | 00.30 | 23.02 | 21.08 | 19.12 | 17.22 | 14.40 | 14.01 |
| 26 | 09.30 | 07.43 | 06.00 | 05.04 | 03.15 | 02.13 | 03.48 | 05.34 | 07.10 | 07.45 | 09.32 | 10.35 |
| | 15.32 | 17.21 | 18.50 | 21.30 | 23.18 | 00.28 | 22.58 | 21.04 | 19.08 | 16.19 | 14.37 | 14.02 |
| 27 | 09.27 | 07.40 | 05.56 | 05.01 | 03.11 | 02.15 | 03.52 | 05.37 | 07.13 | 07.48 | 09.36 | 10.34 |
| | 15.36 | 17.24 | 18.53 | 21.34 | 23.22 | 00.27 | 22.55 | 21.00 | 19.04 | 16.15 | 14.35 | 14.03 |
| 28 | 09.24 | 07.36 | 05.53 | 04.57 | 03.08 | 02.17 | 03.55 | 05.41 | 07.16 | 07.51 | 09.39 | 10.34 |
| | 15.39 | 17.27 | 18.56 | 21.37 | 23.26 | 00.25 | 22.51 | 20.56 | 19.01 | 16.12 | 14.32 | 14.05 |
| 29 | 09.20 | 06.49 | 04.53 | 03.04 | 02.20 | 03.59 | 05.44 | 07.19 | 07.55 | 09.43 | 10.33 | |
| | 15.43 | 19.59 | 21.41 | 23.29 | 00.24 | 22.48 | 20.53 | 18.57 | 16.08 | 14.29 | 14.07 | |
| 30 | 09.17 | 06.45 | 04.49 | 03.01 | 02.22 | 04.02 | 05.47 | 07.22 | 07.58 | 09.46 | 10.32 | |
| | 15.47 | 20.03 | 21.44 | 23.33 | 00.21 | 22.44 | 20.49 | 18.53 | 16.05 | 14.27 | 14.08 | |
| 31 | 09.14 | 06.41 | 02.54 | 02.54 | 04.06 | 05.50 | | | 08.01 | | 10.32 | |
| | 15.50 | 20.06 | 23.37 | 22.40 | 20.45 | | | | 16.01 | | 14.10 | |
| Potential sun hours | 156 | 232 | 362 | 456 | 584 | 657 | 630 | 517 | 395 | 301 | 187 | 116 |
| Total, worst case | | | | | | | | | | | | |
| Sun reduction | | | | | | | | | | | | |
| Oper. time red. | | | | | | | | | | | | |
| Wind dir. red. | | | | | | | | | | | | |
| Total reduction | | | | | | | | | | | | |
| Total, real | | | | | | | | | | | | |

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

| Day in month | Sun rise (hh:mm) | Sun set (hh:mm) | Minutes with flicker | First time (hh:mm) with flicker | Last time (hh:mm) with flicker | (WTG causing flicker first time) | (WTG causing flicker last time) |
|--------------|------------------|-----------------|----------------------|---------------------------------|--------------------------------|----------------------------------|---------------------------------|
|--------------|------------------|-----------------|----------------------|---------------------------------|--------------------------------|----------------------------------|---------------------------------|

SHADOW - Calendar

Calculation: Kovasinkangas V162-6,2MW x 6 x HH199 + Ketunmaankangas V126-3.45MW x 5 x HH137_no forest_20221202shadow receptor: F - Lomarakennus F (Merijärvi)
Assumptions for shadow calculations

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0,60 2,61 4,18 6,47 8,80 10,60 9,50 6,88 4,22 2,77 1,22 0,17

Operational time

| | N | NNE | ENE | E | ESE | SSE | S | SSW | WSW | W | WNW | NNW | Sum |
|--|-----|-----|-----|-----|-----|-----|-----|------|-----|-----|-----|-----|------|
| | 619 | 605 | 559 | 627 | 758 | 839 | 939 | 1102 | 916 | 649 | 504 | 548 | 8664 |

Idle start wind speed: Cut in wind speed from power curve

| | January | February | March | April | May | June | July | August | September | October | November | December |
|---------------------|---------|----------|-------|-------|-------|-------|-------|--------|-----------|---------|----------|----------|
| 1 | 10.32 | 09.11 | 07.33 | 06.38 | 04.45 | 02.50 | 02.23 | 04.09 | 05.53 | 07.25 | 08.06 | 09.50 |
| | 14.12 | 15.54 | 17.31 | 20.09 | 21.48 | 23.42 | 00.22 | 22.38 | 20.42 | 18.50 | 15.57 | 14.23 |
| 2 | 10.31 | 09.08 | 07.29 | 06.34 | 04.42 | 02.46 | 02.25 | 04.13 | 05.56 | 07.28 | 08.09 | 09.54 |
| | 14.14 | 15.57 | 17.34 | 20.13 | 21.52 | 23.46 | 00.20 | 22.34 | 20.38 | 18.46 | 15.54 | 14.21 |
| 3 | 10.29 | 09.05 | 07.25 | 06.30 | 04.38 | 02.43 | 02.28 | 04.16 | 06.00 | 07.31 | 08.12 | 09.57 |
| | 14.17 | 16.01 | 17.37 | 20.16 | 21.55 | 23.49 | 00.17 | 22.30 | 20.34 | 18.42 | 15.50 | 14.19 |
| 4 | 10.28 | 09.01 | 07.22 | 06.27 | 04.34 | 02.40 | 02.32 | 04.20 | 06.03 | 07.35 | 08.16 | 10.00 |
| | 14.19 | 16.04 | 17.41 | 20.19 | 21.59 | 23.53 | 00.14 | 22.27 | 20.31 | 18.39 | 15.47 | 14.16 |
| 5 | 10.26 | 08.58 | 07.18 | 06.23 | 04.31 | 02.37 | 02.35 | 04.23 | 06.06 | 07.38 | 08.19 | 10.03 |
| | 14.22 | 16.08 | 17.44 | 20.22 | 22.03 | 23.57 | 00.11 | 22.23 | 20.27 | 18.35 | 15.44 | 14.14 |
| 6 | 10.24 | 08.55 | 07.14 | 06.19 | 04.27 | 02.34 | 02.38 | 04.27 | 06.09 | 07.41 | 08.23 | 10.06 |
| | 14.24 | 16.12 | 17.47 | 20.25 | 22.06 | 00.00 | 00.08 | 22.19 | 20.23 | 18.31 | 15.40 | 14.12 |
| 7 | 10.22 | 08.51 | 07.11 | 06.15 | 04.23 | 02.31 | 02.42 | 04.30 | 06.12 | 07.44 | 08.26 | 10.09 |
| | 14.27 | 16.15 | 17.50 | 20.28 | 22.10 | 00.03 | 00.05 | 22.16 | 20.19 | 18.28 | 15.37 | 14.10 |
| 8 | 10.20 | 08.48 | 07.07 | 06.12 | 04.19 | 02.28 | 02.45 | 04.34 | 06.15 | 07.47 | 08.30 | 10.11 |
| | 14.30 | 16.19 | 17.53 | 20.32 | 22.13 | 00.07 | 00.02 | 22.12 | 20.16 | 18.24 | 15.33 | 14.08 |
| 9 | 10.18 | 08.44 | 07.03 | 06.08 | 04.16 | 02.25 | 02.49 | 04.37 | 06.18 | 07.50 | 08.34 | 10.14 |
| | 14.33 | 16.22 | 17.57 | 20.35 | 22.17 | 00.10 | 23.59 | 22.08 | 20.12 | 18.20 | 15.30 | 14.07 |
| 10 | 10.16 | 08.41 | 07.00 | 06.04 | 04.12 | 02.22 | 02.52 | 04.41 | 06.21 | 07.53 | 08.37 | 10.16 |
| | 14.36 | 16.26 | 18.00 | 20.38 | 22.21 | 00.13 | 23.56 | 22.04 | 20.08 | 18.17 | 15.27 | 14.05 |
| 11 | 10.13 | 08.37 | 06.56 | 06.00 | 04.08 | 02.20 | 02.56 | 04.44 | 06.24 | 07.56 | 08.41 | 10.19 |
| | 14.40 | 16.29 | 18.03 | 20.41 | 22.24 | 00.16 | 23.52 | 22.01 | 20.04 | 18.13 | 15.23 | 14.03 |
| 12 | 10.11 | 08.34 | 06.52 | 05.57 | 04.05 | 02.17 | 02.59 | 04.48 | 06.27 | 08.00 | 08.44 | 10.21 |
| | 14.43 | 16.33 | 18.06 | 20.45 | 22.28 | 00.19 | 23.49 | 21.57 | 20.01 | 18.09 | 15.20 | 14.02 |
| 13 | 10.08 | 08.30 | 06.49 | 05.53 | 04.01 | 02.15 | 03.03 | 04.51 | 06.30 | 08.03 | 08.48 | 10.23 |
| | 14.46 | 16.36 | 18.09 | 20.48 | 22.32 | 00.22 | 23.46 | 21.53 | 19.57 | 18.06 | 15.17 | 14.01 |
| 14 | 10.06 | 08.27 | 06.45 | 05.49 | 03.57 | 02.13 | 03.03 | 04.55 | 06.34 | 08.06 | 08.51 | 10.25 |
| | 14.49 | 16.40 | 18.13 | 20.51 | 22.35 | 00.24 | 23.42 | 21.49 | 19.53 | 18.02 | 15.13 | 14.00 |
| 15 | 10.03 | 08.23 | 06.41 | 05.45 | 03.54 | 02.11 | 03.07 | 04.58 | 06.37 | 08.09 | 08.55 | 10.27 |
| | 14.53 | 16.43 | 18.16 | 20.54 | 22.39 | 00.27 | 23.39 | 21.46 | 19.49 | 17.58 | 15.10 | 13.59 |
| 16 | 10.01 | 08.20 | 06.38 | 05.42 | 03.50 | 02.09 | 03.10 | 05.01 | 06.40 | 08.12 | 08.58 | 10.29 |
| | 14.56 | 16.47 | 18.19 | 20.58 | 22.43 | 00.29 | 23.35 | 21.42 | 19.46 | 17.55 | 15.07 | 13.58 |
| 17 | 09.58 | 08.16 | 06.34 | 05.38 | 03.46 | 02.08 | 03.14 | 05.05 | 06.43 | 08.16 | 09.02 | 10.31 |
| | 15.00 | 16.50 | 18.22 | 21.01 | 22.46 | 00.31 | 23.32 | 21.38 | 19.42 | 17.51 | 15.04 | 13.58 |
| 18 | 09.55 | 08.13 | 06.30 | 05.34 | 03.43 | 02.07 | 03.18 | 05.08 | 06.46 | 08.19 | 09.06 | 10.32 |
| | 15.03 | 16.54 | 18.25 | 21.04 | 22.50 | 00.32 | 23.28 | 21.34 | 19.38 | 17.47 | 15.01 | 13.57 |
| 19 | 09.52 | 08.09 | 06.26 | 05.30 | 03.39 | 02.06 | 03.21 | 05.11 | 06.49 | 08.22 | 09.09 | 10.33 |
| | 15.07 | 16.57 | 18.28 | 21.08 | 22.54 | 00.33 | 23.25 | 21.31 | 19.35 | 17.44 | 14.57 | 13.57 |
| 20 | 09.49 | 08.05 | 06.23 | 05.27 | 03.35 | 02.06 | 03.25 | 05.15 | 06.52 | 08.25 | 09.13 | 10.34 |
| | 15.10 | 17.01 | 18.32 | 21.11 | 22.57 | 00.34 | 23.21 | 21.27 | 19.31 | 17.40 | 14.54 | 13.57 |
| 21 | 09.46 | 08.02 | 06.19 | 05.23 | 03.32 | 02.06 | 03.29 | 05.18 | 06.55 | 08.29 | 09.16 | 10.35 |
| | 15.14 | 17.04 | 18.35 | 21.14 | 23.01 | 00.35 | 23.18 | 21.23 | 19.27 | 17.37 | 14.51 | 13.57 |
| 22 | 09.43 | 07.58 | 06.15 | 05.19 | 03.28 | 02.06 | 03.32 | 05.21 | 06.58 | 08.32 | 09.20 | 10.36 |
| | 15.17 | 17.07 | 18.38 | 21.18 | 23.05 | 00.35 | 23.14 | 21.19 | 19.23 | 17.33 | 14.48 | 13.58 |
| 23 | 09.40 | 07.55 | 06.11 | 05.15 | 03.25 | 02.07 | 03.36 | 05.24 | 07.01 | 08.35 | 09.23 | 10.36 |
| | 15.21 | 17.11 | 18.41 | 21.21 | 23.09 | 00.35 | 23.11 | 21.16 | 19.20 | 17.29 | 14.45 | 13.58 |
| 24 | 09.37 | 07.51 | 06.08 | 05.12 | 03.21 | 02.08 | 03.40 | 05.28 | 07.04 | 08.38 | 09.27 | 10.36 |
| | 15.25 | 17.14 | 18.44 | 21.24 | 23.12 | 00.34 | 23.07 | 21.12 | 19.16 | 17.26 | 14.42 | 13.59 |
| 25 | 09.34 | 07.47 | 06.04 | 05.08 | 03.17 | 02.09 | 03.44 | 05.31 | 07.07 | 07.42 | 09.30 | 10.36 |
| | 15.28 | 17.17 | 18.47 | 21.28 | 23.16 | 00.33 | 23.03 | 21.08 | 19.12 | 17.22 | 14.40 | 14.00 |
| 26 | 09.31 | 07.44 | 06.00 | 05.04 | 03.14 | 02.11 | 03.47 | 05.34 | 07.10 | 07.45 | 09.34 | 10.36 |
| | 15.32 | 17.21 | 18.50 | 21.31 | 23.20 | 00.32 | 23.00 | 21.04 | 19.08 | 16.19 | 14.37 | 14.01 |
| 27 | 09.28 | 07.40 | 05.57 | 05.00 | 03.10 | 02.13 | 03.51 | 05.37 | 07.13 | 07.49 | 09.37 | 10.36 |
| | 15.35 | 17.24 | 18.54 | 21.35 | 23.24 | 00.30 | 22.56 | 21.01 | 19.05 | 16.15 | 14.34 | 14.02 |
| 28 | 09.24 | 07.36 | 05.53 | 04.57 | 03.07 | 02.15 | 03.55 | 05.41 | 07.16 | 07.52 | 09.40 | 10.36 |
| | 15.39 | 17.27 | 18.57 | 21.38 | 23.27 | 00.29 | 22.52 | 20.57 | 19.01 | 16.12 | 14.31 | 14.04 |
| 29 | 09.21 | 06.49 | 04.53 | 03.03 | 02.17 | 03.58 | 05.44 | 07.19 | 07.55 | 09.44 | 10.35 | |
| | 15.43 | 20.00 | 21.41 | 23.31 | 00.27 | 22.49 | 20.53 | 18.57 | 16.08 | 14.29 | 14.05 | |
| 30 | 09.18 | 06.45 | 04.49 | 03.00 | 02.20 | 04.02 | 05.47 | 07.22 | 07.59 | 09.47 | 10.34 | |
| | 15.46 | 20.03 | 21.45 | 23.35 | 00.24 | 22.45 | 20.49 | 18.54 | 16.04 | 14.26 | 14.07 | |
| 31 | 09.15 | 06.42 | 02.53 | 23.39 | 04.05 | 05.50 | | | | 16.01 | 14.09 | |
| | 15.50 | 20.06 | | | 22.41 | 20.46 | | | | | | |
| Potential sun hours | 155 | 232 | 362 | 456 | 585 | 660 | 631 | 517 | 395 | 301 | 187 | 115 |
| Total, worst case | | | | | | | | | | | | |
| Sun reduction | | | | | | | | | | | | |
| Oper. time red. | | | | | | | | | | | | |
| Wind dir. red. | | | | | | | | | | | | |
| Total reduction | | | | | | | | | | | | |
| Total, real | | | | | | | | | | | | |

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

| Day in month | Sun rise (hh:mm) | Sun set (hh:mm) | Minutes with flicker | First time (hh:mm) with flicker | Last time (hh:mm) with flicker | (WTG causing flicker first time) | (WTG causing flicker last time) |
|--------------|------------------|-----------------|----------------------|---------------------------------|--------------------------------|----------------------------------|---------------------------------|
|--------------|------------------|-----------------|----------------------|---------------------------------|--------------------------------|----------------------------------|---------------------------------|

SHADOW - Calendar

Calculation: Kovasinkangas V162-6,2MW x 6 x HH199 + Ketunmaankangas V126-3.45MW x 5 x HH137_no forest_20221202 Shadow receptor: G - Liikerakennus G (Impivaarantie kämpä Sunshine probability S (Average daily sunshine hours) [LULEA]

Assumptions for shadow calculations

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0,60 2,61 4,18 6,47 8,80 10,60 9,50 6,88 4,22 2,77 1,22 0,17

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum
619 605 559 627 758 839 939 1 102 916 649 504 548 8 664

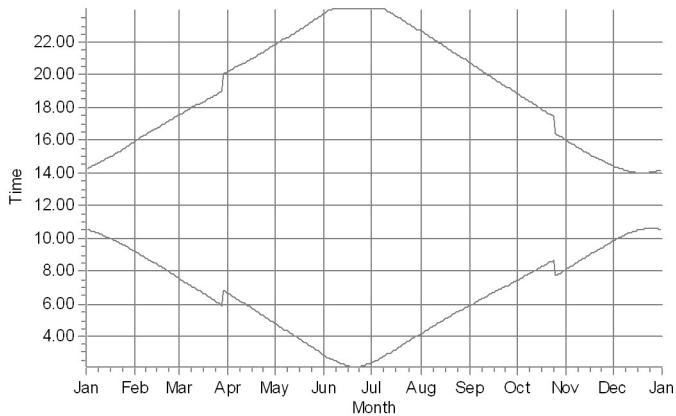
Idle start wind speed: Cut in wind speed from power curve

| | January | February | March | April | May | June | July | August | September | October | November | December |
|------------|---------|-------------------------|-------|-------------------------|-------|-------|-------|--------|-----------|--------------------|-------------------------------|----------|
| 1 10.31 | 09.11 | | 07.32 | 15.51 (10) 06.38 | 04.45 | 02.23 | 04.09 | 05.53 | 07.25 | 08.05 | 13.42 (11) 09.50 | |
| 1 14.12 | 15.54 | | 17.30 | 18 16.09 (10) 20.09 | 21.48 | 23.41 | 00.21 | 22.37 | 20.42 | 18.50 | 15.57 28 14.10 (11) 14.24 | |
| 2 10.30 | 09.07 | 14.22 (11) 07.29 | | 15.52 (10) 06.34 | 04.42 | 02.47 | 02.26 | 04.13 | 05.56 | 07.28 | 08.09 09.53 | |
| 1 14.14 | 15.57 | 7 14.29 (11) 17.34 | 15 | 16.07 (10) 20.12 | 21.51 | 23.45 | 00.18 | 22.33 | 20.38 | 18.46 | 15.54 27 14.10 (11) 14.21 | |
| 3 10.28 | 09.04 | 14.19 (11) 07.25 | | 15.55 (10) 06.30 | 04.38 | 02.44 | 02.29 | 04.16 | 05.59 | 07.31 | 08.12 13.43 (11) 09.56 | |
| 4 10.27 | 09.01 | 14.17 (11) 07.21 | 11 | 16.06 (10) 20.15 | 21.55 | 23.48 | 00.16 | 22.30 | 20.34 | 18.42 | 15.50 27 14.10 (11) 14.19 | |
| 1 14.17 | 16.01 | 14 14.33 (11) 17.37 | | 15.59 (10) 06.26 | 04.34 | 02.40 | 02.32 | 04.20 | 06.02 | 07.34 | 08.15 13.44 (11) 09.59 | |
| 4 10.27 | 09.01 | 14.17 (11) 07.21 | | 15.59 (10) 06.26 | 04.34 | 02.40 | 02.32 | 04.20 | 06.02 | 07.34 | 08.15 13.44 (11) 09.59 | |
| 1 14.19 | 16.04 | 18 14.35 (11) 17.40 | 2 | 16.01 (10) 20.18 | 21.58 | 23.52 | 00.13 | 22.26 | 20.30 | 18.38 | 15.47 25 14.09 (11) 14.17 | |
| 5 10.25 | 08.57 | 14.16 (11) 07.18 | | 16.23 | 04.30 | 02.37 | 02.35 | 04.23 | 06.06 | 07.37 | 08.19 13.45 (11) 10.02 | |
| 1 14.22 | 16.08 | 21 14.37 (11) 17.44 | | 16.22 | 22.02 | 23.55 | 00.10 | 22.22 | 20.27 | 18.35 | 15.43 22 14.07 (11) 14.14 | |
| 6 10.23 | 08.54 | 14.15 (11) 07.14 | | 16.19 | 04.27 | 02.34 | 02.39 | 04.27 | 06.09 | 07.40 | 08.22 13.46 (11) 10.05 | |
| 1 14.25 | 16.12 | 23 14.38 (11) 17.47 | | 16.25 | 22.06 | 23.59 | 00.07 | 22.19 | 20.23 | 18.31 | 15.40 21 14.07 (11) 14.12 | |
| 7 10.21 | 08.51 | 14.14 (11) 07.10 | | 16.15 | 04.23 | 02.31 | 02.42 | 04.30 | 06.12 | 07.44 | 08.26 13.48 (11) 10.08 | |
| 1 14.28 | 16.15 | 25 14.39 (11) 17.50 | | 16.28 | 22.09 | 00.02 | 00.04 | 22.15 | 20.19 | 18.27 | 15.37 17 14.05 (11) 14.10 | |
| 8 10.19 | 08.47 | 14.13 (11) 07.07 | | 16.11 | 04.19 | 02.28 | 02.46 | 04.34 | 06.15 | 07.47 | 08.29 13.50 (11) 10.10 | |
| 1 14.30 | 16.19 | 26 14.39 (11) 17.53 | | 16.31 | 22.13 | 00.06 | 00.01 | 22.11 | 20.15 | 18.24 | 15.33 13 14.03 (11) 14.09 | |
| 9 10.17 | 08.44 | 14.13 (11) 07.03 | | 16.08 | 04.16 | 02.26 | 02.49 | 04.37 | 06.18 | 07.50 | 08.33 13.53 (11) 10.13 | |
| 1 14.33 | 16.22 | 27 14.40 (11) 17.56 | | 16.34 | 22.16 | 00.09 | 23.58 | 22.08 | 20.12 | 18.20 | 15.30 6 13.59 (11) 14.07 | |
| 10 10.15 | 08.40 | 14.12 (11) 06.59 | | 16.04 | 04.12 | 02.23 | 02.53 | 04.41 | 06.21 | 07.53 | 16.30 (10) 08.37 | 10.16 |
| 1 14.37 | 16.26 | 29 14.41 (11) 18.00 | | 16.38 | 22.20 | 00.12 | 23.55 | 22.04 | 20.08 | 18.16 | 8 16.38 (10) 15.27 | 14.05 |
| 11 10.13 | 08.37 | 14.12 (11) 06.56 | | 16.00 | 04.08 | 02.20 | 02.56 | 04.44 | 06.24 | 07.56 | 16.27 (10) 08.40 | 10.18 |
| 1 14.40 | 16.29 | 29 14.41 (11) 18.03 | | 16.41 | 22.24 | 00.15 | 23.51 | 22.00 | 20.04 | 18.13 | 13 16.40 (10) 15.23 | 14.04 |
| 12 10.10 | 08.33 | 14.12 (11) 06.52 | | 16.56 | 04.05 | 02.18 | 03.00 | 04.48 | 06.27 | 07.59 | 16.26 (10) 08.44 | 10.20 |
| 13 14.43 | 16.33 | 30 14.42 (11) 18.06 | | 16.04 | 22.27 | 00.18 | 23.48 | 21.56 | 20.00 | 18.09 | 16 16.42 (10) 15.20 | 14.02 |
| 13 10.08 | 08.30 | 14.12 (11) 06.48 | | 16.53 | 04.01 | 02.16 | 03.00 | 04.51 | 06.30 | 08.02 | 16 16.42 (10) 08.47 | 10.22 |
| 14 14.46 | 16.36 | 30 14.42 (11) 18.09 | | 16.47 | 22.31 | 00.20 | 23.45 | 21.53 | 19.57 | 18.05 | 18 16.42 (10) 15.17 | 14.01 |
| 14 10.05 | 08.26 | 14.12 (11) 06.45 | | 16.59 | 03.57 | 02.14 | 03.03 | 04.54 | 06.33 | 08.06 | 16 16.22 (10) 08.51 | 10.24 |
| 14 14.50 | 16.40 | 30 14.42 (11) 18.12 | | 16.51 | 22.35 | 00.23 | 23.41 | 21.49 | 19.53 | 18.02 | 20 16.42 (10) 15.13 | 14.00 |
| 15 10.02 | 08.23 | 14.12 (11) 06.41 | | 16.55 | 03.54 | 02.12 | 03.07 | 04.58 | 06.36 | 08.09 | 16 16.22 (10) 08.54 | 10.26 |
| 15 14.53 | 16.43 | 30 14.42 (11) 18.15 | | 16.54 | 22.38 | 00.25 | 23.38 | 21.45 | 19.49 | 17.58 | 21 16.43 (10) 15.10 | 13.59 |
| 16 10.00 | 08.19 | 14.13 (11) 06.37 | | 16.51 | 03.50 | 02.10 | 03.11 | 05.01 | 06.39 | 08.12 | 16 16.21 (10) 08.58 | 10.28 |
| 16 14.56 | 16.47 | 28 14.41 (11) 18.19 | | 16.57 | 22.42 | 00.27 | 23.35 | 21.41 | 19.45 | 17.54 | 22 16.43 (10) 15.07 | 13.59 |
| 17 09.57 | 08.16 | 14.13 (11) 06.33 | | 16.58 | 03.46 | 02.09 | 03.14 | 05.05 | 06.42 | 08.15 | 16 16.22 (10) 09.01 | 10.30 |
| 17 15.00 | 16.50 | 28 14.41 (11) 18.22 | | 16.50 | 22.46 | 00.29 | 23.31 | 21.38 | 19.42 | 17.51 | 21 16.43 (10) 15.04 | 13.58 |
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| 18 15.03 | 16.54 | 31 16.04 (10) 18.25 | | 16.54 | 22.49 | 00.30 | 23.28 | 21.34 | 19.38 | 17.47 | 21 16.43 (10) 15.01 | 13.58 |
| 19 09.51 | 08.08 | 14.15 (11) 06.26 | | 16.50 | 03.39 | 02.07 | 03.22 | 05.11 | 06.48 | 08.22 | 14 15.33 (11) 09.08 | 10.32 |
| 19 15.07 | 16.57 | 35 16.07 (10) 18.28 | | 16.57 | 22.53 | 00.32 | 23.24 | 21.30 | 19.34 | 17.44 | 30 16.42 (10) 14.57 | 13.57 |
| 20 09.49 | 08.05 | 14.16 (11) 06.22 | | 16.56 | 03.35 | 02.07 | 03.25 | 05.15 | 06.51 | 08.25 | 14 14.49 (11) 09.12 | 10.33 |
| 20 15.10 | 17.00 | 37 16.09 (10) 18.31 | | 16.59 | 22.57 | 00.32 | 23.21 | 21.27 | 19.30 | 17.40 | 35 16.41 (10) 14.54 | 13.57 |
| 21 09.46 | 08.01 | 14.17 (11) 06.19 | | 16.53 | 03.32 | 02.07 | 03.29 | 05.18 | 06.55 | 08.28 | 14 14.47 (11) 09.16 | 10.34 |
| 21 15.14 | 17.04 | 36 16.10 (10) 18.34 | | 16.54 | 22.60 | 00.33 | 23.17 | 21.23 | 19.27 | 17.36 | 37 16.40 (10) 14.51 | 13.58 |
| 22 09.43 | 07.58 | 14.20 (11) 06.15 | | 16.59 | 03.28 | 02.07 | 03.33 | 05.21 | 06.58 | 08.31 | 14 14.45 (11) 09.19 | 10.35 |
| 22 15.17 | 17.07 | 33 16.11 (10) 18.38 | | 16.54 | 22.64 | 00.33 | 23.13 | 21.19 | 19.23 | 17.33 | 37 16.38 (10) 14.48 | 13.58 |
| 23 09.40 | 07.54 | 14.24 (11) 06.11 | | 16.55 | 03.25 | 02.08 | 03.36 | 05.24 | 07.01 | 08.35 | 14 14.44 (11) 09.23 | 10.35 |
| 23 15.21 | 17.11 | 26 16.11 (10) 18.41 | | 16.54 | 22.68 | 00.33 | 23.10 | 21.15 | 19.19 | 17.29 | 35 16.36 (10) 14.45 | 13.58 |
| 24 09.36 | 07.51 | 15.50 (10) 06.07 | | 16.51 | 03.21 | 02.09 | 03.40 | 05.28 | 07.04 | 08.38 | 14 14.44 (11) 09.26 | 10.35 |
| 24 15.25 | 17.14 | 22 16.12 (10) 18.44 | | 16.54 | 22.74 | 00.32 | 23.06 | 21.21 | 19.16 | 17.26 | 26 15.10 (11) 14.42 | 13.59 |
| 25 09.33 | 07.47 | 15.50 (10) 06.04 | | 16.58 | 03.18 | 02.10 | 03.44 | 05.31 | 07.07 | 07.41 | 13 14.33 (11) 09.30 | 10.36 |
| 25 15.28 | 17.17 | 21 16.11 (10) 18.47 | | 16.54 | 22.78 | 00.31 | 23.03 | 21.08 | 19.12 | 16.22 | 28 14.11 (11) 14.40 | 14.00 |
| 26 09.30 | 07.43 | 15.50 (10) 06.00 | | 16.54 | 03.14 | 02.12 | 03.47 | 05.34 | 07.10 | 07.45 | 13 14.22 (11) 09.33 | 10.35 |
| 26 15.32 | 17.21 | 21 16.11 (10) 18.50 | | 16.54 | 22.81 | 00.30 | 22.59 | 20.04 | 19.08 | 16.18 | 28 14.10 (11) 14.37 | 14.01 |
| 27 09.27 | 07.40 | 21 16.11 (10) 18.56 | | 16.50 | 03.11 | 02.13 | 03.51 | 05.37 | 07.13 | 07.48 | 13 14.31 (11) 09.36 | 10.35 |
| 27 15.35 | 17.24 | 21 16.11 (10) 18.53 | | 16.54 | 22.84 | 00.29 | 22.55 | 21.00 | 19.04 | 16.15 | 30 14.11 (11) 14.34 | 14.03 |
| 28 09.24 | 07.36 | 15.50 (10) 05.53 | | 16.54 | 03.07 | 02.16 | 03.55 | 05.40 | 07.16 | 07.51 | 13 14.31 (11) 09.40 | 10.35 |
| 28 15.39 | 17.27 | 20 16.10 (10) 18.56 | | 16.54 | 22.87 | 00.27 | 22.52 | 20.57 | 19.01 | 16.11 | 30 14.11 (11) 14.31 | 14.04 |
| 29 09.21 | | 06.49 | | 16.54 | 03.04 | 02.18 | 03.58 | 05.44 | 07.19 | 07.55 | 13 14.31 (11) 09.43 | 10.34 |
| 29 15.43 | | 20.00 | | 16.54 | 03.04 | 02.18 | 03.58 | 05.44 | 07.19 | 07.55 | 13 14.31 (11) 09.43 | 10.34 |
| 30 09.17 | | 06.45 | | 16.54 | 03.00 | 02.21 | 04.02 | 05.47 | 07.22 | 07.58 | 13 14.31 (11) 09.46 | 10.33 |
| 31 09.14 | | 06.41 | | 16.54 | 02.93 | 02.23 | 04.05 | 05.50 | 08.02 | 13.41 (11) 09.43 | 10.32 | |
| | 15.50 | | | | | | | | | | | |

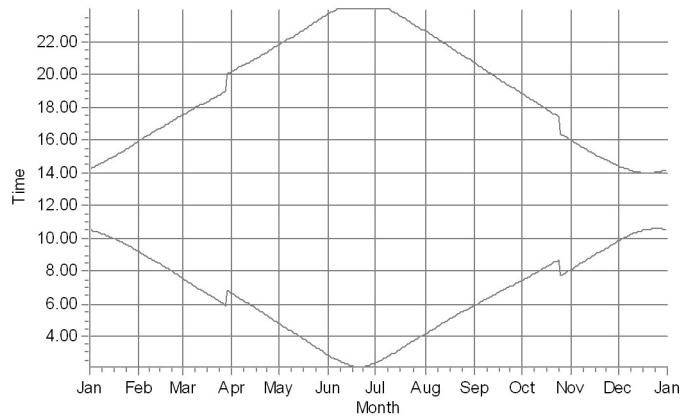
SHADOW - Calendar, graphical

Calculation: Kovasinkangas V162-6,2MW x 6 x HH199 + Ketunmaankangas V126-3.45MW x 5 x HH137_no forest_20221202

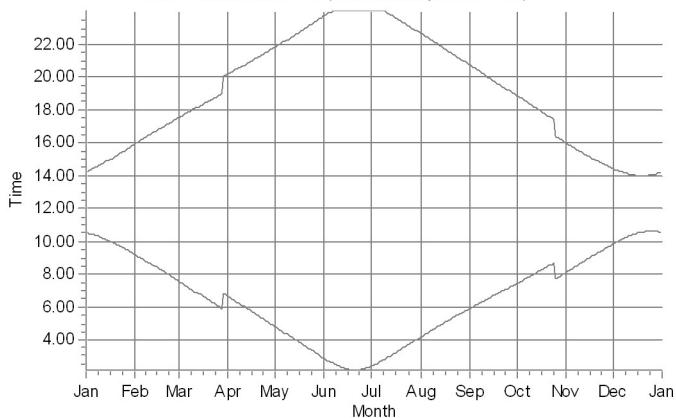
A: Lomarakennus A (Kantolantie 285)



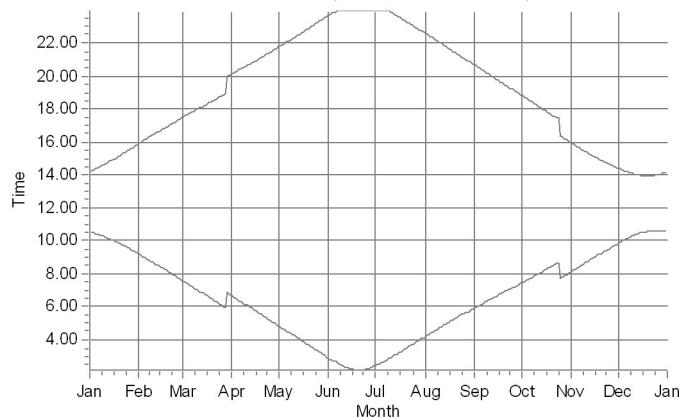
B: Lomarakennus C (Kantolantie 42)



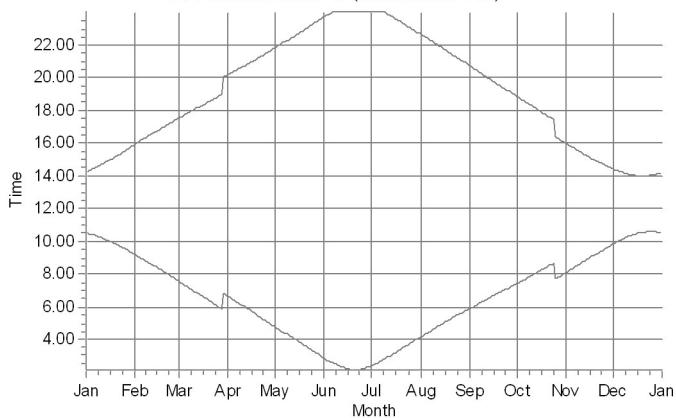
C: Asuinrakennus D (Onkamonkyläntie 280)



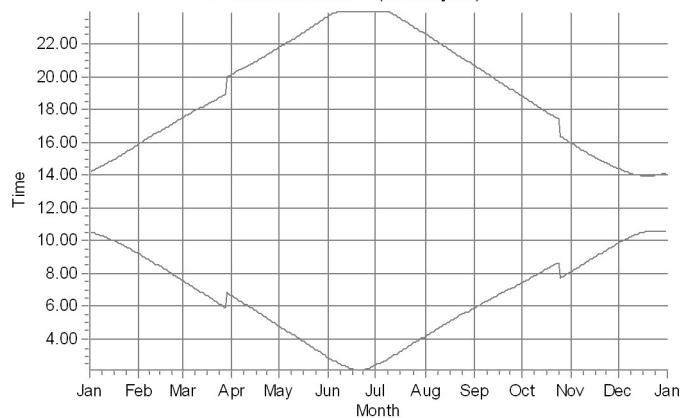
D: Lomarakennus E (Kaunislamenttie 153)



E: Lomarakennus B (Kantolantie 142)



F: Lomarakennus F (Merijärvi)



WTGs

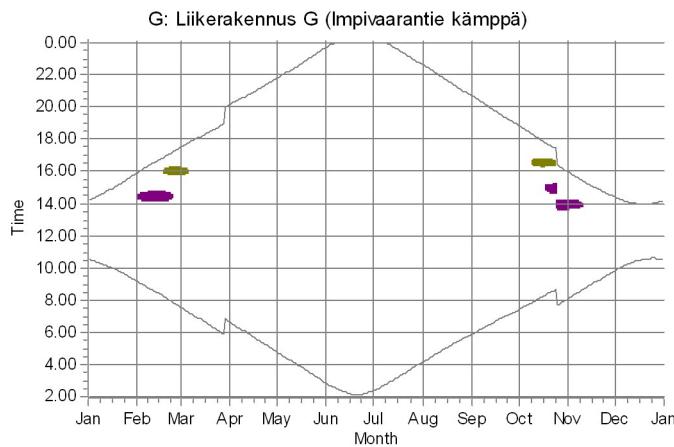
Project:
Kovasinkangas_20191009

Description:
Kovasinkankaan tuulivoimapuisto, II

Licensed user:
FCG Finnish Consulting Group Oy
Osmontie 34, PO Box 950
FI-00601 Helsinki
+358104095666
Liisa KArhu / liisa.karhu@fcg.fi
Calculated:
2.12.2022 13.53/3.5.584

SHADOW - Calendar, graphical

Calculation: Kovasinkangas V162-6,2MW x 6 x HH199 + Ketunmaankangas V126-3.45MW x 5 x HH137_no forest_20221202



WTGs



10: VESTAS V162-6.2 6200 162.0 !O! hub: 199,0 m (TOT: 280,0 m) (41)



11: VESTAS V162-6.2 6200 162.0 !O! hub: 199,0 m (TOT: 280,0 m) (42)

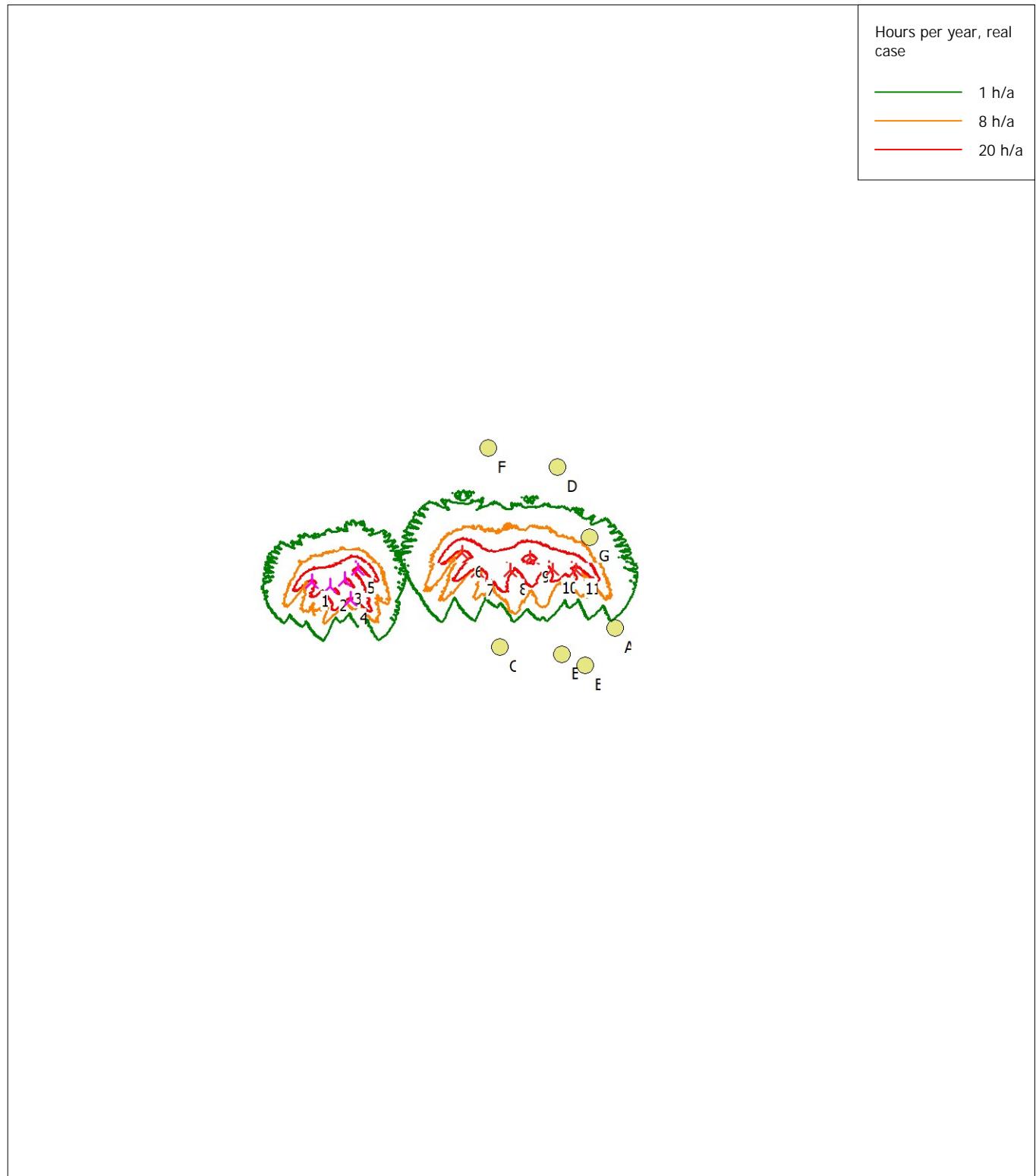
Project:
Kovasinkangas_20191009

Description:
Kovasinkankaan tuulivoimapuisto, II

Licensed user:
FCG Finnish Consulting Group Oy
Osmontie 34, PO Box 950
FI-00601 Helsinki
+358104095666
Liisa KArhu / liisa.karhu@fcg.fi
Calculated:
2.12.2022 13.53/3.5.584

SHADOW - Map

Calculation: Kovasinkangas V162-6,2MW x 6 x HH199 + Ketunmaankangas V126-3.45MW x 5 x HH137_no forest_20221202



Map: Blank map , Print scale 1:200 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 432 420 North: 7 237 530

>New WTG

Shadow receptor

Flicker map level: Height Contours: CONTOURLINE_Kovasinkangas_20191009_4.wpo (4)

Time step: 4 minutes, Day step: 14 days, Map resolution: 30 m, Visibility resolution: 15 m, Eye height: 2,0 m